Appendix E

Modeling Report

Thunder Butte Petroleum Services, Inc.

AIR QUALITY IMPACT ANALYSIS MODELING REPORT

Proposed Crude Oil Topping Plant

December 21, 2023

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Acronyms and Abbreviations

$\mu g/m^3$	micrograms per cubic meter
AERMOD	AMS/EPA Regulatory Model
AMS	American Meteorological Society
AQIA	air quality impacts analysis
ARM	ambient ratio method
AST	above-ground storage tank
ATB	Atmospheric Tower Bottoms
BH	building heights
BIA	Bureau of Indian Affairs
BPD	barrels per day
BPIP	Building Profile Input Program
BPIPPRM	"PRIME" version of BPIP
cal/s	calorie per second
CO	Carbon Monoxide
dba	doing business as
EUI	emission unit identification
FBIR	Fort Berthold Indian Reservation
FLAG	Federal Land Manager's Air Quality Related Values Work Group
g/s	grams per second
GEP	Good Engineering Practice
GLCmax	maximum ground-level concentration
H_2S	Hydrogen Sulfide
HAP	hazardous air pollutant
K	Kelvin
km	kilometers
LPG	liquefied petroleum gas
m	meters
m/s	meters per second
MERP	Modeled Emission Rates for Precursor
MHA	Mandan, Hidatsa, and Arikara Nation
MMBTU/hr	1 million British thermal units per hour
MSS	Maintenance, Startup, and Shutdown

NAAQS	National Ambient Air Quality Standards
NAD83	North American Datum of 1983
NED	National Elevation Dataset
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
NSR	New Source Review
NWR	National Wildlife Refuge
NWS	National Weather Service
O_3	ozone
OLM	Ozone Limiting Method
PM	Particulate Matter
PM_{10}	Particulate Matter, less than 10 microns
$PM_{2.5}$	Particulate Matter, less than 2.5 microns
ppb	parts per billion
ppb	parts per billion
PSD	Prevention of Significant Deterioration
PTE	potential to emit
PVMRM	Plume Volume Molar Ratio Method
Q	Annual Emissions
Q/D	Annual Emissions/Distance
SER	Significant Emission Rate
SIL	Significant Impact Level
SMNSR	Synthetic Minor New Source Review
SO_2	Sulfur dioxide
TBPS	Thunder Butte Petroleum Services, Inc.
tpy	tons per year
UIC	underground injection control
ULS	ultra-low sulfur
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compounds

1. Introduction

This air quality impact analysis (AQIA) modeling report was prepared to conduct modeling in support of the air permit application for a 40,000 barrel per day Topping Plant proposed for construction on the Fort Berthold Indian Reservation (FBIR) in Ward County, North Dakota by the Mandan, Hidatsa, and Arikara (MHA) Nation, doing business as (dba) Thunder Butte Petroleum Services, Inc. (TBPS). TBPS currently operates a Crude Storage and Loading Facility on the FBIR for which USEPA Region 8 issued Synthetic Minor New Source Review Permit to Construct number SMNSR-TAT-000781-2021.002B on July 6, 2022. The current air permit authorized construction of six (6) additional crude oil storage tanks at the Storage and Loading Facility. Construction of the additional tanks has not started and USEPA Region 8 has determined that tank construction should be included with the Topping Plant project. TBPS proposes to construct and operate the Topping Plant adjacent to the existing TBPS Crude Storage and Loading Facility. In addition to unit operations and other tanks, construction of the Topping Plant will include six (6) additional crude oil storage tanks at the Storage and Loading Facility. A Topping Plant is a small petroleum refinery that produces a limited number of products. The Topping Plant would process Bakken light sweet crude oil from the TBPS Crude Storage and Loading Facility to produce liquefied petroleum gas, Light Naphtha, Heavy Naphtha, Jet Fuel, Ultra-Low Sulfur #2 Diesel, and Atmospheric Tower Bottoms. Details on the Topping Plant are provided in Section 1.2, Project Description.

Under the Federal air permitting rules on Indian Lands at 40 CFR §49.154(d), if the U.S. Environmental Protection Agency (USEPA) has reason to be concerned that the construction of a source would cause or contribute to a violation of the National Ambient Air Quality Standards (NAAQS) or Prevention of Significant deterioration (PSD) increment, they may require an air quality impact analysis (i.e., modeling). In order for USEPA to issue the air permit for the facility, the modeling must demonstrate that emissions from the source will not cause or contribute to a NAAQS or PSD increment violation. Given that the proposed project is a petroleum Topping Plant with the potential to significantly increase air emissions on the Fort Berthold Reservation, Arcadis discussed the project with USEPA Region 8 to gather whether an air dispersion modeling demonstration should be included in the application package. The USEPA recommended that the application include an air dispersion modeling demonstration for the following reasons:

1. USEPA is currently developing a policy requiring modeling for sources that emit criteria pollutants over PSD significance levels. The proposed Topping Plant will meet this criterion.
2. A dispersion modeling demonstration conducted in accordance with current widely accepted methods used for major PSD sources will support the conclusion that the Topping Plant will not cause or contribute to a NAAQS or PSD increment violation, thus supporting USEPA's issuance of the permit.

The initial modeling protocol was submitted on November 10, 2023, with a resubmittal to incorporate additional information to satisfy EPA comments and questions on December 6, 2023, and December 15, 2023. The protocol provides the technical description of the methods and input parameters for preparing the air modeling demonstration for this proposed project.

TBPS is providing an air quality impact analysis report (AQIA) that provides the following elements including for conducting the air dispersion modeling analysis:

- Project description, site location, and the layout of the proposed facility.
- Regulatory background for performing this air modeling impact analysis.

- Source descriptions of proposed equipment that provides the estimated emission rates of regulated air pollutants and source parameters including stack height, stack diameters, exit temperatures, and exit velocities.
- Discussion of the good engineering practice (GEP) stack height analysis and how building/structure downwash parameters will be evaluated.
- Description of the air dispersion model data used in the model input setup as well as data representing site-specific characteristics including background ambient concentrations, meteorology, surface roughness, and topography.
- Methodology used for conducting preliminary and cumulative modeling (NAAQS) analyses, including the USEPA recommended approach to account for ground-level contributions from off-site emissions sources if predicted ambient air impacts from the preliminary analysis are greater than the significant impact levels (SILs).
- Description of the methodology used for evaluating the potential impacts of secondarily formed ambient ozone and $PM_{2.5}$ concentrations from the proposed project.
- Discussion on evaluation used to screen out additional Class I Area analyses.

1.1 Site Description

The TBPS Project site is located in Ward County, North Dakota. The MHA Nation owns the 468-acre parcel on which they propose to construct and operate the Topping Plant. The property is on “Indian country” lands as defined at 18 U.S.C. § 1151. In mid-2012, the parcel was accepted into trust by the Bureau of Indian Affairs (BIA). The proposed Topping Plant would be on a 190-acre portion of the parcel west of County Road 366th Street SW and south of the existing Canadian Pacific Rail Easement. **Figure 1** presents a regional map of the project area.

The approximate Universal Transverse Mercator (UTM) North American Datum of 1983 (NAD83) coordinates for the Facility are 286,700 m (meters) E; 5,317,440 m N; Zone 14. The approximate graded elevation of the site is 640 m.

1.2 Project Description

1.2.1 Topping Plant

The MHA Nation, dba TBPS, proposes to construct and operate a 40,000 barrel per day (BPD) Topping Plant on the FBIR in Ward County, North Dakota. The proposed Topping Plant would be adjacent to the existing TBPS Crude Storage and Loading Facility, would process up to 14,600,000 BOPY of Bakken light sweet crude oil, and operate up to 8,760 hours per year. Crude oil for processing in the Topping Plant would be provided directly from the adjacent TBPS Crude Storage and Loading Facility. The Topping Plant project includes construction of six (6) additional crude oil storage tanks at the existing Storage and Loading Facility. The Topping Plant would produce, store, and ship liquefied petroleum gas (LPG), Light Naphtha, Heavy Naphtha, Jet Fuel, Ultra-Low Sulfur (ULS) #2 Diesel, and Atmospheric Tower Bottoms (ATB). The LPG products would be stored in pressure vessels. The Light Naphtha and Heavy Naphtha would be stored in floating roof tanks and the remaining products would be stored in atmospheric storage tanks. For customer delivery, finished LPG would be loaded into tanker trucks and/or rail cars. The other products would be loaded into rail cars at the Topping Plant. Most of the natural gas for the Topping Plant heating needs (99%) would come from the North Dakota natural gas pipeline loop. The remaining 1% of natural gas demand for the Topping Plant would come from a 6 MMscfd on-site gas plant that is part of the Topping Plant operations to produce LPG. The Topping Plant natural gas-fired equipment would have Ultra-Low NOx burners or Low NOx burners and some equipment will have selective catalytic reduction. Dieselfired engines would be Tier 4 engines and would burn Ultra-Low Sulfur Diesel. Process wastewater will be stored in a brine tank until it is trucked offsite for disposal in accordance with regulatory requirements. Topping Plant wastewater would not be discharged to surface water. Rainwater will be gathered into sumps and pumped to an oily water separator system and then discharged onto the surface via an energy dispersion system.

1.2.1.1 Preliminary Topping Plant Air Emissions Sources

Based on preliminary design information at this time, the Topping Plant will include the following emissions sources:

- 40,000 BPD Crude Distillation Unit
- 14,500 BPD Naphtha Splitter
- 15,000 BPD Distillate Hydro Treater
- 25 MMscfd Steam Methane Reformer
- Assorted natural gas-fired heaters and furnaces, approximately 346 MMBtu/hr total heat input
- 6 ton per day Lo-Cat Sulfur Recovery Unit
- 6 MMscfd Gas Plant
- Approximately 20 intermediate and final product storage tanks
- 6 new crude oil storage tanks
- 2 LPG storage pressure vessels
- Truck Loading Racks for LPG
- Rail Car Loading Racks
- 3 Oil/Water Separators
- Emergency Process Flare
- Emergency LPG Tank Flare
- Rail Car Loading Combustor
- 1 x 197-horsepower Diesel Fire Water Pump Engine
- 2,500-horsepower Emergency Diesel Generator Engine

The proposed source locations are shown on the site plan in **Figures 2a** and **2b**.

1.3 Criteria Pollutants

The Tribal Minor New Source Review (NSR) rule, 40 CFR 49.154(d) states that if the permitting authority has reason to be concerned that construction of new minor sources or modifications at existing minor sources would cause or contribute to a NAAQS or PSD increment violation, it may require an AQIA using air dispersion modeling methods per the guidance described in 40 CFR part 51, Appendix W. It is our understanding that the USEPA considers several factors in determining whether an AQIA is necessary for a given project. In general, if the controlled potential to emit (PTE) emissions are less than the Minor NSR thresholds for attainment areas found in Table 1 of 40 CFR 49.153, the USEPA does not require a quantitative analysis (i.e., dispersion modeling) for those pollutants. In addition, if a project has controlled PTE emissions for criteria pollutants greater than the PSD significant emission rates (SER) found in 40 CFR 52.21, then the source will be required to conduct an air dispersion modeling analysis for those pollutants. Based on previous discussions with USEPA, sources/projects that fall in between the minor NSR thresholds and the PSD SERs are to be evaluated qualitatively using several factors to determine whether modeling is necessary. These factors may include items such as stack heights, background concentrations, close nearby development (includes schools, housing, industrial sources), complex terrain and proximity to the fence line.

Total Project potential emission rates are provided and compared to the above-mentioned thresholds in **Table 1**.

Table 1 Pollutants and PSD Review

Pollutant	Major Source Threshold[1] (tons/year)	Significant Emission Rate[2] (tons/year)	Minor NSR Thresholds[3]	Potential Emission Rate (tons/year)	Analysis Requested by EPA?
Carbon Monoxide (CO)	100	100	10	52.91	Yes
Nitrogen Oxides (NO_X)		40	10	42.73	Yes
Sulfur Dioxide (SO_2)		40	10	0.90	Yes
Particulate Matter (PM)		25	10	11.40	Yes
Particulate Matter less than 10 microns (PM_{10})		15	5	11.34	Yes
Particulate Matter less than 2.5 microns ($PM_{2.5}$)		10	3	11.33	Yes
Ozone as Volatile Organic Compounds (VOC)		40	5	84.94	Yes
Hydrogen Sulfide (H_2S)		10	2	0.01	No

Notes:

1 Major Source Threshold is 100 tpy or more of a regulated pollutant including fugitive emissions since Petroleum refineries is one of the listed stationary source categories in 40 CFR § 51.166(b)(1).

2 Per definition of 40 CFR § 51.166(b)(23).

3 Per definition found in Table 1 of 40 CFR 49.153.

Based on the total PTE presented in **Table 1**, the criteria pollutants VOCs, NOx, and $PM_{2.5}$ are greater than their respective SERs. Therefore, based on the recommendation from USEPA Region 8, the potential ambient air quality impacts from NO_X and primary $PM_{2.5}$ emissions have been evaluated via a dispersion modeling analysis. In addition, the potential for secondary $PM_{2.5}$ formation have been evaluated using the current Maximum Emission Rate for Precursors (MERPs) guidance as described in Section 7.2. In addition, ozone as VOCs is evaluated using the MERPs guidance as discussed in Section 7.1.

The potential emissions of CO and PM_{10} are between the minor NSR and PSD SERs reference thresholds, and the potential emissions of SO_2 are below the minor NSR threshold. Per direction from USEPA Region 8, these three pollutants will be evaluated quantitively through dispersion modeling rather than just qualitatively to ensure compliance with all ambient air standards and thus provide a complete AQIA for the proposed project.

Most of the emissions from normal operations (except from haul road fugitives and emergency equipment) are designed and expected to be emitted from elevated release points, including stacks and flares with stack heights of 68 -95 feet located in the center of the proposed site. In addition, the area around the proposed facility is mostly flat with the nearest complex terrain areas located approximately 15 kilometers (km) away (**Figure 3**). The proposed site is in a sparsely populated area with mostly agricultural lands. The nearest resident is located approximately 2 km to the east. The nearest populated areas are Makoti (3.7 km SE) and Plaza (9 km NW). No large industrial source exists in close proximity to the site. Background air quality for the region is considered good and is classified as attainment for all criteria pollutants. Section 5 presents the regional background monitoring concentrations.

Criteria pollutant NAAQS and SILs are listed in **Table 2**. Ward, Mountrail, and McLean Counties are designated as attainment/unclassifiable for all criteria pollutants.

Table 2 National Ambient Air Quality Standards and Significant Impact Levels

Applicable Regulatory Limits				
Pollutant	**Averaging Period**	**Significant Impact Levels (µg/m³)[a,b]**	**Regulatory Limit (µg/m³)**	**Modeled Design Value Used**
PM_{10}[c]	24-hour	5.0	150	Maximum 6th highest[g]
$PM_{2.5}$[e]	24-hour	1.2[j]	35[f]	Avg. of maximum 8th highest[g]
	Annual	0.2[j]	12[h]	Avg. of maximum 1st highest[i]
CO	1-hour	2,000	40,000[d,i]	Maximum 2nd highest[i]
	8-hour	500	10,000[d,i]	Maximum 2nd highest[i]
SO_2	1-hour	3 ppb (7.8 µg/m³)	75 ppb[k] (196 µg/m³)	Avg. of maximum 4th highest[l]
	3-hour	25	1,300[d]	Maximum 2nd highest[k]
Nitrogen Dioxide (NO_2)	1-hour	4 ppb (7.5 µg/m³)	100 ppb[n] (188 µg/m³)	Avg. of maximum 8th highest[o]
	Annual	1.0	100[m]	Maximum 1st highest
Ozone (O_3)	8-hour	1 ppb	70 ppb	3-yr Avg of 4th High

Notes:

a µg/m³ = micrograms/cubic meter.
b The maximum 1st highest modeled value is always used for the significant impact analysis unless indicated otherwise. Modeled design values are calculated for each ambient air receptor.
c Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.
d Not to be exceeded more than once per year on average over 3 years.
e Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
f 3-year average of the upper 98th percentile of the annual distribution of 24-hour concentrations.
g 5-year average of the 8th highest modeled 24-hour concentrations at the modeled receptor for each year of meteorological data modeled. For the SIL analysis, the 5-year mean of the 1st highest modeled 24-hour impacts at the modeled receptor for each year.
h 3-year average of annual concentration.
i Not to be exceeded more than once per year.
j Interim SIL established by USEPA policy memorandum.
k 3-year mean of the upper 99th percentile of the annual distribution of maximum daily 1-hour concentrations.
l 5-year mean of the 4th highest daily 1-hour maximum modeled concentrations for each year of meteorological data modeled. For the significant impact analysis, the 5-year mean of 1st highest modeled 1-hour impacts for each year is used.
m Not to be exceeded in any calendar year.
n 3-year mean of the upper 98th percentile of the annual distribution of maximum daily 1-hour concentrations.
o 5-year mean of the 8th highest daily 1-hour maximum modeled concentrations for each year of meteorological data modeled. For the significant impact analysis, the 5-year mean of maximum modeled 1-hour impacts for each year is used.

1.4 Hazardous Air Pollutants

In order to determine if hazardous air pollutants (HAPs) should be evaluated in this air quality impact analysis, USEPA Region 8 requested a preliminary draft emissions inventory for review (provided on November 23, 2022, via email). USEPA Region 8 conveyed to TBPS that the agency does not expect HAPs to require modeling under the conditions that the PTE of the HAPs is well developed, and that enforceable conditions will be requested for the minor source permit to avoid MACT applicability for the project. Therefore, no modeling analysis for potential HAPs emissions was conducted as part of this air quality analysis.

2. Model Description/Justification

2.1 Screening and Refined Modeling

There are two levels of modeling analyses typically used for regulatory issues such as permitting of new or modified emission sources - screening and refined dispersion modeling. Screening-level models produce conservative estimates of ambient impacts in order to ensure the maximum ambient concentrations will not be underestimated. If the resulting estimates from a screening model indicate a violation or a threat to the NAAQS, the applicant typically must use a refined model to estimate ambient air concentrations. A refined dispersion model requires more detailed input data than a screening model but can provide more realistic estimates of a source's potential impact on ambient air concentrations.

In this analysis, no screening modeling was performed; refined dispersion modeling methods were used.

2.2 Model Selection

The selected model was created by the American Meteorological Society (AMS) and the USEPA AMS/EPA Regulatory Model, (AERMOD), which was used for refined dispersion analysis for the NAAQS analysis. The AERMOD model (version 23132) is a steady-state Gaussian plume model that simultaneously simulates pollutant concentrations from a variety of sources. The AERMOD model was designed to specifically support the USEPA regulatory modeling programs. The *Guideline on Air Quality Models* (USEPA 2017) recommends the use of AERMOD for operating conditions such as those at the proposed TBPS Project, i.e., multiple sources, rural area, possible building downwash, and 1-hour to annual averaging times. The AERMOD Modeling System includes preprocessor programs AERSURFACE (20060; USEPA 2008), AERMET (23132), and AERMAP (18081) to create the required input files for meteorology and receptor terrain elevations. AERMET is used to process the necessary meteorological data per the methodology described in Section 4.

3. Emissions and Source Data

3.1 Sources for Permit Review

Air emission rates proposed for the facility are below the 100 tons per year (tpy) PSD Major Source threshold. Therefore, the permit application and modeling analysis is for the Project operating as a minor source facility.

3.1.1 Existing TBPS Crude Storage and Loading Facility

The existing TBPS Crude Storage and Loading Facility currently operates the following equipment at the site:

- two (2) 140,000-barrel nominal capacity above-ground storage tanks (ASTs),
- truck-to-tank off-loading,
- one (1) firewater pump engine, and
- crude oil shipping from the facility by pipeline only.

The facility is authorized to operate 8,760 hours per year.

3.1.2 Proposed Topping Plant Facilities

As described in Section 1.2.1.1, the MHA Nation proposes to construct and operate a 40,000 BPD Topping Plant on the FBIR in Ward County, North Dakota.

The proposed project has the following emissions sources:

- 17 fixed-roof storage tanks.
- Thirteen (13) internal floating roof storage tanks (including six (6) new crude oil storage tanks).
- Six (6) heaters.
- One (1) boiler.
- Two (2) emergency engines (emergency generator and fire water pump).
- Two (2) emergency flares.
- One (1) combustor for railcar loading.
- Three (3) oil/water separators.
- Truck loading fugitive emissions.
- Truck road dust fugitive emissions.
- Maintenance, start-up, and shutdown (MSS) emissions; and
- Fugitives from process piping and equipment.

3.2 Emissions Inventory

A draft emissions inventory was submitted to USEPA Region 8 on November 23, 2022, for feedback on pollutants to model, specifically pollutants below the SER but above the minor NSR thresholds. Based on the project emission totals shown in **Table 1** and a request from USEPA, TBPS conducted modeling for NO_x, CO, SO_2, PM_{10}, and $PM_{2.5}$. Sulfur dioxide project emissions are calculated to be minimal and under the minor source thresholds; however, are included in this analysis per EPA request as a completeness demonstration. The final emissions inventory is included in the permit application. The emissions rates in the emission inventory analysis are the same rates used for the modeling analysis. Modeled emissions for non-continuous operating sources have been adjusted for 24-hour and annual averaging periods based on equipment and pollutant modeled (i.e., PM_{10}/$PM_{2.5}$). **Table 3** summarizes the short-term emission rates for the criteria pollutants being modeled. Section 3.4 describes any adjusted emission rates for non-continuous sources.

Table 3 Maximum Short-term Emission Rates

EUI	Model ID	Source Description	NO_X (g/s)	CO (g/s)	SO_2 (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
F-590	F_590	Crude Oil Heater	0.096	0.462	0.009	0.119	0.119
F-810	F_810	ATB Storage Tank Heater	0.031	0.023	<0.001	0.005	0.005
F-3490	F_3490	Kerosene Diesel Charge Heater	0.041	0.199	0.004	0.051	0.051
F-5490	F_5490	SMR Auxiliary Boiler	0.049	0.037	0.001	0.008	0.008
47-H01A / 47-H01B	47_H01AB	SMR Reformer Heater	0.939	0.707	0.011	0.143	0.143
FPE-2	(a)	Fire Water Pump Engine - Topping Plant	0.155	0.143	<0.001	0.008	0.008
EMGEN-1	EMGEN1	Emergency Generator Engine[b]	3.149	1.813	0.006	0.104	0.104
C-7210	C_7210	Rail Car Loading Combustor	0.056	0.111	<0.001	--	--
F-8960	F_8960	Emergency LPG Flare	0.006	0.012	<0.001	--	--
F-8950	F_8950	Emergency Process Flare	0.006	0.012	<0.001	--	--
MSS-F8950	F8950MSS	MSS Emissions - Degassing to Flare	2.508	5.007	--	--	--
MSS-DEGAS	F8960MSS	MSS Emissions - Tank Degassing Losses	0.002	0.004	<0.001	--	--
RD-1[c,d]	RD1A, RD1B	Road Dust – Crude Truck Unloading, Storage Facility	--	--	--	0.064	0.016
RD-2[c]	RD2A, RD2B	Road Dust – Propane Truck Loading	--	--	--	0.003	<0.001
RD-3	RD3	Road Dust - Process Water Truck Loading	--	--	--	0.002	<0.001

Notes:

a FPE-2 is not proposed to be modeled but included for evaluation. See Section 3.4 for discussion of modeling exclusion.

b Modeled emissions rates for intermittent source provided in **Table 9**.

c Proposed project schedule expects that the crude truck unloading operations will be reduced to 10 trucks per day once the Makoti pipeline comes online. Emission rate shown reflects current storage facility permit conditions.

d Emissions represented in table are for total road path, but paths may be split up into segments for modeling purposes.

Abbreviations/Acronyms:
g/s = grams per second

3.3 Source Parameters

Table 4 lists all proposed sources in the emissions inventory for the proposed Topping Plant project.

Table 4 Emissions Source Locations

Emission Unit Identification (EUI)	Model ID	Source Description	Source Type	UTM X Coordinate (m)	UTM Y Coordinate (m)	Base Elevation (m)
F-590	F_590	Crude Oil Heater	Point	286494.6	5317370.9	640
F-810	F_810	ATB Storage Tank Heater	Point	286484.6	5317371.3	640
F-3490	F_3490	Kerosene Diesel Charge Heater	Point	286494.4	5317400.3	640
F-5490	F_5490	SMR Auxiliary Boiler	Point	286494.8	5317471.3	640
47-H01A/ 47-H01B	47_H01AB	SMR Reformer Heaters	Point	286506.4	5317479.1	640
FPE-2	(a)	Fire Water Pump Engine – Topping Plant	Point	286152.6	5317440.1	640
EMGEN-1	EMGEN1	Emergency Generator Engine	Point	286152.2	5317434.6	640
C-7210	C_7210	Rail Car Loading Combustor	Point	286404.5	5317261.4	640
F-8960	F_8960	Emergency LPG Flare	Flare	287209.8	5317388.2	640
F-8950	F_8950	Emergency Process Flare	Flare	286157.3	5317362.0	640
MSS-DEGAS	F8960MSS	MSS Emissions - Tank Degassing Losses	Flare	287209.8	5317388.2	640
MSS-F8950	F8950MSS	MSS Emissions - Degassing to Flare	Flare	286157.3	5317362.0	640
RD-1	RD1A, RD1B	Road Dust – Crude Truck Unloading, Storage Facility	Volume	*Varies based on proposed path*		
RD-2[b]	RD2A, RD2B	Road Dust – Propane Truck Loading	Volume	*Varies based on proposed path*		
RD-3[b]	RD3	Road Dust - Process Water Truck Loading	Volume	*Varies based on proposed path*		

Notes:

a Proposed Fire Water Pump, FPE-2 is not included in modeling demonstration. See Section 3.4 for discussion of modeling exclusion.

b The road dust fugitive PM emissions from the crude oil unloading operations (RD-1) will not be modeled with the Topping Plant road dust operations (RD-2, RD-3) since the crude oil truck delivery will cease when the Makoti pipeline is in operation.

3.3.1 Point Source Parameters

For each modeled point source, AERMOD requires stack coordinates, height, diameter, emission rates, exit temperature and exit flow rate. The point sources for this project consist of process heaters, emergency engines, and combustors.

Table 5 lists the model input parameters for the emission sources classified as Point sources.

Table 5 Point Source Model Input Parameters

Model ID	Source Description	Stack Height (m)	Exit Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)
F_590	Crude Oil Heater	27.04	616.5	9.03	1.77
F_810	ATB Storage Tank Heater	8.84	810.9	9.36	0.40
F_3490	Kerosene Diesel Charge Heater	29.14	616.5	9.08	1.16
F_5490	SMR Auxiliary Boiler	7.32	422.0	9.15	0.37
47_H01AB	SMR Reformer Heater	20.73	422.0	9.14	1.13
(a)	Fire Water Pump Engine 2	2.59	780.4	27.06	0.15
EMGEN1	Emergency Generator Engine	4.57	768.2	17.37	0.41
C_7210	Rail Car Loading Combustor	5.0	810.9	12.74	0.56

Notes:
a Proposed Fire Water Pump, FPE-2 is not included in modeling demonstration. See Section 3.4 for discussion of modeling exclusion.

Abbreviations/Acronyms:
K = Kelvin
m/s – meters per second

3.3.2 Flare Source Parameters

There are two flares planned for the Topping Plant, one emergency LPG flare used to control IFR tank landing losses, and one emergency process flare used to control plant degassing events. The flare source parameters were calculated using the USEPA flare guidance provided in the AERSCREEN Users Guide (EPA-454/B-16-004, USEPA 2016a). AERMOD does not include a parameterization like AERSCREEN for flares, therefore, the input parameters for the flares were calculated outside of AERMOD using the equations given in the User's Guide (USEPA 2016b). These parameters used to calculate the stack effective diameter and height are listed in **Table 6**.

Table 6 Flare Source Stack Parameters

Model ID	Source Description	Stack Height (m)	Heat Release (MMBTU/hr)	Total Heat Release, HR (cal/s)	Net Heat Release (cal/s)
F_8960	Emergency LPG Flare	30.48	0.34	23,562	10,603
F_8950	Emergency Process Flare	30.48	0.34	23,562	10,603
F8960MSS	Emergency LPG Flare- Tank Degassing Losses (MSS-DEGAS)	30.48	0.11	7,490	3,370
F8950MSS	MSS Emissions - Degassing to Flare (MSS-F8950)	30.48	144.23	10,096,298	4,543,334

Abbreviations/Acronyms:
MMBTU/hr = 1 million British thermal units
cal/s = calorie per second

The net heat release, Q, is the total heat release with a reduction factor of 55 percent which accounts for heat loss due to entrainment of ambient air. With this, the effective stack height and effective stack diameter is calculated using the respective equations from the AERSCREEN User's guide (USEPA 2016a).

$$D = 9.88\times10^{-4} \times\sqrt{(HR \times(1-HL))}$$

$$H_{eff} = H_s + 4.56\times10^{-3} \times HR^{0.478}$$

Where:

D = effective stack diameter.

HR = heat release rate.

HL = heat loss fraction.

H_{eff} = effective stack height.

H_s = actual stack height.

The model input parameters proposed for the flares are listed in **Table 7**. For the exit temperature and exit velocity, default values of 1,273 K and 20 m/s, respectively, are used. Flare parameter calculations for the effective stack height and diameter are provided in **Appendix A**.

Table 7 Flare Source Model Input Parameters

Model ID	Source Description	Effective Stack Height (m)	Exit Temperature (K)	Exit Velocity (m/s)	Effective Stack Diameter (m)
F_8960	Emergency LPG Flare - pilot	31.04	1273	20	0.102
F_8950	Emergency Process Flare - pilot	31.04	1273	20	0.102
F8960MSS	Emergency LPG Flare- Tank Degassing Losses (MSS-DEGAS)	30.81	1273	20	0.057
F8950MSS	MSS Emissions - Degassing to Flare (MSS-F8950)	40.64	1273	20	2.106

3.3.3 Volume Sources

Emission sources characterized as volume sources are those that disperse in three dimensions with little plume rise, such as emissions from vents and roads. The emissions inventory estimates road dust emissions from tank trucks traveling through the facility's main entrance and along a paved road to the truck loading racks. There are three haul road routes planned at the facility;

- One route for the existing crude oil unloading operations which will occur until the Makoti pipeline is in operation. A maximum of 100 trucks per day is planned.
- One route for the Topping Plant propane truck loading in winter, where the trucks will travel to the propane loading racks and out of the facility. A maximum of 3 trucks per day during the winter months only.
- One route for the Topping Plant process water trucks which will enter the site, travel to the water truck loading rack, and exit the facility. Three trucks per day are planned for this route.

The Makoti pipeline is expected to come online before the Topping Plant is projected to startup operations. The haul road fugitive PM emissions from existing crude oil unloading operations (RD-1) will be reduced to about 10 trucks per day once the Makoti pipeline is in operation. However, the scenario of 100 crude trucks per day is represented in the model as a worst-case scenario.

Following the guidance of USEPA's 2012 Memorandum titled "Haul Road Workgroup Final Report Submission to EPA-OAQPS" (USEPA 2012), the paved road dust emissions will be modeled as volume source parameters with the recommended volume source configuration as adjacent volume sources. See the following parameters configuration as recommended by USEPA.

- Top of Plume Height – 1.7 x VH
- Volume Source Release Height – 0.5 x Top of Plume height
- Width of Plume – VW + 6m for single lane roadways / Road Width + 6m for two lane roadways.
- Initial Sigma Z – Top of Plume / 2.15 (AERMOD User's Guide, Table 3-1 for use when modeling multiple volumes.)
- Initial Sigma Y – Width of Plume / 2.15 (AERMOD User's Guide, Table 3-1)
- Emissions input as g/s

Where;

VH = Vehicle Height

VW = Vehicle Width

Table 8 lists the volume source input parameters calculated for paved road dust modeling.

Table 8 Volume Source Model Input Parameters

Model ID	Source Description	Top of Plume Height (m)	Release Height (m)	Lane Type	Y length (m)	Initial Lateral Dimension (m)	Initial Vertical Dimension (m)
RD1A	Road Dust – Crude Truck Unloading, Storage Facility	5.1	2.55	Two lanes	12	5.58	2.37
RD1B		5.1	2.55	Single lane	9	4.19	2.37
RD2A	Road Dust – Propane Truck Loading	5.1	2.55	Single lane	9	4.19	2.37
RD2B		5.1	2.55	Single lane	9	4.19	2.37
RD3	Road Dust – Process Water Truck Loading	5.1	2.55	Single lane	9	4.19	2.37

3.4 Modeled Operating Conditions

Maximum short-term emissions were evaluated for the heaters and combustors assuming they operate continuously throughout the modeled short-term period (1-hour, 3-hour, etc.). Annual impacts were evaluated using annual emission rates based on each specific activity or equipment if the operations are not continuous (8,760 hours/year).

The emergency process flare and tank degassing flare are used for emergency and maintenance activities (MSS) and only operate intermittently. The emissions from pilot firing are modeled as a continuous source and the MSS activities emissions were annualized for the 1-hour NO_2 SILs and NAAQS evaluation.

In addition, the use of annualized emissions to evaluate the 1-hour NO_2 NAAQS was applied for the emergency equipment. The intermittent or infrequent NO_2 emissions was evaluated using guidance from the USEPA (USEPA 2011). Emissions from emergency generators and fire water pump are expected to be intermittent and infrequent. The Facility plans to conduct maintenance testing on the emergency generator and fire water pump engines approximately once per month. Maintenance testing for each engine is expected to be 30 minutes to 1 hour in duration. The engines associated with the emergency generator and fire water pump are subject to the Standards of Performance for Stationary Compression Ignition Internal Combustion Engines (aka NSPS Subpart IIII) which limits non-emergency use of the engines to 100 hours per year. For the air quality modeling, TBPS annualized the emergency generator emissions (NO_X and $PM_{2.5}$) assuming up to 100 hours/year operation per USEPA intermittent source guidance.

In addition, for PM_{10} and $PM_{2.5}$, an emission rate normalized over a 24-hour period was used in the air quality modeling for the emergency generators. The emission rate accounts for a maximum maintenance testing duration of 30 minutes to 1 hour to cover any longer testing that may occur during facility maintenance activities. Refer to **Table 9** for the modeled annualized (PM, NO_x) and 24-hour emission rates (PM).

Table 9 Emergency and MSS Equipment Emission Rates

Model ID	Source Description	NOx (Annual) (g/s)	SO_2 (Annual) (g/s)	PM_{10} (24-Hr) (g/s)	$PM_{2.5}$ (24-Hr) (g/s)	$PM_{2.5}$ (Annual) (g/s)
EMGEN1[a]	Emergency Generator Engine	0.036	6.55E-05	0.009	0.009	1.18E-03
F8950MSS[b]	MSS Emissions - Degassing to Flare	2.93E-03	--	--	--	--
F8960MSS[c]	MSS Emissions - Tank Degassing Losses	3.01E-06	--	--	--	--

Notes:

a Assumes 100 hours/year and up to 2 hours per 24-hour period. Typical maintenance testing duration will be between 30 minutes and one hour.

b Assumes approximately 10 hours per year for plant degassing to process flare.

c Assumes approximately 14 hours per year for tank degassing losses to LPG flare.

The proposed fire water pump (FPE-2) is expected to be the same engine size as the existing fire water pump (FPE-1) that was permitted in the latest permit amendment. During the permitting evaluation of FPE-1, USEPA determined that modeling was not required for the fire water pump emissions based on further clarification on the intermittent source memo from USEPA headquarters, and review of the size and expected usage of the engine. In the protocol, TBPS proposed that the emissions from FPE-2 are not required in the impact analysis for the Project and requested USEPA's concurrence. Therefore, FPE-2 was not included in the ambient air impact analysis.

4. Meteorological Data

4.1 Climate and Meteorology

North Dakota's location at the geographic center of North America results in a typical continental climate. Primarily because of continental location, the climate of the state is characterized by wide annual and day-to-day fluctuations in temperature; light to moderate precipitation, which tends to be irregular in time and coverage; low relative humidity; plentiful sunshine; and nearly continuous air movement. The Rocky Mountains act as a barrier to the prevailing westerly flow of air in the atmosphere. This mountain barrier modifies the temperature and moisture characteristics of air masses originating over the Pacific Ocean when they flow over the mountains in ways that reinforce the continental characteristics of the climate. Conversely, there are no mountainous barriers to air mass originating in the polar areas to the north or the Gulf of Mexico to the south. Therefore, air masses originating in these regions easily overflow North Dakota, sometimes with only minor changes in the basic weather pattern.

North Dakota has varied weather in all seasons based on cold and dry air masses that originate in the polar regions; warm and moist air masses from tropical regions; or mild and dry air from the northern Pacific (Jensen 1998). The rapid progression of these air masses over North Dakota from the different source regions usually results in frequent and rapid changes of weather patterns. In Ward County, the occurrence of precipitation varies seasonally. Most of the annual precipitation occurs during the April to September growing season. The more limited precipitation that occurs during the rest of the year may fall as rain or snow. Snowfall typically occurs during October through April averaging around of 40+ inches a year (~34 days/year).

Temperature data from the weather stations also show a seasonal pattern that is characteristic of a continental climate. Average high temperatures peak at 83° during July and August. In contrast, January is the coldest month with an average high of 15°. The difference between the average temperatures for January and July is more than 60°F. The highest temperature ever recorded at nearby Parshall station was 107°F on August 7, 1949, and the lowest temperature recorded was -45°F on January 18, 1950.

4.2 Meteorological Input Data and Processing

In the absence of actual meteorological measurements collected at the site as input data to the AERMOD model for a project, five years of representative surface data collected at a national weather service (NWS) station at a nearby airport is typically used.

A figure of the proposed facility and its surrounding nearby meteorological stations was provided to USEPA on November 23, 2022, for preliminary review. This figure, updated based on USEPA input, is provided for reference (**Figure 4)**. USEPA's response on the recommended Meteorology approach included the following (provided via email correspondence) on December 8, 2022:

EPA's air quality modeling guidance recommends that ASOS data be used if the meteorological station collects that data. However, a meteorological dataset that does not have ASOS data can still be used if it is the most representative. After providing Given the meteorological datasets available for this area, we recommend considering one of the following two meteorological stations: Foxtrot/Ryder (721016) or Golf/Plaza (721017). These sites do not have ASOS data, but these sites appear to be the most representative of the available sites given the sites location and surrounding terrain relative to the project area. To have a complete five years of model results, it also appears that the model simulations would need to start in August 2016 and end in August 2021. We also recommend using upper air data from the Bismarck meteorological station. We have attached *processed meteorological datasets using these sites and default configuration options for your consideration. However, please propose your preferred option in the protocol.*

As recommended by USEPA, a non-ASOS meteorological dataset can also be used if it is the most representative of the proposed project site. Based on the direction from USEPA Region 8, Arcadis/TBPS evaluated the provided preprocessed meteorological datasets (via email on December 8, 2022) for use with AERMOD. USEPA processed the surface data with AERMET (v22112) using processing options to substitute for missing cloud cover (CCVR_sub) and/or temperature (TEMP_sub) by linear interpolation across 1 or 2-hour gaps. In addition, the ADJ_U* option was used. ADJ_U* adjusts the surface friction velocity (u*) to address issues with AERMOD over-prediction under stable, low wind speed conditions.

Arcadis/TBPS has reviewed the processed AERMET datasets for the two provided meteorological stations recommended by USEPA as part of the protocol development and providing a summary for the AQIA. Both meteorological stations are relatively close in proximity to the facility compared to other regional sites. Foxtrot/Ryder2 (Station 721016) is 16.5 km (10.3 miles) southeast of the facility while Golf/Plaza (Station 721017) is 17.6 km (~11 miles) to the north. Both stations have similar ground elevation to the proposed facility site. The AERMOD evaluation runs using the USEPA processed Ryder2 station data set (Aug 19, 2016 to Aug 18, 2021) identified 21% cloud-cover values missing (and ~19% wind data) while the Golf Plaza Station data set for the same time period identified 17% cloud cover values missing (and ~7 % wind data) even after the AERMET substitution methods. Arcadis/TBPS evaluated the predicted impacts from the two processed AERMET datasets using preliminary model setup runs. The preliminary model setup runs showed that the Golf-Plaza data set predicted slightly higher offsite impacts than the Ryder data set.

For this permit application resubmittal, USEPA Region 8 reviewed the most recent available meteorological data (through early 2023) and concurred that the previous Gulf-Plaza data (August 2016 to August 2021 period) is representative for the area and that the more recent data contained data gaps that did not meet the completeness requirement for a continuous 5-year period. Therefore, USEPA reprocessed the Gulf-Plaza data using AERMET version 23132 and provided that dataset for the project's air quality impact analysis.

Arcadis/TBPS used the AERMET dataset with meteorological surface data (2016-2021) from Golf/Plaza (48.12 N, 101. 96 W) and upper air radiosonde data from Bismarck, ND (46.77 N, 100.75 W) reprocessed by USEPA was used in the air dispersion analysis to support the permit application.

The 5-year wind rose for this data set (2016-2021) is shown in **Figure 4**.

5. Background Air Quality Concentrations

The NAAQS Analysis must account for background concentrations due to emissions from off-property sources to evaluate the cumulative effects of modeled concentrations with respect to the NAAQS. In this assessment of impacts, the background concentrations obtained through monitoring data were combined with the modeled offsite concentrations for the proposed project planned sources.

USEPA's guidelines recommend that background concentrations should use the most recent quality-assured air quality monitoring data collected in the vicinity of the source for the averaging times of concern. In most cases, the monitor closest to and upwind of the project area should be used to determine the background concentrations to be used in the modeling demonstration. If several monitors are available, preference should be given to the monitor located in an area with characteristics that are more similar to the project study area. If there are no monitors located in the vicinity of the new or modifying source, a "regional site" may be used to determine background concentrations. A regional site is one that is located away from the area of interest but is impacted by similar or adequately representative sources.

After consulting with USEPA, nearby source data may be difficult to obtain for the model. For a preliminary analysis, USEPA recommended using an average of four regional background monitors to represent the area's air quality due to the nearby sources contributions to criteria pollutants and associated averaging periods that may require a cumulative impact analysis. If any of the model results following this recommendation showed cumulative impacts close to the NAAQS, Arcadis/TBPS would work with USEPA to refine or reassess this approach to ensure the analysis accounts for nearby sources accurately. The four regional monitors proposed by USEPA were Lostwood (ID: 38-013-0004), Lake LLO (ID: 38-025-0004), TRNP (ID: 38-053-0002), and Ryder (ID: 38-101-0003), as shown in **Figure 7**. The full table of background values provided by USEPA is included in this report as **Appendix B**. The project used the averaged background concentrations listed in **Table 10** provided by USEPA Region 8 for the area around the Fort Berthold reservation. On October 26, 2023, USEPA provided an updated background dataset that includes the most recent 3-year period (2020-2022).

Table 10 Background Concentrations for Fort Berthold Area in North Dakota

Criteria Pollutant	Averaging Period	Monitoring Site	Monitoring Period	Background Concentration ($\mu g/m^3$)
$PM_{2.5}$ [a,b]	24-hr	[d]	2019-2021	24.8
	Annual	[d]	2019-2021	6.0
PM_{10}	24-hr	[d]	2019-2021	75.8
NO_2 [a,b]	1-hr	[d]	2019-2021	20.7
	Annual	[d]	2019-2021	4.5
SO_2	1-hr	[d]	2019-2021	24.9
	3-hr	[d]	2019-2021	29.9
Ozone [c]	8-hr	[d]	2019-2021	56.8 ppb

Notes:
a 3-year average of 98th percentile
b Annual mean averaged over 3 years
c 3-year average of annual fourth-highest daily maximum 8-hr
d An average of 4 regional monitors is recommended and provided by USEPA

Abbreviations/Acronyms:
ppb = parts per billion

6. Modeling Approach

Dispersion modeling was performed to support the TBPS permit application. The modeling evaluations included a Significance Analysis and NAAQS Analysis.

6.1 AERMOD Model Input Defaults/Options

For the refined dispersion model operation on this Project, several dispersion model options are available. The model options selected for this demonstration were based on the regulatory default selections, which include:

- Final plume rise;
- Stack-tip downwash;
- Buoyancy-induced dispersion;
- Default wind profile exponents;
- Default vertical potential temperature gradients; and,
- Calms processing.

Modeling for the 1-hour NO_2 SILs/NAAQS follows the recommended three tier screening approach provided in the latest version of Appendix W. Tier 1 is identified as full conversion of NO_X to NO_2. According to Appendix W, Tier 2 is when the "Ambient Ratio Method 2 (ARM2) is used, which provides estimates of representative equilibrium ratios of NO_2/NO_X value based on ambient levels of NO_2 and NO_X derived from a national dataset. With the use of ARM2 (default option), special attention is necessary for handling source grouping if different operational scenarios are evaluated. The Tier 2 method uses the national default values including a minimum ambient NO_2/NO_X of 0.5 and a maximum of 0.9. Tier 2 is used for this analysis. A Tier 3 method (use of Ozone Limiting Method [OLM] or Plume Volume Molar Ratio Method [PVMRM]) was not necessary to show compliance with the air quality standards.

6.1.1.1 Land Use Classification

The selection of rural or urban dispersion coefficients for use in a specific modeling exercise should follow either a land use procedure or a population density procedure. The land use procedure is considered more effective. The land use classification scheme proposed by A.H. Auer in *Correlation of Land Use and Cover with Meteorological Anomalies, Journal of Applied Meteorology*, (Auer 1978), is the method recommended by the USEPA. It includes the following categories:

I1 – Heavy industrial (urban) – major chemical, steel, and fabrication industries;

I2 – Light (urban) – moderate industrial rail yards, truck depots, warehouses, minor fabrication;

C1 – Commercial (urban) – office and apartment buildings, hotels;

R1 – Common residential (rural) – single family dwellings with normal easements;

R2 – Compact residential (urban) – single, some multiple family dwellings with close spacing;

R3 – Compact residential (urban) – old multi-family dwellings with close spacing;

R4 – Estate residential (rural) – expansive family dwelling on multi-acre plots;

A1 – Metropolitan natural (rural) – major municipal, state or federal parks, golf courses, cemeteries, campuses;

A2 – Agricultural (rural) – crops;

A3 – Undeveloped (rural) – uncultivated, grasses/weeds;

A4 – Undeveloped (rural) – heavily wooded; and

A5 – Water surfaces (rural) – rivers, lakes.

If the land use types I1, I2, C1, R2, and R3 account for 50 percent or more of the total area inside a 3-km radius circle centered at the site, then urban coefficients should be used. Otherwise, a rural classification is acceptable.

Figure 1 contains a map that shows the area surrounding the proposed site with the 3-km radius circle marked (inner radius). The area inside the circle was evaluated through an aerial photo review. Based on the aerial review, surrounding area is classified as rural because it comprises cropland, uncultivated fields and undeveloped (rural) parcels. According to the available aerial and topographic maps, the only populated area (Makoti, 3.7 km to SE) is outside the 3-km radius of the proposed project. Therefore, rural dispersion coefficients were applied in the dispersion modeling.

6.2 Significance Analysis

The Significance Analysis considers the emissions associated only with the proposed TBPS Project in order to assess whether the Project emissions could have a significant (above de-minimis) impact upon the area surrounding the Project. For each pollutant, the highest predicted modeled concentrations over 5 years of meteorological data are compared to the corresponding modeling SILs, as presented in **Table 1**. A multi-year average of the maximum modeled concentration of each year modeled is used for the probabilistic standards for 24-hour $PM_{2.5}$, annual $PM_{2.5}$, 1-hour NO_2, and 1-hour SO_2. For the NO_2 analysis, the current USEPA-approved ambient ratio method (ARM2) for predicting 1-hour NO_2 concentrations was used. If the Significance Analysis reveals that a specific pollutant exceeds its modeling significance level, then further dispersion modeling analyses are required leading to a NAAQS Analysis. If the Significance Analysis indicates the off-site impacts are below the respective SILs, no further modeling of that pollutant for that specific averaging time will be necessary.

6.3 NAAQS Analysis

If the Significance Analysis shows a pollutant exceeding its respective SIL, a NAAQS analysis is conducted to evaluate all permitted emission sources, including Project sources. The selected refined dispersion model, AERMOD, was used in this analysis. The results of this refined modeling analysis were combined with the appropriate monitored background concentrations and the combined total are compared to the NAAQS presented in **Table 2**.

During the protocol development stage, a review of the surrounding area was conducted, and it indicated that there are some small potential emission sources present (i.e., well pads, grain loading and storage facilities, etc.). Since these nearby emission sources are small, USEPA believes that source data would be difficult to obtain for the model. Therefore, the USEPA recommended using an average of four regional background monitors to cover the nearby sources pollutants and averaging periods that required a cumulative impact analysis. The regional background monitoring concentrations are presented in Section 5.

6.4 Ambient Air Boundary

Figure 2a (Plot Plan) presents the Ambient Air Boundary at the TBPS facility. The ambient air boundary is the area around the facility where the general public (non-TBPS personnel and hired contractors) is excluded. TBPS proposes the following methods by which the facility intends to preclude access to the area of property excluded from this air dispersion modeling analysis. The facility property will be protected by an eight-foot metal chain link security fence placed around the entire property to restrict public access to the facility. The chain link fence will be topped with three strands of barbed wire and a concertina coil.

TBPS plans to construct and maintain fencing on the north, south, east, and west sides of the property. There will be four points of access to the property controlled by sliding gates:

1. The main access road into the plant location in the northern portion of the proposed layout.
2. The truck exit point on the eastern portion of the proposed layout.
3. The rail car entrance on the eastern portion of the proposed layout.
4. The rail car exit on the eastern portion of the proposed layout.

These access points will be monitored by site personnel in the administration building. No other gates will be present along the fence line. The facility operations allow for monitoring in the front gate area and the exit gate area. “Private Property/No Trespassing” signs will be posted on multiple locations along the fence. The main entrance and the truck exit gates will be opened by remote controls. The facility will restrict access using the gates that will require keycard or access code for entrance. Any visitors are required to register at reception.

The rail car entrance and exit will be monitored by operating personnel during regular business hours and will be opened and closed by remote controls. Only operating personnel will have access to the rail car gate controls. **Figure 2a** depicts the fence with above mentioned access facility points with remotely controlled gates.

An external security company will perform a facility check in the event of an alarm or as the need arises. The facility will also operate and maintain video surveillance equipment.

6.5 Receptor Network

A Cartesian receptor network was designed to identify the location of maximum off-site concentrations for each pollutant. The tiered receptor grid includes fine, medium and course spaced receptors as follows:

- 25-m spaced receptors along the Project ambient air boundary (proposed fence line),
- 50-m spaced receptors extending out 300 m from the boundary,
- 100-m spaced receptors extending one km from the fence line,
- 250-m spaced receptor extending 2.5 km from the fence line, and
- 500-m spaced receptors extending out to 10 km from the site.

The receptor grids are presented in **Figures 5** and **6**.

6.6 Terrain Elevations

Digitalized terrain data (National Elevation Dataset (NED) developed by the U.S. Geological Survey [USGS]) is obtained for the area covered by the receptor grid, as 1/3 arc-sec NED data, and used to determine receptor heights. The proposed source locations and structures for the Topping Plant operations are based on the proposed site grade (approximately 2100 ft, 640 m). The site is located in an area ranging from 2,070 ft (631 m) to 2,112 ft (644 m). The most recent version of AERMAP (18081; USEPA 2004) is used to process the receptor elevation data. AERMAP files and NED data are provided to USEPA with this modeling analysis.

6.7 Building Downwash

The presence of structures results in zones of air turbulence referred to as wake effects that influence dispersive forces. The building wake is estimated to extend a distance of five times L downwind from the trailing edge of the structure, where L is the lesser of the building height or maximum projected building width. This wake effect influence can result in high-ground level air concentrations if the emission source plume is influenced by building wake effects. The direction-specific area of influence changes as the wind rotates full circle. A stack that is located within the 5L radius of influence is potentially affected by wake effects.

The Building Profile Input Program (BPIP) was designed by the USEPA to incorporate the concepts and procedures of building downwash into a program that calculates effective building heights (BH) and projected building widths for use by AERMOD. The BPIP incorporates the Huber-Snyder algorithm (stack height between 1.5 BH and 2.5 BH) or the Schulman-Scire algorithm (stack height less than 1.5 BH) when appropriate.

Since each of the stacks is found to be below what is considered to be GEP stack height defined in 40 CFR 51, the BPIP Program (USEPA 1995) is used to compute the model input parameters necessary for AERMOD to account for building wake effects. BPIP execution relies on the dimensions of buildings near the stacks. The “PRIME” version of BPIP (BPIPPRM) (Schulman et al. 1997) is used with AERMOD. BPIPPRM is designed to use a digitized representation of the facility’s buildings and stacks as well as other nearby structures. The position and height of buildings relative to the stack locations are evaluated in the building downwash analysis. Coordinates for each building/structure are identified using geo-referenced CADD and GIS shapefiles of the proposed site.

Downwash effects are taken into account by AERMOD for wind directions that place these structures upwind or downwind of the stacks. Structures that are solid and large enough to affect air flow are included in the modeling setup. Structures that may influence downwash may include existing and proposed tanks, process units, and other solid structures. Based on this understanding and the elevated release heights of the proposed sources, the pipe racks and equipment process units associated with the refining area may allow wind to flow through the lattice structure and therefore are not included in the BPIP analysis. In addition, based on previous pre-protocol discussions with USEPA Region 8, the inclusion of the proposed skinny tall process columns and towers are not required in the downwash analysis. The main structures included in the BPIP analysis are the existing and proposed tanks and the enclosure associated with the emergency equipment. **Tables 11** and **12** represent structure dimensions used in the building downwash calculations.

Table 11 Building Downwash Structures - Circular

Model Building ID	Description	UTM X Coordinate (m)	UTM Y Coordinate (m)	Tier 1 Height (m)	Tank Diameter (m)
T_A-801	Fixed Roof Tank - ATB	286550.8	5317316.4	9.75	27.44
T_A-802	Fixed Roof Tank - ATB	286549.6	5317282.7	9.75	27.44
T_A-803	Fixed Roof Tank - ATB	286597.5	5317314.9	9.75	27.44
T_A-804	Fixed Roof Tank - ATB	286597.3	5317281.2	9.75	27.44
T_D-701	Fixed Roof Tank - ULSD No. 2	286563.8	5317470.5	9.75	33.52
T_D-702	Fixed Roof Tank - ULSD No. 2	286562.2	5317423.3	9.75	33.52
T_D-703	Fixed Roof Tank - ULSD No. 2	286678.6	5317466.1	9.75	33.52
T_D-706	Fixed Roof Tank - ULSD No. 2	286677.6	5317312.2	9.75	27.44
T_D-707	Fixed Roof Tank - Jet JP8 Fuel	286676.9	5317417.9	9.75	33.52
T_D-708	Fixed Roof Tank - Jet Fuel (Test)	286676.4	5317278.1	9.75	27.44
T_J-501	Fixed Roof Tank - Jet Fuel (Test)	286777.6	5317388.5	9.75	30.48
T_J-502	Fixed Roof Tank - Jet Fuel (Test)	286819.6	5317387.0	9.75	30.48
T_J-503	Fixed Roof Tank - ATB	286820.8	5317420.0	9.75	12.2
T_J-504	Fixed Roof Tank - ATB	286856.7	5317418.7	9.75	12.2
T_L-301	Internal Floating Roof Tank - Light Naphtha	286762.6	5317333.6	9.75	30.48
T_L-302	Internal Floating Roof Tank - Light Naphtha	286804.0	5317332.1	9.75	27.44
T_H-401	Internal Floating Roof Tank - Heavy Naphtha	286744.1	5317279.1	9.75	27.44
T_H-402	Internal Floating Roof Tank - Heavy Naphtha	286779.8	5317278.1	9.75	27.44
T_H-403	Internal Floating Roof Tank - Heavy Naphtha	286815.5	5317276.8	9.75	27.44
T_H-404	Internal Floating Roof Tank - Heavy Naphtha	286851.7	5317275.5	17.07	33.52
T_S-805	Internal Floating Roof Tank - Slop	286855.6	5317385.8	17.07	33.52
T_C101	Crude Storage Tank	286735.1	5317574.2	17.07	40.92
T_C102	Crude Storage Tank	286794.8	5317571.7	17.07	40.92
T_C103	Crude Storage Tank	286852.9	5317569.9	17.07	40.92
T_C104	Crude Storage Tank	286911.6	5317567.6	17.07	40.92
T_C105	Crude Storage Tank	286797.3	5317635.3	17.07	40.92
T_C106	Crude Storage Tank	286737.6	5317637	17.07	40.92
T_C107	Crude Storage Tank	286678.7	5317638.8	17.07	40.92
T_C108	Crude Storage Tank	286619.3	5317641.1	17.07	40.92
T_H01A	SMR Reactor	286486.4	5317483.9	15.24	6.52
T_H01B	SMR Reactor	286486.1	5317474.3	15.24	6.52
T_F950	Firewater Tank	286128	5317431	9.75	13.72
T_F957	Firewater Tank	286128.9	5317453.9	9.75	13.72
T_SW960	Storm Water Tank	286147.2	5317411.7	9.75	13.72
T_SW962	Storm Water Tank	286127.6	5317412.4	9.75	13.72

Table 11 Building Downwash Structures - Circular

Model Building ID	Description	UTM X Coordinate (m)	UTM Y Coordinate (m)	Tier 1 Height (m)	Tank Diameter (m)
T_SW964	Storm Water Tank	286107.7	5317412.8	9.75	13.72
T_SW966	Process Water Tank	286108.7	5317432.9	9.75	13.72
T_WT970	Ship Water Tank	286149.2	5317471.6	9.75	13.72
T_FW968	Fresh Water Tank	T_SW968	286109.0	9.75	13.72
T_FW980	Process Water Tank	286109.9	5317473.3	9.75	13.72

Table 12 Building Downwash Structures - Rectangular

Model Building ID	Description	UTM X Coordinate	UTM Y Coordinate	Tier 1 Height (m)	X Length (m)	Y Length (m)
TOPWARE	Topping Plant Warehouse	286093.5	5317709.5	9.14	73.8	50.31
TOPSUP	Topping Plant Support Facility -existing	286282.2	5317663	9.14	26.6	47.3
TOPMAIN	Topping Plant Maintenance Building	286589.7	5317566.7	9.14	30.61	62.29
CONTROL	Control Building by Loading	286474.3	5317598.8	2.44	7.31	22.39
B_FWP	Building for Firewater Pumps	286140.7	5317450.8	3.05	23.8	14.4
B_GAR	Garage Building	286275.6	5317658.8	3.66	8.9	6.59

BPIPPRM input and output files are provided with the modeling files as part of this report.

6.8 Class I Area Review

40 Code of Federal Regulations § 52.21(p) requires the permitting authority to provide written notice of any permit application for a proposed major stationary source which may affect a Class I area to the Federal land manager and the Federal official charged with direct responsibility for management of any lands within any such area. In the past the USEPA, through applicable guidance, has interpreted the meaning of the term “may affect” to include all major source or major modifications which propose to locate within 100 km of a Class I area or any source within 10 km of a Class I area.

The TBPS project is estimated to have emission rates below the major thresholds, so a formal Class I analysis is not required. To support this determination, the Federal Land Manager’s Air Quality Related Values Work Group (FLAG; NPS 2010) screening method (Q/D<=10) is provided to evaluate and show that the proposed facility will not have any adverse impacts on the regional Class I areas.

The closest Class I area is Lostwood National Wildlife Refuge (NWR) North Dakota, which is approximately 46 miles (74 km) north northwest of the site. Other Class I areas within 300 km include: Theodore Roosevelt National Park (112 km), Medicine Lake NWR (183 km), and Fork Peck Indian Reservation (205 km). These Class I areas are presented in **Figure 8.** The screening evaluation is provided in **Table 13**.

Table 13 Class I Screening Analysis

Class I Area	Distance, D (km)	Annual NO_X Emissions (tpy)	Annual SO_2 Emissions (tpy)	Annual PM Emissions (tpy)	Total Emissions (Q) (tpy)	Q/D (ratio)	Potential for Adverse Impacts? (<=10)
Lostwood NWR	74	42.7	0.9	11.4	55.0	0.74	No
Theodore Roosevelt NP	112					0.49	No
Medicine Lake NWR	183					0.30	No
Fork Peck Reservation	205					0.27	No

Abbreviations/Acronyms:
Q = total annual emissions in tpy
Q/D = annual emissions / distance

Based on estimated emissions and distance from the Class I areas, a Class I Impact Analysis is not required.

7. Analysis of Ozone and Secondary $PM_{2.5}$ Pollutants

Secondary $PM_{2.5}$ is formed within the atmosphere from precursor gases such as SO_2, NO_X and organics through gas-phase photochemical reactions or through liquid phase reactions in clouds and fog droplets. Secondary $PM_{2.5}$ and ozone formation may need to be analyzed for a SIL PSD increment and/or NAAQS analysis.

USEPA has developed guidance that provides recommendations to conduct air quality modeling analyses to satisfy compliance demonstration requirements for ozone and secondary $PM_{2.5}$ under the PSD Permitting Program. The recommendations support the methodology to estimate single source impacts on secondary pollutants under the Tier 1 approach presented in the GAQM (Appendix W to 40 CFR 51, 2017). As presented earlier, the project is below the PSD threshold of 100 tpy but the project's requested emissions for VOC, NO_X, and $PM_{2.5}$ is greater than the SERs. Arcadis/TBPS uses the Tier 1 approach for assessing the project's impacts to ozone and secondary $PM_{2.5}$. The method is outlined in USEPA's guidance on MERPs, including EPA's interactive MERPs View Qlik webpage (https://www.epa.gov/scram/merps-view-qlik). The USEPA's guidance includes Revised DRAFT Guidance for Ozone and Fine Particulate Matter Permit Modeling (USEPA 2021) and Guidance on the Development of Modeled Emission Rates for Precursors (MERP) as a Tier 1 Demonstration Tool for Ozone and Fine Particulates in the PSD Permitting Program (USEPA 2019).

Even though this Project is not PSD, Arcadis/TBPS has outlined the methodology to account for the potential secondary formation of $PM_{2.5}$ and ozone from precursors in the following sections.

7.1 Ozone Impact Assessment

The impact on ozone formation is dependent on the contribution of ozone precursor emissions from single sources; the presence of precursor emissions in the airshed; and the transport of emissions and ozone from other areas. Ground-level ozone formation is the result of a complex cycle of chemical reactions, which require large increases in precursor emissions to influence short-term ozone concentrations. The USEPA Region 8 provided a background ozone value based on average concentration from the following regional ozone monitors: Lostwood (ID: 38-013-0004), Lake LLO (ID: 38-025-0004), TRNP (ID: 38-053-0002), and Ryder (ID: 38-101-0003) which is representative of the Fort Berthold Reservation area. As previously shown in **Table 13**, the ozone design value is 56.8 ppb (2020-22). The current 8-hour ozone NAAQS is 0.07 ppm (70 ppb) and 8-hour SIL is 1 ppb.

Since the Project will have proposed NO_X and VOC emissions greater than the 40 tpy SER along with the direction from USEPA Region 8, a Tier 1 demonstration using the MERPs guidance and interactive MERPs View Qlik webpage to evaluate the project's impacts on the area's current ozone concentrations was necessary. The proposed Topping Plant is located in the climatic zone identified as Northern Rockies and Plains. A demonstration using the lowest Regional and/or State-County (most conservative) MERP values for ozone precursors from all sources USEPA modeled for the Rockies/Plains and North Dakota region is provided in **Appendix C** of this report. Based on the evaluation of the regional MERPs data, the most conservative hypothetical source for both NO_X and VOCs is located in Morton County, North Dakota. Based on this analysis, calculated regional ozone levels were less than the ozone 8-hour SIL of 1 ppb (0.29 ppb) and therefore, the Project's proposed VOC and NOx emissions are not expected to significantly affect the nearby air quality.

7.2 Secondary $PM_{2.5}$ Formation

Secondary $PM_{2.5}$ can potentially occur as a result of atmospheric transformation of NO_X and SO_2 precursor emissions. Secondary formation of $PM_{2.5}$ occurs due to chemical reaction in the atmosphere generally downwind from the original emission source. The reactions occur gradually over a period of hours or days depending on atmospheric conditions and other variables. Following USEPA guidance, Arcadis/TBPS conducted a quantitative analysis to address precursors and their potential for increasing ambient levels of $PM_{2.5}$. Arcadis/TBPS followed USEPA issued guidance for using MERPs for precursor emissions for single source evaluations (Tier 1 Approach) to demonstrate that a Tier 2 Approach using Chemical Transport Modeling would not be required. The proposed Project expects to have direct $PM_{2.5}$ emissions greater than the 10 tpy SER as well as having NOx emissions greater than the 40 tpy SER, therefore a Tier 1 approach using the MERPs was used to calculate the secondary $PM_{2.5}$ formation.

As with ozone, USEPA Region 8 provided background 24-hour and annual $PM_{2.5}$ values based on average concentration for from the following regional monitors: Lostwood (ID: 38-013-0004), Lake LLO (ID: 38-025-0004), TRNP (ID: 38-053-0002), and Ryder (ID: 38-101-0003). Arcadis/TBPS used the direct modeled $PM_{2.5}$ offsite concentration and the value of secondary formation of $PM_{2.5}$ to compare to the SILs, and the direct modeled concentration, secondary formation of $PM_{2.5}$ and background data to compare the cumulative results with the NAAQS.

Following the same methodology as ozone, a demonstration using the lowest (most conservative) MERP values were used for 24-hour and annual $PM_{2.5}$ precursors from all sources USEPA modeled for the Rockies/Plains region and the State of North Dakota. Mercer County (ND) was determined to be the most conservative NO_X and SO_2 hypothetical MERP source during the initial review.

The calculation sheets presenting the evaluation of secondary formation of ozone and $PM_{2.5}$ from Project precursors are included in **Appendix C** of this report. The contribution attributed to the secondary formation of 24-hour and annual $PM_{2.5}$ is less than 0.003 ug/m^3 and the specific calculated values are included in the significant impact and NAAQS analyses results presented in **Tables 14** and **15**.

8. Modeling Results and Discussion

A Significance Analysis was completed to assess compliance with ambient standards. The predicted impacts, maximum ground-level concentration (GLCmax), from the project sources are compared with de minimis impact levels for each pollutant presented in **Tables 14** and **15**. If this analysis indicates that predicted ambient air impacts are above de minimis for a pollutant, then a cumulative analysis is needed; if impacts are below de minimis levels, no further analysis is required since the air quality standards are shown to be protected. The impacts from SO_2 and CO were below their respective de minimis levels.

Table 14 Modeling Results (Criteria Pollutants) for SIL / De Minimis Evaluation

Pollutant	Averaging Time	GLCmax (µg/m^3)	De Minimis (µg/m^3)	Distance & Dir of Impact if > SIL (m)[1]
SO_2	1-hr	0.26	7.8	< SIL
SO_2	3-hr	0.23	25	< SIL
PM_{10}	24-hr	25.5	5	290 m, North
NO_2	1-hr	16.9	7.5	650 m, North
NO_2	Annual	0.77	1	<SIL
CO	1-hr	316	2000	< SIL
CO	8-hr	123	500	< SIL

Notes:
1 Distance from proposed fenceline

Pollutant	Averaging Time	GLCmax (µg/m^3)	Secondary PM2.5 Contribution (µg/m^3)	Total Conc. = Secondary PM2.5 + GLCmax (µg/m^3)	De Minimis (µg/m^3)	Distance & Dir of Impact > SIL (m)[1]
$PM_{2.5}$	24-hr	3.81	2.8 E-03	3.81	1.2	200 m, North
$PM_{2.5}$	Annual	0.77	4.29E-05	0.77	0.2	200 m, north

For 1-hour NO_2, 24-hour PM_{10}, and 24-hour and Annual $PM_{2.5}$, modeled results from the project showed predicted impacts above de minimis, and a cumulative NAAQS analysis was required. For the cumulative analysis, the impacts for NO_2, PM_{10}, and $PM_{2.5}$ were combined with their respective background concentrations to represent the contribution from nearby offsite sources and compared with NAAQS. The secondary $PM_{2.5}$ formation contribution (indirect) was also added to the modeled $PM_{2.5}$ concentration (direct contribution) to determine the total $PM_{2.5}$ concentration from the proposed Topping plant. As presented in Table 15, the results are significantly less than the NAAQS for all pollutants and averaging times, and therefore no further analysis is required to show compliance.

Table 15 Modeling Results for Minor NSR NAAQS

Pollutant	Averaging Time	GLCmax ($\mu g/m^3$)[1]	Background ($\mu g/m^3$)	Total Conc. = [Background + GLCmax] ($\mu g/m^3$)	Standard ($\mu g/m^3$)	Percent of Standard %
NO_2	1-hr	14.2	20.7	34.9	188	18.5%
NO_2	Annual	0.64	4.5	5.1	100	5.1%
PM_{10}	24-hr	13.0	75.8	88.8	150	59.2%

Pollutant	Averaging Time	GLCmax ($\mu g/m^3$)[1]	Secondary $PM_{2.5}$ Contribution ($\mu g/m^3$)	Background ($\mu g/m^3$)	Total Conc. = [Background + GLCmax] ($\mu g/m^3$)	Standard ($\mu g/m^3$)	Percent of Standard %
$PM_{2.5}$	24-hr	2.31	2.8 E-03	24.8	27.1	35	77.4%
$PM_{2.5}$	Annual	0.77	4.29E-05	6.0	6.77	12	56.4%

Notes:

1 The reported GLCmax follows the averaging criteria presented in Table 2, “National Ambient Air Quality Standards and Significant Impact Levels”.

8.1 Ambient Air Impact Analysis Conclusions

Based on the modeling analyses, the proposed TBPS Topping Plant resulted in predicted ambient impacts less than the SILs (CO, SO_2, and annual NO_x), and the cumulative impacts (1-hour NO_2, PM_{10}, and $PM_{2.5}$) after adding in regional background monitoring concentrations were less than the current NAAQS. Therefore, the proposed Topping Plant is not expected to cause or contribute to an air quality violation and is expected to meet all air quality comparison criteria.

8.2 Electronic Copies of the Modeling Files

The modeling input/output files (including BPIP and meteorological data, and intermediate files generated by AERMET, AERMAP, and AERMOD) will be provided in electronic format to USEPA Region 8.

9. Guidance Reference Documents

The following references, correspondence, and documents were used in developing the protocol:

Auer, August H. Jr. 1978. *Correlation of Land Use and Cover with Meteorological Anomalies*. Journal of Applied Meteorology, pp 636-643. May 1. 8 pp.

Jensen, R.E. 1998. Climate of North Dakota. Located at http://www.npwrc.usgs.gov/resource/othrdata/climate/climate.htm . Archived link, Accessed: April 6, 2004.

National Park Service (NPS). 2010. Federal Land Managers' Air Quality Related Values Work Group (FLAG), Phase I Report

Schulman, Lloyd L., David G. Strimaitis, and Joseph S. Scire. 1997. "The PRIME Plume Rise and Building Downwash Model," Addendum to ISC3 User's Guide. November. 13 pp.

U.S. Environmental Protection Agency (USEPA). 1995. User's Guide to The Building Profile Input Program. EPA-454/R-93-038. Revised February 8. 86 pp.

USEPA. 2004. User's Guide for The AERMOD Terrain Preprocessor (AERMAP). EPA-454/B-03-003. October. 106 pp.

USEPA. 2008. AERSURFACE User's Guide. EPA-454/B-08-001. OAQPS, Research Triangle Park, NC. January. 36 pp.

USEPA. 2011. Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard. Office of Air Quality Planning and Standards (OAQPS). Memorandum from Tyler Fox to Regional Air Division Directors dated March 1. 27 pp.

USEPA. 2012. Memorandum: Haul Road Workshop Final Report Submission to EPA-OAQPS. From Tyler Fox. March 2. 22 pp.

USEPA. 2016a. AERSCREEN User's Guide. EPA-454/B-16-004. OAQPS, Research Triangle. December. 115 pp.

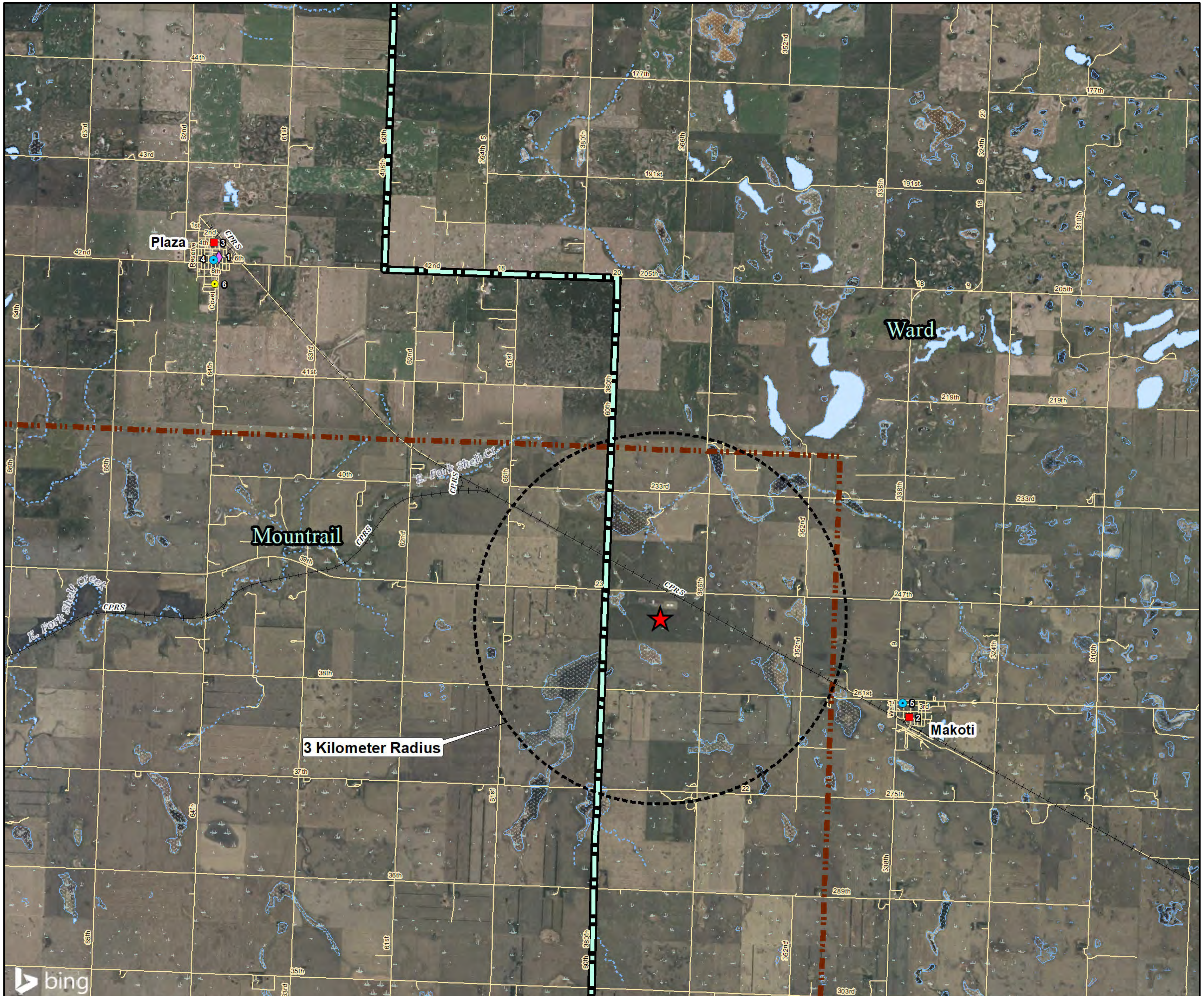
USEPA. 2016b. User's Guide for the AMS/EPA Regulatory Model – AERMOD. EPA-454/B-16-011. December. 333 pp.

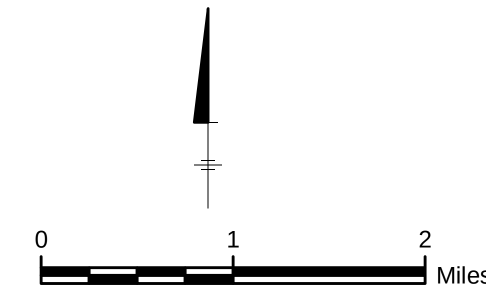
USEPA. 2017. Appendix W: Guideline on Air Quality Models. Federal Register Vol. 82, No. 10. January 17. 54 pp.

USEPA. 2019. Memorandum: Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program. April 30. 72 pp. (Update to 2016 Guidance)

USEPA. 2021. Memorandum: Revised DRAFT Guidance for Ozone and Fine Particulate matter Permit Modeling. EPA-454/P-21-001. September 2021.

Figures





Legend

- Daycare
- Post Office
- Place of Worship
- School
- Thunder Butte Facility Lat/Long: 47.974011, -101.859522
- County Boundary
- Fort Berthold Reservation

Feature ID	Description	Distance (Feet)
1	Daycare	30,220
2	Post Office	14,190
3	Post Office	30,910
4	Place of Worship	30,340
5	Place of Worship	13,610
6	School	29,490

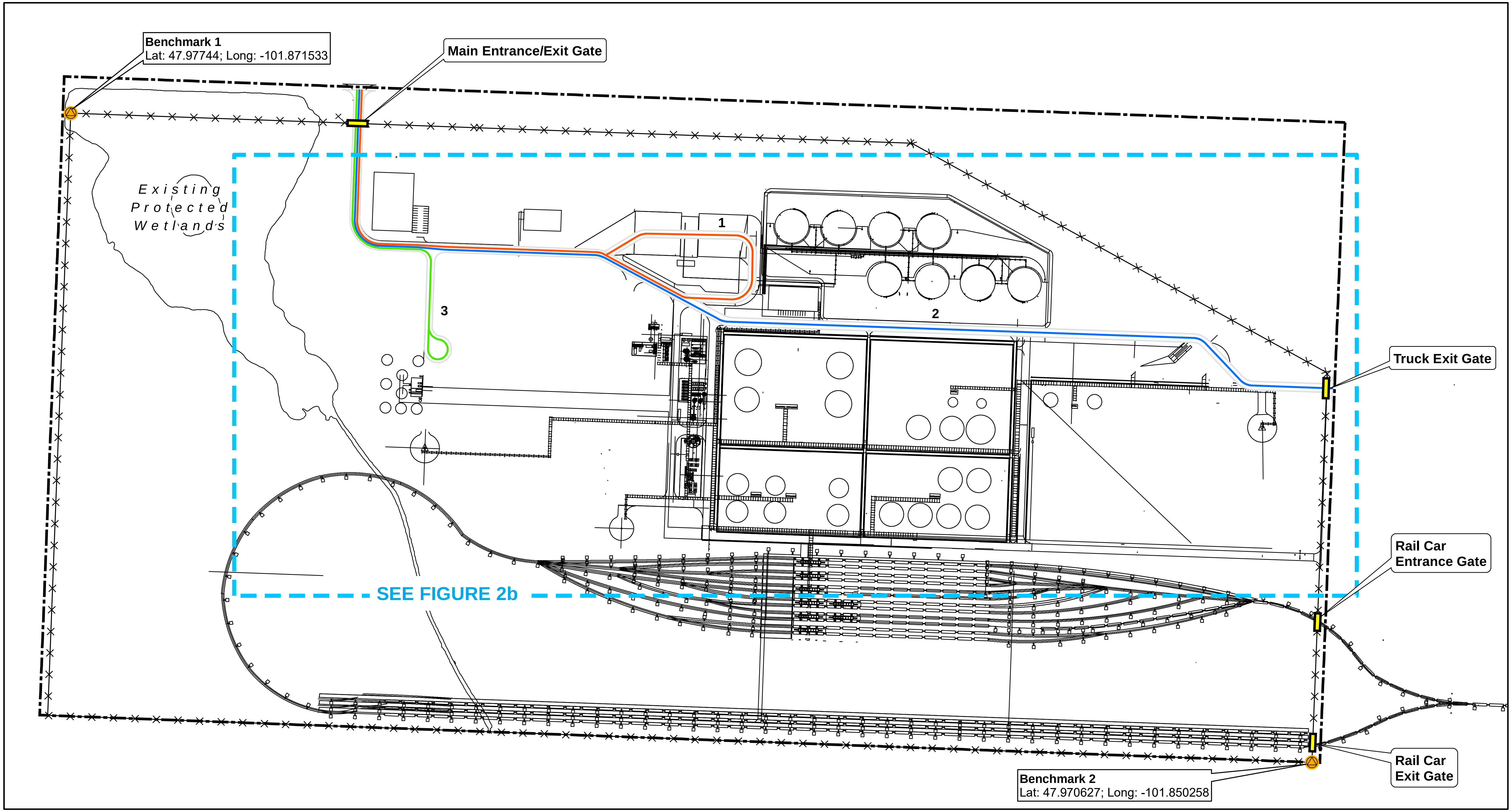
THUNDER BUTTE PETROLEUM SERVICES, INC.
PLAZA, WARD COUNTY, NORTH DAKOTA

Location Map

December 2023

ARCADIS Design & Consultancy for natural and built assets

FIGURE 1



LEGEND

- Benchmark
- Truck Traffic Route 1
- Truck Traffic Route 2
- Truck Traffic Route 3
- Lot Line
- Fenceline (Ambient Air Boundary)
  Eight-foot High Metal Chain Link Security Fence Topped with Three Strands of Barbed Wire and a Concertina Coil.
- Sliding Gate Entrance/Exit (Truck & Railcar) – Controlled Remotely

Benchmark	NAD 83 UTM Zone 14N	
	East (m)	North (m)
1	285,712.4	5,317,783.5
2	287,271.9	5,316,967.5

0 100 200 Meters

THUNDER BUTTE PETROLEUM SERVICES, INC.
PLAZA, WARD COUNTY, NORTH DAKOTA

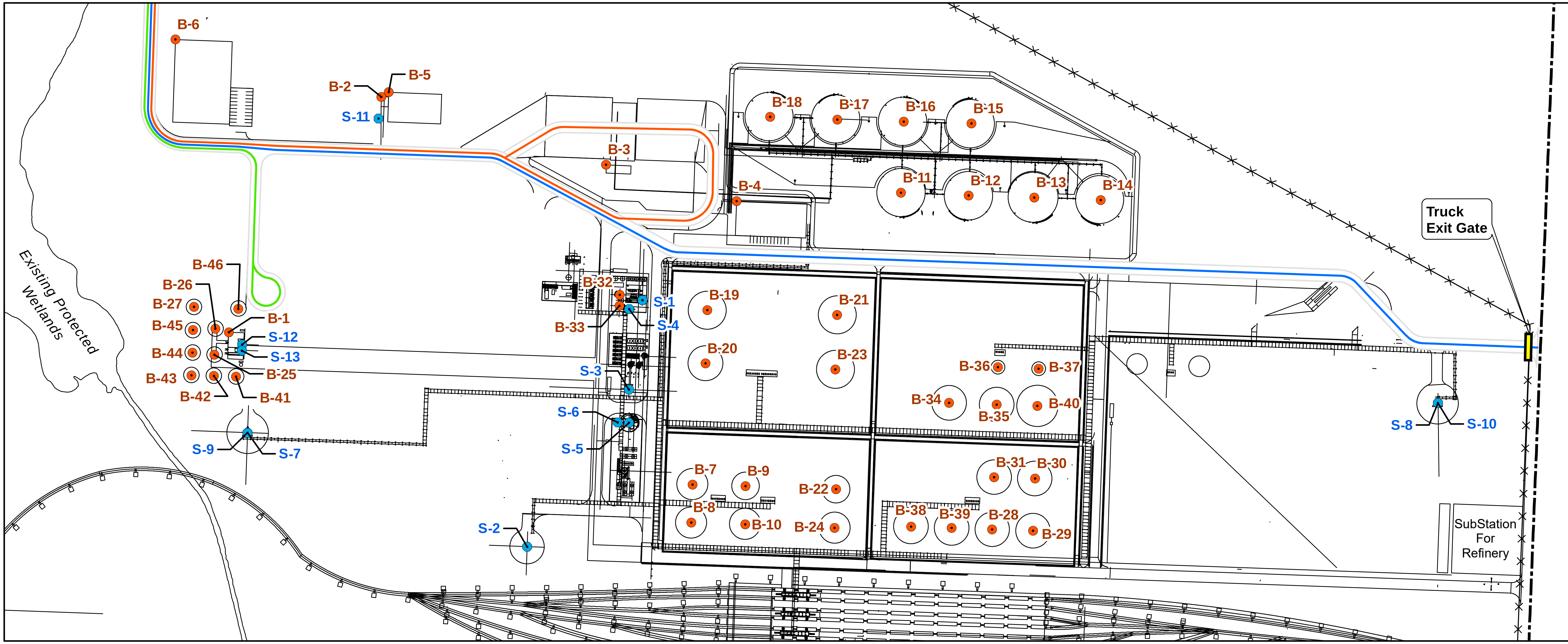
PLOT PLAN

December 2023

ARCADIS Design & Consultancy for natural and built assets

FIGURE **2a**

City: Houston Div/Group: Remediation West -Air Group Created By: W Berry Last Saved By: wberry ; Client (Project #)
D:_Arcadis\Air Services\Thunder_Butte\Fig2a -TB Plot_Plan_Feb2023.mxd 2/22/2023 4:03:28 PM



Map ID	ID Building	Map ID	ID Building	Map ID	ID Building
B-1	B_FWP	B-17	T_C107	B-33	T_H01B
B-2	B_GAR	B-18	T_C108	B-34	T_J-501
B-3	CONTROL	B-19	T_D-701	B-35	T_J-502
B-4	REFMAIN	B-20	T_D-702	B-36	T_J-503
B-5	REFSUP	B-21	T_D-703	B-37	T_J-504
B-6	REFWARE	B-22	T_D-706	B-38	T_L-301
B-7	T_A-801	B-23	T_D-707	B-39	T_L-302
B-8	T_A-802	B-24	T_D-708	B-40	T_S-805
B-9	T_A-803	B-25	T_F950	B-41	T_SW960
B-10	T_A-804	B-26	T_F957	B-42	T_SW962
B-11	T_C101	B-27	T_FW968	B-43	T_SW964
B-12	T_C102	B-28	T_H-401	B-44	T_SW966
B-13	T_C103	B-29	T_H-402	B-45	T_SW968
B-14	T_C104	B-30	T_H-403	B-46	T_WT970
B-15	T_C105	B-31	T_H-404		
B-16	T_C106	B-32	T_H01A		

Map ID	ID Sources
S-1	47_H01AB
S-2	C_7210
S-3	F_3490
S-4	F_5490
S-5	F_590
S-6	F_810
S-7	F_8950
S-8	F_8960
S-9	F8950MSS
S-10	F8960MSS
S-11	FPE1
S-12	FPE2
S-13	EMGEN1

LEGEND

- Buildings
- Sources
- Truck Traffic Route 1
- Truck Traffic Route 2
- Truck Traffic Route 3
- Lot Line
- Fenceline (Ambient Air Boundary)
  Eight-foot High Metal Chain Link Security Fence Topped with Three Strands of Barbed Wire and a Concertina Coil.
- Sliding Gate Entrance/Exit
  (Truck & Railcar) – Controlled Remotely

0 75 150 Meters

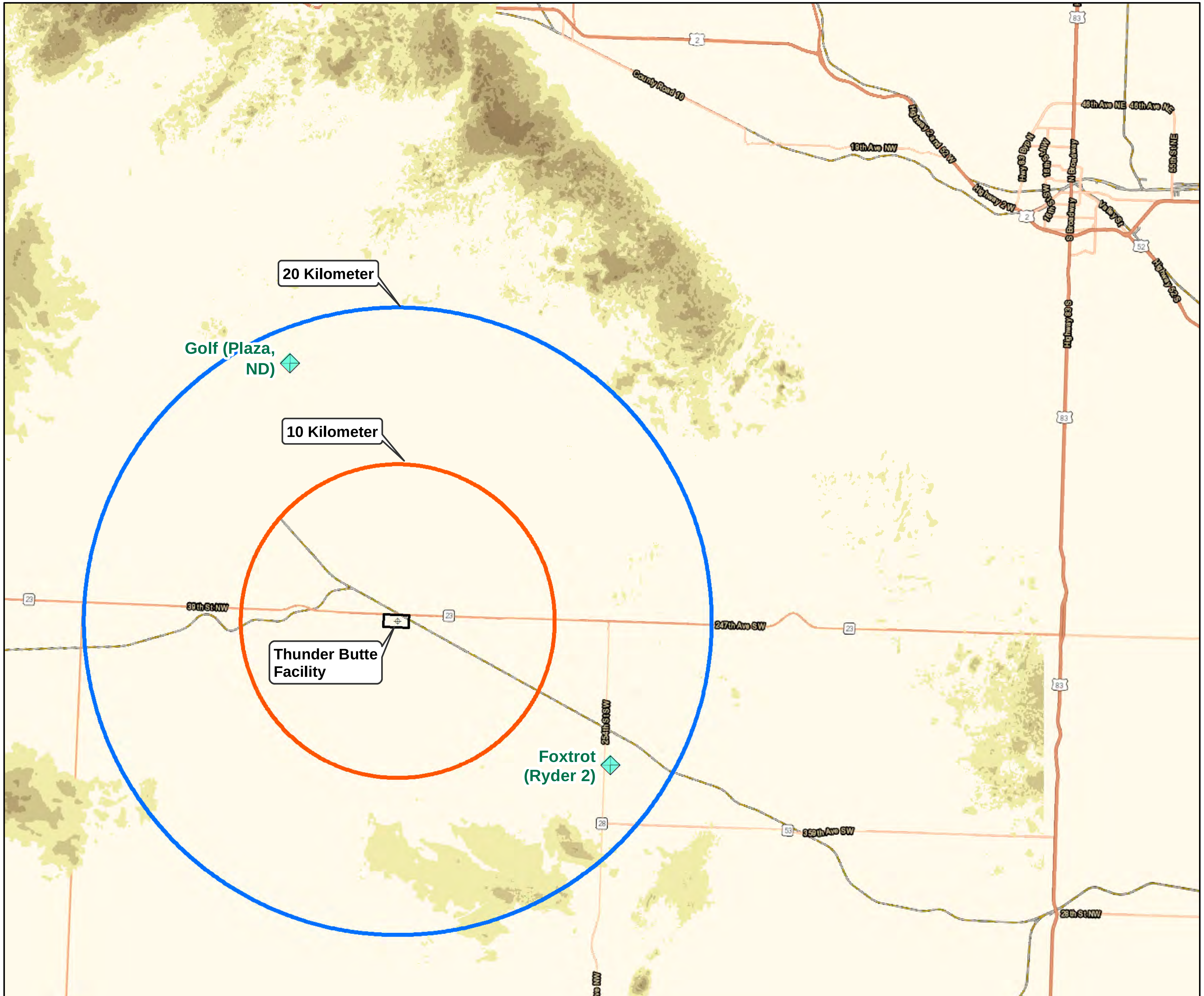
THUNDER BUTTE PETROLEUM SERVICES, INC.
PLAZA, WARD COUNTY, NORTH DAKOTA

PLOT PLAN (Close-in)

December 2023

ARCADIS Design & Consultancy for natural and built assets

FIGURE **2b**



0 2.5 5 7.5 10 Kilometers

USGS NED 1/3 arc-second

Elevation in meters

- < 660 m
- 660 - 670
- 670 - 680
- 680 - 690
- 690 - 700
- 700 - 710
- Met Station

NOTES:

1. Proposed grade elevation for main emission sources 640.5 (m).
   Stack heights (m) range from 20.7 - 28.4 m (68 - 95 ft.)

2. Elevation data a composite of (4) tiles at 1/3 arc-second, resolution from the U.S.G.S. Date range: 2013 - 2017. Data is in geographic coordinates in units of decimal degrees, and in conformance with NAD 83. All elevations are in meters and NAVD 88.

THUNDER BUTTE PETROLEUM SERVICES, INC.
PLAZA, WARD COUNTY, NORTH DAKOTA

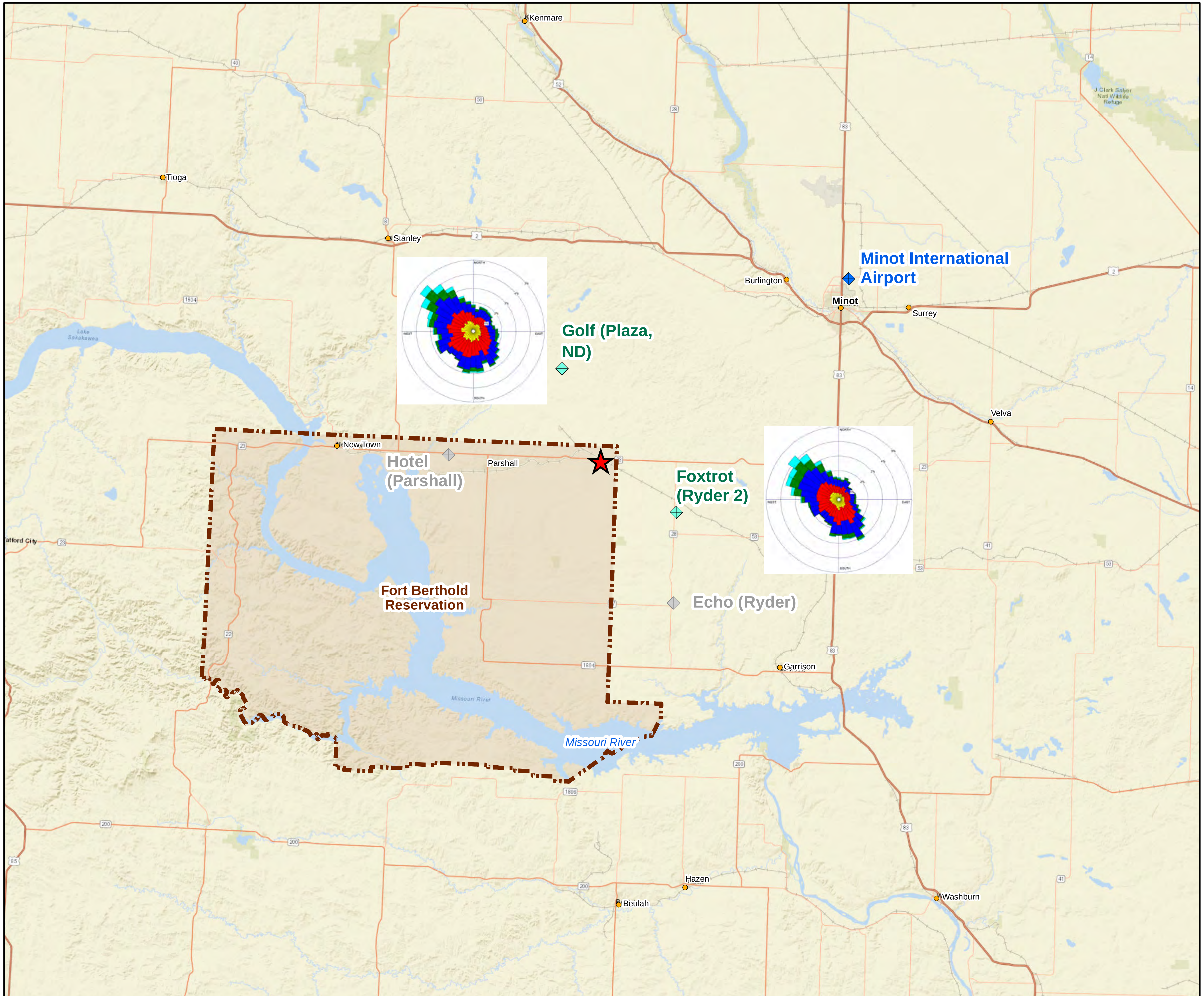
Nearby Terrain Features

April 2023

ARCADIS Design & Consultancy for natural and built assets

FIGURE **3**

City: Houston Div/Group: Remediation West -Air Group Created By: W Berry Last Saved By: wberry ; Client (Project #)
D:_Arcadis\Air Services\Thunder_Butte\Fig3 - TB Nearby_Terrain Jan2023.mxd 1/27/2023 3:41:39 PM



0 7.5 15 22.5 30 Kilometers

Legend

- Met Station (NWS ASOS)
- Other MET Reporting Stations
- Proposed Topping Plant/ Existing Crude Storage and Loading Facility

WIND SPEED (m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10

Golf Plaza ND Airport Calms" 4.89%

Ryder ND Airport Calms" 3.74%

NOTES:

1. Meteorological Station (Met) Source: National Weather Service and NOAA website
2. Sites identified using National Centers for Environmental Information (Hourly/Sub-Hourly Observational Data) website,Further evaluation of data completeness and quality for each site will be necessary.

THUNDER BUTTE PETROLEUM SERVICES, INC.
PLAZA, WARD COUNTY, NORTH DAKOTA

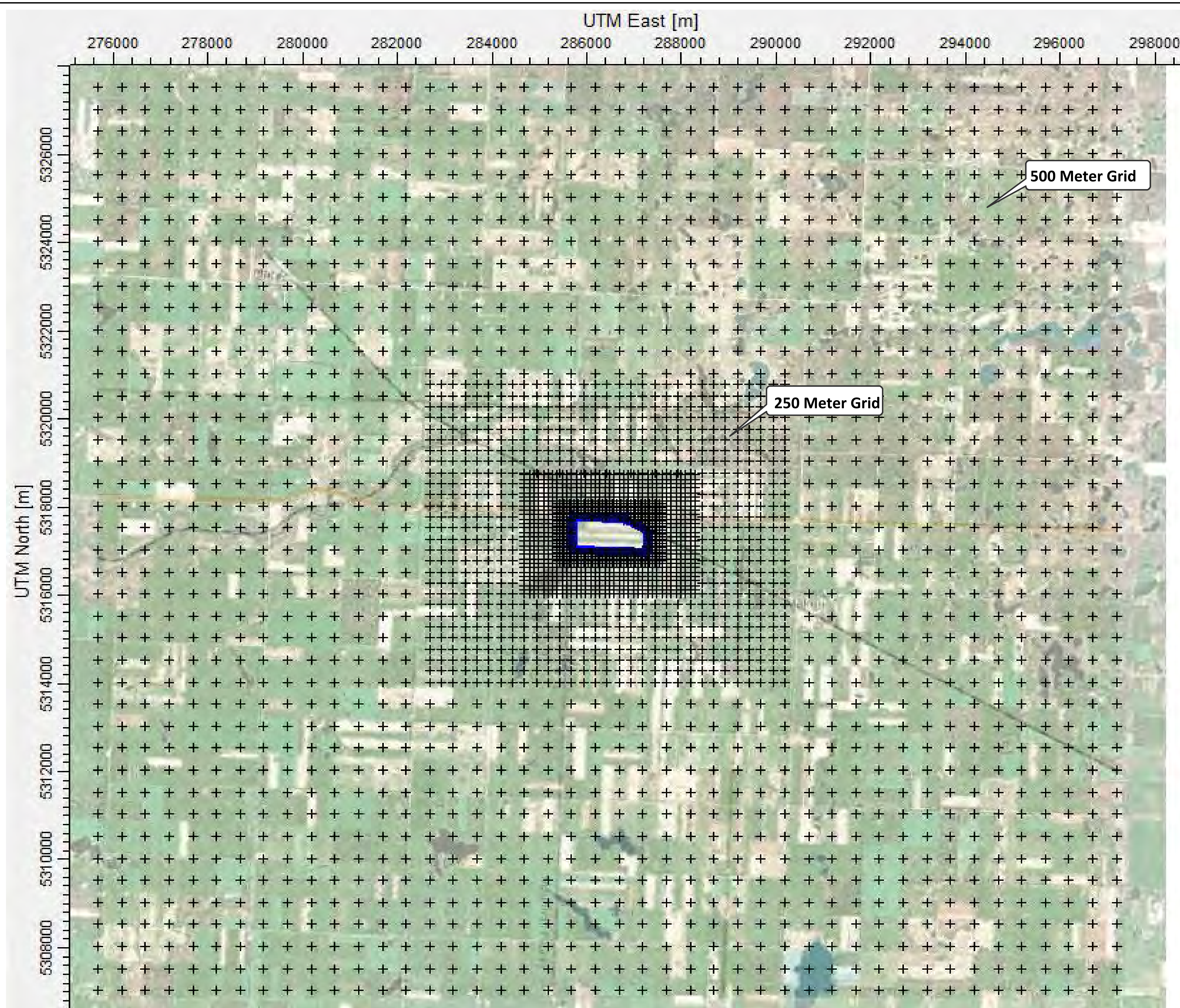
Location Map (Met Stations)

December 2023

ARCADIS Design & Consultancy for natural and built assets

FIGURE 4

City: Houston Div/Group: Remediation West -Air Group Created By: W Berry Last Saved By: wberry ; Client (Project #)
D:_Arcadis\Air Services\Thunder_Butte\Fig4 - TB Met Stations Jan2023.mxd 1/30/2023 4:44:56 PM



Legend

- + Proposed Receptor Grid
- Fenceline

NOTES:

1. 250-m spaced grid extends out 3 km.
2. 500-m spaced grid extends out 10 km.

THUNDER BUTTE PETROLEUM SERVICES, INC.
PLAZA, WARD COUNTY, NORTH DAKOTA

Proposed Receptor Locations
December 2023

ARCADIS Design & Consultancy for natural and built assets

FIGURE
5

Legend

- + Proposed Receptor Grid
- Fenceline

NOTES:

1. 50-m spaced grid extends out 300 m.
2. 100-m spaced grid extends out 1 km.

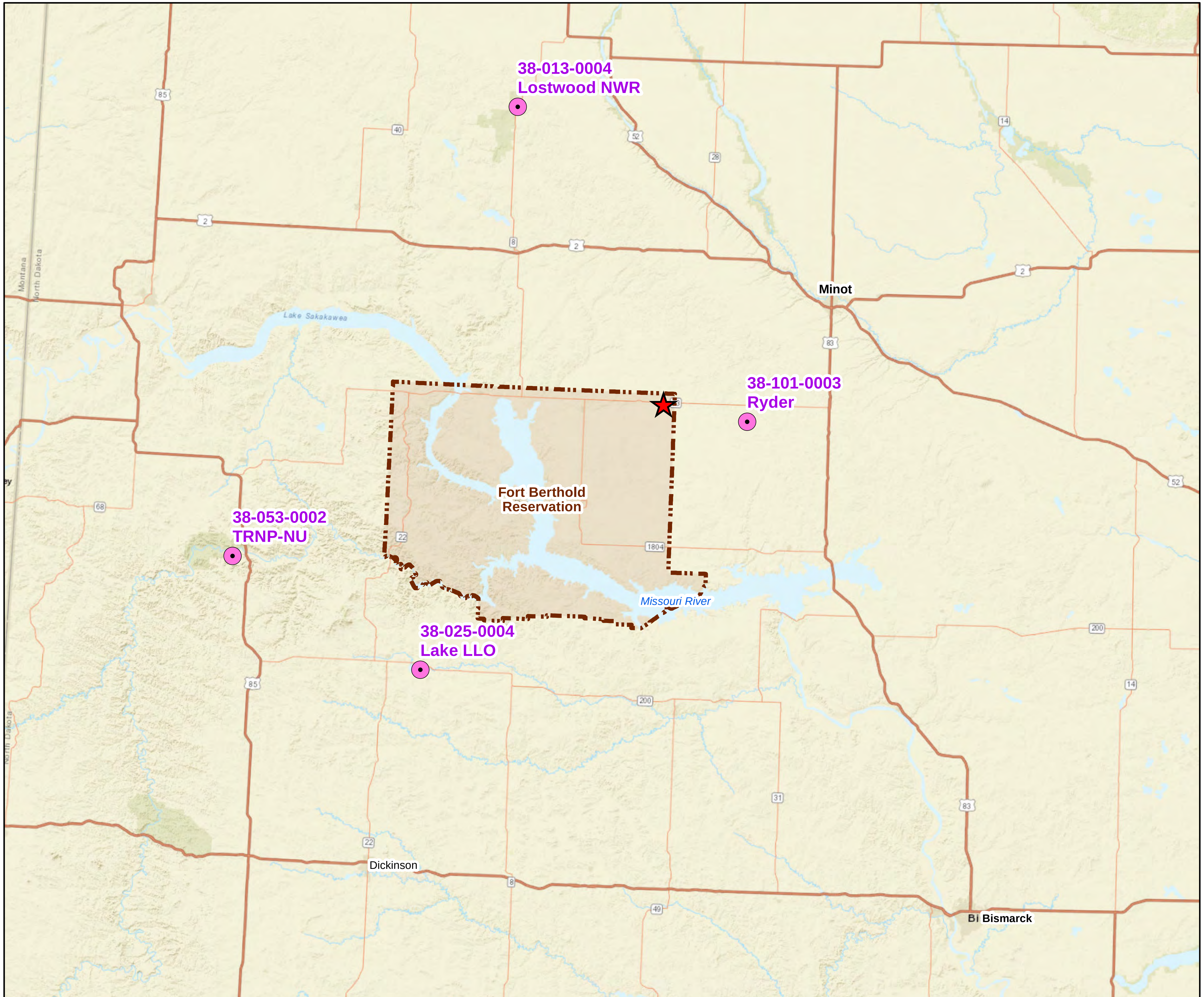
THUNDER BUTTE PETROLEUM SERVICES, INC.
PLAZA, WARD COUNTY, NORTH DAKOTA

Proposed Close-in Receptor Locations

December 2023

ARCADIS Design & Consultancy for natural and built assets

FIGURE 6



Legend

- ★ Proposed Topping Plant/ Existing Crude Storage and Loading Facility
- EPA Air Quality Monitor[(2)]
- Fort Berthold Reservation

NOTES:

1. Air Monitors Source : EPA Interactive Map of Air Quality Monitors, attribute table data download.
2. Proposed Air Quality Monitors for EPA review

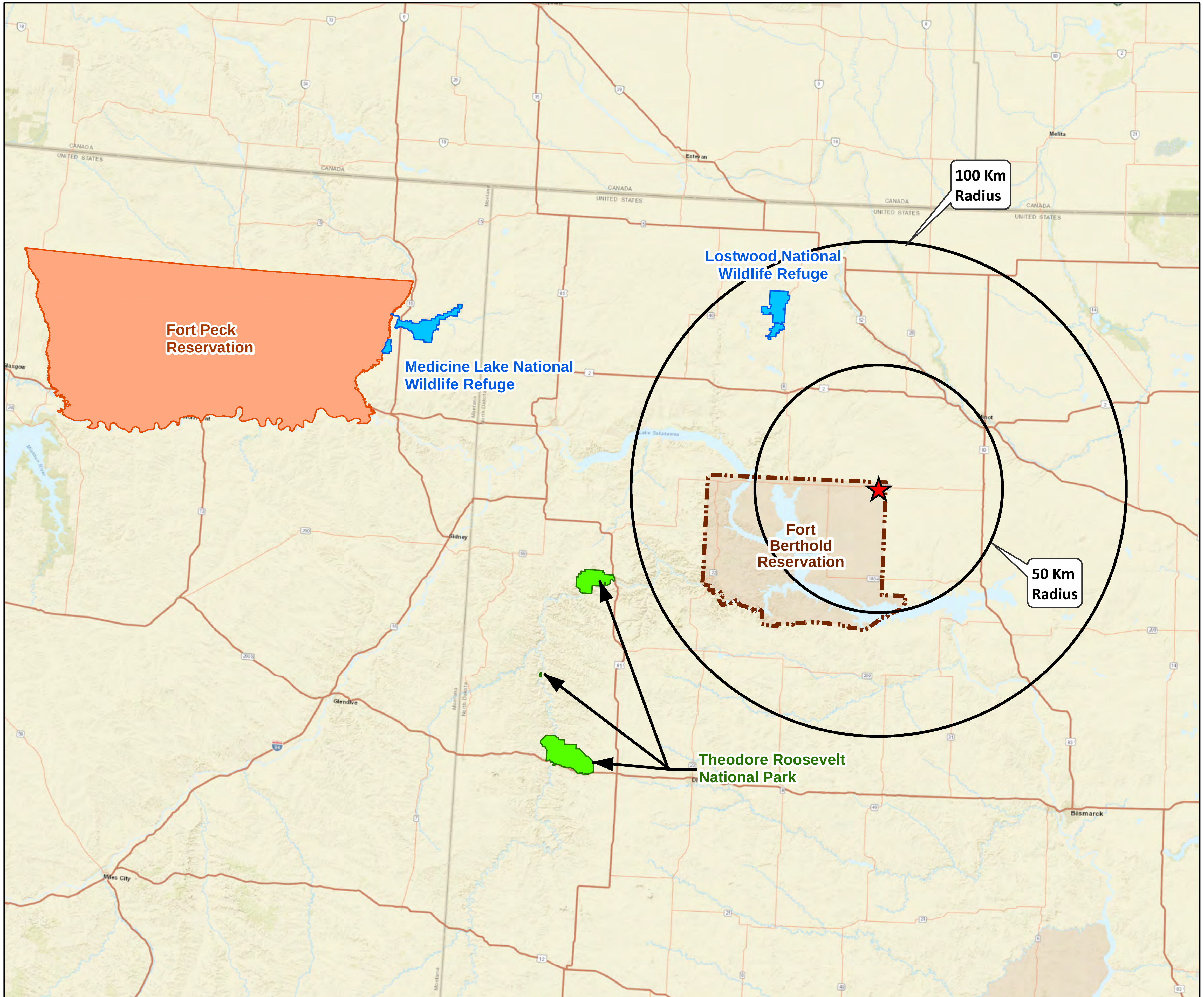
THUNDER BUTTE PETROLEUM SERVICES, INC.
PLAZA, WARD COUNTY, NORTH DAKOTA

Location Map (Air Quality Monitors)
December 2023

ARCADIS Design & Consultancy for natural and built assets

FIGURE
7

City: Houston Div/Group: Remediation West -Air Group Created By: W Berry Last Saved By: wberry ; Client (Project #)
D:_Arcadis\Air Services\Thunder_Butte\Fig7 - TB AQMs Jan2023.mxd 2/2/2023 12:26:25 PM



0 40 80 Kilometers

Legend

- ★ Proposed Topping Plant/ Existing Crude Storage and Loading Facility
- National Park Service Class I Areas
- Fish and Wildlife Service Class I Units
- American Indian Class I Lands
- Fort Berthold Reservation

NOTES:

1. Locations provided by the Department of the Interior Bureaus Tribal Lands CONUS server https://services.arcgis.com/4OV0eRKiLAYkbH2J/arcgis/rest/services/DOI_Bureaus_Tribal_Lands_CONUS/FeatureServer

THUNDER BUTTE PETROLEUM SERVICES, INC.
PLAZA, WARD COUNTY, NORTH DAKOTA

Protected Lands

December 2023

ARCADIS Design & Consultancy for natural and built assets

FIGURE 8

City: Houston Div/Group: Remediation West -Air Group Created By: W Berry Last Saved By: wberry ; Client (Project #)
D:_Arcadis\Air Services\Thunder_Butte\Fig4 TB-EPA Protected Lands.mxd 11/18/2022 1:08:08 PM

Appendix A

Flare Effective Diameter/Height Calculations

TBPS Topping Plant
Source Description: F8960 Emergency LPG Flare, F8950 Process Flare (each)
Normal Operations Emissions - Pilot

STEP 1 Flare Feed Stream	Heat Value BTU/scf	Flow scfm	mmbtu/hr	Heat Release cal/sec *	Note
Pilot stream	1020	5.5	0.34	23,562	330 scf/hr NG pilots
Total Flow		5.5			
Total/Gross Heat Release (H) **				23,562	
Mean MW					

* 1 BTU = 252 calories

** Total heat release (H) of flared gas based on gas heat content and gas consumption rate.

Model Parameters per USEPA Flare Method

Temp	1273	K	(default)
velocity	20	m/s	(default)

STEP 2: Assume that 45% of Total Heat Release (H) is released as sensible heat (Q_H)

Q_H (cal/sec) = 0.45 x H (cal/sec)

Q_H (cal/sec) = 10,602.90

STEP 3: Calculate effective diameter.

d_S (m) = $9.88\times10^{-4} \times [Q_H]^{1/2}$

d_s = 0.102 m

Step 4: Calculate effective stack height

H_{eff} = Hs + (4.56 E - 03) * (((J/sec) / 4.1868)^0.478)

Input	30.48	flare height (m)
	98,647.4	J/sec

H_{eff} = 31.041 m

TBPS Topping Plant
Source Description: F8950 Process Flare
MSS Emissions - Plant Degassing to Emergency Process Flare

STEP 1 Flare Feed Stream	Heat Value BTU/lb	Flow lb/hr	MMbtu/hr	Heat Release cal/sec *
Plant Degassing	19329	7462.0	144.23	10,096,298
Total Flow		7462.0		
Total/Gross Heat Release (H) **				10,096,298
Mean MW				

* 1 BTU = 252 calories

** Total heat release (H) of flared gas based on gas heat content and gas consumption rate.

Model Parameters per USEPA Flare Method

Temp	1273	K	(default)
velocity	20	m/s	(default)

STEP 2: Assume that 45% of Total Heat Release (H) is released as sensible heat (Q_H)

Q_H (cal/sec) = 0.45 x H (cal/sec)

Q_H (cal/sec) = 4,543,334.18

STEP 3: Calculate effective diameter.

d_s (m) = $9.88\times10^{-4} \times [Q_H]^{1/2}$

d_s =	**2.106 m**

Step 4: Calculate effective stack height

H_{eff} = Hs + (4.56 E - 03) * (((J/sec) / 4.1868)^0.478)

Input	30.48	flare height (m)
	42,270,316	J/sec

H_{eff} =	**40.642 m**

TBPS Topping Plant
Source Description: F8960 Process Flare
MSS Emissions -Emergency LPG Flare- Tank Degassing Losses

STEP 1	Heat Value	Flow		Heat Release
Flare Feed Stream	BTU/lb	lb/hr	MMbtu/hr	cal/sec *
Plant Degassing	8103.3	13.2	0.11	7,490
Total Flow		13.2		
Total/Gross Heat Release (H) **				7,490
Mean MW				

* 1 BTU = 252 calories

** Total heat release (H) of flared gas based on gas heat content and gas consumption rate.

Model Parameters per USEPA Flare Method

Temp	1273	K	(default)
velocity	20	m/s	(default)

STEP 2: Assume that 45% of Total Heat Release (H) is released as sensible heat (Q_H)

Q_H (cal/sec) = 0.45 x H (cal/sec)

Q_H (cal/sec) = 3,370.37

STEP 3: Calculate effective diameter.

d_s (m) = $9.88 \times 10^{-4} \times [Q_H]^{1/2}$

d_s = 0.057 m

Step 4: Calculate effective stack height

H_{eff} = Hs + (4.56 E - 03) * (((J/sec) / 4.1868)^0.478)

Input	30.48	flare height (m)
	31,357.3	J/sec

H_{eff} = 30.805 m

Appendix B

USEPA Background Concentrations

Regional Background Monitor Concentrations Provided by USEPA (October 2023)

Pollutant	Form of NAAQS	NAAQS	Units	Site Name	Site ID	Latitude	Longitude	2020	2021	2022	3-Year Average DV	Average
1-hour NO2	3-year average of 98th percentile	188	µg/m^3	Lostwood	38-013-0004	48.642	-102.402	17.5	19.7	18.8	18.7	20.7
				Lake Ilo	38-025-0004	47.342	-102.646	18.1	24.3	22.6	21.6	
				TRNP	38-053-0002	47.581	-103.300	15.2	16.9	16.9	16.4	
				Ryder	38-101-0003	47.941	-101.572	26.9	27.1	24.4	26.1	
Annual NO2	Annual Mean	99.7	µg/m^3	Lostwood	38-013-0004	48.642	-102.402	3.6	3.8	6.6	4.7	4.5
				Lake Ilo	38-025-0004	47.342	-102.646	3.5	4.2	8.4	5.4	
				TRNP	38-053-0002	47.581	-103.300	1.8	2.8	5.8	3.5	
				Ryder	38-101-0003	47.941	-101.572	3.3	3.9	6.3	4.5	
1-hour SO2	3-year average of 99th percentile	196.4	µg/m^3	Lostwood	38-013-0004	48.642	-102.402	52.4	52.4	49.8	51.5	24.9
				Lake Ilo	38-025-0004	47.342	-102.646	13.1	18.3	15.7	15.7	
				TRNP	38-053-0002	47.581	-103.300	10.5	13.1	10.5	11.3	
				Ryder	38-101-0003	47.941	-101.572	21.0	21.0	21.0	21.0	
3-hour SO2	Not to be exceeded	1309	µg/m^3	Lostwood	38-013-0004	48.642	-102.402	68.6	44.0	56.8	56.5	29.9
				Lake Ilo	38-025-0004	47.342	-102.646	11.0	41.4	19.1	23.8	
				TRNP	38-053-0002	47.581	-103.300	9.7	22.0	17.8	16.5	
				Ryder	38-101-0003	47.941	-101.572	24.6	20.2	23.6	22.8	
24-hour PM2.5	3-year average of 98th percentile	35	µg/m^3	Lostwood	38-013-0004	48.642	-102.402	12.7	37.5	23.0	24.4	24.8
				Lake Ilo	38-025-0004	47.342	-102.646	10.4	38.4	22.0	23.6	
				TRNP	38-053-0002	47.581	-103.300	11.5	37.4	22.0	23.6	
				Ryder	38-101-0003	47.941	-101.572	12.2	46.1	24.0	27.4	
Annual PM2.5	Annual mean averaged over 3 years	12	µg/m^3	Lostwood	38-013-0004	48.642	-102.402	4.9	7.9	6.4	6.4	6.0
				Lake Ilo	38-025-0004	47.342	-102.646	3.6	8.1	5.8	5.8	
				TRNP	38-053-0002	47.581	-103.300	3.4	7.5	5.4	5.4	
				Ryder	38-101-0003	47.941	-101.572	4.6	8.6	6.3	6.5	
24-hour PM10	Not to be exceeded	150	µg/m^3	Lostwood	38-013-0004	48.642	-102.402	49.0	121.0	191.0	120.3	75.8
				Lake Ilo	38-025-0004	47.342	-102.646	21.0	92.0	68.0	60.3	
				TRNP	38-053-0002	47.581	-103.300	25.0	53.0	172.0	83.3	
				Ryder	38-101-0003	47.941	-101.572	17.0	NA	61.0	39.0	
8-hour Ozone	Annual 4th-highest daily maximum 8-hr concentration averaged over 3 years	70	ppb	Lostwood	38-013-0004	48.642	-102.402	53.0	61.0	55.0	56.3	56.8
				Lake Ilo	38-025-0004	47.342	-102.646	54.0	68.0	58.0	60.0	
				TRNP	38-053-0002	47.581	-103.300	51.0	64.0	56.0	57.0	
				Ryder	38-101-0003	47.941	-101.572	51.0	57.0	53.0	53.7	
1-hour CO	Not to be exceeded	10304	µg/m^3	NA	NA	NA	NA	NA	NA	NA	NA	NA
8-hour CO	Not to be exceeded	40071	µg/m^3	NA	NA	NA	NA	NA	NA	NA	NA	NA

Appendix C

Regional MERPs Analysis for 24-Hour & Annual $PM_{2.5}$ (NAAQS)

MERPs Analysis for 24-Hour & Annual PM2.5 (NAAQS) - Regional MERPs

Project Name: **ThunderButte Topping Plant**

Project Location: **Fort Berthold Indian Reservation (FBIR) in Ward County, North Dakota**

Proposed Potential Emissions

Project Emissions	Potential TPY[3]
NOx	42.7
VOC	91.6
SO2	0.9
PM2.5[2]	11.3
Basis:	All sources assumed at 8760 hrs/year operation

Release Height:	5 - 30	meters
Used for Analysis:	10	meters

1. Secondary $PM_{2.5}$ Formation Evaluation using MERPs Values
2. Does not includes $PM_{2.5}$ from paved roads.
3. Potential emissions represent facility-wide total which also includes previously permitted crude tanks. Topping Plant: 84.9 tpy.

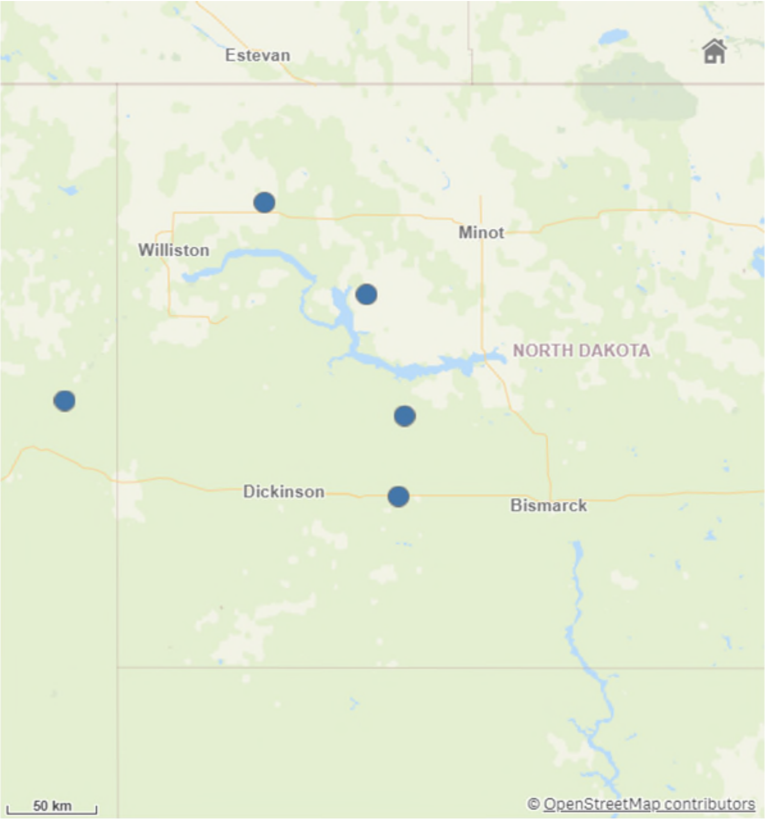
MERPs Analysis for 24-Hour & Annual PM2.5 (NAAQS) - Regional MERPs
Applying State/County MERPs values

Project Name: ThunderButte Topping Plant
Project Location: Fort Berthold Indian Reservation (FBIR) in Ward County, North Dakota

Project NOx	Regional MERPs Hypo NOx	Regional MERPs Hypo NOx Impact	Project SO2	Regional MERPs Hypo SO2	Regional MERPs Hypo SO2 Impact	
TPY	TPY	ug/m^3	TPY	TPY	ug/m^3	
42.7	5,460	0.1099	0.9	525	1.144	**24-hr MERP**
	12,889	0.0078		2,289	0.044	**Annual MERP**
	Mercer, ND			Mercer, ND		**Hypo Source Location**

	PM2.5 SILs	Cumulative MERP PM2.5	Direct PM2.5 (H8H & H1H)	Total PM2.5 (with MERPs)	Less than SIL	Background PM2.5	Cumulative PM2.5	PM2.5 NAAQS	Meets NAAQS
	ug/m^3	ug/m^3	ug/m^3	ug/m^3	(Y/N)	ug/m^3	ug/m^3	ug/m^3	(Y/N)
24-hr Average:	1.2	0.0028	2.31	2.31	N	24.8	**27.1**	35	Y
Annual Average	0.2	4.29E-05	0.77	0.77	N	6	**6.8**	12	Y
Monitor Location:						Regional			
		NAAQS - Cumulative Analysis							

MERPs Quick View
https://www.epa.gov/scram/merps-view-qlik#Modeled_Impacts



Criteria to choose appropriate MERP values:
1. Location of Project: Climatic zone, State, or Country.
2. Appropriate hypothetical source size based on project emissions (500, 1000, or 3000 tpy)
3. Representative release height based on proposed source (90 m - tall release or 10 m near ground release).
4. Choose the most conservative (lowest MERP tpy) for each each pollutant (NOx, VOC, SO2) and polutant/averaging period under review (8-hr O3, 24-hr PM2.5 or Annual PM2.5)

MERP = Critical Air Quality Threshold * (Modeled emission rate from hypothetical source / Modeled air quality impact from hypothethical source)

Critical Air Quality Threshold (ozone) = 1.2 ugm3 (24-hr) & 0.2 ug/m3 (annual)

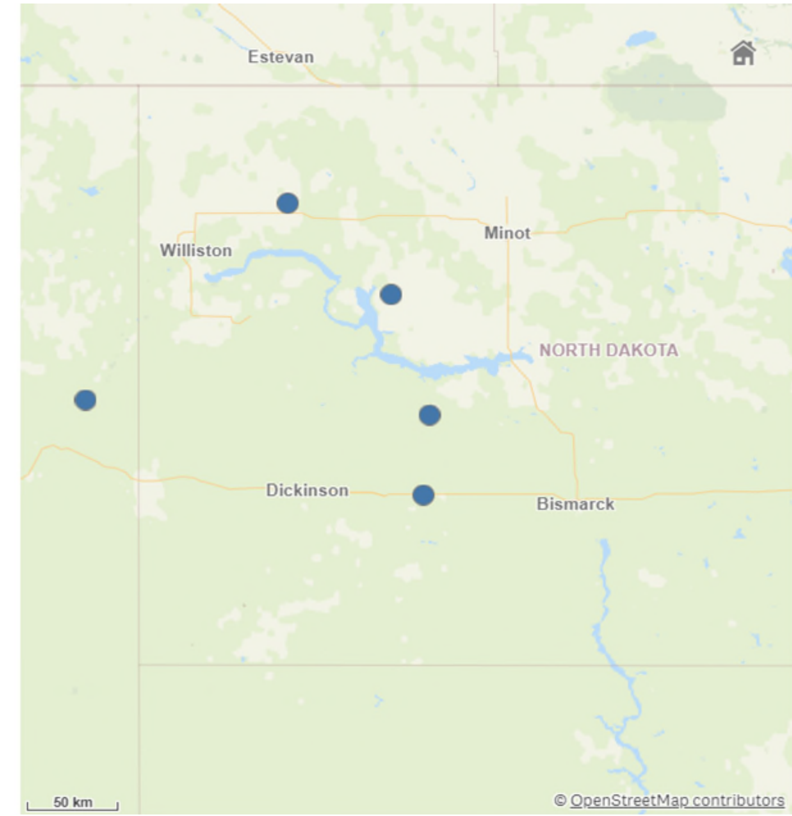
MERPs Analysis for 24-Hour & Annual PM2.5 (SIL and NAAQS) - State/County MERPs
Applying State/County MERPs values

Project Name: ThunderButte Topping Plant
Project Location: Fort Berthold Indian Reservation (FBIR) in Ward County, North Dakota

Project NOx	Regional MERPs NOx	Regional MERPs Hypo NOx Impact	Project SO2	Regional MERPs Hypo SO2	Regional MERPs Hypo SO2 Impact	
TPY	TPY	ug/m^3	TPY	TPY	ug/m^3	
42.7	5,460	0.1099	0.9	525	1.144	**24-hr MERP**
	12,889	0.0078		2,289	0.044	**Annual MERP**
	Mercer, ND			Mercer, ND		**Hypo Source Location**

	PM2.5 SILs	Cumulative MERP PM2.5	Direct PM2.5 (H1H)	Total PM2.5 (with MERPs)	Less than SIL	Background PM2.5	Cumulative PM2.5	PM2.5 NAAQS	Meets NAAQS
	ug/m^3	ug/m^3	ug/m^3	ug/m^3	(Y/N)	ug/m^3	ug/m^3	ug/m^3	(Y/N)
24-hr Average:	1.2	0.003	3.81	3.81	N	24.8	**28.6**	35	Y
Annual Average	0.2	4.29E-05	0.77	0.77	N	6	**6.8**	12	Y
Monitor Location:						Regional			
		SILs - Thunder Butte Topping Plant Only							

MERPs Quick View
https://www.epa.gov/scram/merps-view-qlik#Modeled_Impacts



Criteria to choose appropriate MERP values:
1. Location of Project: Climatic zone, State, or Country.
2. Appropriate hypothetical source size based on project emissions (500, 1000, or 3000 tpy)
3. Representative release height based on proposed source (90 m - tall release or 10 m near ground release).
4. Choose the most conservative (lowest MERP tpy) for each each pollutant (NOx, VOC, SO2) and polutant/averaging period under review (8-hr O3, 24-hr PM2.5 or Annual PM2.5)

MERP = Critical Air Quality Threshold * (Modeled emission rate from hypothetical source / Modeled air quality impact from hypothethical source)

Critical Air Quality Threshold (ozone) = 1.2 ug/m^3 (24-hr) & 0.2 ug/m^3 (annual)

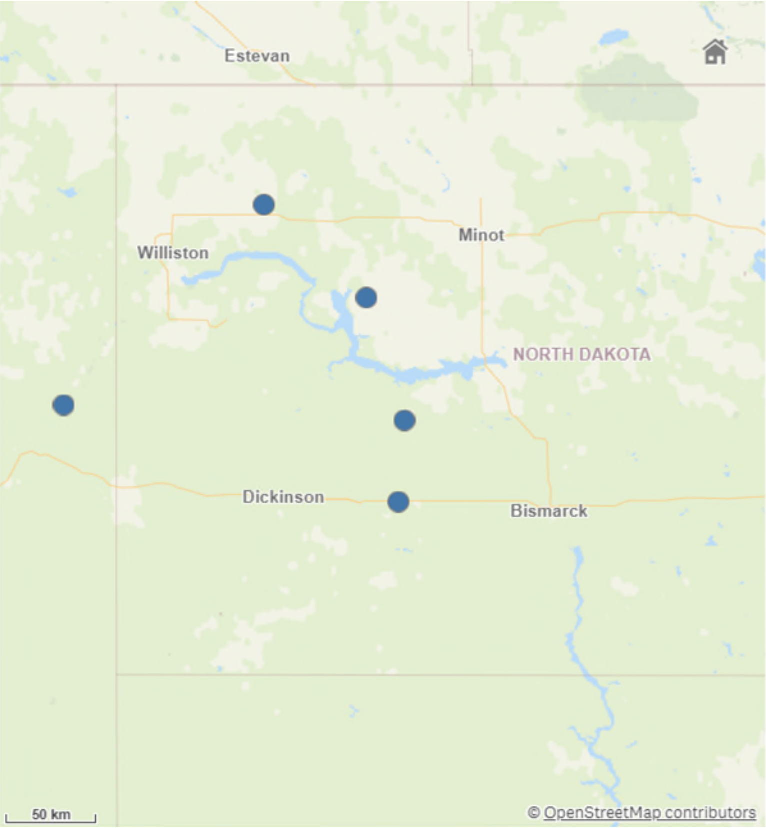
MERPs Analysis for 8-Hour Ozone (SIL and NAAQS) - State/County-specific MERPs
Applying State/County MERPs values

Project Name: ThunderButte Topping Plant
Project Location: Fort Berthold Indian Reservation (FBIR) in Ward County, North Dakota

	Project NOx	State/County MERPs NOx	Project VOC	State County MERPS VOC
	TPY	TPY	TPY	TPY
	42.7	185	91.56	1420
Hypo Src Location		Morton, ND		Morton, ND

	O_3 SILs	Cummulative MERP O_3	Less than SIL	Background O_3	Cummulative Ozone	Ozone NAAQS	Meets NAAQS
	ppb	ppb	(Y/N)	ppb	ppb	ppb	(Y/N)
	1	0.30	Y	56.8	Less than SIL	70	N
Monitor Location:				Regional			

MERPs Quick View
https://www.epa.gov/scram/merps-view-qlik#Modeled_Impacts



Criteria to choose appropriate MERP values:
1. Location of Project: Climatic zone, State, or Country.
2. Appropriate hypothetical source size based on project emissions (500, 1000, or 3000 tpy)
3. Representative release height based on proposed source (90 m - tall release or 10 m near ground release).
4. Choose the most conservative (lowest MERP tpy) for each each pollutant (NOx, VOC, SO2) and polutant/averaging period under review (8-hr O3, 24-hr PM2.5 or Annual PM2.5)

MERP = Critical Air Quality Threshold * (Modeled emission rate from hypothetical source / Modeled air quality impact from hypothethical source)

Critical Air Quality Threshold (ozone) = 1 ppb

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