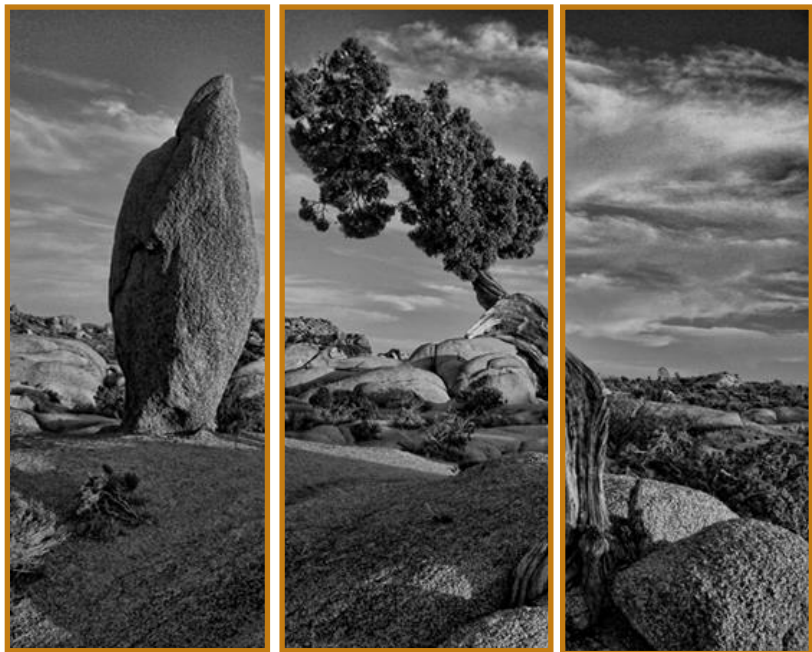


July 12, 2021

Air Quality Impact Analysis

Crusoe Energy Systems Inc.
Crosby Chase CTB
McKenzie County, North Dakota

Pinyon Project No.:
1/19-1347-01



I. Current Environment

Crusoe Energy Systems Inc. has prepared a true minor source air permit application for one (1) 13,106 kilowatt Solar Titan 130 turbine generator, one (1) Waukesha 9394GSI 2,500 horsepower (hp) generator, and one (1) Waukesha VGF H24SE 484 hp compressor to be located on the Fort Berthold Indian Reservation (FBIR) at the WPX Energy Williston, LLC (WPX) Crosby Chase CTB (the Facility) in McKenzie County, North Dakota. The purpose of these units is to consume gas that would otherwise be flared to instead generate power for small data centers. The Facility is located in an attainment area for all criteria pollutants. Since the engines will yield emissions of nitrogen oxides (NO_x) and particulate matter less than 2.5 microns in diameter ($\text{PM}_{2.5}$) and these were determined to be pollutants of concern by the U.S. Environmental Protection Agency (EPA), modeling was performed to demonstrate compliance with the 1-hour and annual nitrogen dioxide (NO_2), as well as 24-hour and annual $\text{PM}_{2.5}$ National Ambient Air Quality Standards (NAAQS).

I.1 National Ambient Air Quality Standards

The Clean Air Act of 1970 and its amendments led to the U.S. Environmental Protection Agency (EPA) establishing National Ambient Air Quality Standards (NAAQS) for criteria air pollutants: carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ground level ozone (O_3), particulate matter less than 10 microns (PM_{10}) and less than 2.5 microns ($\text{PM}_{2.5}$), and particulate matter with a diameter less than 2.5 microns ($\text{PM}_{2.5}$). Multiple revisions to the NAAQS have occurred over time and the current NAAQS are provided in Table I-1. There were previous standards for 24-hour SO_2 and annual SO_2 that are no longer in effect.

The engines and turbine are a contributor of NO_2 , CO , $\text{PM}_{2.5}$, and O_3 precursors, so only these criteria pollutants will be discussed in detail in subsequent sections. CO is a pollutant resulting from combustion that has fairly high NAAQS and generally, units such as the turbine and engines, do not result in NAAQS concerns. Currently all counties in North Dakota, including the Project location, are in attainment with NAAQS. Since ozone is a regional pollutant, it is not evaluated as part of the NAAQS screening process. Ozone and secondary $\text{PM}_{2.5}$ are discussed in the results section of this report through Modeled Emission Rates for Precursors (MERPs).

Table I-1 National Ambient Air Quality Standards

Pollutant	Averaging Time	Primary Standard	Form of Standard
Carbon Monoxide	8 hours	10,000 $\mu\text{g}/\text{m}^3$ (9 ppm)	Not to be exceeded more than once per year
	1 hour	40,000 $\mu\text{g}/\text{m}^3$ (35 ppm)	
Lead	Rolling three-month average	0.15 $\mu\text{g}/\text{m}^3$	Not to be exceeded
Nitrogen Dioxide	1 hour	188 $\mu\text{g}/\text{m}^3$ (100 ppb)	98 th percentile of 1-hour daily maximum, averaged over 3 years
	Annual	100 $\mu\text{g}/\text{m}^3$ (53 ppb)	Annual mean
Ozone	8 hours	140 $\mu\text{g}/\text{m}^3$ (0.070 ppm)	Annual 4 th highest 8-hour daily maximum, averaged over 3 years

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Pollutant	Averaging Time	Primary Standard	Form of Standard
Particulate Matter < 2.5µm (PM _{2.5})	Annual (primary)	12 µg/m ³	Annual mean, averaged over 3 years
	Annual (secondary)	15 µg/m ³	Annual mean, averaged over 3 years
	24 hours (primary and secondary)	35 µg/m ³	98 th percentile, averaged over 3 years
Particulate Matter < 10µm (PM ₁₀)	24 hours	150 µg/m ³	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide	1 hour	75 ppb (196 µg/m ³)	99 th percentile of 1-hour daily maximum, averaged over 3 years
	3 hour	0.5 ppm (1,309 µg/m ³)	Not to be exceeded more than once per year

Source: EPA 2016

ppm parts per million

ppb parts per billion

µm microns

µg/m³ micrograms per cubic meter

1.2 Background Concentrations

The facility is located within the Fort Berthold Indian Reservation in McKenzie County, North Dakota. Upon review of EPA's AirData Air Quality Monitors database, the two nearest air quality monitors nearest to the Crusoe project area are Lake Ilo (38-025-0004) and TRNP (38-053-0002). The background values used in the cumulative analysis (discussed in Section 2), are an average of the Lake Ilo and TRNP monitored values in the form of the standard (shown in Table 1-1) from 2018 to 2020 including exception events data, to be conservative (<https://www.epa.gov/outdoor-air-quality-data/monitor-values-report>)

Table 1-2 Background Concentrations for Cumulative Analysis

Pollutant	Averaging Time	Lake Ilo			TRNP			Background Concentration
		2018	2019	2020	2018	2019	2020	
NO ₂	1 hour	12 ppb	17 ppb	10 ppb	9 ppb	13 ppb	8 ppb	11.5 ppb (21.6 µg/m ³)
	Annual	1.99 ppb	2.42 ppb	1.86 ppb	1.66 ppb	1.73 ppb	0.98 ppb	1.8 ppb (3.4 µg/m ³)
O ₃	8 hours	59 ppb	63 ppb	54 ppb	61 ppb	60 ppb	51 ppb	58 ppb
PM _{2.5}	24 hours	20 µg/m ³	11 µg/m ³	10 µg/m ³	22 µg/m ³	11 µg/m ³	12 µg/m ³	14 µg/m ³
	Annual	5.0 µg/m ³	4.1 µg/m ³	3.6 µg/m ³	5.2 µg/m ³	3.6 µg/m ³	3.4 µg/m ³	4.1 µg/m ³

2. Model Selection Justification and Settings

To demonstrate compliance with ambient air quality standards, the most recent version of the AERSCREEN air dispersion model (version no. 21112) was chosen to assess the potential air quality impacts of NO₂ and PM_{2.5} from the Facility. AERSCREEN is the USEPA approved screening tool that analyzes one source and is based on AERMOD that produces worst-case 1-hour concentrations. AERSCREEN does not utilize hourly meteorological data, but does use default meteorological data sets based on land type and average weather through the use of MAKEMET (version no. 21112).

Since this is a screening of the Facility's impacts conservative inputs were used as described in the following sections to demonstrate no exceedances of NAAQS are anticipated.

2.1 Terrain Options

AERSCREEN, as a screening tool, does not necessarily require location-specific or representative terrain data. Due to the relatively flat nature of the site, the terrain heights were not included with a source elevation of 0 meters in a rural setting. Because the majority of the land surrounding the Facility is not developed and has a low population density, rural dispersion was chosen. As described further in the AERMET processing, the surrounding location is considered grassland.

2.2 Meteorology

No onsite meteorological data were available for the Facility. AERSCREEN does not require any meteorological data and instead uses MAKEMET to generate basic meteorological parameters based on surface characteristics, wind speed, and temperature. Based on the site location, known data, and default parameters within AERSCREEN, the following was used for each of the AERSCREEN runs. Note that the worst-case meteorology wind speed, wind direction, and temperature were used making the modeling of emission sources conservative.

- Minimum Temperature: - 10 degrees Fahrenheit (default)
- Maximum Temperature: 100 degrees Fahrenheit (default)
- Minimum Wind Speed: 0.5 meters per second (default)
- Anemometer Height: 10 meters (default)
- AERMET seasonal tables: option 2
- Dominant Surface Profile: Grassland (6)
- Dominant Climate Profile: Average Moisture (1)
- Non-adjusted (default)

2.3 Receptors

Since AERSCREEN models only one source at a time, a receptor grid is generated by AERSCREEN based on the minimum distance to ambient air, set receptor spacing, and radius length of receptor grid. Receptors were set as along and off of the fenceline to estimate worst-case impacts surrounding the source. Based on known data and default parameters within AERSCREEN, the following was used for each of the AERSCREEN runs.

- Distance to Ambient Air: 1 meter (default)
- Maximum Distance to probe: 5,000 meters (default)
- Receptor spacing: 25 meters (default)
- Discrete receptors: none
- Flagpole receptors: none

2.4 Source Location

For a cumulative analysis, nearby sources not owned or operated by Crusoe are also modeled. In Tables 2-1 and 2-2, the approximate latitude and longitude of each source are shown. The modeled distances to ambient air were assumed to be 1 meter (3.3 feet). Each of the sources is more than 1 meter from ambient making this assumption conservative. An image of the fenceline along with the approximate locations of the emissions units are shown in Figures 2-1 and 2-2. As discussed in Sections 4 and 5, the majority of the sources yield their maximum impact beyond the Crusoe fenceline, and moreover beyond the WPX fenceline and therefore, this approach is still conservative.

Table 2-1 Modeled Crusoe Sources

Source	Latitude (degrees NAD83)	Longitude (degrees NAD83)
Compressor (EU01)	47.83964	-102.69745
Generator (EU02)	47.83974	-102.69724
Turbine (EU03)	47.83973	-102.69707

Table 2-2. Modeled WPX Sources

Source	Latitude (degrees NAD83)	Longitude (degrees NAD83)
729 hrsepower Waukesha F3514 compressor	47.83986	-102.69616
530 hp Waukesha H24Se compressor	47.83993	-102.69618
585 hp Waukesha H24GL compressor	47.84008	-102.69759
880 hp Waukesha L36GI generator	47.83995	-102.69738
Zeeco 4MM flare	47.84004	-102.69682
Zeeco 2.2MM flare	47.84012	-102.69683
DBI Flare tips	47.83820	-102.69568

Source	Latitude (degrees NAD83)	Longitude (degrees NAD83)
Heater Treaters	47.83857	-102.69650

Two approaches to determining cumulative model results against the NAAQS were taken: (1) assume that all of the sources originate at the same central point where dispersion plumes overlap completely and (2) evaluate the maximum 1st high through 8th high results (see Section 2.5) of each individual source additively regardless of location (i.e., one sources' maximum 1st high at 200 meters added to another sources' maximum 1st high at 1 meter). Both approaches are conservative in that they do not account for realistic conditions such as the space between sources and gaps that would occur between individual source dispersion plumes.

Figure 2-1 WPX Pad Boundary with Nested Crusoe Fenceline



Figure 2-2 Nested Crusoe Fenceline



2.5 Standards

Based on how AERSCREEN operates, and the NAAQS shown in Table I-1, the form of the standard is not considered in the model output. Instead, the maximum potential 1-hour concentration is modeled and, if applicable, persistence factors are applied to the maximum 1-hour result based on longer averaging times. Based on AERSCREEN guidance, the maximum 1-hour result is multiplied by 1 for 3-hour standards, multiplied by 0.9 for 8-hour standards, multiplied by 0.6 for 24-hour standards, and multiplied by 0.1 for annual standards. The results summary in the OUT file for AERSCREEN applies these persistence factors when presenting the scaled longer average time period results.

Because the form of the standard for 1-hour NO_2 and 24-hour $\text{PM}_{2.5}$ are both 98th percentile, or the highest 8th high, and averaged over 3 years, utilizing the maximum 1-hour value result to determine concerns with the NAAQS is a conservative approach. As discussed further in the results sections, the 2nd through 8th maximum values of the 1-hour NO_2 and 24-hour $\text{PM}_{2.5}$ cumulative model results are tabulated to demonstrate the model results more accurately in the form of the standard.

3. Emission Sources and Modeled Emission Rates

Detailed emission calculations for the three (3) Crusoe engines are provided in the permit application. A summary of the modeled emission rates for the proposed Crusoe sources are summarized in Tables 3-1 and 3-2. For a cumulative analysis, nearby sources not owned or operated by Crusoe are also modeled. The modeled emissions rates for the WPX sources that have the potential to emit the same pollutants are summarized in Tables 3-3 and 3-4. The modeled emission rates are the maximum potential hourly emissions.

To estimate NO₂ concentrations, the ozone limiting method (OLM) was used in AERSCREEN (Option 2). With OLM, the background ozone concentration from Table 1-2 was used in conjunction with in-stack ratios for each emission unit type (e.g., reciprocating engine, turbine, heater, flare, etc.). The in-stack ratios were retrieved from the most recent version of the EPA NO₂ In-Stack Ratio (ISR) database released in October of 2020. Non-zero values were not included when determining the average ISR used in the AERSCREEN model. The ISR are included in Tables 3-1 through 3-4 below. The “No Chemistry” option was used for all PM_{2.5} model runs.

Table 3-1 NO₂ Modeled Emission Rates of Crusoe Sources

Source	NO _x Emissions (lb/hr)	Emission Unit Classification	NO ₂ /NO _x In-Stack Ratio
Compressor (EU01)	0.16	Reciprocating IC engine	0.17
Generator (EU02)	0.83	Reciprocating IC engine	0.17
Turbine (EU03)	12.79	Turbine – natural gas	0.14

Table 3-2. PM_{2.5} Modeled Emission Rates of Crusoe Sources

Source	PM _{2.5} Emissions (lb/hr)
Compressor (EU01)	0.095
Generator (EU02)	0.38
Turbine (EU03)	0.88

Table 3-3. NO₂ Modeled Emission Rates for WPX Sources

Source	NO _x Emissions (lb/hr)	Emission Unit Classification	NO ₂ /NO _x In-Stack Ratio
729 hp Waukesha F3514 compressor	1.61	Reciprocating IC engine	0.17
530 hp Waukesha H24Se compressor	1.17	Reciprocating IC engine	0.17
585 hp Waukesha H24GL compressor	1.29	Reciprocating IC engine	0.17
880 hp Waukesha L36GI generator	1.94	Reciprocating IC engine	0.17

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Source	NO _x Emissions (lb/hr)	Emission Unit Classification	NO ₂ /NO _x In-Stack Ratio
Zeeco 4MM flare	1.44	Flare	0.5 (default)
Zeeco 2.2MM flare	0.79	Flare	0.5 (default)
DBI Flare tips	0.85	Flare	0.5 (default)
Heater Treaters	0.44	Boiler	0.1

Table 3-4. PM_{2.5} Modeled Emission Rates of WPX Sources

Source	PM _{2.5} Emissions (lb/hr)
729 hp Waukesha F3514 compressor	0.12
530 hp Waukesha H24Se compressor	0.087
585 hp Waukesha H24GL compressor	0.097
880 hp Waukesha L36GI generator	0.15
Zeeco 4MM flare	0.16
Zeeco 2.2MM flare	0.089
DBI Flare tips	0.040
Heater Treaters	0.034

3.1 Source Parameters

The modeled stack parameters are summarized in Tables 3-5 and 3-6. All stack flows and temperatures were determined from manufacturer specifications of the specific make/model equipment or default values, where appropriate. These parameters will be installed and operational upon Crusoe's installation and operation of their equipment.

Table 3-5. Stack Parameters for Crusoe Sources

Source	Source Type	Stack Height (ft)	Stack Diameter (in)	Stack Flow Rate (acfm)	Stack Temp (°F)
Compressor	Point	35	13	2,871	1,265
Generator	Point	35	13	10,544	1,084

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Source	Source Type	Stack Height (ft)	Stack Diameter (in)	Stack Flow Rate (acfm)	Stack Temp (°F)
Turbine	Point	40	72	268,030	910

Table 3-5. Stack Parameters for WPX Sources

Source	Source Type	Stack Height (ft)	Stack Diameter (in)	Stack Flow Rate (acfm)	Stack Temp (°F)
729 hp Waukesha F3514 compressor	Point	26	10	4,077	1,223
530 hp Waukesha H24Se compressor	Point	18	10	2,755	1,154
585 hp Waukesha H24GL compressor	Point	27.5	8	3,058	838
880 hp Waukesha L36GI generator	Point	18.5	10	5,036	847
Zeeco 4MM flare	Point ¹	40	8	4,792	1,832 ³
Zeeco 2.2MM flare	Point ¹	30	8	2,431	1,832 ³
DBI Flare tips	Point ¹	20	10	6,944	1,832 ³
Heater Treaters	Point	23	24	3,770 ²	1,100

¹ Flares are treated as point sources due to their design.

² The stack height and diameter are the most conservative stack parameters for all planned heaters (lowest stack, widest diameter). From that, a conservative estimate of 20 ft/s was used to determine exit velocity where AERSCREEN calculated an exhaust flow.

³ TCEQ default exhaust temperature for flares modeled as point sources.

3.2 Building Downwash and Fumigation

Per EPA guidance, building downwash and fumigation were not included in the AERSCREEN runs.

4. NO₂ AERSCREEN Model Results

NO₂ was modeled for each source to determine the maximum 1-hour result using the OLM method for NO_x to NO₂ conversion in AERSCREEN. The results of the AERSCREEN models of each individual source are in Table 4-1 for 1st high through 8th high 1-hour NO₂ regardless of impact location, Table 4-2 for the 1-hour NO₂ model results assuming the same origin point, Table 4-3 for maximum annual NO₂, and Table 4-4 for the annual NO₂ model results assuming the same origin point. As described in Section 2.5, a persistence factor of 0.1 was applied to 1-hour results to determine annual impacts.

Table 4-1. AERSCREEN Model Results of 1st high through 8th high 1-Hour NO₂

Source	1 st High 1-hour NO ₂	2 nd High 1-hour NO ₂	3 rd High 1-hour NO ₂	4 th High 1-hour NO ₂	5 th High 1-hour NO ₂	6 th High 1-hour NO ₂	7 th High 1-hour NO ₂	8 th High 1-hour NO ₂
WPX 530 hp	33.90	33.74	31.10	26.10	22.91	19.92	17.45	16.67
WPX 585 hp	17.39	17.39	16.41	16.14	14.62	13.24	11.87	10.90
WPX 729 hp	20.90	20.46	19.70	18.79	16.48	15.21	13.90	12.71
WPX 880 hp	45.94	43.43	41.69	35.76	30.49	28.34	25.02	21.71
WPX Zeeco 2.2MM Flare	9.03	8.91	8.73	7.91	7.84	7.30	6.62	6.05
WPX Zeeco 4MM Flare	7.66	7.59	7.55	7.53	7.22	6.71	6.33	6.22
WPX DBI Flare	13.75	13.73	13.01	11.77	10.43	8.71	8.16	7.51
WPX Heaters	9.97	9.22	9.22	7.99	6.94	6.45	5.69	4.94
Crusoe Turbine	15.91	15.87	15.73	15.36	14.51	14.49	13.51	12.49
Crusoe Generator	4.66	4.63	4.54	4.13	3.99	3.91	3.60	3.31
Crusoe Compressor	1.35	1.35	1.30	1.24	1.19	1.13	1.12	1.05
Background	21.60	21.60	21.60	21.60	21.60	21.60	21.60	21.60
Total	202.1	197.9	190.6	174.3	158.2	147.0	134.9	125.2

Table 4-2. AERSCREEN Model Results of Maximum 1-hour NO₂ from Same Origin Point

Source	1 m from Source	25 m from Source	50 m from Source	75 m from Source	100 m from Source	125 m from Source	150 m from Source	175 m from Source
WPX 530 hp	0.47	7.07	33.74	31.1	26.1	22.91	19.92	17.45
WPX 585 hp	0.23	4.42	9.20	16.41	17.39	16.14	14.62	13.24
WPX 729 hp	0.37	4.52	11.64	20.46	19.70	18.79	16.48	15.21

Source	1 m from Source	25 m from Source	50 m from Source	75 m from Source	100 m from Source	125 m from Source	150 m from Source	175 m from Source
WPX 880 hp	0.76	6.51	43.43	41.69	35.76	30.49	28.34	25.02
WPX Zeeco 2.2MM Flare	0.12	2.71	5.31	7.84	8.91	8.73	7.91	7.30
WPX Zeeco 4MM Flare	0.14	2.77	3.76	5.41	6.22	7.55	7.53	7.59
WPX DBI Flare	0.30	1.66	13.01	13.73	11.77	10.43	8.71	8.16
WPX Heaters	0.12	1.71	9.22	9.22	7.99	6.94	6.45	5.69
Crusoe Turbine	3.75	1.07	1.46	1.94	2.38	5.20	10.46	14.49
Crusoe Generator	0.13	1.06	1.66	2.88	3.99	4.63	4.54	4.13
Crusoe Compressor	0.02	0.48	0.77	1.13	1.24	1.35	1.30	1.19
Background	21.60	21.60	21.60	21.60	21.60	21.60	21.60	21.60
Total	28.01	55.56	154.8	173.4	163.1	154.8	147.9	141.1

The rankings of the 1st through 8th high (98th percentile) can be found in the model summary tables included with the modeling files included with this report. As depicted in the tables above and the model results, the maximum impact for each source occurs beyond the minimum assumed distance to ambient air (1 meter). In Table 4-1, with the inclusion of background 1-hour NO₂ value, the 1st high through 3rd high 1-hour NO₂ values show potential exceedances of the NAAQS. It is important to note that the results in Table 4-1 do not account for location of the 1st high through 8th high and therefore adding them together is conservative as it does not account for the locations of the sources. As dispersion for each of the sources drops off, as the sources plumes reach their peak and then drop as distance from the source increases, the 4th through 8th high shows a steady decline in the cumulative impact below the NAAQS. The 8th highest impact values from each of the sources added together plus background, again regardless of location, demonstrates a value of 125.2 µg/m³ which is below the NAAQS standard of 188 µg/m³. Assuming all of the sources originate from the same point and have plumes completely overlapping one another, shows a maximum 1-hour value plus background of 173.4 µg/m³ at a distance of 75 meters from the source in Table 4-2 which is also below the NAAQS standard of 188 µg/m³. The individual source AERSCREEN model runs and analyses are submitted with this report.

Table 4-3. AERSCREEN Model Results of 1st high Annual NO₂

Source	1 st High Annual NO ₂
WPX 530 hp	3.39
WPX 585 hp	1.74

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Source	1 st High Annual NO ₂
WPX 729 hp	2.09
WPX 880 hp	4.59
WPX Zeeco 2.2MM Flare	0.90
WPX Zeeco 4MM Flare	0.77
WPX DBI Flare	1.38
WPX Heaters	1.00
Crusoe Turbine	1.59
Crusoe Generator	0.47
Crusoe Compressor	0.14
Background	3.40
Total	21.4

Table 4-4. AERSCREEN Model Results of Maximum Annual NO₂ from Same Origin Point

Source	1 m from Source	25 m from Source	50 m from Source	75 m from Source	100 m from Source	125 m from Source	150 m from Source	175 m from Source
WPX 530 hp	0.05	0.71	3.37	3.11	2.61	2.29	1.99	1.75
WPX 585 hp	0.02	0.44	0.92	1.64	1.74	1.61	1.46	1.32
WPX 729 hp	0.04	0.45	1.16	2.05	1.97	1.88	1.65	1.52
WPX 880 hp	0.08	0.65	4.34	4.17	3.58	3.05	2.83	2.50
WPX Zeeco 2.2MM Flare	0.01	0.27	0.53	0.78	0.89	0.87	0.79	0.73
WPX Zeeco 4MM Flare	0.01	0.28	0.38	0.54	0.62	0.76	0.75	0.76
WPX DBI Flare	0.03	0.17	1.30	1.37	1.18	1.04	0.87	0.82
WPX Heaters	0.01	0.17	0.92	0.92	0.80	0.69	0.65	0.57
Crusoe Turbine	0.38	0.11	0.15	0.19	0.24	0.52	1.05	1.45
Crusoe Generator	0.01	0.11	0.17	0.29	0.40	0.46	0.45	0.41
Crusoe Compressor	0.00	0.05	0.08	0.11	0.12	0.14	0.13	0.12
Background	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40
Total	4.06	7.05	17.75	19.76	18.62	17.69	16.90	16.13

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As depicted in the tables above and the model results, the maximum impact for each individual source occurs beyond the minimum assumed distance to ambient air (1 meter). In Table 4-3, with the inclusion of background annual NO_2 value, the cumulative 1st high annual NO_2 value of $21.4 \mu\text{g}/\text{m}^3$ is below the NAAQS standard of $100 \mu\text{g}/\text{m}^3$. Assuming all of the sources originate from the same point and have plumes completely overlapping one another, shows a maximum annual value plus background of $19.76 \mu\text{g}/\text{m}^3$ at a distance of 75 meters from the source in Table 4-4 which is also below the NAAQS standard of $100 \mu\text{g}/\text{m}^3$. The individual source AERSCREEN model runs and analyses are submitted with this report.

Based on the results in Section 4, possible scenarios where the cumulative impacts between Crusoe sources and WPX sources result in maximum 1-hour NO_2 impacts less than the NAAQS threshold of $188 \mu\text{g}/\text{m}^3$ and maximum annual NO_2 impacts less than the NAAQS threshold of $100 \mu\text{g}/\text{m}^3$. Therefore, there are no NO_2 NAAQS concerns from this Project.

5. PM_{2.5} AERSCREEN Model Results

PM_{2.5} was modeled for each source to determine the maximum 24-hour result in AERSCREEN. The results of the AERSCREEN models of each individual source are in Table 5-1 for 1st high through 8th high 24-hour PM_{2.5} regardless of impact location, Table 5-2 for the 24-hour PM_{2.5} model results assuming the same origin point, Table 5-3 for maximum annual PM_{2.5}, and Table 5-4 for the annual PM_{2.5} model results assuming the same origin point. As described in Section 2.5, a persistence factor of 0.6 was applied to the 1-hour result to determine 24-hour impacts and a persistence factor of 0.1 was applied to the 1-hour results to determine annual impacts.

Table 4-1. AERSCREEN Model Results of 1st high through 8th high 24-Hour PM_{2.5}

Source	1 st High 24-hour PM _{2.5}	2 nd High 24-hour PM _{2.5}	3 rd High 24-hour PM _{2.5}	4 th High 24-hour PM _{2.5}	5 th High 24-hour PM _{2.5}	6 th High 24-hour PM _{2.5}	7 th High 24-hour PM _{2.5}	8 th High 24-hour PM _{2.5}
WPX 530 hp	1.68	1.67	1.54	1.29	1.14	0.99	0.87	0.83
WPX 585 hp	0.87	0.87	0.82	0.81	0.73	0.66	0.60	0.55
WPX 729 hp	1.04	1.02	0.98	0.93	0.82	0.76	0.69	0.63
WPX 880 hp	2.37	2.24	2.15	1.84	1.57	1.46	1.29	1.12
WPX Zeeco 2.2MM Flare	0.68	0.67	0.66	0.59	0.59	0.55	0.50	0.45
WPX Zeeco 4MM Flare	0.57	0.56	0.56	0.56	0.53	0.50	0.47	0.46
WPX DBI Flare	0.43	0.43	0.41	0.37	0.33	0.27	0.26	0.24
WPX Heaters	0.51	0.48	0.47	0.41	0.36	0.33	0.29	0.25
Crusoe Turbine	0.73	0.73	0.72	0.70	0.67	0.66	0.62	0.57
Crusoe Generator	1.42	1.41	1.39	1.26	1.22	1.19	1.10	1.01
Crusoe Compressor	0.53	0.53	0.52	0.49	0.47	0.45	0.44	0.41
Background	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00
Total	24.84	24.61	24.21	23.27	22.42	21.82	21.12	20.52

Table 4-2. AERSCREEN Model Results of Maximum 24-hour PM_{2.5} from Same Origin Point

Source	1 m from Source	25 m from Source	50 m from Source	75 m from Source	100 m from Source	125 m from Source	150 m from Source	175 m from Source
WPX 530 hp	0.02	0.35	1.67	1.54	1.29	1.14	0.99	0.87
WPX 585 hp	0.01	0.22	0.46	0.82	0.87	0.81	0.73	0.66
WPX 729 hp	0.02	0.22	0.58	1.02	0.98	0.93	0.82	0.76

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Source	1 m from Source	25 m from Source	50 m from Source	75 m from Source	100 m from Source	125 m from Source	150 m from Source	175 m from Source
WPX 880 hp	0.04	0.34	2.24	2.15	1.84	1.57	1.46	1.29
WPX Zeeco 2.2MM Flare	0.01	0.20	0.40	0.59	0.67	0.66	0.59	0.55
WPX Zeeco 4MM Flare	0.01	0.21	0.28	0.40	0.46	0.56	0.56	0.56
WPX DBI Flare	0.01	0.05	0.41	0.43	0.37	0.33	0.27	0.26
WPX Heaters	0.01	0.09	0.48	0.47	0.41	0.36	0.33	0.29
Crusoe Turbine	0.17	0.05	0.07	0.09	0.11	0.24	0.48	0.66
Crusoe Generator	0.04	0.32	0.51	0.88	1.22	1.41	1.39	1.26
Crusoe Compressor	0.01	0.19	0.30	0.45	0.49	0.53	0.52	0.47
Background	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00
Total	14.35	16.24	21.39	22.84	22.71	22.53	22.14	21.63

The rankings of the 1st through 8th high (98th percentile) can be found in the model summary tables included with the modeling files included with this report. As depicted in the tables above and the model results, the maximum impact for each source occurs beyond the minimum assumed distance to ambient air (1 meter). In Table 5-1, with the inclusion of background 24-hour PM_{2.5} value, the 1st high through 8th high 24-hour PM_{2.5} values show a cumulative impact below the NAAQS of 35 µg/m³. It is important to note that the results in Table 5-1 do not account for location of the 1st high through 8th high and therefore adding them together is conservative as it does not account for the locations of the sources. Assuming all of the sources originate from the same point and have plumes completely overlapping one another, shows a maximum 24-hour value plus background of 22.84 µg/m³ at a distance of 75 meters from the source in Table 5-2 which is also below the NAAQS standard of 35 µg/m³. The individual source AERSCREEN model runs and analyses are submitted with this report.

Table 4-3. AERSCREEN Model Results of 1st high Annual PM_{2.5}

Source	1 st High Annual PM _{2.5}
WPX 530 hp	0.28
WPX 585 hp	0.15
WPX 729 hp	0.17
WPX 880 hp	0.39

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Source	1 st High Annual PM _{2.5}
WPX Zeeco 2.2MM Flare	0.11
WPX Zeeco 4MM Flare	0.09
WPX DBI Flare	0.07
WPX Heaters	0.09
Crusoe Turbine	0.12
Crusoe Generator	0.24
Crusoe Compressor	0.09
Background	4.10
Total	5.91

Table 4-4. AERSCREEN Model Results of Maximum Annual PM_{2.5} from Same Origin Point

Source	1 m from Source	25 m from Source	50 m from Source	75 m from Source	100 m from Source	125 m from Source	150 m from Source	175 m from Source
WPX 530 hp	0.00	0.06	0.28	0.26	0.22	0.19	0.16	0.14
WPX 585 hp	0.00	0.04	0.08	0.14	0.15	0.13	0.12	0.11
WPX 729 hp	0.00	0.04	0.10	0.17	0.16	0.16	0.14	0.13
WPX 880 hp	0.01	0.06	0.37	0.36	0.31	0.26	0.24	0.22
WPX Zeeco 2.2MM Flare	0.00	0.03	0.07	0.10	0.11	0.11	0.10	0.09
WPX Zeeco 4MM Flare	0.00	0.03	0.05	0.07	0.08	0.09	0.09	0.09
WPX DBI Flare	0.00	0.01	0.07	0.07	0.06	0.05	0.05	0.04
WPX Heaters	0.00	0.01	0.08	0.08	0.07	0.06	0.06	0.05
Crusoe Turbine	0.03	0.01	0.01	0.01	0.02	0.04	0.08	0.11
Crusoe Generator	0.01	0.05	0.08	0.15	0.20	0.24	0.23	0.21
Crusoe Compressor	0.00	0.03	0.05	0.07	0.08	0.09	0.09	0.08
Background	4.10	4.10	4.10	4.10	4.10	4.10	4.10	4.10
Total	4.15	4.47	5.34	5.58	5.56	5.52	5.46	5.37

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As depicted in the tables above and the model results, the maximum impact for each individual source occurs beyond the minimum assumed distance to ambient air (1 meter). In Table 5-3, with the inclusion of background annual $\text{PM}_{2.5}$ value, the cumulative 1st high annual NO_2 value of $5.91 \mu\text{g}/\text{m}^3$ is below the NAAQS standard of $12 \mu\text{g}/\text{m}^3$. Assuming all of the sources originate from the same point and have plumes completely overlapping one another, shows a maximum annual value plus background of $5.58 \mu\text{g}/\text{m}^3$ at a distance of 75 meters from the source in Table 5-4 which is also below the NAAQS standard of $12 \mu\text{g}/\text{m}^3$. The individual source AERSCREEN model runs and analyses are submitted with this report.

Based on the results in Section 5, possible scenarios where the cumulative impacts between Crusoe sources and WPX sources result in maximum 24-hour $\text{PM}_{2.5}$ impacts less than the NAAQS threshold of $35 \mu\text{g}/\text{m}^3$ and maximum annual $\text{PM}_{2.5}$ impacts less than the NAAQS threshold of $12 \mu\text{g}/\text{m}^3$. Therefore, there are no $\text{PM}_{2.5}$ NAAQS concerns from this Project.

6. Ozone

Ozone is a regionally significant pollutant that is formed by chemical reactions in the atmosphere from the precursors of nitrogen oxides (e.g., NO₂) and volatile organic compounds (VOC). This Project is located in an area that is in attainment with the current ozone NAAQS and not in concern of exceeding the NAAQS. Additionally, the operation of the Crusoe Crosby Chase units would lower NO_x and VOC emissions compared to the business-as-usual case (i.e., flaring of gas).

Per recent April 2019 guidance, EPA released procedures for a Tier I demonstration for ozone and PM_{2.5} under the Prevention for Significant Deterioration (PSD) program called Modeled Emission Rates for Precursors (MERPs). This guidance has also been known to be used for minor sources as well, such as Crusoe's Crosby Chase Project. The MERP guidance provides otherwise photochemically modeled impacts for secondary pollutants such as ozone and secondary PM_{2.5} based on emissions rates to determine whether a project may have negative impacts on these pollutants. The follow analysis was completed for the Crusoe Crosby Chase Project based on the Tier I demonstration guidelines in Section 4.1.1.

The Project is not located in an area with complex terrain, proximity to very large NO_x or VOC sources, or unusual meteorology. Based on the location in North Dakota, the results from the lowest 8-hour O₃ from NO_x and lowest 8-hour O₃ from VOC of the Rockies/Plains can be used:

8-hour O₃ from NO_x: 184 ton/yr

8-hour O₃ from VOC: 1,067 ton/yr

The Project has estimated emissions of the same pollutants of the following:

NO_x: 60.33 ton/yr

VOC: 26.64 ton/yr

The MERP calculation is as follows:

$$(60.33 \text{ ton/yr NO}_x \text{ from Project} / 184 \text{ ton/yr NO}_x \text{ 8-hr daily maximum O}_3 \text{ MERP}) + (26.64 \text{ ton/yr VOC from Project} / 1,067 \text{ ton/yr VOC 8-hr daily maximum O}_3 \text{ MERP}) = 0.33 + 0.02 = \mathbf{0.35 = 35\%}$$

A value less than 100% indicates that the O₃ significant impact level (SIL) would not be exceeded when considering the combined impacts of the precursors. Therefore, the Crusoe Crosby Chase Project is not expected to exceed the 8-hour O₃ SIL.

6.1 Secondary PM_{2.5}

Secondary PM_{2.5} is also a regionally significant pollutant that is formed by chemical reactions in the atmosphere from the precursors of a combination of sulfur dioxide (SO₂), NO_x, VOCs, and ammonia. This Project is located in an area that is in attainment with the current secondary PM_{2.5} NAAQS and not in concern of exceeding the NAAQS. Additionally, the operation of Crusoe Crosby Chase units would lower NO_x and VOC emissions compared to the business-as-usual case (i.e., flaring of gas) and has minimal SO₂ emissions due to being fueled by sweet gas (i.e., low hydrogen sulfide content) and no ammonia content.

Per recent April 2019 guidance, EPA released procedures for a Tier I demonstration for ozone and PM_{2.5} under the Prevention for Significant Deterioration (PSD) program called Modeled Emission Rates for Precursors (MERPs). This guidance has also been known to be used for minor sources as well, such as Crusoe's Crosby

Chase Project. The MERP guidance provides otherwise photochemically modeled impacts for secondary pollutants such as ozone and secondary PM_{2.5} based on emissions rates to determine whether a project may have negative impacts on these pollutants. The follow analysis was completed for the Crusoe Crosby Chase Project based on the Tier I demonstration guidelines in Section 4.1.1.

The Project is not located in an area with complex terrain, proximity to very large NO_x, SO₂, or VOC sources, or unusual meteorology. Based on the location in North Dakota, the results from the lowest 8-hour O₃ from NO_x and lowest 8-hour O₃ from VOC of the Rockies/Plains can be used:

Daily PM_{2.5} from NO_x: 1,740 ton/yr

Daily PM_{2.5} from SO₂: 251 ton/yr

The Project has estimated emissions of the same pollutants of the following:

NO_x: 60.33 ton/yr

SO₂: 2.07 ton/yr

Because there are direct daily and annual PM_{2.5} impacts from the Crusoe Crosby Chase Project, and those direct daily and annual PM_{2.5} impacts were modeled higher than the SIL, a cumulative analysis is required. The hypothetical representative source used in the MERP guidance for cumulative analyses with direct PM_{2.5} impacts was used based on location (Rockies region and elevated source). Conservatively, the 1st high daily PM_{2.5} modeled concentration was used for the annual PM_{2.5} analysis, though it is likely impacts are lower.

Daily

Source nitrate = 60.33 ton/yr × (0.047 µg/m³ / 1,000 ton/yr) = 0.003 µg/m³

Source sulfate = 2.07 ton/yr × (0.094 µg/m³ / 500 ton/yr) = 0.0004 µg/m³

Crusoe Crosby Chase cumulative maximum direct daily PM_{2.5} = 10.8 µg/m³

Background daily PM_{2.5} = 14 µg/m³

Source nitrate + source sulfate + Crusoe Crosby Chase maximum direct daily PM_{2.5} + Background daily PM_{2.5} = 0.003 + 0.0004 + 10.8 + 14 = **25 µg/m³**

Annual

Source nitrate = 60.33 ton/yr × (0.047 µg/m³ / 1,000 ton/yr) = 0.003 µg/m³

Source sulfate = 2.07 ton/yr × (0.094 µg/m³ / 500 ton/yr) = 0.0004 µg/m³

Crusoe Crosby Chase cumulative maximum direct annual PM_{2.5} = 1.81 µg/m³

Background daily PM_{2.5} = 4.1 µg/m³

Source nitrate + source sulfate + Crusoe Crosby Chase maximum direct daily PM_{2.5} + Background daily PM_{2.5} = 0.003 + 0.0004 + 1.81 + 4.1 = **5.9 µg/m³**

The sum total of the four inputs above yields an estimate secondary PM_{2.5} daily maximum impact less than the NAAQS value of 35 µg/m³ and secondary PM_{2.5} annual maximum impact less than the NAAQS value of 15

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$\mu\text{g}/\text{m}^3$. Therefore, the Crusoe Crosby Chase Project is not expected to exceed the 24-hour nor annual secondary $\text{PM}_{2.5}$ NAAQS.

7. Conclusion

The modeling exercise for the Project was conducted with AERSCREEN to estimate conservative potential cumulative impacts of the Crosby Chase location. The results of the conservative AERSCREEN modeling show that the potential impacts of the project are not of concern due to maximum 1-hour, 24-hour, and annual results being less than the NAAQS thresholds. Additionally, since the sources are being utilized to reduce the amount of gas flaring compared to the business-as-usual operation for the site, operation of Crusoe's engines result in a lower-emissions scenario.

Certification of Data Accuracy

Based on information and belief formed after reasonable inquiry, the statements and information in the document, as it relates to equipment stack parameters, emissions rates, and setback distances of WPX equipment are true, accurate, and complete.

At the time of Crusoe equipment startup, the following stack parameters, emissions rates, and setback distances from Crusoe's fenceline will be in operation.

Source	Stack Height (ft)	Stack Diameter (in)	Stack Flow (acfm)	Stack Temp (deg F)	NO _x (lb/hr)	PM _{2.5} (lb/hr)	Setback Distance (ft)
729 horsepower Waukesha F3514 compressor	26	10	4,077	1,223	1.61	0.12	181
530 horsepower Waukesha H24Se compressor	18	10	2,755	1,154	1.17	0.087	184
585 horsepower Waukesha H24GL compressor	27.5	8	3,058	838	1.29	0.097	139
880 horsepower Waukesha L36GI generator	18.5	10	5,036	847	1.94	0.15	73
Zeeco 4MM flare	40	8	4,792	1,832	1.44	0.16	84
Zeeco 2.2MM flare	30	8	2,431	1,832	0.79	0.089	110
DBI Flare tips	20	10	6,944	1,832	0.85	0.040	531
Heater Treaters*	23	24	3,770	1,100	0.44	0.034	305

*Heater treater stack parameters shown are the worst-case (lowest height and largest diameter) of individual units with aggregated unit emissions.

Signed,

WPX Energy Williston, LLC

Print Name: Billy Frazier

Signature: [Signature]

Title: Environmental Manager

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8. References

Environmental Protection Agency (EPA), 2016. "NAAQS Table." Available at: <https://www.epa.gov/criteria-air-pollutants/naaqs-table> last updated December 20, 2016.

Environmental Protection Agency (EPA), 2021. "EPA-454/B-21-005: AERSCREEN User's Guide." April 2021. Available at: https://gaftp.epa.gov/Air/aqmg/SCRAM/models/screening/aerscreen/aerscreen_userguide.pdf