Exhibit 13

Memorandum from Tim Martin, Air Sciences Inc., to Pauline Ruddy, Shell, Updates to Air Quality Impact Analysis—Kulluk Drillship (May 4, 2011)

AIR SCIENCES INC.
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TECHNICAL MEMORANDUM

UPDATES TO AIR QUALITY IMPACT ANALYSIS – KULLUK DRILLSHIP

PREPARED FOR: Pauline Ruddy, Shell

PREPARED BY: Tim Martin, Air Sciences Inc.

PROJECT NO.: 180-20-4

DATE: May 4, 2011

Introduction

On February 28, 2011, Shell Offshore Inc. (Shell) submitted an air quality impact report[1] to Region 10 of the Environmental Protection Agency (EPA) regarding proposed operation of the *Kulluk* Drillship in the Beaufort Sea. Shell's February 28 report describes an impact analysis for the *Kulluk* using the AERMOD model, PVMRM chemistry for NO_2 evaluations, measured meteorological data, and realistic maximum emissions, as well as a 500-meter ambient air boundary, to demonstrate compliance with the National Ambient Air Quality Standards (NAAQS) and Alaska Ambient Air Quality Standards (AAAQS).

This memorandum describes changes/updates made to the February 28, 2011 impact analysis in both the emissions and modeling procedures to respond to comments and suggestions provided by EPA and again demonstrates compliance with the NAAQS/AAAQS. These changes/updates include:

- **Added cumulative impacts analysis:** EPA has requested that Shell include a cumulative impacts analysis. This analysis is included as Attachment B.
- **Updated emissions inventory:** Shell has determined that a separate OSR quartering vessel is not needed in the associated fleet and it is removed from the source inventory. Other minor changes have been made and the result is a substantial decrease in emissions.
- **Revised approach to pairing modeled impacts and background NO_2 data:** EPA has asked that Shell pair the modeled hourly NO_2 impacts from the *Kulluk* with a seasonally based diurnal NO_2 background profile per recommendations in EPA's March 1, 2011, guidance[2] on modeling 1-hour NO_2 impacts. This profile is based on three years of BP Pad A monitoring station data to account

[1] Shell Offshore, Inc., *Supplement to EPA Outer Continental Shelf (OCS) Operating Permit Application Shell Beaufort Sea, Alaska Exploratory Drilling Program: Conical Drilling Unit Kulluk.* Prepared by Air Sciences, Inc. February 28, 2011.

[2] EPA OAQPS. *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard.* From Tyler Fox, Leader – Air Quality Monitoring Group, C439-01, pages 17–21.

for cumulative impacts from shore-based sources on OCS lease blocks located offshore near the Prudhoe Bay area (see Attachment B).

- **Changed the source of $PM_{2.5}$ background data and its use to address cumulative impacts:** As part of EPA's request for a cumulative impacts analysis, $PM_{2.5}$ background data necessarily must be obtained from a location that includes the effects of existing emission sources in the Prudhoe Bay area. Shell established a $PM_{2.5}$ monitor at Deadhorse, which, at present, is the only monitor that collects $PM_{2.5}$ data in the Prudhoe Bay area. These data, with windblown dust-affected measurements removed, are utilized in the updated impacts analysis.

- **Updated annual average background values:** EPA has asked Shell to utilize a full year's worth of data, rather than data based on drilling season months only, when determining the background concentrations for the annual average NAAQS/AAAQS.

- **Updated OCS leases by removing some Prudhoe Bay area leases**: Shell has removed 11 OCS lease blocks from permitting consideration in the Prudhoe Bay area and near Foggy Island Bay (east of Prudhoe Bay) to address cumulative impact issues related to shore-based sources. These OCS lease changes affect the village receptor selection for onshore impacts at Deadhorse.

- **Refined approach to modeling SO_2 impacts:** In the February 28 impacts analysis, SO_2 was modeled using a straightforward worst-case approach, which greatly overestimated impacts. Given EPA's request for a cumulative impacts analysis, SO_2 modeling is now updated to utilize an emissions sequence approach (analogous to NO_2 and PM) to more accurately assess significant SO_2 impacts.

In addition, EPA has asked Shell to provide/reference language that addresses lead impacts. This language has been provided to EPA in the February 28 *Kulluk* impact report, Section 3.11. Consistent with the treatment of lead in previous *Kulluk* and *Discoverer* impact analyses, lead emissions from the *Kulluk* are insignificant and are not evaluated in the impact analysis. Note that the allowable emissions of lead from the *Kulluk* project are 0.069 tons per year, which is substantially less than the significant emission rate of 0.6 tons per year.

Updates to Allowable Emission Inventory

The February 28, 2011, emission inventory, specifically Tables 2-1 through 2-6 (except 2-4 [fuel tanks]) and its Attachment A, has been modified in the following ways. The quartering vessel has been removed from the inventory, the crane engine's power was corrected from 293 hp to 293 kw (which is equal to 393 hp), and the ULSD fuel heat content and density were updated. The net effect of the combined changes in the inventory is a substantial decrease in emissions of all regulated pollutants. The Owner-Requested Restriction (ORR) on annual NO_x emissions has been shifted to the Alaska ORL form (Attachment 2 submitted to EPA Region 10 on April 29, 2011) because it does not serve as a restriction on impacts. Updated Tables 2-1 through 2-6 (except 2-4) are provided below, and the complete updated inventory is included in Attachment A.

Updated Table 2-1: Daily Maximum Emissions for Each Source Group – MLC Activity

Source Group by Vessel	NO_X lb/day	$PM_{2.5}$ lb/day	PM_{10} lb/day	CO lb/day	SO_2 lb/day
Kulluk					
Generation	456.1	71.3	71.3	206.3	12.9
MLC HPUs	887.8	35.5	35.5	47.9	2.7
Air compressors	710.2	14.8	14.8	42.8	2.7
Cranes	85.2	3.4	3.4	4.6	0.3
Heaters & Boilers	22.0	3.6	3.6	5.5	1.5
Seldom-used units	8.7	0.7	0.7	2.4	2.6E-02
Emergency Generator	35.6	2.8	2.8	9.6	0.1
Incinerator	5.0	23.2	27.2	496.8	4.1
Primary Ice Management					
Propulsion & Generation	2,032.8	317.6	317.6	919.6	57.7
Heaters & Boilers	36.6	6.0	6.0	9.1	2.6
Seldom-used units	6.6	0.5	0.5	1.8	2.0E-02
Incinerator	5.5	25.9	30.3	554.4	4.6
Secondary Ice Management / Anchor Handler					
Propulsion & Generation	2,032.8	317.6	317.6	919.6	57.7
Heaters & Boilers	36.6	6.0	6.0	9.1	2.6
Seldom-used units	6.6	0.5	0.5	1.8	2.0E-02
Incinerator	5.5	25.9	30.3	554.4	4.6
Resupply Ship - transport mode					
Propulsion & Generation	0.0	0.0	0.0	0.0	0.0
Seldom-used units	0.0	0.0	0.0	0.0	0.0
Resupply Ship - DP mode					
Propulsion & Generation	1,774.6	73.9	73.9	535.2	6.7
Seldom-used units	1.3	0.1	0.1	0.4	4.0E-03
OSR vessel					
Propulsion & Generation	1,035.2	43.1	43.1	312.2	3.9
Seldom-used units	6.6	0.5	0.5	1.8	2.0E-02
Incinerator	4.5	21.0	24.6	450.0	3.8
OSR work boats					
Work boats	250.2	20.0	20.0	67.5	0.8
TOTAL - (lb/day)	**9,446**	**1,014**	**1,031**	**5,153**	**169**
TOTAL - (lb/day) - w/o Egen	**9,160**	**991**	**1,008**	**5,076**	**169**

shading represents OR to be demonstrated by documentation of daily fuel consumption

shading represents OR to be demonstrated by documentation of weekly fuel consumption

Updated Table 2-2: Daily Maximum Emissions for Each Source Group – Drilling Activity

Source Group by Vessel	NO_X lb/day	$PM_{2.5}$ lb/day	PM_{10} lb/day	CO lb/day	SO_2 lb/day
Kulluk					
Generation	456.1	71.3	71.3	206.3	12.9
MLC HPUs	0.0	0.0	0.0	0.0	0.0
Air compressors	0.0	0.0	0.0	0.0	0.0
Cranes	85.2	3.4	3.4	4.6	0.3
Heaters & Boilers	22.0	3.6	3.6	5.5	1.5
Seldom-used units	8.7	0.7	0.7	2.4	2.6E-02
Emergency Generator	35.6	2.8	2.8	9.6	0.1
Incinerator	5.0	23.2	27.2	496.8	4.1
Primary Ice Management					
Propulsion & Generation	2,032.8	317.6	317.6	919.6	57.7
Heaters & Boilers	36.6	6.0	6.0	9.1	2.6
Seldom-used units	6.6	0.5	0.5	1.8	2.0E-02
Incinerator	5.5	25.9	30.3	554.4	4.6
Secondary Ice Management / Anchor Handler					
Propulsion & Generation	2,032.8	317.6	317.6	919.6	57.7
Heaters & Boilers	36.6	6.0	6.0	9.1	2.6
Seldom-used units	6.6	0.5	0.5	1.8	2.0E-02
Incinerator	5.5	25.9	30.3	554.4	4.6
Resupply Ship - transport mode					
Propulsion & Generation	0.0	0.0	0.0	0.0	0.0
Seldom-used units	0.0	0.0	0.0	0.0	0.0
Resupply Ship - DP mode					
Propulsion & Generation	1,774.6	73.9	73.9	535.2	6.7
Seldom-used units	1.3	0.1	0.1	0.4	4.0E-03
OSR vessel					
Propulsion & Generation	1,035.2	43.1	43.1	312.2	3.9
Seldom-used units	6.6	0.5	0.5	1.8	2.0E-02
Incinerator	4.5	21.0	24.6	450.0	3.8
OSR work boats					
Work boats	250.2	20.0	20.0	67.5	0.8
TOTAL - (lb/day)	**7,848**	**964**	**980**	**5,062**	**164**
TOTAL - (lb/day) - w/o Egen	**7,562**	**941**	**957**	**4,985**	**163**

shading represents OR to be demonstrated by documentation of daily fuel consumption

shading represents OR to be demonstrated by documentation of weekly fuel consumption

Updated Table 2-3: Daily Maximum Emissions for Each Source Group – Cementing and Logging Activity

Source Group by Vessel	NO_X lb/day	$PM_{2.5}$ lb/day	PM_{10} lb/day	CO lb/day	SO_2 lb/day
Kulluk					
Generation	322.0	50.3	50.3	145.7	9.1
MLC HPUs	0.0	0.0	0.0	0.0	0.0
Air compressors	0.0	0.0	0.0	0.0	0.0
Cranes	142.0	5.7	5.7	7.7	0.4
Heaters & Boilers	22.0	3.6	3.6	5.5	1.5
Seldom-used units	8.7	0.7	0.7	2.4	2.6E-02
Emergency Generator	35.6	2.8	2.8	9.6	0.1
Incinerator	5.0	23.2	27.2	496.8	4.1
Primary Ice Management					
Propulsion & Generation	2,032.8	317.6	317.6	919.6	57.7
Heaters & Boilers	36.6	6.0	6.0	9.1	2.6
Seldom-used units	6.6	0.5	0.5	1.8	2.0E-02
Incinerator	5.5	25.9	30.3	554.4	4.6
Secondary Ice Management / Anchor Handler					
Propulsion & Generation	2,032.8	317.6	317.6	919.6	57.7
Heaters & Boilers	36.6	6.0	6.0	9.1	2.6
Seldom-used units	6.6	0.5	0.5	1.8	2.0E-02
Incinerator	5.5	25.9	30.3	554.4	4.6
Resupply Ship - transport mode					
Propulsion & Generation	0.0	0.0	0.0	0.0	0.0
Seldom-used units	0.0	0.0	0.0	0.0	0.0
Resupply Ship - DP mode					
Propulsion & Generation	1,774.6	73.9	73.9	535.2	6.7
Seldom-used units	1.3	0.1	0.1	0.4	4.0E-03
OSR vessel					
Propulsion & Generation	1,035.2	43.1	43.1	312.2	3.9
Seldom-used units	6.6	0.5	0.5	1.8	2.0E-02
Incinerator	4.5	21.0	24.6	450.0	3.8
OSR work boats					
Work boats	250.2	20.0	20.0	67.5	0.8
TOTAL - (lb/day)	**7,771**	**945**	**962**	**5,004**	**160**
TOTAL - (lb/day) - w/o Egen	**7,485**	**922**	**939**	**4,927**	**159**

shading represents OR to be demonstrated by documentation of daily fuel consumption

shading represents OR to be demonstrated by documentation of weekly fuel consumption

Updated Table 2-5: Summary of Impact Analysis – Required Owner-Requested Restrictions

Owner-Requested Limit (ORL)	Value
MLC drilling	480 hours per season (20 days)
MLC and well drilling combined	1,632 hours per season (68 days)
All OCS source activities combined	2,880 hours per season (120 days)
Number of resupply/waste removal trips	24 per season
Kulluk incinerator	12 hours per day, 8 a.m. through 8 p.m.
Fuel Sulfur content – Kulluk and Fleet	Purchase ULSD, less than 0.01% during use
All IC engine and heater groups	A set of emission limits (lb/day) for each pollutant, highlighted in Tables 2-1, 2-2, and 2-3

Updated Table 2-6: Annual Maximum Emissions for Each Source Group

Source Group by Vessel	NO_X tons/year	$PM_{2.5}$ tons/year	PM_{10} tons/year	CO tons/year	SO_2 tons/year
Kulluk					
Generation	23.9	3.7	3.7	10.8	6.8E-01
MLC HPUs	8.9	0.4	0.4	0.5	2.7E-02
Air compressors	7.1	0.1	0.1	0.4	2.7E-02
Cranes	6.6	0.3	0.3	0.4	2.0E-02
Heaters & Boilers	1.3	0.2	0.2	0.3	9.2E-02
Seldom-used units	5.2E-01	4.2E-02	4.2E-02	1.4E-01	1.6E-03
Emergency Generator	7.1E-02	5.7E-03	5.7E-03	1.9E-02	2.2E-04
Incinerator	0.3	1.4	1.6	29.8	0.2
Primary Ice Management					
Propulsion & Generation	46.3	7.2	7.2	21.0	1.3E+00
Heaters & Boilers	0.8	0.1	0.1	0.2	5.8E-02
Seldom-used units	1.5E-01	1.2E-02	1.2E-02	4.1E-02	4.6E-04
Incinerator	0.1	0.6	0.7	12.6	0.1
Secondary Ice Management / Anchor Handler					
Propulsion & Generation	46.3	7.2	7.2	21.0	1.3E+00
Heaters & Boilers	0.8	0.1	0.1	0.2	5.8E-02
Seldom-used units	1.5E-01	1.2E-02	1.2E-02	4.1E-02	4.6E-04
Incinerator	0.1	0.6	0.7	12.6	0.1
Resupply Ship - transport mode					
Propulsion & Generation	10.6	0.4	0.4	3.2	4.0E-02
Seldom-used units	7.9E-02	6.3E-03	6.3E-03	2.1E-02	2.4E-04
Resupply Ship - DP mode					
Propulsion & Generation	21.3	0.9	0.9	6.4	8.1E-02
Seldom-used units	7.9E-02	6.3E-03	6.3E-03	2.1E-02	2.4E-04
OSR vessel					
Propulsion & Generation	37.3	1.6	1.6	11.2	1.4E-01
Seldom-used units	4.0E-01	3.2E-02	3.2E-02	1.1E-01	1.2E-03
Incinerator	0.3	1.3	1.5	27.0	0.2
OSR work boats					
Work boats	15.0	1.2	1.2	4.0	4.5E-02
Total - Annual Allowable	**229**	**28**	**28**	**162**	**5**

Pairing of Modeled Impacts and Background NO_2 Data

In its March 1, 2011, guidance regarding 1-hour NO_2 modeling issues, the EPA notes that the probabilistic form of the new 1-hour NO_2 standard has implications regarding appropriate methods for combining modeled ambient concentrations with monitored background concentrations for comparison to the NAAQS in a modeling analysis. EPA recommends that the modeled contribution to the ambient impact assessment for the 1-hour NO_2 standard should follow the form of the standard based on the 98th percentile of the annual distribution of daily maximum 1-hour concentrations averaged across the number of years modeled.

Page 19 of the March 1, 2011, guidance allows temporal pairing of modeled and monitored values to be considered on a case-by-case basis, with adequate justification and documentation. In Shell's February 28 impact analysis, Shell combined monitored background and modeled concentrations on an hour-by-hour basis, using hourly monitored background data collected concurrently with the meteorological data period being utilized in the model, and provided justification for its use.

EPA has asked that Shell supplement its background pairing approach by considering EPA's recommendation to incorporate background concentrations in the impact assessment by using multiyear averages of the 98th percentile of the available background concentrations by "season" and hour of day. Consistent with EPA's March 1 memo, the rank associated with the 98th percentile of daily maximum 1-hour values should be consistent with the number of "samples" within the distribution. For example, for a data set with 100 percent annual data capture, there would be 365 days (i.e., samples) with valid data for any given hour. According to 40 CFR 50, Appendix S, the eighth highest ranked value from this data set would represent the 98th percentile value for any hour in the data set. As another example, if a data set only contained 182 days of valid data for a given hour (i.e., 50 percent annual data capture), then the fourth highest ranked value from the data set would represent the 98th percentile value for that hour.

Following EPA's guidance in 40 CFR 50, Appendix S, which specifies the rank associated with the 98th percentile values based on the annual number of days with valid data, Shell has constructed a diurnal NO_2 background profile that is applied to each day considered in the modeling analysis. As discussed with EPA personnel, Shell is defining "season" here as Shell's proposed drilling season from July through November so that the 98th percentile background values are determined from this five-month period. Then, the hourly data from these diurnal background profiles are added to Shell's modeled NO_2 impacts on an hourly basis to determine a total impact value. Consistent with the form of the new 1-hour NO_2 NAAQS, the maximum daily 1-hour NO_2 values are determined from these total hourly values, and the 98th percentile of these maximum daily 1-hour impacts is compared to the 1-hour NO_2 NAAQS.

To account for onshore cumulative impact issues near Prudhoe Bay, Region 10 has asked that the diurnal background NO_2 profiles be based on 2006, 2007, and 2009 ambient monitoring data measured at BP's Pad A monitoring station in Prudhoe Bay. Table 1 provides the diurnal NO_2 background profiles from Pad A that were utilized for the updated *Kulluk* impact analysis in the Beaufort Sea. More details on the utilization of Pad A data in the context of cumulative impact issues are provided in Attachment B.

Table 1: Diurnal NO_2 Background Profile Utilized for the Updated Kulluk Impact Analysis

Hour	Three-Year Average of 98th Percentile NO_2 Concs. For Use in Modeling [1] ($\mu g/m^3$)	2006: July – November			2007: July – November			2009: July – November		
		# Samples	High-Nth-High Rank Based on # Samples [2]	98th Percentile NO_2 Conc. ($\mu g/m^3$)	# Samples	High-Nth-High Rank Based on # Samples [2]	98th Percentile NO_2 Conc. ($\mu g/m^3$)	# Samples	High-Nth-High Rank Based on # Samples [2]	98th Percentile NO_2 Conc. ($\mu g/m^3$)
1	40.5	148	3	82.7	153	4	18.8	151	4	19.9
2	47.0	149	3	97.8	153	4	20.7	152	4	22.6
3	29.6	127	3	50.8	132	3	20.7	152	4	17.5
4	50.3	147	3	94.0	153	4	26.3	129	3	30.6
5	51.8	148	3	95.9	153	4	35.7	129	3	23.9
6	65.9	147	3	144.8	153	4	30.1	151	4	22.9
7	33.5	146	3	52.6	153	4	26.3	151	4	21.6
8	37.9	144	3	54.5	153	4	28.2	152	4	30.8
9	54.8	145	3	109.0	150	3	33.8	151	4	21.6
10	49.1	144	3	88.4	149	3	30.1	150	3	28.8
11	45.1	143	3	80.8	149	3	24.4	150	3	29.9
12	52.5	147	3	114.7	150	3	22.6	151	4	20.1
13	42.3	148	3	77.1	150	3	30.1	151	4	19.7
14	39.1	148	3	62.0	151	4	28.2	151	4	27.1
15	45.3	148	3	73.3	151	4	24.4	150	3	38.2
16	33.1	146	3	50.8	152	4	20.7	149	3	27.8
17	36.9	148	3	56.4	152	4	22.6	149	3	31.8
18	35.5	147	3	60.2	153	4	24.4	149	3	21.8
19	33.7	145	3	48.9	153	4	22.6	149	3	29.5
20	51.8	148	3	92.1	153	4	26.3	150	3	36.8
21	47.2	149	3	90.2	153	4	20.7	149	3	30.6
22	40.9	149	3	79.0	153	4	18.8	149	3	24.8
23	48.8	149	3	92.1	153	4	16.9	150	3	37.2
24	35.8	149	3	62.0	153	4	18.8	151	4	26.5

[1] Based on ambient monitoring data from BP Pad A from 2006, 2007, and 2009.
[2] Per 40 CFR 50, Appendix S, Table 1, which prescribes the rank associated with the 98th percentile value based on the number of valid samples in a data set.

Use of Deadhorse $PM_{2.5}$ Background Concentrations in Updated Impact Analysis

As part of EPA's request for a cumulative impacts analysis for the *Kulluk*, EPA has asked that Shell utilize Prudhoe Bay area $PM_{2.5}$ background data in the impact analysis, rather than Badami $PM_{2.5}$ data. Shell established a $PM_{2.5}$ monitor at Deadhorse in conjunction with ConocoPhillips Alaska, Inc. (CPAI), which, at present, is the only monitor that collects $PM_{2.5}$ data in Prudhoe Bay area. These data are now utilized in the updated impact analysis.

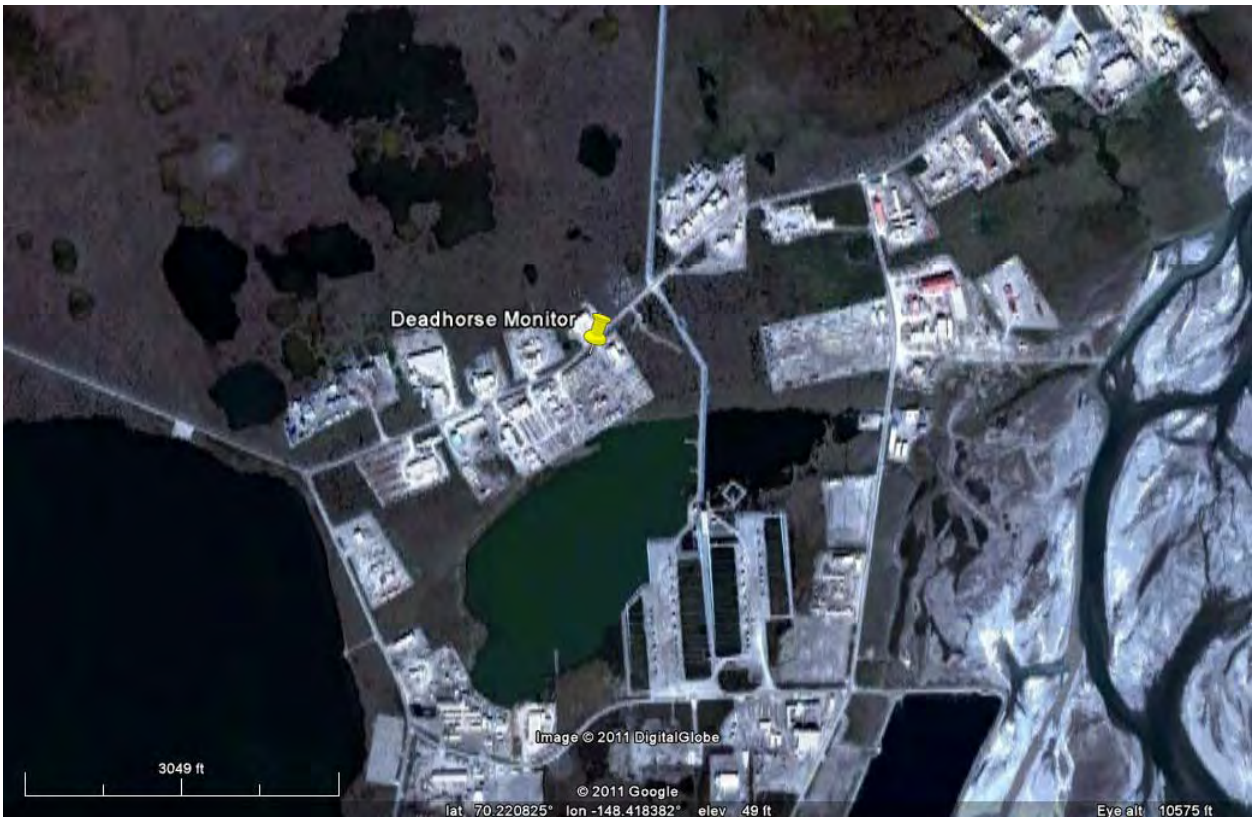
Deadhorse Monitoring Station Overview

CPAI and Shell both maintain a number of Prevention of Significant Deterioration (PSD) monitoring sites on the North Slope of Alaska to support a variety of permitting efforts. The CPAI-Shell North Slope PSD $PM_{2.5}$ Monitoring Network is a network of $PM_{2.5}$ monitoring sites operated by AECOM for CPAI and Shell on the North Slope of Alaska. The Deadhorse $PM_{2.5}$ monitoring program was designed to meet the collocated monitoring requirement required under 40 CFR 58, Appendix A for $PM_{2.5}$ monitoring for the assessment of network precision and bias.

The Deadhorse monitor was added to the CPAI-Shell North Slope PSD $PM_{2.5}$ Monitoring Network in October 2009. The Deadhorse station location was chosen as the location that would likely have the highest concentrations in the monitoring network, which is consistent with the requirements for siting the collocated monitor within the network. In other words, the Deadhorse station was intentionally sited to obtain some of the highest $PM_{2.5}$ concentrations on the North Slope.

As shown in Figure 1, the Deadhorse monitor is located in an industrialized area close to a heavily traveled, unpaved road. The land use in and immediately surrounding the Deadhorse monitoring station area is primarily light industrial, which includes gravel lay-down yards for a number of oil field support companies, the Prudhoe Bay/Deadhorse airport, and several oil field production pads. With the exception of the Prudhoe Bay/Deadhorse airport, the immediate area is dominated by exposed and routinely disturbed gravel pads and gravel roadways. There are $PM_{2.5}$ emission sources, including stationary and mobile combustion sources and many fugitive dust sources in both the upwind and downwind directions, including an exposed river bed approximately a mile upwind to the east and northeast. Nearby emission sources include lay-down yards, camps, and manufacturing and maintenance shops for various oil field support companies, oil field well sites, and numerous unpaved roads. These emission sources are in addition to the heavily industrialized areas of Prudhoe Bay to the north of Deadhorse that have some of the largest combustion-based particulate sources on the North Slope. Thus, the application of the Deadhorse $PM_{2.5}$ background concentrations to remote offshore locations is highly conservative.

Figure 1: Aerial Photograph of the Deadhorse $PM_{2.5}$ Monitor and Surrounding Areas



Analysis of $PM_{2.5}$ Measurements Likely Affected by Local Fugitive Dust Sources

The analysis described below follows the same procedures as the windblown dust analyses performed on the Wainwright $PM_{2.5}$ data sets that have been used in support of the permitting of the *Discoverer* drillship in the Chukchi Sea. The Deadhorse station began operation in late 2009 and $PM_{2.5}$ data corresponding to Shell's proposed drilling season months (July through November) are available for 2010. During this time period, 150 valid daily $PM_{2.5}$ samples were collected. Initial examination of these data reveals there are a limited number of extreme data that are inconsistent with the patterns that are seen in the area, suggesting that local sources (i.e., windblown dust) may have influenced the high measured values. These few localized high impact days are not thought to be representative of regional air quality and thus, consistent with the practices followed for the previous permitting of the *Discoverer*, Shell is proposing to remove these data from the background analysis.

The Deadhorse station is exposed to the regional air of the Beaufort Sea and therefore samples would contain $PM_{2.5}$ from the Beaufort regional air. As previously mentioned, Deadhorse also has local sources of particulate matter contributing to the baseline concentrations, which would affect the Deadhorse sampling. The task here is to use the Deadhorse data to define a reasonable 98th percentile 24-hour $PM_{2.5}$ concentration for use in the *Kulluk* impact analysis. In other words, the goal of this analysis is to separate out particulate matter that is clearly from the very localized emission sources, such as windblown dust.

Although it would be appropriate to gather statistics that could correlate with power generation and vehicle, commercial, and residential heating, etc., this analysis of the Deadhorse data focuses on determining whether there is a local wind-blown soil fugitive dust component, and if so, whether it can be eliminated from the data set to provide a data set representative the Beaufort Sea region, including impacts from the other emission sources in the Prudhoe Bay area. Wind-blown soils are known to be caused by dry and exposed soil surfaces in the presence of high winds. The logic is to segregate the days of high winds and lack of precipitation, both of which are generally conducive to surface dust becoming airborne. Because of the high latitude and human activity around Deadhorse, the surfaces all along this area have little vegetation, and without snow cover, are exposed to the winds.

The 150 samples are divided into days on which precipitation occurred (greater than 0.01 inch) and days without precipitation (0.01 inch and less) because precipitation is known to scavenge particulate matter from the atmosphere and to stabilize soil surfaces. These possible effects need to be separated from the dry conditions.

From Table 2, the average and maximum 24-hour concentrations on precipitation days are lower than concentrations measured on non-precipitation days. It is likely that the soil surface would be stabilized on most precipitation days, and wind would not cause wind-blown dust. The effect of wind is incorporated by counting the number of hours with average speeds greater than 10 meters per second, a speed known to be sufficient to initiate wind-blown dust. High-wind days are defined as days where there are four or more hours with average wind speeds greater than 10 meters per second.

Each group of $PM_{2.5}$ concentrations is subdivided into high-wind days and non-high-wind days. On non-precipitation days, the average daily concentrations on high-wind days are more than two times higher than the low-wind days. The maximum daily concentration on the high-winds days (41 $\mu g/m^3$) is more than two times higher any other daily concentration in the data set.

Table 2: Analysis of $PM_{2.5}$ Measurements Likely Affected by Local Fugitive Dust Sources

Day Categories	# Valid Days	Daily $PM_{2.5}$ Concentration ($\mu g/m^3$)		
		Average	1st-High [5]	2nd-High [5]
Precipitation Days [3]				
Non-High-Wind Days [1]	25	1.7	15	3
High-Wind Days [2]	3	2.7	3	3
Non-Precipitation Days [4]				
Non-High-Wind Days [1]	105	2.6	20	17
High-Wind Days [2]	17	6.1	41	19

[1] Days with less than 4 hours of winds greater than 10 meters/second.
[2] Days with at least 4 hours of winds greater than 10 meters/second.
[3] These days fall within the two-day periods (on that day or on the previous day) where there is total precipitation > 0.01".
[4] These days fall within the two-day periods (on that day or on the previous day) where there is total precipitation < 0.01".
[5] For each category (e.g., precipitation day non-high-wind days, precipitation day high-wind days, etc.).

Given the effect of windblown dust on measurements at Deadhorse, Shell has identified two days in particular that are affected by windblown dust and these days are removed from the data set: August 2, 2010 (41 µg/m^3, 10 hours of winds > 10 meters per second), and November 4, 2010 (19 µg/m^3, 19 hours of winds > 10 meters per second). Then, following EPA's guidance in 40 CFR 50, Appendix N, which specifies the rank associated with the 98th percentile values based on the annual number of days with valid data, Shell has determined a 98th percentile 24-hour $PM_{2.5}$ background concentration for use in the updated *Kulluk* impact analysis. Per 40 CFR 50, Appendix N, the third highest value in the data set represents the 98th percentile value from the data set. With the high windblown dust values removed, the 98th percentile of the July through November, 2010 data set is 17 µg/m^3 and this value is used in the updated *Kulluk* impact analysis. Theoretically, this value does not include blowing dust, but this background value is still very conservative when applied to offshore locations since it includes the impacts from local onshore sources such as unpaved roads, maintenance yard activities, large stationary sources, etc.

The listing of the detailed Deadhorse data values, including $PM_{2.5}$ concentrations, daily precipitation data, and wind data is provided in Attachment C.

Pairing of Modeled $PM_{2.5}$ Impacts and Background $PM_{2.5}$ Data

In Shell's February 28 impact analysis, Shell combined monitored background and modeled concentrations on a daily basis, using daily monitored background data collected concurrently with the meteorological data period being utilized in the model, and provided justification for its use. This was possible since there is concurrent Badami background concentration data and meteorological data for both 2009 and 2010. The Deadhorse $PM_{2.5}$ data are only available for 2010. As a result, EPA has asked Shell to pair modeled and monitored background per the recommendations in its March 23, 2010, guidance memo on $PM_{2.5}$ modeling procedures[3].

Per EPA guidance, the representative monitored $PM_{2.5}$ design value, rather than the overall maximum monitored background concentration, should be used as a component of the impact analysis. For the 24-hour NAAQS analysis, EPA guidance allows for the use of the 98th percentile background concentration (i.e., the 17 µg/m^3 value from Deadhorse discussed above). In addition, EPA recommends that the modeled concentrations to be added to the 98th percentile background concentration be computed based on the highest average of the maximum modeled 24-hour averages across 5 years for National Weather Service meteorological data or the maximum modeled 24-hour average for one year of site-specific meteorological data. According to EPA, the use of the average modeled concentration across the appropriate time period more accurately characterizes the modeled contribution from the facility in relation to the NAAQS rather than utilization of the highest modeled impact from individual years. Shell is considering two years of modeled data, and thus, the modeled 24-hour concentration is calculated based on the average of the highest 24-hour impacts from either 2009 or 2010 on a receptor-by-receptor

[3] EPA OAQPS. *Modeling Procedures for Demonstrating Compliance with PM2.5 NAAQS.* From Steven D. Paige, Director – Office of Air Quality Planning and Standards, pages 7–8.

basis. This two-year average of maximum 24-hour $PM_{2.5}$ concentrations from modeling is then added to the 98th percentile $PM_{2.5}$ background concentration (unpaired in time) to determine a total $PM_{2.5}$ impact value for comparison to the NAAQS.

Updated $PM_{2.5}$ modeling results using this unpaired approach are provided below.

Updated Background Concentrations

EPA has asked Shell to utilize a full year's worth of data, rather than data based on drilling season months only, when determining the background concentrations for the annual average NAAQS/AAAQS. In addition, the updated method of pairing hourly NO_2 modeling results with background NO_2 concentrations and the utilization of Deadhorse $PM_{2.5}$ background data affects the background assumptions that were made in the February 28 analysis. The revised background concentrations utilized in this updated analyses are provided in Updated Table 3-6 below.

Updated Table 3-6: Beaufort Sea Background Data Sources and Use of Background Data

Pollutant	Averaging Period	Background Concentration ($\mu g/m^3$)	Data Source
NO_2	1-hour	Diurnal profile [1], See Table 1	Calculated diurnal NO_2 profile based on the three-year average (2006, 2007, 2009) of the 98th percentile of the hourly values from the BP Pad A monitoring station.
	Annual [4]	10.7	Highest annual average (2007) at the BP Pad A monitoring station (2006, 2007, 2009).
PM_{10} [3]	24-hour	55.1	From Shell *Discoverer* Beaufort Sea PSD Permit Application (Revised September 2009); BPX Prudhoe Bay area (2006, 2007).
$PM_{2.5}$	24-hour	17.0	98th percentile value from Deadhorse (7/2010 – 11/2010); windblown dust days removed from the data set.
	Annual [4]	4.8	Deadhorse (1/2010 – 12/2010); first complete year of monitoring data.
SO_2 [3]	1-hour	13.0	BPX Liberty (7/2007 – 11/2007) for short-term averages, (2/2007 – 1/2008) for the annual average.
	3-hour	11.4	
	24-hour	4.2	
	Annual [4]	2.6	
CO [3]	1-hour	1,746	BPX Liberty (7/2007 – 11/2007) [2]
	8-hour	862	

[1] Diurnal profile of hourly NO_2 background is paired with hourly modeled impacts for the 1-hour NO_2 impact analyses.

[2] This is the same monitoring station utilized for SO_2 and CO background in the Shell *Discoverer* Beaufort Sea PSD Permit (Revised September 2009). The background value presented is the highest concentration representative of the months of Shell's proposed open-water drilling season (July – November).

[3] Short-term (i.e., 1-, 3-, 8-, 24-hour) background concentrations for PM_{10}, SO_2, and CO are conservatively assumed as the maximum values measured.

[4] Per EPA's request, annual background values are updated here to reflect annual average concentrations rather than 120-day period average concentrations specific to the months of the drilling season.

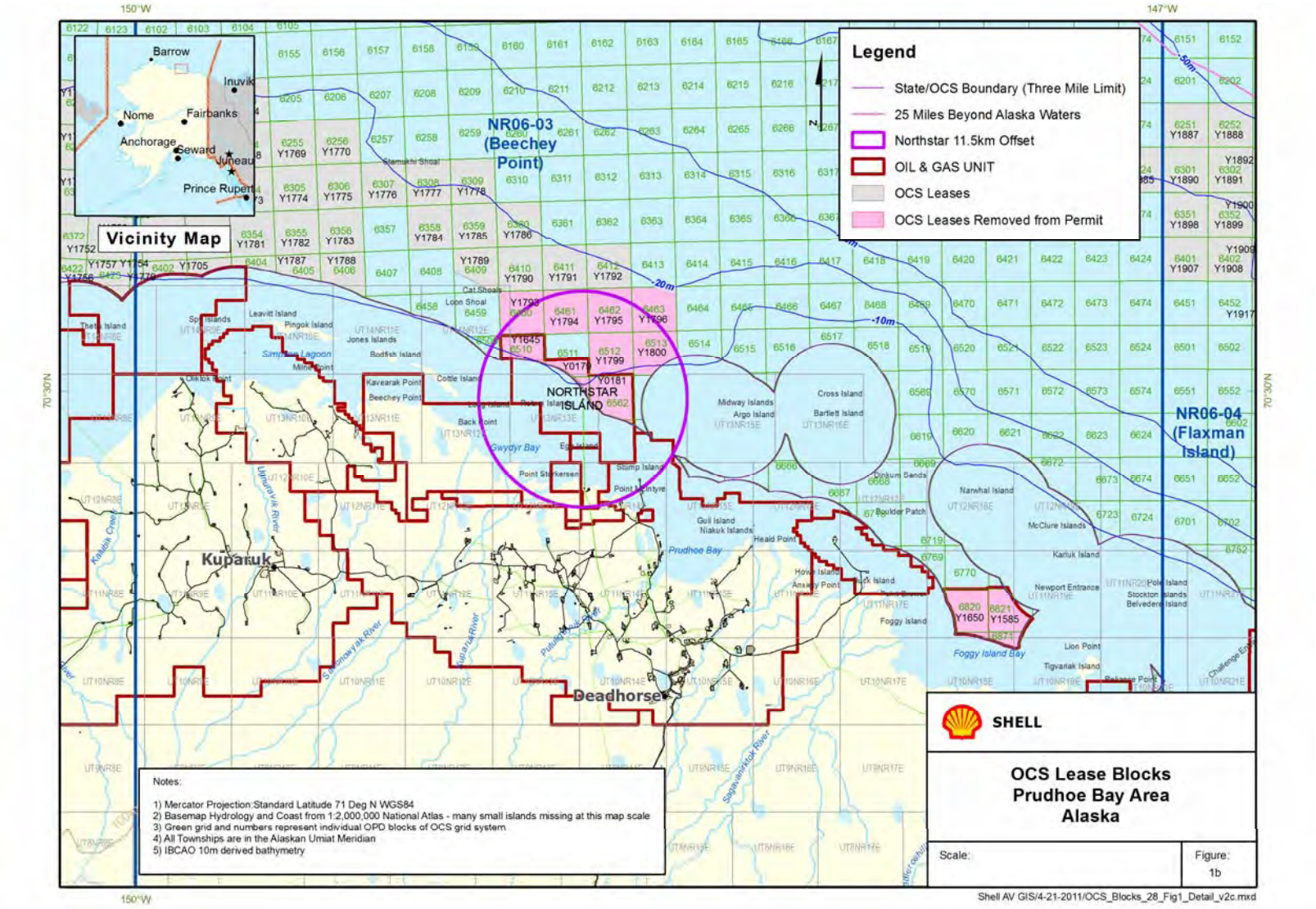
Removal of OCS Lease Blocks from Permitting Consideration

Shell has removed 11 OCS lease blocks from permitting consideration in the Prudhoe Bay area and near Foggy Island Bay (east of Prudhoe Bay) to address cumulative impact issues related to shore-based sources (see Attachment B).

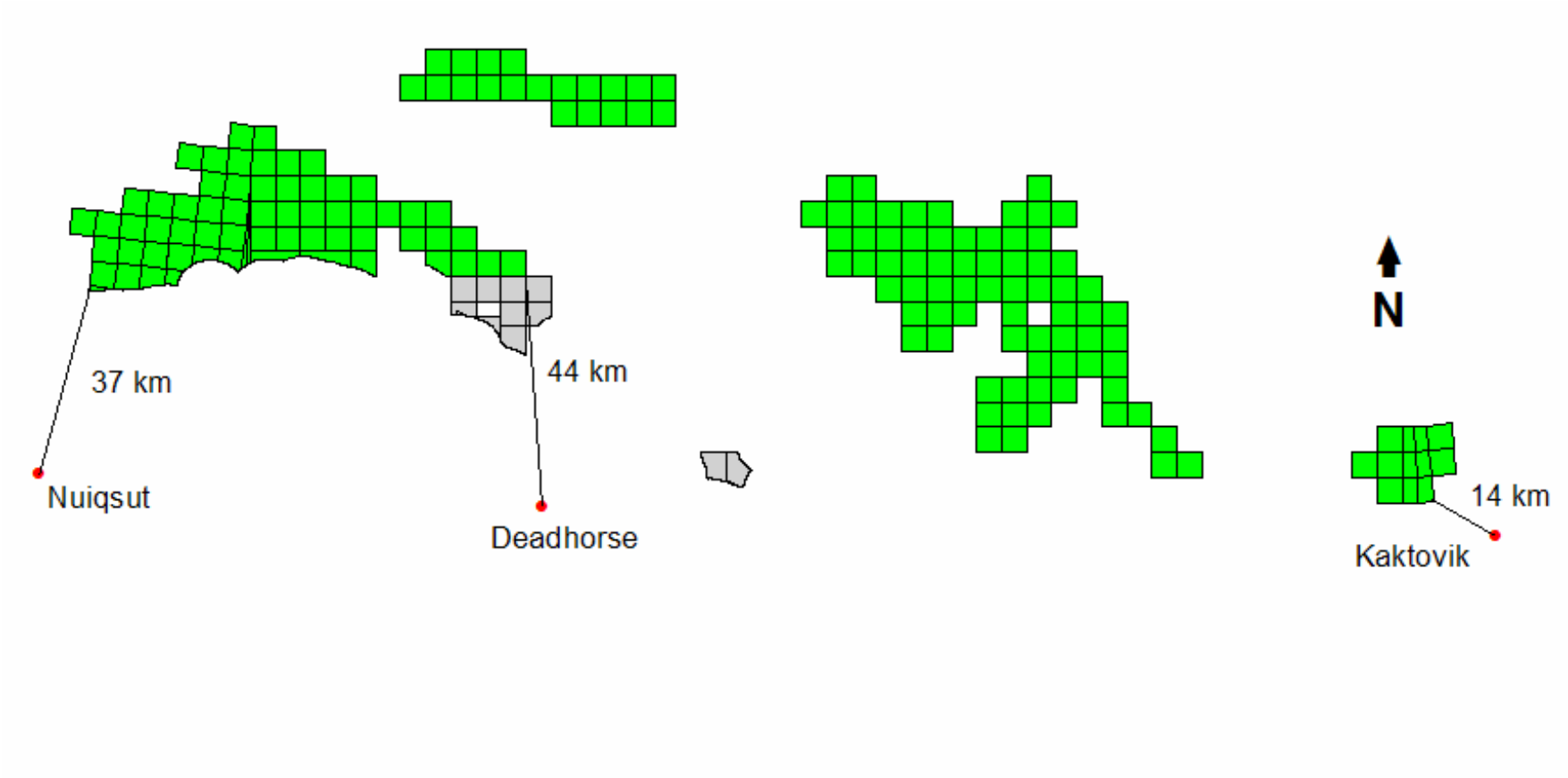
These lease changes affect the village receptor selection for onshore impacts at Deadhorse. The term "village" is used here in the broad sense to identify locations where people are present in the Prudhoe Bay area, and does not refer to villages as designated under the Alaska Native Claims Settlement Act of 1971.

Figure 2 shows the locations of Shell's updated OCS leases and highlights the leases removed from permitting consideration for the *Kulluk* application. Updated Figure 3-11 shows the locations of Shell's OCS leases relative to the nearest onshore villages. With the consideration of the removed leases, the nearest OCS lease block is now approximately 44 kilometers from Deadhorse, whereas Deadhorse was previously located approximately 32 kilometers from the nearest OCS lease blocks in the February 28 analysis.

Figure 2: Shell OCS Lease Blocks Prudhoe Bay Area Alaska



Updated Figure 3-11: Map of the Nearest Villages on the Beaufort Coast Relative to the OCS Leases
Gray-shaded lease blocks have been dropped from permitting consideration for the *Kulluk* application.
Distances shown are the distances from the revised/updated OCS lease blocks to the nearest onshore villages.



Updated Impact Modeling Results

The modeling for this updated analysis was re-performed by the methods explained in the February 28, 2011, Supplement Report. A summary of the maximum modeled impacts of the *Kulluk* and associated fleet plus background concentrations for comparison to the NAAQS/AAAQS is provided in Updated Table 3-9. These results show that Shell's proposed *Kulluk* Beaufort Sea exploratory drilling program will comply with the NAAQS/AAAQS. Note that all maximum impacts are located on or near the ambient air boundary.

The nearest coastal villages to the OCS lease blocks are Nuiqsut, Deadhorse, and Kaktovik, which are located 37, 44, and 14 kilometers from the nearest OCS lease blocks, respectively (see Updated Figure 3-11). Updated Table 3-11 provides a summary of the modeled impacts from the proposed *Kulluk* project at the nearest coastal village locations and shows that impacts are well below the NAAQS/AAAQS. Shell-only impacts are no higher than two percent of the NAAQS/AAAQS for any pollutant.

Table 3 provides a source contribution analysis for 1-hour NO_2 impacts, the pollutant/averaging time with the highest Shell-only impacts relative to the NAAQS/AAAQS. The results of this analysis indicate that the generator, MLC HPU, and air compressor sources dominate the 1-hour NO_2 impacts.

As mentioned previously, details on the nearby sources/cumulative impacts analysis issues are provided in Attachment B. Based on this analysis, only impacts from the *Kulluk* are explicitly modeled in the full impact analysis for the Beaufort Sea.

Updated Table 3-9: Summary of Maximum Modeled Impacts

Pollutant	Averaging Period	Utilize Emissions Sequence?	Pair Background In Time?	Max. Modeled Impact – Shell Only at or Beyond Ambient Air Boundary [1A, 2] ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Max. Total Impact [3, 1B,] ($\mu g/m^3$)	AAAQS/ NAAQS ($\mu g/m^3$)	Comply?
NO_2	1-hour	Yes	Yes – Diurnal	106.3	40.9	147.2	188	Yes
	Annual [1B]	Yes	No	3.4	10.7	14.1	100	Yes
$PM_{2.5}$	24-hour	Yes	No	16.9	17.0	33.9	35	Yes
	Annual [1B]	Yes	No	0.8	4.8	5.6	15	Yes
PM_{10}	24-hour	Yes	No	20.5	55.1	75.6	150	Yes
SO_2	1-hour	Yes	No	14.0	13.0	27.0	196	Yes
	3-hour	Yes	No	8.9	11.4	20.3	1,300	Yes
	24-hour	Yes	No	2.8	4.2	7.0	365	Yes
	Annual [1B]	Yes	No	0.1	2.6	2.7	80	Yes
CO	1-hour	No	No	1,268	1,746	3,014	40,000	Yes
	8-hour	No	No	712	862	1,574	10,000	Yes
NH_3	8-hour	No	No	6.6	---	6.6	2,100	Yes

[1A] Impact analyses for NO_2, $PM_{2.5}$, PM_{10}, and SO_2 span all 5 months of potential drilling activity (July through November) using two 120-day emissions sequences to eliminate bias in the meteorological data. The highest impacts from the two 120-day sequences are shown.

[1B] For the total annual impact values, the total 120-day period average impacts (Shell-only impact plus background) for NO_2, $PM_{2.5}$, and SO_2 are adjusted to annual impacts by taking into account periods of the year when Shell operations don't occur (i.e., multiply the total 120-day average impacts by 0.329 [120 drilling days out of 365 days in a year]).

[2] Impact analyses for CO and NH_3 span all 5 months (153 days) of potential drilling activity (July through November) using a single, worst-case configured model run (153 days) without consideration of emissions sequencing or intermittent source operations.

[3] Total modeled impact is the sum of the highest modeled impact (from either 2009 or 2010) plus background concentrations.
For NO_2, the 98th percentile values consistent with the form of the NAAQS are presented.
For $PM_{2.5}$, the highest two-year average modeled max. 24-hour values at any receptor are presented. For all other pollutants, the max. modeled impacts are presented.

Updated Table 3-11: Summary of Maximum Impacts at the Nearest Villages on the Beaufort Coast

Pollutant	Averaging Period	Max. Total Impacts – Background Included (μg/m³) [3, 1B]			Shell-Only Contribution to Max. Total Impacts (μg/m³) [1A, 2]			AAAQS/ NAAQS (μg/m³)	Comply?	Highest Shell-Only Impacts, Percentage of NAAQS/AAAQS (%)
		Nuiqsut	Deadhorse	Kaktovik	Nuiqsut	Deadhorse	Kaktovik			
NO_2	1-hour	66.0	65.9	66.2	0.04	0.02	0.3	188	Yes	0.2%
	Annual [1B]	10.7	10.7	10.8	0.03	0.02	0.1	100	Yes	0.1%
$PM_{2.5}$	24-hour	17.2	17.1	17.5	0.2	0.1	0.5	35	Yes	1%
	Annual [1B]	4.8	4.8	4.8	0.004	0.004	0.01	15	Yes	0.1%
PM_{10}	24-hour	55.4	55.3	55.6	0.3	0.2	0.5	150	Yes	0.3%
SO_2	1-hour	13.4	13.5	13.7	0.4	0.5	0.7	196	Yes	0.4%
	3-hour	11.6	11.6	11.7	0.2	0.2	0.3	1,300	Yes	0.03%
	24-hour	4.2	4.2	4.3	0.05	0.03	0.1	365	Yes	0.02%
	Annual [1B]	2.6	2.6	2.6	0.001	0.001	0.002	80	Yes	0.002%
CO	1-hour	1,946	1,928	2,079	200.5	181.6	333.0	40,000	Yes	1%
	8-hour	979	967	1,042	116.7	105.3	180.3	10,000	Yes	2%
NH_3	8-hour	1.6	1.5	2.6	1.6	1.5	2.6	2,100	Yes	0.1%

[1A] Impact analyses for NO_2, $PM_{2.5}$, PM_{10}, and SO_2 span all 5 months of potential drilling activity (July through November) using two 120-day emissions sequences to eliminate bias in the meteorological data. The highest impacts from the two 120-day sequences are shown:
Sequence "A" = July 1 through October 28, Sequence "B" = August 3 through November 30.

[1B] For the total annual impact values, the total 120-day period average impacts (Shell-only impact plus background) for NO_2, $PM_{2.5}$, and SO_2 are adjusted to annual impacts by taking into periods of the year when Shell operations don't occur (i.e., multiply the total 120-day average impacts by 0.329 [120 drilling days out of 365 days in a year]).

[2] Impact analyses for CO and NH_3 span all 5 months (153 days) of potential drilling activity (July through November) using a single, worst-case configured model run (153 days) without consideration of emissions sequencing or intermittent source operations.

[3] Total modeled impact is the sum of the highest modeled impact (from either 2009 or 2010) plus background concentrations.
For NO_2, the 98th percentile values consistent with the form of the NAAQS are presented.
For $PM_{2.5}$, the highest two-year average modeled max. 24-hour values at any receptor are presented.
For all other pollutants, the max. modeled impacts are presented.

Table 3: Source Contribution Analysis for 1-hour NO_2

Source	Model ID	1-Hour NO_2 Impact Contribution ($\mu g/m^3$)	(%)
Kulluk			
Generation	MAINENGS	21.1	20%
MLC HPU	MLCHPU_A	18.9	18%
MLC HPU	MLCHPU_B	18.9	18%
Air Compressor (port)	AIRCMP_A	23.7	22%
Air Compressor (starboard)	AIRCMP_B	12.7	12%
Crane	CRANE_A	1.2	1%
Crane	CRANE_B	0.8	1%
Crane	CRANE_C	0.8	1%
Heaters and Boilers	HEATBOIL	1.0	1%
Incinerator	INCIN_K	0	0%
Seldom-Used Units (typical operations)	SELDOML	0.4	0.3%
Seldom-Used Units (emerg. gen. exercising)	SELDOMH	0	0%
Associated Fleet			
Resupply Ship (DP Mode Emissions)	RESUP_DP	0	0%
Ice Management/Anchor Handler	ICEMGMT2	4.5	4%
Main OSR Ship	OSR_MAIN	1.6	2%
OSR Work Boats	OSR_WORK	0.7	1%
	Total >	106.3	100%

[1] Maximum impact receptor (98th percentile) is located near the ambient air boundary, 500 meters from the *Kulluk* (X = -530.1 m, Y = 102.9 m); impact occurs in Sequence B on 11/04/2009, hour 22.

ATTACHMENT A

Source Usage and Allowable Emissions

Air Sciences Inc.	PROJECT TITLE: Shell - Exploration Drilling	BY: S. Pryor		
ENGINEERING CALCULATIONS	PROJECT NO: 180-20-6	PAGE: 1	OF: 1	SHEET: 1
	SUBJECT: Kulluk / Beaufort Pmt App	DATE: April 28, 2011		

SUMMARY - ALLOWABLE EMISSIONS

	NO_X tons/year	$PM_{2.5}$ tons/year	PM_{10} tons/year	CO tons/year	SO_2 tons/year	VOC tons/year	Lead tons/year	GHG tons/year
Engines	227.8	23.7	23.7	80.1	3.9	12.9	1.0E-02	59,870
Incinerators	0.8	3.8	4.5	82.1	0.7	27.4	5.8E-02	539
De-gassing								4.2
Total	228.6	27.5	28.2	162.1	4.6	40.3	6.9E-02	60,413
PSD trigger	250	250	250	250	250	250	250	100,000
Compare	Below	Below	Below	Below	Below	Below	Below	Below

	HAP tons/year	CH_2O tons/year	H_2SO_4 tons/year	Fluorides [a] tons/year	H_2S [b] tons/year	TRS [b] tons/year	RSC [b] tons/year
Engines	5.1E-01	0.2	0.3	-	2.08E-02	2.08E-02	2.08E-02
Incinerators	6.9E-02	0.0	0.3	-	3.64E-01	3.64E-01	3.64E-01
Total	0.6	0.2	0.6	-	0.4	0.4	0.4
PSD trigger	250	250	250	250	250	250	250
Compare	Below	Below	Below	Below	Below	Below	Below

[a] Fluoride is not a listed and quantified trace pollutant from diesel combustion as provided by AP42, so it is assumed to be an extremely small constituent. Furthermore, fluoride is a reduced form of fluorine and diesel combustion is an oxidizing process. Therefore, it is unlikely that it would exist as a combustion bi-product and should be a negligible emission from the project.

[b] H_2S also represents upper limit of total reduced sulfur and reduced sulfur compound emissions

blue values are input, black values are calculated or linked

ALLOWABLE EMISSIONS

shading represents owner restriction (OR) to be demonstrated by documentation of each event
shading represents OR to be demonstrated by documentation of daily fuel consumption
shading represents OR to be demonstrated by documentation of weekly fuel consumption

ANTICIPATED KULLUK OPERATING MAXIMUMS

Kulluk & Associated Fleet

Expected Operating Maximums	Limit		How Defined	How documented
MLC Drilling Activity	480	hrs/activity	20 days/activity	
Well Drilling Activity	1,152	hrs/activity	48 days/activity	
Cementing/Logging Activity	1,248	hrs/activity	52 days/activity	
Season maximum drilling duration as an OCS source (secure and stable for commencement of exploratory activity):	2,880	hrs/season	120 days/season	
Ice mgmt vessel use within 25 miles	38%			
OSR vessel annual fuel limit	60%	of daily maximum - annualized		
MLC Activity				
Generators (three units combined) combined	85%	capacity	System Limitation	
Crane (three units combined) maximum	40%	capacity	System Limitation	
Crane (three units combined) maximum	30%	of time (day)	Shell engineering estimate	
Well Drilling Activity				
Generators (three units combined) combined production maximum	85%	capacity	System Limitation	
Crane (three units combined) maximum	40%	capacity	System Limitation	
Crane (three units combined) maximum	30%	of time (day)	Shell engineering estimate	
Cementing/Logging Activity				
Generators (three units combined) combined	60%	capacity	Shell OR	
Crane (three units combined) maximum	40%	capacity	System Limitation	
Crane (three units combined) maximum	50%	of time (day)	Shell engineering estimate	
All Activities - OR				
Kulluk Incinerator limited to	12	hr/day	Shell OR	manual - recording of start and stop time
Kulluk emergency generator limited to	2	hr/30-days & hr/day		
Sulfur content of all stationary source engines on Kulluk	0.0100%	by wt.	Shell OR	Kulluk fuel testing
Sulfur content of associated fleet	0.0100%	by wt.	Shell OR	Fleet fuel testing
Ice Management Fleet Propulsion & Generation	100%	capacity	System Limitation	
Resupply ship in transport limited to	1,200	gal/1-way	Shell OR	Fuel consumption measurement
Resupply ship in DP mode limited to	4,800	gal/event	Shell OR	Fuel consumption measurement
Resupply ship resupply events limited to	24	rnd trip/season	Shell OR	Manual tracking
Resupply ship DP events limited to	24	hr/day=hr/event	Shell OR	Manual tracking
OSR Vessel p & g aggregate power:	2,600	kW		Manufacturer specifications
OSR Vessel p & g aggregate consumption:	2,800	gal/day	Shell OR	Fuel consumption measurement
OSR work boats	3,789	gallons/wk.	Shell OR	Fuel consumption measurement

OSR Boat Options

OSR vessel: Pt. Oliktuk/Arctic Endeavor

Work Boats			
#1 OSR 34-foot	32	gal/hr	
#2 OSR 34-foot	32	gal/hr	
#1 OSR 47-foot	63	gal/hr	
ALL	6	hr/day	
ALL	5	day/week	
ALL	100%	hourly fuel consumption	

Conversions

0.7457	kW / hp
1,000,000	Btu / MMBtu
453.592	g / lb
2,000	lb / ton
24	hr / day
168	hr / wk
2	one-way trips / round trip
32.07	weight S
64.06	weight SO2
2.00	weight conversion of S to SO2
8.34	lb/gal (Density of water)

Assumptions				Reference
Diesel Density	0.8398	7.00	lb/gal	Tesoro Nikiski, Email Royal Harris 4/20/11
Diesel Engine Thermal Efficiency		7,000	Btu/hp-hr	<600 hp; AP42 Table 3.3-1 Footnote (a) ver. 10/96.
Diesel Heating Value	131,180 Btu/gal	0.1312	MMBtu/gallon	Tesoro Nikiski, Email Royal Harris 4/20/11

** seldom-used engines are those running < 4 hr/wk.

blue values are input, black values are calculated or linked

ALLOWABLE EMISSIONS

EMISSION FACTORS AND CONTROL DEVICES

	Controls				EF Reference				
Emission Unit	**NOx**	**PM**	**CO**	**VOC**	**NOx**	**PM**	**CO**	**VOC**	**Control**
Kulluk									
Generation	Kulluk-SCR	OxyCat-Lg	OxyCat-Lg	OxyCat-Lg	4	7	7	7	SCR, Oxycat
MLC HPUs	None-Sm	OxyCat-Sm	OxyCat-Sm	OxyCat-Sm	2	8	8	8	OxyCat
Air compressors	None-Lg	OxyCat-Lg	OxyCat-Lg	OxyCat-Lg	1	7	7	7	OxyCat
Cranes	None-Sm	OxyCat-Sm	OxyCat-Sm	OxyCat-Sm	2	8	8	8	OxyCat
Heaters & Boilers	heat&boil	heat&boil	heat&boil	heat&boil	3	3	3	3	None
Seldom-used units	None-Sm	None-Sm	None-Sm	None-Sm	2	2	2	2	None
Emergency Generator	None-Sm	None-Sm	None-Sm	None-Sm	2	2	2	2	None
Primary Ice Management									
Propulsion & Generation	SCR	OxyCat-Lg	OxyCat-Lg	OxyCat-Lg	5	7	7	7	SCR, Oxycat
Heaters & Boilers	heat&boil	heat&boil	heat&boil	heat&boil	3	3	3	3	None
Seldom-used units	None-Sm	None-Sm	None-Sm	None-Sm	2	2	2	2	None
Secondary Ice Management / Anchor Handler									
Propulsion & Generation	SCR	OxyCat-Lg	OxyCat-Lg	OxyCat-Lg	5	7	7	7	SCR, Oxycat
Heaters & Boilers	heat&boil	heat&boil	heat&boil	heat&boil	3	3	3	3	None
Seldom-used units	None-Sm	None-Sm	None-Sm	None-Sm	2	2	2	2	None
Resupply Ship - transport mode									
Propulsion & Generation	None-Lg	None-Lg	None-Lg	None-Lg	1	1	1	1	None
Seldom-used units	None-Sm	None-Sm	None-Sm	None-Sm	2	2	2	2	None
Resupply Ship - DP mode									
Propulsion & Generation	None-Lg	None-Lg	None-Lg	None-Lg	1	1	1	1	None
Seldom-used units	None-Sm	None-Sm	None-Sm	None-Sm	2	2	2	2	None
OSR vessel									
Propulsion & Generation	None-Lg	None-Lg	None-Lg	None-Lg	1	1	1	1	None
Seldom-used units	None-Sm	None-Sm	None-Sm	None-Sm	2	2	2	2	None
OSR work boats									
Work boats	None-Sm	None-Sm	None-Sm	None-Sm	2	2	2	2	None

Assumed Control Device Effectiveness	**Restriction**	**Comment**	**Reference**
Oxidation Catalyst CO reduction efficiency	80%	50-100% of capacity	D.E.C. Marine AB letter, October 9, 2008, and initial stack test
Oxidation Catalyst VOC, HAPs (except metals), Formaldehyde reduction efficiency	70%	50-100% of capacity	D.E.C. Marine AB letter, October 9, 2008
Oxidation Catalyst PM reduction efficiency	50%		D.E.C. Marine AB email, February 9, 2009
CDPF reduction efficiency CO, VOC, HAPs	90%		CleanAIR CDPF guarantee
CDPF reduction efficiency PM	85%		CARB Currently verified, Jan. 2009, CleanAIR Systems PERMIT
Kulluk Generator SCR NOx control	1.6 g/kW-hr	50-100% of capacity	June 2010 Discoverer Stack Testing

Engine	**NOx**		**CO**		**VOC**		**PM***		
Emission Factors / Controls	**g/kW-hr**	**lb/gal**	**lb/MMBtu**	**lb/gal**	**lb/MMBtu**	**lb/gal**	**g/kWhr**	**lb/gal**	**Reference**
None-Lg	12.00	0.370	0.85	0.112	0.09	0.012	0.50	0.015	1
None-Sm	15.00	0.462	0.95	0.125	0.35	0.046	1.20	0.037	2
heat&boil	20 lb/kgal	0.020	5 lb/kgal	0.005	1 lb/kgal	0.001	3 lb/kgal	0.003	3
Kulluk-SCR	1.60	0.049	-	-	-	-	-	-	4
SCR	1.60	0.049	-	-	-	-	-	-	5
Kulluk-OxyCat	-	-	-	-	-	-	0.200	0.006	6
OxyCat-Lg	-	-	0.170	0.022	0.027	0.004	0.250	0.008	7
OxyCat-Sm	-	-	0.190	0.025	0.105	0.014	0.600	0.018	8
CDPF-Lg	-	-	0.085	0.011	0.009	0.001	0.075	0.002	9
Electric	0	0	0	0	0	0	0	0	NA

*PM2.5

References

None-Lg	1	NOx & PM: Recent stack test data, CO & VOC:AP-42 Table 3.4-1 Internal Combustion, Large Stationary Engines (fuel Input)-uncontrolled; ver. 10/1996
None-Sm	2	NOx & PM: Recent stack test data, CO & VOC: AP-42.Table 3.3-1 Internal Combustion, Diesel (fuel input)-uncontrolled; ver. 10/1996
heat&boil	3	NOx & PM: Recent Stack test data, CO & VOC: AP-42. Table 1.11-2 External Combustion, Small Boilers-waste oil; ver 10/1996
Kulluk-SCR	4	Emission factors based on stack tests from the Frontier Discoverer
SCR	5	Selective Catalytic Reduction NOx emission factor based on stack tests
Kulluk-OxyCat	6	PM: Tier 2 engines
OxyCat-Lg	7	Oxidation Catalyst controls applied to reference (1) emission factors
OxyCat-Sm	8	Oxidation Catalyst controls applied to reference (2) emission factors
CDPF-Lg	9	Catalytic Diesel Particulate Filters controls applied to reference (1) emission factors

ALLOWABLE EMISSIONS

FUEL USE - MAX DAILY

		Capacity fuel - hourly		Max fuel - daily					
				MLC Case		Drilling Case		Cementing/Logging Case	
Emission Unit	**Capacity Values**	**MMBtu/hr**	**gal/hr**	**MMBtu**	**gal**	**MMBtu**	**gal**	**MMBtu**	**gal**
Kulluk									
Generation	8,500 hp	50.58	386	1,214	9,253	1,214	9,253	857	6,531
MLC HPUs	1,500 hp	10.50	80	252	1,921	0	0	0	0
Air compressors	1,500 hp	10.50	80	252	1,921	0	0	0	0
Cranes	1,200 hp	3.36	26	24	184	24	184	40	307
Heaters & Boilers	6 MMBtu/hr	6.00	46	144	1,098	144	1,098	144	1,098
Seldom-used units	566 gal/30-days	0.10	0.79 group limit	2	19	2	19	2	19
Emergency Generator	77 gal/30-days	5.050	38.50 group limit	10	77	10	77	10	77
			KULLUK - SUBTOTAL		*14,473*		*10,631*		*8,032*
Primary Ice Management									
Propulsion & Generation	32,200 hp	225	1,718	5,410	41,238	5,410	41,238	5,410	41,238
Heaters & Boilers	10 MMBtu/hr	10	76	240	1,830	240	1,830	240	1,830
Seldom-used units	100 gal/wk	0.078	0.60 group limit	2	14	2	14	2	14
			ICE MANAGEMENT - SUBTOTAL		*43,082*		*43,082*		*43,082*
Secondary Ice Management / Anchor Handler									
Propulsion & Generation	32,200 hp	225	1,718	5,410	41,238	5,410	41,238	5,410	41,238
Heaters & Boilers	10 MMBtu/hr	10	76	240	1,830	240	1,830	240	1,830
Seldom-used units	100 gal/wk	0.078	0.60 group limit	2	14	2	14	2	14
			ANCHOR HANDLER - SUBTOTAL		*43,082*		*43,082*		*43,082*
Resupply Ship - transport mode									
Propulsion & Generation	12,000 hp	84	640	157	1,200	157	1,200	157	1,200
Seldom-used units	20 gal/wk	0.016	0.12 group limit	0.4	2.9	0.4	2.9	0.4	2.9
Resupply Ship - DP mode									
Propulsion & Generation	12,000 hp	84	640	630	4,800	630	4,800	630	4,800
Seldom-used units	20 gal/wk	0.016	0.12 group limit	0.4	2.9	0.4	2.9	0.4	2.9
			RESUPPLY SHIPS - SUBTOTAL		*6,006*		*6,006*		*6,006*
OSR vessel									
Propulsion & Generation	3,487 hp	15	117	367	2,800	367	2,800	367	2,800
Seldom-used units	100 gal/wk	0.078	0.60 group limit	2	14	2	14	2	14
OSR work boats									
Work boats	3,789 gal/wk	2.96	23	71	541	71	541	71	541
			OSR SHIPS - SUBTOTAL		*3,356*		*3,356*		*3,356*
			Total daily use		**109,998**		**106,156**		**103,557**

TOTAL WASTE INCINERATED

		MLC Case	Drilling Case	Cementing/Logging case
Incinerators	**Capacity Values**	**lbs/day**	**lbs/day**	**lbs/day**
Kulluk	276 lb/hr	3,312	3,312	3,312
Ice Management	154 lb/hr	3,696	3,696	3,696
Anchor Handler	154 lb/hr	3,696	3,696	3,696
OSR vessel	125 lb/hr	3,000	3,000	3,000
	Total daily use	**13,704**	**13,704**	**13,704**

ALLOWABLE EMISSIONS

FUEL USE - MAX ANNUAL

		Capacity fuel - hourly		Max fuel - Annual (Modeling only)						
				MLC Case		Drilling Case		Cementing/Logging Case		Total
Emission Unit	Capacity Values	MMBtu/hr	gal/hr	MMBtu	gal	MMBtu	gal	MMBtu	gal	gal
Kulluk										
Generation	8,500 hp	50.58	386	24,276	185,059	58,262	444,141	44,554	339,637	968,837
MLC HPUs	1,500 hp	10.50	80	5,040	38,420	0	0	0	0	38,420
Air compressors	1,500 hp	10.50	80	5,040	38,420	0	0	0	0	38,420
Cranes	1,200 hp	3.36	26	484	3,688	1,161	8,852	2,097	15,983	28,523
Heaters & Boilers	6 MMBtu/hr	6.00	46	2,880	21,955	6,912	52,691	7,488	57,082	131,727
Seldom-used units	566 gal/30-days	0.10	0.79 group limit	49	377	119	906	129	981	2,264
Emergency Generator	77 gal/30-days	5.050	38.50 group limit	7	51	16	123	18	133	308
			KULLUK - SUBTOTAL		*287,971*		*506,713*		*413,816*	*1,208,500*
Primary Ice Management										
Propulsion & Generation	32,200 hp	225	1718	41,113	313,409	98,671	752,181	106,894	814,863	1,880,453
Heaters & Boilers	10 MMBtu/hr	10	76	1,824	13,905	4,378	33,371	4,742	36,152	83,427
Seldom-used units	100 gal/wk	0.078	0.60 group limit	14	109	34	261	37	282	651
			ICE MANAGEMENT - SUBTOTAL		*327,422*		*785,813*		*851,297*	*1,964,531*
Secondary Ice Management / Anchor Handler										
Propulsion & Generation	32,200 hp	225	1718	41,113	313,409	98,671	752,181	106,894	814,863	1,880,453
Heaters & Boilers	10 MMBtu/hr	10	76	1,824	13,905	4,378	33,371	4,742	36,152	83,427
Seldom-used units	100 gal/wk	0.078	0.595 group limit	14	109	34	261	37	282	651
			ANCHOR HANDLER - SUBTOTAL		*327,422*		*785,813*		*851,297*	*1,964,531*
Resupply Ship - transport mode										
Propulsion & Generation	12,000 hp	84	640	1,259	9,600	3,022	23,040	3,274	24,960	57,600
Seldom-used units	20 gal/wk	0.016	0.12 group limit	7	57	18	137	19	149	343
Resupply Ship - DP mode										
Propulsion & Generation	12,000 hp	84	640	2,519	19,200	6,045	46,080	6,549	49,920	115,200
Seldom-used units	20 gal/wk	0.016	0.12 group limit	7	57	18	137	19	149	343
			RESUPPLY SHIPS - SUBTOTAL		*28,914*		*69,394*		*75,177*	*173,486*
OSR vessel										
Propulsion & Generation	3,487 hp	15	117	4,408	33,600	10,578	80,640	11,460	87,360	201,600
Seldom-used units	100 gal/wk	0.078	0.6 group limit	37	286	90	686	97	743	1,714
OSR work boats										
Work boats	3,789 gal/wk	2.96	23	1,420	10,827	3,409	25,984	3,693	28,149	64,960
			OSR SHIPS - SUBTOTAL		*44,712*		*107,310*		*116,252*	*268,274*
			Total Annual Use		**1,016,442**		**2,255,042**		**2,307,840**	**5,579,323**
				TOTAL ANNUAL GALLONS		**5,579,323**				

TOTAL WASTE INCINERATED

	Capacity Values	MLC Case	Drilling Case	Cementing/Logging case	Total
Incinerators		lbs/year	lbs/year	lbs/year	tons /year
Kulluk	276 lb/hr	66,240	158,976	172,224	199
Ice Management	154 lb/hr	28,090	67,415	73,033	84
Anchor Handler	154 lb/hr	28,090	67,415	73,033	84
OSR vessel	125 lb/hr	60,000	144,000	156,000	180
	total lbs/yr	**182,419**	**437,806**	**474,290**	**547**

*This activity cannot occur simultaneously with Resupply - DP mode. DP mode has greater impacts.

ALLOWABLE EMISSIONS

NOx EMISSIONS - FOR IMPACT MODELING

shading represents OR to be demonstrated by documentation of daily fuel consumption

shading represents OR to be demonstrated by documentation of weekly fuel consumption

COMBUSTION SOURCE EMISSIONS

Source	Emission Factor	unit	*lb/hr*^	lb/hr	Max *lb/day*^	MLC lb/day	DRILL lb/day	C/L lb/day	TOTAL ton/year
Kulluk									
Generation	0.049	lb/gal		19.00	456	456	456	322	24
MLC HPUs	0.462	lb/gal		36.99	888	888	0	0	9
Air compressors	0.370	lb/gal		29.59	710	710	0	0	7
Cranes	0.462	lb/gal		11.84	142	85	85	142	7
Heaters & Boilers	0.020	lb/gal		0.91	22	22	22	22	1
Seldom-used units	0.462	lb/gal		0.36	8.72	8.72	8.72	8.72	0.52
Emergency Generator	0.462	lb/gal		17.79	35.58	35.58	35.58	35.58	0.07
Primary Ice Management									
Propulsion & Generation	0.049	lb/gal		85	2,033	2,033	2,033	2,033	46
Heaters & Boilers	0.020	lb/gal		1.52	37	37	37	37	0.83
Seldom-used units	0.462	lb/gal		0.28	6.60	6.60	6.60	6.60	0.15
Secondary Ice Management / Anchor Handler									
Propulsion & Generation	0.049	lb/gal		85	2,033	2,033	2,033	2,033	46
Heaters & Boilers	0.020	lb/gal		1.52	37	37	37	37	0.83
Seldom-used units	0.462	lb/gal		0.28	6.60	6.60	6.60	6.60	0.15
Resupply Ship - transport mode									
Propulsion & Generation	0.370	lb/gal	*237*	(0*)	444	(0*)	(0*)	(0*)	11
Seldom-used units	0.462	lb/gal	*0.055*	(0*)	1.32	(0*)	(0*)	(0*)	0.08
Resupply Ship - DP mode									
Propulsion & Generation	0.370	lb/gal		237	1,775	1,775	1,775	1,775	21
Seldom-used units	0.462	lb/gal		0.06	1.32	1.32	1.32	1.32	0.08
OSR vessel									
Propulsion & Generation	0.370	lb/gal		43	1,035	1,035	1,035	1,035	37
Seldom-used units	0.462	lb/gal		0.28	6.60	6.60	6.60	6.60	0.40
OSR work boats									
Work boats	0.462	lb/gal		10	250	250	250	250	15
TOTAL				**580**	**9,927**	**9,425**	**7,827**	**7,750**	**228**

INCINERATOR EMISSIONS

Source	Emission Factor	unit	NO_x lb/hr	NO_x lb/day	NO_x ton/year
Incinerators					
Kulluk	3	lb/ton	0.41	4.97	0.30
Ice Management	3	lb/ton	0.23	5.54	0.13
Anchor Handler	3	lb/ton	0.23	5.54	0.13
OSR vessel	3	lb/ton	0.19	4.50	0.27
TOTAL			**1.06**	**20.56**	**0.82**

	NO_x ton/year
TOTAL ALL SOURCES	**229**

EMISSION FACTORS

Source	Pollutant	EF	unit	Reference
Incinerators	NO_X	3	lb/ton	AP42 Table 2.1-12, 10/96

*This activity cannot occur simultaneously with Resupply - DP mode. DP mode has greater impacts.

^Values in this column represent maximum emissions independent of activity.

ALLOWABLE EMISSIONS

$PM_{2.5}$ EMISSIONS - FOR IMPACT MODELING

shading represents OR to be demonstrated by documentation of daily fuel consumption

shading represents OR to be demonstrated by documentation of weekly fuel consumption

COMBUSTION SOURCE EMISSIONS

Source	Emission Factor	unit	*lb/hr*^	lb/hr	Max *lb/day*^	MLC lb/day	DRILL lb/day	C/L lb/day	TOTAL ton/year
Kulluk									
Generation	0.008	lb/gal		2.97	71	71	71	50	3.73
MLC HPUs	0.018	lb/gal		1.48	36	36	0	0	0.36
Air compressors	0.008	lb/gal		0.62	15	15	0	0	0.15
Cranes	0.018	lb/gal		0.47	6	3	3	6	0.26
Heaters & Boilers	0.003	lb/gal		0.15	4	4	4	4	0.22
Seldom-used units	0.037	lb/gal		0.03	0.70	0.70	0.70	0.70	0.04
Emergency Generator	0.037	lb/gal		1.42	2.85	2.85	2.85	2.85	0.01
Primary Ice Management									
Propulsion & Generation	0.008	lb/gal		13	318	318	318	318	7
Heaters & Boilers	0.003	lb/gal		0.25	6	6	6	6	0.14
Seldom-used units	0.037	lb/gal		0.02	0.53	0.53	0.53	0.53	0.01
Secondary Ice Management / Anchor Handler									
Propulsion & Generation	0.008	lb/gal		13	318	318	318	318	7
Heaters & Boilers	0.003	lb/gal		0.25	6	6	6	6	0.14
Seldom-used units	0.037	lb/gal		0.02	0.53	0.53	0.53	0.53	0.01
Resupply Ship - transport mode									
Propulsion & Generation	0.015	lb/gal	*10*	(0*)	18	(0*)	(0*)	(0*)	0.44
Seldom-used units	0.037	lb/gal	*0.004*	(0*)	0.11	(0*)	(0*)	(0*)	0.01
Resupply Ship - DP mode									
Propulsion & Generation	0.015	lb/gal		10	74	74	74	74	1
Seldom-used units	0.037	lb/gal		0.00	0.11	0.11	0.11	0.11	0.01
OSR vessel									
Propulsion & Generation	0.015	lb/gal		2	43	43	43	43	2
Seldom-used units	0.037	lb/gal		0.02	0.53	0.53	0.53	0.53	0.03
OSR work boats									
Work boats	0.037	lb/gal		0.83	20	20	20	20	1
TOTAL				**47**	**939**	**918**	**868**	**849**	**24**

INCINERATOR EMISSIONS

Source	Emission Factor PM_{10}	Emission Factor $PM_{2.5}$	unit	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	PM_{10} lb/day	$PM_{2.5}$ lb/day	PM_{10} ton/year	$PM_{2.5}$ ton/year
Incinerators									
Kulluk	16.4	14	lb/ton	2.26	1.93	27.16	23.18	1.63	1.39
Ice Management	16.4	14	lb/ton	1.26	1.08	30.31	25.87	0.69	0.59
Anchor Handler	16.4	14	lb/ton	1.26	1.08	30.31	25.87	0.69	0.59
OSR vessel	16.4	14	lb/ton	1.03	0.88	24.60	21.00	1.48	1.26
TOTAL				**5.81**	**4.96**	**112.37**	**95.93**	**4.49**	**3.83**

	PM_{10} ton/year	$PM_{2.5}$ ton/year
TOTAL ALL SOURCES	**28**	**28**

EMISSION FACTORS

Source	Pollutant	EF	unit	Reference
Incinerators	PM_{10}	16.4	lb/ton	Disco Stack Test June 2010 (multiplied by a safety factor of 2)
Incinerators	$PM_{2.5}$	14	lb/ton	Disco Stack Test June 2010 (multiplied by a safety factor of 2)

*This activity cannot occur simultaneously with Resupply - DP mode. DP mode has greater impacts.

^Values in this column represent maximum emissions independent of activity.

ALLOWABLE EMISSIONS

CO EMISSIONS - FOR IMPACT MODELING

COMBUSTION SOURCE EMISSIONS

Source	Emission Factor	unit	*lb/hr^*	lb/hr	Max *lb/day^*	MLC lb/day	DRILL lb/day	C/L lb/day	TOTAL ton/year
Kulluk									
Generation	0.022	lb/gal		8.60	206	206	206	146	10.80
MLC HPUs	0.025	lb/gal		2.00	48	48	0	0	0.48
Air compressors	0.022	lb/gal		1.79	43	43	0	0	0.43
Cranes	0.025	lb/gal		0.64	8	5	5	8	0.36
Heaters & Boilers	0.005	lb/gal		0.23	5	5	5	5	0.33
Seldom-used units	0.125	lb/gal		0.10	2.35	2.35	2.35	2.35	0.14
Emergency Generator	0.125	lb/gal		4.80	9.60	9.60	9.60	9.60	0.02
Primary Ice Management									
Propulsion & Generation	0.022	lb/gal		38.32	920	920	920	920	21
Heaters & Boilers	0.005	lb/gal		0.38	9	9	9	9	0.21
Seldom-used units	0.125	lb/gal		0.07	1.78	1.78	1.78	1.78	0.04
Secondary Ice Management / Anchor Handler									
Propulsion & Generation	0.022	lb/gal		38.32	920	920	920	920	21
Heaters & Boilers	0.005	lb/gal		0.38	9	9	9	9	0.21
Seldom-used units	0.125	lb/gal		0.07	1.78	1.78	1.78	1.78	0.04
Resupply Ship - transport mode									
Propulsion & Generation	0.112	lb/gal	*71*	(0*)	134	(0*)	(0*)	(0*)	3.21
Seldom-used units	0.125	lb/gal	*0.015*	(0*)	0.36	(0*)	(0*)	(0*)	0.02
Resupply Ship - DP mode									
Propulsion & Generation	0.112	lb/gal		71	535	535	535	535	6
Seldom-used units	0.125	lb/gal		0.01	0.36	0.36	0.36	0.36	0.02
OSR vessel									
Propulsion & Generation	0.112	lb/gal		13	312	312	312	312	11
Seldom-used units	0.125	lb/gal		0.07	1.78	1.78	1.78	1.78	0.11
OSR work boats									
Work boats	0.125	lb/gal		3	67	67	67	67	4
TOTAL				**183**	**3,234**	**3,097**	**3,007**	**2,949**	**80**

INCINERATOR EMISSIONS

Source	Emission Factor	unit	CO lb/hr	CO lb/day	CO ton/year
Incinerators					
Kulluk	300	lb/ton	41.40	496.80	29.81
Ice Management	300	lb/ton	23.10	554.40	12.64
Anchor Handler	300	lb/ton	23.10	554.40	12.64
OSR vessel	300	lb/ton	18.75	450.00	27.00
TOTAL			**106.35**	**2,055.60**	**82.09**

	CO ton/year
TOTAL ALL SOURCES	**162**

EMISSION FACTORS

Source	Pollutant	EF	unit	Reference
Incinerators	CO	300	lb/ton	AP42 Table 2.1-12, 10/96

*This activity cannot occur simultaneously with Resupply - DP mode. DP mode has greater impacts.

^Values in this column represent maximum emissions independent of activity.

ALLOWABLE EMISSIONS

SO_2 EMISSIONS - FOR IMPACT MODELING

COMBUSTION SOURCE EMISSIONS

Source	Emission Factor	unit	*lb/hr^*	lb/hr	Max *lb/day^*	MLC lb/day	DRILL lb/day	C/L lb/day	TOTAL ton/year
Kulluk									
Generation	0.001399	lb/gal		0.54	12.95	12.95	12.95	9.14	0.68
MLC HPUs	0.001399	lb/gal		0.11	2.69	2.69	0	0	0.03
Air compressors	0.001399	lb/gal		0.11	2.69	2.69	0	0	0.03
Cranes	0.001399	lb/gal		0.04	0.43	0.26	0.26	0.43	0.02
Heaters & Boilers	0.001399	lb/gal		0.06	1.54	1.54	1.54	1.54	0.09
Seldom-used units	0.001399	lb/gal		0.0011	0.0264	0.0264	0.0264	0.0264	0.0016
Emergency Generator	0.001399	lb/gal		0.0539	0.1077	0.1077	0.1077	0.1077	0.0002
Primary Ice Management									
Propulsion & Generation	0.001399	lb/gal		2.40	57.71	57.71	57.71	57.71	1.32
Heaters & Boilers	0.001399	lb/gal		0.11	2.56	2.56	2.56	2.56	0.06
Seldom-used units	0.001399	lb/gal		0.0008	0.0200	0.0200	0.0200	0.0200	0.0005
Secondary Ice Management / Anchor Handler									
Propulsion & Generation	0.001399	lb/gal		2.40	57.71	57.71	57.71	57.71	1.32
Heaters & Boilers	0.001399	lb/gal		0.11	2.56	2.56	2.56	2.56	0.06
Seldom-used units	0.001399	lb/gal		0.0008	0.0200	0.0200	0.0200	0.0200	0.0005
Resupply Ship - transport mode									
Propulsion & Generation	0.001399	lb/gal	*0.90*	(0*)	1.68	(0*)	(0*)	(0*)	0.04
Seldom-used units	0.001399	lb/gal	*0.000*	(0*)	0.00	(0*)	(0*)	(0*)	0.00
Resupply Ship - DP mode									
Propulsion & Generation	0.001399	lb/gal		0.90	6.72	6.72	6.72	6.72	0.08
Seldom-used units	0.001399	lb/gal		0.0002	0.0040	0.0040	0.0040	0.0040	0.0002
OSR vessel									
Propulsion & Generation	0.001399	lb/gal		0.16	3.92	3.92	3.92	3.92	0.14
Seldom-used units	0.001399	lb/gal		0.0008	0.0200	0.0200	0.0200	0.0200	0.0012
OSR work boats									
Work boats	0.001399	lb/gal		0.03	0.76	0.76	0.76	0.76	0.05
TOTAL				**7**	**154**	**152**	**147**	**143**	**4**

INCINERATOR EMISSIONS

Source	Emission Factor	unit	SO_2 lb/hr	SO_2 lb/day	SO_2 ton/year
Incinerators					
Kulluk	2.5	lb/ton	0.35	4.14	0.25
Ice Management	2.5	lb/ton	0.19	4.62	0.11
Anchor Handler	2.5	lb/ton	0.19	4.62	0.11
OSR vessel	2.5	lb/ton	0.16	3.75	0.23
TOTAL			**0.89**	**17.13**	**0.68**

	SO_2 ton/year
TOTAL ALL SOURCES	**5**

EMISSION FACTORS

S = the weight % Sulfur in the Fuel 0.0100%

Source	Pollutant	EF	unit	Reference
All IC engines & Boilers	SO_2	0.0107	lb/MMBtu	Calculation
Incinerators	SO_2	2.5	lb/ton	AP42 Table 2.1-12, 10/96

*This activity cannot occur simultaneously with Resupply - DP mode. DP mode has greater impacts.

^Values in this column represent maximum emissions independent of activity.

ALLOWABLE EMISSIONS

VOC EMISSIONS

COMBUSTION SOURCE EMISSIONS

Source	Emission Factor	unit	*lb/hr^*	lb/hr	Max *lb/day^*	MLC lb/day	DRILL lb/day	C/L lb/day	TOTAL ton/year
Kulluk									
Generation	0.004	lb/gal		1.37	32.77	32.77	32.77	23.13	1.72
MLC HPUs	0.014	lb/gal		1.10	26.46	26.46	0	0	0.26
Air compressors	0.004	lb/gal		0.28	6.80	6.80	0	0	0.07
Cranes	0.014	lb/gal		0.35	4.23	2.54	2.54	4.23	0.20
Heaters & Boilers	0.001	lb/gal		0.05	1.10	1.10	1.10	1.10	0.07
Seldom-used units	0.046	lb/gal		0.04	0.87	0.87	0.87	0.87	0.05
Emergency Generator	0.046	lb/gal		1.77	3.54	3.54	3.54	3.54	0.01
Primary Ice Management									
Propulsion & Generation	0.004	lb/gal		6.09	146.06	146.06	146.06	146.06	3.33
Heaters & Boilers	0.001	lb/gal		0.08	1.83	1.83	1.83	1.83	0.04
Seldom-used units	0.046	lb/gal		0.03	0.66	0.66	0.66	0.66	0.01
Secondary Ice Management / Anchor Handler									
Propulsion & Generation	0.004	lb/gal		6.09	146.06	146.06	146.06	146.06	3.33
Heaters & Boilers	0.001	lb/gal		0.08	1.83	1.83	1.83	1.83	0.04
Seldom-used units	0.046	lb/gal		0.03	0.66	0.66	0.66	0.66	0.01
Resupply Ship - transport mode									
Propulsion & Generation	0.012	lb/gal	*7.56*	(0*)	14.17	(0*)	(0*)	(0*)	0.34
Seldom-used units	0.046	lb/gal	*0.005*	(0*)	0.13	(0*)	(0*)	(0*)	0.01
Resupply Ship - DP mode									
Propulsion & Generation	0.012	lb/gal		7.56	56.67	56.67	56.67	56.67	0.68
Seldom-used units	0.046	lb/gal		0.0055	0.1312	0.1312	0.1312	0.1312	0.0079
OSR vessel									
Propulsion & Generation	0.012	lb/gal		1.38	33.06	33.06	33.06	33.06	1.19
Seldom-used units	0.046	lb/gal		0.03	0.66	0.66	0.66	0.66	0.04
OSR work boats									
Work boats	0.046	lb/gal		1.04	24.85	24.85	24.85	24.85	1.49
TOTAL				**27**	**503**	**487**	**453**	**445**	**13**

INCINERATOR EMISSIONS

Source	Emission Factor	unit	lb/hr	lb/day	ton/year
Incinerators					
Kulluk	100	lb/ton	13.80	165.60	9.94
Ice Management	100	lb/ton	7.70	184.80	4.21
Anchor Handler	100	lb/ton	7.70	184.80	4.21
OSR vessel	100	lb/ton	6.25	150.00	9.00
TOTAL			**35.45**	**685.20**	**27.36**

	VOC ton/year
TOTAL ALL SOURCES	**40**

EMISSION FACTORS

Source	Pollutant	EF	unit	Reference
Incinerators	VOC	100	lb/ton	AP42 Table 2.1-12, 10/96

*This activity cannot occur simultaneously with Resupply - DP mode. DP mode has greater impacts.

^Values in this column represent maximum emissions independent of activity.

ALLOWABLE EMISSIONS

LEAD EMISSIONS

COMBUSTION SOURCE EMISSIONS

Source	Emission Factor	unit	*lb/hr^*	lb/hr	Max *lb/day^*	MLC lb/day	DRILL lb/day	C/L lb/day	TOTAL ton/year
Kulluk									
Generation	3.80E-06	lb/gal		1.47E-03	3.52E-02	3.52E-02	3.52E-02	2.48E-02	1.84E-03
MLC HPUs	3.80E-06	lb/gal		3.05E-04	7.31E-03	7.31E-03	0.00E+00	0.00E+00	7.31E-05
Air compressors	3.80E-06	lb/gal		3.05E-04	7.31E-03	7.31E-03	0.00E+00	0.00E+00	7.31E-05
Cranes	3.80E-06	lb/gal		9.74E-05	1.17E-03	7.02E-04	7.02E-04	1.17E-03	5.43E-05
Heaters & Boilers	1.18E-06	lb/gal		5.40E-05	1.30E-03	1.30E-03	1.30E-03	1.30E-03	7.78E-05
Seldom-used units	3.80E-06	lb/gal		2.99E-06	7.18E-05	7.18E-05	7.18E-05	7.18E-05	4.31E-06
Emergency Generator	3.80E-06	lb/gal		1.46E-04	2.93E-04	2.93E-04	2.93E-04	2.93E-04	5.86E-07
Primary Ice Management									
Propulsion & Generation	3.80E-06	lb/gal		6.54E-03	1.57E-01	1.57E-01	1.57E-01	1.57E-01	3.58E-03
Heaters & Boilers	1.18E-06	lb/gal		9.00E-05	2.16E-03	2.16E-03	2.16E-03	2.16E-03	4.92E-05
Seldom-used units	3.80E-06	lb/gal		2.26E-06	5.43E-05	5.43E-05	5.43E-05	5.43E-05	1.24E-06
Secondary Ice Management / Anchor Handler									
Propulsion & Generation	3.80E-06	lb/gal		6.54E-03	1.57E-01	1.57E-01	1.57E-01	1.57E-01	3.58E-03
Heaters & Boilers	1.18E-06	lb/gal		9.00E-05	2.16E-03	2.16E-03	2.16E-03	2.16E-03	4.92E-05
Seldom-used units	3.80E-06	lb/gal		2.26E-06	5.43E-05	5.43E-05	5.43E-05	5.43E-05	1.24E-06
Resupply Ship - transport mode									
Propulsion & Generation	3.80E-06	lb/gal	*2.44E-03*	(0*)	4.57E-03	(0*)	(0*)	(0*)	1.10E-04
Seldom-used units	3.80E-06	lb/gal	*4.53E-07*	(0*)	1.09E-05	(0*)	(0*)	(0*)	6.52E-07
Resupply Ship - DP mode									
Propulsion & Generation	3.80E-06	lb/gal		2.44E-03	1.83E-02	1.83E-02	1.83E-02	1.83E-02	2.19E-04
Seldom-used units	3.80E-06	lb/gal		4.53E-07	1.09E-05	1.09E-05	1.09E-05	1.09E-05	6.52E-07
OSR vessel									
Propulsion & Generation	3.80E-06	lb/gal		4.44E-04	1.07E-02	1.07E-02	1.07E-02	1.07E-02	3.83E-04
Seldom-used units	3.80E-06	lb/gal		2.26E-06	5.43E-05	5.43E-05	5.43E-05	5.43E-05	3.26E-06
OSR work boats									
Work boats	3.80E-06	lb/gal		8.58E-05	2.06E-03	2.06E-03	2.06E-03	2.06E-03	1.24E-04
TOTAL				**1.86E-02**	**4.06E-01**	**4.01E-01**	**3.87E-01**	**3.77E-01**	**1.02E-02**

INCINERATOR EMISSIONS

Source	Emission Factor	unit	Lead lb/hr	Lead lb/day	Lead ton/year
Incinerators					
Kulluk	0.213	lb/ton	0.03	0.35	0.02
Ice Management	0.213	lb/ton	0.02	0.39	0.01
Anchor Handler	0.213	lb/ton	0.02	0.39	0.01
OSR vessel	0.213	lb/ton	0.01	0.32	0.02
TOTAL			**0.08**	**1.46**	**0.06**

	Lead ton/year
TOTAL ALL SOURCES	**0.07**

EMISSION FACTORS

Source	Pollutant	EF	unit	EF	unit
IC Engines	Lead	2.90E-05	lb/MMBtu	3.80E-06	lb/gal
Boilers	Lead	9	lb/10^-6 Btu	1.18E-06	lb/gal
Incinerators	Lead			0.213	lb/ton

Reference	
IC Engines	L & E Air Emissions from Sources of Lead and Lead Compounds, EPA 454/R-98-006, May 1998, Section 5.2.2, Distillate oil-fired gas turbines
Boilers	AP42, Table 1.3-10. Emission Factors For Trace Elements From Distillate Fuel Oil Combustion Sources
Incinerators	AP42, Table 2.2-2 - Metals Emission Factors for Mass Burn and Modular Excess Air Combustors

*This activity cannot occur simultaneously with Resupply - DP mode. DP mode has greater impacts.

^Values in this column represent maximum emissions independent of activity.

ALLOWABLE EMISSIONS

HAP EMISSIONS

COMBUSTION SOURCE EMISSIONS

Source	Emission Factor	unit	Control	*lb/hr^*	lb/hr	Max *lb/day^*	MLC lb/day	DRILL lb/day	C/L lb/day	TOTAL ton/year
Kulluk										
Generation	1.60E-04	lb/gal	SCR, OxyCat		6.17E-02	1.48E+00	1.48E+00	1.48E+00	1.04E+00	7.75E-02
MLC HPUs	1.60E-04	lb/gal	OxyCat		1.28E-02	3.07E-01	3.07E-01	0.00E+00	0.00E+00	3.07E-03
Air compressors	1.60E-04	lb/gal	OxyCat		1.28E-02	3.07E-01	3.07E-01	0.00E+00	0.00E+00	3.07E-03
Cranes	1.60E-04	lb/gal	OxyCat		4.10E-03	4.91E-02	2.95E-02	2.95E-02	4.91E-02	2.28E-03
Heaters & Boilers	4.41E-05	lb/gal			2.02E-03	4.84E-02	4.84E-02	4.84E-02	4.84E-02	2.90E-03
Seldom-used units	5.16E-04	lb/gal			4.05E-04	9.73E-03	9.73E-03	9.73E-03	9.73E-03	5.84E-04
Emergency Generator	5.16E-04	lb/gal			1.99E-02	3.97E-02	3.97E-02	3.97E-02	3.97E-02	7.94E-05
Primary Ice Management										
Propulsion & Generation	1.60E-04	lb/gal	SCR, OxyCat		2.75E-01	6.59E+00	6.59E+00	6.59E+00	6.59E+00	1.50E-01
Heaters & Boilers	4.41E-05	lb/gal			3.36E-03	8.06E-02	8.06E-02	8.06E-02	8.06E-02	1.84E-03
Seldom-used units	5.16E-04	lb/gal			3.07E-04	7.37E-03	7.37E-03	7.37E-03	7.37E-03	1.68E-04
Secondary Ice Management / Anchor Handler										
Propulsion & Generation	1.60E-04	lb/gal	SCR, OxyCat		2.75E-01	6.59E+00	6.59E+00	6.59E+00	6.59E+00	1.50E-01
Heaters & Boilers	4.41E-05	lb/gal			3.36E-03	8.06E-02	8.06E-02	8.06E-02	8.06E-02	1.84E-03
Seldom-used units	5.16E-04	lb/gal			3.07E-04	7.37E-03	7.37E-03	7.37E-03	7.37E-03	1.68E-04
Resupply Ship - transport mode										
Propulsion & Generation	5.16E-04	lb/gal		*3.30E-01*	(0*)	6.19E-01	(0*)	(0*)	(0*)	1.48E-02
Seldom-used units	5.16E-04	lb/gal		*6.14E-05*	(0*)	1.47E-03	(0*)	(0*)	(0*)	8.84E-05
Resupply Ship - DP mode										
Propulsion & Generation	5.16E-04	lb/gal			3.30E-01	2.47E+00	2.47E+00	2.47E+00	2.47E+00	2.97E-02
Seldom-used units	5.16E-04	lb/gal			6.14E-05	1.47E-03	1.47E-03	1.47E-03	1.47E-03	8.84E-05
OSR vessel										
Propulsion & Generation	5.16E-04	lb/gal			6.02E-02	1.44E+00	1.44E+00	1.44E+00	1.44E+00	5.20E-02
Seldom-used units	5.16E-04	lb/gal			3.07E-04	7.37E-03	7.37E-03	7.37E-03	7.37E-03	4.42E-04
OSR work boats										
Work boats	5.16E-04	lb/gal			1.16E-02	2.79E-01	2.79E-01	2.79E-01	2.79E-01	1.67E-02
TOTAL					**1.07**	**20.43**	**19.79**	**19.18**	**18.76**	**0.51**

INCINERATOR EMISSIONS

Source	Emission Factor	unit	HAP lb/hr	HAP lb/day	HAP ton/year
Incinerators					
Kulluk	2.51E-01	lb/ton	0.03	0.42	0.02
Ice Management	2.51E-01	lb/ton	0.02	0.46	0.01
Anchor Handler	2.51E-01	lb/ton	0.02	0.46	0.01
OSR vessel	2.51E-01	lb/ton	0.02	0.38	0.02
TOTAL			**0.09**	**1.72**	**0.07**

	HAP ton/year
TOTAL ALL SOURCES	**0.58**

EMISSION FACTORS

Source	Pollutant	EF	unit	Reference
IC Engines-uncontrolled	HAP	5.16E-04	lb/gal	See Page 13
IC Engines-OxyCat controlled	HAP	1.60E-04	lb/gal	See Page 13
Boilers	HAP	4.41E-05	lb/gal	See Page 13
Incinerators	HAP	2.51E-01	lb/ton	See Page 13

*This activity cannot occur simultaneously with Resupply - DP mode. DP mode has greater impacts.

^Values in this column represent maximum emissions independent of activity.

ALLOWABLE EMISSIONS

FORMALDEHYDE EMISSIONS

COMBUSTION SOURCE EMISSIONS

Source	Emission Factor	unit	Control	*lb/hr^*	lb/hr	Max *lb/day^*	MLC lb/day	DRILL lb/day	C/L lb/day	TOTAL ton/year
Kulluk										
Generation	4.64E-05	lb/gal	SCR, OxyCat		1.79E-02	4.30E-01	4.30E-01	4.30E-01	3.03E-01	2.25E-02
MLC HPUs	4.64E-05	lb/gal	OxyCat		3.72E-03	8.92E-02	8.92E-02	0.00E+00	0.00E+00	8.92E-04
Air compressors	4.64E-05	lb/gal	OxyCat		3.72E-03	8.92E-02	8.92E-02	0.00E+00	0.00E+00	8.92E-04
Cranes	4.64E-05	lb/gal	OxyCat		1.19E-03	1.43E-02	8.56E-03	8.56E-03	1.43E-02	6.62E-04
Heaters & Boilers	3.30E-05	lb/gal			1.51E-03	3.62E-02	3.62E-02	3.62E-02	3.62E-02	2.17E-03
Seldom-used units	1.55E-04	lb/gal			1.22E-04	2.92E-03	2.92E-03	2.92E-03	2.92E-03	1.75E-04
Emergency Generator	1.55E-04	lb/gal			5.96E-03	1.19E-02	1.19E-02	1.19E-02	1.19E-02	2.38E-05
Primary Ice Management										
Propulsion & Generation	4.64E-05	lb/gal	SCR, OxyCat		7.98E-02	1.91E+00	1.91E+00	1.91E+00	1.91E+00	4.37E-02
Heaters & Boilers	3.30E-05	lb/gal			2.52E-03	6.04E-02	6.04E-02	6.04E-02	6.04E-02	1.38E-03
Seldom-used units	1.55E-04	lb/gal			9.21E-05	2.21E-03	2.21E-03	2.21E-03	2.21E-03	5.04E-05
Secondary Ice Management / Anchor Handler										
Propulsion & Generation	4.64E-05	lb/gal	SCR, OxyCat		7.98E-02	1.91E+00	1.91E+00	1.91E+00	1.91E+00	4.37E-02
Heaters & Boilers	3.30E-05	lb/gal			2.52E-03	6.04E-02	6.04E-02	6.04E-02	6.04E-02	1.38E-03
Seldom-used units	1.55E-04	lb/gal			9.21E-05	2.21E-03	2.21E-03	2.21E-03	2.21E-03	5.04E-05
Resupply Ship - transport mode										
Propulsion & Generation	1.55E-04	lb/gal		*9.91E-02*	(0*)	1.86E-01	(0*)	(0*)	(0*)	4.46E-03
Seldom-used units	1.55E-04	lb/gal		*1.84E-05*	(0*)	4.42E-04	(0*)	(0*)	(0*)	2.65E-05
Resupply Ship - DP mode										
Propulsion & Generation	1.55E-04	lb/gal			9.91E-02	7.43E-01	7.43E-01	7.43E-01	7.43E-01	8.92E-03
Seldom-used units	1.55E-04	lb/gal			1.84E-05	4.42E-04	4.42E-04	4.42E-04	4.42E-04	2.65E-05
OSR vessel										
Propulsion & Generation	1.55E-04	lb/gal			1.81E-02	4.33E-01	4.33E-01	4.33E-01	4.33E-01	1.56E-02
Seldom-used units	1.55E-04	lb/gal			9.21E-05	2.21E-03	2.21E-03	2.21E-03	2.21E-03	1.33E-04
OSR work boats										
Work boats	1.55E-04	lb/gal			3.49E-03	8.38E-02	8.38E-02	8.38E-02	8.38E-02	5.03E-03
TOTAL					**0.32**	**6.08**	**5.89**	**5.71**	**5.59**	**0.15**

INCINERATOR EMISSIONS

Source	Emission Factor	unit	CH_2O lb/hr	CH_2O lb/day	CH_2O ton/year
Incinerators					
Kulluk	0.00E+00	lb/ton	0.00	0.00	0.00
Ice Management	0.00E+00	lb/ton	0.00	0.00	0.00
Anchor Handler	0.00E+00	lb/ton	0.00	0.00	0.00
OSR vessel	0.00E+00	lb/ton	0.00	0.00	0.00
TOTAL			**0.00**	**0.00**	**0.00**

	CH_2O ton/year
TOTAL ALL SOURCES	**0.15**

EMISSION FACTORS

Source	Pollutant	EF	unit	Reference
IC Engines-uncontrolled	CH_2O	1.55E-04	lb/gal	AP42 Table 3.3-2, Speciated Organic Compound Emission Factors For Uncontrolled Diesel Engines
IC Engines-OxyCat controlled	CH_2O	4.64E-05	lb/gal	AP42 Table 3.3-2, Speciated Organic Compound Emission Factors For Uncontrolled Diesel Engines
Boilers	CH_2O	3.30E-05	lb/gal	AP42 Table 1.3-9, Emission Factors For Speciated Organic Compounds From Fuel Oil Combustion
Incinerators	CH_2O	0.00E+00	lb/ton	

*This activity cannot occur simultaneously with Resupply - DP mode. DP mode has greater impacts.

^Values in this column represent maximum emissions independent of activity.

HAPs Emission Factors -(from AP42)

ICE Engines Emission Factors

AP42 Table 3.3-2, Speciated Organic Compound Emission Factors For Uncontrolled Diesel Engines

Pollutant	EF lb/MMBtu	EF lb/gal
Acaldehyde	7.67E-04	1.01E-04
Acenaphthene	1.42E-06	1.86E-07
Acenaphthylene	5.06E-06	6.64E-07
Acrolein	9.25E-05	1.21E-05
Anthracene	1.87E-06	2.45E-07
Benzene	9.33E-04	1.22E-04
Benzo(a)anthracene	1.68E-06	2.20E-07
Benzo(a)pyrene	1.88E-07	2.47E-08
Benzo(b)fluoranthene	9.91E-08	1.30E-08
Benzo(g,h,l)perylene	4.89E-07	6.41E-08
Benzo(k)fluoranthene	1.55E-07	2.03E-08
1,3-Butadiene	3.91E-05	5.13E-06
Chrysene	3.53E-07	4.63E-08
Dibenz(a,h)anthracene	5.83E-07	7.65E-08
Fluoranthene	7.61E-06	9.98E-07
Fluorene	2.92E-05	3.83E-06
Formaldehyde	1.18E-03	1.55E-04
Indeno(1,2,3-cd)pyrene	3.75E-07	4.92E-08
Naphthalene	8.48E-05	1.11E-05
Phenanthrene	2.94E-05	3.86E-06
Pyrene	4.78E-06	6.27E-07
Toluene	4.09E-04	5.37E-05
Xylenes	2.85E-04	3.74E-05
		5.08E-04

Boiler Emission Factors

AP42 Table 1.3-9, Emission Factors For Speciated Organic Compounds From Fuel Oil Combustion

Pollutant	EF lb/10^3 gal	EF lb/gal
Acenaphthene	2.11E-05	2.11E-08
Acenaphthylene	2.53E-07	2.53E-10
Anthracene	1.22E-06	1.22E-09
Benzene	2.14E-04	2.14E-07
Benz(a)anthracene	4.01E-06	4.01E-09
Benzo(b,k)fluoranthene	1.48E-06	1.48E-09
Benzo(g,h,i)perylene	2.26E-06	2.26E-09
Chrysene	2.38E-06	2.38E-09
Dibenzo(a,h)anthracene	1.67E-06	1.67E-09
Ethylbenzene	6.36E-05	6.36E-08
Fluoranthene	4.84E-06	4.84E-09
Fluorene	4.47E-06	4.47E-09
Formaldehyde	3.30E-02	3.30E-05
Indo(1,2,3-cd)pyrene	2.14E-06	2.14E-09
Naphthalene	1.13E-03	1.13E-06
Phenanthrene	1.05E-05	1.05E-08
Pyrene	4.25E-06	4.25E-09
Toluene	6.20E-03	6.20E-06
o-Xylene	1.09E-04	1.09E-07
		4.08E-05

Incinerator Emission Factors

Table 1.3-10. Emission Factors For Trace Elements From Distillate Fuel Oil Combustion Sources

Metal			EF lb/10^{12} Btu	EF lb/gal
Arsenic	As		4	5.25E-07
Cadmium	Cd		3	3.94E-07
Chromium	Cr		3	3.94E-07
Lead	Pb		9	1.18E-06
Mercury	Hg		3	3.94E-07
Nickel	Ni		3	3.94E-07
	Total Metals			3.28E-06
	Total HAPs			**4.41E-05**

Table 2.2-2 - Metals Emission Factors for Mass Burn and Modular Excess Air Combustors

Metal		lb/ton
Arsenic	As	4.37E-03
Cadmium	Cd	1.09E-02
Chromium	Cr	8.97E-03
Lead	Pb	2.13E-01
Mercury	Hg	5.60E-03
Nickel	Ni	7.85E-03
Total Metals		2.51E-01
Total HAPs		**2.51E-01**

Metal			EF lb/MMBtu	EF lb/gal
Arsenic	As		4.90E-06	6.43E-07
Cadmium	Cd	11 lb/10^{12} Btu	1.10E-05	1.44E-06
Chromium	Cr	0.35 lb/10^6 gal	2.67E-06	3.50E-07
Lead	Pb		2.9E-05	3.80E-06
Mercury	Hg	6.2 lb/10^{12} Btu	6.20E-06	8.13E-07
Nickel	Ni	0.41 lb/10^{9} gal	3.13E-06	4.10E-07
	Total Metals			7.46E-06
	Total HAPs			**5.16E-04**

Greatest Emited HAP

Formaldehyde	1.55E-04	3.30E-05

ICE Metal References

Arsenic	L & E Air Emissions from Sources of Arsenic and Arsenic Compounds, EPA-454/R-98-013, June 1998, Table 4-20, Distillate Oil Fired Turbine
Cadmium	L & E Air Emissions from Sources of Cadmium and Cadmium Compounds, EPA-454/R-93-040, Sept. 1993, Table 6-12, No. 2 Distillate Oil
Chromium	L & E Air Emissions from Sources of Chromium, EPA-450/4-84-007g, July 1984, Table 36, Distillate #2
Lead	L & E Air Emissions from Sources of Lead and Lead Compounds, EPA 454/R-98-006, May 1998, Section 5.2.2, Distillate oil-fired gas turbines
Mercury	L & E Air Emissions from Sources of Mercury and Mercury Compounds, EPA-454/R-97-012, Dec. 1997, Table 6-12, Distillate No. 2
Nickel	L & E Air Emissions from Sources of Nickel, EPA-450/4-84-007f, March 1984, Table 26, Distillate #2

ALLOWABLE EMISSIONS

GREENHOUSE GAS EMISSIONS

COMBUSTION SOURCE EMISSIONS

Source	Emission Factor	unit	*lb/hr*^	lb/hr	Max *lb/day*^	MLC lb/day	DRILL lb/day	C/L lb/day	TOTAL ton/year
Kulluk									
Generation	2.15E+01	lb/gal		8,274	198,581	198,581	198,581	140,175	10,396
MLC HPUs	2.15E+01	lb/gal		1,718	41,228	41,228	0	0	412
Air compressors	2.15E+01	lb/gal		1,718	41,228	41,228	0	0	412
Cranes	2.15E+01	lb/gal		550	6,596	3,958	3,958	6,596	306
Heaters & Boilers	2.15E+01	lb/gal		982	23,559	23,559	23,559	23,559	1,414
Seldom-used units	2.15E+01	lb/gal		17	405	405	405	405	24
Emergency Generator	2.15E+01	lb/gal		826	1,653	1,653	1,653	1,653	3
Primary Ice Management									
Propulsion & Generation	2.15E+01	lb/gal		36,876	885,027	885,027	885,027	885,027	20,179
Heaters & Boilers	2.15E+01	lb/gal		1,636	39,265	39,265	39,265	39,265	895
Seldom-used units	2.15E+01	lb/gal		13	307	307	307	307	7
Secondary Ice Management / Anchor Handler									
Propulsion & Generation	2.15E+01	lb/gal		36,876	885,027	885,027	885,027	885,027	20,179
Heaters & Boilers	2.15E+01	lb/gal		1,636	39,265	39,265	39,265	39,265	895
Seldom-used units	2.15E+01	lb/gal		13	307	307	307	307	7
Resupply Ship - transport mode									
Propulsion & Generation	2.15E+01	lb/gal	*13,743*	(0*)	25,754	(0*)	(0*)	(0*)	618
Seldom-used units	2.15E+01	lb/gal	*3*	(0*)	61	(0*)	(0*)	(0*)	4
Resupply Ship - DP mode									
Propulsion & Generation	2.15E+01	lb/gal		13,743	103,015	103,015	103,015	103,015	1,236
Seldom-used units	2.15E+01	lb/gal		3	61	61	61	61	4
OSR vessel									
Propulsion & Generation	2.15E+01	lb/gal		2,504	60,092	60,092	60,092	60,092	2,163
Seldom-used units	2.15E+01	lb/gal		13	307	307	307	307	18
OSR work boats									
Work boats	2.15E+01	lb/gal		484	11,618	11,618	11,618	11,618	697
TOTAL				**107,880**	**2,363,354**	**2,334,900**	**2,252,444**	**2,196,676**	**59,870**

INCINERATOR EMISSIONS

Source	Emission Factor	unit	CO_2e lb/hr	CO_2e lb/day	CO_2e ton/year
Incinerators					
Kulluk	1,970	lb/ton	271.86	3262.32	195.74
Ice Management	1,970	lb/ton	151.69	3640.56	83.00
Anchor Handler	1,970	lb/ton	151.69	3640.56	83.00
OSR vessel	1,970	lb/ton	123.13	2955.00	177.30
TOTAL			**698.37**	**13,498.44**	**539.05**

OFFGAS EMISSIONS

Source		CH_4 lb/yr [a]	CH_4 ton/year [b]
Drilling Mud De-gassing		399	4.19
[a] Methane Mass Caculation.xls October 22,2010	[b] CH_4 (lb/year) x Muliplier		

	CO_2e ton/year
TOTAL ALL SOURCES	**60,413**

EMISSION FACTORS

$CO_2 + CH_4*21 + N_2O*310 -> CO_2e$

Pollutant	Type	Multiplier	Reference	EF	unit	Reference
CO_2	comb	1	40 CFR 98, Table A-1	73.96	kg/MMBtu	40 CFR Part 98, Subpart C, Table C-1 (Distillate Fuel Oil No. 2)
CH_4	comb	21	40 CFR 98, Table A-1	3.00E-03	kg/MMBtu	40 CFR Part 98, Subpart C, Table C-2 (Fuel Type: Petroleum)
N_2O	comb	310	40 CFR 98, Table A-1	6.00E-04	kg/MMBtu	40 CFR Part 98, Subpart C, Table C-2 (Fuel Type: Petroleum)

Source	Pollutant	EF	unit	EF	unit	
IC Engines & Boilers	CO_2e	1.64E+02	lb/MMBtu	2.15E+01	lb/gal	
Incinerators	CO_2			1,970	lb/ton	AP42 Table 2.1-7, 10/96

*This activity cannot occur simultaneously with Resupply - DP mode. DP mode has greater impacts.

^Values in this column represent maximum emissions independent of activity.

ALLOWABLE EMISSIONS

SULFURIC ACID EMISSIONS

COMBUSTION SOURCE EMISSIONS

Source	Emission Factor	unit	*lb/hr*^	lb/hr	Max *lb/day*^	MLC lb/day	DRILL lb/day	C/L lb/day	TOTAL ton/year
Kulluk									
Generation	1.07E-04	lb/gal		4.13E-02	9.91E-01	9.91E-01	9.91E-01	7.00E-01	5.19E-02
MLC HPUs	1.07E-04	lb/gal		8.57E-03	2.06E-01	2.06E-01	0.00E+00	0.00E+00	2.06E-03
Air compressors	1.07E-04	lb/gal		8.57E-03	2.06E-01	2.06E-01	0.00E+00	0.00E+00	2.06E-03
Cranes	1.07E-04	lb/gal		2.74E-03	3.29E-02	1.98E-02	1.98E-02	3.29E-02	1.53E-03
Heaters & Boilers	1.07E-04	lb/gal		4.90E-03	1.18E-01	1.18E-01	1.18E-01	1.18E-01	7.05E-03
Seldom-used units	1.07E-04	lb/gal		8.42E-05	2.02E-03	2.02E-03	2.02E-03	2.02E-03	1.21E-04
Emergency Generator	1.07E-04	lb/gal		4.12E-03	8.25E-03	8.25E-03	8.25E-03	8.25E-03	1.65E-05
Primary Ice Management									
Propulsion & Generation	1.07E-04	lb/gal		1.84E-01	4.42E+00	4.42E+00	4.42E+00	4.42E+00	1.01E-01
Heaters & Boilers	1.07E-04	lb/gal		8.17E-03	1.96E-01	1.96E-01	1.96E-01	1.96E-01	4.47E-03
Seldom-used units	1.07E-04	lb/gal		6.38E-05	1.53E-03	1.53E-03	1.53E-03	1.53E-03	3.49E-05
Secondary Ice Management / Anchor Handler									
Propulsion & Generation	1.07E-04	lb/gal		1.84E-01	4.42E+00	4.42E+00	4.42E+00	4.42E+00	1.01E-01
Heaters & Boilers	1.07E-04	lb/gal		8.17E-03	1.96E-01	1.96E-01	1.96E-01	1.96E-01	4.47E-03
Seldom-used units	1.07E-04	lb/gal		6.38E-05	1.53E-03	1.53E-03	1.53E-03	1.53E-03	3.49E-05
Resupply Ship - transport mode									
Propulsion & Generation	1.07E-04	lb/gal	*6.86E-02*	(0*)	1.29E-01	(0*)	(0*)	(0*)	3.08E-03
Seldom-used units	1.07E-04	lb/gal	*1.28E-05*	(0*)	3.06E-04	(0*)	(0*)	(0*)	1.84E-05
Resupply Ship - DP mode									
Propulsion & Generation	1.07E-04	lb/gal		6.86E-02	5.14E-01	5.14E-01	5.14E-01	5.14E-01	6.17E-03
Seldom-used units	1.07E-04	lb/gal		1.28E-05	3.06E-04	3.06E-04	3.06E-04	3.06E-04	1.84E-05
OSR vessel									
Propulsion & Generation	1.07E-04	lb/gal		1.25E-02	3.00E-01	3.00E-01	3.00E-01	3.00E-01	1.08E-02
Seldom-used units	1.07E-04	lb/gal		6.38E-05	1.53E-03	1.53E-03	1.53E-03	1.53E-03	9.18E-05
OSR work boats									
Work boats	1.07E-04	lb/gal		2.42E-03	5.80E-02	5.80E-02	5.80E-02	5.80E-02	3.48E-03
TOTAL				**5.38E-01**	**1.18E+01**	**1.17E+01**	**1.12E+01**	**1.10E+01**	**2.99E-01**

INCINERATOR EMISSIONS

Source	Emission Factor	unit	H_2SO_4 lb/hr	H_2SO_4 lb/day	H_2SO_4 ton/year
Incinerators					
Kulluk	1.2	lb/ton	0.17	1.99	0.12
Ice Management	1.2	lb/ton	0.09	2.22	0.05
Anchor Handler	1.2	lb/ton	0.09	2.22	0.05
OSR vessel	1.2	lb/ton	0.08	1.80	0.11
TOTAL			**0.43**	**8.22**	**0.33**

	H_2SO_4 ton/year
TOTAL ALL SOURCES	**0.63**

EMISSION FACTORS

S = the weight % Sulfur in the Fuel 0.0100%

$S + O_2 \rightarrow SO_2$

$2SO_2 + O_2 \rightarrow 2SO_3$

$SO_3 + H_2O \rightarrow H_2SO_4$

Pollutant	Formula	MW	
Sulfuric Acid	H_2SO_4	98.079	g/g-mol
Sulfur	S	32.066	g/g-mol
		3.06	weight conversion of S to H_2SO_4

Source	Pollutant	EF	unit	EF	unit	Reference
IC Engines & Boilers	H_2SO_4	8.17E-04	lb/MMBtu	1.07E-04	lb/gal	Calculation [a]
Incinerators	H_2SO_4			1.2	lb/ton	AP42 Table 2.2-2, 1/95 [b]

[a] Conversion assumed of 5.0% Ref: AP42, Section 1.3.3.2 Sulfur Oxides Emissions. Maximum conversion of SO2 to SO3 from fuel oil combustion in boilers

[b] Acid Gas Emission Factors for Multiple Hearth Sewage Sludge Incinerators, Uncontrolled

*This activity cannot occur simultaneously with Resupply - DP mode. DP mode has greater impacts.

^Values in this column represent maximum emissions independent of activity.

ALLOWABLE EMISSIONS

HYDROGEN SULFIDE EMISSIONS

COMBUSTION SOURCE EMISSIONS

Source	Emission Factor	unit	*lb/hr*^	lb/hr	Max *lb/day*^	MLC lb/day	DRILL lb/day	C/L lb/day	TOTAL ton/year
Kulluk									
Generation	7.45E-06	lb/gal		2.87E-03	6.89E-02	6.89E-02	6.89E-02	4.87E-02	3.61E-03
MLC HPUs	7.45E-06	lb/gal		5.96E-04	1.43E-02	1.43E-02	0.00E+00	0.00E+00	1.43E-04
Air compressors	7.45E-06	lb/gal		5.96E-04	1.43E-02	1.43E-02	0.00E+00	0.00E+00	1.43E-04
Cranes	7.45E-06	lb/gal		1.91E-04	2.29E-03	1.37E-03	1.37E-03	2.29E-03	1.06E-04
Heaters & Boilers	7.45E-06	lb/gal		3.41E-04	8.18E-03	8.18E-03	8.18E-03	8.18E-03	4.91E-04
Seldom-used units	7.45E-06	lb/gal		5.86E-06	1.41E-04	1.41E-04	1.41E-04	1.41E-04	8.44E-06
Emergency Generator	7.45E-06	lb/gal		2.87E-04	5.74E-04	5.74E-04	5.74E-04	5.74E-04	1.15E-06
Primary Ice Management									
Propulsion & Generation	7.45E-06	lb/gal		1.28E-02	3.07E-01	3.07E-01	3.07E-01	3.07E-01	7.01E-03
Heaters & Boilers	7.45E-06	lb/gal		5.68E-04	1.36E-02	1.36E-02	1.36E-02	1.36E-02	3.11E-04
Seldom-used units	7.45E-06	lb/gal		4.44E-06	1.06E-04	1.06E-04	1.06E-04	1.06E-04	2.43E-06
Secondary Ice Management / Anchor Handler									
Propulsion & Generation	7.45E-06	lb/gal		1.28E-02	3.07E-01	3.07E-01	3.07E-01	3.07E-01	7.01E-03
Heaters & Boilers	7.45E-06	lb/gal		5.68E-04	1.36E-02	1.36E-02	1.36E-02	1.36E-02	3.11E-04
Seldom-used units	7.45E-06	lb/gal		4.44E-06	1.06E-04	1.06E-04	1.06E-04	1.06E-04	2.43E-06
Resupply Ship - transport mode									
Propulsion & Generation	7.45E-06	lb/gal	*4.77E-03*	(0*)	8.94E-03	(0*)	(0*)	(0*)	2.15E-04
Seldom-used units	7.45E-06	lb/gal	*8.87E-07*	(0*)	2.13E-05	(0*)	(0*)	(0*)	1.28E-06
Resupply Ship - DP mode									
Propulsion & Generation	7.45E-06	lb/gal		4.77E-03	3.58E-02	3.58E-02	3.58E-02	3.58E-02	4.29E-04
Seldom-used units	7.45E-06	lb/gal		8.87E-07	2.13E-05	2.13E-05	2.13E-05	2.13E-05	1.28E-06
OSR vessel									
Propulsion & Generation	7.45E-06	lb/gal		8.69E-04	2.09E-02	2.09E-02	2.09E-02	2.09E-02	7.51E-04
Seldom-used units	7.45E-06	lb/gal		4.44E-06	1.06E-04	1.06E-04	1.06E-04	1.06E-04	6.39E-06
OSR work boats									
Work boats	7.45E-06	lb/gal		1.68E-04	4.03E-03	4.03E-03	4.03E-03	4.03E-03	2.42E-04
TOTAL				**0.04**	**0.82**	**0.81**	**0.78**	**0.76**	**0.02**

INCINERATOR EMISSIONS

Source	Emission Factor	unit	H_2S lb/hr	H_2S lb/day	H_2S ton/year
Incinerators					
Kulluk	1.33	lb/ton	0.18	2.20	0.13
Ice Management	1.33	lb/ton	0.10	2.46	0.06
Anchor Handler	1.33	lb/ton	0.10	2.46	0.06
OSR vessel	1.33	lb/ton	0.08	2.00	0.12
TOTAL			**0.47**	**9.12**	**0.36**

	H_2S ton/year
TOTAL ALL SOURCES	**0.39**

EMISSION FACTORS

S = the weight % Sulfur in the Fuel 0.0100%

Pollutant	Formula	MW	
Sulfur Dioxide	SO_2	64	g/g-mol
Hydrogen sulfide	H_2S	34.081	g/g-mol

0.53 weight conversion of SO_2 to H_2S

Source	Pollutant	EF	unit	EF	unit	Reference
IC Engines & Boilers	H_2SO_4	5.68E-03	lb/MMBtu	7.45E-06	lb/gal	SO_2 Calculation multiplied by weight conversion of SO2 to H2S [a]
Incinerators	H_2SO_4			1.33	lb/ton	SO_2 emission factor multiplied by weight conversion of SO2 to H2S [a]

[a] It is assumed that SO_2 transformed to H_2S is less than 1%. Ref: AP42, Section 3.3.3.5, "during the combustion process, essentially all the sulfur in the fuel is oxidized to SO_2."

*This activity cannot occur simultaneously with Resupply - DP mode. DP mode has greater impacts.

^Values in this column represent maximum emissions independent of activity.

Air Sciences Inc.	PROJECT TITLE: Shell OCS Permit	BY: S. Pryor		
ENGINEERING CALCULATIONS	PROJECT NO: 180-20-6	PAGE: 1	OF: 4	SHEET: 3
	SUBJECT: Model Emission Summary	DATE: April 28, 2011		

Conical Drilling Unit Kulluk OCS Source - Daily Maximum Emissions for each source group
MLC Case

STACK	NO_X g/s	$PM_{2.5}$ g/s	PM_{10} g/s	CO g/s	SO_2 g/s	NH_3 g/s
Kulluk						
MAINENGS	2.395	0.374	0.374	1.08	6.80E-02	0.09
MLCHPU_A	2.330	0.093	0.093	0.13	7.06E-03	0.00
MLCHPU_B	2.330	0.093	0.093	0.13	7.06E-03	0.00
AIRCMP_A	1.864	0.039	0.039	0.11	7.06E-03	0.00
AIRCMP_B	1.864	0.039	0.039	0.11	7.06E-03	0.00
CRANE_A	0.149	0.006	0.006	0.01	4.52E-04	0.00
CRANE_B	0.149	0.006	0.006	0.01	4.52E-04	0.00
CRANE_C	0.149	0.006	0.006	0.01	4.52E-04	0.00
HEATBOIL	0.115	0.019	0.019	0.03	8.06E-03	0.00
INCIN_K	0.052	0.243	0.285	5.22	0.04	0.00
SELDOML (no egen.)	0.046	0.004	0.004	0.01	1.39E-04	0.00
SELDOMH (egen.)	2.242	0.179	0.179	0.60	6.79E-03	0.00
Primary Ice Management						
Propulsion & Generation	10.672	1.667	1.667	4.83	3.03E-01	0.20
Heaters & Boilers	0.192	0.032	0.032	0.05	1.34E-02	0.00
Seldom-used units	0.035	0.003	0.003	0.01	1.05E-04	0.00
Incinerator	0.029	0.136	0.159	2.91	0.02	0.00
Secondary Ice Management / Anchor Handler						
Propulsion & Generation	10.672	1.667	1.667	4.83	3.03E-01	0.20
Heaters & Boilers	0.192	0.032	0.032	0.05	1.34E-02	0.00
Seldom-used units	0.035	0.003	0.003	0.01	1.05E-04	0.00
Incinerator	0.029	0.136	0.159	2.91	0.02	0.00
Model ID: ICEMGMT; ICE MGMT/AH AREAPOLY [1, 2]	*2.51E-06*	*4.22E-07*	*4.27E-07*	*1.79E-06*	*7.82E-08*	*4.63E-08*
Resupply Ship - DP mode						
Propulsion & Generation	9.316	0.388	0.388	2.81	3.53E-02	0.00
Seldom-used units	0.007	0.001	0.001	0.00	2.10E-05	0.00
Model ID: RESUP_DP	*9.32*	*0.39*	*0.39*	*2.81*	*0.04*	*0.00*
Resupply Ship - transport mode						
Propulsion & Generation	0.000	0.000	0.000	0.00	0.00E+00	0.00
Seldom-used units	0.000	0.000	0.000	0.00	0.00E+00	0.00
OSR vessel						
Propulsion & Generation	5.434	0.226	0.226	1.64	2.06E-02	0.00
Seldom-used units	0.035	0.003	0.003	0.01	1.05E-04	0.00
Incinerator	0.024	0.110	0.129	2.36	0.02	0.00
Model ID: OSR_MAIN; OSR Vessel AREAPOLY [1, 3]	*1.37E-06*	*8.49E-08*	*8.96E-08*	*1.00E-06*	*1.01E-08*	*0.00E+00*
OSR work boats						
Work boats	1.313	0.105	0.105	0.35	3.98E-03	0.00
Model ID: OSR_WORK; OSR Work Boats AREAPOLY [1, 3]	*3.29E-07*	*2.63E-08*	*2.63E-08*	*8.86E-08*	*9.95E-10*	*0.00E+00*

[1] AREAPOLY units = $g/s/m^2$

[2] Ice Mngt/AH divide by area of the AREAPOLY = 8,718,385 sq. meters

[3] OSR divide by area of the AREAPOLY = 3,997,350 sq. meters

blue values are input, black values are calculated or linked

Conical Drilling Unit Kulluk OCS Source - Daily Maximum Emissions for each source group
Drill Case

STACK	NO_X g/s	$PM_{2.5}$ g/s	PM_{10} g/s	CO g/s	SO_2 g/s	NH_3 g/s
Kulluk						
MAINENGS	2.395	0.374	0.374	1.08	6.80E-02	0.09
MLCHPU_A	0.000	0.000	0.000	0.00	0.00E+00	0.00
MLCHPU_B	0.000	0.000	0.000	0.00	0.00E+00	0.00
AIRCMP_A	0.000	0.000	0.000	0.00	0.00E+00	0.00
AIRCMP_B	0.000	0.000	0.000	0.00	0.00E+00	0.00
CRANE_A	0.149	0.006	0.006	0.01	4.52E-04	0.00
CRANE_B	0.149	0.006	0.006	0.01	4.52E-04	0.00
CRANE_C	0.149	0.006	0.006	0.01	4.52E-04	0.00
HEATBOIL	0.115	0.019	0.019	0.03	8.06E-03	0.00
INCIN_K	0.052	0.243	0.285	5.22	0.04	0.00
SELDOML (no egen.)	0.046	0.004	0.004	0.01	1.39E-04	0.00
SELDOMH (egen.)	2.242	0.179	0.179	0.60	6.79E-03	0.00
Primary Ice Management						
Propulsion & Generation	10.672	1.667	1.667	4.83	3.03E-01	0.20
Heaters & Boilers	0.192	0.032	0.032	0.05	1.34E-02	0.00
Seldom-used units	0.035	0.003	0.003	0.01	1.05E-04	0.00
Incinerator	0.029	0.136	0.159	2.91	0.02	0.00
Secondary Ice Management / Anchor Handler						
Propulsion & Generation	10.672	1.667	1.667	4.83	3.03E-01	0.20
Heaters & Boilers	0.192	0.032	0.032	0.05	1.34E-02	0.00
Seldom-used units	0.035	0.003	0.003	0.01	1.05E-04	0.00
Incinerator	0.029	0.136	0.159	2.91	0.02	0.00
Model ID: ICEMGMT; ICE MGMT/AH AREAPOLY [1, 2]	*2.51E-06*	*4.22E-07*	*4.27E-07*	*1.79E-06*	*7.82E-08*	*4.63E-08*
Resupply Ship - DP mode						
Propulsion & Generation	9.316	0.388	0.388	2.81	3.53E-02	0.00
Seldom-used units	0.007	0.001	0.001	0.00	2.10E-05	0.00
Model ID: RESUP_DP	*9.32*	*0.39*	*0.39*	*2.81*	*0.04*	*0.00*
Resupply Ship - transport mode						
Propulsion & Generation	0.000	0.000	0.000	0.00	0.00E+00	0.00
Seldom-used units	0.000	0.000	0.000	0.00	0.00E+00	0.00
OSR vessel						
Propulsion & Generation	5.434	0.226	0.226	1.64	2.06E-02	0.00
Seldom-used units	0.035	0.003	0.003	0.01	1.05E-04	0.00
Incinerator	0.024	0.110	0.129	2.36	0.02	0.00
Model ID: OSR_MAIN; OSR Vessel AREAPOLY [1, 3]	*1.37E-06*	*8.49E-08*	*8.96E-08*	*1.00E-06*	*1.01E-08*	*0.00E+00*
OSR work boats						
Work boats	1.313	0.105	0.105	0.35	3.98E-03	0.00
Model ID: OSR_WORK; OSR Work Boats AREAPOLY [1, 3]	*3.29E-07*	*2.63E-08*	*2.63E-08*	*8.86E-08*	*9.95E-10*	*0.00E+00*

[1] AREAPOLY units = $g/s/m^2$

[2] Ice Mngt/AH divide by area of the AREAPOLY = 8,718,385 sq. meters

[3] OSR divide by area of the AREAPOLY = 3,997,350 sq. meters

Air Sciences Inc.	PROJECT TITLE: Shell OCS Permit	BY: S. Pryor		
ENGINEERING CALCULATIONS	PROJECT NO: 180-20-6	PAGE: 3	OF: 4	SHEET: 3
	SUBJECT: Model Emission Summary	DATE: April 28, 2011		

Conical Drilling Unit Kulluk OCS Source - Daily Maximum Emissions for each source group
Cementing/Logging Case

STACK	NO_X g/s	$PM_{2.5}$ g/s	PM_{10} g/s	CO g/s	SO_2 g/s	NH_3 g/s
Kulluk						
MAINENGS	1.690	0.264	0.264	0.76	4.80E-02	0.09
MLCHPU_A	0.000	0.000	0.000	0.00	0.00E+00	0.00
MLCHPU_B	0.000	0.000	0.000	0.00	0.00E+00	0.00
AIRCMP_A	0.000	0.000	0.000	0.00	0.00E+00	0.00
AIRCMP_B	0.000	0.000	0.000	0.00	0.00E+00	0.00
CRANE_A	0.249	0.010	0.010	0.01	7.53E-04	0.00
CRANE_B	0.249	0.010	0.010	0.01	7.53E-04	0.00
CRANE_C	0.249	0.010	0.010	0.01	7.53E-04	0.00
HEATBOIL	0.115	0.019	0.019	0.03	8.06E-03	0.00
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SELDOML (no egen.)	0.046	0.004	0.004	0.01	1.39E-04	0.00
SELDOMH (egen.)	2.242	0.179	0.179	0.60	6.79E-03	0.00
Primary Ice Management						
Propulsion & Generation	10.672	1.667	1.667	4.83	3.03E-01	0.20
Heaters & Boilers	0.192	0.032	0.032	0.05	1.34E-02	0.00
Seldom-used units	0.035	0.003	0.003	0.01	1.05E-04	0.00
Incinerator	0.029	0.136	0.159	2.91	0.02	0.00
Secondary Ice Management / Anchor Handler						
Propulsion & Generation	10.672	1.667	1.667	4.83	3.03E-01	0.20
Heaters & Boilers	0.192	0.032	0.032	0.05	1.34E-02	0.00
Seldom-used units	0.035	0.003	0.003	0.01	1.05E-04	0.00
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Model ID: ICEMGMT; ICE MGMT/AH AREAPOLY [1, 2]	*2.51E-06*	*4.22E-07*	*4.27E-07*	*1.79E-06*	*7.82E-08*	*4.63E-08*
Resupply Ship - DP mode						
Propulsion & Generation	9.316	0.388	0.388	2.81	3.53E-02	0.00
Seldom-used units	0.007	0.001	0.001	0.00	2.10E-05	0.00
Model ID: RESUP_DP	*9.32*	*0.39*	*0.39*	*2.81*	*0.04*	*0.00*
Resupply Ship - transport mode						
Propulsion & Generation	0.000	0.000	0.000	0.00	0.00E+00	0.00
Seldom-used units	0.000	0.000	0.000	0.00	0.00E+00	0.00
OSR vessel						
Propulsion & Generation	5.434	0.226	0.226	1.64	2.06E-02	0.00
Seldom-used units	0.035	0.003	0.003	0.01	1.05E-04	0.00
Incinerator	0.024	0.110	0.129	2.36	0.02	0.00
Model ID: OSR_MAIN; OSR Vessel AREAPOLY [1, 3]	*1.37E-06*	*8.49E-08*	*8.96E-08*	*1.00E-06*	*1.01E-08*	*0.00E+00*
OSR work boats						
Work boats	1.313	0.105	0.105	0.35	3.98E-03	0.00
Model ID: OSR_WORK; OSR Work Boats AREAPOLY [1, 3]	*3.29E-07*	*2.63E-08*	*2.63E-08*	*8.86E-08*	*9.95E-10*	*0.00E+00*

[1] AREAPOLY units = $g/s/m^2$

[2] Ice Mngt/AH divide by area of the AREAPOLY = 8,718,385 sq. meters

[3] OSR divide by area of the AREAPOLY = 3,997,350 sq. meters

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ENGINEERING CALCULATIONS	PROJECT NO: 180-20-6	PAGE: 4	OF: 4	SHEET: 3
	SUBJECT: Model Emission Summary	DATE: April 28, 2011		

Conical Drilling Unit Kulluk OCS Source - Daily Maximum Emissions for each source group
Maximum

STACK	CO g/s	NH_3 g/s
Kulluk		
MAINENGS	1.08	0.09
MLCHPU_A	0.13	0.00
MLCHPU_B	0.13	0.00
AIRCMP_A	0.11	0.00
AIRCMP_B	0.11	0.00
CRANE_A	0.01	0.00
CRANE_B	0.01	0.00
CRANE_C	0.01	0.00
HEATBOIL	0.03	0.00
INCIN_K	5.22	0.00
SELDOML (no egen.)	0.0123	0.00
SELDOMH (egen.)	0.6045	0.00
Primary Ice Management		
Propulsion & Generation	4.83	0.20
Heaters & Boilers	0.05	0.00
Seldom-used units	0.01	0.00
Incinerator	2.91	0.00
Secondary Ice Management / Anchor Handler		
Propulsion & Generation	4.83	0.20
Heaters & Boilers	0.05	0.00
Seldom-used units	0.01	0.00
Incinerator	2.91	0.00
Model ID: ICEMGMT; ICE MGMT/AH AREAPOLY [1, 2]	*1.79E-06*	*4.63E-08*
Resupply Ship - DP mode		
Propulsion & Generation	2.81	0.00
Seldom-used units	0.00	0.00
Model ID: RESUP_DP	*2.81*	*0.00*
Resupply Ship - transport mode		
Propulsion & Generation	0.00	0.00
Seldom-used units	0.00	0.00
OSR vessel		
Propulsion & Generation	1.64	0.00
Seldom-used units	0.01	0.00
Incinerator	2.36	0.00
Model ID: OSR_MAIN; OSR Vessel AREAPOLY [1, 3]	*1.00E-06*	*0.00E+00*
OSR work boats		
Work boats	0.35	0.00
Model ID: OSR_WORK; OSR Work Boats AREAPOLY [1, 3]	*8.86E-08*	*0.00E+00*

[1] AREAPOLY units = $g/s/m^2$

[2] Ice Mngt/AH divide by area of the AREAPOLY = 8,718,385 sq. meters

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ATTACHMENT B

Nearby Sources/Cumulative Impacts Analysis

Kulluk Permit Application: Nearby Sources/Cumulative Impacts

The purpose of this document is to address the potential cumulative air quality impacts of Shell's proposed Kulluk minor source application[1] (February 28, 2011) when combined with the impacts from on-shore sources. The modeling analysis in the Kulluk Application added regional background concentrations for each pollutant to the potential Kulluk model concentrations, and these combined concentrations were then compared with ambient air quality standards. The regional background concentrations were based on measured data at onshore locations and included the contribution from existing regional sources in the area. However, it could be necessary to explicitly model certain regional sources if they are close enough in location to the proposed Shell operation to cause greater overlapping impact than the monitored data suggest. Therefore, in addition to the analysis done as part of the February 28 Application, in this document Shell determines whether any regional sources need to be explicitly modeled. In addition, Shell has analyzed ambient background data from the Prudhoe Bay area for NO_2, $PM_{2.5}$, and PM_{10} to address the cumulative impacts for the Kulluk. As used here, the term "Prudhoe Bay area" refers to the entire oil and gas development area surrounding Prudhoe Bay itself and includes outlying areas such as the Deadhorse airport area and the A-Pad location.

Nitrogen Dioxide (NO2)

EPA's March 1, 2011 memo on 1-hour NO2 modeling provides guidance on identifying nearby sources to be included in the modeled inventory for 1-hour NO2 assessments and emphasizes the importance of professional judgment in determining whether including regional competing sources is necessary in a full impact analysis:

> *As noted in the July 29, 2010 memo, Section 8.2.3 of Appendix W emphasizes the importance of professional judgment by the reviewing authority in the identification of nearby and other sources to be included in the modeled emission inventory, and establishes "a significant concentration gradient in the vicinity of the source" under consideration as the main criterion for this selection. Appendix W also suggests that "the number of such [nearby] sources is expected to be small except in unusual situations." See Section 8.2.3.b. In light of this guidance, the June 29, 2010 memo cautioned against the literal and uncritical application of very prescriptive procedures for identifying which background sources should be included in the modeled emission inventory for NAAQS compliance demonstrations, such as those described in Chapter C, Section IV.C.1 of the draft New Source Review Workshop Manual (EPA, 1990).....Our main concern is that following such procedures in a literal and uncritical manner may in many cases result in cumulative impact assessments that are overly conservative and could unnecessarily complicate the permitting process in some cases.*

Memo from T. Fox, EPA Air Quality Modeling Group, to Regional Air Division Directors, *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard*, March 1, 2011, pp. 12-13.

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[1] Supplement to EPA Outer Continental Shelf (OCS) Operating Permit Application. Shell Beaufort Sea. Alaska Exploratory Drilling Program: Conical Drilling Unit Kulluk. Air Sciences, Inc. Project 180-20-3, February 28, 2011.

The March 1, 2011 memo emphasizes that the full impact analysis is case-by-case in nature and that factors such as terrain, meteorology, and the impact pattern of the source itself be considered when evaluating the need for a cumulative impact assessment. As mentioned above and in the Guideline on Air Quality Modeling (40 CFR 51, Appendix W), EPA considers whether a regional source causes "a significant concentration gradient in the vicinity of the source" under consideration (i.e., the Kulluk) as the main criterion for determining if a regional source should be included in a full impact analysis. Given the issues and challenges arising from implementing the new 1-hour NO2 standard, EPA offers additional explanation in the March 1, 2011 memo regarding what the Appendix W Guideline means and how it should be applied. For instance, in discussing terrain influences on the location and gradients of maximum 1-hour concentrations, EPA states:

> *Even accounting for some terrain influences on the location and gradients of maximum 1-hour concentrations, these considerations suggest that the emphasis on determining which nearby sources to include in the modeling analysis should focus on the area within about 10 kilometers of the project location in most cases. The routine inclusion of all sources within 50 kilometers of the project location, the nominal distance for which AERMOD is applicable, is likely to produce an overly conservative result in most cases.*

EPA March 1, 2011 memo, p. 16 (emphasis added). The Beaufort Sea setting for the Kulluk and its associated fleet is remote and generally far from any other sources of emissions. However, given that the Prudhoe Bay area has many sources of emissions, and is located on the shores of the Beaufort Sea, further investigation was warranted.

As noted, the March 2011 memo introduces the concept of significant concentration gradients, and suggests that in most cases, distances of 10 kilometers (10,000 meters) are sufficient to effectively evaluate the significant concentration gradients that are seen in areas close to a source. This gradient issue is illustrated by Figure 1, showing the change in concentration with downwind distance for the Kulluk itself and its associated fleet. As the figure shows at distances of 7,000 to 10,000 meters downwind of the Kulluk, concentrations level off and change less rapidly from point to point. The guidance suggests that explicit modeling of regional sources is only necessary for sources that have significant concentration gradients in the vicinity of the Kulluk and its associated fleet. Due to the literally hundreds of sources in the Prudhoe Bay area, we have not modeled the specific concentration gradients for each source. Rather, we have used a screening approach to define a single separation distance between the Kulluk and any regional source that could reasonably be expected in all cases to be sufficient to escape the significant concentration gradients. To be conservative, this screening analysis is based on the separation distance needed for the largest emission source in the Prudhoe Bay area, the BP Central Compressor Plant (CCP).

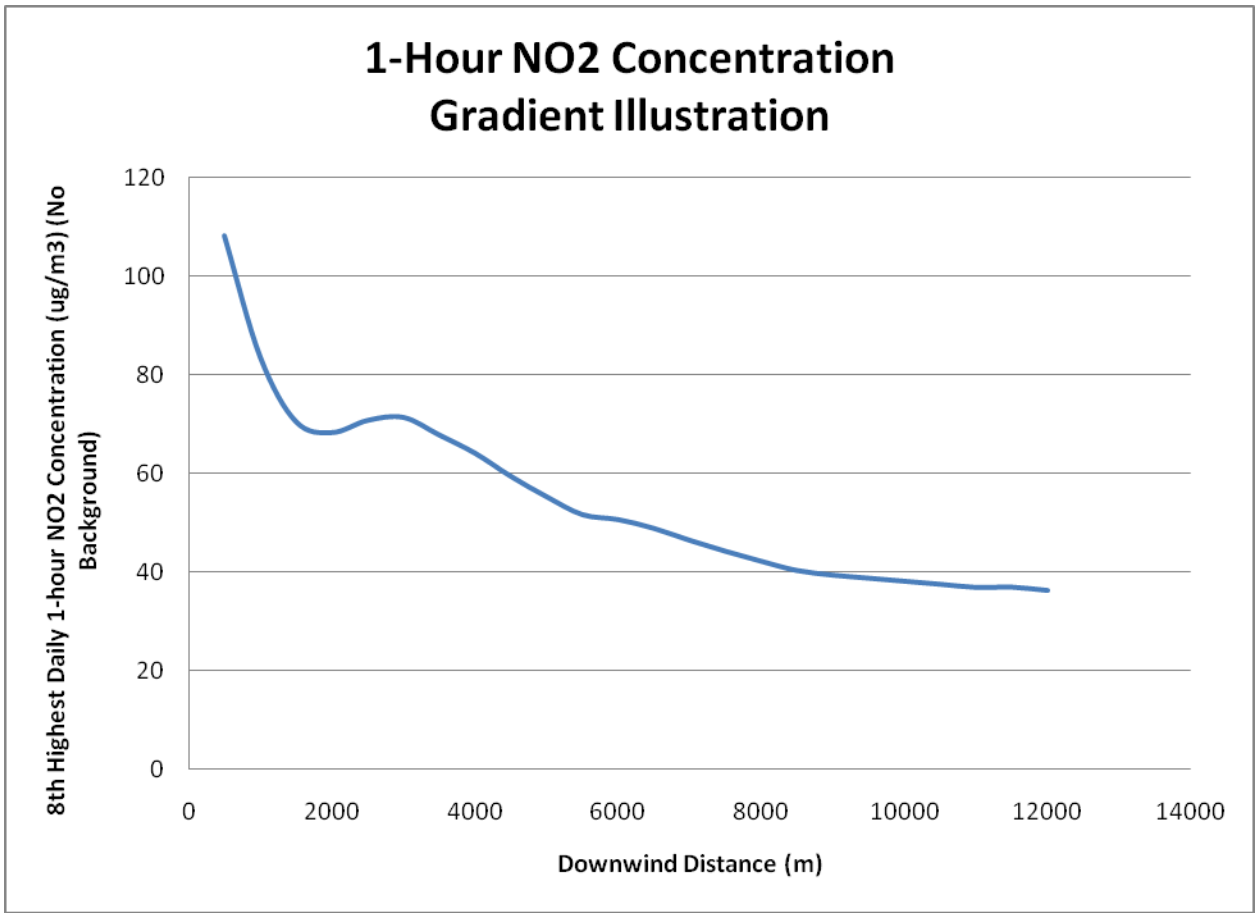

Figure 1. Concentration Gradient Illustration

This does not mean that a distant source and the Kulluk could not have an overlapping impact. Rather, it suggests that this overlapping impact can be addressed using available monitoring data and incorporated in the background concentration, rather than by explicitly modeling the distant source. Conversely, if the regional source is close to the Kulluk, it might be expected to have concentrations at the Kulluk location that vary greatly depending on exactly how close the source is to the Kulluk. In that event, it might be necessary to explicitly model the regional source, rather than relying on monitoring data that might not be located as close to the regional source as the Kulluk could be.

EPA has suggested that Shell consider the distance between ambient monitoring locations in Prudhoe Bay from the largest emission sources in Prudhoe Bay.[2] It is thought that if these monitoring locations are far enough away to be sampling background air quality, the samplers must be out of the region of significant concentration gradient. The largest source of NO_x emissions in the Prudhoe Bay area is the BP Central Compressor Plant (CCP). As shown in the January 2010 Discoverer permit application, the BP CPP emits over 14,000 tons per year of NO_x. This is more than 40 times as much NO_x as will be emitted by the Kulluk and associated fleet. The ambient monitor used to characterize background

[2] April 14, 2011 email from Doug Hardesty, EPA Region 10, to Pauline Ruddy, Shell, and subsequent conversations with EPA modeling personnel.

concentrations for this facility is the A-PAD NO_x monitor. The distance between the A-PAD monitor and the CPP is 11.5 kilometers (11,500 meters). Figure 2 illustrates the location of the A-PAD monitor with respect to the CCP Main Pad.

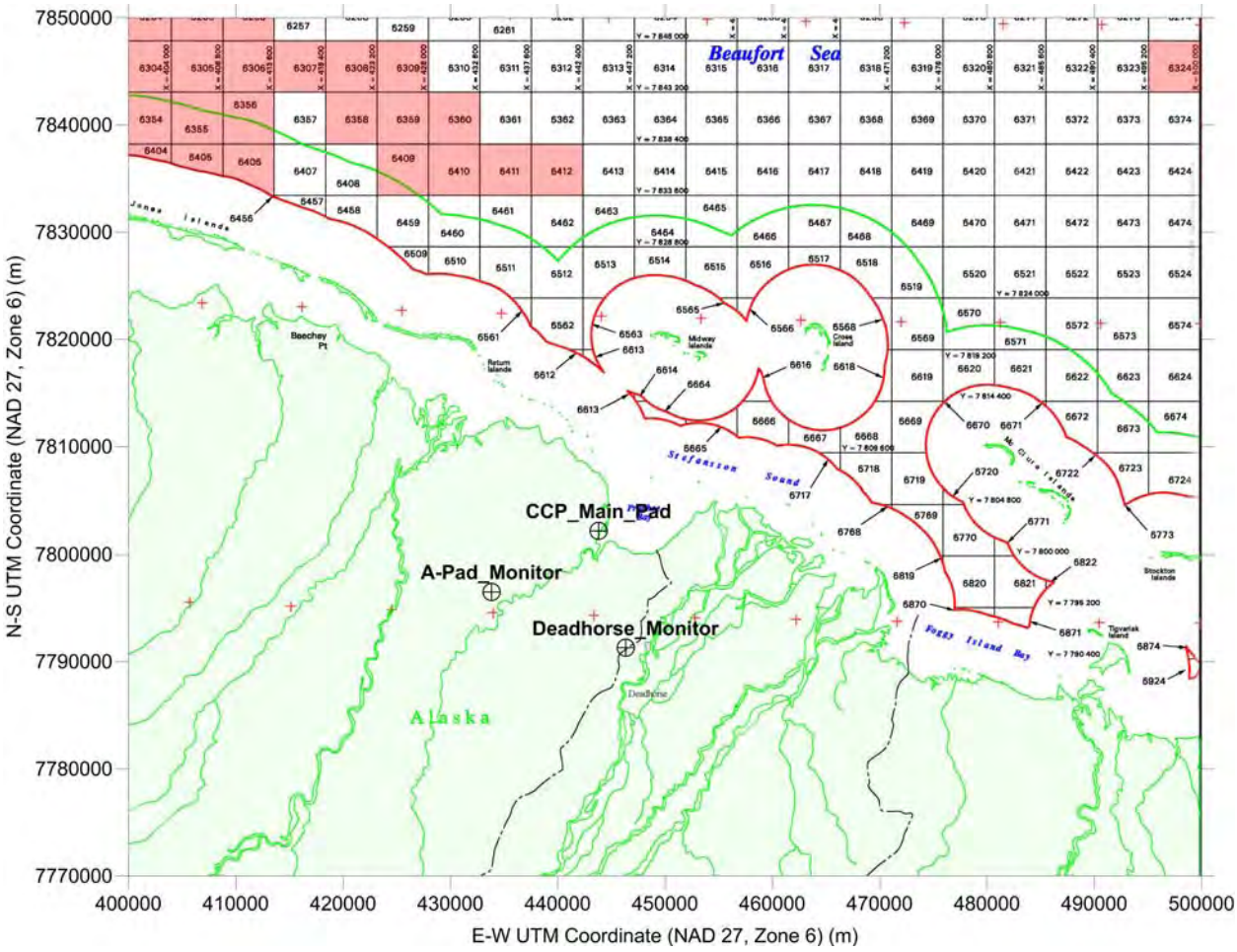

Figure 2. Location of the Air Quality Monitoring Stations and the CCP Main Pad

Because the CCP facility is by far the largest emitter in the Prudhoe Bay area, the distance from A-PAD to CCP of 11,500 meters is considered sufficient to escape the significant concentration gradient for any of the sources in Prudhoe Bay. Shell therefore proposes to use this 11,500 meter distance as a basis for determining which emission sources should be modeled explicitly, and which could be addressed through available monitoring data.

Figure 3 is a plot of the Shell Beaufort Sea Leases with respect to other sources of emissions. A circle of 11,500 meters is drawn around each regional source of emissions, showing that none of the sources are within 11,500 meters of any of Shell's proposed operation leases for the Kulluk.

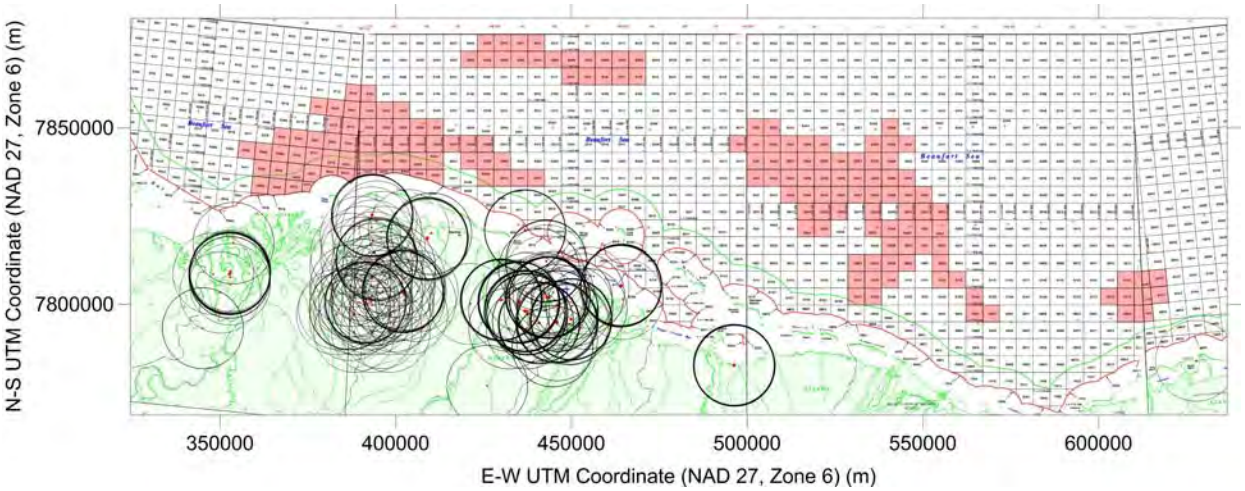

Figure 3. 11,500 meter Radii from Existing Sources Shown with Proposed Shell lease Blocks

Because of the remote offshore location of the Shell leases and the lack of any significant nearby sources and because the nearest shored-based sources are already accounted for in the A-PAD background measurements, only impacts from the Kulluk and its associated fleet are explicitly modeled in the full impact analysis in Section 3 of Shell's February 28, 2011 application. This conclusion is consistent with the analysis presented in this paper, as well as EPA's March 1, 2011 guidance that recommends considering only regional sources generally located within 10 kilometers of the source (i.e., the Kulluk) in a full NO_2 impact analysis.

It should be noted that the analysis in the February Kulluk application used the Badami monitoring data to characterize background concentrations for NO_2. This analysis is presently being revised and submitted to EPA under separate cover using the A-PAD data to be consistent with this cumulative impact analysis.

Particulate Matter (PM10 and PM2.5)

Particulate matter is quantified both as particulate matter smaller than 10 micrometers in mass-mean diameter (PM10) and particulate matter smaller than 2.5 micrometers in mass-mean diameter (PM2.5). In general PM10 is not as significant an issue for the Shell emission sources as is NO_2 above. This results from two factors: 1) Shell's emissions of PM10 are far less than its emissions of NOx (compare 11,061 pounds per day of NOx with only 1,052 pounds per day of PM10), and 2) the PM10 standard is for 24-hour average concentrations, compared with the much more stringent 1-hour concentration for NO_2 even though the magnitude of the ambient standards are very similar in value (188 $\mu g/m^3$ for NO_2 and 150 $\mu g/m^3$ for PM10). Ambient PM10 data are available at the CCP site, directly downwind from the CCP facility and much closer than the A-PAD data used above. The same analysis as presented above for NO2 applies to PM10. The impacts of the regional sources of PM10 are included in the analysis without the need for explicit modeling as long as the CCP site PM10 data are used to characterize the background. These data were used for background PM10 in the February 28, 2011 Kulluk application.

The other metric measure used for particulate matter, PM2.5, results in the same conclusion, but needs further explanation. Like PM10, the emissions of PM2.5 are 10 times smaller than the emissions of NOx,

and the ambient standard is a 24-hour standard. However, the ambient standard for PM2.5 is only 35 $\mu g/m^3$, much smaller than the 1-hour NO2 standard. There is no ambient monitor for PM2.5 at either the A-PAD or the CCP monitor. The Badami monitor was established by Shell and was used in the application to characterize background PM2.5 concentrations, but Badami is considerably further from Prudhoe Bay.

Shell established a PM2.5 monitor at Deadhorse in the Prudhoe Bay area. The Deadhorse monitor collects the only PM2.5 data in Prudhoe Bay at present. The distance between the CCP facility, the largest source of emissions in Prudhoe Bay, and the Deadhorse monitor is 11,300 meters (see Figure 2 above), almost the same as the A-PAD data. Accordingly, it has been assumed here that the 11,500 meter distance can again be used to define sources that need explicit modeling for PM2.5. Following this analysis, no explicit modeling is required for any source of PM2.5 other than the Kulluk and its associated fleet, as long as Deadhorse data are used as background. The air quality impact analysis is presently being revised to use the Deadhorse data for background concentrations. It will be provided to EPA under separate cover.

Other Pollutants (SO2, CO)

The impact of the Kulluk emission sources is less than the Significant Impact Level for all other pollutants at distances greater than 11,000 meters. Accordingly, no cumulative impact analysis is needed for these pollutants.

ATTACHMENT C

Deadhorse $PM_{2.5}$ Measured Concentrations Used in Analysis

Deadhorse $PM_{2.5}$ Measured Concentrations Used in Analysis

Date	24-Hour $PM_{2.5}$ Concentration ($\mu g/m^3$)	Precipitation Day of (inches)	Precipitation Previous Day (inches)	Hour Per Day With Winds > 10 m/sec
07/01/10	4	0	0	0
07/02/10	5	0	0	0
07/03/10	5	0	0	0
07/04/10	4	0	0	0
07/05/10	20	0	0	0
07/06/10	0	0.08	0	0
07/07/10	2	0	0.08	1
07/08/10	15	0.03	0	2
07/09/10	17	0	0.03	0
07/10/10	1	0	0	1
07/11/10	0	0	0	0
07/12/10	1	0.02	0	0
07/13/10	1	0	0.02	0
07/14/10	1	0.01	0	0
07/15/10	2	0	0.01	0
07/16/10	3	0	0	0
07/17/10	0	0.08	0	0
07/18/10	0	0.11	0.08	0
07/19/10	0	0.08	0.11	0
07/20/10	0	0.08	0.08	0
07/21/10	0	0	0.08	0
07/22/10	0	0	0	0
07/23/10	0	0.03	0	0
07/24/10	0	0	0.03	0
07/25/10	1	0	0	0
07/26/10	2	0	0	0
07/27/10	2	0	0	0
07/28/10	1	0	0	0
07/29/10	0	0	0	0
07/30/10	0	0.01	0	0
07/31/10	8	0	0.01	1
08/01/10	11	0	0	0
08/02/10	41	0	0	10
08/03/10	7	0	0	0
08/04/10	2	0	0	0
08/05/10	3	0	0	0
08/06/10	1	0	0	0
08/07/10	2	0.11	0	7
08/08/10	3	0	0.11	16
08/09/10	2	0	0	16

Deadhorse $PM_{2.5}$ Measured Concentrations Used in Analysis (cont'd)

Date	24-Hour $PM_{2.5}$ Concentration ($\mu g/m^3$)	Precipitation Day of (inches)	Precipitation Previous Day (inches)	Hour Per Day With Winds > 10 m/sec
08/10/10	0	0	0	0
08/11/10	0	0.01	0	0
08/12/10	0	0	0.01	0
08/13/10	1	0.03	0	0
08/14/10	1	0.06	0.03	0
08/15/10	3	0	0.06	0
08/16/10	1	0.01	0	0
08/17/10	7	0	0.01	0
08/18/10	1	0	0	0
08/19/10	0	0.01	0	0
08/20/10	1	0	0.01	0
08/21/10	0	0	0	0
08/22/10	0	0.01	0	0
08/23/10	2	0	0.01	0
08/24/10	2	0	0	0
08/25/10	0	0	0	2
08/26/10	0	0	0	7
08/27/10	0	0	0	0
08/28/10	0	0	0	0
08/29/10	0	0	0	0
08/30/10	0	0	0	0
08/31/10	0	0.01	0	0
09/01/10	0	0	0.01	0
09/02/10	0	0	0	0
09/03/10	0	0.01	0	5
09/04/10	0	0	0.01	0
09/05/10	0	0	0	0
09/06/10	2	0	0	0
09/07/10	0	0	0	0
09/08/10	0	0	0	0
09/09/10	0	0.01	0	0
09/10/10	1	0.01	0.01	0
09/11/10	0	0	0.01	0
09/12/10	8	0	0	0
09/13/10	2	0	0	0
09/14/10	1	0	0	0
09/15/10	2	0	0	0
09/16/10	5	0	0	0
09/17/10	1	0.04	0	0
09/18/10	0	0	0.04	0

Deadhorse $PM_{2.5}$ Measured Concentrations Used in Analysis (cont'd)

Date	24-Hour $PM_{2.5}$ Concentration ($\mu g/m^3$)	Precipitation Day of (inches)	Precipitation Previous Day (inches)	Hour Per Day With Winds > 10 m/sec
09/19/10	1	0	0	0
09/20/10	4	0	0	0
09/21/10	3	0	0	0
09/22/10	3	0	0	0
09/23/10	2	0	0	0
09/24/10	1	0	0	0
09/25/10	0	0	0	0
09/26/10	2	0.02	0	0
09/27/10	1	0.01	0.02	0
09/28/10	1	0	0.01	4
09/29/10	1	0	0	4
09/30/10	4	0	0	0
10/01/10	5	0	0	1
10/02/10	12	0	0	17
10/03/10	1	0.01	0	10
10/04/10	3	0	0.01	15
10/05/10	2	0	0	1
10/06/10	3	0	0	0
10/07/10	4	0	0	0
10/08/10	2	0	0	0
10/09/10	2	0	0	0
10/10/10	3	0	0	0
10/11/10	3	0	0	0
10/12/10	3	0	0	0
10/13/10	2	0.03	0	0
10/14/10	3	0	0.03	2
10/15/10	2	0	0	0
10/16/10	3	0	0	7
10/17/10	INVALID	0	0	24
10/18/10	INVALID	0	0	24
10/19/10	3	0.03	0	7
10/20/10	3	0.01	0.03	0
10/21/10	1	0	0.01	13
10/22/10	1	0	0	17
10/23/10	3	0	0	23
10/24/10	3	0	0	1
10/25/10	2	0.01	0	0
10/26/10	3	0.01	0.01	0
10/27/10	1	0	0.01	0
10/28/10	2	0	0	0

Deadhorse $PM_{2.5}$ Measured Concentrations Used in Analysis (cont'd)

Date	24-Hour $PM_{2.5}$ Concentration ($\mu g/m^3$)	Precipitation Day of (inches)	Precipitation Previous Day (inches)	Hour Per Day With Winds > 10 m/sec
10/29/10	0	0	0	0
10/30/10	0	0.01	0	0
10/31/10	2	0	0.01	0
11/01/10	0	0	0	0
11/02/10	4	0	0	0
11/03/10	3	0	0	8
11/04/10	19	0	0	19
11/05/10	5	0	0	0
11/06/10	17	0	0	0
11/07/10	6	0	0	0
11/08/10	2	0	0	0
11/09/10	0	0	0	0
11/10/10	3	0	0	2
11/11/10	0	0	0	0
11/12/10	0	0	0	0
11/13/10	0	0	0	0
11/14/10	4	0	0	0
11/15/10	4	0	0	13
11/16/10	6	0	0	13
11/17/10	INVALID	0	0	22
11/18/10	4	0	0	10
11/19/10	4	0	0	0
11/20/10	0	0.01	0	6
11/21/10	2	0.01	0.01	4
11/22/10	2	0	0.01	0
11/23/10	0	0.06	0	0
11/24/10	1	0.05	0.06	1
11/25/10	6	0	0.05	0
11/26/10	5	0.01	0	0
11/27/10	2	0	0.01	0
11/28/10	5	0	0	0
11/29/10	6	0	0	0
11/30/10	5	0	0	0