Supplemental Information for the Endangered Species Impacts Assessment for the ExxonMobil Oil Corporation - Joliet Refinery Unit Reliability - Efficiency Improvement Projects

Prepared by:

ExxonMobil

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It is our understanding that the United States Environmental Protection Agency (USEPA) and the United States Fish & Wildlife Services (USFWS) are continuing to develop policy on the treatment of certain underlying provisions of the Prevention of Significant Deterioration (PSD) program, developed under the Clean Air Act (CAA) as related to the consultation process under Section 7 of the Endangered Species Act. Included in the topics for policy development is the consideration of PSD netting.

In the case of the current project, the Crude/Coker Utilization Project (CCUP), ExxonMobil has conducted a 5-year contemporaneous netting exercise in accordance with the netting provisions of the PSD program and has netted out of PSD for sulfur dioxide (SO_2). This was possible because of the contemporaneous creditable SO_2 emission reductions that were generated as a result of the recent Coker Blowdown Recovery System (CBRS) project. ExxonMobil, however, was not able to net out of PSD for oxides of nitrogen (NOx), carbon monoxide (CO), and particulate matter emissions. Therefore, PSD permitting was triggered, and as a result, ExxonMobil and the pemitting authority have addressed the recently-added Section 7 ESA consultation requirement.

The Illinois Environmental Protection Agency (IEPA) has issued a proposed construction permit, which is currently at public notice for public and USEPA review. The CBRS was installed and initially started operations in late November 2004 (for shakedown purposes), with permanent operations beginning late in February 2005. One of the objectives of the project was to generate emission reductions within the contemporaneous period that would be used for netting purposes with forthcoming projects. One requirement of the PSD netting program is that reductions must occur within the contemporaneous time period reviewed, and must occur prior to, or simultaneous to the proposed increases. In order for the reductions to be creditable for netting, they must be made federally enforceable, such as through conditions of a construction permit. The proposed CCUP construction permit includes a condition (1.3.1(a)) to ensure the operational limitations and associated emission reduction of 2,593 tons of SO_2 are federally-enforceable, and therefore creditable for netting purposes.

Under the PSD program, "netting out" results in emission rates that USEPA has deemed not significant and, as a result, there is no requirement to conduct an assessment of ambient impacts of SO_2. As USFWS has not approved of the netting concept, ExxonMobil has undertaken additional effort to model and further assess ambient impacts of SO_2 emissions from the CCUP project for purposes of the Section 7 ESA consultation. In order to conduct SO_2 modeling, ExxonMobil has utilized USEPA's ISCST3 model in the same fashion as described for other pollutants in Section 3.2.3 of the August 3, 2005 report "Endangered Species Impacts Assessment, ExxonMobil Oil Corporation, Unit Reliability - Efficiency Improvement Project", for which this report serves as a supplement to expressly address SO_2 impacts.

In the July 7, 2005 "Recommended Scope of Analysis for ExxonMobil Refinery Modification for Endangered Species Evaluation" ("the Roadmap"), the section entitled "Background Levels" specifies that "the same background information that was used for the Indeck-Elwood assessment will be acceptable for this assessment". The background levels utilized in that assessment were from 2003. As a result, the impacts of the more recent CBRS emission reductions to concentrations of SO_2 in ambient air and resultant reductions in ambient sulfur deposition were not included in background. Therefore, in conducting air dispersion and deposition modeling for SO_2, ExxonMobil has incorporated in the discussion the impacts of the CBRS project.

Table 1 shows the modeled habitat-specific average annual ambient air SO_2 concentration impacts from ExxonMobil projects. This data represents the highest annual average impact from five years of analysis (based on 1987 to 1991 meteorological data). Under worst-case conditions, the modeled impact of the CCUP project will result in ambient concentrations that are as much as 2.5% of 2003 background levels. The combined impacts of the Indeck-Elwood project (which has not yet begun construction because its permit has been stayed) and the ExxonMobil CCUP

project, when added to background, are below the 19 $\mu g/m^3$ toxicity value identified by Cambridge Environmental as part of the Indeck-Elwood analysis[1]. When the ambient SO_2 reductions resulting from the ExxonMobil CBRS project (already operational) are incorporated, ambient SO_2 levels at all locations are lower than those of Indeck-Elwood's analysis. This is due to the fact that the modeled ambient reductions from the CBRS project exceed the modeled ambient increases from the CCUP project at each location.

Table 2 shows the modeled habitat-specific, average annual sulfur deposition rate increase from the ExxonMobil projects. As with dispersion modeling, the data table reflects the highest annual average impact from the five modeled years. Cambridge Environmental and its associates have researched the literature for relevant toxicity information and have concluded that low-level sulfur additions of sulfur stimulate plant growth, and that there is nothing in the scientific literature to predict with any certainty which species would benefit more or less from low-level sulfur deposition[2,3].

For assessment purposes, Table 2 provides model results with a comparison to background. Due to its limitations, the ISCST3 model overpredicts (conservative) deposition rates in the near field. As a result, the model predicts that the ExxonMobil CCUP results in increases in sulfur deposition over 2003 background levels at a few receptor locations. However, when the beneficial impacts of the ExxonMobil CBRS project (already operational) are factored in, most locations show a net decrease in deposition rates as compared to 2003. For all receptor locations, the highest "net" modeled increase in sulfur deposition over 2003 background is 9.4% (including Indeck-Elwood). For this highest modeled receptor location, 7.8% of the 9.4% increase is directly attributable to the Indeck-Elwood project, which was deemed not likely to adversely effect the same listed threatened and endangered species at the same habitat locations.

With respect to direct effects, the modeling analysis concludes that SO_2 emissions from the proposed CCUP project result in ambient SO_2 concentrations that are not likely to adversely effect the listed threatened and endangered species. In addition, the emissions have been further pre-mitigated by the emission reductions from the CBRS project consistent with the requirements of the NSR/PSD program, which requires reductions to be in place prior to or at the same time as the increases occur.

With respect to indirect effects of SO_2 emissions, sulfur deposition rates in the near-field are modeled above background for the CCUP. However, no relevant toxicity information is in the literature by which to assess impacts of the additional deposition[2]. In addition, modeling demonstrates that, when the CBRS reductions are incorporated into the analysis, the net sulfur deposition rates attributable to ExxonMobil are slightly above (up to 1.6%), at, or below 2003 background levels. With net deposition rates below those of Indeck-Elwood in comparison to 2003 background levels, a consistent not likely to adversely effect conclusion is reasonable.

In conclusion, it is ExxonMobil's position that this exercise has further validated the concept of PSD netting.

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[1] "Ecological Risk Assessment for the Indeck Elwood Energy Center", prepared by Cambridge Environmental, April 2005, p. 7-13.

[2] "Ecological Risk Assessment for the Indeck Elwood Energy Center", prepared by Cambridge Environmental, April 2005, p. 7-14.

[3] Memorandum from Larry Kapustka of Golder Associates to Steve Zemba of Cambridge Environmental, September 9, 2005, included as Attachment B to this report.

Table 1
Comparison of Modeled Ambient Airborne Sulfur Dioxide Concentrations to Background and Relevant Toxicity Information

Location Name	Distance from ExxonMobil Crude Unit Stack	Published Representative 2003 Background	Maximum Indeck - Elwood Addition to Background Ambient SO_2	Background + Maximum Indeck-Elwood	Modeled Impact of ExxonMobil CCUP on Ambient SO_2	Maximum Combined (not including CBRS decreases) Ambient SO_2	Exceeds "Benchmark" of 19 $\mu g/m^3$	Corresponding Impact of New ExxonMobil CBRS on Ambient SO_2	Maximum Combined (including CBRS decreases) Ambient SO_2	Exceeds "Benchmark" of 19 $\mu g/m^3$
	[km]	[$\mu g/m^3$]	[$\mu g/m^3$]	[$\mu g/m^3$]	[$\mu g/m^3$]	[$\mu g/m^3$]	Yes or No	[$\mu g/m^3$]	[$\mu g/m^3$]	Yes or No
Footnote(s)		1	2		3		4	5		4
Grant Creek Prairie Preserve	5.00	10.5	1	11.5	0.221	11.7	No	-1.114	10.6	No
Drummond Dolomite Prairie (XOM#1)	1.32	10.5	1	11.5	0.164	11.6	No	-0.900	10.7	No
Drummond Dolomite Prairie (XOM#2)	1.13	10.5	1	11.5	0.134	11.6	No	-0.870	10.7	No
Drummond Dolomite Prairie (USFW - MNTP)	0.86	10.5	1	11.5	0.092	11.6	No	-0.688	10.9	No
Fraction Run	20.85	10.5	1	11.5	0.261	11.7	No	-0.440	11.3	No
Dellwood Park Prairie	20.85	10.5	1	11.5	0.254	11.7	No	-0.428	11.3	No
Lockport Prairie #1	20.84	10.5	1	11.5	0.252	11.7	No	-0.417	11.3	No
Lockport Prairie #2	20.77	10.5	1	11.5	0.251	11.7	No	-0.414	11.3	No
Lockport Prairie #3	21.00	10.5	1	11.5	0.248	11.7	No	-0.408	11.3	No
Lockport Prairie #4	21.71	10.5	1	11.5	0.242	11.7	No	-0.394	11.3	No
Material Services Corporation River South	23.46	10.5	1	11.5	0.223	11.7	No	-0.351	11.3	No
Long Run Seep Nature Preserve	26.26	10.5	1	11.5	0.206	11.7	No	-0.317	11.3	No
Romeoville Prairie Nature Preserve	27.36	10.5	1	11.5	0.179	11.6	No	-0.294	11.3	No
Keepataw Preserve	31.80	10.5	1	11.5	0.163	11.6	No	-0.238	11.4	No

[1] 2003 mean annual concentration for Joliet station, from "Illinois Annual Air Quality Report, 2003", August 2004, document IEPA/BOA/04-019.

[2] "Ecological Risk Assessment for the Indeck Elwood Energy Center", Cambridge Environmental, April 2005, page 7-13.

[3] For each receptor location, highest one-year average CCUP modeled impact to ambient air SO_2 concentrations from 5 years of meteorological data (1986 to 1990).

[4] "Benchmark" implies "relevant long-term toxicity information". The 19 $\mu g/m^3$ value is an effect threshold for two species of moss, as documented in "Ecological Risk Assessment for the Indeck Elwood Energy Center", Cambridge Environmental, April 2005, page 7-14.

[5] For each receptor location, corresponding impact of CBRS project on ambient air SO_2 concentrations for the same year as CCUP highest impact.

Table 2
Comparison of Modeled Sulfur Deposition to Background Levels

Location Name	Distance from ExxonMobil Crude Unit Stack	Published Representative 2003 Background S Deposition Rate	Maximum Indeck - Elwood Addition to Background Ambient S Deposition Rate	Background + Maximum Indeck-Elwood S Deposition Rate	Modeled Impact of ExxonMobil CCUP on S Deposition Rate	Maximum Combined (not including CBRS decreases) S Deposition Rate	% Increase in S Deposition Rate over 2003 Background + Indeck Elwood (not including CBRS decreases)	Corresponding Impact of New CBRS on S Deposition Rate[2]	Maximum Combined (including CBRS decreases) S Deposition Rate	% Increase in S Deposition Rate over 2003 Background	% Increase in S Deposition Rate over 2003 Background without Indeck Elwood (including CBRS decreases)
	[km]	g/m^2-yr	g/m^2-yr	g/m^2-yr	g/m^2-yr	g/m^2-yr	%	g/m^2-yr	g/m^2-yr	%	%
Footnote(s)		1	2		3		4	5		4	4
Grant Creek Prairie Preserve	5.00	0.800	0.036	0.837	0.078	0.915	9.4%	-0.107	0.808	1.0%	-3.5%
Drummond Dolomite Prairie (XOM#1)	1.32	0.800	0.072	0.872	0.272	1.144	31.1%	-1.002	0.142	-82.2%	-91.2%
Drummond Dolomite Prairie (XOM#2)	1.13	0.800	0.063	0.863	0.316	1.179	36.6%	-0.303	0.876	9.4%	1.6%
Drummond Dolomite Prairie (USFW - MNTP)	0.86	0.800	-	0.800	0.189	0.990	23.6%	-1.118	-0.128	-116.0%	-
Fraction Run	20.85	0.800	0.010	0.811	0.013	0.823	1.5%	-0.014	0.809	1.1%	-0.2%
Dellwood Park Prairie	20.85	0.800	0.011	0.811	0.015	0.826	1.8%	-0.014	0.812	1.4%	0.1%
Lockport Prairie #1	20.84	0.800	0.012	0.813	0.014	0.827	1.7%	-0.011	0.816	1.9%	0.4%
Lockport Prairie #2	20.77	0.800	0.012	0.813	0.016	0.828	1.9%	-0.017	0.812	1.4%	-0.1%
Lockport Prairie #3	21.00	0.800	-	0.800	0.016	0.816	2.0%	-0.017	0.800	-0.1%	-
Lockport Prairie #4	21.71	0.800	-	0.800	0.015	0.815	1.9%	-0.016	0.800	-0.1%	-
Material Services Corporation River South	23.46	0.800	-	0.800	0.014	0.815	1.8%	-0.014	0.800	0.0%	-
Long Run Seep Nature Preserve	26.26	0.800	0.006	0.807	0.009	0.816	1.1%	-0.008	0.809	1.0%	0.2%
Romeoville Prairie Nature Preserve	27.36	0.800	-	0.800	0.011	0.811	1.4%	-0.010	0.801	0.1%	-
Keepataw Preserve	31.80	0.800	0.0005	0.801	0.008	0.809	1.0%	-0.008	0.801	0.1%	0.0%

[1] Background S deposition rate from Bondville, IL NADP data, 0.80048 g/m^2-yr.

[2] S deposition rates for 9 receptor locations reported in Table 4-3 of "Ecological Risk Assessment for the Indeck Elwood Energy Center", Cambridge Environmental, April 2005, p. 4-6. Selected highest annual mean deposition from five years of modeling analysis.

[3] Total deposition rate using ISC Model (Highest one-year average CCUP modeled wet S deposition impact from 5 years of meteorological data, 1986 to 1990) to determine wet deposition rate, assuming 60% of total deposition is wet deposition, based on discus

[4] No relevant S deposition toxicity information was identified by Cambridge Environmental ("Ecological Risk Assessment for the Indeck Elwood Energy Center", Cambridge Environmental, April 2005, p. 7-14), thus have provided a comparison to background + Indeck Elwood.

[5] Corresponding impact of CBRS project on wet S deposition for the same year as CCUP highest impact, same assumption regarding total deposition calculated from wet deposition.

ATTACHMENT A

Complete Set of SO_2 Model Results

Joliet Refinery CCUP - Annual Impacts of SO2 (ug/m3)

Location Name	UTM East [km]	UTM North [km]	Approximate Elevation (above MSL) [m]	Distance from XOM Crude Unit Stack* [km]	1987 [ug/m3]	1988 [ug/m3]	1989 [ug/m3]	1990 [ug/m3]	1991 [ug/m3]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	0.170	0.221	0.180	0.149	0.168
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	0.103	0.114	0.164	0.097	0.114
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	0.101	0.119	0.134	0.110	0.107
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	0.080	0.092	0.077	0.075	0.060
Fraction Run	411.709	4602.968	164.6	20.85	0.174	0.177	0.129	0.261	0.220
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	0.176	0.174	0.127	0.254	0.215
Lockport Prairie #1	410.212	4603.771	164.6	20.84	0.163	0.163	0.128	0.252	0.211
Lockport Prairie #2	409.992	4603.796	164.6	20.77	0.157	0.159	0.128	0.251	0.210
Lockport Prairie #3	410.049	4604.030	164.6	21.00	0.154	0.157	0.127	0.248	0.207
Lockport Prairie #4	410.415	4604.635	164.6	21.71	0.153	0.154	0.124	0.242	0.203
Material Services Corporation River South	410.734	4606.417	164.6	23.46	0.130	0.139	0.116	0.223	0.185
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	0.136	0.135	0.107	0.206	0.176
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	0.094	0.119	0.105	0.179	0.136
Keepataw Preserve	413.565	4614.291	164.6	31.80	0.089	0.103	0.090	0.163	0.134

*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 Flares - Annual Impacts of SO2 (ug/m3)

Location Name	UTM East [km]	UTM North [km]	Approximate Elevation (above MSL) [m]	Distance from XOM Crude Unit Stack* [km]	1987 [ug/m3]	1988 [ug/m3]	1989 [ug/m3]	1990 [ug/m3]	1991 [ug/m3]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	-1.158	-1.114	-1.157	-0.791	-0.897
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	-0.770	-0.930	-0.900	-0.627	-0.840
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	-0.705	-0.865	-0.870	-0.743	-0.628
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	-0.514	-0.688	-0.461	-0.439	-0.426
Fraction Run	411.709	4602.968	164.6	20.85	-0.363	-0.316	-0.243	-0.440	-0.394
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	-0.346	-0.305	-0.239	-0.428	-0.376
Lockport Prairie #1	410.212	4603.771	164.6	20.84	-0.302	-0.286	-0.236	-0.417	-0.365
Lockport Prairie #2	409.992	4603.796	164.6	20.77	-0.287	-0.282	-0.237	-0.414	-0.360
Lockport Prairie #3	410.049	4604.030	164.6	21.00	-0.281	-0.277	-0.234	-0.408	-0.354
Lockport Prairie #4	410.415	4604.635	164.6	21.71	-0.276	-0.269	-0.225	-0.394	-0.344
Material Services Corporation River South	410.734	4606.417	164.6	23.46	-0.228	-0.237	-0.206	-0.351	-0.303
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	-0.233	-0.221	-0.179	-0.317	-0.280
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	-0.175	-0.192	-0.180	-0.294	-0.234
Keepataw Preserve	413.565	4614.291	164.6	31.80	-0.147	-0.162	-0.146	-0.238	-0.205

*Stack coordinates are 401.010 4585.070

Note: Results are based on the incremental emissions before and after the coker blowdown recovery project.

Joliet Refinery CCUP - Annual Wet Deposition Rate of SO2 (g/m2/yr)

Location Name	UTM East [km]	UTM North [km]	Approximate Elevation (above MSL) [m]	Distance from XOM Crude Unit Stack* [km]	1986		1987		1988		1989		1990	
					SO2 Deposition Rate [g/m2/yr]	S Deposition Rate [g/m2/yr]	SO2 Deposition Rate [g/m2/yr]	S Deposition Rate [g/m2/yr]	SO2 Deposition Rate [g/m2/yr]	S Deposition Rate [g/m2/yr]	SO2 Deposition Rate [g/m2/yr]	S Deposition Rate [g/m2/yr]	SO2 Deposition Rate [g/m2/yr]	S Deposition Rate [g/m2/yr]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	0.094	0.047	0.079	0.040	0.010	0.005	0.057	0.029	0.033	0.017
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	0.144	0.072	0.129	0.065	0.326	0.163	0.185	0.093	0.088	0.044
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	0.101	0.051	0.112	0.056	0.379	0.190	0.184	0.092	0.058	0.029
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	0.227	0.114	0.142	0.071	0.176	0.088	0.125	0.063	0.204	0.102
Fraction Run	411.709	4602.968	164.6	20.85	0.007	0.004	0.015	0.008	0.009	0.005	0.011	0.006	0.011	0.006
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	0.005	0.003	0.018	0.009	0.010	0.005	0.009	0.005	0.015	0.008
Lockport Prairie #1	410.212	4603.771	164.6	20.84	0.004	0.002	0.017	0.009	0.011	0.006	0.007	0.004	0.018	0.009
Lockport Prairie #2	409.992	4603.796	164.6	20.77	0.004	0.002	0.016	0.008	0.011	0.006	0.006	0.003	0.019	0.010
Lockport Prairie #3	410.049	4604.030	164.6	21.00	0.004	0.002	0.015	0.008	0.011	0.006	0.006	0.003	0.019	0.010
Lockport Prairie #4	410.415	4604.635	164.6	21.71	0.004	0.002	0.015	0.008	0.010	0.005	0.006	0.003	0.018	0.009
Material Services Corporation River South	410.734	4606.417	164.6	23.46	0.004	0.002	0.011	0.006	0.009	0.005	0.004	0.002	0.017	0.009
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	0.003	0.002	0.011	0.006	0.008	0.004	0.005	0.003	0.012	0.006
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	0.005	0.003	0.005	0.003	0.008	0.004	0.001	0.001	0.013	0.007
Keepataw Preserve	413.565	4614.291	164.6	31.80	0.002	0.001	0.005	0.003	0.006	0.003	0.002	0.001	0.010	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 Flares - Annual Wet Deposition Rate of SO2 (g/m2/yr)

Location Name	UTM East [km]	UTM North [km]	Approximate Elevation (above MSL) [m]	Distance from XOM Crude Unit Stack* [km]	1986		1987		1988		1989		1990	
					SO2 Deposition Rate [g/m2/yr]	S Deposition Rate [g/m2/yr]	SO2 Deposition Rate [g/m2/yr]	S Deposition Rate [g/m2/yr]	SO2 Deposition Rate [g/m2/yr]	S Deposition Rate [g/m2/yr]	SO2 Deposition Rate [g/m2/yr]	S Deposition Rate [g/m2/yr]	SO2 Deposition Rate [g/m2/yr]	S Deposition Rate [g/m2/yr]
Grant Creek Prairie Preserve	400.481	4580.099	181.5	5.00	-0.128	-0.064	-0.124	-0.062	-0.051	-0.026	-0.063	-0.032	-0.036	-0.018
Drummond Dolomite Prairie (XOM#1)	401.597	4583.886	181.5	1.32	-0.152	-0.076	-0.163	-0.082	-1.202	-0.601	-0.379	-0.190	-0.179	-0.090
Drummond Dolomite Prairie (XOM#2)	401.709	4584.188	181.5	1.13	-0.374	-0.187	-0.271	-0.136	-0.364	-0.182	-0.216	-0.108	-0.354	-0.177
Drummond Dolomite Prairie (USFW - MNTP)	401.729	4584.605	181.5	0.86	-1.341	-0.671	-0.942	-0.471	-0.263	-0.132	-0.722	-0.361	-0.695	-0.348
Fraction Run	411.709	4602.968	164.6	20.85	-0.005	-0.003	-0.017	-0.009	-0.009	-0.005	-0.010	-0.005	-0.013	-0.007
Dellwood Park Prairie	410.818	4603.467	164.6	20.85	-0.004	-0.002	-0.017	-0.009	-0.010	-0.005	-0.007	-0.004	-0.017	-0.009
Lockport Prairie #1	410.212	4603.771	164.6	20.84	-0.005	-0.003	-0.013	-0.007	-0.011	-0.006	-0.005	-0.003	-0.020	-0.010
Lockport Prairie #2	409.992	4603.796	164.6	20.77	-0.005	-0.003	-0.012	-0.006	-0.011	-0.006	-0.004	-0.002	-0.020	-0.010
Lockport Prairie #3	410.049	4604.030	164.6	21.00	-0.005	-0.003	-0.011	-0.006	-0.010	-0.005	-0.004	-0.002	-0.020	-0.010
Lockport Prairie #4	410.415	4604.635	164.6	21.71	-0.005	-0.003	-0.011	-0.006	-0.010	-0.005	-0.004	-0.002	-0.019	-0.010
Material Services Corporation River South	410.734	4606.417	164.6	23.46	-0.005	-0.003	-0.008	-0.004	-0.009	-0.005	-0.002	-0.001	-0.017	-0.009
Long Run Seep Nature Preserve	412.543	4608.660	164.6	26.26	-0.003	-0.002	-0.009	-0.005	-0.008	-0.004	-0.003	-0.002	-0.013	-0.007
Romeoville Prairie Nature Preserve	410.597	4610.692	164.6	27.36	-0.007	-0.004	-0.005	-0.003	-0.008	-0.004	-0.001	-0.001	-0.012	-0.006
Keepataw Preserve	413.565	4614.291	164.6	31.80	-0.003	-0.002	-0.004	-0.002	-0.006	-0.003	-0.001	-0.001	-0.010	-0.005

*Stack coordinates are 401.010 4585.070

Note: Results are based on the incremental emissions before and after the coker blowdown recovery project.

ATTACHMENT B

Golder Associates Memorandum on Sulfur Emission on Plants
September 9, 2005

TECHNICAL MEMORANDUM

Golder Associates Ltd.
1000, 940 – 6th Avenue SW
Calgary, AB, Canada T2P 3T1

Telephone: 403-299-5600
Fax Access: 403-299-5606

TO: Steve Zemba

DATE: 9 Septem ber 2005

FROM: Larry Kapustka

JOB NO: 051-335015

EMAIL: Larry_Kapustka@golder.com

RE: ExxonMobil's Joliet Refinery:Sulfur emissions effects on plants

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This memorandum reports on the generic effects of sulphur emissions on plants, with specific attention given to the likely long-term consequences of deposition to soils in the vicinity of the ExxonMobil Joliet Refinery, Illinois. The issues are of importance in terms of ongoing consultations between ExxonMobil and its consultants with regulatory authorities form the U.S. EPA, Illinois EPA, and U.S. Fish and Wildlife Service; here the primary concern relates to T& E plant species covered under the Threatened and Endangered Species Act.

An extensive body of literature can be found on the adverse effects of SO_2 on plants, for example, the Wisconsin Department of Natural Resources (http://www.dnr.state.wi.us/org/aw/air/health/sulfurdiox.htm) summarizes effects as

> "Sulfur dioxide easily injures many plant species and varieties, both native and cultivated. Some of the most sensitive plants include various commercially valuable pines, legumes, red and black oaks, white ash, alfalfa and blackberry. The effects include:
>
> - Visible injury to the most sensitive plants at exposures as low as 0.12 ppm for 8 hours.
> - Visible injury to many other plant types of intermediate sensitivity at exposures of 0.30 ppm for 8 hours.
> - Positive benefits from low levels, in a very few species growing on sulfur deficient soils."

Regulatory levels of air concentrations over short-term and long-term periods have been established (e.g., http://www.euro.who.int/document/aiq/10effso2.pdf). The direct effects

of SO_2 on plants have been documented in numerous laboratory and field studies. Here we are concerned with the possible adverse effects of sulphate accumulation in soils.

Chemical transformation of SO_2 to H_2SO_3 (sulphurous acid) and then to H_2SO_4 occurs in the atmosphere leading to deposition of $SO_4^=$. Emissions of H_2S also lead to formation of $SO_4^=$. The questions of interest relate to the expected direct and indirect effects that increases in sulphate in soil have on T&E species: Are there direct adverse effects of sulphate to plants? Are there differential responses among speices such that competitive advantages might shift in favour of weedy species that in turn crowd out T&E species?

DIRECT EFFECTS OF SULFATE DEPOSITION/ACCUMULATION IN SOIL

The most commonly cited consequence of sustained $SO_4^=$ deposition on soils pertains to acidification. Prominent examples include smelter emissions such as those near Sudbury, Ontario in which over years of exposure soil pH plummeted to levels that are directly toxic to plants and greatly enhance bioavailability of endogenous and exogenous metals. In those situations, SO_2 emissions were at acutely toxic levels exhibiting direct mortality to plants in the area, leading to "moonscapes" as the Sudbury area was described. One common characteristics of the soils in which SO_2 emissions have resulted in chronic acidification has been the low buffering capacity of the parent material. Areas surrounding smelters that have moderate to high buffering capacity, even after years of acute SO_2 toxicity to plants have not experienced marked acidification of soils. The dolomitic soils of the Joliet, IL area have high buffering capacity, and as such are not prone to acidification, especially at the current and projected SO_2 emissions levels.

INDIRECT EFFECTS OF SULFATE DEPOSITION/ACCUMULATION IN SOIL

Sulfur is a required nutrient for all organisms. It occurs as a consitituent of several amino acids and thus is crucial for synthesis of protein; it also is part of the molecular structure of some enzyme cofactors (vitamins for heterotrophs). Uptake and assimilation of sulfur occurs in plants as sulfate. Various bacteria and fungi play critical roles in transformations of organic and inorganic sulfur in the rather complex biogeochemical cycle. Though sulfur is essential, it is extremely rare for it to be limiting for growth or survival of plants. This reality is reflected in the common composition of fertilizers: the typical order of importance for improving fertility is nitrogen, followed by phosphorus, then potassium (N:P:K) and often with some substance to adjust pH (e.g., lime). If micronutrients are added as fertilizer, the sulfur is often provided as a metal salt such as $CuSO_4$. In terms of levels of S for plant growth, horticultural guidelines (see the following table from http://aggie-horticulture.tamu.edu/plantanswers/turf/publications/fertil.html) for most turfgrass indicates the range from low to high as <8 to >25 ppm S. Note that there is no S listing for "very high" or "very low." These data conform to the scientific consensus that S is seldom limiting and it is seldom in great excess to the level of causing toxic effects; exceptions would be associated with spills of S or around mineral deposits, but not likely from low-level (i.e., <acutely toxic emission levels) deposition.

Fertilization Requirements

Soil Test Levels

	PPM				
	Very High	**High**	**Medium**	**Low**	**Very Low**
Nitrogen (NO_x)		**>10**	5-10	<5	
Phosphorus (P)	>40	**21-40**	11-20	5-10	<5
Potassium	>300	179-300	**121-175**	70-120	<70
Calcium	>3560	751-3560	461-750	180-460	**<180**
Magnesium		>100	50-100	**<50**	
Sulfur		>25	**8-25**	<8	
Zinc		>0.8	**0.3-0.8**	<0.3	
Iron		>4.2	3.2-4.2	**<3.2**	
Manganese		>1.5	1-1.5	**<1.0**	

Bold - Levels needed for most turfgrasses

Without a lot of site-specific experimentation, it is not possible to state absolutely that there would be no shifts in competitive advantage among species in plant communities, including those supporting the T&E species of interest at this site. That is because ecological systems are dynamic and as such always subject to changes in successional trajectory. But likewise, there is nothing to suggest that low level S deposition rates would be expected to trigger such shifts.