Endangered Species Impacts Assessment
ExxonMobil Oil Corporation - Joliet Refinery
Unit Reliability - Efficiency Improvement Projects

Prepared by:

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1.0 EXECUTIVE SUMMARY

The United States Environmental Protection Agency (USEPA) and United States Fish and Wildlife Service (USFWS) are conducting an interagency consultation pursuant to Section 7 of the Endangered Species Act (ESA), (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.). This consultation is being conducted to address impacts for a federal Prevention of Significant Deterioration (PSD) permit to be issued by the Illinois Environmental Protection Agency (IEPA) under delegated permitting authority for modifications to the existing ExxonMobil Oil Corporation - Joliet Refinery (ExxonMobil). This permit is to be issued in response to ExxonMobil's March 18, 2005 permit application.

This impact assessment report has been prepared by ExxonMobil to assist USEPA and USFWS with conducting an "informal" Endangered Species Act Consultation in accordance with the requirements of Section 7 of the ESA.

This federal consultation commenced with a meeting on June 15, 2005 at USEPA Region 5 and has included numerous conference calls, with participation including representatives from USEPA, USFWS, IEPA, ExxonMobil and ExxonMobil's consultant (Cambridge Environmental, Inc.).

<u>Existing Site Description</u>
ExxonMobil Oil Corporation - Joliet Refinery is a fully-integrated petroleum refinery that provides high-quality gasoline, diesel fuels, and other petroleum products to the marketplace. The refinery, which began operations in 1972, is one of the newest grassroots refineries in the United States. The refinery is located on a 1,300-acre tract of land in unincorporated Will County, Illinois. It utilizes state-of-the-art refining technology to perform four common functions for the processing of crude oil into refined products -- separation, conversion, purification, and blending.

<u>Project Description</u>
On March 18, 2005, ExxonMobil submitted an application to IEPA for an air permit for a group of efficiency improvement and/or unit reliability projects that constitute modifications under the PSD program (40 CFR §52.21). These projects are energy efficiency and reliability/utilization improvement projects that will allow the refinery to improve "calendar day" performance (i.e., on an annual average basis). This improved calendar day performance is not realized by increasing existing refinery capacity, but rather by allowing existing units to run closer to their maximum design rates on an annual average basis by reducing downtime and rate reductions that occur due to planned and/or unplanned events.

The proposed modifications do not involve increasing the footprint of the current refining operations, nor will it result in new emission points ("stacks") or new pollutants.

<u>Action Area</u>
The proposed project does not entail an increased footprint or modifications to the existing wastewater treatment plant. The action area has not been defined on a site-specific basis, but rather has been established based on the impact area for a prior ESA consultation. The impact area extends over 30 kilometers from the facility. Although it was agreed that stack heights and emission levels are lower than those of the prior ESA consultation, no technical basis other than proximity of projects was provided for designating the action area as such.

List of Species

As specified by USFWS, project impacts to the following three listed threatened or endangered (T&E) species of flora and a single T&E species of fauna have been assessed:

- Flora: Eastern Prairie Fringed Orchid (Platanthera leucophaea), Lakeside Daisy (Hymenoxis herbacea), and Leafy Prairie Clover (Dalea foliosa);
- Fauna: Hine's Emerald Dragonfly (Somatochlora hineana).

Summary of Analysis

A detailed and thorough analysis of impacts has been conducted by ExxonMobil and its consultant according to the "Recommended Scope of Analysis for ExxonMobil Refinery Modification for Endangered Species Evaluation", originally issued on July 7, 2005 and revised to incorporate comments on July 21, 2005. This detailed "Roadmap" has been included as Attachment B to this report.

As the nature of the proposed project does not allow for increases in short-term emissions above current levels, the project does not result in short-term exposures beyond those of the current operation. As a result, there are no anticipated adverse acute effects to any of the T&E species or their respective habitats.

A recent emission reduction project that was streamed in November 2004 results in actual sulfur dioxide (SO_2) emission decreases that more than offset the emissions from the proposed project. The net decrease in emissions results in airborne concentration and deposition decreases, such that exposures following the proposed modifications will be less than currently-monitored background levels. As a result, there are no anticipated acute or chronic adverse effects to any of the T&E species or their respective habitats.

The balance of the assessment focused in detail on chronic effects of pollutants of concern, as identified during the consultation and the Roadmap. USEPA's Industrial Source Complex Short-Term Model, Version 3 (ISCST3) was used to conduct air dispersion and deposition modeling with the objective of conservatively estimating worst-case, potential concentrations and deposition rates of pollutants of concern at each of the fourteen T&E species habitat locations attributable to the project. As the modifications are such that there is no increase in short-term maximum emissions levels over current values, these modeling estimates were annual averages. The worst-case annual average was developed using five years of representative meteorological data for the site location, as is the standard approved practice for PSD permits.

The following pollutants were part of the modeling analysis:

- Criteria pollutants - carbon monoxide (CO), oxides of nitrogen (NOx) and particulate matter (PM_{10});
- Hazardous air pollutants (HAP) - carbonyl sulfide, hydrogen chloride, nickel, toluene, and xylenes; and
- Other pollutants - phosphorus (originally quantified as a HAP, later identified as not being emitted in the HAP form, "white phosphorus", however maintained in the "Roadmap" for further analysis per USEPA and USFWS).

Modeling results indicate that highest airborne pollutant concentrations (at receptor locations) are not detectable by state-of-the-art ambient monitors (where detection limits are available) and are less than about 1% of ambient background levels for the study area.

Additional simplified models were used to conservatively estimate accumulation of chemicals in near-surface soil (for effects on T&E plant habitat locations) and steady-state concentrations of air-deposited chemicals in water bodies (for effects on larval, aquatic T&E Hine's Emerald dragonfly).

ExxonMobil's consultant, Cambridge Environmental, conducted a thorough review of literature to locate species-specific study results involving the pollutants of concern on the T&E species. The goal of this study was to establish "no observed effects level" or "NOEL" benchmarks that are protective of the T&E species. As no benchmarks were found in the toxicity databases specific to the T&E species of concern, Cambridge conducted, per the Roadmap, a search of scientific literature for relevant toxicity information to provide a basis for assessing risk to the species of concern. In the absence of species-specific information, benchmarks were established collectively for the three flora species. Where no information could be found for the development of a toxicity-based benchmark, representative background values were included for comparison.

For all pollutants, worst-case modeled concentrations and/or deposition rates are below NOEL benchmark levels and/or are small relative to existing background levels. As a result, the proposed modifications that are the subject of this federal permitting action are not likely to have an adverse effect on any of the T&E species.

2.0 INTRODUCTION

This impact assessment report has been prepared by ExxonMobil Oil Corporation to assist the United States Environmental Protection Agency (USEPA) with conducting an "informal" Endangered Species Act Consultation in accordance with the requirements of Section 7 of the Endangered Species Act of 1973 (ESA), as amended.

As further described below, the action (project) for which this report has been prepared is to occur at the ExxonMobil Oil Corporation - Joliet Refinery (ExxonMobil). On March 18, 2005, ExxonMobil submitted to the Illinois Environmental Protection Agency (IEPA) an application for a permit to modify its existing operations.

The proposed project does not constitute a major construction activity. As such, 50 CFR §402.12(b) specifies that no biological assessment is required. Nevertheless, USEPA and USFWS intend to conduct a detailed analysis to determine whether or not the proposed action is likely to adversely affect species or critical habitat(s). This report has been prepared in order to aid in the development of USEPA's assessment report.

This assessment and the consultation as a whole have been conducted according to the "ESA Consultation Handbook"[1], including the use of sound science.

2.1 Reason for the Section 7 ESA Consultation

The proposed federal action is the issuance of a Prevention of Significant Deterioration (PSD) permit pursuant to 40 CFR §52.21. This permit is a federal air permit-to-construct, allowing commencement of the proposed modifications. The permit application for this project was submitted to IEPA on March 18, 2005. USEPA has delegated IEPA authority for the issuance of PSD permits in 40 CFR §52.738.

Through initial consultation, USFWS has determined that the following four federally-listed threatened and endangered species have habitats within the vicinity of the site:

- Eastern Prairie Fringed Orchid (*Platanthera leucophaea*)
- Hine's Emerald Dragonfly (*Somatochlora hineana*)
- Lakeside Daisy (*Hymenoxys herbacea*)
- Leafy Prairie Clover (*Dalea foliosa*)

2.2 Entities involved in the ESA Consultation

The following entities have participated thus far in the consultation:

- United States Fish and Wildlife Service, Chicago Illinois Field Office
- United State Environmental Protection Agency, Region V Office (serving as the Lead Agency for the consultation)
- Illinois Environmental Protection Agency (state permitting authority, responsible for issuing permits under delegated authority from USEPA)
- ExxonMobil Oil Corporation (the applicant)
- Cambridge Environmental, Inc. (ExxonMobil's consultant)

[1] U.S. Fish & Wildlife Service & National Marine Fisheries Service, Endangered Species Consultation Handbook, March 1998 Final.

2.3 Existing Source Description

ExxonMobil is located in Channahon Township on a 1,300-acre tract of land in unincorporated Will County, Illinois. As shown on Figure 1, the site is adjacent to Interstate 55 at the Arsenal Road exit, approximately 50 miles southwest of Chicago. To the immediate north of the refinery is the Des Plaines River, while southeast is the former Joliet Army Arsenal, which is being redeveloped as an industrial complex and the Midewin National Tallgrass Prairie (MNTP).

ExxonMobil's property lies to the west of the Illinois Central Gulf Railroad tracks with the exception of one tract of land. This approximate 40-acre parcel of land, contiguous with MNTP, lies outside the ExxonMobil fenceline and is not utilized for refinery operations. USFWS has surveyed this and other land in the area and has determined that this parcel contains two habitats of the endangered species Leafy Prairie Clover (*Dalea foliosa*)[2].

ExxonMobil is a fully-integrated petroleum refinery that provides high-quality gasoline, diesel fuels, and other petroleum products to the marketplace. The refinery, which began operations in 1972, is one of the newest grassroots refineries in the United States. It utilizes state-of-the-art technology to perform four common functions for the processing of crude oil into refined products -- separation, conversion, purification, and blending.

2.4 Project Description

This permit is for a group of efficiency improvement and/or unit reliability projects. These projects are energy saving projects that will allow the refinery to reduce operating costs, and/or are reliability/efficiency/utilization projects that will improve "calendar day" performance (i.e., on an annual average basis). This improved calendar day performance is not realized by adding new capacity, but rather by allowing existing units to run closer to their maximum design rates on an annual average basis by reducing downtime and rate reductions that occur due to planned and/or unplanned events.

The proposed projects will not increase the footprint of the current refining operations, nor will they result in new emission points ("stacks") or new pollutants. Instead, the proposed action primarily focuses on improvements to ancillary operations that are not themselves emission units, yet can restrict refining performance, due to required downtime for maintenance or reduced performance under periods of extreme weather conditions (i.e., in winter and summer).

2.5 Review of To-Date Consultation Process & Findings

2.5.1 PSD Permit Application

ExxonMobil submitted the permit application[3] for the proposed projects on March 18, 2005. This permit action constitutes the first modification (as defined for PSD purposes under the Clean Air Act) to an existing source to undergo the ESA consultation process in USEPA Region V. Section VII "Additional Impact Analysis" of the application provided a USFWS listing[4] of threatened and endangered species for Will County, Illinois. In addition, the application notes that, as demonstrated through conservative air dispersion modeling conducted as part of the PSD permit

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[2] Ecological Risk Assessment for the Indeck Elwood Energy Center, Cambridge Environmental, Inc., April 2005.

[3] ExxonMobil Oil Corporation, Application to Illinois EPA for Construction Permit: Unit Reliability - Efficiency Improvements Project, March 18, 2005.

[4] USFWS, Rock Island Ecological Services Field Office, http://www.fws.gov/midwest/rockisland/activity/endangrd/il_list.htm.

application submittal, ambient (beyond ExxonMobil's fenceline) concentrations of PSD pollutants meet secondary National Ambient Air Quality Standards (NAAQS) developed and periodically reviewed and updated by USEPA for the protection of public welfare, including protection against damage to animals and vegetation[5].

2.5.2 Supplemental Hazardous Air Pollutant (HAP) Emissions

Representatives of ExxonMobil met with IEPA on May 4, 2005 to further discuss the ESA Consultation process and additional information needs. Although this is the first permit modification to an existing source in Illinois to undergo an ESA consultation, IEPA has conducted prior consultations for new ("greenfield") sources, including within the jurisdictional domain of the USFWS Chicago Illinois Field Office.

At this meeting, IEPA requested that ExxonMobil augment the emission inventory of the permit application to include hazardous air pollutants (HAP), which are not regulated by the PSD program. This supplemental data was provided to IEPA on June 7, 2005[6]. Emissions for fifty-one HAP are quantified in the submittal.

2.5.3 June 15, 2005 Consultation Meeting - USEPA Region V Offices

As a follow-up to the May 4 meeting, IEPA arranged for a consultation meeting to be hosted by USEPA Region V. This meeting was attended by all of the entities described above in Section 2.2. At this meeting, ExxonMobil provided a technical explanation[7] of the proposed modifications, and articulated the following key initial notes regarding impacts of the project:

- Existing, on-site (outside fenceline used for air dispersion modeling analyses), viable habitats of Leafy Prairie Clover (baseline) with over thirty years of refinery operations co-existing with these habitats;
- No increase in the refinery footprint;
- No increase in refining capacity (i.e., "calendar day" increase, not "stream day" increase);
- No impact to current stormwater or wastewater treatment operations;
- No new vent stacks;
- No new pollutants;
- No increase in existing short-term or annualized "allowable" or "potential" emissions for any pollutants;
- Small annualized increase in "actual" emissions;
- Pollutant-specific project emissions are small relative to recent actual emissions from the refinery;
- Worst-case, modeled project ambient air impacts meet both primary (protective of human health) and secondary NAAQS;
- Worst-case, modeled project ambient air impacts are small relative to average monitoring data from the state-wide (rural and urban) network of ambient monitors.

At this meeting, USFWS reviewed the consultation process and options. It was decided to proceed with an informal consultation, including the following notes:

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[5] USEPA Technology Transfer Network, National Ambient Air Quality Standards (NAAQS), http://www.epa.gov/ttn/naaqs/

[6] June 7, 2005 email to Mr. Jeff Sprague and Ms. Laurel Kroack of IEPA by Mr. Brad Sims of ExxonMobil.

[7] "DRAFT Endangered Species Act Assessment, ExxonMobil Oil Corporation - Joliet Refinery, Unit Reliability - Efficiency Improvement Project, June 15, 2005", prepared by ExxonMobil and hand-delivered at meeting, provided as Attachment A to this report.

- USFWS to work with USEPA to develop and provide a "Roadmap" for fulfilling the consultation information needs, as no standard protocol has been developed for general use when assessing air impacts;
- Follow-up calls to review the Roadmap and assessment results;
- Project time constraints and the need for completion of the informal consultation by September, 2005.

2.5.4 Roadmap Issuance and Review Calls & Emails

On July 6, 2005, USEPA and USFWS provided ExxonMobil the "Recommended Scope of Analysis for ExxonMobil Refinery Modification for Endangered Species Evaluation" (the "Roadmap")[8]. Follow-up conference calls were scheduled and conducted on July 7 and 12 to review and discuss various elements of the Roadmap. The second call focused primarily on the scope of a literature survey to be conducted in order to identify pollutant- and species-specific benchmarks.

A few key issues were also addressed through email correspondence, including the following:

- Specific habitat names, coordinates and the associated threatened and endangered (T&E) species were provided by USFWS[9];
- Technical references for impacts on vegetation were provided by USFWS[10]; and
- Indeck Elwood analysis of impacts on the Hine's Emerald Dragonfly was provided by USFWS[11].

On July 21, USEPA issued a revised Roadmap, which is provided as Attachment B to this report.

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[8] Provided via email dated July 6, 2005 to Mr. Brad Sims from Ms. Pamela Blakley, USEPA.
[9] Email dated July 7, 2005 to Mr. Brad Sims of ExxonMobil from Ms. Karla Kramer of USFWS Chicago Illinois Field Office
[10] Email dated July 12 to Mr. Brad Sims of ExxonMobil from Mr. Edward Karecki of USFWS Chicago Illinois Field Office
[11] Email dated July 14 to Mr. Stephen Zemba of Cambridge Environmental, Inc. from Ms. Karla Kramer of USFWS Chicago Illinois Field Office

3.0 ESA IMPACT SCOPE AND METHODOLOGY

This section outlines the scope of and key elements of the methodology used in conducting the impact analysis for each pollutant. Section 3.1 outlines key instructions and guidelines from various sources, including USFWS and USEPA. Section 3.2 outlines the resultant process that has been employed to conduct the analysis.

3.1 Instructions from USFWS & USEPA

3.1.1 Roadmap

Key elements of the Roadmap are as follows:

- Recommended use of USEPA's Draft Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (EPA-530-D-99-001A) as one source for guidance (the "Draft SLERA protocol");
- Pollutants of focus by ExxonMobil - oxides of nitrogen, carbon monoxide, particulates, and HAP;
- Pollutant to be addressed by USEPA - ozone;
- USEPA continues to review with USFWS the concept of PSD netting over the contemporaneous time frame such that a net emissions decrease in sulfur dioxide means a net decrease in ambient concentration of the pollutant;
- Use of "No observed effects levels" or "NOEL" benchmarks;
- ISCST3 identified as a reliable model for air dispersion modeling analyses for both dispersion and deposition modeling to estimate pollutant-specific concentrations at specific habitat locations;
- The assessment area was qualified as less than that of the recent consultation conducted for Indeck Elwood[12] with the recommendation to model impacts at all of the habitat areas used in the prior assessment, which is in close proximity to ExxonMobil;
- Information on background levels and ecotoxicological benchmarks from Indeck Elwood[13] was also deemed acceptable;
- Impacts to be addressed include short-term ("acute"), long-term ("chronic"), acid fog, deposition, and additive/synergistic effects.

3.1.2 Additional Direction from Calls & Emails

Through follow-up conference calls on July 7 and 12, the following additional guidelines were established:

- As there are no short-term emission increases for any pollutants, there is no need to conduct a detailed assessment of acute impacts (see Section 3.2.5 for further documentation of this conclusion); and
- ExxonMobil does not need to assess the impacts of a pollutant for which there is no measurable effect on ambient concentration or deposition rates as compared to background levels.

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[12] Ecological Risk Assessment for the Indeck Elwood Energy Center, prepared by Cambridge Environmental, Inc., April 2005.
[13] Ecological Risk Assessment for the Indeck Elwood Energy Center, prepared by Cambridge Environmental, Inc., April 2005.

Habitat area identifications, locations, and associated species were received from USFWS and are contained in Table 3-1. All habitat areas for two species, Lakeside Daisy and Hine's Emerald Dragonfly, are more than twenty kilometers from the emission sources.

Table 3-1. Listed Threatened & Endangered Species Habitats

Location Name	UTM East	UTM North	Distance from XOM Crude Unit Stack*	Elevation (above MSL)	Leafy Prairie Clover	Eastern Prairie Fringed Orchid	Lakeside Daisy	Hine's Emerald Dragonfly
	[km]	[km]	[km]	[m]				
Grant Creek Prairie Preserve	400.481	4580.099	5.00	182		x		
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	1.32	182	x			
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	1.13	182	x			
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	0.86	182	x			
Fraction Run	411.709	4602.968	20.85	165				x
Dellwood Park Prairie	410.818	4603.467	20.85	165	x			x
Lockport Prairie #1	410.212	4603.771	20.84	165	x		x	
Lockport Prairie #2	409.992	4603.796	20.77	165				x
Lockport Prairie #3	410.049	4604.030	21.00	165				x
Lockport Prairie #4	410.415	4604.635	21.71	165	x		x	
Material Services Corporation River South	410.734	4606.417	23.46	165				x
Long Run Seep Nature Preserve	412.543	4608.660	26.26	165				x
Romeoville Prairie Nature Preserve	410.597	4610.692	27.36	165	x			x
Keepataw Preserve	413.565	4614.291	31.80	165				x

*Stack coordinates are 401.010E, 4585.070N

3.1.3 Additional Direction from Other Sources

In the process of compiling information for and the completion of this assessment, additional insights and guidance from other sources have also been instrumental. Some of these other sources include the following:

- Biological Assessments and Opinions for permit actions involving "greenfield" sites in USEPA Region V;
- The Biological Opinion for the Proposed Land and Resource Management Plan for the Midewin National Tallgrass Prairie;
- USEPA's "A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals";
- USEPA's "How to Measure the Effects of Acid Deposition: A Framework for Ecological Assessments"; and
- IEPA's ISCST3 Modeling files for Indeck Elwood.

3.1.4 Discussion of PSD Netting

USFWS has suggested that, even though SO_2 was a pollutant that "netted-out" of being considered a major modification when considering contemporaneous decreases as allowed under the PSD program, contemporaneous netting is not something that should be given consideration during the Section 7 ESA consultation. In conjunction with on-going discussions that USEPA and USFWS have had regarding this topic, ExxonMobil has conducted a review of this principle of PSD and provides the following discussion on the development of this principle and how it specifically has been applied at ExxonMobil.

The creators of the PSD program recognized that failing to include a contemporaneous time period over which industry could offset emission increases with actual emissions decreases would have a negative impact to the environment. Specifically, the requirement to only recognize decreases that occur simultaneously with increases encourages delaying projects that could result in emission decreases until there are projects with increases that would rely upon such decreases. In response to the decision of the U.S. Court of Appeals for the D.C. Circuit in *Alabama Power Company v. Costle*, EPA issued a Federal Register Notice (Federal Register Vol. 45, No. 154, Thursday, August 7. 1980) amending its regulations for PSD, 40 CFR 51.24 and 52.21. The amendments also included changes that affected new source review in nonattainment areas, including restrictions on major source growth (40 CF 52.24) and requirements under EPA's Emission Offset Interpretive Ruling (40 CFR Part 51, Appendix S) and Section 173 of the Clean Air Act (40 CFR 51.18(j)).

The following clarification regarding the basis of including the contemporaneous time period was included in the Federal Register:

A narrow interpretation of the term "contemporaneous" would restrict creditable decreases in emissions to those occurring at the same time as the emissions increases to be offset. The administrator decided against proposing such an interpretation, since it might promote the continued operation of old obsolete equipment in order to preserve offset credit.[14]" However, while suggestions were made that decreases should always remain creditable, it was stated: "To credit any decrease that occurs before a proposed increase would violate any common sense notion of what is "contemporaneous," since a period of contemporaneity must have some definite boundaries.[14]

The EPA agreed with many comments received by industry " ... that the period of contemporaneity should be fairly large. In particular, EPA believes that the period should be wide enough so as to minimize any incentive for keeping old or obsolete equipment in operation beyond its useful life.[14] "A five year contemporaneous time period (consisting of the five years plus the time to obtain a permit and construct the new project) was decided upon based on the fact that "... five years is frequently used as the time duration over which corporate expansion planning is conducted.[14]

There are specific criteria that must be met for decreases to be considered creditable under the PSD regulations. Specifically, the reductions must be actual reductions, they must be beyond what is required by current or forthcoming regulations, and they must be federally enforceable. Additionally, reductions must be generated prior to any increases that are using the reductions for "netting," with the notable exceptions of shakedown periods for replacement units.

[14] Federal Register, Volume 45, Number 154, Thursday, August 7, 1980, 45 FR 52676.

ExxonMobil voluntarily pursued an emissions reduction project that captures blowdown vapors from the Coking process that would typically be routed through the blowdown system to the flare system. A blowdown recovery system was installed in the fall of 2004 to allow for capture of a high percentage of these blowdown vapors to recover the hydrocarbons in the blowdown vapors and reduce the amount of blowdown vapors that are combusted at the refinery flares. This project results in a substantial reduction in several pollutants, most notably SO_2, due to the relatively high sulfur content of the blowdown stream.

Suggesting that the Section 7 ESA consultation process should not take into consideration net contemporaneous decreases in the same fashion as the PSD program undermines the entire netting process of the PSD program and discourages companies from pursuing voluntary emission reduction projects, such as ExxonMobil's Coker Blowdown Recovery Project. Such an approach is counterproductive to protecting the environment (including the endangered and threatened species in the surrounding vicinity) by potentially encouraging facilities to continue operation of old or obsolete equipment, discouraging pursuit of voluntary emission reduction projects, and promoting inefficiency and extension to the duration of the higher levels of pollution due to such business decisions.

It should be noted that, in the case of ExxonMobil's Coker Blowdown Recovery Project, the project was not streamed until December 2004. As a result, the realized SO_2 emission reductions are too recent to be reflected in monitored background or in the IEPA's state-wide emission inventory. As a result, the coupling of this emission reduction project with the current project results in a net decrease in SO_2 emissions as compared with background. No further analysis is necessary to conclude that a net benefit (direct and indirect effects) is realized by all listed threatened and endangered species at each of their respective habitat locations.

3.2 Description of Methodology Employed

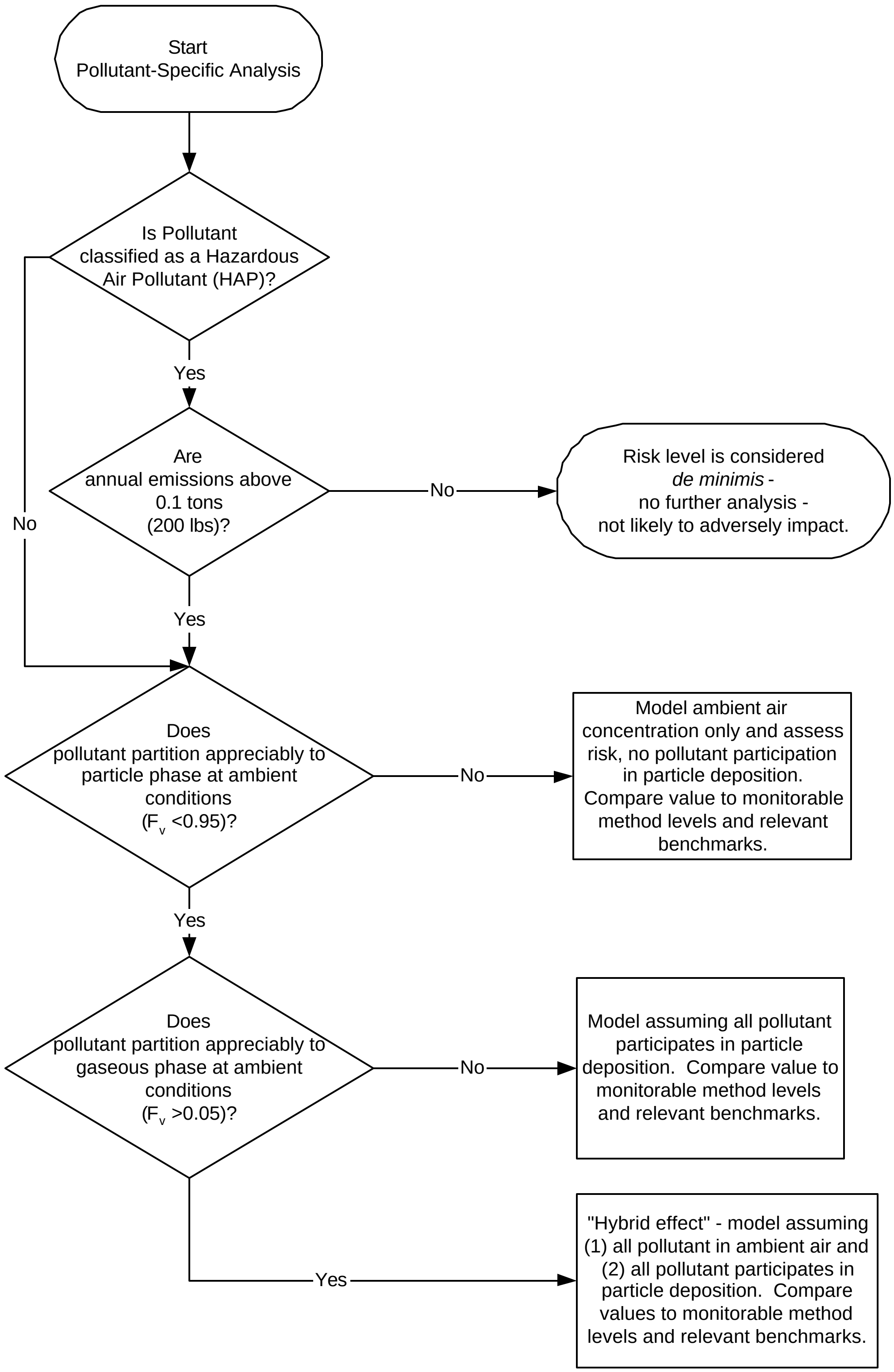
Figure 3-1 depicts the methodology used to assess pollutant-specific impacts. The remainder of Section 3 provides additional information on each step of the process.

3.2.1 *De Minimis* HAP Emission Rate

In prior impact analyses, USFWS has utilized a tiered approach to screening HAP for risk. This approach has been employed for the current analysis, as well. Under this approach, annual HAP emission rates below 0.1 tons per year (200 pounds per year) are considered to represent *de minimis* environmental risk. It was demonstrated for the Indeck Elwood consultation that "the highest ground-level concentration projected for a HAP emitted at 0.1 tons per year is 0.000009 $\mu g/m^3$, a concentration so low that it cannot be typically measured"[15].

[15] Ecological Risk Assessment for the Indeck Elwood Energy Center, prepared by Cambridge Environmental, Inc., April 2005, page 8-10.

Figure 3-1. Process for Pollutant-Specific Impact Analysis



3.2.2 Fate & Transport Analysis

Section 3.4 of the Draft SLERA protocol is entitled "Partitioning of Emissions". This section of the protocol provides a useful explanation of the fate and transport of various pollutants in the environment. Pollutants either manifest themselves in the ambient environment in a vapor (gaseous) phase or particle phase (particle or particle-bound).

As excerpted from the SLERA protocol, "Chemicals of potential concern (COPC) emissions to the environment occur in either vapor or particle phase. In general, most metals and organic COPCs with very low volatility (refer to fraction of COPC in vapor phase [F_v] less than 0.05, as presented in Appendix A-2) are assumed to occur only in the particle phase. Organic COPCs occur either only vapor phase (refer to F_v of 1.0, as presented in Appendix A-2) or with a portion of the vapor condensed onto the surface of particulates (e.g., particle-bound)."

Appendix A-2 of the SLERA protocol defines F_v as the fraction of a chemical in the vapor phase. F_v is a unitless quantity, with 1.0 indicating only vapor phase and 0.0 indicating only particulate phase. Table A-2 provides parameters, including F_v, for over 200 chemicals.

Additional information on the environmental fate of many toxic chemicals is provided through "toxicological profiles" published by the US Department of Heath & Human Services[16]. These profiles dedicate a section to "Environmental Fate", including a section entitled "Transport and Partitioning", which clearly explains pollutant-exchange between environmental media, including deposition and, in many cases, revolatilization from near-surface soil and surface water. Wherever available, these sources have been researched for establishing pollutant-specific pathways of concern (appreciable versus negligible pollutant transport and accumulation).

3.2.3 Air Dispersion and Deposition Modeling

<u>Air Dispersion - Vapor Phase</u>
Initial air dispersion modeling was conducted to fulfill the specific requirements of PSD. This modeling was performed using USEPA's ISCST3 model (Version 02035) in accordance with IEPA protocol for PSD Class II areas. This modeling, including the methodology, model assumptions and inputs, and results are documented in the March 18, 1995 permit application. This modeling specifically focused on airborne concentrations for the following pollutants:

- Carbon monoxide (CO);
- Oxides of Nitrogen (NO_X); and
- Particulate Matter (PM_{10}).

As PSD modeling was able to demonstrate that the project impacts were not significant beyond the fenceline for purposes of the primary (human health) and secondary (public welfare, including vegetation) National Ambient Air Quality Standards (NAAQS), distant receptor locations were not modeled. Instead, the grid of receptors was limited to 8 kilometers. In most cases, the receptor locations of interest to USFWS for the ESA consultation are well beyond 8 kilometers.

For purposes of ESA consultation, these model runs were repeated with the receptor locations in Table 3-1. The models were run to show the difference in ambient concentrations due to the proposed projects (i.e., difference between future potential and past actual).

Airborne HAP concentrations at specific receptor locations of interest are approximated by scaling them to that of carbon monoxide emissions based on emission rates. This is based on the linear nature of ISCST3 (see discussion below under deposition).

[16] Website: http://www.atsdr.cdc.gov/toxfaq.html

Particulate Matter (PM_{10}) Deposition
Deposition modeling was performed using the USEPA's Industrial Source Complex Short-Term (ISCST3) model (Version 02035) to calculate annual particulate matter (PM_{10}) deposition (wet & dry) rate for:

- The maximum future potential emissions scenario, and
- The past actual emissions scenario.

The modeling employed both a conservative approach and assumptions (as detailed below).

- The same stack parameters and meteorological data set (1986 through 1990) were employed;
- As stack test data was not available from various sources to provide particle size distributions, particulate emissions were treated as one size category (i.e., 10 microns). This results in a conservatively higher deposition rate than smaller particles would exhibit[17].
- A liquid scavenging rate coefficient of 6.8E-4 $(s\text{-}mm/hr)^{-1}$ and a frozen precipitation scavenging rate coefficient of 2.3E-4 $(s\text{-}mm/hr)^{-1}$ were used (these values were recommended by the model developer[18] as an approximation for particles equal or greater than 10 microns (scavenging increases with particle size, as noted in the SLERA protocol[19]).
- Plume depletion due to dry or wet removal was not considered. This results in a maximum of both pollutant concentrations and deposition.

For HAP that are a component of particulate matter, the deposition rate is the product of the PM deposition rate and the ratio of chemical-to-PM emission rates. This approach has been validated by USFWS in prior assessments, including the Indeck Elwood assessment, where USFWS noted the following:

"The ISC model is linear and once the deposition for a HAP is known, the deposition for the others can be calculated."[20]

NOx Deposition

Wet deposition modeling was performed using the USEPA's Industrial Source Complex Short-Term (ISCST3) model (Version 02035) to calculate annual wet deposition (wet & dry) rate for:

- The maximum future potential emissions scenario, and
- The past actual emissions scenario.

The modeling employed both a conservative approach and assumptions (as detailed below).

- The same stack parameters and meteorological data set (1986 through 1990) were employed;
- All NOx is assumed to immediately transform (chemical reaction) to particulate NO_3 (and not HNO_3 and not participating in ozone formation) at the stack, rather than downwind, as opposed to about 15% transformation per hour as indicated in the literature[21];

[17] Draft Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (EPA-530-D-99-001B), USEPA Office of Solid Waste, August 1999, Section 3.4.2.
[18] US EPA ISCST3 User's Guide, Website - http://www.epa.gov/scram001/tt22.htm#isc
[19] Draft Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (EPA-530-D-99-001B), USEPA Office of Solid Waste, August 1999, Section 3.4.2.
[20] "Analysis of the Effects of the Proposed Indeck Elwood Energy Facility on the Hine's Emerald Dragonfly", USFWS - Chicago, IL Field Office, 2005.
[21] Seinfeld, J.H. Atmospheric Chemistry and Physics of Air Pollution. New York: John Wiley & Sons, 1986.

- A liquid scavenging rate coefficient of 1.0E-4 $(s\text{-}mm/hr)^{-1}$ was used (this value was used by IEPA for ISCST3 modeling for Indeck Elwood[22]. This corresponds to the coefficient for NO_3 (NOx scavenging coefficient is essentially 0, HNO_3 scavenging coefficient is lower).

Regarding dry deposition of NOx, a USEPA focus-group studying the effects of acid deposition noted in a recent report that "dry deposition is very condition and site specific, and models do not currently exist that accurately quantify the variations. Therefore, some modelers make the assumption that total deposition is twice that of wet deposition.[23]" For modeling purposes for the purpose of this analysis, it has been assumed that dry deposition is equal to wet deposition.

Soil Mixing Model

For purposes of conservatively evaluating the accumulation of metal HAP in near-surface soil, the soil mixing model was used. This same model was employed for the Indeck Elwood consultation[24]. For this model, all deposited metal is assumed to accumulate in the top centimeter (cm) of untilled soil.

The algorithm to estimate chemical accumulation in soil is a simple, steady-state compartmental box model in which chemicals present in the atmosphere near the air-soil interface are assumed to deposit into and remain within a thin layer of surficial soil. Chemicals are assumed to mix uniformly within the shallow layer and accumulate linearly with time. The soil concentration is predicted by the following equation:

$$C_{soil} = \frac{D_{norm} E_{HAP} T_{project}}{d_{soil}\, r_{soil}}$$

where the terms are:

C_{soil}	Concentration, or mass fraction, of the chemical in soil (mg/kg);
D_{norm}	Normalized chemical deposition rate estimated by air dispersion modeling (mg/m^2–year per ton/year emission);
E_{HAP}	Projected chemical emission rate (tons/year);
$T_{project}$	Accumulated time of operation of the modified facility (years);
d_{soil}	Depth of the shallow soil layer (m); and
$?_{soil}$	Bulk density of soil (kg/m^3).

The soil mixing model assumes no chemical removal from the shallow soil layer, even though the processes of leaching, volatilization, or degradation are relevant to many chemicals and serve to reduce concentrations in soil over time. As such, the soil mixing model will likely overpredict actual concentrations that are likely to result while the facility is operating.

The two soil-related parameters d_{soil} and $?_{soil}$ are set at default values recommended in the USEPA's SLERA Protocol. The soil depth d_{soil} is assigned a value of 1 cm, or 0.01 m, appropriate for untilled soils. A soil bulk density $?_{soil}$ of 1.5 g/cm^3, or 1,500 kg/m^3, is a representative value for soils in the area.

Aquatic Model

Modeling to quantify the deposition of chemicals of concern at aquatic sites occupied by Hine's emerald dragonfly during the larval stage (which dominates its overall life cycle) was previously

[22] December 2004 Indeck Elwood ISCST3 model files received as attachments to a July 2005 email to Mr. Brad Sims of ExxonMobil from Mr. Jeff Sprague of IEPA.
[23] "How to Measure the Effects of Acid Deposition, A Framework for Ecological Assessments" (EPA-430-R-01-005), USEPA, Office of Atmospheric Programs, Clean Air Markets Division, June 2001.
[24] Ecological Risk Assessment for the Indeck Elwood Energy Center, prepared by Cambridge Environmental, Inc., April 2005, pages 8-2 and 8-3.

conducted by USFWS[25]. This model is extremely conservative, assuming pollutants of concern deposit from air into shallow water (rivulets with average depth of 5 centimeters) and accumulate uniformly over time within the water column. For purposes of this analysis, a revised model scenario, as described below, was developed with the basis and resultant equation developed by Cambridge Environmental[26].

In reality, the rivulets and wetland water systems inhabited by the dragonfly larvae do "move". Detailed water quality models, such as the algorithms described in the Screening-Level Ecological Risk Assessment (SLERA) guidance[27], attempt to balance mass fluxes into and out of watersheds. Development of the detailed inputs necessary for mass balance models is highly watershed-specific and beyond the scope of this study. A more physically realistic but still conservative (i.e., over-predictive) model to estimate worst-case concentrations of pollutants in water can be generated by assuming that all of the pollutants depositing within a watershed mix into the net amount of water that moves through the watershed. Pollutant deposition is predicted by modeling, as described above. The net amount of water moving through a watershed is estimated as the amount of precipitation less evapotranspiration (*i.e.*, the loss due to evaporation and transpiration from plants). In equation form, the pollutant concentration in water is estimated as:

$$C_{water} = \frac{D_{pollutant} A_{water}}{(P - E) A_{water}} F = \frac{D_{pollutant} F}{P - E}$$

where the terms are:

C_{water}	Pollutant concentration in surface water (µg/l);
$D_{pollutant}$	Pollutant deposition rate to the watershed (g/m^2-yr);
A_{water}	Surface area of water over which deposition occurs (m^2);
P	Precipitation depth (m/yr);
E	Evapotranspiration depth (m/yr); and
F	Units conversion factor of 1,000 µg-m^3/g-l.

The average annual precipitation depth P recorded in Joliet, Illinois is 36.96 in/yr, or 0.94 m/yr, as compiled over a 30-year period from 1971 to 2000[28]. Potential evapotranspiration E in the vicinity of Joliet is about 26 in/yr, or 0.66 m/yr, based on a published nationwide map[29]. The net depth of water retention/infiltration within the watershed is ($P – E$) is thus 0.94 – 0.66 = 0.28 m/yr.

The model predicts steady-state concentrations of pollutants in surface water that are compared directly to benchmark concentrations. Note that the model assumes that all of the pollutants that deposit remain within the water column (dissolved or suspended) and does not account for deposition to sediments (a likely fate for many metals) or degradation over time (an important removal process for many organic pollutants). Thus, the model likely overpredicts actual concentrations in surface water for many pollutants.

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[25] "Analysis of the Effects of the Proposed Indeck Elwood Energy Facility on the Hine's Emerald Dragonfly", USFWS - Chicago, IL Field Office, 2005.

[26] Email dated July 29 to Mr. Brad Sims of ExxonMobil from Dr. Stephen Zemba, Cambridge Environmental, Inc.

[27] Draft Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (EPA-530-D-99-001B), USEPA Office of Solid Waste, August 1999.

[28] Illinois State Water Survey. (2005). On-line climate statistics for Illinois. Available at: http://www.sws.uiuc.edu/atmos/statecli/Summary/114530.htm.

[29] Geraghty, J.J., Miller, D.W., van der Leeden, F., and Troise, F.L. (1973). Water Atlas of the United States. Water Information Center Inc. Plainview NY.

3.2.4 Benchmark Identification

Benchmark identification was conducted by Cambridge Environmental, Inc., serving as a consultant to ExxonMobil for the ESA consultation process. Attachment C contains the Cambridge report which provides a description of the methodology used for establishing benchmarks.

As detailed further in Cambridge's report, three of the four T&E species are plants. For these species, there are three principal mechanisms through which plants can be affected by chemicals released to the air:

- Direct phytotoxicity, in which plants respond directly to the presence of a chemical in air. In this case, the appropriate toxicity benchmark is an airborne concentration of the chemical.
- Non-accumulative deposition to soil, in which a chemical is removed from the air, moves through the soil layer, and is taken up through the roots. This mechanism is of relative importance to many plant nutrients that cycle through the atmosphere and terrestrial ecosystems, and the relevant measure of importance is the rate of deposition (flux) to the soil layer.
- Accumulative deposition to soil, in which a chemical is removed from the air and tends to remain within the upper soil layer, making it available to plants through root uptake over extended periods of time.

The fourth T&E species, the Hine's emerald dragonfly, is a macroinvertebrate with a life cycle dominated by larval development in shallow water. As described in a similar analysis[30], aquatic toxicity data serve as the most appropriate benchmarks for evaluating potential effects to this species. The exposure analysis for the Hine's emerald dragonfly is relevant only for chemicals for which appreciable deposition occurs from the atmosphere.

The matrix of relevant pathways for the T&E species is provided in Table 3-2. For many COPCs, USEPA and other regulatory authorities have established appropriate benchmarks based on the results of relevant toxicity studies. However, some COPCs have not been sufficiently studied to characterize their potential effects on ecological receptors. In other cases, available information might be too limited to develop benchmark levels with sufficient confidence. In still other cases, COPCs have not even been studied.

Table 3-2. Relevant Benchmarks

Exposure Pathway	Direct Phytotoxicity	Deposition to Soil		Deposition to Surface Water
		Accumulative	Non-Accumulative	
Relevant Benchmark	Airborne concentration	Soil screening criteria	Deposition fluxes	Aquatic toxicity data
T&E Species Potentially Affected	Leafy prairie clover Eastern prairie fringed orchid Lakeside daisy			Hine's emerald dragonfly

[30]"Analysis of the Effects of the Proposed Indeck Elwood Energy Facility on the Hine's Emerald Dragonfly", USFWS - Chicago, IL Field Office, 2005.

3.2.5 Impact Assessment

Regulatory Purpose

The objective of the impact assessment is to provide the technical assessment that the lead agency, USEPA, needs to formulate a "biological assessment". As described earlier, this project does not constitute a "major construction activity" and, as such, 50 CFR §402.12(b) specifies that a biological assessment is not a required element of the Section 7 consultation process. The Consultation Handbook notes that, in lieu of a biological assessment, the lead agency is to provide USFWS "with an account of the basis for evaluating the likely effects of the action".

The primary objective of this assessment is thus the following:

- Evaluate likely effects; and
- Document the basis for the determination.

Due to the inexperience of all parties involved in this consultation with assessing impacts on T&E species of a modification of an air permit for an existing source, the approach has been to err on the conservative side and conduct a well-formulated analysis within the context of an informal consultation. As such, the impact assessment has relied on the specifications of "biological assessments" as found in the Endangered Species Act of 1973 (as amended), Title 50 "Wildlife and Fisheries" of the Code of Federal Regulations, Part 402 "Interagency Cooperation - Endangered Species Act of 1973, As Amended", and the Consultation Handbook.

50 CFR §402.12(a) provides the following purpose for a biological assessment:

A biological assessment shall evaluate the potential effects of the action on listed an proposed species and designated and proposed critical habitat and determine whether any such species or habitat are likely to be adversely affected by the action.

Roadmap's Purpose

The impact assessment is focused on the impacts of the specified pollutants (see Section 3.1.1 for list, with USEPA addressing ozone in a separate communication and, for purposes of SO_2, "discussing the level of analysis needed in netting situations which result in an overall decrease in emissions for a pollutant") on the specified federally-listed threatened and endangered species (see Section 2.1 for list). The Roadmap states the following overall objective for the impact assessment:

Overall, the evaluation should focus on increased emissions from the refinery. To complete this analysis we need an understanding of the background concentrations and deposition patterns. The anticipated emissions from permitted but not yet operational facilities should be included in background. The anticipated concentration in air or deposition at sites supporting listed species should be compared against NOEL (No observed effects level) benchmarks thought to be protective of the appropriate group (e.g., plants). The evaluation should look at the incremental addition in the context of background concentrations.

The Roadmap includes the following clarifying language on specific impacts to be addressed:

1. *Short term, depending on pollutant compare worst 1 hour, 8 hour, and 24 hour concentration in air with appropriate benchmarks for acute effects. A discussion of each pathway should be included with an explanation of which is considered most sensitive. This includes, but is not limited to, impact to physical structures, cuticle uptake, stomatal uptake, root uptake, and particulate clogging of stomates;*
2. *Long term, depending upon pollutant compare worst 1 year of 5 concentration in air or deposition on soil with appropriate benchmarks for chronic effects;*

3. *An evaluation of acid fog effects on plants utilizing all acid sources from the facility (S, N, P, HCl). The acid calculation should include the effects of background in the atmosphere, 100% SO2 conversion, and the acidification of acid particles present on the leaves during dry deposition. A discussion of fog history at the site should be included; and*
4. *For compounds that may accumulate, evaluate estimated total deposition over life of project. These concentrations should be compared against benchmarks.*

The Roadmap also specifies that, to the extent that information is available, the impacts assessment should provide information and analysis for potential additive or synergistic effects.

<u>Background Considerations</u>
The Roadmap specifies the following:

To assess background, the same background information that was used for the Indeck-Elwood assessment will be acceptable for this assessment.

<u>Acute Effects</u>
Short-term impacts (Item #1 above) were discussed as part of the July 7, 2005 conference call (see Section 3.1.2). As noted during the call, this permit action would allow for ancillary modifications that will allow ExxonMobil to reduce planned downtime for maintenance activities and prevent short-term capacity restrictions that occur during periods of extreme weather conditions.

For each pollutant, these improvements result in no increase in short-term emissions from the refinery over current emission levels on the vast majority of operating days when units are operating at capacity and meteorological conditions are temperate.

As a result, there are no acute effects for any pollutants to any species for this proposed action.

<u>Acid Fog</u>
Acid fog is defined by the American Meteorological Society (AMS) as "the occurrence of fog or haze in which considerable amounts of acidic material have been taken up from the gas phase, resulting in pH values less than approximately 3 in the liquid phase".

Acid fog is a phenomenon that has been characterized by the United Kingdom's Department of Environment, Food and Rural Affairs (DEFRA) in the following excerpt from their Atmosphere, Climate and Environment (ACE) program[31]:

Forests in high mountain regions receive additional acid from the acidic clouds and fog that often surround them. These clouds and fog are often more acidic than rainfall. When leaves are frequently bathed in this acid fog, their protective waxy coating can wear away. The loss of the coating damages the leaves and creates brown spots.

The following key excerpts are taken from a National Weather Service report on fog in the Chicago area[32]:

Fog forms when condensation occurs in a moist layer of air at or near the ground.... Fog usually forms in air near the ground as it cools. Common types of fog are radiation fog, that often forms on clear, calm nights when the ground cools by radiating infrared heat energy away to space, and advection fog, that forms when a relatively warm, moist air mass is advected over a cold surface such as snow cover. Dense fog, as defined by the National Weather Service (NWS), is fog that reduces horizontal visibility to less than 5/16 of a statute mile.

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[31] Website: http://www.ace.mmu.ac.uk/Resources/Fact_Sheets/Key_Stage_4/Air_Pollution/contents.html
[32] Ratzer, M.A., "Toward a Climatology of Dense Fog at Chicago's O'Hare International Airport", website: http://www.crh.noaa.gov/ssd/techpapers/service/tsp-02/tsp-02.html

In the 13-year span of this period [study period, 1983 through 1995], dense fog with visibilities less than 5/16 of a statute mile was found to have occurred at O'Hare an average of 8 days per year. The year with the greatest number of dense fog days was 1984, when 16 such days occurred. The fewest number of dense fog days occurred in 1994, with dense fog reported on only 1 day that year.

Fog history in the vicinity of ExxonMobil indicates that fog is not a frequent occurrence, nor is it long in duration. In addition, fog events, as described, typically occur under more temperate conditions (advection fog on warm winter days/nights with warm air, radiation fog on nights when the ground cools), conditions upon which ExxonMobil's current operations are not restricted by ancillary heating and cooling operations and already emit at the associated higher rates. As a result, conditions are such that neither acute nor chronic effects to vegetation, including the T&E species, are likely.

4.0 IMPACT ANALYSIS

The structure and order of this section of the report follows that of Figure 3-1 and the methodology described in Section 3. For reasons discussed above in Section 3.2.5, the proposed action does not have the potential for acute impacts from any pollutants on the listed species. Therefore, the analyses in this section of the report focus on chronic effects.

4.1 De Minimis HAP Emission Rate

Attachment 1 provides the HAP-specific emissions increases associated with the proposed projects as previously submitted[33]. Of the fifty-one (51) HAP that were quantified in the supplemental HAP emission inventory, five have emission levels at or above the de minimis levels:

- Carbonyl sulfide (2.70 tons per year)
- Hydrogen chloride (0.69 tons per year)
- Nickel (0.10 tons per year)
- Toluene (0.16 tons per year)
- Xylenes ((0.20 tons per year)

Phosphorus from the proposed project is emitted in the oxidized state (as P_20_5) and not in the elemental form of "white phosphorus" (P_4), which is the HAP. Nevertheless, USEPA and USFWS would like to see these emissions further analyzed. As a result, this pollutant is also retained for further analysis, with annual worst-case emissions of 0.15 tons per year.

4.2 Results of Fate & Transport Analysis

The environmental fate and transport of individual criteria pollutants and HAP has been assessed according to the methodology outlined in Section 3.2.2. The results of this analysis are tabulated in Table 4-1.

[33] June 7, 2005 email to Mr. Jeff Sprague and Ms. Laurel Kroack of IEPA by Mr. Brad Sims of ExxonMobil.

Table 4-1. Pollutant-Specific Ambient Transport Assessment[34,35,36,37,38,39]

Pollutant	Appreciable Transport Pathway(s)			
	Fv	Airborne	Deposition	Footnoted References
Carbon Monoxide (CO)	-	Yes	No	37
Oxides of Nitrogen (NO_X)	-	Yes	Yes	38
Particulate Matter (PM/PM_{10})	-	Yes	Yes	38
Nickel	0.0	No	Yes	34, 35
Toluene	1.0	Yes	No	34, 35
Xylenes, Total	1.0	Yes	No	34, 35
Carbonyl Sulfide (COS)	1.0	Yes	No	34, 36, 39
Hydrogen Chloride (HCl)	1.0	Yes	Yes	34, 35
Phosphorus (P_2O_5)	-	No	Yes	36

Drawing information from Tables 3-2 and 4-1 yields a compilation of COPC-specific relevant exposure pathways. This compilation is provided as Table 4-2. Each of the complete pathways require further exploration, including modeling of COPC-specific concentrations and comparison to a relevant benchmark.

[34] Draft Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (EPA-530-D-99-001B), USEPA Office of Solid Waste, August 1999.

[35] Toxicological Profile for the chemical, website: http://www.atsdr.cdc.gov/toxfaq.html

[36] Toxicological Profile for a similar chemical, white phosphorus for P205 and CS2 for COS

[37] Smith, A.E. and J.B. Levenson. A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils and Animals (EPA-450/2-81-078). USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC. December 1980.

[38] The Particle Pollution Report, Current Understanding of Air Quality and Emissions Through 2003 (EPA-454-R-04-002), USEPA Office of Air Quality Planning and Standards, Research Triangle Park, NC, December 2004.

[39] "Chemical Summary for Carbonyl Sulfide" (EPA/749-F-94-009a), USEPA, Office of Pollution Prevention and Toxics, 1994.

Table 4-2. Relevant Exposure Pathways
(C = Potentially complete, I = Incomplete)

Exposure Pathway	Direct Phytotoxicity	Deposition to Soil		Deposition to Surface Water
		Accumulative	Non-Accumulative	
Relevant Benchmark	Airborne concentration	Soil screening criteria	Deposition fluxes	Aquatic toxicity data
T&E Species Potentially Affected	Leafy prairie clover Eastern prairie fringed orchid Lakeside daisy			Hine's emerald dragonfly
Criteria Pollutants				
Carbon Monoxide	C	I (1)	I (1)	I (1)
Nitrogen Oxides	C	I (2)	C	C
Particulate Matter (PM_{10})	C (3)	C (3)	I (3)	C (3)
Hazardous Air Pollutants				
Carbonyl Sulfide	C	I (1)	I (1)	I (1)
Hydrogen Chloride	C	I (2)	C	C
Nickel	C (4)	C	I (4)	C
Phosphorus	C (4)	I (2)	C	C
Toluene	C	I (1)	I (1)	I (1)
Xylene (Total)	C	I (1)	I (1)	I (1)

Explanatory notes and assumptions
"C" and "I" denote potentially complete and incomplete exposure pathways, respectively
(1) COPC not expected to be appreciably deposited (removed) from air due to its fate and transport characteristics
(2) COPC expected to deposit in soluble forms that do not accumulate in soil
(3) Direct particulate matter toxicity evaluated relative to its overall composition, and indirect deposition assumed to involve COPCs that can accumulate in soil and water.
(4) COPCs are semi-volatile or non-volatile and are assumed to be bound to particles. Direct phytotoxicity is evaluated with respect to the overall composition of particulate matter, and COPCs are treated as potentially accumulative in soil and water.

4.3 Air Dispersion & Deposition Modeling Results

Modeling was conducted according to the methodology outlined in Section 3.2.3. A complete set of modeling results are provided in Attachment D. The habitat-specific results of this analysis are provided in Tables 4-3 through 4-16. For each habitat, the results table provides concentration- and deposition-specific results only for media of concern for the potentially-affected T&E species. For incomplete pathways for a COPC, the cell does not provide a concentration, but rather indicates "I".

Table 4-3. Modeled Concentrations at Grant Creek Prairie Reserve

Exposure Pathway	Direct Phytotoxicity	Deposition to Soil	
		Accumulative	Non-Accumulative
Relevant Benchmark	Airborne Concentration	Soil screening criteria	Deposition fluxes
Units	[µg/m^3]	[g/m^2-yr]	[g/m^2-yr]
T&E Species Potentially Affected	Eastern prairie fringed orchid		
Criteria Pollutants			
Carbon Monoxide	5.0E-02	I	I
Nitrogen Oxides	5.0E-02	I	2.0E-02
Particulate Matter (PM_{10})	8.0E-03	Ni	4.6E-02
Hazardous Air Pollutants			
Carbonyl Sulfide	5.8E-04	I	I
Hydrogen Chloride	1.5E-04	I	2.9E-04
Nickel	PM_{10}	4.4E-05	I
Phosphorus	PM_{10}	I	6.4E-05
Toluene	2.3E-05	I	I
Xylene (Total)	3.1E-05	I	I

Table 4-4. Modeled Concentrations at Drummond Dolomite Prairie (XOM #1)

Exposure Pathway	Direct Phytotoxicity	Deposition to Soil	
		Accumulative	Non-Accumulative
Relevant Benchmark	Airborne Concentration	Soil screening criteria	Deposition fluxes
Units	[µg/m^3]	[g/m^2-yr]	[g/m^2-yr]
T&E Species Potentially Affected	Leafy prairie clover		
Criteria Pollutants			
Carbon Monoxide	3.5E-02	I	I
Nitrogen Oxides	2.3E-02	I	7.0E-02
Particulate Matter (PM_{10})	2.6E-02	Ni	1.3E-01
Hazardous Air Pollutants			
Carbonyl Sulfide	4.0E-04	I	I
Hydrogen Chloride	1.5E-04	I	8.2E-04
Nickel	PM_{10}	1.2E-04	I
Phosphorus	PM_{10}	I	1.8E-04
Toluene	1.6E-05	I	I
Xylene (Total)	3.1E-05	I	I

Table 4-5. Modeled Concentrations at Drummond Dolomite Prairie (XOM #2)

Exposure Pathway	Direct Phytotoxicity	Deposition to Soil	
		Accumulative	Non-Accumulative
Relevant Benchmark	Airborne Concentration	Soil screening criteria	Deposition fluxes
Units	[µg/m^3]	[g/m^2-yr]	[g/m^2-yr]
T&E Species Potentially Affected	Leafy prairie clover		
Criteria Pollutants			
Carbon Monoxide	2.8E-02	I	I
Nitrogen Oxides	2.0E-03	I	2.4E-02
Particulate Matter (PM_{10})	2.9E-02	Ni	1.5E-01
Hazardous Air Pollutants			
Carbonyl Sulfide	3.2E-04	I	I
Hydrogen Chloride	1.5E-04	I	9.8E-04
Nickel	PM_{10}	1.5E-04	I
Phosphorus	PM_{10}	I	2.2E-04
Toluene	1.3E-05	I	I
Xylene (Total)	1.7E-05	I	I

Table 4-6. Modeled Concentrations at Drummond Dolomite Prairie (MNTP)

Exposure Pathway	Direct Phytotoxicity	Deposition to Soil	
		Accumulative	Non-Accumulative
Relevant Benchmark	Airborne Concentration	Soil screening criteria	Deposition fluxes
Units	[µg/m^3]	[g/m^2-yr]	[g/m^2-yr]
T&E Species Potentially Affected	Leafy prairie clover		
Criteria Pollutants			
Carbon Monoxide	2.1E-02	I	I
Nitrogen Oxides	-1.0E-02	I	7.5E-02
Particulate Matter (PM_{10})	8.2E-02	Ni	1.1E-01
Hazardous Air Pollutants			
Carbonyl Sulfide	2.4E-04	I	I
Hydrogen Chloride	6.2E-05	I	7.1E-04
Nickel	PM_{10}	1.1E-04	I
Phosphorus	PM_{10}	I	1.6E-04
Toluene	9.6E-06	I	I
Xylene (Total)	1.3E-05	I	I

Table 4-7. Modeled Concentrations at Fraction Run

Exposure Pathway	Deposition to Surface Water
Relevant Benchmark	Aquatic toxicity data
Units	[µg/l]
T&E Species Potentially Affected	Hine's emerald dragonfly
Criteria Pollutants	
Carbon Monoxide	I
Nitrogen Oxides	1.1E+01
Particulate Matter (PM_{10})	Ni, P
Hazardous Air Pollutants	
Carbonyl Sulfide	I
Hydrogen Chloride	5.3E-01
Nickel	7.9E-02
Phosphorus	1.2E-01
Toluene	I
Xylene (Total)	I

Table 4-8. Modeled Concentrations at Dellwood Park Prairie

Exposure Pathway	Direct Phytotoxicity	Deposition to Soil		Deposition to Surface Water
		Accumulative	Non-Accumulative	
Relevant Benchmark	Airborne Concentration	Soil screening criteria	Deposition fluxes	Aquatic toxicity data
Units	[µg/m^3]	[g/m^2-yr]	[g/m^2-yr]	[µg/l]
T&E Species Potentially Affected	Leafy prairie clover			Hine's emerald dragonfly
Criteria Pollutants				
Carbon Monoxide	3.7E-02	I	I	I
Nitrogen Oxides	1.1E-01	I	3.7E-03	1.3E+01
Particulate Matter (PM_{10})	1.0E-02	Ni	2.9E-02	Ni, P
Hazardous Air Pollutants				
Carbonyl Sulfide	4.3E-04	I	I	I
Hydrogen Chloride	1.1E-04	I	1.9E-04	6.7E-01
Nickel	PM_{10}	2.8E-05	I	1.0E-01
Phosphorus	PM_{10}	I	4.1E-05	1.5E-01
Toluene	1.7E-05	I	I	I
Xylene (Total)	2.3E-05	I	I	I

Table 4-9. Modeled Concentrations at Lockport Prairie #1

Exposure Pathway	Direct Phytotoxicity	Deposition to Soil	
		Accumulative	Non-Accumulative
Relevant Benchmark	Airborne Concentration	Soil screening criteria	Deposition fluxes
Units	[µg/m^3]	[g/m^2-yr]	[g/m^2-yr]
T&E Species Potentially Affected	Leafy prairie clover Lakeside daisy		
Criteria Pollutants			
Carbon Monoxide	3.6E-02	I	I
Nitrogen Oxides	1.1E-01	I	3.7E-03
Particulate Matter (PM_{10})	1.0E-02	Ni	3.3E-02
Hazardous Air Pollutants			
Carbonyl Sulfide	4.1E-04	I	I
Hydrogen Chloride	1.1E-04	I	2.1E-04
Nickel	PM_{10}	3.2E-05	I
Phosphorus	PM_{10}	I	4.6E-05
Toluene	1.6E-05	I	I
Xylene (Total)	2.2E-05	I	I

Table 4-10. Modeled Concentrations at Lockport Prairie #2

Exposure Pathway	Deposition to Surface Water
Relevant Benchmark	Aquatic toxicity data
Units	[µg/l]
T&E Species Potentially Affected	Hine's emerald dragonfly
Criteria Pollutants	
Carbon Monoxide	I
Nitrogen Oxides	1.3E+01
Particulate Matter (PM_{10})	Ni, P
Hazardous Air Pollutants	
Carbonyl Sulfide	I
Hydrogen Chloride	7.6E-01
Nickel	1.1E-01
Phosphorus	1.7E-01
Toluene	I
Xylene (Total)	I

Table 4-11. Modeled Concentrations at Lockport Prairie #3

Exposure Pathway	Deposition to Surface Water
Relevant Benchmark	Aquatic toxicity data
Units	[µg/l]
T&E Species Potentially Affected	Hine's emerald dragonfly
Criteria Pollutants	
Carbon Monoxide	I
Nitrogen Oxides	1.3E+01
Particulate Matter (PM_{10})	Ni, P
Hazardous Air Pollutants	
Carbonyl Sulfide	I
Hydrogen Chloride	7.6E-01
Nickel	1.1E-01
Phosphorus	1.7E-01
Toluene	I
Xylene (Total)	I

Table 4-12. Modeled Concentrations at Lockport Prairie #4

Exposure Pathway	Direct Phytotoxicity	Deposition to Soil	
		Accumulative	Non-Accumulative
Relevant Benchmark	Airborne Concentration	Soil screening criteria	Deposition fluxes
Units	[µg/m^3]	[g/m^2-yr]	[g/m^2-yr]
T&E Species Potentially Affected	Leafy prairie clover Lakeside daisy		
Criteria Pollutants			
Carbon Monoxide	3.5E-02	I	I
Nitrogen Oxides	1.0E-01	I	3.7E-03
Particulate Matter (PM_{10})	1.0E-02	Ni	3.2E-02
Hazardous Air Pollutants			
Carbonyl Sulfide	4.0E-04	I	I
Hydrogen Chloride	1.0E-04	I	2.0E-04
Nickel	PM_{10}	3.1E-05	I
Phosphorus	PM_{10}	I	4.5E-05
Toluene	1.6E-05	I	I
Xylene (Total)	2.1E-05	I	I

Table 4-13. Modeled Concentrations at Material Services Corp. River South

Exposure Pathway	Deposition to Surface Water
Relevant Benchmark	Aquatic toxicity data
Units	[µg/l]
T&E Species Potentially Affected	Hine's emerald dragonfly
Criteria Pollutants	
Carbon Monoxide	I
Nitrogen Oxides	1.3E+01
Particulate Matter (PM_{10})	Ni, P
Hazardous Air Pollutants	
Carbonyl Sulfide	I
Hydrogen Chloride	6.9E-01
Nickel	1.0E-01
Phosphorus	1.5E-01
Toluene	I
Xylene (Total)	I

Table 4-14. Modeled Concentrations at Long Run Seep Nature Preserve

Exposure Pathway	Deposition to Surface Water
Relevant Benchmark	Aquatic toxicity data
Units	[µg/l]
T&E Species Potentially Affected	Hine's emerald dragonfly
Criteria Pollutants	
Carbon Monoxide	I
Nitrogen Oxides	8.7E+00
Particulate Matter (PM_{10})	Ni, P
Hazardous Air Pollutants	
Carbonyl Sulfide	I
Hydrogen Chloride	6.0E-01
Nickel	8.9E-02
Phosphorus	1.3E-01
Toluene	I
Xylene (Total)	I

Table 4-15. Modeled Concentrations at Romeoville Prairie Nature Preserve

Exposure Pathway	Direct Phytotoxicity	Deposition to Soil		Deposition to Surface Water
		Accumulative	Non-Accumulative	
Relevant Benchmark	Airborne Concentration	Soil screening criteria	Deposition fluxes	Aquatic toxicity data
Units	[µg/m^3]	[g/m^2-yr]	[g/m^2-yr]	[µg/l]
T&E Species Potentially Affected	Leafy prairie clover			Hine's emerald dragonfly
Criteria Pollutants				
Carbon Monoxide	2.5E-02	I	I	I
Nitrogen Oxides	7.4E-02	I	3.0E-03	1.1E+01
Particulate Matter (PM_{10})	7.0E-03	Ni	1.9E-02	Ni, P
Hazardous Air Pollutants				
Carbonyl Sulfide	2.9E-04	I	I	I
Hydrogen Chloride	7.4E-05	I	1.2E-04	4.4E-01
Nickel	PM_{10}	1.8E-05	I	6.5E-02
Phosphorus	PM_{10}	I	2.7E-05	9.6E-02
Toluene	1.1E-05	I	I	I
Xylene (Total)	1.5E-05	I	I	I

Table 4-16. Modeled Concentrations at Keepataw Preserve

Exposure Pathway	Deposition to Surface Water
Relevant Benchmark	Aquatic toxicity data
Units	[µg/l]
T&E Species Potentially Affected	Hine's emerald dragonfly
Criteria Pollutants	
Carbon Monoxide	I
Nitrogen Oxides	6.6E+00
Particulate Matter (PM_{10})	Ni, P
Hazardous Air Pollutants	
Carbonyl Sulfide	I
Hydrogen Chloride	4.8E-01
Nickel	7.2E-02
Phosphorus	1.1E-01
Toluene	I
Xylene (Total)	I

4.4 Benchmark Identification Results

Cambridge Environmental has conducted the literature survey for the identification of relevant environmental benchmarks according to the methodology specified in Section 3.2.4. Their report is provided as Attachment C to this report. Table 4-17 provides a compilation of the benchmarks provided by Cambridge.

Table 4-17. Compilation of Benchmarks for Relevant Exposure Pathways

Exposure Pathway	Direct Phytotoxicity	Deposition to Soil		Deposition to Surface Water
		Accumulative	Non-Accumulative	
Relevant Benchmark	Airborne Concentration	Soil screening criteria	Deposition fluxes	Aquatic toxicity data
Units	[$\mu g/m^3$]	[mg/kg]	[g/m^2-yr]	[$\mu g/l$]
T&E Species Potentially Affected	Leafy prairie clover Eastern prairie fringed orchid Lakeside daisy			Hine's emerald dragonfly
Criteria Pollutants				
Carbon Monoxide	11,000	I	I	I
Nitrogen Oxides	30	I	1.0	40,000
Particulate Matter (PM_{10})	50	Ni [4]	10 [1]	Ni, P
Hazardous Air Pollutants				
Carbonyl Sulfide	100 [3]	I	I	I
Hydrogen Chloride	25 [3]	I	0.13 [2]	230
Nickel	PM_{10} [4]	44	I	25
Phosphorus	PM_{10} [4]	I	0.19 [2]	5
Toluene	60,000	I	I	I
Xylene (Total)	160,000	I	I	I

[1] This value is for effects from deposition to plant leaves, as opposed to deposition to soil.
[2] In the absence of a published benchmark, a representative background value has been provided.
[3] In the absence of a published chronic benchmark, a value was developed based on a quantified acute effect level.
[4] No benchmark specified, the specified pollutant's benchmark is protective for the given effect.

4.5 Impact Assessment

4.5.1 Direct Phytotoxicity - Airborne Concentration

As a first analysis, the modeled project impacts to ambient air concentrations for each of the nine pollutants of concern has been compared to the following values:

- Currently-achievable Method detection limits (MDLs) for ambient air monitors; and
- "Background" ambient air concentration values as measured by state and federal monitoring networks.

Table 4-18 presents the results of this analysis. MDLs were compiled from IEPA and USEPA sources, both published and verbal. MDLs were not available for carbonyl sulfide, hydrogen chloride and phosphorus. For the six chemicals for which MDLs were located, these limits were compared to the highest modeled concentration from any of the receptor locations. For each of the six chemicals, the highest concentration is below the MDL. As a result, ambient air monitoring systems are not capable of measuring any effect of the project on airborne concentrations of these chemicals at any of the receptor locations.

For the comparison of modeled project effects to background, three types of background concentrations were considered:

- The most recent (2003) Illinois state-wide average monitored value for a pollutant on an annual basis;
- The monitored value for a pollutant from the nearest monitor, as established through discussions with IEPA staff responsible for the state's monitoring program; and
- For pollutants where local monitoring data does not exist, Cambridge Environmental researched and provided a background concentration as identified from the literature.

For all nine chemicals, the background values were compared to the highest modeled concentration from any of the receptor locations. In each case, the highest modeled concentration is orders of magnitude below background value (for a pollutant where more than one type of background value as described above exists, the lowest value was used for comparison to modeling data). In fact, for all pollutants, the highest modeled concentration from any receptor location is less than about 1% of background. These impacts are within the year-to-year variability of background.

The quantified worst-case project impacts on ambient airborne concentrations of all pollutants of concern at all of the T&E habitats are either immeasurable or indistinguishable from current background levels.

Table 4-18. Comparison of Ambient Airborne Concentrations to Background & Method Detection Limits

Exposure Pathway	Direct Phytotoxicity						
Relevant Benchmark	Airborne Concentration						
Units	[µg/m^3]						
T&E Species Potentially Affected	Leafy prairie clover Eastern prairie fringed orchid Lakeside daisy						
	State-Wide Background Monitor	Nearest Background Monitor	Background from Representative Literature	Method Detection Limit (MDL)	Highest Modeled Concentration at Any Receptor Location	Highest Modeled Concentration at Any Receptor Location as a % of Background	Highest Modeled Concentration at Any Receptor Location as a % of MDL
Table Footnotes	[1]	[2]	[3]	[4]		[5]	
Criteria Pollutants							
Carbon Monoxide	Not Published	Not Published	1.4E+02	2.3E+01	5.0E-02	0.04%	0.2%
Nitrogen Oxides	4.5E+01	1.7E+01		7.5E-01	1.1E-01	0.7%	14.9%
Particulate Matter	2.7E+01	2.7E+01		1.0E+00	8.2E-02	0.3%	0.3%
Hazardous Air Pollutants							
Carbonyl Sulfide	Not Published	Not Published	2.7E-01	Not Published	5.8E-04	0.2%	-
Hydrogen Chloride	Not Published	Not Published	7.0E-01	Not Published	1.5E-04	0.02%	-
Nickel	Not Published	7.0E-03		2.0E-04	7.8E-05	1.1%	39.2%
Phosphorus	Not Published	Not Published	4.2E-02	Not Published	1.1E-04	0.3%	-
Toluene	Not Published	1.3E+00		5.3E-01	2.3E-05	0.002%	0.004%
Xylene (Total)	Not Published	5.4E-01		4.1E-01	3.1E-05	0.006%	0.007%

[1] As presented in Illinois Annual Air Quality Report, 2003, Illinois Environmental Protection Agency, released August 2004.

[2] Nearest air monitors for ExxonMobil Corporation were provided by Mr. Mike Reischel of IEPA. Prescribed locations: CO - Cicero, NOx - Braidwood, PM_{10} - Joliet, HAP - Schiller Park & Northbrook, data from Illinois Annual Air Quality Report, Illinois Environmental Protection Agency, released August 2004.

[3] As detailed in August 2, 2005 letter report from Cambridge Environmental (see Attachment C).

[4] Criteria Pollutant MDLs for newest generation monitors provided in July 26, 2005 phone conversation of B. Sims (ExxonMobil) with T. Hanley of USEPA Office of Air Quality Planning & Standards. HAP MDLs from "Quality Assurance Guidance Document, Quality Assurance Project Plan for the Air Toxics Monitoring Program", USEPA Document #EPA-454/R-01-007, June 2001.

[5] Based on lowest of state-wide and "nearest" background monitored values.

4.5.2 Indirect Phytotoxicity - Deposition to Soil

It is presumable that, as modeled airborne impacts from the proposed project are immeasurable and/or indistinguishable from background that deposition would also be at nondetectable levels. Nevertheless, additional analysis has been conducted with respect to indirect phytotoxicity through deposition of air pollutants to soil.

As noted in Table 4-17, chemicals for which appreciable soil deposition occurs are either accumulative or non-accumulative in nature. Each of these is discussed below.

Accumulative Soil Deposition

Nickel is the only pollutant from the proposed project for which chemical-specific fate and transport indicates accumulation in soil. For this scenario, it is assumed as a general matter that deposited nickel could accumulate and concentrate to levels which are toxic to the T&E plant species. For analysis of potential impacts, the soil mixing model, as described in Section 3.2.3, was used to estimate the potential accumulation rate of nickel in the surface soil from the project. This accumulation rate and the soil screening criteria for nickel (see Section 4.4, Table 4-17) were used to estimate the number of years of operation of the modified operation that would potentially result in levels of accumulation at which observed effects would occur.

The modeling indicates that observed effects from nickel (at a level of 44 mg/kg) would occur after 45 thousand to 365 thousand years of operation, depending on the location, with the earliest impact occurring at the Drummond Dolomite Prairie habitat #2 on ExxonMobil property.

As it is not conceivable that the existing or the modified refinery will continue to operate for these periods of time, the additional nickel emissions from the project are not likely to increase accumulation rates such that any observable adverse impacts are expected to occur over the operating life of the refinery.

Non-Accumulative Soil Deposition

Deposition modeling, as described in Section 3.2.3, was employed for the following chemicals of concern for deposition in near-surface soil: nitrogen (from NOx), chloride (from hydrogen chloride), phosphorus (from diphosphorus pentoxide). Table 4-19 provides a summary of the project impacts to soil deposition fluxes for these chemicals. In relation to background, the project results in a small increase relative to published, representative background fluxes (see Attachment C report by Cambridge Environmental).

The project impact values in Table 4-19 are derived using conservative ISC modeling deposition, as described in Section 3.2.3. Indeck Elwood realized one to two orders of magnitude lower level of estimated NOx deposition rates by using the Calpuff model as opposed to ISC, for which Indeck described the merits of the model over ISC. By comparing their ISC and Calpuff model results at the receptor locations which are in common to the current analysis, ExxonMobil was able to estimate the impact of Calpuff modeling on the NOx deposition results. This comparative analysis is provided in Table 4-20. Factoring in these reductions, the maximum impact to background is estimated at 1.3%.

In addition, due to the nonattainment status of Chicago with respect to the 8-hour ozone National Ambient Air Quality Standards (NAAQS), ExxonMobil is required to obtain emission offsets for NOx from another source within the Chicago airshed, per 35 IAC §203.302(a)(1(B). Offsets are to be provided at a minimum ratio of 1.15 to 1. As a result, ExxonMobil will be required to purchase 752.9 tons to offset the 654.7 tons associated with the project. The exact location of these offsets has not yet been determined, but these offsets will likely be from a source within or benefiting (by resultant reduction in NOx deposition) some, if not all of the fourteen habitats that are the focus of this assessment. See Appendix A for further discussion on emission offsets.

As presented in Table 4-19, the quantified worst-case project impacts on soil deposition of all pollutants of concern are small relative to background and, in conjunction with background, result in a net level that, for all of the T&E habitats, is safely below no observed effect levels.

<u>Particulate Deposition on Plant Leaves</u>

A benchmark of 10 g/m^2-yr for PM_{10} deposition and accumulation on leaves of T&E species was also developed by Cambridge (see Attachment C). At the highest receptor location (Drummond Prairie, site #2 on ExxonMobil property), the worst-case increase in PM_{10} deposition is 1.5% of the established NOEL benchmark. As a result, particle deposition on leaves is small and is not anticipated to adversely impact the T&E plant habitats at any of the receptor locations.

Table 4-19. Comparison of Modeled Deposition Fluxes to Background & Benchmark Levels

Chemical	Highest Modeled Deposition Rate at a Receptor Location	Published Representative Background Deposition Rate	Indeck Elwood Addition to Background Deposition Rate	Total Background	Combined Effect	% Project Increase over Background Deposition Rate	Combined Effect Exceeds Benchmark ?
	[A]	[B]	[C]	=[B]+[C]	=[A]+[B]+[C]	=[A]/([B]+[C])	
	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]	%	Y or N
Nitrogen (ISC)	8.3E-02	7.1E-01	1.1E-02	7.2E-01	8.0E-01	11.5%	N
Nitrogen (Calpuff est.)	9.5E-03	7.1E-01	1.1E-02	7.2E-01	7.3E-01	1.3%	N
Chloride	9.8E-04	1.0E-01	1.3E-02	1.1E-01	1.1E-01	0.9%	N
Phosphorus	2.2E-04	1.9E-01	2.0E-04	1.9E-01	1.9E-01	0.1%	N

Table 4-20. Comparison of ISCST3-Modeled Nitrogen Deposition to Background

Location	Distance from XOM Crude Unit Stack	ExxonMobil Total N Deposition Rate, Based on ISCST3 Model	% of Background Deposition Rate	Indeck Elwood ISCT3 Model Wet Deposition Results	Indeck Elwood Calpuff Model Total Deposition Results	% Indeck Reduction by Change of Model	ExxonMobil Total N Deposition, Scaled Based on Indeck	% of Background Deposition Rate
Footnotes -->	[1]	[2]	[3]			[4]	[5]	
	[km]	[g/m^2-yr]		[g/m^2-yr]	[g/m^2-yr]			
Grant Creek Prairie Preserve	5.00	0.0201	2.8%	0.0278	1.67E-03	97.0%	6.0E-04	0.1%
Drummond Dolomite Prairie (XOM#1)	1.32	0.0700	9.9%	0.0561	1.11E-03	99.0%	6.9E-04	0.1%
Drummond Dolomite Prairie (XOM#2)	1.13	0.0828	11.7%	0.0489	1.01E-03	99.0%	8.5E-04	0.1%
Drummond Dolomite Prairie (MNTP)	0.86	0.0749	10.5%	Not modeled	Not modeled	Not modeled	9.5E-03	1.3%
Fraction Run	20.85	0.0030	0.4%	0.0026	1.26E-03	75.7%	7.4E-04	0.1%
Dellwood Park Prairie	20.85	0.0037	0.5%	0.0027	1.29E-03	76.1%	8.7E-04	0.1%
Lockport Prairie #1	20.84	0.0037	0.5%	0.0034	1.23E-03	82.0%	6.6E-04	0.1%
Lockport Prairie #2	20.77	0.0037	0.5%	0.0033	1.22E-03	81.5%	6.7E-04	0.1%
Lockport Prairie #3	21.00	0.0037	0.5%	Not modeled	Not modeled	Not modeled	7.0E-04	0.1%
Lockport Prairie #4	21.71	0.0037	0.5%	Not modeled	Not modeled	Not modeled	7.0E-04	0.1%
Material Services Corporation River South	23.46	0.0037	0.5%	Not modeled	Not modeled	Not modeled	7.0E-04	0.1%
Long Run Seep Nature Preserve	26.26	0.0024	0.3%	0.0019	7.48E-04	80.3%	4.8E-04	0.1%
Romeoville Prairie Nature Preserve	27.36	0.0030	0.4%	Not modeled	Not modeled	Not modeled	3.2E-04	0.05%
Keepataw Preserve	31.80	0.0018	0.3%	0.0015	4.44E-05	98.5%	2.7E-05	0.004%

[1] Stack coordinates are 401.010E, 4585.070N

[2] Assumes Total = 2 X Wet Deposition (as modeled), includes plume depletion

[3] Background Total N deposition (Bondville, IL location) is 0.71 kg/m^2-yr, as quoted from Indeck Elwood report

[4] Assumes Wet Deposition (IEPA - ISC) = 50% of Total Deposition (Indeck - Calpuff)

[5] Indeck Calpuff results w/o ammonia emissions.

4.5.3 Indirect Effect to Hine's Emerald Dragonfly Larvae - Deposition to Surface Water

The watershed model described in Section 3.2.3 was employed for the following chemicals of concern for deposition in surface water: nitrogen, hydrogen chloride, nickel, and phosphorus. Table 4-21 compares modeled results with tabulated benchmarks (benchmarks provided in Table 4-17). At the highest modeled receptor locations, chemical-specific water concentrations are conservatively estimated as two (phosphorus) to four (nitrogen, hydrogen chloride, and nickel) orders of magnitude below the chemical-specific benchmarks.

The quantified worst-case project impacts on surface water concentrations of all pollutants of concern at all of the T&E habitats are insignificant in comparison to no observed effect levels.

Table 4-21. Comparison of Modeled Surface Water Concentrations to Benchmarks

Exposure Pathway	Deposition to Surface Water							
T&E Species Potentially Affected	Hine's emerald dragonfly							
	Nitrogen		Chloride		Nickel		Phosphorus	
	Benchmark - 40,000 µg/l		Benchmark - 230 µg/l		Benchmark - 25 µg/l		Benchmark - 5 µg/l	
	Resultant Concentration Increase, Watershed Model	Fraction of Benchmark Value	Resultant Concentration Increase, Watershed Model	Fraction of Benchmark Value	Resultant Concentration Increase, Watershed Model	Fraction of Benchmark Value	Resultant Concentration Increase, Watershed Model	Fraction of Benchmark Value
	[µg/l]	%	[µg/l]	%	[µg/l]	%	[µg/l]	%
Fraction Run	1.1E+01	0.03%	5.3E-01	0.2%	7.9E-02	0.3%	1.2E-01	2.3%
Dellwood Park Prairie	1.3E+01	0.03%	6.7E-01	0.3%	1.0E-01	0.4%	1.5E-01	2.9%
Lockport Prairie #2	1.3E+01	0.03%	7.6E-01	0.3%	1.1E-01	0.5%	1.7E-01	3.3%
Lockport Prairie #3	1.3E+01	0.03%	7.6E-01	0.3%	1.1E-01	0.5%	1.7E-01	3.3%
Material Services Corporation	1.3E+01	0.03%	6.9E-01	0.3%	1.0E-01	0.4%	1.5E-01	3.0%
Long Run Seep Nature Preserve	8.7E+00	0.02%	6.0E-01	0.3%	8.9E-02	0.4%	1.3E-01	2.6%
Romeoville Prairie Nature Preserve	1.1E+01	0.03%	4.4E-01	0.2%	6.5E-02	0.3%	9.6E-02	1.9%
Keepataw Preserve	6.6E+00	0.02%	4.8E-01	0.2%	7.2E-02	0.3%	1.1E-01	2.1%

4.6 Uncertainties

The following bulleted items indicate origins of identified uncertainty that are associated with this impact assessment:

- Mathematical models for estimation of chemical-specific airborne concentrations and deposition rates and impacts of deposition on soil and surface water bodies;
- Background concentrations and deposition rates, as determined from local and regional monitoring systems;
- Establishment of chemical-specific benchmarks for the T&E species based on effects measured for other plant species;
- In the absence of identified chronic effects in scientific literature, establishment of chemical-specific benchmarks for chronic, long-term exposure based upon acute effects; and
- Additive and synergistic effects (see discussion in Attachment C)

For the vast majority of the items listed above, uncertainty has been compensated for by using conservative assumptions and inputs. Models are established and inputs made to err on the side of conservatively high values. On the other hand, benchmarks have been established based on lowest NOEL values available in the literature. Comparing biased-high modeling values with biased-low benchmarks results in a conservative analysis.

5.0 Summary and Conclusions

A thorough analysis of impacts from the proposed air permit modification of the existing ExxonMobil refinery has been conducted in order to provide the technical information that USEPA and USFWS need to address impacts on four federally-listed threatened and endangered species and their fourteen known habitats in the vicinity of ExxonMobil. This analysis has been conducted to address the "Roadmap" issues developed by the two agencies. The following bullets summarize some of the key findings and conclusions of this analysis:

- Due to the nature of the proposed modifications (no increase over currently permitted and realizable short-term emissions) no short-term exposure increases are attributable to this project, so no acute effects (including acid fog effects) will occur;
- A recent emission reduction project that was streamed in November 2004 results in actual sulfur dioxide (SO_2) emission decreases that more than offset the emissions from the proposed project. The net decrease in emissions results in net airborne concentration and deposition decreases, such that exposures following the proposed modifications will be less than currently-monitored background levels. As a result, there are no anticipated acute or chronic adverse effects to any of the T&E species or their respective habitats;
- Scientific knowledge of the atmospheric fate and transport of chemicals has allowed for the identification of pollutant-specific exposure pathways of concern by which to focus modeling and identification of environmental benchmarks for the assessment of potential adverse chronic effects;
- Conservative mathematical models and worst-case emission rates have been employed to overestimate media-specific concentrations of potentially-toxic chemicals;
- A literature survey was conducted by Cambridge Environmental using approved methods and databases to locate and/or develop chemical- and media-specific benchmarks for the T&E species. The literature uncovered no benchmarks specific to the three plant or single animal species of concern. As a result, "no observed effect level" or "NOEL" benchmarks were developed conservatively, basing them on toxicity values reported for different plant and animal species where effects have been studied;
- Conservatively-estimated impacts of the project on airborne concentrations for all chemicals of concern at all species locations were below monitor method detection limits and/or are a small fraction fraction (less than 1%) of background concentrations. As a result, there is negligible anticipated direct chronic phytotoxic effect from the proposed project;
- For the Hine's Emerald Dragonfly, the chronic effect analysis has focused on the aquatic larval stage, where the dragonfly spends 96 to 99% of its life. As a result, there is no direct chronic effect from airborne pollutants;
- Nickel is the only air pollutant for which appreciable emissions and potential for accumulation in soil require analysis. This analysis estimated thousands of years of accumulation from the project to accumulate levels at which observable adverse effects occur. It is clear that project-specific nickel impacts are negligible impact relative to existing background and in comparison to the identified benchmark;
- Nitrogen, chloride and phosphorus deposited as a result of the proposed project do not have the potential to accumulate in soil. Highest modeled annual deposition rates are a small fraction of existing background. In the case of nitrogen, where a NOEL benchmark was developed, the combined effect of the project and existing background levels do not result result in a net value that exceeds the benchmark at any of the plant species receptor locations. The modeling does not account for the significant benefit that will occur from the 1.15 to 1 offset of NOx emissions for this project by reductions at another source in the Chicago airshed. The impacts of deposition of these chemicals to soil is not likely to adversely impact the plant species of concern;
- Particulate matter deposition was modeled and shown to be small (about 1.5%) relative to the benchmark established for observed interference with the functionality of plant leaves

(photosynthesis and stomatal activity). As a result, the deposition of particulate matter on plant leaves is not likely to adversely impact the plant species of concern;

- Deposition of nitrogen, chloride, nickel and phosphorus to shallow water bodies that are habitats to aquatic dragonfly larvae were modeled to estimate resultant increases in concentration. With conservative modeling, the highest receptor impact was shown to be small relative to the established benchmark (ranging from 0.3% for chloride to 3.3% for phosphorus). As a result, the deposition of these pollutant species to habitat water bodies is not likely to adversely impact the plant species of concern; and
- Uncertainty in the analysis has been compensated for by the use of conservative models with conservative inputs for comparison with conservative benchmark values.

In summary, the proposed modification of the ExxonMobil does not entail new emission points or new pollutants. The worst-case, potential emission increases over levels that have historically occurred are not expected to adversely impact the federally-listed threatened and endangered species or their habitats.

ATTACHMENT A

DRAFT

Endangered Species Act Assessment

ExxonMobil Oil Corporation - Joliet Refinery

Unit Reliability - Efficiency Improvement Project

June 15, 2005

DRAFT
Endangered Species Act Assessment
ExxonMobil Oil Corporation - Joliet Refinery
Unit Reliability - Efficiency Improvement Project
June 15, 2005

Executive Summary

Proposed Unit Reliability/ Efficiency Improvement Project

- No increase in existing design capacity
- Improvements to ancillary operations to more efficiently utilize current capacity (reduce number and duration of planned shutdowns, remove operational restrictions due to seasonal conditions)
- No increase in footprint of refinery operations
- No impact on current wastewater or stormwater
- No new stacks,
- No new pollutants, no increase in "allowable" or "potential" emissions
- Small increase in "actual" emissions

Status of Project Air Permit

- Submitted Prevention of Significant Deterioration ("PSD") permit application March 18
- Triggers federal PSD air permitting (based on conservative, worst-case emission analysis required by regulation) for the following pollutants:
    - Carbon Monoxide (CO)
    - Oxides of Nitrogen (NOx)
    - Particulate Matter (PM/PM_{10})
- PSD-prescribed air modeling analysis demonstrates insignificant impacts beyond the fence line for the protection of most-sensitive humans (e.g., children, senior citizens)
- Required to secure NOx emission offsets at ratio of 1.15:1 (decreases to offset increases) from another large emission source within the Chicagoland airshed

Status of Endangered Species Act Consultation

- Applicant met with IEPA on May 4 - reviewed the Endangered Species Act (ESA) consultation process and additional information needs
- At IEPA's suggestion, ExxonMobil met with Midewin on May 19, 20 regarding the project
- The Proposed Action does not constitute a "major construction activity" - a full Biological Assessment is <u>not</u> required by 50 CFR §402.12(b)
- Preliminary findings (continuing to research scientific literature and evaluate impacts)
    - Endangered Species of Primary Focus - Leafy Prairie Clover (*Dalea foliosa*), Eastern Prairie Fringed Orchid (*Platanthera leucophaea*), Hine's Emerald Dragonfly (*Somatochlora hineana*), and Lakeside Daisy (*Hymenoxys herbacea*)
    - Leafy Prairie Clover habitat on ExxonMobil property has been shown to be viable under current and past higher emissions of all pollutants for the proposed project (refinery has been in operation for over 30 years)
    - CO - vegetation is not impacted by this pollutant, no Secondary NAAQS standard exists for this pollutant
    - NO_x - ambient nitrate deposition is small relative to background and historical levels, 1.15 to 1 emission offsets to beneficially impact ambient levels in the airshed (reductions to background emissions)
    - PM/PM_{10} - focused analysis of components that make up PM/PM_{10} (e.g., nickel as a heavy metal component of PM/PM_{10})

- HAP - five HAP-specific emission rates are above USFWS "de minimis" risk level of 0.1 ton/year (specified for a recent consultation), each is further evaluated
- Other factors, ExxonMobil is currently considering projects with USEPA and IEPA to significantly reduce pollutant emissions by specified dates.

Introduction

ESA Summary Objectives

This summary has been prepared by the ExxonMobil Oil Corporation to assist the Illinois Environmental Protection Agency (IEPA) with initiating an Endangered Species Consultation in accordance with the requirements of Section 7 of the Endangered Species Act of 1973 (ESA), as amended.

As further described below, the action (project) for which this summary has been prepared is to occur at the ExxonMobil Oil Corporation - Joliet Refinery (ExxonMobil). As the action does not constitute a major construction activity, IEPA is not required by ESA to prepare a biological assessment[1]. Nevertheless, this document contains many of the elements of a biological assessment in order to assist IEPA with evaluating the likely effects of the action.

Site Location and Description

The ExxonMobil Joliet Refinery is located in Channahon Township on a 1,300-acre tract of land in unincorporated Will County, Illinois. As shown on Figure 1, the site is adjacent to Interstate 55 at the Arsenal Road exit, approximately 50 miles southwest of Chicago. To the immediate north of the refinery is the Des Plaines River, while southeast is the former Joliet Army Arsenal, which is being redeveloped as an industrial complex and the Midewin National Tallgrass Prairie (MNTP).

ExxonMobil's property lies to the west of the Illinois Central Gulf Railroad tracks with the exception of one tract of land. This approximate 40-acre parcel of land, contiguous with MNTP, lies outside the ExxonMobil fenceline and is not utilized for refinery operations. The U.S. Fish & Wildlife Service (USFWS) has surveyed this and other land in the area and has determined that this parcel contains specific locations of the endangered species Leafy Prairie Clover (*Dalea foliosa*)[2].

Existing Site Operations

ExxonMobil Oil Corporation - Joliet Refinery is a fully-integrated petroleum refinery that provides high-quality gasoline, diesel fuels, and other petroleum products to the marketplace. The refinery, which began operations in 1972, is one of the newest grassroots refineries in the United States. It utilizes state-of-the-art technology to perform four common functions for the processing of crude oil into refined products -- separation, conversion, purification, and blending.

The refinery currently employs the equivalent of approximately 800 full-time ExxonMobil and contractor employees for the operation, maintenance and administration of the current operations and the planning and execution of future improvements, including the proposed action.

Midewin National Tallgrass Prairie

MNTP is the nation's first federally-designated tallgrass prairie. The MNTP was created in 1996 as part of the Illinois Land Conservation Act (ILCA), signed into law by President Bill Clinton and

[1] U.S. Fish & Wildlife Service & National Marine Fisheries Service, Endangered Species Consultation Handbook, March 1998 Final.
[2] Ecological Risk Assessment for the Indeck Elwood Energy Center, Cambridge Environmental, Inc., April 2005.

placed under the administration of the U.S. Department of Agriculture (USDA) Forest Service. The MNTP is comprised of nearly 20,000 acres of land that was formerly the Joliet Arsenal. The Arsenal was built during World War II and was used for the production of TNT through the 1970's. Beginning in March of 1997, the U.S. Department of Defense (USDOD) transferred lands to the USDA and the MNTP. Additional lands are being transferred from USDOD to USDA as environmental contamination from the former arsenal is addressed.[3]

Summary of Proposed Action

On March 18, 2005, ExxonMobil submitted an application to IEPA for an air permit[4] for a group of efficiency improvement and/or unit reliability projects. These projects are energy saving projects that will allow the refinery to reduce operating costs, and/or are reliability/efficiency/ utilization projects that will improve "calendar day" performance (i.e., on an annual average basis). This improved calendar day performance is not realized by adding new capacity, but rather by allowing existing units to run closer to their maximum design rates on an annual average basis by reducing downtime and rate reductions that occur due to planned and/or unplanned events.

The proposed action will not involve increasing the footprint of the current refining operations, nor will it result in new emission points ("stacks") or new pollutants. Instead, the proposed action primarily focuses on improvements to ancillary operations that are not themselves emission units, yet can result in seasonal restrictions on refining performance.

Status with Respect to "Major Construction Activity"

The following language is quoted from Section 3.4 of the USFWS Final ESA Section 7 Consultation Handbook[5]:

By regulation, a biological assessment is prepared for "major construction activities" considered to be Federal actions significantly affecting the quality of the human environment as referred to in the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 et seq.). A major construction activity is a construction project or other undertaking having similar physical impacts, which qualify under NEPA as a major federal action. Major construction activities include dams, buildings, pipelines, roads, water resource developments, channel improvements, and other such projects that modify the physical environment and that constitute major Federal actions. As a rule of thumb, if an Environmental Impact Statement is required for the proposed action and construction-type impacts are involved, it is considered a major construction activity.

50 CFR §402.12(b) specifies that biological assessments are required for major construction activities. As ExxonMobil's proposed action does not constitute a major construction activity, it is not subject to the requirement to prepare a biological assessment.

[3] U.S. Department of Agriculture Forest Service, Eastern Region, Midewin National Tallgrass Prairie, Record of Decision - Final Environmental Impact Statement & Land and Resource Management Plan", February 8, 2002.

[4] ExxonMobil Refining & Supply, Application to Illinois EPA for Construction Permit: Unit Reliability - Efficiency Improvements Project, March 18, 2005.

[5] U.S. Fish & Wildlife Service & National Marine Fisheries Service, Endangered Species Consultation Handbook, March 1998 Final.

Description of Proposed Action & Associated Air Impacts

Technical Description

The projects, as described in the March 18, 2005 permit application, are as follows:

- Crude Unit Utilization Project
- Coker Unit Utilization Project
- Coker Online Spalling
- Coker Fuel Gas Filtration
- Coker Auto Top Unheading
- Crude Segregation
- North Amine System Piping Replacement
- HPBFW Preheat to CO Boiler
- Syn-Crude to FCC Jumpover
- Addition of Asphalt Vent Packages

The permit application provides more detail on the specifics of each project.

Emissions Inventory

ExxonMobil's March 18, 2005 permit application provides a criteria pollutant emission inventory for the proposed project. As excerpted from the application, Table 1 provides the net emissions increase based on the "worst-case" (comparing past-actual to future-potential) emission inventorying practices in accordance with New Source Review (NSR) rules for attainment pollutants (i.e., federal Prevention of Significant Deterioration (PSD) regulations found in 40 CFR §52.21) and non-attainment pollutants (i.e., Major Stationary Source Construction and Modification, regulations found in 35 IAC Part 203). As a result of the emission analysis, this project is subject to federal PSD permitting for carbon monoxide (CO), oxides of nitrogen (NO_x) and particulate matter (PM/PM_{10}).

Anticipated actual emissions have been quantified and provided in Table 2 to illustrate that anticipated pollutant-specific emission increases are significantly lower than "worst-case" emission increases (Table 1) and are small relative to past actual (i.e., current) emissions rates.

Table 1
NSR "Worst-Case" Emission Analysis for Proposed Action

Pollutant Species	Total "Worst Case" Emission Change from the proposed action	Total Net Contemporaneous Emission Change	Existing Major Source Significant Increase Threshold
	[tons / year]	[tons / year]	[tons / year]
CO	234.0	333.7	100
NO_x	796.6 (43.7)^^	703.4 (-49.5)^^	40
Ozone[6] (NO_x)	654.7 (-98.2)^^	560.1 (-192.8)^^	40[7]
Ozone[3] (VOM)	5.42 (project, not 5-yr)	23.03	25 / 5-yr[8]
PM/PM_{10} ^^^	109.0 / 105.7	128.4 / 125.0	25 / 15
SO_2	2,519.5	-354.2[9]	40

^"Worst Case" = past-actual to future-potential comparison, as defined in PSD regulations
^^In order to comply with nonattainment provisions (35 IAC 203) for the 8-hour ozone, 752.9 tons of NOx offsets are to be acquired from another source within the Chicagoland area airshed. Value in parenthesis reflects the offset quantity
^^^The Chicagoland area has recently been designated nonattainment for $PM_{2.5}$, and during rulemaking, IEPA is following federal guidance for the interim treatment of this pollutant[10].

Table 2
Anticipated Future Actual Emissions for Proposed Action

Pollutant Species	Total "Worst Case" Emission Change from the Proposed Action	Total "Anticipated Actual" Emission Change from the Proposed Action^	% Increase of Anticipated Actual Emissions for the Proposed Action as Compared to Past Actual^^
	[tons / year]	[tons / year]	%
CO	234.0	169.2	4.9
NO_x	796.6	474.3	12.1
PM/PM_{10}	109.0 / 105.7	7.1 / 3.8	1.5 / 0.9

^"Anticipated Actual" = past-actual to future anticipated actual emissions comparison
^^Representative past actual emissions are from calendar year 2002, as reported in Annual Emissions Report.

Ambient Air Quality Analysis

A PSD ambient air quality study was conducted according to the methodology described in the air permit application[11]. The purpose of this modeling was to demonstrate that emissions from the project will not result in ambient (outside the facility's fenceline) air concentrations that violate (i.e., exceed) either Primary (for the protection of public human health, including most "sensitive" populations) and Secondary (for the protection of public welfare, including protection against damage to animals and vegetation) National Ambient

[6] Non-attainment pollutant
[7] Per 35 IAC 203.209(a)(2) for a moderate ozone non-attainment area (8-hour standard).
[8] Per 35 IAC 203.209(b) for severe ozone non-attainment area (1-hour standard). Note that a 182(f) waiver is in place under the 1-hour standard, and as such, these requirements are not applicable to NO_x as a precursor to ozone.
[9] Low-Sulfur Mogas and Coker blowdown gas recovery projects (Permits 01030070 and 03060091, respectively) resulted in 3,170 tons/year in creditable SO_2 emission decreases during the contemporaneous period.
[10] Implementation of New Source Review Requirements in PM-2.5 Nonattainment Areas, Mr. Stephen D. Page, Director, US EPA, April 5, 2005.
[11] ExxonMobil Refining & Supply, Application to Illinois EPA for Construction Permit: Unit Reliability - Efficiency Improvements Project, March 18, 2005.

Air Quality Standards (NAAQS) for PSD Class II areas (the designation for the Joliet area).

Using conservative screening models and five years of conservative meteorological data, it was demonstrated (see Tables 3 and 4) that the project itself does not result in a significant ambient impact and does not require a full PSD impact analysis. US EPA defines the impact area for a project based on this analysis. As all impacts at and beyond the facility's fenceline are below "PSD significant impact levels", the project's significant impact area is limited to within the restricted area of the facility's fenceline. As a result, the standard PSD "Soils and Vegetation Analysis" concludes no impacts to receptors outside the fenceline.

Figures 1, 2 and 3 overlay modeling results for NOx, CO and PM_{10} on a topographic map of the area. For all pollutants, worst-case impacts are generally northeast of the facility, due to prevailing wind conditions. Maximum offsite PM_{10} emissions are at the fenceline and drop off sharply with distance from the fenceline. This is due to the impact of fugitive particulate matter emissions associated with coke handling operations.

Tables 3 and 4 also provide Illinois state-wide average ambient air monitoring data and compare projected concentrations from worst-case project emissions to those of state-wide "background"[11]. For all pollutants, the worst-case impacts to existing ambient air are less than 5%. Using anticipated actual emission increases (see Table 2), the calculated impacts for all pollutants are less than 2% of state-wide ambient values. The greatest impacts are for PM_{10}, with the worst-case value at the fenceline. As illustrated in Figures 3a and 3b, the PM_{10} concentration decreases quickly with distance from the fenceline.

For a more detailed description of the PSD ambient air quality analysis, see the permit application[11].

Table 3
National Ambient Air Quality Standards and Ambient Air Monitoring Data

Pollutant Standard	NAAQS Standard (primary &/or secondary)	PSD - Significant Impact Level (SIL)	Illinois State-Wide Average Monitoring Data, 2003[12]
	[ug/m^3]	[ug/m^3]	[ug/m^3]
CO, 1-hour	40,000^ (35 ppm)	2,000	5,030
CO, 8-hour	10,000^ (9 ppm)	500	3,220
NOx, Annual	100 (0.053 ppm)	1.0	45.3
PM_{10}, 24-hour	150	5	75
PM_{10}, Annual	50	1	27

^US EPA has issued no secondary NAAQS standards for carbon monoxide. Secondary standards are limits established for the protection of public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.
^^Modeling results indicate that the maximum offsite PM_{10} values are at the fenceline.

Table 4
Results of Ambient Air Quality Analysis

Pollutant Standard	Worst Case, Maximum Modeled Impact	Distance of Worst-Case, Modeled Impact from Fenceline	Worst Case % of NAAQS Standard	Worst Case % of Significant Impact Level	Worst Case % of State-Wide Average Ambient
	[ug/m^3]	[miles]	%	%	%
CO, 1-hour	138	0.3	0.35	6.9	2.7
CO, 8-hour	58	0.3	0.58	11.5	1.8
NOx, Annual	0.33	2.5	0.33	33.0	0.73
PM_{10}, 24-hour	3.72	0.0^^	2.48	74.4	5.0
PM_{10}, Annual	0.25	0.0^^	0.50	25.0	0.93

Emission Offsets

With respect to criteria pollutants and the associated National Ambient Air Quality Standards (NAAQS), the Chicagoland area was designated as moderate nonattainment for ozone for the 8-hour standard effective June 15, 2004. Oxides of nitrogen (NOx) are ozone precursors and, as such, NOx is regulated as a nonattainment pollutant under 35 Illinois Administrative Code (IAC) Part 203.

35 IAC Part 203 requires that ExxonMobil obtain emission offsets for NOx from within the Chicago non-attainment area. In accordance with the requirements of 35 IAC §203.302(a)(1)(B), offsets for this major modification must be provided at a ratio of total emission reduction for NOx to total increased emissions of 1.15 to 1. As such, 752.9 tons per year of NOx emission offsets is being obtained to offset the 654.7 ton per year potential increase in NOx emissions from the project. These offsets are to be obtained prior to commencement of construction and must be effective prior to start-up of the

[12] Illinois Annual Air Quality Report, 2003, pp. 10 - 11, Illinois Environmental Protection Agency, Document #IEPA/BOA/04-019, issued August 2004.

modified source. ExxonMobil is working with a third party, Cantor Fitzgerald, to identify a qualifying source from within the Chicago area airshed and administer the transfer of offsets. The arrangements are subject to IEPA approval.

These emission offsets are not reflected in the NOx emission results for the air quality dispersion modeling discussed above.

Hazardous Air Pollutants (HAP)

Hazardous Air Pollutants (HAP) are pollutants that are known or suspected to cause cancer or other serious health effects in humans, or, in some cases, adverse environmental effects. HAPs are listed compounds or groups of compounds in Section 112(b) of the Clean Air Act, as amended. HAPs include organic, inorganic, metal, sulfides, and other compounds. HAP emissions are regulated by National Emission Standards for Hazardous Air Pollutants (NESHAPs). NESHAP regulations are found in 40 CFR Parts 61 and 63. Many of the NESHAPs regulate petroleum-refining operations. For modifications to existing refining operations, emission sources can trigger additional requirements based not on emission increases, but rather on new or reconstructed emission units. As a result, the March 18, 2005 permit application does not quantify HAP emissions for the proposed action.

In order to assist with the Endangered Species Act (ESA) review, ExxonMobil has constructed a HAP emission inventory for the project. This emission inventory (provided as Attachment 1) was constructed consistent with NSR worst-case emission analysis described previously. The HAP emissions have been based on refinery-specific information for fugitive components and storage tanks, consistent with Annual Emission Reports. We have added HAP emission estimates for other sources based on site-specific sample data (e.g., the composition of coke fines and FCC catalyst fines) and externally-developed information (e.g., process heater HAP emission factors for the combustion of refinery fuel gas, as found in the California Air Toxics Emission Factor database).

The emissions are summarized in Table 5. The listed HAP are those for which emissions are anticipated from the project based on best available emissions information. For cases where the emissions are reported as "0.000 tons per year", emissions have been quantified at levels below 0.0005 tons (1 pound) per year, but greater than zero.

Table 5
HAP "Worst-Case" Emission Analysis for Proposed Action

Pollutant	CAS #	Total CCUP Emission Increases (Past-Actual to Future-Potential)	
		[tons / yr]	[pounds / yr]
Metal HAP			
Antimony	7440-36-0	0.001	2.5
Arsenic	7440-38-2	0.002	4.1
Barium	7440-39-3	0.011	22.0
Beryllium	7440-41-7	0.000	0.8
Cadmium	7440-43-9	0.001	2.0
Chromium (Total)	7440-47-3	0.003	5.3
Cobalt	7440-48-4	0.001	1.2
Copper	7440-50-8	0.006	12.2
Cyanide Compounds	varies	0.017	34.3
Lead	7439-92-1	0.004	8.5
Manganese	7439-96-5	0.006	11.9
Mercury	7439-97-6	0.001	1.1
Nickel	7440-02-0	0.101	201.9
Selenium	7782-49-2	0.001	2.1
Silver	7440-22-4	0.001	1.4
Thallium	7440-28-0	0.009	18.0
Zinc	7440-66-6	0.043	86.3
Organic HAP			
1,3-Butadiene	106-99-0	0.000	0.0
2-Methylnaphthalene	91-57-6	0.000	0.2
Acenaphthene	83-32-9	0.000	0.0
Acenaphthylene	208-96-8	0.000	0.0
Acetaldehyde	75-07-0	0.089	177.1
Anthracene	120-12-7	0.000	0.0
Benzene	71-43-2	0.030	59.8
Benzo(a)anthracene	56-55-6	0.000	0.0
Benzo(a)pyrene	50-32-8	0.000	0.0
Benzo(b)fluoranthene	205-99-2	0.000	0.0
Benzo(e)pyrene	192-97-2	0.000	0.0
Benzo(g,h,i)perylene	191-24-2	0.000	0.0
Benzo(k)fluoranthene	207-08-9	0.000	0.0
Chrysene	218-01-9	0.000	0.0
Cumene	98-82-8	0.000	0.0
Dibenz(a,h)anthracene	53-70-3	0.000	0.0
Ethylbenzene	100-41-4	0.011	22.5
Fluoranthene	206-44-0	0.000	0.0
Fluorene	86-73-7	0.000	0.1
Formaldehyde	50-00-0	0.087	173.1
n-Hexane	110-54-3	0.000	0.0
Indeno(1,2,3-cd)pyrene	193-39-5	0.000	0.0
Methanol	67-56-1	0.000	0.0
Naphthalene	91-20-3	0.001	1.0
Perylene	198-55-0	0.000	0.0
Phenanthrene	85-01-8	0.000	0.1
Phenol	108-95-2	0.005	9.5
Propylene	115-07-1	0.006	12.1
Pyrene	129-00-0	0.000	0.0
Toluene	108-88-3	0.107	213.7
Xylene (Total)	1330-20-7	0.143	285.3
Inorganic HAP			
Carbonyl Sulfide	463-58-1	2.696	5,391.1
Hydrogen Chloride	7647-01-0	0.694	1,387.3
Phosphorus	7723-14-0	0.148	296.5

^Phosphorus emissions are in the oxidized state, P_20_5, not "white phosphorus", P_4.

ATTACHMENT B

Recommended Scope of Analysis
for ExxonMobil Refinery Modification
for Endangered Species Evaluation
July 7, 2005 [as revised July 21]
Issued by USEPA & USFWS

Recommended Scope of Analysis for Exxon Mobil Refinery Modification
for Endangered Species Evaluation
July 7 2005

Purpose of analysis:

The analysis is intended to determine whether the proposed modifications to the Exxon Mobil refinery are likely to directly or indirectly adversely affect federally listed species. This recommended scope of analysis or roadmap recommends using USEPA's ecological risk assessment process to inform the decision points in section 7 of the Endangered Species Act. Portions of the USEPA's draft Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (EPA 530-D-99-001A) provides useful guidance for this analysis. Although this guidance was designed specifically to assess the impact of hazardous waste combustion facilities, it offers general approaches for assessing the fate of chemicals released to the air that can be applied to all types of industrial facilities.
Overall, the evaluation should focus on increased emissions from the refinery. To complete this analysis we need an understanding of the background concentrations and deposition patterns. The anticipated emissions from permitted but not yet operational facilities should be included in background. The anticipated concentration in air or deposition at sites supporting listed species should be compared against NOEL (No observed effects level) benchmarks thought to be protective of the appropriate group (e.g., plants). The evaluation should look at the incremental addition in the context of background concentrations.

Benchmarks:

For these analyses, commonly accepted NOEL (no observed effects levels) benchmarks should be used. Where more than one benchmark can be found the most conservative value should be used, unless an explanation is given to justify a less conservative benchmark. When there is no commonly accepted benchmark, there should be a search of the scientific literature for relevant toxicity information to provide a basis for risk assessment for the species of concern.

Modeling protocol:

Modeling should follow the general guidance provided in Chapter 3 of USEPA's SLERA protocol for assessing chemical fate and transport. The modeling should show air concentrations and deposition rates for all pollutants (where appropriate). The air emissions resulting from the project should be modeled at the facility level, not on a unit basis. Total impacts should be evaluated looking at the combined effects of the vapor phase, particle phase and particle-bound phase of pollutants. ISCST3 is an acceptable model for this analysis. For chemicals amenable to deposition, models in the SLERA guidance should be used to estimate concentrations in soil and surface water in conjunction with relevant fate and transport parameters.

Assessment Area:

Because the Exxon-Mobil facility is very close geographically to the Indeck-Elwood site and because the stack heights are much shorter than those in the Indeck-Elwood evaluation, the boundary of the assessment area will be defined as the geographic area where those listed species were already identified by the Indeck-Elwood assessment. Therefore, Exxon-Mobil should determine air concentrations and deposition at the specific sites where the listed species have already been identified by the Indeck-Elwood facility endangered species assessment

Background Levels:

To assess background, the same background information that was used for the Indeck-Elwood assessment will be acceptable for this assessment.

Suite of pollutants to consider:

The assessment should cover all air pollutants emitted from the facility including ozone[1], sulfur compounds[2], oxides of nitrogen, carbon monoxide, particulates, and hazardous air pollutants. USEPA will provide the analysis for ozone for this project.

Types of impact to consider:

1) Short term, depending on pollutant compare worst 1 hr, 8 hr, and 24 hr. concentration in air with appropriate bench marks for acute effects. A discussion of each pathway should be included with an explanation of which is considered most sensitive. This includes, but is not limited to, impact to physical structures, cuticle uptake, stomatal uptake, root uptake, and particulate clogging of stomates.
2) Long term, depending upon pollutant compare worst 1 yr of 5 concentration in air or deposition on soil with appropriate bench marks for chronic effects.
3) An evaluation of acid fog effects on plants utilizing all acid sources from the facility (S, N, P, HCl). The acid calculation should include the effects of background in the atmosphere, 100% SO2 conversion, and the acidification of acid particles present on the leaves during dry deposition. A discussion of fog history at the site should be included.
4) For compounds that may accumulate, evaluate estimated total deposition over life of project. These concentrations should be compared against benchmarks.

Consideration of additive and synergistic effects:

The assessment should provide information and analysis for potential additive or synergistic effects to the extent information is available. If insufficient information is

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[1] USEPA will provide an analysis of the effects of the project increases on ozone.
[2] FWS and USEPA are currently discussing the level of analysis needed in netting situations which result in an overall decrease in emissions for a pollutant.

available for this type of analysis then the issue can be addressed in a discussion on uncertainty.

For example, oxides of nitrogen, sulfur compounds, and phosphorous can act as fertilizers, so the combined effects of these fertilizers on the habitat supporting listed species should be considered. Several studies have shown that nitrogen deposition is associated with loss of plant species diversity, and that nitrogen fixers (e.g., leafy prairie clover), and rare species (e.g., leafy prairie clover, eastern prairie fringed orchid) are more likely to be extirpated (Wedin and Tilman 1996, Weiss 1999; Suding et.al. 2005). The effect is also more pronounced on nutrient poor soils.

NO_x and SO_2 when emitted can act as fumigants, can be deposited, and can combine with water to form acids. Thus the mode of impact can be as fertilizers, as fumigants and as acids. NO_x, SO_2 and Ozone can also have additive and synergistic effects on vegetation.

Listed Species:

The following species occur within a short distance of the refinery:

Leafy Prairie Clover (*Dalea foliosa*) – this species occurs on refinery property and at Midewin National Tallgrass Prairie. This population was discovered in the late 1990's and population numbers have fluctuated from 130 plants to 90 plants to over 300 plants, perhaps in response to rainfall. Midewin National Tallgrass Prairie actively manages the site, and removes invasive species. No information is available on the status of this population prior to construction and operation of the Exxon Mobil Refinery. Other populations exist to the north along the Des Plaines River Valley.

Eastern Prairie Fringed Orchid (*Platanthera leucophaea*) – this species occurs on land owned by the Illinois Department of Natural Resources at Grant Creek.

Lakeside Daisy (*Hymenoxys herbacea*) – an introduced population occurs at Lockport Prairie.

Hine's emerald dragonfly (*Somatochlora hineana*) – Several populations occur along the Des Plaines River Valley.

Literature Search:

Conduct a literature search for the issues related to the effects of air pollutants on the listed species, on species within the same genus, and on species within the same family. Pair these terms with appropriate air pollution related key words such as the following: air pollution, power plant emissions, nitrogen deposition, sulfur deposition, particulate matter, phyto-toxicity, hazardous air pollutants, etc. Document the data bases, search terms, and results. This task may add on to the results already obtained for Indeck. The source of all factual statements should be clearly indicated.

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ATTACHMENT C

Ecotoxicological Benchmarks for the
ExxonMobil Refinery Consultation
August 2, 2005,
Cambridge Environmental, Inc.

Ecotoxicological Benchmarks for the Exxon Mobil Refinery Consultation

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Cambridge Environmental Inc.
August 2, 2005

Introduction

Application of the emissions screening algorithms for the ExxonMobil Refinery project identified nine pollutants of potential concern. Pollutant-specific fate and transport characteristics indicate different modes of potential toxicity, and hence the selection of toxicity-based benchmarks is based on relevant properties of each pollutant.

As a general rule, benchmarks for pollutants with well-characterized ecological effects are generally selected from databases that have considered the relevant bodies of available scientific information. In cases for which information is scarce or lacking, searches of relevant literature are used in an attempt to gauge the potential toxicity of pollutant emissions.

Additive (synergistic or antagonistic) effects on threatened and endangered species due to exposure to multiple pollutants are not explicitly considered. Searches of relevant literature did not yield useful quantitative information on additive effects, which are not well-understood or studied. There are, however, multiple stressors that affect threatened and endangered species, many of which do not involve environmental contaminants. Consideration of multiple stressors – if even feasible with respect to limits on scientific knowledge – is considered beyond the scope of the quantitative biological assessment.

Approach to benchmark identification

At the outset, it must be noted that the approach for establishing benchmark levels is not rigid, as the amount (both quantity and quality) of information available for each pollutant varies considerably. Also, the various pollutants of potential concern (POPCs) have the potential to affect threatened and endangered (T&E) species in various ways based on relevant exposure pathways and fate and transport characteristics. The overall goal is to identify relevant benchmarks that can be used to gauge the potential toxicity of pollutant emissions from the Joliet Refinery.

Three of the four T&E species are plants, and there are three principal mechanisms through which plants can be affected by chemicals released to the air:

- Direct phytotoxicity, in which plants respond directly to the presence of a chemical in air. In this case, the appropriate toxicity benchmark is an airborne concentration of the chemical.
- Non-accumulative deposition to soil, in which a chemical is removed from the air, moves through the soil layer, and is taken up through the roots. This mechanism is of relative importance to many plant nutrients that cycle through the atmosphere and terrestrial ecosystems, and the relevant measure of importance is the rate of deposition (flux) to the soil layer.
- Accumulative deposition to soil, in which a chemical is removed from the air and tends to remain within the upper soil layer, making it available to plants through root uptake over extended periods of time.

The fourth T&E species, the Hine's emerald dragonfly, is a macroinvertebrate with a life cycle dominated by several years of larval development in shallow water. As described in a similar analysis (USF&WS, 2005), aquatic toxicity data serve as the most appropriate benchmarks for evaluating potential deleterious effects to this species. Like the indirect soil pathways for the T&E plant species, the exposure analysis for the Hine's emerald dragonfly is relevant only for chemicals amenable to deposition from the atmosphere.

For many pollutants, the U.S. Environmental Protection Agency and other regulatory authorities have established appropriate benchmarks based on the results of relevant toxicity studies. However, some pollutants have not been sufficiently studied to characterize their potential effects on ecological receptors. In some cases, they simply have not been studied. In other cases, available information might be too limited to develop benchmark levels with sufficient confidence.

A two-step strategy is implemented to identify relevant toxicological data. The approach is designed to identify readily available information, and to make a reasonable (but not exhaustive) attempt to identify additional information outside the realm of established regulatory practice. First, ecotoxicological databases and established guidance documents are searched to identify established benchmark data for the POPCs. Data from recent analyses focused on the same T&E species (developed for the assessment of potential pollutant emissions from a proposed power generation facility) are also relied upon in this step (Cambridge Environmental, 2005; USF&WS, 2005). Second, a literature search is conducted to identify additional relevant information to assess pollutants lacking established benchmarks. Further details of these steps follow.

Step 1: Identification of Established Benchmarks

The list of POPCs overlaps considerably with that of a similar evaluation for a proposed power generation facility (Cambridge Environmental Inc., 2005; USF&WS, 2005). Given the recent completion of this study, toxicity benchmarks identified in this analysis are considered relevant and appropriate for the evaluation of the ExxonMobil Refinery emissions. Additionally, the

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same regulatory databases searched in the previous analysis are also used to identify benchmarks for additional POPCs. Specifically, information for establishing benchmark concentrations in air is sought from:

- Air Quality Criteria and supporting documents developed by the U.S. Environmental Protection Agency;
- International standards and guidelines documents for air pollutants (e.g., WHO, 2000); and
- Other regulatory and reputable technical sources identified in web-based searching.

Benchmark concentrations in soil are obtained from the following sources:

- The U.S. EPA's ECO-SSL values; and
- The Oak Ridge National Laboratory's (ORNL) Risk Assessment Information System online tool.

The ORNL database itself references relevant databases established by various U.S. EPA regional offices and other regulatory groups. These databases are used to preferentially identify soil screening criteria relevant to phytotoxicity (where possible).

Similarly, for the evaluation of the Hine's emerald dragonfly, freshwater benchmark concentrations for additional POPCs are identified from:

- U.S. EPA freshwater Ambient Water Quality Criteria;
- The MacDonald et al. (1999) compilation of water quality benchmarks used in the recent evaluation of the Hine's emerald dragon fly (Kramer, 2005); and
- The Oak Ridge National Laboratory's (ORNL) Risk Assessment Information System online tool.

Like the ORNL online tool, the MacDonald et al. compendium references other relevant ecotoxicity guidelines.

Step 2: Literature Search

Additional searches are performed for POPCs lacking established benchmarks. Initial searches of the U.S. EPA's ECOTOX database are conducted to identify appropriate ecotoxicity data, primarily with the expectation of finding soil and water toxicity data. ECOTOX's coverage of direct phytotxicity data is scant, as the PHYTOTOX database incorporated with ECOTOX largely focuses of POPC toxicity in soil.

As a final step, limited searching of the open literature is performed for POPCs that still lack ecotoxicity information. The goals of the additional searching are to identify information on phytotoxicity recognizing the nature of the collective knowledge regarding the effects of air pollution on plants. Searches are tailored to each POPC depending on the interactive nature of the findings.

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Based on preliminary investigations of databases, Agricola (2005), Biosis (2005), and the Science Citation Index (2005) were determined to provide the largest amount of potentially relevant information regarding POPC ecotoxicity. These preliminary investigations also suggested a broad search strategy to be necessary to identify information for some POPCs. As a result, the initial generic search strategy designed to identify information regarding plant toxicity comprised three initial search strings:

- POPC AND phytoxicity;
- POPC AND plants AND toxicity; and
- POPC AND vegetation AND toxicity,

while searches to identify information relevant to the Hine's emerald dragonfly were initiated with the search string:

- POPC AND water AND toxicity AND invertebrate.

In cases for which these initial search terms yield too many matches, terms are added or modified to narrow the search (e.g., by substituting family names for "vegetation" or "invertebrate"). This process continues until the search terms are specific enough as to yield a "reasonable" amount of matches (e.g., about ten citations). At this point, the individual matches are examined one by one and relevant citations noted.

Narrowing the initial search through the addition of other search terms creates numerous branches. As appropriate, each of these secondary searches can subsequently be coupled to a third search term until a "reasonable" number of matches is yielded. Thus, each initial search term is potentially followed through from several angles that may yield relevant matches.

Upon identifying an appropriate number of citations, the titles and abstracts of the citations are examined to identify potentially promising information, and efforts are made to reference and synthesize relevant information.

Case-by-case consideration of each pollutant follows.

Carbon monoxide

Carbon monoxide is widely thought to not be phytotoxic at ambient concentrations (Air Pollution Control Association, 1970; Oliaei, 2005). Carbon monoxide is believed to be the only major pollutant that appears not to adversely affect forest vegetation (NPS, 2005). The U.S. Environmental Protection Agency initially promulgated Secondary Ambient Air Quality Standards for carbon monoxide in 1971, but revoked the secondary standards in 1980 because no adverse public welfare issues (including phytotoxicity) had been reported at or near ambient concentrations (U.S. EPA, 1991). In fact, carbon monoxide is emitted by plants at low levels (Sanderson, 2002).

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Searches of the Biosis (2005) database, which contains bibliographic information from hundreds of journals published from 1969 until the present, and the online Agricola database (Agricola, 2005), failed to yield relevant information on carbon monoxide phytotoxicity. APCA (1970) states that carbon monoxide can cause plant injury similar to that of ethylene (a known phytotoxin) at concentrations 1,000 to 10,000 times greater. A comprehensive review of the phytotoxicity of volatile organic compounds by Cape (2003) indicates the lowest concentrations of ethylene that cause adverse effects on plants are of the order of 1 to 10 ppb in studies of extended exposure. Applying the relative toxicity indicated in APCA (1970), adverse effects of carbon monoxide would not be expected at concentrations smaller than 1 to 100 ppm. The lower end of this range (1 ppm) is consistent with background concentrations of carbon monoxide in urban areas, while the upper end of the range (100 ppm) is higher than typical concentrations monitored in ambient air. As a screening-level gauge of potential toxicity, the geometric middle of the range (10 ppm) is used. Given the absence of reported phytotoxicity at ambient concentrations, which typically are of the order of a few ppm in urban areas, the proposed screening-level of 10 ppm (11 mg/m^3) is likely to be a protective level, and the actual no adverse effects level may be even higher.

Ambient concentrations of carbon monoxide (CO) are monitored in many U.S. cities because of the National Ambient Air Quality Standards established for this pollutant. Most measurements are of the order of a few parts per million (ppm), but since these measurements are typically collected in areas where concentrations are elevated (*e.g.*, areas of congested traffic), they are not representative of non-urban areas. However, the U.S. EPA (2000) reports measurements of global average concentrations of CO that represent the lowest possible levels of CO in air. In the northern hemisphere, the tropospheric background concentration of CO is 120 ppb, or 140 $\mu g/m^3$. Given the proximity of the refinery to developed (urban) areas, and hence to sources of CO emissions, the background level of CO is expected to be greater than the global background of 140 $\mu g/m^3$.

Nitrogen oxides

Nitrogen oxides (NO_x) have in some cases been shown to be phytotoxic. In establishing guidelines for air quality in Europe, WHO (2000) recommends an annual average concentration of 30 $\mu g/m^3$ for the protection of vegetation, and this value is adopted as an appropriate guideline for direct phytoxicity of NO_x species.

Nitrogen oxides also deposit from the atmosphere. WHO (2000) also recommends critical nitrogen loadings (deposition rates) that may be associated with changes in ecosystems (*e.g.*, species diversity). This potential effect was investigated in a recent biological assessment for a power generation facility proposed for location near the ExxonMobil Refinery that could potentially affect the same habitats (Cambridge Environmental, 2005). As an appropriate benchmark, a critical deposition (loading) rate of 10 kg N/ha-yr is typical of the lower end guidelines recommended by WHO (2000) for heathland (the habitat most similar to that of tallgrass prairies), and is designed to protect sensitive species.

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Deposition of NO_x to freshwater will likely be in the form of nitrate. An appropriate screening-level benchmark for nitrate is 40 mg/l, which is used as a Canadian guideline value (MacDonald, 1999).

Particulate matter

The U.S. EPA Criteria Document provides a comprehensive review of particulate matter (PM) toxicity (U.S. EPA, 2004). Potential direct air-to-leaf effects of PM on vegetation to some extent depend upon particle size and composition, although well-defined dose-response curves observed for gaseous phytotoxins (*e.g.*, ozone and sulfur dioxide) have not generally been observed for particulate matter. A notable exception has been adverse effects on foliation observed in the vicinity of cement production facilities, for which particulate emissions are highly caustic. Particulate emissions from the ExxonMobil refinery are not expected to be strongly basic or acidic, as most derive from lost (neutrally charged) catalyst. Consequently, PM composition *per se* is not likely to harm endangered plant species (with respect to direct foliar damage).

The U.S. EPA has established secondary National Ambient Air Quality Standards (NAAQS) for particulate matter, defined to be identical to the human health-based primary NAAQS. The secondary standards consider potential effects to vegetation, but given the heterogeneous nature of particulate matter, the U.S. EPA has found it impossible to recommend specific numerical criteria for PM that are protective of threatened and endangered species (U.S. EPA, 2005a). Notwithstanding uncertainties, the secondary NAAQS serve as an appropriate benchmark for particulate matter because of their regulatory status. In the case of the ExxonMobil Refinery, PM emissions dominated by lost catalyst are likely to be dominated by coarse particles (consistent with wear and abrasion processes), and hence the secondary NAAQS for PM_{10} (particulate matter smaller than 10 µm in aerodynamic diameter) is most appropriate. Hence, an annual average PM concentration of 50 $\mu g/m^3$ is used as the benchmark concentration.

At high enough levels of deposition, however, particulate matter can interfere with normal plant respiration. Specifically, sufficiently thick coatings of particles can reduce levels of photosynthesis and interfere with stomatal activity. A deposition level of 1–10 g/m^2 of dust is needed to produce these effects (Glenn and Puterka, 2005). Thus, a particulate deposition level of 1 g/m^2 (the low end of the observed effects range) is judged an appropriate criterion. This value represents the level of particles that accumulate on leaf surfaces. Precipitation can be expected to remove these particles on an episodic basis. Consequently, a benchmark annual deposition rate is established at 10 g/m^2-yr under the assumption that leaf surfaces are effectively cleansed ten times per year (a frequency of a little less than once per month).

PM emissions can also potentially affect threatened and endangered species through indirect means. The constituents of particles can also adversely affect vegetation if they deposit to terrestrial ecosystems. Two pollutants of concern, phosphorus and nickel, are expected to

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deposit within particulate matter, and the potential toxicity of these pollutants within soil and water are discussed in pollutant-specific sections.

Carbonyl sulfide

Carbonyl sulfide (COS) is not believed to deposit readily to terrestrial ecosystems (U.S. EPA, 1994), although there is some evidence that COS is taken up at some level by vegetation (Taylor and Selvidge, 1984). Since the potential effect of COS on plants appears to be related to air-to-leaf uptake (and not uptake from soil), COS is evaluated as a direct phytotoxin.

Information on COS phytotoxicity is scant. COS is used at high concentrations as a fumigant to kill insects on harvested crops (flowers, fruits, grains, *etc.*), but this literature is not relevant to ambient exposure levels. EcoTox (2005), a toxicological database maintained by the U.S. EPA and the National Health and Environmental Effects Research Laboratory, yielded no relevant results when searched for carbonyl sulfide toxicity studies, likely because COS does not deposit to terrestrial or aquatic habitats which are the focus of EcoTox. Given the paucity of information on COS in ecotoxicological databases, a literature search was conducted for relevant COS toxicity information. Biosis (2005) yielded several studies that were deemed relevant to the ExxonMobil Refinery case, and data needed for establishing a COS benchmark value was collected from the most appropriate of these publications: Taylor and Selvidge (1984).

Taylor and Selvidge (1984) tested the effects of five sulfur-containing gases, including carbonyl sulfide, on bean plants. Bean seedlings exposed to one sulfur-containing gas for six hours were assessed for changes in rates of transpiration and photosynthesis, as well as for necrotic leaf damage. Transpiration rates remained within +/- 8% of control plants' rates after exposure to the highest dose tested: 82 µmol/m^3 (4,900 µg/m^3) gaseous carbonyl sulfide. However, some effects on rates of photosynthesis were observed. Both sulfur dioxide (SO_2) and hydrogen sulfide (H_2S) were found to decrease photosynthesis rates more significantly than COS. Averaged over twelve hours (a daily period of sunlight), a COS concentration of 1,100 µg/m^3 was found to cause a 20% decrease in photosynthesis. Applying a safety factor of 10 to extrapolate to long-term effects, an effects-based screening-level benchmark concentration of 100 µg/m^3 (rounded) is estimated.

Measurements of carbonyl sulfide (COS) are not plentiful, but some data are provided by the U.S. EPA in its chemical summary of COS (U.S. EPA, 1994). Measurements indicate that rural air contains 0.27 to 0.80 µg/m^3 of COS, while urban locations have concentrations exceeding 1 µg/m^3. Areas near salt marshes, which naturally emit COS, have COS concentrations of 60 to 180 µg/m^3 of COS in air. Based on these reported measurements, the concentration of COS in the vicinity of the ExxonMobil Refinery is expected to be greater than 0.27 µg/m^3 (the lowest level found in rural areas), and most likely of the order of 1 µg/m^3.

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Hydrogen chloride

A search of toxicological benchmark references failed to yield useful information on hydrogen chloride (HCl) phytotoxicity. The historical literature, as reflected in APCA (1970), provides some references regarding short-term toxicity. Adverse effects on some species are described at exposure levels as low as 3 ppm (APCA, 1970). Further searching of the Biosis (2005) and Agricola (2005) databases yielded additional information. In particular, Swiecki *et al.* (1982) provide concentration values of gaseous and aqueous hydrogen chloride that produced no observed effect on pinto bean leaves exposed to the chemical 12 days after sowing. The leaves were exposed to aqueous HCl by dipping for 20 minutes in solutions of various normality, and to gaseous HCl in cylindrical, continuously-stirred tank reactors within a glasshouse. Damage to the leaves was assessed 1 and 24 hours after treatment by light and scanning electron microscopy. It was found that a 20-minute exposure to 0.06 N aqueous HCl caused a comparable amount of damage to leaves as did a 20-minute exposure to 15-20 mg/m^3 (10 to 13 ppm) gaseous HCl. It was also noted that 0.001 N aqueous HCl caused no damage to leaves after a 20-minute exposure, while the second-lowest concentration used, 0.006 N aqueous HCl, did cause injury. From the determination of 0.001 N as an upper no observed adverse effects level (NOAEL) for aqueous HCl exposure, and using Swiecki *et al.*'s equivalence of 0.006 N aqueous HCl exposure to 15-20 mg/m^3 gaseous HCl exposure, a benchmark value for gaseous HCl exposure may be derived. Applying the factor of 60 difference that exists between the NOAEL and the 0.06 N aqueous HCl to the 15 mg/m^3 gaseous HCl, a resulting concentration of 0.25 mg/m^3 gaseous HCl is obtained as a value for permissible short-term exposure. An additional safety factor of 10 is applied to account for greater potential susceptibility by some species and allowance for long-term exposure to derive a benchmark screening-level of 25 µg/m^3.

Hydrogen chloride may also affect threatened and endangered species as it deposits to terrestrial ecosystems. Due to its solubility, the chloride contributed by HCl is not expected to accumulate in soil or water. With respect to soil, dissolved chloride acts to some extent as a plant nutrient, available for uptake through root systems. Based on a similar benchmark analysis, chloride deposition to soil is best compared with the background rate of chloride deposition, which is about 1.3 to 1.5 kg/ha-yr (0.13–0.15 g/m^2-yr) for the ExxonMobil Refinery area based on wet deposition monitoring and dry deposition estimates (Cambridge Environmental, 2005).

Potential toxicity in aquatic systems is characterized by a benchmark chloride concentration of 230 µg/l, which serves as the U.S. EPA's chronic continuous freshwater ambient water quality criterion for freshwater (MacDonald, 1999).

Hydrogen chloride (HCl) is monitored infrequently, but a review of available data in a similar evaluation indicates a representative background concentration of 0.7 µg/m^3 (Cambridge Environmental, 2005).

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Nickel

The direct air-to-leaf phytotoxicity of nickel is not considered because it is a component of particulate matter, which is assessed as a whole. However, nickel also has the potential to indirectly affect T&E species through deposition to soil and water. Based on its fate and transport properties, nickel has the potential to accumulate within these media, and hence may be available for uptake by plants and aquatic receptors.

Established benchmark concentrations are available for both soil and freshwater. The same values used in similar, recent analyses are recommended. For nickel, a mass fraction of 44 mg/kg is used as a benchmark, selected in consideration of the nearby Midewin Tallgrass Prairie habitat (Cambridge Environmental, 2005). Similarly, a freshwater benchmark concentration of 25 µg/l is selected based on area characteristics and a literature review of benchmark values (U.S. F&WS, 2005; MacDonald, 1999).

Phosphorus

Phosphorus (P) is an essential plant nutrient. Similar to other nutrients (nitrogen species and chloride), phosphorus is not expected to accumulate in soil, and hence is most appropriately evaluated in terms of its rates of deposition. Critical loading levels for phosphorus are not as readily defined as for nitrogen, which tends to be the rate-limiting nutrient in tallgrass prairie ecosystems such as the Midewin. Lacking a definitive effect threshold, the benchmark deposition rate is taken as the background rate of deposition. A recent analysis identified measured background phosphorous deposition rates ranging from 0.05–0.38 kg/ha-yr (Cambridge Environmental, 2005). The lower value was measured in a forested area of Wisconsin, while the higher deposition rate was measured in the greater Chicago area. Given the near-urban location of ExxonMobil Refinery, the higher wet deposition value of 0.38 kg/ha-yr (0.038 g/m^2-yr) is judged to be more appropriate.

In addition, research studies indicate that dry deposition of phosphorus is substantially greater than wet deposition. A study of phosphorus deposition in Florida (Tampa Bay) indicates that dry P deposition is four times greater than wet P deposition (U.S. EPA, 1998). A similar finding that dry deposition accounted for 80% of total deposition was found in a monitoring study along the southern Mediterranean (Herut et al, 1999). Still another Iowa study reports dry P deposition to be several times greater than that of wet deposition. Based on (1) an assumed dry:wet deposition ratio of 4:1 and (2) a representative wet deposition rate of 0.038 g/m2-yr, the estimate of total background deposition is 0.19 g/m2-yr (1.9 kg/ha-yr). This value is used as the benchmark rate of background phosphorus deposition.

A chronic freshwater quality guideline concentration of 5 µg/l is selected to evaluate potential water quality impacts (appropriate for the Hine's emerald dragonfly). This value is the lowest of the range of values provided in the MacDonald (1999) review.

Recent measurements (2001 to 2003) of phosphorus at sites in California, Oregon, and Washington indicate average airborne P concentrations ranging from 0.009 to 0.28 μg/m^3, 0.002 to 0.012 μg/m^3, and 0.002 to 0.009 μg/m^3, respectively, at various locations (U.S. EPA, 2005b). The majority of the available data are from California sites. In the sixty-two (62) site-records available from the California locations, the median of the average P concentrations is 0.042 μg/m^3.

Toluene and Xylenes

As part of a detailed review of volatile organic compound (VOC) phytotoxicity, Cape (2003) provides direct (air) phytotoxicity values for toluene and for xylene. A 14-day laboratory study is cited in which the phytotoxicity of 11 VOCs to several plant species was measured. In this study, the effects threshold was defined as a 20% reduction in dry weight of the exposed plant. Cape (2003) reports the maximum concentration of each VOC that resulted in "no effect" on the plant species. Toluene was found to have no effect at 60 mg/m^3. Xylene was found to have no effect at 160 mg/m^3. These values are used as air phytotoxicity benchmarks.

Indirect phytotoxicity of toluene and xylenes is not considered because these VOCs do not readily deposit to soils or vegetation.

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ATTACHMENT D

Modeling Results for Endangered Species Act Assessment
ExxonMobil Oil Corporation - Joliet Refinery
Unit Reliability - Efficiency Improvement Project

Joliet Refinery CCUP - Impacts of Project on Ambient Airborne CO ($\mu g/m^3$), Annual Basis

Location Name	UTM East	UTM North	Approximate Elevation (above MSL)	Distance from XOM Crude Unit Stack*	1987	1988	1989	1990	1991
	[km]	[km]	[m]	[km]	[ug/m3]	[ug/m3]	[ug/m3]	[ug/m3]	[ug/m3]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	0.041	**0.050**	0.046	0.036	0.039
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	0.029	0.034	**0.035**	0.028	0.026
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	0.024	**0.028**	0.028	0.027	0.019
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	0.019	**0.021**	0.017	0.021	0.013
Fraction Run	411.709	4602.968	164.6	20.85	0.028	0.027	0.021	**0.038**	0.034
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	0.029	0.026	0.020	**0.037**	0.033
Lockport Prairie #1	410.212	4603.771	164.6	20.84	0.027	0.024	0.020	**0.036**	0.032
Lockport Prairie #2	409.992	4603.796	164.6	20.77	0.025	0.024	0.020	**0.036**	0.032
Lockport Prairie #3	410.049	4604.030	164.6	21.00	0.025	0.023	0.020	**0.036**	0.032
Lockport Prairie #4	410.415	4604.635	164.6	21.71	0.024	0.023	0.019	**0.035**	0.031
Material Services Corporation River South	410.734	4606.417	164.6	23.46	0.020	0.020	0.018	**0.031**	0.028
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	0.021	0.019	0.016	**0.028**	0.026
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	0.014	0.017	0.016	**0.025**	0.020
Keepataw Preserve	413.565	4614.291	164.6	31.80	0.013	0.014	0.013	**0.022**	0.019
*Stack coordinates are	401.010	4585.070							

Note: Results are based on the incremental emissions between the maximum future potential emissions and the past actual emissions.

Joliet Refinery CCUP - Impacts of Project on Ambient Airborne PM_{10} (mg/m^3), Annual Basis

Location Name	UTM East	UTM North	Approximate Elevation (above MSL)	Distance from XOM Crude Unit Stack*	1987	1988	1989	1990	1991
	[km]	[km]	[m]	[km]	[ug/m3]	[ug/m3]	[ug/m3]	[ug/m3]	[ug/m3]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	0.006	**0.008**	0.006	0.005	0.007
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	0.023	0.019	**0.026**	0.013	0.020
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	0.019	0.019	0.029	0.016	**0.029**
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	**0.082**	0.078	0.075	0.054	0.063
Fraction Run	411.709	4602.968	164.6	20.85	0.007	0.007	0.005	**0.010**	0.009
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	0.007	0.007	0.005	**0.010**	0.009
Lockport Prairie #1	410.212	4603.771	164.6	20.84	0.006	0.006	0.005	**0.010**	0.008
Lockport Prairie #2	409.992	4603.796	164.6	20.77	0.006	0.006	0.005	**0.010**	0.008
Lockport Prairie #3	410.049	4604.030	164.6	21.00	0.006	0.006	0.005	**0.010**	0.008
Lockport Prairie #4	410.415	4604.635	164.6	21.71	0.006	0.006	0.005	**0.010**	0.008
Material Services Corporation River South	410.734	4606.417	164.6	23.46	0.005	0.006	0.005	**0.009**	0.007
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	0.005	0.005	0.004	**0.008**	0.007
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	0.004	0.005	0.004	**0.007**	0.005
Keepataw Preserve	413.565	4614.291	164.6	31.80	0.004	0.004	0.004	**0.007**	0.005
*Stack coordinates are	401.010	4585.070							

Note: Results are based on the incremental emissions between the maximum future potential emissions and the past actual emissions.

Joliet Refinery CCUP - Impacts of Project on Ambient Airborne NOx ($\mu g/m^3$), Annual Basis

Location Name	UTM East	UTM North	Approximate Elevation (above MSL)	Distance from XOM Crude Unit Stack*	1987	1988	1989	1990	1991
	[km]	[km]	[m]	[km]	[ug/m3]	[ug/m3]	[ug/m3]	[ug/m3]	[ug/m3]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	0.086	**0.112**	0.097	0.079	0.087
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	0.008	**0.023**	0.008	0.012	-0.003
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	-0.027	-0.020	-0.007	**0.002**	-0.018
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	-0.015	-0.016	-0.022	-0.011	**-0.010**
Fraction Run	411.709	4602.968	164.6	20.85	0.078	0.076	0.058	**0.110**	0.095
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	0.080	0.073	0.057	**0.106**	0.094
Lockport Prairie #1	410.212	4603.771	164.6	20.84	0.073	0.068	0.057	**0.105**	0.092
Lockport Prairie #2	409.992	4603.796	164.6	20.77	0.069	0.066	0.057	**0.105**	0.092
Lockport Prairie #3	410.049	4604.030	164.6	21.00	0.068	0.065	0.057	**0.104**	0.091
Lockport Prairie #4	410.415	4604.635	164.6	21.71	0.067	0.064	0.055	**0.101**	0.088
Material Services Corporation River South	410.734	4606.417	164.6	23.46	0.056	0.057	0.051	**0.092**	0.079
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	0.059	0.054	0.046	**0.084**	0.074
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	0.040	0.049	0.046	**0.074**	0.057
Keepataw Preserve	413.565	4614.291	164.6	31.80	0.037	0.041	0.039	**0.065**	0.055
*Stack coordinates are	401.010	4585.070							

Note: Results are based on the incremental emissions between the maximum future potential emissions and the past actual emissions.

Joliet Refinery CCUP - Impacts of Project on Ambient Airborne HAP[1] (ng/m^3), Annual Basis

Location Name	UTM East	UTM North	Approximate Elevation (above MSL)	Distance from XOM Crude Unit Stack*	HCl	Ni	P	COS	Toluene	Xylene (Total)
	[km]	[km]	[m]	[km]	[ng/m3]	[ng/m3]	[ng/m3]	[ng/m3]	[ng/m3]	[ng/m3]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	0.148	PM_{10}	PM_{10}	0.576	0.023	0.031
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	0.104	PM_{10}	PM_{10}	0.403	0.016	0.021
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	0.083	PM_{10}	PM_{10}	0.323	0.013	0.017
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	0.062	PM_{10}	PM_{10}	0.242	0.010	0.013
Fraction Run	411.709	4602.968	164.6	20.85	0.113	PM_{10}	PM_{10}	0.438	0.017	0.023
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	0.110	PM_{10}	PM_{10}	0.426	0.017	0.023
Lockport Prairie #1	410.212	4603.771	164.6	20.84	0.107	PM_{10}	PM_{10}	0.415	0.016	0.022
Lockport Prairie #2	409.992	4603.796	164.6	20.77	0.107	PM_{10}	PM_{10}	0.415	0.016	0.022
Lockport Prairie #3	410.049	4604.030	164.6	21.00	0.107	PM_{10}	PM_{10}	0.415	0.016	0.022
Lockport Prairie #4	410.415	4604.635	164.6	21.71	0.104	PM_{10}	PM_{10}	0.403	0.016	0.021
Material Services Corporation River South	410.734	4606.417	164.6	23.46	0.092	PM_{10}	PM_{10}	0.357	0.014	0.019
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	0.083	PM_{10}	PM_{10}	0.323	0.013	0.017
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	0.074	PM_{10}	PM_{10}	0.288	0.011	0.015
Keepataw Preserve	413.565	4614.291	164.6	31.80	0.065	PM_{10}	PM_{10}	0.253	0.010	0.013
*Stack coordinates are	401.010	4585.070								

Note: Results are based on the incremental emissions between the maximum future potential emissions and the past actual emissions.

[1] P from the proposed project is not in the form of "white phosphorus", which is the HAP.

Joliet Refinery CCUP - Impacts of Project on Total Deposition Rate (g/m^2-yr), Annual Basis (Worst of 5 Years)

Location Name	UTM East	UTM North	Approximate Elevation (above MSL)	Distance from XOM Crude Unit Stack[1]	ISCST3 Deposition Model				
					Nitrogen	PM_{10}	Chloride	Nickel	Phosphorus
	[km]	[km]	[m]	[km]	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	2.0E-02	4.6E-02	2.9E-04	4.4E-05	6.4E-05
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	7.0E-02	1.3E-01	8.2E-04	1.2E-04	1.8E-04
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	2.4E-02	1.5E-01	9.8E-04	1.5E-04	2.2E-04
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	7.5E-02	1.1E-01	7.1E-04	1.1E-04	1.6E-04
Fraction Run	411.709	4602.968	164.6	20.85	3.0E-03	2.3E-02	1.5E-04	2.2E-05	3.2E-05
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	3.7E-03	2.9E-02	1.9E-04	2.8E-05	4.1E-05
Lockport Prairie #1	410.212	4603.771	164.6	20.84	3.7E-03	3.3E-02	2.1E-04	3.2E-05	4.6E-05
Lockport Prairie #2	409.992	4603.796	164.6	20.77	3.7E-03	3.3E-02	2.1E-04	3.2E-05	4.6E-05
Lockport Prairie #3	410.049	4604.030	164.6	21.00	3.7E-03	3.3E-02	2.1E-04	3.2E-05	4.6E-05
Lockport Prairie #4	410.415	4604.635	164.6	21.71	3.7E-03	3.2E-02	2.0E-04	3.1E-05	4.5E-05
Material Services Corporation River South	410.734	4606.417	164.6	23.46	3.7E-03	3.0E-02	1.9E-04	2.9E-05	4.2E-05
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	2.4E-03	2.6E-02	1.7E-04	2.5E-05	3.6E-05
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	3.0E-03	1.9E-02	1.2E-04	1.8E-05	2.7E-05
Keepataw Preserve	413.565	4614.291	164.6	31.80	1.8E-03	2.1E-02	1.3E-04	2.0E-05	2.9E-05
[1]Stack coordinates are	401.010	4585.070							

Note: Results are based on the incremental emissions between the maximum future potential emissions and the past actual emissions.

Joliet Refinery CCUP - Modeled Impacts of Project on Nickel Deposition to Near Surface Soil

Location Name	UTM East	UTM North	Approximate Elevation (above MSL)	Distance from XOM Crude Unit Stack[1]	SOIL MIX MODEL[2] Nickel ISC Deposition Rate	Surface Soil Increase Rate,	Screening Criteria (mg/kg)	Time to Accumulate SSC Levels
	[km]	[km]	[m]	[km]	[g/m^2-yr]	[mg/kg-yr]	[mg/kg]	[years]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	4.4E-05	2.9E-03	44	1.5E+04
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	1.2E-04	8.2E-03	44	5.4E+03
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	1.5E-04	9.8E-03	44	4.5E+03
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	1.1E-04	7.1E-03	44	6.2E+03
Fraction Run	411.709	4602.968	164.6	20.85	2.2E-05	1.5E-03	44	3.0E+04
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	2.8E-05	1.8E-03	44	2.4E+04
Lockport Prairie #1	410.212	4603.771	164.6	20.84	3.2E-05	2.1E-03	44	2.1E+04
Lockport Prairie #2	409.992	4603.796	164.6	20.77	3.2E-05	2.1E-03	44	2.1E+04
Lockport Prairie #3	410.049	4604.030	164.6	21.00	3.2E-05	2.1E-03	44	2.1E+04
Lockport Prairie #4	410.415	4604.635	164.6	21.71	3.1E-05	2.0E-03	44	2.2E+04
Material Services Corporation River South	410.734	4606.417	164.6	23.46	2.9E-05	1.9E-03	44	2.3E+04
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	2.5E-05	1.7E-03	44	2.7E+04
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	1.8E-05	1.2E-03	44	3.6E+04
Keepataw Preserve	413.565	4614.291	164.6	31.80	2.0E-05	1.3E-03	44	3.3E+04
[1]Stack coordinates are	401.010	4585.070						
[2] Soil Mix Model Assumptions:								
Soil density	1500	kg/m^3						
Soil mix depth	0.01	m (= 1 cm)						

Joliet Refinery CCUP - Modeled Impacts of Project on Surface Water Concentrations

Location Name	UTM East	UTM North	Approximate Elevation (above MSL)	Distance from XOM Crude Unit Stack[1]	WATERSHED MODEL[2] Nitrogen ISC Model Deposition Rate	Nitrogen Resultant Concentration Increase, Watershed Model	Chloride ISC Model Deposition Rate	Chloride Resultant Concentration Increase, Watershed Model	Nickel ISC Model Deposition Rate	Nickel Resultant Concentration Increase, Watershed Model	Phosphorus ISC Model Deposition Rate	Phosphorus Resultant Concentration Increase, Watershed Model
	[km]	[km]	[m]	[km]	[g/m^2-yr]	[µg/l]	[g/m^2-yr]	[µg/l]	[g/m^2-yr]	[µg/l]	[g/m^2-yr]	[µg/l]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	2.0E-02	7.2E+01	2.9E-04	1.1E+00	4.4E-05	1.6E-01	6.4E-05	2.3E-01
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	7.0E-02	2.5E+02	8.2E-04	3.0E+00	1.2E-04	4.4E-01	1.8E-04	6.5E-01
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	2.4E-02	8.5E+01	9.8E-04	3.5E+00	1.5E-04	5.3E-01	2.2E-04	7.7E-01
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	7.5E-02	2.7E+02	7.1E-04	2.5E+00	1.1E-04	3.8E-01	1.6E-04	5.6E-01
Fraction Run	411.709	4602.968	164.6	20.85	3.0E-03	1.1E+01	1.5E-04	5.3E-01	2.2E-05	7.9E-02	3.2E-05	1.2E-01
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	3.7E-03	1.3E+01	1.9E-04	6.7E-01	2.8E-05	1.0E-01	4.1E-05	1.5E-01
Lockport Prairie #1	410.212	4603.771	164.6	20.84	3.7E-03	1.3E+01	2.1E-04	7.6E-01	3.2E-05	1.1E-01	4.6E-05	1.7E-01
Lockport Prairie #2	409.992	4603.796	164.6	20.77	3.7E-03	1.3E+01	2.1E-04	7.6E-01	3.2E-05	1.1E-01	4.6E-05	1.7E-01
Lockport Prairie #3	410.049	4604.030	164.6	21.00	3.7E-03	1.3E+01	2.1E-04	7.6E-01	3.2E-05	1.1E-01	4.6E-05	1.7E-01
Lockport Prairie #4	410.415	4604.635	164.6	21.71	3.7E-03	1.3E+01	2.0E-04	7.3E-01	3.1E-05	1.1E-01	4.5E-05	1.6E-01
Material Services Corporation River South	410.734	4606.417	164.6	23.46	3.7E-03	1.3E+01	1.9E-04	6.9E-01	2.9E-05	1.0E-01	4.2E-05	1.5E-01
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	2.4E-03	8.7E+00	1.7E-04	6.0E-01	2.5E-05	8.9E-02	3.6E-05	1.3E-01
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	3.0E-03	1.1E+01	1.2E-04	4.4E-01	1.8E-05	6.5E-02	2.7E-05	9.6E-02
Keepataw Preserve	413.565	4614.291	164.6	31.80	1.8E-03	6.6E+00	1.3E-04	4.8E-01	2.0E-05	7.2E-02	2.9E-05	1.1E-01

[1]Stack coordinates are 401.010 4585.070

[2] Watershed Model Assumptions:

Precipitation Depth	0.94	m/yr
Evapotranspiration Depth	0.66	m/yr

Joliet Refinery CCUP - Impacts of Project on Total Deposition Rate of N (g/m^2-yr), Annual Basis

Location Name	UTM East	UTM North	Approximate Elevation (above MSL)	Distance from XOM Crude Unit Stack[1]	1986 Nitrogen Deposition Rate	1987 Nitrogen Deposition Rate	1988 Nitrogen Deposition Rate	1989 Nitrogen Deposition Rate	1990 Nitrogen Deposition Rate
	[km]	[km]	[m]	[km]	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	**0.020**	0.018	0.002	0.012	0.007
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	0.029	0.029	**0.070**	0.040	0.016
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	0.026	0.024	**0.083**	0.040	0.014
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	**0.075**	0.030	0.024	0.019	0.074
Fraction Run	411.709	4602.968	164.6	20.85	0.001	**0.003**	0.002	0.002	0.002
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	0.001	**0.004**	0.002	0.002	0.003
Lockport Prairie #1	410.212	4603.771	164.6	20.84	0.001	**0.004**	0.002	0.002	0.004
Lockport Prairie #2	409.992	4603.796	164.6	20.77	0.001	0.003	0.002	0.001	**0.004**
Lockport Prairie #3	410.049	4604.030	164.6	21.00	0.001	0.002	0.002	0.001	**0.004**
Lockport Prairie #4	410.415	4604.635	164.6	21.71	0.001	0.003	0.002	0.001	**0.004**
Material Services Corporation River South	410.734	4606.417	164.6	23.46	0.001	0.002	0.002	0.001	**0.004**
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	0.001	0.002	0.001	0.001	**0.002**
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	0.001	0.001	0.002	0.000	**0.003**
Keepataw Preserve	413.565	4614.291	164.6	31.80	0.001	0.001	0.001	0.000	**0.002**
[1]Stack coordinates are	401.010	4585.070							

Note: Results are based on the incremental emissions between the maximum future potential emissions and the past actual emissions.

Joliet Refinery CCUP - Impacts of Project on Wet Deposition Rate of N (g/m^2-yr), Annual Basis

Location Name	UTM East	UTM North	Approximate Elevation (above MSL)	Distance from XOM Crude Unit Stack[1]	1986 Nitrogen Deposition Rate	1987 Nitrogen Deposition Rate	1988 Nitrogen Deposition Rate	1989 Nitrogen Deposition Rate	1990 Nitrogen Deposition Rate
	[km]	[km]	[m]	[km]	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	**0.010**	0.009	0.001	0.006	0.003
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	0.015	0.015	**0.035**	0.020	0.008
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	0.013	0.012	**0.041**	0.020	0.007
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	**0.037**	0.015	0.012	0.010	0.037
Fraction Run	411.709	4602.968	164.6	20.85	0.001	**0.002**	0.001	0.001	0.001
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	0.000	**0.002**	0.001	0.001	0.002
Lockport Prairie #1	410.212	4603.771	164.6	20.84	0.001	**0.002**	0.001	0.001	0.002
Lockport Prairie #2	409.992	4603.796	164.6	20.77	0.000	0.002	0.001	0.000	**0.002**
Lockport Prairie #3	410.049	4604.030	164.6	21.00	0.001	0.001	0.001	0.001	**0.002**
Lockport Prairie #4	410.415	4604.635	164.6	21.71	0.000	0.002	0.001	0.001	**0.002**
Material Services Corporation River South	410.734	4606.417	164.6	23.46	0.000	0.001	0.001	0.000	**0.002**
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	0.000	0.001	0.001	0.001	**0.001**
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	0.001	0.000	0.001	0.000	**0.002**
Keepataw Preserve	413.565	4614.291	164.6	31.80	0.000	0.000	0.001	0.000	**0.001**
[1]Stack coordinates are	401.010	4585.070							

Note: Results are based on the incremental emissions between the maximum future potential emissions and the past actual emissions.

Joliet Refinery CCUP - Impacts of Project on Dry Deposition Rate of N (g/m2-yr), Annual Basis

Location Name	UTM East	UTM North	Approximate Elevation (above MSL)	Distance from XOM Crude Unit Stack[1]	1986 Nitrogen Deposition Rate	1987 Nitrogen Deposition Rate	1988 Nitrogen Deposition Rate	1989 Nitrogen Deposition Rate	1990 Nitrogen Deposition Rate
	[km]	[km]	[m]	[km]	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]	[g/m^2-yr]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	**0.010**	0.009	0.001	0.006	0.003
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	0.015	0.015	**0.035**	0.020	0.008
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	0.013	0.012	**0.041**	0.020	0.007
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	**0.037**	0.015	0.012	0.010	0.037
Fraction Run	411.709	4602.968	164.6	20.85	0.001	**0.002**	0.001	0.001	0.001
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	0.000	**0.002**	0.001	0.001	0.002
Lockport Prairie #1	410.212	4603.771	164.6	20.84	0.001	**0.002**	0.001	0.001	0.002
Lockport Prairie #2	409.992	4603.796	164.6	20.77	0.000	0.002	0.001	0.000	**0.002**
Lockport Prairie #3	410.049	4604.030	164.6	21.00	0.001	0.001	0.001	0.001	**0.002**
Lockport Prairie #4	410.415	4604.635	164.6	21.71	0.000	0.002	0.001	0.001	**0.002**
Material Services Corporation River South	410.734	4606.417	164.6	23.46	0.000	0.001	0.001	0.000	**0.002**
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	0.000	0.001	0.001	0.001	**0.001**
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	0.001	0.000	0.001	0.000	**0.002**
Keepataw Preserve	413.565	4614.291	164.6	31.80	0.000	0.000	0.001	0.000	**0.001**
[1]Stack coordinates are	401.010	4585.070							

Note: Results are based on the incremental emissions between the maximum future potential emissions and the past actual emissions.

Joliet Refinery CCUP - Impacts of Project on Total Deposition Rate of PM_{10} (g/m^2-yr), Annual Basis

Location Name	UTM East	UTM North	Approximate Elevation (above MSL)	Distance from XOM Crude Unit Stack[1]	1986	1987	1988	1989	1990
	[km]	[km]	[m]	[km]	[g/m2/yr]	[g/m2/yr]	[g/m2/yr]	[g/m2/yr]	[g/m2/yr]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	0.035	**0.046**	0.010	0.033	0.041
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	0.047	0.052	**0.129**	0.072	0.040
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	0.040	0.039	**0.154**	0.075	0.032
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	**0.111**	0.089	0.092	0.078	0.107
Fraction Run	411.709	4602.968	164.6	20.85	0.011	0.015	0.018	0.010	**0.023**
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	0.012	0.018	0.017	0.010	**0.029**
Lockport Prairie #1	410.212	4603.771	164.6	20.84	0.012	0.018	0.017	0.008	**0.033**
Lockport Prairie #2	409.992	4603.796	164.6	20.77	0.013	0.018	0.015	0.008	**0.033**
Lockport Prairie #3	410.049	4604.030	164.6	21.00	0.012	0.018	0.015	0.007	**0.033**
Lockport Prairie #4	410.415	4604.635	164.6	21.71	0.012	0.017	0.015	0.008	**0.032**
Material Services Corporation River South	410.734	4606.417	164.6	23.46	0.012	0.015	0.012	0.007	**0.030**
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	0.009	0.015	0.013	0.007	**0.026**
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	0.013	0.007	0.010	0.006	**0.019**
Keepataw Preserve	413.565	4614.291	164.6	31.80	0.009	0.009	0.009	0.004	**0.021**
[1]Stack coordinates are	401.010	4585.070							

Note: Results are based on the incremental emissions between the maximum future potential emissions and the past actual emissions.

Joliet Refinery CCUP - Impacts of Project on Total Deposition Rate of PM_{10} (g/m^2-yr), Annual Basis

Location Name	UTM East	UTM North	Approximate Elevation (above MSL)	Distance from XOM Crude Unit Stack[1]	1986	1987	1988	1989	1990
	[km]	[km]	[m]	[km]	[g/m2/yr]	[g/m2/yr]	[g/m2/yr]	[g/m2/yr]	[g/m2/yr]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	0.004	0.005	0.007	0.005	0.005
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	0.006	0.009	0.008	0.015	0.006
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	0.008	0.009	0.009	0.019	0.010
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	0.041	0.046	0.044	0.042	0.037
Fraction Run	411.709	4602.968	164.6	20.85	0.008	0.006	0.007	0.005	0.013
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	0.008	0.006	0.007	0.005	0.013
Lockport Prairie #1	410.212	4603.771	164.6	20.84	0.008	0.005	0.008	0.005	0.013
Lockport Prairie #2	409.992	4603.796	164.6	20.77	0.008	0.005	0.007	0.005	0.012
Lockport Prairie #3	410.049	4604.030	164.6	21.00	0.007	0.005	0.007	0.005	0.013
Lockport Prairie #4	410.415	4604.635	164.6	21.71	0.007	0.005	0.007	0.005	0.013
Material Services Corporation River South	410.734	4606.417	164.6	23.46	0.006	0.004	0.006	0.005	0.011
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	0.006	0.004	0.006	0.005	0.010
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	0.004	0.003	0.005	0.005	0.009
Keepataw Preserve	413.565	4614.291	164.6	31.80	0.004	0.003	0.005	0.003	0.008
[1]Stack coordinates are	401.010	4585.070							

Note: Results are based on the incremental emissions between the maximum future potential emissions and the past actual emissions.

Joliet Refinery CCUP - Impacts of Project on Total Deposition Rate of PM_{10} (g/m^2-yr), Annual Basis

Location Name	UTM East	UTM North	Approximate Elevation (above MSL)	Distance from XOM Crude Unit Stack[1]	1986	1987	1988	1989	1990
	[km]	[km]	[m]	[km]	[g/m2/yr]	[g/m2/yr]	[g/m2/yr]	[g/m2/yr]	[g/m2/yr]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	0.031	0.041	0.003	0.028	0.036
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	0.041	0.043	0.121	0.057	0.034
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	0.032	0.030	0.145	0.056	0.022
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	0.070	0.043	0.048	0.036	0.070
Fraction Run	411.709	4602.968	164.6	20.85	0.003	0.009	0.011	0.005	0.010
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	0.004	0.012	0.010	0.005	0.016
Lockport Prairie #1	410.212	4603.771	164.6	20.84	0.004	0.013	0.009	0.003	0.020
Lockport Prairie #2	409.992	4603.796	164.6	20.77	0.005	0.013	0.008	0.003	0.021
Lockport Prairie #3	410.049	4604.030	164.6	21.00	0.005	0.013	0.008	0.002	0.020
Lockport Prairie #4	410.415	4604.635	164.6	21.71	0.005	0.012	0.008	0.003	0.019
Material Services Corporation River South	410.734	4606.417	164.6	23.46	0.006	0.011	0.006	0.002	0.019
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	0.003	0.011	0.007	0.002	0.016
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	0.009	0.004	0.005	0.001	0.010
Keepataw Preserve	413.565	4614.291	164.6	31.80	0.005	0.006	0.004	0.001	0.013
[1]Stack coordinates are	401.010	4585.070							

Note: Results are based on the incremental emissions between the maximum future potential emissions and the past actual emissions.

Joliet Refinery CCUP - Impacts of Project on Deposition Rate of HAP (g/m2-yr), Annual Basis

Location Name	UTM East	UTM North	Approximate Elevation (above MSL)	Distance from XOM Crude Unit Stack[1]	PM_{10}	Cl	Ni	P
	[km]	[km]	[m]	[km]	[g/m^2-yr]	[mg/m^2-yr]	[mg/m^2-yr]	[mg/m^2-yr]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	0.046	0.294	0.044	0.064
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	0.129	0.824	0.123	0.181
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	0.154	0.983	0.147	0.216
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	0.111	0.709	0.106	0.155
Fraction Run	411.709	4602.968	164.6	20.85	0.023	0.147	0.022	0.032
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	0.029	0.185	0.028	0.041
Lockport Prairie #1	410.212	4603.771	164.6	20.84	0.033	0.211	0.032	0.046
Lockport Prairie #2	409.992	4603.796	164.6	20.77	0.033	0.211	0.032	0.046
Lockport Prairie #3	410.049	4604.030	164.6	21.00	0.033	0.211	0.032	0.046
Lockport Prairie #4	410.415	4604.635	164.6	21.71	0.032	0.204	0.031	0.045
Material Services Corporation River South	410.734	4606.417	164.6	23.46	0.030	0.192	0.029	0.042
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	0.026	0.166	0.025	0.036
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	0.019	0.121	0.018	0.027
Keepataw Preserve	413.565	4614.291	164.6	31.80	0.021	0.134	0.020	0.029
[1]Stack coordinates are	401.010	4585.070						

Note: Results are based on the incremental emissions between the maximum future potential emissions and the past actual emissions.