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STATE OF ILLINOIS
POLLUTION CONTROL BOARD

BEFORE THE POLLUTION CONTROL BOARD
OF THE STATE OF ILLINOIS

IN THE MATTER OF:	)	
	)	R97-28
SITE SPECIFIC PETITION OF	)	(Water - Regulatory)
MOBIL OIL CORPORATION FOR	)	
RELIEF FROM 35 ILL. ADM. CODE 304.122,	)	
AMMONIA NITROGEN EFFLUENT STANDARDS	)	

NOTICE OF FILING

To: See Attached Service List

PLEASE TAKE NOTICE that this day I have filed with the Illinois Pollution Control Board a **PETITION FOR SITE-SPECIFIC RELIEF FROM 35 ILL. ADM. CODE 304.122, AMMONIA NITROGEN EFFLUENT STANDARDS** on behalf of Mobil Oil Corporation. Copies are attached and served upon you.

Respectfully submitted,

By: [signature]

Dated: April 24, 1997

ROSS & HARDIES
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THIS FILING IS SUBMITTED ON RECYCLED PAPER

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PETITION FOR SITE-SPECIFIC RELIEF
FROM 35 ILL. ADM. CODE 304.122,
AMMONIA NITROGEN EFFLUENT STANDARDS

The Mobil Oil Corporation (Mobil), by and through its attorneys, Ross & Hardies, files this petition to seek site-specific relief from 35 Ill. Adm. Code 304.122 and to propose site-specific effluent standard for discharges from Mobil's Joliet, Illinois' refinery.

BACKGROUND AND DESCRIPTION OF THE RELIEF SOUGHT

1. On January 7, 1988, the Illinois Pollution Control Board ("Board") granted Mobil site-specific relief from the ammonia nitrogen standard of 35 Ill. Adm. Code 304.122. (In the matter of: Proposal of Mobil Oil Corporation to Amend the Water Pollution Regulations, R84-16, January 7, 1988) The Board adopted Section 304.214 which included ammonia nitrogen effluent standards applicable only to the Joliet refinery in its discharge to the Des Plaines River but provided that those site-specific standards would terminate as of December 31, 1993.

2. On August 18, 1993, Mobil petitioned the Board for a variance from Section 304.122, identifying continuing nitrification problems caused by the inclusion of

THIS FILING SUBMITTED ON RECYCLED PAPER treatment equipment mandated under the Resource Conservation and Recovery Act and NESHAPs regulations. On March 3, 1994, the Board granted this variance, which is effective from March 3, 1994 to March 3, 1998 and allows a monthly average effluent ammonia concentration of 13 mg/l and a daily maximum of 26 mg/l. (Mobil Oil Corporation v. Illinois Environmental Protection Agency, PCB 93-151) This variance also required Mobil either file a compliance plan with the Illinois Environmental Protection Agency ("Agency") by March 3, 1996 or to file a petition to seek permanent relief by May 3, 1996. (A copy of the order is attached as Exhibit I)

3. On April 16, 1996, Mobil filed a petition to extend the end date of the variance until March 3, 1999 and to extend the date for filing for an alternate standard until May 3, 1997. The Board granted this extension on August 15, 1996. (Mobil Oil Corporation v. Illinois Environmental Protection Agency, PCB 96-218)

4. As will be described in greater detail below, Mobil has made strenuous efforts to identify the source of its nitrification problems and to determine treatment methods to comply with the Board's ammonia nitrogen effluent standards. Mobil has spent nearly $7.8 million on upgrades to its treatment facility in order to meet consistently the Board's effluent standards. Although Mobil's current treatment facility is now able to achieve the required effluent standard for periods of time, knowledge of the unstable nature of the nitrification process and statistical analysis of effluent results indicates that the facility still cannot consistently comply with the Board's standard. Despite these efforts, Mobil has not identified a technologically reasonable and economically feasible ammonia nitrogen treatment

system which will be guaranteed to achieve the required effluent values. Therefore, Mobil now files this petition to seek permanent site-specific relief.

5. Mobil seeks to revise current Section 304.214 as follows:

Section 304.214

a) This Section applies to discharges from Mobil Oil Corporation's Refinery, located near Joliet, into the Des Plaines River.

b) The requirements of Section 304.122(b) shall not apply to Mobil's discharge. Instead Mobil's discharge shall not exceed the following limitations:

CONSTITUENT	CONCENTRATION (mg/l)
Ammonia Nitrogen	
~~Monthly Average~~	~~20~~
~~Daily Composite~~	~~35~~
<u>Monthly Average</u>	<u>9.0</u>
<u>Daily Maximum</u>	<u>23.0</u>

c) Section 304.104(a) shall not apply to this Section. Monthly average and daily composites are as defined in Section 304.104(b).

d) Mobil shall monitor the nitrogen concentration of its oil feedstocks and report on an annual basis such concentrations to the Agency. The report shall be filed with the Agency by January 31 of each year.

~~e) The provisions of this Section shall terminate on December 31, 1993.~~

DESCRIPTION OF THE FACILITY

6. Mobil owns and operates a petroleum refinery located on Arsenal Road near Interstate 55 in Channahon Township, Will County, Illinois, with access to the southern bank of the Des Plaines River. This location is approximately 10 miles southwest of Joliet and 45 miles southwest of Chicago.

7. The Joliet Refinery is Mobil's newest domestic refining facility, beginning operations in early 1973. It has a rated capacity of 200,000 barrels of crude oil throughput per operating day and employs approximately 575 persons. The refinery has been uniquely designed to process high sulfur and high nitrogen North American crudes, which currently comprise 70% of total throughput. Designated a "conventional fuels" refinery, its principal products are motor gasolines and distillate fuel oil. Other products include kerosene jet fuel, propane, petroleum coke, sulfur, and some heavy fuel oil. The products produced at Joliet Refinery are primarily transported by pipeline or barge for marketing in Illinois and other midwestern states.

8. The refinery uses Des Plaines River water for boiler feed, cooling tower make-up, and non-contact cooling. Well water is used for drinking, sanitary purposes, and general services. Separate sewer systems have been provided to segregate the various types of water discharged into the Des Plaines River. These include clean stormwater (Outfall 003), noncontact cooling water (Outfall 002), and process water which is treated at the refinery's wastewater treatment facility before release to the river (Outfall 001). Advanced water conservation practices were incorporated in the refinery design, including:

- Extensive Air Cooling

- Cooling Tower Recycle to Minimize Blowdown
- Steam Condensate Recovery
- Condensate Reuse for Process Water
- Stripped Sour Water Reused for Crude Desalting and Process Wash Water
- Self Contained Coker Water System

9. In fact, only 14 gallons of water are used per barrel of crude refined. This compares with an average of 39 gallons per barrel for the calculated U.S. EPA Best Available Technology economically achievable (BAT) flow for a refinery of Joliet's size. However, the conservation efforts inevitably result in more concentrated effluent. In the case of Mobil Refinery, the multiple between allowable BAT flow and the actual flow is 2.8 (39 gal/BBL/14 gal/BBL). If a similar ratio were applied to the existing ammonia nitrogen standard, it would result in an "equivalent" increase from 3.0 mg/1 to 8.4 mg/1.

WASTEWATER TREATMENT

10. An average of about 1900 gallons per minute (GPM) of process wastewater and contaminated surface run-off is processed through the Refinery Wastewater Treatment Plant (WWTP), shown in Figure I. This is mainly accomplished by a program to increase cooling tower recycling and in-plant water reuse, thereby lessening water discharge to the sewer. In comparison, the calculated U.S. EPA Best Available Technology economically achievable (BAT) guidelines flow for a refinery of Joliet's size and configuration is about 5200 gpm.

11. The Waste Water Treatment process consists of:

- Sour Water Stripper - Primary removal of ammonia and sulfide

●	Desalter	-	Partial removal of phenolics and in-plant water reuse
●	TK 103	-	Primary equalization
●	Benzene Air Stripper	-	Removal of benzene, sulfide, and volatile organics
●	API Oil Separator	-	Primary oil and solids removal
●	Dissolved Air Flotation	-	Residual oil and solids removal
●	Equalization Biological Unit Treatment	-	Secondary equalization, aggressive phenolic removal and partial COD removal
●	Two Aeration Basins	-	Conventional activated sludge system for ammonia, organics, cyanide, and other pollutant removal
●	Two Clarifiers	-	Solids removal
●	Guard Basin	-	Final retention basin
●	Aeration Cone	-	Saturation with oxygen

12. The WWTP discharge is maintained in compliance with all applicable federal and state limitations except for previously noted exceedences of the ammonia nitrogen standard which led to the filing of the variance. With the exception of the facility's ammonia nitrogen monthly average in January, 1995 (caused by an upset in another treatment unit), and March and April of 1996 (caused by a release from a product storage unit) Mobil has complied with its variance limitations from March 1994 to the present.

13. Mobil's waste water treatment facilities are operated well within BAT guidelines. The following is an outline of the BAT requirements and Mobil's practices:

BAT REQUIREMENT * ____________________ MOBIL'S PRACTICE

•	Sour Water Stripper (SWS) sulfur & ammonia removal min. efficiency at 85%		15 MBBL/day at 99.5% efficiency
•	In-Plant Water Reuse	1) 2)	From SWS to Desalter From SWS to Fluid Catalytic Cracker
•	Flow Equalization	1) 2) 3)	Primary Equalization - 4.2 MM gal TK 103 Secondary Equalization - 5.8 MM gal Equalization Biological Treatment Unit Wet Weather Diversion Basin - 1.6 MM gal
•	Oil and Solids Separation	1) 2)	Dual Channel Preseparator Flume Dual Channel API Separator
•	Additional Oil/Solids Separation		Dual Channel Dissolved Air Flotation
•	Biological Treatment		1) Two 900 M gal Aeration Basins 2) Two 500 M gal Clarifiers
•	Final Polishing		1) One 4.9 MM gal Guard Basin for Treated Process Water 2) One 5.8 MM gal Uncontaminated Storm Water Impoundment Basin

* Development Document for Effluent Limitation Guidelines and Standards for the Petroleum Refinery Point Source Category, EPA 440/1-82-014, October, 1982, 64-65.

14. The WWTP is operated and supervised by the K-Operator licensed staff, which is assisted, on full-time basis, by a process engineer. The WWTP engineer's duties include routine parameter monitoring and special project implementation aimed at the plant efficiency optimization. Mobil has contracted Nalco Chemical Company to provide

bioaugmentation services for the WWTP, when required. In this process, specialty bacteria are added to the Activated Sludge system to enhance the removal of organic material and ammonia.

AMMONIA REDUCTION PROGRAM

15. In 1990, Mobil constructed a Benzene Stripping Unit (BRU), as required by RCRA. The unit removes benzene and other volatile hydrocarbons from the major portion of the process water, as well as a substantial amount of sulfide. Similarly, in 1991, upon the listing of F037 and F038 sludges, an equalization basin was converted to an Equalization Biological Treatment Unit. The conversion resulted in additional pretreatment of the process water. However, the cumulative effect of RCRA and NESHAPS changes appears to have enhanced nitrification inhibition.

16. The performance of the WWTP has progressively improved from the start up in 1973 to the present as shown in Exhibit II. From March, 1994 to February, 1997, the WWTP ammonia reduction averaged about 83% and achieved 5.0 mg/l average effluent concentration. The monthly limitation of 13 mg/l was exceeded only in January, 1995 and March and April of 1996. The 1995 exceedance was directly attributable to a malfunction in a Sand Filtration system in the Merox Gasoline Treating Unit, which resulted in intermittent carry over of small amounts of spent caustic into Process Water system. The spent caustic is normally segregated from the Process Water, because of its high pH, phenol and cyanide content, all of which are known to inhibit the nitrification process. However, since this incident, the Refinery has installed a caustic free Merox Gasoline Treating Unit, thus precluding a recurrence of a similar incident. The 1996 exceedence occurred when 100

gallons of diethanol amine (DEA) was drained to a process sewer instead of a holding tank. Maintenance procedures were reviewed and revised to ensure that this event would not reoccur. The daily maximum limitation of 26 mg/l was not exceeded in the first incident but was exceeded in the second incident. The WWTP performance for the period March 8, 1994 through February, 1997 is shown in Exhibit III.

RESULTS OF NITRIFICATION OPTIMIZATION STUDY

17. In seeking the variance in PCB 93-151, Mobil pledged to perform a detailed nitrification optimization study. The variance required that Mobil submit progress reports every six months detailing completed and anticipated events in the study and any process changes made to reduce ammonia nitrogen discharge. So far, Mobil has submitted six progress reports detailing the outcome of the activities listed in Exhibit IV.

18. The reports describe the extent of the investigation and the numerous changes Mobil has made to its waste water treatment system as a result of its findings. The first progress report, dated September 14, 1994, reported that the existing aeration basins were found oxygen deficient at peak loading. In order to correct this deficiency as soon as possible, Mobil obtained a construction permit (Permit No. 1995-EN-3140), from the IEPA on May 9, 1995, to replace the existing mechanical aerators with a fine bubble diffuser network. Additionally, in order to upgrade the existing activated sludge system further, the clarifier internals were changed from suction riser pipe configuration to a more efficient bottom suction header configuration. These mechanical upgrades have already been implemented in both the west and east sides of the activated sludge system.

19. The third Ammonia Optimization Study Progress Report dated October 6, 1995, described how the biological studies referred to as MICROTOX/Nitrification Inhibition Study confirmed Mobil's contention that the installation of Benzene Reduction Unit (BRU) increased toxicity of the WWTP influent. The BRU unit was installed in September of 1990 as required by RCRA and NESHAPS regulations. Since that time, the operation of the WWTP has become less reliable. In order to avoid a recurrence of the WWTP upset caused by spent caustic which occurred in January 1995, Mobil replaced the caustic Merox Gasoline Treaters with a caustic free process. The installation of the caustic free Merox Gasoline Treater not only precludes another upset of the WWTP by spent caustic, it also partially offsets the increase in toxicity resulting from the RCRA mandated installation of the BRU unit. The caustic free Merox Treater was commissioned in June, 1995. Exhibit V shows the toxicity increase across the BRU unit and an overall decrease in toxicity subsequent to the installation of caustic free Merox Gasoline Treater.

20. The MICROTOX/Nitrification Inhibition Study also concluded that the activated sludge process is significantly inhibited by the biodegradation byproducts. Fifteen streams comprising WWTP influent, east and west clarifiers and waste water effluent were tested for nitrification inhibition. An increase in the degree of inhibition in those samples that were diluted with the waste water effluent indicated that an additional organic material, with powerful inhibitory effect, is generated during the activated sludge biodegradation process. Further support for this finding is found in the correlation between the conversion capacity of the aeration basins and the degree of nitrification inhibition in the clarifier samples. An increase in the conversion capacity (higher degree of biological activity) of the

aeration basins results in an increase in the nitrification inhibition in the clarifiers. The summary of these findings is shown in Exhibit VI.

21. Mobil investigated the feasibility of implementing an upstream process that could remove known nitrification inhibitors, such as phenols, from the WWTP influent. A process referred to as a Sour Water Stripper Tail Unit (SWSTU) was investigated from Laboratory to Pilot Plant phase. In spite of the promising results obtained under the Laboratory Study conditions, the Pilot Plant Study results indicated that the removal of phenol was not a result of catalytic oxidation, but a result of absorption by activated carbon support material. As such, the process is not commercially viable for removal of phenol from the Refinery WWTP influent. Even had this process been available, upstream reduction of organic inhibitors may not improve the WWTP performance, due to the signification inhibition caused by the biodegradation byproducts, as described above. Therefore, the investigation associated with SWSTU was discontinued.

22. Mobil retained Parsons Engineering Science to review historical ammonia nitrogen data and the nitrification studies and to draw conclusions regarding the potential for further improvement in nitrification at the facility. This report is included herein as Exhibit VII. Parsons notes that with the completion of the WWTP upgrade and the subsequent plant optimization, the performance of the WWTP has been more robust and generally more consistent. However, Parsons also concludes that in light of the autoinhibition effects, substantiated by the MICROTOX/Nitrification Inhibition Study, it is technically infeasible to assure total consistency with the Board's ammonia effluent limitation. Therefore, Mobil files this site-specific relief.

23. Since beginning the investigation, Mobil has incurred $283,000 in investigation costs to evaluate the nitrification performance of the WWTP. In addition, Mobil has spent $ 7.78 million on the upgrades to its WWTP to improve its performance and encourage more efficient nitrification. It has completely performed the studies it described in its PCB 93-151 petition.

ENVIRONMENTAL IMPACT

24. The impact of the relief on the ammonia nitrogen load in the Des Plaines River will be insignificant. Mobil commissioned a study by Huff and Huff, Inc. regarding the impact on the water quality of the Des Plaines River of the ammonia nitrogen component of the Mobil discharge at the current and proposed levels. This study is attached as Exhibit VIII. This study evaluates the size of the mixing zone and ZID available to Mobil in the Des Plaines River and identifies alternative effluent standards including both a water quality based standard and a standard based on a USEPA Guidance document used by the IEPA in setting permit limits. The report concludes that water quality based effluent standards would be significantly higher than those based on the USEPA Guidance. The report concludes that at the proposed discharge levels, river water quality would not be affected. This sampling also demonstrates that the plume of discharge does not move past the Interstate 55 Bridge which is the dividing line between the designated Secondary Contact Waterway of the Des Plaines River and the General Use Waterway in the Illinois River.

25. This information demonstrates that the continued discharge of ammonia nitrogen at the proposed effluent levels will not significantly change the levels of ammonia nitrogen in the Des Plaines or Illinois Rivers and will not threaten water quality standards for

these parameters. Thus, there will be no negative effect on the aquatic community in the Des Plaines or Illinois Rivers.

ALTERNATE TECHNOLOGIES

26. Mobil's Research and Development Department (MRDC) in Princeton, New Jersey, previously evaluated the available alternate technologies and the associated costs. That evaluation was updated by Parsons in Exhibit VII. As the Parsons report demonstrates, all of the alternative technologies have significant capital and operating costs. Further the incremental cost of removing any additional ammonia nitrogen to meet consistently the Board's standard would be significantly larger than the current cost of nitrification. Further, the optimization studies demonstrated that the other technologies will not be effective since the inhibition appears to arise also within the wastewater treatment system itself and not as a result of other waste streams.

27. The least expensive of the technologies would be breakpoint chlorination. Yet, this process carries significant personnel risks which far outweigh its utility in reducing the ammonia nitrogen levels. In addition, the Board has already acknowledged that the use of breakpoint chlorination is inappropriate since it would result in the formation of chlorinated hydrocarbons. (In the Matter of: Proposal of Mobil Oil Corporation to Amend the Water Pollution Regulations, R84-16, Final Order, January 7, 1988, p. 3.)

28. As shown in Exhibit VII, Mobil has already spent nearly $ 7.78 million on the Ammonia Optimization Study and related equipment upgrades. These costs have increased Mobil's average cost for removal per pound of ammonia by $16. If the Joliet

Refinery must further reduce ammonia in its effluent by means of alternate technology, it can only do so by incurring disproportionately high capital and operating costs. The average cost to remove an incremental pound of ammonia above the upgraded BAT system's capability would be $421/lb. This would result in an annual additional capital cost of $920,000 and operating costs of $1.4 million.

COMPLIANCE WITH FEDERAL LAW

29. Joliet Refinery's WWTP effluent parameters meet or are well below all federal effluent guidelines and standards for the appropriate petroleum refinery point source subcategory (40 CFR 419, Subpart B - Cracking Subcategory). The flow rate used in deriving BAT effluent values for the Joliet Refinery's size and process configuration has been calculated to be 5200 gpm. The calculated BAT ammonia limit is 956 lbs/day monthly average and 2104 lbs/day daily maximum. At the current Joliet Refinery flow rate of 1900 gpm, as well as the maximum hydraulic flow rate of 2500 gpm, the ammonia discharge would be well within BAT limits at requested site-specific limits as shown below.

NH_3-N mg/l	Discharge Flow Rate - GPM	NH_3-N lbs/day
9	1900	205
9	2500	270

Therefore, the Board may grant the requested relief consistent with the Clean Water Act (33 U.S.C. 1251), USEPA effluent guidelines and standards, any other Federal regulations, or any area-wide waste treatment management plan approved by the Administrator of USEPA pursuant to Section 208 of the Clean Water Act.

STATUTORY STANDARDS

30. Section 27(a) of the Act requires the Board to consider numerous factors in determining whether to issue regulations including site-specific regulations. These include: the existing physical conditions, the character of the area involved, the nature of the receiving body of water, and the technical feasibility and economic reasonableness of measuring or reducing the particular type of pollution. (415 ILCS 5/27(a)). Consideration of all of these factors supports the relief which Mobil seeks. The areas involved is primarily industrial and the receiving body of water is a Secondary Contact Water with recognized limits on its ability to support a diverse warmwater aquatic habitat use. The Uno-Ven petroleum refinery upstream of Mobil has also received site-specific relief. (In the Matter of: Petition of Uno-Ven To Amend Regulations Pertaining to Water Pollution, R93-8, December 16, 1993) Clearly the relief is consistent with the use of the waterway and the surrounding area.

31. Further, Mobil has demonstrated in this petition that the relief it seeks is consistent with the statutory requirement that the Board's regulations be technically feasible and economically reasonable. While there are technologies available to achieve complete compliance with the Board's standards, their implementation at the Joliet Refinery would be highly expensive and carry significant safety and environmental risks. The following reasons also demonstrate why the relief is consistent with technical feasibility and economic reasonableness:

- Proven and cost effective technology to insure consistent compliance with the ammonia effluent standard has not been identified, in spite of many years of intensive investigation, significant capital improvements and ammonia reduction efforts.

- Mobil's ammonia discharge has an insignificant effect on the ammonia concentration of the Des Plaines River and no deleterious environmental impact on the environment.
- Requiring compliance with the current standard would not result in any measurable progress toward lowering ammonia concentrations in the receiving waters. Mobil's contribution to river ammonia loading is a minuscule fraction of the existing river loading.
- Mobil has made extensive and strenuous efforts to meet its investigative responsibilities under its previous variance and continues to demonstrate a good faith effort to reduce effluent ammonia levels. During the term of the site-specific rule (R96-14) in effect prior to the variances granted in PCB 93-151 and 96-218, these efforts resulted in the lowest annualized average ammonia concentrations ever achieved by Joliet Refinery. During the term of the variance granted in PCB 93-151 and extended in PCB 96-218, Mobil has undertaken a significant investigation to identify and resolve the problem and has performed numerous plant upgrades in response to the findings. It has spent $283,000 on contract costs for the investigation and $7.78 million on plant upgrades. It now seeks this relief to make final any issues regarding ammonia nitrogen at the facility.

- The addition now of any system designed to upgrade Mobil's treatment plant would cost a minimum of $2.2 million in capital and would require $800,000 dollars in annual operating costs (see Exhibit VII). However, even though the break point chlorination would probably reduce ammonia concentration in the effluent, the formation of chlorinated hydrocarbons as by-products would be of great concern. Furthermore, no single system can assure that the refinery would consistently achieve 3.0 mg/1 effluent standard. Thus, if the Joliet Refinery were now required to add multiple systems in an attempt to comply with 3.0 mg/1 limitation, it would simply constitute a costly technological experiment and undue hardship in comparison to other discharges with similar effluent quality.
- The Board has previously found that site-specific relief is appropriate for the circumstances at the site. That relief only lasted five years. Although Mobil was able to improve its nitrification processes and achieve extraordinary levels of ammonia nitrogen, new regulatory requirements resulted in increased ammonia levels. Mobil has now adjusted to the new regulatory requirements and reduced ammonia levels significantly. Yet because of these other regulatory requirements, Mobil can no longer be assured that it can consistently comply with the Board's current standards. Thus the factors that supported the previous relief continue to support relief here.
- The Board should note that although Mobil has received site-specific relief and several variances in the past, Mobil has never sought to avoid its responsibility

to comply with the ammonia nitrogen standard. Mobil has spent millions of dollars in investigations and upgrades in order to achieve compliance. Further, the current problems are entirely separate from those on which the original variances and the first site-specific rule change were based. The Nitrification Optimization Study and Parsons report attached as Exhibit VIII document that the current problems arose from the installation of new treatment equipment required by federal regulations. Since this nitrification problem arises from new conditions, and is not a result of Mobil's process activities, the Board should base its decision on current conditions.

SUMMARY OF TESTIMONY

32. Mobil intends to call at least three witnesses to support this Petition. Ms. Lilliana Gachich will testify regarding the facility and treatment processes as well as Mobil's past efforts to achieve compliance. Dr. John H. Koon of Parsons Engineering Science, Inc. will testify as to Mobil's past nitrification investigations, availability of alternate technologies and the cost of attempting to implement an alternate technology. Finally Mr. James Huff of Huff and Huff, Inc. will testify as to the lack of environmental impact and the appropriateness of the proposed effluent standards.

ECONOMIC IMPACT STUDY

33. Pursuant to P.A. 87-860, Economic Impact Studies are no longer required for proposed Board regulations. Should this requirement be modified during this rulemaking, Mobil requests that the Board determine that an Economic Impact Study is not necessary. The proposed rule affects only Mobil's facility and will have no environmental

impact. The Board may determine the economic reasonableness and technical feasibility based on the technical information and cost data submitted by Mobil in this proceeding.

WHEREFORE, for the reasons stated in this petition, Mobil Oil Corporation respectfully requests the Board to grant the site specific relief requested in this petition.

Respectfully submitted

MOBIL OIL CORPORATION

By: ______________________
One of its Attorneys

DATED: April 24, 1997

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ILLINOIS POLLUTION CONTROL BOARD
March 3, 1994

MOBIL OIL CORPORATION, Petitioner, v. ILLINOIS ENVIRONMENTAL PROTECTION AGENCY, Respondent.	)	PCB 93-151 (Variance)

DAVID L. RIESER, of ROSS & HARDIES, APPEARED ON BEHALF OF PETITIONER; and

ROBB H. LAYMAN APPEARED ON BEHALF OF RESPONDENT.

OPINION AND ORDER OF THE BOARD (by J. Theodore Meyer):

This matter is before the Board on petitioner Mobil Oil Corporation's August 18, 1993 petition for variance from 35 Ill. Adm. Code 304.122, as that section relates to ammonia nitrogen effluent limitations. Mobil seeks a five-year variance for its Joliet refinery. The Illinois Environmental Protection Agency (Agency) filed its recommendation on October 27, 1993, and Mobil filed a response to that recommendation, and a request for hearing, on November 2, 1993. Hearing was held on December 29, 1993, in Joliet. No members of the public attended.

As set forth below, the Board finds that Mobil would suffer an arbitrary or unreasonable hardship if variance were not granted. Therefore, variance will be granted, subject to conditions.

BACKGROUND

Mobil owns and operates a petroleum refinery on Arsenal Road in Will County, Illinois, approximately 10 miles southwest of Joliet. This refinery began operation in 1973, and is Mobil's newest domestic refining facility. The Joliet facility has a rated capacity of 190,000 barrels of crude oil throughput per operating day, and employs approximately 675 people. The refinery processes high sulfur and high nitrogen North American crudes, which comprise 70% of total throughput. Its principal products are motor gasolines and distillate fuel oil. The refinery also produces kerosene jet fuel, propane, petroleum coke, sulfur, and some heavy fuel oil. The refinery's products are primarily marketed in Illinois and other midwestern states. (Pet. at 2.)

The Joliet refinery uses water from the Des Plaines River

EXHIBIT

I

The Agency recommends that Mobil be granted a variance. However, the Agency recommends that the study period be shortened to 1½ years (instead of 3 years), which could be extended if Mobil can provide more data on the progress of the research and design program. (Agency Rec. at 6-7.) Additionally, the Agency recommends that the variance terminate earlier if the Joliet facility shows compliance with the general effluent standard of Section 304.122(b) for four consecutive quarters. (Agency Rec. at 7.) Mobil objects to both of these recommendations. (Response to Rec. at 1-3.) These issues were the focus of the hearing in this matter.

ENVIRONMENTAL IMPACT

Mobil contends that the impact of the requested variance on the ammonia nitrogen load in the Des Plaines River would be insignificant. Mobil has provided a table which summarizes calculated increases in river ammonia concentrations attributable to Mobil's discharge at actual past average performance, conditions under the now-expired site-specific rule, requested variance conditions, and conditions permissible under BAT. (Pet., Table VII.) Mobil concludes that in all cases, Mobil's impact is negligible, with a maximum change in ammonia concentration of 0.198 mg/l at BAT conditions. (Pet. at 6, Table VII.) Mobil has also included a summary of dissolved oxygen and ammonia water quality data from 1989 to 1992, and states that existing water quality in the vicinity of Mobil's discharge is well within applicable standards. (Pet. at 6, Table VIII.) Therefore, Mobil concludes that its requested discharge of ammonia nitrogen will not threaten water quality standards, and that there will be no negative effect on the aquatic community in the Des Plaines or Illinois Rivers. (Pet. at 6.)

The Agency agrees with Mobil's conclusion that there should be no long-term impairment of the water's uses or aquatic life. (Agency Rec. at 5.)

HARDSHIP

Mobil states that it has evaluated three alternate technologies, and associated costs for those options. Mobil lists those technologies as activated sludge with PAC, granular media filtration/selective ion exchange, and breakpoint chlorination. Mobil states that the capital investment for these options would range from $1.9 to $13.8 million, with annual operating costs between $0.7 to $1.7 million. (Pet., Table IX.) Mobil concludes that these costs are disproportionately high, because the average cost to remove an incremental pound of ammonia above the existing system's current capability would be $40 per pound. Mobil states this figure is $32 over the cost incurred to remove a pound of ammonia using its existing BAT technology. (Pet. at 6.) Mobil contends that denying a variance consultants would not shorten the time frame for study of the problem (Tr. at 78-79), and that the time frame cannot be shortened without compromising the quality of the work (Tr. at 42-43). Mobil also points to the testimony of Dr. William Patterson that the scope of work proposed by Mobil will require a full three years. (Tr. at 66.) Mobil argues that the Agency did not present any evidence in support of its position that the work be performed within 18 months. Thus, Mobil contends that imposing the 18 month study period would be unreasonable, arbitrary, and capricious.

In response, the Agency maintains that it is not convinced that Mobil has exhausted all of the available steps to keep its research timeframe within a "reasonable" time period. The Agency points out that Mobil became aware of the ammonia problem in early 1992, and thus has had almost two years to study, explore, and investigate compliance alternatives. The Agency continues to recommend an 18-month study period, with Mobil having an option to ask the Board to modify the variance to extend the investigation phase by the additional 18 months.

The Board will grant Mobil two years for the study of the problem, and two years to make necessary modifications or seek permanent relief. We recognize that nitrification inhibition is a complicated problem, and that the necessary studies and investigations are time consuming. However, as the Agency points out, Mobil has been aware of the current problems since early 1992. Additionally, prior to the January 1988 grant of the now-expired site-specific rule, Mobil's Joliet facility had operated under five prior variances for ammonia nitrogen. (Mobil Oil Corporation v. Illinois Environmental Protection Agency (September 20, 1984), PCB 84-37; (June 10, 1982), PCB 82-36; (July 10, 1980), PCB 80-54; (June 8, 1978), PCB 78-97; (June 9, 1977), PCB 77-22.) The first of those variances was granted on June 9, 1977. Thus, the Joliet facility has been operating under variance or site-specific rule for the majority of the past 17 years. We will not, at this time, extend that period for five additional years. We believe that the record does support a shortened study period. Mobil's timetable shows that the bulk of the study steps are to be completed by the end of 1995. (Pet. Exh. 3, Table IV.) Granting a two-year study period, until March 3, 1996, will give Mobil some additional time to complete those steps. Mobil will then have an additional two years, as it has requested, to make modifications or seek site-specific relief.[1]

Additionally, the Agency recommends that the variance expire if the Joliet facility shows compliance with Section 304.122(b)

---

[1] Mobil, like any other variance petitioner, can move for modification of variance during the pendency of the variance.

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Additionally, the Agency recommends that the variance expire if the Joliet facility shows compliance with Section 304.122(b)

---

[1] Mobil, like any other variance petitioner, can move for modification of variance during the pendency of the variance.

6. Mobil shall continue to operate its wastewater treatment plant so as to produce the best effluent practicable and to achieve compliance with 35 Ill. Adm. Code 304.122(b) as soon as possible.

7. Within 45 days of the date of the final Board order in this case, Mobil shall execute and forward to Robb Layman, Division of Legal Counsel, Illinois Environmental Protection Agency, 2200 Churchill Road, P.O. Box 19276, Springfield, IL 62794-9276, a certificate of acceptance and agreement to be bound to all terms and conditions of this variance. The 45-day period will be held in abeyance during any period that this matter is appealed. Failure to execute and forward this certificate within 45 days shall render this variance null and void. The form of the certificate shall be as follows:

CERTIFICATION

I (We), ________________________________, hereby accept and agree to be bound by all terms and conditions of the Pollution Control Board's March 3, 1994 order in PCB 93-151.

____
Petitioner

____
Authorized Agent

____
Title

____
Date

IT IS SO ORDERED.

I, Dorothy M. Gunn, Clerk of the Illinois Pollution Control Board, hereby certify that the above opinion and order was adopted on the 3rd day of March, 1994, by a vote of 6-0.

Dorothy M. Gunn, Clerk
Illinois Pollution Control Board

EXHIBIT II

MOBIL OIL CORPORATION - JOLIET REFINERY
BIOLOGICAL SYSTEM AMMONIA REMOVAL RATE

Year	WWTP Influent	WWTP Effluent	% Removal
1973	——	77.0	——
1974	——	55.0	——
1975	30	42.0	-40
1976	30	36.0	-20
1977	15	17.0	-13
1978	17	9.0	47
1979	14	13.0	7
1980	20	17.0	15
1981	23	13.0	43
1982	29	15.0	48
1983	23	4.0	83
1984	20	3.0	85
1985	26	3.0	88
1986	36	4.0	89
1987	28	2.0	93
1988	27	1.0	96
1989	26	0.2	99
1990	22	0.2	99
1991	23	0.6	97
1992	32	3.3	90
1993	29	4.0	86
1994	27	5.0	81
1995	35	6.3	82
1996	34	3.9	89
Period Average	**26**	**13.9**	**61**
1992 - 1996 Average	**31**	**4.5**	**86**

7396wwtp.pfc

EXHIBIT III
MOBIL OIL CORPORATION
JOLIET REFINERY
AMMONIA DISCHARGE HISTORY
MARCH 1994 - FEBRUARY 1997
mg/l

Month	Influent- Average	Influent-Range	Effluent-Average	Effluent-Range	% Average Conversion
Mar-94	34	26 - 30	4.9	1.4 -14.9	86
Apr-94	37	31 - 43	1.6	0.7 - 3.5	96
May-94	32	26 - 40	3.7	0.4 - 12.9	88
Jun-94	37	35 - 39	8.1	1.7 - 16.6	78
Jul-94	43	34 - 58	3.7	0.8 - 14.3	91
Aug-94	37	30 - 43	6.0	2.4 - 10.8	84
Sep-94	23	7 - 35	9.9	5.0 - 16.	57
Oct-94	30	3 - 43	1.2	0.0 - 3.0	96
Nov-94	31	27 - 38	3.5	0.4 - 8.0	89
Dec-94	22	12 - 30	12.2	5.5 - 19.2	45
Jan-95	22	17 - 26	**13.7**	8.7 - 19.1	38
Feb-95	17	14 - 21	7.2	0.6 - 20.4	58
Mar-95	33	30 - 38	1.8	0.4 - 3.7	95
Apr-95	34	31 - 38	6.6	2.4 - 13.9	81
May-95	30	8 - 39	7.5	4.1 - 10.8	75
Jun-95	30	6 - 40	12.2	0.3 - 22.9	59
Jul-95	43	35 - 49	0.4	0.1 - 0.8	99
Aug-95	41	24 - 73	2.0	0.2 - 5.8	95
Sep-95	59	37 - 73	2.2	0.5 - 5.7	96
Oct-95	31	13 - 52	2.7	0.2 - 7.2	91
Nov-95	40	30 - 44	8.1	0.2 - 19.0	80
Dec-95	40	31 - 49	11.0	6.0 - 25.5	73
Jan-96	28	22 - 35	8.5	2.6 - 16.9	70
Feb-96	25	14 - 38	5.3	0 - 21.4	79
Mar-96	24	11 - 30	9.2	**0 - 27.4**	62
Apr-96	33	21 - 49	**14.9**	0.6 - 21.1	55
May-96	37	28 - 55	1.3	0 - 4.2	96
Jun-96	37	32 - 42	3.6	0 - 13.7	90
Jul-96	43	37 - 56	1.3	0 - 4.2	97
Aug-96	40	25 - 45	0.3	0 - 0.7	99
Sep-96	29	16 - 40	0.3	0 - 1.7	99
Oct-96	32	25 - 44	0.1	0 - 0.2	100
Nov-96	38	34 - 45	0.3	0 - 0.8	99
Dec-96	40	36 - 42	1.6	0 - 14	96
Jan-97	35	33 - 36	3.8	0 - 14	89
Feb-97	27	11 - 35	0.3	0 - 0.8	99
Period Average	**34**		**6.0**		**83**
Period Minimum			**0.1**		**38**
Period Maximum			**14.9**		**100**

EXHIBIT IV

AMMONIA REMOVAL OPTIMIZATION ACTIVITIES

ACTIVITY	completion dates	NATURE	COST i	COST e	COST m	COST tot
1st report 3/3/94-9/3/94						
Refinery Sour Water Pollutant Survey		i	$ 10M			$ 10M
Activated Sludge System Aeration Capability Engineering Analysis		i	$ 5M			$ 5M
WWTP API and DAF System Assessment		i	$ 6M			$ 6M
SWSTU Laboratory Investigation - Phase 1		i	$ 25M			$ 25M
2nd report 9/3/94-3/3/95						
Envirex, Inc. Activated Sludge System Field Analysis		i	$ 4M			$ 4M
SWSTU Laboratory Investigation - Phase 2		i	$ 25M			$ 25M
Upgrade Crude Unit Desalter Controls		e		$ 100M		$ 100M
Constructed Caustic Free Merox Treaters		e		$ 3MM		$ 3MM
3rd report 3/3/95-9/3/95						
SWSTU Laboratory Investigation - Phase 3		i	$ 25M			$ 25M
SWSTU Pilot Plant Study		i	$ 30M			$ 30M
MICROTOX/Nitrification Inhibition Study		i	$ 120M			$ 120M
Upgraded West Side of Activated Sludge System		e		$ 1.75MM		$ 1.75MM
Replaced West Clarifier Internals		e		$ 225M		$ 225M
$Mg(OH)_2$ Addition Facilities		e		$ 25M		$ 25M
Bioaugmentation		m			$ 65M	$ 65M
$Mg(OH)_2$ Addition		e		$ 40M		$ 40M
4th report 9/3/95-3/3/96 - Pending						
Upgrade East Side of Activated Sludge System		e				
Upgrade East Clarifier Internals		e				
Complete WWTP Laboratory		e				
Complete DAF Controls Upgrades		e				
Perform WWTP Post Mechanical Upgrade Optimization		m				
5th report 3/3/96 - 9/3/96 - Completed & Pending						
Upgraded East Side of Activated Sludge System	Jun-96	e		$ 1.75MM		$ 1.75MM
Completed WWTP Laboratory	Sep-96	e		$ 100M		$ 100M
Completed DAF Controls & Recycle Upgrades	Sep-96	e		$ 143M		$ 143M
Install Liquid Nutrient (Phosphate) Addition System	Pending	e				
Perform WWTP Post Mechanical Upgrade Optimization	Pending	m				
6th report 9/3/96 - 3/3/97 - Completed & Pending						
Upgrade East Clarifier Internals	Nov-96	e		$ 225M		$ 225M
Perform In-Stream Water Quality Data Collection	Oct-96	i				$ 33M
Install Liquid Nutrient (Phosphate) Addition System	Pending	m		$ 25M		$ 25M
Perform WWTP Post Mechanical Upgrade Optimization	Pending	i	$ 33M		$ 45M	$ 45M
TOTAL			**$ 283 M**	**$ 7,383 M**	**$110 M**	**$ 7,776 MM**

LEGEND

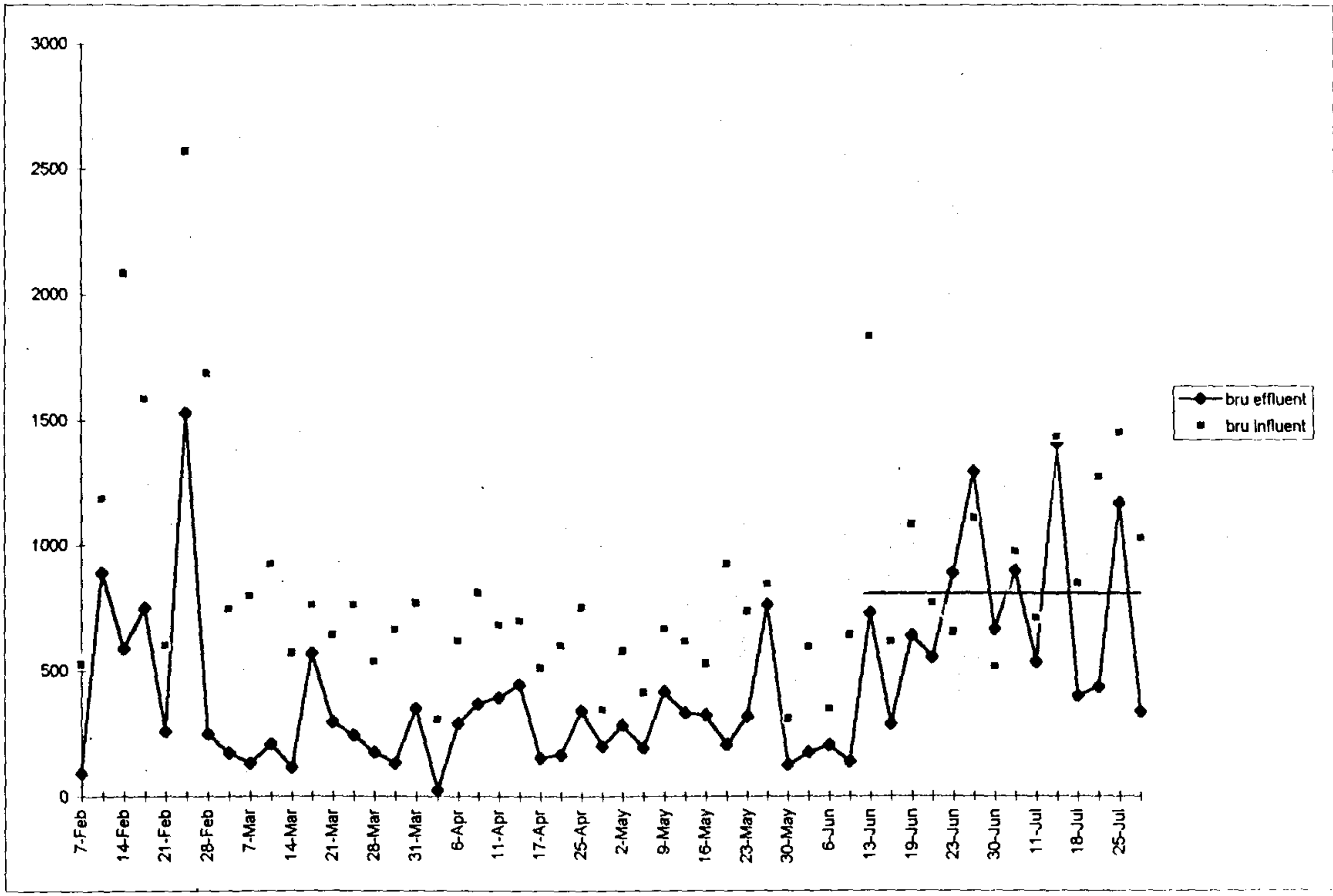
i = investigative activity

e = equipment change or upgrade

m = miscellaneous upgrade

EXHIBIT V

BRU influent/effluent LC 50 vs Time



1996 TEST DATA

Toxicity is inversely proportional to LC 50 value. Lower the value of LC 50, more toxic the material.

bruedt.tox

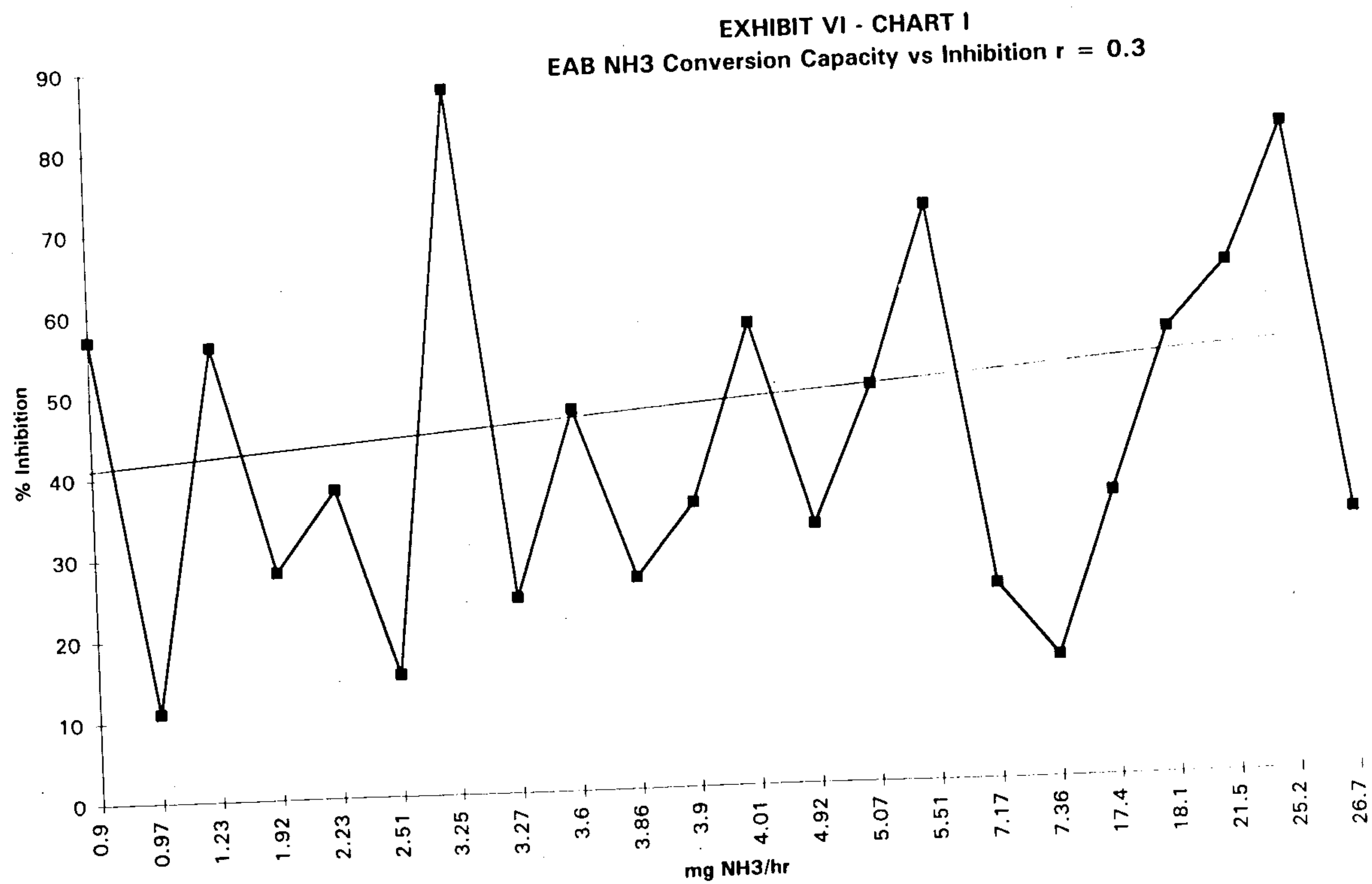
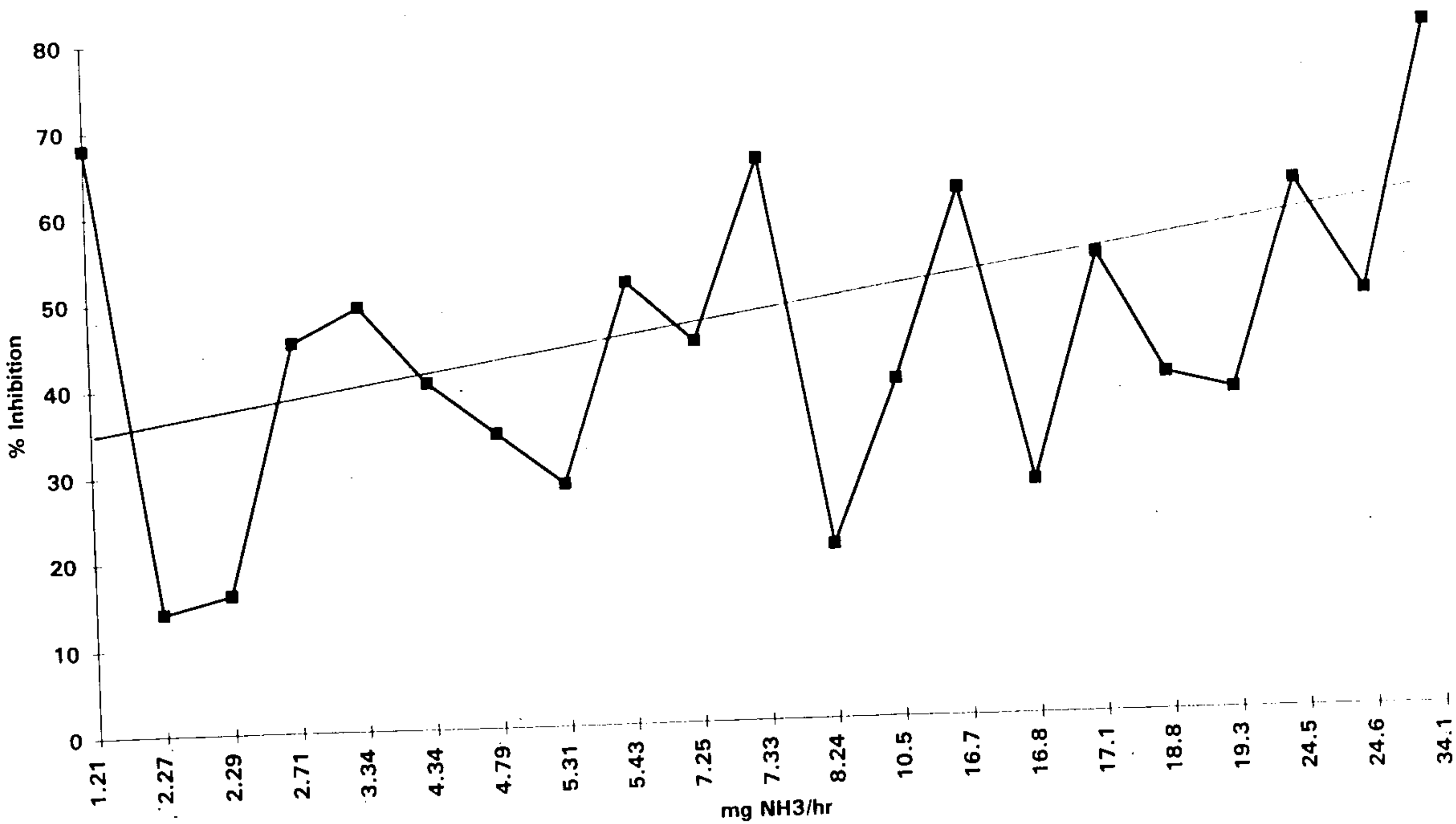


EXHIBIT VI - CHART I
EAB NH3 Conversion Capacity vs Inhibition r = 0.3
% Inhibition
90
80
70
60
50
40
30
20
10
0
0.9
0.97
1.23
1.92
2.23
2.51
3.25
3.27
3.6
3.86
3.9
4.01
4.92
5.07
5.51
7.17
7.36
17.4
18.1
21.5
25.2
26.7
mg NH3/hr

EXHIBIT VI - CHART II

WAB NH3 Conversion vs WCL Inhibition r = 0.4



FINAL

SITE-SPECIFIC AMMONIA RELIEF PETITION REPORT

FOR THE

WASTEWATER TREATMENT PLANT MOBIL OIL REFINERY JOLIET, ILLINOIS

Prepared for:

MOBIL OIL CORPORATION
POST OFFICE BOX 874
JOLIET, ILLINOIS 60434

MARCH 1997

Prepared by:

PARSONS ENGINEERING SCIENCE, INC.
1000 JORIE BOULEVARD, SUITE 250
OAKBROOK, IL 60521

Parsons ES Project No. 730508

EXHIBIT

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SECTION 1
EXECUTIVE SUMMARY

1.1 EXECUTIVE SUMMARY

Mobil Oil Corporation (Mobil) owns and operates a 200,000 barrels per day throughput (bbl/day) refinery on the Des Plaines River in Joliet, Illinois. The refinery treatment system performs very well when judged against its permit and against United States Environmental Protection Agency (USEPA) guidelines. However, the refinery has been unable to consistently meet the state of Illinois ammonia nitrogen standard of 3.0 milligrams per liter (mg/L) that applies to all discharges to rivers of the state. This investigation was conducted to evaluate the wastewater treatment system design and performance, to review and comment on previous work commissioned by and performed by the refinery, to attempt to meet the ammonia standard, to offer suggestions as to how the ammonia standard might be met, and to render an opinion regarding the achievability of the Illinois ammonia standard.

Conclusions reached during this investigation are as follows:

1. The treatment system is properly designed and operated. It consistently meets its discharge permit and performs well above the USEPA Best Available Technology (BAT) guidelines for the refining industry.

2. Many improvements have been made to the system since it was initially placed into operation in 1973. Approximately $10 million has been spent on these improvements. These improvements (presented in detail in Table 3.4) have had the objectives of accomplishing the following:

    - Decrease and control ammonia loadings to the treatment plant;
    - Increase equalization capacity and degree of pretreatment; and
    - Improve the design and performance of the treatment system and create conditions favorable to achieving biological nitrification.

3. This evaluation of the Mobil treatment system revealed no operational changes nor modifications that would likely lead to consistent nitrification. Recent data indicates that the system is operated within the envelope of conditions required to achieve nitrification. In fact, nitrification is achieved in the system on occasion for several months at a time. However, there are other operating periods during which nitrification ceases or is significantly

reduced due to reasons that can best be explained as chemical inhibition of nitrifying organisms.

4. Mobil has conducted studies and implemented changes in operations to reduce sources of inhibition that might prevent effective and consistent nitrification. The efforts to identify and remedy the sources of inhibition have not been completely successful. The most consistent conclusions from these tests are that some toxicity is added to the wastewater with passage through a benzene removal unit (required for compliance with Resource Conservation and Recovery Act [RCRA] and the Clean Air Act) and that byproducts of the degradation of organics in the activated sludge system are inhibitory to the nitrification process.

5. Because of these problems, the treatment system does not consistently meet the Illinois ammonia standard. While effluent ammonia concentrations have progressively decreased from an annual average of 17 mg/L in 1977 to values ranging from less than 1 mg/L to 6 mg/L in recent years, Mobil has not, even with the improvements and studies summarized above, been able to meet the state average standard of 3 mg/L with sufficient consistency.

6. Mobil has investigated a number of technologies with the hope of identifying one which could achieve compliance with the state ammonia standard. No applicable process has been identified. Problems with the technologies evaluated include high cost, site suitability problems, and generation of chlorinated organics. These technologies are not proven for the Mobil Joliet Refinery application, and their cost is prohibitively high to recommend them for implementation.

SECTION 2
INTRODUCTION

2.1 PROJECT BACKGROUND

Mobil operates a petroleum refinery in Joliet, Illinois. Wastewater produced during the refining processes is treated in an on site wastewater treatment plant (WWTP) and discharged under a National Pollution Discharge Elimination System (NPDES) permit to the Des Plaines River.

The WWTP typically meets and is usually far below permit requirements. Mobil has examined a number of options, conducted treatability testing, and implemented equipment changes which increased ammonia removal, but did not achieve total consistency with the state average effluent standard of 3 mg/L. Mobil has undertaken numerous and expensive endeavors to remedy their ammonia problem. Mobil has retained Parsons Engineering Science, Inc. (Parsons ES) to review the WWTP operation including facility modifications, evaluate operational changes that may further enhance the WWTP performance, and identify additional technologies, if any, to be considered. If these evaluations indicate the plant cannot feasibly further reduce ammonia in its discharge, Parsons ES will assist Mobil in their petition to obtain a site-specific rule change to the state of Illinois' effluent ammonia-nitrogen concentration limit (ammonia limit).

The following report presents a history of the treatment plant performance, a description of the efforts made by Mobil to enhance ammonia removal, a summary of the industry standard for refinery wastewater treatment, and the rationale for seeking the site-specific variance to the ammonia limit.

2.2 PROJECT OBJECTIVE

The objective of this project was to evaluate the WWTP and treatment process modifications that have been made or investigated with specific regard to the removal of ammonia. As part of this evaluation, Parsons ES was charged with the following tasks:

1. Evaluate the design, operation, and performance of the existing wastewater treatment system, paying special attention to any circumstances that would interfere with biological nitrification.
2. Determine if changes in the treatment system operation would improve ammonia removal.
3. Determine if the present wastewater treatment system meets USEPA BAT economically achievable criteria.
4. Determine how recent changes in the RCRA regulations have adversely impacted the ammonia removal performance of the system.
5. Review the evaluation of alternative ammonia removal technologies performed by Mobil, evaluate any additional technologies, as appropriate, and develop current cost estimates for the construction of applicable technologies.

The results of these investigations are presented in subsequent sections of this report.

2.3 REPORT ORGANIZATION

The remainder of this introductory section provides an overview of the Joliet refinery and the facility's WWTP and a summary of the Parsons ES project engineers' credentials. Section 3 presents the results of Parsons ES's review of the historical performance of the WWTP, the ammonia standard, and Mobil's efforts to improve ammonia removal. Section 4 presents Parsons ES's evaluation of Mobil's current WWTP configuration and operation, a comparison of their facility to industry practices and guidelines, and an assessment of alternate technologies that might remedy Mobil's nitrification inconsistency.

2.4 THE MOBIL JOLIET REFINERY

Mobil built the Joliet refinery as a "grass roots" facility 1972. The refinery is located on the Des Plaines River near the intersection of Interstate 55 and Arsenal Road, approximately 10 miles southwest of Joliet, Illinois. The refinery began operation in early 1973.

The refinery's rated capacity is 200,000 bbl/day of crude oil throughput. The refinery was designed to process high sulfur and high nitrogen North American crudes, which currently comprise approximately 70 percent of the total feed stock throughput. The plant is a "conventional fuels" refinery and its principal products are gasoline and distillate fuel oil. Other products include kerosene, jet fuel, propane, petroleum coke, sulfur, and some heavy fuel oil.

The refinery draws water from the Des Plaines River for boiler feed, cooling tower make-up, noncontact cooling. Well water is used for potable needs, sanitary purposes, and general service. As noted, treated process wastewater is discharged to the Des Plaines River through Outfall 001 under NPDES Permit No. IL0002861. The facility has eight other permitted outfalls, 002 (noncontact cooling water) and 003 to 009 (storm-water runoff).

2.5 WASTEWATER TREATMENT PLANT OVERVIEW

Process wastewater and contact storm water runoff are treated in the facility's WWTP. A process flow diagram of the treatment plant is provided as Figure 2.1. Major unit process included in the treatment plant include:

- Sour Water Stripper - Primary removal of ammonia and sulfide. This treatment unit is located in the refinery process area.
- Desalter - Partial removal of phenolics and in-plant water reuse. This unit is located in the refinery process area.
- TK 103 - Wastewater flow equalization. This unit is located in the refinery process area.
- Benzene Removal Unit - An air-stripping process for removal of benzene, sulfide, and volatile organic compounds. This unit is located in the refinery process area.
- Diversion Basin -Basin used for hydraulic overflow during wet weather..
- API Oil/Water Separator - Parallel basin process for the oil removal of gravity separable oil.

- Dissolved Air Flotation - Parallel basin process for the removal of suspended oil. The DAF system was modified/upgraded in 1996 with enhanced air injection features.

- Equalization Biological Treatment Unit (EBTU) - Secondary equalization with surface aerators for phenolic and other chemical oxygen demand (COD) oxidation. The EBTU normally receives treated sanitary wastewater and effluent from the dissolved air flotation units (DAF).

- Aeration Basins - Parallel activated sludge basins for ammonia, organic, cyanide and other pollutant removal. The aeration basins were upgraded in 1996 with the installation of a fine bubble air diffuser system and new aeration blowers.

- Clarifiers - Parallel clarifiers for solids removal/sludge settling. The settled sludge and surface skimming mechanisms in the clarifiers were replaced to improve separated solids removal from the units.

- Guard Basin - Effluent retention prior to discharge.

The facility also has a biological-sludge thickening tank, where waste activated sludge is gravity settled and stabilized. Waste bio-sludge is then hauled to the on-site coker for recycling.

The nominal design capacity of the treatment plant is 2,500 gallons per minute (gpm). Current throughput is 1,900 gpm. The calculated USEPA BAT economically achievable (BAT) flow rate for a refinery process of Mobil's size and configuration is 5,200 gpm. Employing the stream segregation aspect of Best Management Practices (BMP), the Mobil facility operates at 37 percent of the BAT flow. This efficiency in water conservation penalizes Mobil in achieving a concentration-based effluent standard. Additional detail on the WWTP is provided in Section 4.2.

2.6 REPORT AUTHORS

The three primary engineers that conducted the evaluation and contributed to this document are:

John H. Koon, PhD., P.E. - Dr. Koon has over 27 years of extensive technical experience, primarily in industrial wastewater treatment. He is a recognized authority in the field and a key contributor to significant advances in technologies used worldwide. He has extensive experience in the evaluation and design of biological wastewater treatment processes, and assisting industrial clients with regulatory issues.

Dr. Koon is a Parsons ES Vice President and the Technical Manager of Industrial and Hazardous Wastes. In this role, he is responsible for directing the company's industrial wastewater program, working with clients on complex technical issues, and providing technical direction on industrial wastewater projects.

Dr. Koon holds a B.E. in Civil Engineering and an M.S. in Environmental Engineering from Vanderbilt University, Nashville, Tennessee; and a Ph.D. in Environmental Engineering from the University of California, Berkeley.

Christopher Donohoe - Mr. Donohoe is a staff engineer in the Parsons ES Oak Brook, Illinois office. He has participated in treatability studies for chemical, pharmaceutical, petroleum refining facilities; including projects involving complex nitrification/denitrification inhibition issues. Mr. Donohoe also has assisted in a Toxicity Reduction Evaluation (TRE) for a petrochemical facility.

Mr. Donohoe holds a B.S. in Mathematics from the University of Notre Dame, South Bend, Indiana; and an M.S. in Environmental Engineering and Science from the University of Illinois, Urbana, Illinois.

Gregory M. Gibbons, P.E. - Mr. Gibbons has over 16 years of experience in the environmental engineering field. He has managed industrial and municipal wastewater treatment system design/upgrade projects. Mr. Gibbons, an Associate of the firm, is the Engineering Manager of the Parsons ES Oak Brook office. In this role he is responsible for oversight of the office engineering projects.

Mr. Gibbons holds a B.S. in Civil Engineering from the University of Notre Dame, South Bend, Indiana; and an M.S. in Sanitary Engineering from the University of Michigan, Ann Arbor, Michigan.

SECTION 3
AMMONIA STANDARD COMPLIANCE EFFORTS

3.1 INTRODUCTION

Parsons ES's evaluation of compliance with the ammonia effluent standard included:

1. Reviewing of the refinery's WWTP history of ammonia removal.
2. Examining and comparing the Illinois Environmental Protection Agency and USEPA effluent limitations.
3. Summarizing the administrative record/past variance petitions; and
4. Evaluating Mobil's efforts to increase ammonia removal and overall WWTP performance.

The results of these investigations are presented in this section. Much of this information has been evaluated and presented to the Illinois Pollution Control Board (IL PCB) in previous variance petitions.

3.2 FACILITY AMMONIA REMOVAL HISTORY

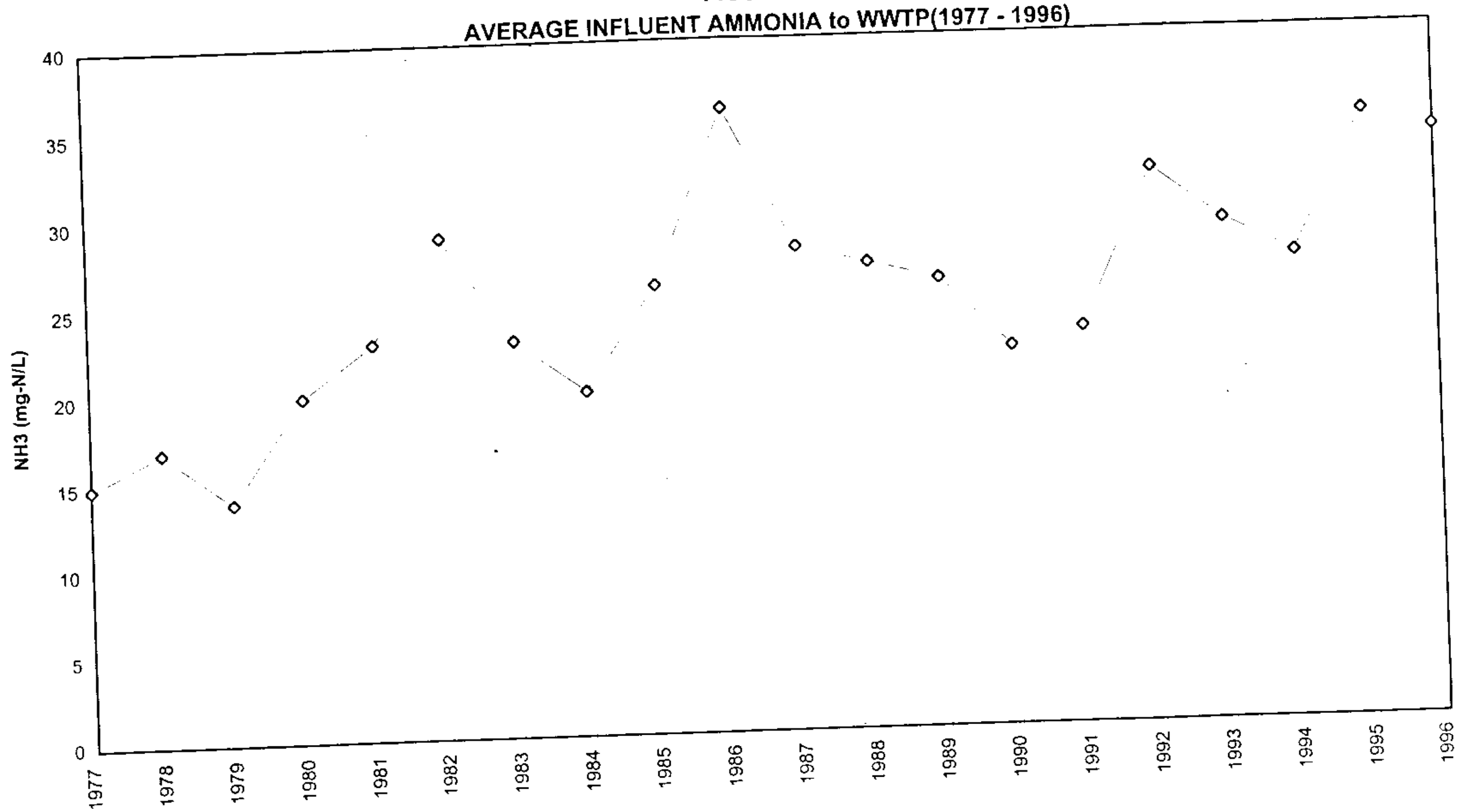
Ammonia loading and ammonia removal histories for the refinery WWTP are provided in the following subsections to provide a basis for the discussions on Mobil's biological nitrification problems.

3.2.1 Influent Ammonia Concentrations

Yearly average influent ammonia-nitrogen (ammonia) levels to the WWTP for 1977 through 1996 are shown on Figure 3.1. There has been a general trend of increasing average influent ammonia concentration during this period. Mobil attributes this to increased nitrogen and sulfur levels in the crude oil supply used by the refinery, as well as to the effects of water reuse and conservation. Mobil utilizes North American crude as their feedstock. Higher sulfur levels are significant since ammonia is produced in the processes designed to remove sulfur from petroleum products.

FIGURE 3.1

AVERAGE INFLUENT AMMONIA to WWTP(1977 - 1996)



Thus, the increase in sulfur removal results in greater generation of ammonia which eventually enters the WWTP, as illustrated on Figure 3.1.

3.2.2 Effluent Ammonia Concentrations

The WWTP's ammonia removal history from 1977 through 1996 is presented in detail in Table 3.1. Ammonia removal from 1977 to 1982 was erratic with fluctuating removal efficiencies. The maximum removal efficiency during this period was 48 percent. The low removal efficiency is attributed to the absence of nitrification during biological treatment.

Removal efficiency increased dramatically in 1983 to 83 percent. The average effluent concentration dropped to 4 mg/L. Removal efficiency continued to increase through 1989.

The WWTP consistently discharged ammonia at concentrations less than 1 mg/L during 1989, 1990, and 1991—indicating excellent nitrification performance—but witnessed much higher levels in the years that followed. Over the past 5 years the refinery WWTP has treated an average influent ammonia level of 31 mg/L to an effluent average of 4.5 mg/L, representing an 86 percent removal. The minimum annual average of 3.3 mg/L was achieved in 1992.

Table 3.2 presents the progression of ammonia treatment, by outlining ammonia concentrations at different stages of the treatment plant—aeration basin influent, east and west clarifier effluent, and treatment plant effluent. Minimum, maximum, and average ammonia data for three different years—1989, 1995, and 1996—are presented. These years were selected since 1989 is representative of a time during which the effluent ammonia was very low—indicating good WWTP ammonia reduction performance—while 1995 and 1996 represent periods of poor and improving performance, respectively.

Mobil's ammonia removal efficiency has varied significantly over the period of operation of the treatment plant. WWTP influent and effluent ammonia concentration

TABLE 3.1
AMMONIA-NITROGEN REMOVAL HISTORY

WASTEWATER TREATMENT PLANT
MOBIL REFINERY
JOLIET, ILLINOIS

Year	Influent (mg-N/L)	Effluent (mg-N/L)	Percent Removal
1977	15	17	-13
1978	17	9	47
1979	14	13	7
1980	20	17	15
1981	23	13	43
1982	29	15	48
1983	23	4	83
1984	20	3	85
1985	26	3	88
1986	36	4	89
1987	28	2	93
1988	27	1	96
1989	26	0.2	99
1990	22	0.2	99
1991	23	0.6	97
1992	32	3.3	90
1993	29	4	86
1994	27	5	81
1995	35	6.3	82
1996	34	3.9	89
Period Average	26	6	75
"1992-1996" Averag	31	4.5	86

TABLE 3.2
AMMONIA-NITROGEN (NH3-N) DATA (mg/L) for 1989, 1995, and 1996

WASTEWATER TREATMENT PLANT
MOBIL REFINERY
JOLIET, ILLINOIS

	Annual	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
							1989						
Aeration Basin Influent													
Minimum	14.50	20	23	9	12	10	15	11	15	22	11	13	13
Maximum	41.42	32	57	58	48	25	31	28	45	46	34	50	43
Average	26.33	25	36	24	27	18	23	20	26	32	26	32	27
East Clarifier													
Minimum	0.00	0	0	0	0	0	0	0	0	0	0	0	0
Maximum	1.85	1.8	1.9	2.4	2.6	0.4	0.3	0.8	0.7	9	1	0.3	1
Average	0.24	0.3	0.2	0.3	0.2	0.1	0.1	0.3	0.3	0.5	0.3	0.1	0.2
West Clarifier													
Minimum	0.00	0	0	0	0	0	0	0	0	0	0	0	0
Maximum	2.23	1.8	2.9	13.1	2.6	0.4	0.4	0.7	0.6	0.6	1	0.3	2.4
Average	0.25	0.3	0.4	0.6	0.3	0.1	0.1	0.3	0.2	0.2	0.3	0	0.2
Outfall 001													
Minimum	0.00	0	0	0	0	0	0	0	0	0	0	0	0
Maximum	0.83	0.6	0.3	3.1	0.4	0.2	0.1	2	0.3	0.6	1	0.3	1
Average	0.19	0.1	0.2	0.5	0.2	0	0.1	0.4	0	0.2	0.3	0	0.3
							1995						
Aeration Basin Influent													
Minimum	23.00	17	14	30	31	8	6	35	24	30	37	13	31
Maximum	45.08	26	21	38	38	38	40	49	73	44	73	52	49
Average	35.00	22	17	33	34	30	30	43	41	40	59	31	40
East Clarifier													
Minimum	0.38	1.5	0.3	0.2	0.4	0.3	0.8	0.3	0	0.6	0	0.2	0
Maximum	14.35	27	19.9	3	6	2.8	32.2	0.8	20	4	6	21.9	28.6
Average	6.90	12	13.2	1	3.4	1.4	17.7	0.6	5.7	1.5	3.1	7.9	15.3
West Clarifier													
Minimum	1.69	7.6	0	0.4	0.4	4.5	0.8	0.3	0	1.1	5	0	0.2
Maximum	18.73	24.9	24.9	11.2	6	20.7	32.5	0.8	20	16.6	22	15	30.2
Average	10.00	17.5	12.6	3.1	3.4	14.9	23.2	0.6	5.8	5.6	14.3	7.5	11.5
Outfall 001													
Minimum	1.98	8.7	0.6	0.4	2.4	4.1	0.3	0.1	0.2	0.5	0.2	0.2	6
Maximum	12.90	19.1	20.4	3.7	13.9	10.8	22.9	0.8	5.8	5.7	7.2	19	25.5
Average	6.29	13.7	7.2	1.8	6.6	7.5	12.2	0.4	2	2.2	2.7	8.1	11.1
							1996						
Aeration Basin Influent													
Minimum	23.10	22	14	11	21	28	32	37	25	16	25	34	36
Maximum	43.40	35	38	30	49	55	42	56	45	40	44	45	42
Average	32.80	28	25	24	33	37	37	43	40	29	32	38	40
East Clarifier													
Minimum	0.00	0	0	0	0	0	0	0	0	0	0	0	0
Maximum	12.45	19	11.5	29.6	17.6	15	22.5	8.7	0.3	0.3	0	9	0
Average	3.76	6.2	2.7	8.8	5.2	4	7.5	2.8	0.2	0.2	0	4.5	0
West Clarifier													
Minimum	1.52	0	0	0.2	15	0	0	0	0	0	0	0	0
Maximum	16.30	31.5	17.5	32.2	42.6	38	0.2	0.4	0.3	0.3	0	0	0
Average	7.72	11.5	5.7	17.9	32.6	8.8	0.1	0.2	0.2	0.2	0	0	0
Outfall 001													
Minimum	0.32	2.6	0	0	0.6	0	0	0	0	0	0	0	0
Maximum	11.15	16.9	21.4	27.4	21.1	4.2	13.7	4.2	0.7	1.7	0.2	0.8	14
Average	4.48	8.5	5.3	9.2	14.9	1.3	3.6	1.3	0.3	0.3	0.1	0.3	1.9

data is also shown graphically for the period of 1989 through October 1996 on figures 3.2 through 3.9. There have been extended periods of low effluent NH_3-N However, the WWTP also has a history of periods of monthly average effluent NH_3-N levels greater than 3 mg/L.

Several events occurred beginning in the latter part of 1990 that preceded a decrease in the ammonia removal performance of the system. In September 1990, a benzene removal unit (BRU) was added in the refinery to strip benzene from benzene-laden streams. The following year, the operational practice of the diversion basin at the wastewater treatment facility was changed to receive wet-weather overflow; the equalization basin in the treatment plant area was converted to an aggressive biological treatment unit. The changes were made in May 1991. All of these changes were necessary to comply with several RCRA and NESHAPS regulations. Soon after these changes were made, a deterioration in the ammonia removal performance of the treatment system was observed. Beginning in the last half of 1991, the ammonia removal performance was significantly less than it had been since 1988. This subject is discussed further in Section 4.2, in which performance-related parameters of the system are discussed.

3.3 APPLICABLE AND RELEVANT AMMONIA STANDARDS

3.3.1 The Illinois Ammonia Standard

The general effluent standard for ammonia discharge in Illinois is 3.0 mg/L as specified in Title 35, Subtitle C (Water Pollution) §304.122 of the Illinois Regulations (35 Ill. Adm. code 304.122 (b)).

3.3.2 USEPA Discharge Limitation

The USEPA has established effluent guidelines or limitations for industry categories based upon the application of the best practical control technology available (BPT) and BAT economically achievable. Limitations for the Cracking Subcategory are specified in 40 CFR 419 Subpart B.

FIGURE 3.2
WWTP NITRIFICATION PERFORMANCE (1989)

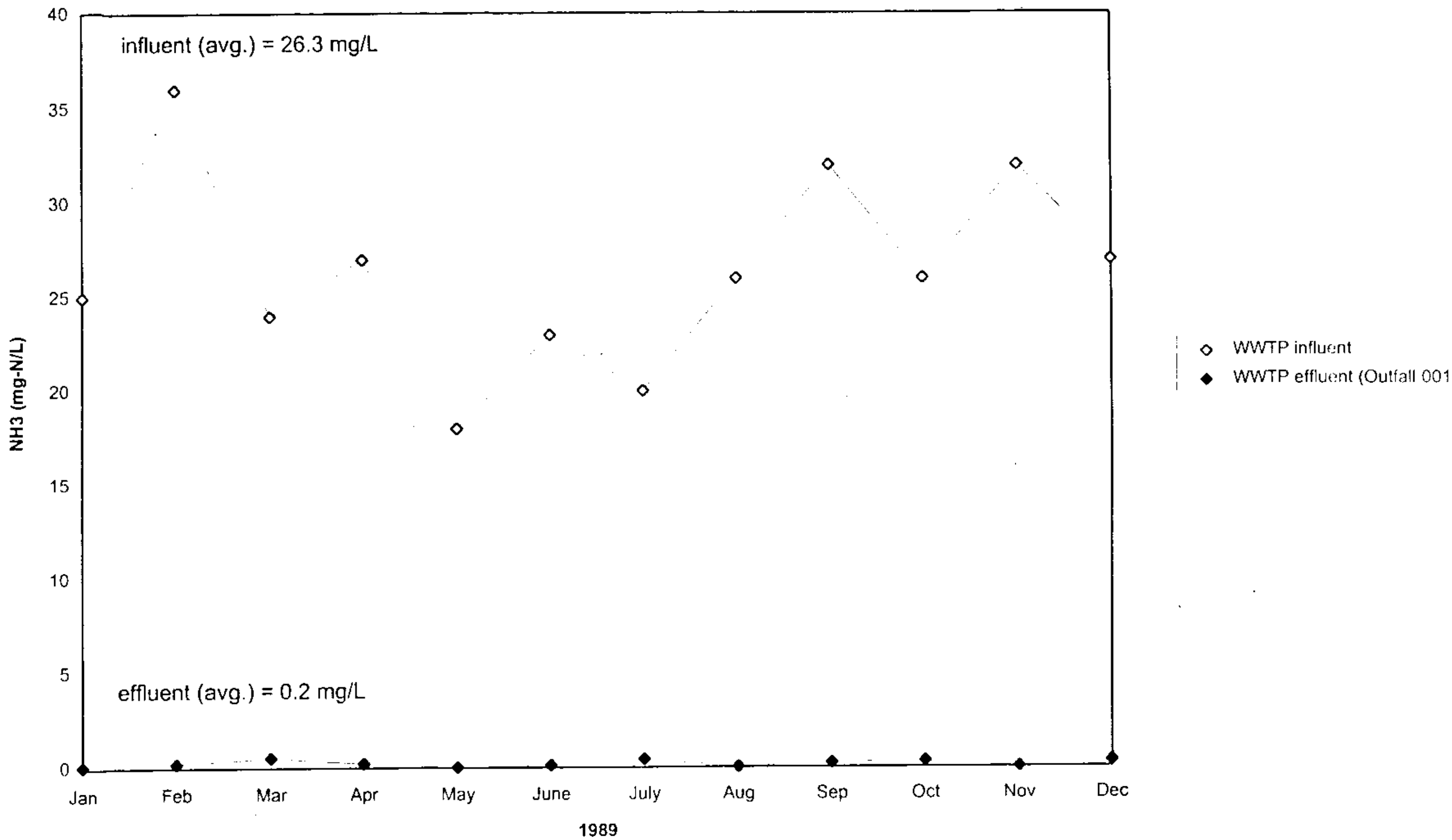


FIGURE 3.3
WWTP NITRIFICATION PERFORMANCE (1990)

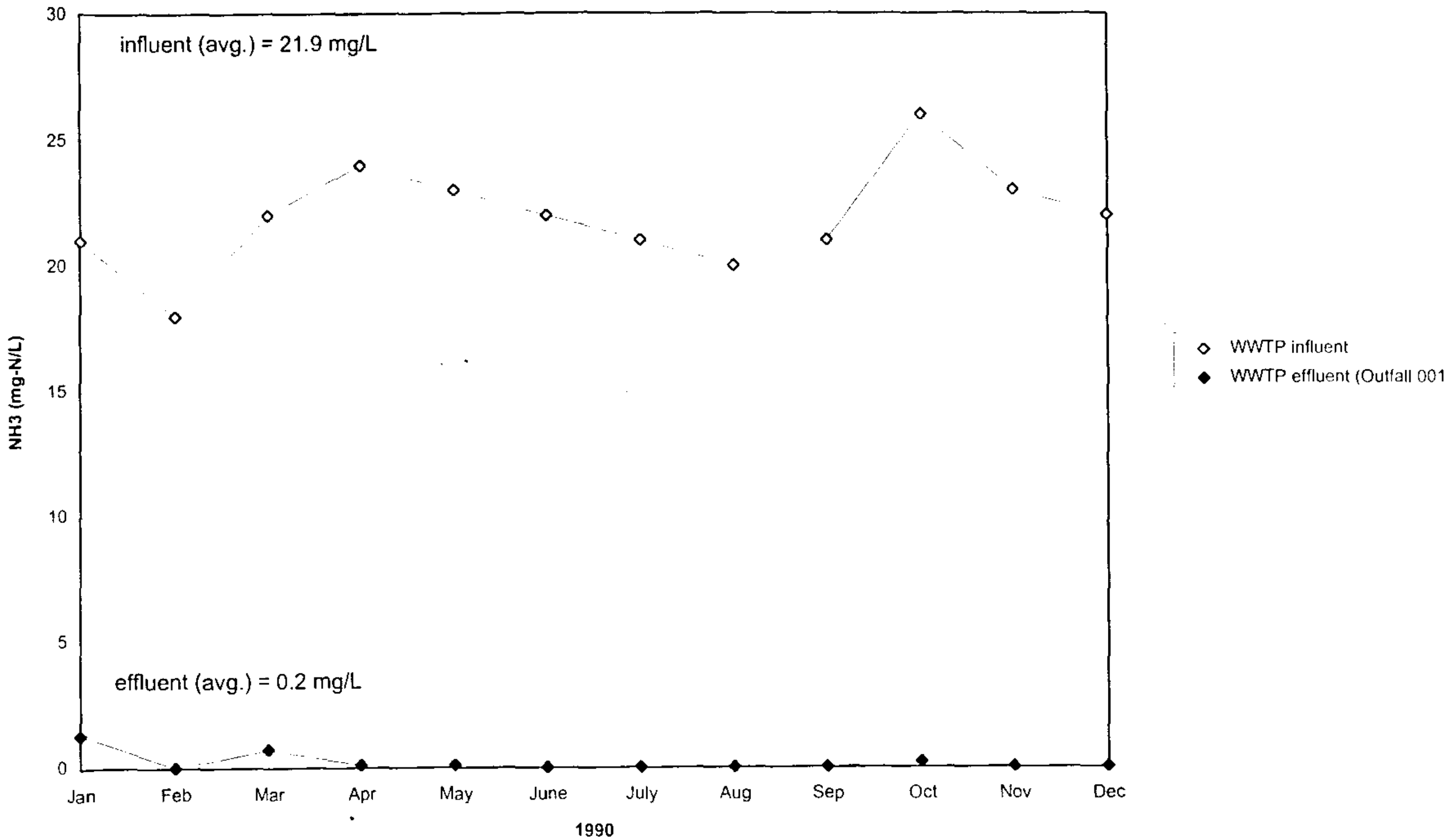


FIGURE 3.4
WWTP NITRIFICATION PERFORMANCE (1991)

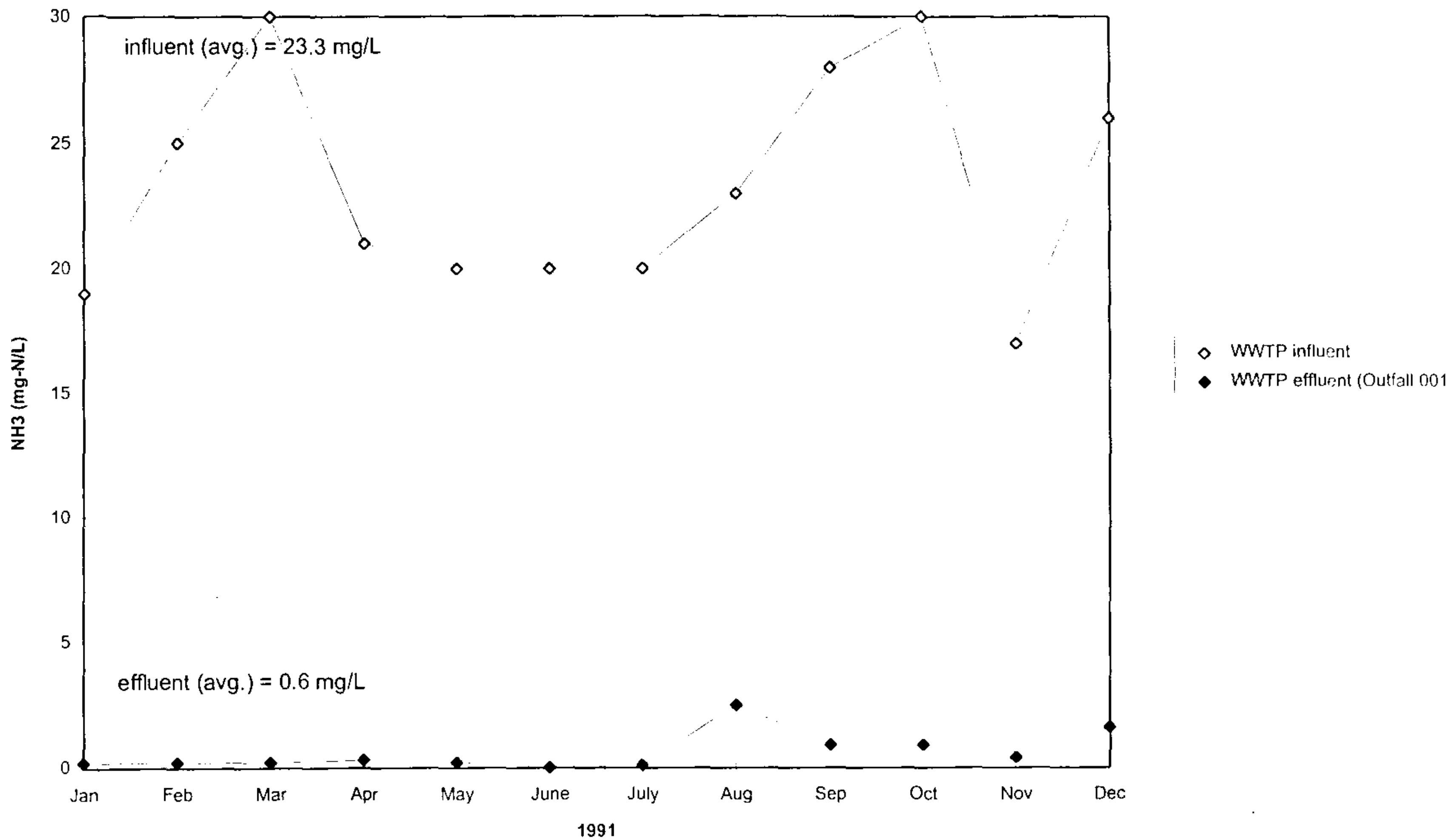


FIGURE 3.5
WWTP NITRIFICATION PERFORMANCE (1992)

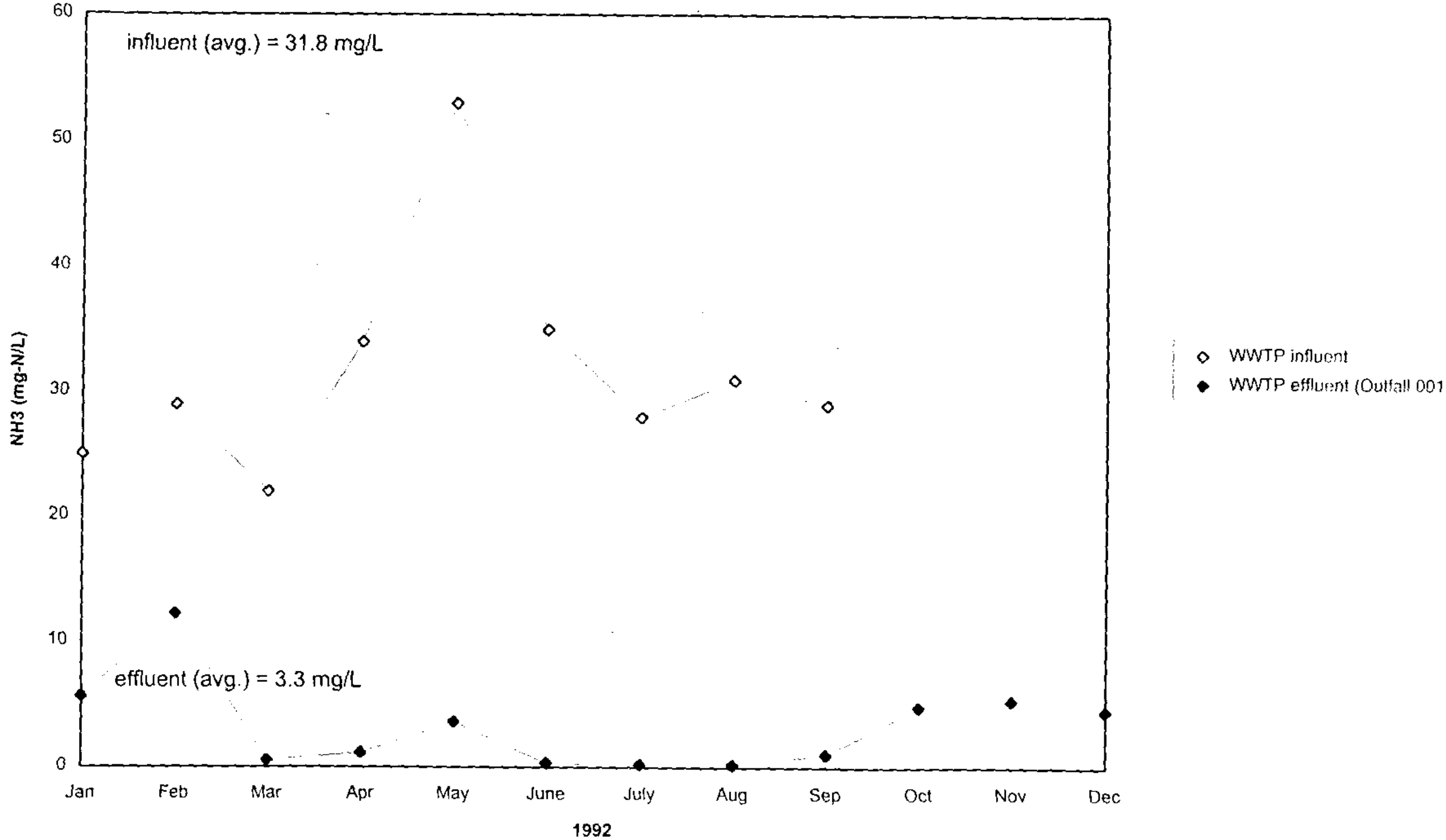


FIGURE 3.6
WWTP NITRIFICATION PERFORMANCE (1993)

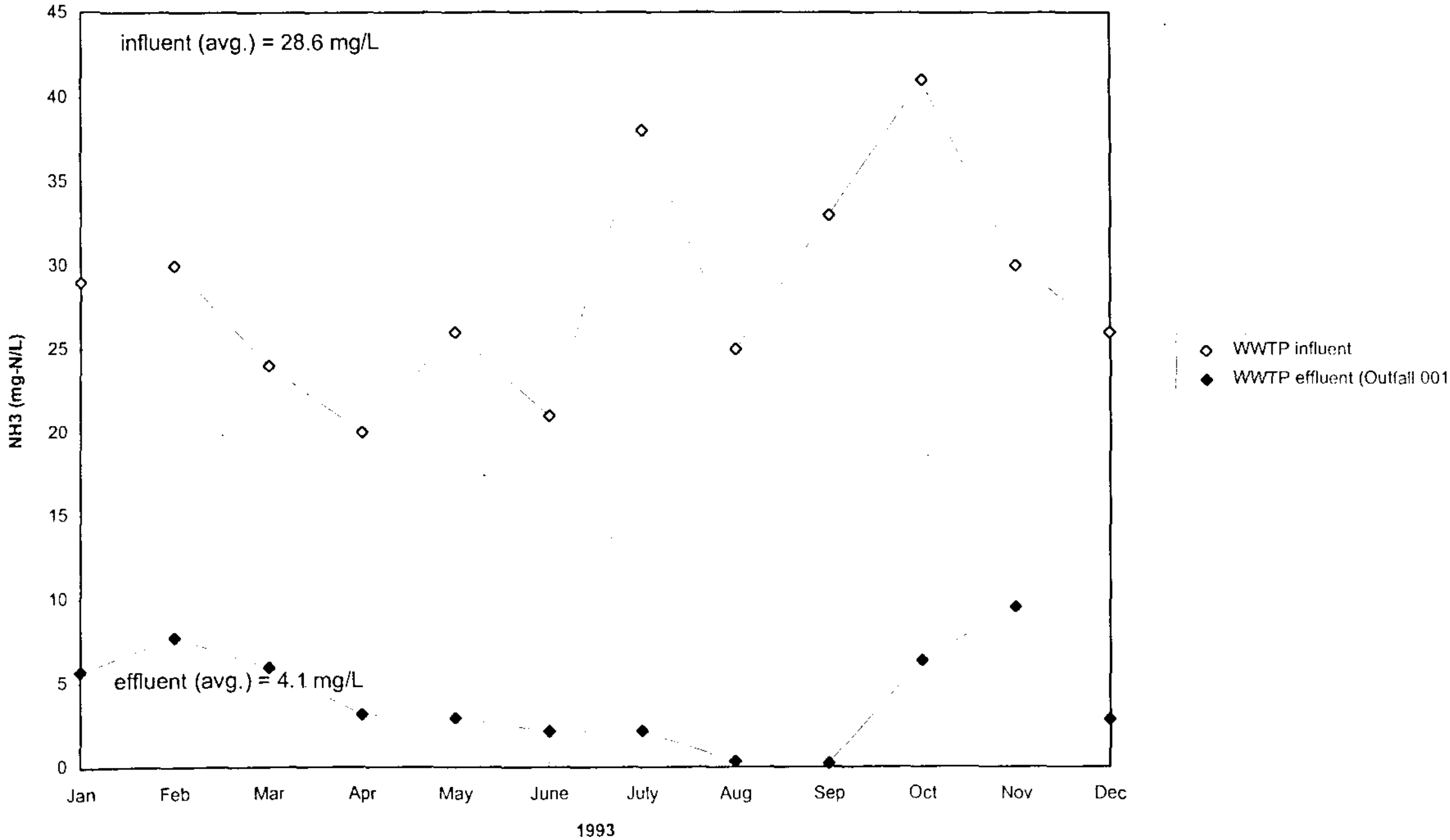


FIGURE 3.7
WWTP NITRIFICATION PERFORMANCE (1994)

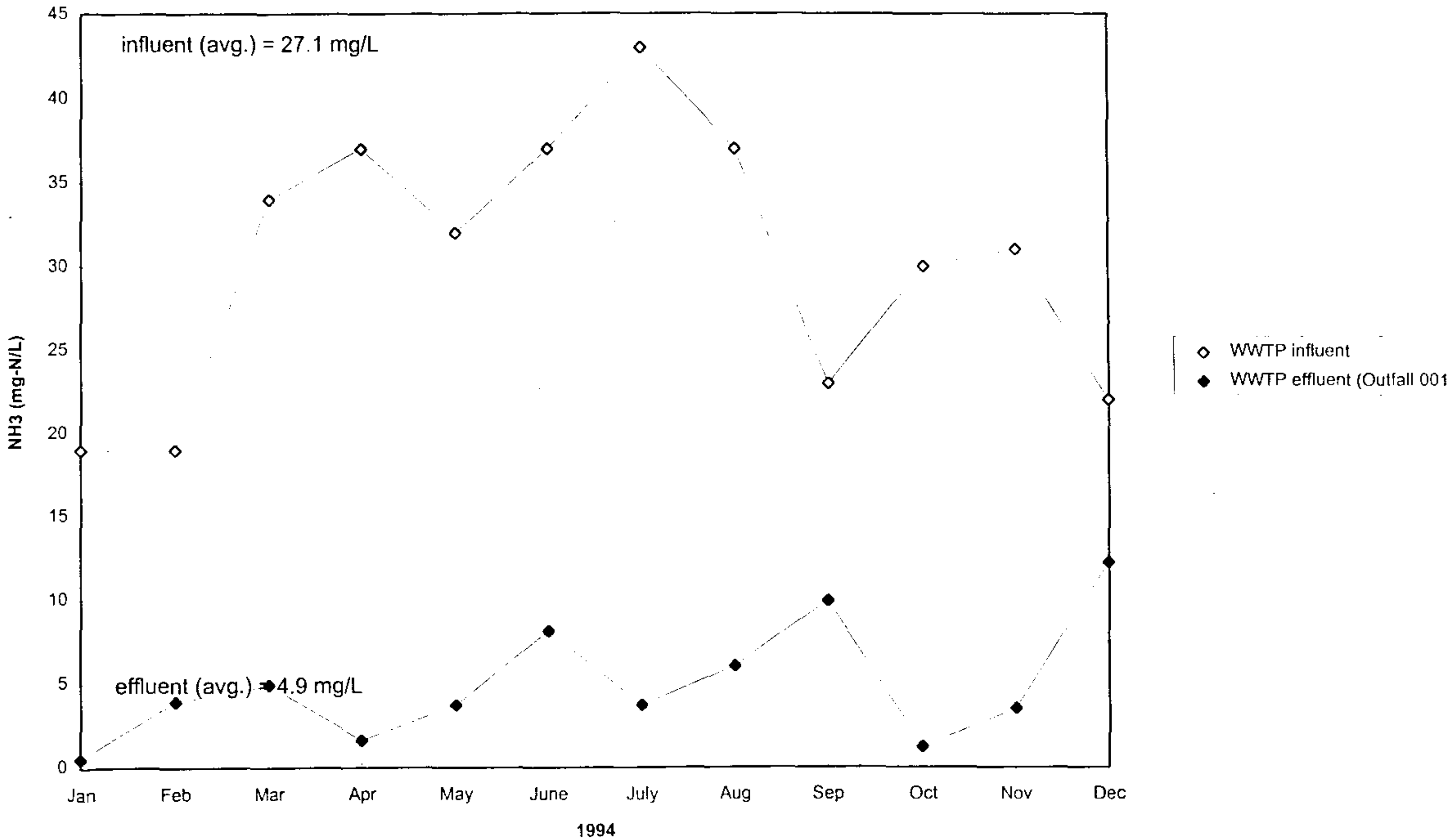


FIGURE 3.8
WWTP NITRIFICATION PERFORMANCE (1995)

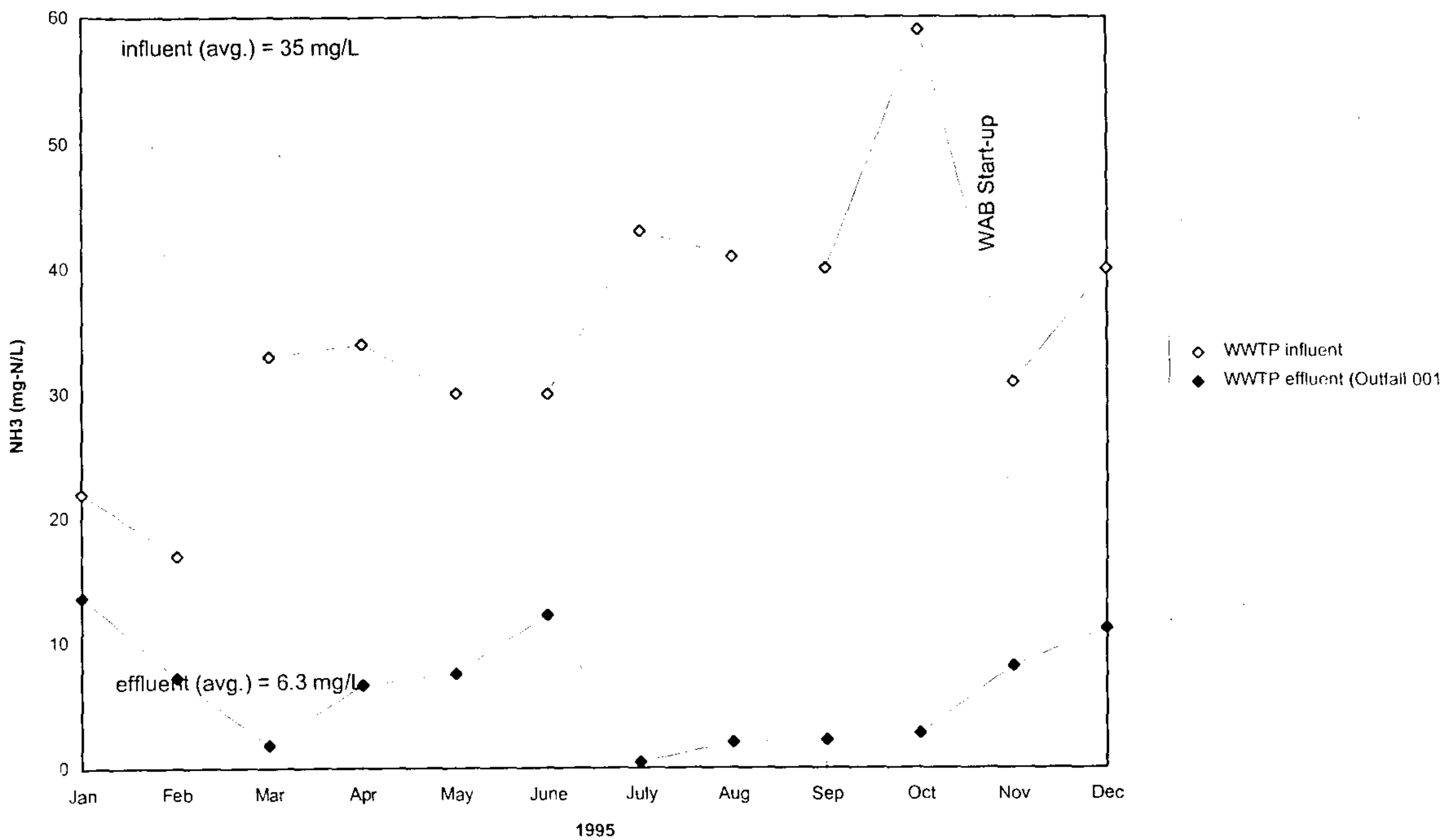
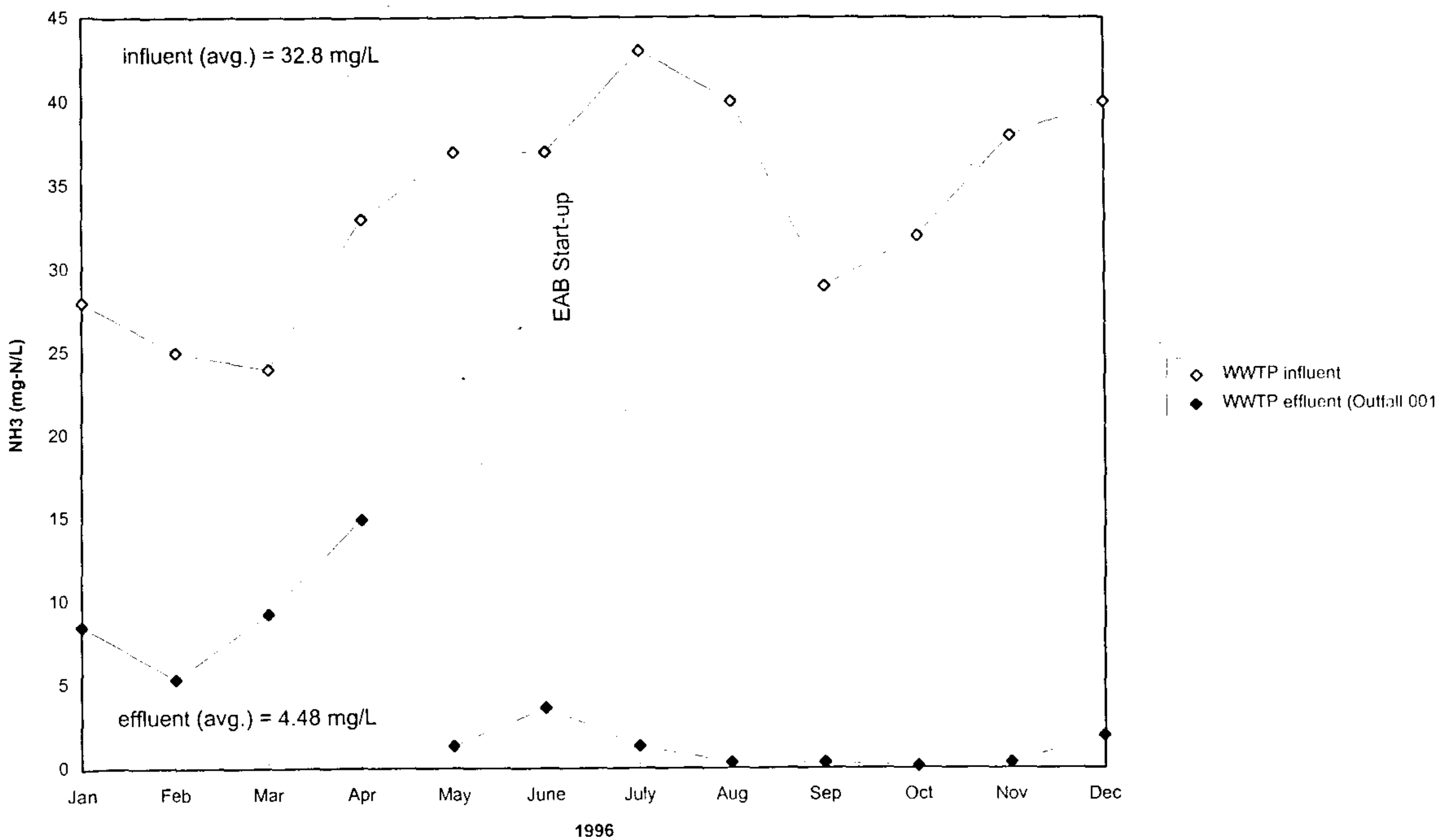


FIGURE 3.9
WWTP NITRIFICATION PERFORMANCE (1996)



The Cracking Subcategory is applicable to the Mobil Joliet refinery. As stated in Subsection 2.4, the refinery's rated capacity in 1996 is 200,000 bbl/day of crude oil throughput. According to 40 CFR 419 Subpart B, both the BPT and BAT effluent limitations for ammonia-nitrogen (ammonia) are 6.6 lb/1,000 bbl daily maximum and 3.0 lb/1,000 bbl daily average (30 days)—hereafter referred to as the "BAT limits". As a result, Mobil's USEPA BAT effluent ammonia limitations would be a daily maximum of 2,215 lb/day and a daily average of 1,007 lb/day. The average daily flow to the WWTP is 1,900 gpm (2.74 million gallons per day [mgd]). Therefore, the BAT effluent limits, on a concentration basis, for the Joliet facility would be 97 mg/L daily maximum and 44 mg/L 30-day average.

The refinery ammonia discharge history is presented as a calculated mass discharge (lb/day) of ammonia in Table 3.3 as a second comparison to the USEPA BAT limits. With respect to effluent ammonia, the plant has consistently exceeded the level of treatment required by the USEPA discharge criteria, and in the period of 1992 to 1996 the facility had an average discharge of only 18 percent of the federal limit.

3.4 ADMINISTRATIVE PROCEEDINGS SUMMARY

The Mobil refinery has operated under some relief from ammonia effluent limit since the limit became effective. The following bulleted items highlight Mobil's recent administrative proceedings to obtain a site-specific ammonia standard:

- January 15, 1988 - The IL PCB granted Mobil 5 year site-specific relief from the state's NH_3-N limitation. The NH_3 standard granted was a 20 mg/L monthly average and a 35 mg/L daily maximum.
- December, 31, 1993 - The site-specific NH_3-N standard relief for Mobil expired.
- March 3, 1994 - The IL PCB granted Mobil a 4-year variance (PCB 93-151) from the state's NH_3-N limitation. The relief standard granted was a 13 mg/L monthly average and a 26 mg/L daily maximum.

TABLE 3.3
COMPARISON OF HISTORICAL EFFLUENT NH_3-N
TO CALCULATED GUIDELINES

WASTEWATER TREATMENT PLANT
MOBIL REFINERY
JOLIET, ILLINOIS

Year	Effluent Ammonia-Nitrogen		% BAT Limit
	(mg-N/L)	(lbs/day)[a]	Monthly Average[b]
1977	17	388	68%
1978	9	205	36%
1979	13	297	52%
1980	17	388	68%
1981	13	297	52%
1982	15	342	60%
1983	4	91	16%
1984	3	68	12%
1985	3	68	12%
1986	4	91	16%
1987	2	46	8%
1988	1	23	4%
1989	0.2	5	1%
1990	0.2	5	1%
1991	0.6	14	2%
1992	3.3	75	13%
1993	4	91	16%
1994	5	114	20%
1995	6.3	144	25%
1996	3.9	89	16%
Period Average	6	129	23%
"1992-1996" Average	4.5	103	18%

Notes:

a. Estimated based on the current WWTP flow rate of 1900 gpm.

b. Calculated for a USEPA BAT monthly effluent limit of 600 lb/day. All BAT values were calculated using 200,000 bbl/day - a value close to, but not the capacity during the entire period shown.

- April 24, 1996 - Mobil filed an amended petition with the IL PCB for a variance extension granted under PCB 93-151.
- August 15, 1996 - The IL PCB granted Mobil a 1-year variance extension until March 3, 1999, with the same limitations as granted in IPCB-93-151.

3.5 FACILITY MODIFICATIONS

From 1973 to 1996, Mobil made numerous modifications to their wastewater treatment facility. These changes were made to both improve the WWTP performance and to comply with NESHAPs and RCRA mandated requirements.

3.5.1 Facility Modifications from 1973 to 1990

From 1973 through 1990, Mobil implemented a number of programs that improved WWTP operation and further reduced the ammonia concentrations in its discharge. During the first 5 years of refinery operation, Mobil conducted major studies to reduce ammonia at its source in the process area. These studies identified numerous ammonia sources and programs required for ammonia control. Mobil made expenditures to enlarge the sour water collection system by constructing a new sour water tank and improving the existing sour water stripping system. This overall effort resulted in significant reduction of the ammonia influent level to the WWTP.

Mobil also provided for ammonia stream equalization during this period by removing a large crude storage tank from service and modifying it to collect several ammonia-bearing process streams that flowed directly to the WWTP. This modification helped to equalize both the flow of these streams as well as the ammonia influent loading, and yielded more uniform biological nitrification performance.

In addition, Mobil focused efforts on temperature and alkalinity, two operational parameters important to nitrification. First, for temperature control, Mobil installed a 40 pounds per square inch gauge (psig) system and later upgraded to a 150 psig system to supply steam to the aeration basins to elevate aeration basin temperatures to 85 to 90^0F to achieve nitrification during the winter months. Second, although tests showed the WWTP influent contained sufficient alkalinity for nitrification, Mobil investigated whether these levels were maintained during nitrification as well as during periods of peak influent ammonia loading. Mobil learned that the WWTP could experience periodic alkalinity deficiencies and that the lime slurry produced from boiler feed water treatment was the most cost-effective potential source of increased alkalinity. Mobil began adding this lime slurry to both aeration basins in 1982 and switched to magnesium hydroxide addition in 1995.

Mobil made WWTP operational improvements to reduce ammonia during this period. First, refinery personnel experimented with varying the WWTP's sludge retention time (SRT) and implemented a procedure of more frequent/reduced volume wasting to stabilize the nitrification conditions and reduce fluctuations in performance of the treatment system.

In October 1981, Mobil initiated a nitrification inhibition study to isolate and identify nitrification inhibitors in facility wastewaters. Although results from 1981 and 1982 indicated some nitrification inhibition, beginning in January 1983, treatment system effluent no longer exhibited nitrification inhibition. The 1983 results indicated that any inhibitors then present were biodegradable under existing treatment system conditions. Mobil was unable to identify the reasons for this change, but believed that the improved nitrification performance during 1983 was due in large part to an apparent change in the nature of nitrification inhibitors.

Mobil made capital expenditures in excess of $2.1 million for the aforementioned ammonia reduction improvements.

3.5.2 Facility Modifications Since 1990

Since 1990, Mobil has made the following modifications:

- Installed a benzene removal unit (BRU).
- Converted an equalization basin to an aerated biological pretreatment unit, referred to as the equalization biological treatment unit (EBTU).
- Switched to a caustic-free Merox gasoline treating unit.
- Upgraded to diffused aerators in the activated sludge basins.
- Upgraded the WWTP clarifiers.

- Made extensive modifications to the dissolved air flotation (DAF) system.

3.5.2.1 RCRA and NESHAP Driven Modifications

The BRU was installed in September of 1990 to meet the requirements of RCRA (40 CFR 261) and the National Emission Standards for Hazardous Air Pollutants (NESHAPS-40 CFR 61) regulations at a cost of $2.1 million. Mobil constructed and operated the unit to remove benzene, other volatile hydrocarbons, and a substantial amount of sulfide from a major portion of their process wastewater.

The EBTU, converted from an existing equalization basin in May 1991, is an aggressive biological treatment unit. This was required to meet RCRA regulations and involved the addition of aerators to the basin. As discussed in Subsection 3.2, the nitrification performance of the treatment system has deteriorated since 1991. This is most likely attributable to increases in some chemical inhibitory substance in the BRU or the EBTU. A nearly identical conclusion was made at the UNO-VEN refinery in Lemont, Illinois, in a 1993 petition to the IL PCB (R 93-8).

3.5.2.2 WWTP Performance Enhancement Driven Modifications

In recent years, Mobil has made various upgrades to their WWTP to improve its performance and to encourage more efficient nitrification. The ammonia reduction costs prior to 1990, the ammonia removal optimization activities undertaken by the refinery, and the associated costs since March 1994 are presented in Table 3.4. Activities have included investigative endeavors, miscellaneous upgrades, and equipment changes or upgrades. In total, Mobil has spent close to $10 million in attempting to identify sources of nitrification inhibition, in pretreating waste streams, and in modifying the treatment system to achieve optimum conditions to achieve biological nitrification.

In June of 1995, Mobil began operating a newly constructed caustic-free Merox gasoline treating unit (Merox unit). The nature of the new Merox unit is such that its operation precludes a recurrence of WWTP upsets caused by incursion of the phenolic

TABLE 3.4
AMMONIA REMOVAL OPTIMIZATION ACTIVITIES

WASTEWATER TREATMENT PLANT
MOBIL REFINERY
JOLIET, ILLINOIS

Tasks	Nature of Task	Investigations Costs ($)	Equipment Upgrades Costs ($)	Miscellaneous Upgrades Costs ($)	Total Costs ($)
1973 through 1990					$2,100,000
3/3/94-9/3/94					
Refinery Sour Water Pollutant Survey	i	$10,000			$10,000
Activated Sludge System Aeration Capability Engineering Analysis	i	$5,000			$5,000
WWTP API and DAF System Assessment	i	$6,000			$6,000
SWSTU Laboratory Investigation - Phase 1[1]	i	$25,000			$25,000
9/3/94-3/3/95					
Envirex, Inc. Activated Sludge System Field Analysis	i	$4,000			$4,000
SWSTU Laboratory Investigation - Phase 2[1]	i	$25,000			$25,000
Upgrade Crude Unit Desalter Controls	e		$100,000		$100,000
Constructed Caustic Free Merox Treaters	e		$3,000,000		$3,000,000
3/3/95-9/3/95					
SWSTU Laboratory Investigation - Phase 3[1]	i	$25,000			$25,000
SWSTU Pilot Plant Study[1]	i	$30,000			$30,000
MICROTOX/Nitrification Inhibition Study	i	$120,000			$120,000
Upgraded West Side of Activated Sludge System	e		$1,750,000		$1,750,000
Replaced West Clarifier Internals	e		$225,000		$225,000
Mg(OH)2 Addition Facilities	e		$25,000		$25,000
Bioaugmentation	m			$65,000	$65,000
Mg(OH)2 Addition	e			$40,000	$40,000
3/3/96-9/3/96 - Completed and Pending					
Upgraded East Side of Activated Sludge System	e		$1,750,000		$1,750,000
Completed WWTP Laboratory	e		$100,000		$100,000
Completed DAF Controls and Recycle Upgrades	e		$143,000		$143,000
Upgrade East Clarifier Internals (11/96)			$225,000		$225,000
Perform In-Stream Water Quality Data Collection	i	$33,000			$33,000
Install Liquid Nutrient (Phosphate) Addition System[2]	e		$25,000		$25,000
Perform WWTP Post Mechanical Upgrade Optimization[2]	m			$45,000	$45,000
Total		$283,000	$7,343,000	$150,000	$9,876,000

Legend:
Nature of Task:
- i - indicates investigation
- e - indicates equipment upgrade
- m - indicates miscellaneous upgrade

[1] SWSTU = Sour Water Stripping Tail Unit
[2] indicates an activity not completed, and therefore a cost not yet incurred.

spent caustic into the wastewater system thus, at least removing one source of known inhibitory substances.

Mobil also upgraded the WWTP's activated sludge basins and clarifiers to enhance nitrification. To promote more efficient oxygen transfer and to increase the dissolved oxygen (DO) levels in the aeration basins—creating a more suitable environment for nitrifiers—Mobil replaced the mechanical aerators of the west and east basins with fine bubble diffusers (November 1995 and June 1996, respectively). Mobil spent $3.5 million in modifying the activated sludge basins. Moreover, Mobil replaced the east and west clarifier internals by removing the suction-riser-pipe and installing bottom-suction-header equipment in each clarifier costing. These changes cost $450,000.

Mobil made upgrades to the dissolved air flotation (DAF) recycle system to increase the efficiency of the air saturation system. This also resulted in improvements operability and reliability over the original system. At the front end of the system the air is released from the water to form small air bubbles that cause the oil particles to float to the surface where the skimming can remove them. Mobil upgraded the recycle system for $143,000.

3.6 LABORATORY STUDY SUMMARY

Mobil's recent ammonia removal optimization activities are outlined in Table 3.4 and further detailed in this section. Mobil performed the following studies per IPCB order in PCB 93-151. Furthermore, since September 1994, Mobil has submitted progress reports every 6 months to the Agency.

3.6.1 SWSTU Process

Mobil suspected that the stripped sour water stream was the most likely source of substances inhibitory to nitrification. As a result, they conducted investigations to pinpoint and possibly remove inhibitors. Mobil's SWSTU activities consisted of a refinery sour water pollutant survey, three phases of laboratory investigations, and a pilot-scale study.

Mobil performed laboratory investigations between March and September 1994. The objective of the investigations was to determine the most probable cause of inhibition and to identify a promising treatment technology. Mobil researchers suspected phenol to be a major cause of inhibition and developed a nickel-tungsten catalyst bonded to activated carbon (Ni/W-AC) to remove phenol by catalytic oxidation. Laboratory investigations with the catalyst yielded positive results. However, pilot-scale testing with the Ni/W-AC process between March and September 1995 was less successful. Mobil researchers observed that phenol was removed by adsorption to the activated carbon, not by catalytic oxidation, and concluded that adsorption was not a commercially viable option for phenol removal from sour water. Mobil spent in excess of $100,000 for the multiple phases of the SWSTU investigation.

3.6.2 MICROTOX Study

Using MICROTOX technology, Mobil performed a toxicity identification study elucidating toxic inputs to the WWTP. This study concluded:

- Toxicity increases across the BRU—supporting Mobil's contention that the operation and performance of the WWTP has become less reliable after the BRU installation.
- Commissioning of the new Merox unit lead to an overall decrease in toxicity.
- River intake water, at some times, may contain toxic constituents that neither the refinery's processes nor the WWTP can remove.

3.6.3 Nalco Chemical Company Ammonia Inhibition Study Summary

Mobil has on several occasions--between 1981 and 1995—attempted to identify sources of inhibition to biological nitrification in its wastewaters. As described in Subsection 3.5.1, Mobil conducted a nitrification inhibition study from October 1981 through January 1983. Results from this study indicated that factors inhibitory to biological nitrification in Mobil's wastewaters were recurring and unpredictable.

In 1995 Mobil contracted with Nalco Chemical Company (Nalco) to conduct a second ammonia inhibition study on input streams to the WWTP. The work involved laboratory testing and a general review of the wastewater generation and treatment processes. Nalco conducted their study to assess the degree of nitrification inhibition of 15 wastewater influent component streams and their overall contribution to the quality of the final effluent. Nalco also attempted to correlate measured nitrification inhibition to such parameters as pH, ammonia, residual COD following biological treatment, cyanide, sulfide, phenols, conductivity (dissolved salts), nitrates, and process unit variability. The principal finding of the study was that inhibition to the nitrification process was caused by biological degradation products produced in the activated sludge process. Thus, by accomplishing its primary objective, i.e., the oxidation of degradable organics, the biological treatment process appeared to be creating conditions that prevented it from achieving high levels of nitrification.

Mobil spent a total of $120,000 for the MICROTOX and the Nalco nitrification inhibition studies.

3.7 SUMMARY

The Mobil Joliet refinery WWTP has a history of varying ammonia removal due to inhibition of nitrification in the treatment plant. Nitrification is a sensitive process that can be affected by many factors. Mobil has been able to identify some causes for reduced nitrification, e.g., increased WWTP influent toxicity resulting from the installation of the BRU; and incursion of the phenolic spent caustic into the wastewater system. However, even after installing the caustic free Merox unit and totally upgrading the WWTP, Mobil is unable to consistently meet the state effluent standard.

The Joliet refinery WWTP effluent is significantly below the USEPA BPT and BAT ammonia effluent limitations (daily maximum of 2,215 lb/day and daily average of 1,007 lb/day). The facility also has operated at flow rates significantly lower than the BPT average flow rate, due to water conservation and stream segregation. These water conservation and segregation practices may, in a sense, hinder Mobil's efforts to meet the Illinois concentration-based effluent limit. The net result of discharging less water is that wastewater constituents are concentrated in the reduced flow.

Mobil has extensively investigated and implemented alternatives to increase ammonia removal and to upgrade the WWTP performance. Mobil has invested close to $10 million in these efforts. Their investment has improved ammonia removal in the WWTP; however, not to a level that will consistently meet the 3 mg/L monthly average effluent standard.

SECTION 4
ANALYSES OF THE
WASTEWATER TREATMENT PLANT OPERATION

4.1 INTRODUCTION

Parsons ES's evaluation of the operation of Mobil's wastewater treatment facility included the following tasks:

1. Reviewing the current operation and configuration of the facility - review includes a description of the WWTP, and both facility nitrification and general WWTP assessment.
2. Comparing the Joliet Refinery WWTP to industry practices and guidelines.
3. Assessing alternative technologies to achieve complete ammonia removal.

4.2 CURRENT FACILITY CONFIGURATION AND OPERATION

4.2.1 Treatment Plant Description

Subsection 2.5 presented a brief overview of the wastewater treatment plant. In Table 4.1 the WWTP is further characterized by the outlining of the functions and specifications of the individual unit processes.

4.2.2 Nitrification Assessment

Table 4.2 presents refinery WWTP operating data for 1989, 1995, and 1996. These years were selected since 1989 is representative of a time during which the effluent ammonia was very low—indicating good WWTP ammonia reduction performance—while 1995 and 1996 represent periods of poor and improving performance, respectively. Outlined in the table are the treatment plant influent, clarifier effluent, and treated-water quality as well as operating parameters (flow, mix-liquor concentration, wasting rate, food-to-mass ratio, and sludge age) within the aeration basins.

Nitrifying bacteria require specific conditions to oxidize ammonia. There is a fairly narrow band of favorable nitrifying conditions, and therefore, nitrification can be an inconsistent process. Table 4.3 compares the values of nitrification factors for

TABLE 4.1
UNIT PROCESSES, DESIGN SPECIFICATIONS, AND TYPICAL OPERATING PARAMETERS

MOBIL REFINERY
JOLIET, ILLINOIS

Process Unit	Function	Specifications
Sour Water Stripper	Ammonia and Sulfide Removal	- 15 MBBL/day @ 99.5% efficiency
Desalter	Phenolics Removal and In-plant Water Reuse	
TK 103	Primary Flow Equalization	- 4.2 million gallons
Benzene Removal Unit	Benzene, Sulfide, and VOC Removal	
Diversion Basin	Wet-weather hydraulic overflow	- 1.6 million gallon capacity
API Oil/Water Separator	Gravity Separable Oil and Settleable Solids Removal	- 2 Channels (specs per channel): - 110 ft x 14 ft x 6 ft = 69,000 gal - Four 8 inch reaction jet distribution nozzles - Rise rate = 2 ft/min at 1250 gpm - Flight Scrapers
Dissolved Air Flotation	Suspended Oil and Solids Removal	- 2 Channels (specs per channel): - 34,000 gal - Rise rate = 4 ft/min at 1250 gpm - Flocculating Agent = Nalco 7134 (added in flash mix chamber) - Q_r = 0.33Q through pressure tank for supersaturation of water with air - Air pressurization (Q_r) = 45 psig
Equalization Biological Treating Unit	Secondary Flow Equalization; Phenolics and COD Oxidation	- 5.8 million gallons
Aeration Basins	Ammonia, Organics, and Cyanide Removal	- 2 basins operated in parallel configuration (specs per basin): - Dimensions: Bottom - 57 ft x 115 ft ; Top - 93 ft x 151 ft; Slope of walls - 1.5 (horiz.) / 1.0 (vert.); water depth - 12 ft - Volume 900,000 gal - 1900 gpm (HRT = 0.66 days = 15.8 hr) - Two 75 hp blowers (per basin) provide 4500 SCFM (air to diffusers) - Fine Bubble Diffuser: four grids combined (850, 700, 700, and 530 diffusers per grid) - Temperature Control: 75 ft steam sparger connected to 40/150 psig steam header

TABLE 4.1
UNIT PROCESSES, DESIGN SPECIFICATIONS, AND TYPICAL OPERATING PARAMETERS

MOBIL REFINERY
JOLIET, ILLINOIS

Process Unit	Function	Specifications
Clarifiers	Sludge Settling	- 2 clarifiers operated in parallel configuration (specs per clarifier): - 80 ft Diameter Dorr-Oliver Clarifiers - Volume = 500,000 gal - Detention time = 6.5 hr - Q_r = 1.09Q - Overflow rate = 515 gpd/ft^2 - Sludge blanket = 3 ft to 4 ft - Vacuum/rake arm (clarifier bottom); surface skimming trough covers radius of tank
Polishing Guard Basin	Storage of clarifier effluent providing for further settling	- Surface Area (equivalent) = 1.25 acres w/ 12 ft water depth - Volume = 4.9 MG - HRT = 43 hrs @ 1,900 gpm
Cascade Aerator	Raise DO in water to near saturation level	- Vertical aeration nozzle assembly (1,500 gpm)

Note: operating parameters taken from plant operations manual.

TABLE 4.2

OPERATING DATA (DEVELOPED FROM MONTHLY MINIMUM, MAXIMUM, AND AVERAGE OPERATING DATA)

WASTEWATER TREATMENT PLANT
MOBIL REFINERY
JOLIET, ILLINOIS

Parameter	Units	1996			1995			1989		
		Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
Aeration Basin Influent										
BOD	mg/L	191	195	193	137	259	197	46	91	72
COD	mg/L	515	815	662	452	1003	710	250	532	354
pH	s.u.	7.9	9.4	N/D	7.4	8.9	N/D	7.6	8.9	N/D
NH_3-N	mg/L	25	43	34	23	45	35	15	41	26
Phenolics	mg/L	15	39	27	8	41	21	1	20	6
O&G	mg/L	12	53	28	10	51	28	5	16	10
Fluoride	mg/L	3.9	12.5	7.5	6	16	9	3	8	5
Alk-T	mg/L	N/D	N/D	290	N/D	N/D	248	N/D	N/D	208
Alk-P	mg/L	N/D	N/D	35	N/D	N/D	6	N/D	N/D	10
TSS	mg/L	N/D	N/D	288	N/D	N/D	131	N/D	N/D	86
Flow	mgd	1.8	3.1	2.4	1.9	3.1	2.5	2	3.5	2.9
East Aeration Basin										
MLSS	mg/L	7023	14208	10276	6552	15814	10581	11375	16420	13324
MLVSS	mg/L	3566	7426	5609	3389	8433	5375	4777	7379	5792
Wasting	gallons/day	429	8750	3374	0	10552	5432	N/D	N/D	N/D
F/M	1/day	0.05	0.05	0.05	0.04	0.05	0.05	0.01	0.02	0.02
SRT	Days	340	61	132	502	63	112	N/D	N/D	N/D
East Clarifier										
COD	mg/L	108	295	168	90	184	134	59	155	100
NH_3-N	mg/L	0	11.1	3.5	0.4	14.4	6.9	0	1.9	0.2
Alkalinity	mg/L	45	277	139	59	241	122	79	157	101
TSS	mg/L	16	44	28	9	27	17	6	39	17
NO3-N	mg/L	7	19	13	N/D	N/D	N/D	N/D	N/D	N/D
PO4-P	mg/L	N/D	N/D	1	N/D	N/D	1	N/D	N/D	N/D
Temp	F	N/D	N/D	90	N/D	N/D	87	N/D	N/D	N/D
West Aeration Basin										
MLSS	mg/L	6354	16380	10435	5620	17260	10178	10667	21104	14422
MLVSS	mg/L	3302	10566	5572	3067	8263	5136	5034	8412	6389
Wasting	gallons/day	429	10286	4173	0	9807	4775	N/D	N/D	N/D
F/M	1/day	0.06	0.03	0.05	0.05	0.05	0.05	0.01	0.02	0.02
SRT	Days	318	62	118	454	66	120	N/D	N/D	N/D
West Clarifier										
COD	mg/L	102	253	166	101	221	141	59	155	100
NH_3-N	mg/L	1.3	13.6	6.4	1.7	18.7	10	0	2	0
Alkalinity	mg/L	59	338	168	71	217	132	73	155	100
TSS	mg/L	14	47	30	9	24	17	5	40	17
NO3-N	mg/L	5	16	9	N/D	N/D	N/D	N/D	N/D	N/D
PO4-P	mg/L	N/D	N/D	1	N/D	N/D	1	N/D	N/D	N/D
Temp		N/D	N/D	92	N/D	N/D	87	N/D	N/D	N/D
Outfall 001										
BOD	mg/L	4	25	9	4	14	8	1	3	2
COD	mg/L	92	196	131	104	167	129	67	126	95
pH	s.u.	7.2	8	N/D	7.2	7.7	N/D	7.2	7.8	N/D
NH_3-N	mg/L	0.3	10.5	3.9	2	12.9	6.3	0	0.8	0.2
Phenolics	mg/L	0.003	0.014	0.006	0.002	0.019	0.007	0.001	0.009	0.004
O&G	mg/L	0.8	3.8	2.2	0.8	3.2	2	0.5	2.1	1.1
Fluoride	mg/L	4.9	9.4	6.9	5.7	14.4	8.8	N/D	N/D	N/D
TSS	mg/L	11	36	20	8	26	14	5	19	12
Flow	mgd	1.8	3.1	2.4	1.9	3.1	2.5	2	3.5	2.9
TOC	mg/L	20	48	30	22	39	29	12	20	15
Sulfide	mg/L	0	0.053	0.018	0	0.028	0.007	0	0	0
CN	mg/L	0.004	0.014	0.008	0.005	0.015	0.01	0.033	0.089	0.06
Cr (VI)	mg/L	0.001	0.006	0.003	0.001	0.007	0.002	0.004	0.014	0.007
Cr (total)	mg/L	0.002	0.014	0.005	0.004	0.011	0.007	0.059	0.087	0.058

N/D indicates not determined

TABLE 4.3
SUMMARY OF NITRIFICATION FACTORS
(AVERAGE OF EAST AND WEST BASINS-1996)

WASTEWATER TREATMENT PLANT
MOBIL REFINERY
JOLIET, ILLINOIS

Parameter	Units	Minimum Level for Nitrification	Mobil Operation
F/M	(lb BODa)/(lb MLVSS/Day)	0.3	0.05
Sludge Age (SRT)	Days	Minimum = 10	107 (1)
Dissolved Oxygen	mg/L	Minimum = 2 (2)	3.0 - 5.5 (3)
Temperature	^{0}C	Greater than 30 (4)	30 - 36
pH	s.u.	$Range_{Optimum}$ = 8 - 9	7.8-9.4
Alkalinity	mg $CaCO_3$/L	Minimum = 50 (5)	180

Notes:

1: Calculated using 11/96 and 12/96 wasting rates for east and west basins (5,000 gpd), along with yearly MLVSS and yearly effluent TSS averages.

2: Up to 4 or 5 mg/L, nitrification performance increases with increasing DO.

3: Observed range since installation of fine bubble diffusers and new DO probes.

4: Nitrification rates decrease with temperatures. Maintenance of "complete" nitrification at temperatures less than approximately 30^{0}C usually not observed; nitrifiers usually cannot survive and reproduce for long periods of time at temperatures greater than 38 - 40^{0}C.

5: Minimum alkalinity value indicated for aeration basin effluent.

Mobil's operating conditions with values of the same parameter required for nitrification. Average 1996 values for both east and west aeration basins were utilized to calculate the values of Mobil's nitrification parameters. While dissolved oxygen (DO), temperature, pH, and alkalinity are directly measured factors, the food-to-mass ratio (F/M) and sludge retention time (SRT) are calculated parameters. The F/M ratio relates the organic matter available (organic loading) to the quantity of biomass within the system. The SRT, which describes the age of the biomass within the aeration basin, is dependent upon the rate at which the biomass grows and on the sludge wasting rate of the treatment plant. Of these two parameters, the sludge age is the critical one. The sludge age must be greater than the inverse of the growth rate of nitrifying bacteria to prevent these organisms from being washed out of the system as sludge is wasted. Under ideal conditions, a minimum sludge age of 3 to 5 days is required. Experience with refinery wastes indicates that a minimum value of approximately 10 days is often required. The approximate value of the F/M ratio (BOD basis) equivalent to a sludge age of 10 days is 0.3/day.

The comparison in Table 4.3 indicates that the treatment system is operated at conditions favorable to achieving nitrification. The fact that nitrifying is not achieved consistently implies that chemical inhibition occurs.

4.2.3 General Facility Performance Assessment

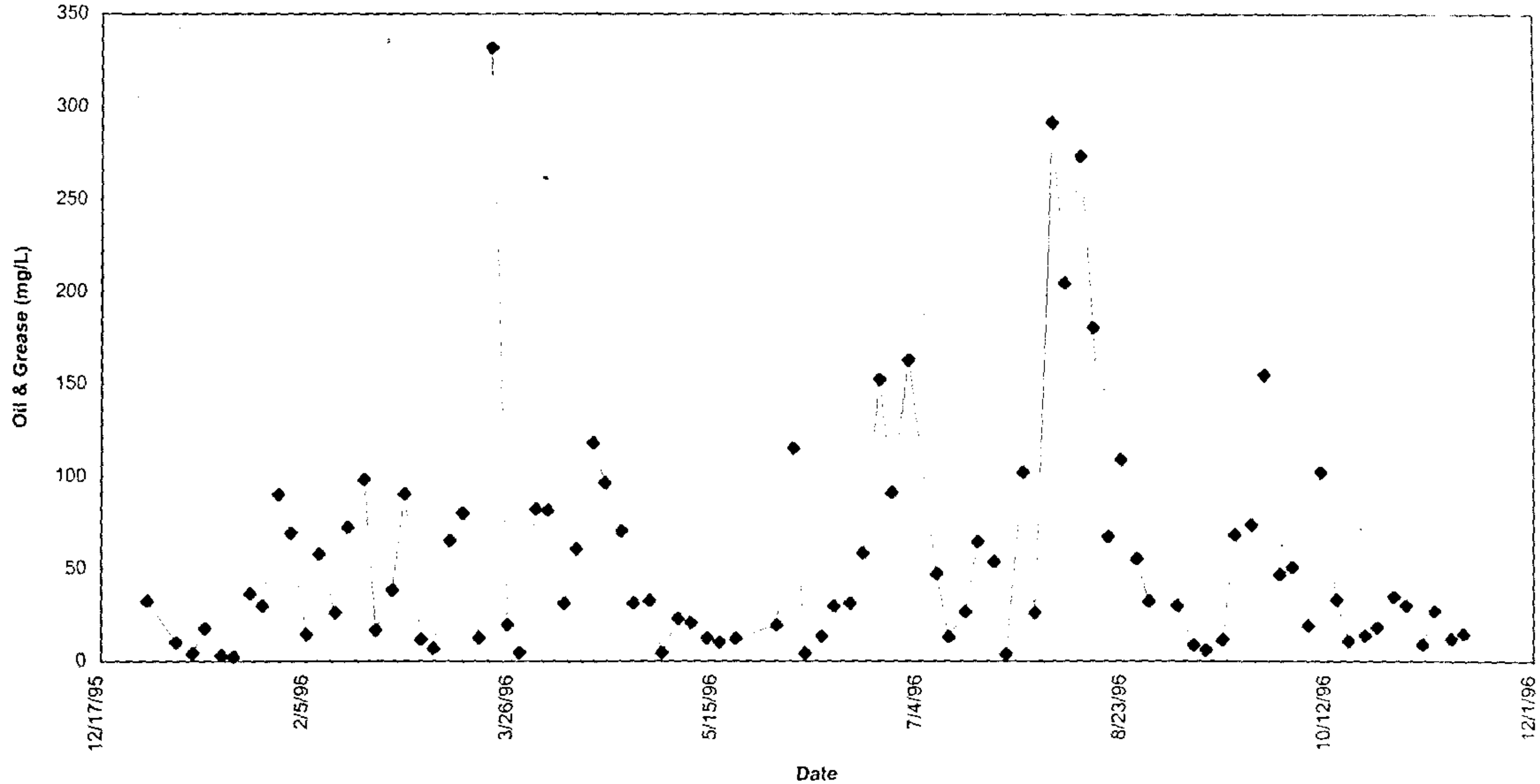
4.2.3.1 API Separators and Dissolved Air Flotation Units

It was possible to assess the performance of the API oil/water separator (API) and dissolved air flotation (DAF) processes, units upstream of the activated sludge process in the WWTP. Figure 4.1 plots 1996 oil and grease effluent values from the DAF. Average influent oil and grease to the API was 1,544 mg/L, and effluent oil and grease was 57 mg/L. This translates into a removal efficiency of 96 percent. The effluent oil and grease concentration at Outfall 001 averaged 2 mg/L in 1996, which is excellent performance for the system.

FIGURE 4.1
DISSOLVED AIR FLOTATION (DAF)
OIL AND GREASE EFFLUENT (mg/L) - 1996

MOBIL OIL REFINERY
JOLIET, ILLINOIS

API INFLUENT: MIN=2, MAX=25,000, and AVG=1,544 mg/L.
DAF EFFLUENT: MIN=2; MAX=332, and AVG=57 mg/L.



4.2.3.2 Aeration Basins (Activated Sludge Process)

The data in Table 4.2 can be used to assess the facility's activated sludge process performance. Table 4.4 presents removal efficiencies determined for relevant water quality parameters using the 1996 summary presented in Table 4.2. The removal efficiencies displayed in Table 4.4 indicate outstanding performance for the treatment of a refinery wastewater.

4.2.3.3 General Facility Operation Observations

Following a thorough inspection of the Mobil WWTP grounds and operating data, Parsons ES concludes that Mobil properly operates their treatment facility. Moreover, performance data are indicative of an exemplary treatment plant, evidenced by BOD_5, TSS, and phenolics data. Although the facility design promotes conditions well within the range for nitrification, the WWTP does not consistently achieve levels of nitrification necessary to meet Illinois regulations. Studies have indicated that this inconsistency can be attributed to inhibitory agents resulting from RCRA and NESHAP mandated upgrades to the WWTP. Therefore, it is the opinion of Parsons ES that ammonia levels above the Illinois ammonia effluent standard do not result from poor facility operation. Furthermore, it is unlikely that significant additional removal of organics and ammonia could be achieved through operating or equipment modifications.

4.3 COMPARISON TO INDUSTRY PRACTICES AND GUIDELINES

Detailed in Subsection 4.2 are the unit processes employed by the Mobil WWTP. A comparison of Mobil's treatment plant practices with BAT requirements are presented in Table 4.5. Mobil meets or exceeds all BAT treatment plant process requirements.

In addition, as previously stated in Subsection 3.3.2 the plant has consistently performed far below the USEPA ammonia discharge criteria, and in the period of 1992 to 1996 the facility has had an average ammonia discharge of only 18 percent of the

TABLE 4.4
REMOVAL EFFICIENCIES FOR RELEVANT WATER QUALITY PARAMETERS (1996)

WASTEWATER TREATMENT PLANT
MOBIL REFINERY
JOLIET, ILLINOIS

Parameter	Units	Influent Concentration	Effluent Concentration	Removal Efficiency (%)
BOD_5	mg/L	193	9	95
COD	mg/L	662	131	80
TSS	mg/L	288	20	93
NH_3-N	mg/L	34	3.9	89
Phenolics	mg/L	27	0.006	99.9

TABLE 4.5
COMPARISON OF BAT REQUIREMENTS WITH MOBIL'S PRACTICES

MOBIL REFINERY
JOLIET, ILLINOIS

BAT REQUIREMENT	MOBIL'S PRACTICE
• Sour Water Stripper (SWS) sulfur and ammonia minimum removal efficiency equal to 85%	• 15 MBBL/day at 99.5% efficiency
• In-Plant Water Reuse	• SWS effluent directed to Desalter • SWS effluent directed to Fluid Catalytic Cracker
• Flow Equalization	• Primary Equalization - 4.2 million gallons (TK 103) • Secondary Equalization - 5.8 million gallons (EBTU) • Wet Weather Diversion Basin - 1.6 million gallons
• Oil and Solids Separation	• Dual Channel Preseparator Flume • Dual Channel API Separator
• Additional Oil and Solids Separation	• Dual Channel Dissolved Air Flotation
• Biological Treatment	• Two 900,000 gallon Aeration Basins • Two 500,000 gallon Clarifiers
• Final Polishing	• One 4.9 million gallon Guard Basin for Treated Process Water • One 5.8 million gallon Uncontaminated Storm Water Impoundment Basin

federal limit. Moreover, Table 4.6 presents a comparison of Mobil's WWTP effluent (1996 average) with BAT effluent guidelines and highlights that the facility is significantly less than all federal effluent requirements.

4.4 ALTERNATIVE TECHNOLOGY ASSESSMENT

On several occasions, Mobil has assessed alternate technologies to promote compliance with the Illinois ammonia standard. This section details Mobil's activities predating their preparation for the ICPB 93-151 variance petition and those related to this petition.

Beginning in the late 1970s Mobil investigated technology options that might be employed to comply with the ammonia standard. From 1979 through 1982, Mobil constructed and operated a two-stage pilot treatment system with the objective of determining if this level of treatment was capable of meeting the state of Illinois standard. The results demonstrated that this system could not produce an effluent that consistently met the standard.

In 1984 Mobil retained consultants who evaluated several technologies potentially capable of complying with the state of Illinois standard. The consultants initially considered ion exchange, breakpoint chlorination, ozonation, air stripping, and land application, but rejected all of these based on considerations including performance limitations and commercial availability, site suitability, production of chlorinated organics, and the generation of other toxic byproducts. In addition, while these processes are frequently listed in textbooks for the removal of ammonia from industrial wastes, there are few full-scale installations on which to judge the performance of these processes. These consultants considered three processes in greater detail:

- Addition of rotating biological contactors (RBCs) as a second stage of treatment.
- Addition of a trickling filter as a second stage of treatment,
- Addition of a third aeration basin and clarifier in parallel to the existing activated sludge system.

TABLE 4.6
COMPARISON OF EFFLUENT (1996) WITH BAT EFFLUENT GUIDELINES

WASTEWATER TREATMENT PLANT
MOBIL REFINERY
JOLIET, ILLINOIS

Parameter	Units	BAT Limit (30-day Average)[1]	Mobil WWTP Discharge[2]
BOD_5	lb/day	1,846	205
COD	lb/day	12,886	3,098
NH_3-N	lb/day	1,007	89
Phenolics	lb/day	12.1	0.16
Oil & Grease	lb/day	537	52
TSS	lb/day	1,477	456
Sulfide	lb/day	9.7	0.4
Flow	gpm	5,200[3]	1,900

Notes:

[1] Calculations made according to 40 CFR 419—using 200,000 bbl/day, size factor = 1.41, and process factor = 1.19.

[2] Calculations made using average Outfall 001 effluent concentrations for 1996 and 1,900 gpm.

[3] Represents BAT flow for refinery of similar size.

The consultants rejected these systems due to prohibitive associated costs and/or because they were unproven technologies in the improvement of ammonia reduction. Parsons ES concurs with these conclusions of the previous consultant.

Mobil also looked at other options in 1995, in preparation of the ICPB 93-151 variance petition. Using in-house research group resources, Mobil conducted an evaluation of treatment technologies that could be added to the existing treatment system to achieve compliance with the state of Illinois ammonia standard. Based upon their review of published literature, previous studies of Joliet's process wastewater, and the experiences at other refineries, Mobil personnel identified the following commercially-available technologies:

- Activated sludge with powdered activated carbon (PACT process) - the PACT Process might adsorb organics inhibitory to nitrifiers.
- Selective ion exchange of WWTP effluent - sodium ions held by electrostatic forces to charged functional groups on the surface of a solid are exchanged for ammonia from a solution in which the solid is immersed.
- Breakpoint chlorination of WWTP effluent - chlorine gas is added to wastewater in sufficient amounts to cause the oxidation of the ammonium ions in solution to end products composed predominantly of nitrogen gas.

Detailed in Table 4.7 are the advantages and disadvantages of the ammonia reduction technologies researched by Mobil. Table 4.8 details activities and costs associated with the implementation of the alternative treatment technologies. The costs presented in Table 4.8 were developed from process designs using literature values for the needed design parameters. Budget quotes from manufacturers were used as the base of the cost estimates. Factors were applied to account for site preparation, electrical, instrumentation, piping, and structural work. Factors were also added to account for engineering, construction management, and administration of the contract. It is the opinion of Parsons ES that Mobil's alternative treatment survey was thorough and included appropriate technologies. Mobil's evaluations included a biological option (the PACT process) which has been applied in other applications to adsorb

TABLE 4.7
POST-TREATMENT AMMONIA REDUCTION TECHNOLOGIES

MOBIL WASTEWATER TREATMENT PLANT
MOBIL REFINERY
JOLIET, ILLINOIS

Post-Trtmnt Technologies	Advantages	Disadvantages
PACT Process	• Improve nitrification • Potential to remove toxics from WWTP influent • Improves solids settling • Improves resistance to shock organic loading • Ammonia destruction (assuming nitrification occurs)	• High operating costs (regeneration necessary) • Very abrasive to mechanical equipment • Higher rates of sludge production • Cross-transfer of pollutants to air during PACT regeneration
Ion Exchange	• Proven technology • Selective for ammonia • Minimal increases in total dissolved solids (TDS)	• Cross-transfer of ammonia to regenerant • High capital cost • Creates regenerant waste stream • Prone to organic fouling • High zeolite make-up rates required • Complex process • Cannot remove organic nitrogen (which might subsequently hydrolyze to ammonia) • Little experience using clinoptilolite in long-term applications
Breakpoint Chlorination	• Low capital cost • Proven technology • One-step process • Ammonia destruction • Low special requirements	• High operating costs • Potential formation of chlorinated organics • Handling/safety hazards with chlorine gas • Requires dechlorination • Potential for increase in TDS

TABLE 4.8
AMMONIA REDUCTION TECHNOLOGIES - ACTIVITIES & COSTS

WASTEWATER TREATMENT PLANT
MOBIL REFINERY
JOLIET, ILLINOIS

Required Facilities to Employ Specific Technology at Joliet WWTP	Costs[a]			
	Capital (10^6 $)	Operating (10^6 $/yr)	Annualized[b] (10^6 $/yr)	Incremental Unit Removal[c] ($/lb NH_3)
PACT Process				
• Makeup carbon silo and carbon feed system • Carbon regeneration system (CRS) - wet air oxidation • Building to house CRS • Additional solids handling equipment • Utilities tie-ins • Retrofits of existing pumping equipment, mechanical aerators, and clarifier drive mechanisms for abrasive service	9.2	1.9	3.3	490
Ion Exchange				
• Ion exchange columns with clinoptilolite charges • Backwash facilities • Regeneration facilities • Granular media filters • Utilities tie-ins • Buildings to house ion exchange equipment	16.2	1.6	4.1	609
Breakpoint Chlorination				
• Chlorine contact chamber and associated metering equipment • Dechlorination facilities • Chlorination/dechlorination facilites building • Utilities tie-ins • Chlorine safety facilities	2.2	0.8	1.1	163

Notes:
[a] Costs estimated in 1993; updated for first quarter 1997 using ENR cost indices.
[b] Annualized cost = operating cost plus capital cost amortized for 10 years at 9 %.
[c] Calculated using 10 year cost of technology, 1,900 gpm WWTP flow, and 1996 average NH_3-N effluent (3.9 mg/L).

inhibitory organics and two physical-chemical processes (selective ion exchange and breakpoint chlorination) that have the potential to remove ammonia and would not be affected by inhibitory substances.

Mobil has experimented with and performed engineering evaluations on a number of processes that might provide the means to comply with the state ammonia standard. None have proved suitable due to a variety of problems including performance shortfalls, unreasonable cost, unsuitability for the Joliet site, and the generation of unacceptable toxic byproducts.

Furthermore, the process costs associated with removing the incremental amount of ammonia necessary to meet the state effluent guideline are prohibitive. Unit removal costs, which reflect the dollars per pound of ammonia removed, are presented in Table 4.8. These values were calculated using the 1996 average ammonia effluent (3.9 mg/L), a flow of 1,900 gpm, and the process technology 10 year cost. Assuming that 3 mg/L effluent ammonia concentration could be consistently reached, in order to remove an additional 0.9 mg/L to meet the 3 mg/L effluent limitation, PACT, ion exchange, and breakpoint chlorination will cost \$490/lb NH_3, \$609/lb NH_3, \$163/lb NH_3, respectively.

To put these costs for ammonia removal in perspective, they were compared to existing Joliet Refinery treatment costs. A baseline ammonia removal cost was calculated that reflects the costs prior to the upgrades made between 1990 and 1996 (these upgrades are presented in Subsection 3.5.2). The cost was derived by dividing the total treatment system operating cost by the quantity of ammonia removed. The "pre-upgraded" cost was \$8/lb of NH_3 removed.

Considering the cost of the upgrades to promote ammonia removal (Subsection 3.5.2), ammonia removal following these upgrades costs \$24/lb. These costs include the treatment system operating cost as well as the amortized capital cost of the upgrades. According to the costs presented in Table 4.8, the least expensive alternate technology, breakpoint chlorination, would add an expense of approximately \$163/lb

NH_3 removed—representing an increase of 20 times the "pre-upgrades" ammonia removal cost (seven times the current ammonia removal cost). Moreover, employing ion exchange technology, the most expensive treatment alternative, would add an expense of approximately $609/lb NH_3 removed, an increase of 76 times the "pre-upgrade" cost (25 times the current ammonia removal cost).

SECTION 5
CONCLUSIONS

Parsons ES reached the following conclusions during this investigation:

1. The treatment system is properly designed and operated. It consistently meets its discharge permit and performs well above the USEPA Best Available Technology (BAT) guidelines for the refining industry.

2. Many improvements have been made to the system since it was initially placed into operation in 1973. Approximately $10 million has been spent on these improvements. These improvements (presented in detail in Table 3.4) have had the objectives of accomplishing the following:

   - Decrease and control ammonia loadings to the treatment plant.

   - Increase equalization capacity and degree of pretreatment.

   - Improve the design and performance of the treatment system, and create conditions favorable to achieving biological nitrification.

3. This evaluation of the Mobil treatment system revealed no operational changes nor modifications that would likely lead to consistent nitrification. Recent data indicates that the system is operated within the envelope of conditions required to achieve nitrification. In fact, nitrification is achieved in the system on occasion for several months at a time. However, there are other operating periods during which nitrification ceases or is significantly reduced due to reasons that can best be explained as chemical inhibition of nitrifying organisms.

4. Mobil has conducted studies and implemented changes in operations to reduce sources of inhibition that might prevent effective and consistent nitrification. The efforts to identify and remedy the sources of inhibition have not been completely successful. The most consistent conclusions from these tests are that some toxicity is added to the wastewater with passage through a benzene removal unit (required for compliance with Resource Conservation and Recovery Act [RCRA] and the Clean Air Act) and that byproducts of the degradation of organics in the activated sludge system are inhibitory to the nitrification process.

5. Because of these problems, the treatment system does not consistently meet the Illinois ammonia standard. While effluent ammonia concentrations have progressively decreased from an annual average of 17 mg/L in 1977 to values ranging from less than 1 mg/L to 6 mg/L in recent years, Mobil has not, even with the improvements and studies summarized above, been able to meet the state average standard of 3 mg/L with sufficient consistency.

6. Mobil has investigated a number of technologies with the hope of identifying one which could achieve compliance with the state ammonia standard. No applicable process has been identified. Problems with the technologies evaluated include high cost, site suitability problems, and generation of chlorinated organics. These technologies are not proven for the Mobil Joliet Refinery application and their cost is prohibitively high to recommend them for implementation.

EXHIBIT VIII

PLUME STUDY
and
EFFLUENT LIMIT
DERIVATIONS REPORT

MOBIL OIL CORPORATION
JOLIET REFINERY
JOLIET, ILLINOIS

Prepared by:

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Sean D. LaDieu

April 21, 1997

HUFF & HUFF, INC.
ENVIRONMENTAL CONSULTANTS
LaGRANGE, ILLINOIS

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APPENDICES

1. INTRODUCTION

The Mobil Oil Corporation - Joliet Refinery (Mobil) operates a wastewater treatment plant (WWTP) for the treatment of process wastewater and in-plant surface run-off. The WWTP flowrate on average is approximately 1,900 gallons per minute (gpm) or 2.7 million gallons per day (mgd) and discharges to the Des Plaines River through Outfall 001. Mobil currently operates the WWTP under National Pollution Discharge Elimination System (NPDES) permit no. IL0002861.

The ammonia limits set forth in the NPDES permit are based on a variance for effluent limits. The variance allows a monthly average ammonia limit of 13 mg/l and a daily maximum limit of 26 mg/l. This was granted on March 3, 1994 and originally expired on March 3, 1998. The variance now expires on March 3, 1999 after a one year extension was granted to Mobil. Unless site specific relief is adopted before the current variance expires, the ammonia effluent limits will be reduced to the applicable Illinois effluent limits of 3.0 mg/l and 6.0 mg/l for the monthly average and daily maximum, respectively.

A plume study was conducted at Outfall 001 in order to determine the extent of mixing that occurs between the outfall and the Des Plaines River. The plume study included an evaluation of the mixing zone and the Zone of Initial Dilution (ZID). The report contained herein documents the procedures used for the study, results, and implications for future limits.

2. BACKGROUND

2.1 Mobil Oil Refinery WWTP

The Mobil refinery is located in Will County approximately 10 miles southwest of Joliet, Illinois, on the south side of the Des Plaines River just east of the Interstate 55 bridge. The location of the refinery is depicted on Figure 2-1 with the WWTP located on the north side of Arsenal Road. The WWTP is an activated sludge system that is preceded by an API oil/water separator system, a dissolved air flotation system, and equalization biological treatment units.

The existing NPDES permit for the refinery covers nine outfalls numbered as Outfall 001 through Outfall 009. Outfall 001 discharges the treated process wastewater to a manmade outfall channel depicted in Figure 2-1. Outfall 002 discharges non-contact cooling water from the plant into the same manmade outfall channel, as does Outfall 003 which discharges stormwater for the west storage basin. The remaining outfalls (004 through 009) are all stormwater runoff discharges.

2.2 Des Plaines River

The refinery WWTP discharges into the Des Plaines River upstream of the I-55 bridge at River Mile 278.5 (approximately). The Des Plaines River originates near Kenosha, Wisconsin and travels south and then southwest before merging with the Kankakee River near Channahon, Illinois, where the combined rivers become the Illinois River. The width of the Des Plaines River at the point of the refinery WWTP outfall is approximately 600 feet.

The Des Plaines River is designated as a Secondary Contact Water under 35 Ill. Adm. Code 303.441 from the confluence with the Chicago Sanitary and Ship Canal to the Interstate 55 bridge. The water quality standards for Secondary Contact Waters are set forth in 35 Ill. Adm. Code 302 Subpart D. The ammonia water quality standard for these waters is based upon the un-ionized portion of ammonia with the established limit being 0.1 mg/l.

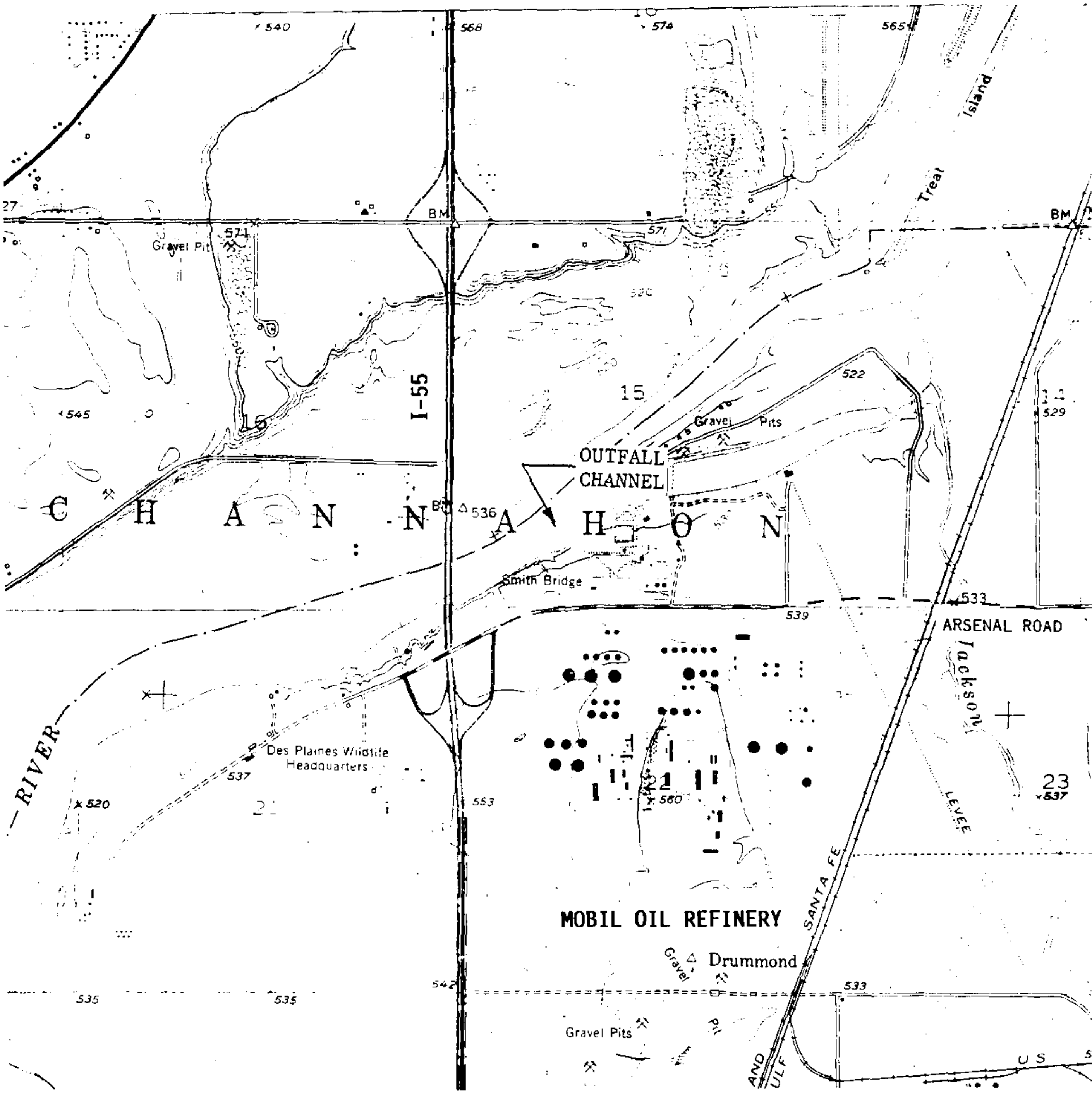

FIGURE 2–1
SITE LOCATION MAP
MOBIL OIL REFINERY
JOLIET, ILLINOIS

2000' 0 2000'

NORTH

SOURCE: UNITED STATES DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY
CHANNAHON, ILLINOIS QUADRANGLE

2.3 Mixing Zone and Zone of Initial Dilution Regulations and Policies

The mixing zone and Zone of Initial Dilution (ZID) are components of the State's program to protect water quality within the vicinity of wastewater outfalls. The mixing zone defines an area within which the acute toxicity standard is to be met but the water quality standard may be exceeded. The water quality standards are to be met at the edge of the mixing zone. The ZID is a portion of the mixing zone and defines a boundary at which the acute toxicity standards are to be met. Both of these components are defined in 35 Ill. Adm. Code 302 as follows:

> " 'Mixing Zone' means a portion of the waters of the State identified as a region within which mixing is allowed pursuant to Section 302.102(d)."

> " 'ZID' or 'Zone of Initial Dilution' means a portion of a mixing zone, identified pursuant to Section 302.102(e), within which acute toxicity standards need not be met."

The concepts of the mixing zone and ZID are used to derive effluent limits protective of the receiving stream's water quality standard. Section 302.102 sets the allowable area for the mixing zone based upon the receiving stream dimensions. The area and volume within which mixing occurs is limited to 25% of the cross-sectional area and volume of the stream. In no case shall the mixing zone area be greater than 26 acres.

Title 35 Ill. Adm Code 302 defines the area allowed for the ZID as an area "within which effluent dispersion is immediate and rapid". The Illinois Environmental Protection Agency (IEPA) has issued a guidance document for mixing zones that states the acute standard (the ZID area) "must be met within 10% of the distance from the edge of the outfall to the edge of the regulatory mixing zone in any spatial direction".

The present study for Mobil was conducted to determine the available dilutional mixing available for Outfall 001. The study was conducted consistent with the regulations and policies described above.

3. FIELD RESULTS

3.1 Plume Study Sampling

Field sampling for the plume study was conducted on October 29, 1996. Mobil provided the boat and driver, the necessary sample bottles, and the laboratory analyses for the plume study evaluation. Sampling locations were determined using a total station surveying system to measure angle and distance.

The weather on the day of sampling was cold and rainy. The temperature during the day was between 45 and 50 degrees fahrenheit. The rain was intermittent with periods of heavy downpour. The rain did not influence the low flow stream conditions that existed during the study period.

3.2 Sampling Methods

Samples were analyzed for conductivity using a YSI Model 33 conductivity meter and temperature was measured with a Cole-Parmer Digi-Sense Type K Digital Thermometer. These two parameters were analyzed at the sample location. Mobil's laboratory analyzed the samples for ammonia, chlorides, and pH on the same day as collected. The rationale for the analyses conducted is as follows:

- Conductivity and Temperature - These parameters were analyzed in the field as a method for tracking the plume. The plume effluent temperature and conductivity are both normally higher than the receiving stream's.

- Chlorides - This parameter was chosen because it is a conservative pollutant. There is usually a large difference between river and effluent chloride levels and the analysis is fairly accurate.

- Ammonia - The intent of the plume study was primarily to determine the available dilution within the mixing zone as it relates to the ammonia levels in the effluent.

- pH - This parameter is easy to measure and is used in calculating un-ionized ammonia.

3.3 Sampling at Effluent Channel

The sampling for the Mobil plume study was conducted on October 29, 1996, a day with low flow river conditions. The United States Geological Survey operates a gaging station on the Des Plaines River at Riverside, Illinois. This station is located approximately 39 miles upstream of the Mobil discharge. The nearest downstream station is the USGS station in Marseilles, Illinois on the Illinois River located 32 miles from Mobil's outfall. The flow values for these two stations, including the day of sampling and the plant effluent flow are presented below:

USGS Monitoring Station	7Q10 Flow, cfs	Sampling Day Flow, October 29, 1996, cfs	Harmonic Mean Flow, cfs
Des Plaines River at Riverside	139	190 (October 28, 1996)	370
Illinois River at Marseilles	3,185	4,700 (October 28, 1996)	7,200
WWTP Effluent Flow	----	2.9	----

The sampling program began by determining the general location and direction of the plume and the depth of the plume. This was determined by measuring the background water conductivity and temperature, and comparing it to the effluent. Using the boat, the river was then traversed to locate the general shape of the plume by observing the conductivity and temperature measurements as they compared to background levels. The measurements made in the field are presented in Table 3-1.

The conductivity at a depth of one foot near the mouth of the outfall channel measured 2,000 umhos/cm, while at a depth of three feet, the conductivity was 750 umhos/cm. Additional conductivity probing consistently showed the plume was spreading on the surface, indicating a "floating" plume. All samples were therefore collected at a depth of one foot.

TABLE 3-1

MIXING ZONE AND ZONE OF INITIAL DILUTION STUDY
FIELD MEASUREMENTS

Mobil Oil Refinery
Joliet, Illinois
October 29, 1996

Sample ID	Time	Conductivity, umhos	Temperature, deg F
Upstream Samples			
US 1	08:17	600	68.1
US 2	08:54	650	68.1
US 3	10:00	625	66.9
US 4	10:50	625	68.1
US 5	11:46	1600	67.6
US 6	12:09	1600	67.4
Effluent Channel Samples			
EC 1	08:20	1700	90.8
EC 2	08:56	1350	81.8
EC 3	09:31	1600	82.5
EC 4	10:07	1600	83.6
EC 5	10:53	1700	83.6
EC 6	11:51	2900	84.2
River Samples			
A1	08:25	1400	82.7
A2	08:30	1200	78.4
A3	08:32	1250	81.8
A4	08:34	1075	76.6
A5	08:36	775	70.5
A6	08:42	850	71.7
A7	08:44	800	71.4
A8	08:47	690	68.7
A9	08:51	700	68.1
B1	09:00	1100	77.1
B2	09:03	1200	76.8
B3	09:05	1400	78.9
B4	09:08	1150	76.1
B5	09:10	1050	74.4
B6	09:12	875	72.8
B7	09:15	850	72.1
B8	09:17	800	70.1
B9	09:20	750	69.2
C1	09:33	1075	73.4
C2	09:37	1300	78.6
C3	09:40	900	70.7
C4	09:43	900	71.9
C5	09:45	1250	79.1
C6	09:48	1050	77.7
C7	09:51	650	70.3
C8	09:55	650	67.8
D1	10:11	700	69.2
D2	10:15	750	69.9
D3	10:19	1200	75.7
D4	10:24	700	70.4
E3	11:08		
E4	11:06		
E5	11:02	900	68.9
E6	11:00	650	68.1
E7	10:56	750	67.6
F1	11:25	1250	65.6
F2	11:23	1200	70.1
F3	11:20	1100	65.6
F4	11:15	1000	68.5
F5	11:17	1000	68.7
G1	11:30	1200	65.1
G2	11:31	1600	67.6
G3	11:34	1600	68.1
G4	11:42	1650	65.6
H1	11:55	1600	67.1
I1	11:58	1700	66.1
I2	12:01	1600	67.4
I3	12:04	1400	67.6

File: f:/1doc/mobil/wrksht/plumdata.wk4

After the general direction and depth of the effluent plume was determined, samples were collected for analysis. Each sample location was labeled with an alpha-numeric character and then a numeric character. The alpha-numeric character increased in the downstream direction while the second numeric character increased with distance from the shoreline. Figure 3-1 depicts the sample locations.

3.4 Sampling Data

The sampling data for the measurements made at the sampling location, which include conductivity and temperature were presented in Table 3-1. The laboratory results for the parameters measured in the laboratory are presented in Table 3-2. These parameters include chlorides, pH, and ammonia. Table 3-3 presents the chlorides values and compares the results to levels measured in the samples collected from the upstream locations. These upstream samples were collected to determine background levels in the river. The chloride results were used to calculate the dilution ratios for the sample locations.

The dilution ratio is used to determine the degree of mixing that is occurring in the river. The ratio is determined by dividing the effluent value above background by the river sample value above background. Higher dilution ratios indicate more dilution as the difference between the effluent levels and the river levels is greater (the river level being lower than the effluent level). The background levels are subtracted from both the effluent sample and river sample to establish the background level as the baseline level. The dilution ratios for the chlorides have been calculated and are presented in Table 3-3.

The ammonia effluent levels on the day of sampling ranged from 0.00 mg/l to 0.16 mg/l. Four out of the six effluent samples collected were 0.00 mg/l. In comparison, the upstream samples ranged from 0.00 mg/l (3 out of 6 samples) to 0.28 mg/l. These levels were too low to produce results that would allow tracking of the ammonia plume at any degree of certainty, and therefore were not used for the plume delineation. The ammonia analytical results as they compare to background levels are included in Appendix A.

TABLE 3-2

MIXING ZONE AND ZONE OF INITIAL DILUTION STUDY
RAW DATA

Mobil Oil Refinery
Joliet, Illinois
October 29, 1996

Sample ID	Time	Chlorides, mg/l	pH, units	Ammonia, mg/l
Upstream Samples				
US 1	08:17	92	7.57	0.28
US 2	08:54	92	7.50	0.05
US 3	10:00	93	7.64	0.00
US 4	10:50	94	7.75	0.16
US 5	11:46	93	7.81	0.00
US 6	12:09	92	7.77	0.00
Effluent Channel Samples				
EC 1	08:20	270	8.09	0.16
EC 2	08:56	227	7.69	0.00
EC 3	09:31	277	8.09	0.00
EC 4	10:07	279	8.00	0.00
EC 5	10:53	313	8.11	0.00
EC 6	11:51	349	8.17	0.05
River Samples				
A1	08:25	228	7.79	0.05
A2	08:30	181	7.49	0.11
A3	08:32	197	7.85	0.00
A4	08:34	166	7.69	0.28
A5	08:36	105	7.65	0.22
A6	08:42	142	7.64	0.11
A7	08:44	121	7.55	0.11
A8	08:47	96	7.29	0.18
A9	08:51	103	7.41	0.28
B1	09:00	178	7.71	0.00
B2	09:03	204	7.73	0.00
B3	09:05	239	7.89	0.12
B4	09:08	184	7.69	0.00
B5	09:10	165	7.74	0.00
B6	09:12	153	7.73	0.00
B7	09:15	135	7.64	0.00
B8	09:17	146	7.67	0.16
B9	09:20	121	8.05	0.11
C1	09:33	174	7.87	0.12
C2	09:37	220	8.02	0.00
C3	09:40	143	7.80	0.00
C4	09:43	150	7.76	0.11
C5	09:45	218	7.93	0.16
C6	09:48	198	7.86	0.00
C7	09:51	133	7.52	0.05
C8	09:55	93	7.62	0.05
D1	10:11	106	7.75	0.00
D2	10:15	128	7.75	0.00
D3	10:19	205	7.90	0.00
D4	10:24	95	7.74	0.00
E3	11:08	120	7.67	0.00
E4	11:06	117	7.78	0.00
E5	11:02	101	7.70	0.16
E6	11:00	99	7.72	0.00
E7	10:56	110	7.73	0.00
F1	11:25	124	7.86	0.00
F2	11:23	148	7.85	0.22
F3	11:20	94	7.86	0.00
F4	11:15	93	7.79	0.00
F5	11:17	93	7.82	0.00
G1	11:30	102	7.75	0.22
G2	11:31	99	7.72	0.00
G3	11:34	94	7.82	0.00
G4	11:42	95	7.86	0.00
H1	11:55	105	7.74	0.05
I1	11:58	96	7.76	0.00
I2	12:01	94	7.76	0.00
I3	12:04	94	7.74	0.11

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TABLE 3-3

CHLORIDE DILUTION RATIOS

Mobil Oil Refinery
Joliet, Illinois
October 29, 1996

Sample ID	Time	Chlorides, mg/l				
		Upstream	Effluent	River	River Above Background	Dilution Ratio
US 1	08:17	92				
EC 1	08:20		270			
A1	08:25			228	136	1.2
A2	08:30	Avg. Upstream=	Avg. Effluent =	181	89	1.8
A3	08:32	92	249	197	105	1.5
A4	08:34			166	74	2.1
A5	08:36			105	13	12.1
A6	08:42			142	50	3.1
A7	08:44			121	29	5.4
A8	08:47			96	4	39.3
A9	08:51			103	11	14.3
US 2	08:54	92				
EC 2	08:56		227			
B1	09:00			178	85	1.9
B2	09:03	Avg. Upstream=	Avg. Effluent =	204	111	1.4
B3	09:05	93	252	239	146	1.1
B4	09:08			184	91	1.7
B5	09:10			165	72	2.2
B6	09:12			153	60	2.7
B7	09:15			135	42	3.8
B8	09:17			146	53	3.0
B9	09:20			121	28	5.7
EC 3	09:31		277			
C1	09:33			174	81	2.3
C2	09:37		Avg. Effluent =	220	127	1.5
C3	09:40		278	143	50	3.7
C4	09:43			150	57	3.2
C5	09:45			218	125	1.5
C6	09:48			198	105	1.8
C7	09:51			133	40	4.6
C8	09:55			93	0	at background
US 3	10:00	93				
EC 4	10:07		279			
D1	10:11			106	12	16.8
D2	10:15	Avg. Upstream=	Avg. Effluent =	128	34	5.9
D3	10:19	94	296	205	111	1.8
D4	10:24			95	1	202.0
US 4	10:50	94				
EC 5	10:53		313			
E7	10:56			110	16	14.8
E6	11:00	Avg. Upstream=	Avg. Effluent =	99	5	47.4
E5	11:02	94	331	101	7	33.9
E4	11:06			117	23	10.3
E3	11:08			120	26	9.1
F4	11:15			93	0	at background
F5	11:17			93	0	at background
F3	11:20			94	0	at background
F2	11:23			148	54	4.4
F1	11:25			124	30	7.9
G1	11:30			102	8	29.6
G2	11:31			99	5	47.4
G3	11:34			94	0	at background
G4	11:42			95	1	237.0
US 5	11:46	93				
EC 6	11:51		349			
H1	11:55			105	12	21.3
I1	11:58	Avg. Upstream=	Avg. Effluent =	96	3	85.3
I2	12:01	93	349	94	1	256.0
I3	12:04			94	1	256.0
US 6	12:09	92				

File: f:/1doc/mobil/wrksht/plumdata.wk4

Dilution Ratio $= \frac{\text{Effluent Value Above Background}}{\text{River Sample Value Above Background}} = \frac{\text{Effluent Avg. - Background Avg.}}{\text{River Sample - Background Avg.}}$

4. MIXING ZONE AND ZID DETERMINATION

4.1 Mixing Zone Size

The mixing zone size is limited to 25% of the cross-sectional area of the stream. The Des Plaines River at the Mobil outfall channel is approximately 600 feet wide. The river is dredged in the area of the Mobil Oil outfall channel, making the bottom of the river fairly level. The mixing zone width is therefore limited to a width of 150 feet (25% of 600 feet). The surface area of the mixing zone is limited to 26 acres. The maximum length of the mixing zone allowed to Mobil is therefore 7,500 feet or approximately 1.4 miles.

Figure 4-1 depicts the chloride plume generated from plotting the dilution ratios. Based upon the chloride dilution ratios, the minimum dilution achieved at the edge of the mixing zone is 21:1. This is the dilution ratio determined from the sample results of sample H1 collected 150 feet from the shoreline. This is the maximum width allowed and is within the main flow pattern of the plume.

4.2 ZID Size

The ZID size is limited to 10% of the mixing zone in any spatial direction. The mixing zone width is 150 feet wide at the outfall location. The ZID would therefore be limited to 15 feet wide, and based upon the IEPA interpretation, also limited to 15 feet in length. This area would be immediately outside the outfall channel.

Figure 4-2 depicts the area outside the outfall channel along with the chloride dilution ratios. The terminus of the effluent channel is defined as the end of the boathouse, as everything to this point is manmade for purposes of the effluent discharge. The 15 foot by 15 foot area allowed for the ZID is depicted in Figure 4-2 and delineated by the sample points A-1, A-2, B-1, and B-2. The minimum mixing achieved within this area is 1.4:1, as determined by the sample collected at B-2.

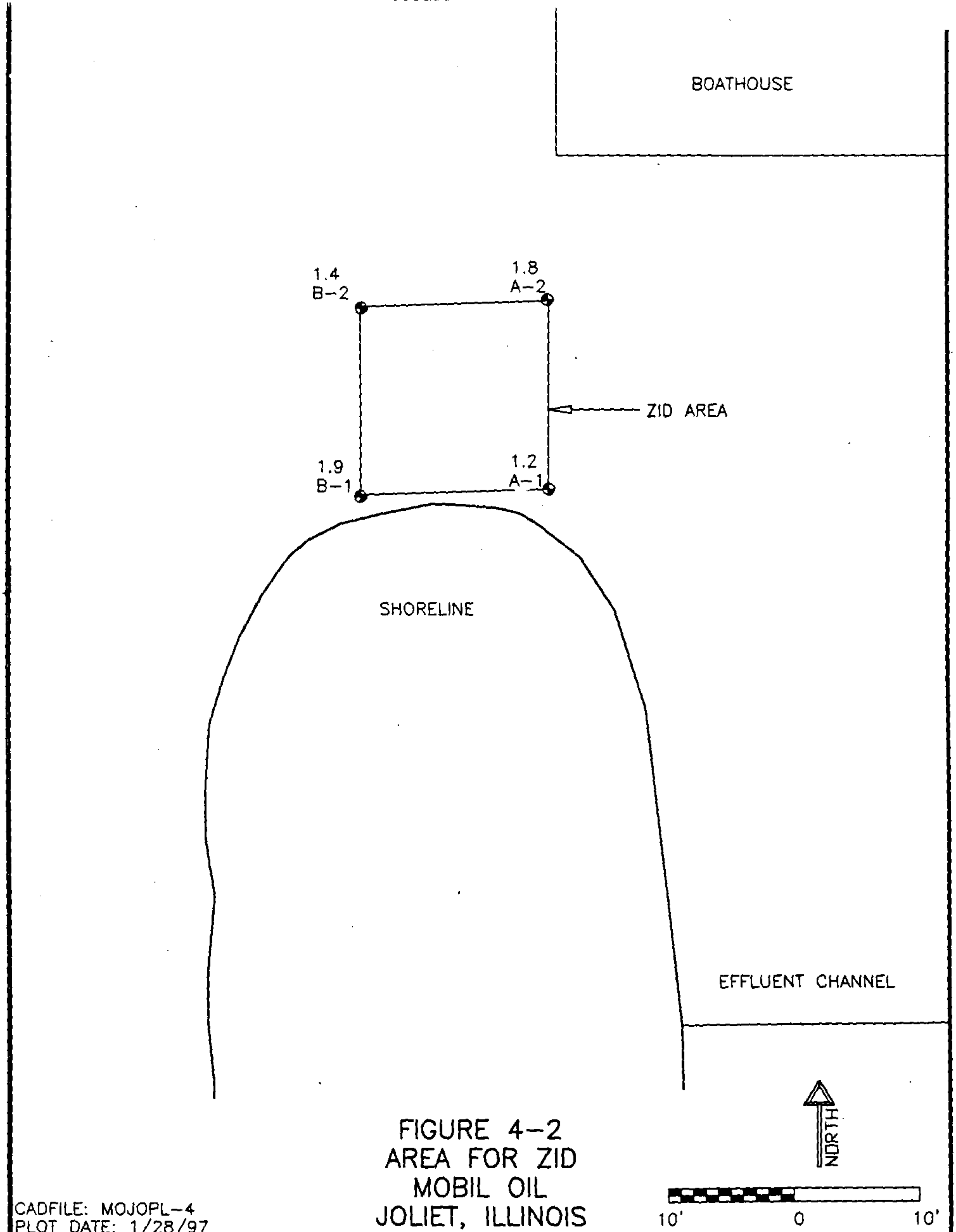


FIGURE 4-2
AREA FOR ZID
MOBIL OIL
JOLIET, ILLINOIS

4.3 Available Mixing Discussion

The dilution achieved at the edge of the mixing zone and edge of the ZID are determined based upon the dilutions determined from the chlorides analysis. Chlorides are conservative pollutants and often used for plume studies. The dilutions achieved for the mixing zone and ZID, based upon chlorides is 21:1 and 1.4:1, respectively.

The dilution ratios for non-conservative pollutants, such as ammonia, would be expected to be higher at the same sample locations for non-conservative pollutants. Effluent ammonia levels are affected by other factors besides mixing when discharged into the receiving stream. Ammonia is subject to continued nitrification, volatilization, and plant uptake. These factors combined make ammonia a non-conservative pollutant and would therefore be expected to have higher dilution ratios than those determined from the chloride samples.

A factor to be included in the WWTP ammonia effluent limit calculation is the mixing of non-contact cooling water prior to the discharge into the Des Plaines River. Based upon the schematic of water flow provided in Appendix B, the non-contact cooling water flow is 6,666 gallons per minute compared to 1,975 gallons per minute for the WWTP effluent. The non-contact cooling water accounts for 77 percent of the discharged water or a ratio of approximately 3:1. Factoring this dilution from the non-contact cooling water prior to the mixing with the river water, the appropriate dilutions to use for the effluent limit calculations for the WWTP through Outfall 001 would be as follows:

Plume Zone	Cooling Water Mixing	Des Plaines River Mixing	Total Dilution
Mixing Zone	3:1	21:1	63:1
Zone of Initial Dilution	3:1	1.4:1	4.2:1

Also of interest from Figure 4-1 is the available mixing at the I-55 Bridge. While the available mixing within the mixing zone is 21:1, by the I-55 Bridge, the available mixing is 85:1. If the maximum un-ionized ammonia at the edge of the mixing zone is 0.1 mg/l, by the I-55 Bridge, the maximum ammonia will be:

$$\frac{0.1 \text{ mg/l} \times 21:1}{85:1} = 0.025 \text{ mg/l}$$

Thus, effluent limits protective of the Secondary Contact Water Quality Standard (0.1 mg/l), will also assure compliance with the General Use Water Quality winter un-ionized standard (0.025 mg/l).

5. APPLICABLE PERMIT LIMITS

5.1 Derivation of Effluent Limits

Ammonia effluent limits are established based upon treatment technology. For dischargers to the Illinois waterway, this treatment technology was established at 3.0 mg/l ammonia, based upon a monthly average. Mobil, like other refineries, has not been able to consistently achieve the 3.0 mg/l limit, and has previously been granted relief by the Illinois Pollution Control Board.

Alternative ammonia effluent limits have been derived based upon the existing effluent quality. The derivation of existing effluent quality limits is specified in U.S. EPA's "Technical Support Document" (1991). The existing adjusted standard effluent limits were derived using this approach. In addition to calculating effluent limits based upon existing effluent quality, water quality-based effluent limits are also appropriately derived, with the lower calculated limits of the two approaches used for establishing effluent limits.

5.2 Water Quality-Based Effluent Limits

The mixing zone study and ZID study were conducted to determine the available dilution near the effluent channel outlet at Mobil. The water quality-based limits for Mobil were calculated for ammonia using the un-ionized ammonia water quality standards and the measured available dilution. The water quality standard for un-ionized ammonia in secondary contact waters is 0.1 mg/l. Using this water quality limit, the corresponding total ammonia level at the edge of the mixing zone can be determined using the 75th percentile pH and temperature values for the receiving stream, consistent with IEPA procedures.

The 75th percentile values for pH and temperature determined from the 1996 Des Plaines River data are as follows:

Season	75th percentile pH	75th percentile temperature, deg C
Summer	8.1	28.9
Winter	8.0	13.9

The dilution ratios determined from the mixing zone study were presented in Chapter 4. The total ammonia effluent limits for the WWTP outfall can be determined using the calculated water quality ammonia levels and the available dilution at the edge of the mixing zone (63:1). The calculations for these limits are provided in Appendix C. The limits derived from the water quality standard, applied at the edge of the mixing zone would establish the monthly effluent limit. The limits calculated are as follows:

Season	Water Quality Based Effluent Limits (Monthly Average Limit)
Summer	70 mg/l
Winter	243 mg/l

5.3 Existing Ammonia Effluent-Based Limits

The existing ammonia effluent data were used to derive ammonia effluent limits based upon existing WWTP performance. The "Technical Support Document for Water Quality-based Toxics Control" (1991) provides a methodology to calculate monthly effluent limits and daily maximum effluent limits based upon the 95th percentile distribution. Different databases were used to determine the monthly average limit and the daily maximum limit. The daily maximum limit was evaluated using ammonia effluent data collected from January 1992 through December 1996. The monthly average limit was calculated using the monthly averages generated from November 1996 through March 1997.

Mobil Oil has recently completed upgrading the WWTP at the refinery. The upgraded plant was fully operational starting in November, 1996. The ammonia effluent quality expected from the upgraded WWTP can be estimated from the November 1996 to March 1997 data. This limited database was therefore used for the monthly average limit determination. Although the upgraded plant provides better control of ammonia effluent quality, the ammonia spikes generated from the refinery operation will still occur, and carry through the upgraded WWTP. However, the WWTP recovery time will be shortened due to the upgrade. The database for determining the daily maximum includes data from January 1992 to December 1996. This data set includes periods of WWTP operation during typical ammonia spikes.

The monthly average permit limit was calculated using the methodology in the "Technical Support Document" for small sample numbers. The daily maximum limit was calculated using the delta-lognormal distribution due to the number of ammonia effluent values below the detection limits. The calculations are provided in Appendix D. The ammonia effluent levels calculated using the U.S. EPA "Technical Support Document" are as follows:

Data Set	Monthly Effluent Limit	Daily Maximum Limit
Nov. 1996 to Mar. 1996 Ammonia Effluent	9 mg/l	- - -
1996 Ammonia Effluent	18 mg/l	28 mg/l
1992 to 1996 Ammonia Effluent	16 mg/l	23 mg/l

5.4 Existing Permit Limits

The Illinois Pollution Control Board granted Mobil an ammonia effluent limit variance in 1994. The existing limits for the WWTP outfall at Mobil as they exist in the NPDES permit are as follows:

Existing Permit Limits	Monthly Effluent Limit	Daily Maximum
Ammonia Effluent	13 mg/l	26 mg/l

5.5 Applicable Ammonia Effluent Limits

The applicable ammonia effluent limits for Mobil's discharge are the most restrictive of the water quality derived limits, existing effluent quality derivation, or the existing effluent NPDES limits. The adjusted standard was granted to Mobil Oil given the inability of the WWTP to consistently achieve the technology-based ammonia effluent limit of 3.0 mg/l. The ammonia effluent limits generated based upon water quality and existing effluent then become viable options for determining appropriate ammonia effluent limits. The ammonia effluent limits generated from these methodologies are summarized as follows:

Methodology		Monthly Effluent Limit	Daily Maximum Limit
Water Quality-based	Summer	70 mg/l	---
	Winter	243 mg/l	---
Existing Effluent Ammonia Data - 1996		18 mg/l	28 mg/l
Existing Effluent Ammonia Data - 1992 to 1996		16 mg/l	**23 mg/l**
Existing Permit Limits		13 mg/l	26 mg/l
Nov. 1996 to Mar. 1997		**9 mg/l**	---

The applicable ammonia limits for Mobil's discharge become the most restrictive of these ammonia effluent limits and have been highlighted in the table. The proposed limits are as follows:

Permit Limit	Effluent Ammonia Limit
Monthly Effluent	9 mg/l
Daily Maximum	23 mg/l

5.6 Discussion

Table 5-1 summarizes Mobil's ammonia effluent quality since 1990. Over this period, Mobil's effluent has averaged 3.1 mg/l, only three percent above the 3.0 mg/l effluent limit. However, effluent limits are to be met every month, not on a long term basis. When predicting the monthly

TABLE 5-1

MOBIL OIL
AMMONIA EFFLUENT HISTORICAL QUALITY

Year	Ammonia, mg/l Annual Average	Maximum Month	Maximum Daily
1990	0.3	1.3	5.2
1991	0.6	2.5	13.0
1992	3.2	12.2	22.0
1993	4.0	9.5	24.0
1994	4.9	12.2	19.2
1995	6.3	13.7	25.5
1996	3.9	14.9	27.4
1997 a/	1.8	3.8	14.0

a/ January, February, and March

C:\1DOC\MOBIL\AMMONIA.WK4

limit based upon the last five years existing effluent quality data, a limit of 16 mg/l is derived, above the current variance limit of 13 mg/l. Due to recent upgrades of the WWTP, a more restrictive effluent limit of 9 mg/l is suggested based upon data obtained after the upgrade was complete. This represents a 31 percent reduction from the current variance limit. The 23 mg/l daily maximum limit, derived from the existing effluent database, reflects a 12 percent reduction from the current variance limit.

The water quality-based effluent limits (70 mg/l summer and 243 mg/l winter) were over five times higher than the existing and proposed monthly average ammonia limits of 13 and 9 mg/l, respectively. Thus, the proposed effluent limits are clearly protective of water quality. With the measured dilution at the I-55 Bridge, where the General Use Water Quality Standards begin, there is adequate dilution to achieve the water quality General Use Standards even if Mobil were discharging at 243 mg/l total ammonia.

Mobil Oil has expended approximately $7.8 million over the past five years to lower its effluent ammonia levels. The last two months of 1996 and the first three months of 1997 have shown a more consistent reduction in ammonia, suggesting the expenditure has resulted in lower effluent ammonia levels. However, in spite of this improvement, unanticipated deviations can occur, as evidenced by historical patterns presented in Table 5-1. In 1990 and 1991, Mobil's effluent averaged 0.3 and 0.6 mg/l, respectively, and it looked like Mobil was on its way toward complying with the 3.0 mg/l effluent standard. In fact, the maximum monthly discharge in 1990/1991 was only 2.5 mg/l. However, 1992 through 1995, Mobil's effluent ammonia level averaged 4.6 mg/l. In 1990 and 1991, Mobil could not have predicted the poorer performance of the sensitive nitrifying bacteria.

Similarly, at this time, Mobil cannot predict the future performance of the WWTP any more than it could have done so in 1990/1991. Therefore, it can only propose effluent limitation on the basis of the existing effluent quality. The proposed limits of 9 mg/l for the monthly average and 23 mg/l for the daily maximum are based on the data generated since the WWTP upgrades and the 1992 to 1996 WWTP performance, respectively. The 1992 - 1996 data set contains 517 ammonia sample measurements with the following concentration distribution:

1992 - 1996 WWTP Ammonia Discharge Samples

Concentration mg/l	No. of Samples
<0.1	83
0.1 to 3.0	215
3.0 to 6.0	72
6.0 to 13.0	88
13.0 to 23.0	56
>23.0	3
Total # Samples	517

The 1992 - 1996 data shows, that in spite of the WWTP performance disruption due to RCRA NESHAP's and other upsets, Mobil's discharge was below the 6.0 mg/l daily ammonia limit 72 percent of the time. With the recent upgrades, it is reasonable to expect that WWTP performance will further improve.

Based upon the most restrictive of the ammonia effluent limits presented, site specific relief with the following effluent limits are proposed:

Monthly Average:	9 mg/l
Daily Maximum:	23 mg/l

REFERENCES

U.S. Environmental Protection Agency, Technical Support Document For Water Quality-based Toxics Control, EPA/505/2-90-001, PB91-127415, March 1991.

APPENDICES

APPENDIX A

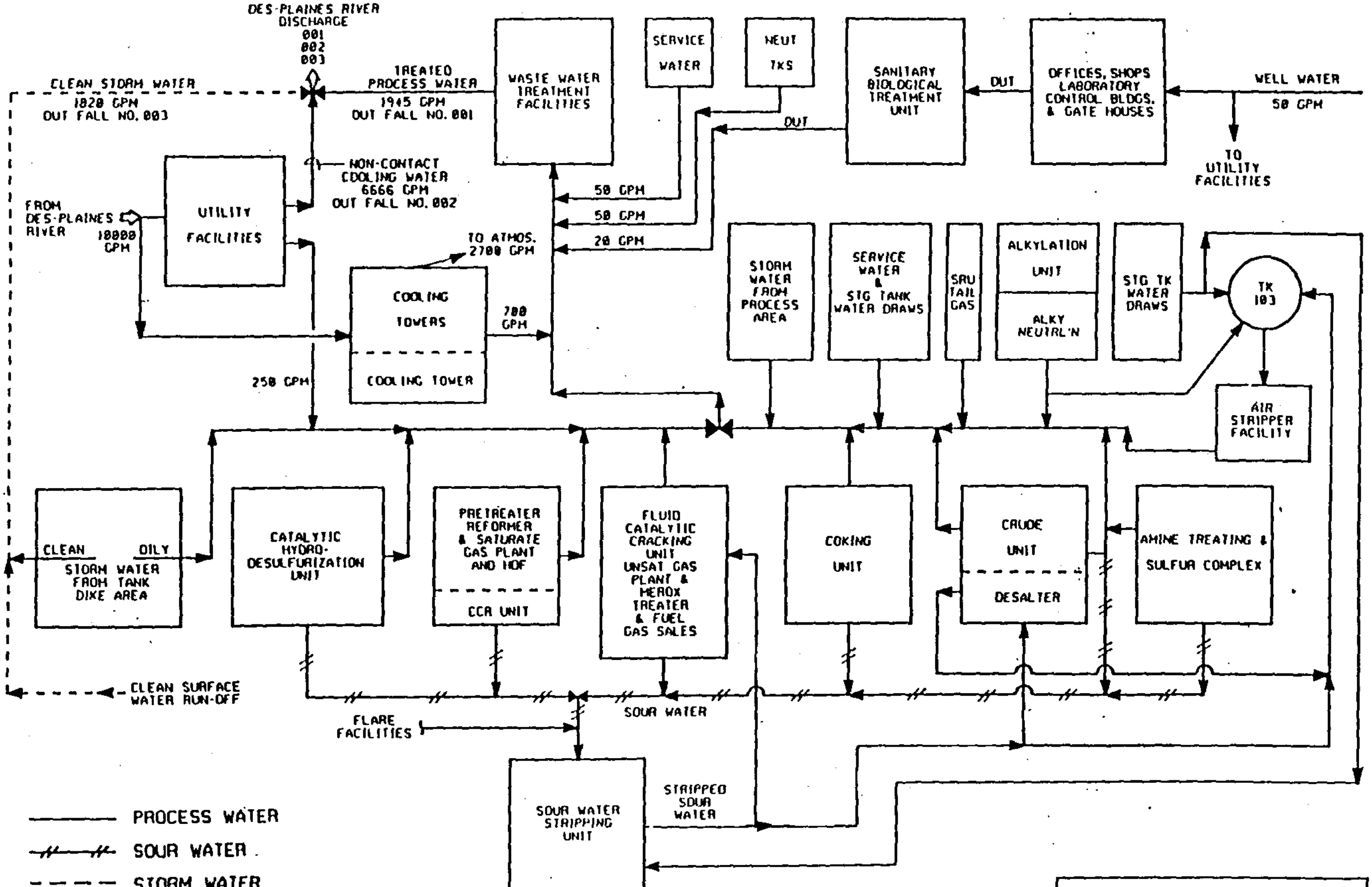
AMMONIA DILUTION RATIOS

Mobil Oil Refinery
Joliet, Illinois
October 29, 1996

Sample ID	Time	Ammonia, mg/l				Dilution Ratio
		Upstream	Effluent	River	Above Background	
US 1	08:17	0.28				
EC 1	08:20		0.16			
A1	08:25			0.05	0.00	
A2	08:30	Avg. Upstream=	Avg. Effluent=	0.11	0.00	
A3	08:32	0.16	0.08	0.00	0.00	
A4	08:34			0.28	0.12	
A5	08:36			0.22	0.06	
A6	08:42			0.11	0.00	
A7	08:44			0.11	0.00	
A8	08:47			0.18	0.02	
A9	08:51			0.28	0.12	
US 2	08:54	0.05				
EC 2	08:56		0.00			
B1	09:00			0.00	0.00	
B2	09:03	Avg. Upstream=	Avg. Effluent=	0.00	0.00	
B3	09:05	0.03	0.00	0.12	0.09	
B4	09:08			0.00	0.00	
B5	09:10			0.00	0.00	
B6	09:12			0.00	0.00	
B7	09:15			0.00	0.00	
B8	09:17			0.16	0.13	
B9	09:20			0.11	0.08	
EC 3	09:31		0.00			
C1	09:33			0.12	0.09	
C2	09:37		Avg. Effluent=	0.00	0.00	
C3	09:40		0.00	0.00	0.00	
C4	09:43			0.11	0.08	
C5	09:45			0.16	0.13	
C6	09:48			0.00	0.00	
C7	09:51			0.05	0.02	
C8	09:55			0.05	0.02	
US 3	10:00	0.00				
EC 4	10:07		0.00			
D1	10:11			0.00	0.00	
D2	10:15	Avg. Upstream=	Avg. Effluent=	0.00	0.00	
D3	10:19	0.08	0.00	0.00	0.00	
D4	10:24			0.00	0.00	
US 4	10:50	0.16				
EC 5	10:53		0.00			
E7	10:56			0.00	0.00	
E6	11:00	Avg. Upstream=	Avg. Effluent=	0.00	0.00	
E5	11:02	0.08	0.03	0.16	0.08	
E4	11:06			0.00	0.00	
E3	11:08			0.00	0.00	
F4	11:15			0.00	0.00	
F5	11:17			0.00	0.00	
F3	11:20			0.00	0.00	
F2	11:23			0.22	0.14	
F1	11:25			0.00	0.00	
G1	11:30			0.22	0.14	
G2	11:31			0.00	0.00	
G3	11:34			0.00	0.00	
G4	11:42			0.00	0.00	
US 5	11:46	0.00				
EC 6	11:51		0.05			
H1	11:55			0.05	0.05	
I1	11:58	Avg. Upstream=	Avg. Effluent=	0.00	0.00	
I2	12:01	0.00	0.05	0.00	0.00	
I3	12:04			0.11	0.11	
US 6	12:09	0.00				

File: f:/1doc/mobil/wrksht/plumdata.wk4

APPENDIX B



SCHEMATIC OF WATER FLOW
MOBIL JOLIET REFINING CORP.
JOLIET, WILL, ILLINOIS

APPENDIX C

CALCULATION OF MOBIL OIL AMMONIA EFFLUENT LIMITS BASED ON WATER QUALITY

FROM PROPOSED AMMONIA WATER QUALITY REGULATIONS:

WATER QUALITY STANDARDS BASED ON UN-IONIZED AMMONIA

SEASON	CHRONIC, mg/l
SUMMER	0.10 (Sec. Contact)
WINTER	0.10 (Sec. Contact)

75th PERCENTILE VALUES FROM MOBIL OIL / COMMINGLED RIVER DATA

SEASON	TEMPERATURE	pH
SUMMER	28.9°C	8.1
WINTER	13.9°C	8.0

USING FORMULA IN 35 Ill Adm Code 302.212 CALCULATE TOTAL AMMONIA (CONFIGURED TO SOLVE FOR N)

$$N = U\left(0.94412 \times (1+10^{x}) + 0.0559\right)$$

$$X = 0.09018 + \frac{2729.92}{(T + 273.16)} - pH$$

CALCULATIONS:

SUMMER CHRONIC LEVEL:

pH = 8.1 TEMP = 28.9°C

$$X = 0.09018 + \frac{2729.92}{28.9 + 273.16} - 8.1$$

$$X = 1.0279$$

$$N = 0.10 \left(0.94412\left(1 + 10^{1.0279}\right) + 0.0559\right)$$

N = 1.1068 mg/l TOTAL AMMONIA

WINTER CHRONIC LEVEL:

pH = 8.0 TEMP = 13.9°C

$$X = 0.09018 + \frac{2729.92}{13.9 + 273.16} - 8.0$$

$$X = 1.600$$

$$N = 0.10 \left(0.94412\left(1 + 10^{1.600}\right) + 0.0559\right)$$

N = 3.8586 mg/l TOTAL AMMONIA

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CALCULATION SHEET

Project Mobil Oil Effluent Ammonia Client Mobil Oil

Title Ammonia Effluent Calc

Signature S. CuDien Date 02/18/97 Sheet 3 of 3

SUMMARY OF TOTAL AMMONIA EFFLUENT WITH NO DILUTION SUMMER - 1.1068 mg/l WINTER - 3.3586 mg/l

BASED ON MIXING ZONE and ZID STUDIES, THE AVAILABLE DILUTION AT THE EDGE OF THESE ZONES, BASED ON THE MEASUREMENT OF A CONSERVATIVE POLLUTANT (CHLORIDES), THE AVAILABLE DILUTION IS AS FOLLOWS:

EDGE OF MIXING ZONE ⇒ 21:1 (MEET CHRONIC)

TO DETERMINE THE AMMONIA EFFLUENT LEVELS FOR THE WWTP, THE COOLING WATER DISCHARGE MUST BE ACCOUNTED FOR. THIS PROVIDES ADDITIONAL DILUTION OF 3:1 THE COMBINED DILUTION FOR THE TWO ZONES BECOMES:

EDGE OF MIXING ZONE ⇒ 63:1

BASED UPON THESE DILUTIONS THE TOTAL AMMONIA EFFLUENT LIMITS BECOME THE FOLLOWING:

SEASON	TO MEET CHRONIC LEVELS (x 63)
SUMMER	69.73 mg/l
WINTER	243.1 mg/l

} MONTHLY AVERAGE LIMITS.

APPENDIX D

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CALCULATION SHEET

1996 DATA

Project MOBIL OIL AMMONIA Client MOBIL

Title EFFLUENT CALCULATIONS BASED UPON TSD FOR WQ BASED TOXICS CONTRO[L] Sheet 1 of 5

Signature S. LaDien Date 02/07/97

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Calculate Ammonia Permit Limits Based upon MOBIL Effluent Data.

Use the delta-lognormal distribution used for data containing a mixture of nondetect values and values above non detect.

Data Set - 1996

- 35 Non detect values (0.0 mg/l)

Daily Average : $\hat{E}(x^*) = \hat{\delta} D + (1-\hat{\delta}) \exp(\hat{\mu}_y + 0.5\hat{\sigma}_y^2)$

Variance : $(1-\hat{\delta}) \exp(2\hat{\mu}_y + \hat{\sigma}^2_y)\,[\exp(\hat{\sigma}_y^2) - (1-\delta)] + \hat{\delta}(1-\hat{\delta}) D\,[D - 2\exp(\hat{\mu}_y + 0.5\hat{\sigma}_y^2)]$

Coefficient of Var: $[\hat{V}(x^*)]^{1/2} / \hat{E}(x^*)$

k = number of Samples
D = detection limits
r = number of nondetect values in sample
k-r = number of values greater than the detection limit.

$y_i = \ln(x_i)$
$\hat{\mu}_y = \Sigma(y_i) / (k-r)$
$\hat{\sigma}_y^2 = \Sigma(y_i - \hat{\mu}_y)^2 / (k-r-1)$
$\hat{\delta} = r/k$

K = 105
r = 35
K-r = 70
D = 0.10 mg/l

n = 8.75 AVG NUMBER OF SAMPLES / MONTH

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CALCULATION SHEET

Project: MOBIL OIL AMMONIA	Client: MOBIL		
Title: EFFLUENT CALCULATIONS BASED UPON TSD FOR WQ BASED TOXICS CON			
Signature: S. LA DIEU	Date: 02/07/97	Sheet 2 of 5	

Checked KDB 2/7/97

USE 95th percentile to determine Monthy Avg. Limit.

$X_{0.95}$ = 95th percentile n-day monthly avg. limit.

$$X_{0.95} = \begin{cases} 0 & \hat{\delta} \geq 0.95 \\ MAX & [0, \exp(\hat{\mu}_n + z^* \hat{\sigma}_n)] \end{cases}$$

where = $z^* = \phi_{.95}^{-1} [(0.95-\delta)/(1-\hat{\delta})]$

$$\phi_{.95}^{-1} = 1.645$$

$$\hat{\delta} = r/k = 35/105 = 0.33$$

$$\hat{\mu}_y = 0.7 \quad \text{(See Lotus Table)}$$

Est. variance $\hat{\sigma}_y^2 = 3.0$ (See Lotus Table)

$$\hat{E}(x^*) = (0.33)(0.10) + (1-0.33)\exp(0.7+0.5(3.0))$$
$$= (0.033) + (0.67)\exp(2.2)$$

$$\underline{\hat{E}(x^*) = 6.0797}$$

$$\hat{V}(x^*) = (1-0.33)\exp(2(0.7)+3.0)[\exp(3.0)-(1-0.33)] + 0.33(1-0.33)(0.1)[0.1-2\exp(0.7+0.5(3))]$$

$$= 0.67\exp(4.4)(19.416) + (0.02211)[-17.95]$$

$$= 1059.57 + (-0.3969)$$

$$\underline{\hat{V}(x^*) = 1059.17}$$

$$\hat{\sigma}_n^2 = \ln\{(1-\hat{\delta}^n)[1+A+B+C]\}$$

WHERE ⇒

$$A = \hat{V}(x^*) \big/ [n(\hat{E}(x^*) - \hat{\delta}^n D)^2]$$

$$A = 1059.17 \big/ [8.75(6.0797 - (0.33)^{8.75}(0.1))^2]$$

$$A = 1059.17 \big/ [8.75(36.963)]$$

$$A = 1059.17/(323.423)$$

$$\underline{\underline{A = 3.275}}$$

$$B = -[\hat{\delta}^n D^2(1-\hat{\delta}^n)] \big/ (\hat{E}(x^*) - \hat{\delta}^n D)^2$$

$$B = -[0.33^{8.75}(0.1)^2(1-0.33^{8.75})] \big/ (6.0797 - 0.33^{8.75}(0.1))^2$$

$$B = -[6123 \times 10^{-7}] \big/ 36.963$$

$$\underline{\underline{B = -1.6566 \times 10^{-8}}}$$

$$C = (2\hat{\delta}^n D) \big/ (\hat{E}(x^*) - \hat{\delta}^n D)$$

$$C = (2(0.33^{8.75})(0.1)) \big/ (6.0797 - (0.33)^{8.75}(0.1))$$

$$C = 1.2247 \times 10^{-5} \big/ 6.0797$$

$$\underline{\underline{C = 2.014 \times 10^{-6}}}$$

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CALCULATION SHEET

Project: MOBIL OIL AMMONIA | Client: MOBIL OIL
Title: EFFLUENT CALCULATIONS BASED UPON TSD
Signature: S. Cadiew | Date: 02/10/07 | Sheet 4 of 5
checked [illegible] 2.11.07

$$\hat{\sigma}_n^2 = \ln\{(1-0.33^{8.75})[1+3.275+(-1.6566\times10^{-8})+2.014\times10^{-6}]\}$$

$$\hat{\sigma}_n^2 = \ln\{(0.9999)(4.2750)\}$$

$$\hat{\sigma}_n^2 = 1.4527$$

$$\hat{\mu}_n = \ln[(\hat{E}(x^*) - \hat{\delta}^n D)/(1-\hat{\delta}^n)] - 0.5\,\hat{\sigma}_n^2$$

$$= \ln[(6.0797 - 0.33^{8.75}(0.1))/(1-0.33^{8.75})] - 0.5(1.4527)$$

$$= \ln[6.0797/0.9999] - (0.5)(1.4527)$$

$$= 1.8050 - 0.7264$$

$$\hat{\mu}_n = 1.0787$$

$$Z^* = \phi_{.95}^{-1}[(0.95-\hat{\delta})/(1-\hat{\delta})]$$

$$= 1.645[0.95-0.33/(1-0.33)]$$

$$= 1.5222$$

WITHOUT CORRECTION TO Z^* FORMULA CORRECTION ($\hat{\delta}^n$) WOULD MAKE Z^* HIGHER.

$$X_{0.95} = \exp(\hat{\mu}_n + Z^*\hat{\sigma}_n)$$

$$= \exp(1.0787 + 1.5222(1.4527)^{1/2})$$

$$= \exp(1.0787 + 1.8347)$$

$$\boxed{X_{0.95} = 18.42 \text{ mg/l}}$$

✓ MONTHLY AVERAGE

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CALCULATION SHEET

Project	MOBIL OIL AMMONIA	Client	MOBIL OIL
Title	EFFLUENT CALCULATIONS		
Signature	S. Cu Diou	Date	2/10/97

DAILY MAXIMUM

$$X_{0.95} = \exp(\mu_Y + z^* \hat{\sigma}_Y)$$

$$= \exp(0\ 7 + 1.522(3.0)^{1/2})$$

$$= \exp(3.407)$$

$$X_{0.95} = 28.11$$

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CALCULATION SHEET

1992-1996 DATA

Project MOBIL OIL AMMONIA　Client MOBIL OIL

Title EFFLUENT CALCULATIONS - Based on TSD

Signature S LaDieu　Date 02/11/97　Sheet 1 of 5

Calculate Ammonia Permit Limits Based upon MOBIL Effluent Data.

Use the delta-lognormal distribution used for data containing a mixture of nondetect values and values above non-detect.

Data Set -, 1992 to 1996 (5 yrs)

- 82 non detect values (0.0 mg/l)

Daily Average: $\hat{E}(X^*) = \hat{\delta} D + (1-\hat{\delta}) \exp(\hat{\mu}_y + 0.5\hat{\sigma}_y^2)$

Variance: $(1-\hat{\delta}) \exp(2\hat{\mu}_y + \hat{\sigma}_y^2)[\exp(\hat{\sigma}_y^2) - (1-\hat{\delta})] + \hat{\delta}(1-\hat{\delta}) D [D - 2\exp(\hat{\mu}_y + 0.5\hat{\sigma}_y^2)]$

Coefficient of Var $[\hat{V}(X^*)]^{1/2} / \hat{E}(X^*)$

k = number of samples
D = detection limits
r = number of nondetect values in sample
k-r = number of values greater than the detection

$y_i = \ln(x_i)$

$\hat{\mu}_y = \Sigma(y_i) / k-r$

$\hat{\sigma}_y^2 = \Sigma(y_i - \hat{\mu}_y)^2 / (k-r-1)$

$\hat{\delta} = r/k$

k = 517.
r = 82
k-r = 435
D = 0.10 mg/l.

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CALCULATION SHEET

Project: MOBIL OIL AMMONIA Client: MOBIL OIL
Title: EFFLUENT CALCS.
Signature: S. LaDieu Date: 02/07/97 Sheet 2 of 5

n = number of samples per month (average)

1992	TOTAL	100
1993	TOTAL	104
1994	TOTAL	104
1995	TOTAL	103
1996	TOTAL	105

60 months

$516 / 60 = 8.6$

$n = 8.6$

USE 95th PERCENTILE TO DETERMINE MONTHLY AVG LIMIT.

$X_{0.95}$ = 95th percentile n-day monthly avg. limit

$$X_{0.95} = \begin{cases} D & \delta \geq 0.95 \\ \text{MAX} & [D, \exp(\hat{\mu}_n + z^* \hat{\sigma}_n)] \end{cases}$$

where $z^* = \phi^{-1} [(0.95 - \delta)/(1 - \hat{\delta})]$

$\phi^{-1} = 1.645$

$\hat{\delta} = r/k = 82/517 = 0.16$

$\hat{\mu}_y = 0.8$ (SEE LOTUS TABLE)

EST. VARIANCE $\hat{\sigma}_y^2 = 2.3$ (SEE LOTUS TABLE)

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CALCULATION SHEET

Project: MOBIL AMMONIA   Client: MOBIL

Title: EFFLUENT CALCULATIONS

Signature: S. LeDien   Date: 02/12/97   Sheet 3 of 5

$$\hat{E}(x^*) = (0.16)(0.1) + (1-0.16)\exp(0.8+0.5(2.3))$$
$$= 0.016 + 0.84(\exp 1.95)$$
$$\hat{E}(x^*) = 5.9201$$

$$\hat{V}(x^*) = (1-0.16)\exp(2(0.8)+2.3)[\exp(2.3)-(1-0.16)] + (0.16)(1-0.16)(0.1)[0.1-2\exp(0.8+0.5(2.3$$
$$= (0.84)\exp(3.9)(9.1342) + 0.1344(-13.9574)$$
$$\hat{V}(x^*) = 377.1757$$

$$\hat{\sigma}_n^2 = \ln\{(1-\delta^n)[1+A+B+C]\}$$

WHERE:

$$A = \hat{V}(x^*) / [n(\hat{E}(x^*) - \delta^n D)^2]$$

$$A = 377.1757 / [8.6(5.9201 - (0.16)^{8.6}(0.1))^2]$$

$$A = 377.1757 / [8.6(35.0476)]$$

$$A = 1.2514$$

$$B = -[\hat{\delta}^n D^2(1-\hat{\delta}^n)] / (\hat{E}(x^*) - \delta^n D)^2$$

$$B = -[0.16^{8.6}(0.1)^2(1-0.16^{8.6})] / (5.9201 - 0.16^{8.6}(0.1))^2$$

$$B = -[1.4303] / 35.0476$$

$$B = -4.0811 \times 10^{-11}$$

$$c = (2\hat{\delta}^n D) / (\hat{E}(x^*) - \hat{\delta}^n D)$$

$$c = (2(0.16)^{8.6}(0.1)) / (5.9201 - (0.16)^{8.6}(0.1))$$

$$c = 2.8606 \times 10^{-8} / 5.9201$$

$$c = 4.8321 \times 10^{-9}$$

$$\hat{\sigma}_n^2 = \ln\{(1 - 0.16^{8.6})(1 + 1.2514 + (-4.0311 \times 10^{-11}) + 4.8321 \times 10^{-9})\}$$

$$= \ln\{(0.9999)(2.2514)\}$$

$$= \ln\{2.2514\}$$

$$\hat{\sigma}_n^2 = 0.8116$$

$$\hat{\mu}_n = \ln[(\hat{E}(x) - \delta^n D) / (1 - \delta^n)] - 0.5\hat{\sigma}_n^2$$

$$= \ln[(5.9201 - (0.16^{8.6})(0.1)) / (1 - 0.16^{8.6})] - 0.5(0.8116)$$

$$= \ln[5.9201 / 0.9999] - 0.4058$$

$$\hat{\mu}_n = 1.3726$$

$$z^* = \phi^{-1}[(0.95 - \hat{\delta}) / (1 - \delta)]$$

$$= 1.645[(0.95 - 0.16) / (1 - 0.16)]$$

$$z^* = 1.5471$$

WITHOUT CORRECTION TO z^* FORMULA. CORRECTION $(\hat{\delta}^n)$ WOULD MAKE z^* HIGHER

$$X_{0.95} = \exp(\hat{\mu}_n + z^* \hat{\sigma}_n)$$

$$= \exp(1.3726 + 1.5471(0.8116)^{1/2})$$

$$= \exp(1.3726 + 1.3938)$$

$$= \exp(27664)$$

$$X_{0.95} = 15.90 \text{ mg/l}$$

DAILY MAXIMUM

$$X_{0.95} = \exp(\hat{\mu}_y + z^* \hat{\sigma}_y)$$

$$= \exp(0.8 + 1.5471(2.3)^{1/2})$$

$$X_{0.95} = 23.25$$

HUFF & HUFF, INC.
Environmental Consultants

CALCULATION SHEET

Project: MOBIL OIL AMMONIA | Client: MOBIL OIL
Title: EFFLUENT CALCULATIONS - MONTHLY AVG
Signature: S Cu Dian | Date: 4.21.97 | Sheet 1 of 1

Calculate Monthly Average

Data set - Nov. 96 through Mar. 97

Monthly Average Ammonia Effluent, mg/l

November 96	0.3
December	1.9
January 97	3.8 ← MAX MONTHLY AVG FOR DATA SET
February	0.3
March	1.3

Coefficient of Variation (CV) = 0.6 (Assumed value for less than 10 samples)

Multiplier for CV = 0.6 and 5 samples = 2.3
(Table 5-2, TSD, EPA/505/2-90-001)

X_{95} = MAX MONTHLY AVG × 2.3

X_{95} = 3.8 mg/l × 2.3

X_{95} = 8.74 mg/l

X_{95} = 9 mg/l

DAILY AMMONIA EFFLUENT VALUES

Mobil Oil Joliet Refinery
1991 - 1997

Date	Ammonia, mg/l	ln (ammonia
01/ 2 /91	0.0	
01/ 3 /91	0.0	
01/ 8 /91	0.0	
01/ 10 /91	0.0	
01/ 15 /91	0.0	
01/ 17 /91	0.0	
01/ 22 /91	0.0	
01/ 24 /91	2.0	0.693147
01/ 29 /91	0.0	
01/ 31 /91	0.0	
02/ 5 /91	0.0	
02/ 7 /91	0.0	
02/ 12 /91	0.0	
02/ 15 /91	1.0	0
02/ 19 /91	0.5	-0.69315
02/ 21 /91	0.0	
02/ 26 /91	0.0	
02/ 28 /91	0.4	-0.91629
03/ 5 /91	0.0	
03/ 7 /91	0.0	
03/ 12 /91	0.4	-0.91629
03/ 14 /91	0.4	-0.91629
03/ 19 /91	0.0	
03/ 21 /91	0.3	-1.20397
03/ 26 /91	0.0	
03/ 28 /91	0.2	-1.60944
04/ 2 /91	0.8	-0.22314
04/ 4 /91	0.4	-0.91629
04/ 9 /91	0.2	-1.60944
04/ 11 /91	0.0	
04/ 16 /91	0.0	
04/ 18 /91	0.4	-0.91629
04/ 23 /91	0.2	-1.60944
04/ 25 /91	0.3	-1.20397
04/ 30 /91	0.1	-2.30259
05/ 2 /91	0.0	
05/ 7 /91	0.0	
05/ 9 /91	0.4	-0.91629
05/ 14 /91	0.0	
05/ 16 /91	0.4	-0.91629
05/ 21 /91	0.2	-1.60944
05/ 23 /91	0.9	-0.10536
05/ 29 /91	0.0	
05/ 30 /91	0.0	
06/ 4 /91	0.0	
06/ 6 /91	0.0	
06/ 11 /91	0.0	
06/ 13 /91	0.0	
06/ 18 /91	0.0	
06/ 20 /91	0.0	
06/ 25 /91	0.0	
07/ 2 /91	0.0	
07/ 5 /91	0.0	
07/ 9 /91	0.0	
07/ 11 /91	0.0	
07/ 16 /91	0.0	
07/ 18 /91	0.0	
07/ 23 /91	0.3	-1.20397
07/ 25 /91	0.3	-1.20397
07/ 30 /91	0.2	-1.60944
08/ 2 /91	0.0	
08/ 6 /91	0.1	-2.30259
08/ 8 /91	0.2	-1.60944
08/ 13 /91	0.8	-0.22314
08/ 15 /91	0.4	-0.91629
08/ 20 /91	0.0	

DAILY AMMONIA EFFLUENT VALUES

Mobil Oil Joliet Refinery
1991 - 1997

Date	Ammonia, mg/l		ln (ammonia
08/ 22 /91	0.3		-1.20397
08/ 28 /91	13.0		2.564949
08/ 30 /91	7.6		2.028148
09/ 3 /91	3.7		1.308333
09/ 5 /91	3.0		1.098612
09/ 10 /91		0.0	
09/ 12 /91	0.3		-1.20397
09/ 17 /91	0.2		-1.60944
09/ 19 /91		0.0	
09/ 24 /91		0.0	
09/ 26 /91	0.3		-1.20397
10/ 1 /91		0.0	
10/ 3 /91		0.0	
10/ 8 /91	0.5		-0.69315
10/ 10 /91	0.5		-0.69315
10/ 15 /91		0.0	
10/ 17 /91		0.0	
10/ 22 /91		0.0	
10/ 24 /91		0.0	
10/ 29 /91	5.6		1.722767
10/ 31 /91	2.5		0.916291
11/ 5 /91	0.2		-1.60944
11/ 7 /91		0.0	
11/ 12 /91	3.0		1.098612
11/ 14 /91	0.3		-1.20397
11/ 19 /91		0.0	
11/ 21 /91	0.3		-1.20397
11/ 22 /91		0.0	
11/ 26 /91		0.0	
11/ 27 /91		0.0	
12/ 3 /91		0.0	
12/ 5 /91	1.0		0
12/ 10 /91	3.0		1.098612
12/ 12 /91	1.0		0
12/ 17 /91	0.8		-0.22314
12/ 19 /91	0.9		-0.10536
12/ 24 /91	3.9		1.360977
12/ 26 /91	2.0		0.693147
12/ 31 /91	2.0		0.693147
01/ 2 /92	0.8		-0.22314
01/ 7 /92	0.3		-1.20397
01/ 9 /92	0.3		-1.20397
01/ 14 /92	5.8		1.757858
01/ 16 /92	12.0		2.484907
01/ 21 /92	16.0		2.772589
01/ 23 /92	4.0		1.386294
01/ 28 /92	0.5		-0.69315
02/ 4 /92	4.5		1.504077
02/ 6 /92	13.3		2.587764
02/ 11 /92	19.0		2.944439
02/ 13 /92	22.0		3.091042
02/ 18 /92	12.0		2.484907
02/ 20 /92	4.0		1.386294
02/ 25 /92	10.4		2.341806
02/ 27 /92	8.6		2.151762
03/ 3 /92	0.4		-0.91629
03/ 5 /92	0.6		-0.51083
03/ 10 /92	0.3		-1.20397
03/ 12 /92	0.3		-1.20397
03/ 17 /92	0.3		-1.20397
03/ 19 /92	0.4		-0.91629
03/ 24 /92	1.0		0
03/ 26 /92	0.3		-1.20397
04/ 2 /92		0.0	
04/ 7 /92	0.4		-0.91629

DAILY AMMONIA EFFLUENT VALUES

Mobil Oil Joliet Refinery
1991 - 1997

Date	Ammonia, mg/l	ln (ammonia
04/ 9 /92	0.7	-0.35667
04/ 14 /92	0.8	-0.22314
04/ 16 /92	6.0	1.791759
04/ 21 /92	0.3	-1.20397
04/ 23 /92	0.2	-1.60944
04/ 28 /92	0.0	
04/ 30 /92	0.0	
05/ 5 /92	16.0	2.772589
05/ 7 /92	8.9	2.186051
05/ 12 /92	0.0	
05/ 14 /92	0.0	
05/ 19 /92	0.0	
05/ 21 /92	0.0	
05/ 26 /92	0.0	
05/ 28 /92	0.0	
06/ 2 /92	0.0	
06/ 4 /92	0.3	-1.20397
06/ 9 /92	1.1	0.09531
06/ 11 /92	0.0	
06/ 16 /92	0.0	
06/ 18 /92	0.3	-1.20397
06/ 23 /92	0.3	-1.20397
06/ 25 /92	0.0	
07/ 2 /92	0.0	
07/ 7 /92	0.0	
07/ 9 /92	0.0	
07/ 14 /92	0.6	-0.51083
07/ 16 /92	0.5	-0.69315
07/ 21 /92	0.0	
07/ 23 /92	0.1	-2.30259
07/ 28 /92	0.3	-1.20397
07/ 30 /92	4.6	1.526056
08/ 4 /92	0.0	
08/ 6 /92	0.0	
08/ 11 /92	0.4	-0.91629
08/ 13 /92	1.0	0
08/ 18 /92	0.0	
08/ 20 /92	0.0	
08/ 25 /92	0.0	
08/ 27 /92	1.4	0.336472
09/ 1 /92	5.0	1.609438
09/ 3 /92	2.0	0.693147
09/ 8 /92	0.0	
09/ 10 /92	0.0	
09/ 15 /92	0.0	
09/ 17 /92	0.0	
09/ 22 /92	0.0	
09/ 24 /92	1.2	0.182322
09/ 29 /92	0.0	
10/ 6 /92	0.0	
10/ 8 /92	0.8	-0.22314
10/ 13 /92	6.7	1.902108
10/ 15 /92	14.0	2.639057
10/ 20 /92	9.3	2.230014
10/ 22 /92	2.7	0.993252
10/ 27 /92	0.0	
10/ 29 /92	5.4	1.686399
11/ 3 /92	22.0	3.091042
11/ 6 /92	13.0	2.564949
11/ 10 /92	1.5	0.405465
11/ 13 /92	0.0	
11/ 17 /92	0.0	
11/ 20 /92	0.2	-1.60944
11/ 24 /92	0.2	-1.60944
11/ 27 /92	0.0	
12/ 1 /92	0.3	-1.20397

DAILY AMMONIA EFFLUENT VALUES

Mobil Oil Joliet Refinery
1991 - 1997

Date	Ammonia, mg/l	ln (ammonia
12/ 3 /92	0.2	-1.60944
12/ 8 /92	0.1	-2.30259
12/ 10 /92	0.8	-0.22314
12/ 15 /92	0.8	-0.22314
12/ 17 /92	3.0	1.098612
12/ 22 /92	11.0	2.397895
12/ 24 /92	20.1	3.00072
12/ 29 /92	14.0	2.639057
01/ 5 /93	11.4	2.433613
01/ 7 /93	6.3	1.84055
01/ 12 /93	6.4	1.856298
01/ 14 /93	6.8	1.916923
01/ 19 /93	2.6	0.955511
01/ 21 /93	3.8	1.335001
01/ 26 /93	2.4	0.875469
01/ 28 /93	5.9	1.774952
02/ 2 /93	4.8	1.568616
02/ 4 /93	6.3	1.84055
02/ 9 /93	14.0	2.639057
02/ 11 /93	14.9	2.701361
02/ 16 /93	3.9	1.360977
02/ 18 /93	3.5	1.252763
02/ 23 /93	6.0	1.791759
02/ 25 /93	8.4	2.128232
03/ 2 /93	2.9	1.064711
03/ 4 /93	4.0	1.386294
03/ 9 /93	6.2	1.824549
03/ 11 /93	8.3	2.116256
03/ 16 /93	10.5	2.351375
03/ 18 /93	8.2	2.104134
03/ 24 /93	8.0	2.079442
03/ 26 /93	4.8	1.568616
03/ 30 /93	0.6	-0.51083
04/ 1 /93	0.3	-1.20397
04/ 6 /93	3.6	1.280934
04/ 8 /93	4.6	1.526056
04/ 13 /93	1.3	0.262364
04/ 15 /93	0.7	-0.35667
04/ 20 /93	0.8	-0.22314
04/ 22 /93	2.7	0.993252
04/ 27 /93	1.8	0.587787
04/ 29 /93	1.8	0.587787
05/ 4 /93	0.4	-0.91629
05/ 6 /93	0.3	-1.20397
05/ 11 /93	0.9	-0.10536
05/ 13 /93	0.6	-0.51083
05/ 18 /93	3.1	1.131402
05/ 20 /93	3.3	1.193922
05/ 25 /93	7.2	1.974081
05/ 27 /93	7.2	1.974081
06/ 1 /93	13.2	2.580217
06/ 3 /93	5.3	1.667707
06/ 8 /93	0.3	-1.20397
06/ 10 /93	0.1	-2.20727
06/ 15 /93	0.2	-1.77196
06/ 17 /93		0.0
06/ 22 /93		0.0
06/ 24 /93		0.0
06/ 29 /93	0.1	-2.20727
07/ 1 /93		0.0
07/ 6 /93		0.0
07/ 8 /93	0.1	-2.30259
07/ 13 /93		0.0
07/ 15 /93		0.0
07/ 20 /93		0.0

DAILY AMMONIA EFFLUENT VALUES

Mobil Oil Joliet Refinery
1991 - 1997

Date	Ammonia, mg/l	ln (ammonia
07/ 22 /93	0.2	-1.60944
07/ 27 /93	12.6	2.533697
07/ 29 /93	6.2	1.824549
08/ 3 /93		0.0
08/ 5 /93		0.0
08/ 10 /93		0.0
08/ 12 /93	0.3	-1.20397
08/ 17 /93	0.3	-1.20397
08/ 19 /93		0.0
08/ 24 /93	0.9	-0.10536
08/ 26 /93	1.1	0.09531
08/ 31 /93	0.2	-1.60944
09/ 2 /93	0.1	-2.30259
09/ 7 /93	0.3	-1.20397
09/ 9 /93	0.2	-1.60944
09/ 14 /93	0.1	-2.30259
09/ 16 /93	0.1	-2.30259
09/ 21 /93	0.2	-1.60944
09/ 23 /93	0.3	-1.20397
09/ 28 /93	0.4	-0.91629
09/ 30 /93	0.3	-1.20397
10/ 5 /93	18.0	2.890372
10/ 7 /93	24.0	3.178054
10/ 12 /93	3.6	1.280934
10/ 14 /93	1.2	0.182322
10/ 19 /93	0.9	-0.10536
10/ 21 /93	0.6	-0.51083
10/ 26 /93	0.6	-0.51083
10/ 28 /93	1.6	0.470004
11/ 2 /93	0.5	-0.69315
11/ 4 /93	0.6	-0.51083
11/ 9 /93	0.2	-1.60944
11/ 11 /93	1.3	0.262364
11/ 16 /93	12.3	2.509599
11/ 18 /93	12.2	2.501436
11/ 23 /93	21.6	3.072693
11/ 24 /93	15.7	2.753661
11/ 30 /93	21.3	3.058707
12/ 2 /93	15.7	2.753661
12/ 7 /93	4.1	1.410987
12/ 9 /93	1.6	0.470004
12/ 14 /93	0.6	-0.51083
12/ 16 /93	0.7	-0.35667
12/ 21 /93	0.8	-0.22314
12/ 23 /93	0.8	-0.22314
12/ 28 /93	0.3	-1.20397
12/ 30 /93	0.6	-0.51083
01/ 4 /94	0.5	-0.69315
01/ 6 /94	0.4	-0.91629
01/ 11 /94	0.6	-0.51083
01/ 13 /94	0.4	-0.91629
01/ 18 /94	0.4	-0.91629
01/ 20 /94	0.2	-1.60944
01/ 25 /94	0.9	-0.10536
01/ 27 /94	0.7	-0.35667
02/ 1 /94	0.6	-0.51083
02/ 3 /94	0.6	-0.51083
02/ 8 /94		0.0
02/ 10 /94	3.5	1.252763
02/ 15 /94	11.4	2.433613
02/ 17 /94	9.0	2.197225
02/ 22 /94	4.5	1.504077
02/ 24 /94	1.9	0.641854
03/ 1 /94	1.4	0.336472
03/ 3 /94	1.4	0.336472

DAILY AMMONIA EFFLUENT VALUES

Mobil Oil Joliet Refinery
1991 - 1997

Date	Ammonia, mg/l	ln (ammonia
03/ 8 /94	1.8	0.587787
03/ 10 /94	2.6	0.955511
03/ 15 /94	2.7	0.993252
03/ 17 /94	6.2	1.824549
03/ 22 /94	10.1	2.312535
03/ 24 /94	14.9	2.701361
03/ 29 /94	4.1	1.410987
03/ 31 /94	3.8	1.335001
04/ 5 /94	1.2	0.182322
04/ 7 /94	3.4	1.223775
04/ 12 /94	0.9	-0.10536
04/ 14 /94	0.8	-0.22314
04/ 19 /94	1.3	0.262364
04/ 21 /94	3.5	1.252763
04/ 26 /94	1.2	0.182322
04/ 28 /94	0.7	-0.35667
05/ 3 /94	0.6	-0.51083
05/ 5 /94	0.4	-0.91629
05/ 10 /94	0.4	-0.91629
05/ 12 /94	0.8	-0.22314
05/ 17 /94	1.0	0
05/ 19 /94	3.4	1.223775
05/ 24 /94	12.9	2.557227
05/ 26 /94	9.9	2.292535
05/ 31 /94	4.0	1.386294
06/ 3 /94	10.4	2.341806
06/ 7 /94	5.8	1.757858
06/ 9 /94	5.4	1.686399
06/ 14 /94	16.6	2.809403
06/ 16 /94	14.0	2.639057
06/ 21 /94	3.2	1.163151
06/ 23 /94	12.0	2.484907
06/ 28 /94	1.7	0.530628
06/ 30 /94	4.2	1.435085
07/ 5 /94	1.2	0.182322
07/ 7 /94	2.1	0.741937
07/ 12 /94	0.8	-0.22314
07/ 14 /94	1.2	0.182322
07/ 19 /94	0.8	-0.22314
07/ 21 /94	4.7	1.547563
07/ 26 /94	14.3	2.66026
07/ 28 /94	4.8	1.568616
08/ 2 /94	2.4	0.875469
08/ 4 /94	10.4	2.341806
08/ 9 /94	4.5	1.504077
08/ 11 /94	3.3	1.193922
08/ 16 /94	7.3	1.987874
08/ 18 /94	3.9	1.360977
08/ 23 /94	7.1	1.960095
08/ 25 /94	10.8	2.379546
08/ 30 /94	4.3	1.458615
09/ 1 /94	5.8	1.757858
09/ 6 /94	11.0	2.397895
09/ 8 /94	12.0	2.484907
09/ 13 /94	7.8	2.054124
09/ 15 /94	5.0	1.609438
09/ 20 /94	16.0	2.772589
09/ 22 /94	11.6	2.451005
09/ 27 /94	6.6	1.88707
09/ 29 /94	13.0	2.564949
10/ 4 /94	2.1	0.741937
10/ 6 /94	0.0	
10/ 11 /94	0.7.	-0.35667
10/ 13 /94	0.6	-0.51083
10/ 18 /94	0.3	-1.20397
10/ 20 /94	0.2	-1.60944

DAILY AMMONIA EFFLUENT VALUES

Mobil Oil Joliet Refinery
1991 - 1997

Date	Ammonia, mg/l	ln (ammonia
10/ 25 /94	2.5	0.916291
10/ 27 /94	3.0	1.098612
11/ 1 /94	3.0	1.098612
11/ 3 /94	8.0	2.079442
11/ 8 /94	6.9	1.931521
11/ 10 /94	3.1	1.131402
11/ 15 /94	1.8	0.587787
11/ 17 /94	2.0	0.693147
11/ 22 /94	0.6	-0.51083
11/ 23 /94	0.4	-0.91629
11/ 29 /94	5.6	1.722767
12/ 1 /94	10.7	2.370244
12/ 6 /94	8.5	2.140066
12/ 8 /94	5.5	1.704748
12/ 13 /94	18.6	2.923162
12/ 15 /94	19.2	2.95491
12/ 20 /94	11.1	2.406945
12/ 22 /94	12.5	2.525729
12/ 27 /94	13.9	2.631889
12/ 29 /94	9.7	2.272126
01/ 3 /95	19.1	2.949688
01/ 5 /95	18.1	2.895912
01/ 10 /95	16.9	2.827314
01/ 12 /95	8.7	2.163323
01/ 17 /95	10.6	2.360854
01/ 19 /95	9.0	2.197225
01/ 24 /95	13.7	2.617396
01/ 26 /95	10.4	2.341806
01/ 31 /95	16.8	2.821379
02/ 2 /95	20.4	3.015535
02/ 7 /95	15.5	2.74084
02/ 9 /95	13.0	2.564949
02/ 14 /95	5.1	1.629241
02/ 16 /95	1.0	0
02/ 21 /95	0.6	-0.51083
02/ 23 /95	1.0	0
02/ 28 /95	0.6	-0.51083
03/ 2 /95	0.4	-0.91629
03/ 7 /95	0.7	-0.35667
03/ 9 /95	0.6	-0.51083
03/ 14 /95	3.7	1.308333
03/ 16 /95	1.1	0.09531
03/ 21 /95	1.2	0.182322
03/ 23 /95	2.8	1.029619
03/ 28 /95	3.5	1.252763
03/ 30 /95	2.2	0.788457
04/ 4 /95	2.4	0.875469
04/ 6 /95	2.6	0.955511
04/ 11 /95	3.3	1.193922
04/ 13 /95	3.8	1.335001
04/ 18 /95	8.5	2.140066
04/ 21 /95	4.4	1.481605
04/ 25 /95	13.9	2.631889
04/ 27 /95	13.7	2.617396
05/ 2 /95	9.6	2.261763
05/ 4 /95	8.0	2.079442
05/ 9 /95	10.2	2.322388
05/ 11 /95	8.3	2.116256
05/ 16 /95	4.8	1.568616
05/ 18 /95	4.1	1.410987
05/ 23 /95	5.8	1.757858
05/ 25 /95	10.8	2.379546
05/ 30 /95	6.1	1.808289
06/ 1 /95	9.0	2.197225
06/ 6 /95	17.1	2.839078

DAILY AMMONIA EFFLUENT VALUES

Mobil Oil Joliet Refinery
1991 - 1997

Date	Ammonia, mg/l	ln (ammonia
06/ 9 /95	20.4	3.015535
06/ 13 /95	20.3	3.010621
06/ 17 /95	22.9	3.131137
06/ 20 /95	10.0	2.302585
06/ 22 /95	8.6	2.151762
06/ 27 /95	0.8	-0.22314
06/ 29 /95	0.3	-1.20397
07/ 5 /95	0.8	-0.22314
07/ 6 /95	0.6	-0.51083
07/ 11 /95	0.2	-1.60944
07/ 13 /95	0.5	-0.69315
07/ 18 /95	0.1	-2.30259
07/ 20 /95	0.2	-1.60944
07/ 25 /95	0.3	-1.20397
07/ 27 /95	0.7	-0.35667
08/ 1 /95	0.3	-1.20397
08/ 4 /95	0.2	-1.60944
08/ 8 /95	0.3	-1.20397
08/ 10 /95	0.3	-1.20397
08/ 15 /95	0.6	-0.51083
08/ 17 /95	5.8	1.757858
08/ 22 /95	4.8	1.568616
08/ 25 /95	0.4	-0.91629
08/ 29 /95	5.1	1.629241
08/ 31 /95	2.6	0.955511
09/ 5 /95	0.5	-0.69315
09/ 7 /95	1.5	0.405465
09/ 12 /95	5.0	1.609438
09/ 14 /95	2.2	0.788457
09/ 19 /95	1.0	0
09/ 21 /95	0.7	-0.35667
09/ 26 /95	0.8	-0.22314
09/ 28 /95	5.7	1.740466
10/ 3 /95	0.7	-0.35667
10/ 5 /95	0.8	-0.22314
10/ 10 /95	0.3	-1.20397
10/ 12 /95	0.2	-1.60944
10/ 17 /95	5.5	1.704748
10/ 19 /95	7.2	1.974081
10/ 24 /95	7.2	1.974081
10/ 26 /95	1.4	0.336472
10/ 31 /95	1.4	0.336472
11/ 2 /95	1.9	0.641854
11/ 7 /95	0.2	-1.60944
11/ 9 /95	5.0	1.609438
11/ 14 /95	1.3	0.262364
11/ 16 /95	1.3	0.262364
11/ 21 /95	13.6	2.61007
11/ 22 /95	19.0	2.944439
11/ 28 /95	17.5	2.862201
11/ 30 /95	12.9	2.557227
12/ 5 /95	10.4	2.341806
12/ 7 /95	11.3	2.424803
12/ 12 /95	11.0	2.397895
12/ 14 /95	25.5	3.238678
12/ 19 /95	6.0	1.791759
12/ 21 /95	8.0	2.079442
12/ 26 /95	10.3	2.332144
12/ 28 /95	6.4	1.856298
01/ 2 /96	7.9	2.066863
01/ 4 /96	10.6	2.360854
01/ 9 /96	2.6	0.955511
01/ 11 /96	5.3	1.667707
01/ 16 /96	7.9	2.066863
01/ 18 /96	6.7	1.902108

DAILY AMMONIA EFFLUENT VALUES

Mobil Oil Joliet Refinery
1991 - 1997

Date	Ammonia, mg/l		ln (ammonia
01/ 23 /96	12.0		2.484907
01/ 25 /96	6.2		1.824549
01/ 30 /96	16.9		2.827314
02/ 1 /96	21.4		3.063391
02/ 6 /96	5.4		1.686399
02/ 8 /96	1.3		0.262364
02/ 13 /96	8.5		2.140066
02/ 15 /96	7.8		2.054124
02/ 20 /96	3.0		1.098612
02/ 22 /96		0.0	
02/ 27 /96		0.0	
02/ 29 /96		0.0	
03/ 5 /96		0.0	
03/ 7 /96		0.0	
03/ 12 /96	0.6		-0.51083
03/ 14 /96	4.8		1.568616
03/ 19 /96	20.6		3.025291
03/ 21 /96	27.4		3.310543
03/ 26 /96	11.8		2.4681
03/ 28 /96	8.2		2.104134
04/ 2 /96	17.3		2.850707
04/ 4 /96	17.5		2.862201
04/ 9 /96	21.1		3.049273
04/ 11 /96	19.0		2.944439
04/ 16 /96	17.1		2.839078
04/ 17 /96	19.5		2.970414
04/ 23 /96	13.4		2.595255
04/ 25 /96	8.5		2.140066
04/ 30 /96	0.6		-0.51083
05/ 2 /96	0.4		-0.91629
05/ 7 /96		0.0	
05/ 9 /96		0.0	
05/ 14 /96	0.3		-1.20397
05/ 16 /96	3.0		1.098612
05/ 21 /96	3.4		1.223775
05/ 23 /96		0.0	
05/ 28 /96	0.2		-1.60944
05/ 30 /96	4.2		1.435085
06/ 4 /96	2.8		1.029619
06/ 6 /96	0.6		-0.51083
06/ 11 /96		0.0	
06/ 13 /96		0.0	
06/ 19 /96		0.0	
06/ 20 /96		0.0	
06/ 25 /96	11.9		2.476538
06/ 27 /96	13.7		2.617396
07/ 2 /96	1.1		0.09531
07/ 3 /96	1.2		0.182322
07/ 9 /96	4.1		1.410987
07/ 11 /96	4.2		1.435085
07/ 16 /96		0.0	
07/ 18 /96		0.0	
07/ 23 /96	0.2		-1.60944
07/ 25 /96	0.4		-0.91629
07/ 30 /96	0.1		-2.30259
08/ 1 /96		0.0	
08/ 6 /96	0.5		-0.69315
08/ 8 /96	0.6		-0.51083
08/ 13 /96		0.0	
08/ 15 /96	0.7		-0.35667
08/ 20 /96	0.2		-1.60944
08/ 22 /96	0.3		-1.20397
08/ 28 /96	0.3		-1.20397
08/ 29 /96	0.2		-1.60944
09/ 3 /96	0.2		-1.60944
09/ 5 /96	0.1		-2.30259

DAILY AMMONIA EFFLUENT VALUES

Mobil Oil Joliet Refinery
1991 - 1997

Date	Ammonia, mg/l		ln (ammonia
09/ 10 /96		0.0	
09/ 12 /96		0.0	
09/ 17 /96		0.0	
09/ 19 /96		0.0	
09/ 25 /96	1.7		0.530628
09/ 26 /96	0.4		-0.91629
10/ 1 /96		0.0	
10/ 3 /96		0.0	
10/ 9 /96	0.1		-2.30259
10/ 10 /96		0.0	
10/ 15 /96	0.2		-1.60944
10/ 17 /96		0.0	
10/ 22 /96	0.2		-1.60944
10/ 24 /96	0.2		-1.60944
10/ 29 /96		0.0	
10/ 31 /96	0.1		-2.30259
11/ 5 /96		0.0	
11/ 7 /96	0.7		-0.35667
11/ 12 /96		0.0	
11/ 14 /96		0.0	
11/ 19 /96		0.0	
11/ 21 /96	0.8		-0.22314
11/ 26 /96	0.5		-0.69315
11/ 27 /96		0.0	
12/ 3 /96	0.4		-0.91629
12/ 5 /96		0.0	
12/ 10 /96		0.0	
12/ 12 /96		0.0	
12/ 17 /96		0.0	
12/ 19 /96		0.0	
12/ 24 /96	14.0		2.639057
12/ 27 /96	1.3		0.262364
12/ 31 /96	1.3		0.262364
01/ 2 /97	2.6		0.955511
01/ 7 /97	0.4		-0.91629
01/ 9 /97		0.0	
01/ 14 /97	1.4		0.336472
01/ 16 /97	0.7		-0.35667
01/ 21 /97	14.0		2.639057
01/ 23 /97	12.0		2.484907
01/ 28 /97	2.0		0.693147
01/ 30 /97	1.0		0
02/ 4 /97		0.0	
02/ 6 /97	0.8		-0.22314
02/ 11 /97	0.3		-1.20397
02/ 13 /97	0.3		-1.20397
02/ 18 /97	0.2		-1.60944
02/ 21 /97	0.3		-1.20397
02/ 25 /97	0.8		-0.22314
02/ 27 /97		0.0	
03/ 4 /97	0.1		-2.30259
03/ 6 /97	6.5		1.871802
03/ 11 /97	0.4		-0.91629
03/ 13 /97	0.6		-0.51083
03/ 18 /97	1.4		0.336472
03/ 20 /97	0.3		-1.20397
03/ 25 /97	0.6		-0.51083
03/ 27 /97	0.6		-0.51083

January 1991 - December 1996			
Average	4.8	0.0	0.6
Minimum	0.1	0.0	-2.3
Maximum	27.4	0.0	3.3
Count	507	140	507
Std. Dev.	5.8	0.0	1.5
Variance	33.4	0.0	2.4

DAILY AMMONIA EFFLUENT VALUES

Mobil Oil Joliet Refinery
1991 - 1997

Date	Ammonia, mg/l		ln (ammonia
January 1992 - December 1996			
Average	5.3	0.0	0.8
Minimum	0.1	0.0	-2.3
Maximum	27.4	0.0	3.3
Count	435	82	435
Std. Dev.	6.0	0.0	1.5
Variance	35.7	0.0	2.3
January 1996 - December 1996			
Average	5.8	0.0	0.7
Minimum	0.1	0.0	-2.3
Maximum	27.4	0.0	3.3
Count	70	35	70
Std. Dev.	7.0	0.0	1.7
Variance	48.6	0.0	3.0
November 1995 - March 1997 (with April 1996 upset)			
Average	5.7	0.0	0.671
Minimum	0.1	0.0	-2.3
Maximum	27.4	0.0	3.3
Count	109	38	109
Std. Dev.	6.8	0.0	1.7
Variance	45.8	0.0	2.8
November 1995 - March 1997 (without April 1996 upse			
Average	4.9	0.0	0.5
Minimum	0.1	0.0	-2.3
Maximum	27.4	0.0	3.3
Count	103	38	103.0
Std. Dev.	6.2	0.0	1.6
Variance	38.1	0.0	2.6
January 1996 - March 1997 (without April 1996 upset)			
Average	4.0	0.0	0.3
Minimum	0.1	0.0	-2.3
Maximum	27.4	0.0	3.3
Count	86	38	86
Std. Dev.	5.6	0.0	1.6
Variance	31.6	0.0	2.5
November 1996 - March 1997			
Average	2.3	0.0	-0.1
Minimum	0.1	0.0	-2.3
Maximum	14.0	0.0	2.6
Count	29.0	13.0	29.0
Std. Dev.	3.9	0.0	1.2
Variance	15.5	0.0	1.5

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PROOF OF SERVICE

I, DAVID L. RIESER, an attorney, hereby certify that on April 24, 1997, I caused copies of the foregoing **PETITION FOR SITE-SPECIFIC RELIEF FROM 35 ILL. ADM. CODE 304.122, AMMONIA NITROGEN EFFLUENT STANDARDS** to be served upon the attached service list.

By: ______________________