Public Notice: Request For Comments

Proposed Air Quality Permit to Construct

Notice issued: March 20, 2014

Written comments due:
5 p.m., April 20, 2014

Permit Writer: Kathy Paser

Who is the applicant?
Arrow Pipeline, LLC
Arrow Pipeline Station #7

Where will the facility be located?
In Dunn County at
Lat 47.672167, Long -102.401833

What is being proposed?
The EPA proposes to approve a new crude oil and natural gas gathering and transmission station on the Fort Berthold Indian Reservation. The operation will consist of crude oil and natural gas gathering from several customers in the region and transmission to a central delivery point located outside the exterior boundaries of the Fort Berthold Indian Reservation. The gathering and the transport will be conducted via pipeline using large engines, storage tanks and a truck load-out operation.

Permit number:
SMNSR-TAT-000661-2013.001

Plant Site Emissions:
The applicant has requested emission limitations that will limit the facility-wide emissions of volatile organic compounds (VOCs), nitrogen oxide (NO_X), carbon monoxide (CO), and hazardous air pollutants (HAPs).

Potential uncontrolled emissions from the proposed construction are estimated to be as follows: NO_X: 805 tons per year (tpy); CO: 545 tpy; VOCs: 408 tpy; HAPs: 45 tpy.

Considering the EPA proposed requirements in the permit, potential controlled emissions will be as follows: NO_X: 59 tpy; CO: 66; tpy; VOCs: 52 tpy; HAPs: 9 tpy

What are the special conditions of this permit?
The Permittee is required to limit the NO_X, CO, VOC, and HAP emissions from the engines using low emission engines or a catalytic control system on each engine. VOC and HAP emissions from all tanks storing crude oil and natural gas must be controlled using hydrocarbon combustion with a 95% emission destruction efficiency. To minimize VOC and HAP emissions from truck loading, the Permittee is required to use submerged loading.

What are the effects on air quality?
Based on the available data, discussed in the application, there do not appear to be any significant air quality concerns within the exterior boundaries of the Fort Berthold Indian Reservation. Additionally, emissions from the proposed operation will be controlled at all times. These controlled emissions do not appear to have a significant impact to the air quality of the surrounding area.

Where can I send comments?
EPA accepts comments by mail, fax and e-mail.

US EPA
Region 8 Air Program, 8P-AR
1595 Wynkoop Street
Denver, CO 80202
R8AirPermitting@epa.gov
Fax: 303-312-6064, Attn: Claudia Smith

How can I review documents?
You can review the proposed permit and administrative record at the:

- Mandan, Hidatsa and Arikara Nation
  Environmental Programs Office
  404 Frontage Road, New Town, ND
  Attn: Edmund Baker

- Fort Berthold Community College
  Library: 220 8th Avenue East
  New Town, ND

- Mandaree West Segment Tribal Office
  440 th Ave NE, Mandaree, ND
  Attn: Cory Sanders

- US EPA Region 8 Office
  Air Program Office
  1595 Wynkoop Street
  Denver, CO
  Attn: Claudia Smith, 303-312-6520

Electronic copies of the draft permit and Statement of Basis may also be viewed at: http://www2.epa.gov/region8/air-permit-public-comment-opportunities

What happens next?
EPA will review and consider all comments received during the comment period. Following this review, the EPA may issue the permit addendum as proposed or modified, or deny the permit addendum.

What are the EPA's responsibilities?
The EPA Region 8 Air Program is the regulatory agency that helps protect and preserve the Mandan, Hidatsa, and Arikara Nation's air quality. One way EPA does this is by requiring permits for certain activities. The purpose of this notice is to invite you to submit written comments on this proposed permit.

Federal Minor New Source Review in Indian Country

United States Environmental Protection Agency

Region 8
Air Program

1595 Wynkoop Street
Denver, CO 80202

Phone 800-227-8917

http://www2.epa.gov/aboutepa/epa-region-8-mountains-and-plains

Air Pollution Control
40 CFR 49.151 Tribal Minor New Source Review In Indian Country
Technical Support Document (TSD)
Proposed Permit No.: SMNSR-TAT-000661-2013.001

Arrow Pipeline, LLC
Arrow Pipeline Station #7
on the Fort Berthold Indian Reservation
Dunn County, North Dakota

In accordance with the requirements of the Tribal Minor New Source Review Permit Program at 40 CFR Part 49 (MNSR), the Region 8 office of the U.S. Environmental Protection Agency (EPA) has prepared this technical support document (TSD) describing the conditions of this synthetic minor MNSR permit for a proposed new crude oil and natural gas gathering and transmission station and presents information that is germane to this permit action.

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I. Project Description

On May 6, 2013, the EPA received an application from Arrow Pipeline, LLC (Arrow) requesting approval to construct a new crude oil and natural gas gathering and transmission station on the Fort Berthold Indian Reservation. The operation will consist of crude oil and natural gas gathering from several customers in the region and transmission to a central delivery point (CDP) located outside the exterior boundaries of the Fort Berthold Indian Reservation. Arrow plans to construct the facility at the following location:

County	Township	Range	Section	Quarter Section	Latitude	Longitude
Dunn	148 N	92 W	4	NE¼	47.672167 N	-102.401833 W

The legal locations given are for the 2011 U.S. Geological Survey Sanish SW quadrangle, North Dakota, 7.5-minute series.

The crude oil and natural gas gathering will be conducted via pipelines from production wells in the area. Upon delivery to the station, the hydrocarbons will be separated into natural gas, crude oil and produced water. The crude oil, natural gas condensate, and produced water will be transported off-site via trucks. The natural gas will be compressed using engine driven compressors and transmitted via pipeline to the central delivery point.

After first entering the station through a crude oil and natural gas system receiver, the crude oil and natural gas will be put through a slug catcher to "knock out" excess liquids consisting of produced water and crude oil and natural gas condensate. Further removal of the crude oil and natural gas condensate will be carried out by a filter separator, after which the natural gas will be routed to the individual compressor units for compression.

The compressor units will each consist of an inlet filter separator, a compressor, a fin fan heat exchanger, and a natural gas–fired engine to power the compressor. Natural gas entering each individual compressor unit will first be passed through the filter separator to further remove the crude oil and natural gas condensate from the natural gas stream before compression, after which the natural gas will be compressed by a compressor.

Compressed natural gas will then be routed to a splitter, with most of the natural gas routed to the natural gas pipeline exiting the station and the remainder routed to a fuel gas coalescer. Natural gas from the fuel gas coalescer will be routed to and combusted by individual compressor engines and/or natural gas–fired electrical generator engines designed to provide power to the station.

The crude oil, natural gas condensate, and produced water removed from the natural gas via the slug catcher and filter separator(s) will be pumped to individual storage tanks. Truck load out racks will be used to truck the crude oil, natural gas condensate, and produced water from the proposed station.

The operation will not be processing natural gas or refining crude oil or natural gas condensate into end products. In addition, no glycol dehydration units will be used in the operation.

Figure 1 illustrates the operations at the proposed station.

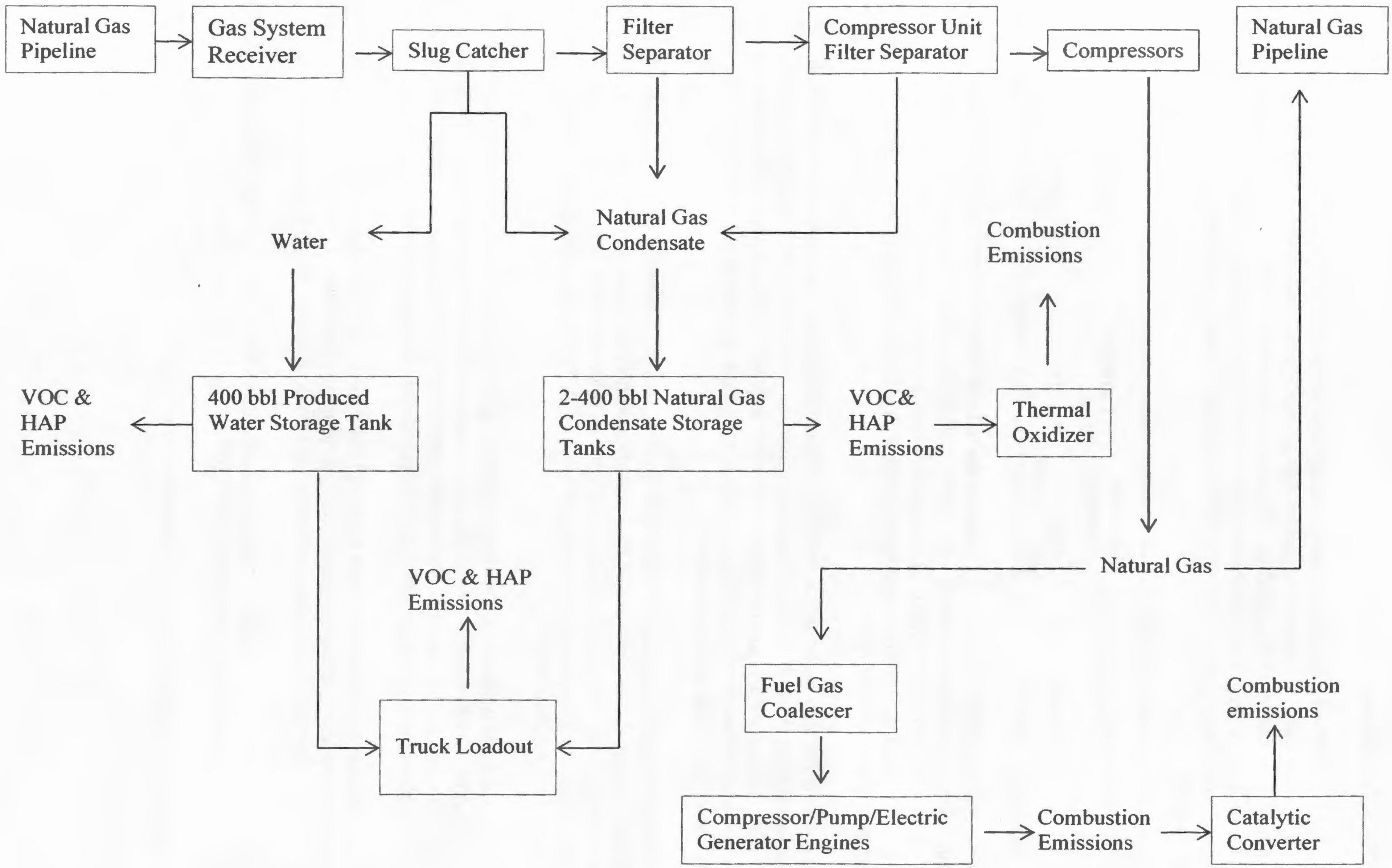

Figure 1 – Simplified Process Flow Diagram

When completed, the station will consist of the following primary emission units:

Two Crude Oil and Natural Gas Condensate Storage Tanks;
One Produced Water Storage Tank;
Two Truck Loading Racks;
Eight Natural Gas-Fired Reciprocating Internal Combustion Engines; and
Hydrocarbon Emission Controls.

II. Uncontrolled Potential Emissions

Pursuant to 40 CFR 52.21, "potential to emit" (PTE) is defined as the maximum capacity of a stationary source to emit a pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the source to emit a pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored, or processed, shall be treated as part of its design if the limitation, or the effect it would have on emissions, is federally enforceable. Therefore, to calculate potential uncontrolled emissions in this proposal, the worst possible case for emissions was considered, such as, 8,760 hours of operation per year, a maximum condensate throughput of 220[1] barrels per day, and operating each engine at its maximum horse power.
Table 2 provides the uncontrolled PTE for the proposed operation.

Table 2 – Uncontrolled Potential Emissions

Criteria Pollutants	Uncontrolled Potential Emissions (tons per year)
PM	2.4
PM_{10}	2.4
$PM_{2.5}$	2.4
SO_x	16.3
NO_X	804.5
CO	544.9
VOC	408.1
Pb	0
Fluorides	0
H_2SO_4	0
H_2S	0
TRS	0
RSC	0
Greenhouse Gases	
CO_2 (mass basis)	33,339
CH_4 (mass basis)	22
N_2O (mass basis)	0
HFCs (mass basis)	0
PFCs (mass basis)	0
SF_6 (mass basis)	0
GHG_{total} (mass basis)	33,361
CO_2e (Total)	**33,822**

PM – Particulate Matter
PM_{10} – Particulate Matter less than 10 microns in size
$PM_{2.5}$ – Particulate Matter less than 2.5 microns in size
SO_x – Sulfur Oxides
NO_X – Nitrogen Oxides
CO – Carbon Monoxide
VOC – Volatile Organic Compounds
Pb – Lead and lead compounds
H_2SO_4 – Sulfuric Acid Mist
H_2S – Hydrogen Sulfide
TRS – Total Reduced Sulfur
RSC – Reduced Sulfur Compounds
CO_2 – Carbon dioxide
CH_4 – Methane
N_2O – Nitrous oxide
HFCs – Hydrofluorocarbons
PFCs – Perfluorocarbons
SF_6 – Sulfur hexafluoride
GHG_{total} – The sum of CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 on a mass basis
CO_2e – Equivalent CO_2. A measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP)

HFCs, PFCs, and SF_6 emissions are not created by oil and natural gas production operations.

[1] In the application, all calculations were based on a maximum throughput of 110 barrels per day for water and condensate, combined. However, the 110 bbls/day throughput resulted in controlled emissions that are only 40% of the facility-wide VOC limit and 30% of the facility-wide n-hexane and total HAP emission limits request by the company. The controlled emission estimates support the approval of a higher maximum throughput while still maintaining the synthetic minor status. The 220 bbl/day limit will provide a great deal more flexibility in operations and increased assurance of compliance with the throughput limit.

Hazardous Air Pollutants (HAPs)	Uncontrolled Potential Emissions (tons per year)
1,1,2,2-Tetrachloroethane	0.01
1,1,2-Trichloroethane	0.00
1,3-Butadiene	0.18
1,3-Dichloropropene	0.00
2-Methylnapthalene	0.00
2,2,4-Tirmethylpentane	0.01
Acenaphthene	0.00
Acenaphthylene	0.00
Acetaldehyde	0.98
Acrolein	0.84
Benzene	0.41
Benzo(b)flouranthene	0.00
Benzo(e)pyrene	0.00
Benzo(g,h,i)perylene	0.00
Biphenyl	0.01
Carbon Tetrachloride	0.01
Chlorobenzene	0.00
Chloroform	0.00
Chrysene	0.00
Ethylbenzene	0.01
Ethylene Dibromide	0.01
Flourathene	0.00
Flourene	0.00
Formaldehyde	6.95
Methanol	0.86
Methylene Chloride	0.01
N-Hexane	34.00
Napthalene	0.03
PAH	0.04
Phenanthrene	0.00
Phenol	0.00
Pyrene	0.00
Styrene	0.00
Tetrachloroethane	0.00
Toluene	0.15
Vinyl Chloride	0.00
Xylene	0.06
Total HAPs	**44.57**

PM – Particulate Matter
PM_{10} – Particulate Matter less than 10 microns in size
$PM_{2.5}$ – Particulate Matter less than 2.5 microns in size
SO_x – Sulfur Oxides
NO_X – Nitrogen Oxides
CO – Carbon Monoxide
VOC – Volatile Organic Compounds
Pb – Lead and lead compounds
H_2SO_4 – Sulfuric Acid Mist
H_2S – Hydrogen Sulfide
TRS – Total Reduced Sulfur
RSC – Reduced Sulfur Compounds
CO_2 – Carbon dioxide
CH_4 – Methane
N_2O – Nitrous oxide
HFCs – Hydrofluorocarbons
PFCs – Perfluorocarbons
SF_6 – Sulfur hexafluoride
CO_2e – Equivalent CO_2. A measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP)

HFCs, PFCs, and SF_6 emissions are not created by oil and natural gas production operations.

III. Potential Regulatory Requirements

Based on the PTE, the proposed operation would be subject to the following regulatory requirements:

A. Prevention of Significant Deterioration (PSD) for criteria pollutants:

PSD applies on a pollutant specific basis to any proposed new source with a potential to emit for any one pollutant regulated by PSD greater than or equal to100 tons per year (tpy) or more for sources included in 28 specified source categories as defined in 40 CFR 52, or 250 tpy or more for any other type of source. For a new source which is major for at least one regulated pollutant, all pollutants which are emitted in amounts greater than or equal to the significance levels identified in the PSD regulations at §52.21(b)(23) are also subject to PSD review.

PSD applies on a pollutant specific basis to any proposed modification to an existing minor source with a potential to emit for any one pollutant regulated by PSD that is greater than or equal to100 tpy or more for sources included in 28 specified source categories as defined in 40 CFR 52, or 250 tpy or more for any other type of source. For a modification which is major for at least one regulated pollutant, all pollutants which are emitted in amounts greater than or equal to the significance levels identified in the PSD regulations at §52.21(b)(23) are also subject to PSD review.

PSD also applies to a proposed modification to an existing major PSD source with a potential to emit of any one pollutant regulated by PSD is greater than or equal to the significance levels identified in the PSD regulations at §52.21(b)(23).

Arrow's proposed new source has triggered PSD review for NO_X, CO, and VOCs based on the major source threshold of 250 tpy. As such, any requested limits to avoid PSD must include limits on NO_X, CO, and VOCs.

B. Requirements for Hazardous Air Pollutants (HAPs):

New construction projects that have the potential to emit 25 tpy or more of total HAPs or 10 tpy or more of any individual HAP are subject to major source requirements for HAPs, such as 40 CFR 63 – National Emissions Standards for Hazardous Air Pollutants for Source Categories (also known as Maximum Achievable Control Technology (MACT)).

Arrow's proposed new source is major for total uncontrolled HAPs and n-hexane. The foremost contributors to the total HAPs are formaldehyde from the engines, and n-hexane from the handling of crude oil and natural gas condensate at the produced water and crude oil and natural gas condensate tanks.

The Permittee requested voluntary emissions limits on each of the 37 individual HAPs and total HAPs to reduce the PTE to below the major source thresholds.

C. Title V (Part 71) Operating Permit Requirements: NO_X, CO, VOCs, n-hexane, and total HAPs

Part 71 permitting applies to any stationary which meets any one of the following emissions levels:

1. 100 tpy or more of any criteria pollutant;

2. 100,000 tpy or more of CO_2e <u>and</u> 100 tpy or more of GHGs on a mass basis;

3. 10 tpy or more of any individual HAP; or

4. 25 tpy or more of all HAPs in aggregate.

For purposes of Part 71 permitting, the proposed facility is major for NO_X, CO, VOCs, n-hexane, and total HAPs. As such, any requested emission limits to become a synthetically minor source for purposes of Part 71 permitting must include limits on these pollutants that are below the major source thresholds for Part 71.

Note: Regardless of emission levels, Part 71 also applies to the following:

1. Any source, including an area source, subject to a standard, limitation, or other requirement under section 111 of the Act;

2. Any source, including an area source, subject to a standard or other requirement under section 112 of the Act, except that a source is not required to obtain a permit solely because it is subject to regulations or requirements under section 112(r) of the Act;

3. Any source subject to the Acid Rain Program; and

4. Any source in a source category designated by the Administrator pursuant to this section.

5. Sources that are exempted until such time as the EPA completes a rulemaking to determine how the program should be structured for non major sources and the appropriateness of any permanent exemptions:

   (a) Non major sources that have not received a major new source review permit;
   (b) Non major sources that are not acid rain sources;
   (c) Non major sources that are not solid waste incineration units required to obtain a permit pursuant to section 129(e) of the Act; and
   (d) In the case of non major sources subject to a standard or other requirement under either section 111 or 112 of the Act after July 21, 1992 publication, the EPA will determine whether to exempt any or all such applicable sources from the requirement to obtain a Part 70 or Part 71 permit at the time that the new standard is promulgated.

6. The following source categories are exempted from the obligation to obtain a Part 71 permit:

   (a) All sources and source categories that would be required to obtain a permit solely because they are subject to 40 CFR Part 60, Subpart AAA—Standards of Performance for New Residential Wood Heaters; and
   (b) All sources and source categories that would be required to obtain a permit solely because they are subject to 40 CFR Part 61, Subpart M—National Emission Standard for Hazardous Air Pollutants for Asbestos, §61.145, Standard for Demolition and Renovation.

IV. Synthetic Minor Permitting

In the MNSR regulations, PTE is defined as the maximum capacity of a source to emit a pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the source to emit a pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored or processed, shall be treated as part of its design if the limitation or the effect it would have on emissions is enforceable as a practical matter. Secondary emissions, as defined at Section 52.21(b)(18), do not count in determining the PTE of a source.

A. "Enforceable as a practical matter"

"Enforceable as a practical matter" means that an emission limitation or other standard is both legally and practically enforceable as follows:

1. An emission limitation or other standard is legally enforceable if the reviewing authority has the right to enforce it.

2. Practical enforceability for an emission limitation or for other standards (design standards, equipment standards, work practices, operational standards, and pollution prevention techniques) in a permit for a source is achieved if the permit's provisions specify:

   (a) A limitation or standard and the emissions units or activities at the source subject to the limitation or standard;
   (b) The time period for the limitation or standard (e.g., hourly, daily, monthly, and/or annual limits such as rolling annual limits); and
   (c) The method to determine compliance, including appropriate monitoring, recordkeeping, reporting, and testing.

B. National EPA Guidance on PTE

National EPA guidance on PTE states that air pollution control equipment can be credited as restricting PTE only if enforceable requirements are in place requiring the use of such air pollution control equipment. EPA approved guidance for establishing PTE limits in a memo titled Guidance on Limiting Potential to Emit in New Source Permitting, (NSR) dated June 13, 1989, to EPA Regional Offices, from Terrell F. Hunt, Associate Enforcement Counsel, Air Enforcement Division, Office of Enforcement and Compliance Monitoring (OECA), and from John Seitz, Director, Stationary Source Compliance Division, Office of Air Quality Planning and Standards. The 1989 guidance (available online at: http://www.epa.gov/ttn/atw/pte/june13_89.pdf) identifies the following as essential components of a restriction on PTE:

1. An emission limitation, in terms of mass of emissions allowed per unit of time, and

2. A production or operational limitation (which can include requirements for the use of in-place air pollution control equipment).

The 1989 guidance explains that restrictions on PTE must be enforceable as a practical matter. This means there must also be adequate monitoring, reporting, and recordkeeping requirements. The 1989 memo also explains that an emission limitation alone, expressed as a long-term rolling average (e.g., a rolling 12-month total) should not be relied upon as the basis for a PTE limit, with the exception of sources that are VOC surface coating operations, and where no add-on emission control equipment is employed at those sources, and where operating and production parameters are not readily limited due to the wide variety of coating and products and due to the unpredictable nature of the operation.

A subsequent memo to the EPA Regional Offices, dated January 25, 1995, from Kathie Stein, Director, Air Enforcement Division, OECA, titled Guidance on Enforceability Requirements for Limiting Potential to Emit through SIP and Section 112 Rules and General Permits, (available online at: http://www.epa.gov/region07/air/title5/t5memos/potoem) explains that the averaging time of the emission limitation must readily allow for determination of compliance: "EPA policy expresses a preference toward short term limits, generally daily but not to exceed 1 month."

Independently enforceable applicable requirements, such as New Source Performance Standards (NSPS) and National Emissions Standards for Hazardous Air Pollutants (NESHAP) are considered enforceable to the extent that the source is in compliance with the standard. In addition, reductions in non-targeted pollutants resulting from compliance with an independently enforceable applicable requirement may be counted as restrictions on PTE, provided the emission reduction of the non-targeted pollutant is enforceable as a practical matter.

V. Arrow's Proposal

A. Natural Gas-fired Engines for Compression, Pumping, and Electric Generation

Arrow has proposed the installation of six (6) rich-burn engines and two (2) lean-burn engines.

Rich-burn engines typically run with low oxygen in their exhausts close to 0.5% oxygen. This is close to the stoichiometric point or a 1:1 Air-to-Fuel Ratio (AFR). This is the theoretical point where all the oxygen and fuel are consumed. In reality, attaining the absolute stoichiometric point is impossible, meaning combustion pollutants remain in the exhaust that must be treated. Engines that operate near the stoichiometric AFR results in higher combustion temperatures causing high NO_X, and CO emissions but low VOC and HAP emissions. The HAP emissions consist primarily of formaldehyde.

Since Arrow seeks to reduce the NOx, CO, VOC, and HAP emissions on all the rich-burn engines, this permit requires the use of AFR ratio controls to ensure that the engine continues to operate rich thereby keeping the VOC and formaldehyde emissions lower, and non-selective catalytic reduction (NSCR) systems to control NO_X and CO emissions.

Lean-burn engines are designed to operate with more dilute fuel gas streams (a higher AFR), with greater than 4% oxygen in the mix. Because they operate on more dilute fuel gas streams, lean-burn engines also operate at lower combustion temperatures producing inherently less NO_X and CO emissions. Lean burn engines also produce VOC and HAP emissions. The HAP emissions consist primarily of formaldehyde.

The primary form of emission control for these engines is an oxidation catalyst system. However, Arrow has proposed that no controls be used on the lean-burn engines, since their overall contribution to the total NO_X, CO, VOC, and HAP emissions at the facility is minimal. Therefore, Arrow proposed that these engines be allowed to operate uncontrolled. This permit does not require the use of catalytic control systems on the lean-burn engines however it does require the use of AFR controls, to ensure that the engines run lean resulting in the smaller contribution to the overall facility emissions.

Emissions from the engines have been estimated using either emission factors from vendor-supplied equipment specification sheets or from AP-42 for natural gas–fired reciprocating engines and operating at the maximum 8,760 hours per year was assumed.

B. Crude Oil and Natural Gas Condensate and Produced Water Storage Tanks

Arrow has proposed the installation of two (2) crude oil and natural gas condensate tanks and one (1) produced water tank. Since Arrow seeks to reduce the VOCs and HAP emissions, they are proposing to control emissions from the two (2) crude oil and natural gas condensate tanks with a combustion control device capable of a 95% VOC destruction efficiency. No controls were proposed for the produced water tank.

The potential emissions of VOCs and HAPs from the crude oil and natural gas condensate tanks were estimated using E&P TANK 2.0 modeling software. The gas volume and emissions from the produced water tank were calculated conservatively as 1% of the uncontrolled VOC and HAP emissions from the condensate tanks.

C. Truck Loadout Racks

Arrow has proposed the use of two (2) truck loadout racks to transfer produced water and crude oil and natural gas condensate from the tanks to trucks. To minimize VOC and HAP emissions, they are proposing the use of submerged loading. During submerged loading, the fill pipe opening is below the liquid surface level. Liquid turbulence is controlled significantly during submerged loading, resulting in lower vapor generation than encountered during splash loading.

Arrow demonstrated in their application that the uncontrolled emissions from the truck loading using submerged loading are minimal and they have proposed that this operation not be controlled any further.

The VOC and HAP emissions due to truck load-outs were calculated using Equation 1 from AP-42 Chapter 5 Section 2 – Transportation of Marketing of Petroleum Liquids. According to AP-42- *Compilation of Air Pollutant Emission Factors,* this equation for estimating emissions has a probable error of ± 30%.

D. Compressor Blowdowns

Arrow has proposed to limit the use of compressor blowdowns to maintenance activities (i.e., to relieve pressure when a compressor is taken offline). They do not plan to use natural gas blowdowns as part of their everyday operations. In addition to blowdown valves used to blow down specific parts of a line for routine maintenance, Arrow plans to include emergency shutdown (ESD) systems, pursuant to the safety requirements of the U.S, Department of Transportation. The activation of an ESD system in the event of an emergency would vent the natural gas to the atmosphere. However, they only intend to use the ESD system in the event of an emergency.

Arrow's application presented the potential compressor blowdown emissions as a minor contribution to the overall VOC and HAP emissions. As such, they proposed no controls.

F. Equipment Leaks

VOC emissions from equipment leaks were estimated using the methodology described in the November 1995 EPA document Protocol for Equipment Leak Emission Estimates (EPA-454/R-95-017). Continuous operation for 8,760 hours per year and typical compressor equipment inventory were assumed.

Arrow did not propose any requirements for identifying or repairing equipment leaks.

VI. Permit Requirements

The conditions in the permit ensure that the operation will meet the relevant regulations and be consistent with applicable guidance.

A. Facility-wide Emission Limits

The permit contains the following facility-wide emission limits:

NO_X – 92 tons in any consecutive 12-month period.
CO – 92 tons in any consecutive 12-month period.
VOC – 92 tons in any consecutive 12-month period.
Total HAPs – 23.0 tons in any consecutive 12-month period.
Each individual HAP – 9.2 tons in any consecutive 12-month period.

The annual NO_X, CO, VOC, and HAP emissions limits must be sufficiently low to ensure that the approved emissions of the operation remain below the PSD and HAP major source threshold(s), and to account for margin of error in emission estimations. For this operation, the annual emission limits are 8% below the major source thresholds.

The uncontrolled potential emissions for all other criteria pollutants are as follows:

SO_2 – 16.3 tpy (uncontrolled potential, not a limit);
PM – 2.4 tpy (uncontrolled potential, not a limit);
PM_{10} – 2.4 tpy (uncontrolled potential, not a limit); and
$PM_{2.5}$ – 2.4 tpy (uncontrolled potential, not a limit).

There are no emission limit requirements for these pollutants.

B. Construction Approved

The EPA is approving the following equipment for the project:

1. Natural gas-fired lean-burn reciprocating internal combustion engines (engines):

   (a) One 4-stroke lean-burn engine, with a maximum rating of 530 hp; and
   (b) One, 4-stroke lean-burn engine, with a maximum rating of 400 hp.

   Both engines may be operated without a catalytic control system, however the permit does require the use of AFRs to control the air-to-fuel ratio. The emissions from each engine must not exceed 2.0 g/hp-hr of NO_X, 1.3 g/hp-hr of CO, 0.75 g/hp-hr of VOCs, and 0.2 g/hp-hr of CH_2O.

   CH_2O is the only HAP with an emission limit as this is the primary HAP from engines. However, all other HAP emissions from the engines must be accounted for when calculating the facility-wide total HAP emissions.

2. Natural gas-fired rich-burn engine:

   (a) Three 4-stroke rich-burn engine, with a maximum rating of 1,480 hp each;
   (b) One 4-stroke rich-burn engine, with a maximum rating of 740 hp;
   (c) One 4-stroke rich-burn engine, with a maximum rating of 435 hp; and
   (d) One 4-stroke rich-burn engine, with a maximum rating of 326 hp.

Each engine must be equipped with an AFR ratio controller and NSCR for emission control. Emissions from each engine must not exceed 1.0 g/hp-hr of NO_X, 2.0 g/hp-hr of CO, 0.7 g/hp-hr of VOCs, and 0.1 g/hp-hr of CH_2O.

CH_2O is the only HAP with emission limits as this is the primary HAP from the engines. However, all other HAP emissions from the engines must be accounted for when calculating the facility-wide total HAP emissions.

3. Condensate and produced water tanks:

(a) Two 400-barrel condensate tanks; and
(b) One 400-barrel produced water storage tank.

The combined water and condensate tank throughput at the facility is limited to 220 bbls/day, which is twice the requested limit. In the application, all calculations were based on a maximum throughput of 110 barrels per day for both water and condensate. However, the 110 bbls/day throughput resulted in controlled emissions that are only 40% of the facility-wide VOC limit and 30% of the facility-wide HAP emission limits. The controlled emission estimates support the approval of a higher maximum throughput while still maintaining the synthetic minor status. The 220 bbl/day limit will provide a great deal more flexibility in operations and increased assurance of compliance with the throughput limit. Since all the engines are approved to operate continuously the increase in the throughput will not cause an increase in potential engine emissions.

The condensate tank emissions must be controlled using a control device that meets a 95% VOC and HAP destruction efficiency. A device that collects the vapors for sale, for on-site fuel, or other beneficial purposes may also be used.

Controls for the produced water tank are not required. However, when calculating facility-wide rolling consecutive 12-month totals, the VOC and HAPs emissions from the water tank assumed to be 1.1% of the actual emissions from both condensate tanks prior to them being controlled. The additional 0.1% is an 8% margin of error added to the assumption made in the application that the VOC and HAP emissions from the water tank would be approximately 1% of the emissions from the condensate tanks.

N- C_{10} is the only HAP with emission limits as this is the primary HAP from the tanks. However, all other HAP emissions from the tanks must be accounted for when calculating the facility-wide total HAP emissions.

4. Truck loadout racks:

The permit approves two (2) loadout racks for the removal of crude oil and natural gas condensate and produced water from the tanks.

The loadout operations must be conducted using submerged loading however, no further emission controls for the loadout operations will be required. When calculating the facility-wide rolling consecutive 12-month totals of VOC and HAP emissions, the permit requires the addition of 30% of the estimated actual emissions to the total loadout emission estimates. The permit requires the use of Equation 1 from AP-42 Chapter 5 Section 2 – Transportation of Marketing of Petroleum Liquids. According to AP-42-

Compilation of Air Pollutant Emission Factors, this equation for estimating emissions has a probable error of ± 30%.

5. Pneumatic pumps and controllers:

The permit requires the installation, maintenance, and operation of pneumatic pumps and controllers in accordance with the manufacturer's specifications, and the use of the following emission control techniques:

(a) Operate air actuated controllers and pneumatic pumps;
(b) Operate solar or electric actuated controllers and pneumatic pumps;
(c) Operate low-bleed with natural gas controllers (6 standard cubic feet per hour);
(d) Operate no-bleed with natural gas controllers;
(e) Route the emissions discharge streams to an operating system designed to recover and inject the emissions into a natural gas gathering pipeline system for sale or other beneficial purpose, such as fuel supply; and/or
(f) Route the discharge stream to a control device.

Emissions from pneumatic pumps and/or controllers must also be included in the operation's rolling consecutive 12-month emission totals. Additionally, emissions from manual and automated blow down episodes associated with maintenance or repair, hydrate clearing, emergency operations, equipment depressurization, etc., are also to be included in the operation's rolling consecutive 12-month emission totals.

D. Operational Requirements

EPA has determined that certain operational requirements are also necessary for the practical enforceability of the operation's NO_X, CO, VOC, and HAP emission limits. EPA is requiring work practice and operational requirements that include, but are not limited to:

1. The installation and operation of temperature-sensing devices before the catalyst bed on each natural gas-fired rich-burn engine in order to continuously monitor the inlet exhaust temperature. Based on the manufacturer's specification sheets submitted by Arrow, the engine exhaust temperature at the inlet to each catalyst bed must be at least 700 °F) but not more than 1,250 °F to ensure the emissions are controlled according to the manufacture's specifications.

2. The installation and operation of pressure measuring devices before and after the catalyst bed on each natural gas-fired rich-burn engine ensure that the catalyst is not clogged or blown out. During operation, the pressure drop across the catalyst bed on each engine is to be maintained to within 2 inches of water from the baseline pressure drop reading taken during the most recent engine performance test.

3. The replacement of the oxygen sensors on all engines within 2,190 hours of engine run time. This is equivalent to 90 days or 1 calendar quarter if the engines were to run continuously.

4. The use of a closed-vent system to capture and route all emissions from all working, breathing, and flashing losses from the crude oil and natural gas condensate tanks to the control device or a device that collects the vapors for sale, for on-site fuel, or other beneficial purposes.

5. The development of a protocol for EPA approval that monitors potential leaks of hydrocarbon gases from each connector, valve, pump, flange, open ended line, or any other appurtenance of the closed-vent system employed to contain and collect vapors and transport them to a control device or a device that collects the vapors for sale, for on-site fuel, or other beneficial purposes.

6. The use of a truck loadout piping system designed for submerged loading of produced water and crude oil and natural gas condensate at each station. The submerged fill pipe must be no more than 12 inches from the bottom of the tanker-truck.

7. The calculation of monthly VOC and HAP emissions released from compressor blowdowns quantified on the basis of the following data:

   (a) The frequency of compressor blowdowns (times/month);
   (b) The volume, in standard cubic feet, of hydrocarbon natural gas released per event, which is a function of normal operating pressure, volume within the compressor, and the natural gas composition (VOC and HAP); and
   (c) The disposition of the discharge (atmosphere or control system).

8. The use of a monitoring device for continuous measurement of crude oil and natural gas received at the site:

   The EPA is requiring the installation of a Lease Automatic Custody Transfer (LACT) unit at the station where crude oil and natural gas is collected, or other EPA-approved continuous monitoring device, to measure the volume of natural gas throughput at the station and the water and crude oil and natural gas condensate liquid transfer. EPA is requiring that the LACT be installed and operated in accordance with Section III.D, "Oil Measurement by Positive Displacement Metering System" of the "Onshore Oil and Gas Operations; Federal and Indian Oil & Gas Leases; Onshore Oil and Gas Order No. 4; Measurement of Oil." [2]

9. Fugitive Dust

   The potential for fugitive dust due to ground disturbances during construction and operation of the station could be significant. In addition, the residents of the Reservation have expressed concerns with regard to increased fugitive dust emissions that have occurred due to increased crude oil and natural gas production and transmission operations. As such, EPA is requiring the development and implementation of a fugitive dust emission prevention plan that specifies the reasonable precautions to be taken and the procedures to be followed to prevent fugitive dust emissions. This requires that the plan meet a minimum requirement, be approved by the EPA, be kept at the station, and be made available for inspection upon EPA request.

[2] 43 CFR 3160 (*Federal Register* Vol. 54, No. 36), U.S. Department of the Interior, Bureau of Land Management, http://www.blm.gov/pgdata/etc/medialib/blm/mt/blm_programs/energy/oil_and_gas/operations/orders.Par.92085.File.dat/ord4.pdf

E. Testing and Monitoring Requirements

Testing and monitoring are necessary for the practical enforceability of the NO_X, CO, VOC, and HAP emission limits. The permit requires the following:

1. Performance testing of each engine for NO_X, CO, VOC, and CH_2O emission in accordance with appropriate reference methods specified in 40 CFR Part 63, Appendix A and 40 CFR Part 60, Appendix A (or the use of an alternative EPA- approved testing method) within 90 days of the start-up of each engine and within 90 days of each of the following:

   (a) Startup of a rebuilt engine;
   (b) Replaced engine;
   (c) Engine restart after correction of a deviation of the temperature to the inlet of the catalyst bed or pressure drop across the catalyst bed that resulted in a required shut-down; and
   (d) Catalyst replacement.

2. Determination, for each engine, of the correlation between the CH_2O emission limit and percentage of CO emissions reduced by the controls. The determination of the percentage of CO emissions reduced may be used to determine compliance with the CH_2O limits during quarterly monitoring of CO.

3. Testing of each engine at least quarterly for NO_X, CO, and VOC emissions using a portable analyzer and a monitoring protocol approved by EPA.

4. The testing of NO_X and CO emissions from each engine simultaneously.

5. The continuous measurement of the volume of natural gas throughput at the station and the water and crude oil and natural gas condensate liquid transfer using a LACT or other EPA-approved continuous monitoring device.

6. Perform, within 1 year of start-up and every 5 years thereafter, an extended laboratory analysis of the crude oil and natural gas received at the station in accordance with 40 CFR 60, Subpart OOOO.

7. Perform quarterly inspections on each tank and perform any necessary repairs for the following:

   (a) Ensure that the thief hatch covers on the condensate storage tanks are weighted and properly seated and the gaskets are in good condition to prevent venting of emissions; and
   (b) Ensure that the pressure relief valves on the condensate storage tanks are set to release at a pressure that will ensure working, breathing, and flashing losses are routed to an emissions control device as specified in this permit, under normal operating conditions, including the maximum instantaneous fill rate that may occur during liquid dumping events by upstream vessels.

8. Determine the total volume losses from each condensate storage tank to be used in calculating monthly VOC and HAP emissions from the produced water and condensate storage tanks using the most recent extended laboratory analysis of the crude oil and

natural gas received at the station, E&P Tanks V2.0 with a 0% control efficiency. Other measurement methods, approved by the EPA, may be used.

9. Calculate VOC and HAP emissions from the truck loading operations for each calendar month using the following:

   (a) The total measured volume of produced water and condensate loaded for the month in barrels;
   (b) The actual physical and chemical properties of the produced water, condensate, and the associated vapors from the most recent semiannual laboratory analysis of the crude oil and natural gas received at the station; and
   (c) The procedures outlined in AP-42 Chapter 5.2, Transportation and Marketing of Petroleum Liquids for the actual method of truck loading.

10. Periodically test, using EPA Reference Method 25A, (40 CFR 60, Appendix A) or other EPA-approved method, the VOC and HAP emissions control to ensure a 95% VOC destruction efficiency.

11. Inspect the condensate storage tank emission control device to confirm proper operation.

12. Calculate monthly and consecutive 12-month emissions at the station monthly and consecutive 12-month emissions of NO_X, CO, VOC, and HAPs. The calculations must include emissions from all controlled and uncontrolled emitting units at the station and shall be made using various required assumptions or emission factors, or results of required measurements or testing.

F. Recordkeeping Requirements

The permit requires that Arrow keep extensive records to be made available upon EPA request, in lieu of extensive reporting requirements. The records to be kept include, but are not limited to, all required measurements, testing, monitoring, and calculations, as well any manufacturer specifications and guarantees, deviations from permit conditions and corrective actions taken. The records are to be kept at the location that has day-to-day operational control over operations.

G. Reporting

The permit requires that Arrow submit an annual report of the operation's consecutive 12-month annual emissions each year covering the period for the previous calendar year. The applicant must also promptly report deviations or exceedances of emission or operational limits and a description of any corrective actions or preventative measures taken. Additionally, a report must be prepared and submitted for any required performance test.

H. Controlled Potential Emissions

Controlled emissions were determined by taking into consideration the equipment design, the maximum capacity of the equipment, the production limits, the operational limits, and emission control equipment.

Permitted emission limits are the legally and practically enforceable limits that are necessary to ensure that the entire operation is synthetically minor for NO_x, CO, VOCs, and HAPs.

Table 3 – Emissions Comparison, provides the uncontrolled PTE, the controlled PTE, and the permitted emissions limits.

Table 3 – Emissions Comparison

Criteria Pollutants	**Uncontrolled Emissions (tpy)**	**Controlled Emissions (tpy)**	**Permitted Emission Limits Enforceable PTE (tpy)**
PM	2.4	5.9	None
PM_{10}	2.4	5.9	None
$PM_{2.5}$	2.4	5.9	None
SO_x	16.3	21.2	None
NO_X	804.5	59.4	92 (facility-wide)
CO	544.9	65.9	92 (facility-wide)
VOC	408.1	52.3	92 (facility-wide)
Greenhouse Gases	**Uncontrolled Emissions (tpy)**	**Controlled Emissions (tpy)**	**Permitted Emission Limits Enforceable PTE (tpy)**
CO_2 (mass basis)	33,339	34,729	None
CH_4 (mass basis)	22	22	None
N_2O (mass basis)	0	0	None
HFCs (mass basis)	0	0	None
PFCs (mass basis)	0	0	None
SF_6 (mass basis)	0	0	None
GHG_{total} (mass basis)	33,361	34,751	None
CO_2e (Total)	**33,822**	**35,212**	None
Hazardous Air Pollutants [a]	**Uncontrolled Emissions (tpy) [b]**	**Controlled Emissions (tpy)**	**Permitted Emission Limits Enforceable PTE (tpy) [c]**
1,1,2,2-Tetrachloroethane	0.01	0.01	9.2 (facility-wide)
1,1,2-Trichloroethane	0.00	0.00	9.2 (facility-wide)
1,3-Butadiene	0.18	0.18	9.2 (facility-wide)
1,3-Dichloropropene	0.00	0.00	9.2 (facility-wide)
2-Methylnapthalene	0.00	0.00	9.2 (facility-wide)
2,2,4-Tirmethylpentane	0.01	0.01	9.2 (facility-wide)
Acenaphthene	0.00	0.00	9.2 (facility-wide)
Acenaphthylene	0.00	0.00	9.2 (facility-wide)
Acetaldehyde	0.98	0.98	9.2 (facility-wide)
Acrolein	0.84	0.84	9.2 (facility-wide)
Benzene	0.41	0.41	9.2 (facility-wide)
Benzo(b)flouranthene	0.00	0.00	9.2 (facility-wide)
Benzo(e)pyrene	0.00	0.00	9.2 (facility-wide)
Benzo(g,h,i)perylene	0.00	0.00	9.2 (facility-wide)
Biphenyl	0.01	0.01	9.2 (facility-wide)
Carbon Tetrachloride	0.01	0.01	9.2 (facility-wide)
Chlorobenzene	0.00	0.00	9.2 (facility-wide)
Chloroform	0.00	0.00	9.2 (facility-wide)
Chrysene	0.00	0.00	9.2 (facility-wide)
Ethylbenzene	0.01	0.01	9.2 (facility-wide)
Ethylene Dibromide	0.01	0.01	9.2 (facility-wide)
Flourathene	0.00	0.00	9.2 (facility-wide)
Flourene	0.00	0.00	9.2 (facility-wide)
Formaldehyde	6.95	2.30	9.2 (facility-wide)
Methanol	0.86	0.86	9.2 (facility-wide)
Methylene Chloride	0.01	0.01	9.2 (facility-wide)
N-Hexane	34.00	2.86	9.2 (facility-wide)
Napthalene	0.03	0.03	9.2 (facility-wide)
PAH	0.04	0.04	9.2 (facility-wide)
Phenanthrene	0.00	0.00	9.2 (facility-wide)

Phenol	0.00	0.00	9.2 (facility-wide)
Pyrene	0.00	0.00	9.2 (facility-wide)
Styrene	0.00	0.00	9.2 (facility-wide)
Tetrachloroethane	0.00	0.00	9.2 (facility-wide)
Toluene	0.15	0.15	9.2 (facility-wide)
Vinyl Chloride	0.00	0.00	9.2 (facility-wide)
Xylene	0.06	0.06	9.2 (facility-wide)
Total HAPs	**44.57**	**8.78**	**23.0 (facility-wide)**

a. The Clean Air Act (CAA) at 112(b) lists 187 regulated hazardous air pollutants. The Permittee has identified 37 hazardous air pollutants potentially emitted from this facility.

b. The major source thresholds for HAPs are 10 tpy for any single HAP and 25 tpy for total HAPs.

c. The Permittee requested facility-wide legally and practically enforceable emission limits of 9.2 tpy on each potential HAP emitted and 23.0 tpy on the total HAPs emitted. On an uncontrolled basis, only one (1) of the individual HAPs is major, and only two (2) have any relevant contribution to the total facility-wide HAPs . Therefore, emission limits for all individual HAPs are not necessary for establishing this facility as a minor HAP source.

VII. Air Quality Review

A. Regulatory Requirements

The MNSR Regulations at 40 CFR 49.154(d) require that an Air Quality Impact Analysis (AQIA) modeling analysis be performed if there is reason to be concerned that new construction would cause or contribute to a National Ambient Air Quality Standard (NAAQS) violation. If the AQIA reveals that the proposed construction could cause or contribute to a NAAQS violation, such impacts must be addressed before a preconstruction permit can be issued.

B. AQIA of the Proposed Project

The EPA Region 8 Air Program required Arrow to submit an AQIA to demonstrate that this proposed operation would not cause or contribute to ambient air concentrations in excess of the NAAQS.

1. CO, NO_2, PM_{10}, $PM_{2.5}$, and SO_2 Impact

Arrow used the EPA AERSCREEN model (Version 11126) to estimate air quality impacts for CO, NO_2, PM_{10}, $PM_{2.5}$, and SO_2. The results have been summarized in Table 4 - Summary EPA AERSCREEN Impact Analysis; below. As the modeling results demonstrate, air quality impacts from each proposed station location would be below the NAAQS for CO, NO_2, $PM_{2.5}$, PM_{10}, and SO_2.

Table 4 – Summary EPA AERSCREEN Impact Analysis
(ppb = parts per billion; μg/m³ = micrograms per meter cubed)

Pollutant	Primary / Secondary	Averaging Period	Representative Maximum Impact	Ambient Background Concentrations	Representative Maximum Impact + Ambient Background concentrations	NAAQS	Exceeds NAAQS?
PM_{10}	Primary and Secondary	24-hour [1]	3.2 μg/m³	103.0 μg/m³	106.2 μg/m³	150 μg/m³	No
$PM_{2.5}$	Primary and Secondary	24-hour [2]	3.2 μg/m³	16.6 μg/m³	19.8 μg/m³	35 μg/m³	No
		Annual [2]	0.3 μg/m³	5.8 μg/m³	6.1 μg/m³	12 μg/m³	No
NO_2	Primary	1-hour [3]	78.0 ppb	16.0 ppb	94.0 ppb	100 ppb	No

Pollutant	Primary / Secondary	Averaging Period	Representative Maximum Impact	Ambient Background Concentrations	Representative Maximum Impact + Ambient Background concentrations	NAAQS	Exceeds NAAQS?
	Primary and Secondary	Annual [3]	7.8 ppb	5.0 ppb	12.8 ppb	53 ppb	No
SO_2	Primary	1-hour [4]	15.2 ppb	19.0 ppb	34.2 ppb	75 ppb	No
	Secondary	3-hour [4]	15.2 ppb	16.3 ppb	31.5 ppb	500 ppb	No
CO	Primary	1-hour [5]	0.1 ppm	2.2 ppm	2.3 ppm	35 ppm	No
		8-hour [5]	0.1 ppm	0.6 ppm	0.7 ppm	9 ppm	No
O_3 (Ozone)	Primary and Secondary	8-hour	See qualitative assessment, below.			0.075 ppm	Not expected

[1] Ambient background 24-hour PM_{10} value taken from the highest recorded 24-hour concentration value for the years analyzed (2010–2012) from EPA Air Monitor 38-025-0003

[2] Ambient background 24-hour and annual $PM_{2.5}$ values taken from highest 98% 24-hour concentration value (for 24-hour $PM_{2.5}$ background level) and highest annual mean 24-hour concentration value (for annual $PM_{2.5}$ background level) for the years analyzed (2010–2012) from EPA Air Monitor 38-025-0003

[3] Ambient background 1-hour and annual NO_2 values taken from the highest 99% 1-hour concentration value (for 1-hour NO_2 background level) and highest annual mean 1-hour concentration value (for annual NO_2 background level) for the years analyzed (2010–2012) from EPA Air Monitor 38-053-0002

[4] Ambient background 1-hour and 3-hour SO_2 value taken from highest 99% 1-hour concentration value (for 1-hour SO_2 background level) and highest record 3-hour concentration value (for 3-hour SO_2 background level) for the years analyzed (2010–2012) from EPA Air Monitor 38-025-0003

[5] Ambient background 1-hour and 8-hour CO values taken from highest recorded 1-hour and 8-hour concentration values, respectively, for the years analyzed (2010–2012) from EPA Air Monitor 38-017-1004

2. Ozone (O_3) Impact

The available O_3 data from the closest two O_3 monitors in the region (38-025-0002 and 38-025-0003) indicted these two monitors did not approach the 8-hour O_3 standard. For 8-hour O_3, NAAQS violations occur when the 3-year average of the 4th maximum 8-hour average O_3 is greater than the NAAQS. Neither of these two monitors had a three year average above the 0.075 ppm O_3 NAAQS. Therefore, the overall conclusion is that the project is unlikely to cause or contribute to a violation of the O_3 NAAQS based on the following:

(a) The current background O_3 values are significantly below the NAAQS;

(b) The increase in ozone precursor emissions is relatively small (approximately 59 tpy of NOx);

(c) The region typically has good air dispersion, with mostly flat terrain; and

(d) Project emissions are not expected to cause a significant increase in ozone and therefore will not cause or contribute to an exceedance of the NAAQS.

3. Class I Area Impacts

Arrow has also assessed the impact of project emissions to nearby Class I areas. The only Class I area identified within 100 kilometers (km) from either proposed project location is the Theodore Roosevelt National Park, whose eastern edge is located approximately 60 km to the west of the westernmost boundary of the project property line. Arrow has therefore conducted a screening level assessment of project impacts to the Theodore Roosevelt National Park using the Federal Land Managers' Air Quality Related Values (AQRV) Workgroup (FLAG) Phase I Report guidance.[3]

Based on the analysis, the project will not adversely affect the Theodore Roosevelt National Park.

4. Conclusion

Based on the available data, discussed above, there do not appear to be any significant air quality concerns within the exterior boundaries of the Fort Berthold Indian Reservation. Additionally, emissions from the proposed operation will be controlled at all times. These controlled emissions do not appear to have a significant impact to the air quality of the surrounding area.

VIII. Tribal Consultations and Communications

We offer Tribal Government Leaders an opportunity to consult on each permit action. We ask the Tribal Government Leaders to respond to our offer to consult within 30 days. We offered the Chairman of the Three Affiliated Tribes an opportunity to consult on this permit action via letter dated June 4, 2013. To date, the EPA has not received a response to our offer to consult on this permit action.

All minor source applications (synthetic minor, modification to an existing facility, new true minor or general permit) are submitted to both the Tribe and us per the application instructions (see http://www2.epa.gov/region8/tribal-minor-new-source-review-permitting). The Tribe has 10 business days from the receipt of the application to respond to us with questions and comments on the application.

Additionally, we notify the Tribe of the public comment period for the proposed permit and provide copies of the notice of public comment opportunity to post in various locations of their choosing on the Reservation. We also notify the Tribe of the issuance of the final permit.

Tribal Environmental Contact:

Edmund Baker, Environmental Director
Mandan, Hidatsa and Arikara Nation
204 West Main Street
New Town, North Dakota 58763-9404
EdmundBaker@mhanation.com
(707) 627-4569

IX. Environmental Justice

Given the presence of potential environmental justice communities in the vicinity of the facility, the EPA is providing an enhanced public participation process for this permit as follows:

1. The applicant has provided a copy of their permit application to the Tribal Environmental Director of the Three Affiliated Tribes and to the EPA Region 8 Air Program office;

[3] The Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report – Revised 2010. Available at: http://www.nature.nps.gov/air/pubs/pdf/flag/FLAG_2010.pdf. Accessed on April 22, 2013.

2. The application, proposed permit, and TSD, will be made available for public review at the Tribal Environmental Division office and satellite locations nearest to the proposed operations;

3. The EPA will provide the Tribal Environmental Director a copy of the public notice bulletin announcing the public comment period for the proposed permit action to post in various appropriate locations throughout the FBIR;

4. The proposed permit and TSD will be made available for review on the EPA Region 8 Air Program website at http://www2.epa.gov/region8/air-permit-public-comment-opportunities; and

5. Interested parties can subscribe to an EPA listserve that notifies them of public comment opportunities on the FBIR for proposed air pollution control permits via email at http://www2.epa.gov/region8/air-permit-public-comment-opportunities.

X. Public Notice, Public Comment, Public Hearing, and Appeals

A. Public Notice

In accordance with Section 49.157, the EPA Region 8 Air Program (Air Program) must provide public notice and a 30-day public comment period to ensure that the affected community and the general public have reasonable access to the application, proposed permit, and related documentation. This documentation is available at the following locations:

Mandan, Hidatsa and Arikara Nation Environmental Programs Office
404 Frontage Road
New Town, ND
Attn: Edmund Baker

Fort Berthold Community College
Library: 220 8th Avenue East, P.O. Box 490
New Town, ND 58763

Mandaree West Segment Tribal Office
440 4th Ave NE
Mandaree, ND
Attn: Cory Sanders

US EPA Region 8 Office
Air Program Office
1595 Wynkoop Street
Denver, Colorado
Attn: Kathleen Paser

All documents are available for review at the EPA Region 8 office Monday through Friday from 8:00 a.m. to 4:00 p.m. (excluding federal holidays). Please call Kathleen Paser at 303-312-6526, Claudia Smith at 303-312-6520, or Eric Wortman at 303-312-6649 in advance of your visit.

The proposed permit, TSD, and related documentation can also be reviewed on the Air Program website at: http://www2.epa.gov/region8/air-permit-public-comment-opportunities.

B. Public Comment

Any person may submit written comments on the proposed permit and may request a public hearing during the public comment period. These comments must raise any reasonably ascertainable issues with supporting arguments by the close of the public comment period (including any public hearing).

EPA accepts comments by mail, fax and e-mail.

US EPA Region 8 Air Program, 8P-AR
Attn: Kathleen Paser
Tribal Air Permit Program
1595 Wynkoop Street
Denver, CO 80202
e-mail: R8AirPermitting@epa.gov
Fax: 303-312-6064

C. Public Hearing

A request for a public hearing must be in writing and must state the nature of the issues proposed to be raised at the hearing. The EPA Region 8 will hold a hearing whenever there is, on the basis of requests, a significant degree of public interest in a proposed permit. The EPA Region 8 may also hold a public hearing at its discretion, whenever, for instance, such a hearing might clarify one or more issues involved in the permit decision.

D. Final Permit Action

In accordance with Section 49.159, a final permit becomes effective 30 days after permit issuance, unless:

1. A later effective date is specified in the permit;

2. An appeal of the final permit is made as detailed in the next section; or

3. The EPA Region 8 may make the permit effective immediately upon issuance if no comments resulted in a change in the proposed permit or a denial of the permit.

The EPA Region 8 will send notice of the final permit action to any individual who commented on the proposed permit during the public comment period.

The final permit will be added to a list of final MNSR permit actions which is posted on the Air Program website at: http://www2.epa.gov/region8/nsr-and-psd-permits-issued-region-8. Anyone may request a copy of the final permit at any time by contacting the EPA Region 8 Tribal Air Permit Program at (800) 227–8917 or sending an email to r8airpermitting@epa.gov.

E. Appeals to the Environmental Appeals Board

In accordance with Section 49.159, within 30 days after a final permit decision has been issued, any person who filed comments on the proposed permit or participated in the public hearing may petition the Environmental Appeals Board (EAB) to review any condition of the permit decision. The 30-day period within which a person may request review under this section begins when the Region has fulfilled the notice requirements for the final permit decision. Motions to reconsider a final order by the EAB must be filed within ten 10 days after service of the final order. A petition to the EAB is under Section 307(b) of the Act, a prerequisite to seeking judicial review of the final agency action. For purposes of judicial review, final agency action occurs when a final permit is issued or denied by the EPA Region 8 and agency review procedures are exhausted.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
DENVER, CO 80202-1129
Phone 800-227-8917
http://www.epa.gov/region08

Ref: 8P-AR

Doug Lee
Sr. Vice President of Operations
10702 Highway 73
Keene, North Dakota 58847

Re: Arrow Pipeline, LLC, Arrow Pipeline Station #7
Proposed Air Pollution Control Pre-Construction Permit
Permit # SMNSR-TAT-000661-2013.001

Dear Mr. Lee:

The U.S. Environmental Protection Agency Region 8 has completed its review of Arrow Pipeline, LLC's application requesting approval to construct a crude oil and natural gas gathering and transmission station pursuant to the Tribal Minor New Source Review Program at 40 CFR Part 49 (MNSR).

Enclosed are the proposed permit and the corresponding technical support document. The MNSR regulations require that the affected community and the general public have the opportunity to submit written comments on any proposed MNSR permit. All written comments submitted within 30 calendar days after the public notice is published will be considered by the EPA in making its final permit decision. Enclosed is a copy of the public notice which will be published on the EPA's website located at: http://www2.epa.gov/region8/air-permit-public-comment-opportunities, on March 20, 2014. The public comment period will end on April 21, 2014.

The conditions contained in the proposed permit will become effective and enforceable by the EPA if the permit is issued final. If you are unable to accept any term or condition of the proposed permit, please submit your written comments, along with the reason(s) for non-acceptance to:

Federal Minor NSR Coordinator
U.S. EPA, Region 8
1595 Wynkoop Street, 8P-AR
Denver, Colorado 80202

or

R8AirPermitting@epa.gov

If you have any questions concerning the enclosed proposed permit or technical support document, please contact Kathy Paser of my staff at (303) 312-6526.

Sincerely,

Debra H. Thomas
Acting Assistant Regional Administrator
Office of Partnerships and Regulatory Assistance
(OPRA)

Enclosures

United States Environmental Protection Agency
Region 8 Air Program
1595 Wynkoop Street
Denver, CO 80202

Air Pollution Control
Synthetic Minor Source Permit to Construct

40 CFR 49.151

#SMNSR-TAT-000661-2013.001

Permit to Construct to establish legally and practically enforceable limitations and requirements on sources at a new facility.

Permittee:

Arrow Pipeline, LLC

Permitted Facility/Source:

Arrow Pipeline Station #7
Crude Oil and Natural Gas Gathering and Transmission
Fort Berthold Operations
Dunn County, North Dakota

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I. Conditional Permit to Construct

A. General Information

Facility/source:	Arrow Pipeline Station #7 Crude Oil and Natural Gas Gathering and Transmission
Permit number:	SMNSR-TAT-000661-2013.001
SIC Code and SIC Description:	4922 – Pipeline Transportation of Natural Gas

Site Location:
Fort Berthold Indian Reservation
Dunn County, ND

Corporate Office Location:
Arrow Pipeline LLC
10702 Highway 73
Keene, ND 58847

The equipment listed in this permit may only be operated by Arrow Pipeline, LLC, at the following location:

County	Township	Range	Section	Quarter Section	Latitude	Longitude
Dunn	148 N	92 W	4	NE¼	47.672167 N	-102.401833 W

The location indicated above is approximate and the final location may be within 1,200 feet of these coordinates. Any adjustment to the station location must comply with the Endangered Species Act and National Historic Preservation Act.

B. Construction

The gathering and transmission operations will consist of the following primary equipment:

Two Crude Oil and Natural Gas Condensate Storage Tanks
One Produced Water Storage Tank
Two Truck Loading Racks
Eight Natural Gas-Fired Reciprocating Internal Combustion Engines
Hydrocarbon Emission Controls

The primary function of the station is to gather crude oil and natural gas via pipeline from the various production wells in the area and transport it to a central delivery point located outside of the external boundaries of the Fort Berthold Indian Reservation. The station will not be processing natural gas or refining crude oil and natural gas condensate into end products.

Crude oil and natural gas condensate and produced water removed from the natural gas via the slug catcher and filter separator(s) will be pumped to individual storage tanks. Truck load out racks will be used to truck the crude oil and natural gas condensate and produced water from the station.

Compressed natural gas will be routed to a splitter, with most of the natural gas routed to a natural gas pipeline exiting the station and the remainder routed to a fuel gas coalescer. Natural gas from the fuel gas coalescer will be routed to and combusted by individual compressor engines and/or natural gas–fired electrical generator engines designed to provide power to the station.

C. Applicability

1. This Conditional Permit to Construct is being issued under the authority of the Tribal Minor New Source Review Program at 40 CFR Part 49 (MNSR).

2. The requirements in this permit have been created, at the Permittee's request, to establish legally and practically enforceable requirements for limiting emissions of volatile organic compounds (VOCs), nitrogen oxide (NO_X), carbon monoxide (CO), and individual and total hazardous air pollutants (HAPs).

3. Any conditions established for this facility or any specific units at this facility pursuant to any Conditional Permit to Construct issued under the authority of the Prevention of Significant Deterioration Permit Program at 40 CFR Part 52 (PSD) or MNSR shall continue to apply.

4. By issuing this permit, the EPA does not assume any risk of loss which may occur as a result of the operation of the permitted facility by the Permittee, Owner, and/or Operator, if the conditions of this permit are not met by the Permittee, Owner, and/or Operator.

D. Requirements for Emission Limits, Construction, and Operation

1. Emission Limits

    (a) VOC emissions shall not exceed 92 tons during any consecutive 12 months.

    (b) NO_X emissions shall not exceed 92 tons during any consecutive 12 months.

    (c) CO emissions shall not exceed 92 tons during any consecutive 12 months.

    (d) Individual HAP emissions, except for CH_2O and n-C_6, shall not exceed 9.8 tons during any consecutive 12 months.

    (e) Total HAP emissions shall not exceed 24.5 tons during any consecutive 12 months.

    (f) Emission limits specified in this permit shall apply at all times.

2. Construction and Operational Limits

    (a) The Permittee shall limit the total maximum engine capacity at the station to 7,000 horsepower (hp).

    (b) All engine capacities shall be based on the manufacturer's maximum site rated hp of each engine.

    (c) The follow reciprocating internal combustion engines (engines) have been approved for installation and operation:

        (i) One 4-stroke lean-burn engine, with a maximum rating of 530 hp;
        (ii) One, 4-stroke lean-burn engine, with a maximum rating of 400 hp;
        (iii) Three 4-stroke rich-burn engine, with a maximum rating of 1,480 hp each;
        (iv) One 4-stroke rich-burn engine, with a maximum rating of 740 hp;

(v) One 4-stroke rich-burn engine, with a maximum rating of 435 hp; and
(vi) One 4-stroke rich-burn engine, with a maximum rating of 326 hp.

(d) The Permittee shall only install 2 - 400 barrel crude oil and natural gas condensate tanks operated and controlled as specified in the **Requirements for Tanks** section of this permit.

(e) The Permittee shall only install 1 - 400 barrel produced water storage tank operated and controlled as specified in the **Requirements for Tanks** section of this permit.

(f) The Permittee shall limit the combined produced water and crude oil and natural gas condensate throughput to 80,500 barrels in any given consecutive 12-month period.

(g) The Permittee shall install a Lease Automatic Custody Transfer (LACT) unit at the inlet to the station to continuously measure the volume of produced water and crude oil and natural gas condensate entering the station. The LACT unit shall be operated as specified in the **Requirements for LACT Units** section of this permit. Upon written approval by the EPA, the Permittee may use other monitoring methods that are capable of continuously measuring the volume of produced water and crude oil and natural gas condensate received.

(h) All produced water and crude oil and natural gas collection, storage, and handling operations, regardless of size, shall be designed, operated and maintained by the Permittee so as to minimize leakage of hydrocarbon emissions to the atmosphere.

3. Testing Requirements:

Within 1 year of the first day that operations begin, the Permittee shall obtain an extended laboratory analysis of the produced water and crude oil and natural gas condensate entering the station to confirm the accuracy of the emissions estimates provided in the application for this permit. Thereafter, the Permittee shall obtain an extended laboratory analysis of the produced water and crude oil and natural gas condensates received at the station every 5 years and use the new data for emissions calculations required in this permit.

4. Monitoring Requirements

(a) The Permittee shall monitor the total maximum engine capacity at the station upon commencement of operations, at the end of each calendar year, and anytime an engine is installed, moved or replaced. All engine capacities shall be based on the maximum site rated hp of each engine.

(b) The Permittee shall use a LACT unit or other monitoring methods approved by EPA that are capable of continuously measuring the volume of produced water and crude oil and natural gas condensate received at the station.

(c) The Permittee shall calculate, at the end of each calendar month, the produced water and crude oil and natural gas condensate throughput at the station, in barrels, beginning with the first calendar month that permitted operations commence. Prior to 12 full months of operation, the Permittee shall, at the end of each calendar month, add the produced water and crude oil and natural gas condensate throughput for that calendar month to the calculated produced water and crude oil and condensate throughput for all previous calendar months since operations commenced and record the total. Thereafter, the Permittee shall, at the end of each calendar month add the produced water and crude oil and natural gas condensate throughput for that calendar month to the calculated produced water and crude oil and natural gas condensate throughput for the preceding 11 calendar months and calculate a new 12-month total.

(d) The Permittee shall calculate, at the end of each calendar month, the VOC, NO_X, CO, and HAP emissions beginning with the first calendar month that permitted operations commence. Prior to 12 full months of operation, the Permittee shall, at the end of each month, add the emissions for that month to the calculated emissions for all previous months since operations commenced and record the total. Thereafter, the Permittee shall, at the end of each month add the emissions for that month to the calculated emissions for the preceding 11 months and calculate a new 12-month total.

(e) Emissions from all controlled and uncontrolled emission sources shall be included in the monthly and consecutive 12-month calculations, including, but not limited to: the crude oil and natural gas condensate tanks; produced water storage tanks; truck load-out operations; produced water and crude oil and natural gas system receivers; fuel gas coalescesers; slug catchers; filter separators; pig launchers and receivers; pneumatic pumps; pneumatic controls; compressor blow-downs; engines; equipment leaks; enclosed combustors; utility flares; or other EPA approved control device.

(f) Emissions from each approved emitting unit shall be calculated by the Permittee as specified in this permit.

(g) Where sufficient to meet the monitoring requirements of this permit, the Permittee may use a Supervisory Control and Data Acquisition (SCADA) system to monitor the needed data in this permit.

(h) Alternative monitoring methods may be used by the Permittee upon EPA approval.

5. Recordkeeping Requirements

(a) The Permittee shall maintain a record of the monthly and consecutive 12-month barrels of produced water and crude oil and natural gas condensate received at the station.

(b) The Permittee shall maintain a record of the monthly and consecutive 12-month VOC, NO_X, CO, and HAP emissions, in tons per year (tpy) from the station.

(c) The Permittee shall maintain a record of the results of each extended laboratory analysis of the produced water and crude oil and natural gas condensate received at the station.

(d) The Permittee shall maintain a record of all input parameters and calculations used to determine the monthly emissions from all controlled and uncontrolled emission sources.

(e) The Permittee shall maintain a record of all deviation from the requirements of this permit.

(f) Where sufficient to meet all the recordkeeping requirements of this permit, the Permittee may use a SCADA system to record the needed data in this permit.

(g) Alternative methods of recordkeeping may be used by the Permittee upon EPA approval.

E. Requirements for LACT Units

The Permittee shall follow the instructions for the installation and operation of the LACT units as specified in the "Onshore Oil and Gas Operations; Federal and Indian Oil & Gas Leases; Onshore Oil and Gas Order No. 4; Measurement of Oil," Section III.D; "Oil Measurement by Positive Displacement Metering System," developed by the US Department of the Interior's Bureau of Land Management.

[Note: EPA is incorporating by reference the measurement methodologies described in this document only. There are no other enforcement implications intended. The Onshore Oil and Gas Operations; Federal and Indian Oil & Gas Leases; Onshore Oil and Gas Order No. 4 can be found 43 CFR 3160; Federal Register/Vol. 54, No. 36 or *on-line at* *http://www.blm.gov/pgdata/etc/medialib/blm/mt/blm_programs/energy/oil_and_gas/operations/orders.Par.92085.File.dat/ord4.pdf]*

F. Requirements for Engines

1. Emission Limits

(a) Emissions from the one (1) natural gas-fired, 530 hp, 4-stroke lean-burn engine shall not exceed the following:

(i) NO_X: 2.0 grams/horse power-hour (g/hp-hr);
(ii) CO: 1.3 g/hp-hr;
(iii) VOC: 0.75 g/hp-hr; and
(iv) CH_2O: 0.2 g/hp-hr.

(b) Emissions from the one (1) natural gas-fired, 400 hp, 4-stroke lean-burn engine shall not exceed the following:

(i) NO_X: 2.0 grams/horse power-hour (g/hp-hr);
(ii) CO: 1.3 g/hp-hr;
(iii) VOC: 0.75 g/hp-hr; and
(iv) CH_2O: 0.2 g/hp-hr.

(c) Emissions from each of the three (3) natural gas-fired, 1,480 hp, 4-stroke rich-burn engines shall not exceed the following:

(i) NO_X: 1.0 g/hp-hr;
(ii) CO: 2.0 g/hp-hr;
(iii) VOC: 0.7 g/hp-hr; and
(iv) CH_2O: 0.1 g/hp-hr.

(d) Emissions from each of the one (1) natural gas-fired, 740 hp, 4-stroke rich-burn engine shall not exceed the following:

(i) NO_X: 1.0 g/hp-hr;
(ii) CO: 2.0 g/hp-hr;
(iii) VOC: 0.7 g/hp-hr; and
(iv) CH_2O: 0.1 g/hp-hr.

(e) Emissions from the one (1) natural gas-fired, 435 hp, 4-stroke rich-burn engine shall not exceed the following:

(i) NO_X: 1.0 g/hp-hr;
(ii) CO: 2.0 g/hp-hr;
(iii) VOC: 0.7 g/hp-hr; and
(iv) CH_2O: 0.1 g/hp-hr.

(f) Emissions from the one (1) natural gas-fired, 326 hp, 4-stroke rich-burn engines shall not exceed the following:

(i) NO_X: 1.0 g/hp-hr;
(ii) CO: 2.0 g/hp-hr;
(iii) VOC: 0.7 g/hp-hr; and
(iv) CH_2O: 0.1 g/hp-hr.

2. Control and Operational Requirements

(a) The Permittee shall equip each 4-stroke lean-burn engine with an air-to-fuel ratio (AFR) controller to ensure that the engine continues to operate as a lean-burn engine. The oxygen sensor associated with each AFR controller must be replaced after every 2190 hours of engine run time.

(b) The Permittee shall equip and operate each 4-stroke rich-burn engine with an AFR controller to ensure that the engine continues to operate as a rich-burn engine. The oxygen sensor associated with each AFR controller must be replaced after every 2190 hours of engine run time.

(c) The Permittee shall equip and operate each 4-stroke rich-burn engine with a non-selective catalytic reduction (NSCR) control system capable of reducing the uncontrolled emissions of NO_X, CO, VOC, and CH_2O to meet the emission limits specified in this permit.

(d) The Permittee shall install, operate, and maintain temperature sensing devices (i.e., thermocouple or resistance temperature detectors) before the NSCR control system on each engine in order to continuously monitor the exhaust temperature at the inlet of the catalyst bed. Each temperature sensing device shall be calibrated and operated by the Permittee according to manufacturer and/or vendor specifications or equivalent specifications developed by the Permittee or vendor.

(e) Except during startups, not to exceed 30 minutes, the engine exhaust temperature of each engine, at the inlet to the catalyst bed, shall be maintained at all times the engines operate with an inlet temperature of at least 450° F and no more than 1,350°F.

(f) During operation, the pressure drop across the catalyst bed on each engine shall be maintained to within ±2 inches of water from the baseline pressure drop measured during the most recent performance test. The baseline pressure drop for the catalyst bed shall be determined at 100% ± 10% of the engine load measured during the most recent performance test.

(g) The Permittee shall only fire each engine with natural gas.

(h) The Permittee shall follow, for each engine and its respective catalytic control system, the manufacturer and/or vendor recommended maintenance schedule and procedures or equivalent maintenance schedule and procedures developed by the Permittee or vendor to ensure optimum performance of each engine and its respective catalytic control system.

(i) The Permittee may rebuild an existing permitted engine or replace an existing permitted engine with an engine of the same horsepower rating, and configured to operate in the same manner as the engine being rebuilt or replaced. Any emission limits, requirements, control technologies, testing or other provisions that apply to the permitted engines that are replaced shall also apply to the rebuilt and replaced engines.

(j) The Permittee may resume operation without the catalytic control system during an engine break-in period, not to exceed 200 operating hours, for rebuilt and replaced engines.

3. Performance Testing Requirements

(a) Performance tests shall be conducted on each engine for measuring NO_X, CO, VOC, and CH_2O emissions to demonstrate compliance with each emission limitation in this permit. The performance tests shall be conducted in accordance with appropriate reference methods specified in 40 CFR Part 63, Appendix A and 40 CFR Part 60, Appendix A, or an EPA approved American Society for Testing and Materials (ASTM) method. The Permittee may submit to the EPA a written request for approval of an alternate test method, but shall only use that alternate test method after obtaining approval from the EPA.

(i) The initial performance test for each engine shall be conducted within 90 calendar days of startup of a new engine.
(ii) Subsequent performance tests for VOC and CH_2O emissions shall be conducted within 12 months of the most recent performance test.
(iii) Performance tests shall be conducted within 90 calendar days of each catalyst replacement.
(iv) Performance tests shall be conducted within 90 calendar days of startup of all rebuilt and replaced engines.

(b) The Permittee shall not perform engine tuning or make any adjustments to engine settings, catalytic control system settings, or processes or operational parameters the day of the engine testing or during the engine testing. Any such tuning or adjustments may result in a determination by the EPA that the test is invalid. Artificially increasing an engine load to meet testing requirements is not considered engine tuning or adjustments.

(c) The Permittee shall not abort any engine tests that demonstrate non-compliance with the emission limits in this permit.

(d) All performance tests conducted on each engine shall meet the following requirements:

(i) The pressure drop across each catalyst bed and the inlet temperature to each catalyst bed shall be measured and recorded at least once during each performance tests.

(ii) All tests for CO and NO_X emissions shall be performed simultaneously.

(iii) All tests shall be performed at a maximum operating rate (90% to 110% of the maximum achievable engine load available on the day of the test). The Permittee may submit to the EPA a written request for approval of an alternate load level for testing, but shall only test at that alternate load level after obtaining approval from the EPA.

(iv) During each test run, data shall be collected on all parameters necessary to document how emissions were measured and calculated (such as test run length, minimum sample volume, volumetric flow rate, moisture and oxygen corrections, etc.).

(v) Each test shall consist of at least three 1-hour or longer valid test runs. Emission results shall be reported as the arithmetic average of all valid test runs and shall be in terms of the emission limits in this permit.

(vi) Performance test plans shall be submitted to the EPA for approval 60 calendar days prior to the date the test is planned.

Performance test plans that have already been approved by the EPA for the emission units approved in this permit may be used in lieu of new test plans unless the EPA requires the submittal and approval of new test plans. The Permittee may submit new plans for EPA approval at any time.

(vii) The test plans shall include and address the following elements:

(A) Purpose of the test;
(B) Engines and catalytic control systems to be tested;
(C) Expected engine operating rate(s) during the test;
(D) Sampling and analysis procedures (sampling locations, test methods, laboratory identification);
(E) Quality assurance plan (calibration procedures and frequency, sample recovery and field documentation, chain of custody procedures); and
(F) Data processing and reporting (description of data handling and quality control procedures, report content).

(e) The Permittee shall notify the EPA at least 30 calendar days prior to scheduled performance testing. The Permittee shall notify the EPA at least 1 week prior to scheduled performance testing if the testing cannot be performed.

(f) If the permitted engine is not operating, the Permittee does not need to start up the engine solely to conduct a performance test. The Permittee may conduct the performance test when the engine is started up again.

4. Monitoring Requirements

(a) The Permittee shall continuously monitor the engine exhaust temperature of each engine at the inlet to the catalyst bed.

(b) Except during startups, not to exceed 30 minutes, if the engine's exhaust temperature at the inlet to the catalyst bed deviates from the acceptable ranges specified in this permit then the following actions shall be taken. The Permittee's completion of any or all of these actions shall not constitute, nor qualify as, an exemption from any other emission limits in this permit.

(i) Within 24 hours of determining a deviation of the engine exhaust temperature at the inlet to the catalyst bed, the Permittee shall investigate. The investigation shall include testing the temperature sensing device, inspecting the engine for performance problems and assessing the catalytic control system for possible damage that could affect catalytic system effectiveness (including, but not limited to, catalyst housing damage, and fouled, destroyed or poisoned catalyst).

(ii) If the engine exhaust temperature at the inlet to the catalyst bed can be corrected by following the engine manufacturer and/or vendor recommended procedures or equivalent procedures developed by the Permittee or vendor, and the catalytic control system has not been damaged, then the Permittee shall correct the engine exhaust temperature at the inlet to the catalyst bed within 24 hours of inspecting the engine and catalytic control system.

(iii) If the engine exhaust temperature at the inlet to the catalyst bed cannot be corrected using the engine manufacturer and/or vendor recommended procedures or equivalent procedures developed by the Permittee or vendor, or the catalytic control system has been damaged, then the affected engine shall cease operating immediately and shall not be returned to routine service until the following has been met:

(A) The engine exhaust temperature at the inlet to the catalyst bed is measured and found to be within the acceptable temperature range for that engine; and

(B) The catalytic control system has been repaired or replaced, if necessary.

(c) The Permittee shall monitor the pressure drop across the catalyst bed on each engine every 30 days using pressure sensing devices before and after the catalyst bed to obtain a direct reading of the pressure drop (also referred to as the differential pressure). *[Note to Permittee: Differential pressure measurements, in general, are used to show the pressure across the filter elements. This information will determine when the elements of* *the catalyst bed are fouling, blocked or blown out and thus require cleaning or replacement.]*

(d) The Permittee shall perform the first measurement of the pressure drop across the catalyst bed on each engine no more than 30 days from the date of the initial performance test. Thereafter, the Permittee shall measure the pressure drop across the catalyst bed, at a minimum, every 30 days. Subsequent performance tests, as required in this permit, can be used to meet the periodic pressure drop monitoring requirements provided it occurs within the 30-day window. The pressure drop reading can be a one-time measurement on that day, the average of performance test runs conducted on that day, or an average of all the measurements taken on that day if continuous readings are taken.

(e) If the pressure drop reading exceeds ± 2 inches of water from the baseline pressure drop established during the most recent performance test, then the following actions shall be taken. The Permittee's completion of any or all of these actions shall not constitute, nor qualify as, an exemption from any other emission limits in this permit:

(i) Within 24 hours of determining a deviation of the pressure drop across the catalyst bed, the Permittee shall investigate. The investigation shall include testing the pressure transducers and assessing the catalytic control system for possible damage that could affect catalytic system effectiveness (including, but not limited to, catalyst housing damage, and plugged, fouled, destroyed or poisoned catalyst).

(ii) If the pressure drop across the catalyst bed can be corrected by following the catalytic control system manufacturer and/or vendor recommended procedures or equivalent procedures developed by the Permittee or vendor, and the catalytic control system has not been damaged, then the Permittee shall correct the problem within 24 hours of inspecting the catalytic control system.

(iii) If the pressure drop across the catalyst bed cannot be corrected using the catalytic control system manufacturer and/or vendor recommended procedures or equivalent procedures developed by the Permittee or vendor, or the catalytic control system is damaged, then the Permittee shall do one of the following:

(A) Conduct a performance test within 90 calendar days, as specified in this permit, to ensure that the NO_X, CO, VOC, and CH_2O emission limits are being met and to re-establish the pressure drop across the catalyst bed. The Permittee shall measure CO and NO_X emissions using a portable analyzer and a monitoring protocol approved by the EPA to establish a new temporary pressure drop baseline until a performance test can be scheduled and completed; or

(B) Cease operating the affected engine immediately. The engine shall not be returned to routine service until the pressure drop is measured and found to be within the acceptable pressure range for that engine as determined from the most recent performance test. Corrective action may include removal and cleaning of the catalyst or replacement of the catalyst.

(f) The Permittee shall measure NO_X and CO emissions from each engine at least quarterly to demonstrate compliance with each engine's emission limits in this permit. To meet this requirement, the Permittee shall:

(i) Measure NO_X and CO emissions at the normal operating load using a portable analyzer and a monitoring protocol approved by the EPA or conduct a performance test as specified in this permit;
(ii) Measure the NO_X and CO emissions simultaneously; and
(iii) Commence monitoring for NO_X and CO emissions within 6 months of the Permittee's submittal of the initial performance test results for NO_X and CO emissions to the EPA.

(g) The Permittee shall not perform engine tuning or make any adjustments to engine settings, catalytic control system settings, or processes or operational parameters on the day of or during measurements. Any such tuning or adjustments may result in a determination by the EPA that the result is invalid. Artificially increasing an engine load to meet the testing requirements is not considered engine tuning or adjustments.

(h) For any one (1) engine: If the results of 2 consecutive quarterly portable analyzer measurements demonstrate compliance with the NO_X and CO emission limits, the required monitoring frequency may change from quarterly to semi-annually.

(i) For any one (1) engine: If the results of any subsequent portable analyzer measurements demonstrate non-compliance with the NO_X or CO emission limits, required monitoring frequency shall change from semi-annually to quarterly.

(j) The Permittee shall submit portable analyzer specifications and monitoring protocols for NO_X and CO to the EPA at the following address for approval at least 45 calendar days prior to the date of initial portable analyzer monitoring:

U.S. Environmental Protection Agency, Region 8
Office of Enforcement, Compliance & Environmental Justice
Air Toxics and Technical Enforcement Program, 8ENF-AT
1595 Wynkoop Street
Denver, Colorado 80202

(k) Portable analyzer specifications and monitoring protocols that have already been approved by the EPA for the emission units approved in this permit may be used in lieu of new protocols unless the EPA requires the submittal and approval of a new protocol. The Permittee may submit a new protocol for EPA approval at any time.

(l) The Permittee is not required to conduct emissions monitoring of NO_X, CO, VOC, and CH_2O emissions, and parametric monitoring of exhaust temperature and catalyst differential pressure on engines that have not operated during the monitoring period. The Permittee shall certify that the engine(s) did not operate during the monitoring period in the annual report specified in this permit.

5. Recordkeeping Requirements

(a) Records shall be kept of manufacturer and/or vendor specifications or equivalent specifications developed by the Permittee or vendor, and maintenance requirements for each engine, AFR controller, NSCR control system, temperature sensing device, and pressure measuring device.

(b) Records shall be kept of all calibration and maintenance conducted for each engine, AFR controller, NSCR control system, temperature sensing device, and pressure measuring device.

(c) Records shall be kept of all temperature measurements required in this permit, as well as a description of any corrective actions taken pursuant to this permit.

(d) Records shall be kept of all pressure drop measurements required in this permit, as well as a description of any corrective actions taken pursuant to this permit.

(e) Records shall be kept of all required testing and monitoring in this permit. The records shall include the following:

(i) The date, place, and time of sampling or measurements;
(ii) The date(s) analyses were performed;
(iii) The company or entity that performed the analyses;
(iv) The analytical techniques or methods used;
(v) The results of such analyses or measurements; and
(vi) The operating conditions as existing at the time of sampling or measurement.

(f) Records shall be kept of all AFR controller, oxygen sensor, and NSCR control system replacements or repairs, engine rebuilds and engine replacements.

(g) Records shall be kept of each rebuilt or replaced engine break-in period, pursuant to the requirements of this permit, where an existing engine that has been rebuilt or replaced resumes operation without the catalyst control system, for a period not to exceed 200 operating hours.

(h) Records shall be kept of each time any engine is shut-down due to a deviation of the inlet temperature to the catalyst bed or pressure drop across the catalyst bed. The Permittee shall include in the record the cause of the problem, the corrective action taken, and the timeframe for bringing the pressure drop and inlet temperature range into compliance.

G. Requirements for Tanks

1. All crude oil and natural gas condensate tanks and produced water storage tanks are subject to the requirements of this permit.

2. The Permittee shall follow, for each tank, the manufacturer's recommended maintenance schedule and procedures or equivalent procedures developed by the Permittee or vendor to ensure good air pollution control practices for minimizing emissions.

3. The Permittee shall install, maintain and operate each tank such that all the emission limits in this permit will be met.

4. The Permittee shall ensure that the produced water storage tank is an enclosed tank.

5. The Permittee shall limit the crude oil and natural gas condensate tank emissions using one or more of the following techniques:

   (a) Route all working, breathing, and flashing losses through a closed-vent system to an operating system designed to recover and inject the emissions into a natural gas gathering pipeline system for sale or other beneficial purpose; and/or

   (b) Route all working, breathing, and flashing losses through a closed-vent system to a control device as specified in the **Requirements for Control Systems for Hydrocarbon Emissions** section of this permit.

6. Covers: The Permittee shall equip all openings on each crude oil and natural gas condensate tank with a cover to ensure that all hydrocarbon emissions are efficiently being routed through a closed-vent system to a natural gas pipeline system for sale or other beneficial purpose and/or a control device as specified in the **Requirements for Control Systems for Hydrocarbon Emissions** section of this permit.

   (a) The Permittee shall ensure that each cover and all openings on the cover (e.g., access hatches, sampling ports, pressure relief valves, and gauge wells) form a continuous impermeable barrier over the entire surface area of the tanks.

   (b) Each cover opening shall be secured in a closed, sealed position (e.g., covered by a gasketed lid or cap) whenever material is in a tank on which the cover is installed except during those times when it is necessary to use an opening as follows:

      (i) To add material to, or remove material from the tank (this includes openings necessary to equalize or balance the internal pressure of the tank following changes in the level of the material in the tank);
      (ii) To inspect or sample the material in the tank; or
      (iii) To inspect, maintain, repair, or replace equipment located inside the tank.

   (c) Each thief hatch cover shall be weighted and properly seated.

   (d) Pressure relief valves shall be set to release at a pressure that will ensure that all hydrocarbon emissions are routed through the closed-vent system to a natural gas pipeline system for sale or other beneficial purpose and/or a control device as specified in the **Requirements for Control Systems for Hydrocarbon Emissions** section of this permit under normal operating conditions.

7. Monitoring Requirements

   (a) The Permittee shall perform quarterly visual inspections of the crude oil and natural gas condensate tank covers, thief hatches, seals, pressure relief valves, and closed vent systems to ensure proper condition and functioning and repair any damaged equipment. The quarterly inspections shall be performed while the tanks are being filled.

(b) The Permittee shall perform quarterly visual inspections of the peak pressure and vacuum values in each closed vent system and control device of each crude oil and natural gas condensate storage tank as specified in the **Requirements for Control Systems for Hydrocarbon Emissions** section of this permit to ensure that the pressure and vacuum relief set-points are not being exceeded in a way that has resulted, or may result, in venting and possible damage to equipment. The quarterly inspections shall be performed while the tanks are being filled.

(c) The Permittee shall calculate the VOC and HAP emissions from each tank. The VOC and HAP emissions at the station shall be determined using the measured monthly volume of produced water and crude oil and natural gas condensate routed to the tanks, the most recent extended laboratory analysis of the produced water and crude oil and natural gas condensate entering the station, E&P Tanks V2.0 and/or EPA Tanks 4.0.9d, as appropriate, and the most recent tested control efficiency of the control device being used. Other measurement methods may be used upon approval by the EPA.

8. Record Keeping Requirements

(a) The Permittee shall maintain a record of the monitored volume of working, breathing, and flashing losses from each tank.

(b) The Permittee shall maintain a record of all quarterly inspections. All inspection records shall include, at a minimum, the following information:

(i) The date of the inspection;
(ii) The findings of the inspection;
(iii) Any required repairs; and
(iv) The inspector's name and signature.

(c) The Permittee shall maintain records of the date of installation of each tank, the manufacturer's recommended maintenance schedule and procedures or equivalent procedures developed by the Permittee or vendor and all scheduled maintenance and repairs.

(d) The Permittee shall maintain records of the VOC and HAP emission calculations for each tank.

H. Requirements for Control Systems for Hydrocarbon Emissions

1. Closed-Vent Systems: The Permittee shall meet the following requirements for closed-vent systems:

(a) Each closed-vent system shall route all hydrocarbon emissions from the crude oil and natural gas condensate tanks to a natural gas pipeline system for sale or other beneficial purpose and/or a control device as specified in this section of the permit.

(b) All vent lines, connections, fittings, valves, pressure relief valves, or any other appurtenance employed to contain and collect hydrocarbon emissions to transport them to a natural gas pipeline system for sale or other beneficial purpose and/or a control device as specified in this section of the permit shall be maintained and operated properly at all times.

(c) Each closed-vent system shall be designed to operate with no detectable hydrocarbon emissions, as required in the **Requirements for Equipment Leaks from Closed-Vent Systems** section of this permit.

(d) If any closed-vent system contains one or more bypass devices that could be used to divert all or a portion of the hydrocarbon emissions, from entering a natural gas pipeline system for sale or other beneficial purpose and/or a control device as specified in this section of the permit, the Permittee shall meet one of following requirements for each bypass device:

(i) At the inlet to the bypass device that could divert the hydrocarbon emissions away from a natural gas pipeline or a control device and into the atmosphere, properly install, calibrate, maintain, and operate a flow indicator that is capable of taking continuous readings and sounding an alarm when the bypass device is open such that hydrocarbon emissions are being, or could be, diverted away from a natural gas pipeline or a control device and into the atmosphere; or

(ii) Secure the bypass device valve installed at the inlet in the non-diverting position using a car-seal or a lock-and-key type configuration.

(e) Low leg drains, high point bleeds, analyzer vents, open-ended valves or lines, and safety devices are not subject to the requirements applicable to bypass devices.

2. Enclosed Combustors and Utility Flares: The Permittee shall meet the following requirements for enclosed combustors and utility flares:

(a) Follow, for each enclosed combustor or utility flare, manufacturer and/or vendor written operating instructions, procedures and maintenance schedules or equivalent operating instructions, procedures, and maintenance schedules developed by the Permittee or vendor to ensure good air pollution control practices for minimizing emissions;

(b) Ensure, for each enclosed combustor or utility flare, that there is sufficient capacity to reduce the mass content of VOCs in the hydrocarbon emissions routed to it by at least 95% for the minimum and maximum volumetric flow rate and BTU content routed to the device;

(c) Operate each enclosed combustor or utility flare such that the mass content of VOCs in the hydrocarbon gas emissions routed to it are reduced by at least 95%; and

(d) Ensure that each utility flare is designed and operated in accordance with requirements of the General Provisions for the New Source Performance Standards (NSPS A) at §60.18(b), for such flares except for §§60.18(c)(2) and 60.18(f)(2) for those utility flares operated with an auto ignition system.

(e) The Permittee shall ensure that each enclosed combustor is:

(i) A model demonstrated by a manufacturer to the meet the 95% VOC destruction efficiency requirements of the New Source Performance Standards for Crude Oil and Natural Gas Production, Transmission and Distribution at 40 CFR Part 60, Subpart OOOO (NSPS OOOO), using the procedure specified in §60.5413(d), by the due date of the first annual report; or
(ii) Demonstrated to meet the 95% VOC destruction efficiency requirements of NSPS OOOO using EPA approved performance test methods specified in §60.5413(b).

(f) The Permittee shall ensure that each enclosed combustor and utility flare is:

(i) Operated properly at all times that natural gas is routed to it;

(ii) Operated with a liquid knock-out system to collect any condensable vapors (to prevent liquids from going through the control device);

(iii) Equipped with a flash-back flame arrestor;

(iv) Equipped with one of the following:

(A) A continuous burning pilot flame, a thermocouple, and a malfunction alarm and notification system if the pilot flame fails; or
(B) An electronically controlled auto-ignition system with a malfunction alarm and notification system if the flame fails while hydrocarbon gas emissions are flowing to the enclosed combustor or utility flare.

(v) Equipped with a continuous recording device, such as a chart recorder, data logger or similar device, or connected to a SCADA system, to monitor and document proper operation of the enclosed combustor or utility flare;

(vi) Maintained in a leak-free condition; and

(vii) Operated with no visible smoke emissions.

3. Other Control Devices: Upon written approval by the EPA, the Permittee may use control devices other than those listed above that are capable of reducing the mass content of VOCs in the hydrocarbon gas routed to it by at least 95%, provided that:

(a) In operating such control devices, the Permittee shall follow the manufacturer's written operating instructions, procedures and maintenance schedules or equivalent operating instructions, procedures, and maintenance schedules developed by the Permittee or vendor to ensure good air pollution control practices for minimizing emissions;

(b) The Permittee shall ensure there is sufficient capacity to reduce the mass content of VOCs in the hydrocarbon gas emissions routed to such other control devices by at least 95% for the minimum and maximum natural gas volumetric flow rate and BTU content routed to each device; and

(c) The Permittee shall operate such a control device to reduce the mass content of VOCs in the produced natural gas and natural gas emissions routed to it by at least 95%.

4. Testing Requirements:

Within 180 days after initial startup at each station, and every 5 years thereafter, the Permittee shall conduct a performance test of the closed-vent system to demonstrate that it is operating in a leak free condition, and a performance test of the control device to which hydrocarbon emissions are routed, to demonstrate 95% destruction efficiency.

(a) Testing of the closed vent system shall be conducted in accordance with EPA Reference Method 21, listed in 40 CFR Part 60, Appendix A.

(b) Testing of the enclosed combustor VOC destruction efficiency shall be conducted in accordance with EPA Reference Method 25A, listed in 40 CFR Part 60, Appendix A.

(c) A 95% VOC destruction efficiency can be assumed for utility flares provide they are designed and operated in accordance with §60.18(b) of NSPS A.

(d) The Permittee may submit a written request to the EPA for an alternate testing method, but shall only use that test method upon receipt of written approval by the EPA.

5. Monitoring Requirements:

(a) The Permittee shall monitor the operation of each enclosed combustor and utility flare to confirm proper operation as follows:

(i) Continuously monitor the enclosed combustor and utility flare operation, using a malfunction alarm and notification system for failures, and checking the alarm and notification system for proper operation whenever an operator is on site, at a minimum quarterly;

(ii) Monitor for visible smoke during operation of any enclosed combustor or utility flare each time an operator is on site, at a minimum quarterly. Upon observation of visible smoke, use EPA Reference Method 22 of 40 CFR Part 60, Appendix A, to confirm that no visible smoke emissions are present. The observation period shall be 1 hour. Visible smoke emissions are present if smoke is observed emitting from the enclosed combustor or utility flare for more than 2 minutes in any 1 hour; and

(iii) Respond to any observation of improper monitoring equipment operation or any malfunction and notification alarm system to ensure the monitoring equipment is returned to proper operation as soon as practicable and safely possible after an observation or an alarm sounds.

(b) Where sufficient to meet the monitoring requirements the Permittee may use a SCADA system to monitor and record the required data.

(c) The Permittee shall calculate VOC, NO_X, CO and HAP emissions from each enclosed combustor and utility flare using the following:

(i) The monitored volume of standing, working, breathing, and flashing gases from the produced water storage tank and crude oil and natural gas condensate tanks, as required in the **Requirements for Tanks** section of this permit;

(ii) The most recent extended laboratory analysis of the produced water and crude oil and natural gas condensate received at each station;

(iii) The most recent performance test results of the closed-vent system and control device; and

(iv) The emission factors in AP-42 Chapter 1.4, Natural Gas Combustion.

6. Recordkeeping Requirements

The Permittee shall keep records of the following:

(a) The site-specific design input parameters provided by the manufacturer or vendor and used to properly size the control device to assure the minimum 95% reduction requirements;

(b) All required monitoring of the control device operations;

(c) Any deviations from the operating parameters specified in the manufacturer or vendor site-specific designs. The records shall include the control's total operating time during the calendar month in which the exceedance occurred, the date, time and length of time that the parameters were exceeded, and the corrective actions taken and any preventative measures adopted to operate the controls within that operating parameter;

(d) Any instances in which any closed-vent system or control device was bypassed or down in each calendar month, the reason for each incident, its duration, and the corrective actions taken and any preventative measures adopted to avoid such bypasses or downtimes;

(e) Any instances in which the pilot flame is not present in an enclosed combustor or the utility flare while hydrocarbon emissions are vented to it, the date and times that the pilot was not present and the corrective actions taken or any preventative measures adopted to improve the operation of the pilot flame;

(f) Any instances in which the thermocouple (or other heat sensing monitoring device) installed to detect the presence of a flame in an enclosed combustor or engineered flare while hydrocarbon emissions are vented to it is not operational, the time period during which it was not operational, and the corrective measures taken;

(g) Any instances in which the recording device installed to record data from the thermocouple is not operational;

(h) Any time periods in which visible emissions are observed emanating from a control system; and

(i) The VOC, NO_X, CO, and HAP emissions calculations included in the consecutive 12-month total for all units covered by this permit.

I. Requirements for Truck Loading Operations

1. The Permittee shall operate truck loading operations such that the emission limits in this permit are met.

2. The Permittee shall install, operate and maintain a piping system designed for submerged loading by either bottom loading or loading through a submerged fill pipe. The submerged fill pipe shall be no more than 12 inches from the bottom of the truck tank. The Permittee shall not conduct truck loading operations unless submerged loading is used.

3. Monitoring Requirements: VOC and HAP emissions from the truck loading operations for each calendar month shall be calculated by the Permittee using the following:

   (a) The total measured volume of produced water and crude oil and natural gas condensate, in barrels, loaded for the month;

   (b) The actual physical and chemical properties of the produced water and crude oil and natural gas condensate and its associated vapors from the most recent semiannual extended laboratory analysis of the produced water and crude oil and natural gas condensate received at the station; and

   (c) The procedures outlined in AP-42 Chapter 5.2, Transportation and Marketing of Petroleum Liquids for the actual method of truck loading for VOC, and HAP emissions.

4. Recordkeeping Requirements

   (a) Records shall be kept by the Permittee of the manufacturer and/or vendor specifications or equivalent specifications developed by the Permittee or vendor, and all scheduled maintenance and repairs on the truck loading equipment.

   (b) Records shall be kept of the VOC and HAP emissions calculations included in the consecutive 12-month total for all units covered by this permit.

J. Requirements for Pneumatic Pumps, Pneumatic Controllers, Compressor Blowdowns

1. Pneumatic Pumps and Controllers

   (a) The Permittee shall install, maintain, and operate any pneumatic pumps and controllers such that the consecutive 12-month emission limit requirements in this permit will be met. This shall be achieved by meeting one or more of the following emission control techniques:

      (i) Operate air actuated controllers and pneumatic pumps;
      (ii) Operate solar or electric actuated controllers and pneumatic pumps;
      (iii) Operate low-bleed with natural gas controllers (6 standard cubic feet per hour);
      (iv) Operate no-bleed with natural gas controllers;
      (v) Route the emissions discharge streams to an operating system designed to recover and inject the emissions into a natural gas gathering pipeline system for sale or other beneficial purpose, such as fuel supply; and/or

(vi) Route the discharge stream to a control device as specified in the **Requirements for Control Systems for Hydrocarbon Emissions** section of this permit.

(b) Each pneumatic pump and controller shall be operated and maintained according to the manufacturer or vendor specifications or equivalent specifications developed by the Permittee or vendor.

(c) Records shall be kept of the date of installation of each pneumatic pump and controller.

(d) Records shall be kept of a description of the steps taken to minimize the emissions, and a description of emission estimation methods used to calculate VOC and HAP emissions.

(e) Emissions from pneumatic pumps and controllers shall be included in the entire gathering and transmission operation's consecutive 12-month total.

2. Compressor Blowdowns

(a) During manual and automated blow down episodes associated with maintenance or repair, hydrate clearing, emergency operations, equipment depressurization, etc., the Permittee shall limit emissions such that the emission limits in this permit are met.

(b) The Permittee's personnel shall remain on site during manual blow downs.

(c) The Permittee shall keep a record of each compressor blowdown, reasons for each episode, the duration of each episode, the volume of gas released during the episode, the steps taken to minimize the emissions, and a description of emission estimation methods used to calculate the VOC and HAP emissions.

(d) Compressor blowdown emissions shall be included in the consecutive 12-month total of all units covered by this permit.

K. Requirements for Equipment Leaks from Closed-Vent Systems

1. The Permittee shall minimize leaks of hydrocarbon gases from each connector, valve, pump, flange, open ended line, or any other appurtenance employed to contain and collect vapors and transport them such that the emission limits in this permit are met.

2. The Permittee shall develop a written leak inspection and repair protocol that, at a minimum, specifies the following:

(a) A detailed description of the procedures to be used for leak detection, which may include audio, visual, and/or or olfactory techniques;

(b) A schedule of inspections to be conducted, at a minimum, semi-annually;

(c) A definition of when a "leak" is detected;

(d) A repair schedule for leaking equipment (including delay of repair); and

(e) A log book that contains a list, summary description, and diagram showing the location of all equipment in hydrocarbon service at the facility, and a record of type of inspections performed, the date of inspections, the results of the inspections, and the date of repairs performed on leaking equipment.

3. In the event that the EPA determines that the protocol on record is not meeting its intended goals, the Permittee shall develop a revised protocol upon request by the EPA.

4. Total emissions from equipment leaks shall be determined by assuming 8,760 hours of operation in a year and with maximum leakage of all components from equipment in hydrocarbon service.

L. Requirements for Minimizing Fugitive Dust

1. Work Practice and Operational Requirements

(a) The Permittee shall take all reasonable precautions to prevent fugitive dust emissions at each station and shall construct, maintain, and operate each station to minimize fugitive dust emissions. Reasonable precautions include, but are not limited to the following:

(i) Use, where possible, of water or chemicals for control of dust during construction and operations, grading of roads, or clearing of land;
(ii) Application of asphalt, water, or other suitable chemicals on unpaved roads, materials stockpiles, and other surfaces, located at the facilities, that can create airborne dust;
(iii) The prompt removal from paved surfaces, located at the station, of earth or other material that does or may become airborne; or
(iv) Restricting vehicle speeds.

(b) The Permittee shall prepare and implement a written fugitive dust emission prevention plan, approved by EPA, that specifies the reasonable precautions to be taken and the procedures to be followed to prevent fugitive dust emissions.

2. Monitoring Requirements

(a) The Permittee shall survey the station during construction and operation to determine if there are obvious visible dust plumes. This survey must be done at a minimum once per week in all active areas and during daylight hours.

(b) The Permittee shall document the results of the survey, including the date and time of the survey, identification of the cause of any visible dust plumes observed, and the precautions taken to prevent continued fugitive dust emissions.

3. Recordkeeping Requirements

The Permittee shall maintain records for 5 years that document the fugitive dust prevention plan, the periodic surveys and the reasonable precautions that were taken to prevent fugitive dust emissions.

M. Requirements for Records Retention

1. The Permittee shall retain all records required by this permit for a period of at least 5 years from the date the record was created.

2. Records shall be kept in the vicinity of the facility, such as at the facility, the location that has day-to-day operational control over the facility, or the location that has day-to-day responsibility for compliance of the facility.

N. Requirements for Reporting

1. Annual Emission Reports

   (a) The Permittee shall submit a written annual report of the actual annual emissions from all emission units at the facility covered under this permit, including emissions from start-ups, shutdowns, and malfunctions, each year no later than April 1st. The annual report shall cover the period for the previous calendar year. All reports shall be certified to truth and accuracy by the person primarily responsible for Clean Air Act compliance for the Permittee.

   (b) The report shall include facility-wide emission of NO_X, CO, VOC, each individual HAP and total HAP emissions.

   (c) The report shall be submitted to:

   U.S. Environmental Protection Agency, Region 8
   Office of Partnerships and Regulatory Assistance
   Tribal Air Permitting Program, 8P-AR
   1595 Wynkoop Street
   Denver, Colorado 80202

   The report may be submitted via electronic mail to r8AirPermitting@epa.gov.

2. All other documents required to be submitted under this permit, with the exception of the Annual Emission Reports, shall be submitted to:

   U.S. Environmental Protection Agency, Region 8
   Office of Enforcement, Compliance & Environmental Justice
   Air Toxics and Technical Enforcement Program, 8ENF-AT
   1595 Wynkoop Street
   Denver, Colorado 80202

   All documents may be submitted electronically to r8airreportenforcement@epa.gov.

3. The Permittee shall promptly submit to the EPA a written report of any deviations of permit requirements and a description of the probable cause of such deviations and any corrective actions or preventative measures taken. A "prompt" deviation report is one that is post marked or submitted via electronic mail to r8airreportenforcement@epa.gov as follows:

(a) Within 30 days from the discovery of any deviation of the emission or operational limits that is left un-corrected for more than 5 days after discovering the deviation; and

(b) By April 1st for the discovery of a deviation of recordkeeping or other permit conditions during the preceding calendar year that do not affect the Permittee's ability to meet the emission limits.

4. The Permittee shall submit a written report for any required performance tests to the EPA Regional Office within 60 days after completing the tests.

5. The Permittee shall submit any record or report required by this permit upon EPA request.

II. General Provisions

A. Conditional Approval

Pursuant to the authority of 40 CFR 49.151, the EPA hereby conditionally grants this permit to construct. This authorization is expressly conditioned as follows:

1. *Document Retention and Availability:* This permit and any required attachments shall be retained and made available for inspection upon request at the location set forth herein.

2. *Permit Application:* The Permittee shall abide by all representations, statements of intent and agreements contained in the application submitted by the Permittee. The EPA shall be notified 10 days in advance of any significant deviation from the permit application as well as any plans, specifications or supporting data furnished.

3. *Permit Deviations:* The issuance of this permit may be suspended or revoked if the EPA determines that a significant deviation from the permit application, specifications, and supporting data furnished has been or is to be made. If the proposed source is constructed, operated, or modified not in accordance with the terms of this permit, the Permittee will be subject to appropriate enforcement action.

4. *Compliance with Permit:* The Permittee shall comply with all conditions of this permit, including emission limitations that apply to the affected emissions units at the permitted facility/source. Noncompliance with any permit term or condition is a violation of this permit and may constitute a violation of the Clean Air Act and is grounds for enforcement action and for a permit termination or revocation.

5. *Fugitive Emissions:* The Permittee shall take all reasonable precautions to prevent and/or minimize fugitive emissions during the construction period.

6. *National Ambient Air Quality Standard and PSD Increment:* The permitted source shall not cause or contribute to a National Ambient Air Quality Standard violation or a PSD increment violation.

7. *Compliance with Federal and Tribal Rules, Regulations, and Orders:* Issuance of this permit does not relieve the Permittee of the responsibility to comply fully with all other applicable federal and tribal rules, regulations, and orders now or hereafter in effect.

8. *Enforcement:* It is not a defense, for the Permittee, in an enforcement action, to claim that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

9. *Facility/Source Modifications:* For proposed modifications, as defined at §49.152(d), that would increase an emissions unit allowable emissions of pollutants above its existing permitted annual allowable emissions limit, the Permittee shall first obtain a permit modification pursuant to the MNSR regulations approving the increase. For a proposed modification that is not otherwise subject to review under the PSD or MNSR regulations, such proposed increase in the annual allowable emissions limit shall be approved through an administrative permit revision as provided at §49.159(f).

10. *Relaxation of Legally and Practically Enforceable Limits:* At such time that a new or modified source within the permitted facility/source or modification of this permitted facility/source becomes a major stationary source or major modification solely by virtue of a relaxation in any legally and practically enforceable limitation which was established after August 7, 1980, on the capacity of this permitted facility/source to otherwise emit a pollutant, such as a restriction on hours of operation, then the requirements of the PSD regulations shall apply to the source or modification as though construction had not yet commenced on the source or modification.

11. *Revise, Reopen, Revoke and Reissue, or Terminate for Cause:* This permit may be revised, reopened, revoked and reissued, or terminated for cause. The filing of a request by the Permittee, for a permit revision, revocation and reissuance, or termination, or of a notification of planned changes or anticipated noncompliance does not stay any permit condition. The EPA may reopen a permit for a cause on its own initiative, e.g., if this permit contains a material mistake or the Permittee fails to assure compliance with the applicable requirements.

12. *Severability Clause:* The provisions of this permit are severable, and in the event of any challenge to any portion of this permit, or if any portion is held invalid, the remaining permit conditions shall remain valid and in force.

13. *Property Rights:* This permit does not convey any property rights of any sort or any exclusive privilege.

14. *Information Requests:* The Permittee shall furnish to the EPA, within a reasonable time, any information that the EPA may request in writing to determine whether cause exists for revising, revoking and reissuing, or terminating this permit or to determine compliance with this permit. For any such information claimed to be confidential, you shall also submit a claim of confidentiality in accordance with 40 CFR Part 2, Subpart B.

15. *Inspection and Entry:* The EPA or its authorized representatives may inspect this permitted facility/source during normal business hours for the purpose of ascertaining compliance with all conditions of this permit. Upon presentation of proper credentials, the Permittee shall allow the EPA or its authorized representative to:

    (a) Enter upon the premises where a permitted facility/source is located or emissions-related activity is conducted, or where records are required to be kept under the conditions of this permit;

(b) Have access to and copy, at reasonable times, any records that are required to be kept under the conditions of this permit;

(c) Inspect, during normal business hours or while the permitted facility/source is in operation, any facilities, equipment (including monitoring and air pollution control equipment), practices, or operations regulated or required under this permit;

(d) Sample or monitor, at reasonable times, substances or parameters for the purpose of assuring compliance with this permit or other applicable requirements; and

(e) Record any inspection by use of written, electronic, magnetic and photographic media.

16. *Permit Effective Date:* This permit is effective immediately upon issuance unless comments resulted in a change in the proposed permit, in which case this permit is effective 30 days after issuance. The Permittee may notify the EPA, in writing, that this permit or a term or condition of it is rejected. Such notice should be made within 30 days of receipt of this permit and should include the reason or reasons for rejection.

17. *Permit Transfers:* Permit transfers shall be made in accordance with 40 CFR 49.159(f). The Air Program Director shall be notified in writing at the address shown below if the company is sold or changes its name.

    U.S. Environmental Protection Agency, Region 8
    Office of Partnerships and Regulatory Assistance
    Tribal Air Permitting Program, 8P-AR
    1595 Wynkoop Street
    Denver, Colorado 80202

18. *Invalidation of Permit:* This permit becomes invalid if construction is not commenced within 18 months after the effective date of the permit, construction is discontinued for 18 months or more, or construction is not completed within a reasonable time. The EPA may extend the 18-month period upon a satisfactory showing that an extension is justified. This provision does not apply to the time period between the construction of the approved phases of a phased construction project. The Permittee shall commence construction of each such phase within 18 months of the projected and approved commencement date.

19. *Notification of Start-Up*: The Permittee shall submit a notification of the anticipated date of initial start-up of the permitted source to the EPA within 60 days of such date, unless the source permitted under this action is an existing source.

B. Authorization

Authorized by the United States Environmental Protection Agency, Region 8

____

Debra H. Thomas Date
Acting Assistant Regional Administrator
Office of Partnerships and Regulatory Assistance

Synthetic Minor Source Pre-Construction Approval Permit Application for the Arrow Pipeline, LLC, Fort Berthold Compressor Project Station 7

Prepared for

Arrow Pipeline, LLC

Prepared by

SWCA Environmental Consultants

May 2013

SYNTHETIC MINOR SOURCE PRE-CONSTRUCTION APPROVAL PERMIT APPLICATION FOR THE ARROW PIPELINE, LLC, FORT BERTHOLD COMPRESSOR PROJECT STATION 7

Prepared for

Arrow Pipeline, LLC
10702 Highway 73
Keene, North Dakota 58847

Prepared by

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SWCA Project No. 16599.26

May 2013

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1.0 INTRODUCTION

Arrow Pipeline, LLC (Arrow), is submitting this Application for New Construction and Application for Synthetic Minor Limit for approval to construct a synthetic minor source with respect to New Source Review (NSR) to the U.S. Environmental Protection Agency (EPA). Arrow is seeking a classification of this project as a synthetic minor source and has proposed emission limits to avoid Prevention of Significant Deterioration (PSD) permitting requirements. Arrow proposes to construct a pipeline station, referred to as Arrow Pipeline Station #7. The proposed Arrow facility is located within the boundaries of the Fort Berthold Indian Reservation in Dunn County, North Dakota.

Natural gas and oil wells in the Bakken formation in North Dakota feed the gas produced from these wells into a pipeline system before entering the facility. The project facility will then boost the natural gas to continue transporting the gas down the pipeline. The produced natural gas will then be conveyed to a Central Distribution Point (CDP) located off the Fort Berthold Reservation.

Project construction is anticipated to commence in 2014, with operation expected to follow within the same year. The proposed project emissions and throughput have been calculated using the maximum designed capacity of the proposed equipment.

The EPA designates the Fort Berthold Indian Reservation as being in attainment or unclassified with respect to the National Ambient Air Quality Standards (NAAQS) for ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter less than 10 microns in diameter (PM_{10}), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), and lead (Pb).

The following list provides the individual section summary of the application:

- Section 2.0 of this application provides general project information, which includes a brief project description, the proposed location, and an overview of the air pollutant emitting activities.
- Section 3.0 provides a detailed description of the operations and a discussion of the emission sources located at this proposed project.
- Section 4.0 provides a discussion of the methodology used for the emission calculations and a description of the emission sources and control devices proposed.
- Section 5.0 of this application includes a discussion of applicable and potentially applicable federal regulations.
- Section 6.0 provides the proposed monitoring and record-keeping requirements.
- Section 7.0 provides a discussion of the surrounding air quality and a discussion of the AERSCREEN modeling analysis conducted for the proposed project.
- Sections 8.0 and 9.0 provide discussions of the impact of the project with regard to the federal Endangered Species Act (ESA) and the National Historic Preservation Act.
- Appendix A provides the required EPA application forms for this permit application. Appendix B provides emission calculations. Appendix C contains equipment specifications for various units at the project. Appendix D includes a Process Flow Diagram of the station. Appendix E includes the AERSCREEN modeling inputs and a summary of outputs used for the air quality impact analysis for the proposed facility.

2.0 GENERAL PROJECT INFORMATION

The proposed station will primarily consist of natural gas compressors and ancillary equipment to continue the pipeline transport of gas from the production wells. The proposed station is not a natural gas processing facility and will not be engaged in processing natural gas. Arrow is submitting this application in order to obtain a permit to construct the station as a synthetic minor source. The project is classified under the Standard Industrial Classification (SIC) code of 4922 (natural gas transmission) and under the North American Industry Classification (NAIC) code of 486210 (pipeline transportation of natural gas).

The main uses for the surrounding area are agricultural and livestock grazing, interspersed with oil and natural gas production and transportation facilities. There are two proposed locations for Station 7, less than 1 mile from each other. Table 1 provides the locations, elevations, and acreages for both proposed locations. Figure 1 shows the proposed locations of the station.

Table 1. Proposed Locations for Station 7

County	Township	Range	Section	Quarter Section	Elevation (feet)	Acreage
Dunn	148 N	92 W	4	NE¼	2,300	6
Dunn	149 N	92 W	36	SE¼	2,250	6

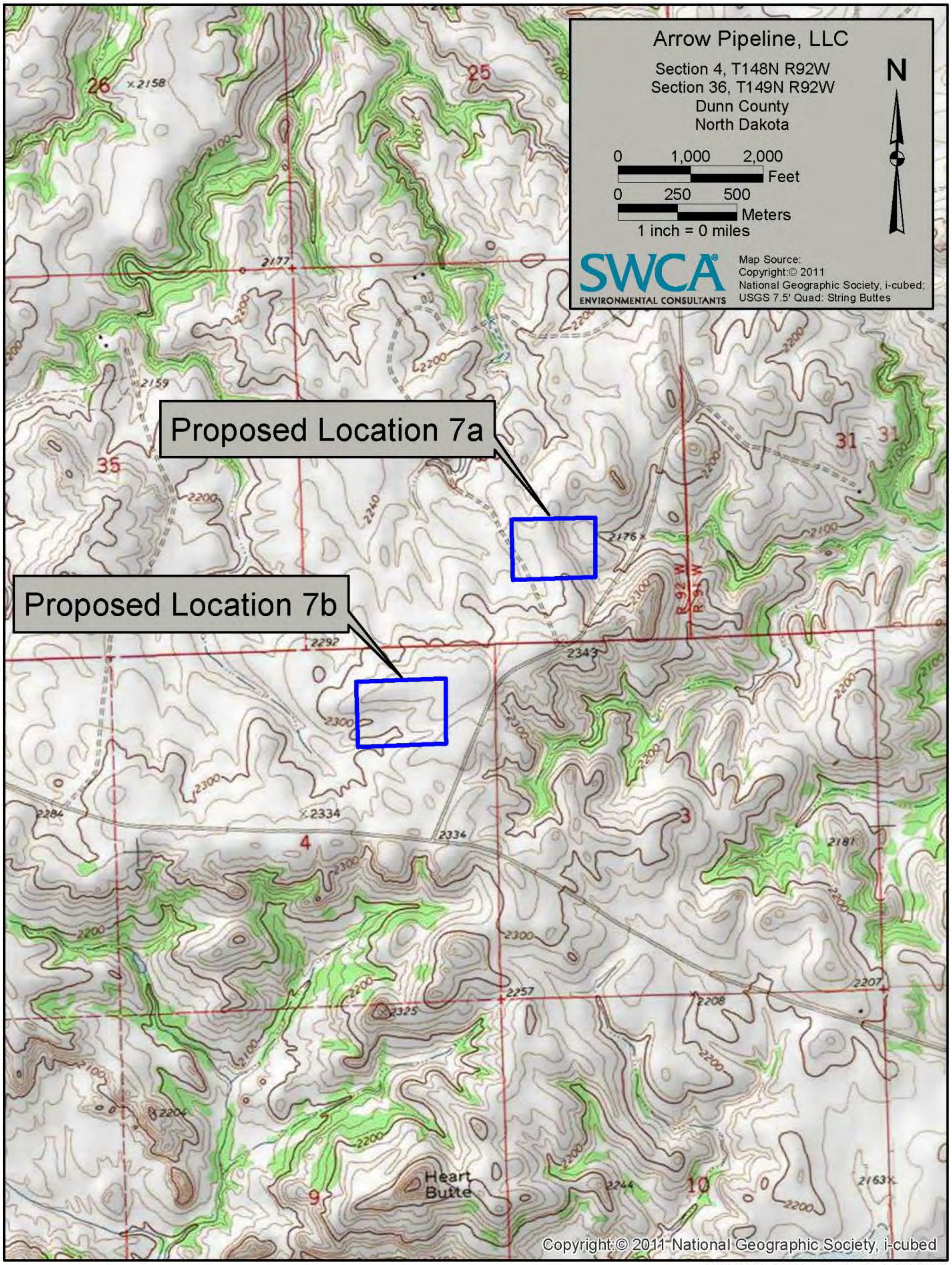
3.0 PROCESS DESCRIPTION

The primary function of the station is to transport natural gas via pipeline from the various production wells in the area to a CDP located off the Fort Berthold Indian Reservation.

After first entering the proposed station through a gas system receiver, the natural gas will be put through a slug catcher to “knock out” excess liquids. Further removal of liquids in the natural gas will be carried out by a filter separator, after which the gas will be routed to the individual compressor units for compression. The compressor units will each consist of an inlet filter separator, a compressor, a fin fan heat exchanger, and a natural gas–fired engine to power the compressor. Gas entering the individual compressor unit will first be passed through the filter separator to further remove liquids from the gas stream before compression, after which the gas will be compressed by the compressor. Compressed gas will then be routed to a splitter, with most of the gas routed to the gas pipeline exiting the station and the remainder routed to a fuel gas coalescer. Gas from the fuel gas coalescer will be routed to and combusted by individual compressor engines and/or natural gas–fired electrical generator engines designed to provide power to the station.

Condensate and water removed from the natural gas via the slug catch and/or filter separator(s) will be pumped to individual storage tanks. Truck load out rack(s) will be built to truck the water and condensate from the proposed station.

When completed, the station will consist of the following primary emission units and air pollutant emitting activities:



16599Station7Fig1.mxd - Revised: 4/18/2013

Figure 1. General location of the project area.

- three (3) natural gas-fired 4-stroke rich-burn engines, with a maximum horsepower rating of 1,480 each;
- one (1) natural gas-fired 4-stroke rich-burn engine, with a maximum horsepower rating of 740;
- one (1) natural gas-fired 4-stroke lean-burn engine, with a maximum horsepower rating of 530;
- one (1) natural gas-fired 4-stroke rich-burn engine, with a maximum horsepower rating of 435;
- one (1) natural gas-fired 4-stroke lean-burn engine, with a maximum horsepower rating of 400;
- one (1) natural gas-fired 4-stroke rich-burn engine, with a maximum horsepower rating of 326;
- two (2) condensate tanks (steel—400 barrels [bbl] [16,800 gallons] each);
- one (1) water tank (steel—400 bbl [16,800 gallons]);
- truck loading emissions vented to the atmosphere; and
- fugitive emissions from pipeline valves and fittings.

Arrow proposes to use the following control equipment to limit emissions from the above equipment where required:

- non-selective catalytic reduction (NSCR) on all of the natural gas—fired 4-stroke rich-burn engines (the 530-hp and the 400-hp lean-burn engines are uncontrolled as they were manufactured in 2006 and are not subject to 40 CFR part 60 subpart JJJJ, as discussed in Section 4.0 below) as control equipment to limit emissions where required; and
- thermal oxidizer or other equivalent control device for the condensate tanks.

Ancillary equipment associated with the project includes the following:

- electric drive compression and pumping engine(s);
- gas receiver(s);
- fuel gas coalescer(s);
- slug catcher(s) and filter separator(s); and
- pig launcher(s) and receiver(s).

For the purposes of this permit application, it was assumed that each station will operate 8,760 hours per year. Arrow is seeking a classification of this project as a synthetic minor source and has proposed emission limits to avoid PSD permitting requirements. The emission limits will result in the potential to emit (PTE) of less than 250 tpy of criteria pollutants, less than 10 tpy of any individual HAP, and less than 25 tpy of total HAPs. Greenhouse gas (GHG) emissions are calculated to be below the PSD permitting threshold of 100,000 tpy; therefore, no emission limits for GHG emissions are being sought in this application.

4.0 PROJECT EMISSIONS

Engine combustion emissions have been calculated based on the assumption that all the engines are operating 8,760 hours per year. Thus, the proposed allowable emission estimates presented herein are conservative, compared with the project's actual emissions during any given average 12-month rolling period.

Emission sources located at the project include both point and fugitive types (Table 2). The emission sources listed in Table 2 are described in further detail in the sections below. Potential uncontrolled and controlled emissions (i.e., taking into account the maximum capacity of the equipment, proposed operational limits, and proposed emission control equipment) were estimated using equipment manufacturers' data and EPA AP-42 emission factors,[1] where appropriate.

Table 2. Project Emission Sources

Source ID	Source Description	Quantity	Make	Model	Date of Manufacture	Maximum Rating
TBD	Natural gas-fired 4-stroke rich-burn engine	3	TBD	TBD	TBD	1,480 bhp
TBD	Natural gas-fired 4-stroke rich-burn engine	1	TBD	TBD	TBD	740 bhp
TBD	Natural gas–fired 4-stroke lean-burn engine	1	TBD	TBD	2006	530 bhp
TBD	Natural gas-fired 4-stroke rich-burn engine	1	TBD	TBD	TBD	435 bhp
TBD	Natural gas-fired 4-stroke lean-burn engine	1	TBD	TBD	2006	400 bhp
TBD	Natural gas-fired 4-stroke rich-burn engine	1	TBD	TBD	TBD	326 bhp
TBD	Condensate tank	2	TBD	TBD	TBD	400 bbl
TBD	Water storage tank	1	TBD	TBD	TBD	400 bbl
TBD	Tank Battery Control Device (e.g., Thermal Oxidizer, Flare, or equivalent)	1	TBD	TBD	TBD	TBD

Reciprocating Internal Combustion Engines

Appendix B presents the proposed uncontrolled PTE calculations for:

- one natural gas-fired 4-stroke lean-burn engine, with a maximum horsepower rating of 530;
- one natural gas-fired 4-stroke lean-burn engine, with a maximum horsepower rating of 400;
- three natural gas-fired 4-stroke rich-burn engines, with a maximum horsepower rating of 1,480 each;
- one natural gas-fired 4-stroke rich-burn engine, with a maximum horsepower rating of 740;
- one natural gas-fired 4-stroke rich-burn engine, with a maximum horsepower rating of 435; and
- one natural gas-fired 4-stroke rich-burn engine, with a maximum horsepower rating of 326.

The vendor-supplied Gas Engine Site Specific Technical Data sheets are included in Appendix C. Natural gas combustion emissions are generated by the natural gas–fired reciprocating internal combustion engines (RICEs) turning the compressors, pumps, and electrical generators. Emissions have been calculated using emission factors obtained from vendor-supplied equipment specification sheets. This vendor-supplied emissions data is considered representative of the emissions of the different power output categories of engines discussed above. Controlled emissions from the actual engines chosen will meet or

[1] U.S. Environmental Protection Agency. 2000. Section 3.2 – Natural Gas-Fired Reciprocating Engines; Chapter 3: Stationary Internal Combustion Sources. In *Compilation of Air Pollutant Emission Factors.* AP-42. August 2000.

exceed the emission thresholds for these representative engines. Where vendor data were not available, emission factors from AP-42 for natural gas–fired reciprocating engines were used.

Emissions of oxides of nitrogen (NO_x), CO, formaldehyde (HCHO), and volatile organic compounds (VOCs) from all engines except one will be controlled using catalytic silencers. Emissions from the lean-burn engines will not be controlled as emissions meet the regulatory threshold without additional controls, as discussed in Section 5.0. GHG emissions are calculated using emission factors provided from 40 CFR 98 Subpart C, Tables C-1 and C-2, for the combustion of natural gas.

A conservative estimate of the uncontrolled potential SO_2 emissions, using an emission factor based on the short-term (hourly) SO_2 emissions for natural gas (20 grains sulfur per 100 standard cubic feet of natural gas [gr S/100 scf NG]), of 0.057 pound per million British thermal units (lb/mmBtu) was used for all engines (40 CFR 72.2).

Potential emissions are calculated based on the assumption that the engines will operate 8,760 hours per year. Maximum hourly emissions are calculated by multiplying the nominal bhp rating or the natural gas consumption rate of the engine and hours of operation per year by the appropriate emission factors.

Storage Tanks

Condensate Tanks

The flashing losses for the two (2) 400-bbl (16,800-gallon) condensate tanks were calculated using E&P TANK 2.0 modeling software. The default meteorological data from Billings, Montana (approximately 320 miles southwest of the site; the closest location to the facility with pre-programed meteorological data) were used as inputs. Appendix B provides detailed printouts, including annual tank conditions and emissions. As the percentage of condensate diverted to each tank was not known, emissions were modeled assuming the entire condensate throughput occurred through a single tank. Working and breathing losses were unable to be quantified as the E&P TANK program was unable to converge based on the input parameters used. As working and breathing losses only represent a small fraction of flash losses (approximately 1%), working and breathing losses were assumed negligible and were not estimated. The uncontrolled flashing, working, and breathing losses for both tanks will be controlled using a single thermal oxidizer (or other equivalent control device).

Water Storage Tank

Flashing losses for the single 400-bbl (16,800-gallon) water tank used to store water removed from the gas pipeline were calculated by conservatively assuming that the hydrocarbon content of liquids entering the water storage tank would be approximately 10% that of the condensate tank. Additionally, the water throughput is expected to be approximately 10% that of the condensate throughput. Uncontrolled VOC and HAP emissions are therefore estimated as being approximately 1% those of the condensate tank emissions. As with the condensate tank, working and breathing losses were not estimated and were assumed to be negligible. The water tank is below regulatory thresholds requiring the control of emissions from the tank as discussed in Section 5.0.

Tank Battery Control Device

As discussed above, emissions from the condensate tanks will be routed to a control device (i.e., thermal oxidizer, flare, or equivalent control device). Combustion emissions are generated by the thermal oxidizer (or equivalent control device) that oxidizes the tank emissions. Emissions were calculated using emission factors obtained from AP-42 for natural gas combustion.[2] GHG emissions were calculated using emission factors provided from 40 CFR 98 Subpart C, Tables C-1 and C-2, for the combustion of natural gas.

Blowdowns

Compressor units typically include a blowdown valve that is used during maintenance activities (i.e., to relieve pressure when a compressor is taken offline). Natural gas blowdowns are not part of everyday operation and, as such, are considered an insignificant emission source because of the negligible amount of vented natural gas emitted from blowdowns annually.

In addition to blowdown valves used to blow down a specific part of a line for routine maintenance, the station will include emergency shutdown (ESD) systems, pursuant to U.S. Department of Transportation safety requirements. Activation of an ESD system in the event of an emergency vents the piping (expelling the natural gas) to the atmosphere. The ESD systems would be used only in the event of an emergency.

Truck Loading Emissions

Transfer of water and condensate from the respective storage tanks to tanker trucks will result in emissions of regulated pollutants. Short-term truck loading emissions were calculated using Equation 1 from AP-42 Section 5.2.2.1.1. A truck loading rate of 7,500 gallons per hour (approximately 180 bbl/hr) and a saturation factor for submerged loading (i.e., S factor = 0.6) were assumed. Annual truck loading emissions were calculated by taking the product of the daily throughput from the tanks (approximately 110 bbl/day) with that of the calculated loading losses (approximately 5.13 lb/1,000 gallons). No add-on controls were assumed.

Fugitive Emissions

The project fugitive emissions were calculated using the methodology described in the November 1995 EPA document *Protocol for Equipment Leak Emission Estimates* (EPA-454/R-95-017). Emission factors were taken from Table 2-4 of that protocol. Continuous operation for 8,760 hours per year and typical compressor equipment inventory were assumed. There was no credit taken for controls. To remain conservative, all “connection” units are treated as “flanges” in the emission calculations. Appendix B presents calculated fugitive emissions from valves and fittings.

Description of Air Pollution Control Equipment

The proposed Arrow project’s uncontrolled PTE emissions exceed the NO_x, CO, VOC and HAP major source PSD thresholds. Arrow is therefore proposing to install and operate the controls discussed in further detail below. All equipment requiring control technology will not operate without controls. Appendix C provides pollution control equipment specifications.

Catalytic Silencer

Arrow is proposing to install and operate NSCR catalytic-silencers on all the natural gas-fired 4-stroke rich-burn engines. As discussed in Section 5.0, the two lean-burn engines are exempt from control requirements because the engines are existing engines that meet the performance standards of their year

[2] U.S. Environmental Protection Agency. 2000. Section 1.4 – Natural Gas Combustion; Chapter 1: External Combustion Sources. In *Compilation of Air Pollutant Emission Factors.* AP-42. July 1998.

of manufacture (2006). The particular NSCR catalytic-silencers chosen for the rest of the natural gas-fired engines and the anticipated destruction and removal efficiency (DRE) are discussed in Table 3. These engines will not be operated without the control technology.

Table 3. Engine Control Technology

Engine Type	NO_x DRE (%)	CO DRE (%)	VOC DRE (%)	HCHO DRE (%)
Minimum DRE for natural gas-fired 4-stroke rich-burn engines	95.0	90.0	80.0	90.0

Note: DRE = Destruction and Removal Efficiency.

Tank Battery Control Device

Arrow is proposing to install and operate a thermal oxidizer or other equivalent control device to control emissions from the 400-bbl condensate tanks. At this time, neither the vendor nor the actual destruction efficiency for the thermal oxidizer is known; however, in accordance with the requirements of the New Source Performance Standards (NSPS), subpart OOOO, a thermal oxidizer (or other equivalent control device[s]) with a minimum VOC destruction efficiency of 95.0% will be used to control tank emissions from condensate tanks. This is discussed further in Section 5.0. The water storage tank will not be routed to this control device as VOC emissions are below regulatory thresholds requiring control, as also discussed in Section 5.0.

Emission Summary

Calculated emissions of regulated air pollutants for the proposed project are summarized in Tables 4 and 5 (Appendix B provides detailed emission calculations). Although the potential uncontrolled emissions exceed major source thresholds for NO_x, CO, VOC, and HAPs, the controlled emissions do not. Therefore, Arrow is requesting a Synthetic Minor Source permit. If control technology is required for equipment, equipment will not be operated without controls. Uncontrolled emissions for SO_2, PM_{10}, $PM_{2.5}$, and carbon dioxide equivalent (CO_2e) are below the major source thresholds; therefore, no controls are necessary to reduce emissions for these pollutants.

Table 4. Summary of Single Unit Uncontrolled Emissions by Equipment in Tons per Year

Emission Source	Quantity	NO_X	CO	SO_x	VOCs	$PM_{10}/PM_{2.5}$	HAPs	HCHO	CO_2e
530 bhp Natural gas–fired 4-stroke lean-burn engine	1	10.24	6.65	1.12	3.84	<0.01	1.42	1.04	2,304
1,480 bhp Natural gas-fired 4-stroke rich-burn engine	3	185.79	128.62	3.64	12.29	0.61	1.47	0.71	7,448
740 bhp Natural gas-fired 4-stroke rich-burn engine	1	111.47	88.61	1.64	1.79	0.27	0.70	0.36	3,367
435 bhp Natural gas-fired 4-stroke rich-burn engine	1	67.21	33.60	1.03	2.81	0.17	1.12	0.90	2,110
400 bhp Natural gas-fired 4-stroke lean-burn engine	1	7.73	5.02	0.79	2.86	<0.01	0.99	0.73	1,608

Table 4. Summary of Single Unit Uncontrolled Emissions by Equipment in Tons per Year (Continued)

Emission Source	Quantity	NO_X	CO	SO_x	VOCs	$PM_{10}/PM_{2.5}$	HAPs	HCHO	CO_2e
326 bhp Natural gas-fired 4-stroke rich-burn engine	1	50.37	25.18	0.77	2.11	0.13	0.84	0.68	1,587
Condensate tank	2	-	-	-	172.24	-	16.39	-	-
Water storage tank	1	-	-	-	1.72	-	0.16	-	-
Truck Load out	-	-	-	-	0.13	-	-	-	-
Total uncontrolled emissions (All Units)	**-**	**804.37**	**544.93**	**16.27**	**229.17**	**2.40**	**26.05**	**5.85**	**33,328.57**

Note: SO_x = sulfur oxides; HCHO = formaldehyde.

Table 5. Summary of Single Unit Controlled Emissions by Equipment in Tons per Year

Emission Source	Quantity	NO_X	CO	SO_x	VOCs	$PM_{10}/PM_{2.5}$	HAPs	HCHO	CO_2e
530 bhp Natural gas–fired 4-stroke lean-burn engine	1	10.24	6.65	1.12	3.84	<0.01	1.42	1.04	2,304
1,480 bhp Natural gas-fired 4-stroke rich-burn engine	3	9.29	12.86	3.64	2.46	0.61	0.83	0.07	7,448
740 bhp Natural gas-fired 4-stroke rich-burn engine	1	5.57	8.86	1.64	0.36	0.27	0.38	0.04	3,367
435 bhp Natural gas-fired 4-stroke rich-burn engine	1	3.36	3.36	1.03	0.56	0.17	0.24	0.02	2,110
400 bhp Natural gas-fired 4-stroke lean-burn engine	1	7.73	5.02	0.79	2.86	<0.01	0.99	0.73	1,608
326 bhp Natural gas-fired 4-stroke rich-burn engine	1	2.52	2.52	0.77	0.42	0.13	0.18	0.02	1,587
Condensate tank	2	-	-	-	8.61	-	0.82	-	-
Water storage tank	1	-	-	-	1.72	-	0.16	-	-
Tank Battery Control Device (e.g., Thermal Oxidizer, Flare, or equivalent)	-	1.63	0.57	3.76	4.82	2.70	0.01	-	696
Truck Load out	-	-	-	-	4.33	-	-	-	-
Fugitive Emissions	-	-	-	-	0.60	-	-	-	11
Total controlled emissions (All Units)		**58.91**	**65.57**	**20.02**	**35.50**	**5.09**	**6.69**	**2.06**	**34,024.74**

Note: SO_x = sulfur oxides; HCHO = formaldehyde.

5.0 AIR QUALITY REGULATORY REVIEW

The following sections summarize the federal air quality regulations applicable to the project. A brief discussion of certain federal requirements and their applicability is included below.

Federal Regulations

New Source Performance Standards

Section 111 of the Clean Air Act authorized the EPA to develop technology-based standards that apply to specific categories of stationary sources. These standards are referred to as NSPS and are found at 40 CFR 60. The NSPS apply to new, modified, and reconstructed affected facilities in specific source categories. Table 6 identifies the subparts of 40 CFR 60 that are potentially applicable to the proposed project and notes whether a subpart is or is not applicable.

Table 6. New Source Performance Standards Applicability Determination

Subpart	Subject	Applicability
A	General Provisions	Yes
Kb	Standards of Performance for Volatile Organic Liquid Storage Vessels (Including Petroleum Liquid Storage Vessels) for which Construction, Reconstructions, or Modification Commenced after July 23, 1984	No
KKK	Standards for Performance for Equipment Leaks of VOC from Onshore Natural Gas Processing Plants	No
LLL	Standards for Performance for Onshore Natural Gas Processing: SO_2	No
JJJJ	Standards of Performance for Stationary Spark Ignition Internal Combustion Engines	Yes
OOOO	Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution	Yes

Subpart A contains general requirements for notification, testing, and reporting for the NSPS program. The subpart applies to each project that has an affected source as defined under another subpart. As the project has units subject to one or more standards under 40 CFR 60 as discussed below, subpart A applies to the project. Table 7 lists potentially applicable requirements and notes whether a requirement is or is not applicable to the project.

Table 7. Subpart A Applicability Determination

Citation	Subject	Applicability
40 CFR 60.1	General Applicability	Yes
40 CFR 60.7	Recordkeeping	Yes
40 CFR 60.8	Performance Testing	Yes
40 CFR 60.13	Monitoring Requirements	Yes
40 CFR 60.14	Modification	Yes
40 CFR 60.18	General Control Device Requirements	No
40 CFR 60.19	General Notification and Reporting Requirements	Yes

Subpart Kb applies to certain storage vessels with a design capacity greater than or equal to 75 cubic meters (m^3) (472 bbl) used to store volatile organic liquids (40 CFR 60.110b(a)). The design capacity of the oil and produced water storage tanks do not exceed 75 m^3. Therefore, subpart Kb does not apply to the project.

Subpart KKK applies to affected facilities in onshore natural gas processing plants (40 CFR 60.630(a)(1)). As the project is not a natural gas processing plant, subpart KKK does not apply to the project.

Subpart LLL applies to sweetening units and to sweetening units followed by a sulfur recovery unit that process natural gas. The project does not contain any sweetening units or sulfur recovery units; therefore, subpart LLL does not apply to the project.

Subpart JJJJ applies to owners and operators of stationary spark ignition (SI) RICEs that commence construction after June 12, 2006. Subpart JJJJ also applies to owners and operators of stationary SI RICEs that commence construction after June 12, 2006, where the stationary SI RICEs are manufactured on or after July 1, 2007, for engines with a maximum engine power greater than or equal to 500 hp (40 CFR 60.4230(a)(4)(i)).

All of the natural gas-fired engines except two meet these criteria and therefore must comply with the applicable requirements of the regulation. Two natural gas-fired lean-burn engines are exempt from subpart JJJJ requirements as they were manufactured before 2007, as discussed below. Table 8 discusses the specific requirements of subpart JJJJ that are applicable to the project.

Table 8. Subpart JJJJ Applicable Citations

Citation	Subject	Discussion
40 CFR 60.4230	Applicability	Engines are not subject to subpart JJJJ if they are manufactured before January 1, 2008, “for lean burn engines with a maximum engine power greater than or equal to 500 HP and less than 1,350 HP” (a)(3)(ii), or if they were manufactured before July 1, 2008 “for engines with a maximum engine power less than 500 HP” (a)(3)(iii). This exempts the lean-burn engines, which were manufactured in 2006, from the emission requirements of §60.4233, as well as any other provisions of subpart JJJJ.
40 CFR 60.4233(e, h)	Emission Standards	Engines with a maximum engine power greater than or equal to 100 hp manufactured after July 1, 2011, and engines greater than or equal to 500 hp manufactured after July 1, 2010, must comply with the following gram per horsepower-hour (g/hp-hr) emission standards: 1.0 g/hp-hr NO_x, 2.0 g/hp-hr CO, and 0.7 g/hp-hr VOCs, as well as the following part per million by volume (ppmvd) emissions at 15% of oxygen (O_2): 82 ppmvd NO_x, 270 ppmvd CO, 60 ppmvd VOCs. Owners and operators with engines required to meet standards referenced in 40 CFR 1048.101 must meet the standards in that section applicable to field testing if testing engines in use.
40 CFR 60.4234	Emission Standards	Owners and operators of engines must operate and maintain the engines within the referenced emission standards over the lifetime of the engines.
40 CFR 69.4243(b)	Compliance Requirements	Compliance with the emission standards of §60.4233 is demonstrated via one of two methods: 1) the operation and maintenance of a manufacturer’s certified engine and control device in accordance with the manufacturer’s emission-related written instructions; or 2) emissions testing of the non-certified engine and control device in accordance with the requirements specified in §60.4244, as applicable. The Arrow engines required to meet the emission standards §60.4233 will have manufacturer’s certified engines and control devices that meet the emission standards of §60.4233; therefore, Arrow is requesting that no performance testing be required for any of the engines located at the project and that Arrow instead be allowed to demonstrate compliance via the requirements outlined in §60.4243(a)(1), which stipulate keeping maintenance records for the individual engines.

Table 8. Subpart JJJJ Applicable Citations (Continued)

Citation	Subject	Discussion
40 CFR 69.4243(g)	Compliance Requirements	Air-to-fuel ratio controllers are required with the operation of three-way catalysts/NSCR. The required controllers must be maintained and operated appropriately.
40 CFR 60.4245	Notification, Reporting, and Recordkeeping Requirements	The following notification, reporting, and record-keeping requirements of §60.4245 are applicable to the Arrow project (§60.4245(a)(1–3)): records, notices, and reports of the following: notifications to comply, maintenance on the engines, and documentation from the engine manufacturer demonstrating compliance with the emission standards of §60.4233.
40 CFR 60.4246	Applicability of General Provisions	Discussed in Table 8 above.

As required by the regulations and based on the date of manufacture of the engines purchased for construction, the engines will meet the required emission limits using the requested controls for non-emergency SI natural gas engines listed in Table 1 of subpart JJJJ (presented in Table 9, citation discussion for §60.4233). Arrow will comply with the emission limits for all the engines except two by installing catalytic converters on the engine exhausts. The two lean-burn engines are certified to the emission limits in place during the date of manufacture (2006). All control technology will be integrated with the engines in such a way that it is impossible without modification to bypass the catalysts during engine operation. Additionally, Arrow will comply with all of the applicable monitoring, record-keeping, and reporting requirements for the engines, along with the applicable general provisions of subpart JJJJ.

Subpart OOOO applies to facilities that store or transmit crude oil or natural gas. Several sections of subpart OOOO apply to storage vessels with a PTE of greater than 6 tpy of VOCs and requires such sources at affected facilities to reduce VOC emissions by 95.0% or greater from storage vessels through the use of a control device. The proposed project contains condensate tanks with a PTE of greater than 6 tpy of VOCs each (the water tank has a PTE of less than 6 tpy of VOCs and thus is exempt from subpart OOOO). As such, the affected tanks installed at the proposed project are required to reduce VOC emissions by 95.0% or greater. The proposed project will install and operate thermal oxidizers (or other equivalent control device) with a minimum VOC destruction efficiency of 95.0% to control VOC emissions from storage vessels. Table 9 discusses the specific requirements of subpart OOOO that are applicable to the proposed project.

Table 9. Subpart OOOO Applicability Determination

Citation	Subject	Applicability	Discussion
40 CFR 60.5410	Initial Compliance	Yes	Determine VOC emission rate and reduce by greater than 95.0% if emitting more than 6 tpy VOCs.
40 CFR 60.5411	Closed Vent Systems	Yes	Design a closed vent system to route all gases, vapors, and fumes emitted from the material in the storage vessel to a control device. Equip storage vessel(s) with cover(s) that shall form a continuous barrier over the entire surface area of the liquid in the storage vessel. Secure each cover in a closed, sealed position (e.g., covered by a gasketed lid or cap) whenever material is in the unit on which the cover is installed, except during those times when it is necessary to use an opening to add or remove material, inspect or sample material, inspect, maintain, repair, or replace equipment located inside the unit, or vent liquids, gases, or fumes from the unit through the closed-vent system.

Table 9. Subpart OOOO Applicability Determination (Continued)

Citation	Subject	Applicability	Discussion
40 CFR 60.5412	Control Devices	Yes	Use one of the following control methods to control VOC emissions: enclosed combustion device, vapor recovery device, or flare. The requirements for an enclosed combustion device (thermal oxidizer) are as follows: reduce VOC emission by 95.0% or greater, reduce total organic carbon (TOC) emissions to a level equal to or less than 20 parts per million by volume (ppmv), and operate at a minimum temperature of 760 degrees Celsius (°C).
40 CFR 60.5413	Performance Testing	Yes	Conduct initial performance test(s) as required within 180 days. Arrow plans to install a thermal oxidizer that meets the exemption requirement under 60.5413(a)(7), Performance Test Conducted by Manufacturer, thus exempting the thermal oxidizer from performance testing. If a manufacturer's certified control device is used, Arrow will keep the necessary records, as outlined in 60.5413(d)(9)(i–vi), and will submit the manufacturer's test report.
40 CFR 60.5415	Continuous Compliance	Yes	Reduce VOC emissions from each storage vessel by 95.0% or greater. If a combustion control device is used, compliance is demonstrated through the following (60.5415(e)(2)(vii)): the inlet gas flow rate must meet the range specified by the manufacturer (parametric measurement of flow rate required), the pilot flame must be present at all times, and monthly visible emission testing must be performed (Method 22).
40 CFR 60.5416	Cover and Closed Vent System Inspection and Monitoring	Yes	Conduct both initial and continuous (annual) inspections of covers and the closed-vent system (including joints, seams, and other welded connections).
40 CFR 60.5417	Continuous Control Device Monitoring	Yes	Install and operate an applicable continuous parameter monitoring system for control devices used for storage vessels. Develop a site-specific monitoring plan.
40 CFR 60.5420	Notification, Reporting, and Recordkeeping	Yes	Submit an annual report. Maintain records.

In addition, subpart OOOO prescribes regulations for centrifugal and reciprocating compressors at natural gas gathering and boosting stations. The proposed Arrow compressors are rotary screw compressors. Excluded from the definition of centrifugal compressors (40 CFR 60.5430) are "screw, sliding vane, and liquid ring compressors;" therefore, the proposed Arrow compressors are not subject to subpart OOOO.

EPA proposed revisions to subpart OOOO on April 12, 2013 (78 FR 22126). While EPA is proposing an alternative VOC emission limit of 4 tpy at which control devices would need to be employed, this emission limit is only proposed to apply to facilities which have initially exceeded the VOC threshold of 6 tpy and are seeking to no longer require control of VOC emissions due to having dropped below the 6 tpy applicability threshold. Should the facility later determine that VOC emissions are below the 6 tpy threshold of applicability for the required use control technology for the condensate tanks, the facility would then need to determine if emissions are below the 4 tpy VOC emission threshold for a period of 12 months for these tanks in order to remove the control technology if the proposed rule is promulgated.

National Emission Standards for Hazardous Air Pollutants

National Emission Standards for Hazardous Air Pollutants (NESHAPs) are stationary source standards for HAPs. HAPs are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. The NESHAPs promulgated after the 1990 Clean Air Act Amendments are found in 40 CFR 63. These standards require application of technology-based emissions standards referred to as Maximum Achievable Control

Technology (MACT). Because of this, these post-1990 NESHAPs are also referred to as MACT standards. Table 10 lists the subparts of 40 CFR 63 that are potentially applicable to the proposed project and notes whether a requirement is or is not applicable to the project.

Table 10. National Emission Standards for Hazardous Air Pollutants Applicability Determination

Subpart	Subject	Applicability
A	General Provisions	Yes
HH	National Emission Standards for Hazardous Air Pollutants from Oil and Natural Gas Production Facilities	No
HHH	National Emission Standards for Hazardous Air Pollutants from Natural Gas Transmission and Storage Facilities	No
ZZZZ	National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines	Yes

Subpart A contains general requirements for notification, testing, and reporting for the NESHAPs program. The subpart applies to each project that has an affected source as defined under another subpart. As the project will have units subject to one or more standards under 40 CFR 63, subpart A applies to the project.

Subpart HH applies to affected point sources of HAPs located at oil and natural gas production facilities. Potentially affected point sources at the project include storage vessels. Subpart HH only regulates storage vessels that have the potential for flash emissions, which are defined as "any storage vessel that contains a hydrocarbon liquid with a stock tank GOR [gas-to-oil ratio] equal to or greater than 0.31 cubic meters per liter and an API gravity equal to or greater than 40 degrees and an actual annual average hydrocarbon liquid throughput equal to or greater than 79,500 liters per day. Flash emissions occur when dissolved hydrocarbons in the fluid evolve from solution when the fluid pressure is reduced" (40 CFR 63.761). None of the project storage vessels will have hydrocarbon liquid throughputs greater than or equal to 79,500 liters per day; therefore, the storage vessels at the project are not subject to subpart HH.

Subpart HHH applies to owners and operators of natural gas transmission and storage facilities that transport or store natural gas prior to entering the pipeline to a local distribution company or to a final end user (if there is not a local distribution company) and that are major sources of HAP emissions, as defined at 40 CFR 63.1271. The project is not a natural gas storage project; therefore, the project is not subject to subpart HHH.

Subpart ZZZZ established national emission limitations and operating limitations for HAP emissions from stationary RICEs located at major and area sources of HAP emissions. Affected sources under subpart ZZZZ are any existing, new, or reconstructed stationary RICEs located at major or area sources of HAP emissions, excluding stationary RICEs being tested at a stationary RICE test cell/stand (40 CFR 63.6590(a)). The engines are considered new stationary RICEs because they are located at an area source of HAP emissions and will have been constructed after December 19, 2002 (40 CFR 63.6590(a)(2)(i)). Because the stationary RICEs meet the criteria of 40 CFR 63.6590(c)(1) (a new or reconstructed stationary RICE located at an area source), the stationary RICEs meet the requirements of subpart ZZZZ by meeting those of subpart JJJJ, Standards of Performance for Stationary Spark Ignition Internal Combustion Engines, discussed in the NSPS regulatory review section above. No further requirements of subpart ZZZZ are applicable to the project.

40 Code of Federal Regulations Part 64 - Compliance Assurance Monitoring

Compliance Assurance Monitoring (CAM) requirements apply to a pollutant-specific emissions unit (PSEU) that satisfies all of the following criteria:

- The unit is located at a major source that is required to obtain a Part 70 or 71 permit.
- The unit is subject to an emission limitation or standard for the applicable regulated air pollutant.
- The unit uses a control device to achieve compliance with any such emissions limitation or standard.
- The unit has potential pre-control device emissions of the applicable regulated air pollutant that are equal to or greater than 100 percent of the amount, in tons per year, required for a source to be classified as a major source.
- The relevant emission limitation is not exempt.
- The unit is not otherwise exempt.

The 1,480-bhp natural gas—fired engines and the 740-bhp natural gas—fired engine were estimated to have potential pre-control device emissions of NO_x and CO which are greater than the major source threshold of 100 tpy and are subject to emission limitations under 40 CFR Part 60, subpart JJJJ and 40 CFR Part 63, subpart ZZZZ and thus meets the exemption criteria of §64.2(b)(1). An emission limitation or standard contained in an NSPS or NESHAP proposed by the Administration after November 15, 1990 is exempt from CAM. The requirements of 40 CFR Part 60, subpart JJJJ and 40 CFR Part 63, subpart ZZZZ were issued after November 15, 1990; therefore, the provisions of the CAM program do not apply to PSEUs at the Fort Berthold Compressor Project.

40 Code of Federal Regulations Part 68 - Chemical Accident Prevention Program

The EPA has established accidental release prevention and risk management plan requirements, as specified in 40 CFR 68, Chemical Accidental Prevention Provisions, which lists regulated substances, along with thresholds for determining the applicability of the associated requirements. If a regulated substance is handled, stored, or processed in greater than threshold quantities at a stationary source, then a risk management plan must be prepared.

Except for constituents of crude oil and natural gas such as CH_4 and ethane, the project is not expected to produce, process, handle, or store any substance regulated under 40 CFR 68 in quantities that exceed applicability thresholds.

40 Code of Federal Regulations 98 — Mandatory Greenhouse Gas Reporting

The provisions of 40 CFR 98 require categorical sources or sources above certain emission thresholds to calculate, monitor, and report GHG emissions. The GHGs included in this reporting rule are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and other fluorinated gases, including nitrogen trifluoride and hydrofluorinated ethers.

Table 11 lists the potentially applicable subparts to 40 CFR 98 and notes whether a requirement is or is not applicable to the project.

Table 11. Title 40 Code of Federal Regulations Part 98 Applicability Determination

Subpart	Subject	Applicability
A	General Provisions	Yes
C	General Stationary Fuel Combustion Sources	Yes
W	Petroleum and Natural Gas Systems	No

Subpart A contains general requirements for notification, testing, and reporting for the GHG reporting program. The subpart applies to each project that has an affected source as defined under another subpart. As the project will have units subject to one or more standards under 40 CFR 98, subpart A applies to the project.

Subpart C applies to certain stationary fuel combustion sources that meet the following requirements: the aggregate maximum rated heat input capacity of combustion equipment is greater than or equal to 30 mmBtu/hr and cumulative project emissions are 25,000 metric tpy CO_2e or greater (40 CFR 98(a)(3)(i–iii)). The project has combustion equipment with aggregate maximum rated heat input capacity of greater than 30 mmBtu/hr. Additionally, the facility has annual CO_2e emissions of 34,025 tons; when converted to metric tons, the annual CO_2e emissions are 30,860 metric tons (using the conversion factor of 1 ton being equal to 0.907 metric tons). Therefore, subpart C is applicable to the project. As such, Table 12 discusses the specific requirements of subpart C that are applicable to the proposed project.

Table 12. Subpart C Applicability Determination

Citation	Subject	Applicability	Discussion
40 CFR 98.32	GHGs to Report	Yes	Report CO_2, CH_4, and N_2O mass emissions from each stationary fuel combustion unit.
40 CFR 98.33	Calculating GHG Emissions	Yes	Calculate annual CO_2 mass emissions using one of four methodologies (Tier 1 through Tier 4). Arrow is requesting that the Tier 2 calculation methodology be used as it is the best representative of the combustion process of the project engines. The calculation is as follows (98.33(a)(2)(i)): $CO_2 = 1 \times 10^{-3} \times \text{Fuel} \times \text{HHV} \times \text{EF}$ (Fuel = Volume of fuel combusted during 1 year in standard cubic feet (scf); HHV = Annual average high heat value of the fuel in mmBtu/scf; EF = Fuel-specific default CO_2 emission factor for natural gas of 53.02 in kg/mmBtu).
40 CFR 98.34	Monitoring and QA/QC Requirements	Yes	For natural gas, sample fuel for HHV analysis semi-annually (98.34(a)(2)(i)). Use one of the fuel sampling and analysis methods outlined in 98.34(a)(6).
40 CFR 98.35	Procedures for Estimating Missing Data	Yes	Procedures to follow if parametric data necessary to perform GHG calculations are missing.
40 CFR 98.36	Data Reporting Requirements	Yes	Report both general facility information and emissions and individual combustion unit information and emissions. Report the unit-level data outlined in 93.36(b)(1–8).
40 CFR 98.37	Records Retention	Yes	Retain records dealing with the compliance of parts 98.34, 98.35, and 98.36 discussed above.

Subpart W applies to natural gas transmission compression facilities that "transport natural gas from production fields, natural gas processing plants, or other transmission compressors through transmission pipelines to natural gas distribution pipelines, LNG [liquefied natural gas] facilities, or into underground storage" (40 CFR 98.230(a)(4)). The Arrow station is transferring the natural gas to a natural gas processing facility. However, the station is not transferring the natural gas to "natural gas distribution pipelines, LNG facilities, or into underground storage." Therefore, subpart W is not applicable to the project.

6.0 PROPOSED EMISSION AND OPERATIONAL LIMIT REQUESTS

As discussed in Section 4.0, the potential uncontrolled emissions exceed major source thresholds for NO_x, CO, VOCs, and HAPs; all other pollutants are below major source thresholds. Therefore, Arrow is requesting the following emission and operational limits for the proposed project for NO_x, CO, VOCs, and HAPs in order to obtain a synthetic minor status with regard to the PSD permitting program. These federally enforceable permit conditions will allow Arrow to operate the project while emitting less than the PSD major source threshold of 250 tpy of a regulated pollutant. If control technology is required for equipment, equipment will not operate without controls.

Proposed Project-Wide Emission Limits

To ensure that the project-wide annual emissions are below the PSD major source thresholds and to account for a margin of error in the proposed project, EPA Region VIII has typically set the project-wide annual emission limits a minimum of 2% below the major source thresholds for PSD pollutants. Arrow will also be seeking synthetic minor status for a Title V operating permit following the issuance of the permit to construction. Therefore, in order to remain below the Title V limits and to account for a greater margin of error, Arrow is proposing the following project-wide emission limits for NO_x , CO, VOCs, and HAPs that are 8% below the major source threshold for Title V pollutants. The pollutants for which synthetic minor status is being sought in order to remain below PSD permitting thresholds are as follows:

- Project-wide NO_x emissions are not to exceed 92 tons during any consecutive 12-month rolling average;
- Project-wide CO emissions are not to exceed 92 tons during any consecutive 12-month rolling average;
- Project-wide VOC emissions are not to exceed 92 tons during any consecutive 12-month rolling average;
- Project-wide total HAP emissions are not to exceed 23 tons during any consecutive 12-month rolling average;
- Project-wide individual HAP emissions are not to exceed 9.2 tons during any consecutive 12-month rolling average.

No emission limits are being sought for SO_2, PM_{10}, $PM_{2.5}$, or CO_2e as uncontrolled emissions for these criteria pollutants are below PSD major source thresholds.

Proposed Construction and Operational Limits

Arrow proposes the following construction and operational limits, consisting of work practices and operational requirements, for the requested NO_x, CO, VOC, and HAP emission limits.

A maximum natural gas-fired reciprocating internal combustion engine (RICE) horsepower of 6,871 (bhp) for the project.

Requested construction and operational limits for the 4-stroke lean-burn engines:

- Project shall be limited to:

    - one (1) unit with a maximum horsepower rating of up to 530 horsepower; and
    - one (1) unit with a maximum horsepower rating of up to 400 horsepower;
- Emissions from the 4-stroke lean-burn engines shall not exceed 2.0 g/hp-hr of NOx, 1.3 g/hp-hr of CO, 0.75 g/hp-hr of VOC emissions (each); and
- Follow the manufacturer's recommended maintenance schedule and procedures to ensure optimum performance.

Requested construction and operational limits for the 4-stroke rich-burn engines:

- Project shall be limited to:
    - three (3) units with a maximum horsepower rating of up to 1,480 horsepower;
    - one (1) unit with a maximum horsepower rating of up to 740 horsepower;
    - one (1) unit with a maximum horsepower rating of up to 435 horsepower; and
    - one (1) unit with a maximum horsepower rating of up to 326 horsepower;
- Emissions from each engine equipped with NSCR and an air/fuel ratio controller shall not exceed 1.0 g/hp-hr of NOx, 2.0 g/hp-hr of CO, 0.7 g/hp-hr of VOC emissions;
- Equip the units with a Nonselective Catalytic Reduction (NSCR) Catalytic/Silencer and an air/fuel ratio controller capable of reducing NOx emissions by at least 95%, CO emissions by at least 90%, VOC emissions by at least 80%, and formaldehyde emissions by at least 90% at maximum operating rate of (90-110% of the engine operating capacity at site elevation); and
- Arrow will follow, with respect to the engine and its respective catalyst, the manufacturer's recommended maintenance schedule and procedures to ensure optimum performance.

Requested construction and operational limits for the condensate tanks: Route all hydrocarbon vapor emissions (standing, working, breathing, and flashing losses) from the separator tanks to thermal oxidizers, flare or other equivalent control device with minimum 95.0% destruction efficiency.

Proposed Monitoring Requirements

Arrow proposes the following monitoring requirements for the requested NO_x, CO, VOC, and HAP emission limits:

- monitor the volume of standing, working, breathing, and flashing gases from the condensate tanks sent to the thermal oxidizer (or other equivalent control device) through direct measurement, gas-to-oil ratio laboratory analysis, or other EPA-approved method;
- directly measure, or calculate using EPA-approved methods, various parameters (e.g., product throughput, temperature, etc.) related to the proper operation of emission units and required control devices to ensure compliance with the proposed emissions and operational limitations; and
- calculate rolling monthly and 12-month project-wide emissions of NO_x, CO, VOCs, SO_2, PM_{10}, HAPs, and CO_2e in tpy; the calculations shall include emissions from all controlled and uncontrolled emitting units at the project and shall be made based on the actual engine usage (hours) for each calendar month.

Proposed Record-Keeping Requirements

Arrow is proposing to maintain the following records for the requested NO_x, CO, VOC, and HAP emission limits:

- emissions-related maintenance on the engines and NSCR catalytic silencers;
- emissions-related certification documentation for the engines and NSCR catalytic silencers;
- measured volume of standing, working, breathing, and flashing gases created from the condensate tanks and sent to the thermal oxidizer (or other equivalent control device), including the method(s) used for monitoring the volume;
- documentation of the rolling monthly project-wide NO_x, CO, VOC, SO_2, PM_{10}, HAP, and CO_2e emissions in tpy;
- documentation of all input parameters and calculations used to determine the rolling monthly emissions from all controlled and uncontrolled emission sources at the project; and
- documentation of any deviations from the requirements of the permit.

7.0 AIR QUALITY ASSESSMENT

The regulations for the Federal Minor New Source Review Program in Indian Country, codified at 40 CFR 49.159(d), require that an air quality impact assessment modeling analysis be performed if there is reason to be concerned that a project would cause or contribute to a NAAQS exceedance or a PSD increment violation. If the air quality impact assessment reveals that the proposed construction could cause or contribute to a NAAQS exceedance or PSD increment violation, such impacts must be analyzed and/or mitigated before a preconstruction permit can be issued.

The project area can be characterized as relatively flat, with only minor terrain features (i.e., gently rolling hills). The main use for the surrounding area is agriculture and livestock grazing, with the exception of an occasional oil and gas well production project.

The western portion of North Dakota has four defined seasons (i.e., summer, fall, winter, and spring). During summer, the average air temperature in degrees Fahrenheit (°F) ranges from the low 60s to the low 70s, with highs reaching the mid-80s. In contrast, the average minimum temperatures in winter generally range from just above 0 to the mid-single digits, with the average maximum temperature reaching the upper 20s. The yearly average precipitation is approximately 14 inches, and precipitation is highest in the summer months.[3]

The project is located within the boundaries of the Fort Berthold Indian Reservation, which is designated by the EPA as being in attainment or unclassified with respect to the NAAQS for O_3, CO, NO_2, SO_2, PM_{10}, $PM_{2.5}$, and Pb. The EPA has collected air monitoring data for O_3, NO_2, SO_2, PM_{10}, and $PM_{2.5}$ in the project area.[4] Table 13 shows the results for the air monitors nearest to the site, the location of the monitors relative to the site, the years of data analyzed, and any recorded exceedances of either the primary or secondary NAAQS.

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[3] National Weather Service Weather Forecast Office. 2013. North Dakota data. Available at: http://www.crh.noaa.gov/bis. Accessed April 18, 2013.

[4] U.S. Environmental Protection Agency. 2013. Air monitoring data. Available at: http://www.epa.gov/airdata. Accessed April 18, 2013.

Table 13. Air Monitoring Exceedance Data

Monitor (Contaminant)	Location (Latitude, Longitude)	Location in Relation to Station	Years Analyzed	Exceedances (primary or secondary)
AQS 38-101-0114 (SO_2, NO_2)	47.97110, −101.84940	32 miles NE	2009–2010	0
AQS 38-053-0002 (SO_2, NO_2, PM_{10}, $PM_{2.5}$, O_3)	47.58120, −103.29950	42 miles SW	2008−2013	1 (primary and secondary): O_3, 2011; 1 (primary): NO_2, 2011; 1 (primary): SO_2, 2011
AQS 38-055-0113 (SO_2, PM_{10})	47.60667, −102.03639	17 miles SE	2006–2008	0
AQS 38-053-0108 (PM_{10})	47.99028, −102.58833	23 miles NW	2006–2008	0
AQS 38-057-1113 (SO_2)	47.49490, −102.07800	19 miles SE	2009–2010	0
AQS 38-057-0124 (SO_2, NO_2)	47.40062, −101.92865	28 miles SE	2009–2011	1 (primary): SO_2, 2010
AQS 38-025-0003 (SO_2, NO_2, PM_{10}, $PM_{2.5}$, O_3)	47.31320, −102.52730	25 miles S	2008–2013	0

As Table 13 demonstrates, the area around the site is in attainment for SO_2, NO_2, PM_{10}, $PM_{2.5}$, and O_3 and is not classified for CO and Pb.

Modeling Parameters and Procedures

An ambient air impact analysis was performed to estimate air quality impacts for CO, NO_2, PM_{10}, $PM_{2.5}$, and SO_2 that may be emitted from each engine proposed for the project. This modeling was conducted using the EPA AERSCREEN model (Version 11126). The following technical options for the AERSCREEN modeling analysis were selected:

- rural terrain;
- probe distance of 3,281 feet (ft);
- maximum building height of 20 ft;
- maximum building dimension of 28 ft;
- minimum building dimension of 15.5 ft;
- building orientation and stack direction of 0 and 90 degrees from north, respectively;
- regulatory default minimum and maximum temperatures (−10 to 100 °F);
- regulatory default minimum wind speed (0.5 meters per second);
- regulatory default anemometer height (10.0 meters);
- dominant surface profile of grassland; and
- dominant climate type of average moisture.

The terrain elevations for both locations are within a fairly tight range, between 2,250 and 2,300 feet in elevation. As such, 2,300 feet in elevation was used in AERSCREEN. The technical parameters for the stack height, stack diameter, stack temperature, stack flow rate, and NO_2 to NO_x chemistry varied from engine to engine. Additionally, the emission rates for CO, NO_2, PM_{10}, $PM_{2.5}$, and SO_2 vary among the different engines. These equipment dependent technical parameters for each engine are discussed in Table 14.

Table 14. Engine Air Modeling Technical Parameters

Parameter	Natural Gas-Fired 4-Stroke Rich-Burn RICE (326 HP)	Natural Gas-Fired 4-Stroke Lean-Burn RICE (400 HP)	Natural Gas-Fired 4-Stroke Rich-Burn RICE (435 HP)	Natural Gas-Fired 4-Stroke Lean-Burn RICE (530 HP)	Natural Gas-Fired 4-Stroke Rich-Burn RICE (740 HP)	Natural Gas-Fired 4-Stroke Rich-Burn RICE (1,480 HP)
Stack Height (feet)	25	25	25	25	32	32
Stack Diameter (inches)	8	8	8	8	10	12
Stack Temperature (°F)	1,207	877	1,205	869	1,200	1,268
Exit Gas Velocity (ACFM)	1,796	2,195	2,384	3,125	4,090	7,056
NO_2 to NO_x Chemistry (ratio)	0.05	0.25	0.05	0.25	0.05	0.05
CO (lb/hr)	0.57	1.15	0.77	1.52	2.02	2.94
NO_x (lb/hr)	0.57	1.76	0.77	2.34	1.27	2.12
PM_{10} (lb/hr)	0.03	0.0002	0.04	0.0003	0.06	0.13
$PM_{2.5}$ (lb/hr)	0.03	0.0002	0.04	0.0003	0.06	0.13
SO_2 (lb/hr)	0.18	0.18	0.24	0.26	0.38	0.75

Note: ACFM = actual cubic feet per minute.

For the NO_2 to NO_x ratio, the Plume Volume Molar Ratio was selected as being the best representative of the in-stack chemistry, based on manufacturer-provided data of the measurement of NO_2 to NO_x as the air-to-fuel ratio changes. The input data of the air modeling analysis using AERSCREEN for the project is included in Appendix E. It should be noted that the results were modeled on a 1-pound per hour (lb/hr) hypothetical basis for all pollutants analyzed and then normalized for the particular pollutant of interest using the correct emission rate.

AERSCREEN Modeling Results

A pre-construction air quality impact analysis for a particular pollutant is normally expected to include an estimate of the projected total pollutant concentration at each modeling receptor site. The total pollutant concentration is the sum of: (i) the baseline concentration in the area of the plant due to existing sources of pollution and (ii) the estimated increase in pollutant concentration in the area, caused by the applicant's proposed emission increase and associated growth. To demonstrate that the proposed project will not cause or contribute to a violation of the NAAQS, the applicant is normally expected to show that the total pollutant concentration will not exceed the NAAQS at any receptor site. A summary of the proposed project AERSCREEN modeling results for CO, NO_2, $PM_{2.5}$, PM_{10}, and SO_2 are provided in Table 15; supporting calculations are provided in Appendix E.

Table 15. Representative Maximum Design AERSCREEN Results Summary

Pollutant	Averaging Period	Representative Maximum Design Impact	Ambient Background	Representative Maximum Design Impacts + Background	NAAQS	Exceeds NAAQS (Yes/No)
PM_{10} [1]	24-hour	2.9 µg/m^3	103.0 µg/m^3	105.9 µg/m^3	150 µg/m^3	No
$PM_{2.5}$ [2]	24-hour	2.9 µg/m^3	16.6 µg/m^3	19.5 µg/m^3	35 µg/m^3	No
	Annual	0.3 µg/m^3	5.8 µg/m^3	6.1 µg/m^3	12 µg/m^3	No

Pollutant	Averaging Period	Representative Maximum Design Impact	Ambient Background	Representative Maximum Design Impacts + Background	NAAQS	Exceeds NAAQS (Yes/No)
PM_{10} [1]	24-hour	2.9 μg/m^3	103.0 μg/m^3	105.9 μg/m^3	150 μg/m^3	No
NO_2 [3]	1-hour	78.0 ppb	16.0 ppb	94.0 ppb	100 ppb	No
	Annual	7.8 ppb	5.0 ppb	12.8 ppb	53 ppb	No
SO_2 [4]	1-hour	13.6 ppb	19.0 ppb	32.6 ppb	75 ppb	No
	3-hour	13.6 ppb	16.3 ppb	29.9 ppb	500 ppb	No
CO [5]	1-hour	0.1 ppm	2.2 ppm	2.3 ppm	35 ppm	No
	8-hour	0.1 ppm	0.6 ppm	0.7 ppm	9 ppm	No

[1] Ambient background 24-hour PM_{10} value taken from the highest recorded 24-hour concentration value for the years analyzed (2010-2012) from EPA Air Monitor 38-025-0003

[2] Ambient background 24-hour and annual $PM_{2.5}$ values taken from highest 98% 24-hour concentration value (for 24-hour $PM_{2.5}$ background level) and highest annual mean 24-hour concentration value (for annual $PM_{2.5}$ background level) for the years analyzed (2010-2012) from EPA Air Monitor 38-025-0003

[3] Ambient background 1-hour and annual NO_2 values taken from the highest 99% 1-hour concentration value (for 1-hour NO_2 background level) and highest annual mean 1-hour concentration value (for annual NO_2 background level) for the years analyzed (2010-2012) from EPA Air Monitor 38-053-0002

[4] Ambient background 1-hour and 3-hour SO_2 value taken from highest 99% 1-hour concentration value (for 1-hour SO_2 background level) and highest record 3-hour concentration value (for 3-hour SO_2 background level) for the years analyzed (2010-2012) from EPA Air Monitor 38-025-0003

[5] Ambient background 1-hour and 8-hour CO values taken from highest recorded 1-hour and 8-hour concentration values, respectively, for the years analyzed (2010-2012) from EPA Air Monitor 38-017-1004

When calculating emissions from the project, it was assumed that the maximum pound per hour CO, NO_x $PM_{2.5}$, PM_{10}, and SO_2 emissions from each engine were emitted. As there are multiple engines and thus multiple point sources associated with the facility, the maximum concentrations predicted at radial distances were overlaid from each engine (additive) to estimate the cumulative impacts from the project. These cumulative impacts were then added to background levels and compared with the NAAQS. The background concentrations were derived from the nearest EPA monitors.

As the modeling results provided in Appendix E demonstrate, air quality impacts from the proposed facility are below the NAAQS for CO, NO_x $PM_{2.5}$, PM_{10} and SO_2 for the project. Ozone was not modeled as there is currently no EPA approved methodology for evaluating the 8-hour O_3 standard on a local scale, as O_3 is a regional pollutant; therefore, no ambient air quality analysis modeling was performed for the O_3 precursor, VOC. This determination is consistent with other nearby state agency modeling requirements.

The available O_3 data from the closest two O_3 monitors in the region are presented in Figures 2 and 3. As indicted above, these two monitors did not approach the 8-hour O_3 standard. For 8-hour O_3, NAAQS violations occur when the 3-year average of the 4th maximum 8-hour average O_3 is greater than the NAAQS. The 3-year 8-hour average design values for the region are shown below. Neither of these two monitors had a three year average above the 0.075 ppm O_3 NAAQS. Therefore, the overall conclusion is that the project is unlikely to cause or contribute to a violation of the O_3 NAAQS.

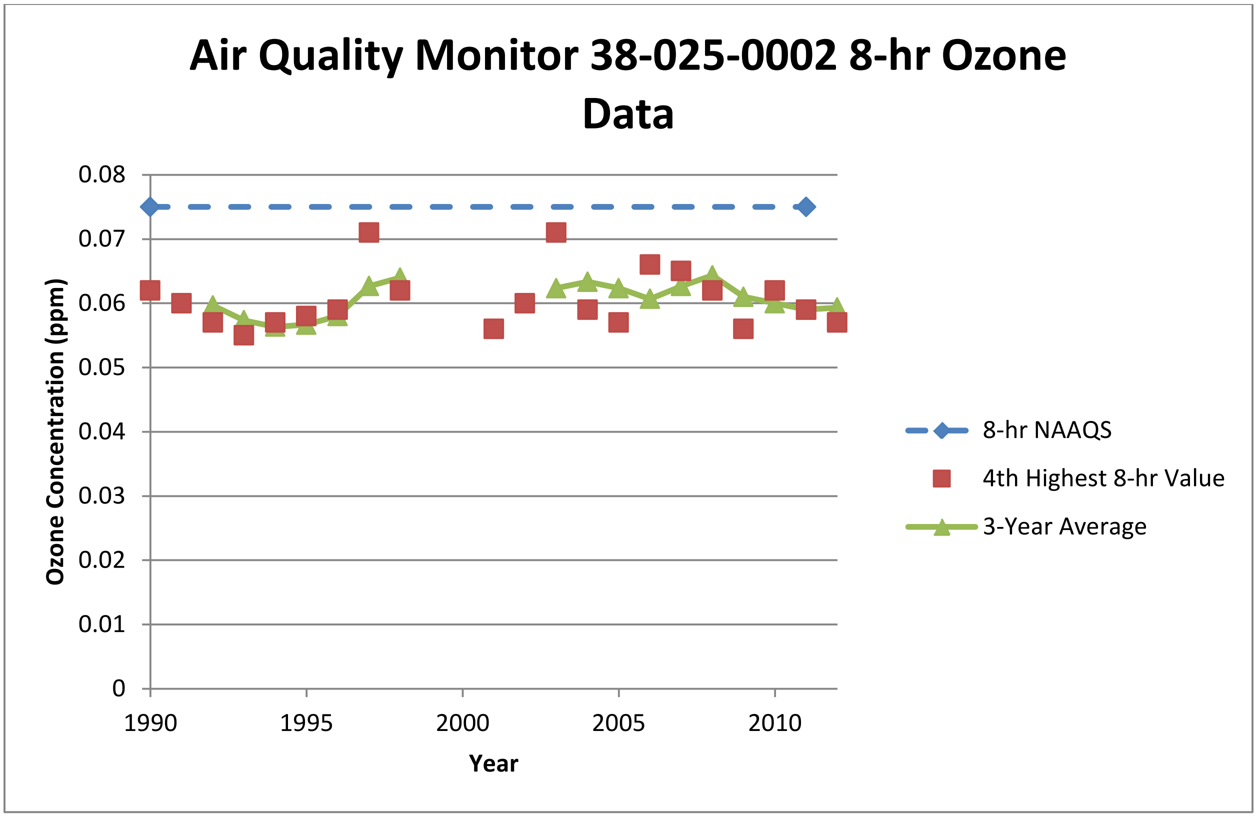

Figure 2. 38-025-0002 Monitor 4th Maximum 8-hour O_3, 1990–2012[5].

[5] Monitoring data taken from EPA Air Quality Monitor 38-025-0002; located at http://www.epa.gov/airdata/

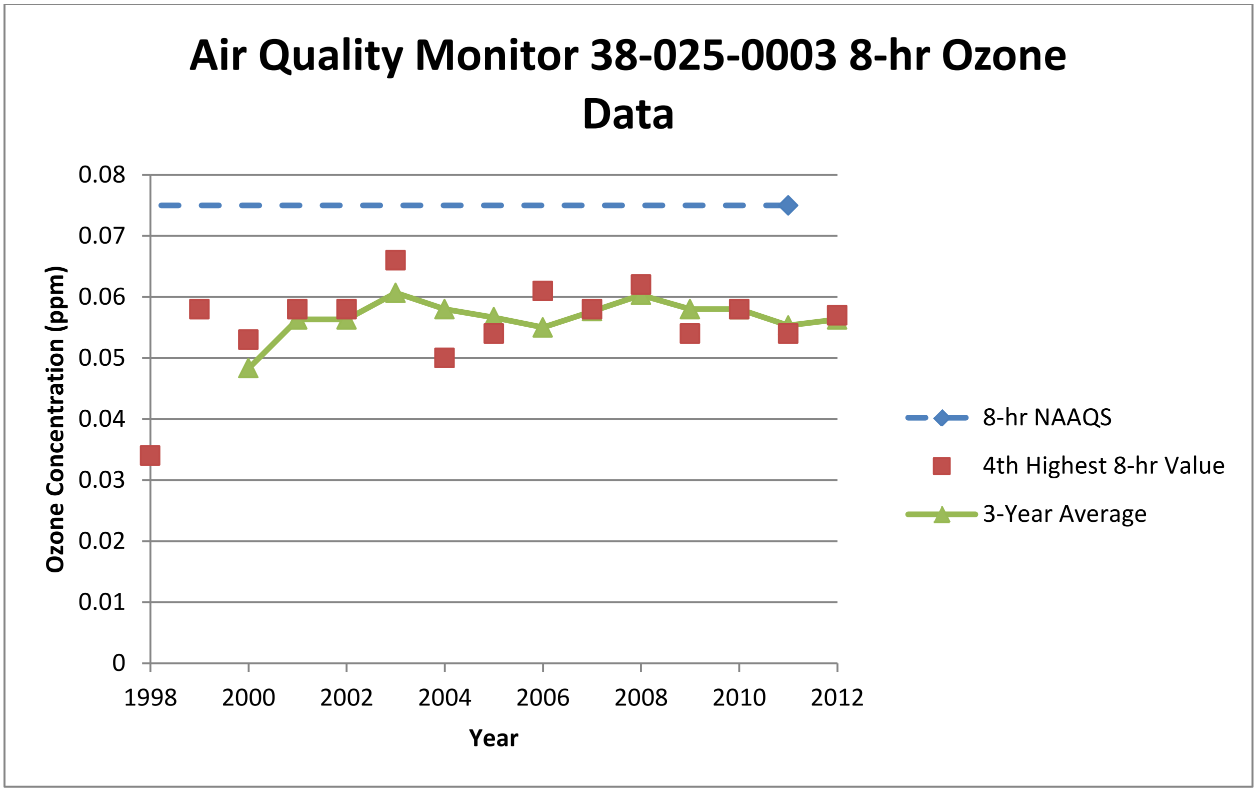

Figure 3. 38-025-0003 Monitor 4th Maximum 8-hour O_3, 1998–2012[6].

As the modeling results and discussion above demonstrate, air quality impacts from the proposed facility are below the NAAQS for CO, NO_x $PM_{2.5}$, PM_{10} and SO_2 for the project. Additionally, based on existing background O_3 levels, it is unlikely that the proposed facility will cause or contribute to a violation of the O_3 NAAQS. Given the projected emissions of the project and the current air quality status, additional ambient impact analysis is not required.

Arrow has also assessed the impact of project emissions to nearby Class I areas. The only Class I area identified within 100 kilometers (km) from either proposed project location is the Theodore Roosevelt National Park, whose eastern edge is located approximately 60 km to the west of the westernmost boundary of the project property line. Arrow has therefore conducted a screening level assessment of project impacts to the Theodore Roosevelt National Park using the Federal Land Managers' Air Quality Related Values (AQRV) Workgroup (FLAG) Phase I Report guidance,[7] which establishes a threshold ratio of emissions to distance below which AQRV review is not required. Specifically, if

Q (tpy) / d (km) < 10, no AQRV analysis is required

Where,

- Q is the emissions increase of SO_2, NO_X, PM_{10}, and sulfuric acid mist (H_2SO_4), combined in tpy [the tpy value must be based on the maximum short-term emission rates]; and
- D is the nearest distance to a Class I Area in km.

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[6] Monitoring data taken from EPA Air Quality Monitor 38-025-0003; located at http://www.epa.gov/airdata/

[7] The Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report – Revised 2010. Available at: http://www.nature.nps.gov/air/pubs/pdf/flag/FLAG_2010.pdf. Accessed on April 22, 2013.

The FLAG 2010 guidance suggests summing the project-wide ton/year emission rates for all sources of NO_X, SO_2, PM_{10}, and H_2SO_4 and dividing this value by the distance from the proposed site to the Class I area. If this value is less than or equal to 10, presumptively there is no adverse impact and a project "screens out" of a Class I AQRV analysis.

The emissions in tons per year of NO_X, SO_2, PM_{10}, and H_2SO_4 were estimated as:

- NO_X: 59 tpy
- PM_{10}: 5 tpy
- SO_2: 20 tpy
- H_2SO_4: 0 tpy
- Total: 84 tons/year

  Q/d = 84 [tons/year pollutants] / 60 [distance in km to nearest Class I area] = 1.4

As the Q/d value is less than 10, the project has "screened out" of any further Class I AQRV analyses and will thus not adversely affect the Theodore Roosevelt National Park.

8.0 ENDANGERED SPECIES ACT

The ESA requires the EPA, in consultation with the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration Fisheries Service, to ensure that the actions the EPA authorizes are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat of such species. An ESA assessment for the project will be submitted under separate cover.

9.0 NATIONAL HISTORIC PRESERVATION ACT

The National Historic Preservation Act requires the EPA, in consultation with State and/or Tribal Historic Preservation Officers, to ensure that the actions authorized are not likely to affect cultural resources. An assessment of cultural resources that could potentially be affected by the project will be submitted under separate cover.

APPENDIX A

Application for Approval of Emissions of Air Pollutants from Minor Sources

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
FEDERAL MINOR NEW SOURCE REVIEW PROGRAM IN INDIAN COUNTRY
40 CFR 49.151

Application For Synthetic Minor Limit

(Form SYNMIN)

Use of this information request form is voluntary and not yet approved by the Office of Management and Budget. The following is a check list of the type of information that Region 8 will use to process information on your proposed project. While submittal of this form is not required, it does offer details on the information we will use to complete your requested approval and providing the information requested may help expedite the process. Use of application forms for this program is currently under Office of Management and Budget review and these information request forms will be replaced/updated after that review is completed.

Please submit information to following two entities:

Federal Minor NSR Permit Coordinator
U.S. EPA, Region 8
1595 Wynkoop Street, 8P-AR
Denver, CO 80202-1129
R8airpermitting@epa.gov

For more information, visit:
http://www.epa.gov/region08/air/permitting/tmnsr.html

The Tribal Environmental Contact for the specific reservation:

If you need assistance in identifying the appropriate Tribal Environmental Contact and address, please contact:

R8airpermitting@epa.gov

A. GENERAL INFORMATION

Company Name Arrow Pipeline, LLC	**Source Name** Arrow Pipeline Station #7
Company Contact or Owner Name Doug Lee	Title Sr. VP of Operations
Mailing Address 10702 Highway 73, Keene, ND 58847	
Email Address doug.lee@arrowmidstream.com	
Telephone Number (701) 675-2048	Facsimile Number (701) 675-2152

B. ATTACHMENTS

For each criteria air pollutant, hazardous air pollutant and for all emission units and air pollutant-generating activities to be covered by a limitation, include the following:

☒ **Item 1 -** The proposed limitation and a description of its effect on current actual, allowable and the potential to emit.

☒ **Item 2 -** The proposed testing, monitoring, recordkeeping, and reporting requirements to be used to demonstrate and assure compliance with the proposed limitation.

☒ **Item 3 -** A description of estimated efficiency of air pollution control equipment under present or anticipated operating conditions, including documentation of the manufacturer specifications and guarantees.

☒ **Item 4 -** Estimates of the Post-Change Allowable Emissions that would result from compliance with the proposed limitation, including all calculations for the estimates.

☒ **Item 5 –** Estimates of the potential emissions of Greenhouse Gas (GHG) pollutants.

☒ **Item 6 –** Estimates of the potential emissions of Hazardous Air Pollutants (HAPs) if seeking a synthetic minor limit for HAPs.

OMB Control No. Pending
Approval expires Pending

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
FEDERAL MINOR NEW SOURCE REVIEW PROGRAM IN INDIAN COUNTRY
40 CFR 49.151

Application for New Construction

(Form NEW)

Please check all that apply to show how you are using this form:

- ☒ **Proposed Construction of a New Source**
- ☐ **Proposed Construction of New Equipment at an Existing Source**
- ☐ **Proposed Modification of an Existing Source**
- ☐ **Other – Please Explain**

Use of this information request form is voluntary and not yet approved by the Office of Management and Budget. The following is a check list of the type of information that Region 8 will use to process information on your proposed project. While submittal of this form is not required, it does offer details on the information we will use to complete your requested approval and providing the information requested may help expedite the process. Use of application forms for this program is currently under Office of Management and Budget review and these information request forms will be replaced/updated after that review is completed.

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http://www.epa.gov/region08/air/permitting/tmnsr.html

The Tribal Environmental Contact for the specific reservation:

If you need assistance in identifying the appropriate Tribal Environmental Contact and address, please contact:

R8airpermitting@epa.gov

A. GENERAL SOURCE INFORMATION

1. (a) **Company Name** Arrow Pipeline, LLC (b) **Operator Name** Arrow Pipeline, LLC	2. **Source Name** Arrow Pipeline Station #7
3. Type of Operation Gas Transmission	4. Portable Source? ☐ Yes ☒ No 5. Temporary Source? ☐ Yes ☒ No
6. NAICS Code 486210	7. SIC Code 4922
8. Physical Address (home base for portable sources) 10702 Highway 73, Keene, ND 58847	

9. Reservation* FBIR	10. County* Dunn	11a. Latitude* See Attached	11b. Longitude* See Attached
12a. Quarter Quarter Section* See Attached	12b. Section* See Attached	12c. Township* See Attached	12d. Range* See Attached

*Provide all proposed locations of operation for portable sources

B. PREVIOUS PERMIT ACTIONS (Provide information in this format for each permit that has been issued to this source. Provide as an attachment if additional space is necessary)

Source Name on the Permit
Permit Number (xx-xxx-xxxxx-xxxx.xx)
Date of the Permit Action

Source Name on the Permit
Permit Number (xx-xxx-xxxxx-xxxx.xx)
Date of the Permit Action

Source Name on the Permit
Permit Number (xx-xxx-xxxxx-xxxx.xx)
Date of the Permit Action

Source Name on the Permit
Permit Number (xx-xxx-xxxxx-xxxx.xx)
Date of the Permit Action

Source Name on the Permit
Permit Number (xx-xxx-xxxxx-xxxx.xx)
Date of the Permit Action

C. CONTACT INFORMATION

Company Contact Doug Lee	Title Sr. VP of Operations
Mailing Address 10702 Highway 73, Keene, ND 58847	
Email Address dlee@arrowmidstream.com	
Telephone Number (701) 675-2048	Facsimile Number (701) 675-2047
Operator Contact (if different from company contact)	Title
Mailing Address	
Email Address	
Telephone Number	Facsimile Number
Source Contact Doug Lee	Title Sr. VP of Operations
Mailing Address 10702 Highway 73, Keene, ND 58847	
Email Address doug.lee@arrowmidstream.com	
Telephone Number (701) 675-2048	Facsimile Number (701) 675-2152
Compliance Contact Albert L. Gallegos	Title Director, EHS
Mailing Address One Warren Place 6100 South Yale, Suite 1700 Tulsa, Ok 74136	
Email Address albert.gallegos@arrowmidstream.com	
Telephone Number (918) 748-3838	Facsimile Number (918) 748-3858

D. ATTACHMENTS

Include all of the following information (see the attached instructions)

☒ **FORM SYNMIN -** New Source Review Synthetic Minor Limit Request Form, if synthetic minor limits are being requested.

☒ Narrative description of the proposed production processes. This description should follow the flow of the process flow diagram to be submitted with this application.

☒ Process flow chart identifying all proposed processing, combustion, handling, storage, and emission control equipment.

☒ A list and descriptions of all proposed emission units and air pollution-generating activities.

☒ Type and quantity of fuels, including sulfur content of fuels, proposed to be used on a daily, annual and maximum hourly basis.

☒ Type and quantity of raw materials used or final product produced proposed to be used on a daily, annual and maximum hourly basis.

☒ Proposed operating schedule, including number of hours per day, number of days per week and number of weeks per year.

☒ A list and description of all proposed emission controls, control efficiencies, emission limits, and monitoring for each emission unit and air pollution generating activity.

☒ **Criteria Pollutant Emissions -** Estimates of Current Actual Emissions, Current Allowable Emissions, Post-Change Uncontrolled Emissions, and Post-Change Allowable Emissions for the following air pollutants: particulate matter, PM_{10}, $PM_{2.5}$, sulfur oxides (SOx), nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compound (VOC), lead (Pb) and lead compounds, fluorides (gaseous and particulate), sulfuric acid mist (H_2SO_4), hydrogen sulfide (H_2S), total reduced sulfur (TRS) and reduced sulfur compounds, including all calculations for the estimates.

These estimates are to be made for each emission unit, emission generating activity, and the project/source in total.

☒ **Air Quality Review**

☐ **ESA (Endangered Species Act)**

☐ **NHPA (National Historic Preservation Act)**

E. TABLE OF ESTIMATED EMISSIONS

The following tables provide the total emissions in tons/year for all pollutants from the calculations required in Section D of this form, as appropriate for the use specified at the top of the form.

E(i) – Proposed New Source

Pollutant	Potential Emissions (tpy)	Proposed Allowable Emissions (tpy)	
PM	3	6	PM - Particulate Matter PM_{10} - Particulate Matter less than 10 microns in size $PM_{2.5}$ - Particulate Matter less than 2.5 microns in size SO2 - Sulfur Oxides NOx - Nitrogen Oxides CO - Carbon Monoxide VOC - Volatile Organic Compound Pb - Lead and lead compounds Fluorides - Gaseous and particulates H_2SO_4 - Sulfuric Acid Mist H_2S - Hydrogen Sulfide TRS - Total Reduced Sulfur RSC - Reduced Sulfur Compounds
PM_{10}	3	6	
$PM_{2.5}$	3	6	
SO_2	17	21	
NO_x	805	59*	
CO	545	66*	
VOC	230	36*	
Pb	0	0	
Fluorides	0	0	
H_2SO_4	0	0	
H_2S	0	0	
TRS	0	0	
RSC	0	0	

* Requesting 92 tpy - values in table are calculated

Emissions calculations must include fugitive emissions if the source is one the following listed sources, pursuant to CAA Section 302(j):

(a) Coal cleaning plants (with thermal dryers);
(b) Kraft pulp mills;
(c) Portland cement plants;
(d) Primary zinc smelters;
(e) Iron and steel mills;
(f) Primary aluminum ore reduction plants;
(g) Primary copper smelters;
(h) Municipal incinerators capable of charging more than 250 tons of refuse per day;
(i) Hydrofluoric, sulfuric, or nitric acid plants;
(j) Petroleum refineries;
(k) Lime plants;
(l) Phosphate rock processing plants;
(m) Coke oven batteries;
(n) Sulfur recovery plants;
(o) Carbon black plants (furnace process);
(p) Primary lead smelters;
(q) Fuel conversion plants;
(r) Sintering plants;
(s) Secondary metal production plants;
(t) Chemical process plants
(u) Fossil-fuel boilers (or combination thereof) totaling more than 250 million British thermal units per hour heat input;
(v) Petroleum storage and transfer units with a total storage capacity exceeding 300,000 barrels;
(w) Taconite ore processing plants;
(x) Glass fiber processing plants;
(y) Charcoal production plants;
(z) Fossil fuel-fired steam electric plants of more that 250 million British thermal units per hour heat input, and
(aa) Any other stationary source category which, as of August 7, 1980, is being regulated under section 111 or 112 of the Act.

FORM NEW ATTACHMENT

Location	County	Township	Range	Section	Quarter Section	Latitude	Longitude
7a	Dunn	148 N	94 W	4	SE 1/4	47 deg 40' 19.8" N	102 deg 24' 6.6" W
7b	Dunn	149 N	94 W	36	NE 1/4	47 deg 40' 40.4" N	102 deg 23' 33.7" W

APPENDIX B

Emission Calculations

```
******************************************************************************************
*     Project Setup Information                                                          *
******************************************************************************************
Project File              : Untitled.Ept
Flowsheet Selection       : Oil Tank with Separator
Calculation Method        : AP42
Control Efficiency        : 100.0%
Known Separator Stream    : Low Pressure Gas
Entering Air Composition  : No

Filed Name                : Condensate Tank Rich Gas Mixture
Date                      : 2013.04.22


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

Separator Pressure        : 51.00[psig]
Separator Temperature     : 45.00[F]
Molar GOR                 : 0.0500
Ambient Pressure          : 14.70[psia]
Ambient Temperature       : 50.00[F]
C10+ SG                   : 0.8990
C10+ MW                   : 166.00

-- Low Pressure Gas ----------------------------------------------------------------------
   No.    Component            mol %
   1      H2S                   0.0000
   2      O2                    0.0000
   3      CO2                   0.5199
   4      N2                    3.8696
   5      C1                   55.2445
   6      C2                   21.8978
   7      C3                   11.9888
   8      i-C4                  1.0599
   9      n-C4                  3.2697
   10     i-C5                  0.4799
   11     n-C5                  0.6999
   12     C6                    0.9699
   13     C7+                   0.0000
   14     Benzene               0.0000
   15     Toluene               0.0000
   16     E-Benzene             0.0000
   17     Xylenes               0.0000
   18     n-C6                  0.0000
   19     224Trimethylp         0.0000

   C7+ Molar Ratio: C7  :     C8  :     C9  :     C10+
                    1.0000    1.0000    1.0000    1.0000

-- Sales Oil -----------------------------------------------------------------------------
Production Rate           : 100[bbl/day]
Days of Annual Operation  : 365 [days/year]
API Gravity               : 46.0
Reid Vapor Pressure       : 15.50[psia]
Bulk Temperature          : 50.00[F]

-- Tank and Shell Data -------------------------------------------------------------------
Diameter                  : 12.00[ft]
Shell Height              : 20.00[ft]
Cone Roof Slope           : 0.06
Average Liquid Height     : 12.00[ft]
Vent Pressure Range       : 0.06[psi]
Solar Absorbance          : 0.54
```

-- Meteorological Data --

City	: Billings, MT
Ambient Pressure	: 14.70[psia]
Ambient Temperature	: 50.00[F]
Min Ambient Temperature	: 35.40[F]
Max Ambient Temperature	: 57.90[F]
Total Solar Insolation	: 1432.00[Btu/ft^2*day]

****

*   Calculation Results   *

****

-- Emission Summary --

Item	Uncontrolled [ton/yr]	Uncontrolled [lb/hr]
Total HAPs	0.000	0.000
Total HC	241.554	55.149
VOCs, C2+	226.447	51.700
VOCs, C3+	172.241	39.324

Uncontrolled Recovery Info.

Vapor	12.5700	[MSCFD]
HC Vapor	12.4900	[MSCFD]
GOR	125.70	[SCF/bbl]

-- Emission Composition --

No	Component	Uncontrolled [ton/yr]	Uncontrolled [lb/hr]
1	H2S	0.000	0.000
2	O2	0.000	0.000
3	CO2	0.950	0.217
4	N2	0.491	0.112
5	C1	15.107	3.449
6	C2	54.206	12.376
7	C3	85.365	19.490
8	i-C4	12.145	2.773
9	n-C4	38.761	8.850
10	i-C5	7.244	1.654
11	n-C5	10.491	2.395
12	C6	16.389	3.742
13	C7	1.294	0.295
14	C8	0.410	0.094
15	C9	0.138	0.032
16	C10+	0.005	0.001
17	Benzene	0.000	0.000
18	Toluene	0.000	0.000
19	E-Benzene	0.000	0.000
20	Xylenes	0.000	0.000
21	n-C6	0.000	0.000
22	224Trimethylp	0.000	0.000
	Total	242.996	55.479

-- Stream Data --

No.	Component	MW	LP Oil mol %	Flash Oil mol %	Sale Oil mol %	Flash Gas mol %	W&S Gas mol %	Total Emissions mol %
1	H2S	34.80	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	O2	32.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	CO2	44.01	0.0401	0.0068	0.0068	0.3564	0.0000	0.3564
4	N2	28.01	0.0279	0.0005	0.0005	0.2896	0.0000	0.2896
5	C1	16.04	1.5728	0.1039	0.1039	15.5537	0.0000	15.5537
6	C2	30.07	4.1375	1.4438	1.4438	29.7754	0.0000	29.7754
7	C3	44.10	8.9756	6.5591	6.5591	31.9756	0.0000	31.9756
8	i-C4	58.12	2.1353	1.9971	1.9971	3.4512	0.0000	3.4512
9	n-C4	58.12	9.7671	9.6360	9.6360	11.0150	0.0000	11.0150
10	i-C5	72.15	3.8906	4.1251	4.1251	1.6583	0.0000	1.6583
11	n-C5	72.15	7.9550	8.5385	8.5385	2.4018	0.0000	2.4018
12	C6	86.16	31.8942	34.9065	34.9065	3.2228	0.0000	3.2228

13	C7	100.20	7.3987	8.1529	8.1529	0.2203	0.0000	0.2203
14	C8	114.23	7.4012	8.1724	8.1724	0.0610	0.0000	0.0610
15	C9	128.28	7.4019	8.1776	8.1776	0.0186	0.0000	0.0186
16	C10+	166.00	7.4022	8.1798	8.1798	0.0005	0.0000	0.0005
17	Benzene	78.11	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
18	Toluene	92.13	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19	E-Benzene	106.17	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	Xylenes	106.17	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	n-C6	86.18	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
22	224Trimethylp	114.24	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MW		84.52	89.18	89.18	40.14	0.00	40.14
	Stream Mole Ratio		1.0000	0.9049	0.9049	0.0951	0.0000	0.0951
	Heating Value	[BTU/SCF]				2289.19	0.00	2289.19
	Gas Gravity	[Gas/Air]				1.39	0.00	1.39
	Bubble Pt. @ 100F	[psia]	99.14	33.58	33.58			
	RVP @ 100F	[psia]	326.70	174.56	174.56			
	Spec. Gravity @ 100F		0.661	0.671	0.671			

Arrow Pipeline, LLC
Fort Berthold Compressor Station #7
Emission Calculations

Table 1 - Equipment List

Source ID	Type of Equipment	Quantity	Manufacturer	Model	Maximum Rated Capacity	Year of Manufacture
TBD	Natural Gas-Fired 4-Stroke Rich-Burn Engine	3	TBD	TBD	1,480 BHP	TBD
TBD	Natural Gas-Fired 4-Stroke Rich-Burn Engine	1	TBD	TBD	740 BHP	TBD
TBD	Natural Gas-Fired 4-Stroke Rich-Burn Engine	1	TBD	TBD	435 BHP	TBD
TBD	Natural Gas-Fired 4-Stroke Rich-Burn Engine	1	TBD	TBD	326 BHP	TBD
TBD	Natural Gas-Fired 4-Stroke Lean-Burn Engine	1	TBD	TBD	530 BHP	2006
TBD	Natural Gas-Fired 4-Stroke Lean-Burn Engine	1	TBD	TBD	400 BHP	2006
TBD	Condensate Tank (400 BBL)	2	TBD	TBD	400 BBL	TBD
TBD	Water Storage Tank (400 BBL)	1	TBD	TBD	400 BBL	TBD

Arrow Pipeline, LLC
Fort Berthold Compressor Station #7
Emission Calculations

Table 2 - 530 bhp Natural-Gas Fired Engine Potential to Emit

Assumption:		***Description:***	
Hours per year/unit operated:	8,760	Natural Gas-Fired 4-stroke Lean-Burn SI RICE	
Number of units	1	Standard Rated Power (bhp):	530
		Fuel Consumption (Btu/bhp-hr):	8,499

Pollutant	Emission Factor [1]	Emission Factor [2]	Single Unit Uncontrolled Potential Emissions [3]			Single Unit Potential Emissions [3,4]		
	(g/bhp-hr)	*(lb/mmBtu)*	*(lb/hr)*	*(lb/yr)*	*(tons/year)*	*(lb/hr)*	*(lb/yr)*	*(tons/year)*
CO	1.30	-	1.52E+00	13,306.38	6.65E+00	1.52E+00	13,306.38	6.65E+00
NO_X	2.00	-	2.34E+00	20,471.35	1.02E+01	2.34E+00	20,471.35	1.02E+01
SO_X [5]	-	5.70E-02	2.57E-01	2,249.17	1.12E+00	2.57E-01	2,249.17	1.12E+00
PM_{10}	-	7.71E-05	3.47E-04	3.04	1.52E-03	3.47E-04	3.04	1.52E-03
$PM_{2.5}$	-	7.71E-05	3.47E-04	3.04	1.52E-03	3.47E-04	3.04	1.52E-03
VOC	0.75	-	8.76E-01	7,676.76	3.84E+00	8.76E-01	7,676.76	3.84E+00
Hazardous Air Pollutants								
1,1,2,2-Tetrachloroethane	-	4.00E-05	1.80E-04	1.58	7.89E-04	1.80E-04	1.58	7.89E-04
1,1,2-Trichloroethane	-	3.18E-05	1.43E-04	1.25	6.27E-04	1.43E-04	1.25	6.27E-04
1,3-Butadiene	-	2.67E-04	1.20E-03	10.54	5.27E-03	1.20E-03	10.54	5.27E-03
1,3-Dichloropropene	-	2.64E-05	1.19E-04	1.04	5.21E-04	1.19E-04	1.04	5.21E-04
2,2,4-Trimethylpentane	-	2.50E-04	1.13E-03	9.86	4.93E-03	1.13E-03	9.86	4.93E-03
Acetaldehyde	-	8.36E-03	3.77E-02	329.88	1.65E-01	3.77E-02	329.88	1.65E-01
Acrolein	-	5.14E-03	2.32E-02	202.82	1.01E-01	2.32E-02	202.82	1.01E-01
Benzene	-	4.40E-04	1.98E-03	17.36	8.68E-03	1.98E-03	17.36	8.68E-03
Carbon Tetrachloride	-	3.67E-05	1.65E-04	1.45	7.24E-04	1.65E-04	1.45	7.24E-04
Chlorobenzene	-	3.04E-05	1.37E-04	1.20	6.00E-04	1.37E-04	1.20	6.00E-04
Chloroform	-	2.85E-05	1.28E-04	1.12	5.62E-04	1.28E-04	1.12	5.62E-04
Ethylbenzene	-	3.97E-05	1.79E-04	1.57	7.83E-04	1.79E-04	1.57	7.83E-04
Ethylene Dibromide	-	4.43E-05	2.00E-04	1.75	8.74E-04	2.00E-04	1.75	8.74E-04
Formaldehyde [5]	-	5.28E-02	2.38E-01	2,083.44	1.04E+00	2.38E-01	2,083.44	1.04E+00
Methanol	-	2.50E-03	1.13E-02	98.65	4.93E-02	1.13E-02	98.65	4.93E-02
Methylene Chloride	-	2.00E-05	9.01E-05	0.79	3.95E-04	9.01E-05	0.79	3.95E-04
n-Hexane	-	1.11E-03	5.00E-03	43.80	2.19E-02	5.00E-03	43.80	2.19E-02
Napthalene	-	7.44E-05	3.35E-04	2.94	1.47E-03	3.35E-04	2.94	1.47E-03
PAH	-	2.69E-05	1.21E-04	1.06	5.31E-04	1.21E-04	1.06	5.31E-04
Phenol	-	2.40E-05	1.08E-04	0.95	4.74E-04	1.08E-04	0.95	4.74E-04
Styrene	-	2.36E-05	1.06E-04	0.93	4.66E-04	1.06E-04	0.93	4.66E-04
Tetrachloroethane	-	2.48E-06	1.12E-05	0.10	4.89E-05	1.12E-05	0.10	4.89E-05
Toluene	-	4.08E-04	1.84E-03	16.10	8.05E-03	1.84E-03	16.10	8.05E-03
Vinyl Chloride	-	1.49E-05	6.71E-05	0.59	2.94E-04	6.71E-05	0.59	2.94E-04
Xylene	-	1.84E-04	8.29E-04	7.26	3.63E-03	8.29E-04	7.26	3.63E-03
		Total HAP	0.32	2,838.02	1.42	0.32	2,838.02	1.42

[1] Emission factors are from a representative 530-bhp lean-burn engine (Waukesha's Gas Engine Site Specific Technical Data for H24GL Gas Compression Engine).

[2] Emission factors for uncontrolled criteria and trace organic compounds are from AP-42 Chapter 3 Section 2 – Natural Gas-fired Reciprocating Engines Table 3.2-2 Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines.

[3] Annual emissions are based on an operating schedule of 24 hours/day, 365 days/year (i.e., 8,760 hours/year).

[4] Emissions are uncontrolled.

[5] Emission factor based on 0.057 lb/mmBtu calculated from 20 gr S/100 scf natural gas (highest default pipeline natural gas value defined in 40 CFR 72.2)

Arrow Pipeline, LLC
Fort Berthold Compressor Station #7
Emission Calculations

Table 3 - 1,480 bhp Natural-Gas Fired Engine Potential to Emit

Assumption:
Hours per year/unit operated: 8,760
Number of units: 3

Description:
Natural Gas-Fired 4-stroke Rich-Burn SI RICE
Standard Rated Power (bhp): 1,480
Fuel Consumption (Btu/bhp-hr): [6] 9,840

Pollutant	Emission Factor [1]	Emission Factor [2]	Destruction or Removal Efficiency[3]	Single Unit Uncontrolled Potential Emissions [4]			Single Unit Controlled Potential Emissions [4]		
	(g/bhp-hr)	*(lb/mmBtu)*	*%*	*(lb/hr)*	*(lb/yr)*	*(tons/year)*	*(lb/hr)*	*(lb/yr)*	*(tons/year)*
CO	9.00	-	90.0	2.94E+01	257,243.77	1.29E+02	2.94E+00	25,724.38	1.29E+01
NO_X	13.00	-	95.0	4.24E+01	371,574.33	1.86E+02	2.12E+00	18,578.72	9.29E+00
SO_X [5]	-	5.70E-02	-	8.30E-01	7,271.70	3.64E+00	8.30E-01	7,271.70	3.64E+00
PM_{10}	-	9.50E-03	-	1.38E-01	1,211.95	6.06E-01	1.38E-01	1,211.95	6.06E-01
$PM_{2.5}$	-	9.50E-03	-	1.38E-01	1,211.95	6.06E-01	1.38E-01	1,211.95	6.06E-01
VOC	0.86	-	80.0	2.81E+00	24,581.07	1.23E+01	5.61E-01	4,916.21	2.46E+00
Hazardous Air Pollutants									
1,1,2,2-Tetrachloroethane	-	2.53E-05	-	3.68E-04	3.23	1.61E-03	3.68E-04	3.23	1.61E-03
1,1,2-Trichloroethane	-	1.53E-05	-	2.23E-04	1.95	9.76E-04	2.23E-04	1.95	9.76E-04
1,3-Butadiene	-	6.63E-04	-	9.66E-03	84.58	4.23E-02	9.66E-03	84.58	4.23E-02
1,3-Dichloropropene	-	1.27E-05	-	1.85E-04	1.62	8.10E-04	1.85E-04	1.62	8.10E-04
Acetaldehyde	-	2.79E-03	-	4.06E-02	355.93	1.78E-01	4.06E-02	355.93	1.78E-01
Acrolein	-	2.63E-03	-	3.83E-02	335.52	1.68E-01	3.83E-02	335.52	1.68E-01
Benzene	-	1.58E-03	-	2.30E-02	201.57	1.01E-01	2.30E-02	201.57	1.01E-01
Carbon Tetrachloride	-	1.77E-05	-	2.58E-04	2.26	1.13E-03	2.58E-04	2.26	1.13E-03
Chlorobenzene	-	1.29E-05	-	1.88E-04	1.65	8.23E-04	1.88E-04	1.65	8.23E-04
Chloroform	-	1.37E-05	-	2.00E-04	1.75	8.74E-04	2.00E-04	1.75	8.74E-04
Ethylbenzene	-	2.48E-05	-	3.61E-04	3.16	1.58E-03	3.61E-04	3.16	1.58E-03
Ethylene Dibromide	-	2.13E-05	-	3.10E-04	2.72	1.36E-03	3.10E-04	2.72	1.36E-03
Formaldehyde [5]	0.05	-	90	1.63E-01	1,429.13	7.15E-01	1.63E-02	142.91	7.15E-02
Methanol	-	3.06E-03	-	4.46E-02	390.38	1.95E-01	4.46E-02	390.38	1.95E-01
Methylene Chloride	-	4.12E-05	-	6.00E-04	5.26	2.63E-03	6.00E-04	5.26	2.63E-03
Napthalene	-	9.71E-05	-	1.41E-03	12.39	6.19E-03	1.41E-03	12.39	6.19E-03
PAH	-	1.41E-04	-	2.05E-03	17.99	8.99E-03	2.05E-03	17.99	8.99E-03
Styrene	-	1.19E-05	-	1.73E-04	1.52	7.59E-04	1.73E-04	1.52	7.59E-04
Toluene	-	5.58E-04	-	8.13E-03	71.19	3.56E-02	8.13E-03	71.19	3.56E-02
Vinyl Chloride	-	7.18E-06	-	1.05E-04	0.92	4.58E-04	1.05E-04	0.92	4.58E-04
Xylene	-	1.95E-04	-	2.84E-03	24.88	1.24E-02	2.84E-03	24.88	1.24E-02
		Total HAP		0.34	2,949.56	1.47	0.19	1,663.35	0.83

[1] Uncontrolled emission factors for criteria pollutants are from a representative 1,480-bhp engine (Waukesha's Gas Engine Site Specific Technical Data for L7042GSI Gas Compression Engine equipped with catalyst converter/silencer housing).

[2] Emission factors for uncontrolled criteria and trace organic compounds are from AP-42 Chapter 3 Section 2 – Natural Gas-fired Reciprocating Engines Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines.

[3] Destruction or removal efficiency factors for typical NSRC Catalytic/Silencer.

[4] Annual emissions are based on an operating schedule of 24 hours/day, 365 days/year (i.e., 8,760 hours/year).

[5] Formaldehyde emission levels are calculated based on GE VGF G series natural-gas combustion turbines.

[6] Fuel consumption only provided on a lower heating value (LHV) basis. To convert to the higher heating value (HHV) basis, the ratio of the HHV to the LHV heat content of the fuel was multiplied by the fuel consumption given at the LHV.

Arrow Pipeline, LLC
Fort Berthold Compressor Station #7
Emission Calculations

Table 4 - 435 bhp Natural-Gas Fired Engine Potential to Emit

Assumption:		
Hours per year/unit operated:	8,760	
Number of units	1	

Description:	
Natural Gas-Fired 4-stroke Rich-Burn SI RICE	
Standard Rated Power (bhp):	435
Fuel Consumption (Btu/bhp-hr):	9,483

Pollutant	Emission Factor [1]	Emission Factor [2]	Destruction or Removal Efficiency[3]	Single Unit Uncontrolled Potential Emissions [4]			Single Unit Controlled Potential Emissions [4]		
	(g/bhp-hr)	*(lb/mmBtu)*	*%*	*(lb/hr)*	*(lb/yr)*	*(tons/year)*	*(lb/hr)*	*(lb/yr)*	*(tons/year)*
CO	8.00	-	90.0	7.67E+00	67,207.83	3.36E+01	7.67E-01	6,720.78	3.36E+00
NO_X	16.00	-	95.0	1.53E+01	134,415.66	6.72E+01	7.67E-01	6,720.78	3.36E+00
SO_X [5]	-	5.70E-02	-	2.35E-01	2,059.75	1.03E+00	2.35E-01	2,059.75	1.03E+00
PM_{10}	-	9.50E-03	-	3.92E-02	343.29	1.72E-01	3.92E-02	343.29	1.72E-01
$PM_{2.5}$	-	9.50E-03	-	3.92E-02	343.29	1.72E-01	3.92E-02	343.29	1.72E-01
VOC	0.67	-	80.0	6.43E-01	5,628.66	2.81E+00	1.29E-01	1,125.73	5.63E-01
Hazardous Air Pollutants									
1,1,2,2-Tetrachloroethane	-	2.53E-05	-	1.04E-04	0.91	4.57E-04	1.04E-04	0.91	4.57E-04
1,1,2-Trichloroethane	-	1.53E-05	-	6.31E-05	0.55	2.76E-04	6.31E-05	0.55	2.76E-04
1,3-Butadiene	-	6.63E-04	-	2.73E-03	23.96	1.20E-02	2.73E-03	23.96	1.20E-02
1,3-Dichloropropene	-	1.27E-05	-	5.24E-05	0.46	2.29E-04	5.24E-05	0.46	2.29E-04
Acetaldehyde	-	2.79E-03	-	1.15E-02	100.82	5.04E-02	1.15E-02	100.82	5.04E-02
Acrolein	-	2.63E-03	-	1.08E-02	95.04	4.75E-02	1.08E-02	95.04	4.75E-02
Benzene	-	1.58E-03	-	6.52E-03	57.09	2.85E-02	6.52E-03	57.09	2.85E-02
Carbon Tetrachloride	-	1.77E-05	-	7.30E-05	0.64	3.20E-04	7.30E-05	0.64	3.20E-04
Chlorobenzene	-	1.29E-05	-	5.32E-05	0.47	2.33E-04	5.32E-05	0.47	2.33E-04
Chloroform	-	1.37E-05	-	5.65E-05	0.50	2.48E-04	5.65E-05	0.50	2.48E-04
Ethylbenzene	-	2.48E-05	-	1.02E-04	0.90	4.48E-04	1.02E-04	0.90	4.48E-04
Ethylene Dibromide	-	2.13E-05	-	8.79E-05	0.77	3.85E-04	8.79E-05	0.77	3.85E-04
Formaldehyde [5]	0.05	-	90	2.06E-01	1,806.80	9.03E-01	4.80E-03	42.00	2.10E-02
Methanol	-	3.06E-03	-	1.26E-02	110.58	5.53E-02	1.26E-02	110.58	5.53E-02
Methylene Chloride	-	4.12E-05	-	1.70E-04	1.49	7.44E-04	1.70E-04	1.49	7.44E-04
Napthalene	-	9.71E-05	-	4.01E-04	3.51	1.75E-03	4.01E-04	3.51	1.75E-03
PAH	-	1.41E-04	-	5.82E-04	5.10	2.55E-03	5.82E-04	5.10	2.55E-03
Styrene	-	1.19E-05	-	4.91E-05	0.43	2.15E-04	4.91E-05	0.43	2.15E-04
Toluene	-	5.58E-04	-	2.30E-03	20.16	1.01E-02	2.30E-03	20.16	1.01E-02
Vinyl Chloride	-	7.18E-06	-	2.96E-05	0.26	1.30E-04	2.96E-05	0.26	1.30E-04
Xylene	-	1.95E-04	-	8.04E-04	7.05	3.52E-03	8.04E-04	7.05	3.52E-03
		Total HAP		0.26	2,237.47	1.12	0.05	472.68	0.24

[1] Uncontrolled emission factors are from a representative 435-bhp engine (Waukesha's Gas Engine Site Specific Technical Data for H24GSI Gas Compression Engine equipped with catalyst converter/silencer housing).

[2] Emission factors for uncontrolled criteria and trace organic compounds are from AP-42 Chapter 3 Section 2 – Natural Gas-fired Reciprocating Engines Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines.

[3] Destruction or removal efficiency factors for typical NSRC Catalytic/Silencer.

[4] Annual emissions are based on an operating schedule of 24 hours/day, 365 days/year (i.e., 8,760 hours/year).

[5] Formaldehyde emission levels are calculated based on GE VGF G series natural-gas combustion turbines.

Arrow Pipeline, LLC
Fort Berthold Compressor Station #7
Emission Calculations

Table 5 - 740 bhp Natural-Gas Fired Engine Potential to Emit

Assumption:	
Hours per year/unit operated:	8,760
Number of units:	1

Description:	
Natural Gas-Fired 4-stroke Rich-Burn SI RICE	
Standard Rated Power (bhp):	740
Fuel Consumption (Btu/bhp-hr):	8,896

Pollutant	Emission Factor [1]	Emission Factor [2]	Destruction or Removal Efficiency[3]	Single Unit Uncontrolled Potential Emissions [4]			Single Unit Controlled Potential Emissions [4]		
	(g/bhp-hr)	*(lb/mmBtu)*	*%*	*(lb/hr)*	*(lb/yr)*	*(tons/year)*	*(lb/hr)*	*(lb/yr)*	*(tons/year)*
CO	12.40	-	90.0	2.02E+01	177,212.37	8.86E+01	2.02E+00	17,721.24	8.86E+00
NO_X	15.60	-	95.0	2.55E+01	222,944.60	1.11E+02	1.27E+00	11,147.23	5.57E+00
SO_X [5]	-	5.70E-02	-	3.75E-01	3,287.04	1.64E+00	3.75E-01	3,287.04	1.64E+00
PM_{10}	-	9.50E-03	-	6.25E-02	547.84	2.74E-01	6.25E-02	547.84	2.74E-01
$PM_{2.5}$	-	9.50E-03	-	6.25E-02	547.84	2.74E-01	6.25E-02	547.84	2.74E-01
VOC	0.25	-	80.0	4.08E-01	3,572.83	1.79E+00	8.16E-02	714.57	3.57E-01
Hazardous Air Pollutants									
1,1,2,2-Tetrachloroethane	-	2.53E-05	-	1.67E-04	1.46	7.29E-04	1.67E-04	1.46	7.29E-04
1,1,2-Trichloroethane	-	1.53E-05	-	1.01E-04	0.88	4.41E-04	1.01E-04	0.88	4.41E-04
1,3-Butadiene	-	6.63E-04	-	4.36E-03	38.23	1.91E-02	4.36E-03	38.23	1.91E-02
1,3-Dichloropropene	-	1.27E-05	-	8.36E-05	0.73	3.66E-04	8.36E-05	0.73	3.66E-04
Acetaldehyde	-	2.79E-03	-	1.84E-02	160.89	8.04E-02	1.84E-02	160.89	8.04E-02
Acrolein	-	2.63E-03	-	1.73E-02	151.67	7.58E-02	1.73E-02	151.67	7.58E-02
Benzene	-	1.58E-03	-	1.04E-02	91.11	4.56E-02	1.04E-02	91.11	4.56E-02
Carbon Tetrachloride	-	1.77E-05	-	1.17E-04	1.02	5.10E-04	1.17E-04	1.02	5.10E-04
Chlorobenzene	-	1.29E-05	-	8.49E-05	0.74	3.72E-04	8.49E-05	0.74	3.72E-04
Chloroform	-	1.37E-05	-	9.02E-05	0.79	3.95E-04	9.02E-05	0.79	3.95E-04
Ethylbenzene	-	2.48E-05	-	1.63E-04	1.43	7.15E-04	1.63E-04	1.43	7.15E-04
Ethylene Dibromide	-	2.13E-05	-	1.40E-04	1.23	6.14E-04	1.40E-04	1.23	6.14E-04
Formaldehyde [5]	0.05	-	90	8.16E-02	714.57	3.57E-01	8.16E-03	71.46	3.57E-02
Methanol	-	3.06E-03	-	2.01E-02	176.46	8.82E-02	2.01E-02	176.46	8.82E-02
Methylene Chloride	-	4.12E-05	-	2.71E-04	2.38	1.19E-03	2.71E-04	2.38	1.19E-03
Napthalene	-	9.71E-05	-	6.39E-04	5.60	2.80E-03	6.39E-04	5.60	2.80E-03
PAH	-	1.41E-04	-	9.28E-04	8.13	4.07E-03	9.28E-04	8.13	4.07E-03
Styrene	-	1.19E-05	-	7.83E-05	0.69	3.43E-04	7.83E-05	0.69	3.43E-04
Toluene	-	5.58E-04	-	3.67E-03	32.18	1.61E-02	3.67E-03	32.18	1.61E-02
Vinyl Chloride	-	7.18E-06	-	4.73E-05	0.41	2.07E-04	4.73E-05	0.41	2.07E-04
Xylene	-	1.95E-04	-	1.28E-03	11.25	5.62E-03	1.28E-03	11.25	5.62E-03
		Total HAP		0.16	1,401.85	0.70	0.09	758.74	0.38

[1] Emission factors for criteria pollutants are from a representative 740-bhp engine (Waukesha's Gas Engine Site Specific Technical Data for L3514GSI Engine equipped with catalyst converter/silencer housing).

[2] Emission factors for uncontrolled criteria and trace organic compounds are from AP-42 Chapter 3 Section 2 – Natural Gas-fired Reciprocating Engines Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines.

[3] Destruction or removal efficiency factors for typical NSRC Catalytic/Silencer.

[4] Annual emissions are based on an operating schedule of 24 hours/day, 365 days/year (i.e., 8,760 hours/year).

[5] Formaldehyde emission levels are calculated based on GE VGF G series natural-gas combustion turbines.

Arrow Pipeline, LLC
Fort Berthold Compressor Station #7
Emission Calculations

Table 6 - 326 bhp Natural-Gas Fired Engine Potential to Emit

Assumption:		**Description:**	
Hours per year/unit operated:	8,760	Natural Gas-Fired 4-stroke Rich-Burn SI RICE	
Number of units	1	Standard Rated Power (bhp):	326
		Fuel Consumption (Btu/bhp-hr):	9,519

Pollutant	Emission Factor [1]	Emission Factor [2]	Destruction or Removal Efficiency [3]	Single Unit Uncontrolled Potential Emissions [4]			Single Unit Controlled Potential Emissions [4]		
	(g/bhp-hr)	*(lb/mmBtu)*	*%*	*(lb/hr)*	*(lb/yr)*	*(tons/year)*	*(lb/hr)*	*(lb/yr)*	*(tons/year)*
CO	8.00	-	90.0	5.75E+00	50,367.25	2.52E+01	5.75E-01	5,036.72	2.52E+00
NO_X	16.00	-	95.0	1.15E+01	100,734.50	5.04E+01	5.75E-01	5,036.72	2.52E+00
SO_X [5]	-	5.70E-02	-	1.77E-01	1,549.49	7.75E-01	1.77E-01	1,549.49	7.75E-01
PM_{10}	-	9.50E-03	-	2.95E-02	258.25	1.29E-01	2.95E-02	258.25	1.29E-01
$PM_{2.5}$	-	9.50E-03	-	2.95E-02	258.25	1.29E-01	2.95E-02	258.25	1.29E-01
VOC	0.67	-	80.0	4.82E-01	4,218.26	2.11E+00	9.63E-02	843.65	4.22E-01
Hazardous Air Pollutants									
1,1,2,2-Tetrachloroethane	-	2.53E-05	-	7.85E-05	0.69	3.44E-04	7.85E-05	0.69	3.44E-04
1,1,2-Trichloroethane	-	1.53E-05	-	4.75E-05	0.42	2.08E-04	4.75E-05	0.42	2.08E-04
1,3-Butadiene	-	6.63E-04	-	2.06E-03	18.02	9.01E-03	2.06E-03	18.02	9.01E-03
1,3-Dichloropropene	-	1.27E-05	-	3.94E-05	0.35	1.73E-04	3.94E-05	0.35	1.73E-04
Acetaldehyde	-	2.79E-03	-	8.66E-03	75.84	3.79E-02	8.66E-03	75.84	3.79E-02
Acrolein	-	2.63E-03	-	8.16E-03	71.49	3.57E-02	8.16E-03	71.49	3.57E-02
Benzene	-	1.58E-03	-	4.90E-03	42.95	2.15E-02	4.90E-03	42.95	2.15E-02
Carbon Tetrachloride	-	1.77E-05	-	5.49E-05	0.48	2.41E-04	5.49E-05	0.48	2.41E-04
Chlorobenzene	-	1.29E-05	-	4.00E-05	0.35	1.75E-04	4.00E-05	0.35	1.75E-04
Chloroform	-	1.37E-05	-	4.25E-05	0.37	1.86E-04	4.25E-05	0.37	1.86E-04
Ethylbenzene	-	2.48E-05	-	7.70E-05	0.67	3.37E-04	7.70E-05	0.67	3.37E-04
Ethylene Dibromide	-	2.13E-05	-	6.61E-05	0.58	2.90E-04	6.61E-05	0.58	2.90E-04
Formaldehyde [5]	0.05	-	90.0	1.55E-01	1,359.20	6.80E-01	3.59E-03	31.48	1.57E-02
Methanol	-	3.06E-03	-	9.50E-03	83.18	4.16E-02	9.50E-03	83.18	4.16E-02
Methylene Chloride	-	4.12E-05	-	1.28E-04	1.12	5.60E-04	1.28E-04	1.12	5.60E-04
Napthalene	-	9.71E-05	-	3.01E-04	2.64	1.32E-03	3.01E-04	2.64	1.32E-03
PAH	-	1.41E-04	-	4.38E-04	3.83	1.92E-03	4.38E-04	3.83	1.92E-03
Styrene	-	1.19E-05	-	3.69E-05	0.32	1.62E-04	3.69E-05	0.32	1.62E-04
Toluene	-	5.58E-04	-	1.73E-03	15.17	7.58E-03	1.73E-03	15.17	7.58E-03
Vinyl Chloride	-	7.18E-06	-	2.23E-05	0.20	9.76E-05	2.23E-05	0.20	9.76E-05
Xylene	-	1.95E-04	-	6.05E-04	5.30	2.65E-03	6.05E-04	5.30	2.65E-03
		Total HAP		0.19	1,683.18	0.84	0.04	355.46	0.18

[1] Emission factors for criteria pollutants are from a representative 326-bhp engine (Waukesha's Gas Engine Site Specific Technical Data for F18GSI Engine equipped with catalyst converter/silencer housing).

[2] Emission factors for uncontrolled criteria and trace organic compounds are from AP-42 Chapter 3 Section 2 – Natural Gas-fired Reciprocating Engines Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines.

[3] Destruction or removal efficiency factors for typical NSRC Catalytic/Silencer.

[4] Annual emissions are based on an operating schedule of 24 hours/day, 365 days/year (i.e., 8,760 hours/year).

[5] Formaldehyde emission levels are calculated based on GE VGF G series natural-gas combustion turbines.

Arrow Pipeline, LLC
Fort Berthold Compressor Station #7
Emission Calculations

Table 7 - 400 bhp Natural-Gas Fired Engine Potential to Emit

Assumption:		***Description:***	
Hours per year/unit operated:	8,760	Natural Gas-Fired 4-stroke Lean-Burn SI RICE	
Number of units:	1	Standard Rated Power (bhp):	400
		Fuel Consumption (Btu/bhp-hr):	7,862

Pollutant	Emission Factor [1]	Emission Factor [2]	Single Unit Uncontrolled Potential Emissions [4]			Single Unit Controlled Potential Emissions [4]		
	(g/bhp-hr)	*(lb/mmBtu)*	*(lb/hr)*	*(lb/yr)*	*(tons/year)*	*(lb/hr)*	*(lb/yr)*	*(tons/year)*
CO	1.30	-	1.15E+00	10,042.55	5.02E+00	1.15E+00	10,042.55	5.02E+00
NO_X	2.00	-	1.76E+00	15,450.08	7.73E+00	1.76E+00	15,450.08	7.73E+00
SO_X [5]	-	5.70E-02	1.79E-01	1,570.26	7.85E-01	1.79E-01	1,570.26	7.85E-01
PM_{10}	-	7.71E-05	2.42E-04	2.12	1.06E-03	2.42E-04	2.12	1.06E-03
$PM_{2.5}$	-	7.71E-05	2.42E-04	2.12	1.06E-03	2.42E-04	2.12	1.06E-03
VOC	0.74	-	6.53E-01	5,716.53	2.86E+00	6.53E-01	5,716.53	2.86E+00
Hazardous Air Pollutants								
1,1,2,2-Tetrachloroethane	-	4.00E-05	1.26E-04	1.10	5.51E-04	1.26E-04	1.10	5.51E-04
1,1,2-Trichloroethane	-	3.18E-05	1.00E-04	0.88	4.38E-04	1.00E-04	0.88	4.38E-04
1,3-Butadiene	-	2.67E-04	8.40E-04	7.36	3.68E-03	8.40E-04	7.36	3.68E-03
1,3-Dichloropropene	-	2.64E-05	8.30E-05	0.73	3.64E-04	8.30E-05	0.73	3.64E-04
2,2,4-Trimethylpentane	-	2.50E-04	7.86E-04	6.89	3.44E-03	7.86E-04	6.89	3.44E-03
Acetaldehyde	-	8.36E-03	2.63E-02	230.31	1.15E-01	2.63E-02	230.31	1.15E-01
Acrolein	-	5.14E-03	1.62E-02	141.60	7.08E-02	1.62E-02	141.60	7.08E-02
Benzene	-	4.40E-04	1.38E-03	12.12	6.06E-03	1.38E-03	12.12	6.06E-03
Carbon Tetrachloride	-	3.67E-05	1.15E-04	1.01	5.06E-04	1.15E-04	1.01	5.06E-04
Chlorobenzene	-	3.04E-05	9.56E-05	0.84	4.19E-04	9.56E-05	0.84	4.19E-04
Chloroform	-	2.85E-05	8.96E-05	0.79	3.93E-04	8.96E-05	0.79	3.93E-04
Ethylbenzene	-	3.97E-05	1.25E-04	1.09	5.47E-04	1.25E-04	1.09	5.47E-04
Ethylene Dibromide	-	4.43E-05	1.39E-04	1.22	6.10E-04	1.39E-04	1.22	6.10E-04
Formaldehyde [5]	-	5.28E-02	1.66E-01	1,454.56	7.27E-01	1.66E-01	1,454.56	7.27E-01
Methanol	-	2.50E-03	7.86E-03	68.87	3.44E-02	7.86E-03	68.87	3.44E-02
Methylene Chloride	-	2.00E-05	6.29E-05	0.55	2.75E-04	6.29E-05	0.55	2.75E-04
n-Hexane	-	1.11E-03	3.49E-03	30.58	1.53E-02	3.49E-03	30.58	1.53E-02
Napthalene	-	7.44E-05	2.34E-04	2.05	1.02E-03	2.34E-04	2.05	1.02E-03
PAH	-	2.69E-05	8.46E-05	0.74	3.71E-04	8.46E-05	0.74	3.71E-04
Phenol	-	2.40E-05	7.55E-05	0.66	3.31E-04	7.55E-05	0.66	3.31E-04
Styrene	-	2.36E-05	7.42E-05	0.65	3.25E-04	7.42E-05	0.65	3.25E-04
Tetrachloroethane	-	2.48E-06	7.80E-06	0.07	3.42E-05	7.80E-06	0.07	3.42E-05
Toluene	-	4.08E-04	1.28E-03	11.24	5.62E-03	1.28E-03	11.24	5.62E-03
Vinyl Chloride	-	1.49E-05	4.69E-05	0.41	2.05E-04	4.69E-05	0.41	2.05E-04
Xylene	-	1.84E-04	5.79E-04	5.07	2.53E-03	5.79E-04	5.07	2.53E-03
		Total HAP	0.23	1,981.37	0.99	0.23	1,981.37	0.99

[1] Emission factors are from a representative 530-bhp lean-burn engine (Waukesha's Gas Engine Site Specific Technical Data for F18GL Gas Compression Engine).

[2] Emission factors for uncontrolled criteria and trace organic compounds are from AP-42 Chapter 3 Section 2 – Natural Gas-fired Reciprocating Engines Table 3.2-2 Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines.

[3] Annual emissions are based on an operating schedule of 24 hours/day, 365 days/year (i.e., 8,760 hours/year).

[4] Emissions are uncontrolled.

[5] Emission factor based on 0.057 lb/mmBtu calculated from 20 gr S/100 scf natural gas (highest default pipeline natural gas value defined in 40 CFR 72.2)

Arrow Pipeline, LLC
Fort Berthold Compressor Station #7
Emission Calculations

Table 8 - Tank Flashing Losses Potential to Emit

Description	Contents	Quantity	Facility Throughput	Tank Gas Emission Characteristics			Destruction or Removal Efficiency	Uncontrolled Flashing Losses		Controlled Flashing Losses	
				Heat Content	Gas Volume	Heat Rating		VOC	HAP	VOC	HAP
			(bbls/day)	*(Btu/SCF)*	*(MSCFD)*	*(MMBtu/hr)*	*%*	*(tpy)*	*(tpy)*	*(tpy)*	*(tpy)*
Condensate Tank (400 bbl) [1, 2]	Condensate	2	100	2,289	12.57	1.20	95	172.24	16.39	8.61	0.82
Water Tank (400 bbl) [2,3]	Water	1	10	2,289	0.13	0.01	0	1.72	0.16	1.72	0.16

[1] Gas volume, and flashing losses are calculated using representative tank throughputs in E&P TANK 2.0 (assuming the rich-burn fuel specs for the engines are representative of the low-pressure gas flashed from the tanks). It was assumed that the hexane emissions were representative of the HAP emissions. Working and breathing losses were unable to be accounted for as the program was unable to converge based on the input data. From experience, working and breathing losses are only a small fraction of flash losses (~1%) and, therefore, quantifying working and breathing losses would not substantively impact emission calculations.

[2] Heat rating is calculated by taking the ratio of the heat content to the gas volume and multiplying by the appropriate conversion factors (24 hrs/day; 1,000 SCF/MSCF; 10^6 Btu/MMBtu).

[3] Water tank gas volume and emissions calculated conservatively assuming a hydrocarbon content of approximately 10% that of the condensate tank and using the ratio of the water tank throughput to that of the condensate tank throughput (i.e., water tank gas volume and emissions are equal to approximately 1% that of the condensate tank). Heat content of the emissions are assumed similiar to those of the condensate tank.

Table 9 - Tank Battery Control Device (e.g., Thermal Oxidizer, Flare, or equivalent) Potential to Emit

Pollutant	Default Emission Factors (lb/MMBtu) [1]
CO	0.096
NO_x	0.274
$PM/PM_{10}/PM_{2.5}$	0.452
SO2	0.630
VOC	0.808
HAP	0.002

Description	Heat Content	Gas Volume	Heat Rating	Tank Emissions (tpy) [4]						
	(Btu/SCF)	*(MSCFD)*	*(MMBtu/hr)*	CO	NO_x	PM_{10}	$PM_{2.5}$	SO2	VOC	HAP
Total Tank Vapor Combustion Emissions [2]	2,289	12.57	1.20	0.50	1.44	2.37	2.37	3.31	4.24	0.01
Supplemental Fuel Combustion Emissions [3]	1,503	2.592	0.16	0.07	0.19	0.32	0.32	0.45	0.57	0.00
Total	**-**	**-**	**1.36**	**0.57**	**1.63**	**2.70**	**2.70**	**3.76**	**4.82**	**0.01**

[1] Emission factors are from AP-42 Chapter 1 Section 4 –Natural Gas Combustion Table 1.4-1 Emission Factors for Nitrogen Oxides (NO_x) and Carbon Monoxide (CO) from Natural Gas Combustion. For conservatism, the highest listed values for NO_x and CO were chosen as representative. To convert from lb/10^6 SCF to lb/MMBtu, the listed emission factors were then divided by 1,020.

[2] Gas volume and heat rating calculated from the separator tank (Table 8 - Tank Flashing Losses PTE).

[3] Supplemental Fuel Combustion based on a 108 SCFH with a HHV of 1,503.

[4] Annual emissions are based on an operating schedule of 24 hours/day, 365 days/year (i.e., 8,760 hours/year).

Arrow Pipeline, LLC
Fort Berthold Compressor Station #7
Emission Calculations

Table 10 - Truck Loadout

Description	Contents	Total Facility Water Tank Throughput	Saturation Factor	Pressure [1]	Molecular Weight of Vapors	Temperature	Loading Loss [2, 3]	Truck Loading Rate	VOC Short Term Emissions [4]	VOC Long Term Emissions [5]
		(bbls/day)	-	*(psia)*	*(lb/lb-mole)*	*(°R)*	*(lb/1,000 gal)*	*(gal/hr)*	*(lb/hr)*	*(ton/yr)*
Water Tank	Water / Condensate	110	0.60	7.00	50	509.67	5.13	7,500	38.50	4.33

[1] Value calculated from Figure 7.1-14a of AP-42 Chapter 7 Section 1 - Organic Liquid Storage Tanks, for converting Reid Vapor Pressure (RVP) to true vapor pressure, conservatively assuming an RVP of 15.5 psi, a bulk liquid temperature of 50 °F, and a slope of the ASTM distillation curve at 10 volume percent evaporation of 4 °F/vol %.

[2] Loading emission estimates are calculated using Equation 1 from AP-42 Chapter 5 Section 2 – Transportation and Marketing of Petroleum Liquids.

LL = 12.46 * (SPM/T), where:
LL = Loading loss, pounds per 1,000 gallons of liquid loaded
S = Saturation factor
P = True vapor pressure of liquid loaded (psia)
M = Molecular weight of vapors
T = Temperature of bulk liquid loaded (°R)

[3] Loading emissions assume that all VOC in produced water tank is released to the atmosphere during loading.

[4] Short-term loading emissions are calculated by taking the product of the loading loss with that of the truck loading rate.

[5] Long-term loading emissions are calculated by taking the product of the calculated loading loss with that of the annual facility throughput (daily throughput multiplied by 365 days per year).

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Emission Calculations

Table 11 - Fugitive Emissions

Equipment Type	Emission Factor [1, 2] (kg/hr/source)	Count [4]	Fugitive VOC Emissions [4] *(lb/hr)*	*(ton/yr)*
Connector	2.00E-04	115	1.92E-03	8.42E-03
Flanges	3.90E-04	610	1.99E-02	8.71E-02
Open-ended lines	2.00E-03	44	7.36E-03	3.22E-02
Others [3]	8.80E-03	35	2.57E-02	1.13E-01
Pump seals	2.40E-03	8	1.61E-03	7.03E-03
Valves	4.50E-03	215	8.09E-02	3.54E-01
Total	**-**	**-**	**0.14**	**0.60**

[1] Emission factor obtained from EPA's Protocol for Equipment Leak Emission Estimates, Table 2-4, EPA-454/R-95-017, November 1995.

[2] These factors are for total organic compound emission rates (including non-VOC's such as methane and ethane) and apply to light crude, heavy crude, gas plant, gas production, and off-shore facilities.

[3] The "other" equipment type was derived from compressors, diaphrams, drains, dump arms, hatches, instruments, meters, pressure relief valves, polished rods, relief valves, and vents. This "other" equipment type should be applied for any equipment type other than connectors, flanges, open-ended line, pumps, or valves.

[4] Continuous operating for 8,760 hours, an assumed 3.8% VOC content of the natural gas, and typical compressor station equipment were used.

Table 12 - GHG Emissions

Greenhouse Gas	Default Emission Factors for Natural Gas (kg/MMBtu) [1]	Global Warming Potential [2]
CO_2	53.02	1
CH_4	1.00E-03	21
N_2O	1.00E-04	310

Combustion Sources

Type of Equipment	Heat Rating	Quantity	Hours of Operation	Single Unit				Total Units
				CO_2	CH_4	N_2O	CO_2e	CO_2e
	(MMBtu/hr) [3]		(hr/yr)	*(ton/yr)* [4]	*(ton/yr)* [4]	*(ton/yr)* [4]	*(ton/yr)* [5]	*(ton/yr)* [5]
530-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	4.5	1	8,760	2,301	0.04	0.00	2,304	2,304
1,480-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	14.6	3	8,760	7,440	0.14	0.01	7,448	22,343
435-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	4.1	1	8,760	2,108	0.04	0.00	2,110	2,110
740-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	6.6	1	8,760	3,363	0.06	0.01	3,367	3,367
326-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	3.1	1	8,760	1,585	0.03	0.00	1,587	1,587
400-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	3.1	1	8,760	1,607	0.03	0.00	1,608	1,608
Tank Battery Control Device (e.g., Thermal Oxidizer, Flare, or equivalent)	1.36	1	8,760	695	0.01	0.00	696	696
Fugitive Emissions [6]	-	-	8,760	0	1	0.00	11	11
			Total					**34,025**

[1] Natural gas emission factors used from 40 CFR 98 Subpart C, Table C-1 and Table C-2.

[2] 40 CFR 98 Subpart A, Table A-1.

[3] Heat rating for tanks calculated from Table 9 - Tank Battery Control Device. Tanks are routed to a combustion control device, where the vapors from the tanks are oxidized.

[4] Greenhouse Gas = 1.0E-03 * Heat Rating * Hours of Operation * Default Emission Factor.

[5] $CO_2e = \sum$ (Greenhouse Gas * Global Warming Potential).

[6] Fugitive emissions are conservatively assumed to contain 84.0772% concentration of methane and 2.3844% concentration of CO_2 in the blowdown gas stream.

Arrow Pipeline, LLC
Fort Berthold Compressor Station #7
Emission Calculations

Table 13 - Facility Annual Potential-to-Emit Summary

Single Unit Uncontrolled Potential Emissions

Type of Equipment	Quantity	PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		HAP		Formaldehyde		CO_2e
		(lb/hr)	*(tpy)*	*(lb/hr)*	*(tpy)*	*(lb/hr)*	*(tpy)*	*(lb/hr)*	*(tpy)*	*(lb/hr)*	*(tpy)*	*(lb/hr)*	*(tpy)*	*(lb/hr)*	*(tpy)*	*(lb/hr)*	*(tpy)*	*(ton/yr)*
530-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	1	0.00	0.00	0.00	0.00	2.34	10.24	1.52	6.65	0.26	1.12	0.88	3.84	0.32	1.42	0.24	1.04	2,304
1,480-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	3	0.14	0.61	0.14	0.61	42.42	185.79	29.37	128.62	0.83	3.64	2.81	12.29	0.34	1.47	0.16	0.71	7,448
435-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	1	0.04	0.17	0.04	0.17	15.34	67.21	7.67	33.60	0.24	1.03	0.64	2.81	0.26	1.12	0.21	0.90	2,110
740-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	1	0.06	0.27	0.06	0.27	25.45	111.47	20.23	88.61	0.38	1.64	0.41	1.79	0.16	0.70	0.08	0.36	3,367
326-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	1	0.03	0.13	0.03	0.13	11.50	50.37	5.75	25.18	0.18	0.77	0.48	2.11	0.19	0.84	0.16	0.68	1,587
400-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	1	0.00	0.00	0.00	0.00	1.76	7.73	1.15	5.02	0.18	0.79	0.65	2.86	0.23	0.99	0.17	0.73	1,608
Condensate Tank Gas Emissions	2	-	-	-	-	-	-	-	-	-	-	39.32	172.24	3.74	16.39	-	-	-
Water Tank Gas Emissions	1	-	-	-	-	-	-	-	-	-	-	0.39	1.72	0.04	0.16	-	-	-
Truck Loadout	-	-	-	-	-	-	-	-	-	-	-	0.99	4.33	-	-	-	-	0
Fugitive Emissions	-	-	-	-	-	-	-	-	-	-	-	0.14	0.60	-	-	-	-	11
Total (All Units)		**0.55**	**2.40**	**0.55**	**2.40**	**183.65**	**804.37**	**124.41**	**544.93**	**3.71**	**16.27**	**52.32**	**229.17**	**5.95**	**26.05**	**1.34**	**5.85**	**33,328.57**

Single Unit Controlled Potential Emissions

Type of Equipment	Quantity	PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		HAP		Formaldehyde		CO_2e
		(lb/hr)	*(tpy)*	*(lb/hr)*	*(tpy)*	*(lb/hr)*	*(tpy)*	*(lb/hr)*	*(tpy)*	*(lb/hr)*	*(tpy)*	*(lb/hr)*	*(tpy)*	*(lb/hr)*	*(tpy)*	*(lb/hr)*	*(tpy)*	*(ton/yr)*
530-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	1	0.00	0.00	0.00	0.00	2.34	10.24	1.52	6.65	0.26	1.12	0.88	3.84	0.32	1.42	0.24	1.04	2,304
1,480-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	3	0.14	0.61	0.14	0.61	2.12	9.29	2.94	12.86	0.83	3.64	0.56	2.46	0.19	0.83	0.02	0.07	7,448
435-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	1	0.04	0.17	0.04	0.17	0.77	3.36	0.77	3.36	0.24	1.03	0.13	0.56	0.05	0.24	0.00	0.02	2,110
740-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	1	0.06	0.27	0.06	0.27	1.27	5.57	2.02	8.86	0.38	1.64	0.08	0.36	0.09	0.38	0.01	0.04	3,367
326-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	1	0.03	0.13	0.03	0.13	0.57	2.52	0.57	2.52	0.18	0.77	0.10	0.42	0.04	0.18	0.00	0.02	1,587
400-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	1	0.00	0.00	0.00	0.00	1.76	7.73	1.15	5.02	0.18	0.79	0.65	2.86	0.23	0.99	0.17	0.73	1,608
Condensate Tank Gas Emissions	2	-	-	-	-	-	-	-	-	-	-	1.97	8.61	0.19	0.82	-	-	-
Water Tank Gas Emissions	1	-	-	-	-	-	-	-	-	-	-	0.39	1.72	0.04	0.16	-	-	-
Tank Battery Control Device (e.g., Thermal Oxidizer, Flare, or equivalent)	1	0.62	2.70	0.62	2.70	0.37	1.63	0.13	0.57	0.86	3.76	1.10	4.82	0.00	0.01	-	-	696
Truck Loadout	-	-	-	-	-	-	-	-	-	-	-	0.99	4.33	-	-	-	-	0
Fugitive Emissions	-	-	-	-	-	-	-	-	-	-	-	0.14	0.60	-	-	-	-	11
Total (All Units)		**1.16**	**5.09**	**1.16**	**5.09**	**13.45**	**58.91**	**14.97**	**65.57**	**4.57**	**20.02**	**8.10**	**35.50**	**1.53**	**6.69**	**0.47**	**2.06**	**34,024.74**

APPENDIX C

Equipment Specifications

GE Energy
Gas Engines

1101 West St. Paul Avenue
Waukesha, WI 53188-4999
USA

T +1 262 547 3311
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Engine Data E423 – Compass Compression, Arrow Bakken 7/6/2012

Engine Model		L7042GSI
IC temperature	°F	130
JW temperature	°F	180
Carb setting		0.38% CO
Timing	°BTDC	ESM

Site Conditions		
Fuel WKI		47.2
Fuel LHV	BTU/ft3	1359
Ambient	°F	100
Altitude	feet	2,300

Engine Performance		100%
Power	BHP	1480
Speed	RPM	1200
BSFC (LHV)	BTU/bhp-hr	8895
Induction Air	SCFM	2575
Exhaust Flow	lb/hr	11493
Exhaust Temp	°F	1268

Heat to	btu/hr x 1000	
Jacket		4073
Lube Oil		407
Intercooler		334
Total Exhaust		4077
Radiation		762

Emissions	g/bhp-hr	
NOx		13
CO		9
THC		2
NMHC		1.39
NM,NEHC		0.86

Fuel must comply with the Gaseous Fuel Specification in affect at time of datasheet.
Fuel consumption is based on dry gas at 60°F and 30” Hg.
BSFC is stated in lower heating value (LHV).
NOx emission at absolute humidity of 75 grains 10.71 g H2O/kg of dry air.
Ignition timing determined by the Engine System Manager (ESM) map based on load, speed and WKI(TM) input.

VGF - F18GL LCR

Gas Compression

ENGINE SPEED (rpm):	1800	COOLING SYSTEM:	JW, IC + OC
DISPLACEMENT (in3):	1096	INTERCOOLER WATER INLET (°F):	130
COMPRESSION RATIO:	8.7:1	JACKET WATER OUTLET (°F):	180
IGNITION SYSTEM:	CEC	JACKET WATER CAPACITY (gal):	16
EXHAUST MANIFOLD:	Water Cooled	AUXILIARY WATER CAPACITY (gal):	6
COMBUSTION:	Lean Burn, Open Chamber	LUBE OIL CAPACITY (gal):	44
ENGINE DRY WEIGHT (lbs):	5725	MAX. EXHAUST BACKPRESSURE (in. H2O):	15
AIR/FUEL RATIO SETTING:	7.8% O2	MAX. AIR INLET RESTRICTION (in. H2O):	15
IGNITION TIMING:	24° BTDC		

SITE CONDITIONS:

FUEL:		ALTITUDE (ft):	2300
FUEL PRESSURE RANGE (psig):	26 - 50	MAXIMUM INLET AIR TEMPERATURE (°F):	100
FUEL HHV (BTU/ft3):	1,503.1	FUEL WKI:	47.2
FUEL LHV (BTU/ft3):	1,358.8		

SITE SPECIFIC TECHNICAL DATA

	UNITS	MAX RATING AT 100 °F AIR TEMP	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE OF 100 °F		
			100%	75%	50%
POWER RATING					
CONTINUOUS ENGINE POWER	BHP	400	400	300	199
OVERLOAD	% 2/24 hr	10	10	-	-
MECHANICAL EFFICIENCY (LHV)	%	35.8	35.8	33.0	28.3
CONTINUOUS POWER AT FLYWHEEL *based on no auxiliary engine driven equipment*	BHP	400	400	300	199
FUEL CONSUMPTION					
FUEL CONSUMPTION (LHV)	BTU/BHP-hr	7107	7108	7723	8993
FUEL CONSUMPTION (HHV)	BTU/BHP-hr	7862	7862	8543	9948
FUEL FLOW *based on fuel analysis LHV*	SCFM	37	37	30	23
HEAT REJECTION					
JACKET WATER (JW)	BTU/hr x 1000	725	725	637	552
LUBE OIL (OC)	BTU/hr x 1000	118	118	111	105
INTERCOOLER (IC)	BTU/hr x 1000	199	199	135	70
EXHAUST	BTU/hr x 1000	789	789	659	522
RADIATION	BTU/hr x 1000	66	66	68	71
EMISSIONS					
NOx (NO + NO2)	g/bhp-hr	2.0	2.0	2.0	1.9
CO	g/bhp-hr	1.3	1.3	1.4	1.6
THC	g/bhp-hr	1.7	1.7	1.9	2.3
NMHC	g/bhp-hr	1.19	1.19	1.35	1.58
NM, NEHC	g/bhp-hr	0.74	0.74	0.84	0.97
CO2	g/bhp-hr	472	472	513	597
AIR INTAKE / EXHAUST GAS					
INDUCTION AIR FLOW	SCFM	855	855	697	539
EXHAUST GAS MASS FLOW	lb/hr	3735	3734	3044	2354
EXHAUST GAS FLOW *at exhaust temp, 14.5 psia*	ACFM	2195	2194	1813	1421
EXHAUST TEMPERATURE	°F	877	877	895	913

HEAT EXHANGER SIZING		
TOTAL JACKET WATER CIRCUIT (JW)	BTU/hr x 1000	822
TOTAL AUXILIARY WATER CIRCUIT (IC + OC)	BTU/hr x 1000	360

COOLING SYSTEM WITH ENGINE MOUNTED WATER PUMPS		
JACKET WATER PUMP MIN. DESIGN FLOW	GPM	130
JACKET WATER PUMP MAX. EXTERNAL RESTRICTION	psig	16
AUX WATER PUMP MIN. DESIGN FLOW	GPM	35
AUX WATER PUMP MAX. EXTERNAL RESTRICTION	psig	15

All data provided per the condtions listed in the notes section on page three.

Data Generated by EngCalc Program Version 3.1. Dresser Inc., Dresser Waukesha
12/11/2011 8:30 AM

FUEL COMPOSITION

HYDROCARBONS:		Mole or Volume %
Methane	CH4	55.25
Ethane	C2H6	21.9
Propane	C3H8	11.99
Iso-Butane	I-C4H10	1.06
Normal Butane	N-C4H10	3.27
Iso-Pentane	I-C5H12	0.48
Normal Pentane	N-C5H12	0.7
Hexane	C6H14	0.97
Heptane	C7H16	0
Ethene	C2H4	0
Propene	C3H6	0
	SUM HYDROCARBONS	95.62
NON-HYDROCARBONS:		
Nitrogen	N2	3.87
Oxygen	O2	0
Helium	He	0
Carbon Dioxide	CO2	0.52
Carbon Monoxide	CO	0
Hydrogen	H2	0
Water Vapor	H2O	0
	TOTAL FUEL	100.01

FUEL:	
FUEL PRESSURE RANGE (psig):	26 - 50
FUEL WKI:	47.2
FUEL SLHV (BTU/ft3):	1335.17
FUEL SLHV (MJ/Nm3):	52.50
FUEL LHV (BUT/ft3):	1358.81
FUEL LHV (MJ/Nm3):	53.43
FUEL HHV (BUT/ft3):	1503.11
FUEL HHV (MJ/Nm3):	59.11
FUEL DENSITY (SG):	0.91

Standard Conditions per ASTM D3588-91 [60°F and 14.696psia] and ISO 6976:1996-02-01[25, V(0;101.325)].
Based on the fuel composition, supply pressure and temperature, liquid hydrocarbons may be present in the fuel. No liquid hydrocarbons are allowed in the fuel. The fuel must not contain any liquid water. Dresser Waukesha recommends both of the following:
1) Dew point of the fuel gas to be at least 20°F (11°C) below the measured temperature of the gas at the inlet of the engine fuel regulator.
2) A fuel filter separator to be used on all fuels except commercial quality natural gas.
Refer to the 'Fuel and Lubrication' section of 'Technical Data' or contact the Dresser Waukesha Application Engineering Department for additional information on fuels, or LHV and WKI® calculations.

FUEL CONTAMINANTS

Total Sulfur Compounds	0	% volume
Total Halogen as Cloride	0	% volume
Total Ammonia	0	% volume
Siloxanes		
Tetramethyl silane	0	% volume
Trimethyl silanol	0	% volume
Hexamethyldisiloxane (L2)	0	% volume
Hexamethylcyclotrisiloxane (D3)	0	% volume
Octamethyltrisiloxane (L3)	0	% volume
Octamethylcyclotetrasiloxane (D4)	0	% volume
Decamethyltetrasiloxane (L4)	0	% volume
Decamethylcyclopentasiloxane (D5)	0	% volume
Dodecamethylpentasiloxane (L5)	0	% volume
Dodecamethylcyclohexasiloxane (D6)	0	% volume
Others	0	% volume

Total Sulfur Compounds	0 µg/BTU
Total Halogen as Cloride	0 µg/BTU
Total Ammonia	0 µg/BTU
Total Siloxanes	0 µg/BTU

Calculated fuel contaminant analysis will depend on the entered fuel composition and selected engine model.

No water or hydrocarbon condensates are allowed in the engine. Requires liquids removal.

NOTES

1. All data is based on engines with standard configurations unless noted otherwise.

2. Power rating is adjusted for fuel, site altitude, and site air inlet temperature, in accordance with ISO 3046/1 with tolerance of ± 3%.

3. Fuel consumption is presented in accordance with ISO 3046/1 with a tolerance of -0 / +5% at maximum rating. Fuel flow calculation based on fuel LHV and fuel consumption with added 5% tolerance.

4. Heat rejection tolerances are ± 30% for radiation, and ± 8% for jacket water, lube oil, intercooler, and exhaust energy.

5. Emission levels are given at engine exhaust outlet flange prior to any after treatment. Values are based on a new engine operating at indicated site conditions, and adjusted to the specified timing and air/fuel ratio at rated load. Emissions are at an absolute humidity of 75 grains H_2O/lb (10.71 g H_2O/kg) of dry air. Emission levels may vary subject to instrumentation, measurement, ambient conditions, fuel quality, and engine variation. Engine may require adjustment on-site to meet emission values, which may affect engine performance and heat output. NOx, CO, THC, and NMHC emission levels are listed as a not to exceed limit, all other emission levels are estimated. CO_2 emissions based on EPA Federal Register/Vol. 74, No. 209/Friday, October 30, 2009 Rules and Regulations 56398, 56399 (3) Tier 3 Calculation Methodology, Equation C-5.

6. Air flow is based on undried air with a tolerance of ± 7%.

7. Exhaust temperature given at engine exhaust outlet flange with a tolerance of ± 75°F (42°C).

8. Exhaust gas mass flow value is based on a "wet basis" with a tolerance of ± 7%.

9. Inlet and Exhaust Restrictions based on full rated engine load Refer to the engine specification section of Dresser Waukesha's standard technical data for more information.

10. Cooling circuit capacity, lube oil capacity, and engine dry weight values are typical.

11. Fuel must conform to Dresser Waukesha "Gaseous Fuel Specification" S7884-7 or most current version. Fuel may require treatment to meet current fuel specification.

12. Heat exchanger sizing values given as the maximum heat rejection of the circuit, with applied tolerances and an additional 5% reserve factor.

13. Cooling system design flow is based on minimum allowable cooling system flow. Cooling system maximum external restriction is defined as the allowable restriction at the minimum cooling system flow. Refer to technical data sheets S-7797-3 and S-7797-5 (or latest version) for more information.

REQUIRED OPTION CODES

DRESSER Waukesha

VGF - F18GSI

Gas Compression

ENGINE SPEED (rpm):	1800	COOLING SYSTEM:	JW, IC + OC
DISPLACEMENT (in3):	1096	INTERCOOLER WATER INLET (°F):	130
COMPRESSION RATIO:	8.6:1	JACKET WATER OUTLET (°F):	180
IGNITION SYSTEM:	CEC	JACKET WATER CAPACITY (gal):	16
EXHAUST MANIFOLD:	Water Cooled	AUXILIARY WATER CAPACITY (gal):	6
COMBUSTION:	Rich Burn, Turbocharged	LUBE OIL CAPACITY (gal):	44
ENGINE DRY WEIGHT (lbs):	5725	MAX. EXHAUST BACKPRESSURE (in. H2O):	15
AIR/FUEL RATIO SETTING:	0.35% CO	MAX. AIR INLET RESTRICTION (in. H2O):	15
IGNITION TIMING:	10° BTDC		

SITE CONDITIONS:

FUEL:		ALTITUDE (ft):	2300
FUEL PRESSURE RANGE (psig):	26 - 50	MAXIMUM INLET AIR TEMPERATURE (°F):	100
FUEL HHV (BTU/ft3):	1,503.1	FUEL WKI:	47.2
FUEL LHV (BTU/ft3):	1,358.8		

SITE SPECIFIC TECHNICAL DATA

		MAX RATING AT 100 °F AIR TEMP	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE OF 100 °F		
POWER RATING	**UNITS**		**100%**	**80%**	**61%**
CONTINUOUS ENGINE POWER	BHP	326	326	261	199
OVERLOAD	% 2/24 hr	0	0	-	-
MECHANICAL EFFICIENCY (LHV)	%	29.6	29.6	28.2	26.3
CONTINUOUS POWER AT FLYWHEEL *based on no auxiliary engine driven equipment*	BHP	326	326	261	199
FUEL CONSUMPTION					
FUEL CONSUMPTION (LHV)	BTU/BHP-hr	8605	8605	9018	9658
FUEL CONSUMPTION (HHV)	BTU/BHP-hr	9519	9519	9976	10684
FUEL FLOW *based on fuel analysis LHV*	SCFM	36	36	30	25
HEAT REJECTION					
JACKET WATER (JW)	BTU/hr x 1000	884	884	767	655
LUBE OIL (OC)	BTU/hr x 1000	175	175	164	153
INTERCOOLER (IC)	BTU/hr x 1000	65	65	45	28
EXHAUST	BTU/hr x 1000	792	792	648	513
RADIATION	BTU/hr x 1000	115	115	111	106
EMISSIONS					
NOx (NO + NO2)	g/bhp-hr	16.0	16.0	16.0	16.0
CO	g/bhp-hr	8.0	8.0	8.0	8.0
THC	g/bhp-hr	1.5	1.5	1.5	1.5
NMHC	g/bhp-hr	1.07	1.07	1.07	1.07
NM, NEHC	g/bhp-hr	0.67	0.67	0.67	0.67
CO2	g/bhp-hr	571	571	599	641
AIR INTAKE / EXHAUST GAS					
INDUCTION AIR FLOW	SCFM	549	549	460	376
EXHAUST GAS MASS FLOW	lb/hr	2452	2452	2055	1680
EXHAUST GAS FLOW *at exhaust temp, 14.5 psia*	ACFM	1796	1796	1487	1195
EXHAUST TEMPERATURE	°F	1207	1207	1186	1157

HEAT EXHANGER SIZING		
TOTAL JACKET WATER CIRCUIT (JW)	BTU/hr x 1000	1002
TOTAL AUXILIARY WATER CIRCUIT (IC + OC)	BTU/hr x 1000	273

COOLING SYSTEM WITH ENGINE MOUNTED WATER PUMPS		
JACKET WATER PUMP MIN. DESIGN FLOW	GPM	130
JACKET WATER PUMP MAX. EXTERNAL RESTRICTION	psig	16
AUX WATER PUMP MIN. DESIGN FLOW	GPM	35
AUX WATER PUMP MAX. EXTERNAL RESTRICTION	psig	15

All data provided per the condtions listed in the notes section on page three.

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12/11/2011 8:36 AM

FUEL COMPOSITION

HYDROCARBONS:		Mole or Volume %
Methane	CH4	55.25
Ethane	C2H6	21.9
Propane	C3H8	11.99
Iso-Butane	I-C4H10	1.06
Normal Butane	N-C4H10	3.27
Iso-Pentane	I-C5H12	0.48
Normal Pentane	N-C5H12	0.7
Hexane	C6H14	0.97
Heptane	C7H16	0
Ethene	C2H4	0
Propene	C3H6	0
	SUM HYDROCARBONS	95.62
NON-HYDROCARBONS:		
Nitrogen	N2	3.87
Oxygen	O2	0
Helium	He	0
Carbon Dioxide	CO2	0.52
Carbon Monoxide	CO	0
Hydrogen	H2	0
Water Vapor	H2O	0
	TOTAL FUEL	100.01

FUEL:	
FUEL PRESSURE RANGE (psig):	26 - 50
FUEL WKI:	47.2
FUEL SLHV (BTU/ft3):	1335.17
FUEL SLHV (MJ/Nm3):	52.50
FUEL LHV (BUT/ft3):	1358.81
FUEL LHV (MJ/Nm3):	53.43
FUEL HHV (BUT/ft3):	1503.11
FUEL HHV (MJ/Nm3):	59.11
FUEL DENSITY (SG):	0.91

Standard Conditions per ASTM D3588-91 [60°F and 14.696psia] and ISO 6976:1996-02-01[25, V(0;101.325)].
Based on the fuel composition, supply pressure and temperature, liquid hydrocarbons may be present in the fuel. No liquid hydrocarbons are allowed in the fuel. The fuel must not contain any liquid water. Dresser Waukesha recommends both of the following:
1) Dew point of the fuel gas to be at least 20°F (11°C) below the measured temperature of the gas at the inlet of the engine fuel regulator.
2) A fuel filter separator to be used on all fuels except commercial quality natural gas.
Refer to the 'Fuel and Lubrication' section of 'Technical Data' or contact the Dresser Waukesha Application Engineering Department for additional information on fuels, or LHV and WKI® calculations.

FUEL CONTAMINANTS

Total Sulfur Compounds	0	% volume
Total Halogen as Cloride	0	% volume
Total Ammonia	0	% volume
Siloxanes		
Tetramethyl silane	0	% volume
Trimethyl silanol	0	% volume
Hexamethyldisiloxane (L2)	0	% volume
Hexamethylcyclotrisiloxane (D3)	0	% volume
Octamethyltrisiloxane (L3)	0	% volume
Octamethylcyclotetrasiloxane (D4)	0	% volume
Decamethyltetrasiloxane (L4)	0	% volume
Decamethylcyclopentasiloxane (D5)	0	% volume
Dodecamethylpentasiloxane (L5)	0	% volume
Dodecamethylcyclohexasiloxane (D6)	0	% volume
Others	0	% volume

Total Sulfur Compounds	0 µg/BTU
Total Halogen as Cloride	0 µg/BTU
Total Ammonia	0 µg/BTU
Total Siloxanes	0 µg/BTU

Calculated fuel contaminant analysis will depend on the entered fuel composition and selected engine model.

No water or hydrocarbon condensates are allowed in the engine. Requires liquids removal.

NOTES

1. All data is based on engines with standard configurations unless noted otherwise.

2. Power rating is adjusted for fuel, site altitude, and site air inlet temperature, in accordance with ISO 3046/1 with tolerance of ± 3%.

3. Fuel consumption is presented in accordance with ISO 3046/1 with a tolerance of -0 / +5% at maximum rating. Fuel flow calculation based on fuel LHV and fuel consumption with added 5% tolerance.

4. Heat rejection tolerances are ± 30% for radiation, and ± 8% for jacket water, lube oil, intercooler, and exhaust energy.

5. Emission levels are given at engine exhaust outlet flange prior to any after treatment. Values are based on a new engine operating at indicated site conditions, and adjusted to the specified timing and air/fuel ratio at rated load. Emissions are at an absolute humidity of 75 grains H2O/lb (10.71 g H2O/kg) of dry air. Emission levels may vary subject to instrumentation, measurement, ambient conditions, fuel quality, and engine variation. Engine may require adjustment on-site to meet emission values, which may affect engine performance and heat output. NOx, CO, THC, and NMHC emission levels are listed as a not to exceed limit, all other emission levels are estimated. CO2 emissions based on EPA Federal Register/Vol. 74, No. 209/Friday, October 30, 2009 Rules and Regulations 56398, 56399 (3) Tier 3 Calculation Methodology, Equation C-5.

6. Air flow is based on undried air with a tolerance of ± 7%.

7. Exhaust temperature given at engine exhaust outlet flange with a tolerance of ± 75°F (42°C).

8. Exhaust gas mass flow value is based on a "wet basis" with a tolerance of ± 7%.

9. Inlet and Exhaust Restrictions based on full rated engine load Refer to the engine specification section of Dresser Waukesha's standard technical data for more information.

10. Cooling circuit capacity, lube oil capacity, and engine dry weight values are typical.

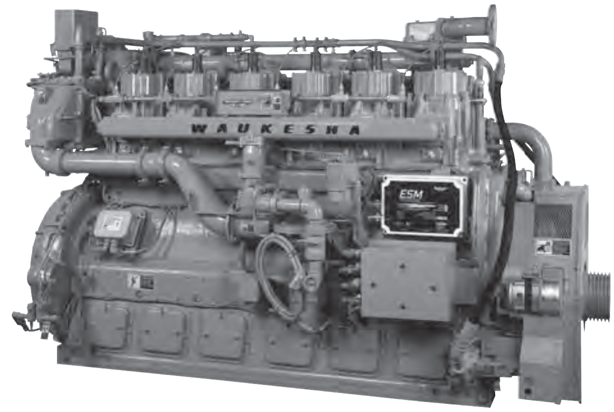
11. Fuel must conform to Dresser Waukesha "Gaseous Fuel Specification" S7884-7 or most current version. Fuel may require treatment to meet current fuel specification.

12. Heat exchanger sizing values given as the maximum heat rejection of the circuit, with applied tolerances and an additional 5% reserve factor.

13. Cooling system design flow is based on minimum allowable cooling system flow. Cooling system maximum external restriction is defined as the allowable restriction at the minimum cooling system flow. Refer to technical data sheets S-7797-3 and S-7797-5 (or latest version) for more information.

REQUIRED OPTION CODES

GE Energy
Gas Engines



Waukesha* gas engine VHP* Series Four*

F3514GSI

493 - 740 BHP (368 - 552 kWb)

GE's Waukesha Series Four rich-burn engines are the engines of choice for the harshest and most demanding gas compression, power generation and mechanical drive applications. The Series Four engines can reliably produce more power on the hottest field gases, a the highest altitudes, and in the most remote locations, all while delivering the lowest available emissions when paired with a 3-way catalyst (NSCR).

technical data

Cylinders	Inline 6
Piston displacement	3520 cu. in.(58 L)
Compression ratio	8:1
Bore & stroke	9.375" x 8.5" (238 x 216)
Jacket water system capacity	48.5 gal. (184 L)
Lube oil capacity	72 gal. (273 L)
Starting system	125 - 150 psi air/gas 24V electric

Dimensions l x w x h inch (mm)

123.61 (3140) x 78.94 (2005) x 75.42 (1916)

Weights lb (kg)

15,000 (6804)

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performance data

Intercooler Water Temperature 130°F (54°C)		1200 RPM	1000 RPM
	Power bhp (kWb)	740 (550)	617 (460)
	BSFC (LHV) Btu/bhp-hr (kJ/kWh)	8168 (11598)	7855 (11110)
	Fuel Consumption Btu/hr x 1000 (kW)	6044 (1772)	4846 (1420)
Emissions	NOx g/bhp-hr (mg/Nm^3 @ 5% O_2)	15.80 (5857)	15.70 (5828)
	CO g/bhp-hr (mg/Nm^3 @ 5% O_2)	12.80 (4743)	12.30 (4544)
	NMHC g/bhp-hr (mg/Nm^3 @ 5% 0_2)	0.16 (59)	0.17 (61)
	THC g/bhp-hr (mg/Nm^3 @ 5% O_2)	0.60 (222)	0.70 (246)
Heat Balance	Heat to Jacket Water Btu/hr x 1000 (kW)	1862 (546)	1503 (440)
	Heat to Lube Oil Btu/hr x 1000 (kW)	285 (84)	227 (67)
	Heat to Intercooler Btu/hr x 1000 (kW)	96 (28)	57 (17)
	Heat to Radiation Btu/hr x 1000 (kW)	365 (107)	325 (95)
	Total Exhaust Heat Btu/hr x 1000 (kW)	1669 (489)	1257 (368)
Intake/ Exhaust System	Induction Air Flow scfm (Nm^3/hr)	1107 (1667)	888 (1337)
	Exhaust Flow lb/hr (kg/hr)	5152 (2337)	4131 (1873)
	Exhaust Temperature °F (°C)	1172 (633)	1106 (597)

All data according to full load and subject to technical development and modification.

Consult your local GE Energy's representative for system application assistance. The manufacturer reserves the right to change or modify without notice, the design or equipment specifications as herein set forth without incurring any obligation either with respect to equipment previously sold or in the process of construction except where otherwise specifically guaranteed by the manufacturer.

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www.waukeshaengine.com

7040 1211 GEA-18925

DRESSER Waukesha

VGF - H24GL LCR

Gas Compression

ENGINE SPEED (rpm):	1800	COOLING SYSTEM:	JW, IC + OC
DISPLACEMENT (in3):	1462	INTERCOOLER WATER INLET (°F):	130
COMPRESSION RATIO:	8.7:1	JACKET WATER OUTLET (°F):	180
IGNITION SYSTEM:	CEC	JACKET WATER CAPACITY (gal):	20
EXHAUST MANIFOLD:	Water Cooled	AUXILIARY WATER CAPACITY (gal):	6
COMBUSTION:	Lean Burn, Open Chamber	LUBE OIL CAPACITY (gal):	56
ENGINE DRY WEIGHT (lbs):	7500	MAX. EXHAUST BACKPRESSURE (in. H2O):	15
AIR/FUEL RATIO SETTING:	7.8% O2	MAX. AIR INLET RESTRICTION (in. H2O):	15
IGNITION TIMING:	24° BTDC		

SITE CONDITIONS:

FUEL:		ALTITUDE (ft):	2300
FUEL PRESSURE RANGE (psig):	26 - 50	MAXIMUM INLET AIR TEMPERATURE (°F):	100
FUEL HHV (BTU/ft3):	1,503.1	FUEL WKI:	47.2
FUEL LHV (BTU/ft3):	1,358.8		

SITE SPECIFIC TECHNICAL DATA

		MAX RATING AT 100 °F AIR TEMP	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE OF 100 °F		
POWER RATING	**UNITS**		**100%**	**75%**	**50%**
CONTINUOUS ENGINE POWER	BHP	530	530	397	266
OVERLOAD	% 2/24 hr	10	10	-	-
MECHANICAL EFFICIENCY (LHV)	%	33.1	33.2	31.5	28.6
CONTINUOUS POWER AT FLYWHEEL *based on no auxiliary engine driven equipment*	BHP	530	530	397	266
FUEL CONSUMPTION					
FUEL CONSUMPTION (LHV)	BTU/BHP-hr	7683	7683	8080	8907
FUEL CONSUMPTION (HHV)	BTU/BHP-hr	8499	8499	8938	9853
FUEL FLOW *based on fuel analysis LHV*	SCFM	52	52	41	30
HEAT REJECTION					
JACKET WATER (JW)	BTU/hr x 1000	1112	1112	941	770
LUBE OIL (OC)	BTU/hr x 1000	160	160	150	141
INTERCOOLER (IC)	BTU/hr x 1000	321	321	190	83
EXHAUST	BTU/hr x 1000	1132	1132	903	667
RADIATION	BTU/hr x 1000	77	77	79	79
EMISSIONS					
NOx (NO + NO2)	g/bhp-hr	2.0	2.0	2.0	1.9
CO	g/bhp-hr	1.3	1.3	1.4	1.6
THC	g/bhp-hr	1.7	1.7	1.9	2.3
NMHC	g/bhp-hr	1.19	1.19	1.35	1.58
NM, NEHC	g/bhp-hr	0.75	0.75	0.84	0.97
CO2	g/bhp-hr	510	510	537	592
AIR INTAKE / EXHAUST GAS					
INDUCTION AIR FLOW	SCFM	1225	1224	966	712
EXHAUST GAS MASS FLOW	lb/hr	5350	5349	4220	3111
EXHAUST GAS FLOW *at exhaust temp, 14.5 psia*	ACFM	3125	3124	2490	1843
EXHAUST TEMPERATURE	°F	869	869	883	888

HEAT EXHANGER SIZING		
TOTAL JACKET WATER CIRCUIT (JW)	BTU/hr x 1000	1261
TOTAL AUXILIARY WATER CIRCUIT (IC + OC)	BTU/hr x 1000	545

COOLING SYSTEM WITH ENGINE MOUNTED WATER PUMPS		
JACKET WATER PUMP MIN. DESIGN FLOW	GPM	130
JACKET WATER PUMP MAX. EXTERNAL RESTRICTION	psig	16
AUX WATER PUMP MIN. DESIGN FLOW	GPM	35
AUX WATER PUMP MAX. EXTERNAL RESTRICTION	psig	15

All data provided per the condtions listed in the notes section on page three.

Data Generated by EngCalc Program Version 3.1. Dresser Inc., Dresser Waukesha
12/11/2011 8:32 AM

FUEL COMPOSITION

HYDROCARBONS:		Mole or Volume %
Methane	CH4	55.25
Ethane	C2H6	21.9
Propane	C3H8	11.99
Iso-Butane	I-C4H10	1.06
Normal Butane	N-C4H10	3.27
Iso-Pentane	I-C5H12	0.48
Normal Pentane	N-C5H12	0.7
Hexane	C6H14	0.97
Heptane	C7H16	0
Ethene	C2H4	0
Propene	C3H6	0
	SUM HYDROCARBONS	95.62
NON-HYDROCARBONS:		
Nitrogen	N2	3.87
Oxygen	O2	0
Helium	He	0
Carbon Dioxide	CO2	0.52
Carbon Monoxide	CO	0
Hydrogen	H2	0
Water Vapor	H2O	0
	TOTAL FUEL	100.01

FUEL:	
FUEL PRESSURE RANGE (psig):	26 - 50
FUEL WKI:	47.2
FUEL SLHV (BTU/ft3):	1335.17
FUEL SLHV (MJ/Nm3):	52.50
FUEL LHV (BUT/ft3):	1358.81
FUEL LHV (MJ/Nm3):	53.43
FUEL HHV (BUT/ft3):	1503.11
FUEL HHV (MJ/Nm3):	59.11
FUEL DENSITY (SG):	0.91

Standard Conditions per ASTM D3588-91 [60°F and 14.696psia] and ISO 6976:1996-02-01[25, V(0;101.325)].
Based on the fuel composition, supply pressure and temperature, liquid hydrocarbons may be present in the fuel. No liquid hydrocarbons are allowed in the fuel. The fuel must not contain any liquid water. Dresser Waukesha recommends both of the following:
1) Dew point of the fuel gas to be at least 20°F (11°C) below the measured temperature of the gas at the inlet of the engine fuel regulator.
2) A fuel filter separator to be used on all fuels except commercial quality natural gas.
Refer to the 'Fuel and Lubrication' section of 'Technical Data' or contact the Dresser Waukesha Application Engineering Department for additional information on fuels, or LHV and WKI® calculations.

FUEL CONTAMINANTS

Total Sulfur Compounds	0	% volume
Total Halogen as Cloride	0	% volume
Total Ammonia	0	% volume
Siloxanes		
Tetramethyl silane	0	% volume
Trimethyl silanol	0	% volume
Hexamethyldisiloxane (L2)	0	% volume
Hexamethylcyclotrisiloxane (D3)	0	% volume
Octamethyltrisiloxane (L3)	0	% volume
Octamethylcyclotetrasiloxane (D4)	0	% volume
Decamethyltetrasiloxane (L4)	0	% volume
Decamethylcyclopentasiloxane (D5)	0	% volume
Dodecamethylpentasiloxane (L5)	0	% volume
Dodecamethylcyclohexasiloxane (D6)	0	% volume
Others	0	% volume

Total Sulfur Compounds	0 µg/BTU
Total Halogen as Cloride	0 µg/BTU
Total Ammonia	0 µg/BTU
Total Siloxanes	0 µg/BTU

Calculated fuel contaminant analysis will depend on the entered fuel composition and selected engine model.

No water or hydrocarbon condensates are allowed in the engine. Requires liquids removal.

NOTES

1. All data is based on engines with standard configurations unless noted otherwise.

2. Power rating is adjusted for fuel, site altitude, and site air inlet temperature, in accordance with ISO 3046/1 with tolerance of ± 3%.

3. Fuel consumption is presented in accordance with ISO 3046/1 with a tolerance of -0 / +5% at maximum rating. Fuel flow calculation based on fuel LHV and fuel consumption with added 5% tolerance.

4. Heat rejection tolerances are ± 30% for radiation, and ± 8% for jacket water, lube oil, intercooler, and exhaust energy.

5. Emission levels are given at engine exhaust outlet flange prior to any after treatment. Values are based on a new engine operating at indicated site conditions, and adjusted to the specified timing and air/fuel ratio at rated load. Emissions are at an absolute humidity of 75 grains H2O/lb (10.71 g H2O/kg) of dry air. Emission levels may vary subject to instrumentation, measurement, ambient conditions, fuel quality, and engine variation. Engine may require adjustment on-site to meet emission values, which may affect engine performance and heat output. NOx, CO, THC, and NMHC emission levels are listed as a not to exceed limit, all other emission levels are estimated. CO2 emissions based on EPA Federal Register/Vol. 74, No. 209/Friday, October 30, 2009 Rules and Regulations 56398, 56399 (3) Tier 3 Calculation Methodology, Equation C-5.

6. Air flow is based on undried air with a tolerance of ± 7%.

7. Exhaust temperature given at engine exhaust outlet flange with a tolerance of ± 75°F (42°C).

8. Exhaust gas mass flow value is based on a "wet basis" with a tolerance of ± 7%.

9. Inlet and Exhaust Restrictions based on full rated engine load Refer to the engine specification section of Dresser Waukesha's standard technical data for more information.

10. Cooling circuit capacity, lube oil capacity, and engine dry weight values are typical.

11. Fuel must conform to Dresser Waukesha "Gaseous Fuel Specification" S7884-7 or most current version. Fuel may require treatment to meet current fuel specification.

12. Heat exchanger sizing values given as the maximum heat rejection of the circuit, with applied tolerances and an additional 5% reserve factor.

13. Cooling system design flow is based on minimum allowable cooling system flow. Cooling system maximum external restriction is defined as the allowable restriction at the minimum cooling system flow. Refer to technical data sheets S-7797-3 and S-7797-5 (or latest version) for more information.

REQUIRED OPTION CODES

VGF - H24GSI

Gas Compression

ENGINE SPEED (rpm):	1800	COOLING SYSTEM:	JW, IC + OC
DISPLACEMENT (in3):	1462	INTERCOOLER WATER INLET (°F):	130
COMPRESSION RATIO:	8.6:1	JACKET WATER OUTLET (°F):	180
IGNITION SYSTEM:	CEC	JACKET WATER CAPACITY (gal):	20
EXHAUST MANIFOLD:	Water Cooled	AUXILIARY WATER CAPACITY (gal):	6
COMBUSTION:	Rich Burn, Turbocharged	LUBE OIL CAPACITY (gal):	56
ENGINE DRY WEIGHT (lbs):	7500	MAX. EXHAUST BACKPRESSURE (in. H2O):	15
AIR/FUEL RATIO SETTING:	0.35% CO	MAX. AIR INLET RESTRICTION (in. H2O):	15
IGNITION TIMING:	10° BTDC		

SITE CONDITIONS:

FUEL:		ALTITUDE (ft):	2300
FUEL PRESSURE RANGE (psig):	26 - 50	MAXIMUM INLET AIR TEMPERATURE (°F):	100
FUEL HHV (BTU/ft3):	1,503.1	FUEL WKI:	47.2
FUEL LHV (BTU/ft3):	1,358.8		

SITE SPECIFIC TECHNICAL DATA

		MAX RATING AT 100 °F AIR TEMP	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE OF 100 °F		
POWER RATING	**UNITS**		**100%**	**80%**	**61%**
CONTINUOUS ENGINE POWER	BHP	435	435	348	266
OVERLOAD	% 2/24 hr	0	0	-	-
MECHANICAL EFFICIENCY (LHV)	%	28.3	28.3	26.7	24.5
CONTINUOUS POWER AT FLYWHEEL *based on 20 HP cooling fan*	BHP	415	415	328	246
FUEL CONSUMPTION					
FUEL CONSUMPTION (LHV)	BTU/BHP-hr	8573	8573	8989	9633
FUEL CONSUMPTION (HHV)	BTU/BHP-hr	9483	9484	9943	10656
FUEL FLOW *based on fuel analysis LHV*	SCFM	48	48	40	33
HEAT REJECTION					
JACKET WATER (JW)	BTU/hr x 1000	1187	1187	1031	883
LUBE OIL (OC)	BTU/hr x 1000	234	234	219	204
INTERCOOLER (IC)	BTU/hr x 1000	87	87	60	37
EXHAUST	BTU/hr x 1000	1058	1058	869	690
RADIATION	BTU/hr x 1000	130	130	126	120
EMISSIONS					
NOx (NO + NO2)	g/bhp-hr	16.0	16.0	16.0	16.0
CO	g/bhp-hr	8.0	8.0	8.0	8.0
THC	g/bhp-hr	1.5	1.5	1.5	1.5
NMHC	g/bhp-hr	1.07	1.07	1.07	1.07
NM, NEHC	g/bhp-hr	0.67	0.67	0.67	0.67
CO2	g/bhp-hr	569	569	597	640
AIR INTAKE / EXHAUST GAS					
INDUCTION AIR FLOW	SCFM	730	730	612	501
EXHAUST GAS MASS FLOW	lb/hr	3258	3258	2733	2236
EXHAUST GAS FLOW *at exhaust temp, 14.5 psia*	ACFM	2384	2384	1975	1587
EXHAUST TEMPERATURE	°F	1205	1205	1184	1155

HEAT EXHANGER SIZING		
TOTAL JACKET WATER CIRCUIT (JW)	BTU/hr x 1000	1346
TOTAL AUXILIARY WATER CIRCUIT (IC + OC)	BTU/hr x 1000	364

COOLING SYSTEM WITH ENGINE MOUNTED WATER PUMPS		
JACKET WATER PUMP MIN. DESIGN FLOW	GPM	130
JACKET WATER PUMP MAX. EXTERNAL RESTRICTION	psig	16
AUX WATER PUMP MIN. DESIGN FLOW	GPM	35
AUX WATER PUMP MAX. EXTERNAL RESTRICTION	psig	15

All data provided per the condtions listed in the notes section on page three.

Data Generated by EngCalc Program Version 3.1. Dresser Inc., Dresser Waukesha
12/14/2011 12:54 PM

FUEL COMPOSITION

HYDROCARBONS:		Mole or Volume %
Methane	CH4	55.25
Ethane	C2H6	21.9
Propane	C3H8	11.99
Iso-Butane	I-C4H10	1.06
Normal Butane	N-C4H10	3.27
Iso-Pentane	I-C5H12	0.48
Normal Pentane	N-C5H12	0.7
Hexane	C6H14	0.97
Heptane	C7H16	0
Ethene	C2H4	0
Propene	C3H6	0
	SUM HYDROCARBONS	95.62
NON-HYDROCARBONS:		
Nitrogen	N2	3.87
Oxygen	O2	0
Helium	He	0
Carbon Dioxide	CO2	0.52
Carbon Monoxide	CO	0
Hydrogen	H2	0
Water Vapor	H2O	0
	TOTAL FUEL	100.01

FUEL:	
FUEL PRESSURE RANGE (psig):	26 - 50
FUEL WKI:	47.2
FUEL SLHV (BTU/ft3):	1335.17
FUEL SLHV (MJ/Nm3):	52.50
FUEL LHV (BUT/ft3):	1358.81
FUEL LHV (MJ/Nm3):	53.43
FUEL HHV (BUT/ft3):	1503.11
FUEL HHV (MJ/Nm3):	59.11
FUEL DENSITY (SG):	0.91

Standard Conditions per ASTM D3588-91 [60°F and 14.696psia] and ISO 6976:1996-02-01[25, V(0;101.325)].
Based on the fuel composition, supply pressure and temperature, liquid hydrocarbons may be present in the fuel. No liquid hydrocarbons are allowed in the fuel. The fuel must not contain any liquid water. Dresser Waukesha recommends both of the following:
1) Dew point of the fuel gas to be at least 20°F (11°C) below the measured temperature of the gas at the inlet of the engine fuel regulator.
2) A fuel filter separator to be used on all fuels except commercial quality natural gas.
Refer to the 'Fuel and Lubrication' section of 'Technical Data' or contact the Dresser Waukesha Application Engineering Department for additional information on fuels, or LHV and WKI® calculations.

FUEL CONTAMINANTS

Total Sulfur Compounds	0	% volume
Total Halogen as Cloride	0	% volume
Total Ammonia	0	% volume
Siloxanes		
Tetramethyl silane	0	% volume
Trimethyl silanol	0	% volume
Hexamethyldisiloxane (L2)	0	% volume
Hexamethylcyclotrisiloxane (D3)	0	% volume
Octamethyltrisiloxane (L3)	0	% volume
Octamethylcyclotetrasiloxane (D4)	0	% volume
Decamethyltetrasiloxane (L4)	0	% volume
Decamethylcyclopentasiloxane (D5)	0	% volume
Dodecamethylpentasiloxane (L5)	0	% volume
Dodecamethylcyclohexasiloxane (D6)	0	% volume
Others	0	% volume

Total Sulfur Compounds	0 µg/BTU
Total Halogen as Cloride	0 µg/BTU
Total Ammonia	0 µg/BTU
Total Siloxanes	0 µg/BTU

Calculated fuel contaminant analysis will depend on the entered fuel composition and selected engine model.

No water or hydrocarbon condensates are allowed in the engine. Requires liquids removal.

NOTES

1. All data is based on engines with standard configurations unless noted otherwise.

2. Power rating is adjusted for fuel, site altitude, and site air inlet temperature, in accordance with ISO 3046/1 with tolerance of ± 3%.

3. Fuel consumption is presented in accordance with ISO 3046/1 with a tolerance of -0 / +5% at maximum rating. Fuel flow calculation based on fuel LHV and fuel consumption with added 5% tolerance.

4. Heat rejection tolerances are ± 30% for radiation, and ± 8% for jacket water, lube oil, intercooler, and exhaust energy.

5. Emission levels are given at engine exhaust outlet flange prior to any after treatment. Values are based on a new engine operating at indicated site conditions, and adjusted to the specified timing and air/fuel ratio at rated load. Emissions are at an absolute humidity of 75 grains H2O/lb (10.71 g H2O/kg) of dry air. Emission levels may vary subject to instrumentation, measurement, ambient conditions, fuel quality, and engine variation. Engine may require adjustment on-site to meet emission values, which may affect engine performance and heat output. NOx, CO, THC, and NMHC emission levels are listed as a not to exceed limit, all other emission levels are estimated. CO2 emissions based on EPA Federal Register/Vol. 74, No. 209/Friday, October 30, 2009 Rules and Regulations 56398, 56399 (3) Tier 3 Calculation Methodology, Equation C-5.

6. Air flow is based on undried air with a tolerance of ± 7%.

7. Exhaust temperature given at engine exhaust outlet flange with a tolerance of ± 75°F (42°C).

8. Exhaust gas mass flow value is based on a "wet basis" with a tolerance of ± 7%.

9. Inlet and Exhaust Restrictions based on full rated engine load Refer to the engine specification section of Dresser Waukesha's standard technical data for more information.

10. Cooling circuit capacity, lube oil capacity, and engine dry weight values are typical.

11. Fuel must conform to Dresser Waukesha "Gaseous Fuel Specification" S7884-7 or most current version. Fuel may require treatment to meet current fuel specification.

12. Heat exchanger sizing values given as the maximum heat rejection of the circuit, with applied tolerances and an additional 5% reserve factor.

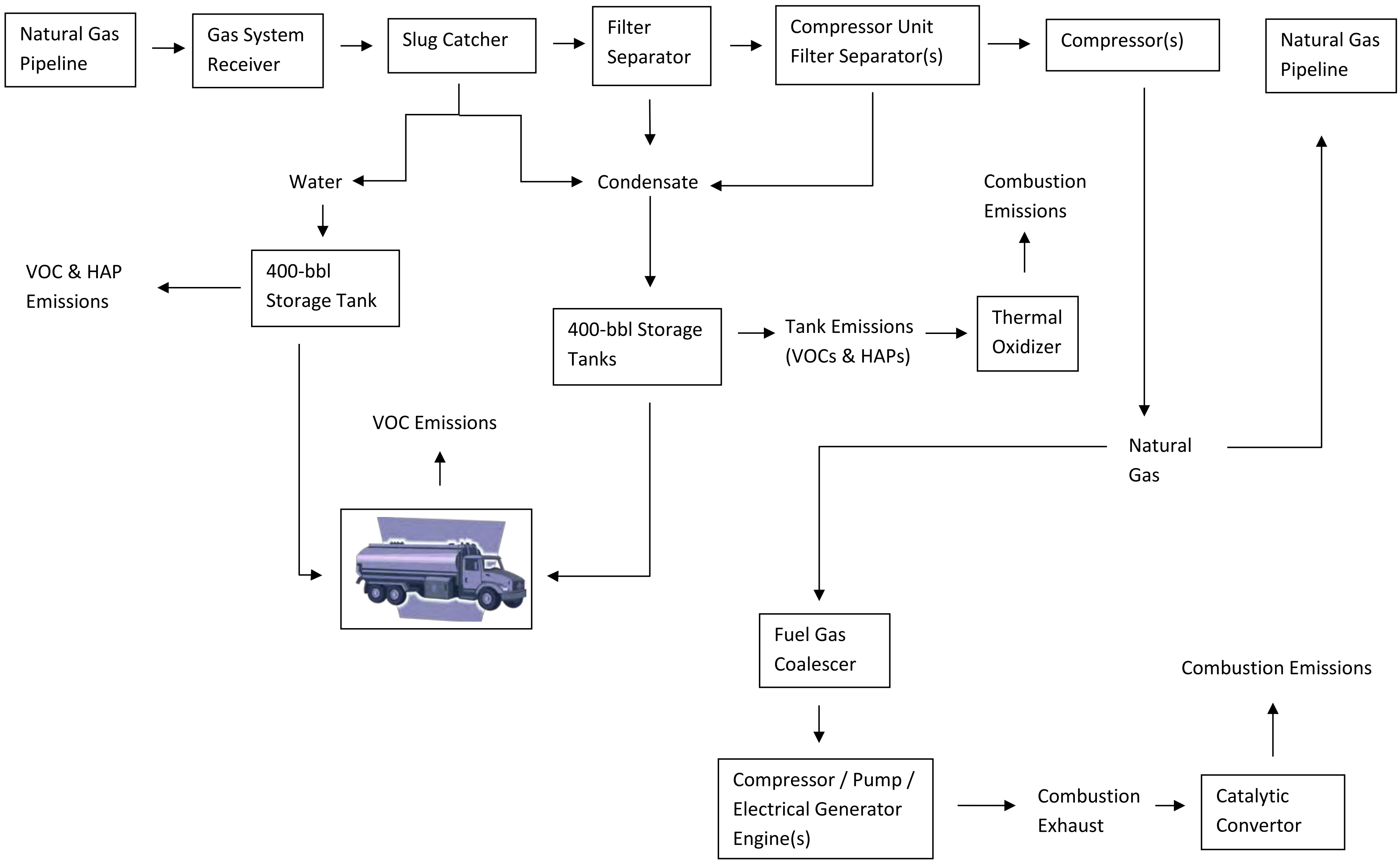
13. Cooling system design flow is based on minimum allowable cooling system flow. Cooling system maximum external restriction is defined as the allowable restriction at the minimum cooling system flow. Refer to technical data sheets S-7797-3 and S-7797-5 (or latest version) for more information.

REQUIRED OPTION CODES

APPENDIX D

Process Flow Diagram

Station 7 Simplified Process Flow Diagram



APPENDIX E

AERSCREEN Results

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.1 - Normalized Emissions

Type	Engine	Power (HP)	1-hr Concentration (ug/m^3)	3-hr Concentration (ug/m3)	8-hr Concentration (ug/m3)	24-hr Concentration (ug/m3)	Annual Concentration (ug/m^3)
1,480-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	L7042GSI	1480	7.4	7.4	6.7	4.4	0.7
740-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	L3514GSI	740	8.5	8.5	7.7	5.1	0.9
530-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	H24GL	530	15.4	15.4	13.8	9.2	1.5
435-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	H24GSI	435	16.2	16.2	14.6	9.7	1.6
400-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	F18GL	400	17.5	17.5	15.7	10.5	1.7
326-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	F18GSI	326	17.9	17.9	16.1	10.7	1.8

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.2 - NO2 Emissions

Engine	Quantity	Power (HP)	NO_x Emission Rate [1] (lb/hr)	Highest 1-hr NO_2 Concentration [2] (ug/m^3)	Highest Annual NO_2 Concentration [2] (ug/m^3)	Highest 1-hr NO_2 Concentration [3] (ppb)	Highest Annual NO_2 Concentration [3] (ppb)
L7042GSI	3	1,480	2.12	47.1	4.7	25.0	2.5
L3514GSI	1	740	1.27	10.8	1.1	5.7	0.6
H24GL	1	530	2.34	35.9	3.6	19.0	1.9
H24GSI	1	435	0.77	12.5	1.2	6.6	0.7
F18GL	1	400	1.76	30.8	3.1	16.3	1.6
F18GSI	1	326	0.57	10.2	1.0	5.4	0.5
			Station Total	**147.3**	**14.7**	**78.0**	**7.8**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

[3] Calculated by multiplying the concentration provided in ug/m^3 by 0.53 to convert to ppb

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.3 - CO Emissions

Engine	Quantity	Power (HP)	CO Emission Rate [1] (lb/hr)	Highest CO 1-hr Concentration [2] (ug/m^3)	Highest CO 1-hr Concentration [2] (ug/m^3)	Highest CO 1-hr Concentration [3] (ppm)	Highest CO 8-hr Concentration [3] (ppm)
L7042GSI	3	1480	2.94	65.3	58.8	0.057	0.051
L3514GSI	1	740	2.02	17.2	15.5	0.015	0.013
H24GL	1	530	1.52	23.3	21.0	0.020	0.018
H24GSI	1	435	0.77	12.5	11.2	0.011	0.010
F18GL	1	400	1.15	20.1	18.1	0.017	0.016
F18GSI	1	326	0.57	10.2	9.2	0.009	0.008
			Station Total	**148.6**	**133.8**	**0.1**	**0.1**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

[3] Calculated by multiplying the concentration provided in ug/m^3 by $8.7*10^{-3}$ to convert to ppm

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.4 - PM10 Emissions

Engine	Quantity	Power (HP)	PM_{10} Emission Rate [1] (lb/hr)	Highest $PM_{2.5}$ 24-hr Concentration [2] (ug/m^3)
L7042GSI	3	1480	0.14	1.9
L3514GSI	1	740	0.06	0.3
H24GL	1	530	0.00	0.0
H24GSI	1	435	0.04	0.4
F18GL	1	400	0.00	0.0
F18GSI	1	326	0.03	0.3
			Station Total	**2.9**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.5 - PM2.5 Emissions

Engine	Quantity	Power (HP)	$PM_{2.5}$ Emission Rate [1] (lb/hr)	Highest $PM_{2.5}$ 24-hr Concentration [2] (ug/m^3)	Highest $PM_{2.5}$ Annual Concentration [2] (ug/m^3)
L7042GSI	3	1480	0.14	1.9	0.1
L3514GSI	1	740	0.06	0.3	0.1
H24GL	1	530	0.00	0.0	0.0
H24GSI	1	435	0.04	0.4	0.1
F18GL	1	400	0.00	0.0	0.0
F18GSI	1	326	0.03	0.3	0.1
			Station Total	**2.9**	**0.3**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.6 - SO2 Emissions

Engine	Quantity	Power (HP)	SO_2 Emission Rate [1] (lb/hr)	Highest SO_2 1-hr Concentration [2] (ug/m^3)	Highest SO_2 3-hr Concentration [2] (ug/m^3)	Highest SO_2 1-hr Concentration [3] (ppb)	Highest SO_2 3-hr Concentration [3] (ppb)
L7042GSI	3	1480	0.83	18.4	18.4	7.0	7.0
L3514GSI	1	740	0.38	3.2	3.2	1.2	1.2
H24GL	1	530	0.26	4.0	4.0	1.5	1.5
H24GSI	1	435	0.24	3.9	3.9	1.5	1.5
F18GL	1	400	0.18	3.1	3.1	1.2	1.2
F18GSI	1	326	0.18	3.2	3.2	1.2	1.2
			Station Total	**35.9**	**35.9**	**13.6**	**13.6**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

[3] Calculated by multiplying the concentration provided in ug/m^3 by 0.38 to convert to ppb

Arrow_Station7_326hp

AERSCREEN 11126 / AERMOD 1206 04/23/13
19:51:16

TITLE: Arrow_Station7_326hp

**************************** STACK PARAMETERS ****************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	925.9 K	1207.0 Deg F
PLUME EXIT VELOCITY:	26.137 m/s	85.75 ft/s
STACK AIR FLOW RATE:	1796 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.05000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

********************** BUILDING DOWNWASH PARAMETERS **********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************* FLOW SECTOR ANALYSIS *************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	17.36	100.0	SUM
20	0.00	0.00	0.00	0.00	17.36	100.0	SUM
30	0.00	0.00	0.00	0.00	17.36	100.0	SUM
40	0.00	0.00	0.00	0.00	17.36	100.0	SUM
50	0.00	0.00	0.00	0.00	17.36	100.0	SUM
60	0.00	0.00	0.00	0.00	17.36	100.0	SUM
70	0.00	0.00	0.00	0.00	17.36	100.0	SUM
80	0.00	0.00	0.00	0.00	17.36	100.0	SUM
90	0.00	0.00	0.00	0.00	17.36	100.0	SUM
100	0.00	0.00	0.00	0.00	17.36	100.0	SUM
110	0.00	0.00	0.00	0.00	17.36	100.0	SUM
120	0.00	0.00	0.00	0.00	17.36	100.0	SUM
130	0.00	0.00	0.00	0.00	17.36	100.0	SUM

140	0.00	0.00	0.00	0.00	17.36	100.0	SUM
150	0.00	0.00	0.00	0.00	17.36	100.0	SUM
160	0.00	0.00	0.00	0.00	17.36	100.0	SUM
170	0.00	0.00	0.00	0.00	17.36	100.0	SUM
180	0.00	0.00	0.00	0.00	17.36	100.0	SUM
190	0.00	0.00	0.00	0.00	17.36	100.0	SUM
200	0.00	0.00	0.00	0.00	17.36	100.0	SUM
210	0.00	0.00	0.00	0.00	17.36	100.0	SUM
220	0.00	0.00	0.00	0.00	17.36	100.0	SUM
230	0.00	0.00	0.00	0.00	17.36	100.0	SUM
240	0.00	0.00	0.00	0.00	17.36	100.0	SUM
250	0.00	0.00	0.00	0.00	17.36	100.0	SUM
260	0.00	0.00	0.00	0.00	17.36	100.0	SUM
270	0.00	0.00	0.00	0.00	17.36	100.0	SUM
280	0.00	0.00	0.00	0.00	17.36	100.0	SUM
290	0.00	0.00	0.00	0.00	17.36	100.0	SUM
300	0.00	0.00	0.00	0.00	17.36	100.0	SUM
310	0.00	0.00	0.00	0.00	17.36	100.0	SUM
320	0.00	0.00	0.00	0.00	17.36	100.0	SUM
330	0.00	0.00	0.00	0.00	17.36	100.0	SUM
340	0.00	0.00	0.00	0.00	17.36	100.0	SUM
350	0.00	0.00	0.00	0.00	17.36	100.0	SUM
360	0.00	0.00	0.00	0.00	17.36	100.0	SUM

* = worst case flow sector

********************** MAKEMET METEOROLOGY PARAMETERS *********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 13.0 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	19	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
58.70	0.087	0.600	0.020	133.	59.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 77.4 meters

************************ AERSCREEN AUTOMATED DISTANCES *********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	3.016	2525.00	3.320
25.00	6.564	2550.00	3.305
50.00	12.31	2575.00	3.290
75.00	17.05	2600.00	3.275
100.00	17.36	2625.00	3.259
125.00	15.60	2650.00	3.244
150.00	14.25	2675.00	3.229
175.00	12.62	2700.00	3.213
200.00	11.87	2725.00	3.197
225.00	10.98	2750.00	3.182
250.00	10.60	2775.00	3.166
275.00	10.53	2800.00	3.150
300.00	10.24	2825.00	3.135
325.00	9.839	2850.00	3.119
350.00	9.673	2875.00	3.103
375.00	9.727	2900.00	3.087
400.00	9.665	2925.00	3.071
425.00	9.571	2950.00	3.056
450.00	9.424	2975.00	3.040
475.00	9.231	3000.00	3.024
500.00	9.007	3025.00	3.008
525.00	8.762	3050.00	2.992
550.00	8.506	3075.00	2.977
575.00	8.245	3100.00	2.961
600.00	7.983	3125.00	2.945
625.00	7.723	3150.00	2.930
650.00	7.468	3175.00	2.914
675.00	7.219	3200.00	2.899
700.00	7.194	3225.00	2.883
725.00	7.176	3250.00	2.868
750.00	7.144	3275.00	2.852

775.00	7.100	3300.00	2.837
800.00	7.047	3325.00	2.822
825.00	6.985	3350.00	2.807
850.00	6.917	3375.00	2.792
875.00	6.843	3400.00	2.777
900.00	6.765	3425.00	2.762
925.00	6.683	3450.00	2.747
950.00	6.598	3475.00	2.732
975.00	6.511	3500.00	2.717
1000.00	6.428	3525.00	2.703
1025.00	6.367	3550.00	2.688
1050.00	6.303	3575.00	2.674
1075.00	6.237	3600.00	2.659
1100.00	6.169	3625.00	2.645
1125.00	6.101	3650.00	2.631
1150.00	6.031	3675.00	2.616
1175.00	5.960	3700.00	2.602
1200.00	5.889	3725.00	2.588
1225.00	5.818	3750.00	2.574
1250.00	5.746	3775.00	2.561
1275.00	5.675	3800.00	2.547
1300.00	5.604	3825.00	2.533
1325.00	5.533	3850.00	2.520
1350.00	5.463	3875.00	2.506
1375.00	5.393	3900.00	2.493
1400.00	5.324	3925.00	2.479
1425.00	5.256	3950.00	2.466
1450.00	5.188	3975.00	2.453
1475.00	5.122	4000.00	2.440
1500.00	5.056	4025.00	2.428
1525.00	4.991	4050.00	2.417
1550.00	4.926	4075.00	2.405
1575.00	4.863	4100.00	2.394
1600.00	4.801	4125.00	2.383
1625.00	4.739	4150.00	2.372
1650.00	4.679	4175.00	2.361
1675.00	4.619	4200.00	2.350
1700.00	4.561	4225.00	2.339
1725.00	4.503	4250.00	2.331
1750.00	4.446	4275.00	2.324
1775.00	4.391	4300.00	2.317
1800.00	4.336	4325.00	2.310
1825.00	4.282	4350.00	2.303
1850.00	4.229	4375.00	2.295
1875.00	4.177	4400.00	2.288
1900.00	4.126	4425.00	2.281
1925.00	4.076	4450.00	2.274
1950.00	4.026	4475.00	2.266
1975.00	3.978	4500.00	2.259
2000.00	3.930	4525.00	2.252
2025.00	3.883	4550.00	2.245
2050.00	3.837	4575.00	2.237
2075.00	3.792	4600.00	2.230
2100.00	3.748	4625.00	2.223
2125.00	3.704	4650.00	2.216
2150.00	3.661	4675.00	2.208
2175.00	3.619	4700.00	2.201
2200.00	3.578	4725.00	2.194
2225.00	3.541	4750.00	2.187
2250.00	3.522	4775.00	2.180
2275.00	3.503	4800.00	2.172
2300.00	3.484	4825.00	2.165
2325.00	3.465	4850.00	2.158

2350.00	3.445	4875.00	2.151
2375.00	3.426	4900.00	2.144
2400.00	3.407	4925.00	2.137
2425.00	3.387	4950.00	2.129
2450.00	3.368	4975.00	2.122
2475.00	3.349	5000.00	2.115
2500.00	3.334		

******************** AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	17.88	17.88	16.09	10.73	1.788

DISTANCE FROM SOURCE 88.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	3.016	3.016	2.714	1.810	0.3016

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 04/18/13
16:05:59

TITLE: Arrow_Station7_400hp

*************************** STACK PARAMETERS ***************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	742.6 K	877.0 Deg F
PLUME EXIT VELOCITY:	31.944 m/s	104.80 ft/s
STACK AIR FLOW RATE:	2195 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.25000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

********************** BUILDING DOWNWASH PARAMETERS **********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************ FLOW SECTOR ANALYSIS *************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	17.07	100.0	SUM
20	0.00	0.00	0.00	0.00	17.07	100.0	SUM
30	0.00	0.00	0.00	0.00	17.07	100.0	SUM
40	0.00	0.00	0.00	0.00	17.07	100.0	SUM
50	0.00	0.00	0.00	0.00	17.07	100.0	SUM
60	0.00	0.00	0.00	0.00	17.07	100.0	SUM
70	0.00	0.00	0.00	0.00	17.07	100.0	SUM
80	0.00	0.00	0.00	0.00	17.07	100.0	SUM
90	0.00	0.00	0.00	0.00	17.07	100.0	SUM
100	0.00	0.00	0.00	0.00	17.07	100.0	SUM
110	0.00	0.00	0.00	0.00	17.07	100.0	SUM
120	0.00	0.00	0.00	0.00	17.07	100.0	SUM
130	0.00	0.00	0.00	0.00	17.07	100.0	SUM

140	0.00	0.00	0.00	0.00	17.07	100.0	SUM
150	0.00	0.00	0.00	0.00	17.07	100.0	SUM
160	0.00	0.00	0.00	0.00	17.07	100.0	SUM
170	0.00	0.00	0.00	0.00	17.07	100.0	SUM
180	0.00	0.00	0.00	0.00	17.07	100.0	SUM
190	0.00	0.00	0.00	0.00	17.07	100.0	SUM
200	0.00	0.00	0.00	0.00	17.07	100.0	SUM
210	0.00	0.00	0.00	0.00	17.07	100.0	SUM
220	0.00	0.00	0.00	0.00	17.07	100.0	SUM
230	0.00	0.00	0.00	0.00	17.07	100.0	SUM
240	0.00	0.00	0.00	0.00	17.07	100.0	SUM
250	0.00	0.00	0.00	0.00	17.07	100.0	SUM
260	0.00	0.00	0.00	0.00	17.07	100.0	SUM
270	0.00	0.00	0.00	0.00	17.07	100.0	SUM
280	0.00	0.00	0.00	0.00	17.07	100.0	SUM
290	0.00	0.00	0.00	0.00	17.07	100.0	SUM
300	0.00	0.00	0.00	0.00	17.07	100.0	SUM
310	0.00	0.00	0.00	0.00	17.07	100.0	SUM
320	0.00	0.00	0.00	0.00	17.07	100.0	SUM
330	0.00	0.00	0.00	0.00	17.07	100.0	SUM
340	0.00	0.00	0.00	0.00	17.07	100.0	SUM
350	0.00	0.00	0.00	0.00	17.07	100.0	SUM
360	0.00	0.00	0.00	0.00	17.07	100.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS ********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 13.6 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	22	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
63.99	0.086	0.600	0.020	134.	58.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 79.6 meters

************************ AERSCREEN AUTOMATED DISTANCES *********************

OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	2.677	2525.00	3.077
25.00	5.859	2550.00	3.062
50.00	11.02	2575.00	3.046
75.00	16.46	2600.00	3.030
100.00	17.07	2625.00	3.018
125.00	15.24	2650.00	3.006
150.00	13.89	2675.00	2.994
175.00	12.36	2700.00	2.982
200.00	11.40	2725.00	2.970
225.00	10.71	2750.00	2.958
250.00	9.989	2775.00	2.945
275.00	9.662	2800.00	2.933
300.00	9.507	2825.00	2.920
325.00	9.214	2850.00	2.908
350.00	8.842	2875.00	2.895
375.00	8.691	2900.00	2.882
400.00	8.773	2925.00	2.869
425.00	8.764	2950.00	2.856
450.00	8.686	2975.00	2.843
475.00	8.558	3000.00	2.830
500.00	8.393	3025.00	2.817
525.00	8.202	3050.00	2.804
550.00	7.995	3075.00	2.791
575.00	7.778	3100.00	2.778
600.00	7.555	3125.00	2.765
625.00	7.331	3150.00	2.752
650.00	7.108	3175.00	2.739
675.00	6.888	3200.00	2.726
700.00	6.673	3225.00	2.713
725.00	6.464	3250.00	2.700
750.00	6.260	3275.00	2.687

775.00	6.217	3300.00	2.674
800.00	6.198	3325.00	2.661
825.00	6.169	3350.00	2.648
850.00	6.133	3375.00	2.635
875.00	6.091	3400.00	2.622
900.00	6.042	3425.00	2.609
925.00	5.992	3450.00	2.596
950.00	5.961	3475.00	2.583
975.00	5.926	3500.00	2.571
1000.00	5.887	3525.00	2.558
1025.00	5.843	3550.00	2.545
1050.00	5.797	3575.00	2.533
1075.00	5.748	3600.00	2.520
1100.00	5.697	3625.00	2.508
1125.00	5.644	3650.00	2.495
1150.00	5.589	3675.00	2.483
1175.00	5.533	3700.00	2.470
1200.00	5.476	3725.00	2.458
1225.00	5.418	3750.00	2.446
1250.00	5.360	3775.00	2.434
1275.00	5.301	3800.00	2.421
1300.00	5.242	3825.00	2.409
1325.00	5.183	3850.00	2.397
1350.00	5.124	3875.00	2.385
1375.00	5.065	3900.00	2.374
1400.00	5.006	3925.00	2.362
1425.00	4.947	3950.00	2.350
1450.00	4.889	3975.00	2.338
1475.00	4.831	4000.00	2.327
1500.00	4.774	4025.00	2.315
1525.00	4.717	4050.00	2.304
1550.00	4.661	4075.00	2.292
1575.00	4.606	4100.00	2.281
1600.00	4.551	4125.00	2.270
1625.00	4.496	4150.00	2.258
1650.00	4.443	4175.00	2.247
1675.00	4.390	4200.00	2.236
1700.00	4.338	4225.00	2.225
1725.00	4.286	4250.00	2.214
1750.00	4.235	4275.00	2.203
1775.00	4.185	4300.00	2.192
1800.00	4.136	4325.00	2.181
1825.00	4.087	4350.00	2.171
1850.00	4.040	4375.00	2.160
1875.00	3.993	4400.00	2.150
1900.00	3.946	4425.00	2.139
1925.00	3.900	4450.00	2.129
1950.00	3.856	4475.00	2.118
1975.00	3.811	4500.00	2.108
2000.00	3.768	4525.00	2.098
2025.00	3.725	4550.00	2.088
2050.00	3.683	4575.00	2.078
2075.00	3.641	4600.00	2.072
2100.00	3.600	4625.00	2.066
2125.00	3.560	4650.00	2.060
2150.00	3.521	4675.00	2.055
2175.00	3.482	4700.00	2.049
2200.00	3.444	4725.00	2.043
2225.00	3.406	4750.00	2.037
2250.00	3.369	4775.00	2.031
2275.00	3.333	4800.00	2.026
2300.00	3.297	4825.00	2.020
2325.00	3.262	4850.00	2.014

2350.00	3.227	4875.00	2.008
2375.00	3.193	4900.00	2.002
2400.00	3.159	4925.00	1.996
2425.00	3.139	4950.00	1.991
2450.00	3.124	4975.00	1.985
2475.00	3.108	5000.00	1.979
2500.00	3.093		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	17.48	17.48	15.73	10.49	1.748

DISTANCE FROM SOURCE 89.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	2.677	2.677	2.409	1.606	0.2677

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 04/23/13
20:15:45

TITLE: Arrow_Station7_435hp

**************************** STACK PARAMETERS ***************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	924.8 K	1205.0 Deg F
PLUME EXIT VELOCITY:	34.695 m/s	113.83 ft/s
STACK AIR FLOW RATE:	2384 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.05000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

********************** BUILDING DOWNWASH PARAMETERS *********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************* FLOW SECTOR ANALYSIS **************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	16.02	100.0	SUM
20	0.00	0.00	0.00	0.00	16.02	100.0	SUM
30	0.00	0.00	0.00	0.00	16.02	100.0	SUM
40	0.00	0.00	0.00	0.00	16.02	100.0	SUM
50	0.00	0.00	0.00	0.00	16.02	100.0	SUM
60	0.00	0.00	0.00	0.00	16.02	100.0	SUM
70	0.00	0.00	0.00	0.00	16.02	100.0	SUM
80	0.00	0.00	0.00	0.00	16.02	100.0	SUM
90	0.00	0.00	0.00	0.00	16.02	100.0	SUM
100	0.00	0.00	0.00	0.00	16.02	100.0	SUM
110	0.00	0.00	0.00	0.00	16.02	100.0	SUM
120	0.00	0.00	0.00	0.00	16.02	100.0	SUM
130	0.00	0.00	0.00	0.00	16.02	100.0	SUM

140	0.00	0.00	0.00	0.00	16.02	100.0	SUM
150	0.00	0.00	0.00	0.00	16.02	100.0	SUM
160	0.00	0.00	0.00	0.00	16.02	100.0	SUM
170	0.00	0.00	0.00	0.00	16.02	100.0	SUM
180	0.00	0.00	0.00	0.00	16.02	100.0	SUM
190	0.00	0.00	0.00	0.00	16.02	100.0	SUM
200	0.00	0.00	0.00	0.00	16.02	100.0	SUM
210	0.00	0.00	0.00	0.00	16.02	100.0	SUM
220	0.00	0.00	0.00	0.00	16.02	100.0	SUM
230	0.00	0.00	0.00	0.00	16.02	100.0	SUM
240	0.00	0.00	0.00	0.00	16.02	100.0	SUM
250	0.00	0.00	0.00	0.00	16.02	100.0	SUM
260	0.00	0.00	0.00	0.00	16.02	100.0	SUM
270	0.00	0.00	0.00	0.00	16.02	100.0	SUM
280	0.00	0.00	0.00	0.00	16.02	100.0	SUM
290	0.00	0.00	0.00	0.00	16.02	100.0	SUM
300	0.00	0.00	0.00	0.00	16.02	100.0	SUM
310	0.00	0.00	0.00	0.00	16.02	100.0	SUM
320	0.00	0.00	0.00	0.00	16.02	100.0	SUM
330	0.00	0.00	0.00	0.00	16.02	100.0	SUM
340	0.00	0.00	0.00	0.00	16.02	100.0	SUM
350	0.00	0.00	0.00	0.00	16.02	100.0	SUM
360	0.00	0.00	0.00	0.00	16.02	100.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS ********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 14.4 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	19	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
58.70	0.087	0.600	0.020	133.	59.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 93.9 meters

*********************** AERSCREEN AUTOMATED DISTANCES ********************

OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	2.117	2525.00	2.766
25.00	4.771	2550.00	2.740
50.00	9.582	2575.00	2.715
75.00	15.51	2600.00	2.690
100.00	16.02	2625.00	2.665
125.00	14.11	2650.00	2.641
150.00	12.98	2675.00	2.617
175.00	11.49	2700.00	2.593
200.00	10.54	2725.00	2.569
225.00	9.943	2750.00	2.546
250.00	9.263	2775.00	2.536
275.00	8.706	2800.00	2.529
300.00	8.164	2825.00	2.522
325.00	8.056	2850.00	2.514
350.00	7.846	2875.00	2.507
375.00	7.575	2900.00	2.499
400.00	7.375	2925.00	2.491
425.00	7.426	2950.00	2.484
450.00	7.408	2975.00	2.475
475.00	7.340	3000.00	2.467
500.00	7.272	3025.00	2.459
525.00	7.172	3050.00	2.451
550.00	7.048	3075.00	2.442
575.00	6.906	3100.00	2.434
600.00	6.753	3125.00	2.425
625.00	6.592	3150.00	2.417
650.00	6.426	3175.00	2.408
675.00	6.258	3200.00	2.399
700.00	6.090	3225.00	2.390
725.00	5.924	3250.00	2.381
750.00	5.759	3275.00	2.372

775.00	5.598	3300.00	2.363
800.00	5.441	3325.00	2.354
825.00	5.288	3350.00	2.345
850.00	5.140	3375.00	2.336
875.00	5.056	3400.00	2.327
900.00	5.044	3425.00	2.318
925.00	5.025	3450.00	2.309
950.00	5.002	3475.00	2.300
975.00	4.974	3500.00	2.290
1000.00	4.942	3525.00	2.281
1025.00	4.907	3550.00	2.272
1050.00	4.870	3575.00	2.263
1075.00	4.830	3600.00	2.254
1100.00	4.787	3625.00	2.244
1125.00	4.743	3650.00	2.235
1150.00	4.698	3675.00	2.226
1175.00	4.651	3700.00	2.217
1200.00	4.604	3725.00	2.207
1225.00	4.557	3750.00	2.198
1250.00	4.524	3775.00	2.189
1275.00	4.489	3800.00	2.180
1300.00	4.454	3825.00	2.171
1325.00	4.418	3850.00	2.162
1350.00	4.381	3875.00	2.152
1375.00	4.343	3900.00	2.143
1400.00	4.305	3925.00	2.134
1425.00	4.267	3950.00	2.125
1450.00	4.228	3975.00	2.116
1475.00	4.189	4000.00	2.107
1500.00	4.149	4025.00	2.098
1525.00	4.110	4050.00	2.089
1550.00	4.070	4075.00	2.080
1575.00	4.031	4100.00	2.071
1600.00	3.992	4125.00	2.062
1625.00	3.953	4150.00	2.054
1650.00	3.913	4175.00	2.045
1675.00	3.875	4200.00	2.036
1700.00	3.836	4225.00	2.027
1725.00	3.798	4250.00	2.019
1750.00	3.759	4275.00	2.010
1775.00	3.722	4300.00	2.001
1800.00	3.684	4325.00	1.993
1825.00	3.647	4350.00	1.984
1850.00	3.610	4375.00	1.975
1875.00	3.574	4400.00	1.967
1900.00	3.538	4425.00	1.958
1925.00	3.502	4450.00	1.950
1950.00	3.467	4475.00	1.942
1975.00	3.432	4500.00	1.933
2000.00	3.397	4525.00	1.925
2025.00	3.363	4550.00	1.917
2050.00	3.329	4575.00	1.908
2075.00	3.296	4600.00	1.900
2100.00	3.263	4625.00	1.892
2125.00	3.231	4650.00	1.884
2150.00	3.199	4675.00	1.876
2175.00	3.167	4700.00	1.868
2200.00	3.136	4725.00	1.860
2225.00	3.105	4750.00	1.852
2250.00	3.075	4775.00	1.844
2275.00	3.045	4800.00	1.836
2300.00	3.015	4825.00	1.828
2325.00	2.986	4850.00	1.820

2350.00	2.957	4875.00	1.812
2375.00	2.929	4900.00	1.805
2400.00	2.901	4925.00	1.797
2425.00	2.873	4950.00	1.789
2450.00	2.846	4975.00	1.782
2475.00	2.819	5000.00	1.774
2500.00	2.792		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	16.18	16.18	14.56	9.708	1.618

DISTANCE FROM SOURCE 93.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	2.117	2.117	1.905	1.270	0.2117

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 04/18/13
08:59:26

TITLE: ARROW_STATION7_530HP

**************************** STACK PARAMETERS ****************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	738.2 K	869.0 Deg F
PLUME EXIT VELOCITY:	45.478 m/s	149.21 ft/s
STACK AIR FLOW RATE:	3125 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.25000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

********************** BUILDING DOWNWASH PARAMETERS **********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************ FLOW SECTOR ANALYSIS ************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	15.29	100.0	SUM
20	0.00	0.00	0.00	0.00	15.29	100.0	SUM
30	0.00	0.00	0.00	0.00	15.29	100.0	SUM
40	0.00	0.00	0.00	0.00	15.29	100.0	SUM
50	0.00	0.00	0.00	0.00	15.29	100.0	SUM
60	0.00	0.00	0.00	0.00	15.29	100.0	SUM
70	0.00	0.00	0.00	0.00	15.29	100.0	SUM
80	0.00	0.00	0.00	0.00	15.29	100.0	SUM
90	0.00	0.00	0.00	0.00	15.29	100.0	SUM
100	0.00	0.00	0.00	0.00	15.29	100.0	SUM
110	0.00	0.00	0.00	0.00	15.29	100.0	SUM
120	0.00	0.00	0.00	0.00	15.29	100.0	SUM
130	0.00	0.00	0.00	0.00	15.29	100.0	SUM

140	0.00	0.00	0.00	0.00	15.29	100.0	SUM
150	0.00	0.00	0.00	0.00	15.29	100.0	SUM
160	0.00	0.00	0.00	0.00	15.29	100.0	SUM
170	0.00	0.00	0.00	0.00	15.29	100.0	SUM
180	0.00	0.00	0.00	0.00	15.29	100.0	SUM
190	0.00	0.00	0.00	0.00	15.29	100.0	SUM
200	0.00	0.00	0.00	0.00	15.29	100.0	SUM
210	0.00	0.00	0.00	0.00	15.29	100.0	SUM
220	0.00	0.00	0.00	0.00	15.29	100.0	SUM
230	0.00	0.00	0.00	0.00	15.29	100.0	SUM
240	0.00	0.00	0.00	0.00	15.29	100.0	SUM
250	0.00	0.00	0.00	0.00	15.29	100.0	SUM
260	0.00	0.00	0.00	0.00	15.29	100.0	SUM
270	0.00	0.00	0.00	0.00	15.29	100.0	SUM
280	0.00	0.00	0.00	0.00	15.29	100.0	SUM
290	0.00	0.00	0.00	0.00	15.29	100.0	SUM
300	0.00	0.00	0.00	0.00	15.29	100.0	SUM
310	0.00	0.00	0.00	0.00	15.29	100.0	SUM
320	0.00	0.00	0.00	0.00	15.29	100.0	SUM
330	0.00	0.00	0.00	0.00	15.29	100.0	SUM
340	0.00	0.00	0.00	0.00	15.29	100.0	SUM
350	0.00	0.00	0.00	0.00	15.29	100.0	SUM
360	0.00	0.00	0.00	0.00	15.29	100.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS ********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 15.4 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	22	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
63.99	0.086	0.600	0.020	134.	58.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 101.3 meters

************************ AERSCREEN AUTOMATED DISTANCES **********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	1.632	2525.00	2.542
25.00	3.726	2550.00	2.520
50.00	8.713	2575.00	2.499
75.00	15.04	2600.00	2.478
100.00	15.29	2625.00	2.457
125.00	13.71	2650.00	2.437
150.00	12.48	2675.00	2.416
175.00	11.08	2700.00	2.396
200.00	9.872	2725.00	2.376
225.00	9.230	2750.00	2.357
250.00	8.752	2775.00	2.337
275.00	8.256	2800.00	2.318
300.00	7.825	2825.00	2.299
325.00	7.419	2850.00	2.281
350.00	6.989	2875.00	2.262
375.00	6.661	2900.00	2.244
400.00	6.472	2925.00	2.226
425.00	6.252	2950.00	2.208
450.00	6.071	2975.00	2.190
475.00	6.128	3000.00	2.173
500.00	6.142	3025.00	2.156
525.00	6.121	3050.00	2.139
550.00	6.071	3075.00	2.122
575.00	6.000	3100.00	2.105
600.00	5.911	3125.00	2.089
625.00	5.810	3150.00	2.073
650.00	5.700	3175.00	2.064
675.00	5.584	3200.00	2.059
700.00	5.463	3225.00	2.054
725.00	5.339	3250.00	2.049
750.00	5.214	3275.00	2.044

775.00	5.090	3300.00	2.038
800.00	4.966	3325.00	2.033
825.00	4.844	3350.00	2.028
850.00	4.724	3375.00	2.022
875.00	4.606	3400.00	2.017
900.00	4.491	3425.00	2.011
925.00	4.378	3450.00	2.005
950.00	4.269	3475.00	2.000
975.00	4.163	3500.00	1.994
1000.00	4.060	3525.00	1.988
1025.00	3.994	3550.00	1.982
1050.00	3.948	3575.00	1.976
1075.00	3.907	3600.00	1.970
1100.00	3.892	3625.00	1.964
1125.00	3.875	3650.00	1.958
1150.00	3.856	3675.00	1.952
1175.00	3.835	3700.00	1.946
1200.00	3.825	3725.00	1.940
1225.00	3.812	3750.00	1.933
1250.00	3.798	3775.00	1.927
1275.00	3.782	3800.00	1.921
1300.00	3.765	3825.00	1.915
1325.00	3.746	3850.00	1.908
1350.00	3.726	3875.00	1.902
1375.00	3.705	3900.00	1.895
1400.00	3.683	3925.00	1.889
1425.00	3.660	3950.00	1.883
1450.00	3.637	3975.00	1.876
1475.00	3.612	4000.00	1.870
1500.00	3.587	4025.00	1.863
1525.00	3.562	4050.00	1.857
1550.00	3.536	4075.00	1.851
1575.00	3.510	4100.00	1.844
1600.00	3.483	4125.00	1.838
1625.00	3.457	4150.00	1.831
1650.00	3.430	4175.00	1.825
1675.00	3.402	4200.00	1.818
1700.00	3.375	4225.00	1.812
1725.00	3.348	4250.00	1.805
1750.00	3.320	4275.00	1.799
1775.00	3.293	4300.00	1.793
1800.00	3.265	4325.00	1.786
1825.00	3.238	4350.00	1.780
1850.00	3.211	4375.00	1.773
1875.00	3.183	4400.00	1.767
1900.00	3.156	4425.00	1.760
1925.00	3.129	4450.00	1.754
1950.00	3.102	4475.00	1.748
1975.00	3.076	4500.00	1.741
2000.00	3.049	4525.00	1.735
2025.00	3.023	4550.00	1.729
2050.00	2.997	4575.00	1.722
2075.00	2.971	4600.00	1.716
2100.00	2.945	4625.00	1.710
2125.00	2.919	4650.00	1.703
2150.00	2.894	4675.00	1.697
2175.00	2.869	4700.00	1.691
2200.00	2.844	4725.00	1.685
2225.00	2.819	4750.00	1.678
2250.00	2.795	4775.00	1.672
2275.00	2.770	4800.00	1.666
2300.00	2.746	4825.00	1.660
2325.00	2.723	4850.00	1.654

2350.00	2.699	4875.00	1.648
2375.00	2.676	4900.00	1.641
2400.00	2.653	4925.00	1.635
2425.00	2.630	4950.00	1.629
2450.00	2.608	4975.00	1.623
2475.00	2.586	5000.00	1.617
2500.00	2.564		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	15.35	15.35	13.82	9.211	1.535

DISTANCE FROM SOURCE 95.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	1.632	1.632	1.468	0.9789	0.1632

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 04/23/13
19:26:25

TITLE: Arrow_Station7_740hp

***************************** STACK PARAMETERS ****************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	9.75 meters	32.00 feet
STACK INNER DIAMETER:	0.254 meters	10.00 inches
PLUME EXIT TEMPERATURE:	922.0 K	1200.0 Deg F
PLUME EXIT VELOCITY:	38.094 m/s	124.98 ft/s
STACK AIR FLOW RATE:	4090 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.05000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

*********************** BUILDING DOWNWASH PARAMETERS ********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************* FLOW SECTOR ANALYSIS *************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	8.430	100.0	SUM
20	0.00	0.00	0.00	0.00	8.430	100.0	SUM
30	0.00	0.00	0.00	0.00	8.430	100.0	SUM
40	0.00	0.00	0.00	0.00	8.430	100.0	SUM
50	0.00	0.00	0.00	0.00	8.430	100.0	SUM
60	0.00	0.00	0.00	0.00	8.430	100.0	SUM
70	0.00	0.00	0.00	0.00	8.430	100.0	SUM
80	0.00	0.00	0.00	0.00	8.430	100.0	SUM
90	0.00	0.00	0.00	0.00	8.430	100.0	SUM
100	0.00	0.00	0.00	0.00	8.430	100.0	SUM
110	0.00	0.00	0.00	0.00	8.430	100.0	SUM
120	0.00	0.00	0.00	0.00	8.430	100.0	SUM
130	0.00	0.00	0.00	0.00	8.430	100.0	SUM

140	0.00	0.00	0.00	0.00	8.430	100.0	SUM
150	0.00	0.00	0.00	0.00	8.430	100.0	SUM
160	0.00	0.00	0.00	0.00	8.430	100.0	SUM
170	0.00	0.00	0.00	0.00	8.430	100.0	SUM
180	0.00	0.00	0.00	0.00	8.430	100.0	SUM
190	0.00	0.00	0.00	0.00	8.430	100.0	SUM
200	0.00	0.00	0.00	0.00	8.430	100.0	SUM
210	0.00	0.00	0.00	0.00	8.430	100.0	SUM
220	0.00	0.00	0.00	0.00	8.430	100.0	SUM
230	0.00	0.00	0.00	0.00	8.430	100.0	SUM
240	0.00	0.00	0.00	0.00	8.430	100.0	SUM
250	0.00	0.00	0.00	0.00	8.430	100.0	SUM
260	0.00	0.00	0.00	0.00	8.430	100.0	SUM
270	0.00	0.00	0.00	0.00	8.430	100.0	SUM
280	0.00	0.00	0.00	0.00	8.430	100.0	SUM
290	0.00	0.00	0.00	0.00	8.430	100.0	SUM
300	0.00	0.00	0.00	0.00	8.430	100.0	SUM
310	0.00	0.00	0.00	0.00	8.430	100.0	SUM
320	0.00	0.00	0.00	0.00	8.430	100.0	SUM
330	0.00	0.00	0.00	0.00	8.430	100.0	SUM
340	0.00	0.00	0.00	0.00	8.430	100.0	SUM
350	0.00	0.00	0.00	0.00	8.430	100.0	SUM
360	0.00	0.00	0.00	0.00	8.430	100.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS ********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	06	06	6	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-46.70	0.861	-9.000	0.020	-999.	1839.	1307.1	0.100	0.80	0.18	10.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash):   16.5 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	22	6	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
63.99	0.086	0.600	0.020	134.	58.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash):   131.9 meters

*********************** AERSCREEN AUTOMATED DISTANCES *********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	0.4999	2525.00	1.880
25.00	1.576	2550.00	1.867
50.00	3.531	2575.00	1.854
75.00	5.723	2600.00	1.841
100.00	8.430	2625.00	1.828
125.00	8.406	2650.00	1.815
150.00	8.246	2675.00	1.803
175.00	7.545	2700.00	1.791
200.00	6.972	2725.00	1.779
225.00	6.495	2750.00	1.767
250.00	5.949	2775.00	1.755
275.00	5.502	2800.00	1.744
300.00	5.172	2825.00	1.732
325.00	4.967	2850.00	1.721
350.00	4.794	2875.00	1.710
375.00	4.627	2900.00	1.699
400.00	4.429	2925.00	1.689
425.00	4.218	2950.00	1.678
450.00	4.037	2975.00	1.667
475.00	4.015	3000.00	1.657
500.00	3.979	3025.00	1.647
525.00	3.928	3050.00	1.637
550.00	3.870	3075.00	1.627
575.00	3.812	3100.00	1.617
600.00	3.787	3125.00	1.608
625.00	3.787	3150.00	1.598
650.00	3.776	3175.00	1.589
675.00	3.761	3200.00	1.579
700.00	3.741	3225.00	1.570
725.00	3.717	3250.00	1.561
750.00	3.691	3275.00	1.552

775.00	3.661	3300.00	1.543
800.00	3.630	3325.00	1.535
825.00	3.597	3350.00	1.526
850.00	3.563	3375.00	1.517
875.00	3.528	3400.00	1.509
900.00	3.492	3425.00	1.501
925.00	3.455	3450.00	1.492
950.00	3.418	3475.00	1.484
975.00	3.381	3500.00	1.476
1000.00	3.344	3525.00	1.468
1025.00	3.306	3550.00	1.461
1050.00	3.269	3575.00	1.453
1075.00	3.233	3600.00	1.445
1100.00	3.196	3625.00	1.437
1125.00	3.160	3650.00	1.430
1150.00	3.124	3675.00	1.423
1175.00	3.089	3700.00	1.415
1200.00	3.054	3725.00	1.408
1225.00	3.020	3750.00	1.401
1250.00	2.986	3775.00	1.394
1275.00	2.953	3800.00	1.387
1300.00	2.921	3825.00	1.380
1325.00	2.888	3850.00	1.375
1350.00	2.857	3875.00	1.369
1375.00	2.826	3900.00	1.364
1400.00	2.796	3925.00	1.358
1425.00	2.766	3950.00	1.352
1450.00	2.737	3975.00	1.347
1475.00	2.708	4000.00	1.341
1500.00	2.680	4025.00	1.336
1525.00	2.652	4050.00	1.331
1550.00	2.625	4075.00	1.325
1575.00	2.598	4100.00	1.320
1600.00	2.572	4125.00	1.315
1625.00	2.547	4150.00	1.309
1650.00	2.522	4175.00	1.304
1675.00	2.497	4200.00	1.299
1700.00	2.473	4225.00	1.294
1725.00	2.449	4250.00	1.289
1750.00	2.426	4275.00	1.283
1775.00	2.403	4300.00	1.278
1800.00	2.381	4325.00	1.273
1825.00	2.359	4350.00	1.268
1850.00	2.338	4375.00	1.263
1875.00	2.316	4400.00	1.258
1900.00	2.296	4425.00	1.253
1925.00	2.275	4450.00	1.249
1950.00	2.255	4475.00	1.244
1975.00	2.236	4500.00	1.239
2000.00	2.217	4525.00	1.234
2025.00	2.198	4550.00	1.229
2050.00	2.179	4575.00	1.225
2075.00	2.161	4600.00	1.220
2100.00	2.143	4625.00	1.215
2125.00	2.125	4650.00	1.211
2150.00	2.108	4675.00	1.206
2175.00	2.091	4700.00	1.201
2200.00	2.074	4725.00	1.197
2225.00	2.058	4750.00	1.192
2250.00	2.042	4775.00	1.188
2275.00	2.026	4800.00	1.183
2300.00	2.010	4825.00	1.179
2325.00	1.995	4850.00	1.175

2350.00	1.980	4875.00	1.170
2375.00	1.965	4900.00	1.166
2400.00	1.950	4925.00	1.162
2425.00	1.936	4950.00	1.157
2450.00	1.921	4975.00	1.153
2475.00	1.907	5000.00	1.149
2500.00	1.894		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY *********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	8.516	8.516	7.665	5.110	0.8516

DISTANCE FROM SOURCE 107.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.4999	0.4999	0.4499	0.2999	0.4999E-01

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 04/17/13
14:17:29

TITLE: Arrow_Station7_1480HP

****************************** STACK PARAMETERS ******************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	9.65 meters	31.67 feet
STACK INNER DIAMETER:	0.305 meters	12.00 inches
PLUME EXIT TEMPERATURE:	959.8 K	1268.0 Deg F
PLUME EXIT VELOCITY:	45.638 m/s	149.73 ft/s
STACK AIR FLOW RATE:	7056 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.05000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

************************ BUILDING DOWNWASH PARAMETERS ************************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

*************************** FLOW SECTOR ANALYSIS ***************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	7.331	125.0	SUM
20	0.00	0.00	0.00	0.00	7.331	125.0	SUM
30	0.00	0.00	0.00	0.00	7.331	125.0	SUM
40	0.00	0.00	0.00	0.00	7.331	125.0	SUM
50	0.00	0.00	0.00	0.00	7.331	125.0	SUM
60	0.00	0.00	0.00	0.00	7.331	125.0	SUM
70	0.00	0.00	0.00	0.00	7.331	125.0	SUM
80	0.00	0.00	0.00	0.00	7.331	125.0	SUM
90	0.00	0.00	0.00	0.00	7.331	125.0	SUM
100	0.00	0.00	0.00	0.00	7.331	125.0	SUM
110	0.00	0.00	0.00	0.00	7.331	125.0	SUM
120	0.00	0.00	0.00	0.00	7.331	125.0	SUM
130	0.00	0.00	0.00	0.00	7.331	125.0	SUM

140	0.00	0.00	0.00	0.00	7.331	125.0	SUM
150	0.00	0.00	0.00	0.00	7.331	125.0	SUM
160	0.00	0.00	0.00	0.00	7.331	125.0	SUM
170	0.00	0.00	0.00	0.00	7.331	125.0	SUM
180	0.00	0.00	0.00	0.00	7.331	125.0	SUM
190	0.00	0.00	0.00	0.00	7.331	125.0	SUM
200	0.00	0.00	0.00	0.00	7.331	125.0	SUM
210	0.00	0.00	0.00	0.00	7.331	125.0	SUM
220	0.00	0.00	0.00	0.00	7.331	125.0	SUM
230	0.00	0.00	0.00	0.00	7.331	125.0	SUM
240	0.00	0.00	0.00	0.00	7.331	125.0	SUM
250	0.00	0.00	0.00	0.00	7.331	125.0	SUM
260	0.00	0.00	0.00	0.00	7.331	125.0	SUM
270	0.00	0.00	0.00	0.00	7.331	125.0	SUM
280	0.00	0.00	0.00	0.00	7.331	125.0	SUM
290	0.00	0.00	0.00	0.00	7.331	125.0	SUM
300	0.00	0.00	0.00	0.00	7.331	125.0	SUM
310	0.00	0.00	0.00	0.00	7.331	125.0	SUM
320	0.00	0.00	0.00	0.00	7.331	125.0	SUM
330	0.00	0.00	0.00	0.00	7.331	125.0	SUM
340	0.00	0.00	0.00	0.00	7.331	125.0	SUM
350	0.00	0.00	0.00	0.00	7.331	125.0	SUM
360	0.00	0.00	0.00	0.00	7.331	125.0	SUM

* = worst case flow sector

```
----------------------------------------------------------------------------
*********************  MAKEMET METEOROLOGY PARAMETERS  *********************
----------------------------------------------------------------------------

MIN/MAX TEMPERATURE:    249.8 / 310.9 (K)

MINIMUM WIND SPEED:       0.5 m/s

ANEMOMETER HEIGHT:     10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE:    Average Moisture
DOMINANT SEASON:          Summer

ALBEDO:                  0.18
BOWEN RATIO:             0.80
ROUGHNESS LENGTH:       0.100 (meters)


       METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT
       -------------------------------------------------------------

 YR MO DY JDY HR
 -- -- -- --- --
 10 06 06   6 01

    H0     U*     W*  DT/DZ ZICNV ZIMCH  M-O LEN    Z0  BOWEN ALBEDO  REF WS
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
-46.70  0.861 -9.000  0.020 -999. 1839.   1307.1 0.100   0.80   0.18   10.00

    HT  REF TA     HT
- - - - - - - - - - -
  10.0   310.9    2.0
```

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 19.8 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	17	6	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
74.27	0.077	0.600	0.020	190.	49.	-1.0	0.050	0.40	0.18	0.50

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 177.0 meters

********************** AERSCREEN AUTOMATED DISTANCES *********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	0.2916	2525.00	1.537
25.00	1.206	2550.00	1.527
50.00	2.571	2575.00	1.517
75.00	5.397	2600.00	1.507
100.00	7.079	2625.00	1.497
125.00	7.331	2650.00	1.488
150.00	6.651	2675.00	1.478
175.00	6.279	2700.00	1.469
200.00	5.830	2725.00	1.459
225.00	5.286	2750.00	1.450
250.00	5.012	2775.00	1.441
275.00	4.771	2800.00	1.432
300.00	4.502	2825.00	1.423
325.00	4.210	2850.00	1.414
350.00	3.919	2875.00	1.406
375.00	3.640	2900.00	1.397
400.00	3.512	2925.00	1.389
425.00	3.426	2950.00	1.381
450.00	3.319	2975.00	1.373
475.00	3.199	3000.00	1.364
500.00	3.072	3025.00	1.356
525.00	2.943	3050.00	1.349
550.00	2.852	3075.00	1.341
575.00	2.834	3100.00	1.333
600.00	2.815	3125.00	1.326
625.00	2.791	3150.00	1.318
650.00	2.763	3175.00	1.311
675.00	2.765	3200.00	1.303
700.00	2.776	3225.00	1.296
725.00	2.781	3250.00	1.289
750.00	2.783	3275.00	1.282

775.00	2.780	3300.00	1.275
800.00	2.773	3325.00	1.268
825.00	2.764	3350.00	1.261
850.00	2.752	3375.00	1.254
875.00	2.737	3400.00	1.248
900.00	2.720	3425.00	1.241
925.00	2.701	3450.00	1.235
950.00	2.680	3475.00	1.228
975.00	2.656	3500.00	1.222
1000.00	2.632	3525.00	1.216
1025.00	2.607	3550.00	1.209
1050.00	2.583	3575.00	1.203
1075.00	2.558	3600.00	1.197
1100.00	2.533	3625.00	1.191
1125.00	2.507	3650.00	1.185
1150.00	2.482	3675.00	1.179
1175.00	2.457	3700.00	1.173
1200.00	2.432	3725.00	1.168
1225.00	2.408	3750.00	1.162
1250.00	2.383	3775.00	1.156
1275.00	2.359	3800.00	1.151
1300.00	2.335	3825.00	1.145
1325.00	2.311	3850.00	1.140
1350.00	2.287	3875.00	1.134
1375.00	2.264	3900.00	1.129
1400.00	2.241	3925.00	1.123
1425.00	2.219	3950.00	1.118
1450.00	2.196	3975.00	1.113
1475.00	2.174	4000.00	1.108
1500.00	2.153	4025.00	1.103
1525.00	2.131	4050.00	1.098
1550.00	2.110	4075.00	1.093
1575.00	2.090	4100.00	1.088
1600.00	2.070	4125.00	1.083
1625.00	2.050	4150.00	1.078
1650.00	2.030	4175.00	1.073
1675.00	2.011	4200.00	1.068
1700.00	1.992	4225.00	1.063
1725.00	1.973	4250.00	1.059
1750.00	1.955	4275.00	1.054
1775.00	1.937	4300.00	1.049
1800.00	1.919	4325.00	1.045
1825.00	1.902	4350.00	1.040
1850.00	1.885	4375.00	1.036
1875.00	1.868	4400.00	1.031
1900.00	1.851	4425.00	1.027
1925.00	1.835	4450.00	1.023
1950.00	1.819	4475.00	1.018
1975.00	1.805	4500.00	1.014
2000.00	1.791	4525.00	1.010
2025.00	1.777	4550.00	1.006
2050.00	1.763	4575.00	1.002
2075.00	1.750	4600.00	0.9974
2100.00	1.736	4625.00	0.9933
2125.00	1.723	4650.00	0.9892
2150.00	1.710	4675.00	0.9852
2175.00	1.697	4700.00	0.9812
2200.00	1.685	4725.00	0.9772
2225.00	1.673	4750.00	0.9733
2250.00	1.660	4775.00	0.9694
2275.00	1.648	4800.00	0.9656
2300.00	1.637	4825.00	0.9617
2325.00	1.625	4850.00	0.9580

2350.00	1.613	4875.00	0.9542
2375.00	1.602	4900.00	0.9505
2400.00	1.591	4925.00	0.9468
2425.00	1.580	4950.00	0.9431
2450.00	1.569	4975.00	0.9395
2475.00	1.558	5000.00	0.9358
2500.00	1.548		

********************** AERSCREEN MAXIMUM IMPACT SUMMARY *********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	7.407	7.407	6.666	4.444	0.7407

DISTANCE FROM SOURCE 116.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.2916	0.2916	0.2624	0.1750	0.2916E-01

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

Paser, Kathleen

From: Bill Jamieson [bjamieson@swca.com]
Sent: Monday, August 19, 2013 12:43 PM
To: Paser, Kathleen
Subject: Updated Tank HAP and Loadout Emissions
Attachments: Arrow Revised Tanks (8.13.2013) (0 ce).pdf; Arrow Revised Tanks (8.13.2013).pdf; Copy of Arrow - Station 7 - Calculations (08192013).xlsx

Kathy –

Here is a bulleted list of the changes made to the Arrow Calculation Tables (changes made to emission calcs have been highlighted in the worksheets):

- Formaldehyde emissions for the rich-burn engines were updated to the AP-42 emission factors (0.0205 lb/MMBtu).
- E&P Tanks emissions modeling was updated as follows:
  - Input chemical composition and separation characteristics are based on the use of the geographical database feature within the program with the use of Low-Pressure Oil Case No. 86 (Sales Oil API of 57 & RVP of 13.1 psia; Separator Conditions of 54 psig & 60 ^{o}F), which was determined to be conservatively representative of the expected separation conditions and RVP of the condensate (51 psig & 45 ^{o}F at the inlet separator; 15.5 psia RVP of the condensate). Since geographical conditions were used as the input criteria, the quantity and conditions of the tank are irrelevant for the purposes of calculating emissions (no input data for entry into E&P TANK 2.0).
  - Before, we modeled emissions in E&P using the gas input composition to the engines as representative of the flash gas from the tanks (using the Low-Pressure Gas criteria as the known separator stream condition). However, this does not provide BTEX emissions from the tanks.
  - E&P tanks modeling outputs/inputs for 95% and 0% control are included.
- Two loading racks were assumed – this changes short-term emissions, but not long-term emissions.
- HAP emissions from loading were calculated by using the Oklahoma Department of Environmental Quality (ODEQ) Guidance found in "Minor Source General Permit for Oil & Gas Facilities" for tank loadout emission units as a percentage (10%) of VOC emissions.
- Additional changes were made as follows:
  - HAPs were added that had emission factors that were below 10^{-5} power for lean-burn engines; before, we had excluded these from our analysis.

The fuel consumption of the 740 bhp engine was updated to the higher heat value basis of 9,034 Btu/bhp-hr from the lower heat value basis of 7,862 Btu/bhp-hr.

Let me know if I can be of further assistance.

Thanks again.

Bill Jamieson
Senior Program Manager
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REVISED AIR QUALITY ASSESSMENT

The regulations for the Federal Minor New Source Review Program in Indian Country, codified at 40 CFR 49.159(d), require that an air quality impact assessment modeling analysis be performed if there is reason to be concerned that a project would cause or contribute to a NAAQS exceedance or a PSD increment violation. If the air quality impact assessment reveals that the proposed construction could cause or contribute to a NAAQS exceedance or PSD increment violation, such impacts must be analyzed and/or mitigated before a preconstruction permit can be issued.

The project area can be characterized as relatively flat, with only minor terrain features (i.e., gently rolling hills). The main use for the surrounding area is agriculture and livestock grazing, with the exception of an occasional oil and gas well production project.

The western portion of North Dakota has four defined seasons (i.e., summer, fall, winter, and spring). During summer, the average air temperature in degrees Fahrenheit (°F) ranges from the low 60s to the low 70s, with highs reaching the mid-80s. In contrast, the average minimum temperatures in winter generally range from just above 0 to the mid-single digits, with the average maximum temperature reaching the upper 20s. The yearly average precipitation is approximately 14 inches, and precipitation is highest in the summer months.[1]

The project is located within the boundaries of the Fort Berthold Indian Reservation, which is designated by the EPA as being in attainment or unclassified with respect to the NAAQS for O_3, CO, NO_2, SO_2, PM_{10}, $PM_{2.5}$, and Pb. The EPA has collected air monitoring data for O_3, NO_2, SO_2, PM_{10}, and $PM_{2.5}$ in the project area.[2] Table 13 shows the results for the air monitors nearest to the site, the location of the monitors relative to the site, the years of data analyzed, and any recorded exceedances of either the primary or secondary NAAQS.

Table 13. Air Monitoring Exceedance Data

Monitor (Contaminant)	Location (Latitude, Longitude)	Location in Relation to Station	Years Analyzed	Exceedances (primary or secondary)
AQS 38-101-0114 (SO_2, NO_2)	47.97110, −101.84940	32 miles NE	2009–2010	0
AQS 38-053-0002 (SO_2, NO_2, PM_{10}, $PM_{2.5}$, O_3)	47.58120, −103.29950	42 miles SW	2008−2013	1 (primary and secondary): O_3, 2011; 1 (primary): NO_2, 2011; 1 (primary): SO_2, 2011
AQS 38-055-0113 (SO_2, PM_{10})	47.60667, −102.03639	17 miles SE	2006–2008	0
AQS 38-053-0108 (PM_{10})	47.99028, −102.58833	23 miles NW	2006–2008	0
AQS 38-057-1113 (SO_2)	47.49490, −102.07800	19 miles SE	2009–2010	0
AQS 38-057-0124 (SO_2, NO_2)	47.40062, −101.92865	28 miles SE	2009–2011	1 (primary): SO_2, 2010
AQS 38-025-0003 (SO_2, NO_2, PM_{10}, $PM_{2.5}$, O_3)	47.31320, −102.52730	25 miles S	2008–2013	0

As Table 13 demonstrates, the area around the site is in attainment for SO_2, NO_2, PM_{10}, $PM_{2.5}$, and O_3 and is not classified for CO and Pb.

[1] National Weather Service Weather Forecast Office. 2013. North Dakota data. Available at: http://www.crh.noaa.gov/bis. Accessed April 18, 2013.

[2] U.S. Environmental Protection Agency. 2013. Air monitoring data. Available at: http://www.epa.gov/airdata. Accessed April 18, 2013.

Modeling Parameters and Procedures

An ambient air impact analysis was performed to estimate air quality impacts for CO, NO_2, PM_{10}, $PM_{2.5}$, and SO_2 that may be emitted from each engine proposed for the project. This modeling was conducted using the EPA AERSCREEN model (Version 11126). The following technical options for the AERSCREEN modeling analysis were selected:

- rural terrain;
- probe distance of 3,281 feet (ft);
- maximum building height of 20 ft;
- maximum building dimension of 28 ft;
- minimum building dimension of 15.5 ft;
- building orientation and stack direction of 0 and 90 degrees from north, respectively;
- regulatory default minimum and maximum temperatures (−10 to 100 °F);
- regulatory default minimum wind speed (0.5 meters per second);
- regulatory default anemometer height (10.0 meters);
- dominant surface profile of grassland; and
- dominant climate type of average moisture.

The terrain elevations for both locations are within a fairly tight range, between 2,250 and 2,300 feet in elevation. As such, 2,300 feet in elevation was used in AERSCREEN. The technical parameters for the stack height, stack diameter, stack temperature, stack flow rate, and NO_2 to NO_x chemistry varied from engine to engine. Additionally, the emission rates for CO, NO_2, PM_{10}, $PM_{2.5}$, and SO_2 vary among the different engines. These equipment dependent technical parameters for each engine are discussed in Table 14.

Table 14. Engine Air Modeling Technical Parameters

Parameter	Natural Gas-Fired 4-Stroke Rich-Burn RICE (326 HP)	Natural Gas-Fired 4-Stroke Lean-Burn RICE (400 HP)	Natural Gas-Fired 4-Stroke Rich-Burn RICE (435 HP)	Natural Gas-Fired 4-Stroke Lean-Burn RICE (530 HP)	Natural Gas-Fired 4-Stroke Rich-Burn RICE (740 HP)	Natural Gas-Fired 4-Stroke Rich-Burn RICE (1,480 HP)
Stack Height (feet)	25	25	25	25	32	32
Stack Diameter (inches)	8	8	8	8	10	12
Stack Temperature (°F)	1,207	877	1,205	869	1,200	1,268
Exit Gas Velocity (ACFM)	1,796	2,195	2,384	3,125	4,090	7,056
NO_2 to NO_x Chemistry (ratio)	0.05	0.25	0.05	0.25	0.05	0.05
CO (lb/hr)	0.57	1.15	0.77	1.52	2.02	2.94
NO_x (lb/hr)	0.57	1.76	0.77	2.34	1.27	2.12
PM_{10} (lb/hr)	0.03	0.0002	0.04	0.0003	0.06	0.13
$PM_{2.5}$ (lb/hr)	0.03	0.0002	0.04	0.0003	0.06	0.13
SO_2 (lb/hr)	0.18	0.18	0.24	0.26	0.38	0.75

Note: ACFM = actual cubic feet per minute.

For the NO_2 to NO_x ratio, the Plume Volume Molar Ratio was selected as being the best representative of the in-stack chemistry, based on manufacturer-provided data of the measurement of NO_2 to NO_x as the air-to-fuel ratio changes. The input data of the air modeling analysis using AERSCREEN for the project is included in Appendix E. It should be noted that the results were modeled on a 1-pound per hour (lb/hr) hypothetical basis for all pollutants analyzed and then normalized for the particular pollutant of interest using the correct emission rate. For the non-NO_2 pollutants, the normalized 1 lb/hr emission rates were modeled without the use of the Plume Volume Molar Ratio method, instead using the "no pollutants are not NO_2 [or the pollutant of interest]" method.

AERSCREEN Modeling Results

A pre-construction air quality impact analysis for a particular pollutant is normally expected to include an estimate of the projected total pollutant concentration at each modeling receptor site. The total pollutant concentration is the sum of: (i) the baseline concentration in the area of the plant due to existing sources of pollution and (ii) the estimated increase in pollutant concentration in the area, caused by the applicant's proposed emission increase and associated growth. To demonstrate that the proposed project will not cause or contribute to a violation of the NAAQS, the applicant is normally expected to show that the total pollutant concentration will not exceed the NAAQS at any receptor site. A summary of the proposed project AERSCREEN modeling results for CO, NO_2, $PM_{2.5}$, PM_{10}, and SO_2 are provided in Table 15; supporting calculations are provided in Appendix E.

Table 15. Representative Maximum Design AERSCREEN Results Summary

Pollutant	Averaging Period	Representative Maximum Design Impact	Ambient Background	Representative Maximum Design Impacts + Background	NAAQS	Exceeds NAAQS (Yes/No)
PM_{10} [1]	24-hour	3.2 µg/m^3	103.0 µg/m^3	106.2 µg/m^3	150 µg/m^3	No
$PM_{2.5}$ [2]	24-hour	3.2 µg/m^3	16.6 µg/m^3	19.8 µg/m^3	35 µg/m^3	No
	Annual	0.3 µg/m^3	5.8 µg/m^3	6.1 µg/m^3	12 µg/m^3	No
NO_2 [3]	1-hour	78.0 ppb	16.0 ppb	94.0 ppb	100 ppb	No
	Annual	7.8 ppb	5.0 ppb	12.8 ppb	53 ppb	No
SO_2 [4]	1-hour	15.2 ppb	19.0 ppb	34.2 ppb	75 ppb	No
	3-hour	15.2 ppb	16.3 ppb	31.5 ppb	500 ppb	No
CO [5]	1-hour	0.1 ppm	2.2 ppm	2.3 ppm	35 ppm	No
	8-hour	0.1 ppm	0.6 ppm	0.7 ppm	9 ppm	No

[1] Ambient background 24-hour PM_{10} value taken from the highest recorded 24-hour concentration value for the years analyzed (2010-2012) from EPA Air Monitor 38-025-0003

[2] Ambient background 24-hour and annual $PM_{2.5}$ values taken from highest 98% 24-hour concentration value (for 24-hour $PM_{2.5}$ background level) and highest annual mean 24-hour concentration value (for annual $PM_{2.5}$ background level) for the years analyzed (2010-2012) from EPA Air Monitor 38-025-0003

[3] Ambient background 1-hour and annual NO_2 values taken from the highest 99% 1-hour concentration value (for 1-hour NO_2 background level) and highest annual mean 1-hour concentration value (for annual NO_2 background level) for the years analyzed (2010-2012) from EPA Air Monitor 38-053-0002

[4] Ambient background 1-hour and 3-hour SO_2 value taken from highest 99% 1-hour concentration value (for 1-hour SO_2 background level) and highest record 3-hour concentration value (for 3-hour SO_2 background level) for the years analyzed (2010-2012) from EPA Air Monitor 38-025-0003

[5] Ambient background 1-hour and 8-hour CO values taken from highest recorded 1-hour and 8-hour concentration values, respectively, for the years analyzed (2010-2012) from EPA Air Monitor 38-017-1004

When calculating emissions from the project, it was assumed that the maximum pound per hour CO, NO_x $PM_{2.5}$, PM_{10}, and SO_2 emissions from each engine were emitted. As there are multiple engines and thus multiple point sources associated with the facility, the maximum concentrations predicted at radial distances were overlaid from each engine (additive) to estimate the cumulative impacts from the project.

These cumulative impacts were then added to background levels and compared with the NAAQS. The background concentrations were derived from the nearest EPA monitors.

As the modeling results provided in Appendix E demonstrate, air quality impacts from the proposed facility are below the NAAQS for CO, NO_x $PM_{2.5}$, PM_{10} and SO_2 for the project.

The available O_3 data from the closest two O_3 monitors in the region are presented in Figures 2 and 3. As indicted above, these two monitors did not approach the 8-hour O_3 standard. For 8-hour O_3, NAAQS violations occur when the 3-year average of the 4th maximum 8-hour average O_3 is greater than the NAAQS. The 3-year 8-hour average design values for the region are shown below. Neither of these two monitors had a three year average above the 0.075 ppm O_3 NAAQS. Therefore, the overall conclusion is that the project is unlikely to cause or contribute to a violation of the O_3 NAAQS based on the following:

- The current background O_3 values as shown from the monitoring data are significantly below the NAAQS;
- The increase in ozone precursor emissions is small (less than 59 tpy of NO_x);
- The region typically has good air dispersion, with mostly flat terrain; and
- Project emissions are not expected to cause a significant increase in ozone and therefore will not cause or contribute to an exceedance of the NAAQS.

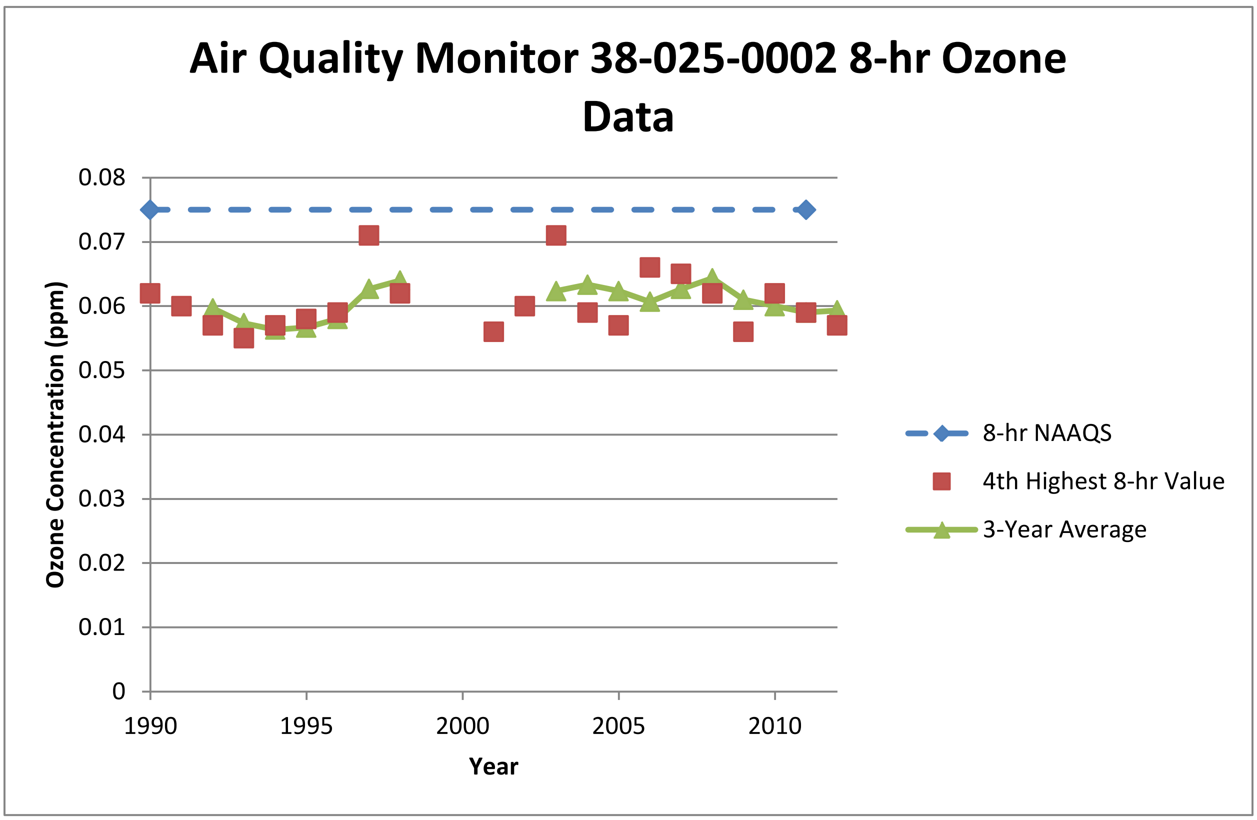

Figure 2. 38-025-0002 Monitor 4th Maximum 8-hour O_3, 1990–2012[3].

[3] Monitoring data taken from EPA Air Quality Monitor 38-025-0002; located at http://www.epa.gov/airdata/

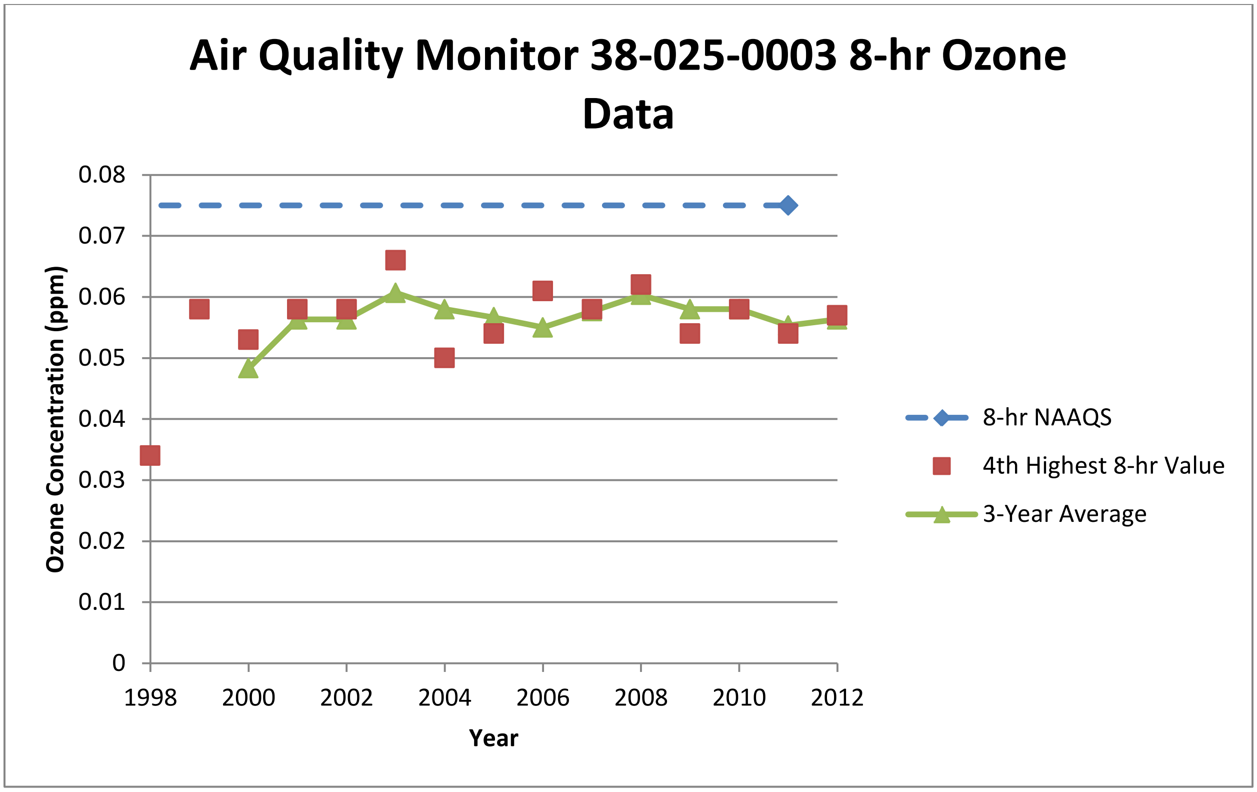

Figure 3. 38-025-0003 Monitor 4th Maximum 8-hour O_3, 1998–2012[4].

As the modeling results and discussion above demonstrate, air quality impacts from the proposed facility are below the NAAQS for CO, NO_x $PM_{2.5}$, PM_{10} and SO_2 for the project. Additionally, based on existing background O_3 levels, it is unlikely that the proposed facility will cause or contribute to a violation of the O_3 NAAQS. Given the projected emissions of the project and the current air quality status, additional ambient impact analysis is not required.

Arrow has also assessed the impact of project emissions to nearby Class I areas. The only Class I area identified within 100 kilometers (km) from either proposed project location is the Theodore Roosevelt National Park, whose eastern edge is located approximately 60 km to the west of the westernmost boundary of the project property line. Arrow has therefore conducted a screening level assessment of project impacts to the Theodore Roosevelt National Park using the Federal Land Managers' Air Quality Related Values (AQRV) Workgroup (FLAG) Phase I Report guidance,[5] which establishes a threshold ratio of emissions to distance below which AQRV review is not required. Specifically, if

$$Q\ (tpy) / d\ (km) < 10, \text{ no AQRV analysis is required}$$

Where,

- Q is the emissions increase of SO_2, NO_X, PM_{10}, and sulfuric acid mist (H_2SO_4), combined in tpy [the tpy value must be based on the maximum short-term emission rates]; and
- D is the nearest distance to a Class I Area in km.

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[4] Monitoring data taken from EPA Air Quality Monitor 38-025-0003; located at http://www.epa.gov/airdata/

[5] The Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report – Revised 2010. Available at: http://www.nature.nps.gov/air/pubs/pdf/flag/FLAG_2010.pdf. Accessed on April 22, 2013.

The FLAG 2010 guidance suggests summing the project-wide ton/year emission rates for all sources of NO_X, SO_2, PM_{10}, and H_2SO_4 and dividing this value by the distance from the proposed site to the Class I area. If this value is less than or equal to 10, presumptively there is no adverse impact and a project “screens out” of a Class I AQRV analysis.

The emissions in tons per year of NO_X, SO_2, PM_{10}, and H_2SO_4 were estimated as:

- NO_X: 59 tpy
- PM_{10}: 5 tpy
- SO_2: 20 tpy
- H_2SO_4: 0 tpy
- Total: 84 tons/year

Q/d = 84 [tons/year pollutants] / 60 [distance in km to nearest Class I area] = 1.4

As the Q/d value is less than 10, the project has “screened out” of any further Class I AQRV analyses and will thus not adversely affect the Theodore Roosevelt National Park.

Appendix E
Revised Air Quality Modeling

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.1 - Normalized Emissions

Type	Engine	Power (HP)	1-hr Concentration (ug/m^3)	3-hr Concentration (ug/m3)	8-hr Concentration (ug/m3)	24-hr Concentration (ug/m3)	Annual Concentration (ug/m^3)
1,480-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	L7042GSI	1480	8.2	8.2	7.4	4.9	0.8
740-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	L3514GSI	740	9.5	9.5	8.5	5.7	0.9
530-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	H24GL	530	17.1	17.1	15.4	10.2	1.7
435-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	H24GSI	435	18.0	18.0	16.2	10.8	1.8
400-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	F18GL	400	19.4	19.4	17.5	11.7	1.9
326-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	F18GSI	326	19.9	19.9	17.9	11.9	2.0

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.3 - CO Emissions

Engine	Quantity	Power (HP)	CO Emission Rate [1] (lb/hr)	Highest CO 1-hr Concentration [2] (ug/m^3)	Highest CO 1-hr Concentration [2] (ug/m^3)	Highest CO 1-hr Concentration [3] (ppm)	Highest CO 8-hr Concentration [3] (ppm)
L7042GSI	3	1480	2.94	72.6	65.3	0.063	0.057
L3514GSI	1	740	2.02	19.1	17.2	0.017	0.015
H24GL	1	530	1.52	25.9	23.3	0.023	0.020
H24GSI	1	435	0.77	13.8	12.5	0.012	0.011
F18GL	1	400	1.15	22.3	20.1	0.019	0.017
F18GSI	1	326	0.57	11.3	10.2	0.010	0.009
			Station Total	**165.1**	**148.6**	**0.1**	**0.1**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

[3] Calculated by multiplying the concentration provided in ug/m^3 by $8.7*10^{-3}$ to convert to ppm

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.4 - PM10 Emissions

Engine	Quantity	Power (HP)	PM_{10} Emission Rate [1] (lb/hr)	Highest $PM_{2.5}$ 24-hr Concentration [2] (ug/m^3)
L7042GSI	3	1480	0.14	2.1
L3514GSI	1	740	0.06	0.3
H24GL	1	530	0.00	0.0
H24GSI	1	435	0.04	0.4
F18GL	1	400	0.00	0.0
F18GSI	1	326	0.03	0.4
			Station Total	**3.2**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.5 - PM2.5 Emissions

Engine	Quantity	Power (HP)	$PM_{2.5}$ Emission Rate [1] (lb/hr)	Highest $PM_{2.5}$ 24-hr Concentration [2] (ug/m^3)	Highest $PM_{2.5}$ Annual Concentration [2] (ug/m^3)
L7042GSI	3	1480	0.14	2.1	0.1
L3514GSI	1	740	0.06	0.3	0.1
H24GL	1	530	0.00	0.0	0.0
H24GSI	1	435	0.04	0.4	0.1
F18GL	1	400	0.00	0.0	0.0
F18GSI	1	326	0.03	0.4	0.1
			Station Total	**3.2**	**0.3**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.6 - SO2 Emissions

Engine	Quantity	Power (HP)	SO_2 Emission Rate [1] (lb/hr)	Highest SO_2 1-hr Concentration [2] (ug/m^3)	Highest SO_2 3-hr Concentration [2] (ug/m^3)	Highest SO_2 1-hr Concentration [3] (ppb)	Highest SO_2 3-hr Concentration [3] (ppb)
L7042GSI	3	1480	0.83	20.5	20.5	7.8	7.8
L3514GSI	1	740	0.38	3.6	3.6	1.4	1.4
H24GL	1	530	0.26	4.4	4.4	1.7	1.7
H24GSI	1	435	0.24	4.3	4.3	1.6	1.6
F18GL	1	400	0.18	3.5	3.5	1.3	1.3
F18GSI	1	326	0.18	3.6	3.6	1.4	1.4
			Station Total	**39.9**	**39.9**	**15.2**	**15.2**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

[3] Calculated by multiplying the concentration provided in ug/m^3 by 0.38 to convert to ppb

AERSCREEN 11126 / AERMOD 1206 06/12/13
15:19:17

TITLE: Arrow_Station7_326hp

**************************** STACK PARAMETERS ***************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	925.9 K	1207.0 Deg F
PLUME EXIT VELOCITY:	26.137 m/s	85.75 ft/s
STACK AIR FLOW RATE:	1796 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

*********************** BUILDING DOWNWASH PARAMETERS *********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************* FLOW SECTOR ANALYSIS ***************************
25 meter receptor spacing: 1. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	19.29	100.0	SUM
20	0.00	0.00	0.00	0.00	19.29	100.0	SUM
30	0.00	0.00	0.00	0.00	19.29	100.0	SUM
40	0.00	0.00	0.00	0.00	19.29	100.0	SUM
50	0.00	0.00	0.00	0.00	19.29	100.0	SUM
60	0.00	0.00	0.00	0.00	19.29	100.0	SUM
70	0.00	0.00	0.00	0.00	19.29	100.0	SUM
80	0.00	0.00	0.00	0.00	19.29	100.0	SUM
90	0.00	0.00	0.00	0.00	19.29	100.0	SUM
100	0.00	0.00	0.00	0.00	19.29	100.0	SUM
110	0.00	0.00	0.00	0.00	19.29	100.0	SUM
120	0.00	0.00	0.00	0.00	19.29	100.0	SUM
130	0.00	0.00	0.00	0.00	19.29	100.0	SUM
140	0.00	0.00	0.00	0.00	19.29	100.0	SUM
150	0.00	0.00	0.00	0.00	19.29	100.0	SUM
160	0.00	0.00	0.00	0.00	19.29	100.0	SUM
170	0.00	0.00	0.00	0.00	19.29	100.0	SUM
180	0.00	0.00	0.00	0.00	19.29	100.0	SUM

190	0.00	0.00	0.00	0.00	19.29	100.0	SUM
200	0.00	0.00	0.00	0.00	19.29	100.0	SUM
210	0.00	0.00	0.00	0.00	19.29	100.0	SUM
220	0.00	0.00	0.00	0.00	19.29	100.0	SUM
230	0.00	0.00	0.00	0.00	19.29	100.0	SUM
240	0.00	0.00	0.00	0.00	19.29	100.0	SUM
250	0.00	0.00	0.00	0.00	19.29	100.0	SUM
260	0.00	0.00	0.00	0.00	19.29	100.0	SUM
270	0.00	0.00	0.00	0.00	19.29	100.0	SUM
280	0.00	0.00	0.00	0.00	19.29	100.0	SUM
290	0.00	0.00	0.00	0.00	19.29	100.0	SUM
300	0.00	0.00	0.00	0.00	19.29	100.0	SUM
310	0.00	0.00	0.00	0.00	19.29	100.0	SUM
320	0.00	0.00	0.00	0.00	19.29	100.0	SUM
330	0.00	0.00	0.00	0.00	19.29	100.0	SUM
340	0.00	0.00	0.00	0.00	19.29	100.0	SUM
350	0.00	0.00	0.00	0.00	19.29	100.0	SUM
360	0.00	0.00	0.00	0.00	19.29	100.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS ********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash):   13.0 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	06	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
5.75	0.032	0.100	0.020	12.	13.	-1.0	0.001	1.50	0.60	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 72.8 meters

*********************** AERSCREEN AUTOMATED DISTANCES *********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
1.00	0.1585	2525.00	3.688
25.00	7.348	2550.00	3.672
50.00	13.68	2575.00	3.655
75.00	18.95	2600.00	3.638
100.00	19.29	2625.00	3.621
125.00	17.33	2650.00	3.604
150.00	15.84	2675.00	3.587
175.00	14.02	2700.00	3.570
200.00	13.18	2725.00	3.553
225.00	12.20	2750.00	3.535
250.00	11.77	2775.00	3.518
275.00	11.70	2800.00	3.500
300.00	11.38	2825.00	3.483
325.00	10.93	2850.00	3.465
350.00	10.75	2875.00	3.448
375.00	10.81	2900.00	3.430
400.00	10.74	2925.00	3.413
425.00	10.63	2950.00	3.395
450.00	10.47	2975.00	3.377
475.00	10.26	3000.00	3.360
500.00	10.01	3025.00	3.342
525.00	9.736	3050.00	3.325
550.00	9.451	3075.00	3.307
575.00	9.161	3100.00	3.290
600.00	8.870	3125.00	3.273
625.00	8.581	3150.00	3.255
650.00	8.298	3175.00	3.238
675.00	8.021	3200.00	3.221
700.00	7.993	3225.00	3.204
725.00	7.973	3250.00	3.186
750.00	7.937	3275.00	3.169
775.00	7.889	3300.00	3.152
800.00	7.830	3325.00	3.136
825.00	7.761	3350.00	3.119
850.00	7.685	3375.00	3.102
875.00	7.603	3400.00	3.085

900.00	7.516	3425.00	3.069
925.00	7.425	3450.00	3.052
950.00	7.331	3475.00	3.036
975.00	7.234	3500.00	3.019
1000.00	7.143	3525.00	3.003
1025.00	7.074	3550.00	2.987
1050.00	7.003	3575.00	2.971
1075.00	6.930	3600.00	2.955
1100.00	6.855	3625.00	2.939
1125.00	6.778	3650.00	2.923
1150.00	6.701	3675.00	2.907
1175.00	6.622	3700.00	2.892
1200.00	6.543	3725.00	2.876
1225.00	6.464	3750.00	2.861
1250.00	6.385	3775.00	2.845
1275.00	6.306	3800.00	2.830
1300.00	6.227	3825.00	2.815
1325.00	6.148	3850.00	2.800
1350.00	6.070	3875.00	2.785
1375.00	5.993	3900.00	2.770
1400.00	5.916	3925.00	2.755
1425.00	5.840	3950.00	2.740
1450.00	5.765	3975.00	2.726
1475.00	5.691	4000.00	2.711
1500.00	5.617	4025.00	2.698
1525.00	5.545	4050.00	2.685
1550.00	5.474	4075.00	2.673
1575.00	5.403	4100.00	2.660
1600.00	5.334	4125.00	2.648
1625.00	5.266	4150.00	2.636
1650.00	5.199	4175.00	2.624
1675.00	5.133	4200.00	2.611
1700.00	5.068	4225.00	2.599
1725.00	5.003	4250.00	2.590
1750.00	4.941	4275.00	2.582
1775.00	4.879	4300.00	2.574
1800.00	4.818	4325.00	2.566
1825.00	4.758	4350.00	2.558
1850.00	4.699	4375.00	2.550
1875.00	4.641	4400.00	2.542
1900.00	4.584	4425.00	2.534
1925.00	4.529	4450.00	2.526
1950.00	4.474	4475.00	2.518
1975.00	4.420	4500.00	2.510
2000.00	4.367	4525.00	2.502
2025.00	4.315	4550.00	2.494
2050.00	4.264	4575.00	2.486
2075.00	4.213	4600.00	2.478
2100.00	4.164	4625.00	2.470
2125.00	4.116	4650.00	2.462
2150.00	4.068	4675.00	2.454
2175.00	4.021	4700.00	2.446
2200.00	3.975	4725.00	2.438
2225.00	3.934	4750.00	2.430
2250.00	3.913	4775.00	2.422
2275.00	3.892	4800.00	2.414
2300.00	3.871	4825.00	2.406
2325.00	3.850	4850.00	2.398
2350.00	3.828	4875.00	2.390
2375.00	3.807	4900.00	2.382
2400.00	3.785	4925.00	2.374
2425.00	3.764	4950.00	2.366
2450.00	3.742	4975.00	2.358

2475.00	3.721	5000.00	2.350
2500.00	3.705		

********************** AERSCREEN MAXIMUM IMPACT SUMMARY *********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	19.86	19.86	17.88	11.92	1.986

DISTANCE FROM SOURCE   88.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.1585	0.1585	0.1427	0.9510E-01	0.1585E-01

DISTANCE FROM SOURCE   1.00 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 06/12/13
15:36:07

TITLE: Arrow_Station7_400hp

***************************** STACK PARAMETERS ****************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	742.6 K	877.0 Deg F
PLUME EXIT VELOCITY:	31.944 m/s	104.80 ft/s
STACK AIR FLOW RATE:	2195 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

*********************** BUILDING DOWNWASH PARAMETERS *********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************** FLOW SECTOR ANALYSIS ***************************
25 meter receptor spacing: 1. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	18.96	100.0	SUM
20	0.00	0.00	0.00	0.00	18.96	100.0	SUM
30	0.00	0.00	0.00	0.00	18.96	100.0	SUM
40	0.00	0.00	0.00	0.00	18.96	100.0	SUM
50	0.00	0.00	0.00	0.00	18.96	100.0	SUM
60	0.00	0.00	0.00	0.00	18.96	100.0	SUM
70	0.00	0.00	0.00	0.00	18.96	100.0	SUM
80	0.00	0.00	0.00	0.00	18.96	100.0	SUM
90	0.00	0.00	0.00	0.00	18.96	100.0	SUM
100	0.00	0.00	0.00	0.00	18.96	100.0	SUM
110	0.00	0.00	0.00	0.00	18.96	100.0	SUM
120	0.00	0.00	0.00	0.00	18.96	100.0	SUM
130	0.00	0.00	0.00	0.00	18.96	100.0	SUM
140	0.00	0.00	0.00	0.00	18.96	100.0	SUM
150	0.00	0.00	0.00	0.00	18.96	100.0	SUM
160	0.00	0.00	0.00	0.00	18.96	100.0	SUM
170	0.00	0.00	0.00	0.00	18.96	100.0	SUM
180	0.00	0.00	0.00	0.00	18.96	100.0	SUM

190	0.00	0.00	0.00	0.00	18.96	100.0	SUM
200	0.00	0.00	0.00	0.00	18.96	100.0	SUM
210	0.00	0.00	0.00	0.00	18.96	100.0	SUM
220	0.00	0.00	0.00	0.00	18.96	100.0	SUM
230	0.00	0.00	0.00	0.00	18.96	100.0	SUM
240	0.00	0.00	0.00	0.00	18.96	100.0	SUM
250	0.00	0.00	0.00	0.00	18.96	100.0	SUM
260	0.00	0.00	0.00	0.00	18.96	100.0	SUM
270	0.00	0.00	0.00	0.00	18.96	100.0	SUM
280	0.00	0.00	0.00	0.00	18.96	100.0	SUM
290	0.00	0.00	0.00	0.00	18.96	100.0	SUM
300	0.00	0.00	0.00	0.00	18.96	100.0	SUM
310	0.00	0.00	0.00	0.00	18.96	100.0	SUM
320	0.00	0.00	0.00	0.00	18.96	100.0	SUM
330	0.00	0.00	0.00	0.00	18.96	100.0	SUM
340	0.00	0.00	0.00	0.00	18.96	100.0	SUM
350	0.00	0.00	0.00	0.00	18.96	100.0	SUM
360	0.00	0.00	0.00	0.00	18.96	100.0	SUM

* = worst case flow sector

********************** MAKEMET METEOROLOGY PARAMETERS *********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 13.6 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	06	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
5.75	0.032	0.100	0.020	12.	13.	-1.0	0.001	1.50	0.60	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 77.4 meters

*********************** AERSCREEN AUTOMATED DISTANCES **********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
1.00	0.1638	2525.00	3.419
25.00	6.510	2550.00	3.402
50.00	12.24	2575.00	3.385
75.00	18.29	2600.00	3.367
100.00	18.96	2625.00	3.353
125.00	16.93	2650.00	3.340
150.00	15.43	2675.00	3.327
175.00	13.73	2700.00	3.314
200.00	12.67	2725.00	3.300
225.00	11.90	2750.00	3.286
250.00	11.10	2775.00	3.273
275.00	10.73	2800.00	3.259
300.00	10.56	2825.00	3.245
325.00	10.24	2850.00	3.231
350.00	9.824	2875.00	3.216
375.00	9.656	2900.00	3.202
400.00	9.748	2925.00	3.188
425.00	9.738	2950.00	3.174
450.00	9.651	2975.00	3.159
475.00	9.509	3000.00	3.145
500.00	9.325	3025.00	3.130
525.00	9.114	3050.00	3.116
550.00	8.884	3075.00	3.101
575.00	8.642	3100.00	3.087
600.00	8.395	3125.00	3.072
625.00	8.145	3150.00	3.058
650.00	7.898	3175.00	3.043
675.00	7.653	3200.00	3.029
700.00	7.414	3225.00	3.014
725.00	7.182	3250.00	3.000
750.00	6.956	3275.00	2.985
775.00	6.907	3300.00	2.971
800.00	6.886	3325.00	2.956
825.00	6.855	3350.00	2.942
850.00	6.815	3375.00	2.927
875.00	6.767	3400.00	2.913

900.00	6.714	3425.00	2.899
925.00	6.657	3450.00	2.885
950.00	6.624	3475.00	2.870
975.00	6.584	3500.00	2.856
1000.00	6.541	3525.00	2.842
1025.00	6.493	3550.00	2.828
1050.00	6.441	3575.00	2.814
1075.00	6.387	3600.00	2.800
1100.00	6.330	3625.00	2.786
1125.00	6.271	3650.00	2.772
1150.00	6.210	3675.00	2.759
1175.00	6.148	3700.00	2.745
1200.00	6.084	3725.00	2.731
1225.00	6.020	3750.00	2.718
1250.00	5.955	3775.00	2.704
1275.00	5.890	3800.00	2.691
1300.00	5.824	3825.00	2.677
1325.00	5.759	3850.00	2.664
1350.00	5.693	3875.00	2.650
1375.00	5.627	3900.00	2.637
1400.00	5.562	3925.00	2.624
1425.00	5.497	3950.00	2.611
1450.00	5.432	3975.00	2.598
1475.00	5.368	4000.00	2.585
1500.00	5.304	4025.00	2.572
1525.00	5.241	4050.00	2.560
1550.00	5.179	4075.00	2.547
1575.00	5.117	4100.00	2.534
1600.00	5.056	4125.00	2.522
1625.00	4.996	4150.00	2.509
1650.00	4.936	4175.00	2.497
1675.00	4.878	4200.00	2.484
1700.00	4.820	4225.00	2.472
1725.00	4.762	4250.00	2.460
1750.00	4.706	4275.00	2.448
1775.00	4.650	4300.00	2.436
1800.00	4.596	4325.00	2.424
1825.00	4.542	4350.00	2.412
1850.00	4.488	4375.00	2.400
1875.00	4.436	4400.00	2.388
1900.00	4.385	4425.00	2.377
1925.00	4.334	4450.00	2.365
1950.00	4.284	4475.00	2.354
1975.00	4.235	4500.00	2.342
2000.00	4.186	4525.00	2.331
2025.00	4.139	4550.00	2.320
2050.00	4.092	4575.00	2.309
2075.00	4.046	4600.00	2.302
2100.00	4.000	4625.00	2.296
2125.00	3.956	4650.00	2.289
2150.00	3.912	4675.00	2.283
2175.00	3.869	4700.00	2.276
2200.00	3.826	4725.00	2.270
2225.00	3.785	4750.00	2.264
2250.00	3.743	4775.00	2.257
2275.00	3.703	4800.00	2.251
2300.00	3.663	4825.00	2.244
2325.00	3.624	4850.00	2.238
2350.00	3.586	4875.00	2.231
2375.00	3.548	4900.00	2.225
2400.00	3.510	4925.00	2.218
2425.00	3.488	4950.00	2.212
2450.00	3.471	4975.00	2.205

2475.00	3.454	5000.00	2.199
2500.00	3.437		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	19.42	19.42	17.48	11.65	1.942

DISTANCE FROM SOURCE 89.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.1638	0.1638	0.1474	0.9827E-01	0.1638E-01

DISTANCE FROM SOURCE 1.00 meters directed toward 10 degrees

ARROW_STATION7_435HP

AERSCREEN 11126 / AERMOD 1206 06/12/13
09:36:12

TITLE: ARROW_STATION7_435HP

****************************** STACK PARAMETERS ******************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	924.8 K	1205.0 Deg F
PLUME EXIT VELOCITY:	34.694 m/s	113.83 ft/s
STACK AIR FLOW RATE:	2384 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

*********************** BUILDING DOWNWASH PARAMETERS **********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************** FLOW SECTOR ANALYSIS **************************

25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	17.80	100.0	SUM
20	0.00	0.00	0.00	0.00	17.80	100.0	SUM
30	0.00	0.00	0.00	0.00	17.80	100.0	SUM
40	0.00	0.00	0.00	0.00	17.80	100.0	SUM
50	0.00	0.00	0.00	0.00	17.80	100.0	SUM
60	0.00	0.00	0.00	0.00	17.80	100.0	SUM
70	0.00	0.00	0.00	0.00	17.80	100.0	SUM
80	0.00	0.00	0.00	0.00	17.80	100.0	SUM
90	0.00	0.00	0.00	0.00	17.80	100.0	SUM
100	0.00	0.00	0.00	0.00	17.80	100.0	SUM
110	0.00	0.00	0.00	0.00	17.80	100.0	SUM
120	0.00	0.00	0.00	0.00	17.80	100.0	SUM
130	0.00	0.00	0.00	0.00	17.80	100.0	SUM
140	0.00	0.00	0.00	0.00	17.80	100.0	SUM
150	0.00	0.00	0.00	0.00	17.80	100.0	SUM
160	0.00	0.00	0.00	0.00	17.80	100.0	SUM
170	0.00	0.00	0.00	0.00	17.80	100.0	SUM
180	0.00	0.00	0.00	0.00	17.80	100.0	SUM

190	0.00	0.00	0.00	0.00	17.80	100.0	SUM
200	0.00	0.00	0.00	0.00	17.80	100.0	SUM
210	0.00	0.00	0.00	0.00	17.80	100.0	SUM
220	0.00	0.00	0.00	0.00	17.80	100.0	SUM
230	0.00	0.00	0.00	0.00	17.80	100.0	SUM
240	0.00	0.00	0.00	0.00	17.80	100.0	SUM
250	0.00	0.00	0.00	0.00	17.80	100.0	SUM
260	0.00	0.00	0.00	0.00	17.80	100.0	SUM
270	0.00	0.00	0.00	0.00	17.80	100.0	SUM
280	0.00	0.00	0.00	0.00	17.80	100.0	SUM
290	0.00	0.00	0.00	0.00	17.80	100.0	SUM
300	0.00	0.00	0.00	0.00	17.80	100.0	SUM
310	0.00	0.00	0.00	0.00	17.80	100.0	SUM
320	0.00	0.00	0.00	0.00	17.80	100.0	SUM
330	0.00	0.00	0.00	0.00	17.80	100.0	SUM
340	0.00	0.00	0.00	0.00	17.80	100.0	SUM
350	0.00	0.00	0.00	0.00	17.80	100.0	SUM
360	0.00	0.00	0.00	0.00	17.80	100.0	SUM

* = worst case flow sector

********************** MAKEMET METEOROLOGY PARAMETERS *********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 14.4 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	22	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
63.99	0.086	0.600	0.020	134.	58.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 91.9 meters

*********************** AERSCREEN AUTOMATED DISTANCES ********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	2.438	2525.00	3.074
25.00	5.301	2550.00	3.045
50.00	10.65	2575.00	3.017
75.00	17.24	2600.00	2.989
100.00	17.80	2625.00	2.961
125.00	15.68	2650.00	2.934
150.00	14.43	2675.00	2.907
175.00	12.77	2700.00	2.881
200.00	11.71	2725.00	2.855
225.00	11.05	2750.00	2.829
250.00	10.29	2775.00	2.818
275.00	9.674	2800.00	2.810
300.00	9.071	2825.00	2.802
325.00	8.951	2850.00	2.794
350.00	8.718	2875.00	2.785
375.00	8.417	2900.00	2.777
400.00	8.195	2925.00	2.768
425.00	8.251	2950.00	2.760
450.00	8.231	2975.00	2.751
475.00	8.156	3000.00	2.742
500.00	8.080	3025.00	2.732
525.00	7.969	3050.00	2.723
550.00	7.831	3075.00	2.714
575.00	7.674	3100.00	2.704
600.00	7.504	3125.00	2.695
625.00	7.324	3150.00	2.685
650.00	7.140	3175.00	2.675
675.00	6.954	3200.00	2.666
700.00	6.767	3225.00	2.656
725.00	6.582	3250.00	2.646
750.00	6.399	3275.00	2.636
775.00	6.221	3300.00	2.626
800.00	6.046	3325.00	2.616
825.00	5.876	3350.00	2.606
850.00	5.711	3375.00	2.596
875.00	5.618	3400.00	2.586

900.00	5.604	3425.00	2.576
925.00	5.584	3450.00	2.565
950.00	5.558	3475.00	2.555
975.00	5.527	3500.00	2.545
1000.00	5.492	3525.00	2.535
1025.00	5.453	3550.00	2.525
1050.00	5.411	3575.00	2.514
1075.00	5.366	3600.00	2.504
1100.00	5.319	3625.00	2.494
1125.00	5.271	3650.00	2.484
1150.00	5.220	3675.00	2.473
1175.00	5.168	3700.00	2.463
1200.00	5.115	3725.00	2.453
1225.00	5.063	3750.00	2.443
1250.00	5.026	3775.00	2.432
1275.00	4.988	3800.00	2.422
1300.00	4.949	3825.00	2.412
1325.00	4.909	3850.00	2.402
1350.00	4.868	3875.00	2.392
1375.00	4.826	3900.00	2.382
1400.00	4.784	3925.00	2.371
1425.00	4.741	3950.00	2.361
1450.00	4.698	3975.00	2.351
1475.00	4.654	4000.00	2.341
1500.00	4.610	4025.00	2.331
1525.00	4.567	4050.00	2.321
1550.00	4.523	4075.00	2.311
1575.00	4.479	4100.00	2.302
1600.00	4.435	4125.00	2.292
1625.00	4.392	4150.00	2.282
1650.00	4.348	4175.00	2.272
1675.00	4.305	4200.00	2.262
1700.00	4.262	4225.00	2.253
1725.00	4.220	4250.00	2.243
1750.00	4.177	4275.00	2.233
1775.00	4.135	4300.00	2.224
1800.00	4.094	4325.00	2.214
1825.00	4.052	4350.00	2.204
1850.00	4.011	4375.00	2.195
1875.00	3.971	4400.00	2.185
1900.00	3.931	4425.00	2.176
1925.00	3.891	4450.00	2.167
1950.00	3.852	4475.00	2.157
1975.00	3.813	4500.00	2.148
2000.00	3.775	4525.00	2.139
2025.00	3.737	4550.00	2.130
2050.00	3.699	4575.00	2.120
2075.00	3.663	4600.00	2.111
2100.00	3.626	4625.00	2.102
2125.00	3.590	4650.00	2.093
2150.00	3.554	4675.00	2.084
2175.00	3.519	4700.00	2.075
2200.00	3.485	4725.00	2.066
2225.00	3.450	4750.00	2.057
2250.00	3.417	4775.00	2.049
2275.00	3.383	4800.00	2.040
2300.00	3.350	4825.00	2.031
2325.00	3.318	4850.00	2.023
2350.00	3.286	4875.00	2.014
2375.00	3.254	4900.00	2.005
2400.00	3.223	4925.00	1.997
2425.00	3.192	4950.00	1.988
2450.00	3.162	4975.00	1.980

2475.00	3.132	5000.00	1.971
2500.00	3.103		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	17.98	17.98	16.18	10.79	1.798

DISTANCE FROM SOURCE 93.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	2.438	2.438	2.194	1.463	0.2438

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 06/12/13
15:42:36

TITLE: Arrow_Station7_530HP

**************************** STACK PARAMETERS ****************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	738.2 K	869.0 Deg F
PLUME EXIT VELOCITY:	45.478 m/s	149.21 ft/s
STACK AIR FLOW RATE:	3125 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

********************** BUILDING DOWNWASH PARAMETERS **********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************* FLOW SECTOR ANALYSIS *************************
25 meter receptor spacing: 1. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	16.99	100.0	SUM
20	0.00	0.00	0.00	0.00	16.99	100.0	SUM
30	0.00	0.00	0.00	0.00	16.99	100.0	SUM
40	0.00	0.00	0.00	0.00	16.99	100.0	SUM
50	0.00	0.00	0.00	0.00	16.99	100.0	SUM
60	0.00	0.00	0.00	0.00	16.99	100.0	SUM
70	0.00	0.00	0.00	0.00	16.99	100.0	SUM
80	0.00	0.00	0.00	0.00	16.99	100.0	SUM
90	0.00	0.00	0.00	0.00	16.99	100.0	SUM
100	0.00	0.00	0.00	0.00	16.99	100.0	SUM
110	0.00	0.00	0.00	0.00	16.99	100.0	SUM
120	0.00	0.00	0.00	0.00	16.99	100.0	SUM
130	0.00	0.00	0.00	0.00	16.99	100.0	SUM
140	0.00	0.00	0.00	0.00	16.99	100.0	SUM
150	0.00	0.00	0.00	0.00	16.99	100.0	SUM
160	0.00	0.00	0.00	0.00	16.99	100.0	SUM
170	0.00	0.00	0.00	0.00	16.99	100.0	SUM
180	0.00	0.00	0.00	0.00	16.99	100.0	SUM

190	0.00	0.00	0.00	0.00	16.99	100.0	SUM
200	0.00	0.00	0.00	0.00	16.99	100.0	SUM
210	0.00	0.00	0.00	0.00	16.99	100.0	SUM
220	0.00	0.00	0.00	0.00	16.99	100.0	SUM
230	0.00	0.00	0.00	0.00	16.99	100.0	SUM
240	0.00	0.00	0.00	0.00	16.99	100.0	SUM
250	0.00	0.00	0.00	0.00	16.99	100.0	SUM
260	0.00	0.00	0.00	0.00	16.99	100.0	SUM
270	0.00	0.00	0.00	0.00	16.99	100.0	SUM
280	0.00	0.00	0.00	0.00	16.99	100.0	SUM
290	0.00	0.00	0.00	0.00	16.99	100.0	SUM
300	0.00	0.00	0.00	0.00	16.99	100.0	SUM
310	0.00	0.00	0.00	0.00	16.99	100.0	SUM
320	0.00	0.00	0.00	0.00	16.99	100.0	SUM
330	0.00	0.00	0.00	0.00	16.99	100.0	SUM
340	0.00	0.00	0.00	0.00	16.99	100.0	SUM
350	0.00	0.00	0.00	0.00	16.99	100.0	SUM
360	0.00	0.00	0.00	0.00	16.99	100.0	SUM

* = worst case flow sector

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-----------------------------------------------------------------------------
*********************  MAKEMET METEOROLOGY PARAMETERS  ********************
-----------------------------------------------------------------------------

MIN/MAX TEMPERATURE:    249.8 / 310.9 (K)

MINIMUM WIND SPEED:       0.5 m/s

ANEMOMETER HEIGHT:     10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE:    Average Moisture
DOMINANT SEASON:          Summer

ALBEDO:                  0.18
BOWEN RATIO:             0.80
ROUGHNESS LENGTH:       0.100 (meters)


       METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT
       -------------------------------------------------------------

 YR MO DY JDY HR
 -- -- -- --- --
 10 05 31  31 01

    H0     U*     W*  DT/DZ ZICNV ZIMCH  M-O LEN    Z0  BOWEN ALBEDO  REF WS
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
-32.40  0.598 -9.000  0.020 -999. 1063.    629.3 0.100   0.80   0.18    7.00

    HT  REF TA     HT
- - - - - - - - - - -
  10.0   310.9    2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash):     15.4 meters


       METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT
       --------------------------------------------------------------
```

YR	MO	DY	JDY	HR
10	01	06	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
5.75	0.032	0.100	0.020	12.	13.	-1.0	0.001	1.50	0.60	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 98.4 meters

********************** AERSCREEN AUTOMATED DISTANCES ********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
1.00	0.1829	2525.00	2.824
25.00	4.140	2550.00	2.800
50.00	9.681	2575.00	2.777
75.00	16.71	2600.00	2.753
100.00	16.99	2625.00	2.730
125.00	15.23	2650.00	2.707
150.00	13.87	2675.00	2.685
175.00	12.31	2700.00	2.663
200.00	10.97	2725.00	2.640
225.00	10.26	2750.00	2.619
250.00	9.724	2775.00	2.597
275.00	9.173	2800.00	2.576
300.00	8.695	2825.00	2.555
325.00	8.243	2850.00	2.534
350.00	7.765	2875.00	2.514
375.00	7.401	2900.00	2.493
400.00	7.191	2925.00	2.473
425.00	6.946	2950.00	2.453
450.00	6.745	2975.00	2.434
475.00	6.809	3000.00	2.414
500.00	6.825	3025.00	2.395
525.00	6.801	3050.00	2.376
550.00	6.746	3075.00	2.358
575.00	6.666	3100.00	2.339
600.00	6.568	3125.00	2.321
625.00	6.456	3150.00	2.303
650.00	6.334	3175.00	2.293
675.00	6.204	3200.00	2.288
700.00	6.070	3225.00	2.282
725.00	5.932	3250.00	2.276
750.00	5.794	3275.00	2.271
775.00	5.655	3300.00	2.265
800.00	5.518	3325.00	2.259
825.00	5.382	3350.00	2.253
850.00	5.248	3375.00	2.247
875.00	5.117	3400.00	2.241

900.00	4.990	3425.00	2.235
925.00	4.865	3450.00	2.228
950.00	4.743	3475.00	2.222
975.00	4.625	3500.00	2.215
1000.00	4.511	3525.00	2.209
1025.00	4.438	3550.00	2.202
1050.00	4.386	3575.00	2.196
1075.00	4.341	3600.00	2.189
1100.00	4.325	3625.00	2.182
1125.00	4.306	3650.00	2.176
1150.00	4.284	3675.00	2.169
1175.00	4.261	3700.00	2.162
1200.00	4.250	3725.00	2.155
1225.00	4.236	3750.00	2.148
1250.00	4.220	3775.00	2.141
1275.00	4.202	3800.00	2.134
1300.00	4.183	3825.00	2.127
1325.00	4.162	3850.00	2.120
1350.00	4.140	3875.00	2.113
1375.00	4.117	3900.00	2.106
1400.00	4.092	3925.00	2.099
1425.00	4.067	3950.00	2.092
1450.00	4.041	3975.00	2.085
1475.00	4.014	4000.00	2.078
1500.00	3.986	4025.00	2.071
1525.00	3.958	4050.00	2.063
1550.00	3.929	4075.00	2.056
1575.00	3.900	4100.00	2.049
1600.00	3.870	4125.00	2.042
1625.00	3.841	4150.00	2.035
1650.00	3.811	4175.00	2.028
1675.00	3.780	4200.00	2.020
1700.00	3.750	4225.00	2.013
1725.00	3.720	4250.00	2.006
1750.00	3.689	4275.00	1.999
1775.00	3.659	4300.00	1.992
1800.00	3.628	4325.00	1.985
1825.00	3.598	4350.00	1.977
1850.00	3.567	4375.00	1.970
1875.00	3.537	4400.00	1.963
1900.00	3.507	4425.00	1.956
1925.00	3.477	4450.00	1.949
1950.00	3.447	4475.00	1.942
1975.00	3.417	4500.00	1.935
2000.00	3.388	4525.00	1.928
2025.00	3.359	4550.00	1.921
2050.00	3.330	4575.00	1.914
2075.00	3.301	4600.00	1.907
2100.00	3.272	4625.00	1.900
2125.00	3.244	4650.00	1.893
2150.00	3.215	4675.00	1.886
2175.00	3.187	4700.00	1.879
2200.00	3.160	4725.00	1.872
2225.00	3.132	4750.00	1.865
2250.00	3.105	4775.00	1.858
2275.00	3.078	4800.00	1.851
2300.00	3.052	4825.00	1.844
2325.00	3.025	4850.00	1.837
2350.00	2.999	4875.00	1.831
2375.00	2.973	4900.00	1.824
2400.00	2.948	4925.00	1.817
2425.00	2.923	4950.00	1.810
2450.00	2.898	4975.00	1.804

2475.00	2.873	5000.00	1.797
2500.00	2.848		

******************** AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	17.06	17.06	15.35	10.23	1.706

DISTANCE FROM SOURCE   95.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.1829	0.1829	0.1646	0.1097	0.1829E-01

DISTANCE FROM SOURCE   1.00 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 06/12/13
15:49:42

TITLE: Arrow_Station7_740HP

****************************** STACK PARAMETERS ****************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	9.75 meters	32.00 feet
STACK INNER DIAMETER:	0.254 meters	10.00 inches
PLUME EXIT TEMPERATURE:	922.0 K	1200.0 Deg F
PLUME EXIT VELOCITY:	38.094 m/s	124.98 ft/s
STACK AIR FLOW RATE:	4090 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

*********************** BUILDING DOWNWASH PARAMETERS **********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************** FLOW SECTOR ANALYSIS ***************************
25 meter receptor spacing: 1. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	9.367	100.0	SUM
20	0.00	0.00	0.00	0.00	9.367	100.0	SUM
30	0.00	0.00	0.00	0.00	9.367	100.0	SUM
40	0.00	0.00	0.00	0.00	9.367	100.0	SUM
50	0.00	0.00	0.00	0.00	9.367	100.0	SUM
60	0.00	0.00	0.00	0.00	9.367	100.0	SUM
70	0.00	0.00	0.00	0.00	9.367	100.0	SUM
80	0.00	0.00	0.00	0.00	9.367	100.0	SUM
90	0.00	0.00	0.00	0.00	9.367	100.0	SUM
100	0.00	0.00	0.00	0.00	9.367	100.0	SUM
110	0.00	0.00	0.00	0.00	9.367	100.0	SUM
120	0.00	0.00	0.00	0.00	9.367	100.0	SUM
130	0.00	0.00	0.00	0.00	9.367	100.0	SUM
140	0.00	0.00	0.00	0.00	9.367	100.0	SUM
150	0.00	0.00	0.00	0.00	9.367	100.0	SUM
160	0.00	0.00	0.00	0.00	9.367	100.0	SUM
170	0.00	0.00	0.00	0.00	9.367	100.0	SUM
180	0.00	0.00	0.00	0.00	9.367	100.0	SUM

190	0.00	0.00	0.00	0.00	9.367	100.0	SUM
200	0.00	0.00	0.00	0.00	9.367	100.0	SUM
210	0.00	0.00	0.00	0.00	9.367	100.0	SUM
220	0.00	0.00	0.00	0.00	9.367	100.0	SUM
230	0.00	0.00	0.00	0.00	9.367	100.0	SUM
240	0.00	0.00	0.00	0.00	9.367	100.0	SUM
250	0.00	0.00	0.00	0.00	9.367	100.0	SUM
260	0.00	0.00	0.00	0.00	9.367	100.0	SUM
270	0.00	0.00	0.00	0.00	9.367	100.0	SUM
280	0.00	0.00	0.00	0.00	9.367	100.0	SUM
290	0.00	0.00	0.00	0.00	9.367	100.0	SUM
300	0.00	0.00	0.00	0.00	9.367	100.0	SUM
310	0.00	0.00	0.00	0.00	9.367	100.0	SUM
320	0.00	0.00	0.00	0.00	9.367	100.0	SUM
330	0.00	0.00	0.00	0.00	9.367	100.0	SUM
340	0.00	0.00	0.00	0.00	9.367	100.0	SUM
350	0.00	0.00	0.00	0.00	9.367	100.0	SUM
360	0.00	0.00	0.00	0.00	9.367	100.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS ********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	06	06	6	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-46.70	0.861	-9.000	0.020	-999.	1839.	1307.1	0.100	0.80	0.18	10.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 16.5 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	06	6	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
5.75	0.032	0.100	0.020	12.	13.	-1.0	0.001	1.50	0.60	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 129.0 meters

********************** AERSCREEN AUTOMATED DISTANCES *********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
1.00	0.1166	2525.00	2.089
25.00	1.751	2550.00	2.074
50.00	3.924	2575.00	2.060
75.00	6.359	2600.00	2.045
100.00	9.367	2625.00	2.031
125.00	9.340	2650.00	2.017
150.00	9.162	2675.00	2.003
175.00	8.383	2700.00	1.990
200.00	7.747	2725.00	1.976
225.00	7.217	2750.00	1.963
250.00	6.610	2775.00	1.950
275.00	6.113	2800.00	1.937
300.00	5.747	2825.00	1.925
325.00	5.519	2850.00	1.912
350.00	5.327	2875.00	1.900
375.00	5.141	2900.00	1.888
400.00	4.921	2925.00	1.876
425.00	4.686	2950.00	1.864
450.00	4.485	2975.00	1.853
475.00	4.461	3000.00	1.841
500.00	4.421	3025.00	1.830
525.00	4.365	3050.00	1.819
550.00	4.300	3075.00	1.808
575.00	4.235	3100.00	1.797
600.00	4.207	3125.00	1.786
625.00	4.208	3150.00	1.776
650.00	4.196	3175.00	1.765
675.00	4.179	3200.00	1.755
700.00	4.157	3225.00	1.745
725.00	4.130	3250.00	1.735
750.00	4.101	3275.00	1.725
775.00	4.068	3300.00	1.715
800.00	4.034	3325.00	1.705
825.00	3.997	3350.00	1.696
850.00	3.959	3375.00	1.686
875.00	3.920	3400.00	1.677

900.00	3.880	3425.00	1.667
925.00	3.839	3450.00	1.658
950.00	3.798	3475.00	1.649
975.00	3.756	3500.00	1.640
1000.00	3.715	3525.00	1.632
1025.00	3.674	3550.00	1.623
1050.00	3.633	3575.00	1.614
1075.00	3.592	3600.00	1.606
1100.00	3.551	3625.00	1.597
1125.00	3.511	3650.00	1.589
1150.00	3.471	3675.00	1.581
1175.00	3.432	3700.00	1.572
1200.00	3.394	3725.00	1.564
1225.00	3.356	3750.00	1.556
1250.00	3.318	3775.00	1.549
1275.00	3.281	3800.00	1.541
1300.00	3.245	3825.00	1.534
1325.00	3.209	3850.00	1.527
1350.00	3.174	3875.00	1.521
1375.00	3.140	3900.00	1.515
1400.00	3.106	3925.00	1.509
1425.00	3.073	3950.00	1.503
1450.00	3.041	3975.00	1.497
1475.00	3.009	4000.00	1.490
1500.00	2.977	4025.00	1.484
1525.00	2.947	4050.00	1.478
1550.00	2.917	4075.00	1.472
1575.00	2.887	4100.00	1.467
1600.00	2.858	4125.00	1.461
1625.00	2.830	4150.00	1.455
1650.00	2.802	4175.00	1.449
1675.00	2.775	4200.00	1.443
1700.00	2.748	4225.00	1.437
1725.00	2.721	4250.00	1.432
1750.00	2.696	4275.00	1.426
1775.00	2.670	4300.00	1.420
1800.00	2.646	4325.00	1.415
1825.00	2.621	4350.00	1.409
1850.00	2.597	4375.00	1.404
1875.00	2.574	4400.00	1.398
1900.00	2.551	4425.00	1.393
1925.00	2.528	4450.00	1.387
1950.00	2.506	4475.00	1.382
1975.00	2.484	4500.00	1.377
2000.00	2.463	4525.00	1.371
2025.00	2.442	4550.00	1.366
2050.00	2.421	4575.00	1.361
2075.00	2.401	4600.00	1.356
2100.00	2.381	4625.00	1.350
2125.00	2.361	4650.00	1.345
2150.00	2.342	4675.00	1.340
2175.00	2.323	4700.00	1.335
2200.00	2.305	4725.00	1.330
2225.00	2.286	4750.00	1.325
2250.00	2.268	4775.00	1.320
2275.00	2.251	4800.00	1.315
2300.00	2.233	4825.00	1.310
2325.00	2.216	4850.00	1.305
2350.00	2.199	4875.00	1.300
2375.00	2.183	4900.00	1.295
2400.00	2.167	4925.00	1.291
2425.00	2.151	4950.00	1.286
2450.00	2.135	4975.00	1.281

2475.00	2.119	5000.00	1.276
2500.00	2.104		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	9.463	9.463	8.516	5.678	0.9463

DISTANCE FROM SOURCE 107.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.1166	0.1166	0.1049	0.6996E-01	0.1166E-01

DISTANCE FROM SOURCE 1.00 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 06/12/13
15:58:53

TITLE: Arrow_Station7_1480HP

*************************** STACK PARAMETERS ***************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	9.65 meters	31.67 feet
STACK INNER DIAMETER:	0.305 meters	12.00 inches
PLUME EXIT TEMPERATURE:	959.8 K	1268.0 Deg F
PLUME EXIT VELOCITY:	45.638 m/s	149.73 ft/s
STACK AIR FLOW RATE:	7056 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

********************** BUILDING DOWNWASH PARAMETERS **********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************ FLOW SECTOR ANALYSIS *************************
25 meter receptor spacing: 1. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	8.145	125.0	SUM
20	0.00	0.00	0.00	0.00	8.145	125.0	SUM
30	0.00	0.00	0.00	0.00	8.145	125.0	SUM
40	0.00	0.00	0.00	0.00	8.145	125.0	SUM
50	0.00	0.00	0.00	0.00	8.145	125.0	SUM
60	0.00	0.00	0.00	0.00	8.145	125.0	SUM
70	0.00	0.00	0.00	0.00	8.145	125.0	SUM
80	0.00	0.00	0.00	0.00	8.145	125.0	SUM
90	0.00	0.00	0.00	0.00	8.145	125.0	SUM
100	0.00	0.00	0.00	0.00	8.145	125.0	SUM
110	0.00	0.00	0.00	0.00	8.145	125.0	SUM
120	0.00	0.00	0.00	0.00	8.145	125.0	SUM
130	0.00	0.00	0.00	0.00	8.145	125.0	SUM
140	0.00	0.00	0.00	0.00	8.145	125.0	SUM
150	0.00	0.00	0.00	0.00	8.145	125.0	SUM
160	0.00	0.00	0.00	0.00	8.145	125.0	SUM
170	0.00	0.00	0.00	0.00	8.145	125.0	SUM
180	0.00	0.00	0.00	0.00	8.145	125.0	SUM

190	0.00	0.00	0.00	0.00	8.145	125.0	SUM
200	0.00	0.00	0.00	0.00	8.145	125.0	SUM
210	0.00	0.00	0.00	0.00	8.145	125.0	SUM
220	0.00	0.00	0.00	0.00	8.145	125.0	SUM
230	0.00	0.00	0.00	0.00	8.145	125.0	SUM
240	0.00	0.00	0.00	0.00	8.145	125.0	SUM
250	0.00	0.00	0.00	0.00	8.145	125.0	SUM
260	0.00	0.00	0.00	0.00	8.145	125.0	SUM
270	0.00	0.00	0.00	0.00	8.145	125.0	SUM
280	0.00	0.00	0.00	0.00	8.145	125.0	SUM
290	0.00	0.00	0.00	0.00	8.145	125.0	SUM
300	0.00	0.00	0.00	0.00	8.145	125.0	SUM
310	0.00	0.00	0.00	0.00	8.145	125.0	SUM
320	0.00	0.00	0.00	0.00	8.145	125.0	SUM
330	0.00	0.00	0.00	0.00	8.145	125.0	SUM
340	0.00	0.00	0.00	0.00	8.145	125.0	SUM
350	0.00	0.00	0.00	0.00	8.145	125.0	SUM
360	0.00	0.00	0.00	0.00	8.145	125.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS *********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	06	06	6	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-46.70	0.861	-9.000	0.020	-999.	1839.	1307.1	0.100	0.80	0.18	10.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 19.8 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	06	6	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
5.75	0.032	0.100	0.020	12.	13.	-1.0	0.001	1.50	0.60	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 191.3 meters

*********************** AERSCREEN AUTOMATED DISTANCES *********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
1.00	0.1418	2525.00	1.708
25.00	1.340	2550.00	1.697
50.00	2.857	2575.00	1.686
75.00	5.997	2600.00	1.675
100.00	7.865	2625.00	1.664
125.00	8.145	2650.00	1.653
150.00	7.390	2675.00	1.642
175.00	6.977	2700.00	1.632
200.00	6.478	2725.00	1.621
225.00	5.873	2750.00	1.611
250.00	5.568	2775.00	1.601
275.00	5.301	2800.00	1.591
300.00	5.002	2825.00	1.581
325.00	4.678	2850.00	1.572
350.00	4.355	2875.00	1.562
375.00	4.044	2900.00	1.553
400.00	3.902	2925.00	1.543
425.00	3.807	2950.00	1.534
450.00	3.688	2975.00	1.525
475.00	3.555	3000.00	1.516
500.00	3.414	3025.00	1.507
525.00	3.270	3050.00	1.498
550.00	3.169	3075.00	1.490
575.00	3.149	3100.00	1.481
600.00	3.128	3125.00	1.473
625.00	3.101	3150.00	1.465
650.00	3.070	3175.00	1.456
675.00	3.072	3200.00	1.448
700.00	3.084	3225.00	1.440
725.00	3.091	3250.00	1.432
750.00	3.092	3275.00	1.424
775.00	3.089	3300.00	1.417
800.00	3.081	3325.00	1.409
825.00	3.071	3350.00	1.401
850.00	3.057	3375.00	1.394
875.00	3.041	3400.00	1.386

900.00	3.022	3425.00	1.379
925.00	3.001	3450.00	1.372
950.00	2.977	3475.00	1.365
975.00	2.951	3500.00	1.358
1000.00	2.924	3525.00	1.351
1025.00	2.897	3550.00	1.344
1050.00	2.870	3575.00	1.337
1075.00	2.842	3600.00	1.330
1100.00	2.814	3625.00	1.323
1125.00	2.786	3650.00	1.317
1150.00	2.758	3675.00	1.310
1175.00	2.730	3700.00	1.304
1200.00	2.703	3725.00	1.297
1225.00	2.675	3750.00	1.291
1250.00	2.648	3775.00	1.285
1275.00	2.621	3800.00	1.278
1300.00	2.594	3825.00	1.272
1325.00	2.568	3850.00	1.266
1350.00	2.541	3875.00	1.260
1375.00	2.516	3900.00	1.254
1400.00	2.490	3925.00	1.248
1425.00	2.465	3950.00	1.242
1450.00	2.440	3975.00	1.237
1475.00	2.416	4000.00	1.231
1500.00	2.392	4025.00	1.225
1525.00	2.368	4050.00	1.219
1550.00	2.345	4075.00	1.214
1575.00	2.322	4100.00	1.208
1600.00	2.300	4125.00	1.203
1625.00	2.277	4150.00	1.197
1650.00	2.256	4175.00	1.192
1675.00	2.234	4200.00	1.187
1700.00	2.213	4225.00	1.182
1725.00	2.192	4250.00	1.176
1750.00	2.172	4275.00	1.171
1775.00	2.152	4300.00	1.166
1800.00	2.132	4325.00	1.161
1825.00	2.113	4350.00	1.156
1850.00	2.094	4375.00	1.151
1875.00	2.076	4400.00	1.146
1900.00	2.057	4425.00	1.141
1925.00	2.039	4450.00	1.136
1950.00	2.021	4475.00	1.132
1975.00	2.006	4500.00	1.127
2000.00	1.990	4525.00	1.122
2025.00	1.974	4550.00	1.117
2050.00	1.959	4575.00	1.113
2075.00	1.944	4600.00	1.108
2100.00	1.929	4625.00	1.104
2125.00	1.915	4650.00	1.099
2150.00	1.900	4675.00	1.095
2175.00	1.886	4700.00	1.090
2200.00	1.872	4725.00	1.086
2225.00	1.858	4750.00	1.081
2250.00	1.845	4775.00	1.077
2275.00	1.832	4800.00	1.073
2300.00	1.818	4825.00	1.069
2325.00	1.805	4850.00	1.064
2350.00	1.793	4875.00	1.060
2375.00	1.780	4900.00	1.056
2400.00	1.768	4925.00	1.052
2425.00	1.755	4950.00	1.048
2450.00	1.743	4975.00	1.044

2475.00	1.731	5000.00	1.040
2500.00	1.720		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	8.230	8.230	7.407	4.938	0.8230

DISTANCE FROM SOURCE 116.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.1418	0.1418	0.1276	0.8508E-01	0.1418E-01

DISTANCE FROM SOURCE 1.00 meters directed toward 10 degrees

Appendix E

Original Submittal Modeling

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.1 - Normalized Emissions

Type	Engine	Power (HP)	1-hr Concentration (ug/m^3)	3-hr Concentration (ug/m3)	8-hr Concentration (ug/m3)	24-hr Concentration (ug/m3)	Annual Concentration (ug/m^3)
1,480-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	L7042GSI	1480	7.4	7.4	6.7	4.4	0.7
740-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	L3514GSI	740	8.5	8.5	7.7	5.1	0.9
530-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	H24GL	530	15.4	15.4	13.8	9.2	1.5
435-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	H24GSI	435	16.2	16.2	14.6	9.7	1.6
400-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	F18GL	400	17.5	17.5	15.7	10.5	1.7
326-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	F18GSI	326	17.9	17.9	16.1	10.7	1.8

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.2 - NO2 Emissions

Engine	Quantity	Power (HP)	NO_x Emission Rate [1] (lb/hr)	Highest 1-hr NO_2 Concentration [2] (ug/m^3)	Highest Annual NO_2 Concentration [2] (ug/m^3)	Highest 1-hr NO_2 Concentration [3] (ppb)	Highest Annual NO_2 Concentration [3] (ppb)
L7042GSI	3	1,480	2.12	47.1	4.7	25.0	2.5
L3514GSI	1	740	1.27	10.8	1.1	5.7	0.6
H24GL	1	530	2.34	35.9	3.6	19.0	1.9
H24GSI	1	435	0.77	12.5	1.2	6.6	0.7
F18GL	1	400	1.76	30.8	3.1	16.3	1.6
F18GSI	1	326	0.57	10.2	1.0	5.4	0.5
			Station Total	**147.3**	**14.7**	**78.0**	**7.8**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

[3] Calculated by multiplying the concentration provided in ug/m^3 by 0.53 to convert to ppb

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.3 - CO Emissions

Engine	Quantity	Power (HP)	CO Emission Rate [1] (lb/hr)	Highest CO 1-hr Concentration [2] (ug/m^3)	Highest CO 1-hr Concentration [2] (ug/m^3)	Highest CO 1-hr Concentration [3] (ppm)	Highest CO 8-hr Concentration [3] (ppm)
L7042GSI	3	1480	2.94	65.3	58.8	0.057	0.051
L3514GSI	1	740	2.02	17.2	15.5	0.015	0.013
H24GL	1	530	1.52	23.3	21.0	0.020	0.018
H24GSI	1	435	0.77	12.5	11.2	0.011	0.010
F18GL	1	400	1.15	20.1	18.1	0.017	0.016
F18GSI	1	326	0.57	10.2	9.2	0.009	0.008
			Station Total	**148.6**	**133.8**	**0.1**	**0.1**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

[3] Calculated by multiplying the concentration provided in ug/m^3 by $8.7*10^{-3}$ to convert to ppm

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.4 - PM10 Emissions

Engine	Quantity	Power (HP)	PM_{10} Emission Rate [1] (lb/hr)	Highest $PM_{2.5}$ 24-hr Concentration [2] (ug/m^3)
L7042GSI	3	1480	0.14	1.9
L3514GSI	1	740	0.06	0.3
H24GL	1	530	0.00	0.0
H24GSI	1	435	0.04	0.4
F18GL	1	400	0.00	0.0
F18GSI	1	326	0.03	0.3
			Station Total	**2.9**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.5 - PM2.5 Emissions

Engine	Quantity	Power (HP)	$PM_{2.5}$ Emission Rate [1] (lb/hr)	Highest $PM_{2.5}$ 24-hr Concentration [2] (ug/m^3)	Highest $PM_{2.5}$ Annual Concentration [2] (ug/m^3)
L7042GSI	3	1480	0.14	1.9	0.1
L3514GSI	1	740	0.06	0.3	0.1
H24GL	1	530	0.00	0.0	0.0
H24GSI	1	435	0.04	0.4	0.1
F18GL	1	400	0.00	0.0	0.0
F18GSI	1	326	0.03	0.3	0.1
			Station Total	**2.9**	**0.3**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.6 - SO2 Emissions

Engine	Quantity	Power (HP)	SO_2 Emission Rate [1] (lb/hr)	Highest SO_2 1-hr Concentration [2] (ug/m^3)	Highest SO_2 3-hr Concentration [2] (ug/m^3)	Highest SO_2 1-hr Concentration [3] (ppb)	Highest SO_2 3-hr Concentration [3] (ppb)
L7042GSI	3	1480	0.83	18.4	18.4	7.0	7.0
L3514GSI	1	740	0.38	3.2	3.2	1.2	1.2
H24GL	1	530	0.26	4.0	4.0	1.5	1.5
H24GSI	1	435	0.24	3.9	3.9	1.5	1.5
F18GL	1	400	0.18	3.1	3.1	1.2	1.2
F18GSI	1	326	0.18	3.2	3.2	1.2	1.2
			Station Total	**35.9**	**35.9**	**13.6**	**13.6**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

[3] Calculated by multiplying the concentration provided in ug/m^3 by 0.38 to convert to ppb

AERSCREEN 11126 / AERMOD 1206 04/23/13
19:51:16

TITLE: Arrow_Station7_326hp

**************************** STACK PARAMETERS ****************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	925.9 K	1207.0 Deg F
PLUME EXIT VELOCITY:	26.137 m/s	85.75 ft/s
STACK AIR FLOW RATE:	1796 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY PVMRM
NO2/NOx IN-STACK RATIO: 0.05000
OZONE BACKGROUND CONCENTRATION: 0.68000E+02 PPB

********************** BUILDING DOWNWASH PARAMETERS **********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************ FLOW SECTOR ANALYSIS *************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	17.36	100.0	SUM
20	0.00	0.00	0.00	0.00	17.36	100.0	SUM
30	0.00	0.00	0.00	0.00	17.36	100.0	SUM
40	0.00	0.00	0.00	0.00	17.36	100.0	SUM
50	0.00	0.00	0.00	0.00	17.36	100.0	SUM
60	0.00	0.00	0.00	0.00	17.36	100.0	SUM
70	0.00	0.00	0.00	0.00	17.36	100.0	SUM
80	0.00	0.00	0.00	0.00	17.36	100.0	SUM
90	0.00	0.00	0.00	0.00	17.36	100.0	SUM
100	0.00	0.00	0.00	0.00	17.36	100.0	SUM
110	0.00	0.00	0.00	0.00	17.36	100.0	SUM
120	0.00	0.00	0.00	0.00	17.36	100.0	SUM
130	0.00	0.00	0.00	0.00	17.36	100.0	SUM

140	0.00	0.00	0.00	0.00	17.36	100.0	SUM
150	0.00	0.00	0.00	0.00	17.36	100.0	SUM
160	0.00	0.00	0.00	0.00	17.36	100.0	SUM
170	0.00	0.00	0.00	0.00	17.36	100.0	SUM
180	0.00	0.00	0.00	0.00	17.36	100.0	SUM
190	0.00	0.00	0.00	0.00	17.36	100.0	SUM
200	0.00	0.00	0.00	0.00	17.36	100.0	SUM
210	0.00	0.00	0.00	0.00	17.36	100.0	SUM
220	0.00	0.00	0.00	0.00	17.36	100.0	SUM
230	0.00	0.00	0.00	0.00	17.36	100.0	SUM
240	0.00	0.00	0.00	0.00	17.36	100.0	SUM
250	0.00	0.00	0.00	0.00	17.36	100.0	SUM
260	0.00	0.00	0.00	0.00	17.36	100.0	SUM
270	0.00	0.00	0.00	0.00	17.36	100.0	SUM
280	0.00	0.00	0.00	0.00	17.36	100.0	SUM
290	0.00	0.00	0.00	0.00	17.36	100.0	SUM
300	0.00	0.00	0.00	0.00	17.36	100.0	SUM
310	0.00	0.00	0.00	0.00	17.36	100.0	SUM
320	0.00	0.00	0.00	0.00	17.36	100.0	SUM
330	0.00	0.00	0.00	0.00	17.36	100.0	SUM
340	0.00	0.00	0.00	0.00	17.36	100.0	SUM
350	0.00	0.00	0.00	0.00	17.36	100.0	SUM
360	0.00	0.00	0.00	0.00	17.36	100.0	SUM

* = worst case flow sector

********************** MAKEMET METEOROLOGY PARAMETERS ********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 13.0 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	19	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
58.70	0.087	0.600	0.020	133.	59.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 77.4 meters

*********************** AERSCREEN AUTOMATED DISTANCES ********************

OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	3.016	2525.00	3.320
25.00	6.564	2550.00	3.305
50.00	12.31	2575.00	3.290
75.00	17.05	2600.00	3.275
100.00	17.36	2625.00	3.259
125.00	15.60	2650.00	3.244
150.00	14.25	2675.00	3.229
175.00	12.62	2700.00	3.213
200.00	11.87	2725.00	3.197
225.00	10.98	2750.00	3.182
250.00	10.60	2775.00	3.166
275.00	10.53	2800.00	3.150
300.00	10.24	2825.00	3.135
325.00	9.839	2850.00	3.119
350.00	9.673	2875.00	3.103
375.00	9.727	2900.00	3.087
400.00	9.665	2925.00	3.071
425.00	9.571	2950.00	3.056
450.00	9.424	2975.00	3.040
475.00	9.231	3000.00	3.024
500.00	9.007	3025.00	3.008
525.00	8.762	3050.00	2.992
550.00	8.506	3075.00	2.977
575.00	8.245	3100.00	2.961
600.00	7.983	3125.00	2.945
625.00	7.723	3150.00	2.930
650.00	7.468	3175.00	2.914
675.00	7.219	3200.00	2.899
700.00	7.194	3225.00	2.883
725.00	7.176	3250.00	2.868
750.00	7.144	3275.00	2.852

775.00	7.100	3300.00	2.837
800.00	7.047	3325.00	2.822
825.00	6.985	3350.00	2.807
850.00	6.917	3375.00	2.792
875.00	6.843	3400.00	2.777
900.00	6.765	3425.00	2.762
925.00	6.683	3450.00	2.747
950.00	6.598	3475.00	2.732
975.00	6.511	3500.00	2.717
1000.00	6.428	3525.00	2.703
1025.00	6.367	3550.00	2.688
1050.00	6.303	3575.00	2.674
1075.00	6.237	3600.00	2.659
1100.00	6.169	3625.00	2.645
1125.00	6.101	3650.00	2.631
1150.00	6.031	3675.00	2.616
1175.00	5.960	3700.00	2.602
1200.00	5.889	3725.00	2.588
1225.00	5.818	3750.00	2.574
1250.00	5.746	3775.00	2.561
1275.00	5.675	3800.00	2.547
1300.00	5.604	3825.00	2.533
1325.00	5.533	3850.00	2.520
1350.00	5.463	3875.00	2.506
1375.00	5.393	3900.00	2.493
1400.00	5.324	3925.00	2.479
1425.00	5.256	3950.00	2.466
1450.00	5.188	3975.00	2.453
1475.00	5.122	4000.00	2.440
1500.00	5.056	4025.00	2.428
1525.00	4.991	4050.00	2.417
1550.00	4.926	4075.00	2.405
1575.00	4.863	4100.00	2.394
1600.00	4.801	4125.00	2.383
1625.00	4.739	4150.00	2.372
1650.00	4.679	4175.00	2.361
1675.00	4.619	4200.00	2.350
1700.00	4.561	4225.00	2.339
1725.00	4.503	4250.00	2.331
1750.00	4.446	4275.00	2.324
1775.00	4.391	4300.00	2.317
1800.00	4.336	4325.00	2.310
1825.00	4.282	4350.00	2.303
1850.00	4.229	4375.00	2.295
1875.00	4.177	4400.00	2.288
1900.00	4.126	4425.00	2.281
1925.00	4.076	4450.00	2.274
1950.00	4.026	4475.00	2.266
1975.00	3.978	4500.00	2.259
2000.00	3.930	4525.00	2.252
2025.00	3.883	4550.00	2.245
2050.00	3.837	4575.00	2.237
2075.00	3.792	4600.00	2.230
2100.00	3.748	4625.00	2.223
2125.00	3.704	4650.00	2.216
2150.00	3.661	4675.00	2.208
2175.00	3.619	4700.00	2.201
2200.00	3.578	4725.00	2.194
2225.00	3.541	4750.00	2.187
2250.00	3.522	4775.00	2.180
2275.00	3.503	4800.00	2.172
2300.00	3.484	4825.00	2.165
2325.00	3.465	4850.00	2.158

Arrow_Station7_1480hp

AERSCREEN 11126 / AERMOD 1206 04/17/13
14:17:29

TITLE: Arrow_Station7_1480HP

*************************** STACK PARAMETERS ***************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	9.65 meters	31.67 feet
STACK INNER DIAMETER:	0.305 meters	12.00 inches
PLUME EXIT TEMPERATURE:	959.8 K	1268.0 Deg F
PLUME EXIT VELOCITY:	45.638 m/s	149.73 ft/s
STACK AIR FLOW RATE:	7056 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.05000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

********************** BUILDING DOWNWASH PARAMETERS **********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************ FLOW SECTOR ANALYSIS *************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	7.331	125.0	SUM
20	0.00	0.00	0.00	0.00	7.331	125.0	SUM
30	0.00	0.00	0.00	0.00	7.331	125.0	SUM
40	0.00	0.00	0.00	0.00	7.331	125.0	SUM
50	0.00	0.00	0.00	0.00	7.331	125.0	SUM
60	0.00	0.00	0.00	0.00	7.331	125.0	SUM
70	0.00	0.00	0.00	0.00	7.331	125.0	SUM
80	0.00	0.00	0.00	0.00	7.331	125.0	SUM
90	0.00	0.00	0.00	0.00	7.331	125.0	SUM
100	0.00	0.00	0.00	0.00	7.331	125.0	SUM
110	0.00	0.00	0.00	0.00	7.331	125.0	SUM
120	0.00	0.00	0.00	0.00	7.331	125.0	SUM
130	0.00	0.00	0.00	0.00	7.331	125.0	SUM

140	0.00	0.00	0.00	0.00	7.331	125.0	SUM
150	0.00	0.00	0.00	0.00	7.331	125.0	SUM
160	0.00	0.00	0.00	0.00	7.331	125.0	SUM
170	0.00	0.00	0.00	0.00	7.331	125.0	SUM
180	0.00	0.00	0.00	0.00	7.331	125.0	SUM
190	0.00	0.00	0.00	0.00	7.331	125.0	SUM
200	0.00	0.00	0.00	0.00	7.331	125.0	SUM
210	0.00	0.00	0.00	0.00	7.331	125.0	SUM
220	0.00	0.00	0.00	0.00	7.331	125.0	SUM
230	0.00	0.00	0.00	0.00	7.331	125.0	SUM
240	0.00	0.00	0.00	0.00	7.331	125.0	SUM
250	0.00	0.00	0.00	0.00	7.331	125.0	SUM
260	0.00	0.00	0.00	0.00	7.331	125.0	SUM
270	0.00	0.00	0.00	0.00	7.331	125.0	SUM
280	0.00	0.00	0.00	0.00	7.331	125.0	SUM
290	0.00	0.00	0.00	0.00	7.331	125.0	SUM
300	0.00	0.00	0.00	0.00	7.331	125.0	SUM
310	0.00	0.00	0.00	0.00	7.331	125.0	SUM
320	0.00	0.00	0.00	0.00	7.331	125.0	SUM
330	0.00	0.00	0.00	0.00	7.331	125.0	SUM
340	0.00	0.00	0.00	0.00	7.331	125.0	SUM
350	0.00	0.00	0.00	0.00	7.331	125.0	SUM
360	0.00	0.00	0.00	0.00	7.331	125.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS *********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	06	06	6	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-46.70	0.861	-9.000	0.020	-999.	1839.	1307.1	0.100	0.80	0.18	10.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 19.8 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	17	6	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
74.27	0.077	0.600	0.020	190.	49.	-1.0	0.050	0.40	0.18	0.50

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 177.0 meters

***************************** AERSCREEN AUTOMATED DISTANCES *****************************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	0.2916	2525.00	1.537
25.00	1.206	2550.00	1.527
50.00	2.571	2575.00	1.517
75.00	5.397	2600.00	1.507
100.00	7.079	2625.00	1.497
125.00	7.331	2650.00	1.488
150.00	6.651	2675.00	1.478
175.00	6.279	2700.00	1.469
200.00	5.830	2725.00	1.459
225.00	5.286	2750.00	1.450
250.00	5.012	2775.00	1.441
275.00	4.771	2800.00	1.432
300.00	4.502	2825.00	1.423
325.00	4.210	2850.00	1.414
350.00	3.919	2875.00	1.406
375.00	3.640	2900.00	1.397
400.00	3.512	2925.00	1.389
425.00	3.426	2950.00	1.381
450.00	3.319	2975.00	1.373
475.00	3.199	3000.00	1.364
500.00	3.072	3025.00	1.356
525.00	2.943	3050.00	1.349
550.00	2.852	3075.00	1.341
575.00	2.834	3100.00	1.333
600.00	2.815	3125.00	1.326
625.00	2.791	3150.00	1.318
650.00	2.763	3175.00	1.311
675.00	2.765	3200.00	1.303
700.00	2.776	3225.00	1.296
725.00	2.781	3250.00	1.289
750.00	2.783	3275.00	1.282

775.00	2.780	3300.00	1.275
800.00	2.773	3325.00	1.268
825.00	2.764	3350.00	1.261
850.00	2.752	3375.00	1.254
875.00	2.737	3400.00	1.248
900.00	2.720	3425.00	1.241
925.00	2.701	3450.00	1.235
950.00	2.680	3475.00	1.228
975.00	2.656	3500.00	1.222
1000.00	2.632	3525.00	1.216
1025.00	2.607	3550.00	1.209
1050.00	2.583	3575.00	1.203
1075.00	2.558	3600.00	1.197
1100.00	2.533	3625.00	1.191
1125.00	2.507	3650.00	1.185
1150.00	2.482	3675.00	1.179
1175.00	2.457	3700.00	1.173
1200.00	2.432	3725.00	1.168
1225.00	2.408	3750.00	1.162
1250.00	2.383	3775.00	1.156
1275.00	2.359	3800.00	1.151
1300.00	2.335	3825.00	1.145
1325.00	2.311	3850.00	1.140
1350.00	2.287	3875.00	1.134
1375.00	2.264	3900.00	1.129
1400.00	2.241	3925.00	1.123
1425.00	2.219	3950.00	1.118
1450.00	2.196	3975.00	1.113
1475.00	2.174	4000.00	1.108
1500.00	2.153	4025.00	1.103
1525.00	2.131	4050.00	1.098
1550.00	2.110	4075.00	1.093
1575.00	2.090	4100.00	1.088
1600.00	2.070	4125.00	1.083
1625.00	2.050	4150.00	1.078
1650.00	2.030	4175.00	1.073
1675.00	2.011	4200.00	1.068
1700.00	1.992	4225.00	1.063
1725.00	1.973	4250.00	1.059
1750.00	1.955	4275.00	1.054
1775.00	1.937	4300.00	1.049
1800.00	1.919	4325.00	1.045
1825.00	1.902	4350.00	1.040
1850.00	1.885	4375.00	1.036
1875.00	1.868	4400.00	1.031
1900.00	1.851	4425.00	1.027
1925.00	1.835	4450.00	1.023
1950.00	1.819	4475.00	1.018
1975.00	1.805	4500.00	1.014
2000.00	1.791	4525.00	1.010
2025.00	1.777	4550.00	1.006
2050.00	1.763	4575.00	1.002
2075.00	1.750	4600.00	0.9974
2100.00	1.736	4625.00	0.9933
2125.00	1.723	4650.00	0.9892
2150.00	1.710	4675.00	0.9852
2175.00	1.697	4700.00	0.9812
2200.00	1.685	4725.00	0.9772
2225.00	1.673	4750.00	0.9733
2250.00	1.660	4775.00	0.9694
2275.00	1.648	4800.00	0.9656
2300.00	1.637	4825.00	0.9617
2325.00	1.625	4850.00	0.9580

2350.00	1.613	4875.00	0.9542
2375.00	1.602	4900.00	0.9505
2400.00	1.591	4925.00	0.9468
2425.00	1.580	4950.00	0.9431
2450.00	1.569	4975.00	0.9395
2475.00	1.558	5000.00	0.9358
2500.00	1.548		

********************** AERSCREEN MAXIMUM IMPACT SUMMARY *********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	7.407	7.407	6.666	4.444	0.7407

DISTANCE FROM SOURCE 116.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.2916	0.2916	0.2624	0.1750	0.2916E-01

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

2350.00	3.445	4875.00	2.151
2375.00	3.426	4900.00	2.144
2400.00	3.407	4925.00	2.137
2425.00	3.387	4950.00	2.129
2450.00	3.368	4975.00	2.122
2475.00	3.349	5000.00	2.115
2500.00	3.334		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY *********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	17.88	17.88	16.09	10.73	1.788

DISTANCE FROM SOURCE 88.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	3.016	3.016	2.714	1.810	0.3016

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

Arrow_Station7_400hp

AERSCREEN 11126 / AERMOD 1206 04/18/13
16:05:59

TITLE: Arrow_Station7_400hp

****************************** STACK PARAMETERS ******************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	742.6 K	877.0 Deg F
PLUME EXIT VELOCITY:	31.944 m/s	104.80 ft/s
STACK AIR FLOW RATE:	2195 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.25000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

*********************** BUILDING DOWNWASH PARAMETERS ***********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************** FLOW SECTOR ANALYSIS **************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	17.07	100.0	SUM
20	0.00	0.00	0.00	0.00	17.07	100.0	SUM
30	0.00	0.00	0.00	0.00	17.07	100.0	SUM
40	0.00	0.00	0.00	0.00	17.07	100.0	SUM
50	0.00	0.00	0.00	0.00	17.07	100.0	SUM
60	0.00	0.00	0.00	0.00	17.07	100.0	SUM
70	0.00	0.00	0.00	0.00	17.07	100.0	SUM
80	0.00	0.00	0.00	0.00	17.07	100.0	SUM
90	0.00	0.00	0.00	0.00	17.07	100.0	SUM
100	0.00	0.00	0.00	0.00	17.07	100.0	SUM
110	0.00	0.00	0.00	0.00	17.07	100.0	SUM
120	0.00	0.00	0.00	0.00	17.07	100.0	SUM
130	0.00	0.00	0.00	0.00	17.07	100.0	SUM

140	0.00	0.00	0.00	0.00	17.07	100.0	SUM
150	0.00	0.00	0.00	0.00	17.07	100.0	SUM
160	0.00	0.00	0.00	0.00	17.07	100.0	SUM
170	0.00	0.00	0.00	0.00	17.07	100.0	SUM
180	0.00	0.00	0.00	0.00	17.07	100.0	SUM
190	0.00	0.00	0.00	0.00	17.07	100.0	SUM
200	0.00	0.00	0.00	0.00	17.07	100.0	SUM
210	0.00	0.00	0.00	0.00	17.07	100.0	SUM
220	0.00	0.00	0.00	0.00	17.07	100.0	SUM
230	0.00	0.00	0.00	0.00	17.07	100.0	SUM
240	0.00	0.00	0.00	0.00	17.07	100.0	SUM
250	0.00	0.00	0.00	0.00	17.07	100.0	SUM
260	0.00	0.00	0.00	0.00	17.07	100.0	SUM
270	0.00	0.00	0.00	0.00	17.07	100.0	SUM
280	0.00	0.00	0.00	0.00	17.07	100.0	SUM
290	0.00	0.00	0.00	0.00	17.07	100.0	SUM
300	0.00	0.00	0.00	0.00	17.07	100.0	SUM
310	0.00	0.00	0.00	0.00	17.07	100.0	SUM
320	0.00	0.00	0.00	0.00	17.07	100.0	SUM
330	0.00	0.00	0.00	0.00	17.07	100.0	SUM
340	0.00	0.00	0.00	0.00	17.07	100.0	SUM
350	0.00	0.00	0.00	0.00	17.07	100.0	SUM
360	0.00	0.00	0.00	0.00	17.07	100.0	SUM

* = worst case flow sector

********************** MAKEMET METEOROLOGY PARAMETERS ********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 13.6 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	22	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
63.99	0.086	0.600	0.020	134.	58.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 79.6 meters

************************ AERSCREEN AUTOMATED DISTANCES **********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	2.677	2525.00	3.077
25.00	5.859	2550.00	3.062
50.00	11.02	2575.00	3.046
75.00	16.46	2600.00	3.030
100.00	17.07	2625.00	3.018
125.00	15.24	2650.00	3.006
150.00	13.89	2675.00	2.994
175.00	12.36	2700.00	2.982
200.00	11.40	2725.00	2.970
225.00	10.71	2750.00	2.958
250.00	9.989	2775.00	2.945
275.00	9.662	2800.00	2.933
300.00	9.507	2825.00	2.920
325.00	9.214	2850.00	2.908
350.00	8.842	2875.00	2.895
375.00	8.691	2900.00	2.882
400.00	8.773	2925.00	2.869
425.00	8.764	2950.00	2.856
450.00	8.686	2975.00	2.843
475.00	8.558	3000.00	2.830
500.00	8.393	3025.00	2.817
525.00	8.202	3050.00	2.804
550.00	7.995	3075.00	2.791
575.00	7.778	3100.00	2.778
600.00	7.555	3125.00	2.765
625.00	7.331	3150.00	2.752
650.00	7.108	3175.00	2.739
675.00	6.888	3200.00	2.726
700.00	6.673	3225.00	2.713
725.00	6.464	3250.00	2.700
750.00	6.260	3275.00	2.687

775.00	6.217	3300.00	2.674
800.00	6.198	3325.00	2.661
825.00	6.169	3350.00	2.648
850.00	6.133	3375.00	2.635
875.00	6.091	3400.00	2.622
900.00	6.042	3425.00	2.609
925.00	5.992	3450.00	2.596
950.00	5.961	3475.00	2.583
975.00	5.926	3500.00	2.571
1000.00	5.887	3525.00	2.558
1025.00	5.843	3550.00	2.545
1050.00	5.797	3575.00	2.533
1075.00	5.748	3600.00	2.520
1100.00	5.697	3625.00	2.508
1125.00	5.644	3650.00	2.495
1150.00	5.589	3675.00	2.483
1175.00	5.533	3700.00	2.470
1200.00	5.476	3725.00	2.458
1225.00	5.418	3750.00	2.446
1250.00	5.360	3775.00	2.434
1275.00	5.301	3800.00	2.421
1300.00	5.242	3825.00	2.409
1325.00	5.183	3850.00	2.397
1350.00	5.124	3875.00	2.385
1375.00	5.065	3900.00	2.374
1400.00	5.006	3925.00	2.362
1425.00	4.947	3950.00	2.350
1450.00	4.889	3975.00	2.338
1475.00	4.831	4000.00	2.327
1500.00	4.774	4025.00	2.315
1525.00	4.717	4050.00	2.304
1550.00	4.661	4075.00	2.292
1575.00	4.606	4100.00	2.281
1600.00	4.551	4125.00	2.270
1625.00	4.496	4150.00	2.258
1650.00	4.443	4175.00	2.247
1675.00	4.390	4200.00	2.236
1700.00	4.338	4225.00	2.225
1725.00	4.286	4250.00	2.214
1750.00	4.235	4275.00	2.203
1775.00	4.185	4300.00	2.192
1800.00	4.136	4325.00	2.181
1825.00	4.087	4350.00	2.171
1850.00	4.040	4375.00	2.160
1875.00	3.993	4400.00	2.150
1900.00	3.946	4425.00	2.139
1925.00	3.900	4450.00	2.129
1950.00	3.856	4475.00	2.118
1975.00	3.811	4500.00	2.108
2000.00	3.768	4525.00	2.098
2025.00	3.725	4550.00	2.088
2050.00	3.683	4575.00	2.078
2075.00	3.641	4600.00	2.072
2100.00	3.600	4625.00	2.066
2125.00	3.560	4650.00	2.060
2150.00	3.521	4675.00	2.055
2175.00	3.482	4700.00	2.049
2200.00	3.444	4725.00	2.043
2225.00	3.406	4750.00	2.037
2250.00	3.369	4775.00	2.031
2275.00	3.333	4800.00	2.026
2300.00	3.297	4825.00	2.020
2325.00	3.262	4850.00	2.014

2350.00	3.227	4875.00	2.008
2375.00	3.193	4900.00	2.002
2400.00	3.159	4925.00	1.996
2425.00	3.139	4950.00	1.991
2450.00	3.124	4975.00	1.985
2475.00	3.108	5000.00	1.979
2500.00	3.093		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	17.48	17.48	15.73	10.49	1.748

DISTANCE FROM SOURCE 89.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	2.677	2.677	2.409	1.606	0.2677

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

Arrow_Station7_435hp

AERSCREEN 11126 / AERMOD 1206 04/23/13
20:15:45

TITLE: Arrow_Station7_435hp

**************************** STACK PARAMETERS ****************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	924.8 K	1205.0 Deg F
PLUME EXIT VELOCITY:	34.695 m/s	113.83 ft/s
STACK AIR FLOW RATE:	2384 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.05000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

*********************** BUILDING DOWNWASH PARAMETERS *********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************* FLOW SECTOR ANALYSIS ***************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	16.02	100.0	SUM
20	0.00	0.00	0.00	0.00	16.02	100.0	SUM
30	0.00	0.00	0.00	0.00	16.02	100.0	SUM
40	0.00	0.00	0.00	0.00	16.02	100.0	SUM
50	0.00	0.00	0.00	0.00	16.02	100.0	SUM
60	0.00	0.00	0.00	0.00	16.02	100.0	SUM
70	0.00	0.00	0.00	0.00	16.02	100.0	SUM
80	0.00	0.00	0.00	0.00	16.02	100.0	SUM
90	0.00	0.00	0.00	0.00	16.02	100.0	SUM
100	0.00	0.00	0.00	0.00	16.02	100.0	SUM
110	0.00	0.00	0.00	0.00	16.02	100.0	SUM
120	0.00	0.00	0.00	0.00	16.02	100.0	SUM
130	0.00	0.00	0.00	0.00	16.02	100.0	SUM

140	0.00	0.00	0.00	0.00	16.02	100.0	SUM
150	0.00	0.00	0.00	0.00	16.02	100.0	SUM
160	0.00	0.00	0.00	0.00	16.02	100.0	SUM
170	0.00	0.00	0.00	0.00	16.02	100.0	SUM
180	0.00	0.00	0.00	0.00	16.02	100.0	SUM
190	0.00	0.00	0.00	0.00	16.02	100.0	SUM
200	0.00	0.00	0.00	0.00	16.02	100.0	SUM
210	0.00	0.00	0.00	0.00	16.02	100.0	SUM
220	0.00	0.00	0.00	0.00	16.02	100.0	SUM
230	0.00	0.00	0.00	0.00	16.02	100.0	SUM
240	0.00	0.00	0.00	0.00	16.02	100.0	SUM
250	0.00	0.00	0.00	0.00	16.02	100.0	SUM
260	0.00	0.00	0.00	0.00	16.02	100.0	SUM
270	0.00	0.00	0.00	0.00	16.02	100.0	SUM
280	0.00	0.00	0.00	0.00	16.02	100.0	SUM
290	0.00	0.00	0.00	0.00	16.02	100.0	SUM
300	0.00	0.00	0.00	0.00	16.02	100.0	SUM
310	0.00	0.00	0.00	0.00	16.02	100.0	SUM
320	0.00	0.00	0.00	0.00	16.02	100.0	SUM
330	0.00	0.00	0.00	0.00	16.02	100.0	SUM
340	0.00	0.00	0.00	0.00	16.02	100.0	SUM
350	0.00	0.00	0.00	0.00	16.02	100.0	SUM
360	0.00	0.00	0.00	0.00	16.02	100.0	SUM

* = worst case flow sector

********************** MAKEMET METEOROLOGY PARAMETERS *********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 14.4 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	19	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
58.70	0.087	0.600	0.020	133.	59.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 93.9 meters

*********************** AERSCREEN AUTOMATED DISTANCES *********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	2.117	2525.00	2.766
25.00	4.771	2550.00	2.740
50.00	9.582	2575.00	2.715
75.00	15.51	2600.00	2.690
100.00	16.02	2625.00	2.665
125.00	14.11	2650.00	2.641
150.00	12.98	2675.00	2.617
175.00	11.49	2700.00	2.593
200.00	10.54	2725.00	2.569
225.00	9.943	2750.00	2.546
250.00	9.263	2775.00	2.536
275.00	8.706	2800.00	2.529
300.00	8.164	2825.00	2.522
325.00	8.056	2850.00	2.514
350.00	7.846	2875.00	2.507
375.00	7.575	2900.00	2.499
400.00	7.375	2925.00	2.491
425.00	7.426	2950.00	2.484
450.00	7.408	2975.00	2.475
475.00	7.340	3000.00	2.467
500.00	7.272	3025.00	2.459
525.00	7.172	3050.00	2.451
550.00	7.048	3075.00	2.442
575.00	6.906	3100.00	2.434
600.00	6.753	3125.00	2.425
625.00	6.592	3150.00	2.417
650.00	6.426	3175.00	2.408
675.00	6.258	3200.00	2.399
700.00	6.090	3225.00	2.390
725.00	5.924	3250.00	2.381
750.00	5.759	3275.00	2.372

775.00	5.598	3300.00	2.363
800.00	5.441	3325.00	2.354
825.00	5.288	3350.00	2.345
850.00	5.140	3375.00	2.336
875.00	5.056	3400.00	2.327
900.00	5.044	3425.00	2.318
925.00	5.025	3450.00	2.309
950.00	5.002	3475.00	2.300
975.00	4.974	3500.00	2.290
1000.00	4.942	3525.00	2.281
1025.00	4.907	3550.00	2.272
1050.00	4.870	3575.00	2.263
1075.00	4.830	3600.00	2.254
1100.00	4.787	3625.00	2.244
1125.00	4.743	3650.00	2.235
1150.00	4.698	3675.00	2.226
1175.00	4.651	3700.00	2.217
1200.00	4.604	3725.00	2.207
1225.00	4.557	3750.00	2.198
1250.00	4.524	3775.00	2.189
1275.00	4.489	3800.00	2.180
1300.00	4.454	3825.00	2.171
1325.00	4.418	3850.00	2.162
1350.00	4.381	3875.00	2.152
1375.00	4.343	3900.00	2.143
1400.00	4.305	3925.00	2.134
1425.00	4.267	3950.00	2.125
1450.00	4.228	3975.00	2.116
1475.00	4.189	4000.00	2.107
1500.00	4.149	4025.00	2.098
1525.00	4.110	4050.00	2.089
1550.00	4.070	4075.00	2.080
1575.00	4.031	4100.00	2.071
1600.00	3.992	4125.00	2.062
1625.00	3.953	4150.00	2.054
1650.00	3.913	4175.00	2.045
1675.00	3.875	4200.00	2.036
1700.00	3.836	4225.00	2.027
1725.00	3.798	4250.00	2.019
1750.00	3.759	4275.00	2.010
1775.00	3.722	4300.00	2.001
1800.00	3.684	4325.00	1.993
1825.00	3.647	4350.00	1.984
1850.00	3.610	4375.00	1.975
1875.00	3.574	4400.00	1.967
1900.00	3.538	4425.00	1.958
1925.00	3.502	4450.00	1.950
1950.00	3.467	4475.00	1.942
1975.00	3.432	4500.00	1.933
2000.00	3.397	4525.00	1.925
2025.00	3.363	4550.00	1.917
2050.00	3.329	4575.00	1.908
2075.00	3.296	4600.00	1.900
2100.00	3.263	4625.00	1.892
2125.00	3.231	4650.00	1.884
2150.00	3.199	4675.00	1.876
2175.00	3.167	4700.00	1.868
2200.00	3.136	4725.00	1.860
2225.00	3.105	4750.00	1.852
2250.00	3.075	4775.00	1.844
2275.00	3.045	4800.00	1.836
2300.00	3.015	4825.00	1.828
2325.00	2.986	4850.00	1.820

2350.00	2.957	4875.00	1.812
2375.00	2.929	4900.00	1.805
2400.00	2.901	4925.00	1.797
2425.00	2.873	4950.00	1.789
2450.00	2.846	4975.00	1.782
2475.00	2.819	5000.00	1.774
2500.00	2.792		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY *********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	16.18	16.18	14.56	9.708	1.618

DISTANCE FROM SOURCE 93.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	2.117	2.117	1.905	1.270	0.2117

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 04/18/13
08:59:26

TITLE: ARROW_STATION7_530HP

STACK PARAMETERS

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	738.2 K	869.0 Deg F
PLUME EXIT VELOCITY:	45.478 m/s	149.21 ft/s
STACK AIR FLOW RATE:	3125 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.25000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

BUILDING DOWNWASH PARAMETERS

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

FLOW SECTOR ANALYSIS
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	15.29	100.0	SUM
20	0.00	0.00	0.00	0.00	15.29	100.0	SUM
30	0.00	0.00	0.00	0.00	15.29	100.0	SUM
40	0.00	0.00	0.00	0.00	15.29	100.0	SUM
50	0.00	0.00	0.00	0.00	15.29	100.0	SUM
60	0.00	0.00	0.00	0.00	15.29	100.0	SUM
70	0.00	0.00	0.00	0.00	15.29	100.0	SUM
80	0.00	0.00	0.00	0.00	15.29	100.0	SUM
90	0.00	0.00	0.00	0.00	15.29	100.0	SUM
100	0.00	0.00	0.00	0.00	15.29	100.0	SUM
110	0.00	0.00	0.00	0.00	15.29	100.0	SUM
120	0.00	0.00	0.00	0.00	15.29	100.0	SUM
130	0.00	0.00	0.00	0.00	15.29	100.0	SUM

140	0.00	0.00	0.00	0.00	15.29	100.0	SUM
150	0.00	0.00	0.00	0.00	15.29	100.0	SUM
160	0.00	0.00	0.00	0.00	15.29	100.0	SUM
170	0.00	0.00	0.00	0.00	15.29	100.0	SUM
180	0.00	0.00	0.00	0.00	15.29	100.0	SUM
190	0.00	0.00	0.00	0.00	15.29	100.0	SUM
200	0.00	0.00	0.00	0.00	15.29	100.0	SUM
210	0.00	0.00	0.00	0.00	15.29	100.0	SUM
220	0.00	0.00	0.00	0.00	15.29	100.0	SUM
230	0.00	0.00	0.00	0.00	15.29	100.0	SUM
240	0.00	0.00	0.00	0.00	15.29	100.0	SUM
250	0.00	0.00	0.00	0.00	15.29	100.0	SUM
260	0.00	0.00	0.00	0.00	15.29	100.0	SUM
270	0.00	0.00	0.00	0.00	15.29	100.0	SUM
280	0.00	0.00	0.00	0.00	15.29	100.0	SUM
290	0.00	0.00	0.00	0.00	15.29	100.0	SUM
300	0.00	0.00	0.00	0.00	15.29	100.0	SUM
310	0.00	0.00	0.00	0.00	15.29	100.0	SUM
320	0.00	0.00	0.00	0.00	15.29	100.0	SUM
330	0.00	0.00	0.00	0.00	15.29	100.0	SUM
340	0.00	0.00	0.00	0.00	15.29	100.0	SUM
350	0.00	0.00	0.00	0.00	15.29	100.0	SUM
360	0.00	0.00	0.00	0.00	15.29	100.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS *********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 15.4 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	22	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
63.99	0.086	0.600	0.020	134.	58.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 101.3 meters

********************** AERSCREEN AUTOMATED DISTANCES **********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	1.632	2525.00	2.542
25.00	3.726	2550.00	2.520
50.00	8.713	2575.00	2.499
75.00	15.04	2600.00	2.478
100.00	15.29	2625.00	2.457
125.00	13.71	2650.00	2.437
150.00	12.48	2675.00	2.416
175.00	11.08	2700.00	2.396
200.00	9.872	2725.00	2.376
225.00	9.230	2750.00	2.357
250.00	8.752	2775.00	2.337
275.00	8.256	2800.00	2.318
300.00	7.825	2825.00	2.299
325.00	7.419	2850.00	2.281
350.00	6.989	2875.00	2.262
375.00	6.661	2900.00	2.244
400.00	6.472	2925.00	2.226
425.00	6.252	2950.00	2.208
450.00	6.071	2975.00	2.190
475.00	6.128	3000.00	2.173
500.00	6.142	3025.00	2.156
525.00	6.121	3050.00	2.139
550.00	6.071	3075.00	2.122
575.00	6.000	3100.00	2.105
600.00	5.911	3125.00	2.089
625.00	5.810	3150.00	2.073
650.00	5.700	3175.00	2.064
675.00	5.584	3200.00	2.059
700.00	5.463	3225.00	2.054
725.00	5.339	3250.00	2.049
750.00	5.214	3275.00	2.044

775.00	5.090	3300.00	2.038
800.00	4.966	3325.00	2.033
825.00	4.844	3350.00	2.028
850.00	4.724	3375.00	2.022
875.00	4.606	3400.00	2.017
900.00	4.491	3425.00	2.011
925.00	4.378	3450.00	2.005
950.00	4.269	3475.00	2.000
975.00	4.163	3500.00	1.994
1000.00	4.060	3525.00	1.988
1025.00	3.994	3550.00	1.982
1050.00	3.948	3575.00	1.976
1075.00	3.907	3600.00	1.970
1100.00	3.892	3625.00	1.964
1125.00	3.875	3650.00	1.958
1150.00	3.856	3675.00	1.952
1175.00	3.835	3700.00	1.946
1200.00	3.825	3725.00	1.940
1225.00	3.812	3750.00	1.933
1250.00	3.798	3775.00	1.927
1275.00	3.782	3800.00	1.921
1300.00	3.765	3825.00	1.915
1325.00	3.746	3850.00	1.908
1350.00	3.726	3875.00	1.902
1375.00	3.705	3900.00	1.895
1400.00	3.683	3925.00	1.889
1425.00	3.660	3950.00	1.883
1450.00	3.637	3975.00	1.876
1475.00	3.612	4000.00	1.870
1500.00	3.587	4025.00	1.863
1525.00	3.562	4050.00	1.857
1550.00	3.536	4075.00	1.851
1575.00	3.510	4100.00	1.844
1600.00	3.483	4125.00	1.838
1625.00	3.457	4150.00	1.831
1650.00	3.430	4175.00	1.825
1675.00	3.402	4200.00	1.818
1700.00	3.375	4225.00	1.812
1725.00	3.348	4250.00	1.805
1750.00	3.320	4275.00	1.799
1775.00	3.293	4300.00	1.793
1800.00	3.265	4325.00	1.786
1825.00	3.238	4350.00	1.780
1850.00	3.211	4375.00	1.773
1875.00	3.183	4400.00	1.767
1900.00	3.156	4425.00	1.760
1925.00	3.129	4450.00	1.754
1950.00	3.102	4475.00	1.748
1975.00	3.076	4500.00	1.741
2000.00	3.049	4525.00	1.735
2025.00	3.023	4550.00	1.729
2050.00	2.997	4575.00	1.722
2075.00	2.971	4600.00	1.716
2100.00	2.945	4625.00	1.710
2125.00	2.919	4650.00	1.703
2150.00	2.894	4675.00	1.697
2175.00	2.869	4700.00	1.691
2200.00	2.844	4725.00	1.685
2225.00	2.819	4750.00	1.678
2250.00	2.795	4775.00	1.672
2275.00	2.770	4800.00	1.666
2300.00	2.746	4825.00	1.660
2325.00	2.723	4850.00	1.654

2350.00	2.699	4875.00	1.648
2375.00	2.676	4900.00	1.641
2400.00	2.653	4925.00	1.635
2425.00	2.630	4950.00	1.629
2450.00	2.608	4975.00	1.623
2475.00	2.586	5000.00	1.617
2500.00	2.564		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	15.35	15.35	13.82	9.211	1.535

DISTANCE FROM SOURCE 95.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	1.632	1.632	1.468	0.9789	0.1632

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 04/23/13 19:26:25

TITLE: Arrow_Station7_740hp

*************************** STACK PARAMETERS ***************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	9.75 meters	32.00 feet
STACK INNER DIAMETER:	0.254 meters	10.00 inches
PLUME EXIT TEMPERATURE:	922.0 K	1200.0 Deg F
PLUME EXIT VELOCITY:	38.094 m/s	124.98 ft/s
STACK AIR FLOW RATE:	4090 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.05000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

********************** BUILDING DOWNWASH PARAMETERS ********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************* FLOW SECTOR ANALYSIS *************************

25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	8.430	100.0	SUM
20	0.00	0.00	0.00	0.00	8.430	100.0	SUM
30	0.00	0.00	0.00	0.00	8.430	100.0	SUM
40	0.00	0.00	0.00	0.00	8.430	100.0	SUM
50	0.00	0.00	0.00	0.00	8.430	100.0	SUM
60	0.00	0.00	0.00	0.00	8.430	100.0	SUM
70	0.00	0.00	0.00	0.00	8.430	100.0	SUM
80	0.00	0.00	0.00	0.00	8.430	100.0	SUM
90	0.00	0.00	0.00	0.00	8.430	100.0	SUM
100	0.00	0.00	0.00	0.00	8.430	100.0	SUM
110	0.00	0.00	0.00	0.00	8.430	100.0	SUM
120	0.00	0.00	0.00	0.00	8.430	100.0	SUM
130	0.00	0.00	0.00	0.00	8.430	100.0	SUM

140	0.00	0.00	0.00	0.00	8.430	100.0	SUM
150	0.00	0.00	0.00	0.00	8.430	100.0	SUM
160	0.00	0.00	0.00	0.00	8.430	100.0	SUM
170	0.00	0.00	0.00	0.00	8.430	100.0	SUM
180	0.00	0.00	0.00	0.00	8.430	100.0	SUM
190	0.00	0.00	0.00	0.00	8.430	100.0	SUM
200	0.00	0.00	0.00	0.00	8.430	100.0	SUM
210	0.00	0.00	0.00	0.00	8.430	100.0	SUM
220	0.00	0.00	0.00	0.00	8.430	100.0	SUM
230	0.00	0.00	0.00	0.00	8.430	100.0	SUM
240	0.00	0.00	0.00	0.00	8.430	100.0	SUM
250	0.00	0.00	0.00	0.00	8.430	100.0	SUM
260	0.00	0.00	0.00	0.00	8.430	100.0	SUM
270	0.00	0.00	0.00	0.00	8.430	100.0	SUM
280	0.00	0.00	0.00	0.00	8.430	100.0	SUM
290	0.00	0.00	0.00	0.00	8.430	100.0	SUM
300	0.00	0.00	0.00	0.00	8.430	100.0	SUM
310	0.00	0.00	0.00	0.00	8.430	100.0	SUM
320	0.00	0.00	0.00	0.00	8.430	100.0	SUM
330	0.00	0.00	0.00	0.00	8.430	100.0	SUM
340	0.00	0.00	0.00	0.00	8.430	100.0	SUM
350	0.00	0.00	0.00	0.00	8.430	100.0	SUM
360	0.00	0.00	0.00	0.00	8.430	100.0	SUM

* = worst case flow sector

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----------------------------------------------------------------------------
*********************  MAKEMET METEOROLOGY PARAMETERS  ********************
----------------------------------------------------------------------------

MIN/MAX TEMPERATURE:    249.8 / 310.9 (K)

MINIMUM WIND SPEED:       0.5 m/s

ANEMOMETER HEIGHT:     10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE:    Average Moisture
DOMINANT SEASON:          Summer

ALBEDO:                  0.18
BOWEN RATIO:             0.80
ROUGHNESS LENGTH:       0.100 (meters)


       METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT
       -------------------------------------------------------------

 YR MO DY JDY HR
 -- -- -- --- --
 10 06 06   6 01

    H0     U*     W*  DT/DZ ZICNV ZIMCH  M-O LEN    Z0  BOWEN ALBEDO  REF WS
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
-46.70  0.861 -9.000  0.020 -999. 1839.   1307.1 0.100   0.80   0.18   10.00

    HT  REF TA     HT
- - - - - - - - - - -
  10.0   310.9    2.0
```

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 16.5 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	22	6	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
63.99	0.086	0.600	0.020	134.	58.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 131.9 meters

************************ AERSCREEN AUTOMATED DISTANCES *********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	0.4999	2525.00	1.880
25.00	1.576	2550.00	1.867
50.00	3.531	2575.00	1.854
75.00	5.723	2600.00	1.841
100.00	8.430	2625.00	1.828
125.00	8.406	2650.00	1.815
150.00	8.246	2675.00	1.803
175.00	7.545	2700.00	1.791
200.00	6.972	2725.00	1.779
225.00	6.495	2750.00	1.767
250.00	5.949	2775.00	1.755
275.00	5.502	2800.00	1.744
300.00	5.172	2825.00	1.732
325.00	4.967	2850.00	1.721
350.00	4.794	2875.00	1.710
375.00	4.627	2900.00	1.699
400.00	4.429	2925.00	1.689
425.00	4.218	2950.00	1.678
450.00	4.037	2975.00	1.667
475.00	4.015	3000.00	1.657
500.00	3.979	3025.00	1.647
525.00	3.928	3050.00	1.637
550.00	3.870	3075.00	1.627
575.00	3.812	3100.00	1.617
600.00	3.787	3125.00	1.608
625.00	3.787	3150.00	1.598
650.00	3.776	3175.00	1.589
675.00	3.761	3200.00	1.579
700.00	3.741	3225.00	1.570
725.00	3.717	3250.00	1.561
750.00	3.691	3275.00	1.552

775.00	3.661	3300.00	1.543
800.00	3.630	3325.00	1.535
825.00	3.597	3350.00	1.526
850.00	3.563	3375.00	1.517
875.00	3.528	3400.00	1.509
900.00	3.492	3425.00	1.501
925.00	3.455	3450.00	1.492
950.00	3.418	3475.00	1.484
975.00	3.381	3500.00	1.476
1000.00	3.344	3525.00	1.468
1025.00	3.306	3550.00	1.461
1050.00	3.269	3575.00	1.453
1075.00	3.233	3600.00	1.445
1100.00	3.196	3625.00	1.437
1125.00	3.160	3650.00	1.430
1150.00	3.124	3675.00	1.423
1175.00	3.089	3700.00	1.415
1200.00	3.054	3725.00	1.408
1225.00	3.020	3750.00	1.401
1250.00	2.986	3775.00	1.394
1275.00	2.953	3800.00	1.387
1300.00	2.921	3825.00	1.380
1325.00	2.888	3850.00	1.375
1350.00	2.857	3875.00	1.369
1375.00	2.826	3900.00	1.364
1400.00	2.796	3925.00	1.358
1425.00	2.766	3950.00	1.352
1450.00	2.737	3975.00	1.347
1475.00	2.708	4000.00	1.341
1500.00	2.680	4025.00	1.336
1525.00	2.652	4050.00	1.331
1550.00	2.625	4075.00	1.325
1575.00	2.598	4100.00	1.320
1600.00	2.572	4125.00	1.315
1625.00	2.547	4150.00	1.309
1650.00	2.522	4175.00	1.304
1675.00	2.497	4200.00	1.299
1700.00	2.473	4225.00	1.294
1725.00	2.449	4250.00	1.289
1750.00	2.426	4275.00	1.283
1775.00	2.403	4300.00	1.278
1800.00	2.381	4325.00	1.273
1825.00	2.359	4350.00	1.268
1850.00	2.338	4375.00	1.263
1875.00	2.316	4400.00	1.258
1900.00	2.296	4425.00	1.253
1925.00	2.275	4450.00	1.249
1950.00	2.255	4475.00	1.244
1975.00	2.236	4500.00	1.239
2000.00	2.217	4525.00	1.234
2025.00	2.198	4550.00	1.229
2050.00	2.179	4575.00	1.225
2075.00	2.161	4600.00	1.220
2100.00	2.143	4625.00	1.215
2125.00	2.125	4650.00	1.211
2150.00	2.108	4675.00	1.206
2175.00	2.091	4700.00	1.201
2200.00	2.074	4725.00	1.197
2225.00	2.058	4750.00	1.192
2250.00	2.042	4775.00	1.188
2275.00	2.026	4800.00	1.183
2300.00	2.010	4825.00	1.179
2325.00	1.995	4850.00	1.175

2350.00	1.980	4875.00	1.170
2375.00	1.965	4900.00	1.166
2400.00	1.950	4925.00	1.162
2425.00	1.936	4950.00	1.157
2450.00	1.921	4975.00	1.153
2475.00	1.907	5000.00	1.149
2500.00	1.894		

********************** AERSCREEN MAXIMUM IMPACT SUMMARY *********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	8.516	8.516	7.665	5.110	0.8516

DISTANCE FROM SOURCE 107.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.4999	0.4999	0.4499	0.2999	0.4999E-01

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

REVISED AIR QUALITY ASSESSMENT

The regulations for the Federal Minor New Source Review Program in Indian Country, codified at 40 CFR 49.159(d), require that an air quality impact assessment modeling analysis be performed if there is reason to be concerned that a project would cause or contribute to a NAAQS exceedance or a PSD increment violation. If the air quality impact assessment reveals that the proposed construction could cause or contribute to a NAAQS exceedance or PSD increment violation, such impacts must be analyzed and/or mitigated before a preconstruction permit can be issued.

The project area can be characterized as relatively flat, with only minor terrain features (i.e., gently rolling hills). The main use for the surrounding area is agriculture and livestock grazing, with the exception of an occasional oil and gas well production project.

The western portion of North Dakota has four defined seasons (i.e., summer, fall, winter, and spring). During summer, the average air temperature in degrees Fahrenheit (°F) ranges from the low 60s to the low 70s, with highs reaching the mid-80s. In contrast, the average minimum temperatures in winter generally range from just above 0 to the mid-single digits, with the average maximum temperature reaching the upper 20s. The yearly average precipitation is approximately 14 inches, and precipitation is highest in the summer months.[1]

The project is located within the boundaries of the Fort Berthold Indian Reservation, which is designated by the EPA as being in attainment or unclassified with respect to the NAAQS for O_3, CO, NO_2, SO_2, PM_{10}, $PM_{2.5}$, and Pb. The EPA has collected air monitoring data for O_3, NO_2, SO_2, PM_{10}, and $PM_{2.5}$ in the project area.[2] Table 13 shows the results for the air monitors nearest to the site, the location of the monitors relative to the site, the years of data analyzed, and any recorded exceedances of either the primary or secondary NAAQS.

Table 13. Air Monitoring Exceedance Data

Monitor (Contaminant)	Location (Latitude, Longitude)	Location in Relation to Station	Years Analyzed	Exceedances (primary or secondary)
AQS 38-101-0114 (SO_2, NO_2)	47.97110, −101.84940	32 miles NE	2009–2010	0
AQS 38-053-0002 (SO_2, NO_2, PM_{10}, $PM_{2.5}$, O_3)	47.58120, −103.29950	42 miles SW	2008−2013	1 (primary and secondary): O_3, 2011; 1 (primary): NO_2, 2011; 1 (primary): SO_2, 2011
AQS 38-055-0113 (SO_2, PM_{10})	47.60667, −102.03639	17 miles SE	2006–2008	0
AQS 38-053-0108 (PM_{10})	47.99028, −102.58833	23 miles NW	2006–2008	0
AQS 38-057-1113 (SO_2)	47.49490, −102.07800	19 miles SE	2009–2010	0
AQS 38-057-0124 (SO_2, NO_2)	47.40062, −101.92865	28 miles SE	2009–2011	1 (primary): SO_2, 2010
AQS 38-025-0003 (SO_2, NO_2, PM_{10}, $PM_{2.5}$, O_3)	47.31320, −102.52730	25 miles S	2008–2013	0

As Table 13 demonstrates, the area around the site is in attainment for SO_2, NO_2, PM_{10}, $PM_{2.5}$, and O_3 and is not classified for CO and Pb.

[1] National Weather Service Weather Forecast Office. 2013. North Dakota data. Available at: http://www.crh.noaa.gov/bis. Accessed April 18, 2013.

[2] U.S. Environmental Protection Agency. 2013. Air monitoring data. Available at: http://www.epa.gov/airdata. Accessed April 18, 2013.

Modeling Parameters and Procedures

An ambient air impact analysis was performed to estimate air quality impacts for CO, NO_2, PM_{10}, $PM_{2.5}$, and SO_2 that may be emitted from each engine proposed for the project. This modeling was conducted using the EPA AERSCREEN model (Version 11126). The following technical options for the AERSCREEN modeling analysis were selected:

- rural terrain;
- probe distance of 3,281 feet (ft);
- maximum building height of 20 ft;
- maximum building dimension of 28 ft;
- minimum building dimension of 15.5 ft;
- building orientation and stack direction of 0 and 90 degrees from north, respectively;
- regulatory default minimum and maximum temperatures (−10 to 100 °F);
- regulatory default minimum wind speed (0.5 meters per second);
- regulatory default anemometer height (10.0 meters);
- dominant surface profile of grassland; and
- dominant climate type of average moisture.

The terrain elevations for both locations are within a fairly tight range, between 2,250 and 2,300 feet in elevation. As such, 2,300 feet in elevation was used in AERSCREEN. The technical parameters for the stack height, stack diameter, stack temperature, stack flow rate, and NO_2 to NO_x chemistry varied from engine to engine. Additionally, the emission rates for CO, NO_2, PM_{10}, $PM_{2.5}$, and SO_2 vary among the different engines. These equipment dependent technical parameters for each engine are discussed in Table 14.

Table 14. Engine Air Modeling Technical Parameters

Parameter	Natural Gas-Fired 4-Stroke Rich-Burn RICE (326 HP)	Natural Gas-Fired 4-Stroke Lean-Burn RICE (400 HP)	Natural Gas-Fired 4-Stroke Rich-Burn RICE (435 HP)	Natural Gas-Fired 4-Stroke Lean-Burn RICE (530 HP)	Natural Gas-Fired 4-Stroke Rich-Burn RICE (740 HP)	Natural Gas-Fired 4-Stroke Rich-Burn RICE (1,480 HP)
Stack Height (feet)	25	25	25	25	32	32
Stack Diameter (inches)	8	8	8	8	10	12
Stack Temperature (°F)	1,207	877	1,205	869	1,200	1,268
Exit Gas Velocity (ACFM)	1,796	2,195	2,384	3,125	4,090	7,056
NO_2 to NO_x Chemistry (ratio)	0.05	0.25	0.05	0.25	0.05	0.05
CO (lb/hr)	0.57	1.15	0.77	1.52	2.02	2.94
NO_x (lb/hr)	0.57	1.76	0.77	2.34	1.27	2.12
PM_{10} (lb/hr)	0.03	0.0002	0.04	0.0003	0.06	0.13
$PM_{2.5}$ (lb/hr)	0.03	0.0002	0.04	0.0003	0.06	0.13
SO_2 (lb/hr)	0.18	0.18	0.24	0.26	0.38	0.75

Note: ACFM = actual cubic feet per minute.

For the NO_2 to NO_x ratio, the Plume Volume Molar Ratio was selected as being the best representative of the in-stack chemistry, based on manufacturer-provided data of the measurement of NO_2 to NO_x as the air-to-fuel ratio changes. The input data of the air modeling analysis using AERSCREEN for the project is included in Appendix E. It should be noted that the results were modeled on a 1-pound per hour (lb/hr) hypothetical basis for all pollutants analyzed and then normalized for the particular pollutant of interest using the correct emission rate. For the non-NO_2 pollutants, the normalized 1 lb/hr emission rates were modeled without the use of the Plume Volume Molar Ratio method, instead using the "no pollutants are not NO_2 [or the pollutant of interest]" method.

AERSCREEN Modeling Results

A pre-construction air quality impact analysis for a particular pollutant is normally expected to include an estimate of the projected total pollutant concentration at each modeling receptor site. The total pollutant concentration is the sum of: (i) the baseline concentration in the area of the plant due to existing sources of pollution and (ii) the estimated increase in pollutant concentration in the area, caused by the applicant's proposed emission increase and associated growth. To demonstrate that the proposed project will not cause or contribute to a violation of the NAAQS, the applicant is normally expected to show that the total pollutant concentration will not exceed the NAAQS at any receptor site. A summary of the proposed project AERSCREEN modeling results for CO, NO_2, $PM_{2.5}$, PM_{10}, and SO_2 are provided in Table 15; supporting calculations are provided in Appendix E.

Table 15. Representative Maximum Design AERSCREEN Results Summary

Pollutant	Averaging Period	Representative Maximum Design Impact	Ambient Background	Representative Maximum Design Impacts + Background	NAAQS	Exceeds NAAQS (Yes/No)
PM_{10} [1]	24-hour	3.2 µg/m^3	103.0 µg/m^3	106.2 µg/m^3	150 µg/m^3	No
$PM_{2.5}$ [2]	24-hour	3.2 µg/m^3	16.6 µg/m^3	19.8 µg/m^3	35 µg/m^3	No
	Annual	0.3 µg/m^3	5.8 µg/m^3	6.1 µg/m^3	12 µg/m^3	No
NO_2 [3]	1-hour	78.0 ppb	16.0 ppb	94.0 ppb	100 ppb	No
	Annual	7.8 ppb	5.0 ppb	12.8 ppb	53 ppb	No
SO_2 [4]	1-hour	15.2 ppb	19.0 ppb	34.2 ppb	75 ppb	No
	3-hour	15.2 ppb	16.3 ppb	31.5 ppb	500 ppb	No
CO [5]	1-hour	0.1 ppm	2.2 ppm	2.3 ppm	35 ppm	No
	8-hour	0.1 ppm	0.6 ppm	0.7 ppm	9 ppm	No

[1] Ambient background 24-hour PM_{10} value taken from the highest recorded 24-hour concentration value for the years analyzed (2010-2012) from EPA Air Monitor 38-025-0003

[2] Ambient background 24-hour and annual $PM_{2.5}$ values taken from highest 98% 24-hour concentration value (for 24-hour $PM_{2.5}$ background level) and highest annual mean 24-hour concentration value (for annual $PM_{2.5}$ background level) for the years analyzed (2010-2012) from EPA Air Monitor 38-025-0003

[3] Ambient background 1-hour and annual NO_2 values taken from the highest 99% 1-hour concentration value (for 1-hour NO_2 background level) and highest annual mean 1-hour concentration value (for annual NO_2 background level) for the years analyzed (2010-2012) from EPA Air Monitor 38-053-0002

[4] Ambient background 1-hour and 3-hour SO_2 value taken from highest 99% 1-hour concentration value (for 1-hour SO_2 background level) and highest record 3-hour concentration value (for 3-hour SO_2 background level) for the years analyzed (2010-2012) from EPA Air Monitor 38-025-0003

[5] Ambient background 1-hour and 8-hour CO values taken from highest recorded 1-hour and 8-hour concentration values, respectively, for the years analyzed (2010-2012) from EPA Air Monitor 38-017-1004

When calculating emissions from the project, it was assumed that the maximum pound per hour CO, NO_x $PM_{2.5}$, PM_{10}, and SO_2 emissions from each engine were emitted. As there are multiple engines and thus multiple point sources associated with the facility, the maximum concentrations predicted at radial distances were overlaid from each engine (additive) to estimate the cumulative impacts from the project.

These cumulative impacts were then added to background levels and compared with the NAAQS. The background concentrations were derived from the nearest EPA monitors.

As the modeling results provided in Appendix E demonstrate, air quality impacts from the proposed facility are below the NAAQS for CO, NO_x $PM_{2.5}$, PM_{10} and SO_2 for the project.

The available O_3 data from the closest two O_3 monitors in the region are presented in Figures 2 and 3. As indicted above, these two monitors did not approach the 8-hour O_3 standard. For 8-hour O_3, NAAQS violations occur when the 3-year average of the 4th maximum 8-hour average O_3 is greater than the NAAQS. The 3-year 8-hour average design values for the region are shown below. Neither of these two monitors had a three year average above the 0.075 ppm O_3 NAAQS. Therefore, the overall conclusion is that the project is unlikely to cause or contribute to a violation of the O_3 NAAQS based on the following:

- The current background O_3 values as shown from the monitoring data are significantly below the NAAQS;
- The increase in ozone precursor emissions is small (less than 59 tpy of NO_x);
- The region typically has good air dispersion, with mostly flat terrain; and
- Project emissions are not expected to cause a significant increase in ozone and therefore will not cause or contribute to an exceedance of the NAAQS.

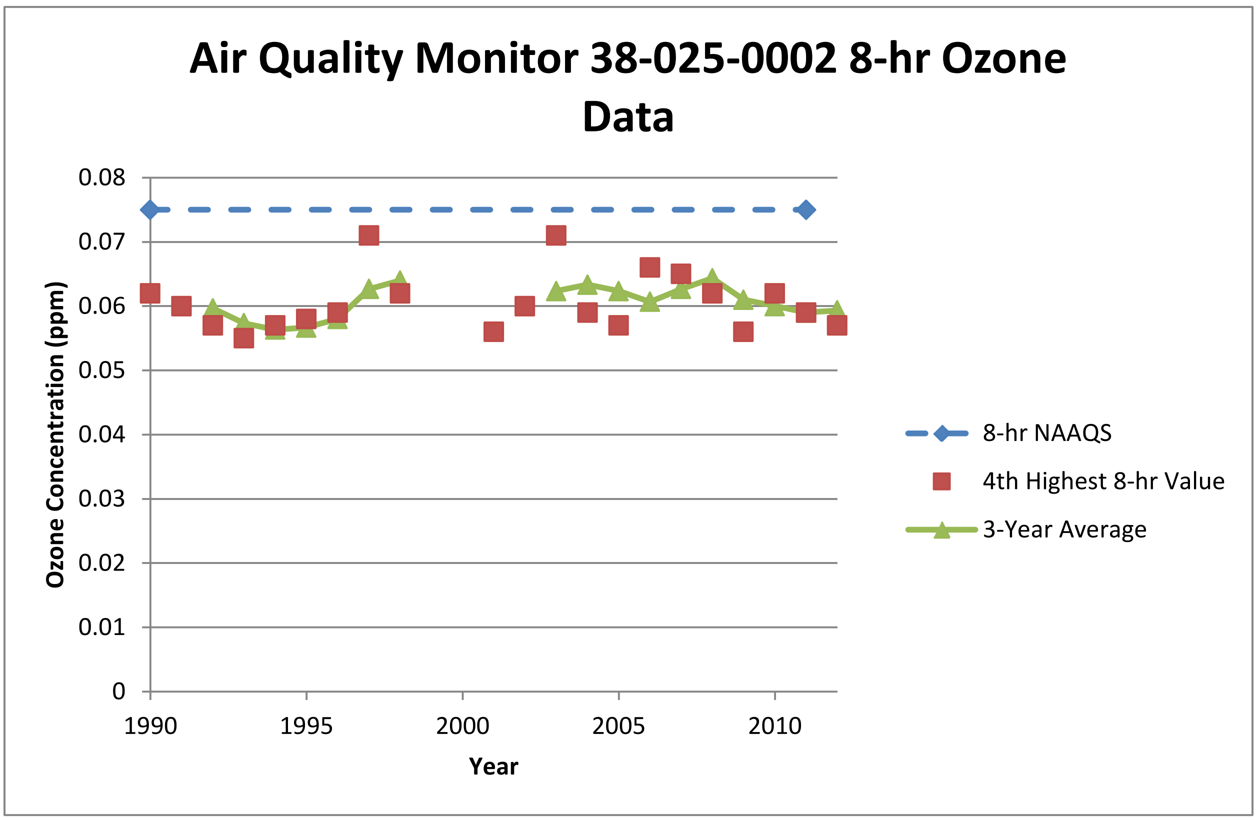

Figure 2. 38-025-0002 Monitor 4th Maximum 8-hour O_3, 1990–2012[3].

[3] Monitoring data taken from EPA Air Quality Monitor 38-025-0002; located at http://www.epa.gov/airdata/

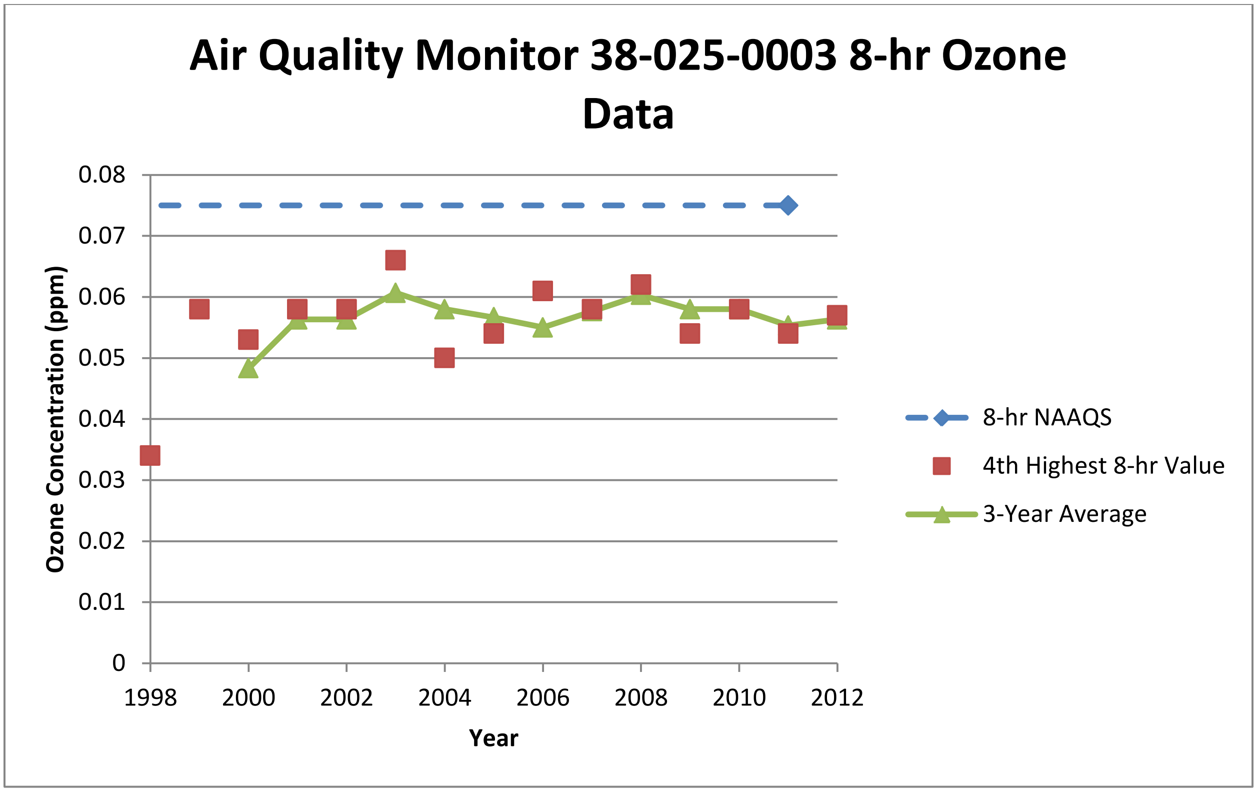

Figure 3. 38-025-0003 Monitor 4th Maximum 8-hour O_3, 1998–2012[4].

As the modeling results and discussion above demonstrate, air quality impacts from the proposed facility are below the NAAQS for CO, NO_x $PM_{2.5}$, PM_{10} and SO_2 for the project. Additionally, based on existing background O_3 levels, it is unlikely that the proposed facility will cause or contribute to a violation of the O_3 NAAQS. Given the projected emissions of the project and the current air quality status, additional ambient impact analysis is not required.

Arrow has also assessed the impact of project emissions to nearby Class I areas. The only Class I area identified within 100 kilometers (km) from either proposed project location is the Theodore Roosevelt National Park, whose eastern edge is located approximately 60 km to the west of the westernmost boundary of the project property line. Arrow has therefore conducted a screening level assessment of project impacts to the Theodore Roosevelt National Park using the Federal Land Managers' Air Quality Related Values (AQRV) Workgroup (FLAG) Phase I Report guidance,[5] which establishes a threshold ratio of emissions to distance below which AQRV review is not required. Specifically, if

Q (tpy) / d (km) < 10, no AQRV analysis is required

Where,

- Q is the emissions increase of SO_2, NO_X, PM_{10}, and sulfuric acid mist (H_2SO_4), combined in tpy [the tpy value must be based on the maximum short-term emission rates]; and
- D is the nearest distance to a Class I Area in km.

[4] Monitoring data taken from EPA Air Quality Monitor 38-025-0003; located at http://www.epa.gov/airdata/

[5] The Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report – Revised 2010. Available at: http://www.nature.nps.gov/air/pubs/pdf/flag/FLAG_2010.pdf. Accessed on April 22, 2013.

The FLAG 2010 guidance suggests summing the project-wide ton/year emission rates for all sources of NO_X, SO_2, PM_{10}, and H_2SO_4 and dividing this value by the distance from the proposed site to the Class I area. If this value is less than or equal to 10, presumptively there is no adverse impact and a project “screens out” of a Class I AQRV analysis.

The emissions in tons per year of NO_X, SO_2, PM_{10}, and H_2SO_4 were estimated as:

- NO_X: 59 tpy
- PM_{10}: 5 tpy
- SO_2: 20 tpy
- H_2SO_4: 0 tpy
- Total: 84 tons/year

  Q/d = 84 [tons/year pollutants] / 60 [distance in km to nearest Class I area] = 1.4

As the Q/d value is less than 10, the project has “screened out” of any further Class I AQRV analyses and will thus not adversely affect the Theodore Roosevelt National Park.

Appendix E
Revised Air Quality Modeling

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.1 - Normalized Emissions

Type	Engine	Power (HP)	1-hr Concentration (ug/m^3)	3-hr Concentration (ug/m3)	8-hr Concentration (ug/m3)	24-hr Concentration (ug/m3)	Annual Concentration (ug/m^3)
1,480-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	L7042GSI	1480	8.2	8.2	7.4	4.9	0.8
740-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	L3514GSI	740	9.5	9.5	8.5	5.7	0.9
530-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	H24GL	530	17.1	17.1	15.4	10.2	1.7
435-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	H24GSI	435	18.0	18.0	16.2	10.8	1.8
400-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	F18GL	400	19.4	19.4	17.5	11.7	1.9
326-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	F18GSI	326	19.9	19.9	17.9	11.9	2.0

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.3 - CO Emissions

Engine	Quantity	Power (HP)	CO Emission Rate [1] (lb/hr)	Highest CO 1-hr Concentration [2] (ug/m^3)	Highest CO 1-hr Concentration [2] (ug/m^3)	Highest CO 1-hr Concentration [3] (ppm)	Highest CO 8-hr Concentration [3] (ppm)
L7042GSI	3	1480	2.94	72.6	65.3	0.063	0.057
L3514GSI	1	740	2.02	19.1	17.2	0.017	0.015
H24GL	1	530	1.52	25.9	23.3	0.023	0.020
H24GSI	1	435	0.77	13.8	12.5	0.012	0.011
F18GL	1	400	1.15	22.3	20.1	0.019	0.017
F18GSI	1	326	0.57	11.3	10.2	0.010	0.009
			Station Total	**165.1**	**148.6**	**0.1**	**0.1**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

[3] Calculated by multiplying the concentration provided in ug/m^3 by $8.7*10^{-3}$ to convert to ppm

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.4 - PM10 Emissions

Engine	Quantity	Power (HP)	PM_{10} Emission Rate [1] (lb/hr)	Highest $PM_{2.5}$ 24-hr Concentration [2] (ug/m^3)
L7042GSI	3	1480	0.14	2.1
L3514GSI	1	740	0.06	0.3
H24GL	1	530	0.00	0.0
H24GSI	1	435	0.04	0.4
F18GL	1	400	0.00	0.0
F18GSI	1	326	0.03	0.4
			Station Total	**3.2**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.5 - PM2.5 Emissions

Engine	Quantity	Power (HP)	$PM_{2.5}$ Emission Rate [1] (lb/hr)	Highest $PM_{2.5}$ 24-hr Concentration [2] (ug/m^3)	Highest $PM_{2.5}$ Annual Concentration [2] (ug/m^3)
L7042GSI	3	1480	0.14	2.1	0.1
L3514GSI	1	740	0.06	0.3	0.1
H24GL	1	530	0.00	0.0	0.0
H24GSI	1	435	0.04	0.4	0.1
F18GL	1	400	0.00	0.0	0.0
F18GSI	1	326	0.03	0.4	0.1
			Station Total	**3.2**	**0.3**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.6 - SO2 Emissions

Engine	Quantity	Power (HP)	SO_2 Emission Rate [1] (lb/hr)	Highest SO_2 1-hr Concentration [2] (ug/m^3)	Highest SO_2 3-hr Concentration [2] (ug/m^3)	Highest SO_2 1-hr Concentration [3] (ppb)	Highest SO_2 3-hr Concentration [3] (ppb)
L7042GSI	3	1480	0.83	20.5	20.5	7.8	7.8
L3514GSI	1	740	0.38	3.6	3.6	1.4	1.4
H24GL	1	530	0.26	4.4	4.4	1.7	1.7
H24GSI	1	435	0.24	4.3	4.3	1.6	1.6
F18GL	1	400	0.18	3.5	3.5	1.3	1.3
F18GSI	1	326	0.18	3.6	3.6	1.4	1.4
			Station Total	**39.9**	**39.9**	**15.2**	**15.2**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

[3] Calculated by multiplying the concentration provided in ug/m^3 by 0.38 to convert to ppb

AERSCREEN 11126 / AERMOD 1206 06/12/13 15:19:17

TITLE: Arrow_Station7_326hp

****************************** STACK PARAMETERS ****************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	925.9 K	1207.0 Deg F
PLUME EXIT VELOCITY:	26.137 m/s	85.75 ft/s
STACK AIR FLOW RATE:	1796 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

*********************** BUILDING DOWNWASH PARAMETERS *********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************** FLOW SECTOR ANALYSIS ***************************
25 meter receptor spacing: 1. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	19.29	100.0	SUM
20	0.00	0.00	0.00	0.00	19.29	100.0	SUM
30	0.00	0.00	0.00	0.00	19.29	100.0	SUM
40	0.00	0.00	0.00	0.00	19.29	100.0	SUM
50	0.00	0.00	0.00	0.00	19.29	100.0	SUM
60	0.00	0.00	0.00	0.00	19.29	100.0	SUM
70	0.00	0.00	0.00	0.00	19.29	100.0	SUM
80	0.00	0.00	0.00	0.00	19.29	100.0	SUM
90	0.00	0.00	0.00	0.00	19.29	100.0	SUM
100	0.00	0.00	0.00	0.00	19.29	100.0	SUM
110	0.00	0.00	0.00	0.00	19.29	100.0	SUM
120	0.00	0.00	0.00	0.00	19.29	100.0	SUM
130	0.00	0.00	0.00	0.00	19.29	100.0	SUM
140	0.00	0.00	0.00	0.00	19.29	100.0	SUM
150	0.00	0.00	0.00	0.00	19.29	100.0	SUM
160	0.00	0.00	0.00	0.00	19.29	100.0	SUM
170	0.00	0.00	0.00	0.00	19.29	100.0	SUM
180	0.00	0.00	0.00	0.00	19.29	100.0	SUM

190	0.00	0.00	0.00	0.00	19.29	100.0	SUM
200	0.00	0.00	0.00	0.00	19.29	100.0	SUM
210	0.00	0.00	0.00	0.00	19.29	100.0	SUM
220	0.00	0.00	0.00	0.00	19.29	100.0	SUM
230	0.00	0.00	0.00	0.00	19.29	100.0	SUM
240	0.00	0.00	0.00	0.00	19.29	100.0	SUM
250	0.00	0.00	0.00	0.00	19.29	100.0	SUM
260	0.00	0.00	0.00	0.00	19.29	100.0	SUM
270	0.00	0.00	0.00	0.00	19.29	100.0	SUM
280	0.00	0.00	0.00	0.00	19.29	100.0	SUM
290	0.00	0.00	0.00	0.00	19.29	100.0	SUM
300	0.00	0.00	0.00	0.00	19.29	100.0	SUM
310	0.00	0.00	0.00	0.00	19.29	100.0	SUM
320	0.00	0.00	0.00	0.00	19.29	100.0	SUM
330	0.00	0.00	0.00	0.00	19.29	100.0	SUM
340	0.00	0.00	0.00	0.00	19.29	100.0	SUM
350	0.00	0.00	0.00	0.00	19.29	100.0	SUM
360	0.00	0.00	0.00	0.00	19.29	100.0	SUM

* = worst case flow sector

********************** MAKEMET METEOROLOGY PARAMETERS *********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 13.0 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	06	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
5.75	0.032	0.100	0.020	12.	13.	-1.0	0.001	1.50	0.60	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash):   72.8 meters

********************** AERSCREEN AUTOMATED DISTANCES **********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
1.00	0.1585	2525.00	3.688
25.00	7.348	2550.00	3.672
50.00	13.68	2575.00	3.655
75.00	18.95	2600.00	3.638
100.00	19.29	2625.00	3.621
125.00	17.33	2650.00	3.604
150.00	15.84	2675.00	3.587
175.00	14.02	2700.00	3.570
200.00	13.18	2725.00	3.553
225.00	12.20	2750.00	3.535
250.00	11.77	2775.00	3.518
275.00	11.70	2800.00	3.500
300.00	11.38	2825.00	3.483
325.00	10.93	2850.00	3.465
350.00	10.75	2875.00	3.448
375.00	10.81	2900.00	3.430
400.00	10.74	2925.00	3.413
425.00	10.63	2950.00	3.395
450.00	10.47	2975.00	3.377
475.00	10.26	3000.00	3.360
500.00	10.01	3025.00	3.342
525.00	9.736	3050.00	3.325
550.00	9.451	3075.00	3.307
575.00	9.161	3100.00	3.290
600.00	8.870	3125.00	3.273
625.00	8.581	3150.00	3.255
650.00	8.298	3175.00	3.238
675.00	8.021	3200.00	3.221
700.00	7.993	3225.00	3.204
725.00	7.973	3250.00	3.186
750.00	7.937	3275.00	3.169
775.00	7.889	3300.00	3.152
800.00	7.830	3325.00	3.136
825.00	7.761	3350.00	3.119
850.00	7.685	3375.00	3.102
875.00	7.603	3400.00	3.085

900.00	7.516	3425.00	3.069
925.00	7.425	3450.00	3.052
950.00	7.331	3475.00	3.036
975.00	7.234	3500.00	3.019
1000.00	7.143	3525.00	3.003
1025.00	7.074	3550.00	2.987
1050.00	7.003	3575.00	2.971
1075.00	6.930	3600.00	2.955
1100.00	6.855	3625.00	2.939
1125.00	6.778	3650.00	2.923
1150.00	6.701	3675.00	2.907
1175.00	6.622	3700.00	2.892
1200.00	6.543	3725.00	2.876
1225.00	6.464	3750.00	2.861
1250.00	6.385	3775.00	2.845
1275.00	6.306	3800.00	2.830
1300.00	6.227	3825.00	2.815
1325.00	6.148	3850.00	2.800
1350.00	6.070	3875.00	2.785
1375.00	5.993	3900.00	2.770
1400.00	5.916	3925.00	2.755
1425.00	5.840	3950.00	2.740
1450.00	5.765	3975.00	2.726
1475.00	5.691	4000.00	2.711
1500.00	5.617	4025.00	2.698
1525.00	5.545	4050.00	2.685
1550.00	5.474	4075.00	2.673
1575.00	5.403	4100.00	2.660
1600.00	5.334	4125.00	2.648
1625.00	5.266	4150.00	2.636
1650.00	5.199	4175.00	2.624
1675.00	5.133	4200.00	2.611
1700.00	5.068	4225.00	2.599
1725.00	5.003	4250.00	2.590
1750.00	4.941	4275.00	2.582
1775.00	4.879	4300.00	2.574
1800.00	4.818	4325.00	2.566
1825.00	4.758	4350.00	2.558
1850.00	4.699	4375.00	2.550
1875.00	4.641	4400.00	2.542
1900.00	4.584	4425.00	2.534
1925.00	4.529	4450.00	2.526
1950.00	4.474	4475.00	2.518
1975.00	4.420	4500.00	2.510
2000.00	4.367	4525.00	2.502
2025.00	4.315	4550.00	2.494
2050.00	4.264	4575.00	2.486
2075.00	4.213	4600.00	2.478
2100.00	4.164	4625.00	2.470
2125.00	4.116	4650.00	2.462
2150.00	4.068	4675.00	2.454
2175.00	4.021	4700.00	2.446
2200.00	3.975	4725.00	2.438
2225.00	3.934	4750.00	2.430
2250.00	3.913	4775.00	2.422
2275.00	3.892	4800.00	2.414
2300.00	3.871	4825.00	2.406
2325.00	3.850	4850.00	2.398
2350.00	3.828	4875.00	2.390
2375.00	3.807	4900.00	2.382
2400.00	3.785	4925.00	2.374
2425.00	3.764	4950.00	2.366
2450.00	3.742	4975.00	2.358

2475.00	3.721	5000.00	2.350
2500.00	3.705		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	19.86	19.86	17.88	11.92	1.986

DISTANCE FROM SOURCE 88.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.1585	0.1585	0.1427	0.9510E-01	0.1585E-01

DISTANCE FROM SOURCE 1.00 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 06/12/13
15:36:07

TITLE: Arrow_Station7_400hp

*************************** STACK PARAMETERS ***************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	742.6 K	877.0 Deg F
PLUME EXIT VELOCITY:	31.944 m/s	104.80 ft/s
STACK AIR FLOW RATE:	2195 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

********************** BUILDING DOWNWASH PARAMETERS *********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************ FLOW SECTOR ANALYSIS **************************
25 meter receptor spacing: 1. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	18.96	100.0	SUM
20	0.00	0.00	0.00	0.00	18.96	100.0	SUM
30	0.00	0.00	0.00	0.00	18.96	100.0	SUM
40	0.00	0.00	0.00	0.00	18.96	100.0	SUM
50	0.00	0.00	0.00	0.00	18.96	100.0	SUM
60	0.00	0.00	0.00	0.00	18.96	100.0	SUM
70	0.00	0.00	0.00	0.00	18.96	100.0	SUM
80	0.00	0.00	0.00	0.00	18.96	100.0	SUM
90	0.00	0.00	0.00	0.00	18.96	100.0	SUM
100	0.00	0.00	0.00	0.00	18.96	100.0	SUM
110	0.00	0.00	0.00	0.00	18.96	100.0	SUM
120	0.00	0.00	0.00	0.00	18.96	100.0	SUM
130	0.00	0.00	0.00	0.00	18.96	100.0	SUM
140	0.00	0.00	0.00	0.00	18.96	100.0	SUM
150	0.00	0.00	0.00	0.00	18.96	100.0	SUM
160	0.00	0.00	0.00	0.00	18.96	100.0	SUM
170	0.00	0.00	0.00	0.00	18.96	100.0	SUM
180	0.00	0.00	0.00	0.00	18.96	100.0	SUM

190	0.00	0.00	0.00	0.00	18.96	100.0	SUM
200	0.00	0.00	0.00	0.00	18.96	100.0	SUM
210	0.00	0.00	0.00	0.00	18.96	100.0	SUM
220	0.00	0.00	0.00	0.00	18.96	100.0	SUM
230	0.00	0.00	0.00	0.00	18.96	100.0	SUM
240	0.00	0.00	0.00	0.00	18.96	100.0	SUM
250	0.00	0.00	0.00	0.00	18.96	100.0	SUM
260	0.00	0.00	0.00	0.00	18.96	100.0	SUM
270	0.00	0.00	0.00	0.00	18.96	100.0	SUM
280	0.00	0.00	0.00	0.00	18.96	100.0	SUM
290	0.00	0.00	0.00	0.00	18.96	100.0	SUM
300	0.00	0.00	0.00	0.00	18.96	100.0	SUM
310	0.00	0.00	0.00	0.00	18.96	100.0	SUM
320	0.00	0.00	0.00	0.00	18.96	100.0	SUM
330	0.00	0.00	0.00	0.00	18.96	100.0	SUM
340	0.00	0.00	0.00	0.00	18.96	100.0	SUM
350	0.00	0.00	0.00	0.00	18.96	100.0	SUM
360	0.00	0.00	0.00	0.00	18.96	100.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS ********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash):   13.6 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	06	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
5.75	0.032	0.100	0.020	12.	13.	-1.0	0.001	1.50	0.60	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 77.4 meters

********************** AERSCREEN AUTOMATED DISTANCES *********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
1.00	0.1638	2525.00	3.419
25.00	6.510	2550.00	3.402
50.00	12.24	2575.00	3.385
75.00	18.29	2600.00	3.367
100.00	18.96	2625.00	3.353
125.00	16.93	2650.00	3.340
150.00	15.43	2675.00	3.327
175.00	13.73	2700.00	3.314
200.00	12.67	2725.00	3.300
225.00	11.90	2750.00	3.286
250.00	11.10	2775.00	3.273
275.00	10.73	2800.00	3.259
300.00	10.56	2825.00	3.245
325.00	10.24	2850.00	3.231
350.00	9.824	2875.00	3.216
375.00	9.656	2900.00	3.202
400.00	9.748	2925.00	3.188
425.00	9.738	2950.00	3.174
450.00	9.651	2975.00	3.159
475.00	9.509	3000.00	3.145
500.00	9.325	3025.00	3.130
525.00	9.114	3050.00	3.116
550.00	8.884	3075.00	3.101
575.00	8.642	3100.00	3.087
600.00	8.395	3125.00	3.072
625.00	8.145	3150.00	3.058
650.00	7.898	3175.00	3.043
675.00	7.653	3200.00	3.029
700.00	7.414	3225.00	3.014
725.00	7.182	3250.00	3.000
750.00	6.956	3275.00	2.985
775.00	6.907	3300.00	2.971
800.00	6.886	3325.00	2.956
825.00	6.855	3350.00	2.942
850.00	6.815	3375.00	2.927
875.00	6.767	3400.00	2.913

900.00	6.714	3425.00	2.899
925.00	6.657	3450.00	2.885
950.00	6.624	3475.00	2.870
975.00	6.584	3500.00	2.856
1000.00	6.541	3525.00	2.842
1025.00	6.493	3550.00	2.828
1050.00	6.441	3575.00	2.814
1075.00	6.387	3600.00	2.800
1100.00	6.330	3625.00	2.786
1125.00	6.271	3650.00	2.772
1150.00	6.210	3675.00	2.759
1175.00	6.148	3700.00	2.745
1200.00	6.084	3725.00	2.731
1225.00	6.020	3750.00	2.718
1250.00	5.955	3775.00	2.704
1275.00	5.890	3800.00	2.691
1300.00	5.824	3825.00	2.677
1325.00	5.759	3850.00	2.664
1350.00	5.693	3875.00	2.650
1375.00	5.627	3900.00	2.637
1400.00	5.562	3925.00	2.624
1425.00	5.497	3950.00	2.611
1450.00	5.432	3975.00	2.598
1475.00	5.368	4000.00	2.585
1500.00	5.304	4025.00	2.572
1525.00	5.241	4050.00	2.560
1550.00	5.179	4075.00	2.547
1575.00	5.117	4100.00	2.534
1600.00	5.056	4125.00	2.522
1625.00	4.996	4150.00	2.509
1650.00	4.936	4175.00	2.497
1675.00	4.878	4200.00	2.484
1700.00	4.820	4225.00	2.472
1725.00	4.762	4250.00	2.460
1750.00	4.706	4275.00	2.448
1775.00	4.650	4300.00	2.436
1800.00	4.596	4325.00	2.424
1825.00	4.542	4350.00	2.412
1850.00	4.488	4375.00	2.400
1875.00	4.436	4400.00	2.388
1900.00	4.385	4425.00	2.377
1925.00	4.334	4450.00	2.365
1950.00	4.284	4475.00	2.354
1975.00	4.235	4500.00	2.342
2000.00	4.186	4525.00	2.331
2025.00	4.139	4550.00	2.320
2050.00	4.092	4575.00	2.309
2075.00	4.046	4600.00	2.302
2100.00	4.000	4625.00	2.296
2125.00	3.956	4650.00	2.289
2150.00	3.912	4675.00	2.283
2175.00	3.869	4700.00	2.276
2200.00	3.826	4725.00	2.270
2225.00	3.785	4750.00	2.264
2250.00	3.743	4775.00	2.257
2275.00	3.703	4800.00	2.251
2300.00	3.663	4825.00	2.244
2325.00	3.624	4850.00	2.238
2350.00	3.586	4875.00	2.231
2375.00	3.548	4900.00	2.225
2400.00	3.510	4925.00	2.218
2425.00	3.488	4950.00	2.212
2450.00	3.471	4975.00	2.205

2475.00	3.454	5000.00	2.199
2500.00	3.437		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY *********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	19.42	19.42	17.48	11.65	1.942

DISTANCE FROM SOURCE 89.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.1638	0.1638	0.1474	0.9827E-01	0.1638E-01

DISTANCE FROM SOURCE 1.00 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 06/12/13
09:36:12

TITLE: ARROW_STATION7_435HP

**************************** STACK PARAMETERS ***************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	924.8 K	1205.0 Deg F
PLUME EXIT VELOCITY:	34.694 m/s	113.83 ft/s
STACK AIR FLOW RATE:	2384 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

********************** BUILDING DOWNWASH PARAMETERS *********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************* FLOW SECTOR ANALYSIS **************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	17.80	100.0	SUM
20	0.00	0.00	0.00	0.00	17.80	100.0	SUM
30	0.00	0.00	0.00	0.00	17.80	100.0	SUM
40	0.00	0.00	0.00	0.00	17.80	100.0	SUM
50	0.00	0.00	0.00	0.00	17.80	100.0	SUM
60	0.00	0.00	0.00	0.00	17.80	100.0	SUM
70	0.00	0.00	0.00	0.00	17.80	100.0	SUM
80	0.00	0.00	0.00	0.00	17.80	100.0	SUM
90	0.00	0.00	0.00	0.00	17.80	100.0	SUM
100	0.00	0.00	0.00	0.00	17.80	100.0	SUM
110	0.00	0.00	0.00	0.00	17.80	100.0	SUM
120	0.00	0.00	0.00	0.00	17.80	100.0	SUM
130	0.00	0.00	0.00	0.00	17.80	100.0	SUM
140	0.00	0.00	0.00	0.00	17.80	100.0	SUM
150	0.00	0.00	0.00	0.00	17.80	100.0	SUM
160	0.00	0.00	0.00	0.00	17.80	100.0	SUM
170	0.00	0.00	0.00	0.00	17.80	100.0	SUM
180	0.00	0.00	0.00	0.00	17.80	100.0	SUM

190	0.00	0.00	0.00	0.00	17.80	100.0	SUM
200	0.00	0.00	0.00	0.00	17.80	100.0	SUM
210	0.00	0.00	0.00	0.00	17.80	100.0	SUM
220	0.00	0.00	0.00	0.00	17.80	100.0	SUM
230	0.00	0.00	0.00	0.00	17.80	100.0	SUM
240	0.00	0.00	0.00	0.00	17.80	100.0	SUM
250	0.00	0.00	0.00	0.00	17.80	100.0	SUM
260	0.00	0.00	0.00	0.00	17.80	100.0	SUM
270	0.00	0.00	0.00	0.00	17.80	100.0	SUM
280	0.00	0.00	0.00	0.00	17.80	100.0	SUM
290	0.00	0.00	0.00	0.00	17.80	100.0	SUM
300	0.00	0.00	0.00	0.00	17.80	100.0	SUM
310	0.00	0.00	0.00	0.00	17.80	100.0	SUM
320	0.00	0.00	0.00	0.00	17.80	100.0	SUM
330	0.00	0.00	0.00	0.00	17.80	100.0	SUM
340	0.00	0.00	0.00	0.00	17.80	100.0	SUM
350	0.00	0.00	0.00	0.00	17.80	100.0	SUM
360	0.00	0.00	0.00	0.00	17.80	100.0	SUM

* = worst case flow sector

```
----------------------------------------------------------------------------
*********************  MAKEMET METEOROLOGY PARAMETERS  ********************
----------------------------------------------------------------------------

MIN/MAX TEMPERATURE:    249.8 / 310.9 (K)

MINIMUM WIND SPEED:       0.5 m/s

ANEMOMETER HEIGHT:     10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE:    Average Moisture
DOMINANT SEASON:          Summer

ALBEDO:                  0.18
BOWEN RATIO:             0.80
ROUGHNESS LENGTH:       0.100 (meters)


       METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT
       -------------------------------------------------------------

 YR MO DY JDY HR
 -- -- -- --- --
 10 05 31  31 01

    H0     U*     W*  DT/DZ ZICNV ZIMCH  M-O LEN    Z0  BOWEN ALBEDO  REF WS
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
-32.40  0.598 -9.000  0.020 -999. 1063.    629.3 0.100   0.80   0.18    7.00

    HT  REF TA     HT
- - - - - - - - - - -
  10.0   310.9    2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash):     14.4 meters


       METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT
       --------------------------------------------------------------
```

YR	MO	DY	JDY	HR
10	01	22	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
63.99	0.086	0.600	0.020	134.	58.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash):   91.9 meters

************************ AERSCREEN AUTOMATED DISTANCES *********************

OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	2.438	2525.00	3.074
25.00	5.301	2550.00	3.045
50.00	10.65	2575.00	3.017
75.00	17.24	2600.00	2.989
100.00	17.80	2625.00	2.961
125.00	15.68	2650.00	2.934
150.00	14.43	2675.00	2.907
175.00	12.77	2700.00	2.881
200.00	11.71	2725.00	2.855
225.00	11.05	2750.00	2.829
250.00	10.29	2775.00	2.818
275.00	9.674	2800.00	2.810
300.00	9.071	2825.00	2.802
325.00	8.951	2850.00	2.794
350.00	8.718	2875.00	2.785
375.00	8.417	2900.00	2.777
400.00	8.195	2925.00	2.768
425.00	8.251	2950.00	2.760
450.00	8.231	2975.00	2.751
475.00	8.156	3000.00	2.742
500.00	8.080	3025.00	2.732
525.00	7.969	3050.00	2.723
550.00	7.831	3075.00	2.714
575.00	7.674	3100.00	2.704
600.00	7.504	3125.00	2.695
625.00	7.324	3150.00	2.685
650.00	7.140	3175.00	2.675
675.00	6.954	3200.00	2.666
700.00	6.767	3225.00	2.656
725.00	6.582	3250.00	2.646
750.00	6.399	3275.00	2.636
775.00	6.221	3300.00	2.626
800.00	6.046	3325.00	2.616
825.00	5.876	3350.00	2.606
850.00	5.711	3375.00	2.596
875.00	5.618	3400.00	2.586

900.00	5.604	3425.00	2.576
925.00	5.584	3450.00	2.565
950.00	5.558	3475.00	2.555
975.00	5.527	3500.00	2.545
1000.00	5.492	3525.00	2.535
1025.00	5.453	3550.00	2.525
1050.00	5.411	3575.00	2.514
1075.00	5.366	3600.00	2.504
1100.00	5.319	3625.00	2.494
1125.00	5.271	3650.00	2.484
1150.00	5.220	3675.00	2.473
1175.00	5.168	3700.00	2.463
1200.00	5.115	3725.00	2.453
1225.00	5.063	3750.00	2.443
1250.00	5.026	3775.00	2.432
1275.00	4.988	3800.00	2.422
1300.00	4.949	3825.00	2.412
1325.00	4.909	3850.00	2.402
1350.00	4.868	3875.00	2.392
1375.00	4.826	3900.00	2.382
1400.00	4.784	3925.00	2.371
1425.00	4.741	3950.00	2.361
1450.00	4.698	3975.00	2.351
1475.00	4.654	4000.00	2.341
1500.00	4.610	4025.00	2.331
1525.00	4.567	4050.00	2.321
1550.00	4.523	4075.00	2.311
1575.00	4.479	4100.00	2.302
1600.00	4.435	4125.00	2.292
1625.00	4.392	4150.00	2.282
1650.00	4.348	4175.00	2.272
1675.00	4.305	4200.00	2.262
1700.00	4.262	4225.00	2.253
1725.00	4.220	4250.00	2.243
1750.00	4.177	4275.00	2.233
1775.00	4.135	4300.00	2.224
1800.00	4.094	4325.00	2.214
1825.00	4.052	4350.00	2.204
1850.00	4.011	4375.00	2.195
1875.00	3.971	4400.00	2.185
1900.00	3.931	4425.00	2.176
1925.00	3.891	4450.00	2.167
1950.00	3.852	4475.00	2.157
1975.00	3.813	4500.00	2.148
2000.00	3.775	4525.00	2.139
2025.00	3.737	4550.00	2.130
2050.00	3.699	4575.00	2.120
2075.00	3.663	4600.00	2.111
2100.00	3.626	4625.00	2.102
2125.00	3.590	4650.00	2.093
2150.00	3.554	4675.00	2.084
2175.00	3.519	4700.00	2.075
2200.00	3.485	4725.00	2.066
2225.00	3.450	4750.00	2.057
2250.00	3.417	4775.00	2.049
2275.00	3.383	4800.00	2.040
2300.00	3.350	4825.00	2.031
2325.00	3.318	4850.00	2.023
2350.00	3.286	4875.00	2.014
2375.00	3.254	4900.00	2.005
2400.00	3.223	4925.00	1.997
2425.00	3.192	4950.00	1.988
2450.00	3.162	4975.00	1.980

2475.00	3.132	5000.00	1.971
2500.00	3.103		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	17.98	17.98	16.18	10.79	1.798

DISTANCE FROM SOURCE 93.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	2.438	2.438	2.194	1.463	0.2438

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 06/12/13
15:42:36

TITLE: Arrow_Station7_530HP

**************************** STACK PARAMETERS ****************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	738.2 K	869.0 Deg F
PLUME EXIT VELOCITY:	45.478 m/s	149.21 ft/s
STACK AIR FLOW RATE:	3125 ACFM	
RURAL OR URBAN:	RURAL	

INITIAL PROBE DISTANCE = 5000. meters 16404. feet

********************** BUILDING DOWNWASH PARAMETERS **********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************* FLOW SECTOR ANALYSIS *************************
25 meter receptor spacing: 1. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	16.99	100.0	SUM
20	0.00	0.00	0.00	0.00	16.99	100.0	SUM
30	0.00	0.00	0.00	0.00	16.99	100.0	SUM
40	0.00	0.00	0.00	0.00	16.99	100.0	SUM
50	0.00	0.00	0.00	0.00	16.99	100.0	SUM
60	0.00	0.00	0.00	0.00	16.99	100.0	SUM
70	0.00	0.00	0.00	0.00	16.99	100.0	SUM
80	0.00	0.00	0.00	0.00	16.99	100.0	SUM
90	0.00	0.00	0.00	0.00	16.99	100.0	SUM
100	0.00	0.00	0.00	0.00	16.99	100.0	SUM
110	0.00	0.00	0.00	0.00	16.99	100.0	SUM
120	0.00	0.00	0.00	0.00	16.99	100.0	SUM
130	0.00	0.00	0.00	0.00	16.99	100.0	SUM
140	0.00	0.00	0.00	0.00	16.99	100.0	SUM
150	0.00	0.00	0.00	0.00	16.99	100.0	SUM
160	0.00	0.00	0.00	0.00	16.99	100.0	SUM
170	0.00	0.00	0.00	0.00	16.99	100.0	SUM
180	0.00	0.00	0.00	0.00	16.99	100.0	SUM

190	0.00	0.00	0.00	0.00	16.99	100.0	SUM
200	0.00	0.00	0.00	0.00	16.99	100.0	SUM
210	0.00	0.00	0.00	0.00	16.99	100.0	SUM
220	0.00	0.00	0.00	0.00	16.99	100.0	SUM
230	0.00	0.00	0.00	0.00	16.99	100.0	SUM
240	0.00	0.00	0.00	0.00	16.99	100.0	SUM
250	0.00	0.00	0.00	0.00	16.99	100.0	SUM
260	0.00	0.00	0.00	0.00	16.99	100.0	SUM
270	0.00	0.00	0.00	0.00	16.99	100.0	SUM
280	0.00	0.00	0.00	0.00	16.99	100.0	SUM
290	0.00	0.00	0.00	0.00	16.99	100.0	SUM
300	0.00	0.00	0.00	0.00	16.99	100.0	SUM
310	0.00	0.00	0.00	0.00	16.99	100.0	SUM
320	0.00	0.00	0.00	0.00	16.99	100.0	SUM
330	0.00	0.00	0.00	0.00	16.99	100.0	SUM
340	0.00	0.00	0.00	0.00	16.99	100.0	SUM
350	0.00	0.00	0.00	0.00	16.99	100.0	SUM
360	0.00	0.00	0.00	0.00	16.99	100.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS *********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 15.4 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	06	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
5.75	0.032	0.100	0.020	12.	13.	-1.0	0.001	1.50	0.60	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 98.4 meters

********************** AERSCREEN AUTOMATED DISTANCES **********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
1.00	0.1829	2525.00	2.824
25.00	4.140	2550.00	2.800
50.00	9.681	2575.00	2.777
75.00	16.71	2600.00	2.753
100.00	16.99	2625.00	2.730
125.00	15.23	2650.00	2.707
150.00	13.87	2675.00	2.685
175.00	12.31	2700.00	2.663
200.00	10.97	2725.00	2.640
225.00	10.26	2750.00	2.619
250.00	9.724	2775.00	2.597
275.00	9.173	2800.00	2.576
300.00	8.695	2825.00	2.555
325.00	8.243	2850.00	2.534
350.00	7.765	2875.00	2.514
375.00	7.401	2900.00	2.493
400.00	7.191	2925.00	2.473
425.00	6.946	2950.00	2.453
450.00	6.745	2975.00	2.434
475.00	6.809	3000.00	2.414
500.00	6.825	3025.00	2.395
525.00	6.801	3050.00	2.376
550.00	6.746	3075.00	2.358
575.00	6.666	3100.00	2.339
600.00	6.568	3125.00	2.321
625.00	6.456	3150.00	2.303
650.00	6.334	3175.00	2.293
675.00	6.204	3200.00	2.288
700.00	6.070	3225.00	2.282
725.00	5.932	3250.00	2.276
750.00	5.794	3275.00	2.271
775.00	5.655	3300.00	2.265
800.00	5.518	3325.00	2.259
825.00	5.382	3350.00	2.253
850.00	5.248	3375.00	2.247
875.00	5.117	3400.00	2.241

900.00	4.990	3425.00	2.235
925.00	4.865	3450.00	2.228
950.00	4.743	3475.00	2.222
975.00	4.625	3500.00	2.215
1000.00	4.511	3525.00	2.209
1025.00	4.438	3550.00	2.202
1050.00	4.386	3575.00	2.196
1075.00	4.341	3600.00	2.189
1100.00	4.325	3625.00	2.182
1125.00	4.306	3650.00	2.176
1150.00	4.284	3675.00	2.169
1175.00	4.261	3700.00	2.162
1200.00	4.250	3725.00	2.155
1225.00	4.236	3750.00	2.148
1250.00	4.220	3775.00	2.141
1275.00	4.202	3800.00	2.134
1300.00	4.183	3825.00	2.127
1325.00	4.162	3850.00	2.120
1350.00	4.140	3875.00	2.113
1375.00	4.117	3900.00	2.106
1400.00	4.092	3925.00	2.099
1425.00	4.067	3950.00	2.092
1450.00	4.041	3975.00	2.085
1475.00	4.014	4000.00	2.078
1500.00	3.986	4025.00	2.071
1525.00	3.958	4050.00	2.063
1550.00	3.929	4075.00	2.056
1575.00	3.900	4100.00	2.049
1600.00	3.870	4125.00	2.042
1625.00	3.841	4150.00	2.035
1650.00	3.811	4175.00	2.028
1675.00	3.780	4200.00	2.020
1700.00	3.750	4225.00	2.013
1725.00	3.720	4250.00	2.006
1750.00	3.689	4275.00	1.999
1775.00	3.659	4300.00	1.992
1800.00	3.628	4325.00	1.985
1825.00	3.598	4350.00	1.977
1850.00	3.567	4375.00	1.970
1875.00	3.537	4400.00	1.963
1900.00	3.507	4425.00	1.956
1925.00	3.477	4450.00	1.949
1950.00	3.447	4475.00	1.942
1975.00	3.417	4500.00	1.935
2000.00	3.388	4525.00	1.928
2025.00	3.359	4550.00	1.921
2050.00	3.330	4575.00	1.914
2075.00	3.301	4600.00	1.907
2100.00	3.272	4625.00	1.900
2125.00	3.244	4650.00	1.893
2150.00	3.215	4675.00	1.886
2175.00	3.187	4700.00	1.879
2200.00	3.160	4725.00	1.872
2225.00	3.132	4750.00	1.865
2250.00	3.105	4775.00	1.858
2275.00	3.078	4800.00	1.851
2300.00	3.052	4825.00	1.844
2325.00	3.025	4850.00	1.837
2350.00	2.999	4875.00	1.831
2375.00	2.973	4900.00	1.824
2400.00	2.948	4925.00	1.817
2425.00	2.923	4950.00	1.810
2450.00	2.898	4975.00	1.804

2475.00	2.873	5000.00	1.797
2500.00	2.848		

********************** AERSCREEN MAXIMUM IMPACT SUMMARY *********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	17.06	17.06	15.35	10.23	1.706

DISTANCE FROM SOURCE 95.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.1829	0.1829	0.1646	0.1097	0.1829E-01

DISTANCE FROM SOURCE 1.00 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 06/12/13
15:49:42

TITLE: Arrow_Station7_740HP

****************************** STACK PARAMETERS ******************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	9.75 meters	32.00 feet
STACK INNER DIAMETER:	0.254 meters	10.00 inches
PLUME EXIT TEMPERATURE:	922.0 K	1200.0 Deg F
PLUME EXIT VELOCITY:	38.094 m/s	124.98 ft/s
STACK AIR FLOW RATE:	4090 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

*********************** BUILDING DOWNWASH PARAMETERS ***********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************** FLOW SECTOR ANALYSIS ***************************
25 meter receptor spacing: 1. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	9.367	100.0	SUM
20	0.00	0.00	0.00	0.00	9.367	100.0	SUM
30	0.00	0.00	0.00	0.00	9.367	100.0	SUM
40	0.00	0.00	0.00	0.00	9.367	100.0	SUM
50	0.00	0.00	0.00	0.00	9.367	100.0	SUM
60	0.00	0.00	0.00	0.00	9.367	100.0	SUM
70	0.00	0.00	0.00	0.00	9.367	100.0	SUM
80	0.00	0.00	0.00	0.00	9.367	100.0	SUM
90	0.00	0.00	0.00	0.00	9.367	100.0	SUM
100	0.00	0.00	0.00	0.00	9.367	100.0	SUM
110	0.00	0.00	0.00	0.00	9.367	100.0	SUM
120	0.00	0.00	0.00	0.00	9.367	100.0	SUM
130	0.00	0.00	0.00	0.00	9.367	100.0	SUM
140	0.00	0.00	0.00	0.00	9.367	100.0	SUM
150	0.00	0.00	0.00	0.00	9.367	100.0	SUM
160	0.00	0.00	0.00	0.00	9.367	100.0	SUM
170	0.00	0.00	0.00	0.00	9.367	100.0	SUM
180	0.00	0.00	0.00	0.00	9.367	100.0	SUM

190	0.00	0.00	0.00	0.00	9.367	100.0	SUM
200	0.00	0.00	0.00	0.00	9.367	100.0	SUM
210	0.00	0.00	0.00	0.00	9.367	100.0	SUM
220	0.00	0.00	0.00	0.00	9.367	100.0	SUM
230	0.00	0.00	0.00	0.00	9.367	100.0	SUM
240	0.00	0.00	0.00	0.00	9.367	100.0	SUM
250	0.00	0.00	0.00	0.00	9.367	100.0	SUM
260	0.00	0.00	0.00	0.00	9.367	100.0	SUM
270	0.00	0.00	0.00	0.00	9.367	100.0	SUM
280	0.00	0.00	0.00	0.00	9.367	100.0	SUM
290	0.00	0.00	0.00	0.00	9.367	100.0	SUM
300	0.00	0.00	0.00	0.00	9.367	100.0	SUM
310	0.00	0.00	0.00	0.00	9.367	100.0	SUM
320	0.00	0.00	0.00	0.00	9.367	100.0	SUM
330	0.00	0.00	0.00	0.00	9.367	100.0	SUM
340	0.00	0.00	0.00	0.00	9.367	100.0	SUM
350	0.00	0.00	0.00	0.00	9.367	100.0	SUM
360	0.00	0.00	0.00	0.00	9.367	100.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS *********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	06	06	6	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-46.70	0.861	-9.000	0.020	-999.	1839.	1307.1	0.100	0.80	0.18	10.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 16.5 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	06	6	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
5.75	0.032	0.100	0.020	12.	13.	-1.0	0.001	1.50	0.60	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 129.0 meters

*********************** AERSCREEN AUTOMATED DISTANCES *********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
1.00	0.1166	2525.00	2.089
25.00	1.751	2550.00	2.074
50.00	3.924	2575.00	2.060
75.00	6.359	2600.00	2.045
100.00	9.367	2625.00	2.031
125.00	9.340	2650.00	2.017
150.00	9.162	2675.00	2.003
175.00	8.383	2700.00	1.990
200.00	7.747	2725.00	1.976
225.00	7.217	2750.00	1.963
250.00	6.610	2775.00	1.950
275.00	6.113	2800.00	1.937
300.00	5.747	2825.00	1.925
325.00	5.519	2850.00	1.912
350.00	5.327	2875.00	1.900
375.00	5.141	2900.00	1.888
400.00	4.921	2925.00	1.876
425.00	4.686	2950.00	1.864
450.00	4.485	2975.00	1.853
475.00	4.461	3000.00	1.841
500.00	4.421	3025.00	1.830
525.00	4.365	3050.00	1.819
550.00	4.300	3075.00	1.808
575.00	4.235	3100.00	1.797
600.00	4.207	3125.00	1.786
625.00	4.208	3150.00	1.776
650.00	4.196	3175.00	1.765
675.00	4.179	3200.00	1.755
700.00	4.157	3225.00	1.745
725.00	4.130	3250.00	1.735
750.00	4.101	3275.00	1.725
775.00	4.068	3300.00	1.715
800.00	4.034	3325.00	1.705
825.00	3.997	3350.00	1.696
850.00	3.959	3375.00	1.686
875.00	3.920	3400.00	1.677

900.00	3.880	3425.00	1.667
925.00	3.839	3450.00	1.658
950.00	3.798	3475.00	1.649
975.00	3.756	3500.00	1.640
1000.00	3.715	3525.00	1.632
1025.00	3.674	3550.00	1.623
1050.00	3.633	3575.00	1.614
1075.00	3.592	3600.00	1.606
1100.00	3.551	3625.00	1.597
1125.00	3.511	3650.00	1.589
1150.00	3.471	3675.00	1.581
1175.00	3.432	3700.00	1.572
1200.00	3.394	3725.00	1.564
1225.00	3.356	3750.00	1.556
1250.00	3.318	3775.00	1.549
1275.00	3.281	3800.00	1.541
1300.00	3.245	3825.00	1.534
1325.00	3.209	3850.00	1.527
1350.00	3.174	3875.00	1.521
1375.00	3.140	3900.00	1.515
1400.00	3.106	3925.00	1.509
1425.00	3.073	3950.00	1.503
1450.00	3.041	3975.00	1.497
1475.00	3.009	4000.00	1.490
1500.00	2.977	4025.00	1.484
1525.00	2.947	4050.00	1.478
1550.00	2.917	4075.00	1.472
1575.00	2.887	4100.00	1.467
1600.00	2.858	4125.00	1.461
1625.00	2.830	4150.00	1.455
1650.00	2.802	4175.00	1.449
1675.00	2.775	4200.00	1.443
1700.00	2.748	4225.00	1.437
1725.00	2.721	4250.00	1.432
1750.00	2.696	4275.00	1.426
1775.00	2.670	4300.00	1.420
1800.00	2.646	4325.00	1.415
1825.00	2.621	4350.00	1.409
1850.00	2.597	4375.00	1.404
1875.00	2.574	4400.00	1.398
1900.00	2.551	4425.00	1.393
1925.00	2.528	4450.00	1.387
1950.00	2.506	4475.00	1.382
1975.00	2.484	4500.00	1.377
2000.00	2.463	4525.00	1.371
2025.00	2.442	4550.00	1.366
2050.00	2.421	4575.00	1.361
2075.00	2.401	4600.00	1.356
2100.00	2.381	4625.00	1.350
2125.00	2.361	4650.00	1.345
2150.00	2.342	4675.00	1.340
2175.00	2.323	4700.00	1.335
2200.00	2.305	4725.00	1.330
2225.00	2.286	4750.00	1.325
2250.00	2.268	4775.00	1.320
2275.00	2.251	4800.00	1.315
2300.00	2.233	4825.00	1.310
2325.00	2.216	4850.00	1.305
2350.00	2.199	4875.00	1.300
2375.00	2.183	4900.00	1.295
2400.00	2.167	4925.00	1.291
2425.00	2.151	4950.00	1.286
2450.00	2.135	4975.00	1.281

2475.00	2.119	5000.00	1.276
2500.00	2.104		

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********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************
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CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	9.463	9.463	8.516	5.678	0.9463

DISTANCE FROM SOURCE 107.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.1166	0.1166	0.1049	0.6996E-01	0.1166E-01

DISTANCE FROM SOURCE 1.00 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 06/12/13
15:58:53

TITLE: Arrow_Station7_1480HP

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----------------------------------------------------------------------------
****************************  STACK PARAMETERS  ***************************
----------------------------------------------------------------------------

SOURCE EMISSION RATE:           0.1260 g/s            1.000 lb/hr
STACK HEIGHT:                     9.65 meters         31.67 feet
STACK INNER DIAMETER:            0.305 meters         12.00 inches
PLUME EXIT TEMPERATURE:          959.8 K             1268.0 Deg F
PLUME EXIT VELOCITY:            45.638 m/s           149.73 ft/s
STACK AIR FLOW RATE:              7056 ACFM
RURAL OR URBAN:                  RURAL

INITIAL PROBE DISTANCE =         5000. meters        16404. feet


----------------------------------------------------------------------------
**********************  BUILDING DOWNWASH PARAMETERS  *********************
----------------------------------------------------------------------------

BUILDING HEIGHT:                   6.1 meters          20.0 feet
MAX BUILDING DIMENSION:            8.5 meters          28.0 feet
MIN BUILDING DIMENSION:            4.7 meters          15.5 feet
BUILDING ORIENTATION TO NORTH:      0. degrees
STACK DIRECTION FROM CENTER:       90. degrees
STACK DISTANCE FROM CENTER:       45.0 meters         147.6 feet


----------------------------------------------------------------------------
*************************  FLOW SECTOR ANALYSIS  **************************
          25 meter receptor spacing: 1. meters - 5000. meters
----------------------------------------------------------------------------
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FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	8.145	125.0	SUM
20	0.00	0.00	0.00	0.00	8.145	125.0	SUM
30	0.00	0.00	0.00	0.00	8.145	125.0	SUM
40	0.00	0.00	0.00	0.00	8.145	125.0	SUM
50	0.00	0.00	0.00	0.00	8.145	125.0	SUM
60	0.00	0.00	0.00	0.00	8.145	125.0	SUM
70	0.00	0.00	0.00	0.00	8.145	125.0	SUM
80	0.00	0.00	0.00	0.00	8.145	125.0	SUM
90	0.00	0.00	0.00	0.00	8.145	125.0	SUM
100	0.00	0.00	0.00	0.00	8.145	125.0	SUM
110	0.00	0.00	0.00	0.00	8.145	125.0	SUM
120	0.00	0.00	0.00	0.00	8.145	125.0	SUM
130	0.00	0.00	0.00	0.00	8.145	125.0	SUM
140	0.00	0.00	0.00	0.00	8.145	125.0	SUM
150	0.00	0.00	0.00	0.00	8.145	125.0	SUM
160	0.00	0.00	0.00	0.00	8.145	125.0	SUM
170	0.00	0.00	0.00	0.00	8.145	125.0	SUM
180	0.00	0.00	0.00	0.00	8.145	125.0	SUM

190	0.00	0.00	0.00	0.00	8.145	125.0	SUM
200	0.00	0.00	0.00	0.00	8.145	125.0	SUM
210	0.00	0.00	0.00	0.00	8.145	125.0	SUM
220	0.00	0.00	0.00	0.00	8.145	125.0	SUM
230	0.00	0.00	0.00	0.00	8.145	125.0	SUM
240	0.00	0.00	0.00	0.00	8.145	125.0	SUM
250	0.00	0.00	0.00	0.00	8.145	125.0	SUM
260	0.00	0.00	0.00	0.00	8.145	125.0	SUM
270	0.00	0.00	0.00	0.00	8.145	125.0	SUM
280	0.00	0.00	0.00	0.00	8.145	125.0	SUM
290	0.00	0.00	0.00	0.00	8.145	125.0	SUM
300	0.00	0.00	0.00	0.00	8.145	125.0	SUM
310	0.00	0.00	0.00	0.00	8.145	125.0	SUM
320	0.00	0.00	0.00	0.00	8.145	125.0	SUM
330	0.00	0.00	0.00	0.00	8.145	125.0	SUM
340	0.00	0.00	0.00	0.00	8.145	125.0	SUM
350	0.00	0.00	0.00	0.00	8.145	125.0	SUM
360	0.00	0.00	0.00	0.00	8.145	125.0	SUM

* = worst case flow sector

********************** MAKEMET METEOROLOGY PARAMETERS *********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	06	06	6	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-46.70	0.861	-9.000	0.020	-999.	1839.	1307.1	0.100	0.80	0.18	10.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 19.8 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	06	6	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
5.75	0.032	0.100	0.020	12.	13.	-1.0	0.001	1.50	0.60	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 191.3 meters

********************** AERSCREEN AUTOMATED DISTANCES *********************

OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
1.00	0.1418	2525.00	1.708
25.00	1.340	2550.00	1.697
50.00	2.857	2575.00	1.686
75.00	5.997	2600.00	1.675
100.00	7.865	2625.00	1.664
125.00	8.145	2650.00	1.653
150.00	7.390	2675.00	1.642
175.00	6.977	2700.00	1.632
200.00	6.478	2725.00	1.621
225.00	5.873	2750.00	1.611
250.00	5.568	2775.00	1.601
275.00	5.301	2800.00	1.591
300.00	5.002	2825.00	1.581
325.00	4.678	2850.00	1.572
350.00	4.355	2875.00	1.562
375.00	4.044	2900.00	1.553
400.00	3.902	2925.00	1.543
425.00	3.807	2950.00	1.534
450.00	3.688	2975.00	1.525
475.00	3.555	3000.00	1.516
500.00	3.414	3025.00	1.507
525.00	3.270	3050.00	1.498
550.00	3.169	3075.00	1.490
575.00	3.149	3100.00	1.481
600.00	3.128	3125.00	1.473
625.00	3.101	3150.00	1.465
650.00	3.070	3175.00	1.456
675.00	3.072	3200.00	1.448
700.00	3.084	3225.00	1.440
725.00	3.091	3250.00	1.432
750.00	3.092	3275.00	1.424
775.00	3.089	3300.00	1.417
800.00	3.081	3325.00	1.409
825.00	3.071	3350.00	1.401
850.00	3.057	3375.00	1.394
875.00	3.041	3400.00	1.386

900.00	3.022	3425.00	1.379
925.00	3.001	3450.00	1.372
950.00	2.977	3475.00	1.365
975.00	2.951	3500.00	1.358
1000.00	2.924	3525.00	1.351
1025.00	2.897	3550.00	1.344
1050.00	2.870	3575.00	1.337
1075.00	2.842	3600.00	1.330
1100.00	2.814	3625.00	1.323
1125.00	2.786	3650.00	1.317
1150.00	2.758	3675.00	1.310
1175.00	2.730	3700.00	1.304
1200.00	2.703	3725.00	1.297
1225.00	2.675	3750.00	1.291
1250.00	2.648	3775.00	1.285
1275.00	2.621	3800.00	1.278
1300.00	2.594	3825.00	1.272
1325.00	2.568	3850.00	1.266
1350.00	2.541	3875.00	1.260
1375.00	2.516	3900.00	1.254
1400.00	2.490	3925.00	1.248
1425.00	2.465	3950.00	1.242
1450.00	2.440	3975.00	1.237
1475.00	2.416	4000.00	1.231
1500.00	2.392	4025.00	1.225
1525.00	2.368	4050.00	1.219
1550.00	2.345	4075.00	1.214
1575.00	2.322	4100.00	1.208
1600.00	2.300	4125.00	1.203
1625.00	2.277	4150.00	1.197
1650.00	2.256	4175.00	1.192
1675.00	2.234	4200.00	1.187
1700.00	2.213	4225.00	1.182
1725.00	2.192	4250.00	1.176
1750.00	2.172	4275.00	1.171
1775.00	2.152	4300.00	1.166
1800.00	2.132	4325.00	1.161
1825.00	2.113	4350.00	1.156
1850.00	2.094	4375.00	1.151
1875.00	2.076	4400.00	1.146
1900.00	2.057	4425.00	1.141
1925.00	2.039	4450.00	1.136
1950.00	2.021	4475.00	1.132
1975.00	2.006	4500.00	1.127
2000.00	1.990	4525.00	1.122
2025.00	1.974	4550.00	1.117
2050.00	1.959	4575.00	1.113
2075.00	1.944	4600.00	1.108
2100.00	1.929	4625.00	1.104
2125.00	1.915	4650.00	1.099
2150.00	1.900	4675.00	1.095
2175.00	1.886	4700.00	1.090
2200.00	1.872	4725.00	1.086
2225.00	1.858	4750.00	1.081
2250.00	1.845	4775.00	1.077
2275.00	1.832	4800.00	1.073
2300.00	1.818	4825.00	1.069
2325.00	1.805	4850.00	1.064
2350.00	1.793	4875.00	1.060
2375.00	1.780	4900.00	1.056
2400.00	1.768	4925.00	1.052
2425.00	1.755	4950.00	1.048
2450.00	1.743	4975.00	1.044

2475.00	1.731	5000.00	1.040
2500.00	1.720		

********************** AERSCREEN MAXIMUM IMPACT SUMMARY *********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	8.230	8.230	7.407	4.938	0.8230

DISTANCE FROM SOURCE 116.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.1418	0.1418	0.1276	0.8508E-01	0.1418E-01

DISTANCE FROM SOURCE 1.00 meters directed toward 10 degrees

Appendix E
Original Submittal Modeling

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.1 - Normalized Emissions

Type	Engine	Power (HP)	1-hr Concentration (ug/m^3)	3-hr Concentration (ug/m3)	8-hr Concentration (ug/m3)	24-hr Concentration (ug/m3)	Annual Concentration (ug/m^3)
1,480-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	L7042GSI	1480	7.4	7.4	6.7	4.4	0.7
740-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	L3514GSI	740	8.5	8.5	7.7	5.1	0.9
530-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	H24GL	530	15.4	15.4	13.8	9.2	1.5
435-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	H24GSI	435	16.2	16.2	14.6	9.7	1.6
400-bhp Natural Gas-Fired 4-Stroke Lean-Burn Engine	F18GL	400	17.5	17.5	15.7	10.5	1.7
326-bhp Natural Gas-Fired 4-Stroke Rich-Burn Engine	F18GSI	326	17.9	17.9	16.1	10.7	1.8

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.2 - NO2 Emissions

Engine	Quantity	Power (HP)	NO_x Emission Rate [1] (lb/hr)	Highest 1-hr NO_2 Concentration [2] (ug/m^3)	Highest Annual NO_2 Concentration [2] (ug/m^3)	Highest 1-hr NO_2 Concentration [3] (ppb)	Highest Annual NO_2 Concentration [3] (ppb)
L7042GSI	3	1,480	2.12	47.1	4.7	25.0	2.5
L3514GSI	1	740	1.27	10.8	1.1	5.7	0.6
H24GL	1	530	2.34	35.9	3.6	19.0	1.9
H24GSI	1	435	0.77	12.5	1.2	6.6	0.7
F18GL	1	400	1.76	30.8	3.1	16.3	1.6
F18GSI	1	326	0.57	10.2	1.0	5.4	0.5
			Station Total	**147.3**	**14.7**	**78.0**	**7.8**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

[3] Calculated by multiplying the concentration provided in ug/m^3 by 0.53 to convert to ppb

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.3 - CO Emissions

Engine	Quantity	Power (HP)	CO Emission Rate [1] (lb/hr)	Highest CO 1-hr Concentration [2] (ug/m^3)	Highest CO 1-hr Concentration [2] (ug/m^3)	Highest CO 1-hr Concentration [3] (ppm)	Highest CO 8-hr Concentration [3] (ppm)
L7042GSI	3	1480	2.94	65.3	58.8	0.057	0.051
L3514GSI	1	740	2.02	17.2	15.5	0.015	0.013
H24GL	1	530	1.52	23.3	21.0	0.020	0.018
H24GSI	1	435	0.77	12.5	11.2	0.011	0.010
F18GL	1	400	1.15	20.1	18.1	0.017	0.016
F18GSI	1	326	0.57	10.2	9.2	0.009	0.008
			Station Total	**148.6**	**133.8**	**0.1**	**0.1**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

[3] Calculated by multiplying the concentration provided in ug/m^3 by $8.7*10^{-3}$ to convert to ppm

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.4 - PM10 Emissions

Engine	Quantity	Power (HP)	PM_{10} Emission Rate [1] (lb/hr)	Highest $PM_{2.5}$ 24-hr Concentration [2] (ug/m^3)
L7042GSI	3	1480	0.14	1.9
L3514GSI	1	740	0.06	0.3
H24GL	1	530	0.00	0.0
H24GSI	1	435	0.04	0.4
F18GL	1	400	0.00	0.0
F18GSI	1	326	0.03	0.3
			Station Total	**2.9**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.5 - PM2.5 Emissions

Engine	Quantity	Power (HP)	$PM_{2.5}$ Emission Rate [1] (lb/hr)	Highest $PM_{2.5}$ 24-hr Concentration [2] (ug/m^3)	Highest $PM_{2.5}$ Annual Concentration [2] (ug/m^3)
L7042GSI	3	1480	0.14	1.9	0.1
L3514GSI	1	740	0.06	0.3	0.1
H24GL	1	530	0.00	0.0	0.0
H24GSI	1	435	0.04	0.4	0.1
F18GL	1	400	0.00	0.0	0.0
F18GSI	1	326	0.03	0.3	0.1
			Station Total	**2.9**	**0.3**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

Arrow Pipeline, LLC
Fort Berthold Pipeline Compressor Station #7
Representative Maximum Design AERSCREEN Results Summary

Table E.6 - SO2 Emissions

Engine	Quantity	Power (HP)	SO_2 Emission Rate [1] (lb/hr)	Highest SO_2 1-hr Concentration [2] (ug/m^3)	Highest SO_2 3-hr Concentration [2] (ug/m^3)	Highest SO_2 1-hr Concentration [3] (ppb)	Highest SO_2 3-hr Concentration [3] (ppb)
L7042GSI	3	1480	0.83	18.4	18.4	7.0	7.0
L3514GSI	1	740	0.38	3.2	3.2	1.2	1.2
H24GL	1	530	0.26	4.0	4.0	1.5	1.5
H24GSI	1	435	0.24	3.9	3.9	1.5	1.5
F18GL	1	400	0.18	3.1	3.1	1.2	1.2
F18GSI	1	326	0.18	3.2	3.2	1.2	1.2
			Station Total	**35.9**	**35.9**	**13.6**	**13.6**

[1] From Controlled Potential Emissions, Table 12 - PTE Summary, Appendix B

[2] Calculated from EPA AERSCREEN (see attached)

[3] Calculated by multiplying the concentration provided in ug/m^3 by 0.38 to convert to ppb

AERSCREEN 11126 / AERMOD 1206 04/23/13
19:51:16

TITLE: Arrow_Station7_326hp

STACK PARAMETERS

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	925.9 K	1207.0 Deg F
PLUME EXIT VELOCITY:	26.137 m/s	85.75 ft/s
STACK AIR FLOW RATE:	1796 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.05000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

BUILDING DOWNWASH PARAMETERS

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

FLOW SECTOR ANALYSIS
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	17.36	100.0	SUM
20	0.00	0.00	0.00	0.00	17.36	100.0	SUM
30	0.00	0.00	0.00	0.00	17.36	100.0	SUM
40	0.00	0.00	0.00	0.00	17.36	100.0	SUM
50	0.00	0.00	0.00	0.00	17.36	100.0	SUM
60	0.00	0.00	0.00	0.00	17.36	100.0	SUM
70	0.00	0.00	0.00	0.00	17.36	100.0	SUM
80	0.00	0.00	0.00	0.00	17.36	100.0	SUM
90	0.00	0.00	0.00	0.00	17.36	100.0	SUM
100	0.00	0.00	0.00	0.00	17.36	100.0	SUM
110	0.00	0.00	0.00	0.00	17.36	100.0	SUM
120	0.00	0.00	0.00	0.00	17.36	100.0	SUM
130	0.00	0.00	0.00	0.00	17.36	100.0	SUM

140	0.00	0.00	0.00	0.00	17.36	100.0	SUM
150	0.00	0.00	0.00	0.00	17.36	100.0	SUM
160	0.00	0.00	0.00	0.00	17.36	100.0	SUM
170	0.00	0.00	0.00	0.00	17.36	100.0	SUM
180	0.00	0.00	0.00	0.00	17.36	100.0	SUM
190	0.00	0.00	0.00	0.00	17.36	100.0	SUM
200	0.00	0.00	0.00	0.00	17.36	100.0	SUM
210	0.00	0.00	0.00	0.00	17.36	100.0	SUM
220	0.00	0.00	0.00	0.00	17.36	100.0	SUM
230	0.00	0.00	0.00	0.00	17.36	100.0	SUM
240	0.00	0.00	0.00	0.00	17.36	100.0	SUM
250	0.00	0.00	0.00	0.00	17.36	100.0	SUM
260	0.00	0.00	0.00	0.00	17.36	100.0	SUM
270	0.00	0.00	0.00	0.00	17.36	100.0	SUM
280	0.00	0.00	0.00	0.00	17.36	100.0	SUM
290	0.00	0.00	0.00	0.00	17.36	100.0	SUM
300	0.00	0.00	0.00	0.00	17.36	100.0	SUM
310	0.00	0.00	0.00	0.00	17.36	100.0	SUM
320	0.00	0.00	0.00	0.00	17.36	100.0	SUM
330	0.00	0.00	0.00	0.00	17.36	100.0	SUM
340	0.00	0.00	0.00	0.00	17.36	100.0	SUM
350	0.00	0.00	0.00	0.00	17.36	100.0	SUM
360	0.00	0.00	0.00	0.00	17.36	100.0	SUM

* = worst case flow sector

********************** MAKEMET METEOROLOGY PARAMETERS *********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 13.0 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	19	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
58.70	0.087	0.600	0.020	133.	59.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 77.4 meters

*********************** AERSCREEN AUTOMATED DISTANCES *********************

OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	3.016	2525.00	3.320
25.00	6.564	2550.00	3.305
50.00	12.31	2575.00	3.290
75.00	17.05	2600.00	3.275
100.00	17.36	2625.00	3.259
125.00	15.60	2650.00	3.244
150.00	14.25	2675.00	3.229
175.00	12.62	2700.00	3.213
200.00	11.87	2725.00	3.197
225.00	10.98	2750.00	3.182
250.00	10.60	2775.00	3.166
275.00	10.53	2800.00	3.150
300.00	10.24	2825.00	3.135
325.00	9.839	2850.00	3.119
350.00	9.673	2875.00	3.103
375.00	9.727	2900.00	3.087
400.00	9.665	2925.00	3.071
425.00	9.571	2950.00	3.056
450.00	9.424	2975.00	3.040
475.00	9.231	3000.00	3.024
500.00	9.007	3025.00	3.008
525.00	8.762	3050.00	2.992
550.00	8.506	3075.00	2.977
575.00	8.245	3100.00	2.961
600.00	7.983	3125.00	2.945
625.00	7.723	3150.00	2.930
650.00	7.468	3175.00	2.914
675.00	7.219	3200.00	2.899
700.00	7.194	3225.00	2.883
725.00	7.176	3250.00	2.868
750.00	7.144	3275.00	2.852

775.00	7.100	3300.00	2.837
800.00	7.047	3325.00	2.822
825.00	6.985	3350.00	2.807
850.00	6.917	3375.00	2.792
875.00	6.843	3400.00	2.777
900.00	6.765	3425.00	2.762
925.00	6.683	3450.00	2.747
950.00	6.598	3475.00	2.732
975.00	6.511	3500.00	2.717
1000.00	6.428	3525.00	2.703
1025.00	6.367	3550.00	2.688
1050.00	6.303	3575.00	2.674
1075.00	6.237	3600.00	2.659
1100.00	6.169	3625.00	2.645
1125.00	6.101	3650.00	2.631
1150.00	6.031	3675.00	2.616
1175.00	5.960	3700.00	2.602
1200.00	5.889	3725.00	2.588
1225.00	5.818	3750.00	2.574
1250.00	5.746	3775.00	2.561
1275.00	5.675	3800.00	2.547
1300.00	5.604	3825.00	2.533
1325.00	5.533	3850.00	2.520
1350.00	5.463	3875.00	2.506
1375.00	5.393	3900.00	2.493
1400.00	5.324	3925.00	2.479
1425.00	5.256	3950.00	2.466
1450.00	5.188	3975.00	2.453
1475.00	5.122	4000.00	2.440
1500.00	5.056	4025.00	2.428
1525.00	4.991	4050.00	2.417
1550.00	4.926	4075.00	2.405
1575.00	4.863	4100.00	2.394
1600.00	4.801	4125.00	2.383
1625.00	4.739	4150.00	2.372
1650.00	4.679	4175.00	2.361
1675.00	4.619	4200.00	2.350
1700.00	4.561	4225.00	2.339
1725.00	4.503	4250.00	2.331
1750.00	4.446	4275.00	2.324
1775.00	4.391	4300.00	2.317
1800.00	4.336	4325.00	2.310
1825.00	4.282	4350.00	2.303
1850.00	4.229	4375.00	2.295
1875.00	4.177	4400.00	2.288
1900.00	4.126	4425.00	2.281
1925.00	4.076	4450.00	2.274
1950.00	4.026	4475.00	2.266
1975.00	3.978	4500.00	2.259
2000.00	3.930	4525.00	2.252
2025.00	3.883	4550.00	2.245
2050.00	3.837	4575.00	2.237
2075.00	3.792	4600.00	2.230
2100.00	3.748	4625.00	2.223
2125.00	3.704	4650.00	2.216
2150.00	3.661	4675.00	2.208
2175.00	3.619	4700.00	2.201
2200.00	3.578	4725.00	2.194
2225.00	3.541	4750.00	2.187
2250.00	3.522	4775.00	2.180
2275.00	3.503	4800.00	2.172
2300.00	3.484	4825.00	2.165
2325.00	3.465	4850.00	2.158

AERSCREEN 11126 / AERMOD 1206 04/17/13
14:17:29

TITLE: Arrow_Station7_1480HP

**************************** STACK PARAMETERS ****************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	9.65 meters	31.67 feet
STACK INNER DIAMETER:	0.305 meters	12.00 inches
PLUME EXIT TEMPERATURE:	959.8 K	1268.0 Deg F
PLUME EXIT VELOCITY:	45.638 m/s	149.73 ft/s
STACK AIR FLOW RATE:	7056 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.05000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

********************** BUILDING DOWNWASH PARAMETERS **********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************ FLOW SECTOR ANALYSIS ************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	7.331	125.0	SUM
20	0.00	0.00	0.00	0.00	7.331	125.0	SUM
30	0.00	0.00	0.00	0.00	7.331	125.0	SUM
40	0.00	0.00	0.00	0.00	7.331	125.0	SUM
50	0.00	0.00	0.00	0.00	7.331	125.0	SUM
60	0.00	0.00	0.00	0.00	7.331	125.0	SUM
70	0.00	0.00	0.00	0.00	7.331	125.0	SUM
80	0.00	0.00	0.00	0.00	7.331	125.0	SUM
90	0.00	0.00	0.00	0.00	7.331	125.0	SUM
100	0.00	0.00	0.00	0.00	7.331	125.0	SUM
110	0.00	0.00	0.00	0.00	7.331	125.0	SUM
120	0.00	0.00	0.00	0.00	7.331	125.0	SUM
130	0.00	0.00	0.00	0.00	7.331	125.0	SUM

140	0.00	0.00	0.00	0.00	7.331	125.0	SUM
150	0.00	0.00	0.00	0.00	7.331	125.0	SUM
160	0.00	0.00	0.00	0.00	7.331	125.0	SUM
170	0.00	0.00	0.00	0.00	7.331	125.0	SUM
180	0.00	0.00	0.00	0.00	7.331	125.0	SUM
190	0.00	0.00	0.00	0.00	7.331	125.0	SUM
200	0.00	0.00	0.00	0.00	7.331	125.0	SUM
210	0.00	0.00	0.00	0.00	7.331	125.0	SUM
220	0.00	0.00	0.00	0.00	7.331	125.0	SUM
230	0.00	0.00	0.00	0.00	7.331	125.0	SUM
240	0.00	0.00	0.00	0.00	7.331	125.0	SUM
250	0.00	0.00	0.00	0.00	7.331	125.0	SUM
260	0.00	0.00	0.00	0.00	7.331	125.0	SUM
270	0.00	0.00	0.00	0.00	7.331	125.0	SUM
280	0.00	0.00	0.00	0.00	7.331	125.0	SUM
290	0.00	0.00	0.00	0.00	7.331	125.0	SUM
300	0.00	0.00	0.00	0.00	7.331	125.0	SUM
310	0.00	0.00	0.00	0.00	7.331	125.0	SUM
320	0.00	0.00	0.00	0.00	7.331	125.0	SUM
330	0.00	0.00	0.00	0.00	7.331	125.0	SUM
340	0.00	0.00	0.00	0.00	7.331	125.0	SUM
350	0.00	0.00	0.00	0.00	7.331	125.0	SUM
360	0.00	0.00	0.00	0.00	7.331	125.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS ********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	06	06	6	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-46.70	0.861	-9.000	0.020	-999.	1839.	1307.1	0.100	0.80	0.18	10.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 19.8 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	17	6	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
74.27	0.077	0.600	0.020	190.	49.	-1.0	0.050	0.40	0.18	0.50

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 177.0 meters

********************** AERSCREEN AUTOMATED DISTANCES **********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	0.2916
25.00	1.206
50.00	2.571
75.00	5.397
100.00	7.079
125.00	7.331
150.00	6.651
175.00	6.279
200.00	5.830
225.00	5.286
250.00	5.012
275.00	4.771
300.00	4.502
325.00	4.210
350.00	3.919
375.00	3.640
400.00	3.512
425.00	3.426
450.00	3.319
475.00	3.199
500.00	3.072
525.00	2.943
550.00	2.852
575.00	2.834
600.00	2.815
625.00	2.791
650.00	2.763
675.00	2.765
700.00	2.776
725.00	2.781
750.00	2.783
2525.00	1.537
2550.00	1.527
2575.00	1.517
2600.00	1.507
2625.00	1.497
2650.00	1.488
2675.00	1.478
2700.00	1.469
2725.00	1.459
2750.00	1.450
2775.00	1.441
2800.00	1.432
2825.00	1.423
2850.00	1.414
2875.00	1.406
2900.00	1.397
2925.00	1.389
2950.00	1.381
2975.00	1.373
3000.00	1.364
3025.00	1.356
3050.00	1.349
3075.00	1.341
3100.00	1.333
3125.00	1.326
3150.00	1.318
3175.00	1.311
3200.00	1.303
3225.00	1.296
3250.00	1.289
3275.00	1.282

775.00	2.780	3300.00	1.275
800.00	2.773	3325.00	1.268
825.00	2.764	3350.00	1.261
850.00	2.752	3375.00	1.254
875.00	2.737	3400.00	1.248
900.00	2.720	3425.00	1.241
925.00	2.701	3450.00	1.235
950.00	2.680	3475.00	1.228
975.00	2.656	3500.00	1.222
1000.00	2.632	3525.00	1.216
1025.00	2.607	3550.00	1.209
1050.00	2.583	3575.00	1.203
1075.00	2.558	3600.00	1.197
1100.00	2.533	3625.00	1.191
1125.00	2.507	3650.00	1.185
1150.00	2.482	3675.00	1.179
1175.00	2.457	3700.00	1.173
1200.00	2.432	3725.00	1.168
1225.00	2.408	3750.00	1.162
1250.00	2.383	3775.00	1.156
1275.00	2.359	3800.00	1.151
1300.00	2.335	3825.00	1.145
1325.00	2.311	3850.00	1.140
1350.00	2.287	3875.00	1.134
1375.00	2.264	3900.00	1.129
1400.00	2.241	3925.00	1.123
1425.00	2.219	3950.00	1.118
1450.00	2.196	3975.00	1.113
1475.00	2.174	4000.00	1.108
1500.00	2.153	4025.00	1.103
1525.00	2.131	4050.00	1.098
1550.00	2.110	4075.00	1.093
1575.00	2.090	4100.00	1.088
1600.00	2.070	4125.00	1.083
1625.00	2.050	4150.00	1.078
1650.00	2.030	4175.00	1.073
1675.00	2.011	4200.00	1.068
1700.00	1.992	4225.00	1.063
1725.00	1.973	4250.00	1.059
1750.00	1.955	4275.00	1.054
1775.00	1.937	4300.00	1.049
1800.00	1.919	4325.00	1.045
1825.00	1.902	4350.00	1.040
1850.00	1.885	4375.00	1.036
1875.00	1.868	4400.00	1.031
1900.00	1.851	4425.00	1.027
1925.00	1.835	4450.00	1.023
1950.00	1.819	4475.00	1.018
1975.00	1.805	4500.00	1.014
2000.00	1.791	4525.00	1.010
2025.00	1.777	4550.00	1.006
2050.00	1.763	4575.00	1.002
2075.00	1.750	4600.00	0.9974
2100.00	1.736	4625.00	0.9933
2125.00	1.723	4650.00	0.9892
2150.00	1.710	4675.00	0.9852
2175.00	1.697	4700.00	0.9812
2200.00	1.685	4725.00	0.9772
2225.00	1.673	4750.00	0.9733
2250.00	1.660	4775.00	0.9694
2275.00	1.648	4800.00	0.9656
2300.00	1.637	4825.00	0.9617
2325.00	1.625	4850.00	0.9580

2350.00	1.613	4875.00	0.9542
2375.00	1.602	4900.00	0.9505
2400.00	1.591	4925.00	0.9468
2425.00	1.580	4950.00	0.9431
2450.00	1.569	4975.00	0.9395
2475.00	1.558	5000.00	0.9358
2500.00	1.548		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY *********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	7.407	7.407	6.666	4.444	0.7407

DISTANCE FROM SOURCE   116.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.2916	0.2916	0.2624	0.1750	0.2916E-01

DISTANCE FROM SOURCE   15.24 meters directed toward 10 degrees

2350.00	3.445	4875.00	2.151
2375.00	3.426	4900.00	2.144
2400.00	3.407	4925.00	2.137
2425.00	3.387	4950.00	2.129
2450.00	3.368	4975.00	2.122
2475.00	3.349	5000.00	2.115
2500.00	3.334		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	17.88	17.88	16.09	10.73	1.788

DISTANCE FROM SOURCE 88.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	3.016	3.016	2.714	1.810	0.3016

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

Arrow_Station7_400hp

AERSCREEN 11126 / AERMOD 1206 04/18/13
16:05:59

TITLE: Arrow_Station7_400hp

**************************** STACK PARAMETERS ****************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	742.6 K	877.0 Deg F
PLUME EXIT VELOCITY:	31.944 m/s	104.80 ft/s
STACK AIR FLOW RATE:	2195 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.25000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

*********************** BUILDING DOWNWASH PARAMETERS *********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************* FLOW SECTOR ANALYSIS **************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	17.07	100.0	SUM
20	0.00	0.00	0.00	0.00	17.07	100.0	SUM
30	0.00	0.00	0.00	0.00	17.07	100.0	SUM
40	0.00	0.00	0.00	0.00	17.07	100.0	SUM
50	0.00	0.00	0.00	0.00	17.07	100.0	SUM
60	0.00	0.00	0.00	0.00	17.07	100.0	SUM
70	0.00	0.00	0.00	0.00	17.07	100.0	SUM
80	0.00	0.00	0.00	0.00	17.07	100.0	SUM
90	0.00	0.00	0.00	0.00	17.07	100.0	SUM
100	0.00	0.00	0.00	0.00	17.07	100.0	SUM
110	0.00	0.00	0.00	0.00	17.07	100.0	SUM
120	0.00	0.00	0.00	0.00	17.07	100.0	SUM
130	0.00	0.00	0.00	0.00	17.07	100.0	SUM

140	0.00	0.00	0.00	0.00	17.07	100.0	SUM
150	0.00	0.00	0.00	0.00	17.07	100.0	SUM
160	0.00	0.00	0.00	0.00	17.07	100.0	SUM
170	0.00	0.00	0.00	0.00	17.07	100.0	SUM
180	0.00	0.00	0.00	0.00	17.07	100.0	SUM
190	0.00	0.00	0.00	0.00	17.07	100.0	SUM
200	0.00	0.00	0.00	0.00	17.07	100.0	SUM
210	0.00	0.00	0.00	0.00	17.07	100.0	SUM
220	0.00	0.00	0.00	0.00	17.07	100.0	SUM
230	0.00	0.00	0.00	0.00	17.07	100.0	SUM
240	0.00	0.00	0.00	0.00	17.07	100.0	SUM
250	0.00	0.00	0.00	0.00	17.07	100.0	SUM
260	0.00	0.00	0.00	0.00	17.07	100.0	SUM
270	0.00	0.00	0.00	0.00	17.07	100.0	SUM
280	0.00	0.00	0.00	0.00	17.07	100.0	SUM
290	0.00	0.00	0.00	0.00	17.07	100.0	SUM
300	0.00	0.00	0.00	0.00	17.07	100.0	SUM
310	0.00	0.00	0.00	0.00	17.07	100.0	SUM
320	0.00	0.00	0.00	0.00	17.07	100.0	SUM
330	0.00	0.00	0.00	0.00	17.07	100.0	SUM
340	0.00	0.00	0.00	0.00	17.07	100.0	SUM
350	0.00	0.00	0.00	0.00	17.07	100.0	SUM
360	0.00	0.00	0.00	0.00	17.07	100.0	SUM

* = worst case flow sector

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-----------------------------------------------------------------------------
*********************  MAKEMET METEOROLOGY PARAMETERS  *********************
-----------------------------------------------------------------------------

MIN/MAX TEMPERATURE:    249.8 / 310.9 (K)

MINIMUM WIND SPEED:       0.5 m/s

ANEMOMETER HEIGHT:     10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE:    Average Moisture
DOMINANT SEASON:          Summer

ALBEDO:                  0.18
BOWEN RATIO:             0.80
ROUGHNESS LENGTH:       0.100 (meters)


       METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT
       -------------------------------------------------------------

 YR MO DY JDY HR
 -- -- -- --- --
 10 05 31  31 01

    H0     U*     W*  DT/DZ ZICNV ZIMCH  M-O LEN    Z0  BOWEN ALBEDO  REF WS
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
-32.40  0.598 -9.000  0.020 -999. 1063.    629.3 0.100   0.80   0.18    7.00

    HT  REF TA     HT
- - - - - - - - - - -
  10.0   310.9    2.0
```

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 13.6 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	22	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
63.99	0.086	0.600	0.020	134.	58.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 79.6 meters

************************ AERSCREEN AUTOMATED DISTANCES ********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	2.677	2525.00	3.077
25.00	5.859	2550.00	3.062
50.00	11.02	2575.00	3.046
75.00	16.46	2600.00	3.030
100.00	17.07	2625.00	3.018
125.00	15.24	2650.00	3.006
150.00	13.89	2675.00	2.994
175.00	12.36	2700.00	2.982
200.00	11.40	2725.00	2.970
225.00	10.71	2750.00	2.958
250.00	9.989	2775.00	2.945
275.00	9.662	2800.00	2.933
300.00	9.507	2825.00	2.920
325.00	9.214	2850.00	2.908
350.00	8.842	2875.00	2.895
375.00	8.691	2900.00	2.882
400.00	8.773	2925.00	2.869
425.00	8.764	2950.00	2.856
450.00	8.686	2975.00	2.843
475.00	8.558	3000.00	2.830
500.00	8.393	3025.00	2.817
525.00	8.202	3050.00	2.804
550.00	7.995	3075.00	2.791
575.00	7.778	3100.00	2.778
600.00	7.555	3125.00	2.765
625.00	7.331	3150.00	2.752
650.00	7.108	3175.00	2.739
675.00	6.888	3200.00	2.726
700.00	6.673	3225.00	2.713
725.00	6.464	3250.00	2.700
750.00	6.260	3275.00	2.687

775.00	6.217	3300.00	2.674
800.00	6.198	3325.00	2.661
825.00	6.169	3350.00	2.648
850.00	6.133	3375.00	2.635
875.00	6.091	3400.00	2.622
900.00	6.042	3425.00	2.609
925.00	5.992	3450.00	2.596
950.00	5.961	3475.00	2.583
975.00	5.926	3500.00	2.571
1000.00	5.887	3525.00	2.558
1025.00	5.843	3550.00	2.545
1050.00	5.797	3575.00	2.533
1075.00	5.748	3600.00	2.520
1100.00	5.697	3625.00	2.508
1125.00	5.644	3650.00	2.495
1150.00	5.589	3675.00	2.483
1175.00	5.533	3700.00	2.470
1200.00	5.476	3725.00	2.458
1225.00	5.418	3750.00	2.446
1250.00	5.360	3775.00	2.434
1275.00	5.301	3800.00	2.421
1300.00	5.242	3825.00	2.409
1325.00	5.183	3850.00	2.397
1350.00	5.124	3875.00	2.385
1375.00	5.065	3900.00	2.374
1400.00	5.006	3925.00	2.362
1425.00	4.947	3950.00	2.350
1450.00	4.889	3975.00	2.338
1475.00	4.831	4000.00	2.327
1500.00	4.774	4025.00	2.315
1525.00	4.717	4050.00	2.304
1550.00	4.661	4075.00	2.292
1575.00	4.606	4100.00	2.281
1600.00	4.551	4125.00	2.270
1625.00	4.496	4150.00	2.258
1650.00	4.443	4175.00	2.247
1675.00	4.390	4200.00	2.236
1700.00	4.338	4225.00	2.225
1725.00	4.286	4250.00	2.214
1750.00	4.235	4275.00	2.203
1775.00	4.185	4300.00	2.192
1800.00	4.136	4325.00	2.181
1825.00	4.087	4350.00	2.171
1850.00	4.040	4375.00	2.160
1875.00	3.993	4400.00	2.150
1900.00	3.946	4425.00	2.139
1925.00	3.900	4450.00	2.129
1950.00	3.856	4475.00	2.118
1975.00	3.811	4500.00	2.108
2000.00	3.768	4525.00	2.098
2025.00	3.725	4550.00	2.088
2050.00	3.683	4575.00	2.078
2075.00	3.641	4600.00	2.072
2100.00	3.600	4625.00	2.066
2125.00	3.560	4650.00	2.060
2150.00	3.521	4675.00	2.055
2175.00	3.482	4700.00	2.049
2200.00	3.444	4725.00	2.043
2225.00	3.406	4750.00	2.037
2250.00	3.369	4775.00	2.031
2275.00	3.333	4800.00	2.026
2300.00	3.297	4825.00	2.020
2325.00	3.262	4850.00	2.014

2350.00	3.227	4875.00	2.008
2375.00	3.193	4900.00	2.002
2400.00	3.159	4925.00	1.996
2425.00	3.139	4950.00	1.991
2450.00	3.124	4975.00	1.985
2475.00	3.108	5000.00	1.979
2500.00	3.093		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	17.48	17.48	15.73	10.49	1.748

DISTANCE FROM SOURCE 89.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	2.677	2.677	2.409	1.606	0.2677

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

Arrow_Station7_435hp

AERSCREEN 11126 / AERMOD 1206 04/23/13
20:15:45

TITLE: Arrow_Station7_435hp

****************************** STACK PARAMETERS ******************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	924.8 K	1205.0 Deg F
PLUME EXIT VELOCITY:	34.695 m/s	113.83 ft/s
STACK AIR FLOW RATE:	2384 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY PVMRM
NO2/NOx IN-STACK RATIO: 0.05000
OZONE BACKGROUND CONCENTRATION: 0.68000E+02 PPB

*********************** BUILDING DOWNWASH PARAMETERS ***********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************** FLOW SECTOR ANALYSIS **************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	16.02	100.0	SUM
20	0.00	0.00	0.00	0.00	16.02	100.0	SUM
30	0.00	0.00	0.00	0.00	16.02	100.0	SUM
40	0.00	0.00	0.00	0.00	16.02	100.0	SUM
50	0.00	0.00	0.00	0.00	16.02	100.0	SUM
60	0.00	0.00	0.00	0.00	16.02	100.0	SUM
70	0.00	0.00	0.00	0.00	16.02	100.0	SUM
80	0.00	0.00	0.00	0.00	16.02	100.0	SUM
90	0.00	0.00	0.00	0.00	16.02	100.0	SUM
100	0.00	0.00	0.00	0.00	16.02	100.0	SUM
110	0.00	0.00	0.00	0.00	16.02	100.0	SUM
120	0.00	0.00	0.00	0.00	16.02	100.0	SUM
130	0.00	0.00	0.00	0.00	16.02	100.0	SUM

140	0.00	0.00	0.00	0.00	16.02	100.0	SUM
150	0.00	0.00	0.00	0.00	16.02	100.0	SUM
160	0.00	0.00	0.00	0.00	16.02	100.0	SUM
170	0.00	0.00	0.00	0.00	16.02	100.0	SUM
180	0.00	0.00	0.00	0.00	16.02	100.0	SUM
190	0.00	0.00	0.00	0.00	16.02	100.0	SUM
200	0.00	0.00	0.00	0.00	16.02	100.0	SUM
210	0.00	0.00	0.00	0.00	16.02	100.0	SUM
220	0.00	0.00	0.00	0.00	16.02	100.0	SUM
230	0.00	0.00	0.00	0.00	16.02	100.0	SUM
240	0.00	0.00	0.00	0.00	16.02	100.0	SUM
250	0.00	0.00	0.00	0.00	16.02	100.0	SUM
260	0.00	0.00	0.00	0.00	16.02	100.0	SUM
270	0.00	0.00	0.00	0.00	16.02	100.0	SUM
280	0.00	0.00	0.00	0.00	16.02	100.0	SUM
290	0.00	0.00	0.00	0.00	16.02	100.0	SUM
300	0.00	0.00	0.00	0.00	16.02	100.0	SUM
310	0.00	0.00	0.00	0.00	16.02	100.0	SUM
320	0.00	0.00	0.00	0.00	16.02	100.0	SUM
330	0.00	0.00	0.00	0.00	16.02	100.0	SUM
340	0.00	0.00	0.00	0.00	16.02	100.0	SUM
350	0.00	0.00	0.00	0.00	16.02	100.0	SUM
360	0.00	0.00	0.00	0.00	16.02	100.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS *********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 14.4 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	19	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
58.70	0.087	0.600	0.020	133.	59.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	280.4	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 93.9 meters

************************ AERSCREEN AUTOMATED DISTANCES *********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	2.117	2525.00	2.766
25.00	4.771	2550.00	2.740
50.00	9.582	2575.00	2.715
75.00	15.51	2600.00	2.690
100.00	16.02	2625.00	2.665
125.00	14.11	2650.00	2.641
150.00	12.98	2675.00	2.617
175.00	11.49	2700.00	2.593
200.00	10.54	2725.00	2.569
225.00	9.943	2750.00	2.546
250.00	9.263	2775.00	2.536
275.00	8.706	2800.00	2.529
300.00	8.164	2825.00	2.522
325.00	8.056	2850.00	2.514
350.00	7.846	2875.00	2.507
375.00	7.575	2900.00	2.499
400.00	7.375	2925.00	2.491
425.00	7.426	2950.00	2.484
450.00	7.408	2975.00	2.475
475.00	7.340	3000.00	2.467
500.00	7.272	3025.00	2.459
525.00	7.172	3050.00	2.451
550.00	7.048	3075.00	2.442
575.00	6.906	3100.00	2.434
600.00	6.753	3125.00	2.425
625.00	6.592	3150.00	2.417
650.00	6.426	3175.00	2.408
675.00	6.258	3200.00	2.399
700.00	6.090	3225.00	2.390
725.00	5.924	3250.00	2.381
750.00	5.759	3275.00	2.372

775.00	5.598	3300.00	2.363
800.00	5.441	3325.00	2.354
825.00	5.288	3350.00	2.345
850.00	5.140	3375.00	2.336
875.00	5.056	3400.00	2.327
900.00	5.044	3425.00	2.318
925.00	5.025	3450.00	2.309
950.00	5.002	3475.00	2.300
975.00	4.974	3500.00	2.290
1000.00	4.942	3525.00	2.281
1025.00	4.907	3550.00	2.272
1050.00	4.870	3575.00	2.263
1075.00	4.830	3600.00	2.254
1100.00	4.787	3625.00	2.244
1125.00	4.743	3650.00	2.235
1150.00	4.698	3675.00	2.226
1175.00	4.651	3700.00	2.217
1200.00	4.604	3725.00	2.207
1225.00	4.557	3750.00	2.198
1250.00	4.524	3775.00	2.189
1275.00	4.489	3800.00	2.180
1300.00	4.454	3825.00	2.171
1325.00	4.418	3850.00	2.162
1350.00	4.381	3875.00	2.152
1375.00	4.343	3900.00	2.143
1400.00	4.305	3925.00	2.134
1425.00	4.267	3950.00	2.125
1450.00	4.228	3975.00	2.116
1475.00	4.189	4000.00	2.107
1500.00	4.149	4025.00	2.098
1525.00	4.110	4050.00	2.089
1550.00	4.070	4075.00	2.080
1575.00	4.031	4100.00	2.071
1600.00	3.992	4125.00	2.062
1625.00	3.953	4150.00	2.054
1650.00	3.913	4175.00	2.045
1675.00	3.875	4200.00	2.036
1700.00	3.836	4225.00	2.027
1725.00	3.798	4250.00	2.019
1750.00	3.759	4275.00	2.010
1775.00	3.722	4300.00	2.001
1800.00	3.684	4325.00	1.993
1825.00	3.647	4350.00	1.984
1850.00	3.610	4375.00	1.975
1875.00	3.574	4400.00	1.967
1900.00	3.538	4425.00	1.958
1925.00	3.502	4450.00	1.950
1950.00	3.467	4475.00	1.942
1975.00	3.432	4500.00	1.933
2000.00	3.397	4525.00	1.925
2025.00	3.363	4550.00	1.917
2050.00	3.329	4575.00	1.908
2075.00	3.296	4600.00	1.900
2100.00	3.263	4625.00	1.892
2125.00	3.231	4650.00	1.884
2150.00	3.199	4675.00	1.876
2175.00	3.167	4700.00	1.868
2200.00	3.136	4725.00	1.860
2225.00	3.105	4750.00	1.852
2250.00	3.075	4775.00	1.844
2275.00	3.045	4800.00	1.836
2300.00	3.015	4825.00	1.828
2325.00	2.986	4850.00	1.820

2350.00	2.957	4875.00	1.812
2375.00	2.929	4900.00	1.805
2400.00	2.901	4925.00	1.797
2425.00	2.873	4950.00	1.789
2450.00	2.846	4975.00	1.782
2475.00	2.819	5000.00	1.774
2500.00	2.792		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	16.18	16.18	14.56	9.708	1.618

DISTANCE FROM SOURCE 93.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	2.117	2.117	1.905	1.270	0.2117

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 04/18/13
08:59:26

TITLE: ARROW_STATION7_530HP

*************************** STACK PARAMETERS ***************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	7.62 meters	25.00 feet
STACK INNER DIAMETER:	0.203 meters	8.00 inches
PLUME EXIT TEMPERATURE:	738.2 K	869.0 Deg F
PLUME EXIT VELOCITY:	45.478 m/s	149.21 ft/s
STACK AIR FLOW RATE:	3125 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.25000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

********************** BUILDING DOWNWASH PARAMETERS **********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************ FLOW SECTOR ANALYSIS *************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	15.29	100.0	SUM
20	0.00	0.00	0.00	0.00	15.29	100.0	SUM
30	0.00	0.00	0.00	0.00	15.29	100.0	SUM
40	0.00	0.00	0.00	0.00	15.29	100.0	SUM
50	0.00	0.00	0.00	0.00	15.29	100.0	SUM
60	0.00	0.00	0.00	0.00	15.29	100.0	SUM
70	0.00	0.00	0.00	0.00	15.29	100.0	SUM
80	0.00	0.00	0.00	0.00	15.29	100.0	SUM
90	0.00	0.00	0.00	0.00	15.29	100.0	SUM
100	0.00	0.00	0.00	0.00	15.29	100.0	SUM
110	0.00	0.00	0.00	0.00	15.29	100.0	SUM
120	0.00	0.00	0.00	0.00	15.29	100.0	SUM
130	0.00	0.00	0.00	0.00	15.29	100.0	SUM

140	0.00	0.00	0.00	0.00	15.29	100.0	SUM
150	0.00	0.00	0.00	0.00	15.29	100.0	SUM
160	0.00	0.00	0.00	0.00	15.29	100.0	SUM
170	0.00	0.00	0.00	0.00	15.29	100.0	SUM
180	0.00	0.00	0.00	0.00	15.29	100.0	SUM
190	0.00	0.00	0.00	0.00	15.29	100.0	SUM
200	0.00	0.00	0.00	0.00	15.29	100.0	SUM
210	0.00	0.00	0.00	0.00	15.29	100.0	SUM
220	0.00	0.00	0.00	0.00	15.29	100.0	SUM
230	0.00	0.00	0.00	0.00	15.29	100.0	SUM
240	0.00	0.00	0.00	0.00	15.29	100.0	SUM
250	0.00	0.00	0.00	0.00	15.29	100.0	SUM
260	0.00	0.00	0.00	0.00	15.29	100.0	SUM
270	0.00	0.00	0.00	0.00	15.29	100.0	SUM
280	0.00	0.00	0.00	0.00	15.29	100.0	SUM
290	0.00	0.00	0.00	0.00	15.29	100.0	SUM
300	0.00	0.00	0.00	0.00	15.29	100.0	SUM
310	0.00	0.00	0.00	0.00	15.29	100.0	SUM
320	0.00	0.00	0.00	0.00	15.29	100.0	SUM
330	0.00	0.00	0.00	0.00	15.29	100.0	SUM
340	0.00	0.00	0.00	0.00	15.29	100.0	SUM
350	0.00	0.00	0.00	0.00	15.29	100.0	SUM
360	0.00	0.00	0.00	0.00	15.29	100.0	SUM

* = worst case flow sector

********************* MAKEMET METEOROLOGY PARAMETERS ********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	05	31	31	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-32.40	0.598	-9.000	0.020	-999.	1063.	629.3	0.100	0.80	0.18	7.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 15.4 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	22	31	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
63.99	0.086	0.600	0.020	134.	58.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 101.3 meters

************************ AERSCREEN AUTOMATED DISTANCES *********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	1.632	2525.00	2.542
25.00	3.726	2550.00	2.520
50.00	8.713	2575.00	2.499
75.00	15.04	2600.00	2.478
100.00	15.29	2625.00	2.457
125.00	13.71	2650.00	2.437
150.00	12.48	2675.00	2.416
175.00	11.08	2700.00	2.396
200.00	9.872	2725.00	2.376
225.00	9.230	2750.00	2.357
250.00	8.752	2775.00	2.337
275.00	8.256	2800.00	2.318
300.00	7.825	2825.00	2.299
325.00	7.419	2850.00	2.281
350.00	6.989	2875.00	2.262
375.00	6.661	2900.00	2.244
400.00	6.472	2925.00	2.226
425.00	6.252	2950.00	2.208
450.00	6.071	2975.00	2.190
475.00	6.128	3000.00	2.173
500.00	6.142	3025.00	2.156
525.00	6.121	3050.00	2.139
550.00	6.071	3075.00	2.122
575.00	6.000	3100.00	2.105
600.00	5.911	3125.00	2.089
625.00	5.810	3150.00	2.073
650.00	5.700	3175.00	2.064
675.00	5.584	3200.00	2.059
700.00	5.463	3225.00	2.054
725.00	5.339	3250.00	2.049
750.00	5.214	3275.00	2.044

775.00	5.090	3300.00	2.038
800.00	4.966	3325.00	2.033
825.00	4.844	3350.00	2.028
850.00	4.724	3375.00	2.022
875.00	4.606	3400.00	2.017
900.00	4.491	3425.00	2.011
925.00	4.378	3450.00	2.005
950.00	4.269	3475.00	2.000
975.00	4.163	3500.00	1.994
1000.00	4.060	3525.00	1.988
1025.00	3.994	3550.00	1.982
1050.00	3.948	3575.00	1.976
1075.00	3.907	3600.00	1.970
1100.00	3.892	3625.00	1.964
1125.00	3.875	3650.00	1.958
1150.00	3.856	3675.00	1.952
1175.00	3.835	3700.00	1.946
1200.00	3.825	3725.00	1.940
1225.00	3.812	3750.00	1.933
1250.00	3.798	3775.00	1.927
1275.00	3.782	3800.00	1.921
1300.00	3.765	3825.00	1.915
1325.00	3.746	3850.00	1.908
1350.00	3.726	3875.00	1.902
1375.00	3.705	3900.00	1.895
1400.00	3.683	3925.00	1.889
1425.00	3.660	3950.00	1.883
1450.00	3.637	3975.00	1.876
1475.00	3.612	4000.00	1.870
1500.00	3.587	4025.00	1.863
1525.00	3.562	4050.00	1.857
1550.00	3.536	4075.00	1.851
1575.00	3.510	4100.00	1.844
1600.00	3.483	4125.00	1.838
1625.00	3.457	4150.00	1.831
1650.00	3.430	4175.00	1.825
1675.00	3.402	4200.00	1.818
1700.00	3.375	4225.00	1.812
1725.00	3.348	4250.00	1.805
1750.00	3.320	4275.00	1.799
1775.00	3.293	4300.00	1.793
1800.00	3.265	4325.00	1.786
1825.00	3.238	4350.00	1.780
1850.00	3.211	4375.00	1.773
1875.00	3.183	4400.00	1.767
1900.00	3.156	4425.00	1.760
1925.00	3.129	4450.00	1.754
1950.00	3.102	4475.00	1.748
1975.00	3.076	4500.00	1.741
2000.00	3.049	4525.00	1.735
2025.00	3.023	4550.00	1.729
2050.00	2.997	4575.00	1.722
2075.00	2.971	4600.00	1.716
2100.00	2.945	4625.00	1.710
2125.00	2.919	4650.00	1.703
2150.00	2.894	4675.00	1.697
2175.00	2.869	4700.00	1.691
2200.00	2.844	4725.00	1.685
2225.00	2.819	4750.00	1.678
2250.00	2.795	4775.00	1.672
2275.00	2.770	4800.00	1.666
2300.00	2.746	4825.00	1.660
2325.00	2.723	4850.00	1.654

2350.00	2.699	4875.00	1.648
2375.00	2.676	4900.00	1.641
2400.00	2.653	4925.00	1.635
2425.00	2.630	4950.00	1.629
2450.00	2.608	4975.00	1.623
2475.00	2.586	5000.00	1.617
2500.00	2.564		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	15.35	15.35	13.82	9.211	1.535

DISTANCE FROM SOURCE 95.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	1.632	1.632	1.468	0.9789	0.1632

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

AERSCREEN 11126 / AERMOD 1206 04/23/13
19:26:25

TITLE: Arrow_Station7_740hp

***************************** STACK PARAMETERS ****************************

SOURCE EMISSION RATE:	0.1260 g/s	1.000 lb/hr
STACK HEIGHT:	9.75 meters	32.00 feet
STACK INNER DIAMETER:	0.254 meters	10.00 inches
PLUME EXIT TEMPERATURE:	922.0 K	1200.0 Deg F
PLUME EXIT VELOCITY:	38.094 m/s	124.98 ft/s
STACK AIR FLOW RATE:	4090 ACFM	
RURAL OR URBAN:	RURAL	
INITIAL PROBE DISTANCE =	5000. meters	16404. feet

NOx TO NO2 CHEMISTRY	PVMRM
NO2/NOx IN-STACK RATIO:	0.05000
OZONE BACKGROUND CONCENTRATION:	0.68000E+02 PPB

*********************** BUILDING DOWNWASH PARAMETERS *********************

BUILDING HEIGHT:	6.1 meters	20.0 feet
MAX BUILDING DIMENSION:	8.5 meters	28.0 feet
MIN BUILDING DIMENSION:	4.7 meters	15.5 feet
BUILDING ORIENTATION TO NORTH:	0. degrees	
STACK DIRECTION FROM CENTER:	90. degrees	
STACK DISTANCE FROM CENTER:	45.0 meters	147.6 feet

************************** FLOW SECTOR ANALYSIS **************************
25 meter receptor spacing: 15. meters - 5000. meters

FLOW SECTOR	BUILD WIDTH	BUILD LENGTH	XBADJ	YBADJ	MAX 1-HR CONC	DIST (m)	TEMPORAL PERIOD
10*	0.00	0.00	0.00	0.00	8.430	100.0	SUM
20	0.00	0.00	0.00	0.00	8.430	100.0	SUM
30	0.00	0.00	0.00	0.00	8.430	100.0	SUM
40	0.00	0.00	0.00	0.00	8.430	100.0	SUM
50	0.00	0.00	0.00	0.00	8.430	100.0	SUM
60	0.00	0.00	0.00	0.00	8.430	100.0	SUM
70	0.00	0.00	0.00	0.00	8.430	100.0	SUM
80	0.00	0.00	0.00	0.00	8.430	100.0	SUM
90	0.00	0.00	0.00	0.00	8.430	100.0	SUM
100	0.00	0.00	0.00	0.00	8.430	100.0	SUM
110	0.00	0.00	0.00	0.00	8.430	100.0	SUM
120	0.00	0.00	0.00	0.00	8.430	100.0	SUM
130	0.00	0.00	0.00	0.00	8.430	100.0	SUM

140	0.00	0.00	0.00	0.00	8.430	100.0	SUM
150	0.00	0.00	0.00	0.00	8.430	100.0	SUM
160	0.00	0.00	0.00	0.00	8.430	100.0	SUM
170	0.00	0.00	0.00	0.00	8.430	100.0	SUM
180	0.00	0.00	0.00	0.00	8.430	100.0	SUM
190	0.00	0.00	0.00	0.00	8.430	100.0	SUM
200	0.00	0.00	0.00	0.00	8.430	100.0	SUM
210	0.00	0.00	0.00	0.00	8.430	100.0	SUM
220	0.00	0.00	0.00	0.00	8.430	100.0	SUM
230	0.00	0.00	0.00	0.00	8.430	100.0	SUM
240	0.00	0.00	0.00	0.00	8.430	100.0	SUM
250	0.00	0.00	0.00	0.00	8.430	100.0	SUM
260	0.00	0.00	0.00	0.00	8.430	100.0	SUM
270	0.00	0.00	0.00	0.00	8.430	100.0	SUM
280	0.00	0.00	0.00	0.00	8.430	100.0	SUM
290	0.00	0.00	0.00	0.00	8.430	100.0	SUM
300	0.00	0.00	0.00	0.00	8.430	100.0	SUM
310	0.00	0.00	0.00	0.00	8.430	100.0	SUM
320	0.00	0.00	0.00	0.00	8.430	100.0	SUM
330	0.00	0.00	0.00	0.00	8.430	100.0	SUM
340	0.00	0.00	0.00	0.00	8.430	100.0	SUM
350	0.00	0.00	0.00	0.00	8.430	100.0	SUM
360	0.00	0.00	0.00	0.00	8.430	100.0	SUM

* = worst case flow sector

********************** MAKEMET METEOROLOGY PARAMETERS ********************

MIN/MAX TEMPERATURE: 249.8 / 310.9 (K)

MINIMUM WIND SPEED: 0.5 m/s

ANEMOMETER HEIGHT: 10.000 meters

SURFACE CHARACTERISTICS INPUT: AERMET SEASONAL TABLES

DOMINANT SURFACE PROFILE: Grassland
DOMINANT CLIMATE TYPE: Average Moisture
DOMINANT SEASON: Summer

ALBEDO: 0.18
BOWEN RATIO: 0.80
ROUGHNESS LENGTH: 0.100 (meters)

METEOROLOGY CONDITIONS USED TO PREDICT OVERALL MAXIMUM IMPACT

YR	MO	DY	JDY	HR
10	06	06	6	01

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
-46.70	0.861	-9.000	0.020	-999.	1839.	1307.1	0.100	0.80	0.18	10.00

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 16.5 meters

METEOROLOGY CONDITIONS USED TO PREDICT AMBIENT BOUNDARY IMPACT

YR	MO	DY	JDY	HR
10	01	22	6	12

H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS
63.99	0.086	0.600	0.020	134.	58.	-1.0	0.100	0.80	0.18	0.50

HT	REF TA	HT
10.0	310.9	2.0

ESTIMATED FINAL PLUME HEIGHT (non-downwash): 131.9 meters

************************ AERSCREEN AUTOMATED DISTANCES ***********************
OVERALL MAXIMUM CONCENTRATIONS BY DISTANCE

DIST (m)	MAXIMUM 1-HR CONC (ug/m3)	DIST (m)	MAXIMUM 1-HR CONC (ug/m3)
15.24	0.4999	2525.00	1.880
25.00	1.576	2550.00	1.867
50.00	3.531	2575.00	1.854
75.00	5.723	2600.00	1.841
100.00	8.430	2625.00	1.828
125.00	8.406	2650.00	1.815
150.00	8.246	2675.00	1.803
175.00	7.545	2700.00	1.791
200.00	6.972	2725.00	1.779
225.00	6.495	2750.00	1.767
250.00	5.949	2775.00	1.755
275.00	5.502	2800.00	1.744
300.00	5.172	2825.00	1.732
325.00	4.967	2850.00	1.721
350.00	4.794	2875.00	1.710
375.00	4.627	2900.00	1.699
400.00	4.429	2925.00	1.689
425.00	4.218	2950.00	1.678
450.00	4.037	2975.00	1.667
475.00	4.015	3000.00	1.657
500.00	3.979	3025.00	1.647
525.00	3.928	3050.00	1.637
550.00	3.870	3075.00	1.627
575.00	3.812	3100.00	1.617
600.00	3.787	3125.00	1.608
625.00	3.787	3150.00	1.598
650.00	3.776	3175.00	1.589
675.00	3.761	3200.00	1.579
700.00	3.741	3225.00	1.570
725.00	3.717	3250.00	1.561
750.00	3.691	3275.00	1.552

775.00	3.661	3300.00	1.543
800.00	3.630	3325.00	1.535
825.00	3.597	3350.00	1.526
850.00	3.563	3375.00	1.517
875.00	3.528	3400.00	1.509
900.00	3.492	3425.00	1.501
925.00	3.455	3450.00	1.492
950.00	3.418	3475.00	1.484
975.00	3.381	3500.00	1.476
1000.00	3.344	3525.00	1.468
1025.00	3.306	3550.00	1.461
1050.00	3.269	3575.00	1.453
1075.00	3.233	3600.00	1.445
1100.00	3.196	3625.00	1.437
1125.00	3.160	3650.00	1.430
1150.00	3.124	3675.00	1.423
1175.00	3.089	3700.00	1.415
1200.00	3.054	3725.00	1.408
1225.00	3.020	3750.00	1.401
1250.00	2.986	3775.00	1.394
1275.00	2.953	3800.00	1.387
1300.00	2.921	3825.00	1.380
1325.00	2.888	3850.00	1.375
1350.00	2.857	3875.00	1.369
1375.00	2.826	3900.00	1.364
1400.00	2.796	3925.00	1.358
1425.00	2.766	3950.00	1.352
1450.00	2.737	3975.00	1.347
1475.00	2.708	4000.00	1.341
1500.00	2.680	4025.00	1.336
1525.00	2.652	4050.00	1.331
1550.00	2.625	4075.00	1.325
1575.00	2.598	4100.00	1.320
1600.00	2.572	4125.00	1.315
1625.00	2.547	4150.00	1.309
1650.00	2.522	4175.00	1.304
1675.00	2.497	4200.00	1.299
1700.00	2.473	4225.00	1.294
1725.00	2.449	4250.00	1.289
1750.00	2.426	4275.00	1.283
1775.00	2.403	4300.00	1.278
1800.00	2.381	4325.00	1.273
1825.00	2.359	4350.00	1.268
1850.00	2.338	4375.00	1.263
1875.00	2.316	4400.00	1.258
1900.00	2.296	4425.00	1.253
1925.00	2.275	4450.00	1.249
1950.00	2.255	4475.00	1.244
1975.00	2.236	4500.00	1.239
2000.00	2.217	4525.00	1.234
2025.00	2.198	4550.00	1.229
2050.00	2.179	4575.00	1.225
2075.00	2.161	4600.00	1.220
2100.00	2.143	4625.00	1.215
2125.00	2.125	4650.00	1.211
2150.00	2.108	4675.00	1.206
2175.00	2.091	4700.00	1.201
2200.00	2.074	4725.00	1.197
2225.00	2.058	4750.00	1.192
2250.00	2.042	4775.00	1.188
2275.00	2.026	4800.00	1.183
2300.00	2.010	4825.00	1.179
2325.00	1.995	4850.00	1.175

2350.00	1.980	4875.00	1.170
2375.00	1.965	4900.00	1.166
2400.00	1.950	4925.00	1.162
2425.00	1.936	4950.00	1.157
2450.00	1.921	4975.00	1.153
2475.00	1.907	5000.00	1.149
2500.00	1.894		

********************* AERSCREEN MAXIMUM IMPACT SUMMARY ********************

CALCULATION PROCEDURE	MAXIMUM 1-HOUR CONC (ug/m3)	SCALED 3-HOUR CONC (ug/m3)	SCALED 8-HOUR CONC (ug/m3)	SCALED 24-HOUR CONC (ug/m3)	SCALED ANNUAL CONC (ug/m3)
FLAT TERRAIN	8.516	8.516	7.665	5.110	0.8516

DISTANCE FROM SOURCE 107.00 meters directed toward 10 degrees

IMPACT AT THE AMBIENT BOUNDARY	0.4999	0.4999	0.4499	0.2999	0.4999E-01

DISTANCE FROM SOURCE 15.24 meters directed toward 10 degrees

FUEL COMPOSITION

HYDROCARBONS:		Mole or Volume %
Methane	CH4	55.25
Ethane	C2H6	21.9
Propane	C3H8	11.99
Iso-Butane	I-C4H10	1.06
Normal Butane	N-C4H10	3.27
Iso-Pentane	I-C5H12	0.48
Normal Pentane	N-C5H12	0.7
Hexane	C6H14	0.97
Heptane	C7H16	0
Ethene	C2H4	0
Propene	C3H6	0
	SUM HYDROCARBONS	95.62
NON-HYDROCARBONS:		
Nitrogen	N2	3.87
Oxygen	O2	0
Helium	He	0
Carbon Dioxide	CO2	0.52
Carbon Monoxide	CO	0
Hydrogen	H2	0
Water Vapor	H2O	0
	TOTAL FUEL	100.01

FUEL:	
FUEL PRESSURE RANGE (psig):	26 - 50
FUEL WKI:	47.2
FUEL SLHV (BTU/ft3):	1335.17
FUEL SLHV (MJ/Nm3):	52.50
FUEL LHV (BUT/ft3):	1358.81
FUEL LHV (MJ/Nm3):	53.43
FUEL HHV (BUT/ft3):	1503.11
FUEL HHV (MJ/Nm3):	59.11
FUEL DENSITY (SG):	0.91

Standard Conditions per ASTM D3588-91 [60°F and 14.696psia] and ISO 6976:1996-02-01[25, V(0;101.325)].
Based on the fuel composition, supply pressure and temperature, liquid hydrocarbons may be present in the fuel. No liquid hydrocarbons are allowed in the fuel. The fuel must not contain any liquid water. Dresser Waukesha recommends both of the following:
1) Dew point of the fuel gas to be at least 20°F (11°C) below the measured temperature of the gas at the inlet of the engine fuel regulator.
2) A fuel filter separator to be used on all fuels except commercial quality natural gas.
Refer to the 'Fuel and Lubrication' section of 'Technical Data' or contact the Dresser Waukesha Application Engineering Department for additional information on fuels, or LHV and WKI ® calculations.

FUEL CONTAMINANTS

Total Sulfur Compounds	0	% volume
Total Halogen as Cloride	0	% volume
Total Ammonia	0	% volume
Siloxanes		
Tetramethyl silane	0	% volume
Trimethyl silanol	0	% volume
Hexamethyldisiloxane (L2)	0	% volume
Hexamethylcyclotrisiloxane (D3)	0	% volume
Octamethyltrisiloxane (L3)	0	% volume
Octamethylcyclotetrasiloxane (D4)	0	% volume
Decamethyltetrasiloxane (L4)	0	% volume
Decamethylcyclopentasiloxane (D5)	0	% volume
Dodecamethylpentasiloxane (L5)	0	% volume
Dodecamethylcyclohexasiloxane (D6)	0	% volume
Others	0	% volume

Total Sulfur Compounds	0 µg/BTU
Total Halogen as Cloride	0 µg/BTU
Total Ammonia	0 µg/BTU
Total Siloxanes	0 µg/BTU

Calculated fuel contaminant analysis will depend on the entered fuel composition and selected engine model.

No water or hydrocarbon condensates are allowed in the engine. Requires liquids removal.

```
******************************************************************************************
*     Project Setup Information                                                          *
******************************************************************************************
Project File              : Untitled.Ept
Flowsheet Selection       : Oil Tank with Separator
Calculation Method        : RVP Distillation
Control Efficiency        : 95.0%
Known Separator Stream    : Geographical Region
Geographical Region       : All Regions in US
Entering Air Composition  : No

Date                      : 2013.08.13


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

Separator Pressure        : 54.00[psig]
Separator Temperature     : 60.00[F]
Ambient Pressure          : 14.70[psia]
Ambient Temperature       : 45.00[F]
C10+ SG                   : 0.8680
C10+ MW                   : 268.00

-- Low Pressure Oil ----------------------------------------------------------------------
   No.    Component           mol %
   1      H2S                 0.0000
   2      O2                  0.0000
   3      CO2                 0.0800
   4      N2                  0.0000
   5      C1                  1.4800
   6      C2                  2.9100
   7      C3                  6.9600
   8      i-C4                2.6300
   9      n-C4                7.2100
   10     i-C5                4.6400
   11     n-C5                5.7100
   12     C6                  5.0100
   13     C7                 13.5500
   14     C8                 15.0600
   15     C9                  6.2300
   16     C10+               18.8400
   17     Benzene             0.5900
   18     Toluene             2.5000
   19     E-Benzene           0.2400
   20     Xylenes             1.4900
   21     n-C6                4.8700
   22     224Trimethylp       0.0000

-- Sales Oil -----------------------------------------------------------------------------
Production Rate           : 100[bbl/day]
Days of Annual Operation  : 365 [days/year]
API Gravity               : 57.0
Reid Vapor Pressure       : 15.50[psia]


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

-- Emission Summary ----------------------------------------------------------------------
Item                Uncontrolled   Uncontrolled   Controlled    Controlled
                    [ton/yr]       [lb/hr]        [ton/yr]      [lb/hr]
Total HAPs          1.560          0.356          0.078         0.018
Total HC            146.885        33.535         7.344         1.677
```

VOCs, C2+	137.086	31.298	6.854	1.565
VOCs, C3+	103.265	23.576	5.163	1.179

Uncontrolled Recovery Info.

Vapor	7.8200	[MSCFD]
HC Vapor	7.7500	[MSCFD]
GOR	78.20	[SCF/bbl]

-- Emission Composition --

No	Component	Uncontrolled [ton/yr]	Uncontrolled [lb/hr]	Controlled [ton/yr]	Controlled [lb/hr]
1	H2S	0.000	0.000	0.000	0.000
2	O2	0.000	0.000	0.000	0.000
3	CO2	1.448	0.331	1.448	0.331
4	N2	0.000	0.000	0.000	0.000
5	C1	9.800	2.237	0.490	0.112
6	C2	33.820	7.721	1.691	0.386
7	C3	53.491	12.213	2.675	0.611
8	i-C4	11.223	2.562	0.561	0.128
9	n-C4	21.375	4.880	1.069	0.244
10	i-C5	6.277	1.433	0.314	0.072
11	n-C5	5.502	1.256	0.275	0.063
12	C6	1.667	0.381	0.083	0.019
13	C7	1.542	0.352	0.077	0.018
14	C8	0.547	0.125	0.027	0.006
15	C9	0.078	0.018	0.004	0.001
16	C10+	0.000	0.000	0.000	0.000
17	Benzene	0.126	0.029	0.006	0.001
18	Toluene	0.154	0.035	0.008	0.002
19	E-Benzene	0.005	0.001	0.000	0.000
20	Xylenes	0.026	0.006	0.001	0.000
21	n-C6	1.251	0.286	0.063	0.014
22	224Trimethylp	0.000	0.000	0.000	0.000
	Total	148.332	33.866	7.417	1.693

-- Stream Data ---

No.	Component		MW	LP Oil mol %	Flash Oil mol %	Sale Oil mol %	Flash Gas mol %	W&S Gas mol %	Total Emissions mol %
1	H2S		34.80	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	O2		32.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	CO2		44.01	0.0800	0.0190	0.0003	0.9365	0.7054	0.8739
4	N2		28.01	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	C1		16.04	1.4800	0.1267	0.0000	20.4726	4.7879	16.2241
6	C2		30.07	2.9100	1.1651	0.2035	27.3993	36.5326	29.8732
7	C3		44.10	6.9600	5.2701	4.4246	30.6771	36.3677	32.2185
8	i-C4		58.12	2.6300	2.4583	2.3792	5.0393	5.3680	5.1283
9	n-C4		58.12	7.2100	7.0375	6.9532	9.6313	10.1352	9.7678
10	i-C5		72.15	4.6400	4.8078	4.8738	2.2855	2.3790	2.3109
11	n-C5		72.15	5.7100	5.9741	6.0798	2.0028	2.0862	2.0254
12	C6		86.16	5.0100	5.3299	5.4600	0.5205	0.5449	0.5271
13	C7		100.20	13.5500	14.4858	14.8677	0.4161	0.4391	0.4223
14	C8		114.23	15.0600	16.1239	16.5586	0.1286	0.1370	0.1309
15	C9		128.28	6.2300	6.6727	6.8537	0.0163	0.0187	0.0169
16	C10+		166.00	18.8400	20.1824	20.7311	0.0000	0.0000	0.0000
17	Benzene		78.11	0.5900	0.6290	0.6449	0.0422	0.0444	0.0428
18	Toluene		92.13	2.5000	2.6750	2.7465	0.0438	0.0465	0.0445
19	E-Benzene		106.17	0.2400	0.2570	0.2640	0.0012	0.0013	0.0013
20	Xylenes		106.17	1.4900	1.5957	1.6389	0.0065	0.0070	0.0066
21	n-C6		86.18	4.8700	5.1899	5.3201	0.3804	0.3992	0.3855
22	224Trimethylp		114.24	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MW			118.42	124.12	126.36	38.50	41.82	39.40
	Stream Mole Ratio			1.0000	0.9335	0.9088	0.0665	0.0247	0.0912
	Heating Value	[BTU/SCF]					2191.53	2376.48	2241.63
	Gas Gravity	[Gas/Air]					1.33	1.44	1.36
	Bubble Pt. @ 100F	[psia]		87.81	30.61	18.84			
	RVP @ 100F	[psia]		35.40	20.39	15.59			
	Spec. Gravity @ 100F			0.700	0.705	0.708			

****
*   Project Setup Information   *
****

Project File	: Untitled.Ept
Flowsheet Selection	: Oil Tank with Separator
Calculation Method	: RVP Distillation
Control Efficiency	: 0.0%
Known Separator Stream	: Geographical Region
Geographical Region	: All Regions in US
Entering Air Composition	: No
Date	: 2013.08.13

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

Separator Pressure	: 54.00[psig]
Separator Temperature	: 60.00[F]
Ambient Pressure	: 14.70[psia]
Ambient Temperature	: 45.00[F]
C10+ SG	: 0.8680
C10+ MW	: 268.00

-- Low Pressure Oil --

No.	Component	mol %
1	H2S	0.0000
2	O2	0.0000
3	CO2	0.0800
4	N2	0.0000
5	C1	1.4800
6	C2	2.9100
7	C3	6.9600
8	i-C4	2.6300
9	n-C4	7.2100
10	i-C5	4.6400
11	n-C5	5.7100
12	C6	5.0100
13	C7	13.5500
14	C8	15.0600
15	C9	6.2300
16	C10+	18.8400
17	Benzene	0.5900
18	Toluene	2.5000
19	E-Benzene	0.2400
20	Xylenes	1.4900
21	n-C6	4.8700
22	224Trimethylp	0.0000

-- Sales Oil ---

Production Rate	: 100[bbl/day]
Days of Annual Operation	: 365 [days/year]
API Gravity	: 57.0
Reid Vapor Pressure	: 15.50[psia]

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

-- Emission Summary --

Item	Uncontrolled [ton/yr]	Uncontrolled [lb/hr]	Controlled [ton/yr]	Controlled [lb/hr]
Total HAPs	1.560	0.356	1.560	0.356
Total HC	146.885	33.535	146.885	33.535

VOCs, C2+	137.086	31.298	137.086	31.298
VOCs, C3+	103.265	23.576	103.265	23.576

Uncontrolled Recovery Info.

Vapor	7.8200	[MSCFD]
HC Vapor	7.7500	[MSCFD]
GOR	78.20	[SCF/bbl]

-- Emission Composition ---

No	Component	Uncontrolled [ton/yr]	Uncontrolled [lb/hr]	Controlled [ton/yr]	Controlled [lb/hr]
1	H2S	0.000	0.000	0.000	0.000
2	O2	0.000	0.000	0.000	0.000
3	CO2	1.448	0.331	1.448	0.331
4	N2	0.000	0.000	0.000	0.000
5	C1	9.800	2.237	9.800	2.237
6	C2	33.820	7.721	33.820	7.721
7	C3	53.491	12.213	53.491	12.213
8	i-C4	11.223	2.562	11.223	2.562
9	n-C4	21.375	4.880	21.375	4.880
10	i-C5	6.277	1.433	6.277	1.433
11	n-C5	5.502	1.256	5.502	1.256
12	C6	1.667	0.381	1.667	0.381
13	C7	1.542	0.352	1.542	0.352
14	C8	0.547	0.125	0.547	0.125
15	C9	0.078	0.018	0.078	0.018
16	C10+	0.000	0.000	0.000	0.000
17	Benzene	0.126	0.029	0.126	0.029
18	Toluene	0.154	0.035	0.154	0.035
19	E-Benzene	0.005	0.001	0.005	0.001
20	Xylenes	0.026	0.006	0.026	0.006
21	n-C6	1.251	0.286	1.251	0.286
22	224Trimethylp	0.000	0.000	0.000	0.000
	Total	148.332	33.866	148.332	33.866

-- Stream Data ---

No.	Component		MW	LP Oil mol %	Flash Oil mol %	Sale Oil mol %	Flash Gas mol %	W&S Gas mol %	Total Emissions mol %
1	H2S		34.80	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	O2		32.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	CO2		44.01	0.0800	0.0190	0.0003	0.9365	0.7054	0.8739
4	N2		28.01	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	C1		16.04	1.4800	0.1267	0.0000	20.4726	4.7879	16.2241
6	C2		30.07	2.9100	1.1651	0.2035	27.3993	36.5326	29.8732
7	C3		44.10	6.9600	5.2701	4.4246	30.6771	36.3677	32.2185
8	i-C4		58.12	2.6300	2.4583	2.3792	5.0393	5.3680	5.1283
9	n-C4		58.12	7.2100	7.0375	6.9532	9.6313	10.1352	9.7678
10	i-C5		72.15	4.6400	4.8078	4.8738	2.2855	2.3790	2.3109
11	n-C5		72.15	5.7100	5.9741	6.0798	2.0028	2.0862	2.0254
12	C6		86.16	5.0100	5.3299	5.4600	0.5205	0.5449	0.5271
13	C7		100.20	13.5500	14.4858	14.8677	0.4161	0.4391	0.4223
14	C8		114.23	15.0600	16.1239	16.5586	0.1286	0.1370	0.1309
15	C9		128.28	6.2300	6.6727	6.8537	0.0163	0.0187	0.0169
16	C10+		166.00	18.8400	20.1824	20.7311	0.0000	0.0000	0.0000
17	Benzene		78.11	0.5900	0.6290	0.6449	0.0422	0.0444	0.0428
18	Toluene		92.13	2.5000	2.6750	2.7465	0.0438	0.0465	0.0445
19	E-Benzene		106.17	0.2400	0.2570	0.2640	0.0012	0.0013	0.0013
20	Xylenes		106.17	1.4900	1.5957	1.6389	0.0065	0.0070	0.0066
21	n-C6		86.18	4.8700	5.1899	5.3201	0.3804	0.3992	0.3855
22	224Trimethylp		114.24	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MW			118.42	124.12	126.36	38.50	41.82	39.40
	Stream Mole Ratio			1.0000	0.9335	0.9088	0.0665	0.0247	0.0912
	Heating Value	[BTU/SCF]					2191.53	2376.48	2241.63
	Gas Gravity	[Gas/Air]					1.33	1.44	1.36
	Bubble Pt. @ 100F	[psia]		87.81	30.61	18.84			
	RVP @ 100F	[psia]		35.40	20.39	15.59			
	Spec. Gravity @ 100F			0.700	0.705	0.708			

```
******************************************************************************************
*     Project Setup Information                                                          *
******************************************************************************************
Project File              : Untitled.Ept
Flowsheet Selection       : Oil Tank with Separator
Calculation Method        : RVP Distillation
Control Efficiency        : 95.0%
Known Separator Stream    : Geographical Region
Geographical Region       : All Regions in US
Entering Air Composition  : No

Date                      : 2013.08.13


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

Separator Pressure        : 54.00[psig]
Separator Temperature     : 60.00[F]
Ambient Pressure          : 14.70[psia]
Ambient Temperature       : 45.00[F]
C10+ SG                   : 0.8680
C10+ MW                   : 268.00

-- Low Pressure Oil ----------------------------------------------------------------------
   No.    Component            mol %
   1      H2S                  0.0000
   2      O2                   0.0000
   3      CO2                  0.0800
   4      N2                   0.0000
   5      C1                   1.4800
   6      C2                   2.9100
   7      C3                   6.9600
   8      i-C4                 2.6300
   9      n-C4                 7.2100
   10     i-C5                 4.6400
   11     n-C5                 5.7100
   12     C6                   5.0100
   13     C7                  13.5500
   14     C8                  15.0600
   15     C9                   6.2300
   16     C10+                18.8400
   17     Benzene              0.5900
   18     Toluene              2.5000
   19     E-Benzene            0.2400
   20     Xylenes              1.4900
   21     n-C6                 4.8700
   22     224Trimethylp        0.0000

-- Sales Oil -----------------------------------------------------------------------------
Production Rate           : 100[bbl/day]
Days of Annual Operation  : 365 [days/year]
API Gravity               : 57.0
Reid Vapor Pressure       : 15.50[psia]


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

-- Emission Summary ----------------------------------------------------------------------
Item               Uncontrolled   Uncontrolled   Controlled   Controlled
                   [ton/yr]       [lb/hr]        [ton/yr]     [lb/hr]
Total HAPs         1.560          0.356          0.078        0.018
Total HC           146.885        33.535         7.344        1.677
```

VOCs, C2+	137.086	31.298	6.854	1.565
VOCs, C3+	103.265	23.576	5.163	1.179

Uncontrolled Recovery Info.

Vapor	7.8200	[MSCFD]
HC Vapor	7.7500	[MSCFD]
GOR	78.20	[SCF/bbl]

-- Emission Composition ---

No	Component	Uncontrolled [ton/yr]	Uncontrolled [lb/hr]	Controlled [ton/yr]	Controlled [lb/hr]
1	H2S	0.000	0.000	0.000	0.000
2	O2	0.000	0.000	0.000	0.000
3	CO2	1.448	0.331	1.448	0.331
4	N2	0.000	0.000	0.000	0.000
5	C1	9.800	2.237	0.490	0.112
6	C2	33.820	7.721	1.691	0.386
7	C3	53.491	12.213	2.675	0.611
8	i-C4	11.223	2.562	0.561	0.128
9	n-C4	21.375	4.880	1.069	0.244
10	i-C5	6.277	1.433	0.314	0.072
11	n-C5	5.502	1.256	0.275	0.063
12	C6	1.667	0.381	0.083	0.019
13	C7	1.542	0.352	0.077	0.018
14	C8	0.547	0.125	0.027	0.006
15	C9	0.078	0.018	0.004	0.001
16	C10+	0.000	0.000	0.000	0.000
17	Benzene	0.126	0.029	0.006	0.001
18	Toluene	0.154	0.035	0.008	0.002
19	E-Benzene	0.005	0.001	0.000	0.000
20	Xylenes	0.026	0.006	0.001	0.000
21	n-C6	1.251	0.286	0.063	0.014
22	224Trimethylp	0.000	0.000	0.000	0.000
	Total	148.332	33.866	7.417	1.693

-- Stream Data ---

No.	Component		MW	LP Oil mol %	Flash Oil mol %	Sale Oil mol %	Flash Gas mol %	W&S Gas mol %	Total Emissions mol %
1	H2S		34.80	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	O2		32.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	CO2		44.01	0.0800	0.0190	0.0003	0.9365	0.7054	0.8739
4	N2		28.01	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	C1		16.04	1.4800	0.1267	0.0000	20.4726	4.7879	16.2241
6	C2		30.07	2.9100	1.1651	0.2035	27.3993	36.5326	29.8732
7	C3		44.10	6.9600	5.2701	4.4246	30.6771	36.3677	32.2185
8	i-C4		58.12	2.6300	2.4583	2.3792	5.0393	5.3680	5.1283
9	n-C4		58.12	7.2100	7.0375	6.9532	9.6313	10.1352	9.7678
10	i-C5		72.15	4.6400	4.8078	4.8738	2.2855	2.3790	2.3109
11	n-C5		72.15	5.7100	5.9741	6.0798	2.0028	2.0862	2.0254
12	C6		86.16	5.0100	5.3299	5.4600	0.5205	0.5449	0.5271
13	C7		100.20	13.5500	14.4858	14.8677	0.4161	0.4391	0.4223
14	C8		114.23	15.0600	16.1239	16.5586	0.1286	0.1370	0.1309
15	C9		128.28	6.2300	6.6727	6.8537	0.0163	0.0187	0.0169
16	C10+		166.00	18.8400	20.1824	20.7311	0.0000	0.0000	0.0000
17	Benzene		78.11	0.5900	0.6290	0.6449	0.0422	0.0444	0.0428
18	Toluene		92.13	2.5000	2.6750	2.7465	0.0438	0.0465	0.0445
19	E-Benzene		106.17	0.2400	0.2570	0.2640	0.0012	0.0013	0.0013
20	Xylenes		106.17	1.4900	1.5957	1.6389	0.0065	0.0070	0.0066
21	n-C6		86.18	4.8700	5.1899	5.3201	0.3804	0.3992	0.3855
22	224Trimethylp		114.24	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MW			118.42	124.12	126.36	38.50	41.82	39.40
	Stream Mole Ratio			1.0000	0.9335	0.9088	0.0665	0.0247	0.0912
	Heating Value		[BTU/SCF]				2191.53	2376.48	2241.63
	Gas Gravity		[Gas/Air]				1.33	1.44	1.36
	Bubble Pt. @ 100F		[psia]	87.81	30.61	18.84			
	RVP @ 100F		[psia]	35.40	20.39	15.59			
	Spec. Gravity @ 100F			0.700	0.705	0.708			

NDCRS *ARCHEOLOGICAL* SITE FORM
PAGE 1

Field Code S-CW-1-CS7 **SITS# 32** DU 1891

SITE IDENTIFICATION

Map Quad String Buttes (1973) Site Name ______
Map Quad ______ Site Name ______

LTL	TWP	R	SEC	QQQ	QQ	Q
	148	92	4	6	8	5

Subsection:
1 = N½
2 = E½
3 = S½
4 = W½
5 = NE¼
6 = SE¼
7 = SW¼
8 = NW¼

UTM 5283217 N ZONE 13N
UTM 694966 E NAD 1927 ___ NAD 1983 ✓

SITE DATA

FEATURE TYPE

1 Cairn
___ Conical Timber Lodge
___ CM Scatter
___ Eagle Trapping/Catching Pit
___ Earthlodge Village
___ Earthworks
___ Fortification
___ Grave
___ Hearth
___ Jump
___ Mound
___ Other Rock Features
___ Pit
___ Quarry/Mine
___ Rock Art
___ Rock Shelter
___ Stone Circle
___ Trail
___ Miscellaneous

CULTURAL MATERIAL

___ Bone, Worked
___ Ceramics
___ Charcoal
___ Copper
___ Faunal Remains
___ Fire-Cracked Rock
___ Floral Remains
___ Fossil
___ Hide, Hair, Fur
___ Human Remains
___ Projectile Point
___ Shell, Worked
___ Stone, Chipped
___ Stone, Ground
___ Trade Good
___ Wood, Worked
___ Other
___ Isolated Find

31 Site Area (**m²**)
___ Cultural Depth
___ Depth Indicator
1 Basis for Dating
___ CM Density

Cultural/Temporal Affiliation

___ Paleo-Indian
___ Archaic
___ Woodland
___ Late Prehistoric
1 Period Unknown

ENVIRONMENT

Landform 1 1 Landform 2 10 Slope/Exposure 10 Ecosystem 7
Landform 1 ___ Landform 2 ___ Slope/Exposure ___ Ecosystem ___
Elevation 714 **m** Drainage System Missouri River
View Degree 4 View Distance 1
Distance to Permanent Water 6,000 **m** Permanent Water Type 1
Distance to Seasonal Water 500 **m** Seasonal Water Type 4

CRM

Ownership 5 Fieldwork Date 6/14/2013 Test/Probe ___ Excavation ___
Site Condition 6 Collection ___ Management Recommendation 5

Additional Information: One stone cairn on a ridgetop.

SHSND USE

Area of Significance ___ Ecozone ___ Verified Site ___ CR Type ___
Area of Significance ___ Ecozone ___ Non-Site ___
Area of Significance ___ Ecozone ___

Recorded By Scott Yost, Cole Wandler **Date Recorded** 6/14/2013
(First Name & Last Name) **(mm/dd/year)**

Instructions to complete a digital version of this form: (1) Download a copy to your hard drive; (2) Open the saved blank copy; (3) Fill out the form; (4) Use the Save As command to rename the form appropriately and save; (5) *Print* and submit to SHSND.

NDCRS *ARCHEOLOGICAL* SITE FORM
PAGE 2—*Descriptive Section*

Field Code S-CW-1-CS7 **SITS# 32** DU 1891

1. Access:

   From Manderee, North Dakota, take BIA 12 14.6 miles east. Then turn onto BIA 13 and travel 0.33 mile north. The site is apporoximately 250 meters west of BIA 13

2. *Site* Description (include features):

   S32DU1891 is a cairn of unknown cultural or temporal origin located on a prominent ridge surrounded by rolling grasslands. The ridge is approximately 8.6 kilometers south of the Lake Sakakawea portion of the Missouri River. A north-flowing unnamed intermittent drainage, which eventually empties into the lake, is located approximately 430 m west/southwest of the site. Local vegetation consists of little bluestem, prairie smoke, fringed sagebrush, and prairie coneflower, allowing for 15 to 25 percent bare ground surface visibility. Surface soil is pale yellow sandy loam formed through residual processes. The resource is in good condition with impacts to the site consisting of erosion, grazing, construction of a pipeline approximately 75 meters south of the site, and evidence of vehicle traffic near the site.

   (See Continuation Sheet)

3. Description of *Cultural Material* (quantify & identify artifacts, not features):

   No cultural material was observed on the site

0 # of Artifacts ____ # of Artifacts Collected

4. Artifact Repository:

   N/A

Recorded By Scott Yost, Cole Wander **Date Recorded** 6/14/2013
(First Name & Last Name) **(mm/dd/year)**

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NDCRS *ARCHEOLOGICAL* SITE FORM
PAGE 3—*Descriptive Section*

Field Code S-CW-1-CS7 **SITS# 32** DU 1891

5. Description of Subsurface Testing:

N/A

6. Field Conditions:
Wet ___ Dry ✓ Windy ___ Rainy ___
Snowy ___ Overcast ___ Sunny ✓ Twilight ___

7. Technique(s) Used to Estimate Site Area:
Transit ___ Tape Measure ___ Paced ___ Visual Estimate ___
GPS ✓ Other (Explain) ___

8. Rationale for Site Boundary Determination:
Surface Cultural Materials ___ Features ✓ Topography ___
Continuous Stratigraphic Exposure ___ Systematic Subsurface Probing ___
Subsurface Testing ___ Other (Explain) ___

9. Current Use of Site: Rangeland

10. Landowner Contact Information: Bureau of Indian Affairs, -202 Main St.- New Town, ND -58763

11. Vegetation: Little bluestem, Prairie-smoke, Fringed sagebrush, Prairie coneflower.

12. Vegetation Cover (% of visible ground): 20

13. Snow Cover (% of ground obscured by snow/ice): 0

14. Person-Hours Spent at Site: 1

15. Project Title & Principal Investigator:

Arrow Compressor Station #7
William Harding

Recorded By Scott Yost, Cole Wander **Date Recorded** 6/14/2013
(First Name & Last Name) **(mm/dd/year)**

Instructions to complete a digital version of this form: (1) Download a copy to your hard drive; (2) Open the saved blank copy; (3) Fill out the form; (4) Use the Save As command to rename the form appropriately and save; (5) *Print* and submit to SHSND.

NDCRS *ARCHEOLOGICAL* SITE FORM
PAGE 4—*Descriptive Section*

Field Code S-CW-1-CS7 **SITS# 32** DU 1891

16. Report Title & Author(s):

A Class I and Class III Cultural Resource Inventory of the Arrow Compressor Station #7, Fort Berthold Indian Reservation, Dunn County, North Dakota
Authors: Jolene Schleicher and Scott Yost

17. Description of Collection(s) Observed & Contact Information:

N/A

18. Statement of Integrity:

32DU1891 is a stone cairn of unknown cultural or temporal origin located on top of a prominent ridgeline. It retains integrity of location, design, setting, material, and workmanship, though feeling and association have been impacted by modern oil and gas disturbances in the surrounding area. There has been minimal disturbance from erosion through aeolian and colluvial processes.

19. Statement of Significance:

Due to the presence of a cultural feature that may be considered of a sacred nature, it is recommended that the site remain unevaluated regarding its eligibility for listing on the NRHP under Criterion A, pending tribal consultation. Historical research did not return any information connecting the property to any person or persons significant in our past; therefore, SWCA recommends the site not eligible for nomination to the NRHP under Criterion B. No standing structures remain on site; therefore, SWCA recommends the site not eligible for nomination to the NRHP under Criterion C. Though the feature is only lightly sodded, the potential for the site to contain buried cultural deposits exists; however, shovel testing was not conducted by project design. Therefore, SWCA recommends the site remain unevaluated regarding its eligibility for listing on the NRHP under Criterion D, pending subsurface testing.

20. References Cited/Comments:

See Continuation Sheet

Recorded By Scott Yost, Cole Wander **Date Recorded** 6/14/2013
(First Name & Last Name) **(mm/dd/year)**

Instructions to complete a digital version of this form: (1) Download a copy to your hard drive; (2) Open the saved blank copy; (3) Fill out the form; (4) Use the Save As command to rename the form appropriately and save; (5) *Print* and submit to SHSND.

NDCRS SITE FORM
CONTINUATION PAGE

Field Code S-CW-1-CS7 **SITS# 32** DU

Complete a *Continuation Page(s)* for information that does not fit in the space available on other sections of a Site Form.

Site Description (Continued)

SWCA identified and recorded 32DU1891 on June 14, 2013. The site consists of a single, oval-shaped stone cairn (Feature 1), measuring 330 by 220 centimeters (cm) and 45 cm in height, positioned on a prominent ridgeline overlooking a valley to the north. The cairn is very well defined and lightly sodded, consisting of more than 60 tabular sandstone rocks ranging in size from 5 to 70 cm exhibiting up to 90 percent surface coverage by black and orange lichen. The feature is fairly well preserved with a few stones scattered down the slope. Judging by the construction techniques, it may have once been a "pillared" cairn. No cultural materials were observed in association with the cairn.

Historic Background Research

SWCA completed a land records search for the delimited parcel encompassing the site area using Bureau of Land Management-General Land Office records (BLM-GLO). The search was conducted in order to gain a better understanding of the land use associated with the site location. The search indicated a serial land patent was issued to Emma M. Baker for Lot 2 (NW¼ NE¼) of Section 4, T148N, R92W on August 29, 1924 (BLM 2013 [1916]:Accession Number 943491).

Emma M. Baker was born in 1917 on the Fort Berthold Indian Reservation, and by the time the 1924 Indian Census was taken, her name had changed to Emma Jane Baker (United States Indian Census Schedules 1924: Roll: M595_134; Line: 16). At the time the patent was issued, Emma Jane Baker (formerly Emma M. Baker) would have been approximately seven years old and was living with her father, James Baker; her mother, Ethel T. Baker; and her six brothers and sisters (United States Indian Census Schedules 1924: Roll: M595_134; Line: 16). In 1935, Emma Jane Baker married Felix Huber (United States Indian Census Schedules 1936: Roll: M595_136; Page: 62; Line: 3). It could not be determined through any available records whether or not Emma Jane Huber (nee Baker) or her family lived on the property or if she is associated with the site.

References Cited

Bureau of Land Management
2013 Bureau of Land Management: General Land Office Records. Online database available at http://www.glorecords.blm.gov/default.aspx. Accessed on July 8, 2013.

United States Indian Census Schedules
1924 Indian Census Rolls, 1885-1940, 1910, M595, 692 rolls. Records of the Bureau of Indian Affairs, Record Group 75. National Archives and Records Administration, Washington D.C.

1936 Indian Census Rolls, 1885-1940, 1910, M595, 692 rolls. Records of the Bureau of Indian Affairs, Record Group 75. National Archives and Records Administration, Washington D.C.

Recorded By Scott Yost, Cole Wandler **Date Recorded** 6/14/2013
(First Name & Last Name) **(mm/dd/year)**

Instructions to complete a digital version of this form: (1) Download a copy to your hard drive; (2) Open the saved blank copy; (3) Fill out the form; (4) Use the Save As command to rename the form appropriately and save; (5) *Print* and submit to SHSND.

NDCRS SITE FORM *ATTACHMENTS SECTION*

Field Code: S-CW-1-CS7 **SITS# 32DU1891**

Figure 1: 32DU1891 site overview, facing north.

Figure 2: 32DU1891, feature 1, cairn, facing east.

Recorded By: Scott Yost, Cole Wandler **Date Recorded**: 6/14/2013

Field Code: S-CW-1-CS7 **SITS# 32DU1891**

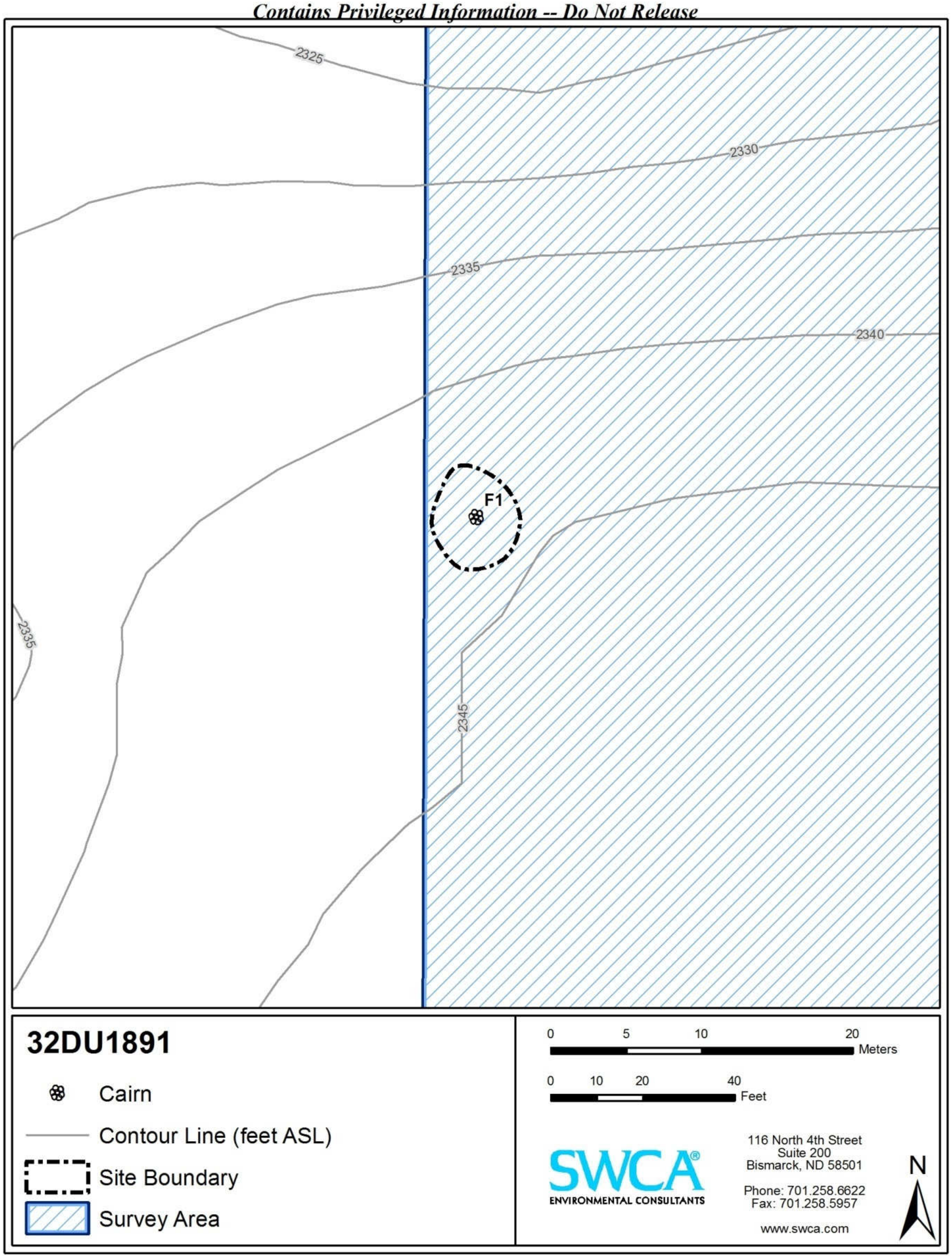

Figure 3: Sketch map of site 32DU1891.

Recorded By: Scott Yost, Cole Wandler **Date Recorded**: 6/14/2013

Field Code: S-CW-1-CS7 **SITS# 32DU1891**

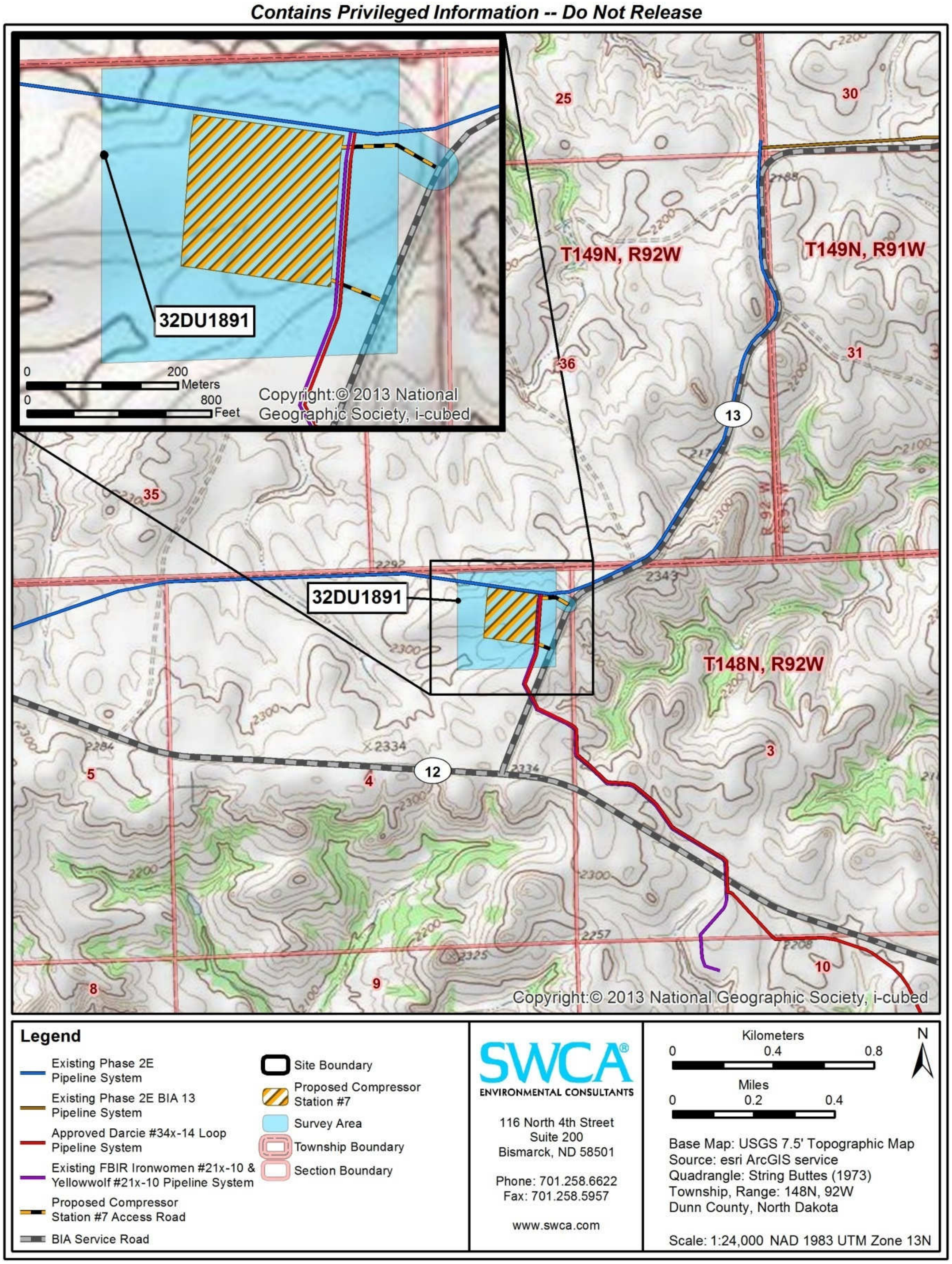

Figure 4: Topographic map showing location of 32DU1891.

Recorded By: Scott Yost, Cole Wandler **Date Recorded**: 6/14/2013

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A Class I and Class III Cultural Resource Inventory of the Arrow Compressor Station #7, Fort Berthold Indian Reservation, Dunn County, North Dakota

Prepared for

Arrow Pipeline, LLC

Prepared by

SWCA Environmental Consultants

August 2013

MANUSCRIPT DATA RECORD FORM

1. Manuscript Number:
2. SHPO Reference #:
3. Author(s): Jolene Schleicher and Scott Yost
4. Title: A Class I and Class III Cultural Resource Inventory of the Arrow Compressor Station #7, Fort Berthold Indian Reservation, Dunn County, North Dakota
5. Report Date: August 22, 2013
6. Number of Pages: 70
7. Type – I, T, E, O: I
8. Acres: 39.28
9. Legal Location(s) (no quarter sections) with Historic Context Study Unit(s): Consult the township tables in *The North Dakota Comprehensive Plan for Historic Preservation: Archeological Component*, (SHSND 2008; available online at http://history.nd.gov/hp/hpforms.html) for Study Unit assignments.
   Study Units: LM, CB, KN, HE, SM, GA, JA, GR, NR, SR, SO, SH, YE

COUNTY	TWP	RNG	SEC	SU
Dunn	148N	92W	3, 4	LM

A Class I and Class III Cultural Resource Inventory of the Arrow Compressor Station #7, Fort Berthold Indian Reservation, Dunn County, North Dakota

Submitted to:

Bureau of Indian Affairs – Great Plains Regional Office

Prepared for:

Arrow Pipeline, LLC
6100 S. Yale Avenue, Suite 1700,
Tulsa, Oklahoma 74136

Prepared by:

Jolene Schleicher and Scott Yost

Principal Investigator:

William Harding

SWCA Environmental Consultants
116 North 4th Street, Suite 200
Bismarck, North Dakota 58501
(701) 258-6622

www.swca.com

SWCA Cultural Resource Report No. 13-326

August 22, 2013

ABSTRACT

SWCA Environmental Consultants (SWCA) conducted a Class I and Class III cultural resource inventory on behalf of Arrow Pipeline, LLC, (Arrow) for the proposed Arrow Compressor Station #7 project in Dunn County, North Dakota, on April 8, 2013, and on June 14 and August 13, 2013, respectively. Arrow proposes to construct a single compressor station within the inventoried area. The compressor station would disturb approximately 11.58 acres and would support the existing Arrow Phase 2E pipeline system and associated lateral pipelines. Additionally, Arrow proposes to construct two 66-foot-wide access roads, a "north" and "south" access road. The north access road would be approximately 381.2 feet long and would disturb approximately 0.58 acre, and the south access road would be approximately 175.4 feet long and would disturb approximately 0.26 acre. Total disturbance for the proposed project would be approximately 12.42 acres. The project is located within the boundaries of the Fort Berthold Indian Reservation (FBIR) on allotted lands managed by the Bureau of Indian Affairs (BIA) Great Plains Regional Office (GPRO).

The Class III inventory, located in Sections 3 and 4 of Township 148 North, Range 92 West, consists of a 38.07-acre block surrounding the proposed compressor station. The south access road is completely contained within the block survey area. A 1.21-acre survey area extends outside of the block survey area to cover the north access road. In total, 39.28 acres were inventoried.

During the inventory, SWCA archaeologists newly recorded one cultural resource (32DU1891). A cairn of unknown cultural or temporal origin, 32DU1891 is unevaluated regarding its eligibility for listing on the National Register of Historic Places (NRHP). Therefore, avoidance of the site is recommended, pending tribal consultation and subsurface testing. Located approximately 359 feet west of the proposed compressor station disturbance, 32DU1891 is therefore adequately avoided. No further work is recommended for the site at this time. SWCA recommends a determination of *No Historic Properties Affected* to be granted and for the project to proceed as planned.

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INTRODUCTION

SWCA Environmental Consultants (SWCA) conducted a Class I and Class III cultural resource inventory on behalf of Arrow Pipeline, LLC, (Arrow) for the proposed Arrow Compressor Station #7 project in Dunn County, North Dakota. Arrow proposes to construct one compressor station within the inventoried area, located on allotted lands within the exterior boundaries of the Fort Berthold Indian Reservation (FBIR), managed by the Bureau of Indian Affairs (BIA) Great Plains Regional Office (GPRO). The compressor station would support the existing Phase 2E pipeline system and associated lateral pipelines. Surface disturbance associated with the development of the compressor station is anticipated to be approximately 11.58 acres. Additionally, Arrow proposes to construct two 66-foot-wide access roads, a "north" and "south" access road. The north access road would be approximately 381.2 feet long and would disturb approximately 0.58 acre, and the south access road would be approximately 175.4 feet long and would disturb approximately 0.26 acre. Total disturbance for the proposed project would be approximately 12.42 acres. Proposed project vehicle traffic would be limited to existing upgraded roads and the proposed access roads, and all construction activities would remain within the inventoried area.

The Class III inventory was conducted by SWCA archaeologists on June 14 and August 13, 2013, and consisted of a 38.07-acre survey block surrounding the proposed compressor station and encompassing the south access road and a portion of the north access road. A 1.21-acre survey area extends outside of the block survey area to cover the remaining portion of the north access road. In total, 39.28 acres were inventoried. The inventory area is located approximately 13 miles southeast of Mandaree, North Dakota, in the SW¼ NW¼ NW¼ of Section 3 and the N½ SE¼ NE¼, NE¼ NE¼, E½ NW¼ NE¼, NE¼ SW¼ NE¼ of Section 4, Township (T) 148 North (N), Range (R) 92 West (W) (Figure 1). The project area is situated on the String Buttes, North Dakota, (1973) U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle.

Though the location of the proposed compressor station is largely undisturbed, the inventory area is bisected by the Phase 2E pipeline system on the north, the FBIR Ironwoman #21x-10 & Yellowwolf #21x-10 pipeline system on the east, and BIA Road 13 on the southeast and eastern most end of the north access road.

For the cultural resource investigation, William Harding served as principal investigator. Cole Wandler, Scott Yost, and Craig Picka, SWCA archaeologists, completed all fieldwork. Tribal monitors for the Three Affiliated Tribes Tribal Historic Preservation Office (TAT–THPO) were not in attendance during survey, and they were invited to the on-site visit with the BIA on June 18, 2013, but declined to attend. All field notes and photographs are on file at SWCA's Bismarck, North Dakota, office under project number 16599. The BIA–GPRO is the lead federal agency for this undertaking.

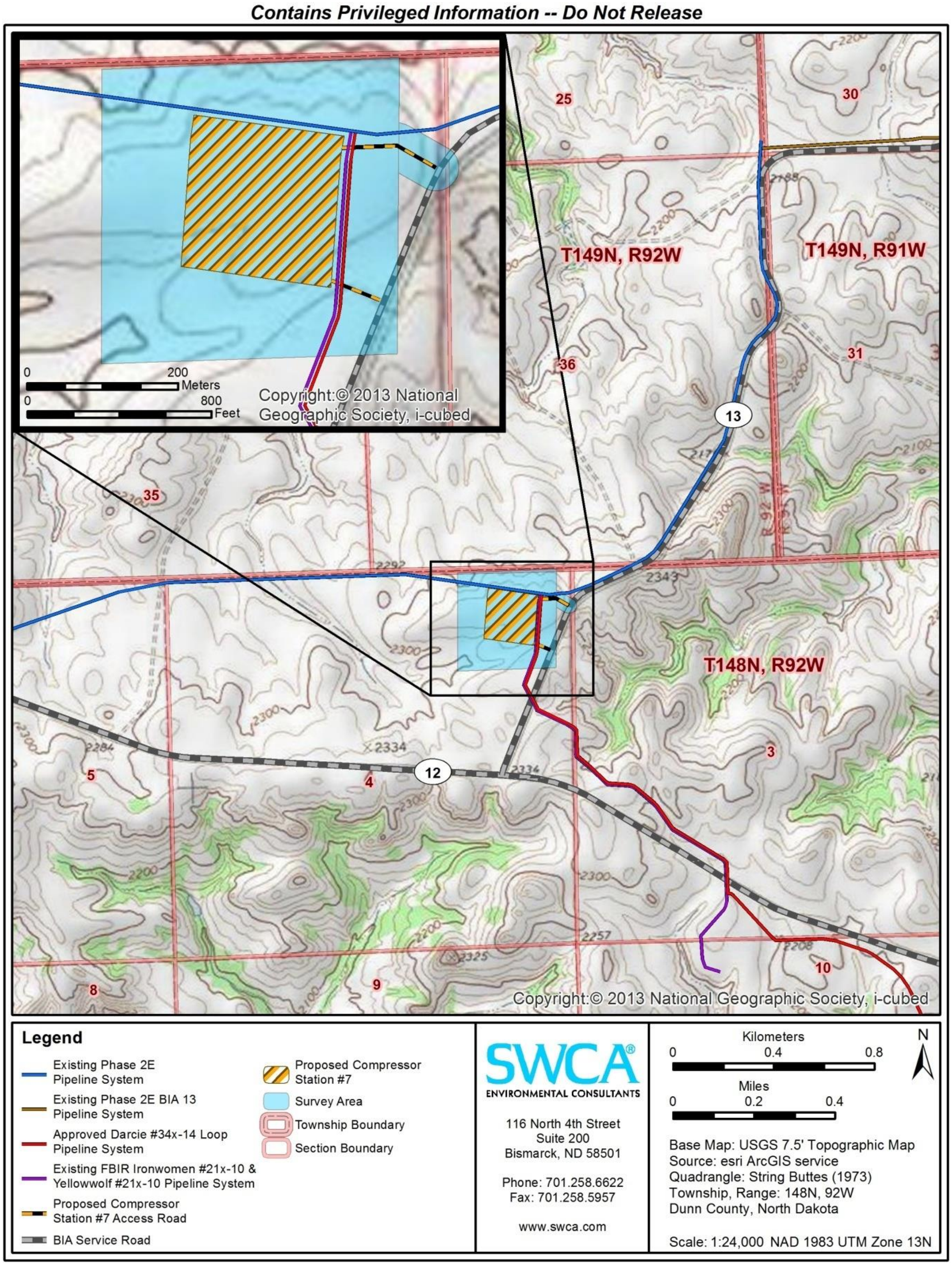

Figure 1. Project area map.

PROJECT SETTING

TOPOGRAPHY

The project area is located in the unglaciated Missouri Plateau section of the Great Plains physiographic province in west-central North Dakota and is characterized by old plateaus and isolated mountains (Fenneman 1931). The project area is located in the River Breaks portion of the Northwestern Great Plains ecoregion, which comprises semiarid rolling plains of shale, siltstone, and sandstone, with the occasional butte and badland (Bryce et al. 1998). Additionally, the River Breaks, formed by soft, easily erodible strata, consist of broken terraces and uplands that descend into the Missouri River and its tributaries (Bryce et al. 1998). The project area is located on top of a broad, rolling ridge line, surrounded by ephemeral drainages that all drain into unnamed tributaries of the Lake Sakakawea portion of the Missouri River (Figure 2). The elevation in the project area ranges from approximately 2,280 to 2,350 feet, with the highest elevations in the central portions of the project area.

Figure 2. Project area overview, depicting general topography of the project area, facing southwest.

CLIMATE

The climate for west-central North Dakota is temperate. Based on climatic data collected from Dunn Center 2 SW, North Dakota, between 1971 and 2000, January is the coldest month, with a mean daily temperature of 12.8 degrees Fahrenheit (°F), while July is the warmest month, with a mean daily temperature of 70.2°F (National Climatic Data Center [NCDC] 2013). Temperature extremes on record range from -46°F at the coldest to 110°F at the warmest. On average, 137 days are frost-free (28°F or above); the average date of the first fall frost is September 27 and the average date of the last spring frost is May 12 (North Dakota

Agricultural Statistics Service 2009). Per annum, Dunn Center receives 16.36 inches of precipitation (NCDC 2013). The wettest month is June, with an average of 3.26 inches of precipitation received; December is the driest, with only 0.39 inch of precipitation received on average. Thirty-seven inches of snow are received annually, on average, with the highest accumulations (7.2 inches, on average) received in March (NCDC 2013). The highest monthly snow fall on record occurred in March, at which time 32.0 inches of snow fell. Overall, west-central North Dakota, like much of the northwestern Great Plains, has a moderate to cool climate, with cold, dry winters and mild to warm, dry to moderately wet summers.

HYDROLOGY

The project area is located on a broad rolling ridgetop with unnamed drainages 0.17 mile to the southeast, 0.5 mile to the northeast, 0.35 mile to the north, and 0.22 mile to the west/southwest. All of the drainages flow northeast or north, eventually draining into the Lake Sakakawea portion of the Missouri River, approximately 3 miles west of the project area.

GEOLOGY

In general, the geology of the project area is characterized by the Paleocene-age Sentinel Butte Formation. The Sentinel Butte Formation consists of gray/brown silt, sand, clay, sandstone, and lignite riparian and swamp sediments that are up to 600 feet thick (Clayton 1980).

SOILS

Four soil series, including the Cohagen-Vebar fine Sandy loams, Vebar-Parshall fine sandy loams, Vebar fine sandy loams, and Flaxton-Williams complex, are present in the project area (Natural Resources Conservation Service [NRCS] 2013); however, the dominant soil materials are coarse-loamy residuum, weathered from sandstone or calcareous sandstone, found on hills and ridges. Table 1 summarizes the soils within the project area, in order of greatest prevalence.

Table 1. Summary of Soil Series within the Project Area

Soil Series	Parent Material	Drainage	Slope	Landform
Cohagen-Vebar fine Sandy loams	Coarse-loamy residuum weathered from sandstone; coarse-loamy residuum weathered from calcareous sandstone	Well-drained	9%–25%	Hills, ridges
Vebar-Parshall fine sandy loams	Coarse-loamy residuum weathered from calcareous sandstone; coarse-loamy residuum derived from sedimentary rock	Well-drained	6%–9%	Hills, ridges
Vebar fine sandy loams	Coarse-loamy residuum weathered from calcareous sandstone	Well-drained	9%–15%	Hills, ridges

Soil Series	Parent Material	Drainage	Slope	Landform
Flaxton-Williams complex	Aeolian deposits over fine-loamy till	Well-drained	0%–6%	Rises

Source: NRCS 2013.

FLORA AND FAUNA

The project area is situated within the River Breaks portion of the northwestern Great Plains ecoregion, characterized by native grasslands over rolling plains (Figure 3). Common vegetation within this ecoregion includes such species as blue grama (*Bouteloua gracilis*), western wheatgrass (*Pascopyrum smithii*), buffalograss (*Buchloe dactyloides*), and some bluestem (*Schizachyrium scoparium*) (Bryce et al. 1998). Additionally, juniper (*Juniperus scopulorum*) and deciduous trees are found on north-facing slopes, and cottonwoods (*Populus deltoides*) are found in floodplains (Bryce et al. 1998). Vegetation observed within the project area includes mixed grasses, yarrow (*Achillea millefolium*), fringed sagebrush (*Artemisia frigida*), prairie coneflower (*Ratibida columnifera*), purple coneflower (*Echinacea angustifolia*), and prairie smoke (*Geum triflorum*), allowing for 0 to 30 percent bare ground surface visibility across the project area.

Figure 3. Overview of the vegetation characteristic of the project area, facing southeast.

Approximately 160 wildlife species are resident or seasonal visitors to the Missouri River ecosystem, and hundreds of native fish species live in the mainstream and tributaries. Some of the animal species that would have been common and available for human use in the Missouri River Valley area—both prehistorically and historically—include fur-bearing mammals such as beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), eastern cottontail (*Sylvilagus floridanus*), elk (*Cervus elaphus*), moose (*Alces alces*), mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), pronghorn (*Antilocapra americana*), and bison (*Bison bison*), as well as bird and waterfowl species such as mallard (*Anas platyrhynchos*), Canada goose (*Branta canadensis*), sharp-tailed grouse (*Tympanuchus phasianellus campestris*), golden eagle (*Aquila chrysaetos*), and bald eagle (*Haliaeetus leucocephalus*) (Seabloom et al. 1978). At present, one federally listed threatened species resides in the area—piping plover (*Charadrius melodus*)—and five federally listed endangered species inhabit the area, including the interior least tern (*Sterna antillarum*), pallid sturgeon (*Scaphirhynchus albus*), whooping crane (*Grus americana*), black-footed ferret (*Mustela nigripes*), and gray wolf (*Canis lupus*) (U.S. Fish and Wildlife Service 2013). Additionally, Sprague's pipit (*Anthus spragueii*) and Dakota skipper (*Hesperia dacotae*) reside in the area and are federal candidates for endangered species listing (U.S. Fish and Wildlife Service 2013).

ENVIRONMENTAL CONSTRAINTS

Preservation of archaeological materials within or adjacent to the project area has been affected largely by oil and gas development. Secondary sources of impact to archaeological resources in the general vicinity of the project area include: natural erosion, including ongoing aeolian and hydrological processes; livestock grazing; and prairie dog bioturbation.

Oil and gas development has occurred adjacent to and within the project area and is presently increasing as demand for domestic energy sources has grown in recent years. An existing upgraded road and pipelines bisect the project area, and well pads and additional infrastructure are in the surrounding area. In some places, these varied land uses have resulted in increased ground visibility and removal of overburden, allowing for the identification of numerous sites and an interpretation of high site density. In other cases, these impacts have simply removed the archaeological materials and resulted in an interpretation of low site densities. In combination, these factors may have disrupted the contexts of a moderate percentage of cultural materials.

CULTURAL/HISTORICAL OVERVIEW

PREHISTORIC CONTEXTS

The following discussion incorporates a variety of sources to develop a prehistoric overview for the work conducted for this project and includes information from the Little Missouri River Study Unit (LMRSU) in which the project area is located (Gregg and Bleier 2008). As of 2007, 2,329 archaeological sites were identified in the LMRSU, the majority of which were identified on ridges (35.8 percent); hills, bluffs, and knolls (21.2 percent); and terraces (17.8 percent) (Gregg and Bleier 2008).

Paleoindian Tradition (ca. 11,500–7,900 years before present [B.P.])

Although speculation exists regarding the possibility of earlier habitation of the Great Plains, the Paleoindian tradition is the oldest of the region and, in general, is associated with a hunting and gathering adaptation (Gregg 1985). The Paleoindian tradition is subdivided here into six main complexes: Clovis, Goshen, Folsom, Hell Gap/Agate Basin, Alberta/Cody, and Parallel Oblique Flaked. In total, 30 Paleoindian archaeological resources have been identified in the LMRSU (Gregg and Bleier 2008).

The Clovis complex (ca. 11,500–10,800 B.P.), defined by large, fluted lanceolate projectile points, is the earliest unequivocal complex in North America. Clovis artifacts have been found with megafauna, such as mammoth, in buried contexts in the Southwest and Great Plains (Grayson and Meltzer 2002); although megafauna were probably dietary constituents, it is debated to what degree Early Paleoindians pursued large game (Cannon and Meltzer 2004; Grayson and Meltzer 2002). Few Clovis sites have been recorded in the region and only one Clovis archaeological resource has been identified in the LMRSU (Gregg and Bleier 2008). In the South Dakota Badlands, the Lange-Ferguson site yields the best evidence for proboscidean exploitation (Hannus 1990). Here, modified mammoth bones are directly associated with a flake and three projectile points that were recovered from deposits similar to those containing mammoth, indicating that Clovis hunter-gatherers either killed the animals or scavenged their carcasses (Hannus 1990).

Goshen (ca. 10,900–10,100 B.P.) is a technological complex first identified at Hell Gap, Wyoming (Irwin 1967, 1971), but it is also found at Mill Iron, Montana; Carter-Kerr/McGee, Wyoming; and the Jim Pitts site, located in the South Dakota Black Hills (Sellet 2001). Goshen is poorly understood—the basally thinned, unfluted projectile points share affinities with both Clovis and Folsom, but are also similar to Southern Plains Plainview points. In stratified deposits, Goshen materials typically underlie Folsom (Frison et al. 1996). No Goshen material has been identified in the LMRSU (Gregg and Bleier 2008).

The Folsom complex (ca. 10,900–10,200 B.P.) is typified by distinctive fluted lanceolate projectile points. With most large grazers extinct by Folsom times and grasslands dominating the Great Plains, bison populations flourished, providing resources for Folsom hunters (Frison 1991). However, many high-elevation Folsom sites also demonstrate broad diets of diverse small prey (Hill 2007). Probable structures recorded at the Mountaineer and Barger Gulch sites in Colorado suggest long-term occupations in mountain settings (Stiger 2006; Surovell and Waguespack 2007). In North Dakota, there are numerous documented Folsom sites (Gregg 1985), including the Bobtail Wolf (32DU955A), Big Black (32DU955C), and Young-Man-Chief (32DU955D) sites (Root 2000; Shifrin 2000; William 2000). These sites are interpreted as camps, quarries, and lithic workshops where Knife River flint was procured and used for tool production. In the LMRSU, three Folsom archaeological resources have been identified (Gregg and Bleier 2008).

Both the Agate Basin (ca. 10,500–10,000 B.P.) and Hell Gap (ca. 10,000–9,500 B.P.) technocomplexes are typified by lanceolate projectile points with thick lenticular cross-sections (Frison 1991). Based on morphological similarities and stratigraphic evidence, Hell Gap is technologically descended from Agate Basin. Agate Basin and Hell Gap hunter-gatherers were probably specialized bison hunters. Sites like Agate Basin II (Hill 2001) and Casper (Todd et al. 1997) indicate more frequent extraction of marrow and within-bone nutrients, suggesting a greater focus on planning than previously evident. Some sites associated with this tradition have been recorded in North Dakota and South Dakota, but these mainly consist of isolated and surface finds (Gregg 1985). A Hell Gap/Agate Basin-style projectile point was identified at 32MZ1447 (Klinner and Wermers 2000).

Alberta (9800–9000 B.P.) is a poorly dated technology that probably descends from Hell Gap and is documented at the Hell Gap, Wyoming, and Hudson-Meng, Nebraska, sites (Agenbroad 1978; Frison 1991). Hudson-Meng is one of the largest documented bison kill sites and suggests that Alberta people focused on bison hunting (Agenbroad 1978); however, more recent work suggests that humans were not responsible for killing the bison and that they died of a natural event (Todd and Rapson 1999). The Cody complex (9200–8800 B.P.), which includes stemmed/shouldered Eden and Scottsbluff projectile points and the distinctive Cody knife, apparently arose from Alberta (Frison 1991). These sites are widespread across the northwestern and central Great Plains, with components at the Wyoming Horner I, Finley, and Medicine Lodge Creek sites (Frison and Todd 1986; Frison and Walker 2007) and the Mammoth Meadows, Myers-Hindman, and MacHaffie sites in Montana (Davis 1993). Such sites indicate that Cody adaptations were diverse and utilized large fauna as well as small prey and floral resources (Frison et al. 1996; Galvan 2007). Alberta/Cody sites have been recorded in North Dakota and South Dakota. In fact, Hudson-Meng contains a substantial amount of Knife River flint, showing a strong connection to the Missouri River region.

The Parallel Oblique Flaked complex is a catch-all grouping of Paleoindian projectile point types (Gregg 1985) including Angostura, Milnesand, Browns Valley, Lusk, Allen, and Frederick; these range in age from around 9400 to 7900 B.P. All types are lanceolate with parallel oblique flaking. Bison kill-butcheries became rare on the northwestern and northern Great Plains after approximately 8000 B.P. (Frison 1998), perhaps due to severe ecological deterioration that could no longer support large bison populations. In the LMRSU, 14 archaeological resources defined under the general Plano category have been identified (Gregg and Bleier 2008).

Plains Archaic Tradition (ca. 8000–1500 B.P.)

The transition from Paleoindian to Archaic is archaeologically visible as an abrupt shift to large notched projectile points (Frison 1991), perhaps indicating a shift to atlatl-propelled darts from hand-thrown spears. This transition is also associated with warming/drying trends that prompted diverse subsistence adaptations among hunter-gatherers (Carlson 1994). Ground stone appears in the Archaic, suggesting a greater focus on processing floral resources. In conjunction with the appearance of pithouses and storage pits in the western intermontane basins, this suggests a shift in subsistence base, a reduction in overall residential mobility, and more predictable seasonal rounds (Frison 1991). In the LMRSU, 241 Archaic archaeological resources have been identified (Gregg and Bleier 2008).

The Logan Creek/Mummy Cave complex (5700–4000 B.P.) is the earliest example of large side-notched projectile points on the northern Great Plains. The blending of the Logan Creek and Mummy Cave for this complex is due to regionally varied nomenclature used among archaeologists for similar archaeological complexes (Gregg 1985). Settlement types associated with this complex include bison kills, transient camps, and some stone circle sites. Twenty-three archaeological resources containing large side-notched projectile point varieties have been identified in the LMRSU (Gregg and Bleier 2008).

The Oxbow complex (5600–3500 B.P.), typified by side-notched, deeply concave-based projectile points, is concentrated in northern Montana, Alberta, and Saskatchewan (Hannus 1994), but is also quite common in North Dakota and South Dakota, with numerous sites along the Missouri River and its tributary system. Oxbow subsistence apparently centered on bison and sites include bison impoundments and jumps, encampments on stream terraces, stone circles, and processing areas (Hannus 1994; Reeves 1969). However, numerous birds and small mammals were probably exploited (Aaberg et al. 2006). Some northern Great Plains sites further yield evidence of complex cultural behavior, including bundle burials with elaborate grave goods (Bryan 1991). Fifteen Oxbow archaeological resources have been identified in the LMRSU (Gregg and Bleier 2008), including three subsurface Oxbow projectile points that were found at 32MZ1184 (Borchert and Wermers 1994).

The McKean complex (ca. 4500–3400 B.P.) encompasses three distinct subphases—the McKean lanceolate, Duncan, and Hannah. The McKean complex is widespread across the Great Plains, and sites from this period can be found associated with bison kills, stone circles, lithic caching, and seasonal settlements (Frison 1991). Slab-lined pit hearths are common, as are ground stone artifacts, suggesting a greater reliance on plant resources (Carlson 1994; Frison 1991). McKean complex sites often demonstrate evidence of lithic raw material exchange, including Swan River chert, Tongue River silicified sediment, and Knife River flint (Gregg 1985). In the LMRSU, 70 archaeological resources dating to the McKean complex have been identified (Gregg and Bleier 2008), including four McKean lanceolate points that were recovered from the Big Gulch–Chase site (32DU273) (Artz et al. 1983).

Pelican Lake (ca. 3000–2700 B.P.), typified by broad, thin corner-notched projectile points, is likely a descendant of McKean and is found across the northern and central Great Plains (Frison 1991). This wide spatial distribution may indicate significant population growth in response to the favorable moist conditions of the Sub-Atlantic episode (Reeves 1983). Numerous communal bison kills, such as Head-Smashed-In (Frison 1991), indicate communal bison hunting, but this does not suggest it was an exclusive feature of their subsistence. Rather, Pelican Lake populations probably relied on a broad-based economy across diverse ecozones (Hannus 1994). Sixty-three Pelican Lake archaeological resources have been identified in the LMRSU (Gregg and Bleier 2008). These include the Sunday Sage site (32BI22) (Simon and Borchert 1981b) and Ice Box Canyon Ridge site (32MZ38) (Simon and Borchert 1981a).

Plains Woodland Tradition (ca. 2000–450 B.P.)

Temporally overlapping with the Northwestern Plains Late Archaic, the Plains Woodland is characterized by increased sedentism, garden horticultural activity, expanding regional exchange networks with eastern Woodland populations (Adena and Hopewell), and the elaboration of ceremonial activities and mortuary practices—specifically, mound burials (Griffin 1967). Significant technological advances such as bow and arrow and ceramics use are also apparent (Gregg 1985); however, the fundamental subsistence strategies of the Plains Woodland did not drastically differ from their Archaic predecessors (Zimmerman 1985). It is assumed that this tradition saw the beginning of horticultural practices in the region. For the purposes of this study, the complexes that are classed as belonging to the Plains Woodland include Besant, Sonota, Laurel, Avonlea, Old Woman’s, and Blackduck.

The Besant complex (ca. 2000–1500 B.P.), typified by small- to medium-sized side-notched triangular projectile points, represents the earliest presence of ceramics in North Dakota, probably resulting from eastern woodland influence (Walde 2006). Besant ceramics are more common in the eastern half of the Dakotas; the vessels show a basic conoidal shape and suggest lump modeling manufacture with some coarse cording (Wood and Johnson 1973). Besant sites show extensive use of Knife River flint (Reeves 1970). Site types include stone circle sites, habitations on stream and river terraces, and bison kills. Numerous communal kill sites, including the Ruby bison pound in Wyoming (Frison 1991), suggest that Besant people were sophisticated bison hunters. The Sonota complex (1850–1350 B.P.) appears to be a possible subcomplex of Besant, but differs in that burial mounds are common at Sonota sites (Reeves 1983; Wood 1967). These mounds include rectangular subfloor pits/tombs with dismembered bodies and, commonly, articulated bison remains (Johnson and Johnson 1998). The presence of associated exotic artifacts is often cited as evidence of Hopewell influence on Middle Plains Woodland populations (Johnson and Johnson 1998). In the LMRSU, 31 Besant/Sonota archaeological resources have been identified, including at the Sunday Sage site (32BI22) (Simon and Borchert 1981b) and at 32MZ333 (Floodman et al. 1982).

Sites from the Laurel complex (2100–850 B.P.) are generally found in the eastern portions of North Dakota, northern Minnesota, and southern Canada. Laurel pottery and mound building are fairly distinct, but lithics associated with this complex tend to be various and lack a particular style (Gregg 1985).

Avonlea complex (ca. 1800–1000 B.P.) sites occur across the northern Great Plains and are contemporaneous with Besant. This complex includes a variety of site types, including stone circles, bison kills, and rock shelter habitations (Reeves 1970). Avonlea represents the first regional complex to produce arrow points exclusively, suggesting a transition to bow and arrow technology (Frison 1988). Avonlea point types are small and indistinctly side-notched. Saskatchewan Basin complex: Early Variant pottery have been found at Avonlea sites (Byrne 1973). Avonlea subsistence in the north relied heavily on communal bison procurement, but in their southern range, bison hunting was supplemented by smaller game (e.g., pronghorn), fish, and seasonal plant exploitation (Smith and Walker 1988). Avonlea sites are relatively rare in the Dakotas (Vickers 1994). In North Dakota, the Evans site (32MN301) contained Avonlea projectile points and ceramics (Schneider and Kinney 1978). Seven Avonlea-aged archaeological resources have been identified in the LMRSU.

Rare in North Dakota is the Old Woman's complex (A.D. 700–1300). This complex is contemporary with the Plains Village tradition, so it would seem likely that many associated sites would be granted the latter designation (Gregg 1985).

The Blackduck complex (A.D. 1150–450) derives from northern Minnesota and was concentrated in southern Manitoba. It is contemporary with both Avonlea and Old Woman's complexes, and with Extended and Terminal Middle Missouri traditions. Some evidence of possible Blackduck pottery has been found along the Missouri River, which suggests trade between the Missouri River villagers and the Blackduck people to the north (Joyes 1970).

Plains Village Tradition (ca. 1050–350 B.P.)

Lehmer (1971) defined the Plains Village tradition as possessing the following diagnostic traits: equal reliance on horticulture and hunting and gathering strategies, semipermanent villages near the Missouri River floodplain, earthlodges, large storage and refuse pits, distinctive ceramics, abundant end scrapers and arrow points, bison scapula hoes, and a well-developed bone tool industry. The Plains Village tradition is divided into the Middle Missouri tradition (A.D. 969–1500) and the Coalescent tradition (A.D. 1300–1650), discussed below. Twenty-three Plains Village archaeological resources have been identified in the LMRSU (Gregg and Bleier 2008).

Three primary Middle Missouri variants are recognized: Initial Middle Missouri (A.D. 969–1297), Extended Middle Missouri (A.D. 1075–1443), and Terminal Middle Missouri (A.D. 1300–1500) (Eighmy and LaBelle 1996). These represent a continuation and intensification of Northern Plains Woodland lifeways and their appearance coincides with the onset of the Medieval Warm Period (Bryson et al. 1970), when a moisture increase likely permitted horticulture in areas previously characterized by tenuous farming conditions (Wood 2001).

The Initial Middle Missouri Variant (IMMV) is thought to have developed as an outgrowth of the Great Oasis (Tiffany 2007) or via the arrival of eastern populations already exploiting a Plains Village lifeway (Lehmer 1971). The IMMV was concentrated in the southern portions of the Middle Missouri region and characterized by highly fortified villages of large, semi-subterranean, rectangular houses (Lehmer 1971; Winham and Calabrese 1998). In the LMRSU, an Initial Middle Missouri deposit has been identified at site 32MZ380D (Jorstad et al. 1986).

The Extended Middle Missouri Variant (EMMV) is concentrated in the northern portions of the Middle Missouri region (Lehmer 1971). EMMV groups resided in small villages of semi-subterranean rectangular houses; southern villages were more often fortified than those in the north (Wood 2001). It is unclear whether the EMMV replaced the IMMV or represents a contemporaneous offshoot of the IMMV. Origins aside, it is assumed that IMMV populations were eventually absorbed into EMMV populations. The final expression of this tradition was the Terminal Middle Missouri (Winham and Calabrese 1998). These sites were concentrated in a smaller geographic area along the Missouri River in southern North Dakota and characterized by fewer but much larger villages (Wood 2001). Sites again contained long, rectangular semi-subterranean houses but were highly fortified (Wood 2001). A continuation of the Middle Missouri tradition is recognized historically as the Siuoan-speaking Mandan and Hidatsa (Wood 2001).

The Coalescent period is temporally divided into Initial (650–350 B.P.), Extended (500–300 B.P.), and Post-Contact Coalescent (300 B.P.–Historic period) (Johnson 1998; Lehmer 1971). The Coalescent tradition is thought to represent a geographic movement of Central Plains–tradition village-dwelling populations to the Missouri River Valley in South Dakota (Blakeslee 1993). Central Plains traditions might have migrated from Nebraska and Kansas in response to drought brought on by the Pacific climatic episode (Lehmer 1971). Similar to Middle Missouri–tradition groups, Coalescent populations practiced an economy split between mixed cultigen horticulture and bison hunting (Johnson 1998).

Initial Coalescent Variant sites are located on bluffs overlooking the Missouri River and its drainages in southern South Dakota. Populations lived in fortified villages consisting of subrectangular to circular/oval earthlodges and often surrounded by complex fortifications (Johnson 1998). Violence among Coalescent groups is evidenced at the Crow Creek site (39BF11), where approximately 486 individuals were killed in the village fortification ditch around 625 B.P. (Willey and Emerson 1993). Crow Creek is interpreted as evidence of internecine warfare among Initial Coalescent groups over land competition (Zimmerman and Bradley 1993) or, conversely, as evidence of warfare between immigrant Coalescent groups and resident Middle Missouri–tradition peoples (Johnson 1998). The Extended Coalescent Variant apparently descended from the Initial Coalescent sometime in the fifteenth century A.D. Sites are concentrated along the Missouri River and its tributaries in central and northern South Dakota (Krause 2001). Extended Coalescent sites are far more abundant than during the Initial Coalescent and are characterized by a dispersed, unfortified village structure of circular earthlodges (Johnson 1998; Krause 2001; Lehmer 1971). In the LMRSU, the Connell Ranch site (32BI439) has been identified as an Extended Coalescent bison butchering site (Metcalf et al. 1988). The Extended Coalescent Variant evolved into the Post-Contact Coalescent during the Protohistoric and Historic, and the Coalescent tradition is recognized as the Arikara (Krause 2001). The last post-contact village was Like-a-Fishhook Village, occupied by the Arikara, Mandan, and Hidatsa; it was abandoned in 1886 when groups relocated to the Fort Berthold Indian Reservation (Smith 1972).

HISTORIC CONTEXTS

European Trade and Exploration (1738–1858)

Perhaps the earliest attempts at exploring the northern Great Plains came as a result of the ventures of Pierre Gaultier de Varennes Siure de la Verendrye (Dill 1983). His travels from New France into North Dakota led him as far as the Missouri River (somewhere near Bismarck), then led to subsequent expeditions by his sons, who went farther south into South Dakota (near Pierre) and west towards the Black Hills. While the elder la Verendrye met the Mandan, his sons encountered the Arikara and other tribes in South Dakota. Their reports heightened interest in the region and the possibilities that existed for trade with its inhabitants.

Following the la Verendryes, a modest fur trade developed in the region, but until the expedition of Captains Meriwether Lewis and William Clark returned successfully from their voyage up the Missouri, the region was considered a wild unknown (Schulenberg 1957). Lewis and Clark established winter quarters with the Hidatsa and Mandan near the Knife River (near present-day Stanton), founding Fort Mandan, the first permanent U.S. settlement in North Dakota. It was at their winter quarters that the pair secured the services of Charbonneau and his wife Sakakawea as guides to lead them through the Rocky Mountains (Works Progress Administration [WPA] 1938).

In 1807, Manuel Lisa established a short-lived post at the mouth of the Bighorn, and by 1809 his St. Louis Missouri Fur Company was building posts among most of the tribes all along the Missouri River. Other notable companies, such as the Northwest Company, Hudson Bay Company, the Columbia Fur Company, and the American Fur Company, soon followed suit (Schulenberg 1957). The life of these posts tended to be short, but they did much to influence the tribes who frequented the Missouri River in both North and South Dakota. Fort Union—at the confluence of the Yellowstone and Missouri rivers—was the last of the great posts, and its waning during the late 1850s saw the fur trade in the Dakotas in its last throes.

In addition to the tribes that arose from the Middle Missouri and Coalescent traditions (Mandan, Hidatsa, and Arikara), countless other had tribes used the northern Great Plains and the Missouri River since before European contact.

The Assiniboine were known to frequent the northern Missouri River (mainly near the confluence with the Yellowstone) and were active in the fur trade throughout the eighteenth and nineteenth centuries. As well, the Cheyenne were pushed westward by the Chippewa during the middle of the eighteenth century and took up at least a temporary settlement period on the Missouri River. At least one earthlodge village has been attributed to the Cheyenne in eastern North Dakota, and some Cheyenne villages on the Missouri River were located between the Mandan to the north and the Arikara to the south, where they built earthlodges and pursued horticulture and buffalo hunting (Schlesier 1968).

The Plains Cree and Plains Chippewa also frequented the northern Missouri—mainly near the confluence with the Yellowstone, but also near Fort Clark. Both tribes traded actively with the Mandan and Hidatsa. The Crow, although more westerly in their territory, were related to the Hidatsa and would often trade and visit with the Missouri River tribes (Schulenberg 1957).

Based on linguistic evidence, the Sioux (or Dakota) originated from the southwest Great Lakes region (DeMallie 2001a). The timing of the migration is unclear, but ceramic evidence suggests that the Dakota were living on the plains several centuries before the arrival of Europeans (Hanson 1998). Based on linguistics, it is thought that the Assiniboine split from the Sioux sometime before the mid-seventeenth century (Hanson 1998). The Teton Dakota are divided into seven subtribes, including the Oglala, Brule, Sans Arc, Hunkpapa, Blackfeet, Miniconjou, and Two Kettles (Hanson 1998). According to DeMallie (2001a), by the mid-eighteenth century, the Teton Dakota hunted bison in the area east of the Missouri River, their movements limited in part by the Arikara stronghold along the Missouri River. However, a series of smallpox epidemics from 1771 to 1781 devastated the Arikara villages (Johnson 1998) and permitted the Teton Dakota to move west of the Missouri River. Like the Teton Dakota, the Yankton and Yanktonai Dakota occupied the prairies east of the Missouri River and north into Minnesota in the mid-seventeenth century (DeMallie 2001a). By the mid-nineteenth century, the Yankton and Yanktonai occupied the prairies east of the Missouri River from the mouth of the Big Sioux River in the south to the Red River in the north (DeMallie 2001b).

Native American Reservations, Allotment, and Reorganization (1860–1936)

The Reservation Period began in the 1860s and continues into today. This time period contains numerous accounts of government actions to stop tribal ceremonialism, of forced boarding school education of Native American children, and of attempts at termination and relocation to solve the "Indian problem" in the Dakotas. Disease, traders, missionaries, and new technology had significant impacts on the Native American people living in the region. Populations declined dramatically due to the introduction of infectious diseases, such as smallpox (Limerick 1987). Many Americans, hungry for land, believed that the Native Americans did not need the vast expanses of prairie that were under their control, and they wanted to see the government open up the land for settlement. This sentiment was in many ways echoed by the federal government, which also believed it was appropriate for native peoples to learn skills and adopt lifestyles familiar to Euro-Americans (e.g., large-scale farming, blacksmithing, and construction) (Hoxie et al. 2001). Native Americans within and near the project area were no exception to this general trend, which resulted in circumscription of Native American peoples onto bounded reservations and opened up lands for Euro-American settlement of previously native-occupied territory (Limerick 1987).

Relocation of Native American peoples to the new reservations followed treaty ratification but was a slow process. With the passage of the Fort Laramie Treaty in 1851, the U.S. government established several forts along the Missouri River. One of these forts, Fort Berthold, was occupied by U.S. Calvary from 1864 until its destruction by Sioux Warriors in 1867 (North Dakota Department of Public Instruction [NDDPI] 2002). The fort was then reestablished 18 miles downriver and become known as Fort Stevenson, located in the modern-day town of Garrison, North Dakota. The Three Affiliated Tribes and other Native American societies were transformed by the presence of the U.S. military and steamboats carrying settlers and supplies into this region (NDDPI 2002). The presence of Indian agency personnel residing on the reservation after 1868, day schools being opened on reservations, and the establishment of the Fort Berthold Indian Reservation under the Executive Order of 1870 forever changed the Three Affiliated Tribes (NDDPI 2002). By 1888, under the policy of allotment in severalty, most of the residents of Like-a-Fishhook Village were encouraged to set up residences elsewhere on the reservation, one of them becoming Elbowoods. Elbowoods was located on the northeast side of the river and served as the center for the reservation until its destruction during the construction of the Garrison Dam (NDDPI 2002).

The result of the debate over the “Indian problem” continued, and not just in North Dakota, but across the United States. At the end of the nineteenth century, the United States formally adopted a policy of allotment in severalty, a policy epitomized in the General Allotment Act of 1887 (also known as the Dawes Act). With the pressure on government officials from settlers who wanted reservation land open for settlement and social groups promoting the “civilization” of Native Americans, allotment in severalty was a solution that seemed to please all parties (with the exception perhaps of the Indians themselves who were not often consulted on Indian policy). For expansionists, it allowed for additional Euro-American settlement by freeing up non-allotted lands for homesteading. For those sympathetic to the Indian cause, the belief in the civilizing effect of private property and commercial enterprise made allotment seem like a favorable way to end the “savage” ways of the western Indian (Limerick 1987).

Others were less favorable towards the idea of allotment. A delegation of Creek Indians was sent to address the House of Representatives in 1882, with regards to the U.S. allotment policy. The Creek delegation presented evidence that among many tribes for whom allotment in severalty had already taken place, populations had decreased, the amount of land being farmed had diminished, and overall the lives of the Indians had been worsened (U.S. House of Representatives 1882). Although voices of dissent were present, they were too few, when compared to the strong voices of allotment supporters. The Dawes Act was initially seen as a great success, and the policy soon began to spread to the other tribes across the country.

The concept of allotment and the "civilizing" of the American Indian preceded the Dawes Act by several centuries. The discourse of some of the earliest treaties, enacted under colonial governments in the seventeenth century, includes the idea of introducing Native Americans to a sedentary lifestyle, Christianity, and agriculture (Miles 1999). Although mention of individually allotted land did appear in discussions of Indian policy in both colonial governments and in early U.S. policy, it was not until the middle of the nineteenth century that allotment was included in any treaties or acts with Indian groups. The earliest treaties to include allotment policies were formed in the 1850s, during President Andrew Jackson's administration. Initially, these policies were voluntary, with title to the land being offered with brief trust periods during which the land was tax exempt. In most cases, these treaties included language allowing the government to revoke the patents, should the holder break certain conditions associated with their "Americanization," such as excessive drinking or practicing traditional religious practices (Froehling 1993).

The act establishing allotments on the Fort Berthold Indian Reservation was signed on December 14, 1886, almost two months before the passing of the Dawes Act. The Act of December 14, 1886, signed by federal representatives, as well as representatives of the Gros Ventres, the Mandan, and the Arikara, states that the tribes had:

> …vastly more land in their present reservation than they need or will make use of, and are desirous of disposing of a portion thereof in order to obtain the means necessary to enable them to become wholly self-supporting by the cultivation of the soil and other pursuits of husbandry. (Kappler 1904)

Under the articles of the Act of December 14, 1886, the Arikara, Gros Ventres, and the Mandan ceded large portions of their reservation to the U.S. government for an annuity to help support the tribes. The act also called for the survey of the former reservation and the allotment of the land to individuals and families of the three tribes. The distribution of the allotments provided 160 acres to each head of family, 80 acres to each single person over 18 years of age, 80 acres to every orphan child under 18 years of age, and 40 acres to each other person under 18 years of age (Kappler 1904). Each head of household chose the location of their allotment and the allotments of their children. The allotments of orphans were selected by an Indian Agent. Unlike many allotment, acts that opened all non-allotted land to immediate non-native settlement, the Act of December 14, 1886, left all non-allotted lands in trust for a period of 25 years. The purpose of this trust was to provide for future generations of Mandan, Arikara, and Gros Ventres to receive allotments on their former reservation (Kappler 1904).

The titles to the allotted lands were also held in trust by the U.S. government. While allotments were chosen by, and were under the control of, the individual head of household, the actual land patent was held in trust by the U.S. government for 25 years. At the end of the 25-year trust period, a fee patent would be issued to the allottee and the land would officially become taxable private property. This trust period was meant to allow the Native Americans to establish themselves on their land before it became taxable property and to prevent the immediate sale of the land to Euro-American settlement. If the head of household passed away before the end of the trust period, the allotted land would be divided evenly among his or her heirs (Kappler 1904).

Though the trust period was meant to prevent the dispossession of the allotted lands, additional legislation regarding allotment lands was passed beginning in the early twentieth century that allowed land to be removed from trust before the 25-year trust period had elapsed. The first of these acts was passed on May 27, 1902. This act allowed for the sale of inherited land, which required the removal of the land from the trust. Inheritance was not determined by the will of the deceased, but by territorial law, which stated that inherited land was divided evenly among the heirs (Froehling 1993; Kappler 1904). The death of the original allottee sometimes resulted in more than 10 heirs to a property. Dividing this land evenly among the heirs resulted in parcels so small that they were useless for farming or for leasing. Even when considered together, the land was rarely sufficient to meet the needs of the family, and so land sale was the most economic option for the use of the land. In the short term, the sale of inherited land was a favorable solution for both the government and the allottees, but it resulted in further alienation of Native American land and scattered families far afield, as the loss of the land forced them to leave the area in search of employment.

A second act that impacted Native American land sales was the Burke Act, passed in 1906. The Burke Act allowed an allottee to remove land from the trust and be issued a fee patent if the allottee was proven to be "competent" (Froehling 1993). There were no set standards or guidelines to measure "competency," leaving the agent in charge, or the "boss farmer," to determine competency based on whatever criteria they saw fit. Like many of the regulations regarding allotment, the idea was intended (at least on the surface) to be beneficial to Native Americans. The Burke Act would allow the allottees to free themselves of any government restrictions on their land and become free farmers like their neighbors. The result, similar to the inherited land act, was that large acreages of land were sold off for quick cash, often to pay off debts incurred to local merchants.

In 1907, an additional decision by Congress allowed for the sale of land of allottees determined to be "non-competent" by the Indian Agent (Froehling 1993). The land would be sold and an annuity provided for the original allottee. As with the determination of competency, there were no set criteria for determining someone as non-competent and the decision was left entirely at the discretion of the agent.

In 1910, another act was passed to create allotments of the remaining open lands within the boundaries of the former reservation. This act made provisions for the establishment of additional allotments based on the non-surveyed lands held in trust by the U.S. government within the former Fort Berthold Indian Reservation. New allotments were established as well as additional land added to already existing allotments. The area selected for these new allotments was limited to the area south and west of the Missouri River or located in select townships north and east of the Missouri River. The Act of 1910 allowed the U.S. government the right to remove some land from allotment for establishing schools, a government-operated ranch to provide for the three tribes, and any land containing coal deposits. The Act of 1910 removed the last of the non-allotted land held in trust by the government. After the new allotments were established, all remaining land was open to U.S. settlement under the various Homestead Acts (Kappler 1929).

Between 1895 and 1929, 3,401 allotments were made as part of the various allotment policies affecting the Mandan, the Arikara, and the Gros Ventres. Although the allotment of Fort Berthold was initiated under the Act of 1886, the first allotments were not distributed until 1900. In 1900, 949 allotments were established, almost all of which were located along the Missouri River. In 1910, another 765 were established, both along the river and in the neighboring foothills. In 1912 and 1913, under the revised allotment Act of 1910, 1,131 allotments were established. Most of these were located on open range land rather than along the river. Although U.S. settlement was allowed under the Act of 1910, an additional 556 allotments were established in the 1920s, mostly for children who had not previously received allotments (McCullough 1948). The U.S. policy of allotment in severalty officially ended with passing of the Indian Reorganization Act in 1934.

The Mandan, the Arikara, and the Gros Ventres reorganized in 1936 as the "Three Affiliated Tribes." The tribes live in different portions of the reservation, but act under a single governing council. During the 1930s and 1940s, agriculture and stock raising were the two largest industries on the Fort Berthold Indian Reservation. Many Native Americans living on Fort Berthold supplemented ranching and farming with the hunting of wild game, working for the Indian Agency, or leasing lands to non-native ranchers and farmers. Renting and leasing land was an important source of income for most households on the reservation. Lease agreements took a variety of forms but included both sharecropping and fee rentals. Between 1942 and 1945, more than one-third of the annual income for households on the reservation was generated through rental and lease agreements.

In the LMRSU, 34 Hidatsa, 1 Sioux, and 15 unspecified historic Native American archaeological resources have been identified (Gregg and Bleier 2008).

The Homestead Boom and the Ethnic Settlement of North Dakota (1868–1915)

Even outside of the reservation lands, where open public land was available for settlement, the true rush for homesteads in North Dakota did not take place until 1885 and was spurred by the extension of the Northern Pacific Railroad across the Red River from Minnesota (WPA 1938). The first homestead in North Dakota was filed in 1868, which was the only homestead filed until 1871. The earliest settlers in were a mixture of American-born settlers from diverse locations across the United States. Midwestern farmers, struggling on small rented lands in the Midwest, eyed the open plains, looking for the opportunity to claim their own lands. Single men, looking for an escape from hard labor in mines, oil fields, and factories, looked to the plains for new opportunities for work on farms, ranches, or on the railroads (Hudson 1976).

The Great Dakota Boom from 1878 to 1885 represented the first wave of large-scale settlement in North Dakota. The boom was driven by several factors, including the expansion of the railroad into the state, increased industrialization and population pressure in the eastern states, and improved technologies in processing "spring wheat," a crop that was well-adapted to conditions on the northern plains. In 1873, the bankruptcy of Northern Pacific forced them to sell off most of their land holdings in the state, which, combined with the land available through the Homestead Act, made the northern Great Plains an enticing location for settlers from the East Coast and the Midwest (Wilkins and Wilkins 1977).

The land west of the Missouri River did not see much settlement prior to the 1890s, and the major settlement of this region did not start in any great numbers until between 1900 and 1910. In general, those homesteaders who selected lands along the Missouri River were able to do some crop farming, but the majority of homesteads were arranged as ranch operations for sheep or cattle. These areas were far from uninhabited, with many of the Plains Indians settled on reservations near the river, stage lines extending to mining operations in the Black Hills and Montana, and cowboys and cattlemen driving herds from Texas to pasture on the plains grassland. Initially, settlement in the western part of the state was limited to areas along the river, where steamboat access could provide supplies and a means of transporting crops and herds for sale in larger markets. When the railroads crossed the Missouri into the western part of the state, North Dakota saw a second homestead boom, from 1898 to 1915, driven by settlers seeking the last available free homestead land.

In addition to the homesteading, which brought an increasing number of people to western North Dakota, the discovery of large deposits of lignite coal further boosted interest in the development of northwestern North Dakota and the surrounding area (WPA 1938). Although slow at first, the mining industry started to flourish during the 1930s; to this day it remains a major focus of activity that drives the economy of both the county and the state.

<u>Ethnic Settlement</u>

Unlike the first wave of settlement (1878–1885), which consisted primarily of Americans and Canadians of British, Scottish, and French descent resettling from the midwestern and eastern states, the second wave (1898–1915) was dominated by foreign-born settlers arriving in large numbers from across Europe. Motivated by the lack of available land in most European countries, along with economic systems that equated land with status, the United States and their new liberal land policies attracted many Europeans to immigrate to the United States. Helping fuel this immigration, U.S. railroad companies actively advertised in Europe to entice settlers to purchase available land grants and settle along newly created rail lines (Hoover 2005; Hudson 1976). Environmental conditions in the northern Great Plains were not attractive to all European immigrants, but immigration from across northern Europe resulted in many communities dominated by large ethnic populations, bringing with them their traditional agricultural practices, architecture, and cultural traditions. Unlike the first wave of settlers, the immigrants from eastern Europe tended to settle in culturally homogenous communities, preserving the language and cultural practices of their homeland.

German-Russians

One of the largest ethnic groups in the Great Plains, the German-Russians, established communities across the Great Plains, including the Dakotas, Nebraska, Colorado, and Montana. The German-Russians emigrated to the United States from two different regions of eastern Russia: the Volga region and the region to the north of the Black Sea (Hudson 1976). Originally from large agricultural communities in Germany, these groups first emigrated to Russia in 1763, when the German-born Empress Catherine the Great invited the Germans to develop the largely empty Russian Steppes, granting them limited autonomy and exemption from military service. The Germans established small, close-knit communities in Russia that allowed them to retain many of their cultural traditions (Baltensperger 1983; Hoover 2005).

In 1871, Czar Alexander II withdrew many of the privileges granted to the German settlers, including exemption from military service. As a result, many of the Germans chose to leave Russia to settle in the newly opened American West. The German-Russians attempted to create the same close-knit communities they had left in Russia, establishing small towns across the American West. The Volga Germans mostly settled in Kansas and Nebraska, while the Black Sea Germans settled in North Dakota and South Dakota (Koop 1986). Within their close communities, the German-Russians maintained many of their traditions, something that occasionally set them apart from neighboring communities.

Although ethnically German, the German-Russian settlers were religiously diverse, including Catholics, Lutherans, Mennonites, and Hutterites (Hoover 2005). The German-Russians represent the largest European ethnic group to settle in Dunn County, North Dakota. German-Russian settlers moved into North Dakota in large numbers after 1880, although it took them somewhat longer to settle as far northwest as Dunn County. Settlers would often relocate several times throughout the Midwest and even in eastern or southern North Dakota before finally moving to permanent homesteads in the northwestern part of the territory. The strong sense of community felt by the German-Russians and the frequent re-migration across North Dakota meant that most German-Russians had families and friends in all of the neighboring communities (Hudson 1976).

The similar environment of the Russian steppe provided a level of experience most ethnic groups in the area did not have. This can be seen in their architectural styles, which made use of available resources to build sturdy homes without an ample supply of lumber. The German-Russian architecture used a combination of clay mixed with straw and manure, rammed earth blocks, and timber, when available, to build strong, multiple-room homes. Another method used clay bricks known as Batsa. The use of Batsa continued even after the German-Russians adopted American architectural styles, using the clay bricks as wall insulation between wood-framed walls (Koop 1986).

Scandinavians

Settlers from Sweden, Denmark, and Norway were present in large numbers in northwestern North Dakota. By 1910 there were nearly 30,000 Swedes in North Dakota and four times as many Norwegians (Hudson 1976). Scandinavian immigration after 1850 was driven by overcrowding in the rural parts of those countries and was encouraged by U.S. commercial interests, specifically by railroad companies looking to populate towns in the ever-expanding American West. Most Scandinavians moved first to the Midwest, settling in Wisconsin or Illinois, before moving on to establish homesteads in North Dakota during the Dakota Boom of the 1870s and 1880s (Hoover 2005; Hudson 1976). Unlike the German-Russians, who settled in large groups to form whole communities, most Scandinavian settlements grew over time, with a few settlers moving to an unsettled area and writing letters to friends and family to encourage additional settlers (Hudson 1976).

The single-pen, gable-roofed style was common for both Norwegian and Swedish settlers, who prior to coming to America were united under one crown, as the United Kingdoms of

Sweden and Norway, from 1814 to 1905. Availability of materials often dictated the form that Scandinavian homes took in North Dakota; in areas lacking timber resources, sod-built structures were often constructed, and even in areas with limited timber, sod roofs were common features on both log and wood-framed houses. The quality of timber available for home construction made some types of traditional log notching difficult, and dovetail notching, with the spaces between logs filled with some type of mortar, dominated Scandinavian-American homes.

Other Ethnic Groups

While Scandinavians and German-Russians represented the two largest ethnic groups in western North Dakota, ethnic groups from other parts of the world were present, albeit in smaller numbers. Canadian immigrants, particularly from Ontario, moved to North Dakota in large numbers between 1875 and 1880, with the largest groups settling in the northeast and north-central portions of the state along the Canadian border. Most of these settlers were the children of immigrants themselves, their families having arrived from Great Britain a generation before. Germans, Bohemians, Luxembourgians, and Icelanders also settled in North Dakota, though most never settled in concentrated communities (Hudson 1976).

Agricultural Development and the Growth of North Dakota Farming (1890–1920)

The dominant crop grown in North Dakota during the early years of settlement was spring wheat. Spring wheat is a dark, coarse grain that was easy to grow in drier climates, but was difficult to process for use in a form appealing to most consumers (Danborn 1998). Towards the end of the nineteenth century, a new way of processing spring wheat into what was known as Minnesota patent flour was developed. This new process significantly increased demand for this hardy crop. Many of the agricultural practices used to develop the crop were similar to growing other forms of wheat, and the farming practices already in place across the Midwest were adopted by new settlers in North Dakota. Distinctive to spring-wheat farming, many believed that using broadcast seeders was more favorable to the crop than using the more traditional grain drills. Other equipment used to produce spring wheat was similar to equipment used for other crops in the region, including plows, cultivators, seeders, and harvesters (Coulter 1910).

Demand for wheat and other agricultural projects increased dramatically across the country during the first decades of the twentieth century. Between 1910 and 1914, increased demand fueled by the growth of urban populations across the United States and increased immigration and settlement due to the westward expansion led to dramatic increases in prices on agricultural products. Declining production in Europe during World War I encouraged the federal government to heavily promote increases in agricultural production (Opie 2004; Wilkins and Wilkins 1977). The government fixed wheat prices during the war, which encouraged farmers to expand their holdings and increase their crop yields. By the 1920s, North Dakota was one of the largest producers of wheat in the United States (Etulain and Malone 1989). These practices would come to haunt the American farmer in the 1920s, when dramatic decreases in crop values would result in harsh economic conditions across the Great Plains (Wilkins and Wilkins 1977).

Confined-Range Ranching on Fort Berthold (1891–1953)

While agriculture played an important role across the state, the land west of the Mississippi was dominated by ranching and livestock production. Following the Civil War, the growth of urban populations in the east resulted in an increased demand for beef production. The restriction of Native American tribes to reservations opened up vast tracts of grassland in the Great Plains and the expansion of the railroad into these areas facilitated the transportation of livestock to larger markets (McLaughlin 1994; Wilkins and Wilkins 1977). Taking advantage of these favorable conditions, several large ranches were established in central and western North Dakota. Two of the largest operations along the Missouri River in North Dakota were the Birdhead Ranch and the Long X Ranch (McLaughlin 1994).

By the turn of the century, the expansion of homestead settlement had reached the areas west of the Missouri. Homesteaders and ranchers were immediately at odds over the use of land, with homesteaders fencing off and restricting access to what was once open range land. Between 1900 and 1910, the number of farms west of the Missouri increased from 5,096 to 28,826. With open range land in diminishing quantity, the undeveloped lands on the Fort Berthold Indian Reservation that had access to water, abundant grasses, and trees for shelter along the Missouri River became increasingly attractive to the eyes of American ranchers; however, the boundaries of the reservation were protected and not open to Euro-American settlement (McLaughlin 1994).

Some ranchers had begun illegally grazing livestock on reservation lands during the nineteenth century, but by the end of the century, ranchers had found a way of legally grazing their livestock on the reservation. The Act of February 28, 1891, (26 Stat.794) was an amendment of the Dawes Act, which allowed Indian allottees who were unable to use lands due to age or disability to lease their lands with the approval of the tribal authority. Over the next few years, some of the restrictions on the use of this land were relaxed, but the leasing was still managed by the BIA with the funds used to support government programs on the reservation (McLaughlin 1994; Parker 2011). Ranchers took advantage of these leased lands to continue the practice of open ranching, a method that was becoming impossible outside of reservation boundaries.

The grazing of livestock on the Fort Berthold Indian Reservation by Euro-American ranchers was not the same as the open range ranching of the past. In many ways, the methods used in what is referred to as "confined-range ranching" borrowed elements from both open range grazing and ranch farming. Similar to open range ranching, seasonal crews were used to herd and tend livestock on the leased reservation lands; and livestock was allowed to graze in common lands, with several round-ups a year to keep track of cattle for breeding, and for sale (McLaughlin 1994). During round-ups, cattle were kept in large corrals established at seasonal line camps on the reservation. Unlike the open range ranching of the past, grazing was limited to broad leasing areas on the reservation—leasing areas that were fenced to avoid livestock from wandering onto privately owned land.

In 1916, the Office of Indian Affairs divided the Fort Berthold Indian Reservation into three grazing units and changed the leasing costs to a rate per acre, rather than per head of cattle. This type of ranching continued until the Office of Indian Affairs made changes in the mid-

1930s and persisted in a similar fashion until the 1950s. Over the years, ranchers saw many benefits of using leased reservation lands. The use of cheap leases on prime grassland on the reservation allowed many ranchers to better weather the difficult years of the 1920s and 1930s, with many of the original ranchers becoming successful and prominent businessmen in the state. Leased grazing, while certainly beneficial to Euro-American cattlemen, and to the Office of Indian Affairs and BIA offices that provided for Fort Berthold, was not entirely favorable for those living on the reservation. Overgrazing became a serious concern for those on the reservation, and while they had limited means to control overgrazing through restrictions on herd sizes, many of these were overlooked by Euro-American ranchers and the government (McLaughlin 1994; Parker 2011). The Native Americans themselves grazed livestock on their reservation lands, kept separate from the lands leased by Euro-American ranchers, and conflicts between the two occasionally occurred. The construction of Garrison Dam in 1953 flooded most of the prime grazing lands along the river and put a stop to confined-range grazing on leased lands. What little pasture land remained along the river was subdivided and allocated to Native American stockmen to compensate for losses caused by flooding (McLaughlin 1994).

Depression, Recovery, and the Damming of the Missouri River (1921–1953)

Economic decline came early to North Dakota, with many farmers seeing troubles as early as 1921. North Dakota famers were heavily dependent on wheat production, which led to great prosperity during World War I, when the price of wheat was fixed by the federal government. During these prosperous years, many farmers mortgaged their properties and invested their prosperous earnings on expanding the land they had under cultivation. Following World War I, with demand low and the federal government releasing control of wheat prices, the price of wheat plummeted, falling from more than $2.00 per bushel in 1920 to less than $1.00 per bushel in 1921 (Opie 2004). Prices continued to fall during the 1920s and farmers across the Midwest and Great Plains states found themselves in deep financial distress. With farmers unable to pay their mortgages, banks across the state began to fail, adding to the economic turmoil. By the time drought and the effects of the Great Depression began to ravage the rest of the United States, the situation in North Dakota was already dire (Wilkins and Wilkins 1977).

During the years of early settlement across North Dakota, farmers formed cooperatives. Cooperatives helped farmers pool their resources to purchase or rent expensive equipment, to share the use of grain elevators, and to help stabilize prices. While these cooperatives had helped support farmers during the first decade of the twentieth century, they were incapable of buoying the losses caused by the falling prices in the 1920s. Many established cooperatives that had thrived during the boom years, but failed during the 1920s and 1930s, including the Equity Cooperative Exchange, which went bankrupt in 1923, and the North Dakota Wheat Growers Association, which closed in 1931 (Wilkins and Wilkins 1977). Many farmers were forced to abandon their lands, moving to urban areas to find work. Other farmers, anticipating better times ahead, purchased failing farms to expand their holdings. Fearing a mass acquisition of farming land by outside corporate interests, the state government passed the Anti-Corporate Farming Act of 1932, which prohibited corporations from engaging in agriculture in the state. While this act prevented outside corporate farms from acquiring these failed farms, it did not prevent family farms from acquiring massive holdings (Hoffman and

Libecap 1990; Leahy 2003; Wilkins and Wilkins 1977). North Dakota's agricultural industry did not recover until the 1940s, when wartime demand for crops increased prices, creating resurgence in agricultural activity.

The Pick-Sloan Plan and the Development of the Missouri River (1940–Present)

Following the Great Depression, new demands for power, irrigation, economic development, and flood control in the northern Great Plains focused greater attention on the Missouri River. Starting in the early 1940s, a series of legislative measures and agency plans were developed to address the difficult task of harnessing the Missouri River. Initial efforts were directed towards establishing a Missouri Valley Authority (MVA), similar to the successful Tennessee Valley Authority, which had created dams that provided rural electrification for the southern states. The concept of an MVA did not meet with a favorable response from the local citizens or government officials, who feared losing control of the Missouri River to the federal government. After several attempts to resurrect the plan, the idea of an MVA was lost (Harvey 1996; Linenberger 1998). Nevertheless, continued flooding along the river (and the lack of electricity on rural farms) eventually drove the communities on the river to embrace some kind of federal actions to manage the river. Two separate plans were proposed to legislation.

The first plan presented to legislation was the Pick Plan, named after Lewis Pick, the director of the Missouri River Office of the U.S. Army Corps of Engineers. It focused on flood control and navigation improvement, calling for the U.S. Army Corps of Engineers to construct 1,500 miles of levees, five multipurpose dams and reservoirs along the mainstem of the river, and other dams on various tributaries of the river (Harvey 1996; Linenberger 1998). Pick's plan conflicted with the alternate plan proposed by William Glenn Sloan, director of the Billings, Montana, office of the U.S. Bureau of Reclamation. Sloan's Plan, which had been several years in the making, was initially created in response to the severe droughts during the 1930s. Following the droughts, the Dakotas, Wyoming, and Montana appealed to the U.S. Bureau of Reclamation to construct irrigation works. Sloan created a plan, focusing primarily on providing irrigation and hydroelectric power, calling for the creation of dams and reservoirs on tributaries in the upper Missouri Basin (Harvey 1996).

In October 1944, representatives from the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation met and agreed on a combined plan, called the Pick-Sloan Plan. Six intents for the management of the Missouri River were created under this plan. These intents included providing hydroelectric power, flood control, and surplus water supply; facilitating navigation; and supplying areas for public use, including fish and wildlife and recreation (Ferrell 1993). President Franklin D. Roosevelt signed the act on December 22, 1944. Under this plan, both agencies would have influence over hydroelectric power; the U.S. Bureau of Reclamation would have responsibility for all irrigation issues, and the U.S. Army Corps of Engineers would have responsibility over the mainstem dams (Billington et al. 2005). The development of the mainstem system of dams was authorized under the Pick-Sloan Flood Control Act of 1944 (Public Law 78-534) (Ferrell 1993). Along with the previously constructed Fort Peck Reservoir in Montana, five dams were to be constructed and overseen by the U.S. Army Corps of Engineers. The dams to be constructed included Gavin's Point (located immediately west of Yankton, South Dakota), Fort Randall (located just north of the

Nebraska–South Dakota border), Big Bend (located immediately upstream from the tail waters of Fort Randall), Oahe (located upstream from Pierre, South Dakota), and Garrison (located north of Stanton, North Dakota) (Figure 4).

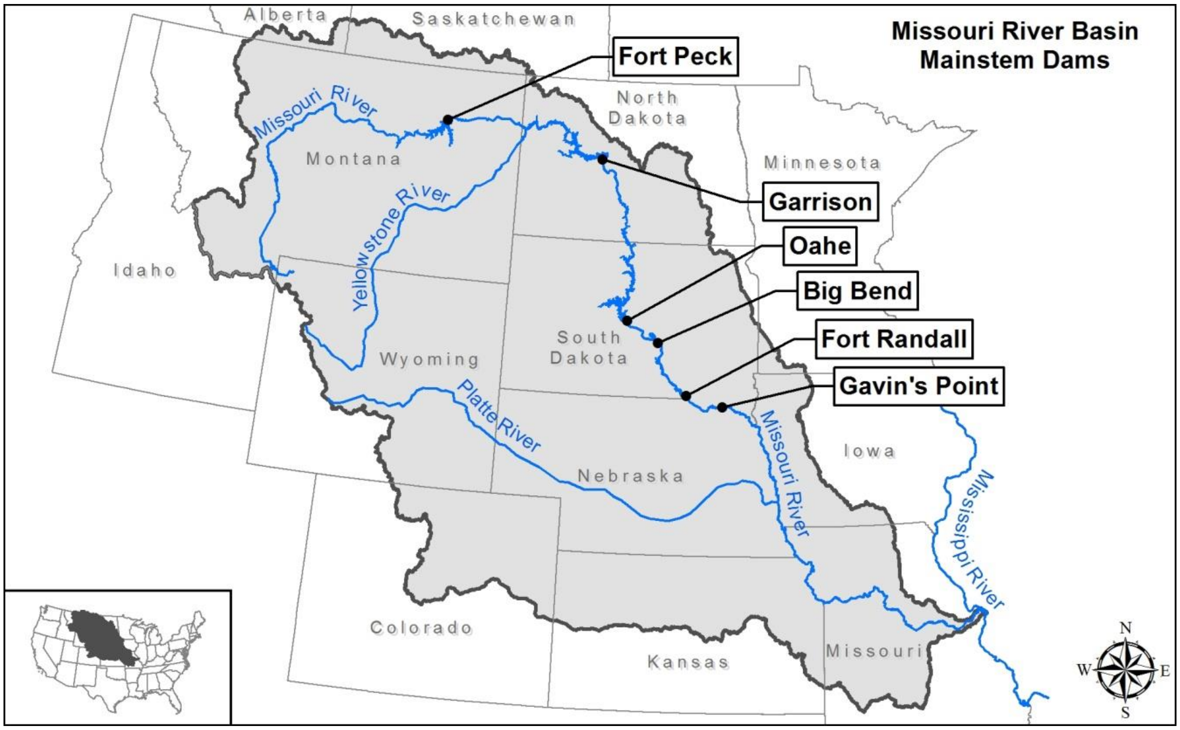

Figure 4. Missouri River mainstem dams.

The creation of the Pick-Sloan reservoirs displaced thousands of Native Americans from their lands along the Missouri River. By some counts, the five mainstem dams displaced approximately 900 Native American families. All the mainstem dams in North and South Dakota (except Gavin's Point Dam) flooded some of the most productive tribal lands. Garrison Dam/Lake Sakakawea, completed in 1953, inundated more than 152,360 acres, a quarter of the Fort Berthold Indian Reservation, and forced the relocation of over half of the reservation population (Morris 1990). The BIA reported in 1948 that 257 of the 357 homes in the Fort Berthold Indian Reservation would be destroyed by the project (McCullough 1948). The inundation also cost the tribe the majority of its timber and wild game resources—most of which relied on the natural bottomlands of the Missouri River. Similarly, the Oahe Reservoir inundated hundreds of thousands of acres at the Standing Rock and Cheyenne River reservations. The Big Bend and Fort Randall dams were also significant in impacting Native American families on the Yankton, Lower Brule, and Crow Creek Reservations; the dams flooded over 20,000 acres of tribal land, with the majority (approximately 17,000 acres) of those acres on the Crow Creek and Lower Brule reservations, where over 120 families were displaced against their will (Lawson 1982).

Although the Three Affiliated Tribes living on the Fort Berthold Indian Reservation were not included in the initial discussions about the dam, they demanded that the federal government compensate them for the land that would be lost when the dam was completed. They requested that the government provide them with an equivalent acreage of land to what would be lost from the flooding, permission to graze their cattle on U.S. Army Corps of Engineers lands along the banks of the lake, 20,000 kilowatt/hours per year of electricity generated by the dam, and first right to collect timber felled during the flooding (Griffen 1996). Their requests were rejected, although the federal government provided some compensation for their loss. They were given $5,105,625 for lost lands (approximately $33 per acre), were denied grazing access to the lands adjacent to the lakes, did not receive any free electricity, and were not allowed to collect fallen timber (Griffen 1996). The tribes would eventually get an additional 7.5 million dollars in compensatory funds, but overall, the deal fell far short of what they had requested.

The U.S. Army Corps of Engineers has continued to develop its relationship with the tribes. In 1987, the Joint Tribal Advisory Committee released its final report concerning the impact that the Pick-Sloan Plan had on the tribes. The tribes within the Omaha district soon afterward requested an “Indian Desk” at the U.S. Army Corps of Engineers. In 1992 this request was fulfilled and the U.S. Army Corps of Engineers developed a position for a full-time Native American liaison (U.S. Army Corps of Engineers 2013).

Development of Transportation (1864–Present)

Early settlement in North Dakota followed along the expansion of the rail lines, with the railroad companies establishing towns to support the settlement of the vast expanse of the Great Plains. By the early twentieth century, little had changed, and the railroad continued to dominate settlement and transportation across the state, with settlers reliant upon the railroads for importing supplie, and for exporting products of their farms and ranches to more lucrative markets. At the same time, the system of roads and trails, in place before a single track of rail was placed in North Dakota, continued to operate, albeit as marginalized by the expanding rail networks (Wilkins and Wilkins 1977).

As early as 1848, officials in Washington were beginning to consider the possibility of creating a network of railroads across the country. Three routes were initially proposed for alignments crossing from the Atlantic Ocean to the Pacific Ocean. The northernmost route proposed crossed the Great Plains from Minnesota to Oregon, crossing through Fort Union in the Dakota Territory. Congress authorized the northern route and, in 1864, President Lincoln signed a charter for the Northern Pacific Railroad (Northern Pacific). To help fund the railroad project, the Northern Pacific received a massive land grant from the government, amounting to 40 sections per mile through the Dakota Territory (Tweton and Jelliff 1976).

Although Washington had interest in completing the northern route, finding investors to back the 2,000-mile journey proved more difficult. Northern Pacific was unable to secure sufficient financial backing until 1869, the same year that the Union Pacific Railroad completed their transcontinental route. Financial troubles continued to plague the railroad and, by 1873, with the line completed from Duluth to Bismarck, the investment company funding the construction was bankrupt. In 1875, the Northern Pacific reorganized under the leadership of Frederick Billings, and with strong revenues from the completed part of the line, the Northern Pacific was able to secure the financial support to continue construction, completing its path to the Pacific in 1881. Between 1881 and 1887, the Northern Pacific continued to expand its operations in North Dakota, building several branch lines to reach the important agricultural and population centers across the state (Tweton and Jelliff 1976).

The second major railroad to begin construction in North Dakota was the Great Northern Railroad. Starting as the St. Paul and Pacific Railroad in 1857, Congress supplied a similar grant to the railroad company and construction began heading west from St. Paul, Minnesota. Like the Northern Pacific, the St. Paul and Pacific had trouble securing the financial support for the project, going bankrupt in 1872. Under the direction of James J. Hill, the St. Paul and Pacific began construction again in 1878. Rather than building straight west, Hill expanded branch lines across North Dakota and Minnesota, and by the 1890s, Hill's railroad had more miles of track in North Dakota than the Northern Pacific. The railroad finally reached the Pacific Ocean in 1893 and the name was changed to the Great Northern Railroad (Tweton and Jelliff 1976).

A third railroad, the Minneapolis, St. Paul & Sault St. Marie, or the "Soo," built a track across North Dakota in 1883. The primary focus of the Soo was to access grain farmers in the northern part of the state, providing connections for agricultural goods to both the Northern Pacific and the Great Northern rail lines. With the three railroads completed, North Dakota settlers had a means to transport wheat crops to milling centers in Minnesota or to larger markets across the country. The railroad also supplied a means to support expanded settlement across the state, with important depots at Grand Forks, Bismarck, and Fargo becoming prominent buildings driving economic activity (Tweton and Jelliff 1976; Wilkins and Wilkins 1977).

Although railroads supported the expanded settlement during the Dakota Boom, the state was also crossed by a series of roads and trails that expanded into a broad network during the twentieth century. Some of the earliest roads in the state were developed by the military, connecting forts established to monitor the activities of Native Americans and to protect Euro-American interests in the area. These roads were heavily travelled by the military, by postal carriers, and by early settlers. In the winter months, when snow covered much of the state, these trails were often travelled by sled (Carlson and Sprunk 1979). When North Dakota became a state in 1889, the state constitution made it a requirement to have a two-thirds majority for the approval of state road construction. This meant that the responsibility for road construction was mostly left to the counties. Early roads mostly followed the local topography, providing the most direct route between destinations. Later roads, established during the settlement booms, generally followed section lines. In 1899, in an effort to regulate road construction and provide some standards, the state legislature declared that section roads would be considered public land and that the roads should measure at least 33 feet (2 rods) wide (Carlson and Sprunk 1979).

Leaving the counties responsible for road construction proved sufficient until the arrival of the automobile in the early twentieth century. The automobile increased the demand for roads across the state and demand for existing roads to be better maintained to remain passable. Access to funding became the determining factor in road construction, with roads often built disproportionally to the actual demand. Lack of funding in some areas led to lapses in maintenance, which in turn led to washouts, collapsed bridges, and heavy rutting. The poor conditions of roads across the state attracted the attention of A. L. Fellows, the state engineer, who voiced his concern about road conditions in 1906. However, it would take several years before that concern turned into action (Carlson and Sprunk 1979).

In 1909, State Senator George A. Welch introduced a bill that would allow North Dakota to receive federal funding for the construction of "demonstration" roads. These roads were federally funded experiments that tested new road-building materials and engineering methods. These demonstration roads were only constructed in Bismarck, but it was the beginning of a state-level interest in road conditions that would continue throughout the early twentieth century (Carlson and Sprunk 1979). In 1911, the state authorized the state engineer's office to provide plans for road construction to any county that requested it, and in 1913, the state engineer was tasked with approving all bridge designs prior to construction. The year 1913 also marked the creation of the South Dakota State Highway Commission. The commission was established to give the state engineer the authority to oversee all road construction. It also required that maps be created that showed the location of all roads, culverts, and bridges (Carlson and Sprunk 1979).

The federal government also took steps to assist the states in road construction. In 1916, the Federal Aid Road Act made funding available for creating and maintaining roads. Funding through this act was limited at first, but in the 1920s, interest in developing a federal highway system resulted in additional federal allocations. Due to an ambitious and perhaps exaggerated assessment of the number of roads in North Dakota, it received a disproportionate amount of federal funding in the 1920s (Carlson and Sprunk 1979). The state ranked 36th (out of 48) in population, but 16th in road funding. As a result of this funding, the state proposed the creation and improvement of an extensive series of paved, graveled, and graded roads. Most of these roads were concentrated in the eastern and central portions of the state. In the western counties, such as Dunn, Mercer, and McKenzie, most roads remained little more than rutted two-tracks.

In 1924, the Rand McNally Company created an auto-trails map, attempting to provide an easier means of navigating the highway systems across the country. The auto-trails used blazed markers to identify highways that could be followed between destinations. To many early-twentieth-century motorists, driving was as about recreation as it was transportation, and as such, the early auto trails were intended to enhance the driving experience. Roads did not always take the most direct routes between cities, but would wind through scenic locations and historical landmarks. The intent was also to improve tourism across the country. The auto-trail system was quickly replaced in 1925, when Congress passed the Federal Highway Act, which established a numbered highway system, most of which followed similar alignments to the old auto-trail system (Wilkerson 2000). Several of the numbered highways continued to use their auto-trail names.

During the Great Depression, road projects at the local level dropped significantly. Federal assistance helped buoy the losses of local funding, with New Deal programs continuing to provide support for road and bridge projects. The lack of local funding for road projects continued through World War II. Coupled with the lack of available labor during the war, many of North Dakota's roads fell into disrepair. During the 1940s, the government began to crack down on several states, including North Dakota, for the conditions of its roads, threatening to cut off funding if the existing roads were not better maintained. In an effort to assert more control over road projects across the country, Congress passed the Federal Highway Act in 1944, which changed the approach to funding road construction, setting aside money specifically to maintain a federal highway system (Carlson and Sprunk 1979).

BACKGROUND RESEARCH

As part of the initial phase of this investigation, on April 8, 2013, SWCA conducted a background search of archaeological and historical literature and records for the project area and surrounding 1-mile radius. The relevant records holdings at the State Historical Society of North Dakota were searched and information was collected regarding previously recorded historic and prehistoric sites located within the project area.

Twenty-four previous studies have been performed within 1 mile of the project area between 1953 and 2012. These previous studies are dominated by oil and gas infrastructure, with 19 studies completed for well pads, access roads, and oil and gas pipelines. Other studies include those completed for water pipelines, U.S. Army Corps of Engineers land, archaeological excavations, and stock dams. A bibliographic listing of previous cultural resource inventory studies for project lands and the 1-mile study area in Dunn County, North Dakota, is provided in Appendix A.

Sixteen previously recorded cultural resources are within 1 mile of the project area (Table 2). Of these 16 resources, 13 are prehistoric and 3 are historic. Eleven of the resources are archaeological sites: nine prehistoric and two historic. The five remaining resources consist of four isolated finds (prehistoric) and one site lead (historic). All of the isolated finds are considered not eligible for the National Register of Historic Places (NRHP). The site lead and all 11 sites are left unevaluated regarding their NRHP eligibility.

Site 32DU23 is a battlefield site where Hidatsa and Mandan warriors engaged Sioux raiders. The engagement is verified by a cultural material scatter, in which projectile points and musket balls were found; ethnographic accounts suggest that the skirmish was between 1860 and 1872. Contact with national parks is suggested in the site form recommendations. Site 32DU117 consists of a prehistoric cultural material lithic scatter. 32DU1497, 32DU1706, and 32DU1707 are prehistoric cairn sites. 32DU1498 is a prehistoric site with a cairn, pit feature, and associated stone circle. 32DU1519, 32DU1520 and 32DU1521 are stone circle sites with an associated rock feature. 32DU1543 is a stone circle site. Without further research the function and precise temporal affiliation of these sites is unknown, but the sites suggest that prehistoric, temporary habitation or ceremonial activities occurred in the area. Lastly, 32DU1544 is a dilapidated homestead and is considered not eligible for listing on the NRHP.

The isolated finds, located within the files search area, display evidence of lithic processing activities. The finds are each composed of one or more pieces of lithic debitage (32DUX789, 32DUX833, 32DUX916), including one bifacial tool fragment (32DUX769). The remaining resource is an historic cairn site lead (32DUX491). No previously recorded cultural resources are within the project inventory area.

Table 2. Previously Recorded Resources

Site Number	Location	Site Type(s)	Cultural Affiliation	NRHP Eligibility
32DU23	SW¼ Section 2, T148N, R92W	Battlefield	Sioux, Mandan, and Hidatsa Historic	Unevaluated
32DU117	E½ NW¼ SW¼ & SW¼ NE¼ Section 4, T148N, R92W	Cultural material scatter	Unknown Prehistoric	Unevaluated
32DU1497	NW¼ NE¼ NW¼ Section 5, T149N, R92W	Cairn	Unknown Prehistoric	Unevaluated
32DU1498	W½ NW¼ SW¼ Section 4, T148N, R92W & E½ NE¼ S SE¼ Section 5, T148N, R92W	Cairn, pit, and stone circle	Unknown Prehistoric	Unevaluated
32DU1519	SE¼ SE¼ SW¼ Section 26, T148N, R92W	Stone circle and other rock feature	Unknown Prehistoric	Unevaluated
32DU1520	SW¼ SE¼ SW¼ Section 26, T148N, R92W	Cairn and stone circle	Unknown Prehistoric	Unevaluated
32DU1521	SW¼ SW¼ SW¼ Section 26, T148N, R92W	Stone circle and other rock feature	Unknown Prehistoric	Unevaluated
32DU1543	SE¼ NW¼ SW¼ Section 3, T148N, R92W	Stone circle	Unknown Prehistoric	Unevaluated
32DU1544	NE¼ NE¼ SE¼ & SE¼ SE¼ NE¼ Section 4, T148N, R92W	Homestead	Unknown Historic	Not eligible
32DU1706	SW¼ SE¼ SW¼ Section 35, T149N, R92W	Two cairns	Unknown Prehistoric	Unevaluated
32DU1707	SW¼ SE¼ SE¼ Section 36, T149N, R92W	Cairn	Unknown Prehistoric	Unevaluated
32DUX491	SE¼ NE¼ SW¼ Section 4, T148N, R92W	Cairn	Unknown Historic	Unevaluated
32DUX769	NE¼ NE¼ NW¼ Section 10, T148N, R92W	Bifacial scraper	Unknown Prehistoric	Not eligible
32DUX789	NE¼ NW¼ NW¼ Section 5, T148N, R92W	Isolated chipped stone find	Unknown Prehistoric	Not eligible
32DUX833	SE¼ SE¼ SE¼ Section 31, T149N, R91W	Isolated chipped stone find	Unknown Prehistoric	Not eligible
32DUX916	SE¼ SE¼ SE¼ Section 31, T149N, R91W	Isolated chipped stone find	Unknown Prehistoric	Not eligible

FIELDWORK METHODS

Fieldwork was designed so that project archaeologists could collect all appropriate and necessary data for the completion of the project report of results and recommendations and could ensure accurate completion of site forms for all resources encountered.

In accordance with the scope of work, archaeologists surveyed a 39.28-acre area, including a 38.07-acre block surrounding the proposed compressor station and encompassing the south access road and a portion of the north access road, as well as 1.21-acre area extending outside of the block to cover the remaining portion of the north access road. The survey was completed using parallel linear transects with spacing not exceeding 30 meters (m). The ground surface was examined for artifacts, features, or other evidence of cultural occupation. Cut banks, eroded surfaces, and other areas with significant exposure were examined intensively throughout fieldwork. In areas with high vegetation cover and high probability of cultural resources, survey transects were reduced to 10 m to maintain adequate visibility. Bare ground surface visibility across the project area averaged 0 to 30 percent during the inventory.

Where cultural resources were located, project archaeologists made an intensive effort to fully and accurately establish the extent and boundaries of sites. As such, sites were mapped using submeter accurate Trimble global positioning system (GPS) units. When detailed mapping or remapping was required, all linear site features, such as site boundaries, roads, and fence lines, as well as point features, such as the site datum, cultural features, artifact concentrations, diagnostic artifacts and tools, and other necessary data, were mapped with the Trimble GPS unit for post-processing into ArcMap 10.0 shapefiles, and for plotting onto associated USGS 7.5-minute quadrangles to ensure accuracy and to produce required location maps of all sites and resources.

In addition to site mapping, project personnel photographed sites in overview and for other data collection needs. Associated features and diagnostic artifacts were described, measured, recorded using a handheld GPS unit, and photographed as appropriate. Field personnel noted environmental setting, context, topography, and geographical location for each cultural resource. No collection or subsurface testing was conducted during the inventory.

SITE EVALUATION

SWCA evaluated sites and their significance as defined by criteria set forth in Title 36 Code of Federal Regulations 60.4 (National Park Service [NPS] 1991), which states:

> The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:
>
> A) That are associated with events that have made a significant contribution to the broad patterns of our history; or

B) That are associated with the lives of persons significant in our past; or

C) That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D) That have yielded, or may be likely to yield, information important in prehistory or history.

A site might meet one or more of the four eligibility criteria listed above, but if it is considered to not retain sufficient integrity, it may be recommended not eligible for inclusion on the NRHP.

Prehistoric Archaeological Sites

Prehistoric lithic scatters/campsites (sites without any structures or association with known significant events or persons) recorded for the project are generally not considered eligible for NRHP inclusion under Criterion A, B, or C. Instead, for NRHP recommendation purposes, these properties will be discussed for their potential to yield information significant to prehistory or the archaeological record under NRHP Criterion D. Special cases generally apply to Criterion A, where a prehistoric site type (such as a stone circle site) may not be recommended eligible for listing in the NRHP from an archaeological perspective, but may be considered important to cultures of Native American peoples.

Evaluation of the significance of archaeological sites under Criterion D considers general characteristics such as the nature, size, and diversity of the site assemblage; the potential presence or absence of subsurface cultural deposits; the nature of any features within the site (construction techniques, building materials, structural integrity); and the age range reflected by the site assemblage. Sites considered to be significant generally contain an assemblage of cultural remains that reflects sufficient diversity to permit identification of activities and to allow confirmation of the period of site use. Sites with the most potential to address research questions about human lifeways contain associated features, structures, and/or relatively intact and dateable artifacts.

Historical Archaeological Sites or Components

Historical sites containing or consisting of preserved features or structures are evaluated primarily under Criteria A, B, and C. Historical trash scatters lacking associated features or structures are primarily evaluated under Criterion D. In general, these types of sites represent ephemeral prospecting or stock-management activities, but they lack identifiable or important association with specific persons or events of regional or national history (Criteria A and B), and they lack the formal and structural attributes necessary to qualify as eligible under Criterion C. The evaluation of significance of historical archaeological sites under Criterion D focuses on the capacity of the sites or components to yield significant information regarding knowledge of history during the period(s) of site significance. Evaluation of the significance of historical sites considers general characteristics such as the nature, size, and diversity of the site assemblage; the potential presence or absence of subsurface cultural deposits; the nature of any features within the site; construction techniques; building materials; structural integrity; and the age range reflected by the site assemblage.

Historical sites considered to be significant under Criterion D generally contain an assemblage of cultural remains that reflects sufficient diversity to permit identification of activities and to allow confirmation of the period of site use. Sites with the most potential to address research questions contain associated features, structures, and relatively intact and datable artifacts. Significant sites are those that could impart information not available solely from historical documents. Although archival research might provide an essential form of information, often historical records are inaccurate or incomplete. For example, examination of construction techniques or household assemblages can provide information on economic slumps, reuse of structures for other-than-original purposes, and re-occupation cycles. As a result, insight may be gained into questions about human lifeways that are often asked in archaeology, but rarely specified directly in historical documentation.

Non-Archaeological Historical Sites or Components

Non-archaeological historical sites or sites with non-archaeological components are those primarily assessed for NRHP eligibility under Criteria A, B, and C, rather than Criterion D and typically are not subject to subsurface testing. Individual segments of significant historical sites are evaluated as contributing or non-contributing in terms of physical and environmental integrity. Examples of historical site types include linear historical features, such as transportation routes and water conduits, and standing building and structure sites, and classification may potentially be extended to any historical feature on an otherwise archaeological site, such as traditional cultural property features. Historical and ethnographic sites evaluated for potential contribution to history or cultural traditions for reasons beyond their possible future research value tend to receive different evaluation and management considerations than do archaeological sites. Typically, the integrity of historical sites is addressed using the guidelines presented in National Register Bulletin 15 (NPS 1991), which defines the seven elements of integrity as location, design, setting, materials, workmanship, feeling, and association. As such, properties are basically evaluated in consideration of their physical integrity and the integrity of their surroundings. Traditional cultural properties are also considered under the guidelines of National Register Bulletin 38 (Parker and King 1998). In accordance with tribal protocol, a 75-foot buffer is maintained around all eligible, potentially eligible, and unevaluated sites.

INVENTORY RESULTS AND RECOMMENDATIONS

During the inventory, SWCA personnel newly recorded one site (32DU1891). The site consists of a stone cairn of unknown cultural and temporal origin. 32DU1891 has been recommended as unevaluated regarding its eligibility for listing on the NRHP. The site is discussed in detail below, and a copy of the North Dakota Site Form is included in Appendix B (detached). A resource location map showing the location of the site is provided in Appendix C.

32DU1891

Site Type:	Cairn
Association:	Unknown
Site Size:	6.97 × 5.84 m (30.62 m²); 22.87 × 19.16 feet (329.61 feet²)
NRHP Recommendation:	Unevaluated
Management Recommendation/Project Effect:	Avoidance/No Effect

Site Description

32DU1891 is a cairn of unknown cultural or temporal origin located on a prominent ridge surrounded by rolling grasslands (figures 5 and 6). The ridge is approximately 8.6 kilometers south of the Lake Sakakawea portion of the Missouri River. A north-flowing unnamed intermittent drainage, which eventually empties into the lake, is located approximately 430 m west/southwest of the site. Local vegetation consists of little bluestem, prairie smoke, fringed sagebrush, and prairie coneflower, allowing for 15 to 25 percent bare ground surface visibility. Surface soil is pale yellow sandy loam formed through residual processes. The resource is in good condition, with impacts to the site consisting of erosion, grazing, construction of a pipeline approximately 75 m south of the site and evidence of vehicle traffic near the site.

Figure 5. Site overview of 32DU1891, facing north.

Contains Privileged Information -- Do Not Release

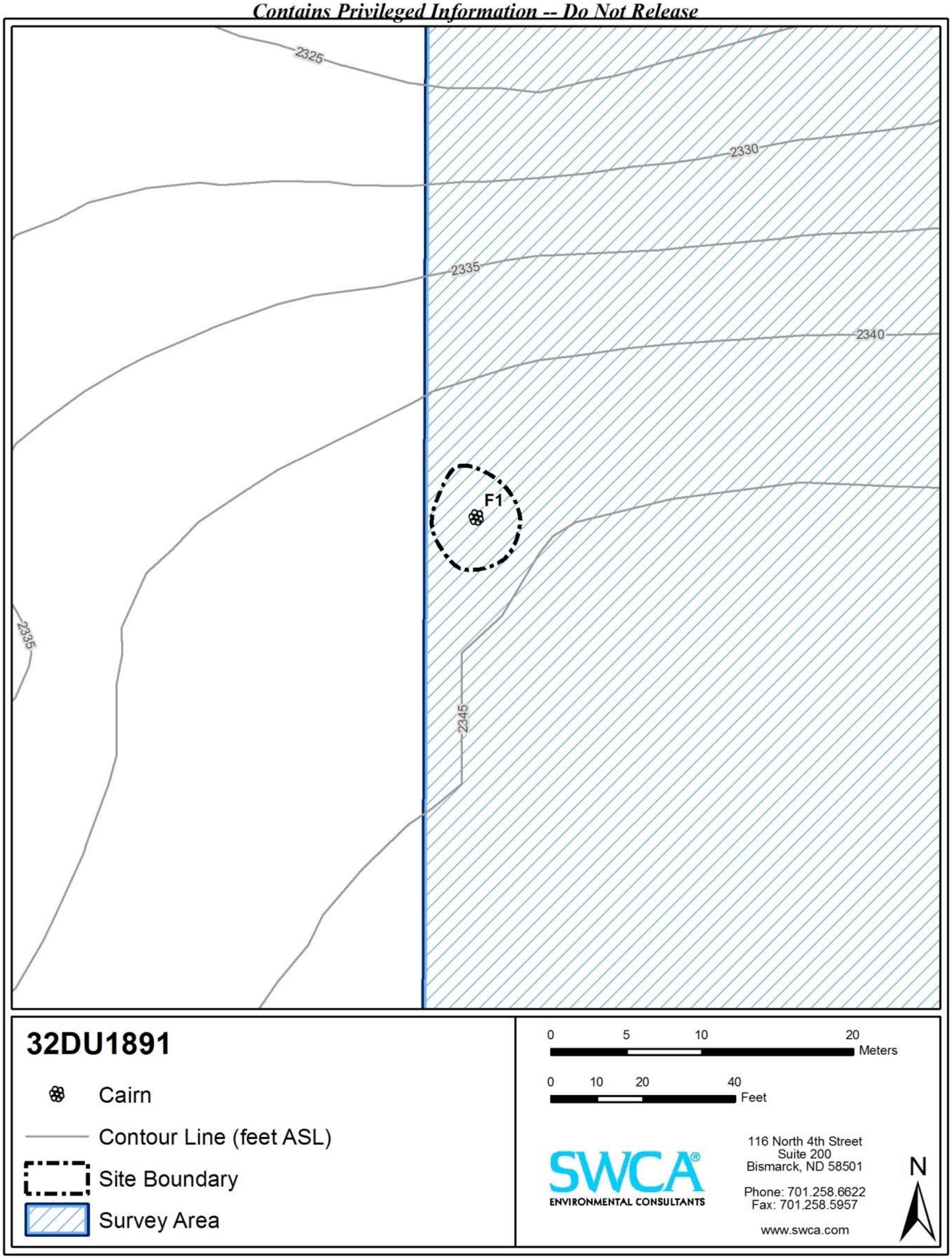

Figure 6. Sketch map of 32DU1891.

Survey Results

SWCA identified and recorded 32DU1891 on June 14, 2013. The site consists of a single, oval-shaped stone cairn (Feature 1), measuring 330 × 220 centimeters (cm) and 45 cm in height, positioned on a prominent ridgeline overlooking a valley to the north (Figure 7). The cairn is very well-defined and lightly sodded, consisting of more than 60 tabular sandstone rocks ranging in size from 5 to 70 cm and exhibiting up to 90 percent surface coverage by black and orange lichen. The feature is fairly well-preserved, with a few stones scattered down the slope. Judging by the construction techniques, it may have once been a “pillared” cairn. No cultural materials were observed in association with the cairn.

Figure 7. Feature 1, 32DU1891, cairn, facing east.

Historic Background

SWCA completed a land records search for the delimited parcel encompassing the site area using BLM General Land Office (GLO) records. The search was conducted in order to gain a better understanding of the land use associated with the site location. The search indicated a serial land patent was issued to Emma M. Baker for Lot 2 (NW¼ NE¼) of Section 4, T148N, R92W on August 29, 1924 (BLM 2013 [1916]: Accession Number 943491).

Emma M. Baker was born in 1917 on the Fort Berthold Indian Reservation, and by the time the 1924 Indian Census was taken, her name had changed to Emma Jane Baker (United States Indian Census Schedules 1924: Roll: M595_134; Line: 16). At the time the patent was issued, Emma Jane Baker (formerly Emma M. Baker) would have been approximately seven years old and was living with her father, James Baker; her mother, Ethel T. Baker; and her six brothers and sisters (United States Indian Census Schedules 1924: Roll: M595_134; Line: 16). In 1935, Emma Jane Baker married Felix Huber (United States Indian Census Schedules 1936: Roll: M595_136; Page: 62; Line: 3). It could not be determined through any available records whether or not Emma Jane Huber (nee Baker) or her family lived on the property or if she is associated with the site.

NRHP Eligibility Recommendation

32DU1891 is a stone cairn of unknown cultural or temporal origin located on top of a prominent ridgeline. It retains good integrity, with minimal disturbance by erosion through aeolian and colluvial processes, grazing, pipeline construction, and vehicle traffic. Due to the presence of a cultural feature that may be considered of a sacred nature, it is recommended that the site remain unevaluated regarding its eligibility for listing on the NRHP under Criterion A, pending tribal consultation. Historical research did not return any information connecting the property to any person or persons significant in our past; therefore, SWCA recommends the site not eligible for nomination to the NRHP under Criterion B. No standing structures remain on-site; therefore, SWCA recommends the site not eligible for nomination to the NRHP under Criterion C. Though the feature is only lightly sodded, the potential for the site to contain buried cultural deposits exists; however, shovel testing was not conducted by project design. Therefore, SWCA recommends the site remain unevaluated regarding its eligibility for listing on the NRHP under Criterion D, pending subsurface testing.

Management Recommendation

Avoidance is recommended at 32DU1891, pending tribal consultation and subsurface testing. The site is approximately 359 feet west of the proposed project area and is considered adequately avoided. No further work is recommended.

CONCLUSIONS

SWCA conducted a Class I and Class III cultural resource inventory on behalf of Arrow for the proposed Arrow Station #7 compressor station. The Class III inventory was conducted on June 14 and August 13, 2013, and consisted of a 39.28-acre area surrounding and encompassing the proposed compressor station and two access roads. The project is located within the external boundaries of the Fort Berthold Indian Reservation on allotted lands managed by the BIA-GPRO.

During the inventory, SWCA recorded one site (32DU1891). 32DU1891 is a cairn of unknown cultural or temporal origin which is unevaluated regarding its eligibility for listing on the NRHP. Therefore, avoidance of the site is recommended, pending tribal consultation and subsurface testing. 32DU1891 is approximately 359 feet west of the proposed compressor station disturbance and is therefore adequately avoided. No further work is recommended for the site at this time. It is recommended that a determination of *No Historic Properties Affected* be granted and for the project to proceed as planned.

REFERENCES CITED

Aaberg, Stephen A., Rebecca R. Hanna, Chris Crofutt, Jayme Green, and Marc Vischer

2006 *Class I Overview of Paleontological & Cultural Resources in Eastern Montana.* Miles City Field Office Resource Management Plan (RMP) and Environmental Impact Statement (EIS). Volume 1. Report prepared by Aaberg Cultural Resource Consulting Service for the U.S. Department of the Interior, BLM, Miles City, Montana.

Agenbroad, Larry D.

1978 The Hudson-Meng Site: An Alberta Bison Kill in the Nebraska High Plains. In *Bison Procurement and Utilization: A Symposium*, edited by L. B. Davis and M. Wilson. *Plains Anthropologist, Memoir* 14:128–131.

Artz, Joe Alan, Matthew J. Root, and Michael L. Gregg (editors)

1983 *Archeological Investigations at 32DU37 and 32DU273: Two Sites Near the Killdeer Mountains in Dunn County, North Dakota.* Department of Anthropology, University of North Dakota, Grand Forks. Submitted to the Northern Border Pipeline Co., Omaha, Nebraska.

Baltensperger, Bradley H.

1983 Agricultural Change among Great Plains Russian Germans. *Annals of the Association of American Geographers* 73(1):75–78.

Billington, David P., Donald C. Jackson, and Martin V. Melosi

2005 *The History of Large Federal Dams: Planning, Design, and Construction*. U.S. Department of the Interior, Bureau of Reclamation, Denver, Colorado.

Blakeslee, Donald J.

1993 Modeling the Abandonment of the Central Plains: Radiocarbon Dates and the Origin of the Initial Coalescent. In *Prehistory and Human Ecology of the Western Prairies and Northern Plains*, edited by Joseph A. Tiffany, pp. 199–214. Plains Anthropologist Memoir 27.

Borchert, Jeani L., and Greg L. Wermers

1994 *32MZ1184 Evaluative Testing.* UNDAR-West, University of North Dakota. Submitted to Meridian Oil, Inc., Englewood, Colorado.

Bryan, Liz

1991 *The Buffalo People: Prehistoric Archaeology on the Canadian Plains*. University of Alberta Press, Edmonton.

Bryce, Sandra, James M. Omernik, David E. Pater, Michael Ulmer, Jerome Schaar, Jerry Freeouf, Rex Johnson, Pat Kuck, and Sandra H. Azevedo

1998 Ecoregions of North Dakota and South Dakota. Jamestown, North Dakota: Northern Prairie Wildlife Research Center Online. Available at: http://www.npwrc.usgs.gov/resource/habitat/ndsdeco/index.htm (Version 30NOV1998). Accessed February 14, 2012.

Bryson, Reid A., David A. Baerreis, and Wayne M. Wendland

1970 The Character of Late-Glacial and Post-Glacial Climatic Changes. In *Pleistocene and Recent Environments of the Central Great Plains,* edited by Wakefield Dort, Jr., and J. Knox Jones, Jr., pp. 53–74. University of Kansas, Special Report of the Department of Geology 3.

Byrne, William J.

1973 *The Archaeology and Prehistory of Southern Alberta as Reflected by Ceramics.* Archaeological Survey of Canada Paper 14. National Museum of Man Mercury Series, Ottawa.

Bureau of Land Management

2013 Bureau of Land Management: General Land Office Records. Online database available at http://www.glorecords.blm.gov/default.aspx. Accessed on July 8, 2013.

Cannon, Michael D., and David J. Meltzer

2004 Early Paleoindian Foraging: Examining the Faunal Evidence for Large Mammal Specialization and Regional Variability in Prey Choice. *Quaternary Science Reviews* 23:1955–1987.

Carlson, Gayle F.

1994 The Foragers: Diversified Lifestyle. In *The Cellars of Time: Paleontology and Archaeology in Nebraska*. Nebraskaland Magazine 72(1):95–106.

Carlson, Robert, L., and Larry J. Sprunk

1979 *History of the North Dakota State Highway Department*. Capitol Grounds, Bismarck, North Dakota.

Clayton, Lee

1980 Geologic Map of North Dakota, U.S. Geological Survey, Scale 1:500,000. Available at: http://tin.er.usgs.gov/geology/state/state.php?state=ND. Accessed August 12, 2013.

Coulter, John Lee

1910 Industrial History of the Valley of the Red River of the North. In *Collections of the State Historical Society of North Dakota, Volume 3*, edited by O. G. Libby, pp. 529–672. Tribune State Binders and Printers, Bismarck, North Dakota.

Danborn, David B.

1998 North Dakota: The Most Midwestern State. In *Heart Land: Comparative Histories of the Midwestern States*, edited by James H. Madison, pp. 107–126. Indiana University Press, Bloomington, IN.

Davis, Leslie B.

1993 Paleo-Indian Archaeology in the High Plains and Rocky Mountains of Montana. In *From Kostenki to Clovis: Upper Paleolithic-Paleo-Indian Adaptations*, edited by Olga Soffer and Nikolai D. Praslov, pp. 263–277. Plenum Press. New York.

DeMallie, Raymond J.

2001a Sioux Until 1850. In *Handbook of North American Indians: Plains*, Vol. 13, Part 2, edited by Raymond J. DeMallie, pp. 718–760. William C. Sturtevant, general editor. Smithsonian Institution, Washington, D.C.

2001b Yankton and Yanktonai. In *Handbook of North American Indians: Plains*, Vol. 13, Part 2, edited by Raymond J. DeMallie, pp. 777–793. William C. Sturtevant, general editor. Smithsonian Institution, Washington, D.C.

Dill, Christopher L.

1983 *Early Peoples of North Dakota (before 1858)*. Occasional Publication No. 5, State Historical Society of North Dakota, North Dakota Heritage Center, Bismarck.

Eighmy, Jeffrey L., and Jason M. LaBelle

1996 Radiocarbon Dating of Twenty-seven Plains Complexes and Phases. *Plains Anthropologist* 41(155):53–69.

Etulain, Richard W., and Michael P. Malone

1989 *The American West: A Modern History to the Present*. University of Nebraska Press, Lincoln, NE.

Fenneman, Nevin M.

1931 *Physiography of Western United States*. McGraw-Hill, New York.

Ferrell, John R.

1993 *Big Dam Era: A Legislative and Institutional History of the Pick-Sloan Missouri Basin Program*. U.S. Army Corps of Engineers, Missouri River Divisions, Omaha, Nebraska.

Floodman, Mervin G., Marcia J. Tate, and Robert A. Williams

1982 *Final Report: Archaeological Mitigation at 32MZ333 and 32MZ334, McKenzie County, North Dakota*. Powers Elevation Co., Inc., Denver, Colorado. Submitted to Abraixas Petroleum, San Antonio, Texas.

Frison, George C.

1988 Avonlea and Contemporaries in Wyoming. In *Avonlea Yesterday and Today: Archaeology and Prehistory*, edited by Leslie B. Davis, pp. 81–88. Saskatchewan Archaeological Society, Saskatoon, Saskatchewan.

1991 *Prehistoric Hunters on the High Plains*, 2nd ed. Academic Press, New York.

1998 Paleoindian Large Mammal Hunters on the Plains of North America. *Proceedings of the National Academy of Sciences* 95:14576–14583.

Frison, George C., David Schwab, L. Adrien Hannus, Peter Winham, David Walter, and Robert C. Mainfort

1996 Archeology of the Northwestern Plains. In *Archeological and Bioarcheological Resources of the Northern Plains*, edited by George C. Frison and Robert C. Mainfort, pp. 8–40. Arkansas Archeological Survey Research Series No. 47, Fayetteville.

Frison, George C., and Larry C. Todd

1986 *The Colby Mammoth Site: Taphonomy and Archaeology of a Clovis Kill in Northern Wyoming*. University of New Mexico Press, Albuquerque.

Frison, George C., and Danny N. Walker

2007 The Medicine Lodge Creek Archaeological Project. In *Medicine Lodge Creek: Holocene Archaeology of the Eastern Big Horn Basin, Wyoming*, edited by George C. Frison and Danny N. Walker, pp. 11–31. Volume 1. Clovis Press.

Froehling, Oliver Raimund

1993 Allotment in Severalty in the Northern Ponca Reservation – The Geography of Dispossession. Master's Thesis presented to the Graduate College of the University of Nebraska Geography Department.

Galvan, Mary Elizabeth

2007 Vegetative Ecology. In *Medicine Lodge Creek: Holocene Archaeology of the Eastern Big Horn Basin, Wyoming*, edited by George C. Frison and Danny N. Walker, pp. 155–176. Volume 1. Clovis Press.

Grayson, Donald K., and David J. Meltzer

2002 Clovis Hunting and Large Mammal Extinction: A Critical Review of the Evidence. *Journal of World Prehistory* 16:313–359.

Gregg, Michael L.

1985 *An Overview of the Prehistory of Western and Central North Dakota: Class I Cultural Resources Inventory, Dickinson District, Bureau of Land Management, February 1984*. Cultural Resources Series No. 1. University of North Dakota, Grand Forks. Prepared for the Bureau of Land Management, Billings, Montana.

Gregg, Michael L., and Amy Bleier

2008 The Little Missouri River Study Unit. *North Dakota Comprehensive Plan for Historic Preservation: Archaeological Component.* North Dakota State Historic Preservation Office, Bismarck.

Griffen, Karen M.

1996 Reservoirs and Reservations. *The Nebraska Anthropologist* 12(1):23–30.

Griffin, James B.

1967 Eastern North American Archaeology: A Summary. *Science* 56:175–191.

Hannus, L. Adrien

1990 The Lange-Ferguson Site: A Case for Mammoth Bone Butchering Tools. In *Megafaua & Man: Discovering America's Heartland*, edited by Larry D. Agenbroad, Jim I. Mead, and Lisa W. Nelson, pp. 86–99. Scientific Papers, Volume 1. The Mammoth Site of Hot Springs, South Dakota, Inc., Hot Springs.

1994 Cultures of the Heartland: Beyond the Black Hills. In *Plains Indians, A.D. 500-1500: The Archaeological Past of Historic Groups,* edited by Karl H. Schlesier. University of Oklahoma Press, Norman.

Hanson, Jeffrey R.

1998 The Late High Plains Hunters. In *Archaeology of the Great Plains,* edited by W. Raymond Wood, pp.456–480.

Harvey, Mark

1996 North Dakota, the Northern Plains, and the Missouri Valley Authority. In *The Centennial Anthology of North Dakota History, Journal of the Northern Plains*, edited by Janet Daley Lysengen and Ann M. Rathke, pp. 376–389. State Historical Society of North Dakota, Bismarck, North Dakota.

Hill, Matthew E.

2007 A Moveable Feast: Variation in Faunal Resource Use among Central and Western North American Paleoindian Sites. *American Antiquity* 72(3):417–438.

Hill, Matthew G.

2001 Paleoindian Diet and Subsistence Behavior on the Northwestern Great Plains. Unpublished Ph.D. Dissertation, Department of Anthropology, University of Wisconsin, Madison.

Hoffman, Elizabeth, and Gary D. Libecap

1990 Institutional Choice and the Development of U.S. Agricultural Policies in the 1920s. Discussion Paper 90-40, University of Arizona.

Hoover, Herbert T.

2005 *A New South Dakota History*. Center for Western Studies/Augustana College, Sioux Falls, SD.

Hoxie, Frederick E., Peter C. Mancall, and James H. Merrell

2001 *American Nations: Encounters in Indian Country, 1850 to the Present*. Routledge, New York, NY.

Hudson, John C.

1976 Migration to an American Frontier. *Annals of the Association of American Geographers* 66(2):242–265.

Irwin, Henry T.

1967 The Itama: Late Pleistocene Inhabitants on the Plains of the United States and Canada and the American Southwest. Unpublished Ph.D. Dissertation, Department of Anthropology, Harvard University, Cambridge.

1971 Developments in Early Man Studies in Western North America, 1960–1970. *Arctic Anthropology* 8(2):42–67.

Johnson, Craig M.

1998 Coalescent Tradition. In *Archaeology on the Great Plains*, edited by W. Raymond Wood, pp. 308–344. University Press of Kansas, Lawrence.

Johnson, Anne M., and Alfred E. Johnson

1998 The Plains Woodland. In *Archaeology on the Great Plains*, edited by W. Raymond Wood, pp. 201–234. University Press of Kansas, Lawrence.

Jorstad, T., T. East, J. M. Adovasio, J. Donahue, and R. Stuckenrath

1986 Paleosols and Prehistoric Populations in the High Plains. *Geoarchaeology* 1:163–181.

Joyes, Dennis C.

1970 The Culture Sequence at the Avery Site at Rock Lake. In *Ten Thousand Years: Archaeology in Manitoba*, edited by W. M. Hlady, pp. 209–222. D. W. Friensen and Sons, Altona, Manitoba.

Kappler, Charles J.

1904 *Indian Affairs and Treaties*, Volume 2. Government Printing Office, Washington, D.C.

1929 *Indian Affairs and Treaties*, Volume 4. Government Printing Office, Washington, D.C.

Klinner, Duane, and Greg L. Wermers

2000 *Evaluative Testing at 32MZ1447, 32MZ1484, and 32MZx85.* UNDAR-West, University of North Dakota. Submitted to the North Dakota Department of Transportation, Bismarck.

Koop, Micahel

1986 German Russians. In *America's Architectural Roots*, edited by Dell Uption, pp. 130–135. National Trust for Historic Preservation. Preservation Press, Washington, D.C.

Krause, Richard A.

2001 Plains Village Tradition: Coalescent. In *Handbook of North American Indians: Plains,* Vol. 13, Part 1, edited by Raymond J. DeMallie, pp. 196–206. William C. Sturtevant, general editor. Smithsonian Institution, Washington, D.C.

Lawson, Michael L.

1982 *Dammed Indians: The Pick-Sloan Plan and the Missouri River Sioux, 1944–1980*. University of Oklahoma Press, Norman.

Leahy, James E.

2003 *The North Dakota State Constitution, A Reference Guide*. Praeger Publishing, Westport, Connecticut.

Lehmer, Donald J.

1971 *Introduction to Middle Missouri Archeology*. U.S. Department of the Interior, National Park Service, Washington, D.C.

Limerick, Patricia Nelson

1987 *The Legacy of Conquest: The Unbroken Past of the American West*. W.W. Norton and Company, Inc. New York, NY.

Linenberger, Toni Rae

1998 *The Pick Sloan Missouri Basin Program: Overview*. Bureau of Reclamation History Program, Denver, CO.

McCullough, H. D.

1948 *Farm and Range Resources of the Residual Segments of the Fort Berthold Reservation*. Department of the Interior, Bureau of Indian Affairs, Missouri River Basin Investigations. Missouri River Basin Investigations Staff, Region No. 2, Bureau of Indian Affairs, Billings, MT.

McLaughlin, Castle

1994 The Big Lease: Confined-range Ranching on the Fort Berthold Indian Reservation, 1910–1950. *North Dakota History* 61(4):2–15.

Metcalf, Michael D., Anne McKibbin, Julia A. Medsker, Kurt P. Schweigert, and Michael L. McFaul

1988 *A Class II Cultural Resource Survey of Five Coal Study Areas, Western North Dakota*. Metcalf Archaeological Consultants, Inc., Eagle, Colorado. Submitted to the Bureau of Land Management, Dickinson.

Miles, Lion G.

1999 The Red Man Dispossessed: The Williams Family and the Alienation of Indian Land in Stockbridge, Massachusetts, 1763-1818. In *New England Encounters: Indians and Euroamericans, ca 1600-1850,* edited by Alden T. Vaughn, pp. 276–304. Northeastern University Press. Boston, Massachusetts.

Morris, C. Patrick

1990 Hydroelectric Power and the Human Rights of Indigenous People. In *The Struggle for the Land: Indigenous Insight and Industrial Empire in the Semiarid World,* edited by Paul A. Olson. University of Nebraska Press, Lincoln.

National Climatic Data Center (NCDC)

2013 Climatography of the United States, No. 20, 1971–2000. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Asheville, North Carolina. Available at: http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl. Accessed July 29, 2013.

National Park Service (NPS)

1991 *How to Apply the National Register Criteria for Evaluation*. National Register Bulletin 15. U.S. Department of the Interior, Washington, D.C.

Natural Resources Conservation Service (NRCS)

2013 Web Soil Survey – Dunn County, North Dakota. Available at: http://websoilsurvey.nrcs.usda.gov. Accessed July 29, 2013.

North Dakota Agricultural Statistics Service

2009 Crop and Weather Data, 2009. Electronic document available at: http://www.nass.usda.gov/Statistics_by_State/North_Dakota/Publications/Annual_Statistical_Bulletin/79Annual/weather79.pdf. Accessed August 5, 2013. North Dakota Department of Public Instruction (NDDPI)

2002 *The History and Cultural of the Mandan, Hidatsa, Sahnish (Arikara)*. North Dakota Department of Public Instruction, Bismarck, North Dakota.

Opie, John

2004 Ecology and Environment. In *The Great Plains Region*, edited by Amanda Rees, pp. 67–100. Greenwood Press, Westport, CT.

Parker, Angela K.

2011 Taken Lands: Territory and Sovereignty on the Fort Berthold Indian Reservation, 1934-1960. A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy (History), University of Michigan.

Parker, Patricia L., and Thomas F. King

1998 *Guidelines for Evaluating and Documenting Traditional Cultural Properties*. National Register Bulletin 38. U.S. Department of the Interior, Washington, D.C.

Reeves, Brian

1969 The Southern Alberta Paleo-Cultural Paleo-Environmental Sequence. In *Post Pleistocene Man and His Environment on the Northern Plains*, edited by R. G. Forbis. Student Press, University of Calgary.

1970 Culture Change in the Northern Plains; 1000 B.C.–A.D. 1000. Unpublished Ph.D. dissertation, Department of Archaeology, University of Calgary.

1983 *Culture Change in the Northern Plains: 1000 B.C.–A.D. 1000*. Occasional Paper No. 20. Archaeological Survey of Alberta, Edmonton.

Root, Matthew J. (editor)

2000 *The Archaeology of the Bobtail Wolf Site: Folsom Occupations of the Knife River Flint Quarry Area, North Dakota*. Washington State University, Pullman. Submitted to the U.S. Fish and Wildlife Service, Denver.

Schlesier, Karl H.

1968 Migration and Cultural Ways of the Middle Missouri, 1550–1850. *Journal for Ethnologies* Vol. 93 (1–2). Braunschweig, Delaware.

Schneider, Fred E., and W. Jeffrey Kinney

1978 Evans: A Multi-Component Site in Northwestern North Dakota. *Archaeology in Montana* 19(1,2):1–39.

Schulenberg, Raymond F.

1957 Indians of North Dakota. *North Dakota History* 23(3,4). State Historical Society, Bismarck.

Seabloom, Robert W., Richard D. Crawford, and Michael G. McKenna

1978 *Vertebrates of Southwestern North Dakota: Amphibians, Reptiles, Birds, Mammals*. Institute for Ecological Studies, University of North Dakota, Grand Forks, North Dakota.

Sellet, Frederic

2001 A Changing Perspective on Paleoindian Chronology and Typology: A View from the Northwestern Plains. *Arctic Anthropology* 38(2):48–63.

Shifrin, Lisa K.

2000 *Young-Man-Chief (32DU955D): A Folsom, Late Plains Archaic, and Late Prehistoric Site*. Bilby Research Center, Northern Arizona University, Flagstaff. Submitted to the U.S. Fish and Wildlife Service, Denver.

Simon, Arleyn, and Jeani Borchert

1981a *Archaeological Test Excavations, Ice Box Canyon Ridge Site, 32MZ38.* Department of Anthropology, University of North Dakota, Grand Forks. Submitted to Matador Pipelines, Wichita, Kansas.

1981b *Archaeological Test Excavations, Sunday Sage Site—32BI22, Billings County, North Dakota.* Department of Anthropology, University of North Dakota, Grand Forks. Submitted to Koch Exploration Company, Bowman, North Dakota.

Smith, Brian J., and Ernest G. Walker

1988 Evidence for Diverse Subsistence Strategies in an Avonlea Component. In *Avonlea Yesterday and Today: Archaeology and Prehistory*, edited by Leslie B. Davis, pp. 81–88. Saskatchewan Archaeological Society, Saskatoon, Saskatchewan.

Smith, G. Hubert

1972 *Like-a-Fishhook Village and Fort Berthold, Garrison Reservoir, North Dakota*. Anthropological Papers No. 2. U.S. Department of the Interior, National Park Service, Washington, D.C.

Stiger, Mark

2006 A Folsom Structure in the Colorado Mountains. *American Antiquity* 71(2):321–352.

Surovell, Todd A., and Nicole M. Waguespack

2007 Folsom Hearth-Centered Use of Space at Barger Gulch, Locality B. In *Frontiers in Colorado Paleoindian Archaeology*, edited by Robert Brunswig and Bonnie Pitblado, pp. 219–259. University of Colorado Press, Boulder.

Tiffany, Joseph A.

2007 Examining the Origins of the Middle Missouri Tradition. In *Plains Village Archaeology: Bison Hunting Farmers in the Central and Northern Plains*, edited by Stanley A. Ahler and Marvin Kay, pp. 3–14. University of Utah Press, Salt Lake City.

Todd, Larry C., Matthew G. Hill, David J. Rapson, and George C. Frison

1997 Cutmarks, Impacts, and Carnivores at the Casper Site Bison Bonebed. In *Proceedings of the 1993 Bone Modification Conference Hot Springs, South Dakota*, edited by L. A. Hannus, L. Rossum, and L. Winham, pp. 136–157. Occasional Publication No. 1. Archaeological Laboratory, Augustana College, Sioux Falls.

Todd, Larry C., and David J. Rapson

1999 Formational Analysis of Bison Bonebeds and Interpretation of Paleoindian Subsistence. In *Le Bison: Gibier et Moyen de Subsistance des Hommes du Paléolithique aux Paléoindiens des Grandes Plaines*, edited by J.-Ph. Brugal, F. David, J. G. Enloe, and J. Jaubert, pp. 479–499. Editions APDCA, Antibes, France.

Tweton, D. Jerome, and Theodore B. Jelliff

1976 *North Dakota: The Heritage of a People*. North Dakota Institute for Regional Studies, Fargo, North Dakota.

U.S. Army Corps of Engineers

2013 U.S. Army Corps of Engineers, Omaha District, History, Tribal Relations. Available at: http://www.nwo.usace.army.mil/About/History.aspx. Accessed June 16, 2013.

United States Indian Census Schedules

1924 Indian Census Rolls, 1885-1940, 1910, M595, 692 rolls. Records of the Bureau of Indian Affairs, Record Group 75. National Archives and Records Administration, Washington D.C.

1936 Indian Census Rolls, 1885-1940, 1910, M595, 692 rolls. Records of the Bureau of Indian Affairs, Record Group 75. National Archives and Records Administration, Washington D.C.

U.S. Fish and Wildlife Service

2013 County Occurrence of Endangered, Threatened, and Candidate Species and Designated Critical Habitat in North Dakota. Available at: http://www.fws.gov/northdakotafieldoffice/countylist.htm. Accessed August 5, 2013.

U.S. House of Representatives

1882 *Allotment of Lands in Severalty Among Indian Tribes: Memorial of the Creek Nation on the Subject of Lands in Severalty Among the Several Indian Tribes, with Accompanying Papers*. Second Session of the 47th Congress, Miscellaneous document No. 18. In Index to the Miscellaneous Documents of the House of Representatives for the Second Session of the forty-seventh congress, 1882-1883. Government Printing Office, Washington, D.C.

Vickers, J. Roderick

1994 Cultures of the Northwestern Plains: From the Boreal Forest Edge to Milk River. In *Plains Indians, A.D. 500-1500: The Archaeological Past of Historic Groups*, edited by Karl H. Schlesier, pp. 3–33. University of Oklahoma Press, Norman.

Walde, Dale A.

2006 Avonlea and Athabaskan Migrations: A Reconsideration. *Plains Anthropologist* 51(198):185–197.

Wilkerson, Lyn

2000 *Roads Less Travelled: Exploring America's Past on its Back Roads*. Writer's Club Press, Lincoln, NE.

Wilkins, Robert P., and Wynona H. Wilkins

1977 *North Dakota: A Bicentennial History*. W.W. Norton and Company, New York, NY.

Willey, P., and Thomas E. Emerson

1993 The Archaeology and Osteology of the Crow Creek Massacre. In *Prehistory and Human Ecology of the Western Prairies and Northern Plains,* edited by Joseph A. Tiffany, pp. 227–269. *Plains Anthropologist* Memoir 27.

William, Jerry D.

2000 *The Big Black Site (32DU955C): A Folsom Complex Workshop in the Knife River Flint Quarry Area, North Dakota*. Washington State University Press, Pullman.

Winham, R. Peter, and F. A. Calabrese

1998 The Middle Missouri Tradition. In *Archaeology on the Great Plains*, edited by W. Raymond Wood, pp. 269–307. University Press of Kansas, Lawrence.

Wood, W. Raymond

1967 *An Interpretation of Mandan Culture History*. Bureau of American Ethnology Bulletin 198, River Basin Surveys Paper 39.

2001 Plains Village Tradition: Middle Missouri. In *Handbook of North American Indians: Plains,* Vol. 13, Part 1, edited by Raymond J. DeMallie, pp. 186–195. William C. Sturtevant, general editor. Smithsonian Institution, Washington, D.C.

Wood, W. Raymond, and Ann M. Johnson

1973 High Butte, 32ME13: A Missouri Valley Woodland-Besant Site. *Archaeology in Montana* 14(3):35–83.

Works Progress Administration (WPA)

1938 *North Dakota: A Guide to the Prairie State*. Compiled by workers of the Federal Writers' Project of the Works Progress Administration for the State of North Dakota. Oxford University Press.

Zimmerman, Larry J.

1985 *Peoples of Prehistoric South Dakota.* University of Nebraska Press, Lincoln.

Zimmerman, Larry J., and Lawrence E. Bradley

1993 The Crow Creek Massacre: Initial Coalescent Warfare and Speculations about the Genesis of Extended Coalescent. In *Prehistory and Human Ecology of the Western Prairies and Northern Plains,* edited by Joseph A. Tiffany, pp. 215–226. *Plains Anthropologist* Memoir 27.

APPENDIX A
List of Previous Studies

Bibliographic Listing of Previous Archaeological and Historical Studies for Project Lands in Dunn County, North Dakota.

Manuscript Number	Location	Title	Authors	Year
000080	Section 2, T148N, R92W	Archaeological Inventory Missouri River Reach Between Fort Benton, Montana, and Sioux City, Iowa	T. Adamczyk	1975
000112	Section 2, T148N, R92W	Appraisal of the Archaeological and Paleontological Resources of the Garrison Reservoir, North Dakota, Supplement	G. Metcalf, T. White	1953
002465	Section 4, T148N, R92W	Test Excavations at 32DU117, Dunn County, North Dakota	T. Van Hoy	1982
002707	Section 4, T148N, R92W	A Class III Intensive Inventory of the Proposed Young Bear 32-4 Well Pad and Access in Dunn County, North Dakota	C. Sheldon	1982
002708	Section 4, T148N, R92W	A Class III Cultural Resource Inventory for the Proposed Young Bear 24-4 Well Location in Dunn County, North Dakota	S. Montgomery, D. Hungerford	1982
002714	Section 4, T148N, R92W	Shell Oil Young Bear 23-4 Test Excavations, Dunn Co., North Dakota	T. Van Hoy	1982
006297	Section 9, T148N, R92W	Fort Berthold Indian Reservation, Stock Dam locations in McKenzie, Mountrail and Dunn Counties, Class III Cultural Resource Inventory UW#1727	J. Borchert	1994
010407	Section 5, T148N, R92W	Fredericks 5-11 Well Pad and Access Road: A Class III Cultural Resource Inventory, Dunn Co., North Dakota	J. Harty	2008
011937	Section 31, T149N, R91W; Sections 35, 36, T149N, R92W; Sections 3-5, 10, T148N, R92W	Ft Berthold Rural Water Mandaree 3 & 4 Pipeline: A Class III Cultural Resource Inventory in McKenzie & Dunn Counties, North Dakota.	B. O’Donnchadha	2010
012407	Sections 3, 4, 9, T148N, R92W	A Class I and Class III Cultural Resource Inventory of the Arrow XTO FBIR Young Bear #31x-9 Gathering Pipeline, Fort Berthold Indian Reservation, Dunn Co., North Dakota.	S. Baer	2011
012409	Sections 3, 10, T148N, R92W	A Class I and Class III Cultural Resource Inventory of the Arrow XTO Darcie #34x-14 Gathering Pipeline Reroute, Fort Berthold Indian Reservation, Dunn Co., North Dakota.	S. Baer	2011
012612	Section 31, T149N, R91W	A Class I and Class III Cultural Resource Inventory of the Arrow Phase 2E BIA 13 Pipeline Connecting to the Arrow Phase 2E and East Mandaree Pipelines on the Fort Berthold Indian Reservation, Dunn Co., North Dakota.	S. Lechert, N. Klitzka	2010

Manuscript Number	Location	Title	Authors	Year
012613	Section 31, T149N, R91W; Section 36, T149N, R 92W; Sections 3-5, T148N, R92W	A Class I and Class III Cultural Resource Inventory of the Arrow Midstream Holdings Phase 2E Pipeline, Fort Berthold Indian Reservation, Dunn Co., North Dakota.	M. Delmas	2010
012618	Sections 3, 4, 10, T148N, R92W	A Class I and Class III Cultural Resource Inventory of the Arrow XTO Ironwoman-Yellowwolf Gathering Line, Fort Berthold Indian Reservation, Dunn Co., North Dakota.	A. Wesson, S. Lechert	2010
012623	Sections 3, 10, T148N, R92W	A Class I and Class III Cultural Resource Inventory of the Arrow XTO Darcie #34x-14 Gathering Line, Fort Berthold Indian Reservation, Dunn Co., North Dakota	S. Lechert	2011
012939	Section 31, T149N, R91W	A Class I and Class III Cultural Resource Inventory of the Arrow FBIR Hunts Along #31-2 Gathering Pipeline, Fort Berthold Indian Reservation, Dunn County, North Dakota	A. Leroy, C. Riordan	2011
013080	Section 5, T148N, R92W	A Class I and Class III Cultural Resource Inventory of the Black Hawk #15-34H Well Pad Expansion, Fort Berthold Indian Reservation, Dunn County, North Dakota and Addendum	C. Herson, N. Eisenhauer, J. Cooper, V. Rose, S. Lechert	2012
013175	Section 35, T149N, R92W; Section 5, T148N, R92W	A Class I and Class III Cultural Resource Inventory of the Rebutia #149-92-35CH and Cactus #149-92-35CH TF Well Pad and Access Road/Utility Corridor, Fort Berthold Indian Reservation, Dunn County, North Dakota	A. Hutchinson	2012
013405	Sections 35, 36, T149N, R92W	A Class I and Class III Cultural Resource Inventory of the Enerplus Resources Rebutia #149-92-35B-05H, Cactus #149-92-35B-05H TF, Ocatillo #149-92-35A-04H, and Saguaro #149-92-35A-04H TF Well Pad and Access Road/Utility Corridor, Dunn County, North Dakota	M. Cox, S. Yost, C. Wandler, K. Altizer	2012
013730	Section 5, T148N, R92W	A Class I and Class III Cultural Resource Inventory of the Rita Blackhawk #34H Gathering Pipeline, Fort Berthold Indian Reservation, Dunn County, North Dakota	D. Reinhart	2012
013925	Sections 5, 10, T148N, R92W	Yellowwolf #31x-10C and Ironwoman #31x-10C Well Pad and Access Road: A Class III Cultural Resource Inventory in Dunn County, North Dakota	J. Rodgers, B. O'Donnchadha	2012

Manuscript Number	Location	Title	Authors	Year
013929	Section 36, T149N, R92W	Walker #31x-36C Well Pad and Access Road: A Class III Cultural Resource Inventory in Dunn County, North Dakota	J. Rodgers, B. O'Donnchadha	2012
013939	Section 35, T149N, R92W	FBIR Lawrence 24-26 Well Pad and Access Road: A Class III Cultural Resource Inventory in Dunn County, North Dakota	D. Klinner	2010
013941	Sections 4, 9, T148N, R92W	FBIR Young Bear 31x-9 Well Pad and Access Road: A Class III Cultural Resource Inventory in Dunn County, North Dakota	D. Klinner	2010

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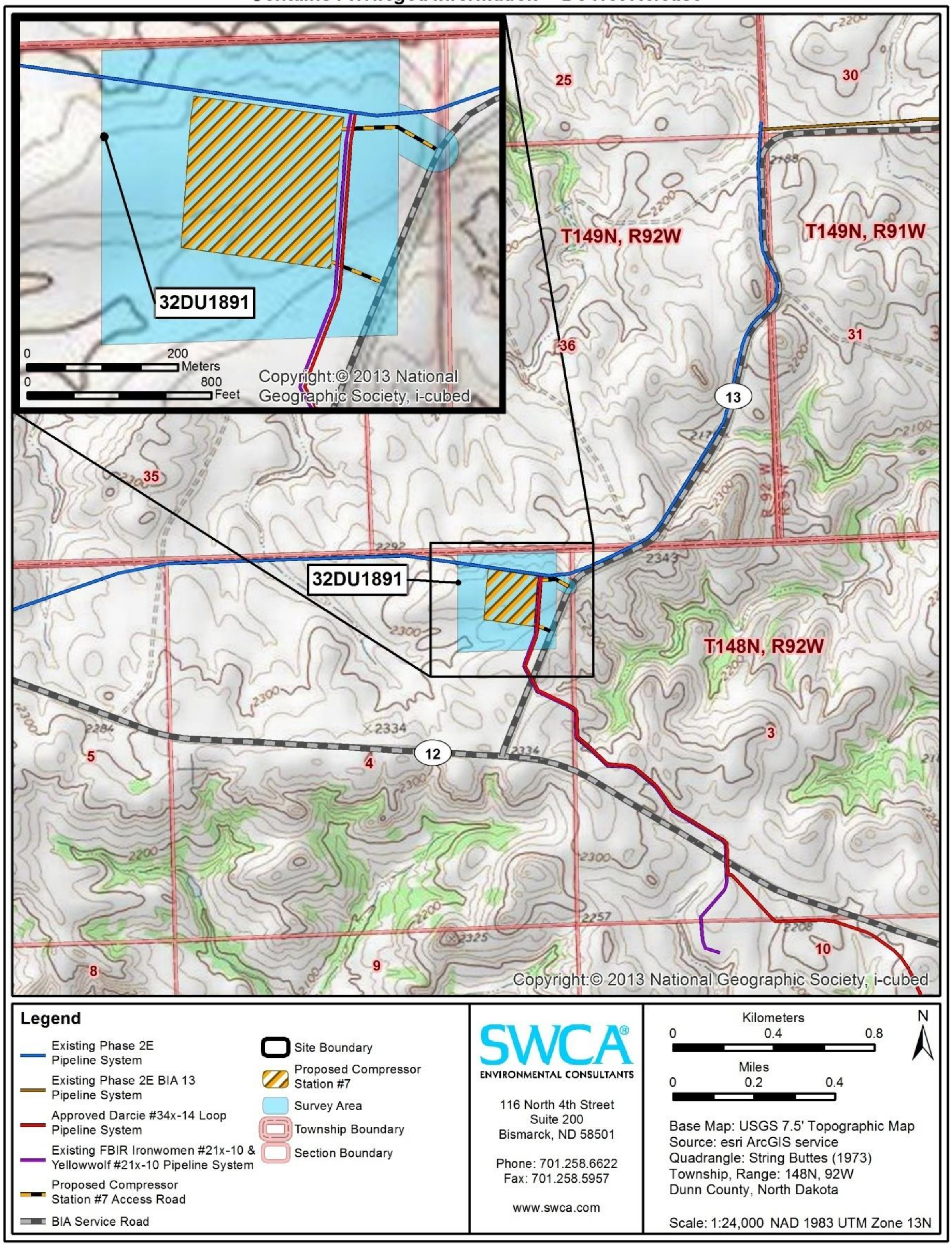
APPENDIX B
(Detached)

North Dakota Site Form

APPENDIX C

Resource Location Map

Contains Privileged Information -- Do Not Release



Resource location map at 1:24,000 scale.

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U.S. Fish and Wildlife Service

Natural Resources of Concern

This resource list is to be used for planning purposes only — it is not an official species list.

Endangered Species Act species list information for your project is available online and listed below for the following FWS Field Offices:

NORTH DAKOTA ECOLOGICAL SERVICES FIELD OFFICE
3425 MIRIAM AVENUE
BISMARCK, ND 58501
(701) 250-4481
http://www.fws.gov/northdakotafieldoffice/endspecies/endangered_species.htm

Project Name:

Arrow Station 7 SMNSR-TAT-000661-2013.001 Permit

Project Counties:

Dunn, ND

Project Type:

Oil Or Gas

Endangered Species Act Species List (USFWS Endangered Species Program).

There are a total of **8** threatened, endangered, or candidate species, and/or designated critical habitat on your species list. Species on this list are the species that may be affected by your project and could include species that exist in another geographic area. For example, certain fishes may appear on the species list because a project could cause downstream effects on the species. Please contact the designated FWS office if you have questions.

Species that may be affected by your project: (View all critical habitat on one map)

Birds	Status	Species Profile	Contact

U.S. Fish and Wildlife Service

Natural Resources of Concern

Least tern (*Sterna antillarum*) Population: interior pop.	Endangered	species info		North Dakota Ecological Services Field Office
Piping Plover (*Charadrius melodus*) Population: except Great Lakes watershed	Threatened	species info		North Dakota Ecological Services Field Office
Sprague's Pipit (*Anthus spragueii*)	Candidate	species info		North Dakota Ecological Services Field Office
Whooping crane (*Grus americana*) Population: except where EXPN	Endangered	species info		North Dakota Ecological Services Field Office
Fishes				
Pallid sturgeon (*Scaphirhynchus albus*) Population: Entire	Endangered	species info		North Dakota Ecological Services Field Office
Insects				
Dakota Skipper (*Hesperia dacotae*)	Candidate	species info		North Dakota Ecological Services Field Office
Mammals				
Black-Footed ferret (*Mustela nigripes*) Population: U.S.A. (specific portions of AZ, CO, MT, SD, UT, and WY)	Experimental Population, Non-Essential	species info		North Dakota Ecological Services Field Office

Gray wolf (*Canis lupus*) Population: U.S.A.: All of AL, AR, CA, CO, CT, DE, FL, GA, KS, KY, LA, MA, MD, ME, MO, MS, NC, NE, NH, NJ, NV, NY, OK, PA, RI, SC, TN, VA, VT and WV; those portions of AZ, NM, and TX not included in an experimental population; and portions of IA, IN, IL, ND, OH, OR, SD, UT, and WA. Mexico.	Endangered	species info		North Dakota Ecological Services Field Office

FWS National Wildlife Refuges (USFWS National Wildlife Refuges Program).

There are **1** refuges in your refuge list

Lake Ilo National Wildlife Refuge (701) 442-5474 3375 11TH STREET N.W. COLEHARBOR, ND58531	refuge profile

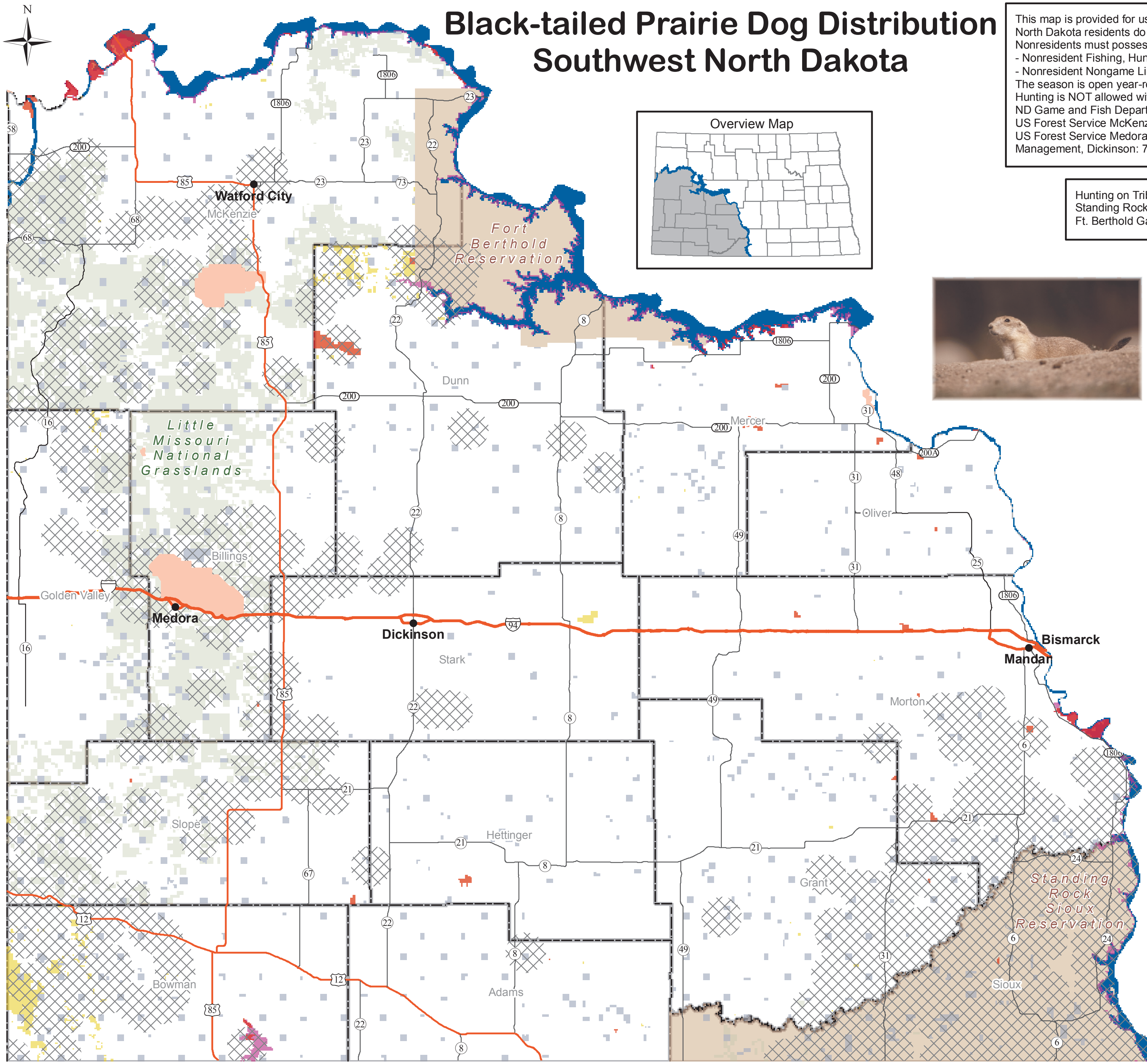
FWS Migratory Birds (USFWS Migratory Bird Program).

Most species of birds, including eagles and other raptors, are protected under the Migratory Bird Treaty Act (16 U.S.C. 703). Bald eagles and golden eagles receive additional protection under the Bald and Golden Eagle Protection Act (16 U.S.C. 668). The Service's Birds of Conservation Concern (2008) report identifies species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become listed under the Endangered Species Act as amended (16 U.S.C 1531 et seq.).

NWI Wetlands (USFWS National Wetlands Inventory).

The U.S. Fish and Wildlife Service is the principal Federal agency that provides information on the extent and status of wetlands in the U.S., via the National Wetlands Inventory Program (NWI). In addition to impacts to wetlands within your immediate project area, wetlands outside of your project area may need to be considered in any evaluation of project impacts, due to the hydrologic nature of wetlands (for example, project activities may affect local hydrology within, and outside of, your immediate project area). It may be helpful to refer to the USFWS National Wetland Inventory website. The designated FWS office can also assist you. Impacts to wetlands and other aquatic habitats from your project may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal Statutes. Project Proponents should discuss the relationship of these requirements to their project with the Regulatory Program of the appropriate U.S. Army Corps of Engineers District.

Black-tailed Prairie Dog Distribution
Southwest North Dakota



This map is provided for use in locating black-tailed prairie dog towns.
North Dakota residents do not need a license to hunt prairie dogs.
Nonresidents must possess the following licenses:
- Nonresident Fishing, Hunting, and Furbearer Certificate - $2
- Nonresident Nongame License - $15

The season is open year-round.
Hunting is NOT allowed within the US National Parks.
ND Game and Fish Department, Bismarck: 701-328-6300
US Forest Service McKenzie Ranger District, Watford City: 701-842-2393
US Forest Service Medora Ranger District and Bureau of Land Management, Dickinson: 701-227-7700

Overview Map

Hunting on Tribal Land may require an additional license:
Standing Rock Game, Fish & Parks, Ft. Yates: 701-854-7236
Ft. Berthold Game & Fish, New Town: 701-627-4760

Map Features

- Active Prairie Dog Areas
- US National Park Service
- US Forest Service
- US Bureau of Land Management
- US Army Corps of Engineers
- ND Game and Fish Department
- ND Land Department
- Tribal Land
- Missouri River System

0 5 10 20 Miles

DO NOT SHOOT

The burrowing owl is a small ground-dwelling bird standing less then one foot tall. It is brown with pale spots. They are often seen standing at the mouth of an abandoned prairie dog burrow, in which they nest and raise an average of 7-9 young. Please be aware of their presence and DO NOT SHOOT them. The burrowing owl population is declining in North Dakota and killing them or any other raptor can result in significant fines.

NDGF GIS
S. Johnson
February 2008

SWCA®
ENVIRONMENTAL CONSULTANTS
Sound Science. Creative Solutions.

Bismarck Office
116 N. 4th Street, Suite 200
Bismarck, ND 58501
701.258.6622
www.swca.com

August 20, 2013

Jeffrey K. Towner
U.S. Fish and Wildlife Service
3425 Miriam Avenue
Bismarck, North Dakota 58501

RE: Request for Concurrence Letter

Dear Mr. Towner,

Arrow Pipeline, LLC (Arrow) is applying for a synthetic minor source pre-construction approval permit (air quality permit) in cooperation with the Environmental Protection Agency (EPA). The proposed action (Project) includes approval by the EPA and private landowners for the construction of a single compressor station within the boundaries of the Fort Berthold Indian Reservation (Reservation).

The proposed Compressor Station #7-Darcie Interconnect Phase 2E (station) and associated access roads would connect to existing pipelines on Reservation trust land in portions of the E½ of the NE¼ of Section 4, Township 148 North, Range 92 West, Dunn County, North Dakota (Figures 1 and 2). The Project would primarily consist of natural gas compressors, oil and water pumps, and ancillary equipment. Additional ancillary equipment that would be installed at the station includes a generator; one 96-inch (outside diameter) Inlet Slug Catcher; a filter separator; two 1,000-barrel (bbl) storage tanks; two 400-bbl water tanks; a header system for suction and discharge piping; a pig launcher; and pig receiver. The Project includes two access roads 432.15 and 227.91 linear feet by 66 feet wide that would be purchased right-of-way (ROW), and would be used to access the station from BIA Road 13. In total, land conversion from grassland to impervious surface would be 10.36 acres (0.36 for roads and 10.0 for station pad).

The purpose and need for the station would be to facilitate pipeline transport of natural gas, crude oil, and produced water from various wells in the area; in some cases the station would boost the pressure of the natural gas and pump the oil and water to a Central Distribution Point (CDP) (the CDP is not located on the Reservation and is not part of the proposed action).

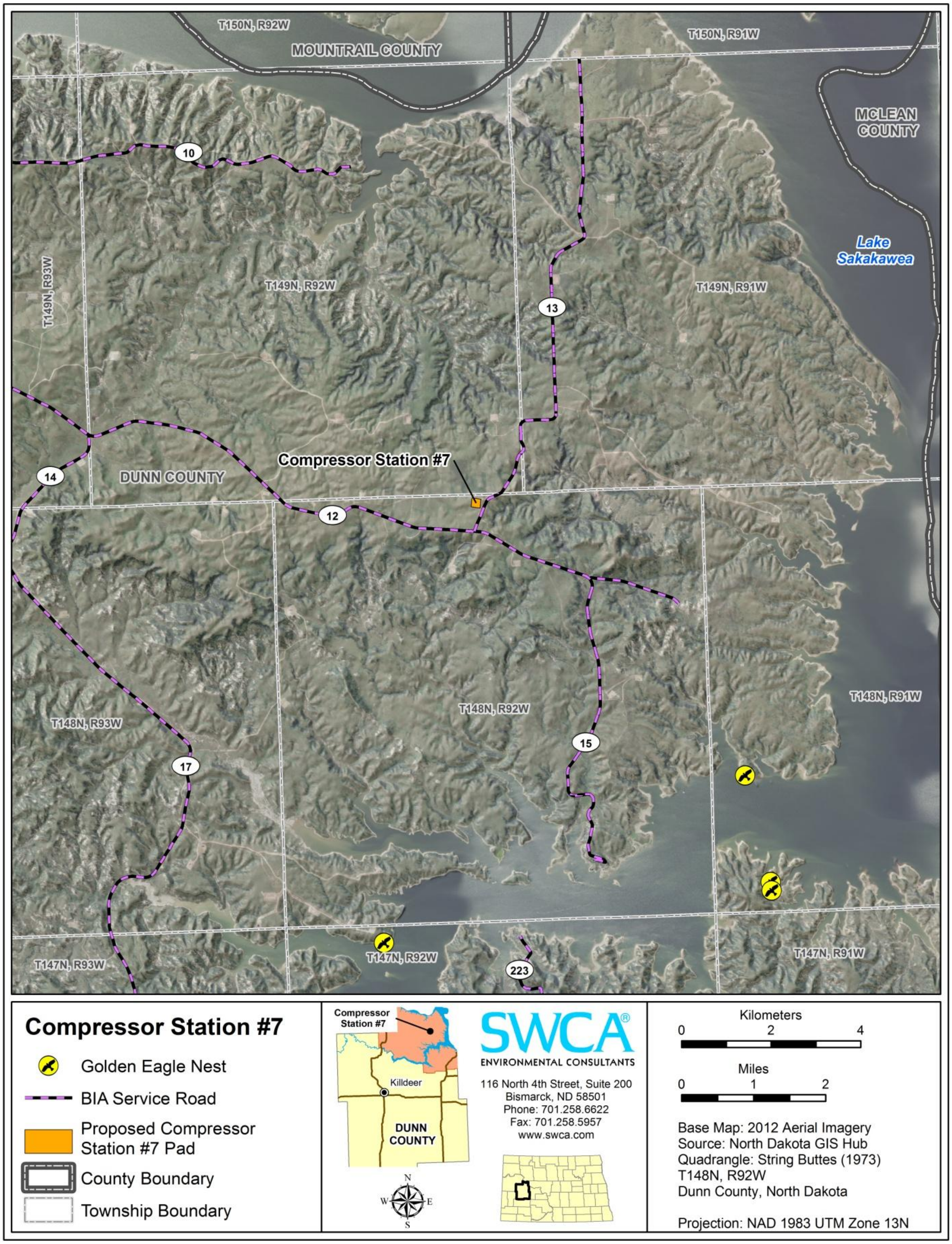


Figure 1. Proposed Action Location in Dunn County.

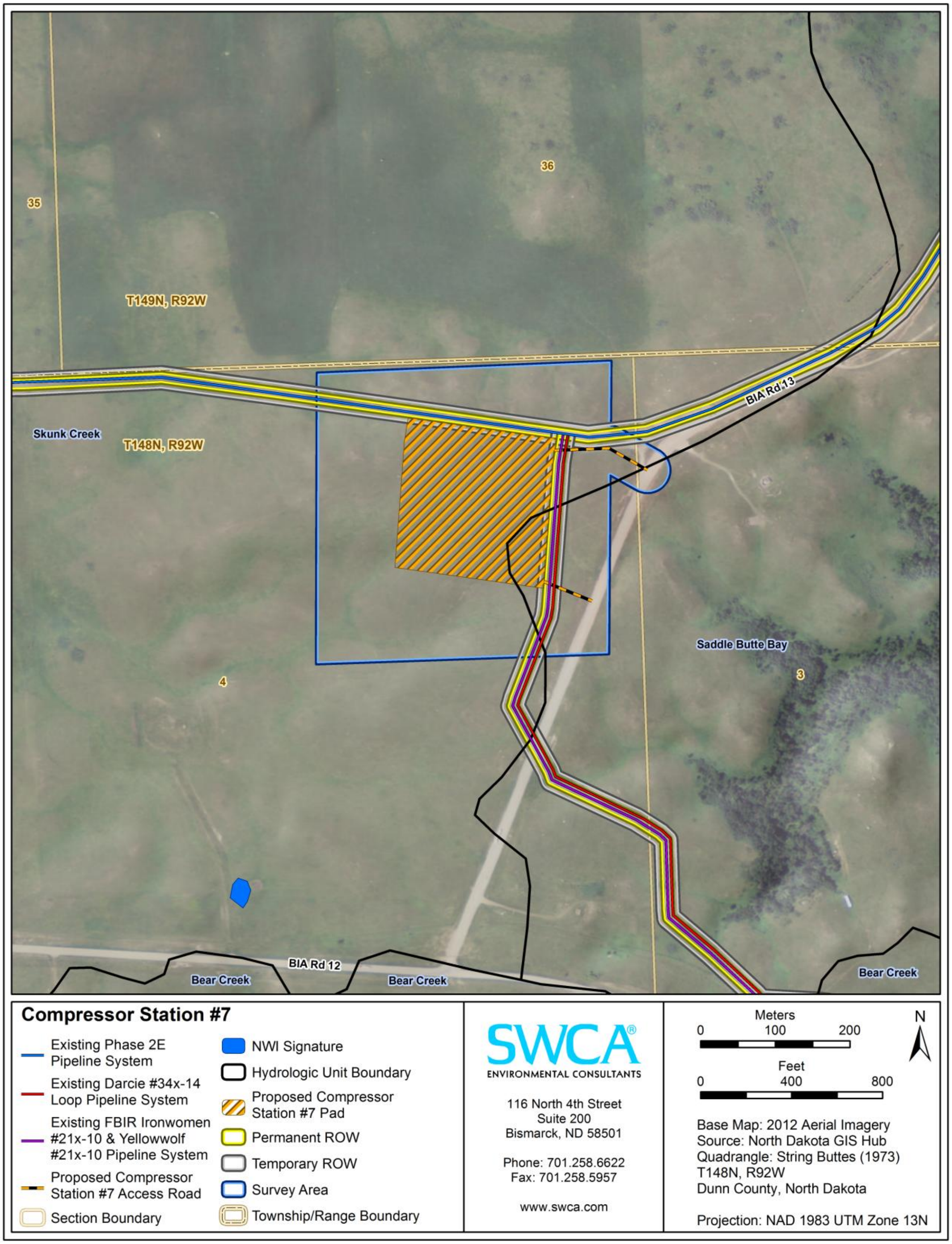


Figure 2. Proposed Compressor Station #7 Next to Existing Pipelines and BIA Rd 13.

Wildlife and Habitat

Biologists from SWCA Environmental Consultants (SWCA) conducted vegetation and wildlife surveys, including threatened and endangered species habitat assessments, on June 4, 2013 for the proposed pad, and August 13, 2013 for the proposed access roads. Dominant grasses (compromising greater than 50% of the species composition) observed in the vicinity (within the site and surrounding area) of the Project included little bluestem (*Schizachyrium scoparium*) and Kentucky bluegrass (*Poa pratensis*). Other grass species observed in the vicinity of the project area (compromising <50% of the species composition), included crested wheatgrass (*Agropyron cristatum*), smooth brome (*Bromus inermis*), big bluestem (*Andropogon gerardii*), green needlegrass (*Nassella viridula*) and western wheatgrass (*Pascopyrum smithii*). Dominant forbs (compromising greater than 50% of the species composition) observed in the vicinity of the Project included: common yarrow (*Achillea millefolium*), fringed sage (*Artemesia frigida*), prairie coneflower (*Ratibida columnifera*), and purple coneflower (*Echinacea angustifolia*). Other forb species (compromising <50% of the species composition) included: prairie smoke (*Geum triflorum*), prairie rose (*Rosa arkansana*), stiff goldenrod (*Solidago rigida*), silver-leaf scurf pea (*Psoralea argophylla*), alfalfa (*Medicago sativa*), white sagebrush (*Artemesia ludoviciana*), yellow salsify (*Tragopogon dubius*), and field sagewort (*Artemesia campestris*). Two species of noxious weeds, Canada thistle (*Cirsium arvense*) and absinthe wormwood (*Artemesia absinthium*), were observed in small communities on/near the proposed access roads.

The vegetation observed within the Project area is representative of mixed grass prairie, although the condition is somewhat degraded from the presence of nonnative grasses, noxious weeds, and low composition of native forbs representative of mixed grass prairie. The site has also been lightly to moderately grazed. The project area overall is not particularly suitable habitat for the Dakota skipper, due to low diversity and composition of preferred grasses (needlegrass and bluestem species) as well as preferred forbs (wood lily [*Lilium philadelphicum*], harebell [*Campanula rotundifolia*], smooth camas [*Zygadenus elegans*], and blanketflower [*Gaillardia sp.*]), even with the high presence (>50%) of Echinacea for nectaring. A small wetland and wooded ephemeral draw are within 0.5 miles of the Project, providing habitat complexity to compliment the grassland. Lack of wetland/cropland associations within the vicinity indicates a low probability for whooping crane use of the Project area for foraging/stop over. The presence of low visual obstruction, moderate litter cover, and no woody vegetation, lends itself to suitable cover for Sprague’s pipit.

Avian species observed were common yellowthroat (*Geothypis trichas*), bobolink (*Dolichonyx oryzivorus*), western meadowlark (*Sturnella neglecta*), mourning dove (*Zenaida macroura*), clay-colored sparrow (*Spizella pallida*), killdeer (*Charadrius vociferous*), grasshopper sparrow (*Ammodramus savannarum*), lark sparrow (*Chondestes grammacus*), horned lark (*Eremophila alpestris*), and upland sandpiper (*Bartramia longicauda*). These are typical bird species of the region that utilize open fields, woodland edges, and/or native grasslands for nesting and foraging purposes. No other animal species were observed, and no active nests or nesting behavior was documented during the field surveys.

Raptor habitat survey was conducted. No suitable nesting or foraging habitat was observed for bald eagles within the project area. However, potentially suitable nesting habitat may exist along the Little Missouri River and Lake Sakakawea, approximately 3.2 straight line miles and 4.6 river miles, respectively, east of the proposed project. Multiple golden eagle nest sites are located to the southeast on perches around Lake Sakakawea near Water Chief Bay and Moccasin Creek Bay. The nearest of these is approximately 5.2 miles southeast (see point locations on Figure 1).

Surface Water Flows to Lake Sakakawea

The Project is in a headwater position of the Lower Lake Sakakawea (HUC 10110101) drainage basin (Figure 3). Located at a subwatershed divide, most of the Project is expected to be tributary to the Skunk Creek (Hydrologic Unit Code [HUC] 101101012102) subwatershed, Independence Point (HUC 1011010121) watershed. The south access road is expected to flow toward the Saddle Butte Bay (HUC 101101012903) sub-watershed, Saddle Butte (HUC 1011010129) watershed. Lake Sakakawea is approximately 5.7 river miles following the Skunk Creek drainage and approximately 4.6 river miles following the Saddle Butte Bay drainage.

No wetlands were identified within the Project boundary. The nearest wetland identified on the National Wetlands Inventory map is approximately 0.38 mile to the southwest. The nearest U.S. Geological Survey National Hydrography Dataset waterbody (unknown intermittent stream) is approximately 0.25 mile southeast of the project area (U.S. Geological Survey 2012[1]).

[1] U.S. Geological Survey. 2012. National Hydrography Dataset. U.S. Geological Survey in cooperation with the U.S. Environmental Protection Agency. Available online at http://nhd.usgs.gov/. Accessed August 2012.

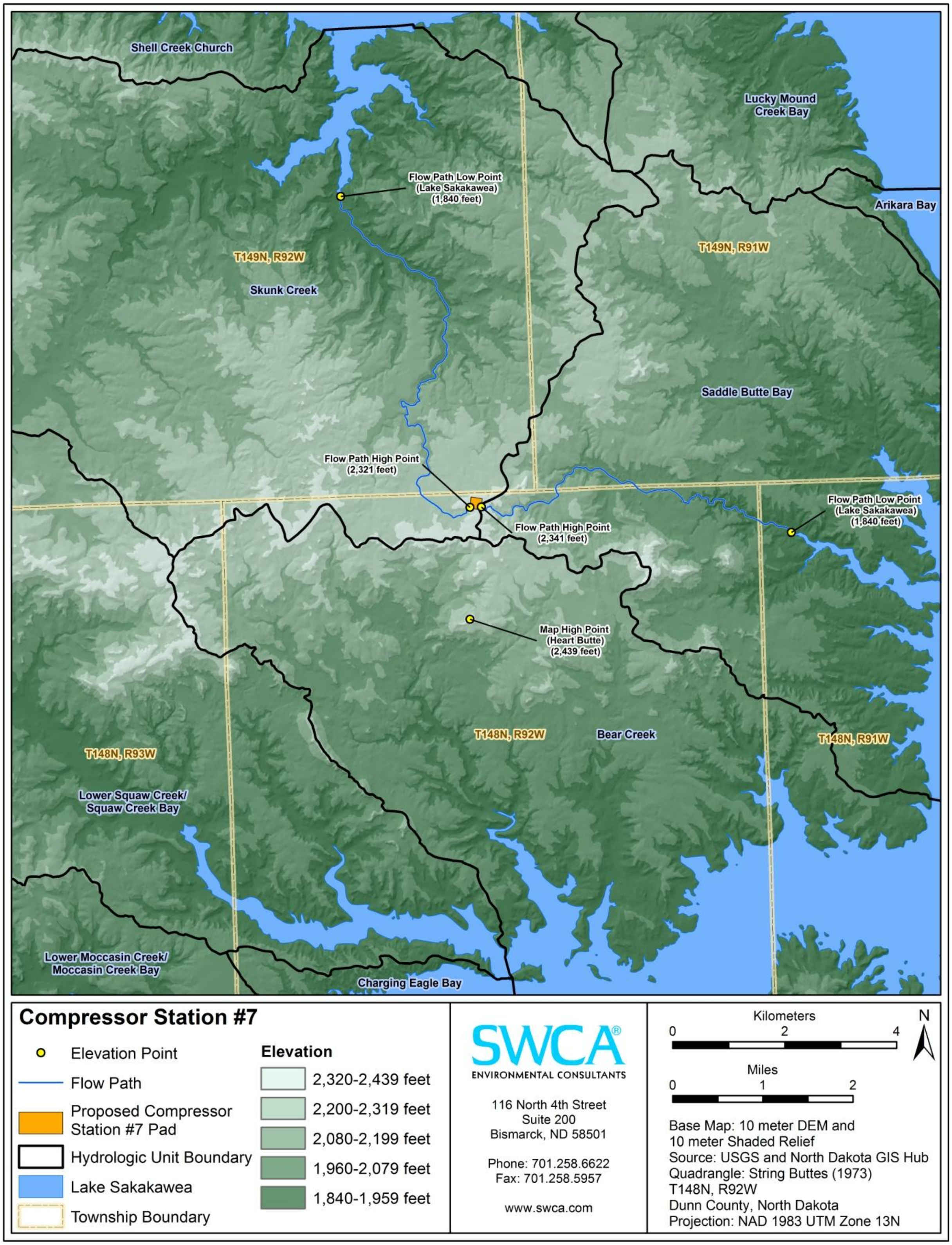


Figure 3. Headwaters of Skunk Creek and Saddle Butte Bay Subwatersheds of Lake Sakakawea.

Threatened and Endangered Species Occurrence and Habitat

Several wildlife species that may exist, or have been known to exist in Dunn County are listed as threatened or endangered under the Endangered Species Act (16 United States Code [USC] 1531 et seq.) (ESA). According to the U.S. Fish and Wildlife Service (USFWS), listed species in Dunn County, North Dakota, include the gray wolf (*Canis lupus*), black-footed ferret (*Mustela nigripes*), whooping crane (*Grus americana*), piping plover (*Charadrius melodus*) and its Designated Critical Habitat, interior least tern (*Sterna antillarum*), and pallid sturgeon (*Scaphirhynchus albus*), as well as two federal candidate species, the Dakota skipper (*Hesperia dacotae*) and Sprague's pipit (*Anthus spragueii*). The listed species and their federal status are summarized in Table 1.

Table 1. Summary of Potential Effects on Threatened and Endangered Species

Species	Federal Status	Habitat Suitability or Known Occurrence	Operator-Committed Measures	Effects Determination
Black-footed Ferret (*Mustela nigripes*)	Endangered	Species is presumed extirpated from North Dakota.	None	No Effect
Gray Wolf (*Canis lupus*)	Endangered	Nearest known gray wolf populations exist in Minnesota, Canada, Montana, and Wyoming. Western North Dakota sightings in the late twentieth century are speculated to be solitary, transient, young adult males seeking to establish territory.	None	No Effect
Whooping Crane (*Grus americana*)	Endangered	Birds are unlikely to be present due to lack of suitable stopover habitat near the project area.	Construction activity will cease, and the U.S. Fish and Wildlife Service will be notified if whooping cranes are sighted within 1 mile of the project area. Activities may commence when the birds have left the 1-mile buffer area.	May Affect, Is Not Likely to Adversely Affect

Species	Federal Status	Habitat Suitability or Known Occurrence	Operator-Committed Measures	Effects Determination
Piping Plover (*Charadrius melodus*)	Threatened	This species is unlikely to be present due to lack of suitable foraging or nesting habitat. The nearest suitable nesting and foraging habitat occurs on the shoreline and islands of Lake Sakakawea, approximately 3.2 straight line miles from the proposed project area.	See Designated Critical Habitat protective measures for piping plover and migratory bird protective measures listed below.	May Affect, Is Not Likely to Adversely Affect
Designated Critical Habitat for Piping Plover	Designated Critical Habitat	Critical Habitat occurs within the watershed of the project area, on the shoreline and islands of Lake Sakakawea, approximately 4.6 river miles from the proposed project area.	Arrow will implement all best management practices, erosion control measures, and spill prevention practices required by the Clean Water Act.	May Affect, Is Not Likely to Adversely Affect
Interior Least Tern (*Sterna antillarum*)	Endangered	The nearest suitable nesting and foraging habitat occurs on the shoreline and islands of Lake Sakakawea, approximately 3.2 straight line miles, from the proposed project area. Migrating or foraging interior least terns may transition through the project area.	See Designated Critical Habitat protective measures for piping plover and migratory bird protective measures listed below.	May Affect, Is Not Likely to Adversely Affect
Pallid Sturgeon (*Scaphirhynchus albus*)	Threatened	Lake Sakakawea is approximately 4.6 river miles from the proposed project area.	See Designated Critical Habitat protective measures for piping plover listed above.	May Affect, Is Not Likely to Adversely Affect
Dakota Skipper (*Hesperia dacotae*)	Candidate	Suitable habitat was not noted within the project area. Therefore, no adverse impact is anticipated as a result of construction activities.	The proposed compressor station will be reclaimed as soon as possible after its lifespan is complete. Impacted areas will be returned to pre-construction contours.	May Affect, Is Not Likely to Adversely Affect

Species	Federal Status	Habitat Suitability or Known Occurrence	Operator-Committed Measures	Effects Determination
Sprague's Pipit (*Anthus spragueii*)	Candidate	Suitable habitat was noted within the project area. However, no adverse impact is anticipated as a result of construction activities.	See Migratory Bird protective measures below. The proposed compressor station will be reclaimed as soon as possible after its lifespan is complete. Impacted areas will be returned to pre-construction contours.	May Affect, Is Not Likely to Adversely Affect
Other Federally Protected Species				
Bald Eagle (*Haliaeetus leucocephalus*)	BGEPA and MBTA	No suitable nesting or foraging habitat was observed within the project area. However, potentially suitable nesting habitat may exist along the Little Missouri River and Lake Sakakawea, approximately 3.2 straight line miles and 4.6 river miles, respectively, east of the proposed project. Therefore, transient and foraging individuals may enter the project area on occasion.	A 0.5-mile line of sight survey was conducted during the initial field survey.	No Adverse Effects Anticipated
Golden Eagle (*Aquila chrysaetos*)	BGEPA and MBTA	No eagle nests were observed in the project area. Golden eagles may occasionally visit or forage within or around the project area. The closest known golden eagle nest occurrence is approximately 5.2 miles southeast of the proposed project (see Figure 1).	A 0.5-mile line of sight survey was conducted during the initial field survey.	No Adverse Effects Anticipated

Species	Federal Status	Habitat Suitability or Known Occurrence	Operator-Committed Measures	Effects Determination
Migratory Birds	MBTA	Suitable habitat for nesting migratory grassland birds occurs within the project area.	Arrow will either conduct construction outside of the migratory bird breeding season **or** mow and maintain vegetation within the project construction area prior to and during the migratory bird breeding season **or** if construction is to occur within the migratory bird breeding season (between February 1 and July 15), conduct an avian survey no sooner than 5 days prior to construction and postpone construction until any active nests observed have been abandoned.	No Adverse Effects Anticipated

Potential Effects

Construction phase vehicle movement, dust, noise, site clearing, human presence will directly impact habitat at the Project and nearby area. During operation, vehicle movement, dust, noise, and human activity for daily compressor station condition checks will disturb the area around the access road and station.

Construction best management practices (BMPs) would be implemented for all ground-disturbing activities, National Pollutant Discharge Elimination System permit. Federal requirements for implementation of adequate spill prevention, control, and countermeasures would also be in place. No impacts to water quality are anticipated. In the event of unanticipated erosion and runoff, the Skunk Creek and Saddle Butte Bay drainages could be subject to increased total dissolved solids and turbidity.

Approximately 10.36 acres of grassland conversion to impervious surface would increase run off rates from this headwater location to Skunk Creek. This could trigger some scouring in the upstream reach. The potential downstream effects have not been modeled.

SWCA biologists have evaluated the status, life history, and potential effects of the Project on listed species. The potential effects of the Project on these species is described in detail in Attachment 1 and summarized in Table 1.

In addition to the ESA, the Bald and Golden Eagle Protection Act (BGEPA) and the Migratory Bird Treaty Act (MBTA) protect eagles and nesting migratory bird species. With implementation of the protective and other specific measures identified in Table 1, and owner-committed measures discussed in this letter, the Project is unlikely to adversely affect bald or golden eagles or nesting migratory birds.

The Project area may still be classified as native mixed grass prairie, however, the encroachment of nonnative species and noxious weeds has degraded the quality and consequent habitat value for species like the Dakota skipper.

Owner-Committed Best Management Practices, Mitigation, and Safety Measures

Arrow has committed to implementing the following measures for all construction and operations on the Reservation, including for the proposed Project.

Construction and Design Measures

- Locate the proposed compressor station and access roads in areas with existing disturbances to the extent possible.
- Implement approved Stormwater Pollution Prevention Plan and BMPs for the construction of each roadway and proposed compression station to prevent erosion and sedimentation.
- Lay matting and/or conduct hydro-seeding on high slope areas.
- Install appropriately sized culverts.
- Install covers under drip buckets and spigots.
- Conduct interim reclamation.
- Grind/mulch trees and other woody material removed from the construction area and add to the topsoil.
- Design roads and facility sites to minimize visual impacts.
- Use existing roads to the extent possible, upgrading as needed.
- Minimize the size of facility sites and types of roads to reduce surface disturbance.
- Minimize topsoil removal and stockpile stripped topsoil and protect it from erosion until reclamation activities commence.
- During reclamation, redistribute and seed the topsoil on the disturbed areas and protect and maintain reclaimed areas until the sites are fully stabilized.
- Avoid removal of, or damage to, trees and woody shrubs where possible.
- Follow the contour (form and line) of the landscape.
- Avoid locating ROWs on steep slopes.
- Share any common ROWs whenever possible.
- Co-locate multiple lines in the same trench.

- Use natural (topography, vegetation) or artificial (berms) features to help screen facilities such as valves and metering stations.
- Paint facilities a color that will blend with the environment.
- Contour disturbed areas to approximate the original contours of the landscape.
- Develop a final reclamation plan that allows disturbed areas to be quickly absorbed into the natural landscape.
- Implement proper storage of chemicals (including secondary containment).
- Keep sites clean, including containing trash in a portable trash cage. The trash cage will be emptied at a state-approved sanitary landfill.
- Conduct snow removal activities in a manner that does not adversely impact reclaimed areas and areas adjacent to reclaimed areas.
- Avoid or minimize topographic alterations, activities on steep slopes, and disturbances within stream channels and floodplains to the extent possible.
- Require construction crews to carry fire extinguishers in their vehicles and/or equipment.
- Require construction crews be trained in the proper use of fire extinguishers.
- Plan transportation to reduce vehicle density.
- Avoid construction and vehicle use during wet conditions that could result in excessive rutting.
- Minimize noxious weed invasions by continuing seeding efforts and herbicide applications until native vegetation has been established.

<u>Bald and Golden Eagle Protective Measures</u>

- SWCA biologists conducted a 0.5-mile line of sight survey from the project area for bald and golden eagle nests. No suitable nesting habitat was observed within the project area. Potential golden eagle nesting habitat does not occur within 0.5 mile of the project area; and no previously recorded golden eagle nests are known to be present within 0.5 mile of the project area. No additional eagle surveys are planned at this time.
- The nearest known golden eagle nest to the project area occurs approximately 5.2 miles southeast of the proposed project area (see Figure 1).

<u>Migratory Bird Protective Measures</u>

- Arrow will conduct all construction outside of the migratory bird breeding season (between July 16 and January 31); or, if construction occurs during the bird breeding season (between February 1 and July 15), Arrow will either:
    - mow, maintain, or completely remove vegetation within the Project construction area (access road and proposed well pad disturbance) prior to the migratory bird breeding season and maintain such conditions during the breeding season to deter

migratory birds from nesting in the project area until construction is underway, weather conditions permitting; or

  - if the project area is not mowed and maintained as indicated above, conduct an avian survey of the project area no sooner than 5 days before construction begins, and if nests are discovered, notify the USFWS.

ESA Protective Measures

- **Piping Plover and Its Designated Critical Habitat, Interior Least Tern, and Pallid Sturgeon:** Erosion control mechanisms will be deployed to reduce the potential for sediment transport into drainages and subsequently Lake Sakakawea. The disturbed area will be reclaimed in accordance with the private landowner's requirements as soon as practicable after construction is complete.
- **Whooping Crane:** If a whooping crane is sighted within 1 mile of the proposed project area, work will be stopped and the USFWS will be notified. In coordination with the USFWS, work may resume after the bird(s) leaves the area.

With the implementation of the above standard BMPs, general design measures, and species-specific measures, no riparian areas or wetlands would be directly or indirectly affected by the proposed access roads or proposed compressor station.

No effects on black-footed ferret or gray wolf are anticipated because of the low likelihood of their occurrence in the proposed project area and other factors discussed in Attachment 1. With implementation of the protective and other specific measures identified in Table 1 and operator-committed measures discussed in this letter, the proposed Project **may affect, but is not likely to adversely affect** the whooping crane, piping plover and its Designated Critical Habitat, the interior least tern, and the pallid sturgeon.

We are requesting that a concurrence letter be sent before September 20, 2013, so that it may be addressed in the final air quality permit. Please send the concurrence letter to the address below.

SWCA Environmental Consultants
Jason Bivens
Environmental Specialist
116 North 4th Street, Suite 200
Bismarck, North Dakota 58501
(701) 258-6622
jbivens@swca.com

Sincerely,

Jason Bivens

Enclosure: Attachment 1

ATTACHMENT 1 – SPECIES ACCOUNTS AND EFFECTS DETERMINATIONS

ENDANGERED SPECIES ACT

Black-footed Ferret (*Mustela nigripes*)
Effects Determination: No Effect

Black-footed ferrets are nocturnal, solitary carnivores of the weasel family that have been largely extirpated from the wild primarily due to range-wide decimation of the prairie dog (*Cynomys* sp.) ecosystem (Kotliar et al. 1999). They have been listed by the U.S. Fish and Wildlife Service (USFWS) as endangered since 1967 and have been the object of extensive re-introduction programs (USFWS 2010a). Ferrets inhabit extensive prairie dog complexes of the Great Plains, typically composed of several smaller colonies in proximity to one another that provide a sustainable prey base. The *Black-footed Ferret Survey Guidelines for Compliance with the Endangered Species Act* (USFWS 1989) states that ferrets require black-tailed prairie dog (*Cynomys ludovicianus*) towns or complexes greater than 80 acres in size, and towns of this dimension may be important for ferret recovery efforts (USFWS 1988a). Prairie dog towns of this size are not found in the project area. In addition, this species has not been observed in the wild for more than 20 years. The proposed Project will have **no effect** on this species.

Gray Wolf (*Canis lupus*)
Effects Determination: No Effect

The gray wolf, listed as endangered in the United States in 1978 (USFWS 1978), was believed extirpated from North Dakota in the 1920s and 1930s with only sporadic reports from the 1930s to present (Licht and Huffman 1996). The presence of wolves in most of North Dakota consists of occasional dispersing animals from Minnesota and Manitoba (Licht and Fritts 1994; Licht and Huffman 1996). Most documented gray wolf sightings that have occurred within North Dakota are believed to be young males seeking to establish territory (Hagen et al. 2005). The Turtle Mountains region in north-central North Dakota provides marginal habitat that may be able to support a very small population of wolves. The closest known pack of wolves is the Minnesota population, located approximately 17.4 miles from the northeast corner of North Dakota.

The gray wolf uses a variety of habitats that support a large prey base, including montane and low-elevation forests, grasslands, and desert scrub (USFWS 2010b). Due to a lack of forested habitat and the distance from Minnesota and Manitoba populations, as well as the troubled relationship between humans and wolves and their vulnerability to being shot in open habitats (Licht and Huffman 1996), the re-establishment of gray wolf populations in North Dakota is unlikely. Additionally, habitat fragmentation, in particular road construction as a result of oil and gas development, may further act as a barrier against wolf recolonization in western North Dakota. Therefore, the proposed Project will have **no effect** on the gray wolf.

Whooping Crane (*Grus americana*)
Effects Determination: May Affect, Is Not Likely to Adversely Affect

The whooping crane was listed as endangered in 1970 in the United States by the USFWS and in 1978 in Canada. Historically, population declines were caused by shooting and destruction of nesting habitat in the prairies from agricultural development. Current threats to the species include habitat destruction, especially suitable wetland habitats that support breeding and nesting, as well as feeding and roosting during their fall and spring migration (Canadian Wildlife Service and U.S. Fish and Wildlife Service 2007).

The July 2010 total wild population was estimated at 383 (USFWS 2010c). There is only one self-sustaining wild population, the Aransas-Wood Buffalo National Park population, which nests in Wood Buffalo National Park and adjacent areas in Canada, where approximately 83% of the wild nesting sites occur (Canadian Wildlife Service and U.S. Fish and Wildlife Service 2007; USFWS 2010c). Dunn County, including the project area, is within the primary migratory flyway of whooping cranes.

Whooping cranes probe the soil subsurface with their bills for foods on the soil or vegetation substrate (Canadian Wildlife Service and U.S. Fish and Wildlife Service 2007). Whooping cranes are omnivores, and foods typically include agricultural grains, as well as insects, frogs, rodents, small birds, minnows, berries, and plant tubers. The largest amount of time during migration is spent feeding in harvested grain fields (Canadian Wildlife Service and U.S. Fish and Wildlife Service 2007). Studies indicate that whooping cranes use a variety of habitats during migration, in addition to cultivated croplands, and generally roost in small palustrine (marshy) wetlands within 1 kilometer (km) of suitable feeding areas (Howe 1987, 1989). Whooping cranes have been recorded in riverine habitats during their migration, with eight sightings along the Missouri River in North Dakota (Canadian Wildlife Service and U.S. Fish and Wildlife Service 2007:18). In these cases, they roost on submerged sandbars in wide, unobstructed channels that are isolated from human disturbance (Armbruster 1990).

Suitable whooping crane foraging habitat was not observed near the project area. However, project precautionary measures would be implemented if a whooping crane is sighted within 1 mile of the project area. Arrow would cease all construction activities and notify the USFWS of the sighting, should a whooping crane be spotted within 1 mile of the project area. As a result, the proposed Project **may affect, but is not likely to adversely affect** the endangered whooping crane.

Piping Plover (*Charadrius melodus*)
Effects Determination: May Affect, Is Not Likely to Adversely Affect

The piping plover is a small shorebird which breeds only in three geographic regions of North America: the Atlantic Coast, the Northern Great Plains, and the Great Lakes. Piping plover populations were federally listed as threatened and endangered in 1985, with the Northern Great Plains and Atlantic Coast populations listed as threatened and the Great Lakes population listed as endangered (USFWS 1985a).

Plovers in the Great Plains make their nests on open, sparsely vegetated sand or gravel beaches adjacent to alkali wetlands, and on beaches, sand bars, and dredged material islands of major river systems (USFWS 2002, 2010d). The shorelines of lakes of the Missouri River constitute significant nesting areas for the bird. Piping plovers nest on the ground, making shallow scrapes in the sand, which they line with small pebbles or rocks (USFWS 1988b). Anthropogenic alterations of the landscape along rivers and lakes where piping plover nest have increased the number and type of predators, subsequently decreasing nest success and chick survival (USFWS 2002, 2010d). The birds fly south by mid to late August to areas along the Texas coast and Mexico (USFWS 2002). The Northern Great Plains population has continued to decline despite federal listing, with population estimates of 1,500 breeding pairs in 1985 reduced to fewer than 1,100 in 1990. Low survival of adult birds has been identified as a factor (Root et al. 1992). Current conservation strategies include identification and preservation of known nesting sites, public education, and limiting or preventing shoreline disturbances near nests and hatched chicks (USFWS 1988b, 2010d).

Suitable shoreline habitat for breeding and nesting plovers does not occur in the project area, and Lake Sakakawea is approximately 3.2 straight line miles away from the proposed project area. It is unlikely that migrating plovers would visit the project area during their migration. Therefore, the proposed Project **may affect, but is not likely to adversely affect** piping plovers.

Designated Critical Habitat of Piping Plover

Effects Determination: May Affect, Is Not Likely to Adversely Affect

The USFWS has designated Critical Habitat for the Great Lakes and Northern Great Plains populations of piping plover (USFWS 2002). Designated Critical Habitat for the piping plover includes 183,422 acres and 1,207.5 river miles of habitat, including areas near the proposed Project, along the shoreline of Lake Sakakawea in Dunn and McKenzie Counties, North Dakota (USFWS 2002).

It is unlikely that the Project will modify, alter, disturb, or affect the shoreline of Lake Sakakawea; however, the potential exists for designated critical habitat to be affected in the event of a spill or release of produced water or petroleum products. Therefore, the proposed Project **may affect, but is not likely to adversely affect** Designated Critical Habitat of the piping plover.

Interior Least Tern (*Sterna antillarum*)

Effects Determination: May Affect, Is Not Likely to Adversely Affect

The population of the interior least tern is listed as endangered by the USFWS (1985b). This bird is the smallest member of the gull and tern family, measuring approximately 9 inches in length. Terns remain near flowing water, where they feed by hovering over and diving into standing or flowing water to catch small fish (USFWS 2010e).

The population of interior least terns breeds in isolated areas along the Missouri, Mississippi, Ohio, Red, and Rio Grande river systems, where they nest in small colonies. From late April to August, terns nest in a shallow hole scraped in an open sandy area, gravel patch, or exposed flat and bare sandbars along rivers, sand and gravel pits, or lake and reservoir shorelines. The adults continue to care for chicks after they hatch. Least terns in North Dakota will often be found sharing sandbars with the piping plover, a threatened species (USFWS 2010e).

Census data indicate over 8,000 interior least terns in the population. In North Dakota, the least tern is found mainly on the Missouri River from Garrison Dam south to Lake Oahe, and on the Missouri and Yellowstone Rivers upstream of Lake Sakakawea (USFWS 1990a, 2010e). Approximately 100 pairs breed in North Dakota (USFWS 2010e). Details of their migration are not known, but their winter range is reported to include the Gulf of Mexico and Caribbean Islands (USFWS 1990a, 2010e).

Loss of suitable breeding and nesting habitat for terns has resulted from dam construction and river channelization on major rivers throughout the Mississippi, Missouri, and Rio Grande river systems. River and reservoir changes have led to reduced sandbar formation and other shoreline habitats for breeding, resulting in population declines. In addition, other human shoreline disturbances affect the species (USFWS 1990a). Critical Habitat has not been designated for the species (USFWS 2010e).

Current conservation strategies include identification and avoidance of known nesting areas, public education, and limiting or preventing shoreline disturbances near nests and hatched chicks (USFWS 2010e).

Suitable shoreline habitat for breeding and nesting terns does not occur in the project area, and Lake Sakakawea is approximately 3.2 straight line miles away from the proposed project area. It is unlikely that terns would visit the upland habitats present in the project area. Therefore, the proposed Project **may affect, but is not likely to adversely affect** endangered least terns.

Pallid Sturgeon (*Scaphirhynchus albus*)
Effects Determination: May Affect, Is Not Likely to Adversely Affect

The pallid sturgeon was listed as Endangered in 1990 in the United States by the USFWS (1990b). The primary factor leading to the decline of this species is the alteration of habitat through river channelization, creation of impoundments, and alteration of flow regimes (USFWS 1990b). These alterations within the Missouri River have blocked movements to spawning, feeding, and rearing areas, destroyed spawning habitat, altered flow conditions, which can delay spawning cues, and reduced food sources by lowering productivity (USFWS 2007a). The fundamental elements of pallid sturgeon habitat are defined as the bottom of swift waters of large, turbid, free-flowing rivers with braided channels, dynamic flow patterns, flooding of terrestrial habitats, and extensive microhabitat diversity (USFWS 1990b).

The pallid sturgeon population, which is found near the project area, occurs from the Missouri River below Fort Peck Dam to the headwaters of Lake Sakakawea and the lower Yellowstone River up the confluence of the Tongue River, Montana (USFWS 2007a). This population consists of approximately 136 wild adult pallid sturgeon (USFWS 2007a). Hatchery reared sturgeon have also been stocked since 1998. The pallid sturgeon has been found to use the 25 km of riverine habitat that would be inundated by Lake Sakakawea at full pool (Bramblett 1996, cited in USFWS 2007a). Larval pallid sturgeons have also been found to drift into Lake Sakakawea. While the majority of pallid sturgeons are found in the headwaters of Lake Sakakawea, the North Dakota Game and Fish Department has caught and released pallid sturgeon in nets set in 80 to 90 feet of water between the New Town and Van Hook area. Based on this information, pallid sturgeon could be found throughout Lake Sakakawea (personal communication, email from Steve Krentz, Pallid Sturgeon Project Lead, USFWS, to Mike Cook, Aquatic Ecologist, SWCA Environmental Consultants, September 3, 2010).

Suitable habitat for pallid sturgeon does not occur in the project area, and Lake Sakakawea is a minimum of 4.6 river miles away from the proposed Project. Potential pollution and sedimentation occurring within the project area are concerns for downstream populations of endangered pallid sturgeon. Activities associated with the construction, production, or reclamation of the proposed project area are not anticipated to adversely affect water quality and subsequently the pallid sturgeon. Therefore, the proposed Project **may affect, but is not likely to adversely affect** the pallid sturgeon.

Dakota Skipper (*Hesperia dacotae*)
Effects Determination: May Affect, Is Not Likely to Adversely Affect

The Dakota skipper is a small butterfly with a 1-inch wingspan and is found primarily in undisturbed native tall grass and upland dry Northern mixed grass prairie areas with a high diversity of wildflowers and grasses (Committee on the Status of Endangered Wildlife in Canada 2003). The Dakota skipper appears to require a range of precipitation-evaporation ratios between 60 and 105 and a soil pH between 7.2 and 7.9 (McCabe 1981). Larvae feed on grasses, favoring little bluestem (*Schizachyrium scoparium*). Adults commonly feed on nectar of flowering native forbs such as harebell (*Campanula rotundifolia*), wood lily (*Lilium philadelphicum*), and purple coneflower (*Echinacea angustifolia*). The species is threatened by conversion of native prairie to cultivated agriculture or shrublands, over-grazing, invasive species, gravel mining, and inbreeding (USFWS 2005). Suitable habitat does not exist within the proposed project area; however surrounding areas may contain suitable habitat and Dakota skippers could traverse into the project area. Therefore, the Project **may affect, but is not likely to adversely affect** this species. The use of best management practices and conservation guidelines (USFWS 2007b) during construction and operation and immediate reclamation of short-term disturbance should decrease direct, indirect, and cumulative impacts to this species.

Sprague's Pipit (*Anthus spragueii*)
Effects Determination: May Affect, Is Not Likely to Adversely Affect

The Sprague's pipit is a small passerine bird that is native to the North American grasslands. It is a ground nester that breeds and winters on open grasslands and feeds mostly on insects and spiders and some seeds. The Sprague's pipit is closely tied with native prairie habitat and breeds in the north-central United States in Minnesota, Montana, North Dakota, and South Dakota, as well as in south-central Canada (USFWS 2010f). Wintering occurs in the southern states of Arizona, Texas, Oklahoma, Arkansas, Mississippi, Louisiana, and New Mexico. Sprague's pipit is not known to occur within the project area; however, suitable habitat does occur. The proposed Project **may affect, but is not likely to adversely affect** this species. The use of best management practices and conservation guidelines (USFWS 2007b) during construction and operation and immediate reclamation of short-term disturbance should decrease direct, indirect, and cumulative impacts to this species.

MIGRATORY BIRD TREATY ACT / THE BALD AND GOLDEN EAGLE PROTECTION ACT

Bald Eagle (*Haliaeetus leucocephalus*)
Status: Delisted in 2007; protected under the MBTA and BGEPA
Effects of Project: No adverse effects anticipated

Suitable nesting or foraging habitat for bald eagles includes old-growth trees relatively close (usually less than 1.24 miles [Hagen et al. 2005]) to perennial water bodies. The project area does not contain old-growth trees and is located at the closest approximately 4.93 straight line miles from Lake Sakakawea. No nests or eagles were observed within 0.5 mile line-of-sight during the field surveys. Therefore, no adverse effects are anticipated. However, the possibility of transient, flying bald eagle individuals traversing the project area does exist.

Golden Eagle (*Aquila chrysaetos*)
Status: Not listed; protected under the MBTA and BGEPA
Effects of Project: No adverse effects anticipated

No eagles or nests were observed during the field surveys; however, golden eagles may occur within or near the project area. The closest known golden eagle nest occurs approximately 5.2 miles southeast of the proposed project area. The golden eagle prefers habitat characterized by open prairie, plains, and forested areas. Usually, golden eagles can be found in proximity to badland cliffs, which provide suitable nesting habitat. However, no primary or secondary indication of golden eagle presence, including nests, was observed within or near the project area during the field survey. Therefore, the Project is unlikely to cause any adverse effects on golden eagles.

Literature Cited

Armbruster, M.J. 1990. Characterization of habitat used by whooping cranes during migration. *Biological Report* 90(4):1–16.

Bramblett, R.G. 1996. Habitats and movements of pallid and shovelnose sturgeon in the Yellowstone and Missouri Rivers, Montana and North Dakota. Doctoral dissertation, Montana State University, Bozeman.

Canadian Wildlife Service and U.S. Fish and Wildlife Service. 2007. *International Recovery Plan for the Whooping Crane*. Ottawa: Recovery of Nationally Endangered Wildlife (RENEW); and Albuquerque, New Mexico: U.S. Fish and Wildlife Service.

Committee on the Status of Endangered Wildlife in Canada. 2003. *COSEWIC Assessment and Status Report on the Dakota Skipper* Hesperia dacotae *in Canada*. Ottawa: Committee on the Status of Endangered Wildlife in Canada.

Hagen, S.K., P.T. Isakson, and S.R. Dyke. 2005. *North Dakota Comprehensive Wildlife Conservation Strategy*. Bismarck, North Dakota: North Dakota Game and Fish Department.

Howe, M.A. 1987. Habitat use by migrating whooping cranes in the Aransas-Wood Buffalo corridor. In *Proceedings of the 1985 Crane Workshop*, edited by J.C. Lewis and J.W. Ziewitz, pp. 303–311. Grand Island, Nebraska: Platte River Whooping Crane Habitat Maintenance Trust and USFWS.

———. 1989. *Migration of Radio-marked Whooping Cranes from the Aransas-Wood Buffalo Population: Patterns of Habitat Use, Behavior, and Survival*. USFWS Technical Report.

Kotliar, N.B., B.W. Baker, A.D. Whicker, and G. Plumb. 1999. A critical review of assumptions about the prairie dog as a keystone species. *Environmental Management* 24(2):177–192.

Licht, D.S., and S.H. Fritts. 1994. Gray wolf *(Canis lupus)* occurrences in the Dakotas. *American Midland Naturalist* 132:74–81.

Licht, D.S., and L.E. Huffman. 1996. Gray wolf status in North Dakota. *The Prairie Naturalist* 28(4):169–174.

McCabe, T.L. 1981. The Dakota skipper (*Hesperia dacotae*) (Skinner): Range and biology, with special reference to North Dakota. *Journal of the Lepidopterists' Society* 35(3):179–193.

Root, B.G., M.R. Ryan, and P.M. Mayer. 1992. Piping plover survival in the Great Plains. *Journal of Field Ornithology* 63(1):10–15.

U.S. Fish and Wildlife Service (USFWS). 1978. Reclassification of the gray wolf in the United States and Mexico, with determination of critical habitat in Michigan and Minnesota. *Federal Register* 43(47):9607–9615.

———. 1985a. Endangered and Threatened wildlife and plants: Determination of Endangered and Threatened status for the piping plover. *Federal Register* 50(238):50726–50734.

———. 1985b. Interior population of the least tern. *Federal Register* 50:21784–21792. May 28.

———. 1988a. *Black-footed Ferret Recovery Plan*. Denver, Colorado: U.S. Fish and Wildlife Service.

———. 1988b. *Great Lakes and Northern Great Plains Piping Plover Recovery Plan*. Twin Cities, Minnesota: U.S. Fish and Wildlife Service.

———. 1989. *Black-footed Ferret Survey Guidelines for Compliance with the Endangered Species Act*. Denver and Albuquerque: U.S. Fish and Wildlife Service.

———. 1990a. *Interior Population of the Least Tern Recovery Plan*. Twin Cities, Minnesota: U.S. Fish and Wildlife Service.

———. 1990b. Endangered and threatened wildlife and plants; Determination of endangered status for the pallid sturgeon. *Federal Register* 55(173):36641–36647.

———. 2002. Designation of Critical Habitat for the Northern Great Plains breeding population of the piping plover; Final Rule. *Federal Register* 67(176):57637–57717. September 11.

———. 2005. Endangered and Threatened wildlife and plants; Review of native species that are candidates or proposed for listing as Endangered or Threatened; Annual notice of findings on resubmitted petitions; Annual description of progress on listing actions; Proposed Rule. *Federal Register* 70(90):24870–24934.

———. 2007a. *Pallid Sturgeon* (Scaphirhynchus albus) *5-Year Review Summary and Evaluation*. Billings, Montana: U.S. Fish and Wildlife Service, Pallid Sturgeon Recovery Coordinator.

———. 2007b. Dakota skipper conservation guidelines *Hesperia dacotae* (Skinner) (Lepidoptera: Hesperiidae). U.S. Fish and Wildlife Service, Twin Cities Field Office. Available at: http://www.fws.gov/midwest/endangered/insects/dask-cons-guid2007.pdf. Accessed September 3, 2010.

———. 2010a. Black-footed ferret. Available at: http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A004. Accessed September 7, 2010.

———. 2010b. Gray wolf. Available at: http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A00D. Accessed September 7, 2010.

———. 2010c. Whooping crane. Available at: http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B003. Accessed September 2, 2010.

———. 2010d. Piping plover. Available at: http://www.fws.gov/mountain-prairie/species/birds/pipingplover. Accessed September 7, 2010.

———. 2010e. Least tern (interior population). Available at: http://www.fws.gov/southwest/es/oklahoma/lestern.htm. Accessed September 7, 2010.

———. 2010f. Sprague’s pipit. Available at: http://www.fws.gov/mountain-prairie/species/birds/spraguespipit/index.html. Accessed December 28, 2010.

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U.S. FISH AND WILDLIFE SERVICE

ECOLOGICAL SERVICES
ND FIELD OFFICE

Project as described will have no significant impact on fish and wildlife resources. No endangered or threatened species are known to occupy the project area. IF PROJECT DESIGN CHANGES ARE MADE, PLEASE SUBMIT PLANS FOR REVIEW.

11/12/13 Jeffrey K. Towner
Date Jeffrey K. Towner
Field Supervisor

August 20, 2013

Jeffrey K. Towner
U.S. Fish and Wildlife Service
3425 Miriam Avenue
Bismarck, North Dakota 58501

RE: Request for Concurrence Letter

Dear Mr. Towner,

Arrow Pipeline, LLC (Arrow) is applying for a synthetic minor source pre-construction approval permit (air quality permit) in cooperation with the Environmental Protection Agency (EPA). The proposed action (Project) includes approval by the EPA and private landowners for the construction of a single compressor station within the boundaries of the Fort Berthold Indian Reservation (Reservation).

The proposed Compressor Station #7-Darcie Interconnect Phase 2E (station) and associated access roads would connect to existing pipelines on Reservation trust land in portions of the E½ of the NE¼ of Section 4, Township 148 North, Range 92 West, Dunn County, North Dakota (Figures 1 and 2). The Project would primarily consist of natural gas compressors, oil and water pumps, and ancillary equipment. Additional ancillary equipment that would be installed at the station includes a generator; one 96-inch (outside diameter) Inlet Slug Catcher; a filter separator; two 1,000-barrel (bbl) storage tanks; two 400-bbl water tanks; a header system for suction and discharge piping; a pig launcher; and pig receiver. The Project includes two access roads 432.15 and 227.91 linear feet by 66 feet wide that would be purchased right-of-way (ROW), and would be used to access the station from BIA Road 13. In total, land conversion from grassland to impervious surface would be 10.36 acres (0.36 for roads and 10.0 for station pad).

The purpose and need for the station would be to facilitate pipeline transport of natural gas, crude oil, and produced water from various wells in the area; in some cases the station would boost the pressure of the natural gas and pump the oil and water to a Central Distribution Point (CDP) (the CDP is not located on the Reservation and is not part of the proposed action).

migratory birds from nesting in the project area until construction is underway, weather conditions permitting; or

- if the project area is not mowed and maintained as indicated above, conduct an avian survey of the project area no sooner than 5 days before construction begins, and if nests are discovered, notify the USFWS.

ESA Protective Measures

- **Piping Plover and Its Designated Critical Habitat, Interior Least Tern, and Pallid Sturgeon:** Erosion control mechanisms will be deployed to reduce the potential for sediment transport into drainages and subsequently Lake Sakakawea. The disturbed area will be reclaimed in accordance with the private landowner's requirements as soon as practicable after construction is complete.
- **Whooping Crane:** If a whooping crane is sighted within 1 mile of the proposed project area, work will be stopped and the USFWS will be notified. In coordination with the USFWS, work may resume after the bird(s) leaves the area.

With the implementation of the above standard BMPs, general design measures, and species-specific measures, no riparian areas or wetlands would be directly or indirectly affected by the proposed access roads or proposed compressor station.

No effects on black-footed ferret or gray wolf are anticipated because of the low likelihood of their occurrence in the proposed project area and other factors discussed in Attachment 1. With implementation of the protective and other specific measures identified in Table 1 and operator-committed measures discussed in this letter, the proposed Project **may affect, but is not likely to adversely affect** the whooping crane, piping plover and its Designated Critical Habitat, the interior least tern, and the pallid sturgeon.

We are requesting that a concurrence letter be sent before September 20, 2013, so that it may be addressed in the final air quality permit. Please send the concurrence letter to the address below.

SWCA Environmental Consultants
Jason Bivens
Environmental Specialist
116 North 4th Street, Suite 200
Bismarck, North Dakota 58501
(701) 258-6622
jbivens@swca.com

Sincerely,

Jason Bivens

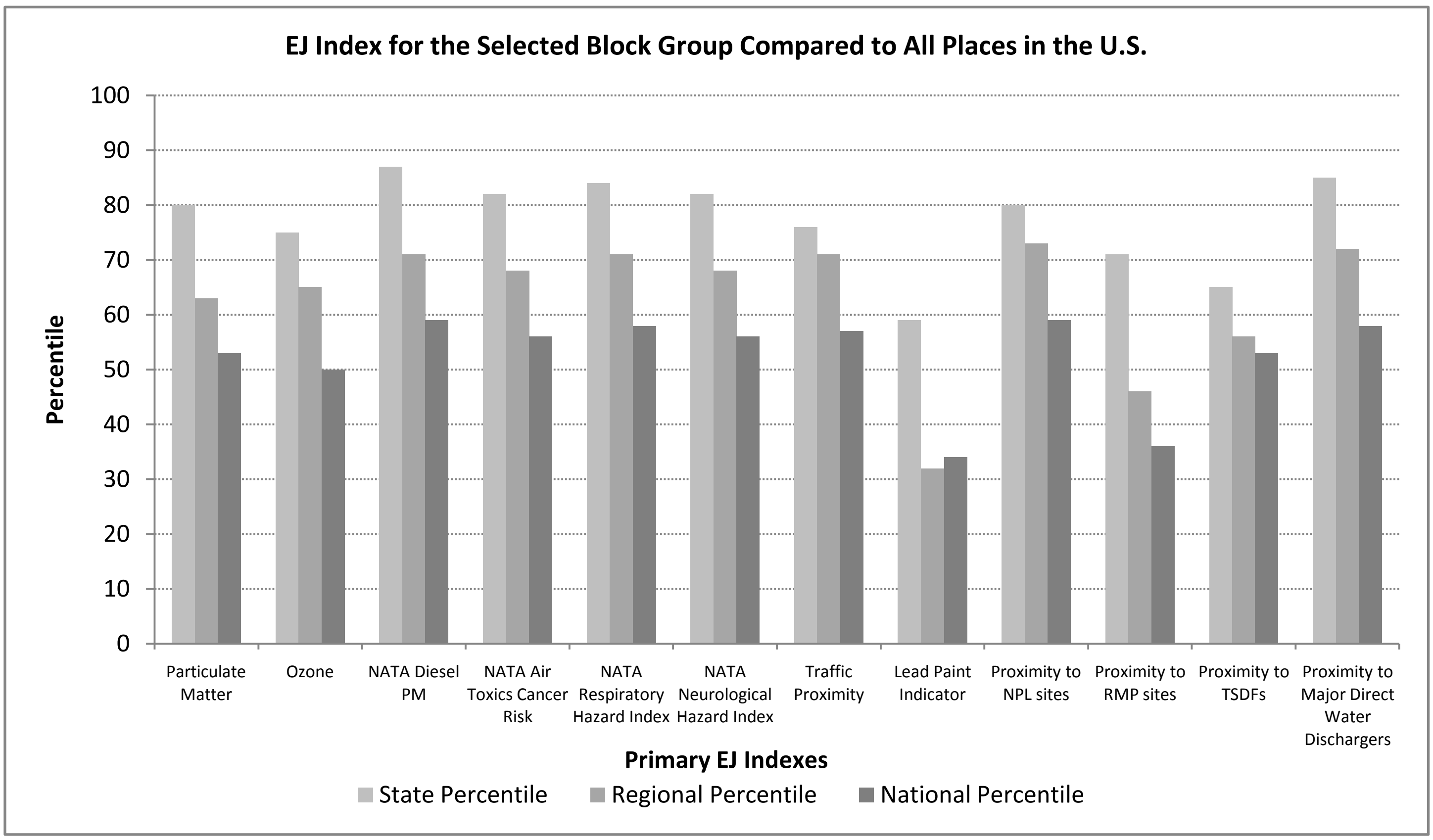
Enclosure: Attachment 1

United States Environmental Protection Agency

01/09/14

EJScreen Version 1 Report for Block Group 380259622002, North Dakota Population: 1699

Selected Variables	State Percentile	EPA Region Percentile	USA Percentile
Primary EJ Indexes			
Particulate Matter	80	63	53
Ozone	75	65	50
NATA Diesel PM	87	71	59
NATA Air Toxics Cancer Risk	82	68	56
NATA Respiratory Hazard Index	84	71	58
NATA Neurological Hazard Index	82	68	56
Traffic Proximity	76	71	57
Lead Paint Indicator	59	32	34
Proximity to NPL sites	80	73	59
Proximity to RMP sites	71	46	36
Proximity to TSDFs	65	56	53
Proximity to Major Direct Water Dischargers	85	72	58



This report shows environmental, demographic, and EJ indicator values. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators.

United States Environmental Protection Agency

EJScreen Version 1 Report for Block Group 380259622002, North Dakota Population: 1699

01/09/14

Selected Variables	Raw Data	State Avg.	State %ile	EPA Region Avg.	EPA Region %ile	USA Avg.	USA %ile
Environmental Factors							
Particulate Matter (PM 2.5 in $\mu g/m^3$)	7.21	8.73	6	8.05	42	10.7	7
Ozone (ppb)	44.4	40.6	95	51.8	18	46	38
NATA Diesel PM ($\mu g/m^3$)	0.0121	0.1730	2	0.66	6	0.8250	1
NATA Air Toxics Cancer Risk (risk per MM)	18	26	18	42	5	61	1
NATA Respiratory Hazard Index	0.24	0.64	19	1.8	2	3.1	1
NATA Neurological Hazard Index	0.019	0.0320	14	0.0470	5	0.0630	1
Traffic Proximity (daily traffic count/distance to road)	2	19	22	79	7	110	5
Lead Paint Indicator (% Pre-1960s Housing)	0.31	0.31	51	0.23	70	0.31	59
Proximity to NPL sites (facility count/km distance)	0.002	0.0034	24	0.0810	2	0.0960	0
Proximity to RMP sites (facility count/km distance)	0.23	0.39	53	0.25	72	0.31	68
Proximity to TSDFs (facility count/km distance)	0.0096	0.0740	54	0.0560	32	0.0660	18
Proximity to Major Direct Dischargers (count/km)	0.012	0.24	12	0.21	4	0.25	1
Primary Demographic Index	29%	20%	83	26%	67	34%	52
Minority Population	25%	11%	93	22%	70	35%	51
Low Income Population	32%	30%	59	30%	59	32%	55
Linguistically Isolated Population	1%	1%	80	3%	63	5%	52
Population With Less Than High School Education	13%	10%	69	10%	73	15%	55
Population Under 5 years of age	7%	6%	65	8%	52	7%	60
Population over 64 years of age	19%	15%	72	11%	85	13%	82

For additional information, see: www.epa.gov/environmentaljustice

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
DENVER, CO 80202-1129
Phone 800-227-8917
http://www.epa.gov/region08

Ref: 8P-AR

JUN 4, 2013

Honorable Tex Hall, Chairman
Three Affiliated Tribes
404 Frontage Road
New Town, North Dakota 58763

Re: Notification of Consultation and Coordination on Issuance of a Synthetic Minor NSR Air Pollution Control Permit to Arrow Pipeline, LLC, for the Arrow Pipeline Station 7 Project on the Fort Berthold Indian Reservation

Dear Chairman Hall,

The U.S. Environmental Protection Agency Region 8 (EPA) is initiating consultation and coordination with the Three Affiliated Tribes on issuance of a Synthetic Minor NSR Air Pollution Control Permit for the Arrow Pipeline Station 7 Project on the Fort Berthold Indian Reservation. The company, in accordance with the Federal Tribal New Source Review Clean Air Act (CAA) air pollution control permitting program found at 40 CFR Part 49, is requesting legally and practically enforceable restrictions on nitrogen oxide (NO_X), carbon monoxide (CO), volatile organic compound (VOC), total hazardous air pollutant (HAP) and each individual HAP emissions to avoid the permitting requirements of the Prevention of Significant Deterioration Permit Program at 40 CFR Part 52 (PSD) and to become a minor source with respect to the Title V Operating Permit Program at 40 CFR Part 71 (Part 71).

This consultation and coordination process is being conducted based on the *EPA Policy on Consultation and Coordination with Indian Tribes* (www.epa.gov/tribal/consultation/consult-policy.htm). We invite you and your designated consultation representative(s) to participate in this process. Our anticipated timeline for the consultation and coordination period is expected to close 30 days after you receive this letter.

Whether or not you decide to accept this offer for government-to-government consultation, we plan to regularly coordinate and communicate with the Three Affiliated Tribes' Environmental Director, Edmund Baker, for facilities located within the exterior boundaries of the Fort Berthold Indian Reservation. If you would prefer to designate an alternative representative for communication on permitting matters, please notify us of that person's name and contact information. We will keep the tribal government informed and will seek your input on these permits.

The EPA welcomes the opportunity to consult and coordinate with the Three Affiliated Tribes. If you choose to consult about this permitting action, we will work with your tribal government to develop a consultation plan including a description of the process we would follow, opportunity for your input, and timeline for the Region to provide feedback and to complete the consultation. We will send a draft consultation plan for your review as soon as practicable after we receive your reply to this letter. The Agency's goal will be to ensure that you have an opportunity to provide tribal input into this permit action either through the formal consultation process or through communication from your staff related to the proposed permit.

Please reply in writing to this letter within the next 30 days if the Three Affiliated Tribes desires to consult on this permit action. The official EPA contact person for this consultation and coordination process is Kathy Paser, a permit engineer on my staff.

Thank you very much for your attention to this matter. Please contact me at (303) 312-6611, or your staff can contact Kathy Paser at (303) 312-6526 or paser.kathleen@epa.gov, if you have any questions on this action. We look forward to hearing from you on this important matter.

Sincerely,

Derrith R. Watchman-Moore
Assistant Regional Administrator
Office of Partnerships and Regulatory Assistance

cc:

Edmund Baker, Environmental Director, Three Affiliated Tribes
Blake Huff, Tribal Assistance Program, U.S. Environmental Protection Agency, Region 8