Additional Supporting Information

INEOS Email 2-24-2012 with amended permit application

INEOS/EPA email requesting additional information

Enclosure on the email – EPA Completeness Comments

INEOS Email 5-24-2012 providing response to EPA and amended application

(This is the application in the public records file)

INEOS response to EPA completeness comments

INEOS email on revised calculations

Revised Calculations

Air Quality Analysis Report

INEOS Email on Environmental Calculations 6-12-2012

INEOS GHG PSD Application NACE Calculations

Permit application document

Daniel Lutz to: Bonnie Braganza, Brian Tomasovic

From: Daniel Lutz <daniel.lutz@ineos.com>

To: Bonnie Braganza/R6/USEPA/US@EPA, Brian Tomasovic/R6/USEPA/US@EPA

INEOS amended permit application 0242012.pdf

The attached document updates some information from the original application, incorporating our responses to TCEQ Notices of Deficiency. It also incorporates the information INEOS supplied on November 1, 2011, in response to EPA's request for additional information.

There is no information in this application that is claimed CBI, so the entire application is in one complete document. It is our understanding that EPA will return the initial application so that the agency doesn't retain any CBI documents.

INEOS has also augmented some information regarding MRR, as we discussed at our meeting last week.

Bonnie, I will check back with you next week after you've had a chance to review this information. If you have any questions, please don't hesitate to let me know. If you think it will be useful to meet in person to go over anything, feel free to suggest a date.

Regards,

Dan Lutz
Environmental Advisor
INEOS Olefins & Polymers
(713) 373-9300 (m)

<<...>>

RE: Additional information request

Daniel Lutz to: Bonnie Braganza

Cc: Jeffrey Robinson

From: Daniel Lutz <daniel.lutz@ineos.com>
To: Bonnie Braganza/R6/USEPA/US@EPA
Cc: Jeffrey Robinson/R6/USEPA/US@EPA

Acknowledging receipt. There are a few questions here that are in addition to what we discussed last week. I'll get with our experts this morning to start resolving those.

I talked to our permitting consultant, and apparently the costs for CCS in Table 5.1 came from another company and may be quite generalized. I'm asking our engineering contractor if they can quickly determine a site-specific cost.

Dan

From: Bonnie Braganza [mailto:Braganza.Bonnie@epamail.epa.gov]
Sent: Wednesday, April 11, 2012 8:17 AM
To: daniel.lutz@ineos.com
Cc: Jeffrey Robinson
Subject: Additional information request

Dan: As we had discussed last week on obtaining some additional information. I am sending you a copy of the enclosure on a proposed letter. Also please note that the cross cutting issues need to be evaluated by EPA as final information prior to putting the permit on public notice. Please let me know the progress and timing of the TCEQ draft PSD permit.
Thank you. I will be available to discuss any questions you have this his week. I will be out of the office from April 25th through April 30th

POSITIONS or VIEWS EXPRESSED DO NOT REPRESENT OFFICIAL EPA POLICY

Bonnie Braganza P.E.
US EPA Region 6
Air Permits Section
Multimedia Permitting & Planning Division

Phone:214 -665-7340
Fax: 214-665-6762

Remember Life Rewards Actions!
If you continue to do what you have always done, you will get what you always got!

ENCLOSURE

EPA Completeness Comments on the INEOS USA LLC Greenhouse Gas Permit Application of February 24, 2012

1. Page 3 of this application indicates that some information on the TCEQ Table 2, process flow diagram (PFD) and emission calculations are considered confidential. There is no mark of confidentiality on the Tables or PFD. Please clarify.
2. The application details the cost for Carbon Capture and Storage (CCS) on Table 5.1. Please provide additional information that determined the costs for the compressors and amine towers such as equipment type and size.
3. Page 24 provides information on the energy efficient design and operation of the new furnace. Please provide benchmark data to indicate such efficiencies. One resource of such data is the Solomon Townsend and Associates database on chemical plants.
4. The BACT for energy efficiency refers to t he Energy Star Guide for Energy and Plant Managers, Energy Efficiency Improvement and Cost Saving Opportunities for the Petrochemical Industry by Ernest Orlando, Lawrence Berkeley National Laboratory, sponsored by the U.S. EPA. This is a good document that provides several energy capture opportunities. Your application includes information for some equipment. Please also evaluate and discuss:
    a. The recovery of steam condensate for your plant. It appears that several of your compressors and turbines are steam driven and condensate from these areas can be used in the feedwater to the steam boilers.
    b. The latest technology for the furnace. The referenced document, page 58 has special design considerations such as ceramic coated furnace tubes for improved heat transfer surface and maintenance procedures. Table 5.2 proposes maintenance per vendor recommendations. Please clarify if all or some of the design and maintenance procedures will be used for this new furnace.
    c. The BACT emission limit in heat recovery. Table 5.2 of your application states that the "proposed MRR" for heat recovery is to record flue gas and steam temperature as well as the steam rate. This will be done by design and operations to reduce the final stack temperature to its "practical limit." Please propose such a limit based on heat and material balances.
    d. The use of a low carbon fuel such as hydrogen instead of the proposed fuel gas and natural gas as BACT.
    e. A maintenance plan for reducing the fouling in the heat exchangers.

5. Emission Calculations: The fuel gas HHV on the emission calculations has two values one for plant gas at 732 BTU/SCF and the other for natural gas. The plant fuel gas can be up to 40% volume hydrogen. Please clarify the fuel gas that was used in the calculations. Also please note that the discrepancy for the maximum value for the hydrogen in the fuel gas analysis as 35%, where as in the emission calculations it states up to 40%. Please clarify the correlation between 40% volume of hydrogen and 35% average mol fraction and the fuel molecular weight factor used in the equations.

6. There is a discrepancy in the calculated emissions for the furnace, decoking operation in Appendix B from the PSD contemporaneous emission table in Appendix C. Please explain.

7. There is no recommended monitoring recordkeeping and reporting for the CO2 emissions. CEMS will be required, unless it is shown to be technically infeasible or an alternate more accurate method such as PEMS is proposed.

INEOS permit

Daniel Lutz to: Bonnie Braganza

From: Daniel Lutz <daniel.lutz@ineos.com>

To: Bonnie Braganza/R6/USEPA/US@EPA

Response - 2012-0518.pdf INEOS No 2 Furnace Comb Draft 2012-0518.pdf

Bonnie,

The "response" document contains the final answers to your questions from your original e-mail. Also attached is a revised version of the full permit application incorporating the answers to your questions.

Please let me know if you have any questions.

Dan.

1. Page 3 of this application indicates that some information on the TCEQ Table 2, process flow diagram (PFD) and emission calculations are considered confidential. There is no mark of confidentiality on the Tables or PFD. Please clarify.

    This statement was in error. The TCEQ Table 2, process flow diagram (PFD) and emissions calculation that were included in the application are not confidential. The revised application has been updated to reflect this change.

2. The application details the cost for Carbon Capture and Storage (CCS) on Table 5.1. Please provide additional information that determined the costs for the compressors and amine towers such as equipment type and size.

    <Reserved>

3. Page 24 provides information on the energy efficient design and operation of the new furnace. Please provide benchmark data to indicate such efficiencies. One resource of such data is the Solomon Townsend and Associates database on chemical plants.

    The best available benchmark data that applies to Olefins furnace is the design information from the five companies from which INEOS received proposals. The energy efficiencies of the modern furnaces are all very similar.

    INEOS has added a table (Table 5-2) in the revised permit application section 5.3.4.2. The table notes the overall furnace efficiency from the five designs considered by INEOS. Also included in the table for comparison are the existing furnaces at the INEOS facility; the date refers to the installation of these furnaces. INEOS has also included in this section of the permit application additional information about other performance aspects of the furnace (such as yield, availability, and steam production) which influence emissions.

4. The BACT for energy efficiency refers to the Energy Star Guide for Energy and Plant Managers, Energy Efficiency Improvement and Cost Saving Opportunities for the Petrochemical Industry by Ernest Orlando, Lawrence Berkeley National Laboratory, sponsored by the U.S. EPA. This is a good document that provides several energy capture opportunities. Your application includes information for some equipment. Please also evaluate and discuss:

    The following information has also been incorporated into section 5.3.4.2 of the furnace application.

    a. The recovery of steam condensate for your plant. It appears that several of your compressors and turbines are steam driven and condensate from these areas can be used in the feedwater to the steam boilers.

Steam condensate from this equipment is routinely recovered as feed water for the steam-producing equipment at the plant.

b. The latest technology for the furnace. The referenced document, page 58 has special design considerations such as ceramic coated furnace tubes for improved heat transfer surface and maintenance procedures. Table 5.2 proposes maintenance per vendor recommendations. Please clarify if all or some of the design and maintenance procedures will be used for this new furnace.

(Note that Table 5.2 has been renumbered as Table 5.3.) All of the practices listed in Table 5.3 will be used for this new furnace.

Ceramic coatings were tested in the ethylene industry—including at our plant site—many years ago. This technology was examined both for its potential to improve heat transfer and its potential to reduce coking. The coatings proved impactical because of a lack of adhesion to the metal surface. This was aggravated because of the thermal cycling of the tubes (i.e., decoking) in Olefins furnaces. To INEOS's knowledge, there is no ongoing development concerning ceramic coatings for ethylene furnace tubes.

INEOS specifically did not include decoking as a maintenance procedure to reduce GHG emissions. This is because loss of heat transfer and degradation of ethylene yield are not the factors which drive decoking for this technology. Instead, pressure drop and coil plugging are the triggers for decoking the furnace. While decoking also has the effect of restoring optimum heat transfer (i.e., clean furnace tubes), INEOS has not observed a measurable difference in energy efficiency between start-of-run and end-of-run conditions.

c. The BACT emission limit in heat recovery. Table 5.2 of your application states that the "proposed MRR" for heat recovery is to record flue gas and steam temperature as well as the steam rate. This will be done by design and operations to reduce the final stack temperature to its "practical limit." Please propose such a limit based on heat and material balances.

INEOS proposes a limit of 340ºF for the flue gas temperature, based on an annual (365-day rolling) average. The revised permit application goes into further detail about how INEOS arrived at this limit.

d. The use of a low carbon fuel such as hydrogen instead of the proposed fuel gas and natural gas as BACT.

Some of the hydrogen produced by the No. 2 Olefins process is sold as a chemical product and some is used as fuel. Market conditions will dictate how much hydrogen is sold. Market conditions such as the cost of various feedstocks can also affect the total amount of hydrogen produced. Therefore, substitution of hydrogen for natural gas as an enforceable GHG BACT alternative is not considered to be a viable control strategy. Rather, a requirement to use hydrogen as fuel in place of natural gas when available and not sold as product is a viable operating practice.

e. A maintenance plan for reducing the fouling in the heat exchangers.

There are three heat exchangers involved in the furnace. The primary and secondary exchangers cool the cracked gas effluent by producing steam from boiler feed water. The tertiary exchanger cools the cracked gas effluent by pre-heating the feed.

The cracked gas effluent remains in the gaseous state through all three exchangers, and is not expected to have any fouling. INEOS treats the boiler feed water to remove dissolved solids, and has no experience with any fouling in this service. The feed material is also gaseous, and is not expected to have any fouling.

5. Emission Calculations: The fuel gas HHV on the emission calculations has two values one for plant gas at 732 BTU/SCF and the other for natural gas. The plant fuel gas can be up to 40% volume hydrogen. Please clarify the fuel gas that was used in the calculations. Also please note that the discrepancy for the maximum value for the hydrogen in the fuel gas analysis as 35%, where as in the emission calculations it states up to 40%. Please clarify the correlation between 40% volume of hydrogen and 35% average mol fraction and the fuel molecular weight factor used in the equations.

There are several locations in the application that state the hydrogen content as averaging "up to 40%". More precisely, the hydrogen content of the combined fuel gas for the No. 2 Olefins unit is typically between 30% and 50% by volume. A value of 35% by volume was used as a conservative value for the annual average. This clarification was made throughout the revised permit application.

Also, the previous permit application used natural gas as the fuel basis for the annual limit. The revised calculations and emissions summary is based on 35% by volume hydrogen.

6. There is a discrepancy in the calculated emissions for the furnace, decoking operation in Appendix B from the PSD contemporaneous emission table in Appendix C. Please explain.

The calculations in Appendix B show CO2 emissions of 3,631 lb/hr and 87.14 ton/year. These values are also shown in the emissions summary in Table 1(a). The PSD contemporaneous netting table is in error; it used 3,631 ton/year as the emissions rate. This is corrected in Appendix C in the revised permit application.

7. There is no recommended monitoring recordkeeping and reporting for the CO2 emissions. CEMS will be required, unless it is shown to be technically infeasible or an alternate more accurate method such as PEMS is proposed.

INEOS proposes to use a carbon material balance for the recordkeeping and reporting of CO2 emissions. This approach essentially mirrors the Tier 3 requirements of 40 CFR 98 Subpart C. This would be done as follows:

- **Measure the fuel gas flow rate (SCF/hr) continuously with an orifice meter or equivalent. The meter will meet the applicable specifications of §98.3(i) and §98.34(b)(1).**
- **Measure the fuel gas composition daily. INEOS employs a gas chromatograph (GC) to measure the composition, and the GC is installed, operated, maintained, and calibrated in accordance with manufacturer's instructions. The GC will meet the specifications of §98.34(b)(3)-(4).**
- **Calculate the fuel gas molecular weight (lb/lbmol), carbon content (lb C/lb fuel), and heating value (Btu/lb) from the GC results according to the procedures in §98.33(a)(2)(ii). Calculate the CO2e emissions according to §98.33(a)(3)(iii) and §98.33(c)(1).**

This approach will be at least as accurate as installing a CEMS. This is reflected in Table 5-3 of the revised permit application.

8. Previously, EPA had asked INEOS to propose a BACT limit based on lb CO2/lb ethylene produced.

INEOS proposes a short-term (24-hour rolling average) limit of 1.04 lb CO2e/lb ethylene. This is based on natural gas fuel and a set of worst-case process conditions. This limit would not be appropriate during decoking, when there is no ethylene production.

INEOS proposes a long-term (365-day rolling average) limit of 0.85 lb CO2e/lb ethylene. This is based on firing the average fuel gas (35 volume % hydrogen) as noted in question 5 and a set of normal process conditions. This value takes into account that the furnace is decoking for 420 hours per year with no ethylene production and approximately 44% firing rate.

This information is included in Section 5.5 of the revised permit application.

9. EPA asked for information about Additional Impacts Analysis [cf. 40 CFR 52.21(o)].

   This information has been added as a new section 6.11 of the permit application.

Revised calculations for furnace and Table 1(a)

Daniel Lutz to: Bonnie Braganza, Daniel Smothers

From: Daniel Lutz <daniel.lutz@ineos.com>

To: Bonnie Braganza/R6/USEPA/US@EPA, Daniel Smothers <daniel.smothers@tceq.texas.gov>

Calculations (Revised 2012-0605).pdf

Bonnie and Daniel,

Attached are revised calculations for the furnace. This includes the background calculations and a revised Table 1(a). Daniel, I'm including the CO2, N2O, CH4, and CO2e from the EPA application in this copy. If you want a "clean" version, let me know.

The previous calculations were based on using a HHV of 732 Btu/SCF for a conversion factor; these calculations use 768 Btu/SCF to be consistent with the fuel gas composition on which we are basing the permit.

This didn't affect the NOx, CO, and CO2 values. It reduced the lb/hr and ton/yr for N2O, CH4, VOC, PM (all sizes), and SO2 by approximately 5%, because these were all based on factors in lb/SCF.

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Table 1(a) Emission Point Summary

Date:	February 2012	**Permit No.:**	NA	**Regulated Entity No.:**	100238708
Area Name:	No. 2 Olefins Unit			**Customer Reference No.:**	602817884

Review of applications and issuance of permits will be expedited by supplying all necessary information requested on this Table.

AIR CONTAMINANT DATA					
1. Emission Point			**2. Component or Air Contaminant Name**	**3. Air Contaminant Emission Rate**	
EPN (A)	**FIN (B)**	**NAME (C)**		**Pounds per Hour (A)**	**TPY (B)**
DDB-105	DDB-105	Furnace No. 105	NO_X	14.85	21.68
			CO	21.78	95.40
			VOC	3.55	15.53
			SO_2	0.39	1.69
			NH_3	4.77	10.45
			PM	2.84	12.43
			PM_{10}	2.24	9.82
			$PM_{2.5}$	1.28	5.59
			CO_2	59,919.95	214,504.88
			N_2O	1.42	6.21
			CH_4	1.48	6.50
			CO_2e	60,390.89	216,567.58
FUG-ADDF	FUG-ADDF	Furnace No. 105 Hydrocarbon Fugitives	VOC	0.94	4.12
			CH_4	0.27	1.19
			CO_2e	5.70	24.96
FUG-SCR2	FUG-SCR2	Furnace No. 105 Ammonia Fugitives	NH_3	0.02	0.10
DDF-106	DDF-106	Furnace No. 105 Decoke Cyclone	CO	103.46	2.48
			VOC	0.09	0.01
			PM	2.29	0.05
			PM_{10}	1.35	0.03
			$PM_{2.5}$	0.84	0.02
			CO_2	3,630.95	87.14

EPN = Emission Point Number
FIN = Facility Identification Number

INEOS USA LLC
CHOCOLATE BAYOU PLANT
INITIAL PERMIT APPLICATION
FURNACE EMISSIONS (EPN: DDB-105)

Emissions Basis

The proposed furnace will have the capability to be fueled with either natural gas or fuel gas from a variety of sources. NO_x and CO emissions are based on vendor guarantees. The maximum allowable (hourly) emissions for the permit allowable are based on the operating scenario that would result in the highest emissions, which is the combustion of fuel gas. The annual average emissions are also based on the combustion of fuel gas. The fuel gas composition will contain mostly methane, 1 -2% other materials, and hydrogen (averaging up to 40% by volume) for fuel gas. The hourly and annual emissions, including GHG (N_2O and CH_4), calculations are based on natural gas emission factors in AP-42, Chapter 1.4, adjusted for the heating value of fuel gas. The particulate size distribution from AP-42, Appendix B.2, Table B:2-2 was used to estimate the PM_{10} and $PM_{2.5}$ emission factors. Category 2 covers boilers firing a mixture of fuels, regardless of the fuel combination. Category 2 for combustion of mixed fuels has a 79% distribution for PM_{10} and 45% for $PM_{2.5}$ which was applied to the natural

Max Hourly Heat Input:	495	MMBtu/hr	*Design Capacity*				
Fuel Gas HHV:	768	Btu/scf	*Based on Dedicated Fuel Gas*	Fuel Gas HHV	995.09	Btu/scf	*Based on Natural Gas*
Volume of feed (Fdstk)	0.50	MMscf/hr	*Based on Natural Gas*				
Average Carbon Content (CC) :	0.71	lb C/lb fuel	*Based on Natural Gas*				
Molecular Weight (MW) :	17.99	lb/lb-mol	*Based on Natural Gas*				
Molar Volume Conversion Factor (M'	386.1	scf/lb-mol					
Hourly NO_X Factor:	0.03	lb/MMBtu	*Vendor Specifications*				
Annual NO_X Factor:	0.01	lb/MMBtu	*Vendor Specifications*				
CO Factor:	0.044	lb/MMBtu	*Vendor Specifications*				
VOC Factor:	5.5	lb/MMscf	*AP-42, Chapter 1.4, Table 1.4-2*				
PM Factor:	4.4	lb/MMscf	*Stack testing data on previous like-kind sources at site*				
PM10 Factor:	3.5	lb/MMscf	*stack testing data & AP-42, Appendix B.2: Generalized Particle Size Distributions, Table B:2-2, Category: 2, Combustion, Mixed Fuels*				
PM2.5 Factor:	2.0	lb/MMscf	*stack testing data & AP-42, Appendix B.2: Generalized Particle Size Distributions, Table B:2-2, Category: 2, Combustion, Mixed Fuels*				
SO_2 Factor:	0.6	lb/MMscf	*AP-42, Chapter 1.4, Table 1.4-2*				
Calculated CO_2 Factor	121.1	lb/MMscf					
CH_4 Factor:	2.3	lb/MMscf	*AP-42, Chapter 1.4, Table 1.4-2*				
N_2O Factor:	2.2	lb/MMscf	*AP-42, Chapter 1.4, Table 1.4-2*				

Emissions Summary

Pollutant	Hourly Emissions (lb/hr)	Annual Emissions (tpy)
NO_X	14.85	21.68
CO	21.78	95.40
VOC	3.55	15.53
SO_2	0.39	1.69
PM	2.84	12.43
PM_{10}	2.24	9.82
$PM_{2.5}$	1.28	5.59
CO_2	59,919.95	214,504.88
CO_2 e	60,390.89	216,567.58
CH_4	1.48	6.50
N_2O	1.42	6.21

Total CO_2 e based on Global Warming Potential for CO_2, CH_4 and N_2O found on Part 98's Table A–1 . [CO_2 e]= [CO_2] + [CH_4 x 21] + [N_2O x 310]

NO_X Emissions

$$0.03\ \frac{\text{lb } NO_X}{\text{MMBtu}} * 495\ \frac{\text{MMBtu}}{\text{hr}} = \boxed{14.85\ \frac{\text{lb } NO_X}{\text{hr}}}$$

$$0.01\ \frac{\text{lb } NO_X}{\text{MMBtu}} * 495\ \frac{\text{MMBtu}}{\text{hr}} * 8{,}760\ \frac{\text{hr}}{\text{yr}} * \frac{1}{2{,}000}\ \frac{\text{ton}}{\text{lb}} = \boxed{21.68\ \frac{\text{ton } NO_X}{\text{yr}}}$$

CO Emissions

$$0.044\ \frac{\text{lb CO}}{\text{MMBtu}} * 495\ \frac{\text{MMBtu}}{\text{hr}} = \boxed{21.78\ \frac{\text{lb CO}}{\text{hr}}}$$

$$0.044\ \frac{\text{lb CO}}{\text{MMBtu}} * 495\ \frac{\text{MMBtu}}{\text{hr}} * 8{,}760\ \frac{\text{hr}}{\text{yr}} * \frac{1}{2{,}000}\ \frac{\text{ton}}{\text{lb}} = \boxed{95.40\ \frac{\text{ton CO}}{\text{yr}}}$$

INEOS USA LLC
CHOCOLATE BAYOU PLANT
INITIAL PERMIT APPLICATION
FURNACE EMISSIONS (EPN: DDB-105)

CO_2 Emissions

$CO_2 = (44/12) * F_{dstk} * CC * (MW/MVC) * 0.001$ *(metric units)*
$CO_2 = (44/12) * F_{dstk} * CC * (MW/MVC) * 0.0005$ *(english units)*

44	MW CO_2	*	0.50	MMscf	*	1,000,000	scf	*	0.71	lb C	*					
12	MW C			hr			MMscf			lb fuel						
17.99	lb	*	1	scf							=	59,920	lb CO_2			
	lb-mol		386	lb-mol									hr			
44	MW CO_2	*	0.64	MMscf	*	1,000,000	scf	*	8760	hr	*					
12	MW C			hr			MMscf			yr						
0.71	lb C	*	11.34	lb	*	1	scf	*	1	ton	=	214,504.88	ton CO_2			
	lb fuel			lb-mol		386	lb-mol		2000	lb			yr			

VOC Emissions

5.5	lb VOC	*	495	MMBtu	*	1	scf							=	3.55	lb VOC
	MMscf			hr		768	Btu									hr
5.5	lb VOC	*	495	MMBtu	*	8,760	hr	*	1	ton	*	1	scf	=	15.53	ton VOC
	MMscf			hr			yr		2,000	lb		768	Btu			yr

PM Emissions

4.4	lb PM	*	495	MMBtu	*	1	scf							=	2.84	lb PM
	MMscf			hr		768	Btu									hr
4.4	lb PM	*	495	MMBtu	*	8,760	hr	*	1	ton	*	1	scf	=	12.43	ton PM
	MMscf			hr			yr		2,000	lb		768	Btu			yr

PM_{10} Emissions

3.5	lb PM_{10}	*	495	MMBtu	*	1	scf							=	2.24	lb PM_{10}
	MMscf			hr		768	Btu									hr
3.5	lb PM_{10}	*	495	MMBtu	*	8,760	hr	*	1	ton	*	1	scf	=	9.82	ton PM_{10}
	MMscf			hr			yr		2,000	lb		768	Btu			yr

$PM_{2.5}$ Emissions

2.0	lb $PM_{2.5}$	*	495	MMBtu	*	1	scf							=	1.28	lb $PM_{2.5}$
	MMscf			hr		768	Btu									hr
2.0	lb $PM_{2.5}$	*	495	MMBtu	*	8,760	hr	*	1	ton	*	1	scf	=	5.59	ton $PM_{2.5}$
	MMscf			hr			yr		2,000	lb		768	Btu			yr

SO_2 Emissions

0.6	lb SO_2	*	495	MMBtu	*	1	scf							=	0.39	lb SO_2
	MMscf			hr		768	Btu									hr
0.6	lb SO_2	*	495	MMBtu	*	8,760	hr	*	1	ton	*	1	scf	=	1.69	ton SO_2
	MMscf			hr			yr		2,000	lb		768	Btu			yr

CH_4 Emissions

2.3	lb CH_4	*	495	MMBtu	*	1	scf							=	1.48	lb CH_4
	MMscf			hr		768	Btu									hr
2.3	lb CH_4	*	495	MMBtu	*	8,760	hr	*	1	ton	*	1	scf	=	6.50	ton CH_4
	MMscf			hr			yr		2,000	lb		768	Btu			yr

N_2O Emissions

2.2	lb N_2O	*	495	MMBtu	*	1	scf							=	1.42	lb N_2O
	MMscf			hr		768	Btu									hr
2.2	lb N_2O	*	495	MMBtu	*	8,760	hr	*	1	ton	*	1	scf	=	6.21	ton N_2O
	MMscf			hr			yr		2,000	lb		768	Btu			yr

Air Quality Analysis (AQA) Report

Chocolate Bayou Plant
Alvin, Brazoria County, Texas

INEOS USA LLC

Project Number 412-15

December 2011

TITAN ENGINEERING, INC.

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LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION AND PROJECT IDENTIFICATION INFORMATION

INEOS USA LLC (INEOS) operates an existing olefins manufacturing facility (No. 2 Olefins Unit) in Alvin, Brazoria County, Texas under Permit No. 95-PSD-TX-854 and various permits by rule. The INEOS Chocolate Bayou Plant has submitted a permit application in accordance with TCEQ Chapter 116 to authorize the installation and operation of a new cracking furnace, decoking drum and associated equipment. There will be no effect on the emissions from existing operations (No. 2 Olefins Unit) associated with this application. The purpose of the project is to allow an increase in capacity by ensuring that unit rates are maximized during periods when a furnace is off-line for decoking. Because the furnace is new, it will have increased yield, increased energy efficiency and lower NO_X emissions than the existing furnaces.

Specifically, the new proposed facilities will primarily consist of one cracking furnace, a new decoke cyclone/stack (dedicated to the new furnace), and fugitive emissions components (i.e., the Project). The new furnace will be rated at 495 MMBtu/hr (HHV) to produce ethylene. The furnace will be equipped with an ammonia selective catalytic reduction (SCR) system to reduce NO_X emissions. Since INEOS is still in the vendor selection phase of this project, the most likely operating scenario is being represented for permitting purposes. However, INEOS is committed to meet the emission limitations and control measures represented in this application.

The air permit application requests that the TCEQ issue a state and PSD air permit to authorize the Project in accordance with 30 Texas Administrative Code (TAC) Chapter 116. The Project triggers Prevention of Significant Deterioration (PSD) permitting requirements for particulate matter (PM) having an aerodynamic diameter of ten microns or less (PM_{10}) and PM having an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$), but does not trigger PSD review for the other criteria air pollutants. TITAN Engineering, Inc. (TITAN) has prepared a PSD Air Quality Analysis (AQA) for the Project to demonstrate that the proposed post-Project Plant off-site contaminant impacts will be in compliance with state and federal requirements. The PSD AQA Report is submitted as a separate stand-alone document subsequent to the submittal of the PSD air permit application.

This PSD AQA has been performed in support of the permit application in accordance with the TCEQ guidance, and this AQA Report has been prepared in accordance with the guidance contained in Appendix F (Air Quality Analysis Reporting Guidance) in the TCEQ's Air Quality Modeling Guidelines (AQMG, RG-25, Revised; February 1999).

As discussed in Section 13 of this AQA Report, the AQA results demonstrate that the maximum predicted Project criteria air pollutant concentrations are less than all applicable Significant Impact Levels (SILs), are below the TCEQ-specified *de minimis* levels for the applicable State property-line air standards (i.e., 2% of the applicable standards). Therefore, additional modeling analyses of post-Project Plant emissions to demonstrate compliance with the National Ambient Air Quality Standards (NAAQS), the State property-line standards, and TCEQ Health Effects Review evaluation criteria were not required.

Figure 4-1 presented in Section 4 of this AQA Report is an area map that shows the property boundaries and the surrounding region in Brazoria County. Currently, the TCEQ designates Brazoria County as severe Nonattainment area for ozone.

As stipulated in Table D-1 in Appendix D of the TCEQ ADMT AQMG, the following information is presented to clearly identify the analysis:

- Applicant: **INEOS USA LLC**
- Facility: **Chocolate Bayou Plant**
- Permit Numbers: **95-PSD-TX-854**
- Air Quality Account Number: **BL0002S(RN100238708)**
- Nearest City and County: **Alvin, Brazoria County**
- Applicant's Modeler: **TITAN Engineering, Inc.**

It should be noted, in an effort to facilitate the review of this AQA Report, all figures and tables have been presented in separate groupings at the end of the document (i.e., after the text portions of the document).

2. PROJECT OVERVIEW

This section provides an overview of the Plant location, the proposed post-Project Plant operations, and the modeling analyses conducted. The Plant is located approximately two miles south of intersection of FM 2917 and FM 2004, near Alvin, in Brazoria County, Texas.

The Plant manufactures two main products—olefins and polypropylene. After the Project, the Plant will consist primarily of one cracking furnace, a new decoke cyclone/stack (dedicated to the new furnace), and fugitive emissions components.

2.1 Types of Permit Review

The first objective of this AQA is to provide the TCEQ with confirmation that Project emission increases do not contribute significantly to predicted criteria air pollutant (i.e., carbon monoxide [CO], nitrogen dioxide [NO_2], [PM_{10}], [$PM_{2.5}$], and sulfur dioxide [SO_2]) design concentrations that are above the applicable NAAQS. As discussed in Section 13 of this AQA Report, Project criteria air pollutant design concentrations are below the respective SILs. Therefore, analyses of the post-Project Plant criteria air pollutant concentrations were not required in order to demonstrate compliance with the NAAQS.

The second objective of this AQA is to demonstrate that Project emission increases do not contribute significantly to predicted post-Project Plant concentrations that are above the applicable TCEQ State property-line concentration standards (i.e., for 30-minute SO_2). As discussed in Section 13, the Project 30-minute SO_2 design concentration is below the *de minimis* concentration established by the TCEQ (i.e., 2% of the respective standard). Therefore, modeling analysis of the post-Project Plant 30-minute SO_2 concentration was not required in order to demonstrate compliance with the applicable State property-line standards.

2.2 Significant Impacts Analysis for State NAAQS Analyses

Because the Project has CO, NO_X, PM_{10}, $PM_{2.5}$, and SO_2 emissions increases, this AQA Report contains documentation of the Project impacts for the following criteria air pollutants and averaging periods for State NAAQS analysis purposes:

- 8-hour and 1-hour CO,
- annual and 1-hour NO_2, and
- annual, 24-hour, 3-hour, and 1-hour SO_2.

For these criteria air pollutants and averaging periods, the Project emission sources were modeled using one year (i.e., 1988) of the TCEQ-specified meteorological data to determine whether the Project has impacts above the respective SILs. As discussed in Section 13, because all Project criteria air pollutant impacts were less than the applicable SILs for 8-hour and 1-hour CO, annual and 1-hour NO_2, and annual, 24-hour, 3-hour, and 1-hour SO_2, a multi-source (i.e., including both Project and off-property, non-Project sources) State NAAQS analysis was not required for any of those pollutants.

2.3 PSD NAAQS-Related Analyses

Because the Project has PM_{10} and $PM_{2.5}$ emissions increases that trigger PSD review, this PSD AQA Report contains documentation of the Project impacts for annual and 24-hour PM_{10} and $PM_{2.5}$ for PSD NAAQS and PSD increment analysis purposes.

The Project PM_{10} and $PM_{2.5}$ emission sources were modeled using five years (i.e., 1987 through 1991) of the TCEQ-specified meteorological data to determine whether the Project has impacts above the respective SILs. As discussed in Section 13, because all Project criteria air pollutant impacts were less than the applicable SILs for annual and 24-hour PM_{10} and $PM_{2.5}$, a multi-source PSD NAAQS analysis and a multi-source PSD increment analysis were not required for those pollutants.

2.4 State Property-Line Analysis

As discussed in Section 13, modeling analyses showed that the Project 30-minute SO_2 design impact was below the TCEQ's *de minimis* concentrations of 2% of the applicable air standard. Therefore, analyses to predict the post-Project Plant-wide 30-minute SO_2 concentrations were not required.

3. PLOT PLAN

Figure 3-1 is a plot plan depicting all Project criteria air pollutant emission points as well as the footprints of the process fugitive emissions areas.

Figure 3-2 was generated by the Surfer® graphics package using the Project criteria air pollutant emission points (i.e., DDB105 and DDF106) and property-line UTM data that were inputs to the AERMOD analyses. As discussed in Sections 2 and 6, only the Project emissions increases were modeled to demonstrate that the Project has impacts below the respective SILs for all criteria air pollutants.

The Plant property line is also depicted on the Area Map (i.e., Figure 4-1) and on the receptor distribution diagrams and concentration posting diagrams presented and discussed in Sections 11 and 13, respectively, of this AQA Report.

4. AREA MAP

Figure 4-1 is an area map of the region and depicts the Plant location, the approximate property boundary and the surrounding area out to a distance of approximately 3,000 meters in all directions. As shown in Figure 4-1, there are no schools within 3,000 feet of the plant location.

As Table D-1 of the TCEQ AQMG stipulates, Figure 4-1 includes the following items:

- 1,000-meter UTM coordinate labels (NAD83, UTM Zone 15) on the horizontal and vertical axes of the map section,
- the Plant property lines,
- a depiction of the footprint of the 3,000-foot radius circle emanating from the Project emission sources,
- a depiction of the footprint of the 1-mile radius circle emanating from the Project emission sources,
- a map scale, and
- a true north arrow.

5. AIR QUALITY MONITORING DATA

As summarized in Table 13-1 of Section 13 in this AQA Report, all predicted Project criteria air pollutant impacts are below the respective SILs. Therefore, no additional criteria air pollutant modeling was required for the Project, so that air quality monitoring data are not included in this AQA Report.

6. MODELING EMISSIONS INVENTORY

This section of the AQA Report presents the inventories of source parameters and emission rates for the Project criteria air pollutants. These Project data were used to perform air dispersion modeling analyses to predict whether the Project design concentrations:

1) for individual criteria air pollutants were below the respective SILs in association with the State NAAQS and PSD NAAQS analyses,
2) for 30-minute SO_2 was below the applicable TCEQ *de minimis* concentration for the State property-line standard (i.e., 2% of the respective property-line standard), and

As discussed in Section 13, all Project criteria air pollutant impacts were below the applicable SILs and/or *de minimis* concentrations, so that post-Project Plant-wide modeling was not required for any criteria air pollutant.

Section 6 is comprised of the following subsections:

- Section 6.1 presents stack parameters and emission rates for the Project criteria air pollutant emission sources;
- Section 6.2 addresses the correlation of the Project source names and EPNs with the source number in the modeling output file;
- Section 6.3 is a stack parameter justification discussion; and
- Section 6.4 discusses scaling factor usage in the AQA.

6.1 Project Sources for Criteria Air Pollutant Significant Impact Analyses

This section presents a summary of the Project criteria air pollutant emissions source parameters and emission rates. The sources that have Project-related emission increases for one or more criteria air pollutants are:

- DDB105
- DDF106

Table 6-1 is a copy of the Table 1(a) that was submitted with the permit application (i.e., in July 2011). The Project EPNs listed on the Table 1(a) are the same as the EPNs that are shown on the Figure 3-1 plot plan and the Figure 3-2 Project sources depiction diagrams. Those two EPNs were modeled in the State NAAQS and the PSD NAAQS significant impacts modeling analyses.

All stack parameters and emission rates apply for 100% load operations. The Project sources are not anticipated to operate at loads of less than 100%, so the stack parameters and emission rates modeled in the AQA and presented in this AQA Report represent worst-case operating conditions.

6.1.1 Source Parameters

Table 6-2 lists the Project criteria air pollutant source UTM coordinates (NAD83, UTM Zone 15), stack base elevations (in feet and meters above mean sea level [msl]) and source parameters, in metric and English units.

6.1.2 Emission Rates

Table 6-3 lists the Project CO, NO_X, PM_{10}, $PM_{2.5}$, and SO_2 emissions increases.

6.2 Tables Correlating the Project Source Name and EPN with the Source Number in the Modeling Output File

Tables 6-1 through 6-3 contain the Project source names and EPNs that were used in the AQA and that appear in the modeling output files.

6.3 Stack Parameter Justification

The two Project combustion sources are not anticipated to operate at loads of less than 100% load. Therefore, analyses to identify the worst-case Project load configurations (i.e., for a load below 100%) were not necessary.

6.4 Scaling Factors

In accordance with written TCEQ guidance, the EPA- and TCEQ-recommended Ambient Ratio Method (i.e., ARM) factor of 0.8 was used in the AQA to convert NO_X emissions to NO_2 concentrations.

7. MODELS PROPOSED AND MODELING TECHNIQUES

Section 7 provides a discussion of the dispersion model, the model version number, and the primary model entry data options that have been used in this AQA. Section 7 also includes a discussion of the modeling methodology that was used to demonstrate that all Project criteria air pollutant impacts are predicted to be below the applicable EPA-specified SILs and TCEQ *de minimis* concentrations.

7.1 Proposed Models and Model Entry Data Options

The AERMOD model, dated 11103 (i.e., Julian Day 103 of 2011), was the dispersion model used to conduct the analyses. The AERMOD model is contained in a software package produced by BEE-Line Software (i.e., "BEEST", Version 9.92).

The regulatory default model options were engaged in AERMOD, as recommended by the TCEQ ADMT and as described in the EPA's Guideline on Air Quality Models. Enabling these options ensured a conservative assessment of impacts.

Other aspects of the modeling methodology, which were applied in accordance with TCEQ AQMG guidance, are presented in other sections of this AQA Report, and include:

- As shown in Figure 4-1, land use within 3 kilometers of the Plant is primarily rural. Therefore, as discussed in Section 8, AERMOD was executed in the "no urban area" mode.

- As discussed in Section 9, building wake effects were not considered in the AERMOD analysis since the stack heights for the two sources are 125 feet and 161 feet, which are much higher than any surrounding structures.

- As discussed in Section 10, terrain elevations were determined for all Project emission sources and receptors using the National Elevation Data (NED) file for the region (downloaded from the USGS website) and the AERMAP algorithm (i.e., version 09040) that is incorporated into AERMOD and the BEEST software package.

- As discussed in Section 12, the TCEQ-recommended and produced IAH/LCH hourly sequential meteorological data sets were used for the analysis. "IAH" is the 3-letter station identifier for the Houston Intercontinental, Texas surface observation station, and "LCH" is the 3-letter station identifier for the Lake Charles, Texas upper air station. The IAH/LCH data sets were downloaded from the TCEQ ADMT Internet web site. The TCEQ-recommended data sets for five data years (i.e., 1987-1991) were used for the PM_{10} and $PM_{2.5}$ PSD NAAQS-related analyses, in accordance with TCEQ guidance. The TCEQ-recommended meteorological data year, the

1988 IAH/LCH data set, was used for all Project criteria air pollutant significant impacts analyses.

AERMOD was used to predict both short-term and long-term (i.e., annual) impacts.

7.2 General Modeling Approach and Assumptions

The modeling methodology used for all aspects of this AQA is in accordance with the written guidance in the TCEQ AQMG.

All stack parameters and emission rates presented in Section 6 apply for 100% load operations. The Project and sources are not anticipated to operate at loads of less than 100%, so the stack parameters and emission rates presented represent worst-case operating conditions.

As presented in Section 13 of this AQA Report, because all Project criteria air pollutant design impacts are predicted to be below the respective SILs and *de minimis* levels, no additional analyses (i.e., post-Project Plant-wide analyses) were required.

The basic approach for the demonstration of insignificant Project impacts is summarized below.

7.2.1 Determination of Project Impacts for Comparison with the SILs for the State NAAQS and PSD NAAQS Analyses

For the State NAAQS analyses, the 8-hour and 1-hour CO, annual and 1-hour NO_2, and annual, 24-hour, 3-hour, and 1-hour SO_2 (i.e., the applicable criteria air pollutants and averaging periods) Project emission sources were modeled using one year (1988) of IAH/LCH meteorological data to determine whether the Project had impacts above the respective SILs. Because all Project design impacts were below the applicable SILs, a State NAAQS analysis was not required.

For the PSD NAAQS analyses, the annual and 24-hour PM_{10} and $PM_{2.5}$ (i.e., the applicable criteria air pollutants and averaging periods) Project emission sources were modeled using five years (i.e., 1987 through 1991) of IAH/LCH meteorological data to determine whether the Project had impacts above the respective SILs. A five-year concatenated meteorological data record was used for the $PM_{2.5}$ analyses and five individual meteorological years were used for the PM_{10} analyses. Because all Project PM_{10} and $PM_{2.5}$ design impacts were below the applicable SILs, neither a PSD NAAQS analysis nor a PSD increment analysis was required.

7.2.2 Determination of Project Impacts for Comparison with *de minimis* Concentrations for the State Property Line Standard Analyses

The Project SO_2 emission sources were modeled to determine whether the Project would have design impacts above the applicable TCEQ *de minimis* concentration for the respective State 30-minute property-line standard. The TCEQ *de minimis* concentration is defined as 2% of the associated property-line standard. For 30-minute SO_2 analysis, the 1-hour concentration was used as a surrogate for the 30-minute concentration.

Because the Project SO_2 impact was less than the respective *de minimis* values, the analysis was complete and the post-Project Plant sources of this criteria air pollutant did not need to be modeled to demonstrate compliance with the applicable standards.

7.3 Specialized Modeling Techniques (Screening, Collocating Sources, and Ratioing)

7.3.1 Screening and Ratioing

The analysis consisted of refined AERMOD modeling analyses for criteria air pollutants. Screening modeling and ratioing (e.g., Ratio Technique Number 1) for the speciated constituents were prepared in a separate attachment.

7.3.2 Source Collocation

The Project emission sources were not collocated in the AQA.

8. SELECTION OF DISPERSION COEFFICIENT OPTION

AERMOD is executed using dispersion coefficients that are based upon the predominant land use in the area within which the Project emissions will disperse. An Auer Land Use Analysis, which classifies all regions within three kilometers of the Plant using rural and urban land use classification criteria, is usually used to quantify the percentages of the region having urban and rural land usage and thereby determine whether the rural or urban dispersion mode is appropriate for the modeling analysis. The dispersion mode selected for modeling a region affects the rate at which the AERMOD model allows wind speed to increase with height and determines the horizontal and vertical plume dispersion and hourly mixing-height formulations which AERMOD uses for computing downwind concentrations.

The Plant is located in a region having flat terrain, with the terrain elevations ranging from approximately 3.3 meters (10.8 feet) above mean sea level (msl) at the stack base elevations to approximately 0 meters (0 feet) msl approximately 10 kilometers to the southeast of the Plant and a maximum of 9.8 meters (32.2 feet) msl approximately 7 kilometers to the northwest of the Plant. Based upon review of aerial photographs and USGS maps of the region within the three-kilometer radius circle depicted in Figure 4-1, it is evident that over 70 percent of the region within three kilometers of the Plant has rural land use.

Therefore, the land use for the AQA was classified as rural (i.e., "no urban area" was incorporated into the analyses), and, as discussed in Section 12 of this AQA Report, the "medium roughness" TCEQ ADMT-produced AERMET meteorological data set was used in the AQA.

Because of the predominantly rural classification of the Plant region, this AQA Report does not contain a detailed land use analysis mosaic diagram.

9. BUILDING WAKE EFFECTS (DOWNWASH)

An AERMOD downwash analysis was not conducted for this AQA because the stack heights of the two point sources, 161 feet and 125 feet, are much higher than any nearby buildings or structures.

10. RECEPTOR DISTRIBUTIONS—TERRAIN

The Plant is located in a region with flat terrain. Terrain heights were AERMOD inputs for all emission sources and receptors. The terrain heights were derived by incorporating a NED terrain elevation file, produced and downloaded from the United States Geological Survey (USGS) website, into the AERMOD input files using the AERMAP algorithm (version 09040) to generate the terrain heights.

11. RECEPTOR DISTRIBUTIONS—DESIGN

The design of the receptor distributions used in this AQA complies with the TCEQ AQMG Sections 5.5 and 9.4 specifications. The following sections describe the receptor distributions that were used for the Project significant impacts analyses for:

- State NAAQS and PSD NAAQS criteria air pollutants, and
- the State property-line standard analysis (i.e. , 30-minute SO_2).

11.1 Project Significant Impacts Analysis

Figures 11-1, 11-2, and 11-3 depict the receptor distributions that were used to perform the Project significant impacts modeling analyses for criteria air pollutants. The receptor diagrams illustrate both the full distribution and close-up views of the near-Plant receptors (i.e., the tight, fine, and medium-spaced receptors). The distribution emphasizes tight and fine receptor spacing in the vicinity of the Plant because the maximum predicted Project impacts occurred at or near the Plant property line for the criteria air pollutants. The maximum predicted concentrations monotonically decreased with increasing radial distance from the Plant property line because of the nature of the Project emission sources.

As Figure 11-1 illustrates, the full receptor distribution consisted of 10,560 receptors. The receptor spacing and distribution were as follows:

- 25-meter (tight) spacing along the Plant property line,
- 25-meter (tight) spaced receptors extending out to 100 meters from the property line,
- 100-meter (fine) spaced grids extending out to a distance of at least 1,000 meters in all directions from the Plant property line, and
- 250-meter (medium) spaced grids covering the area that lies between 1,000 meters and 5,000 meters from the Plant property line.

Figure 11-2 presents an approximately 8-kilometer by 8-kilometer intermediate-range view of the receptor distribution shown in Figure 11-1, showing the 25-meter and 100-meter spaced receptors and near-field portions of the 250-meter spaced receptors that were used in the analyses. Figure 11-3 shows a 2-kilometer by 2-kilometer close-up view of the 25-meter spaced receptor distribution that surrounds the Plant as well as portions of the 100-meter receptor distribution shown in Figures 11-1 and 11-2.

11.2 Criteria Air Pollutants Significant Impacts Analysis (State NAAQS and PSD NAAQS Analyses)

As stated above, the receptor distributions shown in Figures 11-1 through 11-3 were used to predict the Project State NAAQS and PSD NAAQS criteria air pollutant impacts. As discussed in Section 13 of this AQA Report, because all Project impacts were less than the applicable SILs for each criteria air pollutant and applicable averaging period, no additional analyses for criteria air pollutants (i.e., for State NAAQS and/or PSD NAAQS) were necessary.

11.3 State Property-line Analyses Significant Impacts Analysis

The receptor distribution shown in Figures 11-1 through 11-3 was used to perform the Project impact analyses for 30-minute SO_2. As discussed in Section 13, the maximum predicted Project 30-minute SO_2 impact was below the TCEQ-specified *de minimis* concentration (i.e., 2% of the standard), so that post-Project Plant-wide modeling of this compound to demonstrate compliance with the State property-line standards was not required.

11.4 Receptor Adequacy

In accordance with the guidance presented in Section 5.5.2 of the TCEQ AQMG, the distribution of 25-meter, 100-meter, and 250-meter spaced receptors that was used in this analysis satisfies the TCEQ ADMT receptor distribution requirements.

The AQA results in Section 13 demonstrate that the Project design concentrations are nested within the receptor distribution in each modeling run, occurring at near-field receptors having 25-meter spacing. Additional receptors were not needed because all concentration “hotspots” occurred at 25-meter spaced receptors. The concentrations decreased with increasing distance from the Plant.

11.5 Receptor Generation Procedures

As stated previously in this section, in accordance with TCEQ ADMT receptor placement guidance, the basic receptor distribution was comprised of the following elements:

- 25-meter spaced (i.e., tight) receptors along the Plant property line,
- 25-meter (i.e., tight) spaced receptors extending out to approximately 100 meters in all directions from the Plant property line,
- 100-meter spaced (i.e., fine) receptors extending out to approximately 1,000 meters in all directions from the Plant property line, and
- 250-meter spaced (i.e., medium) receptors extending out to approximately 5,000 meters in all directions from the Plant property line.

All basic gridded receptors were automatically generated by the AERMOD model interface algorithm, using the “Special Grid” feature. These “Special Grid” receptors were then converted into discrete receptors.

12. METEOROLOGICAL DATA

This section describes the meteorological data that were used in the AQA. Because the Plant is in Brazoria County, the meteorological data set comprised of surface data from Houston Intercontinental, Texas surface station (IAH) and upper air profiles from the Lake Charles, Texas (LCH) upper air station was used for the AQA, as recommended in the TCEQ AQMG. The ADMT preprocessed these data using the updated AERMET (Version 06341) module of AERMOD, incorporating the IAH surface data and LCH upper air profile data as inputs.

Five years of IAH/LCH meteorological data (i.e., the 1987, 1988, 1989, 1990, and 1991 data years, as recommended and provided by the TCEQ ADMT in the *Brazoria5Y* directory on the TCEQ Internet web site) was used for the following analyses:

- The Preliminary Project Impact Determinations for PM_{10} and $PM_{2.5}$ to demonstrate the Project PM_{10} and $PM_{2.5}$ impacts are below the applicable PSD/TCEQ SILs.

One year of IAH/LCH meteorological data (i.e., the 1988 data year, as recommended and provided by the TCEQ ADMT in the *Brazoria1Y* directory on the TCEQ Internet web site), was used for the following analyses:

- The Preliminary Project Impact Determinations for CO, NO_2, and SO_2 to demonstrate that the Project CO, NO_2, and SO_2 impacts are below the applicable PSD/TCEQ SILs,.
- State property-line Project impacts analysis for 30-minute SO_2.

For the State NAAQS analyses, Project emission sources were modeled using one year (1988) of IAH/LCH meteorological data to determine whether the Project had impacts above the respective SILs.

For the PSD NAAQS analyses, Project emission sources were modeled using five years (i.e., 1987 through 1991) of IAH/LCH meteorological data to determine whether the Project had impacts above the respective SILs. A five-year concatenated meteorological data record was used for the $PM_{2.5}$ analyses and five individual meteorological years were used for the PM_{10} analyses.

In accordance with TCEQ ADMT guidance, a profile base elevation of 122 feet msl (37.19 meters), the TCEQ-provided elevation of the IAH surface meteorological station, was input to AERMOD.

The region over which the Project emissions will be released and disperse during transport to the receptors is flat and has a medium roughness length. In accordance with TCEQ verbal and written guidance, the EPA's AERSURFACE (dated 08009) algorithm and downloaded land usage data inputs were used to confirm that the medium roughness data set that represents a 0.5-meter roughness length is applicable to the Plant region. Table 12-1 presents the AERSURFACE analysis output. AERSURFACE computed that the roughness length for the region within a one-kilometer radius of the Plant centroid is

0.269 meter. Because this roughness length is within the 0.1-meter to 1.0-meter roughness length range that the TCEQ associates with a medium roughness length in rural/suburban areas, the IAHL88E**M**.SFC [surface] and IAHL88E**M**.PFL [upper air] meteorological data sets, where YY is the data year, were AERMOD inputs for this AQA. The default Bowen ratio and albedo values that the TCEQ has incorporated into the *.SFC meteorological data sets were used in the AQA without revision.

As discussed in Section 8 of this AQA Report, within approximately three kilometers of the Plant site, over 70 percent of the region can be classified as having rural land use. Therefore, the land use for the AQA was classified as rural (i.e., the urban options in AERMOD were not engaged).

13. MODELING RESULTS

Section 13 of the AQA Report presents the following modeling results:

- Project criteria air pollutant design impacts to assess significant impacts in association with State NAAQS and PSD NAAQS analyses,
- Project design impacts to assess *de minimis* impacts in association with State property-line standards analyses, and

As the AQA results presented in this section show, all Project design impacts are below the applicable SILs and *de minimis* concentrations. Therefore, no post-Project Plant-wide modeling analyses are required in order to demonstrate compliance with the NAAQS and State property-line standards for criteria air pollutants.

Selected concentration posting diagrams of the Project impacts are included in the presentation of Project modeling results in this section.

In accordance with previous discussions with the TCEQ ADMT, all AQA input and output files (i.e., including PLOTFILES) will be provided to the TCEQ ADMT along with the input data in the template formats recommended by the TCEQ for AQA submittals.

The following sections describe the analysis results.

13.1 Results for Criteria Air Pollutants Subject to State NAAQS and PSD NAAQS Modeling Requirements

The two Project sources of criteria air pollutant emissions associated with a State NAAQS analysis (i.e., EPNs DDB105 and DDF106) were modeled using one year (1988) of IAH/LCH meteorological data to determine whether the design impacts were above the respective SILs for the following pollutants and averaging periods:

- 8-hour and 1-hour CO,
- annual and 1-hour NO_2, and
- annual, 24-hour, 3-hour, 1-hour, and 30-minute SO_2.

The Project sources of criteria air pollutants associated with a PSD NAAQS analysis were modeled using five years (1987 through 1991) of IAH/LCH meteorological data to determine whether the design impacts were above the respective SILs for the following pollutants and averaging periods:

- annual and 24-hour PM_{10} and

- annual and 24-hour $PM_{2.5}$.

Table 13-1 summarizes the Project criteria air pollutants results. As Table 13-1 demonstrates, the predicted design concentrations for all criteria air pollutants and associated averaging periods were well below the applicable SILs. Therefore, a post-Project Plant-wide State NAAQS analysis and/or PSD NAAQS and PSD increment modeling analyses were not necessary for any criteria air pollutant.

Figures 13-1 through 13-4, respectively, depict the maximum predicted Project impacts for annual NO_2, 1-hour NO_2, annual $PM_{2.5}$, and 24-hour $PM_{2.5}$. As shown in the figures, all design concentrations occurred at 25-meter spaced receptors on the Plant property/fence line and were well below the respective SILs. Predicted concentrations decreased with increasing distance from the Plant. Concentration postings were prepared only for the Project annual NO_2, 1-hour NO_2, annual $PM_{2.5,}$ and 24-hour $PM_{2.5}$ and not for PM_{10}, CO, and SO_2 results because the design concentrations for the four NO_2 and $PM_{2.5}$ pollutant/averaging period combinations were closest to (i.e., although below) the respective SILs. Additional concentration postings would have had very limited usefulness because the design PM_{10}, CO, and SO_2 concentrations were such small percentages of the applicable SILs.

13.2 Results for the Pollutant Subject to State Property-Line Standards Modeling Requirements

The two Project sources of emissions associated with a State Property-line standards modeling analysis (i.e., EPNs DDB105 and DDF106) were modeled using 1988 IAH/LCH meteorological data to determine whether the Project 30-minute SO_2 impact was above the respective TCEQ *de minimis* concentration (i.e., 2% of the applicable State Property-line standard).

As Table 13-1 demonstrates, the predicted Project design 30-minute SO_2 concentration was well below the applicable *de minimis* concentrations. Therefore, a post-Project Plant-wide State Property-line standards modeling analysis was not necessary.

Posting diagrams were not prepared for the Project 30-minute SO_2 concentrations because of the very minimal magnitude of the design concentration compared with the respective *de minimis* concentrations.

13.3 PSD additional Impacts Analysis

The PSD Additional Impacts Analysis has three components: growth, soils and vegetation, and visibility impairment. The analysis methodology follows the guidance in the TCEQ AQMG, and the assessment is mostly qualitative in nature.

13.3.1 Growth Analysis

As stated in the AQMG document, "the growth analysis evaluated the impact associated with the Project on the general commercial, residential, and industrial growth within the AOI. An in-depth growth analysis would only be required if the Project would result in a significant shift of population and associated activity into an area- that is, a population increase on the order of thousands of people."

Based upon data provided by INEOS, after construction, the Project will not create new jobs. It is expected that the operation of the Project will be performed by the staff already living in the area. Therefore, little, if any, permanent growth that would produce secondary emissions is expected as a result of the Project.

13.3.2 Soils and Vegetation Analysis

As stated in the AQMG document, "the soils and vegetation analysis evaluates the impact associated with the Project on soils and vegetation within the AOI. Modeling results from NAAQS analysis can usually be used for this analysis."

The Project NO_2, $PM_{2.5}$, and PM_{10} impacts are well below the EPA/TCEQ SILs. Because the Project NO_2, $PM_{2.5}$, and PM_{10} impacts are not significant, the Project will not impact soils and vegetation within the surrounding area of the Project.

13.3.3 Visibility Impairment Analysis

As stated in the AQMG document, "the visibility impairment analysis evaluates the impact associated with the Project on the visibility with the AOI and upon any Class I areas within 100km of the Project."

A visibility impairment analysis to evaluate the Project's impacts on visibility has not been included in the AQA report. The Project will comply with the visibility and opacity regulations and standards and the permit requirements.

14. REFERENCES

EPA, 1990. New Source Review Workshop Manual: Prevention of Significant Deterioration and Nonattainment Area Permitting. (Draft), October 1990.

EPA, 2005. Guideline on Air Quality Models, 40 CFR Part 51, Appendix W, 2005.

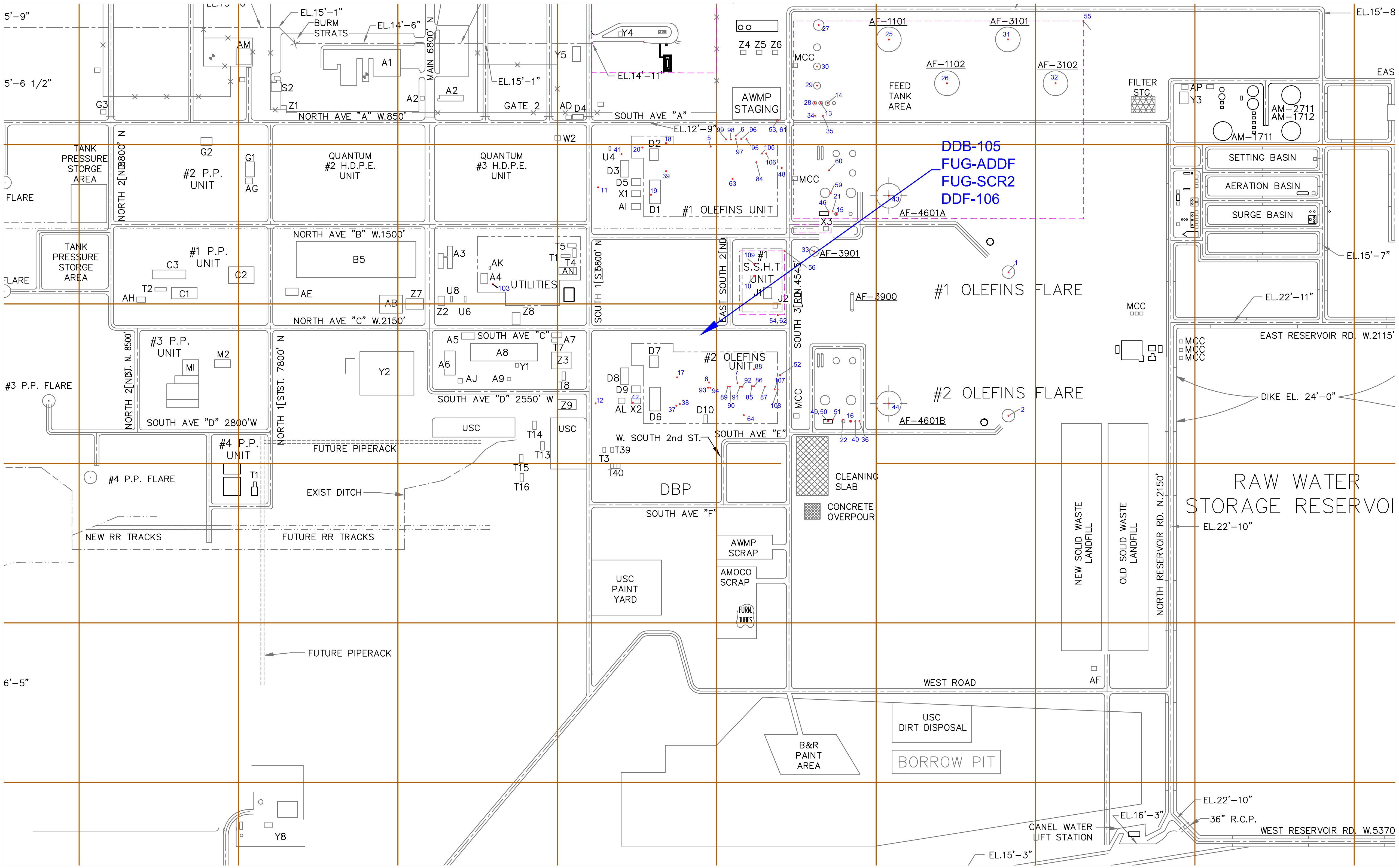
INEOS, 2011 Air Permit Application for the INESO Chocolate Bayou Plant, Alvin, Brazoria County, Texas, submitted in July 2011.

TCEQ, 1999. Texas Commission on Environmental Quality, Air Quality Modeling Guidelines RG-25 (Revised February 1999).

TCEQ, 2011. TCEQ Effects Screening Level (ESL) List, revised July 2011.

FIGURES

EPN	Description	Easting	Northing
DDB-105	Furnace No. 105	286,473.18	3,235,408.88
FUG-ADDF	Furnace No. 105 VOC Fugitives	286,473.18	3,235,408.88
FUG-SCR2	Furnace No. 105 Ammonia Fugitives	286,473.18	3,235,408.88
DDF-106	Furnace No. 105 Decoke Cyclone	286,473.18	3,235,408.88



NOTES

Map provided by RMT

GRAPHIC SCALE

0 200' 400'

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SUITE 200
FRISCO, TEXAS 75034
(469) 365-1100 (469) 365-1199 fax
www.titanengineering.com

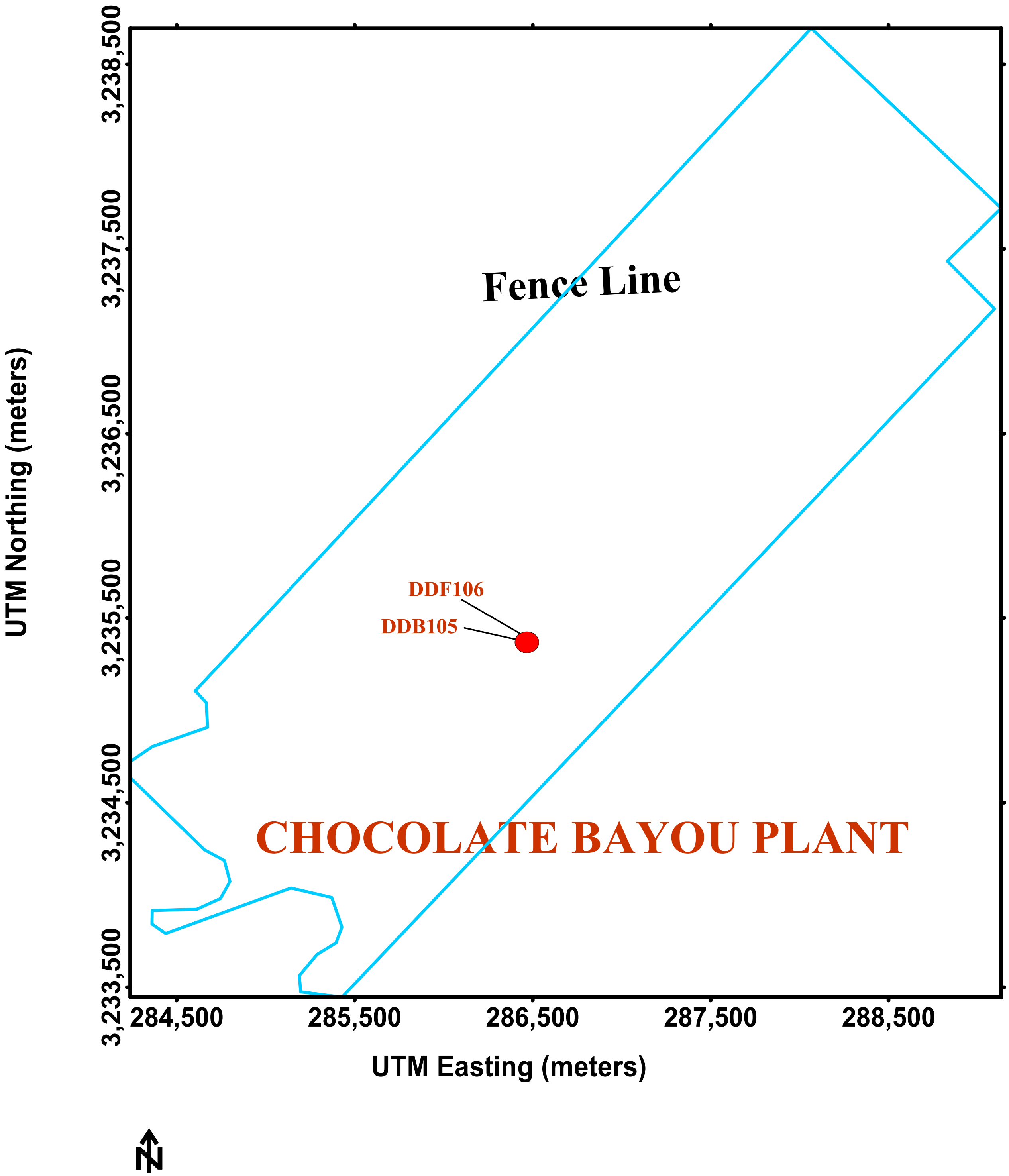
FIGURE 3-1
PLOT PLAN

INEOS USA LLC
Chocolate Bayou Plant

DESIGNED BY:	DETAILED BY:	CHECKED BY:
RMT	TEI	AL

FILE NAME:
T:\INEOS/412-15 Olefins No. 2 Furnace\Figures

DATE:	PROJECT NO.:	PLOT SCALE:
07/2011	412-15	1"=200'
DRAWING NO.:	REVISION:	FIGURE:
TEI-0000	0	1-2



Red dots are INEOS Chocolate Bayou Plant criteria air pollutant point sources.

TITAN Engineering, Inc. *Environmental Consulting and Management* 2801 Network Boulevard • Suite 200 • Frisco, Texas 75034 *Phone: (469) 365-1100 • Fax: (469) 365-1199* www.titanengineering.com	INEOS **INEOS USA LLC** ***Chocolate Bayou Plant***	**FIGURE 3-2** **Plant Fence Line and Criteria Air Pollutant Point Sources** **December 2011**

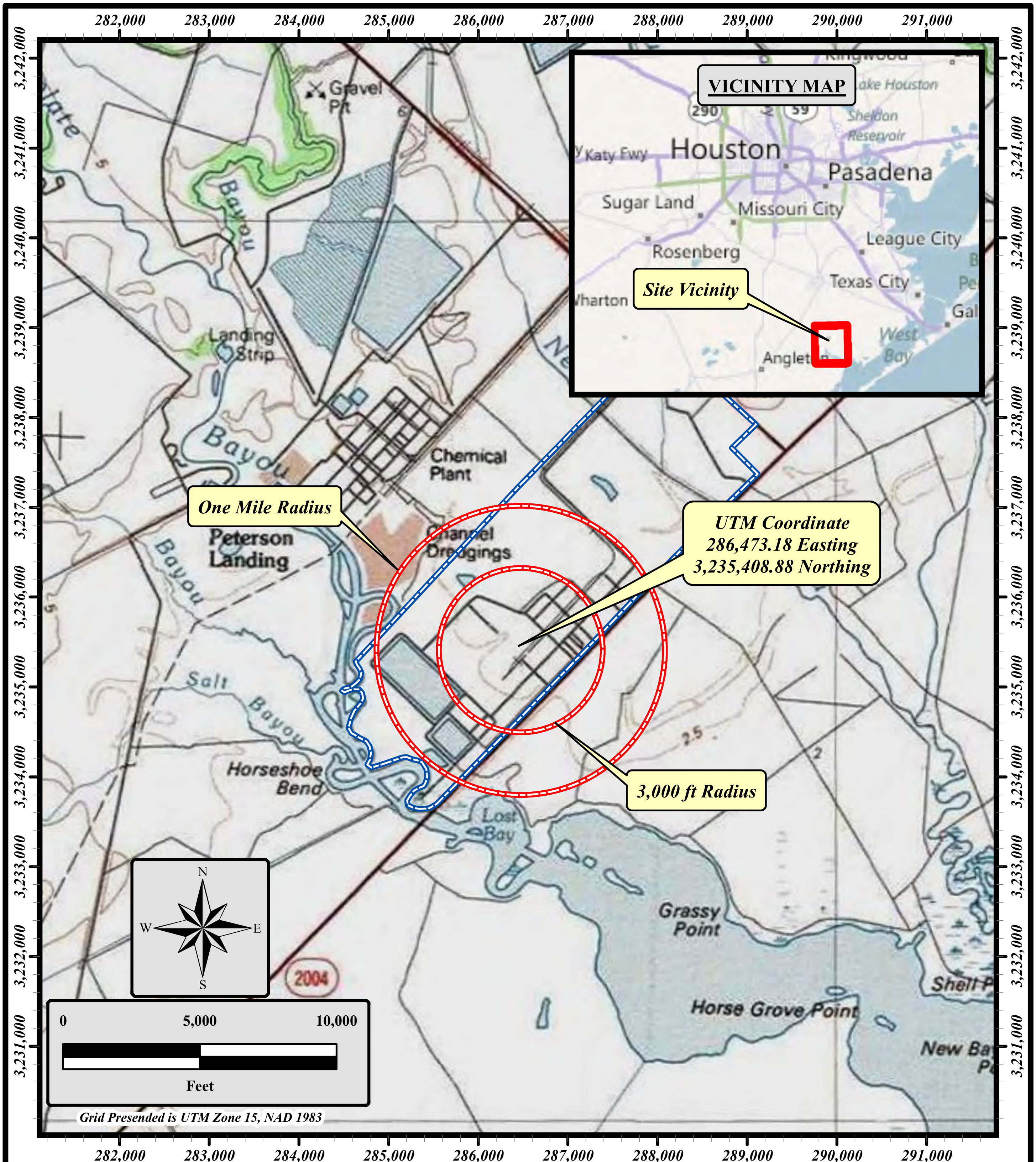


FIGURE 4-1 AREA MAP

INEOS USA LLC
Chocolate Bayou Plant
December 2011
TITAN Project No. 412-15

from USGS Quadrangles Mustang Bayou & Hoskins Mound, Texas, Published 1977
Digital Data Courtesy of ESRI Online Datasets

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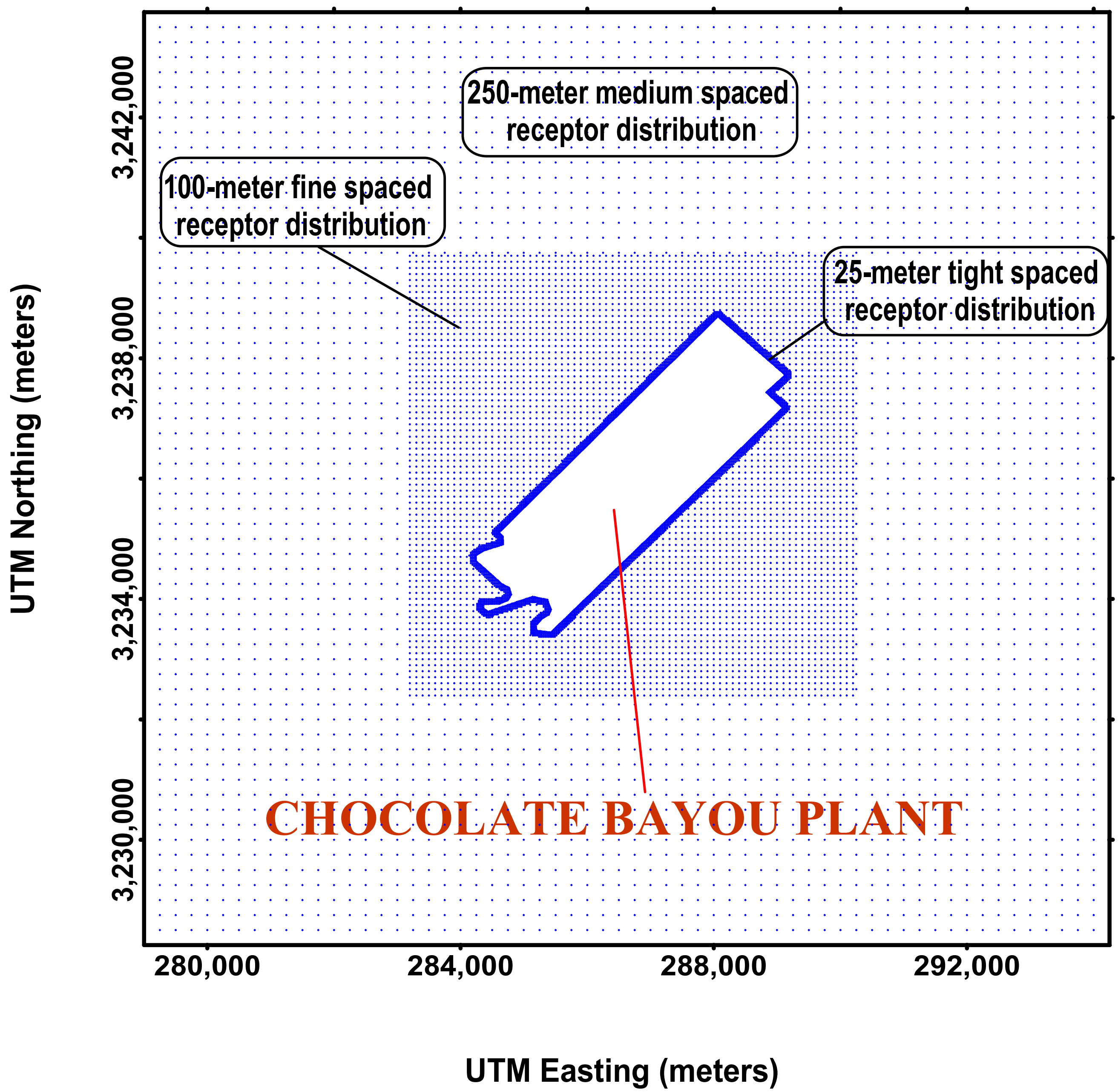

N

Blue dots are modeling receptors.

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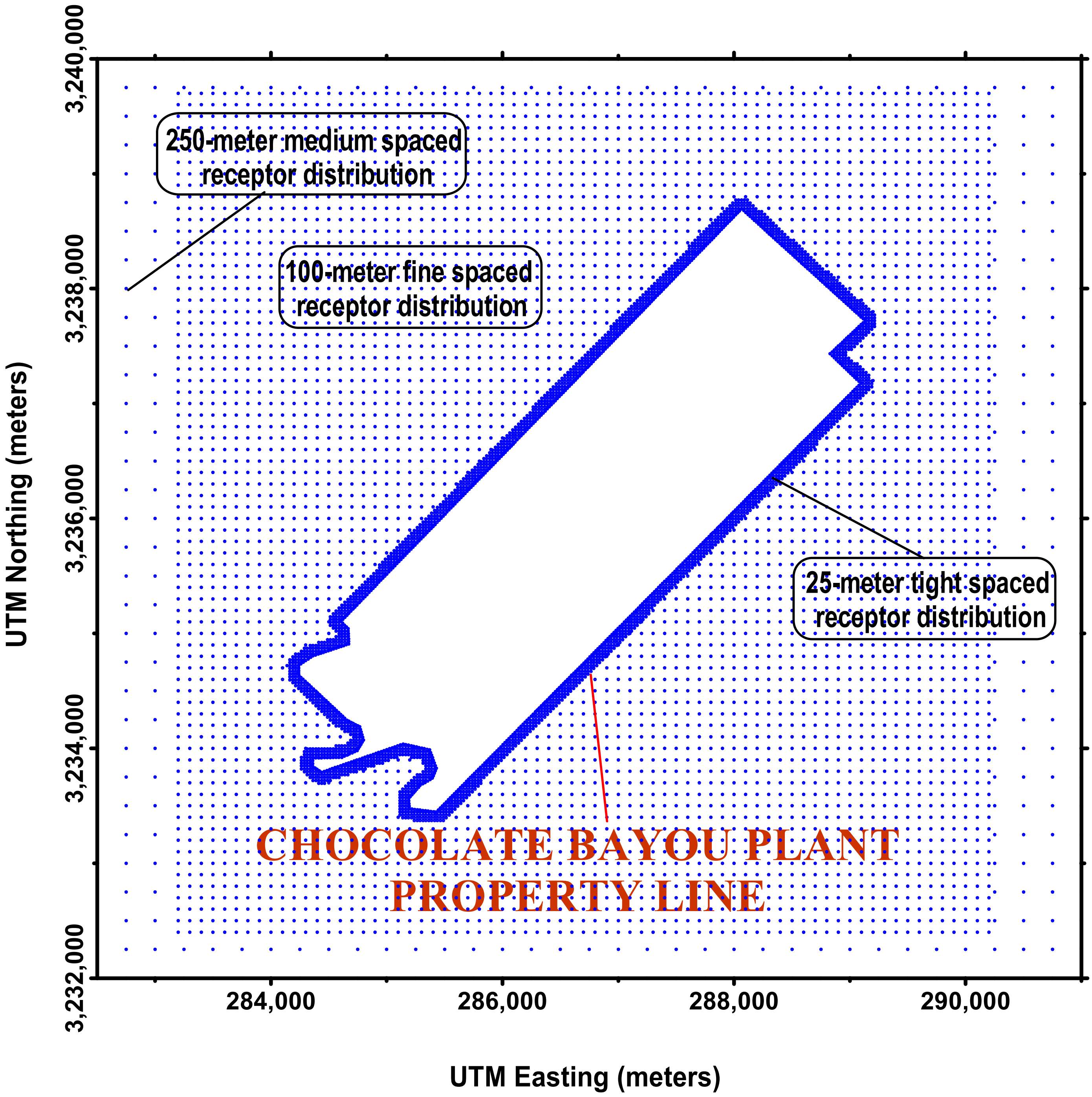
FIGURE 11-1
Full Receptor Distribution
December 2011



Blue dots are modeling receptors.

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FIGURE 11-2
Medium, Fine, Tight Receptor Distribution, Plant Location, and Property Line
December 2011

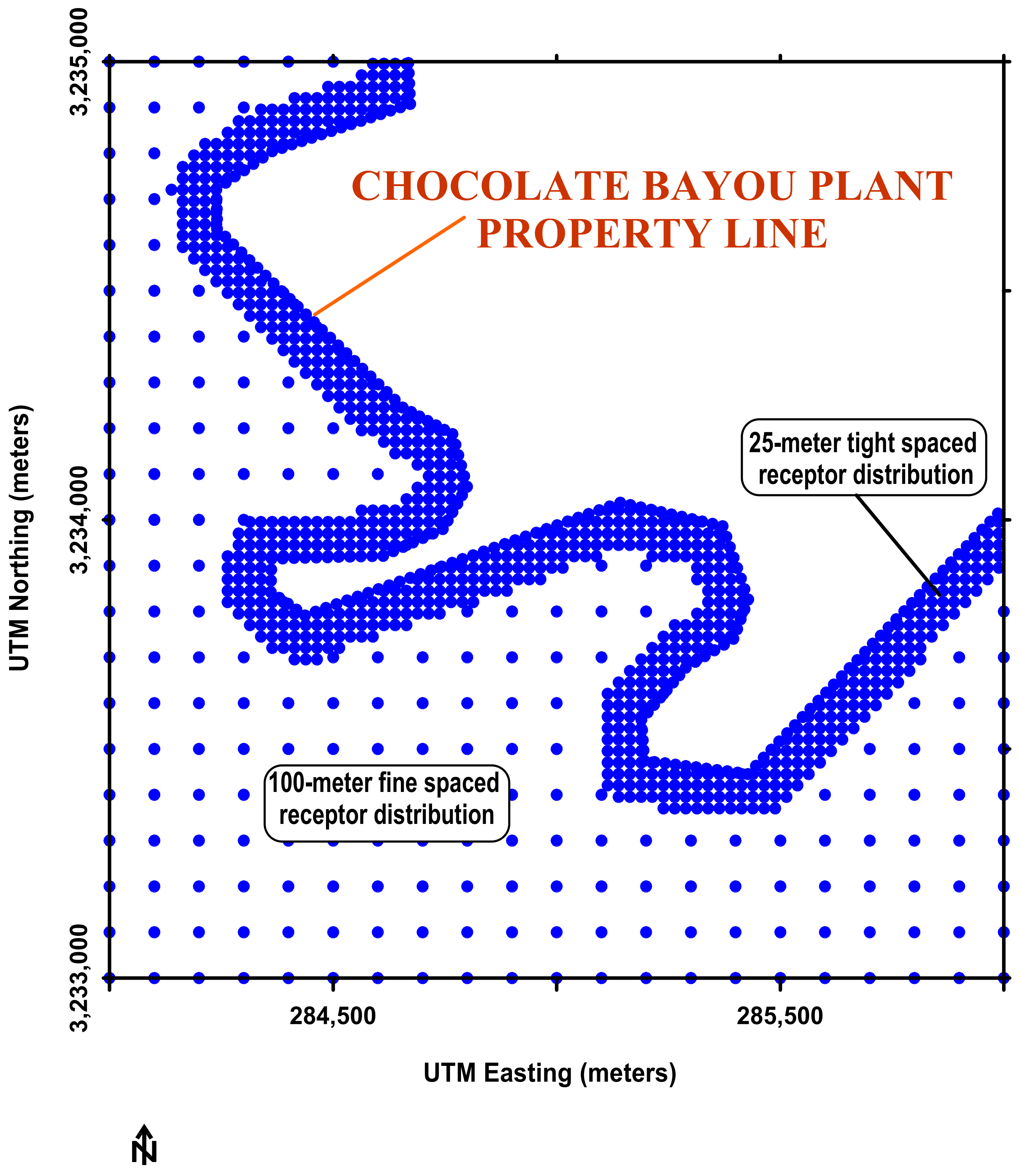

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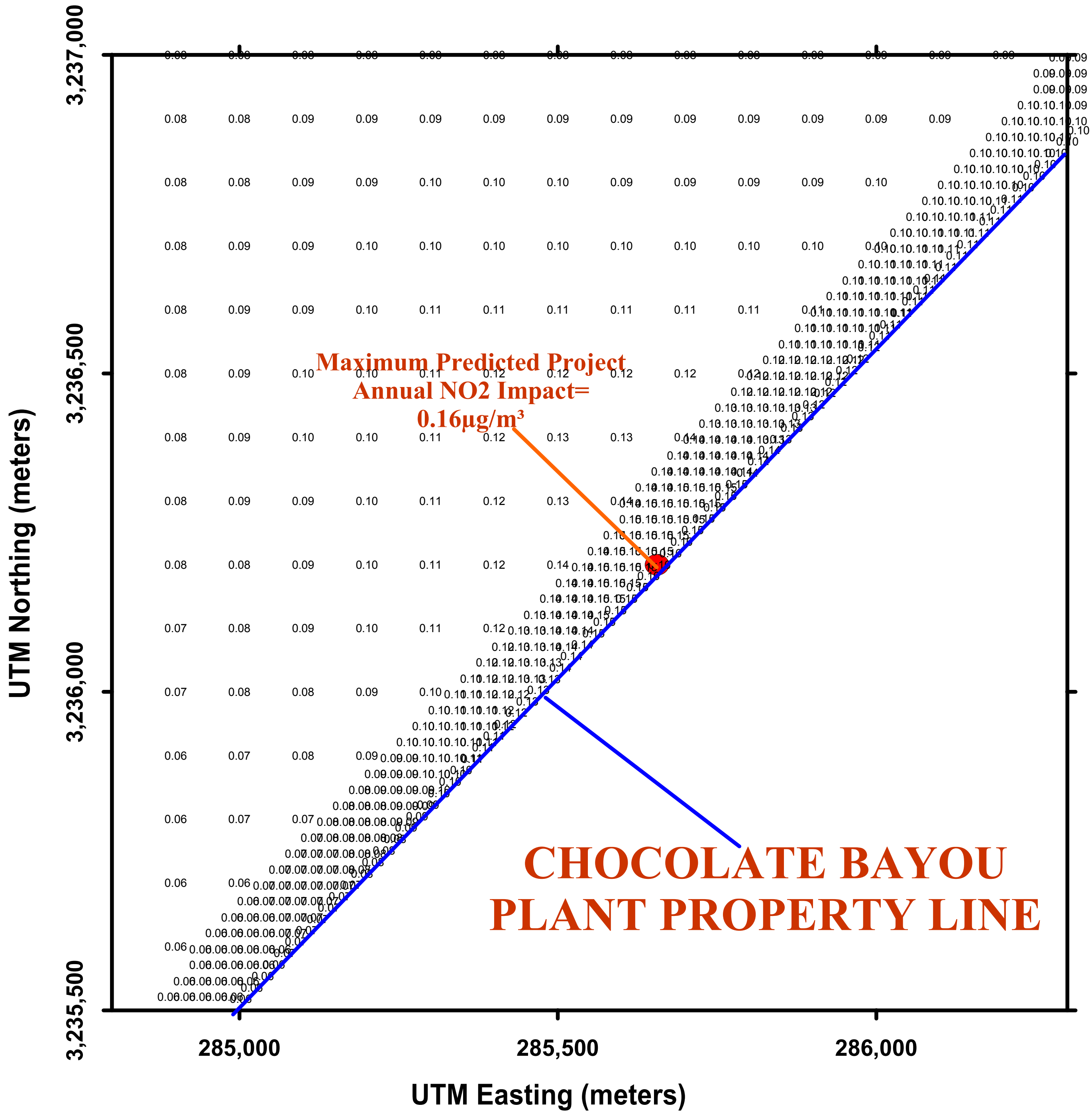
FIGURE 11-3
Fine, Tight Receptor Distribution, and Property Line
December 2011



N

Annual NO2 de minimis Concentration 1µg/m³.

Concentrations are in µg/m³.

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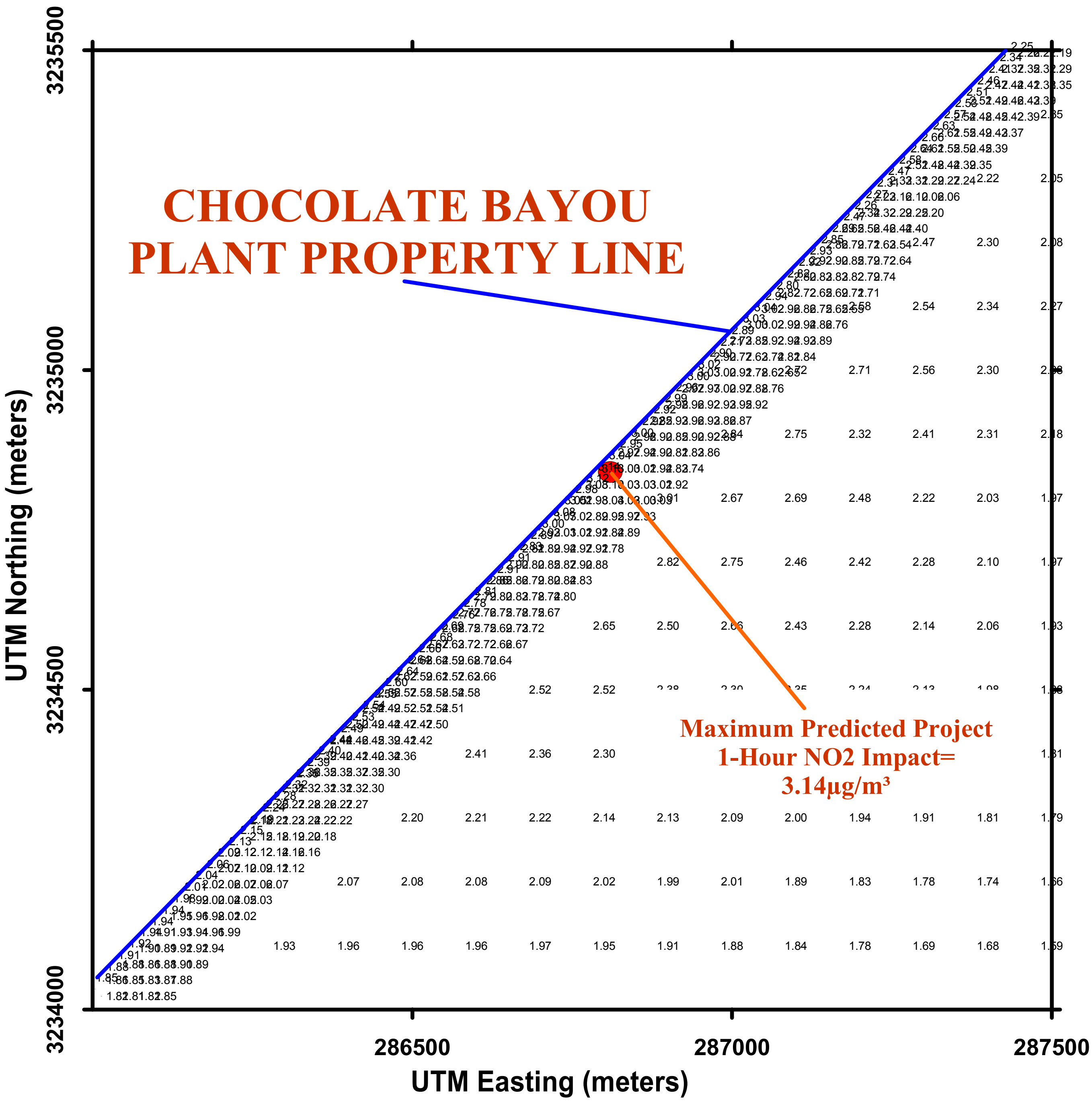
FIGURE 13-1

Maximum Predicted Project Annual NO2 Concentrations
December 2011



1-Hour de minimis Concentration 7.54µg/m³.

Concentrations are in µg/m³.

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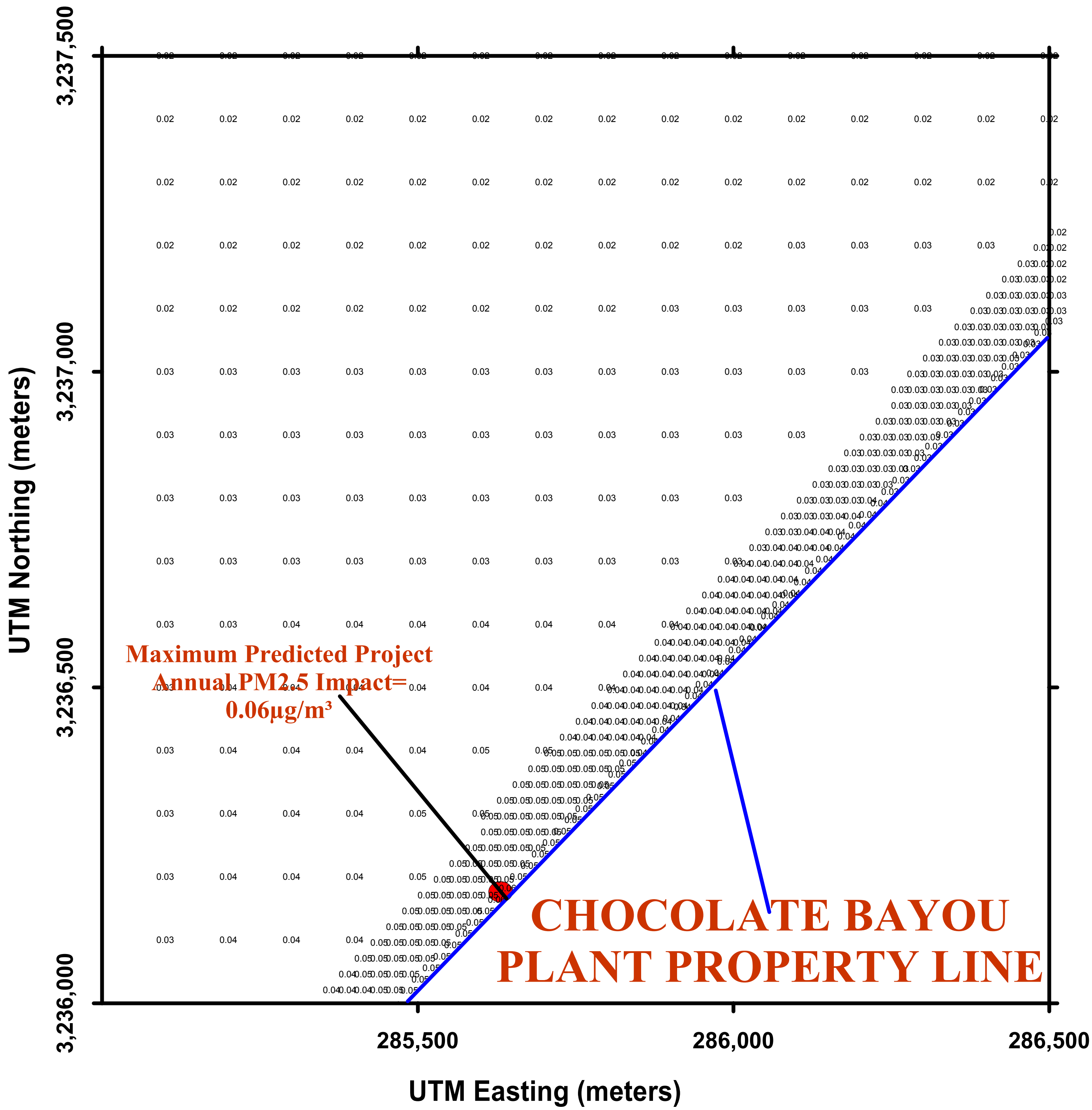
FIGURE 13-2
Maximum Predicted Project 1-Hour NO2 Concentrations
December 2011



Annual PM2.5 de minimis Concentration 0.3µg/m³.

Concentrations are in µg/m³.

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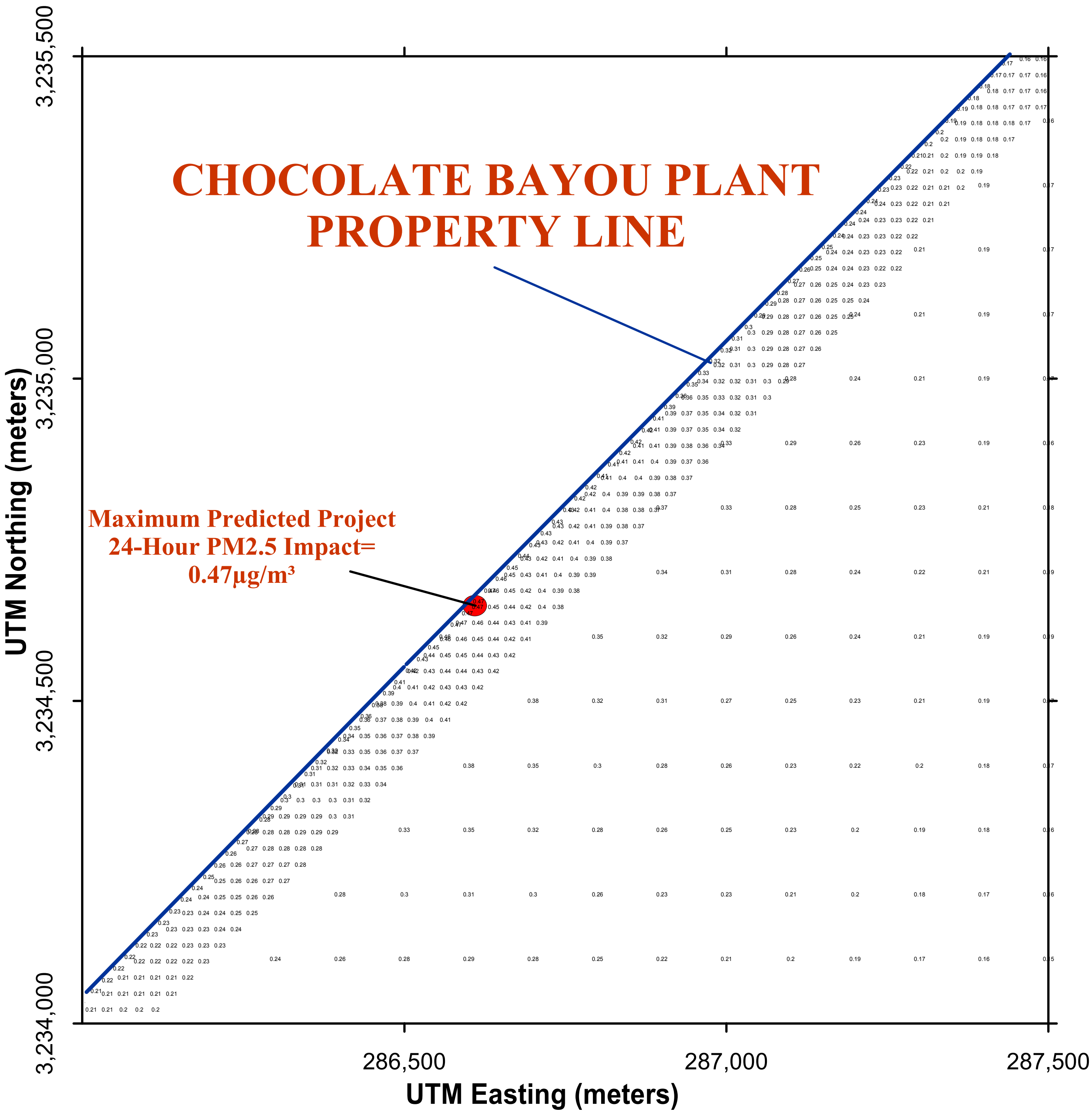
FIGURE 13-3

Maximum Predicted Project Annual PM2.5 Concentrations
December 2011



24-Hour PM2.5 de minimis Concentration 1.2µg/m³.

Concentrations are in µg/m³.

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FIGURE 13-4
Maximum Predicted Project 24-Hour PM2.5 Concentrations
December 2011

TABLES

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Table 6-1 (Table 1(a)) Emission Point Summary

Date:	July 2010	Permit No.:	NA	Regulated Entity No.:	100238708
Area Name:	No. 2 Olefins Unit			Customer Reference No.:	602817884

Review of applications and issuance of permits will be expedited by supplying all necessary information requested on this Table.

AIR CONTAMINANT DATA					
1. Emission Point			2. Component or Air Contaminant Name	3. Air Contaminant Emission Rate	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
DDB-105	DDB-105	Furnace No. 105	NO_X	14.85	21.68
			CO	21.78	95.40
			VOC	3.72	16.28
			SO_2	0.41	1.78
			NH_3	4.77	10.45
			PM	5.14	22.50
			PM_{10}	4.06	17.77
			$PM_{2.5}$	2.31	10.12
			CO_2e	81,592.35	255,588.70
FUG-ADDF	FUG-ADDF	Furnace No. 105 VOC Fugitives	VOC	0.94	4.12
FUG-SCR2	FUG-SCR2	Furnace No. 105 Ammonia Fugitives	NH_3	0.02	0.10
DDF-106	DDF-106	Furnace No. 105 Decoke Cyclone	CO	103.46	2.48
			VOC	0.09	0.01
			PM	1.36	0.39
			PM_{10}	1.35	0.39
			$PM_{2.5}$	0.84	0.24
			CO_2	3,630.95	87.14

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Table 6-1 (Table 1(a)) Emission Point Summary

Date:	July 2010	**Permit No.:**	NA	**Regulated Entity No.:**	100238708
Area Name:	No. 2 Olefins Unit			**Customer Reference No.:**	602817884

Review of applications and issuance of permits will be expedited by supplying all necessary information requested on this Table.

AIR CONTAMINANT DATA			EMISSION POINT DISCHARGE PARAMETERS										
1. Emission Point			4. UTM Coordinates of Emission Point			Source							
						5. Building	6. Height	7. Stack Exit Data			8. Fugitives		
EPN (A)	FIN (B)	NAME (C)	Zone	East (Meters)	North (Meters)	Height (Feet)	Above Ground (Feet)	Diameter (Feet) (A)	Velocity (fps) (B)	Temperature (°F) (C)	Length (Feet) (A)	Width (Feet) (B)	Axis Degrees (C)
DDB-105	DDB-105	Furnace No. 105	15	286,473.18	3,235,408.88		161.0	6.0	76.5	300			
FUG-ADDF	FUG-ADDF	Furnace No. 105 VOC Fugitives	15	286,473.18	3,235,408.88		3.3				300	300	47
FUG-SCR2	FUG-SCR2	Furnace No. 105 Ammonia Fugitives	15	286,473.18	3,235,408.88		3.3				544	358	47
DDF-106	DDF-106	Furnace No. 105 Decoke Cyclone	15	286,473.18	3,235,408.88		125.0	2.5	60.0	600			

EPN = Emission Point Number
FIN = Facility Identification Number

TABLE 6-2

PROJECT CRITERIA AIR POLLUTANT STACK PARAMETERS

INEOS USA LLC

AERMOD Source ID[a]	Emission Point Identification[b]	Zone 15 (NAD83) UTM Coordinates[c]		Base Elevation[d] (msl)		Stack Parameters							
		Easting	Northing			Stack Height		Stack Exit Temperature		Stack Exit Velocity		Stack Diameter	
		(m)	(m)	(ft)	(m)	(ft)	(m)	(°F)	(K)	(ft/sec)	(m/sec)	(ft)	(m)
DDB105	Furnance DDB105	286,473	3,235,409	11.0	3.3	161.0	49.1	300	422	76.5	23.3	6.0	1.8
DDF106	Decoke Stack DDF106	286,473	3,235,409	11.0	3.3	125.0	38.1	600	589	60.0	18.3	2.5	0.8

[a] The AERMOD Source ID is the unique source identification used in the AERMOD model input files. The Project sources have the EPN nomenclature listed in the Table 1(a) of the permit application.

[b] The "Emission Point Description" in this table is also entered in the AERMOD source file and describes the EPN.

[c] The UTM coordinates are in the NAD83, UTM Zone 15, system.

[d] The elevation is above mean sea level (msl) and was determined using the BEE-Line algorithm contained in the AERMAP package to calculate the terrain heights using the elevations contained in the NED file for the location as input.

TABLE 6-3

PROJECT CRITERIA AIR POLLUTANT EMISSION RATE INCREASES

INEOS USA LLC

AERMOD Source ID[a]	Emission Point Identification[b]	Criteria Air Pollutant Emission Rate (lb/hr)				
		CO	NO_X[c]	PM_{10}	$PM_{2.5}$	SO_2
DDB105	Furnance DDB105	21.78	14.85	4.06	2.31	0.41
DDB106	Decoke Stack DDF106	103.46	N/A	1.35	0.84	N/A

[a] The AERMOD Source ID is the unique source identification used in the AERMOD model input files. The Project sources have the EPN nomenclature listed in the Table 1(a) of the permit application.

[b] The "Emission Point Description" in this table is also entered in the AERMOD source file.

[c] The Ambient Ratio Method (ARM) will be used in the NO_2 modeling, as recommended in the TCEQ AQMG. Therefore, the NO_X emission rate will be scaled by a factor of 0.8 in the AERMOD model run to convert from NO_X emissions to NO_2 concentrations.

TABLE 12-1

AERSURFACE ROUGHNESS LENGTH OUTPUT

INEOS USA LLC


```
** Generated by AERSURFACE, dated 08009
** Center UTM Easting (meters):    286500.0
** Center UTM Northing (meters):  3235500.0
** UTM Zone:  15    Datum: NAD83
** Study radius (km) for surface roughness:   1.0
** Airport? N, Continuous snow cover? N
** Surface moisture? Average, Arid region? N
** Month/Season assignments? Default
** Late autumn after frost and harvest, or winter with no snow:
12 1 2
** Winter with continuous snow on the ground: 0
** Transitional spring (partial green coverage, short annuals):
3 4 5
** Midsummer with lush vegetation: 6 7 8
** Autumn with unharvested cropland: 9 10 11
**
   FREQ_SECT  ANNUAL  1
   SECTOR   1    0  360
**                     Sect    Alb      Bo        Zo
   SITE_CHAR    1       1     0.15     0.35     0.269
```

Table 13-1

MAXIMUM PREDICTED PROJECT CO, NO_2, $PM_{2.5}$, PM_{10}, AND SO_2 IMPACTS

INEOS OLEFINS NO. 2 FURNACE

Criteria Air Pollutant	Averaging Period	EPA/TCEQ Significant Impact Level (µg/m³)	Maximum Predicted Project Impact (µg/m³)	Percent of Applicable Significant Impact Level (%)	Is the Maximum Predicted Project Impact Above the Applicable Significant Impact Level?
CO	8-Hour	500	46.9[a]	9.4%	**No**
CO	1-Hour	2,000	65.1[a]	3.3%	**No**
NO_2	Annual	1	0.16[a,b]	16%	**No**
NO_2	1-Hour	7.54	3.14[a,b]	41.6%	**No**
$PM_{2.5}$	Annual	0.3	0.06[c]	20.0%	**No**
$PM_{2.5}$	24-hour	1.2	0.47[c]	39.2%	**No**
PM_{10}	Annual	1	0.11[d]	11.0%	**No**
PM_{10}	24-hour	5	0.94[d]	18.8%	**No**
SO_2	Annual	1	0.005[a]	0.5%	**No**
SO_2	24-hour	5	0.05[a]	1.0%	**No**
SO_2	3-hour	25	0.1[a]	0.4%	**No**
SO_2	1-hour	7.8	0.11[a]	1.4%	**No**
SO_2	30-minute	20.42[e]	0.11[a]	0.5%	**No**

[a] The maximum project impact predicted using one year (1988) of TCEQ-provided IAH/LCH (Houston, Texas/Lake Charles, Louisiana) meteorological data for a medium roughness length location.

[b] The EPA-recommended 1-hour NO_X-to-NO_2 conversion rate of 0.8 was used to scale the 1-hour and annual NO_2 concentrations.

[c] The maximum project impact predicted using a five-year (1987-1991) concatenated TCEQ-provided IAH/LCH meteorological data record for a medium roughness length location.

[d] The maximum project impact predicted using five individual years (1987-1991) of TCEQ-provided IAH/LCH meteorological data record for a medium roughness length location.

[e] The Texas 30-minute property-line SO_2 standard is 1,021 µg/m³. Therefore, the significant impact level for 30-minute SO_2 is 2% of 1,021 µg/m³, or 20.42 µg/m³.

Additional information

Daniel Lutz to: Bonnie Braganza

From: Daniel Lutz <daniel.lutz@ineos.com>

To: Bonnie Braganza/R6/USEPA/US@EPA

INEOS GHG PSD APPLICATION NACE CALCS_SAL_RevD_11Jun12.pdf

Here is the information that we discussed on yesterday's phone call:

* The new furnace is designed to crack ethane. Propane and liquid (DNG) feeds

* I'm attaching a document prepared by KBR that adds more details on CCS costs. This was done essentially from scratch, and uses more site-specific information that the assumptions used in the original document. The total capital cost of $238 million is more than two times the cost of the furnace installation itself. The net annualized cost is $163/ton of CO2e.

* Also attached is some proposed permit language, based on BASF-Fina's draft permit. The most substantive changes are in paragraphs (h), (i), and (j). Paragraph (i) is where I've put the lb CO2e/lb C2= value. The furnace efficiency in paragraph (j) is described as we discussed--that INEOS will do a Material and Energy Balance upon request to demonstrate 91.5% efficiency, but that 340 F stack temperature would be the more common demonstration. I used the 340 F number from our permit application due to the reasons stated in the application. I also used 91.5% efficiency--this number is lower than the design efficiency of 92.6%; however, it corresponds to the actual performance of the five similar furnaces that INEOS operates. The case for both the stack temperature and efficiency, in other words, both represent values that INEOS believes are achievable for our design. Since paragraph (j) represents a compliance option along with paragraph (i), please let me know if you believe that EPA cannot issue the permit with these values.

Thanks,

Dan Lutz
713-373-9300 (m)

KBR ENVIRONMENTAL CALCULATIONS - NET ANNUAL COST EFFECTIVENESS

				Revision No.	B	C	D
JOB NO.	D967	DOC NO.	D967-EV-CAL-EV2-0002	Date	14-May-12	4-Jun-12	11-Jun-12
CLIENT	INEOS	ITEM NO.	DDB-105	Prepared By:	MO	SAL	SAL
PROJECT	GHG PSD Application Support	ITEM NAME	OL2 SCORE FURNACE	Check By:	SAL	SAL	SAL
LOCATION	Chocolate Bayou, TX	SERVICE	Continuous	Approved By:	---	---	---
UNIT	OL2	SUBJECT	CCS - Stack to Pipeline	Purpose:	IFI	IFI	IFI
CASE	Permitting						

Revision

Line	PROJECT DEFINITON	Rev

BASIS	DESCRIPTION	Rev
1	Fired source CO_2 emissions from INEOS Permit Application with 495 MMBtu/hr (HHV) natural gas firing.	
2	Source stack spatial dimentions per project drawings: D967-MB-DWG-MB1-D001/D002/D003/D004, RevA, 11APR12	
3	Source Location per Plot Plan Dwg. No. D-H-AP-006-SH-1 RevB, 9APR12	
4	Stack tie-in, ducting to CO_2 capture, and isolation valving outside Furnace Licensor design scope, i.e, independent design add-on. Instrumentation and controls must be tied	
5	Stack gas conveyed to CO_2 capture via ducting and induced draft blower using electric motor driver.	
6	CO_2 Recovery System designed to provide 90% collection efficiency for design furnace exhaust gas flow with natural gas firing	
7	CO_2 Recovery System to have exhaust gas stack to same elevation as DDB-105 exhaust stack, with sampling ports, utilities, lighting, and 360 degree platform access	
8	CO_2 compressor uses electric motor driver. Two 50% 5-Stage reciprocating compressors, one spare, assumed configuration.	
9	CO_2 pressure, flow, density, dew point and temperature are measured on compressed flow at chain-of-custody transfer point to offsite pipeline.	
10	Collection, Compresssion, and Transport (CCT) Systems' process/environmental monitoring data to be integrated into existing site DCS via new Junction/Interface Box	
11	CO_2 pipeline from Compression System routed on A/G piperacks and then via U/G route to INEOS fenceline along FM2004; see D967-EV-DWG-EV2-1000 & 1001	
12	Assumed tie-in to Denbury Green Pipeline (feeding CO_2 for EOR at Hastings Field on north side of Alvin, TX) near intersection of TX roads FM 646 & 517.	
13	Assumed routing from INEOS to tie-in with Denbury Green Pipeline, 18.6 miles along public right-of-way; see Dwg D967-EV-DWG-EV2-1001	
14	CO_2 pipeline will have 4 isolation block valves: 1 at fencline custody transfer point, 1 at Denbury tie-in, and 2 intermediate locations to create 3 sections of ~ 6 miles length.	
15	CO_2 pipeline will have supervisory control and data acquisition (SCADA) system stations at each isolation block valve location.	
16	Project equipment life is 15 years per INEOS Finance Department.	
17	Utility costs and labor rates per INEOS, based upon 2011 averages.	
18	New CO_2 CCT Cooling Tower required, as existing site cooling systems have no spare capacity	C
19	New Substation area & equipment (switchgear, transformers, and MCC required for CO_2 CCT's 4160 V and 480 V loads, as existing site infrastructure has no spare c	C
20	Large 4160 V Loads and 480 V transformer at CCT fed by cabling on existing piperacks using new cable tray from main substation.	C
21	Major CCT Equipment Listing By Block (Piping and Bulks not included) Per GHG PSD Application CCT DWGs (D967-EV-DWG-EV2-0001 to 0007):	

CCT Block Item		TYPE	REMARKS	EST. LINE REF.
Block A	**EXHAUST GAS COLLECTION SYSTEM**			
A-1	Ducting "T-Spool" Sections	Piping Components		
A-2	Exhaust Shut-off Damper	SP item		
A-3	CCT Isolation Damper	SP item		
A-4	Collection Blower	Centrifugal Blower	Power Demand	
A-5	Collection Blower Driver	Electric		
Block B	**GAS COOLING AND DEHYDRATION SYSTEM**			
B-1	Contact Gas Cooler	Vertical Drum		
B-2	Gas Cooler Recirculation Pump (A/B)	Centrifugal		
B-3	Gas Cooler Recirculation Pump Driver (A/B)	Electric	Power Demand	
B-4	Gas Cooler Recirculation Exchanger	Shell & Tube	Cooling Water Demand	
Block C	**CO2 RECOVERY SYSTEM**			
C-1	Absorber	Tower, packed		
C-2	Rich Amine Pump (A/B)	Centrifugal	Power Demand	
C-3	Rich Amine Pump Driver (A/B)	Electric		
C-4	Rich Amine Filter	Duplex Basket		
C-5	Rich Amine-Lean Amine Exchanger	Plate & Frame		
C-6	Stripper	Tower, packed		
C-7	Stripper Overheads Condenser	Shell & Tube	Cooling Water Demand	
C-8	Stripper Condenser Accumulator	Drum		
C-9	Stripper Reflux Pump (A/B)	Centrifugal		
C-10	Stripper Reflux Pump Driver (A/B)	Electric	Power Demand	
C-11	Stripper Reboiler	Kettle	Steam Demand	
C-12	Lean Amine Pump (A/B)	Centrifugal		
C-13	Lean Amine Pump Driver (A/B)	Electric	Power Demand	
C-14	Lean Amine Filter	Duplex Basket		
C-15	Lean Amine Cooler	Shell & Tube	Cooling Water Demand	
C-16	Carbon Filter Pump (A/B)	Centrifugal		
C-17	Carbon Filter Pump Driver (A/B)	Electric	Power Demand	
C-18	Carbon Filter	Drum, Packed Bed	Activated Carbon Bed	
C-19	Wash Water Recirculation Pump (A/B)	Centrifugal		
C-20	Wash Water Recirculation Pump Driver (A/B)	Electric	Power Demand	
C-21	Wash Water Cooler	Shell & Tube	Cooling Water Demand	
C-22	Solvent Reclaimer	Shell & Tube Exchanger	Steam Demand	
Block D	**RECOVERY SOLVENT STORAGE AND HANDLING SYSTEM**			
D-1	Rich Amine Surge Tank	Fixed Roof	Utility N2 demand	
D-2	Rich Amine Transfer Pump (A/B)	Centrifugal		
D-3	Rich Amine Transfer Pump Driver (A/B)	Electric	Power Demand	
D-4	Lean/Fresh Amine Tank	Fixed Roof	Utility N2 demand	
D-5	Lean Fresh Amine Transfer Pump (A/B)	Centrifugal		
D-6	Lean Fresh Amine Transfer Pump Driver (A/B)	Electric	Power Demand	
D-7	Amine Tanks Vent Scrubber	Pipe Scrubber	Utility Water Demand	

ENVIRONMENTAL CALCULATIONS - NET ANNUAL COST EFFECTIVENESS

JOB NO.	D967	DOC NO.	D967-EV-CAL-EV2-0002	Revision No.	B	C	D	Revision
CLIENT	INEOS	ITEM NO.	DDB-105	Date	14-May-12	4-Jun-12	11-Jun-12	
PROJECT	GHG PSD Application Support	ITEM NAME	OL2 SCORE FURNACE	Prepared By:	MO	SAL	SAL	
LOCATION	Chocolate Bayou, TX	SERVICE	Continuous	Check By:	SAL	SAL	SAL	
UNIT	OL2	SUBJECT	CCS - Stack to Pipeline	Approved By:	---	---	---	
CASE	Permitting			Purpose:	IFI	IFI	IFI	

D-8	Amine Loading and Unloading Pad	Curbed Concrete		
D-9	Amine Sump	Concrete Box		
D-10	Amine Sump Pump (A/B)	Vertical Turbine		
D-11	Amine Sump Pump Driver (A/B)	Electric		Power Demand
Block E	**CO2 COMPRESSION**			
E-1	CO2 COMPRESSOR A/B/C	Reciprocating		
E-2	CO2 COMPRESSOR DRIVER A/B/C	Electric		Power Demand
E-3	Interstage Cooler 1	Shell & Tube		Cooling Water Demand
E-4	Interstage Separator 1	Drum		
E-5	Interstage Cooler 2	Shell & Tube		Cooling Water Demand
E-6	Interstage Separator 2	Drum	Estimated as Package	
E-7	Interstage Cooler 3	Shell & Tube		Cooling Water Demand
E-8	Interstage Separator 3	Drum		
E-9	Interstage Cooler 4	Shell & Tube		Cooling Water Demand
E-10	Interstage Separator 4	Drum		
E-11	Interstage Cooler 5	Shell & Tube		Cooling Water Demand
E-12	Interstage Separator 5	Drum		
E-13	Compression Condensate Drum	Drum		
E-14	Compression Condensate Pump	Centrifugal		
E-15	Compression Condensate Pump Driver	Electric		Power Demand
Block F	**INTERSTAGE DEHYDRATION SYSTEM**			
F-1	TEG Contactor	Tower , Trayed		
F-2	Rich TEG Heater	Shell & Tube		Steam Demand
F-3	Rich TEG Filter	Duplex Basket		
F-4	Flash Drum	Drum		
F-5	TEG Regenerator, Condenser, Accumulator	Tower, packed; Shell & Tube	Estimated as Package	Cooling Water Demand
F-6	TEG Regenerator Still Reboiler	Kettle		Steam Demand
F-7	Lean TEG-Rich TEG Exchanger	Shell & Tube		
F-8	Lean TEG Pump (A/B)	Centrifugal		
F-9	Lean TEG Pump Driver (A/B)	Electric		Power Demand
F-10	TEG Contactor KO Drum	Drum		
F-11	TEG Storage Tank	Fixed Roof		Utility N2 demand
F-12	TEG Make-up Pump (A/B)	Centrifugal		
F-13	TEG Make-up Pump Driver (A/B)	Electric		Power Demand
F-14	TEG Loading and Unloading Pad	Curbed Concrete		
F-15	TEG Sump	Concrete Box		
F-16	TEG Sump Pump (A/B)	Vertical Turbine		
F-17	TEG Sump Pump Driver	Electric		Power Demand
Block G	**CUSTODY TRANSFER METERING SYSTEM**			
G-1	Continuous CO2 Density Analyzer			
G-2	Continuous CO2 Dew Point Analyzer			
Block H	**CO2 PIPELINE**			
H-1	CO2 Pipeline SCADA System			Power Demand
Block I	**UTILITY - MISC. SUPPORT SYSTEMS**			
I-1	Cooling Water System			
I-2	CT Basin	Concrete Basin	Estimated as Package	
I-3	CT Cells	Mech Draft		
I-4	CT Fans			
I-5	CT Fan Drivers	Electric		Power Demand
I-6	CT Pumps	Vertical Turbine		
I-7	CT Pump Drivers	Electric		Power Demand
I-8	CT Chem Treatment Packages			
I-9	Oxidizing Biocide (Hypochlorite)	Injection Skid Package		Power Demand
I-10	Non-Oxidizing Biocide	Injection Skid Package		Power Demand
I-11	Dispersant	Injection Skid Package		Power Demand
I-12	Anti-scale Inhibitor	Injection Skid Package		Power Demand
I-13	Anti-corrosion inhibitor	Injection Skid Package		Power Demand
I-14	ph Control Instrumentation			
I-14A	Sulfuric Acid		Estimated as Package	
I-14B	Caustic			
I-17	Hypochlorite Solution Tank	Fixed Roof		
I-18	Sulfuric Acid Tank	Fixed Roof		
I-19	Caustic Tank	Fixed Roof		
I-20	Electrical Substation - Transformer 1 (4160 V)			
I-21	Electrical Substation - Transformer 2 (4160 V)			
I-22	Electrical Substation - Transformer 3 (480 V)			
I-23	Electrical Substation - Motor Control Center / DCS - Process Information Building			

SUMMARY OF NET ANNUAL COST EFFECTIVENESS DETERMINATION (BASED UPON EPA COST MANUAL + SITE & PROJECT SPECIFIC ADJUSTMENTS)

Reference

KBR

ENVIRONMENTAL CALCULATIONS - NET ANNUAL COST EFFECTIVENESS

JOB NO.	D967	DOC NO.	D967-EV-CAL-EV2-0002	Revision No.	B	C	D	Revision
CLIENT	INEOS	ITEM NO.	DDB-105	Date	14-May-12	4-Jun-12	11-Jun-12	
PROJECT	GHG PSD Application Support	ITEM NAME	OL2 SCORE FURNACE	Prepared By:	MO	SAL	SAL	
LOCATION	Chocolate Bayou, TX	SERVICE	Continuous	Check By:	SAL	SAL	SAL	
UNIT	OL2	SUBJECT	CCS - Stack to Pipeline	Approved By:	---	---	---	
CASE	Permitting			Purpose:	IFI	IFI	IFI	

TOTAL CAPITAL INVESTMENT (TCI)

			EPA COST MODEL DEFAULTS			
		% PEC	New	Retrofit		
Total Purchased Equipment Cost (PEC) =	$54,580,500				Line 226	
Direct Installation Cost (DIC) =	$99,879,701	183.0%	30	50 - 200+	Line 275	
Indirect Installation Cost (IIC) =	$82,128,038	150.5%	31	50 - 200+	Line 298	
Total Capital Investment (TCI) Cost =	$236,588,238	433%			Line 301	
Annualized TCI =	$26,133,552	Capital Cost Recovery at 7% Interest & Equipment Life =15 Years			Line 306	D

TOTAL ANNUAL COST (TAC)

Total Direct Costs (DC) =	$9,457,335	Line 432	
Total Indirect Costs (IC) =	$2,612,951	Line 439	
Total Annualized Cost (TAC) = DC + IC =	$10,845,063	Line 452	
NET ANNUALIZED COST = ANNUALIZED TCI + TAC =	$36,978,615	Line 454	D

POLLUTANT REDUCTION

	lb/hr	tpy			
Baseline Pollutant Release Rate =	57,500	251,850		Line 461	
New Controlled Pollutant Release Rate =	5,750	25,185	Pollution Control Equipment Efficiency = 90%	Line 462	
Pollutant Reduction =	**51,750**	**226,665**		Line 463	

NET ANNUALIZED COST PER TON OF POLLUTANT REMOVED =	**$163**	Line 465	D

SITE COSTS

NOTE : SPREADSHEET DATA ENTERED IN Cells

Incoming Real Estate (RE) Property Costs	Base Cost	% Accuracy	Est. RE Cost		REMARKS	
Survey	$ -	50	$0			
Due Diligence	$ -	50	$0			
Land Right-of-Way	$ 815,934	50	$1,223,901		18.6 mile Pipeline, 30 foot wide easement	Line 646
Site Clearing Misc.	$ 135,000	50	$202,500		67.6 acres for Pipeline access	
Site Preparation/Demolition	$ 5,000	50	$7,500		Clearing debris etc. from 2 acres for CCT Facilities	
Decontamination costs	$ -	50	$0		None Identified	
Fees	$ -	50	$0			
Title Insurance	$ -	50	$0			
Misc. Closing Costs/Improvements	$ -	50	$0			
	Subtotal, Incoming Real Estate Costs =			$1,433,901		

Outgoing Real Estate Property Costs	Base Cost	% Accuracy	Est. RE Cost		
					None identified
Demolition Costs	$ -	50	$0		
Decontamination Costs	$ -	50	$0		
Restoration Costs	$ -	50	$0		
Certification Costs	$ -	50	$0		
Fees	$ -	50	$0		
Other costs	$ -	50	$0		
Environmental Monitoring	$ -	50	$0		
Misc. Long Term Accruals	$ -	50	$0		
	Subtotal, Outgoing Real Estate Costs =			$0	
	Total, Real Estate (RE) Property Costs =			$1,433,901	

TOTAL CAPITAL INVESTMENT (TCI)

Base Equipment Costs By Class	Base Cost	% Accuracy	Est. Class Cost	REMARKS
Furnaces	$ -	50	$0	
Exchangers	$ 9,380,000	50	$14,070,000	
Air Cooled Exchangers	$ -	50	$0	
Surface Condensers	$ -	50	$0	
Converters	$ -	50	$0	
Towers	$ 7,250,000	50	$10,875,000	
Drums	$ 797,000	50	$1,195,500	
Tanks	$ 75,000	50	$112,500	
Pumps	$ 3,020,000	50	$4,530,000	
Compressors	$ 12,200,000	50	$18,300,000	
Fans & Blowers	$ -	50	$0	
Special Package Equipment	$ 180,000	50	$270,000	Cooling Tower Chemicals Skids Included
Filters	$ -	50	$0	
Lubrication Systems	$ -	50	$0	
Sieves and Desiccants	$ -	50	$0	
Catalyst & Chemicals Skids	$ -			
Utility Equipment	$ 1,000,000	50	$1,500,000	

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LOCATION	Chocolate Bayou, TX	SERVICE	Continuous	Check By:	SAL	SAL	SAL	
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Row	Item	Base % of PEC	Base Cost	% Accuracy	Est. Cost	Total	Notes	Line
212	Material Handling Equipment (Conveyors etc.)		$ -	50	$0			
213	Instrumentation		$ -	50	$0			
214	CEMS - CO2 Analyzer		$ 15,000	50	$22,500		C-1 Absorber Exhaust - Stream 7	
215	PROCESS - Flow		$ 10,000	50	$15,000		C-1 Absorber Exhaust - Stream 7	
216	PROCESS - Pressure		$ 10,000	50	$15,000		Block G - Custody Transfer Metering	
217	PROCESS - Flow		$ 5,000	50	$7,500		Block G - Custody Transfer Metering	
218	PROCESS - Dew Point		$ 10,000	50	$15,000		Block G - Custody Transfer Metering	
219	PROCESS - Temperature		$ 3,000	50	$4,500		Block G - Custody Transfer Metering	
220	Analyzer Shelter		$ 200,000	50	$300,000		Block G - Custody Transfer Metering	
221	Fire & Safety Equipment		$ -	50	$0			
222	Catalyst & Chemicals Equipment		$ -	50	$0			
223	Pipeline SCADA		$ 105,000	50	$157,500			
224	RESERVED		$ -	50	$0			
225	RESERVED		$ -	50	$0			
226					**Subtotal, Purchased Equipment Cost By Class =**	**$51,390,000**		
227								
228		**Base % of PEC**	**Base Cost**	**% Accuracy**	**Est. Cost**			
229	Freight to Site Location	4.14	2,127,000	50	$3,190,500		Purchased Equipment and Bulks	
230	Sales Tax	0	0	50	$0		Tax Exemption for Pollution Control Equipment in TX	
231	Instrumentation & Controls	0	0	50	$0		Included in Bulk Materials	
232					**Subtotal, Purchased Equipment Cost (others) =**	**$3,190,500**		
233					**Total Purchased Equipment Cost (PEC) =**	**$54,580,500**		
234								
235	**Direct Installation Costs**	**Base % of PEC**	**Base Cost**	**% Accuracy**	**Est. Cost**			
236	Subcontracts							
237	Furnaces	0.0	$0	50	$0			
238	Converters	0.0	$0	50	$0			
239	Towers	0.0	$0	50	$0			
240	Field Fab Tanks	1.36	$700,000	50	$1,050,000			
241	Special Equipment	0.0	$0	50	$0			
242	Utility Equipment	0.0	$0	50	$0			
243	Heavy Haul/Heavy Lift	0.0	$0	50	$0			
244	Civil (Excavations, Foundatior	0.25	$129,000	50	$193,500			
245	Demo & Alteration Work	0.0	$0	50	$0			
246	Site Improvements	5.76	$2,958,000	50	$4,437,000			
247	Buildings	0.0	$0	50	$0			
248	Piping	0.77	$397,000	50	$595,500			
249	Ducting	0.0	$0	50	$0			
250	Valving	0.0	$0	50	$0			
251	Steel	0.0	$0	50	$0			
252	Electrical	0.0	$0	50	$0			
253	Paint/Fireproofing	1.34	$688,000	50	$1,032,000			
254	Insulation	9.57	$4,920,000	50	$7,380,000			
255	Instruments	0.0	$0	50	$0			
256	Catalyst/Chemicals							
257	CO2 Pipeline (Internal)		$1,592,500	50	$2,388,750		From Compression To Fence (See D967-EV-DWG-1000)	Line 567
258	CO2 Pipeline (External)		$7,518,514	50	$11,277,771		To Denbury Green Pipeline Tie In (See D967-EV-DWG-100	Line 595
259					**Subtotal, Subcontracts =**	**$28,354,521**		Line 644
260								
261	Bulk Materials		**Base Cost**	**% Accuracy**	**Est. Cost**			
262	Civil Concrete (includes paving)		$ 1,065,000	50	$1,597,500			
263	Site Improvements		$ -	50	$0			
264	Structural Steel		$ 2,062,000	50	$3,093,000			
265	Buildings		$ -	50	$0			
266	A/G Piping		$ 22,522,000	50	$33,783,000			
267	U/G Piping		$ -	50	$0			
268	Electrical		$ 11,642,000	50	$17,463,000			
269	Instruments (incls wiring)		$ 6,143,000	50	$9,214,500			
270	Fireproofing (paint w/ Subs)		$ -	50	$0		Included in Subcontracts	
271	Insulation		$ -	50	$0		Included in Subcontracts	
272	CO2 Pipeline Materials		$ 1,907,824	50	$2,861,736			Line 643
273	CO2 Pipeline Misc		$ 2,341,629	50	$3,512,444		See Line	Line 645
274					**Subtotal, Bulk Materials =**	**$71,525,180**		
275					**Direct Installation Cost (DIC) =**	**$99,879,701**		
276								
277	**Indirect Installation Costs**	**Base % of PEC**	**Base Cost**	**% Accuracy**	**Est. Cost**			
278	Engineering, supervision	23.27	$11,960,000	50	$17,940,000			
279	Construction, field expense	76.57	$39,351,000	50	$59,026,500			
280	Construction fee		-	50	$0			
281	Service Contracts		-	50	$0			
282	Scaffolding		-	50	$0			
283	Crane Rental		-	50	$0			

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ENVIRONMENTAL CALCULATIONS - NET ANNUAL COST EFFECTIVENESS

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CLIENT	INEOS	ITEM NO.	DDB-105	Date	14-May-12	4-Jun-12	11-Jun-12	
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UNIT	OL2	SUBJECT	CCS - Stack to Pipeline	Approved By:	---	---	---	
CASE	Permitting			Purpose:	IFI	IFI	IFI	

Row	Item							Notes	Rev.
284	Inspectors		-	50	$0				
285	Fixits		-	50	$0				
286	Rework		-	50	$0				
287	Contingencies	3	1,637,415	50	$2,456,123				
288	Startup	2	1,091,610	50	$1,637,415				
289	Washes		-	50	$0				
290	Rinses / Circulation Fluids		-	50	$0				
291	Material Handling Costs		-	50	$0				
292	Disposal Costs		-	50	$0				
293	Q/A Costs		-	50	$0				
294	Feedstock		-	50	$0				
295	Tests								
296	All Risk Insurance	2.32	$1,191,000						
297	Project Completion	1.39	$712,000	50	$1,068,000				
298					**Indirect Installation Cost (IIC) =**	**$82,128,038**			
299					**Equipment Installation Costs (Direct + Indirect) =**	**$182,007,738**			
300									
301					**Total Capital Investment (TCI = RE+ PEC + DIC + IIC) Costs =**	**$238,022,140**			
302									
303	**Capital Cost Recovery Factor (CCRF)**			**@ % Interest =**	7		**0.109795**		D
304				**Equipment Life, yr =**	15				
305									
306						**Annualized TCI Cost = CCRF x TCI =**	**$26,133,552**		D
307									
308	**TOTAL ANNUAL COST (TAC)**								
309	**Direct Operating Costs**					Day / Yr =	365		
310									
311	**Operating Labor**	**Shifts/day**	**Man Hr/Shift**	**Hr/day**	**Cost, $ /Hr**	**Est. Cost**			
312	Operator - General	3	1	3	52	56,940		Operations Control Board Monitoring	
313	Operator - Field	3	1	3	52	56,940		Unit Walk-thrus & Equiment Inspections	
314	Operator - Technician	1	1	1	52	18,980		Process Sample Collection & Handling	
315			Sum =	7					
316	Supervision	% Op. Hr. =	15	1.05	55	21,079			
317					**Subtotal, Annual Operating Labor Cost=**		**$153,939**		
318									
319	**Maintenance**	**Days/yr**	**Man Hr/day**	**Hr/yr**	**Cost, $ /Hr**	**Est. Cost**			
320	Maintenance Labor	50	12	600	52	31,200		General Equipment Change-out & Repair	
321	Maintenance Labor	24	4	96	52	4,992		Preventive Maintanance	
322	Maintenance - Technician	120	2	240	52	12,480		Instrument Calibrations	
323			Sum =	936					
324	Supervision	% Maint. Hr. =	15	140.4	55	7,722			
325					**Subtotal, Annual Maintenance Labor Cost =**		**$56,394**		
326									
327	**Maintenance Materials**		**Unit Cost**	**# of Units/yr**	**% Accuracy**	**Est. Cost**			
328	Service Contracts		1,000	3	50	$4,500			
329	Consumable Supplies		500	12	50	$9,000			
330	Tooling and Equipment		1,000	25	50	$37,500			
331	Equipment Replacement Costs		25,000	2	50	$75,000			
332	Spare Parts and materials Costs		1,000	20	50	$30,000			
333	Scaffolding		10,000	2	50	$30,000			
334	Crane Rental		5,000	2	50	$15,000			
335	CO2 Pipeline External (Fixed O&M Gen P/L)		160,555	1	50	$240,833		Line 648	
336	CO2 Pipeline External (Fixed O&M)		1,300,000	1	50	$1,950,000		Line 649	
337	Reserved				50	$0			
338	Reserved				50	$0			
339					**Subtotal, Annual Maintenance Materials Cost =**		**$2,391,833**		
340									
341	**Maintenance Turnaround (TAR)**								
342	**TAR Labor**	**Days/TAR**	**MH/day**	**Hr/TAR**	**Cost, $ /Hr**	**Est. Cost**			
343	Turnaround Labor	7	120	840	52	$ 43,680			
344	Supervision	% Mnt.. Hr. =	15	126	55	$ 6,930			
345					**Subtotal, Turnaround Labor Cost =**	**$50,610**			
346									
347	**TAR Materials**	**Days/TAR**	**Unit Cost**	**Units/TAR**	**% Accuracy**	**Est. Cost**			
348	Service Contracts	2	1,000	3	50	$9,000			
349	Consumable Supplies	6	500	10	50	$45,000			
350	Tooling and Equipment	5	1,000	5	50	$37,500			
351	Equipment Replacement Costs	1	25,000	2	50	$75,000			
352	Spare Parts and materials Costs	6	1,000	5	50	$45,000			
353	Scaffolding	9	10,000	1	50	$135,000			
354	Crane Rental	9	5,000	1	50	$67,500			
355	Equipment Refurbishment Costs	1	5,000	4	50	$30,000			

Row		
356	Subtotal, Turnaround Materials Cost =	$487,680
357	Subtotal, Maintenance Turnaround Cost =	$538,290
358		
359	Maintenance Turnaround Period (yr Frequency) =	3
360	Maintenance Turnaround Annual Accrual Cost =	$179,430
361		

Row	% Util & Chem Costs	Utility and Chemical Costs		Unit Cost, $	Cost Units	Usage Units	Usage Rate	$/yr	
363	0.0	Electricity	Demand	0.049	$/kwhr	kw	0.0	$0	
364	0.0	CO2 Pipeline SCADA System		0.049	$/kwhr	kw	4.0	$1,717	
365	6.8	Collection Blower				Hp	1,416.3	$453,502	
366	0.7	Gas Cooler Recirculation Pump Driver (A/B)				Hp	139.9	$44,784	
367	1.5	Rich Amine Pump (A/B)				Hp	307.3	$98,407	
368	0.0	Stripper Reflux Pump Driver (A/B)				Hp	0.0	$0	
369	1.5	Lean Amine Pump Driver (A/B)				Hp	304.1	$97,382	
370	0.1	Carbon Filter Pump Driver (A/B)				Hp	18.6	$5,953	
371	0.0	Wash Water Recirculation Pump Driver (A/B)				Hp	8.8	$2,827	
372	0.0	Rich Amine Transfer Pump Driver (A/B)				Hp	0.0	$0	Intermittent - Minor Cost
373	0.0	Lean Fresh Amine Transfer Pump Driver (A/B)				Hp	0.0	$0	Intermittent - Minor Cost
374	0.0	Amine Sump Pump Driver (A/B)				Hp	0.2	$63	
375	19.3	CO2 COMPRESSOR DRIVER A/B/C (2 Operating 1 Spare)				Hp	4,026.8	$1,289,427	
376	0.0	Compression Condensate Pump Driver				Hp	0.0	$0	
377	0.0	Lean TEG Pump Driver (A/B)				Hp	0.3	$92	
378	0.0	TEG Make-up Pump Driver (A/B)				Hp	0.9	$301	
379	0.0	TEG Sump Pump Driver				Hp	0.5	$171	
380	1.4	CT Fan Drivers				Hp	296.4	$94,897	Minor Source Allowance
381	8.5	CT Pump Drivers				Hp	1,780.3	$570,076	18800 gpm recirculation, 180 ft TDH
382	0.0	CT Oxidizing Biocide (Hypochlorite) Skid				Hp	0.1	$32	Minor Source Allowance
383	0.0	CT Non-Oxidizing Biocide Skid				Hp	0.1	$32	Minor Source Allowance
384	0.0	CT Dispersant Skid				Hp	0.1	$32	Minor Source Allowance
385	0.0	CT Anti-scale Inhibitor Skid				Hp	0.1	$32	Minor Source Allowance
386	0.0	CT Anti-corrosion inhibitor Skid				Hp	0.1	$32	Minor Source Allowance
387	0.0	CT Sulfuric Acid Pump				Hp	0.1	$32	
388	0.0	Plant H2O		0.221	$/kgal	gpm		$0	
389	0.7	Cooling Tower Makeup		0.221	$/kgal	gpm	377.5	$43,853	5 Cycles of Concentration
390	0.0	Amine Tanks Vent Scrubber		0.221	$/kgal	gpm	4.4	$511	
391	0.0	BFW-DEMIN		1.28	$/klbs.	klb/hr		$0	Condensate used for MEA Makeup
392	0.0	Nitrogen		23.34	$/ton	lb/hr		$0	
393	0.0	Rich Amine Surge Tank		23.34	$/ton	lb/hr	2.0	$204	Tank Blanket Gas
394	0.0	Lean/Fresh Amine Tank		23.34	$/ton	lb/hr	2.0	$204	Tank Blanket Gas
395	0.0	TEG Storage Tank		23.34	$/ton	lb/hr	2.0	$204	Tank Blanket Gas
396	0.0	Oxygen		39	$/ton	lb/hr		$0	
397	0.0	Plant Air		0.122	$/kscf	kscf/hr	0.26	$280	
398	0.0	Steam	(LP)	2.96	$/klbs.	klb/hr		$0	35 psig Steam
399	54.8	MEA Stripper Reboiler		2.96	$/klbs.	klb/hr	141.1	$3,657,843	
400	1.3	MEA Solvent Reclaimer		2.96	$/klbs.	klb/hr	3.3	$84,320	3% MEA Recirc; 65 psig Steam
401	0.0	Rich TEG Heater		2.96	$/klbs.	klb/hr	0.004	$100	
402	0.0	Steam	(MP)	4.82	$/klbs.	klb/hr		$0	
403	0.0	TEG Still Reboiler		4.82	$/klbs.	klb/hr	0.021	$890	250 psig Steam
404	0.0	Steam	(HP)	6.17	$/klbs.	klb/hr		$0	
405	0.0	Steam	(VHP)	7.50	$/klbs.	klb/hr		$0	
406	0.0	Nat.Gas	(1000 Btu/scf)	4.80	$/kscf	kscf/hr		$0	
407	0.0	Bulk (98% Sulfuric Acid)		75	$/ton	lb/hr	2.9	$948	CT Alkalinity Control
408	0.0	Bulk (50% Caustic)		520	$/ton	lb/hr		$0	
409	0.0	Bulk (NH3)		212	$/ton	lb/hr		$0	
410	0.0	Bulk Absorbent		0.00	$/lb	lb/hr		$0	
411	0.4	Activated Carbon Usage		0.75	$/lb	lb/hr	3.7	$24,026	Equivalent AC Burn Rate (3 beds/yr)
412	0.5	MEA Decomp./Losses		1.26	$/lb	lb/hr	3.0	$33,113	4 ppmv in Absorber Tail Gas
413	0.0	TEG Decomp./Losses		0.65	$/lb	lb/hr	0.437	$2,491	0.1 gal per MMSCF
414	0.0	Sodium Carbonate		0.60	$/lb	lb/hr	0.000	$0	Soda Ash Addition to MEA Reclaimer
415	1.9	Sodium Hypochlorite		2000	$/ton	lb/hr	14.6	$128,137	Cooling Tower Chem
416	0.1	Dispersant Skid		3000	$/ton	lb/hr	0.5	$6,570	Cooling Tower Chem
417	0.2	Anti-scale Inhibitor Skid		2500	$/ton	lb/hr	1.2	$12,814	Cooling Tower Chem
418	0.2	Anti-corrosion inhibitor Skid		2500	$/ton	lb/hr	1.0	$10,678	Cooling Tower Chem
419	0.0	Sodium Hyposulfite		900	$/ton	lb/hr		$0	
420	0.0	Chem Recovery Credit, $/lb :		0.29	$/lb	lb/hr		$0	
421	0.0	Chem Recovery Credit, $/lb :		0.15	$/lb	lb/hr		$0	
422	0.0	Waste Disposal Cost =		200	$/ton	lb/hr		$0	
423	0.0	HW Disposal		1.00	$/lb	lb/hr		$0	
424	0.0	Class1Disposal		1.00	$/lb	lb/hr		$0	
425	0.0	Class2 Disposal		1.00	$/lb	lb/hr		$0	
426	0.1	MEA Corrosion Inhibitor		2000	$/ton	lb/hr	1.0	$8,760	Minor Chem Cost Allowance
427	100.0						Subtotal, Utilities and Chemicals =	$6,675,740	

ENVIRONMENTAL CALCULATIONS - NET ANNUAL COST EFFECTIVENESS

JOB NO.	D967	DOC NO.	D967-EV-CAL-EV2-0002	Revision No.	B	C	D
CLIENT	INEOS	ITEM NO.	DDB-105	Date	14-May-12	4-Jun-12	11-Jun-12
PROJECT	GHG PSD Application Support	ITEM NAME	OL2 SCORE FURNACE	Prepared By:	MO	SAL	SAL
LOCATION	Chocolate Bayou, TX	SERVICE	Continuous	Check By:	SAL	SAL	SAL
UNIT	OL2	SUBJECT	CCS - Stack to Pipeline	Approved By:	---	---	---
CASE	Permitting			Purpose:	IFI	IFI	IFI

Revision

Not Applicable	Operating Expendables:	Cost Basis	% Contingency	Est. Cost			
Not Applicable	Catalyst Charge	$0	10	$0			
Not Applicable	Cat. Cost Annualized @	% Interest =	5	Life, Yr =	5	$ -	
					Total Annual Direct Costs (ADC) =	$9,457,335	

Indirect Operating Costs

Overhead (as % of Labor + Maintenance Materials)	60	$1,561,299	
Property Taxes, Insurance, Administrative Costs as % of TCI	4	$1,045,342	
Operating Suppliers Costs as % of TCI	0.0	$0	
Training Cost as % of Labor	3.0	$6,310	
Total Annual Indirect Costs (AIC) =		$2,612,951	

Possible Credits (PC)			Credits, $/yr		
Material or Waste Credit from 3rd Party	11.2 MMSCFD	0.3 $/1000 scf	$ 1,225,224	CO2 Supply (Replacement Value) Credit	
Government Subsidies					
Training					
Designs					
Socio-Economic / Other					
Defense					
Reduction	$/ERC = 0	ERC/yr = 0.0	$ -		
Insurance Rebates					
Warranties					
			Total Possible Credits (PC) =	$ (1,225,224)	
			Total Annualized Cost (TAC) = ADC + AIC - PC =	$10,845,063	
			NET ANNUALIZED COST = TCI + TAC =	**$36,978,615**	D

JOB NO.	D967	DOC NO.	D967-EV-CAL-EV2-0002	Revision No.	B	C	D	Revision
CLIENT	INEOS	ITEM NO.	DDB-105	Date	14-May-12	4-Jun-12	11-Jun-12	
PROJECT	GHG PSD Application Support	ITEM NAME	OL2 SCORE FURNACE	Prepared By:	MO	SAL	SAL	
LOCATION	Chocolate Bayou, TX	SERVICE	Continuous	Check By:	SAL	SAL	SAL	
UNIT	OL2	SUBJECT	CCS - Stack to Pipeline	Approved By:	---	---	---	
CASE	Permitting			Purpose:	IFI	IFI	IFI	

POLLUTANT REMOVAL BASIS

Pollution Control Equipment Efficiency = **90.00**

	lb/hr	tpy
Baseline Pollutant Release Rate =	57,500	251,850
New Controlled Pollutant Release Rate =	5,750	25,185
Pollutant Reduction =	**51,750**	**226,665**

NET ANNUALIZED COST PER TON OF POLLUTANT REMOVED = **$163** D

PROCESS SKETCH / DRAWINGS

D967-EV-DWG-EV2-1000 below shows 3185 foot CO2 pipeline route from Compression System to INEOS fenceline along FM2004

JOB NO.	D967	DOC NO.	D967-EV-CAL-EV2-0002	Revision No.	B	C	D	Revision
CLIENT	INEOS	ITEM NO.	DDB-105	Date	14-May-12	4-Jun-12	11-Jun-12	
PROJECT	GHG PSD Application Support	ITEM NAME	OL2 SCORE FURNACE	Prepared By:	MO	SAL	SAL	
LOCATION	Chocolate Bayou, TX	SERVICE	Continuous	Check By:	SAL	SAL	SAL	
UNIT	OL2	SUBJECT	CCS - Stack to Pipeline	Approved By:	---	---	---	
CASE	Permitting			Purpose:	IFI	IFI	IFI	

D967-EV-DWG-EV2-1001 below shows 18.6 mile CO2 pipeline route from INEOS fenceline along FM2004 to Denbury Green Pipeline tie-in point near FM517 & FM 646

TRANSPORT PIPELINE (P/L) CALCULATIONS

BASIS

DOE/NETL-2010/1447

18.6 Mile P/L Route

8 Inch P/L Diameter

PIPELINE COST AREAS	Units	P/L COST FORMULA	Unit Cost	Total Cost
Materials	$; P/L Diameter in inches; P/L Length in miles	$64632+(1.85*L*(330.5*(D^2)+686.7*D+26920))		1907824
Labor	$; P/L Diameter in inches; P/L Length in miles	$341627+(1.85*L*(343.2*(D^2)+2074*D+$170013))		7518514
Misc	$; P/L Diameter in inches; P/L Length in miles	$150166+(1.58*L*(8417*D+7234))		2341629
Right of Way	$; P/L Diameter in inches; P/L Length in miles	$48037+(1.2*L*(577*D+29788))		815934
Fixed O&M	$/mile/year		8632	160555.2
Fixed O&M	$ (vendor data)		1300000	1300000

NOTES

1 RESERVED
2 RESERVED
3 RESERVED
4 RESERVED
5 RESERVED
6 RESERVED
7 RESERVED

RE: Additional information

Daniel Lutz to: Bonnie Braganza

From: Daniel Lutz <daniel.lutz@ineos.com>

To: Bonnie Braganza/R6/USEPA/US@EPA

We are using only gaseous fuels. We are also cracked only ethane feed. Somehow I left the phrase "are not part of the design" off my first bullet point. It should have read, "The new furnace is designed to crack ethane. Propane and liquid (DNG) feeds are not part of the design." I hope that simplifies things.

Thus the efficiency numbers are on that same basis (gas fuel, ethane-only feed).

Dan

From: Bonnie Braganza [mailto:Braganza.Bonnie@epamail.epa.gov]
Sent: Friday, June 15, 2012 11:43 AM
To: Daniel Lutz
Subject: Re: Additional information

Thanks Dan, for your information. I will need to significantly revise the draft of the permit and SOB because I understood you were using only " gaseous fuels" like BASF.

Since your BACT discussion was based on the 92.6 efficiency, I will consult with HQ, but do not think I can use a lower efficiency number for compliance purposes. Were those numbers based on use of gaseous fuels?. Also please check your previous information where the 1993 furnace was estimated to have 92.2% efficient.

The stack temperature is higher than what is in BASF which will need an explanation which according to the information is based on the flue gas properties/condensation. The BASF furnace duty is 491MMbtu/hr (INEOS is rated at 495MMbtu/hr) so I will use your justification for the higher stack temperature. I will also proposing an output lb GHG/lb ethylene limit and compare it to the other issued permits.

I will be in the office next week so that we can discuss. Let me know a time and phone number to call you probably Tuesday afternoon

POSITIONS or VIEWS EXPRESSED DO NOT REPRESENT OFFICIAL EPA POLICY
3:00pm

Bonnie Braganza P.E.
US EPA Region 6
Air Permits Section
Multimedia Permitting & Planning Division
Phone:214 -665-7340
Fax: 214-665-6762

Remember Life Rewards Actions!
If you continue to do what you have always done, you will get what you always got!

From: Daniel Lutz <daniel.lutz@ineos.com>
To: Bonnie Braganza/R6/USEPA/US@EPA
Date: 06/12/2012 04:08 PM
Subject: Additional information

Here is the information that we discussed on yesterday's phone call:

* The new furnace is designed to crack ethane. Propane and liquid (DNG) feeds (not what I was told last week)

* I'm attaching a document prepared by KBR that adds more details on CCS costs. This was done essentially from scratch, and uses more site-specific information that the assumptions used in the original document. The total capital cost of $238 million is more than two times the cost of the furnace installation itself. The net annualized cost is $163/ton of CO2e.

* Also attached is some proposed permit language, based on BASF-Fina's draft permit. The most substantive changes are in paragraphs (h), (i), and (j). Paragraph (i) is where I've put the lb CO2e/lb C2= value. The furnace efficiency in paragraph (j) is described as we discussed--that INEOS will do a Material and Energy Balance upon request to demonstrate 91.5% efficiency, but that 340 F stack temperature would be the more common demonstration. I used the 340 F number from our permit application due to the reasons stated in the application. I also used 91.5% efficiency--this number is lower than the design efficiency of 92.6%; however, it corresponds to the actual performance of the five similar furnaces that INEOS operates. The case for both the stack temperature and efficiency, in other words, both represent values that INEOS believes are achievable for our design. Since paragraph (j) represents a compliance option along with paragraph (i), please let me know if you believe that EPA cannot issue the permit with these values.

Thanks,

Dan Lutz
713-373-9300 (m)

[attachment "INEOS GHG PSD APPLICATION NACE CALCS_SAL_RevD_11Jun12.pdf" deleted by Bonnie Braganza/R6/USEPA/US] [attachment "Proposed Draft Permit Conditions.doc" deleted by Bonnie Braganza/R6/USEPA/US]