Hydrostatic Test Water Treatment and Disposal Options For Liquid Pipeline Systems

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Hydrostatic Test Water Treatment and Disposal Options For Liquid Pipeline Systems

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ABSTRACT

This research study was initiated to provide the liquid pipeline industry with credible data and information relative to hydrostatic test water so that reasonable treatment technologies, permit discharge limitations and other management options could be assessed and evaluated. This information will be utilized to assist the industry in discussing and negotiating appropriate discharge permit limitations and control technologies with both state and federal agencies. This study was conducted from February 1997 to December 1997 and involved data provided by 15 pipeline companies. The companies participating in this study represent approximately 45% of the national liquid pipeline system mileage. Data was received for 172 hydrostatic tests consisting of 40 crude oil, 113 refined product, 4 highly volatile liquids (HVL), and 15 other pipeline tests. Data was received for tests conducted from 1990 through the first quarter of 1997. This data was characterized in 26 charts and graphs, treatment technologies and costs were reviewed for both existing and alternative treatment options, and other hydrostatic test water management options were evaluated. The primary results and conclusions of this study found that activated carbon adsorption was the single most frequently utilized treatment technology for existing pipelines representing 30.5% of the hydrostatic tests on existing lines. However, this treatment technology was used by only six of the 15 companies. Approximately 70% of all the tests for existing lines utilized either hay bales, hay bales in combination with additional treatment, other treatment technology, or no pipeline discharge treatment at all. Pre-pigging and/or pre-washing of existing pipelines was utilized in 68% of the tests. Reported costs for treatment on a per-gallon basis vary significantly with total volume treated and type of treatment used. The average treatment costs for the majority of volume discharged and types of treatment ranged from $0.02 to $0.15 per gallon. Removal efficiencies for benzene and benzene-toluene-ethylbenzene-xylene (BTEX) were the highest with activated carbon adsorption and were typically in the range of 95 - 100%. Alternate water treatment technologies, beyond activated carbon adsorption, hay bales and air stripping, were also evaluated for cost and practicality. These

alternatives include dissolved air flotation and ultraviolet light oxidation. Neither of these options proved viable for use in the pipeline industry due to cost, performance or practicality of implementation. Compliance with permit discharge conditions was reported for 84 tests. Of the 329 permit conditions contained in these 84 tests, 327 (99+%) demonstrated compliance. This is an overall excellent compliance history for the liquid pipeline industry.

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EXECUTIVE SUMMARY

This report presents the results of a research study to define acceptable and cost effective hydrostatic test water treatment and disposal methods that will enable compliance with DOT requirements for testing of liquid pipelines, while meeting regulatory agency permitting requirements for disposal and/or discharge. This study was conducted from February 1997 to December 1997 and involved data provided by 15 pipeline companies. The companies participating in this study represent approximately 45% of the national pipeline system mileage.

This study was undertaken to provide the industry with credible data and information relative to hydrostatic test water so that reasonable treatment technologies, permit discharge limitations and other management options could be assessed and evaluated. This information will be utilized to assist the industry in discussing and negotiating appropriate permit limitations and control technologies with both state and federal agencies.

Data was received from 172 hydrostatic tests consisting of 40 crude oil, 113 refined product, 4 highly volatile liquids (HVL), and 15 other pipeline tests. Of the 172 tests, 131 tests were on existing lines and 41 were on new lines. Data was received for tests conducted from 1990 through the first quarter of 1997. This data was characterized in 26 charts and graphs, treatment technologies and costs were reviewed for both existing and alternative treatment options, and other hydrostatic test water management options were evaluated.

The primary results and conclusions of this study found that activated carbon adsorption was the single most frequently utilized treatment technology for existing pipelines representing 30.5% of the hydrostatic tests on existing lines. However, this treatment technology was used by only six of the 15 companies. Approximately 70% of all the tests for existing lines utilized either hay bales, other treatment or no pipeline

discharge treatment at all. Pre-pigging and/or pre-washing of existing pipelines was utilized in 68% of the tests.

Treatment costs reported by the membership ranged from $0.00 to $0.85 per gallon; with activated carbon adsorption being the most expensive option for water treatment overall. Reported costs for treatment on a per-gallon basis vary significantly with total volume treated and type of treatment used. The average treatment costs for the majority of volume discharged and types of treatment ranged from $0.02 to $0.15 per gallon.

Removal efficiencies for benzene and BTEX were the highest with activated carbon adsorption and were typically in the range of 95 - 100%. Activated carbon adsorption appears to be a viable option for the smaller projects of 100,000 gallons or less but may have significant limitations for larger projects due to flow volume limitations and logistical considerations for equipment.

Alternate water treatment technologies, beyond activated carbon adsorption, hay bales and air stripping, were also evaluated for cost and practicality. These alternatives include dissolved air flotation and ultraviolet light oxidation. Neither of these options proved viable for use in the pipeline industry due to cost, performance or practicality of implementation.

Other test water management options that are potentially available to the liquid pipeline industry were also identified. These options include pre-treating the influent water, routing hydrostatic test water to fixed waste water treatment facilities in a refinery, terminal, or plant, use of an oil and water separator with air sparging, use of dilution water to reduce the concentration of contaminants, discharge to a Publically Owned Treatment Works (POTW), water re-use, land disposal, and pigging and/or pre-washing of pipelines.

Inadequate data or cost information was available to evaluate these options but they may be valuable options to consider depending on the specific circumstances of the discharge.

Compliance with permit discharge conditions was reported for 84 tests. Of the 329 permit conditions contained in these 84 tests, 327 (99+%) demonstrated compliance. This is an overall excellent compliance history based on these tests.

Section 1
INTRODUCTION

BACKGROUND

The environmental considerations related to the regulations, characterization, treatment and disposal of water discharged from the hydrostatic testing of liquid pipelines is an area of considerable importance to the liquid pipeline industry. There are approximately 169,000 miles of liquid gathering and transmission pipeline in the United States (O&GJ, 1997). These liquid systems include gathering (32,000 miles), crude oil (57,000 miles) and refined products (80,000 miles) pipelines. Every year, this national network is modified to some degree through new pipeline extensions, pipeline rehabilitations and other changes.

Federal and state laws require that the integrity of these pipeline systems be maintained. The U.S. Department of Transportation (DOT) and selected state agencies are the governing bodies that regulate hydrostatic testing. Hydrostatic testing is regulated under 49 CFR 195, Subpart E and is conducted when there is a new pipeline installation, a pipeline relocation, replacement of existing pipeline segments, or when there are other changes to a pipeline system which may impact integrity.

Hydrostatic testing is conducted by isolating the pipeline segment, and filling the system with water. After the pipeline is full, the pressure is increased to the desired level using a high pressure pump system. The pressure is then held for a pre-set time to check the integrity of the pipeline. The pipeline may be pigged and pre-washed prior to hydrostatic testing to remove residual product and scale. Fill water is typically obtained from a surface water body, such as a lake or stream, a municipal water source or a groundwater well.

Following hydrostatic testing, the pressure is removed and the pipeline is dewatered by pushing a pig or spacer through the line; typically with product or crude. In some

cases, test waters are staged in tankage prior to treatment and discharge. Test waters may contain some residual oil and grease, BTEX and suspended solids and, therefore, must be properly managed.

Test water may be discharged to surface waters (rivers or streams), municipal POTWs or it may be managed through a refinery, terminal, or plant water treatment system. The discharge of hydrostatic test water is typically regulated at the state level, through requirements under the National Pollutant Discharge Elimination System (NPDES) program. The management option ultimately selected will depend on the types and levels of constituents present, the site-specific regulatory discharge limits, the location of the discharge and the overall pipeline system design.

RESEARCH OBJECTIVE

The objective of this research project is to identify reasonable, acceptable and cost effective hydrostatic test water treatment and disposal methods that will allow for compliance with DOT requirements for testing of pipelines, while meeting regulatory agency permitting requirements for disposal and/or discharge.

SCOPE

This research involved conducting a literature search and industry survey to establish industry demographics and existing treatment technologies, characterization of discharge water, evaluation of treatment technologies, performing an economic analysis of treatment options and reviewing other hydrostatic test water management options available to the industry. These tasks are described in more detail below:

Literature Research and Industry Survey

An electronic survey questionnaire was distributed to members of the Hydrostatic Test Water Treatment and Disposal Operations Workgroup and the full API Committee On Environmental Health and Safety. This questionnaire was in a spreadsheet format which is attached in Appendix A. Data was gathered for tests from 1990 to the 1st

Quarter of 1997 for both new and existing pipeline hydrostatic test water discharges. A total of 172 tests (131 Existing and 41 New) were evaluated. Reports from several other hydrostatic test water research projects such as those conducted by the Gas Research Institute (GRI) were also reviewed.

Characterization of Water

The industry survey and literature research produced a very sizable database from which to characterize the test water quantity and quality. Following development of the database and evaluation of the data, twenty-six (26) summary graphs and tables were generated to characterize the discharge waters. These graphs and tables are discussed in Section 2 and 3.

Evaluation of Treatment Technologies

Treatment technologies which were identified through the industry survey and through the literature search were evaluated on several factors, including among others:

- Practicality
- Mobility
- Set-up Time Requirements
- Power Requirements
- Storage Requirements
- Amounts and Types of Wastes Generated
- Impact/Ability to Meet Various Potential Discharge Limits
- Treatment Discharge Rates
- Water Storage/Tankage Requirements

A summary of these evaluations is contained in Table 27.

Economic Analysis

Capital and operating costs were developed based on published data, vendor quotes, cost information from member pipeline companies, and best professional engineering judgment.

Recognizing that several site specific factors are pertinent to operations of this nature, the cost evaluation included considerations of the following factors:

- Mobilization/Demobilization Mileage to Site
- Site Constraints: Space, Surface, Distance to Discharge Point
- Climatic Conditions: Seasonal Considerations
- Site Preparation: Clearing, Surface Preparation, Power Requirements
- Waste Disposal: Pre-Pig Fluids, Solids, Spent Carbon, Used Hay bales, etc.
- Fees: Easement Access, Construction, Permitting
- Treatment Throughput Rate
- Water Storage Requirements and Containment

A summary table of the capital and operating costs for each technology was prepared and is contained in Section 5.

Test Water Management Options

Pipeline operating procedures that could be employed prior, during or after a test are identified in this section. These procedures were identified in part through the results of the industry survey, through a review of available technical studies such as GRI's hydrostatic test water reports, through the operating experience of the staff and through individual discussions with the members of the Committee. Options such as pre-pigging or pre-washing of pipelines, pre-treating fill water, discharging to a municipal POTW and other options were reviewed and summarized.

Section 2

LITERATURE RESEARCH AND INDUSTRY SURVEY

APPROACH

Members of the Hydrostatic Test Water Treatment/Disposal Options Workgroup and the full API Committee on Environment, Health & Safety (CEHS) were sent an information request packet on February 19, 1997. The packet contained a set of written guidelines on the type of information sought and a diskette with a formatted spreadsheet for reporting the requested information. Spreadsheets were the chosen tool for reporting members' data because of their simplicity to use and ubiquitous nature. A copy of the data gathering spreadsheet is included in Appendix A. A summary of the information requested follows.

DATA SOURCES

Data was gathered for 172 hydrostatic tests conducted on both new and existing pipelines, from 1990 to the first quarter of 1997. Parameters requested were:

- the year the test was completed;
- the source of the test water;
- the total volume of discharge;
- the maximum discharge rate;
- the State in which the water was discharged;
- the type of discharge;
- the type of receiving body (lake, river, POTW, ground surface, etc.);
- an indication if the location was remote (rural);
- an indication if the pipeline was new or existing;
- the type of product transported in the pipe;
- the pre-treatment method selected (pigging, pre-washing, or combinations, etc.);

- the type of treatment used prior to discharge (activated carbon adsorption, hay bales, etc.);
- an indication if the results met permit requirements;
- the unit cost of treatment;
- analytical data for both before treatment and after treatment, including benzene, BTEX, biochemical oxygen demand (BOD) , dissolved oxygen (DO), iron (Fe), Methyltertiary-butyl-ether (MTBE), diesel range organics (DRO), gasoline range organics (GRO), Oil & Grease, pH, and total suspended solids (TSS).

After the diskettes were returned from member companies, they were virus scanned, the spreadsheets printed and the results loaded to Microsoft Access® for efficient analysis. The data were checked for completeness and consistency. Information which seemed anomalous was confirmed with the submitting company. All data was maintained on a confidential basis and appropriately coded to ensure its confidentiality.

OTHER DATA SOURCES

Numerous reports from the Gas Research Institute were reviewed along with articles from the Oil and Gas Journal and other sources. A complete listing of literature reviewed is contained in the References.

Section 3

CHARACTERIZATION OF WATER

APPROACH

One hundred seventy-two (172) usable test results were received from the member companies. Of those 172 tests, 131 were conducted on existing pipes (76%), 41 were conducted on new pipes (24%). Seventy seven (45%) of the 172 reported cost information. Fifty-seven tests (33%) reported both before-treatment and after-treatment data for a particular test, enabling an assessment of removal efficiencies. Data were evaluated in 26 tables and were categorized into five main sections. These sections include test demographics, treatment methods, treatment effectiveness, treatment costs and treatment analysis.

DATA EVALUATION

Test Demographics

Eleven tables and graphs were constructed to examine distributions of test date, test location, test volume, water sources, receiving water body types, and type of material transported.

- Table 1 is a listing of the miles of interstate liquid pipelines owned by respondent companies in comparison to the total U.S. liquids pipeline mileage (August 4, 1997 Oil & Gas Journal Special Report).
- Table 2 is a plot of hydrostatic tests grouped by year for both new and existing pipes (all 172 test points were used to create this plot).
- Table 3 is a plot of the number of discharges grouped by state for existing pipes (131 test points were used to create this plot).
- Table 4 is a plot of the number of discharges grouped by state for new pipes (41 test points were used to create this plot).
- Table 5 is a plot of hydrostatic tests grouped by discharge volume range for both new and existing pipes (all 172 test points were used to create this plot).

- Table 6 is a plot of distribution of receiving body types (no discernment was made between new and existing pipes; all 172 data points were used to create this plot).
- Table 7 is a plot of test water sources indicating the total volume used and number of uses from a particular source (all 172 test points were used to create this plot).
- Table 8 is a plot of the distribution of the liquids transported for new and existing pipelines (crude, refined products, HVL, or other; all 172 data points were used to create this plot).
- Tables 9, 9A and 9B are listings of the sum and average discharges for particular receiving bodies, grouped by USEPA Region and receiving State. Table 9A is a summary of discharges by USEPA Region. Table 9B is summary of discharges by receiving State.

Treatment Methods

Three tables were created to examine the relationship between the type of pipe (new versus existing), the liquids being transported and types of pre-treatment and discharge treatment.

- Table 10 is a listing of the distribution of pre-treatment methods (e.g., pre-pigging) used for various products transported (separated by type of pipe) all 172 data points were used to create this plot.
- Table 11 is a listing of the distribution of treatment methods used for the liquids being transported (separated by type of pipe); all 172 data points were used to create this plot).
- Table 12 is a listing of all the combinations of pre-treatment and discharge treatments reported for this study.

Treatment Effectiveness

Nine tables were created to present the before and after treatment data reported, and examine the removal efficiencies.

- Tables 13, 13A and 13B are listings of the removal efficiencies and discharge treatment costs for 57 tests on new and existing lines which reported both before and after treatment analytical data. Table 13A is grouped by receiving State, Table 13B is grouped by test.
- Tables 14 and 15 are summary tables of the removal efficiencies and discharge treatment costs for 57 tests on existing (55) and new (2) pipes, respectively. These tables were based upon tests which reported both before and after treatment analytical data.
- Tables 16, 17, 18 and 19 are listings of the raw analytical data reported for existing and new pipes before and after treatment. These tables show averages, maximums and minimums for selected constituents.

Treatment Costs

Four tables/graphs were created to describe the costs associated with treatment of hydrostatic discharge water.

- Table 20 is a summary table showing discharge volumes and weighted average costs for ranges of treatment costs (we have assumed reasonable groupings of <1 cent, 1 to <5 cents, etc.) for new and existing pipelines.
- Table 21 is a graph of the distribution of cost information for new and existing pipelines.
- Table 22 is a graph of the average discharge volumes for various cost groupings, for new and existing pipelines.
- Table 23 is a graph of the economies of scale for different cost ranges.

Treatment Analysis

Three tables were developed to assist decision-makers in drawing conclusions regarding the use of various methods of treatment and the success of those methods in meeting permit requirements.

- Table 24 is a summary of costs by treatment technology for existing lines.
- Table 25 is a summary of pre-pig/pre-wash data.
- Table 26 is a summary of permit compliance data.

DATA VALIDITY, COMPLETENESS AND REPRESENTATIVENESS

Confidence in the validity and representativeness of the data is high. There were very few results which appeared anomalous and required confirmation. Respondents answered the questions as completely as possible, however, some data gaps exist as some of the requested information was simply not available. Of the 21 companies represented on the CEHS, 15 companies (71%) provided data for this study. As described below, the respondents operate nearly 45% of all the liquid pipeline miles in the U.S. which represents a significant portion of the nation's liquid pipeline system.

The data were received from the membership in electronic (spreadsheet) format. Upon receipt, the diskettes were scanned for viruses. If found, the virus was eradicated and the respondent was notified. The spreadsheets were then printed and checked for information which appeared anomalous. Those pieces of information were then confirmed with the respondent.

Some careful interpretation of the data was necessary to develop a consistent database. Changes included consistency in units and analytical parameter spellings. Where no answer was given, with the exception of the analytical data, a designation of "N/R" (Not Reported) was entered for that piece of information. In cases where respondents reported information other than the requested abbreviations (such as use

of "Ref. Prod." instead of "RP" to denote refined product), those answers were interpreted to comply with requested formats/categories.

The data was converted from spreadsheet format to MS Access, a database software package which allowed quick querying and data reporting. A series of queries were developed to report the desired data. The final report graph and tabular formats were developed in Excel in part to meet API formatting requirements.

SUMMARY COMMENTS - DATA PRESENTATION

According to the August 4, 1997 Oil and Gas Journal Special Article, "Pipeline Economics Construction Plans Jump; Operations Skid in 1996," 169,435 miles of interstate liquid transmission pipeline were reported in 1996 by major and non-major companies on US FERC annual reports. Of the mileage reported , approximately 45% (80,421 miles) was owned by member companies who provided the information requested. This information is summarized in Table 1.

Table 2 indicates that the number of tests conducted peaked in 1995 with a total of 45 tests reported, 33 of which were on existing pipelines, 12 on new pipelines. The number of tests conducted on new pipes appears to be increasing, since the first tests, which were reported in 1993. Due to the timing of the canvass, the number of tests reported for 1997 covers only the first quarter.

Table 3 indicates that Louisiana, Texas, Oklahoma, Indiana and Pennsylvania accounted for 71 (54%) of the total number of tests (131) conducted on existing pipelines. Twenty-eight different states (including the District of Columbia) were reported to receive test waters from existing pipes.

Table 4 illustrates that Louisiana, Montana, Oklahoma and Arkansas accounted for 27 (66%) of the total number of tests (41) conducted on new pipelines. Fourteen different states were reported to receive test waters from new pipes.

Table 5 indicates that 78 (59.5%) tests of over 1,000,000 gallons and 20 (15%) tests of less than 100,000 gallons were conducted on existing pipelines. Conversely, 26 (63%) tests of less than 100,000 gallons and only 5 (12%) tests of over 1,000,000 gallons were conducted on new pipelines.

Table 6 shows that surface water bodies, rivers/streams and lakes/ponds were the most frequently used receiving body, accounting for 122 of 172 tests (71%).

Table 7 indicates that municipal sources were used most frequently as sources for water used in hydrostatic testing, accounting for 75 of 172 tests (43.6%). However, rivers/streams and lakes/ponds provided more total volume than did municipal sources (221,082,307 gallons versus 113,758,704 gallons).

Table 8 illustrates that refined product was reported as the liquid transported in nearly 66% (113 of 172) of the total number of tests conducted and in nearly 76% (99 of 131) of the tests conducted on existing pipelines. Refined product pipelines comprise just over 50% of the total miles of pipeline owned by respondent companies.

Tables 9, 9A and 9B demonstrate that USEPA Regions 6, 5 and 3 received the most water from tests on existing pipes. Region 6 received the largest quantity of water discharged and the most frequent discharges from existing pipelines. Region 5 received the highest average discharge for existing pipelines. Region 8 received the smallest total volume of water discharged from existing pipelines. Regions 8 and 1 both had only one discharge from existing pipelines. Wisconsin received the highest total discharge and had the highest average discharge from existing pipelines. Louisiana had the most discharges and the second highest total volume discharged. Montana received the smallest total volume discharged and had only one discharge from existing pipelines.

Also from Tables 9, 9A and 9B, USEPA Regions 3, 5 and 8 received the most water from tests on new pipes. Region 3 received the largest quantity in a single discharge from a new pipeline. Region 9 received the smallest quantity of water discharged and the smallest average volume of discharge for new pipelines. Pennsylvania, North Dakota and Minnesota received the greatest volume discharged from new pipelines. Louisiana and Montana had the most discharges reported for new pipelines. California received the smallest average volume discharged from new pipelines. Pennsylvania had the highest average discharge.

Table 10 indicates that pre-washing and pigging used separately or in combination are the most common forms of pre-treatment (treatment prior to hydrostatic testing) for new and existing pipelines carrying crude, refined products and HVLs. Of all existing lines, 32% were pigged, 33.5% were pre-washed and 2.2% used a combination of pigging and pre-washing. Of all new lines, 21.9% were pigged, 12.2% were pre-washed and 2.4% used a combination of pigging and pre-washing.

Table 11 illustrates that activated carbon adsorption was the most frequently used treatment (at time of discharge) for existing pipelines transporting refined products or crude. For existing lines, 30.5% used activated carbon adsorption, 1.5% used activated carbon adsorption in combination with hay bales or other treatment, 7.6% used hay bales, 13% used other treatments, 23.7% used no treatment, and 23.7% did not report the treatment type. Hay bales, which minimize erosion, oxygenate water, and remove suspended solids, appear to be the treatment technology used most frequently for new pipelines.

Table 12 describes the combined use of pre-treatment and treatment technologies. Pigging and activated carbon adsorption was the most commonly used treatment combination for existing pipelines. For existing lines, 16% of all tests used a combination of pigging and activated carbon adsorption for treatment. Existing pipelines carrying crude were most frequently pre-treated by only pigging or pre-

washing. It appears that new pipelines receive either pre-treatment or treatment, but rarely receive both technologies, with the exception of new pipelines which transport highly volatile liquids. The new HVL pipelines were reported to be treated by pigging and hay bales.

While activated carbon adsorption was the most frequently used treatment, it was utilized by only 6 out of 15 different companies as a treatment for a total of only 40 tests on existing lines (40/131, 30.5%). Pigging and activated carbon adsorption were used in combination on 25 different tests (25/131, 19.1%), but by only 3 different companies. Pre-washing and activated carbon adsorption were used by only one company on one test.

Tables 13, 13A and 13B present the water contaminant level prior to treatment and after treatment for individual samples, estimated removal efficiencies and treatment cost ranges for tests where both before treatment and after treatment analytical results were reported. A total of two tests for new lines and 55 tests for existing lines reported both before and after treatment data.

The removal efficiencies are summarized separately for existing and new pipelines in Tables 14 and 15, respectively. Those tables indicate that removal efficiencies for activated carbon adsorption, where calculable, are nearly 100% for both benzene and BTEX. The costs associated with these technologies appear to range from less than one cent per gallon to $0.85 per gallon.

Tables 16 through 19 are listings of analytical data reported and selected summary statistics. For existing pipelines, the average before-treatment and after-treatment concentrations were approximately: benzene (before = 12,452 ug/L; after = 9.3 ug/L); BTEX (before = 38,176 ug/L; after = 139 ug/L); Oil & Grease (before = 180.8 mg/L; after = 2.74 mg/L); TSS (before = 62.6 mg/L; after = 20.7 mg/L). And for new pipelines, the average before-treatment and after-treatment concentrations were approximately :

benzene (before = 3 ug/L; after = 11 ug/L); BTEX (before = < 2 ug/L; after = < 2 ug/L); Oil & Grease (before = 2.3 mg/L; after = 3.3 mg/L); TSS (before = 54.7 mg/L; after =44.8 mg/L). In calculating the average, where a compound was not detected, one half the detection limit was used for summary statistics. In some cases, use of one-half the detection limit produced artificially high statistics as noted above for benzene and oil and grease in the average "after treatment" numbers.

Table 20, indicates that member companies reported treatment by activated carbon adsorption anywhere from less than one cent/gallon to over 50 cents/gallon. The average weighted cost for testing new pipeline (corresponding to treatment only by removal of suspended particles) is less than one cent (0.16 cents) per gallon.

Table 21 indicates the most frequently reported cost for both new and existing pipelines was less than one cent/gallon. Table 22 indicates that the average discharge volume in the cost range of 1 to <5 cents/gallon is almost 5,500,000 gallons. Table 23 shows the economies of scale for treatment technologies with a best-fit line drawn through the data.

Table 24 presents test frequency, average discharge volume, cost average and cost range information for tests conducted where cost information was reported for existing pipes. The table is grouped by the type of liquid transported and the treatment technology used.

Table 25 lists the range and average concentrations for selected compounds and an indication if permit requirements were met for tests where pigging, pre-washing, or pigging and pre-washing were used as the only treatment technology. This table reflects only existing pipelines where refined product was transported. This table was prepared to evaluate if pigging or pre-washing or a combination of just these two options clean the pipeline such that the effluent meets permit limits. Overall, this technology provided very encouraging results relative to permit compliance.

Table 26 is a summary of the reports for permit compliance for particular chemical compounds, grouped by product type and treatment method.

Section 4
EVALUATION OF TREATMENT TECHNOLOGIES

APPROACH

This section of the report covers the procedures used in evaluating the available technologies for the treatment of wastewater resulting from hydrostatic testing of pipelines used for the transport of crude oil, highly volatile liquids, and refined products. The evaluations were carried out with respect to present practices as identified in the industry survey and with the consideration of alternate technologies that are available to the industry.

The following tasks were performed to address the issues of volume and frequency of test water discharges; water characteristics such as BTEX, TSS, and Oil & Grease; treatment effectiveness; and cost estimates.

An industry survey was performed of pipeline companies which have conducted hydrostatic testing. Information requested from these companies included such items as:

- Treatment Technology used;
- Product carried in the pipeline;
- Volumes of water used in the test;
- Pre-test treatment, if any;
- Water quality, before and after testing, i.e. hydrostatic test water characterization for constituents of concern;
- Number of tests conducted per year; and
- Cost per gallon of water treated.

Data from 172 tests were received from the companies contacted, and the data submitted by them were compiled and are contained in Sections 2 and 3. These data, together with other information which was reviewed, such as the Gas Research Institute

Report: "Environmental Aspects of Hydrostatic Test Water Discharges: Operations, Characterization, Treatment and Disposal", 1996, were evaluated and form the basis for this section of the report.

Hydrostatic test water treatment data were collected and classified into a Technology Summary, which examines the treatment effectiveness with respect to expected required discharge limits.

Possible alternate treatment technologies for the hydrostatic water treatment were also examined with respect to the parameters of concern to the liquids pipeline industry. Recommendations were made for treatment of the hydrostatic test water from crude oil pipelines, highly volatile liquid pipelines and refined product pipelines. These recommendations were based mainly on the effectiveness of the treatment technologies as observed in the data and from the referenced reports.

Finally, cost estimates of the existing and alternate treatment technologies were prepared and are detailed in Section 5.

TECHNOLOGY SUMMARY

The industry survey supplied information for the following treatment technologies:

Pipeline Pre-Cleaning

Pigging. This treatment consists of pushing a pig through the pipeline with air or natural gas before filling it with test water for hydrostatic testing. Various types of pigs such as squeegee, brush, and others may be used individually, or in combination. A single or multiple pass may be used. It should be noted that not all pipelines are equipped for on-line pigging operations. For this reason, it may be necessary to install pig launchers and receivers to conduct pipeline cleaning and hydrostatic testing activities.

Pigging and Pre-Washing. In addition to pigging, this approach includes the use of a cleaning solution to remove BTEX and other residuals before filling the system with test water. This cleaning solution, typically consisting of water and a detergent solution, is pushed through the system with a pig and is collected, tested and properly disposed of.

Pipeline Treatment

Activated Carbon Adsorption. This treatment consists of pumping the hydrostatic test water through a column or several columns in parallel packed with activated carbon. This technology is primarily effective in removing Benzene and BTEX. An oil/water separator is typically installed in front of the packed column to remove free product from test water.

Air Stripping. Air stripping involves the transfer of volatile compounds contained in the water to air, via mass transfer across a gas-liquid interface created by counter-current contact of air and water streams. In the process, the water flows downward through packing against an upward air flow. From the packed column, the air flows to the atmosphere.

Hay Bales/High Rate Of Treatment. This treatment consists of a round or rectangular structure of bales of hay onto which the test water is discharged in order to remove TSS and Oil and Grease. VOCs are driven out of the water to some extent because of the splashing caused by the impact of the water on the hay bale structure. An example of a hay bale structure designed for a high rate of treatment (HRT) is contained in figure 1. This technology includes a filter cloth, splash plate, and absorbent boom to improve effectiveness.

Combinations of Carbon Adsorption, Air Stripping, and Hay bales. Combining activated carbon adsorption with air stripping or hay bales was also noted in some cases.

PERFORMANCE OF EXISTING TECHNOLOGIES

The performance, or effectiveness, of the technologies described in the industry survey is summarized below, in relation to hydrostatic test waters from several different types of pipelines. A summary of the positive aspects (+) and negative drawbacks (-) of each technology as it relates to specific evaluation criteria such as practicality, mobility, discharge rates, etc., is contained in Table 27. These assessments are based on the evaluation of the effectiveness of the technologies as per the data contained in Section 3. These assessments of the positive attributes and negative drawbacks represent general conclusions and may vary depending on the type of pipeline system and volume of discharge.

Pigging

Inadequate data was available to assess the effectiveness of pigging as a treatment technology, in and of itself. Preliminary information obtained in the industry survey indicates that pre-pigging combined with pre-washing, activated carbon adsorption or other treatment may be necessary to meet permit discharge limits in many cases.

Pigging and Pre-Washing

As with pre-pigging, inadequate data was available to assess the effectiveness of pre-pigging combined with pre washing. Based on the limited available data, however, this option does appear to be satisfactory for crude oil pipelines with respect to oil & grease and TSS, but may not be satisfactory for benzene and BTEX without additional treatment. This option may be satisfactory for refined product pipelines based on the results illustrated in Table 25. Further test results are necessary to verify this conclusion, however.

Hay Bales/High Rate Of Treatment

This treatment and an improved version, the High Rate Treatment (HRT) System, are easily constructed, and the materials are readily available. No large equipment is needed, and there are no pumps, blowers, nor other related equipment. This option

should be effective for TSS and oil and grease removal. Additionally, the splash plate in the HRT aerates the water and removes VOCs and the haybales are effective for erosion control. The HRT System includes primary components used in hay bale structures (i.e., hay bales, oil adsorbent boom, splash plate), along with an additional level of filtration, which is provided by using filter cloth. The water from testing is routed to the center of the system, where the velocity of the discharge water is reduced upon impacting a splash plate. A diagram of this design is contained in Figure 1.

Inadequate data was available to assess the effectiveness of hay bales as the sole treatment technology. Table 26 illustrates that oil and grease are effectively controlled but inadequate data is available to judge performance for benzene and BTEX. After both pre-pigging and pre-washing, hay bale treatment may provide a viable option but the pipeline may also need additional treatment for removal of benzene and BTEX.

Activated Carbon Adsorption

This is a well known technology that has been used often to remove organic constituents from water. However, there is a flow rate limitation which can be a significant drawback for some pipeline operations. Because of the large volumes of test water from some hydrostatic tests, treatment flow rates of 2000 to 3500 gpm may be necessary to keep system downtime to a minimum. At present, one of the largest activated carbon adsorption canisters available is limited to a maximum water throughput of 550 gpm. To obtain a total throughput rate of 2000 gpm will require four such canisters in parallel; resulting in significant capital costs. Also, for a system of this size, when the carbon is spent, a waste slurry of 80,000 pounds of carbon in water is generated. Access and transport are also difficult for this treatment option under certain circumstances. In some cases, the hydrostatic test water from the pipeline may have to be stored in temporary tankage. Results of the effectiveness of activated carbon adsorption are very good, however, as illustrated in Tables 14 and 26. Overall assessments for crude oil and refined products were as follows:

Crude Oil Pipelines. After pigging pretreatment, activated carbon adsorption appears to be suitable for hydrostatic test water from crude oil pipelines. Results from the data presented in section 3 were as follows for input vs. output:

- BTEX: 27 mg/L to < 0.004 mg/L
- O&G: 300 mg/L to < 4.0 mg/L
- TSS: 22 mg/L to < 2 mg/L

Refined Product Pipelines. After pigging pretreatment this technology also appears to be suitable for refined product pipelines. The results of tests were:

- BTEX: 153 mg/L to < 0.001 mg/L
- O&G 3500 mg/L to <5.5 mg/L
- TSS: 160 mg/L to < 6 mg/L

HVL Pipelines. Inadequate data was available to assess the effectiveness of activated carbon adsorption on HVL Pipelines.

Activated Carbon Adsorption Followed by Air Stripping

Refined Product Pipelines. After pigging, this combination technology appears to be suitable for benzene and BTEX. Oil and grease and TSS were not measured, but would have likely been removed by the activated carbon adsorption step.

Activated Carbon Adsorption Followed by Hay bales

Refined Product Pipelines. After pigging, this combination technology appears to be suitable for benzene and BTEX. Oil and grease and TSS were not measured, but would have likely been removed by the activated carbon adsorption step.

Air Stripping

This is also a widely used and well known treatment for removing VOCs from water but generally not at the discharge rates required for a pipeline system. Other problems can arise because temporary storage of test water may also be necessary. Use of this

technology may also require air permitting, utilization of control technology, and will impact a facility's emission inventory. Transport of equipment and access to remote sites are also an issue that make this technology very limited in application. Very limited data was available to assess this technology, yet after pre-pigging on a combined crude oil and refined products pipeline the following results were obtained:

- Benzene: 4.4 mg/L to 0.024 mg/L
- BTEX: 12.7 mg/L to 0.039 mg/L
- O&G 666 mg/L to 35 mg/L
- TSS: not measured

Oil/Water Separator With Air Sparging

The use of an oil/water separator may be a viable option in some cases where equipment mobility, siting, and throughput capacity are not a limitation to the discharge. This option may have limited effect on BTEX depending on the contaminant level but it may be effective in some circumstances. Suspended solids will need to be addressed with hay bales or another filtration approach to utilize this system. Disposal/recycling of separated oil must also be managed properly with this system. Some state air divisions may also require notification or a permit prior to venting BTEX from the test water via the air sparging operation. Insufficient data was available to assess the effectiveness of this treatment technology.

OTHER TREATMENT TECHNOLOGIES

There are other well-known treatment technologies for the removal of oil, grease, benzene, BTEX and solid materials from wastewater. Some of these technologies include filtration, dissolved air flotation, and ultra-violet oxidation. These technologies are not currently used by the pipeline industry in most cases but are presented here as options for consideration and evaluation.

Filtration

Filtration is useful for removing suspended solids, and can also lower the concentration of non-emulsified oil and grease. There are many types of filters available, such as fixed multimedia, moving bed sand filters, plate and frame filters, rotary vacuum filters, belt pressure filters and centrifuges. Every type of filter will produce a sludge that must be dewatered and the filter must be cleaned periodically; therefore, filtration is labor intensive.

Most filters can be made mobile. However, throughput is a definite drawback to their use in treating hydrostatic test water; 2,000 to 3,500 gpm is out of the question as a processing rate in most cases. Another drawback is that filtration does not address the problem of BTEX nor other light hydrocarbons which are present in the wastewater. Additional treatment would be required.

For these reasons, filtration, in and of itself, is most likely not a viable alternative technology except possibly on new pipeline systems with limited volumes of discharge.

Dissolved Air Flotation (DAF)

This technology is an effective way to remove suspended solids and emulsified oils from wastewater streams. Air bubbles are produced and attach themselves to the suspended particles, which gives the particles a net buoyancy, and form clusters. The clusters of particles and air bubbles rise to the surface of the water, forming a float which is removed by skimming. The solids concentration of the skimmings ranges between 3% and 10%. Thus de-watering of the skimmings is necessary before they can be removed for disposal.

Removal rates of up to 97% are obtained, resulting in effluent TSS and oil and grease concentrations of less then 100 mg/L.

The technology does not, however, meet requirements with respect to BTEX and other VOC's; additional treatment would be required.

If improved effluent quality with respect to TSS and oil and gas is required, chemical pre-treatment including neutralization, coagulation, and flocculation can be beneficial.

DAF systems are available in standard sizes to handle 600 gpm of wastewater. A 600 gpm unit is 62 feet long by 12 feet wide, which is large and essentially makes it unacceptable for the pipeline industry due to mobility. At 600 gpm, a 100,000 gallon discharge of hydrostatic test water would require a run time of 2.8 hours, and a 1 million gallon discharge would require 28 hours.

A 600 gpm unit would cost approximately $200,000 which results in a capital cost that exceeds that of many other treatment technologies.

Ultra-Violet Light Oxidation

This is a process in which dissolved organic compounds are oxidized by the application of high intensity ultra-violet (UV) light with the presence of hydrogen peroxide. The UV light converts the hydrogen peroxide into hydroxyl radicals (OH-) which are powerful oxidizers. The combination of light and hydroxyl radicals promotes the rapid breakdown of the organics to carbon dioxide and water. Any halogens present are converted to halides. One of the advantages for the process is that there are typically no hazardous air emissions released.

However, if the wastewater contains TSS and/or oil and gas, some pretreatment is required, and this results in a requirement for solids removal and handling. The presence of iron or calcium in the wastewater requires pH adjustment and precipitation to prevent scaling on the UV tube lamps.

This process might have very limited applications on light, clean refined product pipelines, and on highly volatile liquid pipelines. However, flow rates are low and costs are high, making it overall impractical for the liquid pipeline industry.

TECHNOLOGY EVALUATION PROCESS

The above performance evaluation showed that the most promising technologies are pigging and pre-washing, activated carbon adsorption, hay bales or combination of these. These performances must be coupled with cost estimates to assess the total effectiveness of the technology for meeting the needs of the pipeline industry and the requirements of permitting agencies.

The results of the technology evaluation process is shown in Table 27, "Summary of Hydrostatic Test Water Treatment Technologies." Each technology was examined with respect to criteria, such as practicality, mobility, time requirements, power, related storage requirements, wastes generated, discharge rates, ability to meet discharge limits and cost. The positive aspects (+) and negative drawbacks (-) of each treatment technology were assessed against the evaluation criteria. For example, the Mobility of Carbon Adsorption was assessed as a negative, because of the size and weight of the adsorption columns, and because of the need for water storage. These assessments are based on the integrated consideration of the data presented in Section 3, the effectiveness of the technology presented in Section 4 and cost considerations presented in Section 5. Furthermore, these assessments are overall value judgments of all the above factors and are subject to exception under site specific circumstances. These evaluations are not intended to limit the utilization or application of any technology but rather to provide guidance to the industry in considering treatment alternatives which best meet the requirements for a particular discharge application.

Section 5

ECONOMIC ANALYSIS

APPROACH

Capital and operating costs were developed based on published data, vendor quotes, cost information from member pipeline companies, and best professional engineering judgment.

Recognizing that several site specific factors are pertinent to operations of this nature, the cost evaluation included considerations of the following factors:

- Mobilization/Demobilization Mileage to Site
- Site Constraints: Space, Surface, Distance to Discharge Point
- Climatic Conditions: Seasonal Considerations
- Site Preparation: Clearing, Surface Preparation, Power Requirements
- Waste Disposal: Pre-Pig Fluids, Solids, Spent Carbon, Used Hay bales, etc.
- Fees: Easement Access, Construction, Permitting
- Treatment Throughput Rate
- Water Storage Requirements and Containment

A summary of the capital and operating costs for each technology was prepared and is contained in Table 40.

ESTIMATED COSTS

Cost estimates were prepared for Pigging and Pre-washing, HRT System, Carbon Adsorption, Air Stripping, Dissolved Air Flotation and Ultraviolet Light Oxidation. Three values of hydrostatic waste water discharges were chosen for each cost estimate, 100,000 gallons, 1 million gallons, and 10 million gallons. The cost estimates are shown in Tables 28 through 39. To ensure a consistent means of relative cost

comparison between treatment operations, all cost estimates assume a one-time use of equipment with no reuse, amortization of costs, or depreciation cost recovery.

Pigging and Pre-Washing

Costs for the Pigging and Pre-washing technologies were based on the data from the referenced GRI Topical Report: Environmental Aspects of Hydrostatic Test Water Discharges: Operations, Characterization, Treatment and Disposal, April 1996. Tables 28 and 29 present these cost estimates which are based on actual test data, and are sufficient for the purpose of this report. These estimates assume that pig launchers and receivers are in place and do not need to be installed.

Hay Bales/High Rate of Treatment

The cost estimates for this system are shown in Tables 30 and 31. As with the above costs for Pigging and Pre-washing, the estimates for HRT were taken from the Reference GRI report.

Activated Carbon Adsorption

The cost estimates for the Carbon Adsorption technology are shown in Tables 32 - 35 and are based on vendors' quotes. One of the pertinent factors in the treatment of the hydrostatic test water is the treatment flow rate; for this study, a range of 2,000 to 3,000 gpm was selected. These high rates were selected to keep the treatment processing time to a minimum, especially with discharge volumes of up to 10 million gallons. However, the flow rate for the largest available adsorption canister is 550 gpm. This means that a flow rate of 3,000 gpm requires 6 canisters in parallel, which influences the capital cost adversely. Therefore, the following scenario was devised to keep the capital cost at acceptable levels.

100,000 Gallon Discharge. A processing rate of 2,000 gpm would require 4 canisters in parallel, with a processing time of 50 minutes. Table 32 shows the cost estimate for this case. But with one canister, and a processing rate of 550 gpm, the processing time

would be 3.03 hours, which is certainly reasonable. The cost of one canister is $26,900 compared with the cost of 4 canisters at $107,600. Table 33 shows the total cost estimate for the single canister alternative at $79,375 compared to the total cost of $258,706 for four canisters as reflected in Table 32..

1,000,000 Gallon Discharge. One canister was also used for this case, which increased the processing time to 30.3 hours or slightly more than one day. The operating labor is increased, but the capital equipment cost is the same as for the 100,000 gallon case. Table 34 shows the cost estimate for this case.

10,000,000 Gallon Discharge. In this case, a single canister requires a run time of 303 hours, which may not be acceptable in many circumstances. The use of 4 canisters in parallel, with a total rate of 2,200 gpm and a processing time of 75.8 hours or 3.1 days may be more appropriate at this total volume. This processing run time may still be considered too long from an operational standpoint in some situations. The cost estimate for this case is shown in Table 35.

Air Stripping

Cost estimates for the air stripping technology are based on vendor quotes and are shown in Tables 36 and 37. As in the cost estimate for Carbon Adsorption, the processing rate became an important design factor. Previous research conducted by GRI indicated that a 2,000 gpm rate was used for all three volume discharges, with a fixed stripping tower diameter and differing processing time durations. This approach results in a 50 minute processing time for the 100,000 gallon case, with a 9.5 foot diameter column. An alternative method is to use a reasonable processing rate and duration time, certainly for the 100,000 gallon case, and the higher rate for the one million to ten million gallon volumes. Air stripping will potentially require additional costs for permitting and the use of emission controls in certain circumstances. These costs have not been included in these estimates.

100,000 Gallon Discharge. The stripping column was designed for a processing time of 2.4 hours, and a rate of 700 gpm. This results in a tower diameter of 5 feet, and a more reasonable cost with respect to capital and labor. The cost estimate is given in Table 36.

1,000,000 and 10,000,000 Gallon Discharges. For these two cases the processing rate was set at 2,000 gpm. This gave a processing time of 8.33 hours for the 1 million gallon case, and 3.5 days for the ten million gallon case. The column diameter is 9 feet for both cases, and the capital is the same for both, but the operating labor is greater for the ten million gallon case. Table 37 gives the cost estimates for both of these discharge volumes. Note that separate operating costs are given for each volume.

Dissolved Air Flotation (DAF)

Table 38 shows the cost estimate for this technology. It is based on a vendor quote for a 75 gpm unit, while the largest standard unit has a processing rate of 600 gpm. The cost of the 600 gpm unit was estimated from the cost of the 75 gpm unit by multiplying by the size ratio raised to the 0.6 power. Table 38 shows costs for a 100,000 gallon discharge, and operating costs for the 1 and 10 million gallon discharges. The total costs for 100,000 and 1 million gallons differ only by a small amount; the total cost for 10 million gallons is about $6,000 more because of higher operational costs.

The high capital costs of DAF relative to other technologies will likely make it unsatisfactory from an operational standpoint. Additionally, the need for additional treatment for BTEX and the long processing times for the 10 million gallon case are negative factors.

Ultra-Violet Light Oxidation

The cost estimate presented in Table 39 is based on a 400 gpm capacity unit and is based on vendor quotes. The capital cost of the unit is $423,976 for the 100,000 gallon discharge application. No pretreatment costs for removing solid matter, grease, or

metals are included. This assumes that the technology is intended for use on only clean refined product pipelines or light hydrocarbons. The high costs of this treatment technology compared to other options will aslo likely make it unacceptable from an operational standpoint.

ESTIMATED CAPITAL/OPERATING COSTS

Table 40 is a summary of the estimated capital and operating costs of each technology, and for each of the three chosen hydrostatic test water discharge volumes. These cost estimates have an accuracy of +/- 30%. Also shown in Table 40 are figures representing cost per gallon of water treated. The costs in the column labeled "Estimated Costs" are based on the costs presented in Tables 28 through 39.

The following assumptions have been utilized in developing these costs:

- Cost estimates are based on a combination of existing published literature such as GRI's *"Environmental Aspects Of Hydrostatic Test Water Discharges: Operations, Characterization, Treatment, And Disposal"*, vendor quotes, and best engineering judgement.
- Unit cost estimates assume a one time use of the equipment with no reuse, amortization of costs, or depreciation cost recovery.
- All wastes associated with pre-pigging/pre-washing and haybale treatment are non-hazardous.
- No costs are included for installing pig launchers and receivers for pre-pigging/pre-washing.
- No costs have been included for disposal or regeneration of activated carbon.
- No costs have been included for the installation of air emission control technology for the air stripping treatment option.

Section 6
TEST WATER MANAGEMENT OPTIONS

Several alternative hydrostatic test water management options which are practical and logistically feasible were identified during the industry survey and literature search. Detailed research has not been conducted on these options but they may have potential benefit in evaluating alternatives to conventional end of pipe treatment approaches. These options are listed below for consideration in future hydrostatic test water projects:

PRETREATING INLET WATER TO THE PIPELINE SYSTEM

Inlet water to the pipeline system may contain significant contaminants such as suspended solids, high iron levels, and may even contain some oil and grease and other organics depending on the source. Many discharge permits do not take into consideration the inlet water loading level for a hydrostatic test with regards to permit compliance. Filtering the water or otherwise treating it to remove inlet contaminants many be of considerable value particularly if the source water has a high level of suspended solids. Where the permitting agency is agreeable and the inlet water and discharge water bodies are the same, discharge limits should be set based on the net contribution of the pipeline discharge rather than the absolute value of the discharge contaminants. This permitting approach addresses the contribution of the constituents in the pipeline and not those that are in the inlet water.

UTILIZING REFINERY, TERMINAL, OR PLANT WASTE WATER TREATMENT SYSTEMS

Avoiding an actual hydrostatic test water discharge all together may be the best alternative of all if accessibility to a refinery, terminal, or plant waste water treatment system exists operationally. Utilizing a fixed waste water treatment system and an existing NPDES permit greatly increases the chances of compliance since these systems can usually handle fluctuations in inlet concentrations much more effectively

than an end of pipe treatment in the field. Furthermore, this approach avoids the need for a separate NPDES discharge permit and thereby can reduce the overall project time by avoiding delays in the application process.

DISCHARGE TO A MUNICIPAL POTW

Another option for utilizing an existing NPDES permit is to discharge to a municipal POTW. This option is excellent where access to the system is possible and the municipality agrees to accept the discharge. This approach will typically require fees to be paid to the city based on the volume and contaminant level in the discharge. An analysis of the water will also be required by the city; therefore, some estimate will have to be given of the contaminant level based on past experience. This is another option that can reduce project time as long as arrangements with the city can be made effectively. Municipalities in some instances may also require a permit application which must be considered relative to other management options. Discharges to a POTW may have discharge rate limitations which must be considered in the overall project timing and tankage requirements.

USE OF DILUTION WATER

Some members indicated that dilution water had been used as an option under certain circumstances. This approach is not prohibited under the NPDES program and may be an effective alternative where dilution water is available and can be introduced into the discharge. Use of dilution water must be reviewed with each respective state jurisdictional agency to ensure that there are no restrictions against this alternative. This option will likely have very limited application but certain circumstances may make it a viable approach.

PRE-PIGGING/PRE-WASHING

Prepigging and prewashing of pipelines is primarily used for preconditioning of pipe prior to the introduction of hydrostatic test water. A pig(s) is/are run through the system in single or multiple passes to remove oil and grease and scale. A wash solution

typically of mild detergent or just water is then introduced into the system between two pigs to further clean the pipeline. Waste material is collected from the pipeline system and properly disposed of in accordance with regulatory requirements. Hydrostatic test water is then introduced into the system for testing. Based on the limited data provided by the industry survey, it appears that prepigging and prewashing may be a viable treatment alternative in and of itself in some cases. Section 4 and 5 discuss this option in more detail. Tables 25 and 40 present both effectiveness and cost summary data regarding pre-pigging and pre-washing

WATER RE-USE

Storing water for reuse is also an effective strategy for the management of hydrostatic test water where tankage is available and accessible in the portion of the pipeline system being tested. Staging water from one section of the pipeline system to the next can also be employed to minimize the amount of water volume required for storage and ultimate discharge. This water can be stored indefinitely if there is an ongoing need for hydrostatic testing in this portion of the system. Water quality after multiple reuse will degrade over time, however, as long as it is contained and properly managed at the time of discharge this should not be an issue.

LAND DISPOSAL

Management of hydrostatic test water through land disposal in an alternative that may be appropriate under certain circumstances where other acceptable options do not exist. Land disposal will likely require a disposal permit from the respective state agency. Utilization of this option must ensure that the disposal waters are not hazardous and that they are contained such that there is no discharge which would make them subject to the jurisdiction of the NPDES permitting program. Depending on the volume involved, this management option may require considerable planning for storage and controlled discharge to ensure that test waters do not leave the site.

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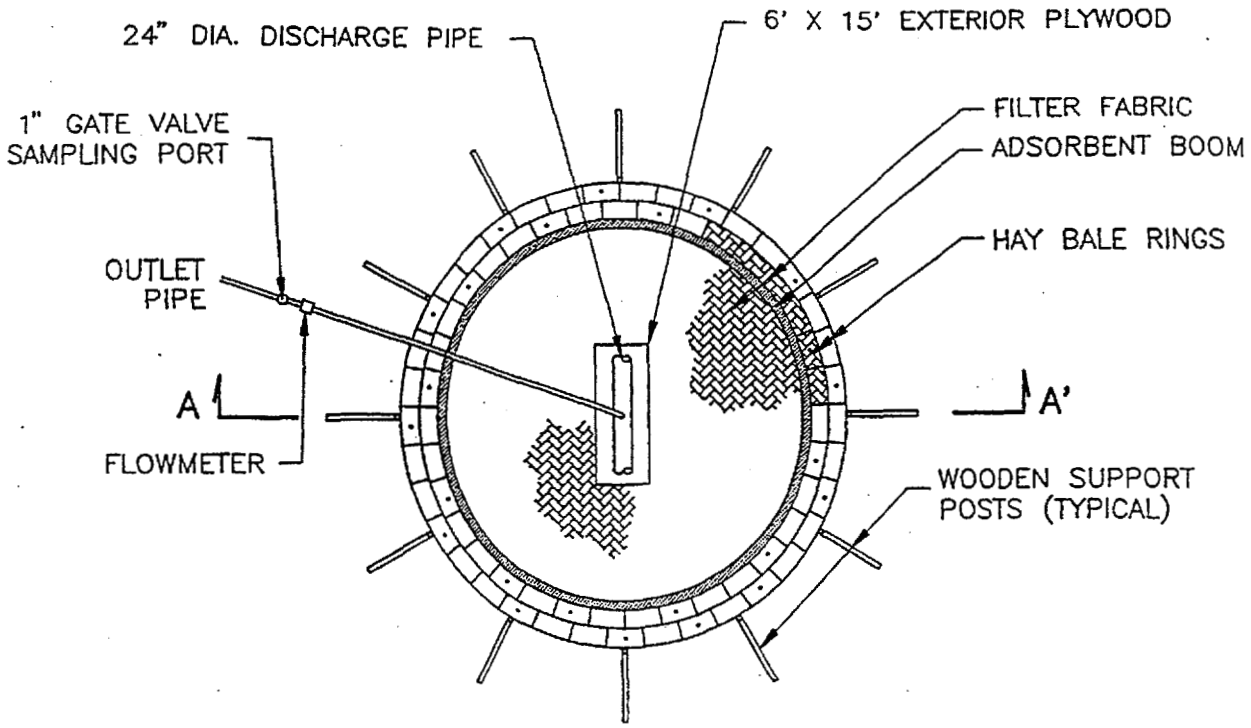

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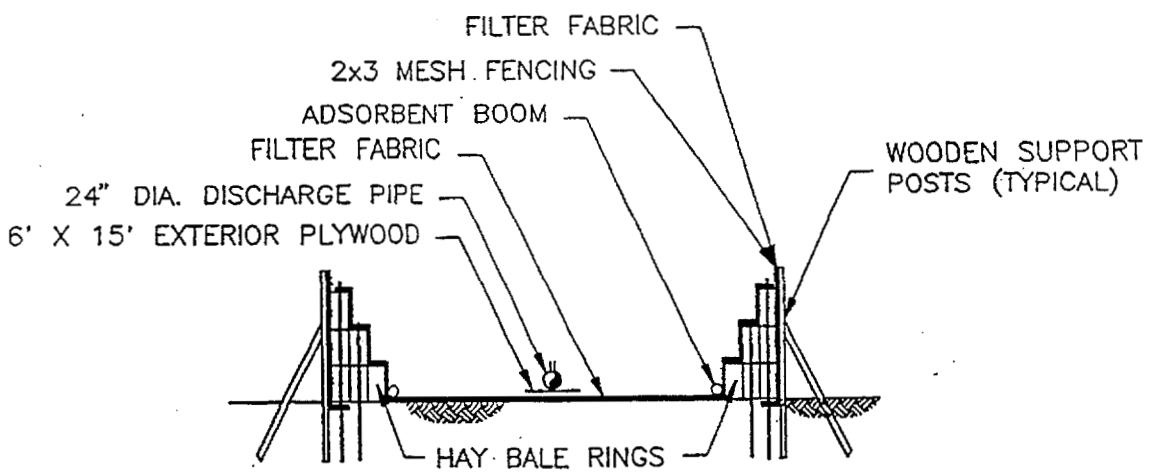

SECTION A–A'
VERTICAL SCALE EXAGGERATED TO SHOW DETAIL

2950-007/295065a

SCHEMATIC OF HIGH RATE TREATMENT SYSTEM

Figure 1
High Rate Of Treatment Hay Bale System

Attachm
Hydrostatic Test Water Indus

Task 2
API Hydrostatic Test
Woodward-Clyd

A	B	C	D	E	F	G	H	I	J	K	L
		Discharge Information									
Year Test Comp.	Source of Hydro Test Water	Total Disch Vol (gal)	Max Disch Rate (gpm)	State in which water discharged	Type of Discharge	Type of Receiving Water Body	Remote Location?	New or Existing Pipe?	Type of product carried in this line	Pipeline Pre-conditioning	Parameter
											Benzene BETX BOD DO Fe MTBE Oil & Grease pH TSS List Others Be

General Notes:

Thank you for your participation!

Please complete the worksheet labelled "Test Info" per the instructions provided below. Enter test information for one test in each file. Please refer to the cover letter for further in
The information requested below in columns N & O and T & U [separation of qualifier (a character) from result (a number)] was done to minimize data manipulation for statistical e

Explanation of columns & information to enter

Column Name Info to enter

A Enter the year the test was completed

B What was the source of the test water? Choose one of the following codes: R=river L=lake S=stream M=municipal source O=other (please list)

C Enter the total volume of the test water discharged (in gallons)

D What was the maximum rate of discharge in gallons per minute (gpm) which you treated?

E In what state was the water discharged? Enter the two letter abbreviation for that state.

F Enter the type of discharge. Choose one of the following codes: P=pipe or pipeline T=tank O=other (please list)

G Enter the type of the receiving body. Choose one of the following codes: R=river L=lake S=stream M=municipal POTW O=other (please list)

H Was the discharge location remote (e.g.not in a city or town)? Y=yes, N=no. (Consider lack of available electricity; the proximity to major roadways)

I Was the pipe being tested a new or existing pipe? N=new E=existing

J What type of product was carried in this line? Choose one of the following: HVL=highly volatile liquid C=crude RP=refined products

K Enter the type of pipeline preconditioning prior to the test. Choose from the following codes: P=pre-pigging PW=pre-wash N/A=not applicable

L For analysis of hydrostatic test water prior to treatment, enter the names of the analytes. If additional chemicals were tested, enter those too.

M For the compound entered in Column L, enter the analytical method used for that test, if known

N For the compound entered in Column L, enter the corresponding numerical result.

O Enter any qualifiers for the result which was entered in Column L. For example, if a compound was not detected at a detection limit of 5, put 5 in the result colum

P For the result entered, enter the corresponding units. Examples are: mg/L, ug/L

Q Enter the type of treatment technology used. Choose one or more from the following: H=hay bales C=carbon filter S=sand filter O=other (please describe

R For analysis of hydrostatic test water after treatment, enter the names of the analytes. If additional chemicals were tested, enter those too.

S For the compound entered in Column R, enter the analytical method used for that test, if known.

T For the compound entered in Column R, enter the corresponding numerical result.

U Enter any qualifiers for the result entered in in Column T. For example, if a compound was not detected at a detection limit of 5, put 5 in the result column (Colu

V For the result entered, enter the corresponding units. Examples are: mg/L, ug/L

W Did this result meet your permit requirements? Y=yes N=no (This question is optional)

X Enter the cost of the treatment of the water discharge in cents per gallon, if available.

nt A
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6E03092

M	N	O	P	Q	R	S	T	U	V	W	X
Pre-treatment Results					Post-treatment Results						
Analytical Method	Result	Qual	Units	Treatment Technology Used	Parameter	Analytical Method	Result	Qual	Units	Did this result meet permit requirements ?	Cost of Treatment and/or disposal method (cents/gal.)
					Benzene BETX BOD DO Fe MTBE Oil & Grease pH TSS List Others Below						

ow

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aluation of information collected.

(Column N) and < in the qualifier column (Column O)

n T) and < in the qualifier column (Column U)

Table 1
Miles of Interstate Liquids Pipelines Reported on U.S. FERC Form No. 6:
Annual Report of Oil Pipelines, December 31, 1996.
(As reported in Oil & Gas Journal, August 4, 1997)

Respondents Which Reported Test Data	Gathering	Trunk Lines		Totals
		Crude	Products	
Company-1	2,409	6,253	1,871	10,533
Company-2	0	0	2,868	2,868
Company-3	813	2,275	1,919	5,007
Company-4	218	675	1,080	1,973
Company-5	0	0	5,349	5,349
Company-6	1,019	2,874	2,722	6,615
Company-7	0	0	2,671	2,671
Company-8	0	2,643	0	2,643
Company-9	1,052	1,671	1,493	4,216
Company-10	3,795	32	3,805	7,632
Company-11	0	0	3,340	3,340
Company-12	0	0	4,321	4,321
Company-13	0	0	7,296	7,296
Company-14	1,033	3,287	849	5,169
Company-15	1,332	3,336	871	5,539
Mileage Totals Owned by Respondents Providing Data	11,671	23,046	40,455	75,172
Mileage Totals Reported on FERC forms in 1996	32,002	57,012	80,421	169,435
Percent of Total Mileage Owned by Respondents Providing Data	36.5	40.4	50.3	44.4

Table 2
Hydrostatic Tests Grouped by Year Conducted

Year	Existing	New
1990	6	0
1991	12	0
1992	15	0
1993	15	5
1994	20	8
1995	33	12
1996	26	13
1997	4	3
	131	41

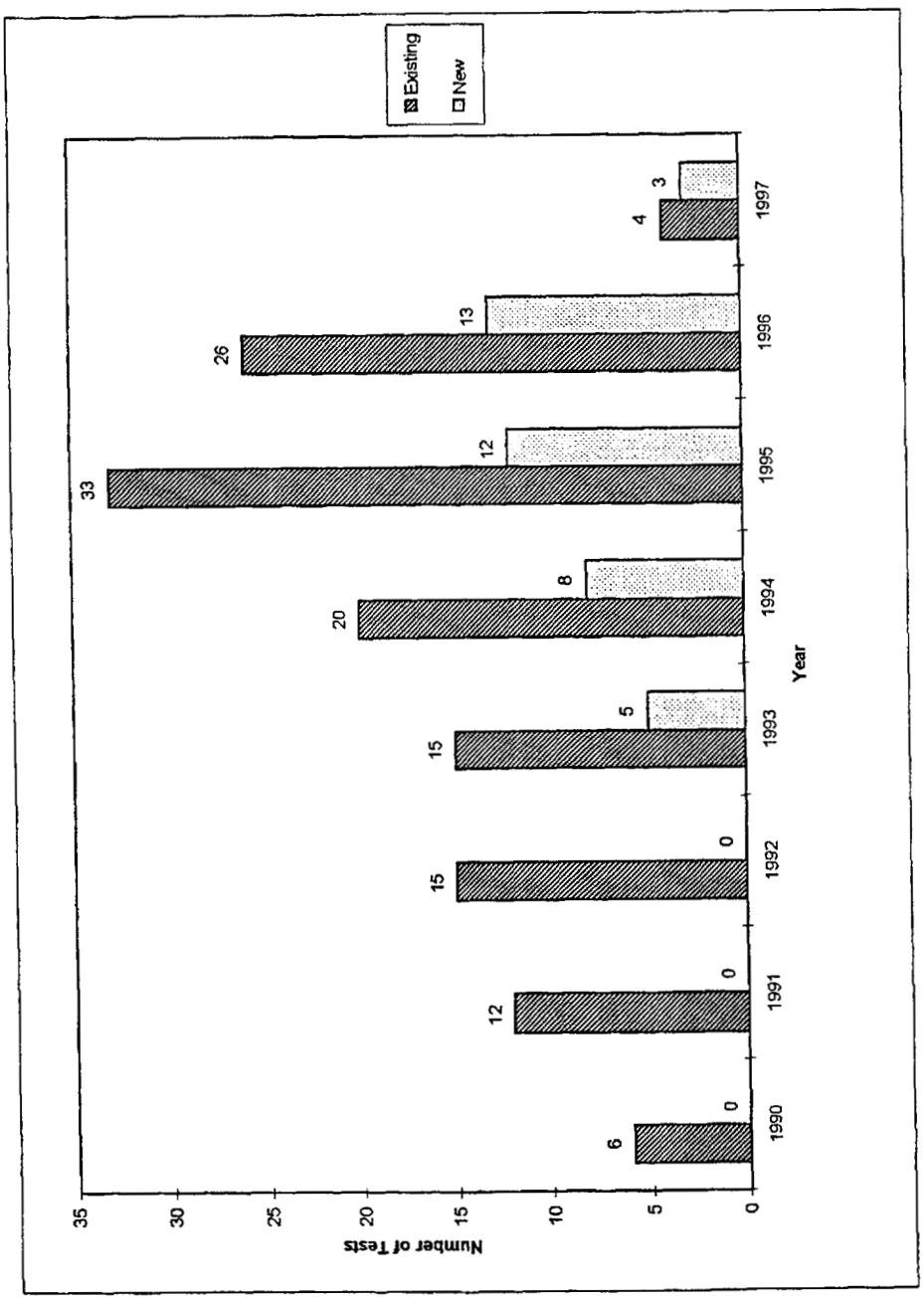
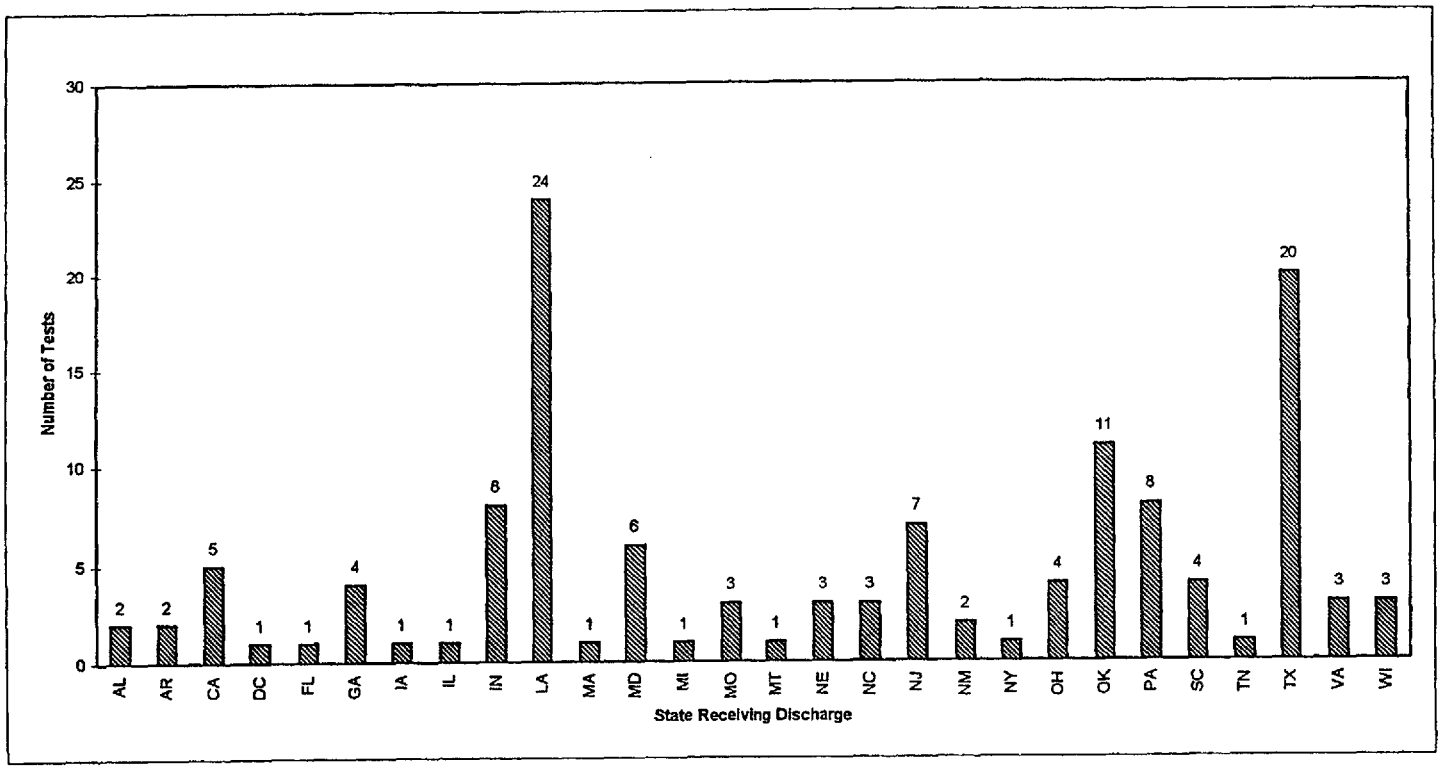
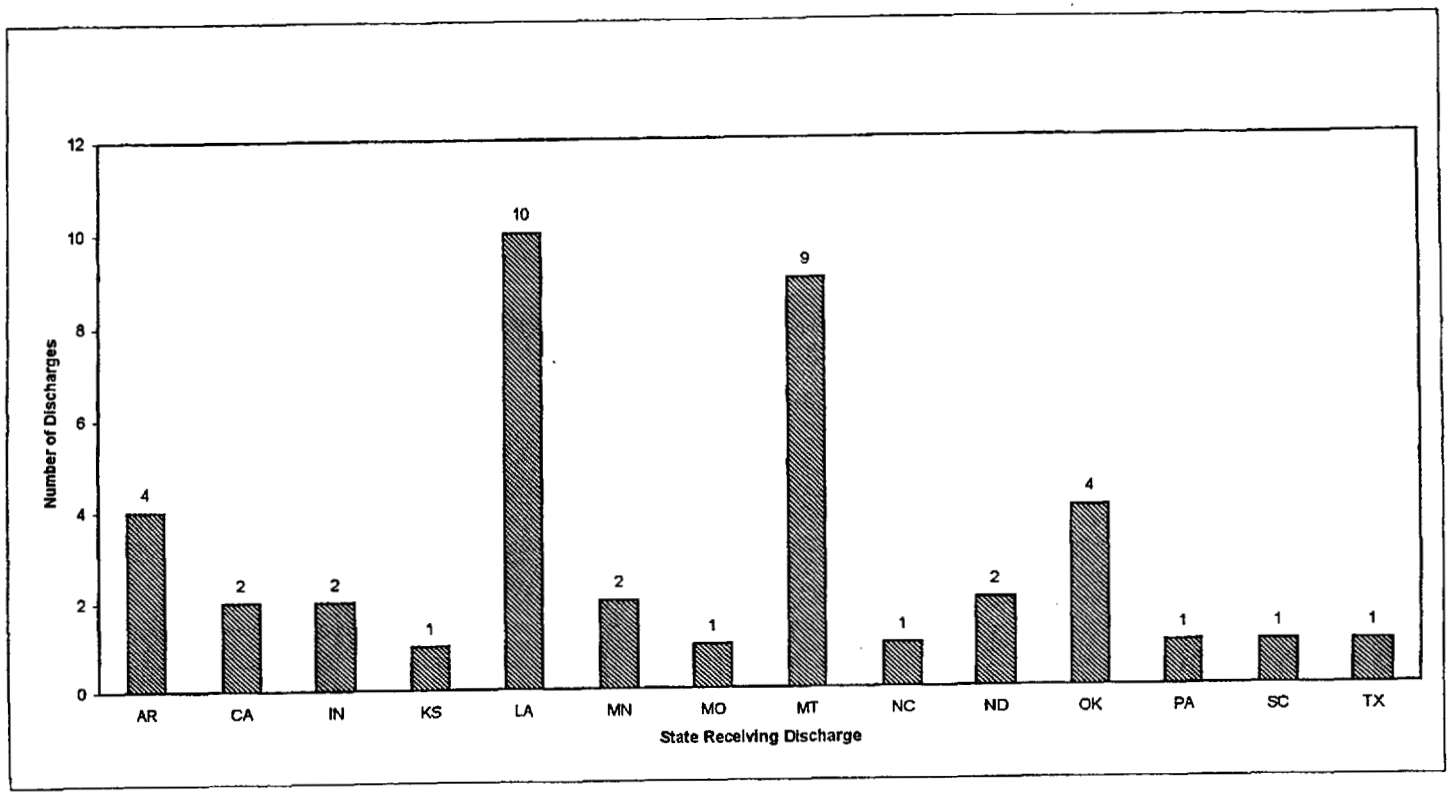


Table 3
States Receiving Discharges from Existing Pipelines



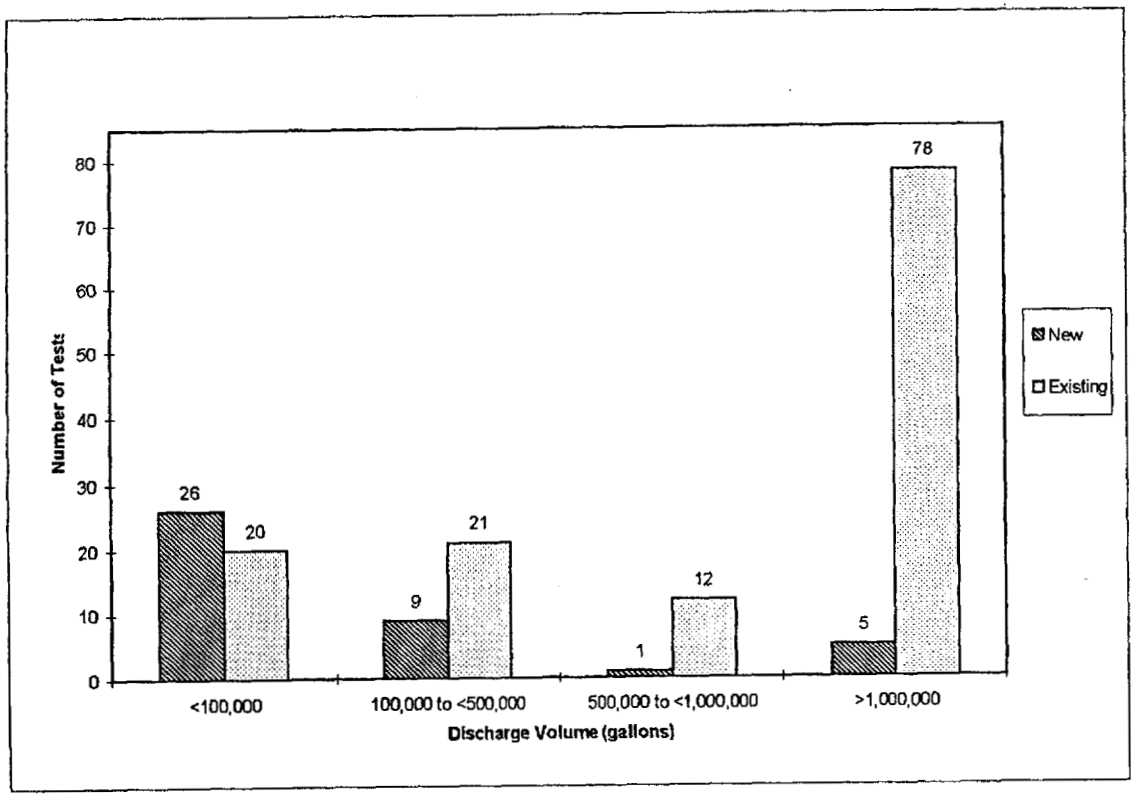
State Receiving Discharge	Number of Discharges
AL	2
AR	2
CA	5
DC	1
FL	1
GA	4
IA	1
IL	1
IN	8
LA	24
MA	1
MD	6
MI	1
MO	3
MT	1
NE	3
NC	3
NJ	7
NM	2
NY	1
OH	4
OK	11
PA	8
SC	4
TN	1
TX	20
VA	3
WI	3
Total Number of Tests	131

Table 4
States Receiving Discharges from New Pipelines



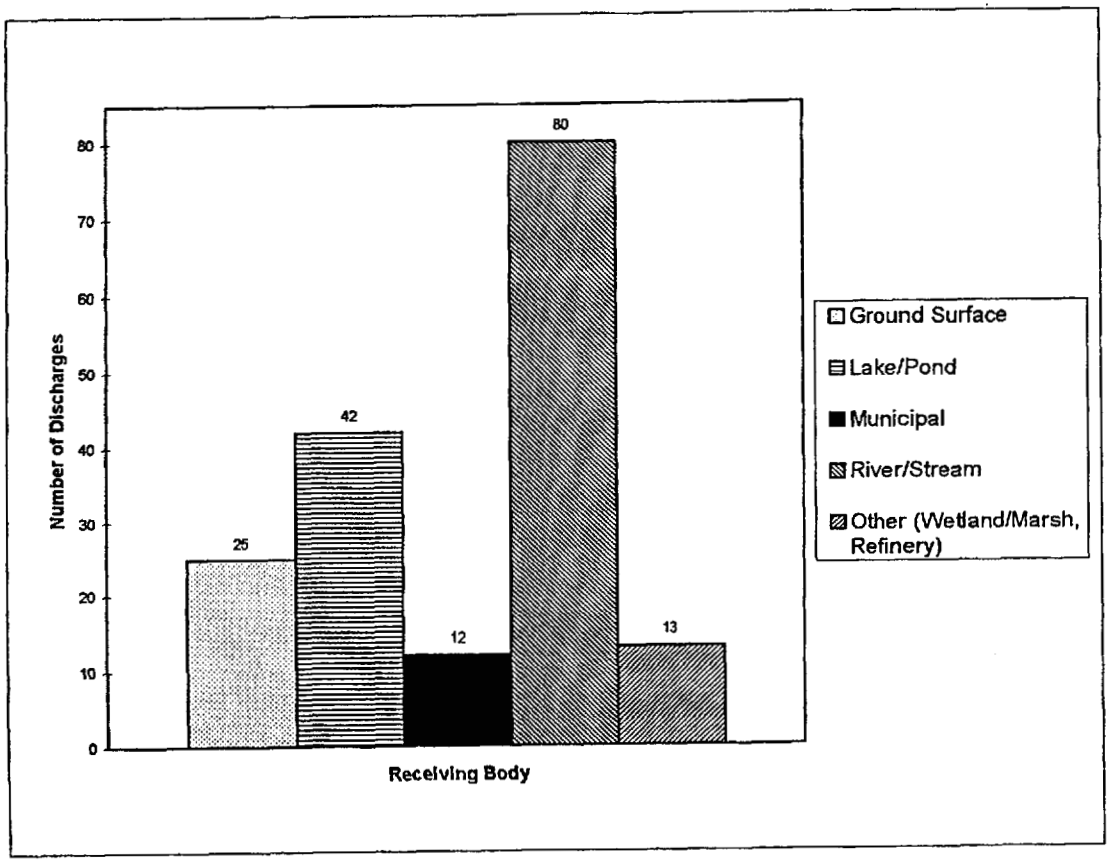
State Receiving Discharge	Number of Discharges
AR	4
CA	2
IN	2
KS	1
LA	10
MN	2
MO	1
MT	9
NC	1
ND	2
OK	4
PA	1
SC	1
TX	1
Total Number of Tests	41

Table 5
Number of Discharges Grouped by Discharge Volume



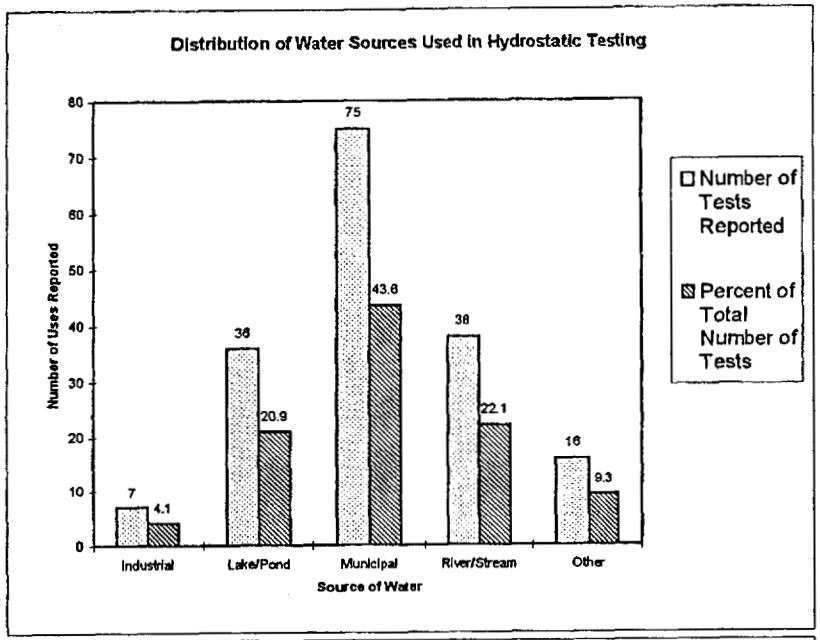
Discharge volume (gal)	New	Existing
<100,000	26	20
100,000 to <500,000	9	21
500,000 to <1,000,000	1	12
>1,000,000	5	78
	41	131

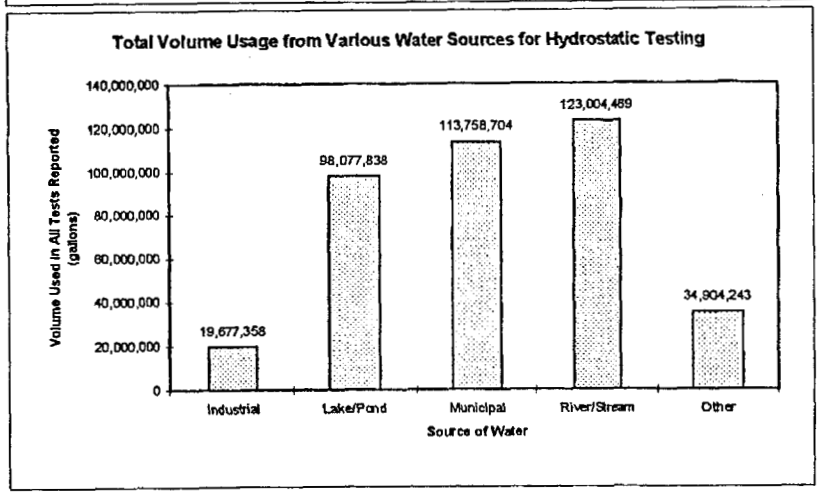
Table 6
Distribution of Receiving Body Types



Receiving Body	Number of Discharges Reported	States Receiving Discharge
Ground Surface	25	CA, MT, OK, SC, TX
Lake/Pond	42	AL, AR, GA, LA, MD, MO, NC, NJ, OK, SC
Municipal	12	CA, Washington DC, FL, OK, TX, VA
River/Stream	80	AR, IA, IL, IN, KS, LA, MA, MD, MO, MT, ND, NE, NM, NY, OH, OK, PA, SC, TN, TX, VA, WI, WI
Other (Wetland/Marsh, Refinery)	13	IN, LA, MI, MN
	172	

Table 7
Distribution of Test Water Sources





Source of Water	Number of Tests Reported	Percent of Total Number of Tests	Total Discharge Reported (gal.)	Percent of Total Volume Used
Industrial	7	4.1	19,677,358	5
Lake/Pond	36	20.9	98,077,838	25
Municipal	75	43.6	113,758,704	29
River/Stream	38	22.1	123,004,469	32
Other (Sources include: brackish water from bayou; well; treated wastewater; not reported source (4 uses, 30,560,000 gallons))	16	9.3	34,904,243	9
	172	100	389,422,612	100

Table 8
Plot of Number of Tests for Product Type

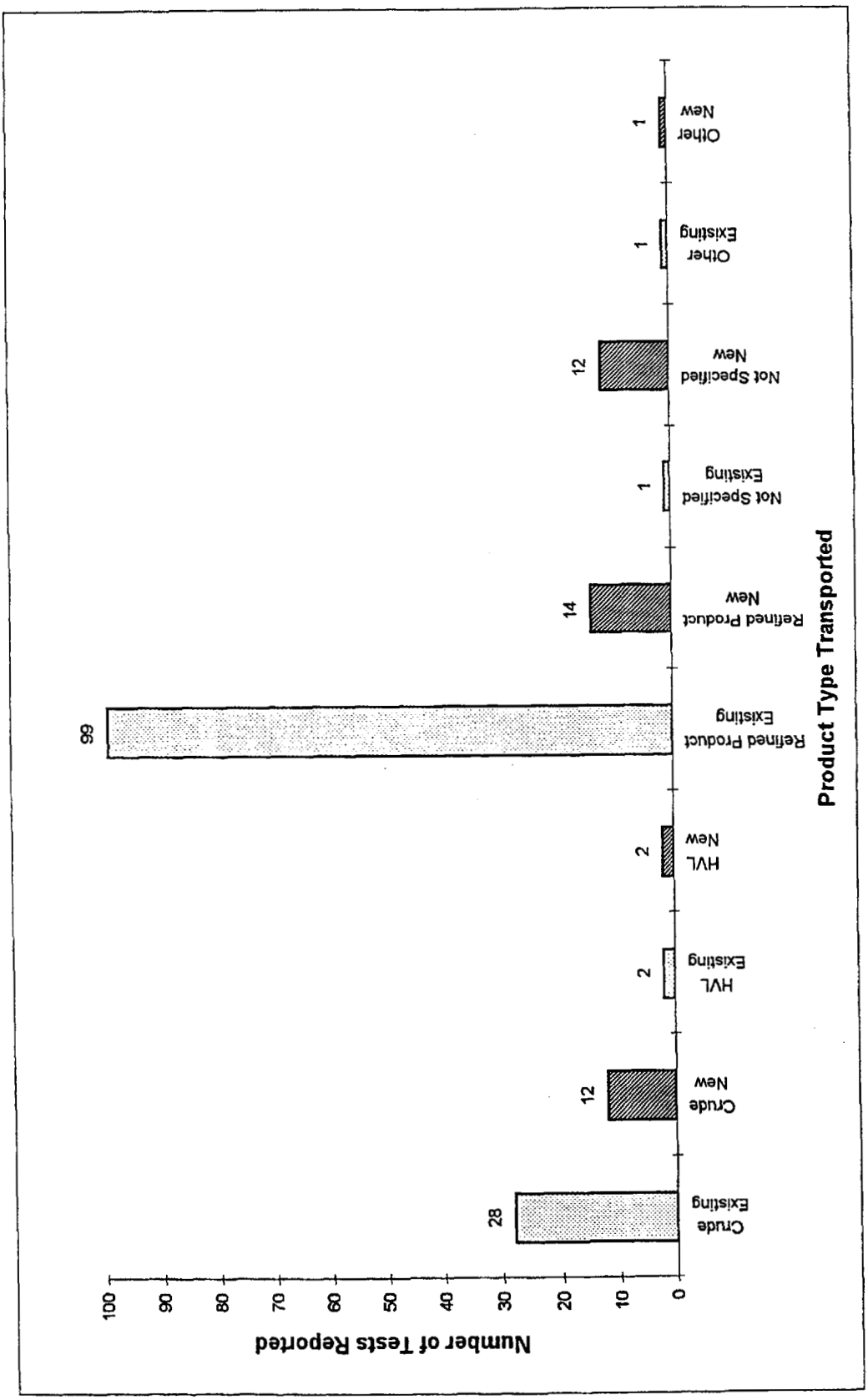


Table 9
Sum & Average of Discharges Reported
Grouped by USEPA Region and Receiving State

Sum of Discharges (gallons)	Average Discharge (gallons)	Number of Discharges	New or Existing	USEPA Region	State Receiving Discharge	Type of Receiving Body
3,057,390	3,057,390	1	E	1	MA	River/Stream
32,424,000	4,632,000	7	E	2	NJ	Lake/Pond
2,520,000	2,520,000	1	E	2	NY	River/Stream
407,500	407,500	1	E	3	DC	Municipal
16,098,768	3,219,754	5	E	3	MD	Lake/Pond
31,920,000	31,920,000	1	E	3	MD	River/Stream
27,389,986	3,423,748	8	E	3	PA	River/Stream
3,360,000	3,360,000	1	E	3	VA	Municipal
44,520	22,260	2	E	3	VA	River/Stream
5,628,000	2,814,000	2	E	4	AL	Lake/Pond
1,260,000	1,260,000	1	E	4	FL	Municipal
14,154,000	3,538,500	4	E	4	GA	Lake/Pond
6,174,000	2,058,000	3	E	4	NC	Lake/Pond
15,000	15,000	1	E	4	SC	Ground Surface
3,192,000	1,596,000	2	E	4	SC	Lake/Pond
651,000	651,000	1	E	4	SC	River/Stream
918,596	918,596	1	E	4	TN	River/Stream
6,720,000	6,720,000	1	E	5	IL	River/Stream
6,922,368	1,153,728	6	E	5	IN	River/Stream
1,200,000	1,200,000	1	E	5	IN	RF
7,225,000	7,225,000	1	E	5	MI	Other
6,842,892	1,710,723	4	E	5	OH	River/Stream
58,811,461	14,702,865	4	E	5	WI	River/Stream
3,060,288	3,060,288	1	E	6	AR	Lake/Pond
462,000	462,000	1	E	6	AR	River/Stream
36,138,000	3,011,500	12	E	6	LA	Lake/Pond
7,398,258	1,056,894	7	E	6	LA	Other (Marsh)
5,694,721	1,138,944	5	E	6	LA	River/Stream
448,975	224,488	2	E	6	NM	River/Stream
504,000	504,000	1	E	6	OK	Ground Surface
5,632,000	1,877,333	3	E	6	OK	Lake/Pond
4,000,000	2,000,000	2	E	6	OK	Municipal
9,105,344	1,821,069	5	E	6	OK	River/Stream
17,992,500	1,635,682	11	E	6	TX	Ground Surface
1,684,600	842,300	2	E	6	TX	Municipal
7,938,800	1,134,114	7	E	6	TX	River/Stream

Table 9 Continued
Sum & Average of Discharges Reported
Grouped by USEPA Region and Receiving State

Sum of Discharges (gallons)	Average Discharge (gallons)	Number of Discharges	New or Existing	USEPA Region	State Receiving Discharge	Type of Receiving Body
1,523,000	1,523,000	1	E	7	IA	River/Stream
2,000,000	2,000,000	1	E	7	MO	Lake/Pond
1,700,000	850,000	2	E	7	MO	River/Stream
6,600,000	2,200,000	3	E	7	NE	River/Stream
38,346	38,346	1	E	8	MT	Other (Unspecified Surface Water Discharge)
840,000	840,000	1	E	9	CA	Ground Surface
17,835,932	4,458,983	4	E	9	CA	Municipal
367,533,245		*131*				*Totals (Existing Only)*
6,846,000	6,846,000	1	N	3	PA	River/Stream
48,000	48,000	1	N	4	NC	Lake/Pond
133,666	133,666	1	N	4	SC	River/Stream
13,500	6,750	2	N	5	IN	River/Stream
4,604,000	2,302,000	2	N	5	MN	Other (Wetland)
252,330	63,083	4	N	6	AR	River/Stream
420,000	210,000	2	N	6	LA	Other (Marsh)
367,951	45,994	8	N	6	LA	River/Stream
2,142	2,142	1	N	6	OK	Lake/Pond
2,314,200	771,400	3	N	6	OK	River/Stream
121,000	121,000	1	N	6	TX	Ground Surface
5,292	5,292	1	N	7	KS	River/Stream
294,400	294,400	1	N	7	MO	River/Stream
161,186	17,910	9	N	8	MT	Ground Surface
6,300,000	3,150,000	2	N	8	ND	River/Stream
3,000	3,000	1	N	9	CA	Ground Surface
2,700	2,700	1	N	9	CA	Municipal
21,889,367		*41*				*Totals (New Only)*
389,422,612		*172*				*Totals (Combined)*

Table 9A
Summary of Discharges by USEPA Region

Sum of Discharges (gallons)	Average Discharge (gallons)	Number of Discharges	New or Existing	USEPA Region
3,057,390	3,057,390	1	E	1
34,944,000	4,368,000	8	E	2
79,220,774	4,401,154	18	E	3
31,992,596	2,132,840	15	E	4
87,721,721	5,160,101	17	E	5
100,059,486	1,695,923	59	E	6
11,823,000	1,689,000	7	E	7
38,346	38,346	1	E	8
18,675,932	3,735,186	5	E	9
367,533,245		*131*	*Totals (Existing Only)*	
6,846,000	6,846,000	1	N	3
181,666	90,833	2	N	4
4,617,500	1,154,375	4	N	5
3,477,623	183,033	19	N	6
299,692	149,846	2	N	7
6,461,186	587,381	11	N	8
5,700	2,850	2	N	9
21,889,367		*41*	*Totals (New only)*	
389,422,612		*172*	*Totals (Combined)*	

Table 9B
Summary of Discharges by Receiving State

Sum of Discharges (gallons)	Average Discharge (gallons)	Number of Discharges	New or Existing	USEPA Region	State Receiving Discharge
3,057,390	3,057,390	1	E	1	MA
32,424,000	4,632,000	7	E	2	NJ
2,520,000	2,520,000	1	E	2	NY
407,500	407,500	1	E	3	DC
48,018,768	8,003,128	6	E	3	MD
27,389,986	3,423,748	8	E	3	PA
3,404,520	1,134,840	3	E	3	VA
5,628,000	2,814,000	2	E	4	AL
1,260,000	1,260,000	1	E	4	FL
14,154,000	3,538,500	4	E	4	GA
6,174,000	2,058,000	3	E	4	NC
3,858,000	964,500	4	E	4	SC
918,596	918,596	1	E	4	TN
6,720,000	6,720,000	1	E	5	IL
8,122,368	1,160,338	7	E	5	IN
7,225,000	7,225,000	1	E	5	MI
6,842,892	1,710,723	4	E	5	OH
58,811,461	14,702,865	4	E	5	WI
3,522,288	1,761,144	2	E	6	AR
49,230,979	2,051,291	24	E	6	LA
448,975	224,488	2	E	6	NM
19,241,344	1,749,213	11	E	6	OK
27,615,900	1,380,795	20	E	6	TX
1,523,000	1,523,000	1	E	7	IA
3,700,000	1,233,333	3	E	7	MO
6,600,000	2,200,000	3	E	7	NE
38,346	38,346	1	E	8	MT
18,675,932	3,735,186	5	E	9	CA
367,533,245		*131*	*Totals (Existing Only)*		
6,846,000	6,846,000	1	N	3	PA
48,000	48,000	1	N	4	NC
133,666	133,666	1	N	4	SC
13,500	6,750	2	N	5	IN
4,604,000	2,302,000	2	N	5	MN
252,330	63,083	4	N	6	AR
787,951	78,795	10	N	6	LA

Table 9B Continued
Summary of Discharges by Receiving State

Sum of Discharges (gallons)	Average Discharge (gallons)	Number of Discharges	New or Existing	USEPA Region	State Receiving Discharge
2,316,342	579,086	4	N	6	OK
121,000	121,000	1	N	6	TX
5,292	5,292	1	N	7	KS
294,400	294,400	1	N	7	MO
161,186	17,910	9	N	8	MT
6,300,000	3,150,000	2	N	8	ND
5,700	2,850	2	N	9	CA
21,889,367		*41*	*Totals (New Only)*		
389,422,612		*172*	*Totals (Combined)*		

Table 10
Pre-Treatment Methods Used, Grouped by Type of Liquid Transported

Type of Liquid	New or Existing	Pre-Treatment	Number of Discharges	Discharge Range (gallons)
Crude	E	Pigging	10	2,520 - 7,225,000
Crude	E	Pigging and Pre-washing	2	46,200 - 1,260,000
Crude	E	Pre-washing	12	229,986 - 3,528,000
Crude	E	None	1	4,380,000 - 4,380,000
Crude	E	N/R	2	2,231,461 - 51,000,000
Crude	N	Pre-washing	4	2,700 - 210,000
Crude	N	None	6	65 - 3,900,000
Crude	N	N/R	2	2,142 - 5,292
Crude and Refined Product	E	Pigging	1	15,900,000
Refined Product	E	Pigging	29	51,966 - 31,920,000
Refined Product	E	Pre-washing	31	15,000 - 16,800,000
Refined Product	E	None	19	200 - 4,200,000
Refined Product	E	Other (Tank cleaned prior to filling)	12	400,000 - 7,224,000
Refined Product	E	N/R	8	16,800 - 6,720,000
Refined Product	N	Pigging and Pre-washing	1	3,200
Refined Product	N	Pre-washing	1	8,500
Refined Product	N	None	4	133,666 - 6,846,000
Refined Product	N	N/R	8	300 - 188,500
Highly Volatile Liquid	E	Pigging and Pre-washing	1	403,200
Highly Volatile Liquid	E	None	1	12,735
Highly Volatile Liquid	N	Pigging	2	121,000 - 294,400
Other (Fertilizers)	E	None	1	5,344
Other (Thermal Fluid)	N	None	1	2,500
N/R	E	None	1	2,000,000
N/R	N	Pigging	7	1,962 - 67,334
N/R	N	None	3	4,200 - 195,000
N/R	N	N/R	2	6,891 - 9,676
			172	

Notes:
N/R = Not Reported; E = Existing; N = New

Table 11
Discharge Treatment Methods Used, Grouped by Type of Liquid Transported

Type of Liquid	New or Existing	Pre-Treatment	Number of Discharges	Discharge Range (gallons)
Crude	E	Carbon Adsorption	7	1,247,000 - 51,000,000
Crude	E	Haybales	3	995,000 - 2,100,000
Crude	E	Other (Indirect Industrial Discharge)	2	2,000,000
Crude	E	Other (Tank Separation)	1	1,630,000
Crude	E	N/R	14	2,520 - 3,394,062
Crude	N	Haybales	6	65 - 3,900,000
Crude	N	N/R	6	2,142 - 210,000
Crude and Refined Product	E	Other (Air stripping)	1	15,900,000
Highly Volatile Liquid	E	Haybales	2	12,735 - 403,200
Highly Volatile Liquid	N	Haybales	2	121,000 - 294,400
Refined Product	E	Carbon Adsorption	33	200 - 31,920,000
Refined Product	E	Carbon Adsorption and Air Strip	1	1,523,000
Refined Product	E	Carbon Adsorption and Haybales	1	651,000
Refined Product	E	Haybales	5	462,000 - 3,150,000
Refined Product	E	None	29	355,175 - 7,224,000
Refined Product	E	Other (Air Stripping)	1	6,720,000
Refined Product	E	Other (Bag filter; oil/water separation; air sparging)	2	N/R - 1,700,000
Refined Product	E	Other (Comercial Pretreatment)	1	4,600
Refined Product	E	Other (Dilution)	1	504,000
Refined Product	E	Other (Precleaned Tank Prior to Discharge)	1	1,200,000
Refined Product	E	Other (Refinery WWTP)	1	1,200,000
Refined Product	E	Other (Tank Separation)	1	126,000
Refined Product	E	Other (Unspecified)	2	1,260,000 - 2,520,000
Refined Product	E	N/R	20	15,000 - 16,800,000
Refined Product	N	Haybales	6	2,950 - 188,500
Refined Product	N	Haybales and Other (filter bag)	1	3,200
Refined Product	N	None	5	48,000 - 6,846,000
Refined Product	N	N/R	2	300 - 400
Other (Fertilizers)	E	None	1	5,344
Other (Thermal Fluid)	N	Haybales	1	2,500
N/R	E	None	1	2,000,000
N/R	N	None	1	4,200
N/R	N	O (Filter Screens to remove suspended solids)	2	142,000 - 195,000
N/R	N	N/R	9	1,962 - 67,334
			172	

Notes:

Table 12
Types of Pre and Discharge Treatment Combinations Used

Type of Product	New or Existing	Number of Discharges	Treatment Combination	
			Pre-Conditioning	Treatment
Crude	E	3	Pigging	Carbon Adsorption
Crude	E	2	Pigging	Other (Indirect Industrial Discharge)
Crude	E	5	Pigging	N/R
Crude	E	1	Pigging and Pre-washing	Haybales
Crude	E	1	Pigging and Pre-washing	N/R
Crude	E	1	Pre-washing	Carbon Adsorption
Crude	E	2	Pre-washing	Haybales
Crude	E	8	Pre-washing	N/R
Crude	E	1	Pre-washing	Other (Tank Separation)
Crude	E	1	None	Carbon Adsorption
Crude	E	2	N/R	Carbon Adsorption
Crude	N	4	Pre-washing	N/R
Crude	N	6	None	Haybales
Crude	N	2	N/R	N/R
Crude and Refined Product	E	1	Pigging	Other (Air stripping)
Highly Volatile Liquid	E	1	Pigging and Pre-washing	Haybales
Highly Volatile Liquid	E	1	None	Haybales
Highly Volatile Liquid	N	2	Pigging	Haybales
Refined Product	E	22	Pigging	Carbon Adsorption
Refined Product	E	1	Pigging	Carbon Adsorption and Air Stripping
Refined Product	E	1	Pigging	Carbon Adsorption and Haybales
Refined Product	E	2	Pigging	N/R
Refined Product	E	1	Pigging	Other (Refinery WWTP)
Refined Product	E	2	Pigging	Other (Unspecified)
Refined Product	E	4	Pre-washing	Haybales
Refined Product	E	14	Pre-washing	N/R
Refined Product	E	12	Pre-washing	None
Refined Product	E	1	Pre-washing	Other (Tank Separation)
Refined Product	E	9	None	Carbon Adsorption
Refined Product	E	5	None	None
Refined Product	E	2	None	Other (Bag filter; oil/water separation; air sparging)
Refined Product	E	1	None	Other (Comercial Pretreatment)
Refined Product	E	1	None	Other (Dilution)
Refined Product	E	1	None	Other (Precleaned Tank Prior to Discharge)
Refined Product	E	1	Other (Tank cleaned prior to filling)	Haybales
Refined Product	E	11	Other (Tank cleaned prior to filling)	None
Refined Product	E	2	N/R	Carbon Adsorption
Refined Product	E	1	N/R	None
Refined Product	E	1	N/R	Other (Air Stripping)
Refined Product	E	4	N/R	N/R
Refined Product	N	1	Pigging and Pre-washing	Haybales and Other (Filter Bag)
Refined Product	N	1	Pre-washing	Haybales
Refined Product	N	4	None	None

Table 12 Continued
Types of Pre and Discharge Treatment Combinations Used

Type of Product	New or Existing	Number of Discharges	Treatment Combination	
			Pre-Conditioning	Treatment
Refined Product	N	1	N/R	None
Refined Product	N	2	N/R	N/R
Other (Fertilizers)	E	1	None	None
Other (Thermal Fluid)	N	1	None	Haybales
N/R	E	1	None	None
N/R	N	7	Pigging	N/R
N/R	N	2	None	Other (Filter Screens to remove suspended solids)
N/R	N	1	None	None
N/R	N	2	N/R	N/R

172

Notes:
N/R = Not Reported; E = Existing; N = New; WWTP = Wastewater Treatment Plant

Table 13
Removal Efficiencies and Treatment Costs Grouped by Treatment Type

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents /gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	Benzene	ug/L	2623	< 5	99.9
117	1,247,000	E	IN	Crude	2.75	Carbon Adsorption	Y	BETX	ug/L	25000	< 4	100
118	2,900,000	E	NE	Crude	2.82	Carbon Adsorption	Y	BETX	ug/L	27000	< 4	100
119	7,225,000	E	MI	Crude	0.775	Carbon Adsorption	Y	BETX	ug/L	3700	< 4	99.9
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	BETX	ug/L	4210	21	99.5
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	DRO	mg/L	7.24	1.44	80.1
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	GRO	mg/L	3.44	1.26	63.4
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	MTBE	ug/L	32	9	71.9
119	7,225,000	E	MI	Crude	0.775	Carbon Adsorption	Y	Oil & Grease	mg/L	300	< 4	99.3
118	2,900,000	E	NE	Crude	2.82	Carbon Adsorption	Y	Oil & Grease	mg/L	63	< 4	96.8
117	1,247,000	E	IN	Crude	2.75	Carbon Adsorption	Y	Oil & Grease	mg/L	43	< 4	95.3
119	7,225,000	E	MI	Crude	0.775	Carbon Adsorption	Y	pH	SU	7.8	8.2	-5.1
118	2,900,000	E	NE	Crude	2.82	Carbon Adsorption	Y	pH	SU	7.6	8.2	-7.9
117	1,247,000	E	IN	Crude	2.75	Carbon Adsorption	Y	pH	SU	7.4	8	-8.1
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	Trimethylbenzene	ug/L	134	6.8	94.9
118	2,900,000	E	NE	Crude	2.82	Carbon Adsorption	Y	TSS	mg/L	22	< 2	95.5
119	7,225,000	E	MI	Crude	0.775	Carbon Adsorption	Y	TSS	mg/L	17	< 2	94.1
117	1,247,000	E	IN	Crude	2.75	Carbon Adsorption	Y	TSS	mg/L	16	< 2	93.8
90	1,260,000	E	TX	Crude	N/R	Haybales	Y	Benzene	ug/L	23	115	NC
90	1,260,000	E	TX	Crude	N/R	Haybales	Y	BETX	ug/L	147	733	NC
90	1,260,000	E	TX	Crude	N/R	Haybales	Y	Chlorides	mg/L	135	119	11.9
25	995,000	E	TX	Crude	0	Haybales	Y	COD	mg/L	20.7	36	NC
25	995,000	E	TX	Crude	0	Haybales	Y	Oil & Grease	mg/L	< 1	< 1	NC
25	995,000	E	TX	Crude	0	Haybales	Y	TSS	mg/L	3	175	NC
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	Benzene	ug/L	4400	24	99.5
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	BETX	ug/L	12700	39	99.7
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	COD	mg/L	479	105	78.1
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	Oil & Grease	mg/L	666	35	94.7
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	pH	SU	7.2	7.5	-4.2

Table 13 Continued

Removal Efficiencies and Treatment Costs Grouped by Treatment Type

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents /gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
101	121,000	N	TX	**Highly Volatile Liquid**	0.2	Haybales	Y	Benzene	ug/L	< 10	< 30	NC
101	121,000	N	TX	**Highly Volatile Liquid**	0.2	Haybales	Y	BOD	mg/L	42	36	14.3
102	294,400	N	MO	**Highly Volatile Liquid**	N/R	Haybales	Y	Oil & Grease	mg/L	3.2	< 0.2	96.9
101	121,000	N	TX	**Highly Volatile Liquid**	0.2	Haybales	Y	Oil & Grease	mg/L	< 5	< 5	NC
102	294,400	N	MO	**Highly Volatile Liquid**	N/R	Haybales	Y	pH	SU	8.27	6.48	21.6
102	294,400	N	MO	**Highly Volatile Liquid**	N/R	Haybales	Y	TSS	mg/L	6	60	NC
101	121,000	N	TX	**Highly Volatile Liquid**	0.2	Haybales	Y	TSS	mg/L	126	68	46
101	121,000	N	TX	**Highly Volatile Liquid**	0.2	Haybales	Y	Turbidity	NTU	260	62	76.2
75	407,500	E	DC	**Refined Product**	N/R	Carbon Adsorption	N/R	Benzene	ug/L	< 1	2.15	NC
10	256,998	E	PA	**Refined Product**	11	Carbon Adsorption	Y	Benzene	ug/L	29000	< 1	100
11	7,848,666	E	PA	**Refined Product**	4	Carbon Adsorption	Y	Benzene	ug/L	29000	< 1	100
14	16,191,546	E	PA	**Refined Product**	3	Carbon Adsorption	Y	Benzene	ug/L	45000	< 2	100
15	850,546	E	IN	**Refined Product**	2	Carbon Adsorption	Y	Benzene	ug/L	46000	< 2	100
17	2,604,000	E	OH	**Refined Product**	1	Carbon Adsorption	Y	Benzene	ug/L	7000	< 1	100
19	290,892	E	OH	**Refined Product**	2	Carbon Adsorption	Y	Benzene	ug/L	2200	< 2	100
3	1,554,000	E	OH	**Refined Product**	6	Carbon Adsorption	Y	Benzene	ug/L	10070	< 2	100
6	835,590	E	PA	**Refined Product**	6	Carbon Adsorption	Y	Benzene	ug/L	27000	< 5	100
7	51,966	E	PA	**Refined Product**	24	Carbon Adsorption	Y	Benzene	ug/L	79000	< 1	100
8	62,832	E	PA	**Refined Product**	26	Carbon Adsorption	Y	Benzene	ug/L	79000	< 1	100
9	168,388	E	PA	**Refined Product**	10	Carbon Adsorption	Y	Benzene	ug/L	79000	< 1	100
29	200	E	TX	**Refined Product**	85	Carbon Adsorption	Y	Benzene	ug/L	913	< 2	99.9
57	386,400	E	TX	**Refined Product**	2	Carbon Adsorption	Y	Benzene	ug/L	1500	< 2	99.9
58	31,920,000	E	MD	**Refined Product**	2	Carbon Adsorption	N/R	Benzene	ug/L	980	2.1	99.8
12	3,057,390	E	MA	**Refined Product**	1	Carbon Adsorption	Y	Benzene	ug/L	600	< 5	99.6
16	143,682	E	IN	**Refined Product**	19	Carbon Adsorption	Y	Benzene	ug/L	200	< 2	99.5
13	194,040	E	IN	**Refined Product**	3	Carbon Adsorption	Y	Benzene	ug/L	80	< 2	98.8
4	2,394,000	E	OH	**Refined Product**	6	Carbon Adsorption	Y	Benzene	ug/L	21800	< 2000	95.4
30	300	E	TX	**Refined Product**	85	Carbon Adsorption	Y	Benzene	ug/L	645	2 70	94.6
5	1,974,000	E	PA	**Refined Product**	6	Carbon Adsorption	Y	Benzene	ug/L	29000	< 5000	91.4
31	200	E	TX	**Refined Product**	85	Carbon Adsorption	Y	Benzene	ug/L	< 2	< 2	NC
75	407,500	E	DC	**Refined Product**	N/R	Carbon Adsorption	N/R	BETX	ug/L	< 3	3	NC
10	256,998	E	PA	**Refined Product**	11	Carbon Adsorption	Y	BETX	ug/L	79000	< 1	100
11	7,848,666	E	PA	**Refined Product**	4	Carbon Adsorption	Y	BETX	ug/L	79000	< 1	100
14	16,191,546	E	PA	**Refined Product**	3	Carbon Adsorption	Y	BETX	ug/L	100000	< 2	100
15	850,546	E	IN	**Refined Product**	2	Carbon Adsorption	Y	BETX	ug/L	133000	< 2	100
17	2,604,000	E	OH	**Refined Product**	1	Carbon Adsorption	Y	BETX	ug/L	15000	< 1	100
19	290,892	E	OH	**Refined Product**	2	Carbon Adsorption	Y	BETX	ug/L	8000	< 2	100
3	1,554,000	E	OH	**Refined Product**	6	Carbon Adsorption	Y	BETX	ug/L	65310	< 2	100
6	835,590	E	PA	**Refined Product**	6	Carbon Adsorption	Y	BETX	ug/L	80000	< 5	100

Table 13 Continued
Removal Efficiencies and Treatment Costs Grouped by Treatment Type

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents /gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
7	51,966	E	PA	Refined Product	24	Carbon Adsorption	Y	BETX	ug/L	153000	< 1	100
8	62,832	E	PA	Refined Product	26	Carbon Adsorption	Y	BETX	ug/L	153000	< 1	100
9	168,388	E	PA	Refined Product	10	Carbon Adsorption	Y	BETX	ug/L	153000	< 1	100
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	N/R	BETX	ug/L	23600	< 6	100
115	2,762,200	E	IN	Refined Product	2.125	Carbon Adsorption	Y	BETX	ug/L	30000	< 4	100
116	1,724,900	E	IN	Refined Product	1.2	Carbon Adsorption	Y	BETX	ug/L	50000	< 4	100
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	BETX	ug/L	3000	< 5	99.9
16	143,682	E	IN	Refined Product	19	Carbon Adsorption	Y	BETX	ug/L	1000	< 2	99.9
13	194,040	E	IN	Refined Product	3	Carbon Adsorption	Y	BETX	ug/L	350	< 2	99.7
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	N/R	BETX	ug/L	4700	12.5	99.7
29	200	E	TX	Refined Product	85	Carbon Adsorption	Y	BETX	ug/L	50000	< 1000	99
30	300	E	TX	Refined Product	85	Carbon Adsorption	Y	BETX	ug/L	< 100000	< 1000	NC
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	BETX	ug/L	80200	< 2000	98.8
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	BETX	ug/L	81000	< 5000	96.9
31	200	E	TX	Refined Product	85	Carbon Adsorption	Y	BETX	ug/L	< 1000	< 1000	NC
88	16,800	E	VA	Refined Product	N/R	Carbon Adsorption	Y	Chlorine	mg/L	1.8	0.075	95.8
89	27,720	E	VA	Refined Product	N/R	Carbon Adsorption	Y	Chlorine	mg/L	1.9	0.08	95.8
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	Y	COD	mg/L	709	43	93.9
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	COD	mg/L	34	25	26.5
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	DO	mg/L	5	9.5	NC
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	DO	mg/L	7.8	9.5	NC
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	DO	mg/L	2.5	> 5	NC
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	Fe	mg/L	200.7	< 0.03	100
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	Fe	mg/L	8	< 0.08	99.5
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	Fe	mg/L	28.6	0.99	96.5
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	Fe	mg/L	20	6.2	69
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	Fe, Dissolved	mg/L	2.9	< 0.08	98.6
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	N/R	Naphthalene	ug/L	27	2.7	90
75	407,500	E	DC	Refined Product	N/R	Carbon Adsorption	N/R	Oil & Grease	mg/L	< 1	1.2	NC
3	1,554,000	E	OH	Refined Product	6	Carbon Adsorption	Y	Oil & Grease	mg/L	3.6	< 0.002	100
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	Y	Oil & Grease	mg/L	3500	5.5	99.8
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	Oil & Grease	mg/L	95	< 1	99.5
16	143,682	E	IN	Refined Product	19	Carbon Adsorption	Y	Oil & Grease	mg/L	30	< 1	98.3
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	Oil & Grease	mg/L	9.5	< 0.5	97.4
59	918,596	E	TN	Refined Product	8	Carbon Adsorption	Y	Oil & Grease	mg/L	30.6	< 2	96.7
116	1,724,900	E	IN	Refined Product	1.2	Carbon Adsorption	Y	Oil & Grease	mg/L	57	< 4	96.5
115	2,762,200	E	IN	Refined Product	2.125	Carbon Adsorption	Y	Oil & Grease	mg/L	40	< 4	95
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	Y	Oil & Grease	mg/L	21	1.5	92.9
15	850,546	E	IN	Refined Product	2	Carbon Adsorption	Y	Oil & Grease	mg/L	6	< 1	91.7
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	Oil & Grease	mg/L	3.8	< 1	86.8

Table 13 Continued
Removal Efficiencies and Treatment Costs Grouped by Treatment Type

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents /gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	Oil & Grease	mg/L	3.1	< 2	67.7
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	Oil & Grease	mg/L	< 5	< 5	NC
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	PCB	mg/L	< 0.05	< 0.05	NC
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	N	pH	SU	6.6	9.9	NC
15	850,546	E	IN	Refined Product	2	Carbon Adsorption	Y	pH	SU	7.4	6.5	12.2
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	pH	SU	7.2	6.9	4.2
161	1,500,000	E	NE	Refined Product	0.07	Carbon Adsorption	Y	pH	SU	7.2	6.9	4.2
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	Y	pH	SU	6.6	6.5	1.5
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	pH	SU	7.59	7.8	-2.8
16	143,682	E	IN	Refined Product	19	Carbon Adsorption	Y	pH	SU	6.3	6.5	-3.2
88	16,800	E	VA	Refined Product	N/R	Carbon Adsorption	Y	pH	SU	7.75	8	-3.2
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	pH	SU	7.63	7.9	-3.5
89	27,720	E	VA	Refined Product	N/R	Carbon Adsorption	Y	pH	SU	7.5	7.9	-5.3
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	pH	SU	6.97	7.5	-7.6
59	918,596	E	TN	Refined Product	8	Carbon Adsorption	Y	pH	SU	6.59	7.23	-9.7
116	1,724,900	E	IN	Refined Product	1.2	Carbon Adsorption	Y	pH	SU	7.4	8.2	-10.8
75	407,500	E	DC	Refined Product	N/R	Carbon Adsorption	N/R	pH	SU	6.3	7.1	-12.7
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	pH	SU	7	8	-14.3
3	1,554,000	E	OH	Refined Product	6	Carbon Adsorption	Y	pH	SU	7.16	8.33	-16.3
115	2,762,200	E	IN	Refined Product	2.125	Carbon Adsorption	N/R	pH	SU	6.2	7.38	-19
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	N/R	Phenols	mg/L	0.3	0.2	33.3
88	16,800	E	VA	Refined Product	N/R	Carbon Adsorption	Y	TPH	mg/L	1.74	4.5	NC
89	27,720	E	VA	Refined Product	N/R	Carbon Adsorption	Y	TPH	mg/L	1.9	0.66	65.3
161	1,500,000	E	NE	Refined Product	0.07	Carbon Adsorption	Y	TPH	mg/L	< 0.1	< 0.1	NC
3	1,554,000	E	OH	Refined Product	6	Carbon Adsorption	Y	TSS	mg/L	15	< 0.002	100
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	TSS	mg/L	160.2	< 6	98.1
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	TSS	mg/L	26	< 1	98.1
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	TSS	mg/L	40	< 2	97.5
115	2,762,200	E	IN	Refined Product	2.125	Carbon Adsorption	N/R	TSS	mg/L	24	< 2	95.8
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	TSS	mg/L	32	< 4	93.8
116	1,724,900	E	IN	Refined Product	1.2	Carbon Adsorption	Y	TSS	mg/L	12	< 2	91.7
59	918,596	E	TN	Refined Product	8	Carbon Adsorption	Y	TSS	mg/L	16.8	2.8	83.3
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	TSS	mg/L	11	< 4	81.8
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	Y	TSS	mg/L	2.7	1.3	51.9
15	850,546	E	IN	Refined Product	2	Carbon Adsorption	Y	TSS	mg/L	10	5	50
16	143,682	E	IN	Refined Product	19	Carbon Adsorption	Y	TSS	mg/L	10	5	50
161	1,500,000	E	NE	Refined Product	0.07	Carbon Adsorption	Y	TSS	mg/L	< 1	< 1	NC

Table 13 Continued
Removal Efficiencies and Treatment Costs Grouped by Treatment Type

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents /gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
93	1,523,000	E	IA	Refined Product	<2.0	Carbon Adsorption and Air Stripping	Y	Benzene	ug/L	4440	< 2	100
93	1,523,000	E	IA	Refined Product	<2.0	Carbon Adsorption and Air Stripping	Y	BETX	ug/L	8542	< 2	100
93	1,523,000	E	IA	Refined Product	<2.0	Carbon Adsorption and Air Stripping	Y	pH	SU	8.25	8.25	NC
78	651,000	E	SC	Refined Product	8	Carbon Adsorption and Haybales	Y	Benzene	ug/L	361	< 1	99.9
78	651,000	E	SC	Refined Product	8	Carbon Adsorption and Haybales	Y	TPH	mg/L	4.55	< 1	89
41	3,150,000	E	TX	Refined Product	0	Haybales	Y	COD	mg/L	21.2	42	NC
41	3,150,000	E	TX	Refined Product	0	Haybales	Y	Oil & Grease	mg/L	12	13	-8.3
41	3,150,000	E	TX	Refined Product	0	Haybales	Y	pH	SU	8.2	7.95	3
46	714,000	E	LA	Refined Product	0	Haybales	Y	TSS	mg/L	105	< 5	97.6
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	Benzene	ug/L	< 1	< 1	NC
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	BETX	ug/L	< 3	1	NC
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	Oil & Grease	mg/L	< 1	< 1	NC
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	pH	SU	6.82	6.7	1.8
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	TOC	mg/L	< 10	< 10	NC
66	1,008,000	E	NC	Refined Product	N/R	None	Y	Benzene	ug/L	< 1	1	NC
18	6,846,000	N	PA	Refined Product	0	None	Y	Benzene	ug/L	< 2	< 2	NC
69	5,544,000	E	MD	Refined Product	N/R	None	N/R	Benzene	ug/L	< 2	< 2	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	Benzene	ug/L	< 1	< 1	NC
62	6,300,000	E	GA	Refined Product	N/R	None	N/R	Benzene	ug/L	< 1	< 1	NC
66	1,008,000	E	NC	Refined Product	N/R	None	Y	BETX	ug/L	< 1	5.2	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	BETX	ug/L	< 3	< 1	NC
18	6,846,000	N	PA	Refined Product	0	None	Y	BETX	ug/L	< 2	< 2	NC
69	5,544,000	E	MD	Refined Product	N/R	None	N/R	BETX	ug/L	< 2	< 2	NC
63	5,040,000	E	GA	Refined Product	N/R	None	Y	BOD	mg/L	< 4	< 4	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	Chlorine	mg/L	< 0.02	< 0.02	NC
62	6,300,000	E	GA	Refined Product	N/R	None	Y	Naphthalene	ug/L	2.07	< 1	75.8
64	1,806,000	E	GA	Refined Product	N/R	None	Y	Oil & Grease	mg/L	1.33	< 1	62.4
66	1,008,000	E	NC	Refined Product	N/R	None	Y	Oil & Grease	mg/L	5.3	< 5	52.8
62	6,300,000	E	GA	Refined Product	N/R	None	Y	Oil & Grease	mg/L	1	< 1	50
171	4,200,000	E	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	2	< 2	50
69	5,544,000	E	MD	Refined Product	N/R	None	N/R	Oil & Grease	mg/L	0.67	0.6	10.4

Table 13 Continued
Removal Efficiencies and Treatment Costs Grouped by Treatment Type

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents /gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
18	6,846,000	N	PA	Refined Product	0	None	Y	Oil & Grease	mg/L	2	2	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 1	< 1	NC
60	3,360,000	E	AL	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 1	< 1	NC
61	2,268,000	E	AL	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 1	< 1	NC
63	5,040,000	E	GA	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 1	< 1	NC
169	1,800,000	E	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 8	< 8	NC
170	210,000	N	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 3	< 3	NC
172	2,940,000	E	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 5	< 5	NC
163	1,200,000	E	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 5	< 5	NC
60	3,360,000	E	AL	Refined Product	N/R	None	Y	pH	SU	7.45	6.78	9
66	1,008,000	E	NC	Refined Product	N/R	None	Y	pH	SU	7.4	7.3	1.4
61	2,268,000	E	AL	Refined Product	N/R	None	Y	pH	SU	6.91	6.88	0.4
18	6,846,000	N	PA	Refined Product	0	None	Y	pH	SU	7	7	NC
169	1,800,000	E	OK	Refined Product	N/R	None	Y	pH	SU	7.5	7.5	NC
170	210,000	N	OK	Refined Product	N/R	None	Y	pH	SU	8.46	8.46	NC
171	4,200,000	E	OK	Refined Product	N/R	None	Y	pH	SU	7.2	7.2	NC
172	2,940,000	E	OK	Refined Product	N/R	None	Y	pH	SU	7.63	7.63	NC
163	1,200,000	E	OK	Refined Product	N/R	None	Y	pH	SU	7.29	7.29	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	pH	SU	6.3	6.8	-7.9
63	5,040,000	E	GA	Refined Product	N/R	None	Y	pH	SU	6.3	6.8	-7.9
62	6,300,000	E	GA	Refined Product	N/R	None	Y	pH	SU	6.6	7.3	-10.6
62	6,300,000	E	GA	Refined Product	N/R	None	Y	Phenols	mg/L	< 0.05	< 0.005	NC
60	3,360,000	E	AL	Refined Product	N/R	None	Y	TOC	mg/L	2.7	3.9	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	TOC	mg/L	< 10	< 10	NC
61	2,268,000	E	AL	Refined Product	N/R	None	Y	TOC	mg/L	3.3	3.4	-3
62	6,300,000	E	GA	Refined Product	N/R	None	Y	Toluene	ug/L	1.13	< 1	55.8
18	6,846,000	N	PA	Refined Product	0	None	Y	TSS	mg/L	2	2	NC
169	1,800,000	E	OK	Refined Product	N/R	None	Y	TSS	mg/L	6	6	NC
170	210,000	N	OK	Refined Product	N/R	None	Y	TSS	mg/L	32	32	NC
171	4,200,000	E	OK	Refined Product	N/R	None	Y	TSS	mg/L	6	6	NC
172	2,940,000	E	OK	Refined Product	N/R	None	Y	TSS	mg/L	< 10	< 10	NC
163	1,200,000	E	OK	Refined Product	N/R	None	Y	TSS	mg/L	< 10	< 10	NC
159	N/R	E	MO	Refined Product	N/R	Other (Bag filter; oil/water separation; air sparging)	Y	Oil & Grease	mg/L	4	< 0.5	93.8
159	N/R	E	MO	Refined Product	N/R	Other (Bag filter; oil/water separation; air sparging)	Y	TPH	mg/L	5.68	8.92	NC
159	N/R	E	MO	Refined Product	N/R	Other (Bag filter; oil/water separation; air sparging)	Y	TSS	mg/L	< 1	< 1	NC

Table 13 Continued
Removal Efficiencies and Treatment Costs Grouped by Treatment Type

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents /gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	Benzene	ug/L	1360	< 20	99.3
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	BETX	ug/L	156660	< 120	100
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	BOD	mg/L	180	< 1	99.7
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	COD	mg/L	844	31	96.3
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	Y	Oil & Grease	mg/L	577	6	99
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	Y	pH	SU	8.12	7.08	12.8
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	Total Lead	mg/L	0.11	0.1	9.1
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	TPH-E	mg/L	632	1.42	99.8
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	Y	TSS	mg/L	90	5	94.4
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	Y	COD	mg/L	25	15	40
42	126,000	E	TX	Refined Product	0	Other (Tank Separation)	Y	Oil & Grease	mg/L	< 1	< 1	NC
42	126,000	E	TX	Refined Product	0	Other (Tank Separation)	Y	pH	SU	8	8	NC
42	126,000	E	TX	Refined Product	0	Other (Tank Separation)						

Notes:
1. N/R = Not Reported by Respondents; E = Existing; N = New; NC = Not Calculated
2. Removal efficiencies calculated using one half the detection limit where the compound was not detected. That is, if a value was <1, 0.5 was used for the calculation.

Table 13A
Removal Efficiencies and Treatment Costs Grouped by State

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
60	3,360,000	E	AL	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 1	< 1	NC
61	2,268,000	E	AL	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 1	< 1	NC
61	2,268,000	E	AL	Refined Product	N/R	None	Y	pH	SU	6.91	6.88	0.4
60	3,360,000	E	AL	Refined Product	N/R	None	Y	pH	SU	7.45	6.78	9
61	2,268,000	E	AL	Refined Product	N/R	None	Y	TOC	mg/L	3.3	3.4	-3
60	3,360,000	E	AL	Refined Product	N/R	None	Y	TOC	mg/L	2.7	3.9	NC
75	407,500	E	DC	Refined Product	N/R	Carbon Adsorption	N/R	Benzene	ug/L	< 1	2.15	NC
75	407,500	E	DC	Refined Product	N/R	Carbon Adsorption	N/R	BETX	ug/L	< 3	3	NC
75	407,500	E	DC	Refined Product	N/R	Carbon Adsorption	N/R	Oil & Grease	mg/L	< 1	1.2	NC
75	407,500	E	DC	Refined Product	N/R	Carbon Adsorption	N/R	pH	SU	6.3	7.1	-12.7
62	6,300,000	E	GA	Refined Product	N/R	None	N/R	Benzene	ug/L	< 1	< 1	NC
63	5,040,000	E	GA	Refined Product	N/R	None	Y	BOD	mg/L	< 4	< 4	NC
62	6,300,000	E	GA	Refined Product	N/R	None	Y	Naphthalene	ug/L	2.07	< 1	75.8
64	1,806,000	E	GA	Refined Product	N/R	None	Y	Oil & Grease	mg/L	1.33	< 1	62.4
62	6,300,000	E	GA	Refined Product	N/R	None	Y	Oil & Grease	mg/L	1	< 1	50
63	5,040,000	E	GA	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 1	< 1	NC
63	5,040,000	E	GA	Refined Product	N/R	None	Y	pH	SU	6.3	6.8	-7.9
62	6,300,000	E	GA	Refined Product	N/R	None	Y	pH	SU	6.6	7.3	-10.6
62	6,300,000	E	GA	Refined Product	N/R	None	Y	Phenols	mg/L	< 0.05	< 0.005	NC
62	6,300,000	E	GA	Refined Product	N/R	None	Y	Toluene	ug/L	1.13	< 1	55.8
93	1,523,000	E	IA	Refined Product	<2.0	Carbon Adsorption and Air Stripping	Y	Benzene	ug/L	4440	< 2	100
93	1,523,000	E	IA	Refined Product	<2.0	Carbon Adsorption and Air Stripping	Y	BETX	ug/L	8542	< 2	100
93	1,523,000	E	IA	Refined Product	<2.0	Carbon Adsorption and Air Stripping	Y	pH	SU	8.25	8.25	NC
117	1,247,000	E	IN	Crude	2.75	Carbon Adsorption	Y	BETX	ug/L	25000	< 4	100
117	1,247,000	E	IN	Crude	2.75	Carbon Adsorption	Y	Oil & Grease	mg/L	43	< 4	95.3
117	1,247,000	E	IN	Crude	2.75	Carbon Adsorption	Y	pH	SU	7.4	8	-8.1
117	1,247,000	E	IN	Crude	2.75	Carbon Adsorption	Y	TSS	mg/L	16	< 2	93.8
15	850,546	E	IN	Refined Product	2	Carbon Adsorption	Y	Benzene	ug/L	46000	< 2	100
16	143,682	E	IN	Refined Product	19	Carbon Adsorption	Y	Benzene	ug/L	200	< 2	99.5
13	194,040	E	IN	Refined Product	3	Carbon Adsorption	Y	Benzene	ug/L	80	< 2	98.8
15	850,546	E	IN	Refined Product	2	Carbon Adsorption	Y	BETX	ug/L	133000	< 2	100

Table 13A Continued
Removal Efficiencies and Treatment Costs Grouped by State

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
115	2,762,200	E	IN	Refined Product	2.125	Carbon Adsorption	Y	BETX	ug/L	30000	< 4	100
116	1,724,900	E	IN	Refined Product	1.2	Carbon Adsorption	Y	BETX	ug/L	50000	< 4	100
16	143,682	E	IN	Refined Product	19	Carbon Adsorption	Y	BETX	ug/L	1000	< 2	99.9
13	194,040	E	IN	Refined Product	3	Carbon Adsorption	Y	BETX	ug/L	350	< 2	99.7
16	143,682	E	IN	Refined Product	19	Carbon Adsorption	Y	Oil & Grease	mg/L	30	< 1	98.3
116	1,724,900	E	IN	Refined Product	1.2	Carbon Adsorption	Y	Oil & Grease	mg/L	57	< 4	96.5
115	2,762,200	E	IN	Refined Product	2.125	Carbon Adsorption	Y	Oil & Grease	mg/L	40	< 4	95
15	850,546	E	IN	Refined Product	2	Carbon Adsorption	Y	Oil & Grease	mg/L	6	< 1	91.7
15	850,546	E	IN	Refined Product	2	Carbon Adsorption	Y	pH	SU	7.4	6.5	12.2
16	143,682	E	IN	Refined Product	19	Carbon Adsorption	Y	pH	SU	6.3	6.5	-3.2
116	1,724,900	E	IN	Refined Product	1.2	Carbon Adsorption	Y	pH	SU	7.4	8.2	-10.8
115	2,762,200	E	IN	Refined Product	2.125	Carbon Adsorption	N/R	pH	SU	6.2	7.38	-19
115	2,762,200	E	IN	Refined Product	2.125	Carbon Adsorption	N/R	TSS	mg/L	24	< 2	95.8
116	1,724,900	E	IN	Refined Product	1.2	Carbon Adsorption	Y	TSS	mg/L	12	< 2	91.7
15	850,546	E	IN	Refined Product	2	Carbon Adsorption	Y	TSS	mg/L	10	5	50
16	143,682	E	IN	Refined Product	19	Carbon Adsorption	Y	TSS	mg/L	10	5	50
46	714,000	E	LA	Refined Product	0	Haybales	Y	TSS	mg/L	105	< 5	97.6
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	Benzene	ug/L	600	< 5	99.6
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	BETX	ug/L	3000	< 5	99.9
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	COD	mg/L	34	25	26.5
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	DO	mg/L	7.8	9.5	NC
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	Fe	mg/L	20	6.2	69
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	Oil & Grease	mg/L	< 5	< 5	NC
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	PCB	mg/L	< 0.05	< 0.05	NC
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	pH	SU	7.2	6.9	4.2
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	TSS	mg/L	32	< 4	93.8
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	N/R	Benzene	ug/L	980	2.1	99.8
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	N/R	BETX	ug/L	4700	12.5	99.7
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	N/R	Naphthalene	ug/L	27	2.7	90
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	Y	Oil & Grease	mg/L	21	1.5	92.9
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	N/R	Phenols	mg/L	0.3	0.2	33.3
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	Y	TSS	mg/L	2.7	1.3	51.9
69	5,544,000	E	MD	Refined Product	N/R	None	N/R	Benzene	ug/L	< 2	< 2	NC
69	5,544,000	E	MD	Refined Product	N/R	None	N/R	BETX	ug/L	< 2	< 2	NC
69	5,544,000	E	MD	Refined Product	N/R	None	N/R	Oil & Grease	mg/L	0.67	0.6	10.4

Table 13A Continued
Removal Efficiencies and Treatment Costs Grouped by State

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
119	7,225,000	E	MI	Crude	0.775	Carbon Adsorption	Y	BETX	ug/L	3700	< 4	99.9
119	7,225,000	E	MI	Crude	0.775	Carbon Adsorption	Y	Oil & Grease	mg/L	300	< 4	99.3
119	7,225,000	E	MI	Crude	0.775	Carbon Adsorption	Y	pH	SU	7.8	8.2	-5.1
119	7,225,000	E	MI	Crude	0.775	Carbon Adsorption	Y	TSS	mg/L	17	< 2	94.1
159	N/R	E	MO	Refined Product	N/R	Other (Bag filter; oil/water separation; air sparging)	Y	Oil & Grease	mg/L	4	< 0.5	93.8
159	N/R	E	MO	Refined Product	N/R	Other (Bag filter; oil/water separation; air sparging)	Y	TPH	mg/L	5.68	8.92	NC
159	N/R	E	MO	Refined Product	N/R	Other (Bag filter; oil/water separation; air sparging)	Y	TSS	mg/L	< 1	< 1	NC
102	294,400	N	MO	Highly Volatile Liquid	N/R	Haybales	Y	Oil & Grease	mg/L	3.2	< 0.2	96.9
102	294,400	N	MO	Highly Volatile Liquid	N/R	Haybales	Y	pH	SU	8.27	6.48	21.6
102	294,400	N	MO	Highly Volatile Liquid	N/R	Haybales	Y	TSS	mg/L	6	60	NC
66	1,008,000	E	NC	Refined Product	N/R	None	Y	Benzene	ug/L	< 1	1	NC
66	1,008,000	E	NC	Refined Product	N/R	None	Y	BETX	ug/L	< 1	5.2	NC
66	1,008,000	E	NC	Refined Product	N/R	None	Y	Oil & Grease	mg/L	5.3	< 5	52.8
66	1,008,000	E	NC	Refined Product	N/R	None	Y	pH	SU	7.4	7.3	1.4
118	2,900,000	E	NE	Crude	2.82	Carbon Adsorption	Y	BETX	ug/L	27000	< 4	100
118	2,900,000	E	NE	Crude	2.82	Carbon Adsorption	Y	Oil & Grease	mg/L	63	< 4	96.8
118	2,900,000	E	NE	Crude	2.82	Carbon Adsorption	Y	pH	SU	7.6	8.2	-7.9
118	2,900,000	E	NE	Crude	2.82	Carbon Adsorption	Y	TSS	mg/L	22	< 2	95.5
161	1,500,000	E	NE	Refined Product	0.07	Carbon Adsorption	Y	pH	SU	7.2	6.9	4.2
161	1,500,000	E	NE	Refined Product	0.07	Carbon Adsorption	Y	TPH	mg/L	< 0.1	< 0.1	NC
161	1,500,000	E	NE	Refined Product	0.07	Carbon Adsorption	Y	TSS	mg/L	< 1	< 1	NC
17	2,604,000	E	OH	Refined Product	1	Carbon Adsorption	Y	Benzene	ug/L	7000	< 1	100
19	290,892	E	OH	Refined Product	2	Carbon Adsorption	Y	Benzene	ug/L	2200	< 2	100
3	1,554,000	E	OH	Refined Product	6	Carbon Adsorption	Y	Benzene	ug/L	10070	< 2	100
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	Benzene	ug/L	21800	< 2000	95.4
17	2,604,000	E	OH	Refined Product	1	Carbon Adsorption	Y	BETX	ug/L	15000	< 1	100

Table 13A Continued
Removal Efficiencies and Treatment Costs Grouped by State

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
19	290,892	E	OH	Refined Product	2	Carbon Adsorption	Y	BETX	ug/L	8000	< 2	100
3	1,554,000	E	OH	Refined Product	6	Carbon Adsorption	Y	BETX	ug/L	65310	< 2	100
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	BETX	ug/L	80200	< 2000	98.8
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	Fe	mg/L	28.6	0.99	96.5
3	1,554,000	E	OH	Refined Product	6	Carbon Adsorption	Y	Oil & Grease	mg/L	3.6	< 0.002	100
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	Oil & Grease	mg/L	3.1	< 2	67.7
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	pH	SU	6.97	7.5	-7.6
3	1,554,000	E	OH	Refined Product	6	Carbon Adsorption	Y	pH	SU	7.16	8.33	-16.3
3	1,554,000	E	OH	Refined Product	6	Carbon Adsorption	Y	TSS	mg/L	15	< 0.002	100
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	TSS	mg/L	40	< 2	97.5
171	4,200,000	E	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	2	< 2	50
169	1,800,000	E	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 8	< 8	NC
172	2,940,000	E	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 5	< 5	NC
163	1,200,000	E	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 5	< 5	NC
169	1,800,000	E	OK	Refined Product	N/R	None	Y	pH	SU	7.5	7.5	NC
171	4,200,000	E	OK	Refined Product	N/R	None	Y	pH	SU	7.2	7.2	NC
172	2,940,000	E	OK	Refined Product	N/R	None	Y	pH	SU	7.63	7.63	NC
163	1,200,000	E	OK	Refined Product	N/R	None	Y	pH	SU	7.29	7.29	NC
169	1,800,000	E	OK	Refined Product	N/R	None	Y	TSS	mg/L	6	6	NC
171	4,200,000	E	OK	Refined Product	N/R	None	Y	TSS	mg/L	6	6	NC
172	2,940,000	E	OK	Refined Product	N/R	None	Y	TSS	mg/L	< 10	< 10	NC
163	1,200,000	E	OK	Refined Product	N/R	None	Y	TSS	mg/L	< 10	< 10	NC
170	210,000	N	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 3	< 3	NC
170	210,000	N	OK	Refined Product	N/R	None	Y	pH	SU	8.46	8.46	NC
170	210,000	N	OK	Refined Product	N/R	None	Y	TSS	mg/L	32	32	NC
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	Benzene	ug/L	1360	< 20	99.3
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	BETX	ug/L	156660	< 120	100
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	BOD	mg/L	180	< 1	99.7
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	COD	mg/L	844	31	96.3
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	Y	Oil & Grease	mg/L	577	6	99
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	Y	pH	SU	8.12	7.08	12.8
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	Total Lead	mg/L	0.11	0.1	9.1
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	TPH-E	mg/L	632	1.42	99.8
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	Y	TSS	mg/L	90	5	94.4

Table 13A Continued
Removal Efficiencies and Treatment Costs Grouped by State

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
10	256,998	E	PA	Refined Product	11	Carbon Adsorption	Y	Benzene	ug/L	29000	< 1	100
11	7,848,666	E	PA	Refined Product	4	Carbon Adsorption	Y	Benzene	ug/L	29000	< 1	100
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	Benzene	ug/L	45000	< 2	100
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	Benzene	ug/L	27000	< 5	100
7	51,966	E	PA	Refined Product	24	Carbon Adsorption	Y	Benzene	ug/L	79000	< 1	100
8	62,832	E	PA	Refined Product	26	Carbon Adsorption	Y	Benzene	ug/L	79000	< 1	100
9	168,388	E	PA	Refined Product	10	Carbon Adsorption	Y	Benzene	ug/L	79000	< 1	100
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	Benzene	ug/L	29000	< 5000	91.4
10	256,998	E	PA	Refined Product	11	Carbon Adsorption	Y	BETX	ug/L	79000	< 1	100
11	7,848,666	E	PA	Refined Product	4	Carbon Adsorption	Y	BETX	ug/L	79000	< 1	100
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	BETX	ug/L	100000	< 2	100
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	BETX	ug/L	80000	< 5	100
7	51,966	E	PA	Refined Product	24	Carbon Adsorption	Y	BETX	ug/L	153000	< 1	100
8	62,832	E	PA	Refined Product	26	Carbon Adsorption	Y	BETX	ug/L	153000	< 1	100
9	168,388	E	PA	Refined Product	10	Carbon Adsorption	Y	BETX	ug/L	153000	< 1	100
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	BETX	ug/L	81000	< 5000	96.9
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	DO	mg/L	5	9.5	NC
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	DO	mg/L	2.5	> 5	NC
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	Fe	mg/L	200.7	< 0.03	100
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	Fe	mg/L	8	< 0.08	99.5
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	Fe, Dissolved	mg/L	2.9	< 0.08	98.6
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	Oil & Grease	mg/L	95	< 1	99.5
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	Oil & Grease	mg/L	9.5	< 0.5	97.4
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	Oil & Grease	mg/L	3.8	< 1	86.8
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	pH	SU	7.59	7.8	-2.8
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	pH	SU	7.63	7.9	-3.5
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	pH	SU	7	8	-14.3
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	TSS	mg/L	160.2	< 6	98.1
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	TSS	mg/L	26	< 1	98.1
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	TSS	mg/L	11	< 4	81.8
18	6,846,000	N	PA	Refined Product	0	None	Y	Benzene	ug/L	< 2	< 2	NC
18	6,846,000	N	PA	Refined Product	0	None	Y	BETX	ug/L	< 2	< 2	NC
18	6,846,000	N	PA	Refined Product	0	None	Y	Oil & Grease	mg/L	2	2	NC
18	6,846,000	N	PA	Refined Product	0	None	Y	pH	SU	7	7	NC
18	6,846,000	N	PA	Refined Product	0	None	Y	TSS	mg/L	2	2	NC

Table 13A Continued

Removal Efficiencies and Treatment Costs Grouped by State

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
78	651,000	E	SC	Refined Product	8	Carbon Adsorption and Haybales	Y	Benzene	ug/L	361	< 1	99.9
78	651,000	E	SC	Refined Product	8	Carbon Adsorption and Haybales	Y	TPH	mg/L	4.55	< 1	89
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	Benzene	ug/L	< 1	< 1	NC
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	BETX	ug/L	< 3	1	NC
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	Oil & Grease	mg/L	< 1	< 1	NC
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	pH	SU	6.82	6.7	1.8
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	TOC	mg/L	< 10	< 10	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	Benzene	ug/L	< 1	< 1	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	BETX	ug/L	< 3	< 1	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	Chlorine	mg/L	< 0.02	< 0.02	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 1	< 1	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	pH	SU	6.3	6.8	-7.9
74	1,806,000	E	SC	Refined Product	N/R	None	Y	TOC	mg/L	< 10	< 10	NC
59	918,596	E	TN	Refined Product	8	Carbon Adsorption	Y	Oil & Grease	mg/L	30.6	< 2	96.7
59	918,596	E	TN	Refined Product	8	Carbon Adsorption	Y	pH	SU	6.59	7.23	-9.7
59	918,596	E	TN	Refined Product	8	Carbon Adsorption	Y	TSS	mg/L	16.8	2.8	83.3
90	1,260,000	E	TX	Crude	N/R	Haybales	Y	Benzene	ug/L	23	115	NC
90	1,260,000	E	TX	Crude	N/R	Haybales	Y	BETX	ug/L	147	733	NC
90	1,260,000	E	TX	Crude	N/R	Haybales	Y	Chlorides	mg/L	135	119	11.9
25	995,000	E	TX	Crude	0	Haybales	Y	COD	mg/L	20.7	36	NC
25	995,000	E	TX	Crude	0	Haybales	Y	Oil & Grease	mg/L	< 1	< 1	NC
25	995,000	E	TX	Crude	0	Haybales	Y	TSS	mg/L	3	175	NC
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	Benzene	ug/L	4400	24	99.5
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	BETX	ug/L	12700	39	99.7
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	COD	mg/L	479	105	78.1
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	Oil & Grease	mg/L	666	35	94.7
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	pH	SU	7.2	7.5	-4.2

Table 13A Continued
Removal Efficiencies and Treatment Costs Grouped by State

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
29	200	E	TX	Refined Product	85	Carbon Adsorption	Y	Benzene	ug/L	913	< 2	99.9
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	Y	Benzene	ug/L	1500	< 2	99.9
30	300	E	TX	Refined Product	85	Carbon Adsorption	Y	Benzene	ug/L	645	2 70	94.6
31	200	E	TX	Refined Product	85	Carbon Adsorption	Y	Benzene	ug/L	< 2	< 2	NC
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	N/R	BETX	ug/L	23600	< 6	100
29	200	E	TX	Refined Product	85	Carbon Adsorption	Y	BETX	ug/L	50000	< 1000	99
30	300	E	TX	Refined Product	85	Carbon Adsorption	Y	BETX	ug/L	< 100000	< 1000	NC
31	200	E	TX	Refined Product	85	Carbon Adsorption	Y	BETX	ug/L	< 1000	< 1000	NC
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	Y	COD	mg/L	709	43	93.9
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	Y	Oil & Grease	mg/L	3500	5.5	99.8
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	N	pH	SU	6.6	9.9	NC
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	Y	pH	SU	6.6	6.5	1.5
41	3,150,000	E	TX	Refined Product	0	Haybales	Y	COD	mg/L	21.2	42	NC
41	3,150,000	E	TX	Refined Product	0	Haybales	Y	Oil & Grease	mg/L	12	13	-8.3
41	3,150,000	E	TX	Refined Product	0	Haybales	Y	pH	SU	8.2	7.95	3
42	126,000	E	TX	Refined Product	0	Other (Tank Separation)	Y	COD	mg/L	25	15	40
42	126,000	E	TX	Refined Product	0	Other (Tank Separation)	Y	Oil & Grease	mg/L	< 1	< 1	NC
42	126,000	E	TX	Refined Product	0	Other (Tank Separation)	Y	pH	SU	8	8	NC
101	121,000	N	TX	Highly Volatile Liquid	0.2	Haybales	Y	Benzene	ug/L	< 10	< 30	NC
101	121,000	N	TX	Highly Volatile Liquid	0.2	Haybales	Y	BOD	mg/L	42	36	14.3
101	121,000	N	TX	Highly Volatile Liquid	0.2	Haybales	Y	Oil & Grease	mg/L	< 5	< 5	NC
101	121,000	N	TX	Highly Volatile Liquid	0.2	Haybales	Y	TSS	mg/L	126	68	46
101	121,000	N	TX	Highly Volatile Liquid	0.2	Haybales	Y	Turbidity	NTU	260	62	76.2
88	16,800	E	VA	Refined Product	N/R	Carbon Adsorption	Y	Chlorine	mg/L	1.8	0.075	95.8
89	27,720	E	VA	Refined Product	N/R	Carbon Adsorption	Y	Chlorine	mg/L	1.9	0.08	95.8
88	16,800	E	VA	Refined Product	N/R	Carbon Adsorption	Y	pH	SU	7.75	8	-3.2
89	27,720	E	VA	Refined Product	N/R	Carbon Adsorption	Y	pH	SU	7.5	7.9	-5.3
88	16,800	E	VA	Refined Product	N/R	Carbon Adsorption	Y	TPH	mg/L	1.74	4.5	NC
89	27,720	E	VA	Refined Product	N/R	Carbon Adsorption	Y	TPH	mg/L	1.9	0.66	65.3

Table 13A Continued
Removal Efficiencies and Treatment Costs Grouped by State

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	Benzene	ug/L	2623	< 5	99.9
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	BETX	ug/L	4210	21	99.5
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	DRO	mg/L	7.24	1.44	80.1
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	GRO	mg/L	3.44	1.26	63.4
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	MTBE	ug/L	32	9	71.9
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	Trimethylbenzene	ug/L	134	6.8	94.9

Notes:
1. N/R = Not Reported by Respondents; E = Existing; N = New; NC = Not Calculated
2. Removal efficiencies calculated using one half the detection limit where the compound was not detected. That is, if a value was <1, 0.5 was used for the calculation.

Table 13B
Removal Efficiencies and Treatment Costs Grouped by Test ID Number

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
3	1,554,000	E	OH	Refined Product	6	Carbon Adsorption	Y	BETX	ug/L	65310	< 2	100
3	1,554,000	E	OH	Refined Product	6	Carbon Adsorption	Y	Oil & Grease	mg/L	3.6	< 0.002	100
3	1,554,000	E	OH	Refined Product	6	Carbon Adsorption	Y	pH	SU	7.16	8.33	-16.3
3	1,554,000	E	OH	Refined Product	6	Carbon Adsorption	Y	TSS	mg/L	15	< 0.002	100
3	1,554,000	E	OH	Refined Product	6	Carbon Adsorption	Y	Benzene	ug/L	10070	< 2	100
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	Benzene	ug/L	21800	< 2000	95.4
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	BETX	ug/L	80200	< 2000	98.8
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	Fe	mg/L	28.6	0.99	96.5
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	Oil & Grease	mg/L	3.1	< 2	67.7
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	pH	SU	6.97	7.5	-7.6
4	2,394,000	E	OH	Refined Product	6	Carbon Adsorption	Y	TSS	mg/L	40	< 2	97.5
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	Benzene	ug/L	29000	< 5000	91.4
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	BETX	ug/L	81000	< 5000	96.9
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	Fe	mg/L	200.7	< 0.03	100
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	Oil & Grease	mg/L	3.8	< 1	86.8
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	pH	SU	7.59	7.8	-2.8
5	1,974,000	E	PA	Refined Product	6	Carbon Adsorption	Y	TSS	mg/L	160.2	< 6	98.1
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	Benzene	ug/L	27000	< 5	100
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	BETX	ug/L	80000	< 5	100
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	DO	mg/L	2.5	> 5	NC
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	Oil & Grease	mg/L	9.5	< 0.5	97.4
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	pH	SU	7.63	7.9	-3.5
6	835,590	E	PA	Refined Product	6	Carbon Adsorption	Y	TSS	mg/L	26	< 1	98.1
7	51,966	E	PA	Refined Product	24	Carbon Adsorption	Y	Benzene	ug/L	79000	< 1	100
7	51,966	E	PA	Refined Product	24	Carbon Adsorption	Y	BETX	ug/L	153000	< 1	100
8	62,832	E	PA	Refined Product	26	Carbon Adsorption	Y	Benzene	ug/L	79000	< 1	100
8	62,832	E	PA	Refined Product	26	Carbon Adsorption	Y	BETX	ug/L	153000	< 1	100
9	168,388	E	PA	Refined Product	10	Carbon Adsorption	Y	Benzene	ug/L	79000	< 1	100
9	168,388	E	PA	Refined Product	10	Carbon Adsorption	Y	BETX	ug/L	153000	< 1	100
10	256,998	E	PA	Refined Product	11	Carbon Adsorption	Y	Benzene	ug/L	29000	< 1	100
10	256,998	E	PA	Refined Product	11	Carbon Adsorption	Y	BETX	ug/L	79000	< 1	100
11	7,848,666	E	PA	Refined Product	4	Carbon Adsorption	Y	Benzene	ug/L	29000	< 1	100
11	7,848,666	E	PA	Refined Product	4	Carbon Adsorption	Y	BETX	ug/L	79000	< 1	100
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	Benzene	ug/L	600	< 5	99.6
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	BETX	ug/L	3000	< 5	99.9
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	COD	mg/L	34	25	26.5
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	DO	mg/L	7.8	9.5	NC
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	Fe	mg/L	20	6.2	69
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	Oil & Grease	mg/L	< 5	< 5	NC
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	PCB	mg/L	< 0.05	< 0.05	NC

Table 13B Continued

Removal Efficiencies and Treatment Costs Grouped by Test ID Number

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	pH	SU	7.2	6.9	4.2
12	3,057,390	E	MA	Refined Product	1	Carbon Adsorption	Y	TSS	mg/L	32	< 4	93.8
13	194,040	E	IN	Refined Product	3	Carbon Adsorption	Y	Benzene	ug/L	80	< 2	98.8
13	194,040	E	IN	Refined Product	3	Carbon Adsorption	Y	BETX	ug/L	350	< 2	99.7
13	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	Benzene	ug/L	45000	< 2	100
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	BETX	ug/L	100000	< 2	100
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	DO	mg/L	5	9.5	NC
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	Fe	mg/L	8	< 0.08	99.5
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	Fe, Dissolved	mg/L	2.9	< 0.08	98.6
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	Oil & Grease	mg/L	95	< 1	99.5
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	pH	SU	7	8	-14.3
14	16,191,546	E	PA	Refined Product	3	Carbon Adsorption	Y	TSS	mg/L	11	< 4	81.8
15	850,546	E	IN	Refined Product	2	Carbon Adsorption	Y	Benzene	ug/L	46000	< 2	100
15	850,546	E	IN	Refined Product	2	Carbon Adsorption	Y	BETX	ug/L	133000	< 2	100
15	850,546	E	IN	Refined Product	2	Carbon Adsorption	Y	Oil & Grease	mg/L	6	< 1	91.7
15	850,546	E	IN	Refined Product	2	Carbon Adsorption	Y	pH	SU	7.4	6.5	12.2
15	850,546	E	IN	Refined Product	2	Carbon Adsorption	Y	TSS	mg/L	10	5	50
16	143,682	E	IN	Refined Product	19	Carbon Adsorption	Y	Benzene	ug/L	200	< 2	99.5
16	143,682	E	IN	Refined Product	19	Carbon Adsorption	Y	BETX	ug/L	1000	< 2	99.9
16	143,682	E	IN	Refined Product	19	Carbon Adsorption	Y	Oil & Grease	mg/L	30	< 1	98.3
16	143,682	E	IN	Refined Product	19	Carbon Adsorption	Y	pH	SU	6.3	6.5	-3.2
16	143,682	E	IN	Refined Product	19	Carbon Adsorption	Y	TSS	mg/L	10	5	50
17	2,604,000	E	OH	Refined Product	1	Carbon Adsorption	Y	Benzene	ug/L	7000	< 1	100
17	2,604,000	E	OH	Refined Product	1	Carbon Adsorption	Y	BETX	ug/L	15000	< 1	100
18	6,846,000	N	PA	Refined Product	0	None	Y	Benzene	ug/L	< 2	< 2	NC
18	6,846,000	N	PA	Refined Product	0	None	Y	BETX	ug/L	< 2	< 2	NC
18	6,846,000	N	PA	Refined Product	0	None	Y	Oil & Grease	mg/L	2	2	NC
18	6,846,000	N	PA	Refined Product	0	None	Y	pH	SU	7	7	NC
18	6,846,000	N	PA	Refined Product	0	None	Y	TSS	mg/L	2	2	NC
19	290,892	E	OH	Refined Product	2	Carbon Adsorption	Y	Benzene	ug/L	2200	< 2	100
19	290,892	E	OH	Refined Product	2	Carbon Adsorption	Y	BETX	ug/L	8000	< 2	100
25	995,000	E	TX	Crude	0	Haybales	Y	COD	mg/L	20.7	36	NC
25	995,000	E	TX	Crude	0	Haybales	Y	Oil & Grease	mg/L	< 1	< 1	NC
25	995,000	E	TX	Crude	0	Haybales	Y	TSS	mg/L	3	175	NC
29	200	E	TX	Refined Product	85	Carbon Adsorption	Y	Benzene	ug/L	913	< 2	99.9
29	200	E	TX	Refined Product	85	Carbon Adsorption	Y	BETX	ug/L	50000	< 1000	99
30	300	E	TX	Refined Product	85	Carbon Adsorption	Y	Benzene	ug/L	645	2 70	94.6
30	300	E	TX	Refined Product	85	Carbon Adsorption	Y	BETX	ug/L	< 100000	< 1000	NC

Table 13B Continued
Removal Efficiencies and Treatment Costs Grouped by Test ID Number

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
31	200	E	TX	Refined Product	85	Carbon Adsorption	Y	Benzene	ug/L	< 2	< 2	NC
31	200	E	TX	Refined Product	85	Carbon Adsorption	Y	BETX	ug/L	< 1000	< 1000	NC
41	3,150,000	E	TX	Refined Product	0	Haybales	Y	COD	mg/L	21.2	42	NC
41	3,150,000	E	TX	Refined Product	0	Haybales	Y	Oil & Grease	mg/L	12	13	-8.3
41	3,150,000	E	TX	Refined Product	0	Haybales	Y	pH	SU	8.2	7.95	3
42	126,000	E	TX	Refined Product	0	Other (Tank Separation)	Y	COD	mg/L	25	15	40
42	126,000	E	TX	Refined Product	0	Other (Tank Separation)	Y	Oil & Grease	mg/L	< 1	< 1	NC
42	126,000	E	TX	Refined Product	0	Other (Tank Separation)	Y	pH	SU	8	8	NC
46	714,000	E	LA	Refined Product	0	Haybales	Y	TSS	mg/L	105	< 5	97.6
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	Y	Benzene	ug/L	1500	< 2	99.9
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	N/R	BETX	ug/L	23600	< 6	100
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	Y	COD	mg/L	709	43	93.9
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	Y	Oil & Grease	mg/L	3500	5.5	99.8
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	N	pH	SU	6.6	9.9	NC
57	386,400	E	TX	Refined Product	2	Carbon Adsorption	Y	pH	SU	6.6	6.5	1.5
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	N/R	Benzene	ug/L	980	2.1	99.8
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	N/R	BETX	ug/L	4700	12.5	99.7
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	N/R	Naphthalene	ug/L	27	2.7	90
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	Y	Oil & Grease	mg/L	21	1.5	92.9
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	N/R	Phenols	mg/L	0.3	0.2	33.3
58	31,920,000	E	MD	Refined Product	2	Carbon Adsorption	Y	TSS	mg/L	2.7	1.3	51.9
59	918,596	E	TN	Refined Product	8	Carbon Adsorption	Y	Oil & Grease	mg/L	30.6	< 2	96.7
59	918,596	E	TN	Refined Product	8	Carbon Adsorption	Y	pH	SU	6.59	7.23	-9.7
59	918,596	E	TN	Refined Product	8	Carbon Adsorption	Y	TSS	mg/L	16.8	2.8	83.3
60	3,360,000	E	AL	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 1	< 1	NC
60	3,360,000	E	AL	Refined Product	N/R	None	Y	pH	SU	7.45	6.78	9
60	3,360,000	E	AL	Refined Product	N/R	None	Y	TOC	mg/L	2.7	3.9	NC
61	2,268,000	E	AL	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 1	< 1	NC
61	2,268,000	E	AL	Refined Product	N/R	None	Y	pH	SU	6.91	6.88	0.4
61	2,268,000	E	AL	Refined Product	N/R	None	Y	TOC	mg/L	3.3	3.4	-3
62	6,300,000	E	GA	Refined Product	N/R	None	N/R	Benzene	ug/L	< 1	< 1	NC
62	6,300,000	E	GA	Refined Product	N/R	None	Y	Naphthalene	ug/L	2.07	< 1	75.8
62	6,300,000	E	GA	Refined Product	N/R	None	Y	pH	SU	6.6	7.3	-10.6
62	6,300,000	E	GA	Refined Product	N/R	None	Y	Phenols	mg/L	< 0.05	< 0.005	NC
62	6,300,000	E	GA	Refined Product	N/R	None	Y	Toluene	ug/L	1.13	< 1	55.8

Table 13B Continued
Removal Efficiencies and Treatment Costs Grouped by Test ID Number

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
62	6,300,000	E	GA	Refined Product	N/R	None	Y	Oil & Grease	mg/L	1	< 1	50
63	5,040,000	E	GA	Refined Product	N/R	None	Y	BOD	mg/L	< 4	< 4	NC
63	5,040,000	E	GA	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 1	< 1	NC
63	5,040,000	E	GA	Refined Product	N/R	None	Y	pH	SU	6.3	6.8	-7.9
64	1,806,000	E	GA	Refined Product	N/R	None	Y	Oil & Grease	mg/L	1.33	< 1	62.4
66	1,008,000	E	NC	Refined Product	N/R	None	Y	Benzene	ug/L	< 1	1	NC
66	1,008,000	E	NC	Refined Product	N/R	None	Y	BETX	ug/L	< 1	5.2	NC
66	1,008,000	E	NC	Refined Product	N/R	None	Y	Oil & Grease	mg/L	5.3	< 5	52.8
66	1,008,000	E	NC	Refined Product	N/R	None	Y	pH	SU	7.4	7.3	1.4
69	5,544,000	E	MD	Refined Product	N/R	None	N/R	Benzene	ug/L	< 2	< 2	NC
69	5,544,000	E	MD	Refined Product	N/R	None	N/R	BETX	ug/L	< 2	< 2	NC
69	5,544,000	E	MD	Refined Product	N/R	None	N/R	Oil & Grease	mg/L	0.67	0.6	10.4
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	Benzene	ug/L	< 1	< 1	NC
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	BETX	ug/L	< 3	1	NC
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	Oil & Grease	mg/L	< 1	< 1	NC
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	pH	SU	6.82	6.7	1.8
73	1,386,000	E	SC	Refined Product	N/R	N/R	Y	TOC	mg/L	< 10	< 10	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	Benzene	ug/L	< 1	< 1	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	BETX	ug/L	< 3	< 1	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	Chlorine	mg/L	< 0.02	< 0.02	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 1	< 1	NC
74	1,806,000	E	SC	Refined Product	N/R	None	Y	pH	SU	6.3	6.8	-7.9
74	1,806,000	E	SC	Refined Product	N/R	None	Y	TOC	mg/L	< 10	< 10	NC
75	407,500	E	DC	Refined Product	N/R	Carbon Adsorption	N/R	Benzene	ug/L	< 1	2.15	NC
75	407,500	E	DC	Refined Product	N/R	Carbon Adsorption	N/R	BETX	ug/L	< 3	3	NC
75	407,500	E	DC	Refined Product	N/R	Carbon Adsorption	N/R	Oil & Grease	mg/L	< 1	1.2	NC
75	407,500	E	DC	Refined Product	N/R	Carbon Adsorption	N/R	pH	SU	6.3	7.1	-12.7
78	651,000	E	SC	Refined Product	8	Carbon Adsorption and Haybales	Y	Benzene	ug/L	361	< 1	99.9
78	651,000	E	SC	Refined Product	8	Carbon Adsorption and Haybales	Y	TPH	mg/L	4.55	< 1	89
88	16,800	E	VA	Refined Product	N/R	Carbon Adsorption	Y	Chlorine	mg/L	1.8	0.075	95.8
88	16,800	E	VA	Refined Product	N/R	Carbon Adsorption	Y	pH	SU	7.75	8	-3.2
88	16,800	E	VA	Refined Product	N/R	Carbon Adsorption	Y	TPH	mg/L	1.74	4.5	NC
89	27,720	E	VA	Refined Product	N/R	Carbon Adsorption	Y	Chlorine	mg/L	1.9	0.08	95.8
89	27,720	E	VA	Refined Product	N/R	Carbon Adsorption	Y	pH	SU	7.5	7.9	-5.3
89	27,720	E	VA	Refined Product	N/R	Carbon Adsorption	Y	TPH	mg/L	1.9	0.66	65.3

Table 13B Continued

Removal Efficiencies and Treatment Costs Grouped by Test ID Number

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
90	1,260,000	E	TX	Crude	N/R	Haybales	Y	Benzene	ug/L	23	115	NC
90	1,260,000	E	TX	Crude	N/R	Haybales	Y	BETX	ug/L	147	733	NC
90	1,260,000	E	TX	Crude	N/R	Haybales	Y	Chlorides	mg/L	135	119	11.9
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	Benzene	ug/L	4400	24	99.5
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	BETX	ug/L	12700	39	99.7
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	COD	mg/L	479	105	78.1
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	Oil & Grease	mg/L	666	35	94.7
92	15,900,000	E	TX	Crude and Refined Product	2.36	Other (Air stripping)	Y	pH	SU	7.2	7.5	-4.2
93	1,523,000	E	IA	Refined Product	<2.0	Carbon Adsorption and Air Stripping	Y	Benzene	ug/L	4440	< 2	100
93	1,523,000	E	IA	Refined Product	<2.0	Carbon Adsorption and Air Stripping	Y	BETX	ug/L	8542	< 2	100
93	1,523,000	E	IA	Refined Product	<2.0	Carbon Adsorption and Air Stripping	Y	pH	SU	8.25	8.25	NC
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	Benzene	ug/L	2623	< 5	99.9
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	BETX	ug/L	4210	21	99.5
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	DRO	mg/L	7.24	1.44	80.1
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	GRO	mg/L	3.44	1.26	63.4
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	MTBE	ug/L	32	9	71.9
94	51,000,000	E	WI	Crude	N/R	Carbon Adsorption	N/R	Trimethylbenzene	ug/L	134	6.8	94.9
101	121,000	N	TX	Highly Volatile Liquid	0.2	Haybales	Y	Benzene	ug/L	< 10	< 30	NC
101	121,000	N	TX	Highly Volatile Liquid	0.2	Haybales	Y	BOD	mg/L	42	36	14.3
101	121,000	N	TX	Highly Volatile Liquid	0.2	Haybales	Y	Oil & Grease	mg/L	< 5	< 5	NC
101	121,000	N	TX	Highly Volatile Liquid	0.2	Haybales	Y	TSS	mg/L	126	68	46
101	121,000	N	TX	Highly Volatile Liquid	0.2	Haybales	Y	Turbidity	NTU	260	62	76.2
102	294,400	N	MO	Highly Volatile Liquid	N/R	Haybales	Y	Oil & Grease	mg/L	3.2	< 0.2	96.9
102	294,400	N	MO	Highly Volatile Liquid	N/R	Haybales	Y	pH	SU	8.27	6.48	21.6

Table 13B Continued

Removal Efficiencies and Treatment Costs Grouped by Test ID Number

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
102	294,400	N	MO	Highly Volatile Liquid	N/R	Haybales	Y	TSS	mg/L	6	60	NC
115	2,762,200	E	IN	Refined Product	2.125	Carbon Adsorption	Y	BETX	ug/L	30000	< 4	100
115	2,762,200	E	IN	Refined Product	2.125	Carbon Adsorption	Y	Oil & Grease	mg/L	40	< 4	95
115	2,762,200	E	IN	Refined Product	2.125	Carbon Adsorption	N/R	pH	SU	6.2	7.38	-19
115	2,762,200	E	IN	Refined Product	2.125	Carbon Adsorption	N/R	TSS	mg/L	24	< 2	95.8
116	1,724,900	E	IN	Refined Product	1.2	Carbon Adsorption	Y	BETX	ug/L	50000	< 4	100
116	1,724,900	E	IN	Refined Product	1.2	Carbon Adsorption	Y	Oil & Grease	mg/L	57	< 4	96.5
116	1,724,900	E	IN	Refined Product	1.2	Carbon Adsorption	Y	pH	SU	7.4	8.2	-10.8
116	1,724,900	E	IN	Refined Product	1.2	Carbon Adsorption	Y	TSS	mg/L	12	< 2	91.7
117	1,247,000	E	IN	Crude	2.75	Carbon Adsorption	Y	BETX	ug/L	25000	< 4	100
117	1,247,000	E	IN	Crude	2.75	Carbon Adsorption	Y	Oil & Grease	mg/L	43	< 4	95.3
117	1,247,000	E	IN	Crude	2.75	Carbon Adsorption	Y	pH	SU	7.4	8	-8.1
117	1,247,000	E	IN	Crude	2.75	Carbon Adsorption	Y	TSS	mg/L	16	< 2	93.8
118	2,900,000	E	NE	Crude	2.82	Carbon Adsorption	Y	BETX	ug/L	27000	< 4	100
118	2,900,000	E	NE	Crude	2.82	Carbon Adsorption	Y	Oil & Grease	mg/L	63	< 4	96.8
118	2,900,000	E	NE	Crude	2.82	Carbon Adsorption	Y	pH	SU	7.6	8.2	-7.9
118	2,900,000	E	NE	Crude	2.82	Carbon Adsorption	Y	TSS	mg/L	22	< 2	95.5
119	7,225,000	E	MI	Crude	0.775	Carbon Adsorption	Y	BETX	ug/L	3700	< 4	99.9
119	7,225,000	E	MI	Crude	0.775	Carbon Adsorption	Y	Oil & Grease	mg/L	300	< 4	99.3
119	7,225,000	E	MI	Crude	0.775	Carbon Adsorption	Y	pH	SU	7.8	8.2	-5.1
119	7,225,000	E	MI	Crude	0.775	Carbon Adsorption	Y	TSS	mg/L	17	< 2	94.1
159	N/R	E	MO	Refined Product	N/R	Other (Bag filter; oil/water separation; air sparging)	Y	Oil & Grease	mg/L	4	< 0.5	93.8
159	N/R	E	MO	Refined Product	N/R	Other (Bag filter; oil/water separation; air sparging)	Y	TPH	mg/L	5.68	8.92	NC
159	N/R	E	MO	Refined Product	N/R	Other (Bag filter; oil/water separation; air sparging)	Y	TSS	mg/L	< 1	< 1	NC
161	1,500,000	E	NE	Refined Product	0.07	Carbon Adsorption	Y	pH	SU	7.2	6.9	4.2
161	1,500,000	E	NE	Refined Product	0.07	Carbon Adsorption	Y	TPH	mg/L	< 0.1	< 0.1	NC
161	1,500,000	E	NE	Refined Product	0.07	Carbon Adsorption	Y	TSS	mg/L	< 1	< 1	NC
163	1,200,000	E	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 5	< 5	NC
163	1,200,000	E	OK	Refined Product	N/R	None	Y	pH	SU	7.29	7.29	NC
163	1,200,000	E	OK	Refined Product	N/R	None	Y	TSS	mg/L	< 10	< 10	NC

Table 13B Continued
Removal Efficiencies and Treatment Costs Grouped by Test ID Number

Test ID	Total Volume (gallons)	New or Existing	State	Type of Product	Cost per Gallon (cents/gal)	Treatment Technology Used	Were Permit Limits Met?	Parameter	Units	Initial Condition of Water	Condition After Treatment	Estimated Treatment Efficiency (%)
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	Benzene	ug/L	1360	< 20	99.3
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	BETX	ug/L	156660	< 120	100
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	BOD	mg/L	180	< 1	99.7
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	COD	mg/L	844	31	96.3
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	Y	Oil & Grease	mg/L	577	6	99
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	Y	pH	SU	8.12	7.08	12.8
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	Total Lead	mg/L	0.11	0.1	9.1
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	N/R	TPH-E	mg/L	632	1.42	99.8
167	504,000	E	OK	Refined Product	N/R	Other (Dilution)	Y	TSS	mg/L	90	5	94.4
169	1,800,000	E	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 8	< 8	NC
169	1,800,000	E	OK	Refined Product	N/R	None	Y	pH	SU	7.5	7.5	NC
169	1,800,000	E	OK	Refined Product	N/R	None	Y	TSS	mg/L	6	6	NC
170	210,000	N	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 3	< 3	NC
170	210,000	N	OK	Refined Product	N/R	None	Y	pH	SU	8.46	8.46	NC
170	210,000	N	OK	Refined Product	N/R	None	Y	TSS	mg/L	32	32	NC
171	4,200,000	E	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	2	< 2	50
171	4,200,000	E	OK	Refined Product	N/R	None	Y	pH	SU	7.2	7.2	NC
171	4,200,000	E	OK	Refined Product	N/R	None	Y	TSS	mg/L	6	6	NC
172	2,940,000	E	OK	Refined Product	N/R	None	Y	Oil & Grease	mg/L	< 5	< 5	NC
172	2,940,000	E	OK	Refined Product	N/R	None	Y	pH	SU	7.63	7.63	NC
172	2,940,000	E	OK	Refined Product	N/R	None	Y	TSS	mg/L	< 10	< 10	NC

Notes:
1. N/R = Not Reported by Respondents; E = Existing; N = New; NC = Not Calculated
2. Removal efficiencies calculated using one half the detection limit where the compound was not detected. That is, if a value was <1, 0.5 was used for the calculation.
3. Only tests with before and after treatment data are included in this table.

Table 14
Summary of Before and After Treatment Data, Removal Efficiencies and Costs, Grouped by Type of Liquids Transported for Existing Pipelines

Material Transported in Pipeline	*Treatment Technology*	*Number of Tests Reported Using Technology*	*Reported Treatment Cost (cents/gal)*	Benzene (ug/L)		BETX (ug/L)		Oil & Grease (mg/L)		TPH (mg/L)		TSS (mg/L)	
				Conc. Range (Before/ After)	*Typical Removal Efficiency (%)*	*Conc. Range (Before/ After)*	*Typical Removal Efficiency (%)*	*Conc. Range (Before/ After)*	*Typical Removal Efficiency (%)*	*Conc. Range (Before/ After)*	*Typical Removal Efficiency (%)*	*Conc. Range (Before/ After)*	*Typical Removal Efficiency (%)*
Crude	Hay Bales	2	0 to Not Reported	Insufficient Data to Calculate Averages - After treatment concentrations higher than initial concentrations.									
Crude	Carbon Adsorption	4	0.775 to 2.82	2623 / <5	>99	27000 / < 4	100	300 / < 4	97	NC - ND	ND	22 / < 2	94
Crude and Refined Product	Other (Air stripping)	1	2.36	4400 / 24	>99	12700 / 39	100	666 / 35	95	NC - ND	ND	NC - ND	ND
Refined Product	Carbon Adsorption	28	0.07 to 85	79000 / < 1	>99	153000 / < 1	95	3500 / 5.5	94	NC-ND[5]	ND	160.2 / < 6	83
Refined Product	Carbon Adsorption and Air Stripping	1	< 2.0	4440 / < 2	100	8542 / < 2	100	NC - ND	ND	NC - ND	ND	NC - ND	ND
Refined Product	Carbon Adsorption and Hay Bales	1	8	361 / < 1	100	NC - ND	ND	NC - ND	ND	4.55 / < 1	89	NC - ND	ND
Refined Product	Hay Bales	2	0	NC - ND	ND	NC - ND	ND	C - Net Inc.	ND	NC - ND	ND	105 / < 5	98

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Notes:
1. Concentration ranges and removal efficiencies were not reported where insufficient data existed to calculate representative results. Conditions which were considered as unrepresentative were: few samples were reported and indicated net increases (before vs. after) in concentration. (This was thought to be a variation in sampling) OR "non-detect" initial concentration and "non-detect" final concentration pairs.
2. Where concentration results were below detection limit, concentration was assumed to be equal to one half the detection limit for calculation of the removal efficiency.
3. NC = Not Calculated ND = No Data DL Diff = Difference in detection limits Net Inc = Net increase in concentration
4. Only one result available
5. Insufficient Data to Calculate Averages - After treatment concentrations typically higher than initial concentrations.
6. Other treatment methods reported include: tank separation; dilution; bag filter & oil separation & air sparging.

Table 15
Summary of Before and After Treatment Data, Removal Efficiencies and Costs, Grouped by Type of Liquids Transported for New Pipelines

Material Transported in Pipeline	Treatment Technology	Number of Tests Reported Using Technology	Reported Treatment Cost (cents/gal)	Benzene (ug/L)		BETX (ug/L)		Oil & Grease (mg/L)		TPH (mg/L)		TSS (mg/L)	
				Conc. Range (Before/ After)	Typical Removal Efficiency (%)	Conc. Range (Before/ After)	Typical Removal Efficiency (%)	Conc. Range (Before/ After)	Typical Removal Efficiency (%)	Conc. Range (Before/ After)	Typical Removal Efficiency (%)	Conc. Range (Before/ After)	Typical Removal Efficiency (%)
Highly Volatile Liquid	Hay Bales	2	0.2 to N/R	NC - DL Diff		NC - ND		3.2 / < 0.2	97[4]	NC - ND		NC - Net Inc.	
		2											

Notes:
1. Concentration ranges and removal efficiencies were not reported where insufficient data existed to calculate representative results. Conditions which were considered as unrepresentative were: few samples were reported and indicated net increases (before vs. after) in concentration. (This was thought to be a variation in sampling) OR "non-detect" initial concentration and "non-detect" final concentration pairs.
2. Where concentration results were below detection limit, concentration was assumed to be equal to one half the detection limit for calculation of the removal efficiency.
3. NC = Not Calculated ND = No Data DL Diff = Difference in detection limits Net Inc = Net increase in concentration
4. Only one result available

Table 16
Water Conditions Prior to Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units
Ammonia	21	417E	< 1	mg/L
Ammonia	22	417E	8.5	mg/L
Benzene	1		16000	ug/L
Benzene	2	602	53	ug/L
Benzene	3		10070	ug/L
Benzene	4		21800	ug/L
Benzene	5	624	29000	ug/L
Benzene	6	8260	27000	ug/L
Benzene	7	624	79000	ug/L
Benzene	8	624	79000	ug/L
Benzene	9	624	79000	ug/L
Benzene	10		29000	ug/L
Benzene	11		29000	ug/L
Benzene	12		600	ug/L
Benzene	13		80	ug/L
Benzene	14		45000	ug/L
Benzene	15		46000	ug/L
Benzene	16		200	ug/L
Benzene	17		7000	ug/L
Benzene	19		2200	ug/L
Benzene	20	8020	23000	ug/L
Benzene	21	8020	34200	ug/L
Benzene	22	8020	13200	ug/L
Benzene	23	8020	< 10000	ug/L
Benzene	24	624	< 5	ug/L
Benzene	26	8020	770	ug/L
Benzene	29	602	913	ug/L
Benzene	30	602	645	ug/L
Benzene	31	602	< 2	ug/L
Benzene	35	8020	500	ug/L
Benzene	41	8020	< 5	ug/L
Benzene	42	8020	5.2	ug/L
Benzene	57	8020	1500	ug/L
Benzene	58	8020	980	ug/L
Benzene	59	602	555	ug/L
Benzene	62	602	< 1	ug/L
Benzene	64	8020	2	ug/L
Benzene	66	602	< 1	ug/L
Benzene	69	602	< 2	ug/L
Benzene	73	602	< 1	ug/L

Table 16 Continued
Water Conditions Prior to Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units
Benzene	74	602	< 1	ug/L
Benzene	75	602	< 1	ug/L
Benzene	78	8020	361	ug/L
Benzene	90	8020.503	23	ug/L
Benzene	92	8020.503	4400	ug/L
Benzene	93	EPA 8020	4440	ug/L
Benzene	94	8020	2623	ug/L
Benzene	154	EPA 624	21	ug/L
Benzene	156	GC/MS	4624	ug/L
Benzene	158	8020	11000	ug/L
Benzene	167	8020	1360	ug/L
BETX	2	602	2276	ug/L
BETX	3		65310	ug/L
BETX	4		80200	ug/L
BETX	5	624	81000	ug/L
BETX	6	8260	80000	ug/L
BETX	7		153000	ug/L
BETX	8	624	153000	ug/L
BETX	9	624	153000	ug/L
BETX	10		79000	ug/L
BETX	11		79000	ug/L
BETX	12		3000	ug/L
BETX	13		350	ug/L
BETX	14		100000	ug/L
BETX	15		133000	ug/L
BETX	16		1000	ug/L
BETX	17		15000	ug/L
BETX	19		8000	ug/L
BETX	20	8020	31400	ug/L
BETX	21	8020	45900	ug/L
BETX	22	8020	18400	ug/L
BETX	23	8020	< 10000	ug/L
BETX	26	8020	36000	ug/L
BETX	29	602	50000	ug/L
BETX	30	602	< 100000	ug/L
BETX	31	602	< 1000	ug/L
BETX	41	8020	< 15	ug/L
BETX	42	8020	64	ug/L
BETX	57	8020	23600	ug/L
BETX	58	8020	4700	ug/L

Table 16 Continued
Water Conditions Prior to Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units
BETX	59	602	5160	ug/L
BETX	66	602	< 1	ug/L
BETX	69	602	< 2	ug/L
BETX	73	602	< 3	ug/L
BETX	74	602	< 3	ug/L
BETX	75	602	< 3	ug/L
BETX	78	8020	1953	ug/L
BETX	90	8050.503	147	ug/L
BETX	92	8020.503	12700	ug/L
BETX	93	EPA 8020	8542	ug/L
BETX	94	8020	4210	ug/L
BETX	115		30000	ug/L
BETX	116		50000	ug/L
BETX	117		25000	ug/L
BETX	118		27000	ug/L
BETX	119		3700	ug/L
BETX	154	EPA 624	383	ug/L
BETX	157	GC/MS	55261.875	ug/L
BETX	167	8020	156660	ug/L
BOD	2	405.1	99.6	mg/L
BOD	20	405.1	75	mg/L
BOD	21	507	726	mg/L
BOD	22	507	45.7	mg/L
BOD	63	405.1	< 4	mg/L
BOD	92		120	mg/L
BOD	167	405.1	180	mg/L
Chlorides	90	SM 407-6	135	mg/L
Chlorine	74	Field	< 0.02	mg/L
Chlorine	88	330.1	1.8	mg/L
Chlorine	89	330.1	1.9	mg/L
Chlorine, Total Residual	154	SM 4500	0.1	mg/L
Cl	92		357	mg/L
COD	12		34	mg/L
COD	22	5220D	204	mg/L
COD	25	410.4	20.7	mg/L
COD	41	410.4	21.2	mg/L
COD	42	5220	25	mg/L
COD	57	508C	709	mg/L
COD	79	410.4	< 5	mg/L
COD	80	410.4	< 5	mg/L

Table 16 Continued
Water Conditions Prior to Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units
COD	81	410.4	< 10	mg/L
COD	82	410.4	10	mg/L
COD	83	410.4	< 10	mg/L
COD	84	410.4	< 10	mg/L
COD	85	410.4	< 10	mg/L
COD	92	410.4	479	mg/L
COD	167	410.4	844	mg/L
DO	2	418.1	10	mg/L
DO	6	8260	2.5	mg/L
DO	12		7.8	mg/L
DO	14		5	mg/L
DRO	94	Wisc.	7.24	mg/L
Fe	3		4.12	mg/L
Fe	4		28.6	mg/L
Fe	5		200.7	mg/L
Fe	6	8260	7.5	mg/L
Fe	12		20	mg/L
Fe	13		43	mg/L
Fe	14		8	mg/L
Fe, Dissolved	14		2.9	mg/L
Fluoride	21	EPA 300.0	40.7	mg/L
GRO	94	Wisc.	3.44	mg/L
Lead	79	6010	0.003	mg/L
Lead	80	6010	0.003	mg/L
MTBE	2	602	< 5	ug/L
MTBE	4		10800	ug/L
MTBE	5	624	250000	ug/L
MTBE	6	8260	17000	ug/L
MTBE	7		17000	ug/L
MTBE	8	624	17000	ug/L
MTBE	9	624	17000	ug/L
MTBE	12		1900	ug/L
MTBE	78	8020	< 5	ug/L
MTBE	94	8020	32	ug/L
MTBE	157	GC/MS	1209	ug/L
Naphthalene	58	8020	27	ug/L
Naphthalene	62	602	2.07	ug/L
Napthalene	154	EPA 624	15	ug/L

Tabel 16 Continued
Water Conditions Prior to Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units
Oil & Grease	2	413.2	10	mg/L
Oil & Grease	3		3.6	mg/L
Oil & Grease	4		3.1	mg/L
Oil & Grease	5		3.8	mg/L
Oil & Grease	6	8260	9.5	mg/L
Oil & Grease	12		< 5	mg/L
Oil & Grease	14		95	mg/L
Oil & Grease	15		6	mg/L
Oil & Grease	16		30	mg/L
Oil & Grease	21	503A	2253	mg/L
Oil & Grease	22	503A	0.4	mg/L
Oil & Grease	23	503A	15	mg/L
Oil & Grease	25	413.1	< 1	mg/L
Oil & Grease	41	413.1	12	mg/L
Oil & Grease	42	413.1	< 1	mg/L
Oil & Grease	57	503A	3500	mg/L
Oil & Grease	58	418.1	21	mg/L
Oil & Grease	59	413.1	30.6	mg/L
Oil & Grease	60	413.1	< 1	mg/L
Oil & Grease	61	413.1	< 1	mg/L
Oil & Grease	62	413.2	1	mg/L
Oil & Grease	63	413.2	< 1	mg/L
Oil & Grease	64	413.2	1.33	mg/L
Oil & Grease	66	413.1	5.3	mg/L
Oil & Grease	67	413.1	< 5	mg/L
Oil & Grease	68	413.1	5	mg/L
Oil & Grease	69	418.1	0.67	mg/L
Oil & Grease	73	418.1	< 1	mg/L
Oil & Grease	74	418.1	< 1	mg/L
Oil & Grease	75	418.1	< 1	mg/L
Oil & Grease	90	600.413.2	1	mg/L
Oil & Grease	92	413.1	666	mg/L
Oil & Grease	115		40	mg/L
Oil & Grease	116		57	mg/L
Oil & Grease	117		43	mg/L
Oil & Grease	118		63	mg/L
Oil & Grease	119		300	mg/L
Oil & Grease	159	413.1	4	mg/L
Oil & Grease	163	413.1	< 5	mg/L
Oil & Grease	167	200.7	577	mg/L
Oil & Grease	169	413.1	< 8	mg/L
Oil & Grease	171	413.1	2	mg/L
Oil & Grease	172	413.1	< 5	mg/L

Table 16 Continued
Water Conditions Prior to Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units
Ortho-phosphorous	21	EPA 300.0	< 0.01	mg/L
PCB	12		< 0.05	mg/L
PCBs	59	SW-846	< 1	ug/L
pH	2	150.1	7.2	SU
pH	3		7.16	SU
pH	4		6.97	SU
pH	5		7.59	SU
pH	6		7.63	SU
pH	12		7.2	SU
pH	14		7	SU
pH	15		7.4	SU
pH	16		6.3	SU
pH	41	150.1	8.2	SU
pH	42	150.1	8	SU
pH	57	423	6.6	SU
pH	59	150.1	6.59	SU
pH	60	150.1	7.45	SU
pH	61	150.1	6.91	SU
pH	62	pH meter	6.6	SU
pH	63	150.1	6.3	SU
pH	66	150.1	7.4	SU
pH	67	150.1	7	SU
pH	68	150.1	7.65	SU
pH	73	150.1	6.82	SU
pH	74	150.1	6.3	SU
pH	75	150.1	6.3	SU
pH	79	Field	7.2	SU
pH	80	Field	7.5	SU
pH	81	Field	7.5	SU
pH	82	Field	7.6	SU
pH	83	Field	7.7	SU
pH	84	Field	7.5	SU
pH	85	Field	7.6	SU
pH	88		7.75	SU
pH	89		7.5	SU
pH	90	SM 423	7.34	SU
pH	92		7.2	SU
pH	93	electronic	8.25	SU
pH	115		6.2	SU
pH	116		7.4	SU

Table 16 Continued
Water Conditions Prior to Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units
pH	117		7.4	SU
pH	118		7.6	SU
pH	119		7.8	SU
pH	161	9045	7.2	SU
pH	163	150.1	7.29	SU
pH	167	150.1	8.12	SU
pH	169	150.1	7.5	SU
pH	171	150.1	7.2	SU
pH	172	150.1	7.63	SU
Phenols	21	510C	0.34	mg/L
Phenols	58	510	0.3	mg/L
Phenols	59	420.1	0.213	mg/L
Phenols	62	420.1	< 0.05	mg/L
Sulfates	21	426C	1.6	mg/L
TBA	5	624	110	mg/L
TBA	6		36	mg/L
TOC	60	415.1	2.7	mg/L
TOC	61	415.1	3.3	mg/L
TOC	73	415.1	< 10	mg/L
TOC	74	415.1	< 10	mg/L
TOC	78	415.1	17	mg/L
TOC	92		10	mg/L
TOC	154	EPA 415.1	3	mg/L
Toluene	62	602	1.13	ug/L
Total Lead	13		0.099	mg/L
Total Lead	167	200.7	0.11	mg/L
TPH	13		1806	mg/L
TPH	59	418.1	56.2	mg/L
TPH	78	418.1	4.55	mg/L
TPH	79	418.1	< 0.5	mg/L
TPH	80	418.1	< 0.5	mg/L
TPH	81	418.1	< 1.5	mg/L
TPH	82	418.1	< 1.5	mg/L
TPH	83	418.1	< 1.5	mg/L
TPH	84	418.1	< 1.5	mg/L
TPH	85	418.1	< 1.5	mg/L
TPH	86	418.1	0.6	mg/L
TPH	87	418.1	1.1	mg/L
TPH	88	418.1	1.74	mg/L
TPH	89	418.1	1.9	mg/L

Table 16 Continued
Water Conditions Prior to Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units
TPH	158	418.1	10.7	mg/L
TPH	159	418.1	5.68	mg/L
TPH	161	418.1	< 0.1	mg/L
TPH-E	167	8015-Mod	632	mg/L
Trimethylbenzene	94	8020	134	ug/L
TSS	2	160.2	14	mg/L
TSS	3		15	mg/L
TSS	4		40	mg/L
TSS	5		160.2	mg/L
TSS	6		26	mg/L
TSS	12		32	mg/L
TSS	14		11	mg/L
TSS	15		10	mg/L
TSS	16		10	mg/L
TSS	21	209D	1442	mg/L
TSS	23	209D	53	mg/L
TSS	25	160.2	3	mg/L
TSS	46	160.2	105	mg/L
TSS	58	209C	2.7	mg/L
TSS	59	160.2	16.8	mg/L
TSS	79	160.2	2	mg/L
TSS	80	160.2	5	mg/L
TSS	81	160.2	2	mg/L
TSS	82	160.2	46	mg/L
TSS	83	160.2	14	mg/L
TSS	84	160.2	0.1	mg/L
TSS	85	160.2	24	mg/L
TSS	92	60.2	12	mg/L
TSS	115		24	mg/L
TSS	116		12	mg/L
TSS	117		16	mg/L
TSS	118		22	mg/L
TSS	119		17	mg/L
TSS	158	160.2	4	mg/L
TSS	159	160.2	< 1	mg/L

Table 16 Continued
Water Conditions Prior to Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units
TSS	161	160.2	< 1	mg/L
TSS	163	160.2	< 10	mg/L
TSS	167	160.2	90	mg/L
TSS	169	160.2	6	mg/L
TSS	171	160.2	6	mg/L
TSS	172	160.2	< 10	mg/L
TSS	21	209D	1160	mg/L

Summary Concentrations for Selected Compounds
Prior to Discharge Treatment (Existing Lines)

Parameter	Number of Results	Maximum	Minimum	Average
Benzene, (ug/L)	49	79,000	< 1	12,452
BETX, (ug/L)	48	156,660	< 1	38,176
COD, (mg/L)	15	844	< 5	158.13
Lead, (mg/L)	2	0.003	0.003	0.003
MTBE, (ug/L)	11	250,000	< 5	30,177
Oil & Grease, (mg/L)	42	3500	0.4	180.87
pH, (SU)	45	8.25	6.2	7.27
TOC, (mg/L)	6	17	2.7	6.57
TPH, (mg/L)	16	1,806	< 0.1	111.34
TSS, (mg/L)	35	1,442	0.1	62.61

Notes:
1. One half of the detection limit was used for non-detected results (i.e. qualifier = "<") to calculate averages.

Table 17
Water Conditions Prior to Discharge Treatment
(New Pipelines)

Parameter	Test ID	Method	Result	Units
Benzene	18		< 2	ug/L
Benzene	101	EPA 8240	< 10	ug/L
BETX	18		< 2	ug/L
BOD	101	EPA 410.1	42	mg/L
Fecal Coliform	102	SM 960C	300	COL/100mL
Oil & Grease	18		2	mg/L
Oil & Grease	101	EPA 413.1	< 5	mg/L
Oil & Grease	102	EPA 413.1	3.2	mg/L
Oil & Grease	170	413.1	< 3	mg/L
pH	18		7	SU
pH	102	EPA 150.1	8.27	SU
pH	170	150.1	8.46	SU
TSS	18		2	mg/L
TSS	101	EPA 160.2	126	mg/L
TSS	102	EPA 160.2	6	mg/L
TSS	170	160.2	32	mg/L
Turbidity	101	EPA 180.1	260	NTU

Summary Concentrations for Selected Compounds
Prior to Discharge Treatment (New Lines)

Parameter	Number of Results	Maximum	Minimum	Average
Benzene, (ug/L)	2	<10	<2	3
BETX, (ug/L)	1	<2	<2	<2
Oil & Grease, (mg/L)	4	3.2	2	2.30
pH, (SU)	3	8.46	7	7.91
TSS, (mg/L)	4	126	2	54.67

Notes:
1. One half of the detection limit was used for non-detected results (i.e. qualifier = "<") to calculate averages.

Table 18
Water Conditions After Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
Benzene	3		< 2	ug/L	Y
Benzene	4		< 2000	ug/L	Y
Benzene	5		< 5000	ug/L	Y
Benzene	6		< 5	ug/L	Y
Benzene	7		< 1	ug/L	Y
Benzene	8		< 1	ug/L	Y
Benzene	9		< 1	ug/L	Y
Benzene	10		< 1	ug/L	Y
Benzene	11		< 1	ug/L	Y
Benzene	12		< 5	ug/L	Y
Benzene	13		< 2	ug/L	Y
Benzene	14		< 2	ug/L	Y
Benzene	15		< 2	ug/L	Y
Benzene	16		< 2	ug/L	Y
Benzene	17		< 1	ug/L	Y
Benzene	19		< 2	ug/L	Y
Benzene	29	602	< 2	ug/L	Y
Benzene	30	602	2 70	ug/L	Y
Benzene	31	602	< 2	ug/L	Y
Benzene	34	8020	< 2	ug/L	Y
Benzene	38	8020	< 2	ug/L	Y
Benzene	39	8020	13	ug/L	Y
Benzene	43	8020	< 10	ug/L	Y
Benzene	44	8020	< 5	ug/L	Y
Benzene	45	8020	< 2	ug/L	Y
Benzene	46	8020	< 10	ug/L	Y
Benzene	48	8020	< 10	ug/L	Y
Benzene	49	8020	< 10	ug/L	Y
Benzene	50	8020	< 500	ug/L	Y
Benzene	51	8020	< 10	ug/L	Y
Benzene	52	8020	< 1	ug/L	Y
Benzene	53	8020	< 10	ug/L	Y
Benzene	54	624	< 1	ug/L	Y
Benzene	57	602	< 2	ug/L	Y
Benzene	58	8020	2.1	ug/L	N/A

Table 18 Continued
Water Conditions After Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
Benzene	62	602	< 1	ug/L	N/A
Benzene	63	8020	< 1	ug/L	N/A
Benzene	66	602	1	ug/L	Y
Benzene	69	602	< 2	ug/L	N/A
Benzene	70	602	< 2	ug/L	N/A
Benzene	71	602	< 2	ug/L	N/A
Benzene	72		< 1	ug/L	N/A
Benzene	73	602	< 1	ug/L	Y
Benzene	74	602	< 1	ug/L	Y
Benzene	75	602	2.15	ug/L	N/A
Benzene	78	602	< 1	ug/L	Y
Benzene	90	8020.503	115	ug/L	Y
Benzene	92	8020.503	24	ug/L	Y
Benzene	93	EPA 8020	< 2	ug/L	Y
Benzene	94	8020	< 5	ug/L	N/A
Benzene	95	8020	< 5	ug/L	N/A
Benzene	96	8020	< 0.5	ug/L	N/A
Benzene	137		< 5	ug/L	Y
Benzene	138		< 5	ug/L	Y
Benzene	141		< 5	ug/L	Y
Benzene	142		< 5	ug/L	Y
Benzene	143		< 5	ug/L	Y
Benzene	153	EPA 8020	< 0.5	ug/L	Y
Benzene	167	8020	< 20	ug/L	N/R
BETX	3		< 2	ug/L	Y
BETX	4		< 2000	ug/L	Y
BETX	5		< 5000	ug/L	Y
BETX	6		< 5	ug/L	Y
BETX	7		< 1	ug/L	Y
BETX	8		< 1	ug/L	Y
BETX	9		< 1	ug/L	Y
BETX	10		< 1	ug/L	Y
BETX	11		< 1	ug/L	Y
BETX	12		< 5	ug/L	Y
BETX	13		< 2	ug/L	Y

Table 18 Continued
Water Conditions After Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
BETX	14		< 2	ug/L	Y
BETX	15		< 2	ug/L	Y
BETX	16		< 2	ug/L	Y
BETX	17		< 1	ug/L	Y
BETX	19		< 2	ug/L	Y
BETX	28	8020	22	ug/L	Y
BETX	29	602	< 1000	ug/L	Y
BETX	30	602	< 1000	ug/L	Y
BETX	31	602	< 1000	ug/L	Y
BETX	32	602	< 1000	ug/L	Y
BETX	33	602	< 1000	ug/L	Y
BETX	34	8020	< 1000	ug/L	Y
BETX	35	8020	< 1	ug/L	Y
BETX	38	8020	< 1000	ug/L	Y
BETX	39	8020	90000	ug/L	Y
BETX	43	8020	< 10	ug/L	Y
BETX	44	8020	< 5	ug/L	Y
BETX	45	8020	< 2	ug/L	Y
BETX	46	8020	< 10	ug/L	Y
BETX	48	8020	< 10	ug/L	Y
BETX	49	8020	< 10	ug/L	Y
BETX	51	8020	< 10	ug/L	Y
BETX	52	8020	< 1	ug/L	Y
BETX	57	602	< 6	ug/L	N/A
BETX	58	8020	12.5	ug/L	N/A
BETX	63	8020	5.6	ug/L	N/A
BETX	66	602	5.2	ug/L	Y
BETX	69	602	< 2	ug/L	N/A
BETX	70	602	< 2	ug/L	N/A
BETX	71	602	< 2	ug/L	N/A
BETX	72		3.55	ug/L	N/A
BETX	73	602	1	ug/L	Y
BETX	74	602	< 1	ug/L	Y
BETX	75	602	3	ug/L	N/A
BETX	90	8020.503	733	ug/L	Y

Table 18 Continued
Water Conditions After Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
BETX	92	8020.503	39	ug/L	Y
BETX	93	EPA 8020	< 2	ug/L	Y
BETX	94	8020	21	ug/L	N/A
BETX	95	8020	25	ug/L	N/A
BETX	96	8020	< 0.5	ug/L	N/A
BETX	115		< 4	ug/L	Y
BETX	116		< 4	ug/L	Y
BETX	117		< 4	ug/L	Y
BETX	118		< 4	ug/L	Y
BETX	119		< 4	ug/L	Y
BETX	137		< 250	ug/L	Y
BETX	138		< 250	ug/L	Y
BETX	141		165	ug/L	Y
BETX	142		40	ug/L	Y
BETX	143		45	ug/L	Y
BETX	167	8020	< 120	ug/L	N/R
BOD	17		5.2	mg/L	Y
BOD	19		4	mg/L	Y
BOD	63	405.1	< 4	mg/L	Y
BOD	64	405.1	< 4	mg/L	Y
BOD	65	405.1	< 4	mg/L	Y
BOD	78	405.1	< 4	mg/L	Y
BOD	167	405.1	< 1	mg/L	N/R
Chlorides	90	SM407-C	119	mg/L	Y
Chlorine	74	field	< 0.02	mg/L	Y
Chlorine	88	330.1	0.075	mg/L	Y
Chlorine	89	330.1	0.08	mg/L	Y
COD	12		25	mg/L	Y
COD	17		27	mg/L	Y
COD	19		< 10	mg/L	Y
COD	24	410.4	23	mg/L	Y
COD	25	410.4	36	mg/L	Y
COD	29	Hach8000	< 10	mg/L	Y
COD	30	Hach8000	< 10	mg/L	Y
COD	31	Hach8000	< 10	mg/L	Y

Table 18 Continued
Water Conditions After Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
COD	34	HACH8000	< 10	mg/L	Y
COD	38	Hach8000	< 10	mg/L	Y
COD	39	Hach8000	< 10	mg/L	Y
COD	40	Hach8000	< 10	mg/L	Y
COD	41	410.4	42	mg/L	Y
COD	42	5220	15	mg/L	Y
COD	47	410.4	25	mg/L	Y
COD	49	410.4	19	mg/L	Y
COD	50	410.4	33	mg/L	Y
COD	53	8000	18	mg/L	Y
COD	54	410.4	46	mg/L	Y
COD	57	8000	43	mg/L	Y
COD	64	410.4	34.3	mg/L	Y
COD	90	600.410.1	< 10	mg/L	Y
COD	91	600.41	20	mg/L	Y
COD	92	600.410.4	105	mg/L	Y
COD	108		36	mg/L	Y
COD	122	5220D	< 10	mg/L	Y
COD	167	410.4	31	mg/L	N/R
Conductivity	90	SM 205	935	umhos/cm	Y
Conductivity	91	600.120.1	517	umhos/cm	Y
Conductivity	122	120.1	1250	umhos/cm	Y
DO	6		> 5	mg/L	Y
DO	10		6.8	mg/L	Y
DO	11		7.8	mg/L	Y
DO	12		9.5	mg/L	Y
DO	14		9.5	mg/L	Y
DRO	94	Wisc.	1.44	mg/L	N/A
Ethylbenzene	153	EPA 8020	< 0.5	ug/L	Y
Fe	4		0.99	mg/L	Y
Fe	5		< 0.03	mg/L	Y
Fe	10		0.16	mg/L	Y
Fe	11		0.1	mg/L	Y
Fe	12		6.2	mg/L	Y
Fe	14		< 0.08	mg/L	Y

Table 18 Continued
Water Conditions After Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
Fe	78	236.1	0.203	mg/L	Y
Fe, Dissolved	10		0.05	mg/L	Y
Fe, Dissolved	11		0.05	mg/L	Y
Fe, Dissolved	14		< 0.08	mg/L	Y
FE, Dissolved	78	236.1	< 0.04	mg/L	Y
GRO	94	Wisc.	1.26	mg/L	N/A
Lead	28		< 0.05	mg/L	Y
Lead	35		< 0.05	mg/L	Y
Lead	43	239.2	< 0.001	mg/L	Y
Lead	44	239.2	< 0.05	mg/L	Y
Lead	45	239.2	0.038	mg/L	Y
Lead	46	239.2	< 0.05	mg/L	Y
Lead	48	239.2	< 0.05	mg/L	Y
Lead	51	239.2	< 0.05	mg/L	Y
Lead	52	239.2	< 0.01	mg/L	Y
Lead	137		< 0.005	mg/L	Y
Lead	138		< 0.005	mg/L	Y
Lead	141		< 0.005	mg/L	Y
Lead	142		< 0.005	mg/L	Y
Lead	143		< 0.005	mg/L	Y
MTBE	94	8020	9	ug/L	N/A
Naphthalene	58	8020	2.7	ug/L	N/A
Naphthalene	62	610	< 1	ug/L	Y
Oil & Grease	1		15	mg/L	Y
Oil & Grease	3		< 0.002	mg/L	Y
Oil & Grease	4		< 2	mg/L	Y
Oil & Grease	5		< 1	mg/L	Y
Oil & Grease	6		< 0.5	mg/L	Y
Oil & Grease	7		< 0.5	mg/L	Y
Oil & Grease	8		< 0.5	mg/L	Y
Oil & Grease	9		< 0.5	mg/L	Y
Oil & Grease	10		< 5	mg/L	Y
Oil & Grease	11		< 5	mg/L	Y
Oil & Grease	12		< 5	mg/L	Y
Oil & Grease	13		< 1	mg/L	Y
Oil & Grease	14		< 1	mg/L	Y

Table 18 Continued
Water Conditions After Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
Oil & Grease	15		< 1	mg/L	Y
Oil & Grease	16		< 1	mg/L	Y
Oil & Grease	17		< 5	mg/L	Y
Oil & Grease	19		< 2	mg/L	Y
Oil & Grease	24	413.1	24	mg/L	Y
Oil & Grease	25	413.1	< 1	mg/L	Y
Oil & Grease	28	5520	2	mg/L	Y
Oil & Grease	29	413.1	5	mg/L	Y
Oil & Grease	30	413.1	< 2	mg/L	Y
Oil & Grease	31	413.1	< 2	mg/L	Y
Oil & Grease	32	413.1	< 2	mg/L	Y
Oil & Grease	33	413.1	< 3	mg/L	Y
Oil & Grease	34	5520	< 2	mg/L	Y
Oil & Grease	35	5520	< 2	mg/L	Y
Oil & Grease	38	413.1	< 2	mg/L	Y
Oil & Grease	39	5520B	3	mg/L	Y
Oil & Grease	40	413.1	< 2	mg/L	Y
Oil & Grease	41	413.1	13	mg/L	Y
Oil & Grease	42	413.1	< 1	mg/L	Y
Oil & Grease	43	413.1	< 10	mg/L	Y
Oil & Grease	44	413.1	6	mg/L	Y
Oil & Grease	45	413.1	1.1	mg/L	Y
Oil & Grease	46	413.1	9.7	mg/L	Y
Oil & Grease	47	413.1	2	mg/L	Y
Oil & Grease	48	413.1	12	mg/L	Y
Oil & Grease	49	413.1	4	mg/L	Y
Oil & Grease	50	413.1	< 1	mg/L	Y
Oil & Grease	51	413.1	< 1	mg/L	Y
Oil & Grease	52	413.1	3.2	mg/L	Y
Oil & Grease	53	503A	< 1	mg/L	Y
Oil & Grease	54	413.1	5	mg/L	Y
Oil & Grease	57	413.1	5.5	mg/L	Y
Oil & Grease	58	418.1	1.5	mg/L	Y
Oil & Grease	59	413.1	< 2	mg/L	Y
Oil & Grease	60	413.1	< 1	mg/L	Y

Table 18 Continued
Water Conditions After Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
Oil & Grease	61	413.1	< 1	mg/L	Y
Oil & Grease	62	413.2	< 1	mg/L	Y
Oil & Grease	63	413.2	< 1	mg/L	Y
Oil & Grease	64	413.2	< 1	mg/L	Y
Oil & Grease	65	413.2	< 1	mg/L	Y
Oil & Grease	66	413.2	< 5	mg/L	Y
Oil & Grease	69	418.1	0.6	mg/L	N/A
Oil & Grease	70	418.1	< 0.5	mg/L	N/A
Oil & Grease	71	418.1	< 0.5	mg/L	N/A
Oil & Grease	73	418.1	< 1	mg/L	Y
Oil & Grease	74	418.1	< 1	mg/L	Y
Oil & Grease	75	413.1	1.2	mg/L	N/A
Oil & Grease	91	600.413.2	< 0.5	mg/L	Y
Oil & Grease	92	600.413.1	35	mg/L	Y
Oil & Grease	93	EPA 413.2	< 0.1	mg/L	Y
Oil & Grease	105		2.3	mg/L	Y
Oil & Grease	107		1.6	mg/L	Y
Oil & Grease	108		5	mg/L	Y
Oil & Grease	115		< 4	mg/L	Y
Oil & Grease	116		< 4	mg/L	Y
Oil & Grease	117		< 4	mg/L	Y
Oil & Grease	118		< 4	mg/L	Y
Oil & Grease	119		< 4	mg/L	Y
Oil & Grease	122	5520B	< 1	mg/L	Y
Oil & Grease	123	5520B	< 1	mg/L	Y
Oil & Grease	124	5520B	2	mg/L	Y
Oil & Grease	135		2	mg/L	Y
Oil & Grease	136		< 1	mg/L	Y
Oil & Grease	137		2	mg/L	Y
Oil & Grease	138		1	mg/L	Y
Oil & Grease	141		< 1	mg/L	Y
Oil & Grease	142		1	mg/L	Y
Oil & Grease	143		1	mg/L	Y
Oil & Grease	145		2	mg/L	Y
Oil & Grease	149		2	mg/L	Y

Table 18 Continued
Water Conditions After Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
Oil & Grease	159	413.1	< 0.5	mg/L	Y
Oil & Grease	160	413.1	< 0.1	mg/L	Y
Oil & Grease	162	413.1	9.11	mg/L	Y
Oil & Grease	163	413.1	< 5	mg/L	Y
Oil & Grease	165	413.1	< 2	mg/L	Y
Oil & Grease	167	200.7	6	mg/L	Y
Oil & Grease	168	413.1	6	mg/L	Y
Oil & Grease	169	413.1	< 8	mg/L	Y
Oil & Grease	171	413.1	< 2	mg/L	Y
Oil & Grease	172	413.1	< 5	mg/L	Y
PCB	12		< 0.05	mg/L	Y
PCB	59	SW-846	< 0.001	mg/L	Y
pH	1		7.5	SU	Y
pH	3		8.33	SU	Y
pH	4		7.5	SU	Y
pH	5		7.8	SU	Y
pH	6		7.9	SU	Y
pH	10		6.9	SU	Y
pH	11		6.9	SU	Y
pH	12		6.9	SU	Y
pH	13		5.9	SU	N
pH	14		8	SU	Y
pH	15		6.5	SU	Y
pH	16		6.5	SU	Y
pH	17		6.96	SU	Y
pH	19		7	SU	Y
pH	28	150.1	6.5	SU	Y
pH	29	150.1	8.8	SU	Y
pH	30	150.1	8.3	SU	Y
pH	31	150.1	8.5	SU	Y
pH	32	150.1	7	SU	Y
pH	33	150.1	6.4	SU	Y
pH	34	150.1	7.5	SU	Y
pH	35	150.1	6.7	SU	Y
pH	39	150.1	7.9	SU	Y
pH	40	150.1	7.8	SU	Y
pH	41	150.1	7.95	SU	Y

Table 18 Continued
Water Conditions After Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
pH	42	150.1	8	SU	Y
pH	43	150.1	6.7	SU	Y
pH	44	150.1	6.8	SU	Y
pH	45	150.1	7	SU	Y
pH	46	150.1	7	SU	Y
pH	47	150.1	7	SU	Y
pH	49	150.1	7.5	SU	Y
pH	50	150.1	6.4	SU	Y
pH	51	150.1	6.9	SU	Y
pH	53	150.1	6.1	SU	Y
pH	57	150.1	6.5	SU	Y
pH	57	150.1	9.9	SU	N
pH	59	150.1	7.23	SU	Y
pH	60	150.1	6.78	SU	Y
pH	61	150.1	6.88	SU	Y
pH	62	pH meter	7.3	SU	Y
pH	63	150.1	6.8	SU	Y
pH	64	150.1	4.65	SU	Y
pH	65	150.1	5.9	SU	Y
pH	66	150.1	7.3	SU	Y
pH	73	150.1	6.7	SU	Y
pH	74	150.1	6.8	SU	Y
pH	75	150.1	7.1	SU	N/A
pH	78	150.1	8.29	SU	Y
pH	88		8	SU	Y
pH	89		7.9	SU	Y
pH	92	150.1	7.5	SU	Y
pH	93	electronic	8.25	SU	Y
pH	105		6.3	SU	Y
pH	107		6.1	SU	Y
pH	108		7.2	SU	Y
pH	115		7.38	SU	N/A
pH	116		8.2	SU	Y
pH	117		8	SU	Y
pH	118		8.2	SU	Y

Table 18 Continued
Water Conditions After Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
pH	119		8.2	SU	Y
pH	123	4500B	7.78	SU	Y
pH	124	4500B	7.8	SU	Y
pH	136		6.8	SU	Y
pH	137		7.2	SU	Y
pH	138		7.2	SU	Y
pH	141		7.6	SU	Y
pH	142		7.2	SU	Y
pH	143		8	SU	Y
pH	153	EPA 150.1	7.7	SU	Y
pH	160	9045	7.7	SU	Y
pH	161	9045	6.9	SU	Y
pH	162	150.1	8.9	SU	Y
pH	163	150.1	7.29	SU	Y
pH	165	150.1	7.9	SU	Y
pH	167	150.1	7.08	SU	Y
pH	168	150.1	7.4	SU	Y
pH	169	150.1	7.5	SU	Y
pH	171	150.1	7.2	SU	Y
pH	172	150.1	7.63	SU	Y
Phenols	58	510	0.2	mg/L	N/A
Phenols	62	420.1	< 0.005	mg/L	Y
Phenols	65	420.1	< 0.005	mg/L	Y
SVOCs	65	GC/MS	< 50	ug/L	Y
TOC	28		1	mg/L	Y
TOC	32		6.5	mg/L	Y
TOC	33		9	mg/L	Y
TOC	35		2	mg/L	Y
TOC	40	415.1	5	mg/L	Y
TOC	43	415.1	2	mg/L	Y
TOC	44	415.1	4	mg/L	Y
TOC	45	415.1	9.4	mg/L	Y
TOC	46	415.1	4	mg/L	Y
TOC	48	415.1	8	mg/L	Y
TOC	51	415.1	6	mg/L	Y

Table 18 Continued
Water Conditions After Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
TOC	52	415.1	6.2	mg/L	Y
TOC	60	415.1	3.9	mg/L	Y
TOC	61	415.1	3.4	mg/L	Y
TOC	73	415.1	< 10	mg/L	Y
TOC	74	415.1	< 10	mg/L	Y
TOC	136		6.3	mg/L	Y
TOC	137		1.2	mg/L	Y
TOC	138		1	mg/L	Y
TOC	141		4.3	mg/L	Y
TOC	142		2.4	mg/L	Y
TOC	143		2.7	mg/L	Y
Toluene	62	602	< 1	ug/L	Y
Toluene	153	EPA 8020	0.65	ug/L	Y
Total Lead	167	200.7	0.1	mg/L	N/R
Total Xylene	153	EPA 8020	< 1.5	ug/L	Y
TPH	10		< 0.5	mg/L	Y
TPH	11		< 0.5	mg/L	Y
TPH	17		< 0.01	mg/L	Y
TPH	19		< 1	mg/L	Y
TPH	72	418.1	< 1	mg/L	N/A
TPH	78	418.1	< 1	mg/L	Y
TPH	88	418.1	4.5	mg/L	Y
TPH	89	418.1	0.66	mg/L	Y
TPH	153	EPA 418.1	< 1	mg/L	Y
TPH	159	418.1	8.92	mg/L	Y
TPH	161	418.1	< 0.1	mg/L	Y
TPH-E	167	8015-Mod	1.42	mg/L	N/R
TPHOS	17		0.251	mg/L	Y
TPHOS	19		0.05	mg/L	Y
Trimethylbenzene	94	8020	6.8	ug/L	N/A
TSS	1		45	mg/L	Y
TSS	3		< 0.002	mg/L	Y
TSS	4		< 2	mg/L	Y
TSS	5		< 6	mg/L	Y
TSS	6		< 1	mg/L	Y

Table 18 Continued
Water Conditions After Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
TSS	10		< 4	mg/L	Y
TSS	11		< 4	mg/L	Y
TSS	12		< 4	mg/L	Y
TSS	13		7	mg/L	Y
TSS	14		< 4	mg/L	Y
TSS	15		5	mg/L	Y
TSS	16		5	mg/L	Y
TSS	17		5.7	mg/L	Y
TSS	19		14	mg/L	Y
TSS	24	160.2	6	mg/L	Y
TSS	25	160.2	175	mg/L	Y
TSS	28	160.2	2	mg/L	Y
TSS	32	160.2	7	mg/L	Y
TSS	33	160.2	395	mg/L	Y
TSS	35	160.2	7.7	mg/L	Y
TSS	43	160.2	5	mg/L	Y
TSS	44	160.2	26	mg/L	Y
TSS	45	160.2	14.7	mg/L	Y
TSS	46	160.2	< 5	mg/L	Y
TSS	48	160.2	5	mg/L	Y
TSS	51	160.2	4	mg/L	Y
TSS	52	160.2	4	mg/L	Y
TSS	58	209C	1.3	mg/L	Y
TSS	59	160.2	2.8	mg/L	Y
TSS	69	209C	5.8	mg/L	Y
TSS	70	209C	7.11	mg/L	Y
TSS	71	209C	7.11	mg/L	Y
TSS	72		20.4	mg/L	N/A
TSS	78	160.2	< 2	mg/L	Y
TSS	90	600.160.2	21	mg/L	Y
TSS	91	600.160.2	21	mg/L	Y
TSS	105		3	mg/L	Y
TSS	107		30	mg/L	Y
TSS	115		< 2	mg/L	N/A
TSS	116		< 2	mg/L	Y

Table 18 Continued
Water Conditions After Discharge Treatment
(Existing Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
TSS	117		< 2	mg/L	Y
TSS	118		< 2	mg/L	Y
TSS	119		< 2	mg/L	Y
TSS	122	2540D	24	mg/L	Y
TSS	123	2540D	13.3	mg/L	Y
TSS	124	2540D	9.2	mg/L	Y
TSS	135		60	mg/L	Y
TSS	136		20	mg/L	Y
TSS	137		7	mg/L	Y
TSS	138		13	mg/L	Y
TSS	141		51	mg/L	Y
TSS	142		33	mg/L	Y
TSS	143		84	mg/L	Y
TSS	145		60	mg/L	Y
TSS	149		60	mg/L	Y
TSS	159	160.2	< 1	mg/L	Y
TSS	160	160.2	< 1	mg/L	Y
TSS	161	160.2	< 1	mg/L	Y
TSS	162	160.2	24	mg/L	Y
TSS	163	160.2	< 10	mg/L	Y
TSS	165	160.2	< 5	mg/L	Y
TSS	167	160.2	5	mg/L	Y
TSS	168	160.2	7	mg/L	Y
TSS	169	160.2	6	mg/L	Y
TSS	171	160.2	6	mg/L	Y
TSS	172	160.2	< 10	mg/L	Y
Turbidity	90	600.180.1	58.7	NTU	Y
Turbidity	91	600.180.1	28	NTU	Y
Turbidity	122	2130B	< 10	NTU	Y
VOCs	65	GC/MS	8	ug/L	Y

Table 18 Continued
Summary Concentrations for Selected Compounds
After Discharge Treatment (Existing Lines)

Parameter	*Number of Results*	*Maximum*	*Minimum*	*Average*
Benzene, (ug/L) [2]	59	115	< 0.5	9.3
BETX, (ug/L) [3]	62	90,000	< 0.5	139
COD, (mg/L)	27	105	< 10	23.27
Lead, (mg/L)	14	0.038	< 0.005	0.01
Oil & Grease, (mg/L)	93	35	< 0.002	2.74
pH, (SU)	80	9.9	4.65	7.32
TOC, (mg/L)	22	9.4	1	4.47
TPH, (mg/L)	11	8.92	< 0.01	1.51
TSS, (mg/L)	66	395	< 0.002	20.76

Notes:

[1] One half of the detection limit was used for non-detected results (i.e. qualifier = "<") to calculate averages except as noted.

[2] The <2000 and <5000 non-detect results were not included in the average calculation since they inappropriately weight the average.

[3] The 90,000 ug/L result was not included in the average calculation since it is an anomaly and disproportionately modifies the average.

Table 19
Water Conditions After Discharge Treatment
(New Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
Benzene	18		< 2	ug/L	Y
Benzene	27	8020	24	ug/L	Y
Benzene	101	EPA 8240	< 30	ug/L	Y
Benzene	113		5	ug/L	Y
BETX	18		< 2	ug/L	Y
BOD	101	EPA 410.1	36	mg/L	Y
Boron	146		0.37	mg/L	Y
Boron	148		0.17	mg/L	Y
Chlorides	146		57	mg/L	Y
Chlorides	148		110	mg/L	Y
COD	112		26	mg/L	Y
COD	113		14	mg/L	Y
Fe	112		10.4	mg/L	N
Fe	113		6.79	mg/L	N
Lead	27		< 0.05	mg/L	Y
Oil & Grease	18		2	mg/L	Y
Oil & Grease	27	413.1	8	mg/L	Y
Oil & Grease	36	5520	< 2	mg/L	Y
Oil & Grease	37	5520	< 2	mg/L	Y
Oil & Grease	55	413.1	4	mg/L	Y
Oil & Grease	56	413.1	2	mg/L	Y
Oil & Grease	97	418.1	< 1	mg/L	Y
Oil & Grease	99	418.1	< 1	mg/L	Y
Oil & Grease	100	418.1	< 1	mg/L	Y
Oil & Grease	101	EPA 413.1	< 5	mg/L	Y
Oil & Grease	102	EPA 413.1	< 0.2	mg/L	Y
Oil & Grease	103		7	mg/L	Y
Oil & Grease	104		8	mg/L	Y
Oil & Grease	106		1	mg/L	Y
Oil & Grease	109		5	mg/L	Y
Oil & Grease	110		29.5	mg/L	N
Oil & Grease	111		1.86	mg/L	Y
Oil & Grease	112		1	mg/L	Y
Oil & Grease	113		1	mg/L	Y
Oil & Grease	114		2	mg/L	Y
Oil & Grease	121	5520B	< 1	mg/L	Y
Oil & Grease	139		1	mg/L	Y
Oil & Grease	140		2	mg/L	Y
Oil & Grease	164	413.1	< 2	mg/L	Y

Table 19 Continued
Water Conditions After Discharge Treatment
(New Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
Oil & Grease	166	413.1	< 3	mg/L	Y
Oil & Grease	170	413.1	< 3	mg/L	Y
pH	18		7	SU	Y
pH	27	150.1	7.3	SU	Y
pH	36	150.1	8.2	SU	Y
pH	37	150.1	7.9	SU	Y
pH	55	150.1	4	SU	Y
pH	56	150.1	4	SU	Y
pH	76		6.9	SU	Y
pH	97		7.6	SU	Y
pH	99		8.4	SU	Y
pH	100		8.3	SU	Y
pH	102	EPA 150.1	6.48	SU	Y
pH	103		6.38	SU	Y
pH	104		7.84	SU	Y
pH	106		7.18	SU	Y
pH	109		7.64	SU	Y
pH	110		7.12	SU	Y
pH	111		7.36	SU	Y
pH	112		8.25	SU	Y
pH	113		8.25	SU	Y
pH	114		6.37	SU	Y
pH	121	4500B	8.3	SU	Y
pH	139		7.4	SU	Y
pH	140		7.6	SU	Y
pH	146		7.9	SU	Y
pH	148		7.6	SU	Y
pH	164	150.1	7.8	SU	Y
pH	166	150.1	8.46	SU	Y
pH	170	150.1	8.46	SU	Y
Sulfate	146		110	mg/L	Y
Sulfate	148		220	mg/L	Y
TDS	146		370	mg/L	Y
TDS	148		510	mg/L	Y
TOC	139		13	mg/L	Y
TOC	140		1.1	mg/L	Y
Total Coliform Bacteria	102	SM9222B	150	COL/100mL	Y
TPH	76		< 0.12	mg/L	Y
TSS	18		2	mg/L	Y
TSS	27	160.2	4	mg/L	Y

Table 19 Continued
Water Conditions After Discharge Treatment
(New Pipelines)

Parameter	Test ID	Method	Result	Units	Were Permit Conditions Met?
TSS	36	160.2	24	mg/L	Y
TSS	37	160.2	8	mg/L	Y
TSS	55	160.2	7.6	mg/L	Y
TSS	56	160.2	6.8	mg/L	Y
TSS	76		58	mg/L	Y
TSS	97		127	mg/L	N
TSS	98		24	mg/L	Y
TSS	99		270	mg/L	N
TSS	100		350	mg/L	N
TSS	101	EPA 160.2	68	mg/L	Y
TSS	102	EPA 160.2	60	mg/L	Y
TSS	103		6	mg/L	Y
TSS	104		5	mg/L	Y
TSS	106		22	mg/L	Y
TSS	109		19.8	mg/L	Y
TSS	110		8	mg/L	Y
TSS	111		18.9	mg/L	Y
TSS	112		15	mg/L	Y
TSS	113		1	mg/L	Y
TSS	114		102	mg/L	N
TSS	121	2540D	2	mg/L	Y
TSS	139		9	mg/L	Y
TSS	140		16	mg/L	Y
TSS	164	160.2	< 5	mg/L	Y
TSS	166	160.2	< 32	mg/L	Y
TSS	170	160.2	32	mg/L	Y
Turbidity	101	EPA 180.1	62	NTU	Y

Table 19 Continued
Summary Concentrations for Selected Compounds
After Discharge Treatment (New Lines)

Parameter	Number of Results	Maximum	Minimum	Average
Benzene, (ug/L)	4	24	<2	11
BETX, (ug/L)	1	<2	<2	<2
COD, (mg/L)	2	26	14	20
Oil & Grease, (mg/L)	26	29.5	<0.2	3.31
pH, (SU)	28	8.46	4	7.36
TPH, (mg/L)	1	< 0.12	< 0.12	< 0.12
TSS, (mg/L)	28	350	1	44.81

Notes:

1. One half of the detection limit was used for non-detected results (i.e. qualifier = "<") to calculate averages.

Table 20
Summary of Costs, Grouped by Treatment Cost Ranges

Cost per Gallon (cents)	Number of Tests	Range of Discharge Volumes (Gallons)	Average Discharge (gallons)	Weighted Average Cost for Group (cents/gal)	Treatment Technologies
Existing Pipes					
<1	28	12,735 - 16,800,000	2,937,383	0.35	Discharge to Refinery WWTP or Other Indirect Industrial Discharge, Hay bales, Carbon Adsorption, Tank Separation, No Treatment, Tank Separation;
1 to <5	19	194,040 - 31,920,000	5,351,777	2.36	Carbon Adsorption; Air Stripping; Carbon Adsorption and Air Stripping; Not Reported
5 to <10	7	378,000 - 2,394,000	1,243,598	6.32	Carbon Adsorption; Carbon Adsorption and Hay bales
10 to <25	9	1,200 - 420,000	116,204	14.2	Carbon Adsorption
25 to <50	2	62,832 - 840,000	451,416	34.37	Carbon Adsorption
>=50	4	200 - 4,600	1,325	54.68	Carbon Adsorption, Commercial Pre-treatment
New Pipes					
<1	8	65 - 6,846,000	1,066,381	0.16	Hay bales, Filter Screens, Not reported, Tank Pre-cleaning

	Existing	New
Minimum Discharge (gallon)	200	65
Maximum Discharge (gallon)	31,920,000	6,846,000
Average Discharge (gallon)	see above	
Median Discharge (gallon)	1,200,000	131,500
Minimum Cost (cents/gallon)	0	0
Maximum Reported Cost (cents/gallon)	85	<1
Median Cost (cents/gallon)	2	0.1
Arithmetic Average Cost (cents/gallon)	8.55	0.36
Weighted Average Cost (cents/gallon)	1.9	0.16
Grouped Weighted Average Cost (cents/gallon)	see above	
Number of Tests for which cost data was submitted	69	8
Number of Test for which no cost data was reported	62	33

Notes:
1. Where cost was reported as "<", the cost was assumed to be 0.1 cent less than the number reported (i.e. <1 was 0.9 for calculation purposes).
2. Weighted average costs calculated as the sum of total discharge multiplied by its corresponding reported unit cost. That sum is then divided by the total discharge.

Table 21
Distribution of Cost Information for New and Existing Pipelines

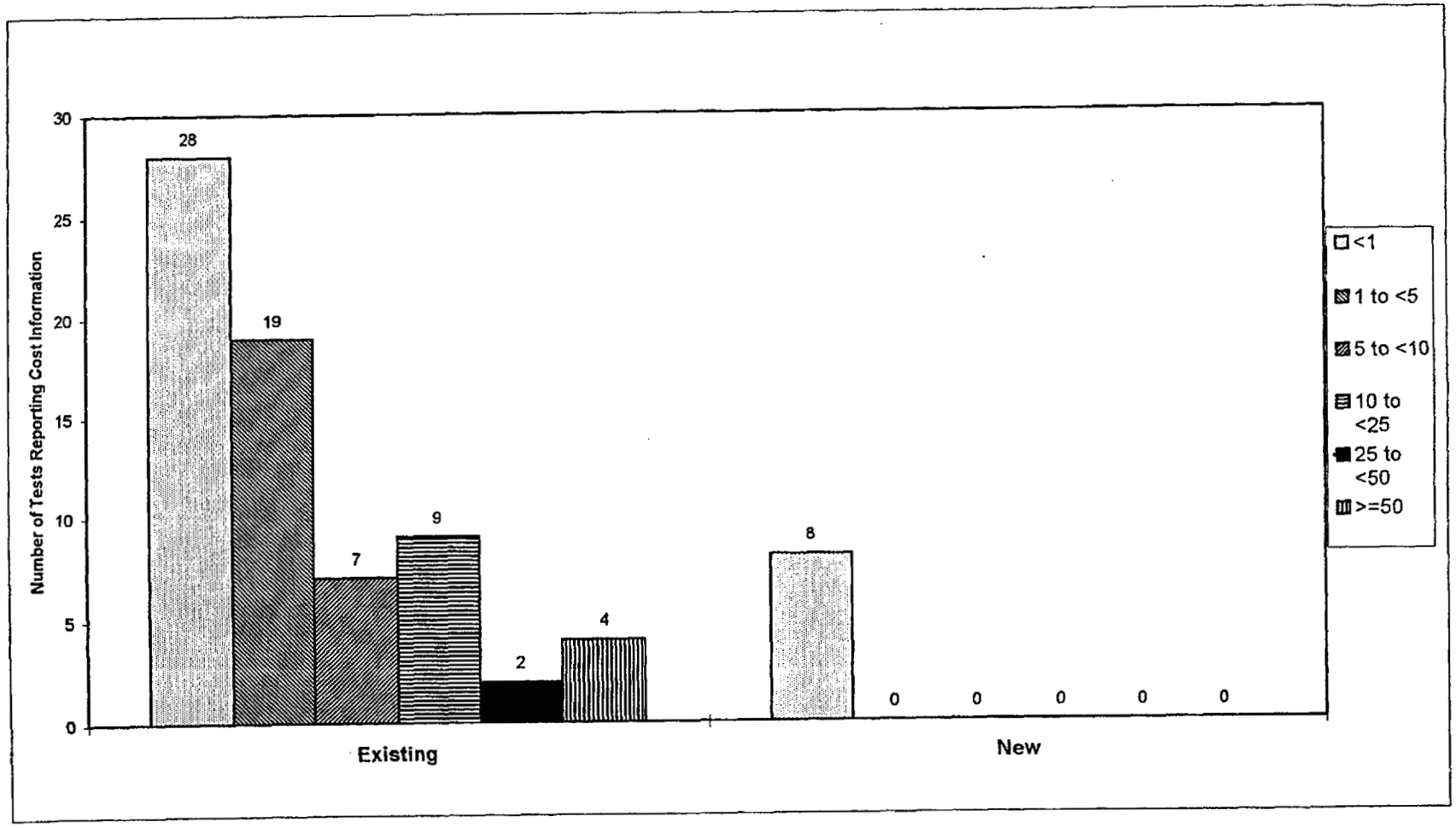

Table 22
Average Discharge Volumes for Cost Ranges

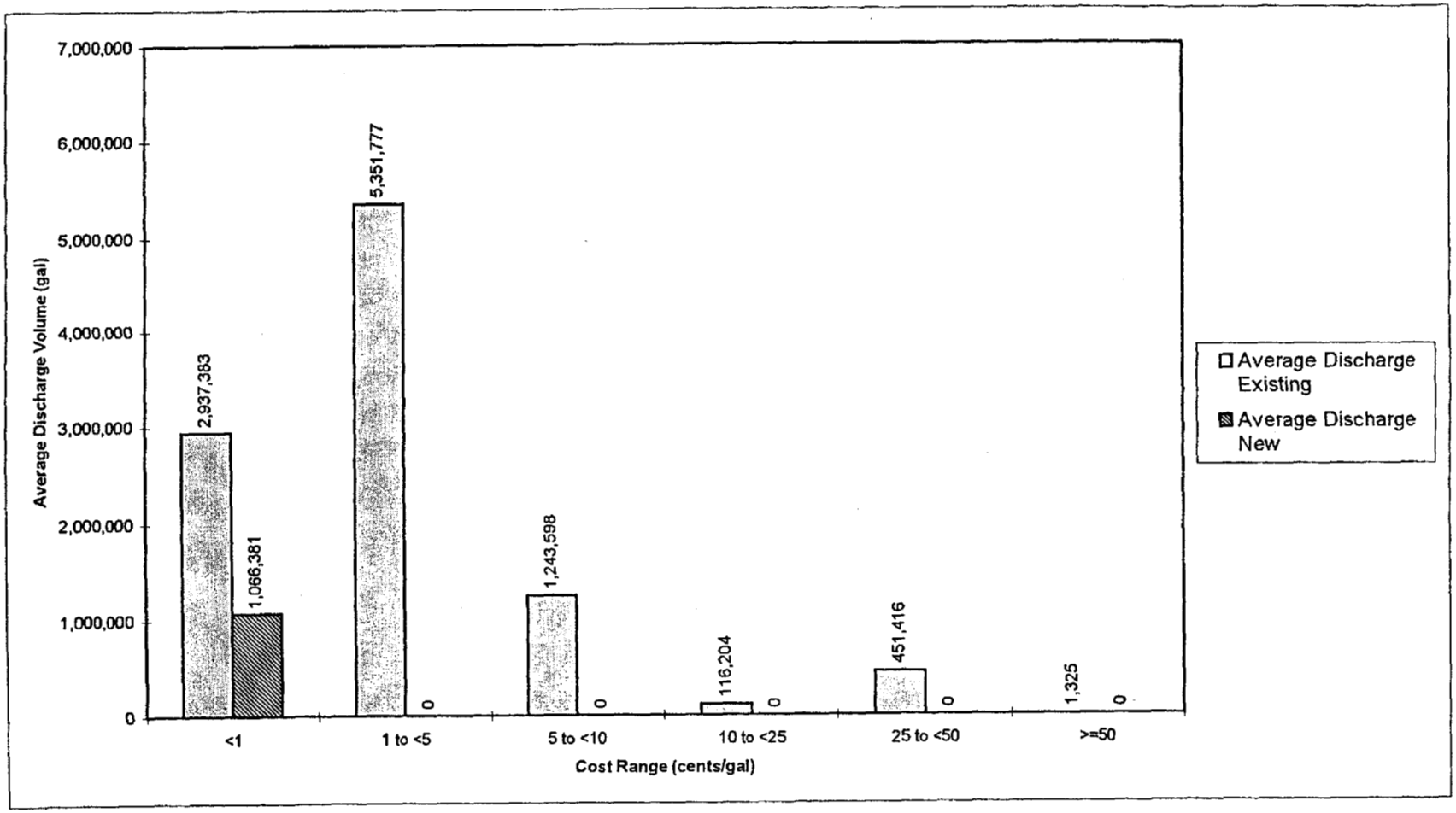

Table 23
Economies of Scale Plot for Cost Range Groupings

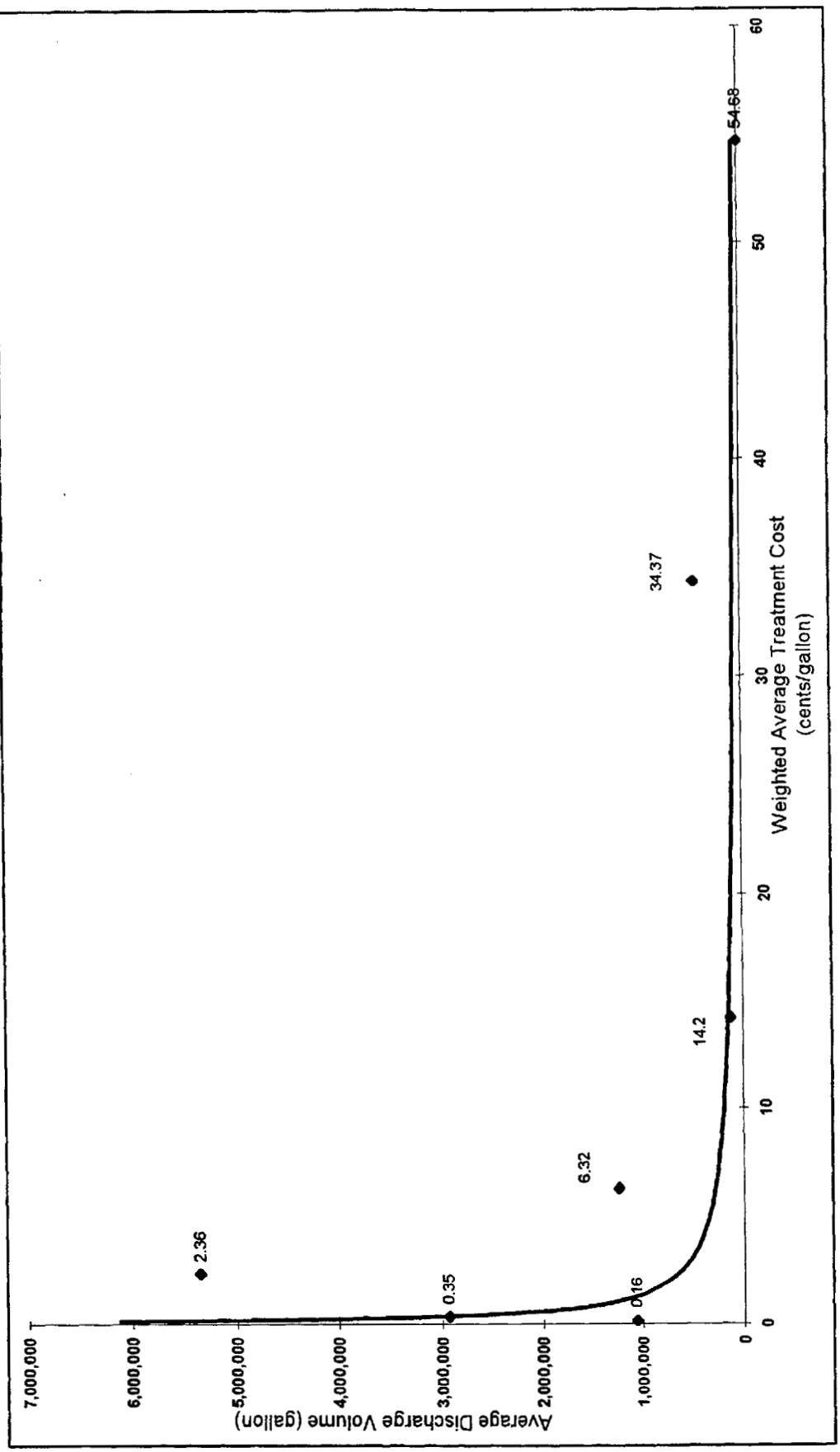

Table 24
Summary of Costs by Treatment Technology
(Existing Pipelines)

Treatment Technology	Type of Liquid Transported	Number of Tests Where Used	Average Discharge Volume	Cost Range (cents/gal)	Average Cost (cents/gal)
Carbon Adsorption	Crude	4	3,725,000	0.775 - 3	2.34
	Refined Product	28	2,679,177	0.07 - 85	15.6
	HVL	No data			
Air Stripping	Crude	1	15,900,000	2.36	2.36
	Refined Product	1	6,720,000	2.1	2.1
	HVL	No data			
Carbon Adsorption & Air Stripping	Crude	No data			
	Refined Product	1	1,523,000	1.9	1.9
	HVL	No data			
Carbon Adsorption & Haybales	Crude	No data			
	Refined Product	1	651,000	8	8
	HVL	No data			
Haybales	Crude	2	1,547,500	0	0
	Refined Product	2	1,932,000	0	0
	HVL	1	12,735	0	0
Other	Crude	3	1,876,667	0 - < 1	0.6
	Refined Product	6	1,051,767	0 - 50	8.63
	HVL	No data			
N/R	Crude	3	482,662	0 - 35	13.33
	Refined Product	4	55,650,000	< 1 - 15	4.48
	HVL	No Data			

57

N/R = Not Reported

Table 25
Use of Pigging, Pre-Washing or Pigging & Pre-Washing without Treatment Technologies
(Existing Lines Transporting Refined Product - Pre Wash Pre-treatment - No Treatment Technology Reported)

	Did the result meet specified permit limits?				Concentration		
	Number of Responses	Number of "Nos"	Number of "Yesses"	Percent Meeting Limits	Maximum	Minimum	Average
Benzene, (ug/L)	4	0	2	50.0	< 2	< 1	0.625
BETX, (ug/L)	3	0	2	66.7	< 3	< 1	2
BOD, (mg/L)	1	0	1	100.0	4	4	4
Chlorine, (mg/L)	1	0	1	100.0	< 0.02	< 0.02	< 0.02
Naphthalene, (ug/L)	1	0	1	100.0	2.07	2.07	2.07
Oil & Grease, (mg/L)	8	0	7	87.5	5.3	< 1	1.29
pH, (SU)	6	0	6	100.0	7.45	6.3	6.83
Phenols, (mg/L)	1	0	1	100.0	< 0.05	< 0.05	< 0.05
TOC, (mg/L)	3	0	3	100.0	< 10	2.7	3.7
Toluene, (ug/L)	1	0	1	100.0	1.13	1.13	1.13

Notes:
1. One half the detection limit was used for non-detected results (i.e. qualifier - "<") to calculate averages.

Table 26
Summary of Permit Compliance for Treatment Technology and Liquid Types*

Treatment	Parameter	Number of Responses	Number of "Not Reported"	Number of No's	Number of Yesses	% Meeting Permit Limits
Crude Oil - Carbon Adsorption	Benzene	3	3	0	0	-
7 Tests	BETX	7	3	0	4	57.1
	Lead	1	0	0	1	100.0
	Oil & Grease	4	0	0	4	100.0
	pH	4	0	0	4	100.0
	TOC	1	0	0	1	100.0
	TSS	4	0	0	4	100.0
Refined Product - Carbon Adsorption	Benzene	25	2	0	23	92.0
32 Tests	BETX	27	3	0	24	88.9
	COD	11	0	0	11	100.0
	Oil & Grease	30	1	0	29	96.7
	pH	29	2	2	25	86.2
	TOC	1	0	0	1	100.0
	TPH	7	0	0	7	100.0
	TSS	19	1	0	18	94.7
Refined Product - Carbon Adsorption & Air Stripping	Benzene	1	0	0	1	100.0
1 Test	BETX	1	0	0	1	100.0
	Oil & Grease	1	0	0	1	100.0
	pH	1	0	0	1	100.0
Refined Product - Carbon Adsorption & Haybales	Benzene	1	0	0	1	100.0
1 Test	pH	1	0	0	1	100.0
	TPH	1	0	0	1	100.0
	TSS	1	0	0	1	100.0
Crude - Haybales	Benzene	1	0	0	1	100.0
3 Tests	BETX	1	0	0	1	100.0
	COD	3	0	0	3	100.0
	Oil & Grease	2	0	0	2	100.0
	TSS	3	0	0	3	100.0
HVL - Haybales	BETX	1	0	0	1	100.0
2 Tests	COD	1	0	0	1	100.0
	Oil & Grease	2	0	0	2	100.0
	pH	1	0	0	1	100.0
	TOC	1	0	0	1	100.0
	TSS	2	0	0	2	100.0

Table 26 Continued
Summary of Permit Compliance for Treatment Technology and Liquid Types*

Treatment	Parameter	Number of Responses	Number of "Not Reported"	Number of No's	Number of Yesses	% Meeting Permit Limits
Refined Product - Haybales	Benzene	1	0	0	1	100.0
5 Tests	BETX	1	0	0	1	100.0
	COD	2	0	0	2	100.0
	Lead	1	0	0	1	100.0
	Oil & Grease	5	0	0	5	100.0
	pH	5	0	0	5	100.0
	TOC	1	0	0	1	100.0
	TSS	3	0	0	3	100.0
Refined Product - No Treatment	Benzene	17	4	0	13	76.5
27 Tests	BETX	12	3	0	9	75.0
	COD	6	0	0	6	100.0
	Lead	6	0	0	6	100.0
	Oil & Grease	26	2	0	24	92.3
	pH	22	0	0	22	100.0
	TOC	9	0	0	9	100.0
	TPH	1	0	0	1	100.0
	TSS	13	0	0	13	100.0
Crude - Other Treatments	Benzene	1	0	0	1	100.0
(Other includes: Air Stripping, Tank Separation)	BETX	2	0	0	2	100.0
(One test reporting Crude & Refined Product was counted here)	COD	1	0	0	1	100.0
2 Tests	Oil & Grease	2	0	0	2	100.0
	pH	2	0	0	2	100.0
	TOC	1	0	0	1	100.0
	TSS	1	0	0	1	100.0
Refined Product - Other Treatment	Benzene	1	1	0	0	-
(Other treatment includes: dilution; bag filter, oil water separation and air sparging; tank separation)	BETX	1	1	0	0	0.0
4 Tests	COD	2	1	0	1	50.0
	Oil & Grease	4	0	0	4	100.0
	pH	4	0	0	4	100.0
	TPH	1	0	0	1	100.0
	TSS	3	0	0	3	100.0
84 Tests		356	27	2	327	

* Based on 84 tests which provided permit compliance data

Table 27
Summary
Hydrostatic Test Water Treatment Technologies*

	Pigging& Washing	*Activated Carbon Adsorption*	*Air Stripping*	*Hay Bales*	*HRT*	*Filtration*	*Dissolved Air Flotation*	*Ultra Violet Oxidation*
Practicality	+	-	-	+	+	+	-	-
Mobility	+	-	-	+	+	+	-	-
Time Requirements	+	-	-	+	+	-	-	-
Power	+	+	+	+	+	+	-	-
Water Storage Requirements	+	-	-	+	+	-	-	-
Wastes Generated	+	-	+	+	+	-	-	+
Discharged Rates	+	-	-	+	+	-	-	-
Ability to Meet Discharge Limits	+	+	+	-	-	-	-	+
Cost	+	-	-	+	+	-	-	-
Remarks	May need to be combined with HRT or Activated Carbon Adsorption to meet discharge limits.	May be appropriate for smaller, low volume systems	May be acceptable for smaller, low volume applications.	Most likely will need to be combined with pre-pigging and pre-washing. May require further treatment with activated carbon adsorption.	Most likely will need to be combined with pre-pigging and pre-washing. May require further treatment with activated carbon adsorption.	Practicality for TSS Only		Requires pre-treatment to remove oils/grease and metals

+ = Provided overall positive benefits for this treatment technology
- = Provided overall negative benefits for this treatment technology
* These assessments represent general conclusions which may vary depending on type of pipeline system and volume of discharge.

Table 28
Pre-Pigging/Pre-Washing
100 Thousand and One Million Gallon Volume Equivalent Discharges

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
CONSTRUCTION/INSTALLATION						
Open Top Tank - Fiberglass (10000 gal.)	1	MO	$50.00	$50.00		GRI Cost Estimate (based on $50/month)
Diesel Pump (Rental	2	DY	$147.00	$294.00		1995 Means, item 016-420-5650
Piping (6 in. steel)	100	LF	$20.00	$2,000.00		1995 Means, item151-701-1260, updated with 1995 ENR index
Labor	24	HR	$15.00	$360.00		GRI Cost Estimate
Sludge Pump (Rental)	2	DY	$147.00	$294.00		1995 Means, item 016-420-5650
					$2,998.00	
OPERATION						
Labor	48	HR	$15.00	$720.00		GRI Cost Estimate
Squeegee Pigs	2	EA	$0.00	$0.00		Assumed Provided by Gas Company
Detergent Solutions	4	DR	$1,307.00	$5,228.00		Kent Hobbs, BioChem Systems, 12/6/95, Diluted to 10% solution
					$5,948.00	
WATER/SLUDGE DISPOSAL						
Liquid Sample and Analysis	1	LS	$175.00	$175.00		GRI Laboratory (based on 1 sample analyzed for pH, TSS, oil and grease, and TOC)
Liquid Transportation	50	MI	$2.00	$100.00		GRI Cost Estimate (based on a 50 mile round trip)
Liquid Treatment/Disposal	2000	GA	$0.30	$600.00		GRI Cost Estimate (assumed non-hazardous)
55 Gallon Storage	1	EA	$27.00	$27.00		GRI Cost Estimate (assumed 55 gallon volume of solids)
Solids Transportation	50	MI	$2.00	$100.00		GRI Cost Estimate (based on a 50 mile round trip)
Solids Treatment/Disposal	1	DR	$100.00	$100.00		GRI Cost Estimate (assumed non-hazardous)
Sampling	2	EA	$700.00	$1,400.00		GRI Cost Estimate (includes sludge analysis which includes paint filter test, TCLP, and ignitability)
Labor	8	HR	$15.00	$120.00		GRI Cost Estimate (based on 1 person for 8 hours for sampling and to oversee loadings of disposal trucks)
					$2,622.00	

Table 28 Continued

Pre-Pigging/Pre-Washing 100 Thousand and One Million Gallon Volume Equivalent Discharges						
	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
DEMOBILIZATION						
Labor	12	HR	$15.00	$180.00		GRI Cost Estimate
					$180.00	
Subtotal					**$11,748.00**	
Engineering & Contingency		***LS***	***$500.00***		***$500.00***	***GRI Cost Estimate***
Total					***$12,248.00***	

Source: Tabel E-1. GRI Topical Report Environmental Aspects of Hydrostatic Test Water Discharges: Operations, Characterization, Treatment and Disposal. April, 1996.

Table 29
Pre-Pigging/Pre-Washing
10 Million Gallon Volume Equivalent Discharges

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
CONSTRUCTION/INSTALLATION						
Open Top Tank - Fiberglass (10000 gal.)	1	MO	$50.00	$50.00		GRI Cost Estimate (based on $50/month)
Diesel Pump (Rental	2	DY	$147.00	$294.00		1995 Means, item 016-420-5650
Piping (6 in. steel)	100	LF	$20.00	$2,000.00		1995 Means, item151-701-1260, updated with 1995 ENR index
Labor	24	HR	$15.00	$360.00		GRI Cost Estimate
Sludge Pump (Rental)	2	DY	$147.00	$294.00		1995 Means, item 016-420-5650
					$2,998.00	
OPERATION						
Labor	48	HR	$15.00	$720.00		GRI Cost Estimate
Squeegee Pigs	2	EA	$0.00	$0.00		Assumed Provided by Gas Company
Detergent Solutions	8	DR	$1,307.00	$10,456.00		Kent Hobbs, BioChem Systems, 12/6/95, Diluted to 10% solution
					$11,176.00	
WATER/SLUDGE DISPOSAL						
Liquid Sample and Analysis	2	LS	$175.00	$350.00		GRI Laboratory (based on 1 sample analyzed for pH, TSS, oil and grease, and TOC)
Liquid Transportation	50	MI	$2.00	$100.00		GRI Cost Estimate (based on a 50 mile round trip)
Liquid Treatment/Disposal	4000	GA	$0.30	$1,200.00		GRI Cost Estimate (assumed non-hazardous)
55 Gallon Storage	1	EA	$27.00	$27.00		GRI Cost Estimate (assumed 55 gallon volume of solids)
Solids Transportation	50	MI	$2.00	$100.00		GRI Cost Estimate (based on a 50 mile round trip)
Solids Treatment/Disposal	2	DR	$100.00	$200.00		GRI Cost Estimate (assumed non-hazardous)
Sampling	2	EA	$700.00	$1,400.00		GRI Cost Estimate (includes sludge analysis which includes paint filter test, TCLP, and ignitability)
Labor	8	HR	$15.00	$120.00		GRI Cost Estimate (based on 1 person for 8 hours for sampling and to oversee loadings of disposal trucks)
					$3,497.00	

Table 29 Continued

Table 29 Pre-Pigging/Pre-Washing 10 Million Gallon Volume Equivalent Discharges						
	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
DEMOBILIZATION						
Labor	12	HR	$15.00	$180.00		GRI Cost Estimate
					$180.00	
Subtotal					**$17,851.00**	
Engineering and Contingency		***LS***	***$500.00***		***$500.00***	***GRI Cost Estimate***
Total					***$18,351.00***	

Source: Tabel E-2. GRI Topical Report Environmental Aspects of Hydrostatic Test Water Discharges: Operations, Characterization, Treatment and Disposal. April, 1996.

Table 30
HRT System
100 Thousand Gallon Discharge

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
CONSTRUCTION/INSTALLATION						
Hay Bales	120	EA	$3.00	$360.00		GRI Cost Estimate
Fence Posts (10' spacing around exterior, and support)	14	EA	$20.00	$280.00		GRI Cost Estimate
Reinforcing Rods-steel - 6 foot	25	EA	$1.20	$30.00		Allegheny Brick and Builder's Supply - Pittsburgh, PA
Reinforcing Rods-steel - 8 foot	37	EA	$1.60	$59.00		Allegheny Brick and Builder's Supply - Pittsburgh, PA
Filter Fabric - "floor" + interior/exterior walls	4500	SF	$0.11	$495.00		Trivera 1128 Geotextile - Fluid Systems, Inc. (800) 346-9107 - sold as 500 sq. yd. roll
Wire Fencing - 6 foot (interior and exterior of structure)	130	FT	$2.00	$260.00		1995 Mean's item 028-320-0300
Reinforced Polyethylene Sheeting - 4 mil.	500	SF	$0.09	$45.00		1995 Mean's item 022-704-0060
Plywood (1/2 in. thick)	2	EA	$18.59	$37.00		84 Lumber, Pittsburgh, PA
Absorbent Boom	55	LF	$1.33	$73.00		Oil Mop, Inc. (Phone: 504-394-6110)
Piping (6 in. steel)	100	LF	$27.50	$2,750.00		1995 Mean's item 151-701-0670
Piping 24 in. steel)	12	LF	$0.00	$0.00		Provided by Pipeline Company
Piping (1 in. steel)	1	LF	$2.18	$2.00		1995 Mean's Item 151-701-0580
1 in. Gate Valve	1	EA	$18.25	$18.00		1995 Mean's item 151-955-2950
Labor	24	HR	$15.00	$360.00		GRI Cost Estimate
Post Hole Digger	1	DY	$540.00	$540.00		1995 Mean's item 016-408-0060
					$5,310.00	
OPERATION						
Labor	2	HR	$15.00	$25.00		GRI Cost Estimate
					$25.00	
DEMOBILIZATION						
Labor	24	HR	$15.00	$360.00		GRI Cost Estimate
					$360.00	

Table 30
HRT System
100 Thousand Gallon Discharge

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
WATER/SLUDGE DISPOSAL						
Disposal of Booms and Filter Fabric in Industrial Landfill	2	CY	$100.00	$200.00		GRI Cost Estimate
Miscellaneous Disposal (wire, rod, wood)						
Transportation Costs	50	MI	$2.00	$100.00		GRI Cost Estimate (20 CY truck, 100 mile round trips)
Sampling	5	EA	$650.00	$3,250.00		GRI Cost Estimate (includes analysis, which includes TCLP and ignitability)
Labor	24	HR	$15.00	$360.00		GRI Cost Estimate
					$3,910.00	**GRI Cost Estimate (based on 1 person for 2-12 hour days to oversee truck loadings)**
Subtotal					**$9,605.00**	
Engineering and Contingency		***LS***	***$500.00***		***$500.00***	***GRI Cost Estimate***
Total					***$10,105.00***	

Source: Tabel E-3. GRI Topical Report Environmental Aspects of Hydrostatic Test Water Discharges: Operations, Characterization, Treatment and Disposal. April, 1996.

Table 31
HRT System
1 and 10 Million Gallon Discharges

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
CONSTRUCTION/INSTALLATION						
Hay Bales	250	EA	$3.00	$750.00		GRI Cost Estimate
Fence Posts (10' spacing around exterior, and support)	30	EA	$20.00	$600.00		GRI Cost Estimate
Reinforcing Rods-steel - 6 foot	60	EA	$1.20	$72.00		Allegheny Brick and Builder's Supply - Pittsburgh, PA
Reinforcing Rods-steel - 8 foot	70	EA	$1.60	$112.00		Allegheny Brick and Builder's Supply - Pittsburgh, PA
Filter Fabric - "floor" + interior/exterior walls	4500	SF	$0.11	$495.00		Trivera 1128 Geotextile - Fluid Systems, Inc. (800) 346-9107 - sold as 500 sq. yd. roll
Wire Fencing - 6 foot (interior and exterior of structure)	300	FT	$2.00	$600.00		1995 Mean's item 028-320-0300
Reinforced Polyethylene Sheeting - 4 mil.	2000	SF	$0.09	$180.00		1995 Mean's item 022-704-0060
Plywood (1/2 in. thick)	2	EA	$18.59	$37.00		84 Lumber, Pittsburgh, PA
Absorbent Boom	132	LF	$1.33	$176.00		Oil Mop, Inc. (Phone: 504-394-6110)
Piping (6 in. steel)	100	LF	$27.50	$2,750.00		1995 Mean's item 151-701-0670
Piping 24 in. steel)	12	LF	$0.00	$0.00		Provided by Pipeline Company
Piping (1 in. steel)	1	LF	$2.18	$2.00		1995 Mean's Item 151-701-0580
1 in. Gate Valve	1	EA	$18.25	$18.00		1995 Mean's item 151-955-2950
Labor	36	HR	$15.00	$540.00		GRI Cost Estimate
Post Hole Digger	1	DY	$540.00	$540.00		1995 Mean's item 016-408-0060
					$6,872.00	
OPERATION						
Labor	17	HR	$15.00	$250.00		GRI Cost Estimate
					$250.00	
DEMOBILIZATION						
Labor	24	HR	$15.00	$360.00		GRI Cost Estimate
					$360.00	

Table 31 Continued
HRT System
1 and 10 Million Gallon Discharges

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
WATER/SLUDGE DISPOSAL						
Disposal of Booms and Filter Fabric in Industrial Landfill	5	CY	$100.00	$500.00		GRI Cost Estimate
Miscellaneous Disposal (wire, rod, wood)						
Transportation Costs	50	MI	$2.00	$100.00		GRI Cost Estimate (20 CY truck, 100 mile round trips)
Sampling	5	EA	$650.00	$3,250.00		GRI Cost Estimate (includes analysis, which includes TCLP and ignitability)
Labor	24	HR	$15.00	$360.00		GRI Cost Estimate
					$4,210.00	**GRI Cost Estimate (based on 1 person for 2-12 hour days to oversee truck loadings)**
Subtotal					**$11,692.00**	
Engineering and Contingency		***LS***	***$500.00***		***$500.00***	***GRI Cost Estimate***
Total					***$12,192.00***	

Source: Tabel E-4. GRI Topical Report Environmental Aspects of Hydrostatic Test Water Discharges: Operations, Characterization, Treatment and Disposal. April, 1996.

Table 32
Carbon Adsorption
100,000 Gallon Discharge

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
SITE PREPARATION						
Clearing				$1,000.00		
Equipment Pad	1			$5,000.00		
					$6,000.00	
TRANSPORTATION						
	100	MI	$5.00	$500.00		
					$500.00	
CONSTRUCTION/INSTALLATION						
Carbon Canister	4		$26,900.00	$107,600.00		CarbonAir PC-78, 550 gpm, 4 in. Parallel
10 ft. Diameter x 18.5 ft. high						
Activated Carbon	80,000	LB	$0.95	$76,000.00		
Water Pump 2,000 gpm	1			$26,000.00		2,000 gpm, Run Time = 50 Minutes
Piping 6"	100	FT	$27.00	$2,700.00		
Valves 6"	6			$4,000.00		
Labor	50	22		$1,100.00		
					$217,400.00	

Table 32 Continued
Carbon Adsorption
100,000 Gallon Discharge

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
OPERATION						
Labor	24	HR	$22.00	$528.00		Allow 1 Day Minimum
					$528.00	
DEMOBILIZATION						
Labor	24	HR	$22.00	$528.00		
					$528.00	
Subtotal					**$224,956.00**	
Engineering (5%)					***$11,250.00***	
Contingency (10%)					***$22,500.00***	
Total					***$258,706.00***	

Table 33
Carbon Adsorption
100,000 Gallon Discharge* --Alternate

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
SITE PREPARATION						
Clearing				$1,000.00		
Equipment Pad	1			$5,000.00		
					$6,000.00	
TRANSPORTATION						
	100	MI	$5.00	$500.00		
					$500.00	
CONSTRUCTION/INSTALLATION						
Carbon Canister	1		$26,900.00	$26,900.00		CarbonAir PC-78, 550 gpm*
10 ft. Diameter x 18.5 ft. high						
Activated Carbon	20,000	LB	$0.95	$19,000.00		
Water Pump 550 gpm	1			$11,100.00		550 gpm, Run Time 3.03 Hours*
Piping 6"	50	FT	$27.00	$1,350.00		
Valves 6"	3			$2,000.00		
Labor	50	HR	$22.00	$1,100.00		
					$61,450.00	

Table 33 Continued
Active Carbon Adsorption
100,000 Gallon Discharge* --Alternate

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
OPERATION						
Labor	24	HR	$22.00	$528.00		One Day Minimum
Electrical	268	KWH	$0.06	$16.00		
					$544.00	
DEMOBILIZATION						
Labor	24	HR	$22.00	$528.00		
					$528.00	
Subtotal					**$69,022.00**	
Engineering (5%)					**$3,451.00**	
Contingency (10%)					**$6,902.00**	
Total					**$79,375.00**	

*Alternate Configuration, Using One Cannister at 550 gpm

Table 34
Carbon Adsorption
1 Million Gallon Discharge

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
SITE PREPARATION						
Clearing				$1,000.00		
Equipment Pad	1			$5,000.00		
					$6,000.00	
TRANSPORTATION						
	100	MI	$5.00	$500.00		
					$500.00	
CONSTRUCTION/INSTALLATION						
Carbon Canister	1		$26,900.00	$26,900.00		CarbonAir PC-78, 550 gpm
10 ft. Diameter x 18.5 ft. high						
Activated Carbon	20,000	LB	$0.95	$19,000.00		
Water Pump 550 gpm	1			$11,100.00		
Piping	50	FT	$27.00	$1,350.00		
Valves	3			$2,000.00		
Labor	50	HR	$22.00	$1,100.00		
					$61,450.00	

Table 34 Continued
Carbon Adsorption
1 Million Gallon Discharge

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
OPERATION						
Labor	31	HR	$22.00	$682.00		Operate at 550 gpm for 30 Hours instead of 2,000 gpm for 8 Hours
Electrical	339	KWH	$0.06	$20.00		
					$702.00	
DEMOBILIZATION						
Labor	24	HR	$22.00	$528.00		
					$528.00	
Subtotal					**$69,180.00**	
Engineering (5%)					***$3,459.00***	
Contingency (10%)					**$6,918.00**	
Total					***$79,557.00***	

Table 35
Carbon Adsorption
10 Million Gallon Discharge

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
SITE PREPARATION						
Clearing	1			$2,000		
Equipment Pad				$20,000		
					$22,000	
TRANSPORTATION						
	100	MI	$10	$1,000		
					$1,000	
CONSTRUCTION/INSTALLATION						
Carbon Canister	4		$26,900	$107,000		CarbonAir PC-78, 550 gpm, 4 Units in Parallel, Total Flow 2,200 gpm
Activated Carbon	80000	LB	$1	$76,000		
Water Pump 2,000 gpm	1		$26,000	$26,000		
Piping 6"	100	FT	$27	$2,700		
Valves 6"	12			$7,000		
Labor	60	HR	$22	$1,320		
					$220,020	

Table 35 Continued
Carbon Adsorption
10 Million Gallon Discharge

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
OPERATION						
Labor	76	HR	$22	$1,672		
Electrical	626	KWH	$0	$118		3. 1 Days Operation
					$1,790	
DEMOBILIZATION						
Labor	60	HR	$22	$1,320		
					$1,320	
Subtotal					**$246,130**	
Engineering (5%)					**$12,306**	
Contingency (10%)					**$24,612**	
Total					***$283,048***	

Table 36
Air Stripping
100,000 Gallon Discharge

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
SITE PREPARATION						
Clearing				$1,000.00		
Equipment Pad	1			$5,000.00		
					$6,000.00	
TRANSPORTATION						
Equipment	100	MI	$5.00	$500.00		
					$500.00	
CONSTRUCTION/INSTALLATION						
Column	1			$28,110.00		5 ft. Diameter
Packing, 3" Rashing Rings	225	FT^3	$7.80	$1,991.00		13 ft. Packing
Air Blower	1			$2,900.00		2,150 $ft.^3$/min.
Water Pump	1			$12,800.00		700 gpm
Mist Eliminator	1			$1,250.00		
Column Internals				$5,370.00		
Piping and Ducts				$13,900.00		
Electrical				$9,000.00		
Labor	48	HR	$22.00	$1,056.00		
Generator Rental	1	WK		$750.00		
					$77,127.00	

Table 36 Continued
Air Stripping
100,000 Gallon Discharge

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
OPERATION						
Labor	24	HR	$22.00	$528.00		2.4 hrs. Operation @ 694 gpm
Fuel	4	G/D	$3.00	$12.00		
					$540.00	
DEMOBILIZATION						
Labor	24	HR	$22.00	$528.00		
					$528.00	
Subtotal					**$84,695.00**	
Engineering (5%)					***$4,235.00***	
Contingency (10%)					***$8,470.00***	
Total					***$97,400.00***	

Table 37
Air Stripping
1 Million and 10 Million Gallon Discharge*

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
SITE PREPARATION						
Clearing				$1,000.00		
Equipment Pad	1			$5,000.00		
					$6,000.00	
TRANSPORTATION						
Equipment	100	MI	$5.00	$500.00		
					$500.00	
CONSTRUCTION/INSTALLATION						
Column	1			$40,000.00		9 ft. Diameter
Packing 3" Rashing Rings	827	FT^3	$7.80	$6,450.00		13 ft. of Packing
Air Blower	1			$5,531.00		6,350 $ft.^3$/min.
Water Pump	1			$24,100.00		2,000 gpm
Mist Eliminator	1			$3,000.00		
Column Internals				$8,600.00		Bed Supports, Distributor Plate
Piping and Ducts				$19,800.00		
Electrical				$9,000.00		
Labor	48	HR	$22.00	$1,056.00		
Generator Rental	1	WK		$750.00		
					$118,287.00	

Table 37 Continued
Air Stripping
1 Million and 10 Million Gallon Discharge*

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
OPERATION						
Labor	3 1/2	D	$528.00	$1,848.00		3 1/2 Day Run @ 2,000 gpm for the 10 Million Gallon Case. 8.33 Hour Run for the 1 Million Gallon Case.
Fuel	4	G/D	$3.00	$42.00		Operating Cost for 1 Million: Labor: 24 hr. = $528 Fuel: 4 x $3 = $ 12 Total: $540
					$1,890.00	
DEMOBILIZATION						
Labor	24	HR	$22.00	$528.00		
					$528.00	
Subtotal					**$127,205.00**	
Engineering (5%)					***$6,360.00***	
Contingency (10%)					***$12,720.00***	
Total					***$146,285.00***	

* Operating Costs for a 1 million gallon discharge is $540. Total cost for a 1 million gallon discharge is $144,935.

Table 38
Dissolved Air Flotation (DAF)
All Discharges*

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
SITE PREPARATION						
Clearing				$1,000.00		
Equipment Pad	1			$30,000.00		
					$31,000	
TRANSPORTATION						
Equipment	100	MI	$10.00	$1,000.00		
					$1,000	
CONSTRUCTION/INSTALLATION						
Dissolved Air Flotation Unit	1		$200,000.00	$200,000.00		Great Lakes DAF - 600, includes Recycle Air Pressure System (RPS)
Water Pump - 600 gpm	1		$12,000.00	$12,000.00		
Piping for RPS						Included Items as follows
Valves - 6"	3		$600.00	$1,800.00		600 gpm = 2.8 hr run time for 100,000 gallon discharge; 28 hrs for 1 M; 11 days for 10 M.
Float Piping - 4"	50	FT	$20.00	$1,000.00		
Sludge Piping	50	FT	$20.00	$1,000.00		
Labor	48	HR	$22.00	$1,056.00		
					$216,856	

Table 38 Continued
Dissolved Air Flotation (DAF)
All Discharges*

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
OPERATION						
Electrical						
DAF Motors - 1/2 & 1/2 HP	2.24	KWH	$0.06	$0.13		
Air Compressor - 1 HP	2.24	KWH	$0.06	$0.13		
Water Pump - 5 HP	11.20	KWH	$0.06	$0.67		
Labor	24	HR	$22.00	$528.00		One Day Minimum
					$529	
DEMOBILIZATION						
Labor	24	HR	$22.00	$528.00		
					$528	
Subtotal					**$249,913**	
Engineering (5%)					***$12,500***	
Contingency (10%)					***$25,000***	
Total					***$287,413***	***100,000 & 1,000,000 Gallon Operation***

* Operation costs for 10,000,000 Gallons = $5,908. Total cost for 10,000,000 gallons = $292,792.

Table 39
Ultra Violet Oxidation
All Discharges*

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
SITE PREPARATION						
Clearing				$1,000.00		
Equipment Pad				$5,000.00		
					$6,000	
TRANSPORTATION						
Equipment	100	MI	$5.00	$500.00		
					$500	
CONSTRUCTION/INSTALLATION						
Ultra Violet Unit	1		$350,000.00	$350,000.00		
Water Pump - 400 gpm	1		$9,170.00	$9,170.00		400 gpm gives a 4.2 hr run time for 100,000 gal; 42 hrs for 1 M gal & 17 days for 10 M
Piping for UV Unit						
Valves	3			$1,000.00		
Piping	50	FT	$18.00	$900.00		
Labor	24	HR	$22.00	$528.00		
					$361,598	

Table 39 Continued
Ultra Violet Oxidation
All Discharges*

	Quantity	Units	Unit Price	Subtotal	Total Cost	Comments
OPERATION						
Electrical						
128 KWH	538.00	KWH	$0.06	$16.00		
Labor	24	HR	$22.00	$528.00		One Day Minimum
					$544	
DEMOBILIZATION						
Labor	24	HR	$22.00	$528.00		
					$528	
Subtotal					**$369,170**	
Engineering (5%)					***$18,450***	
Contingency (10%)					***$36,900***	
Total					***$424,520***	***100,000 & 1,000,000 Gallon Operation***

* Operation costs for 10,000,000 Gallons = $8,976. Total cost for 10,000,000 gallons = $432,952

Table 40
Summary of Capital/Operating Cost Estimates
For Treatment Technologies

(See Page 5-5 For Assumptions Made In Developing Cost Estimates)

	Capital	Operating	Estimated(¢/gal)
Pre-Pigging and Pre-Cleaning			
100,000 Gallons	$6,300	$5,948	12.25
1,000,000 Gallons	$6,300	$5,948	1.22
10,000,000 Gallons	$7,175	$11,176	0.180
Hay Bales/HRT Sytem			
100,000 Gallons	$10,080	$25	10.11
1,000,000 Gallons	$11,942	$250	1.22
10,000,000 Gallons	$11,942	$250	0.122
Carbon Adsorption			
100,000 Gallons (Alt. Config Tbl 33)	$78,831	$544	79.38
1,000,000 Gallons	$78,855	$702	7.96
10,000,000 Gallons	$281,258	$1,790	2.83
Air Stripping			
100,000 Gallons	$96,860	$540	97.40
1,000,000 Gallons	$144,395	$540	14.50
10,000,000 Gallons	$144,395	$1,890	1.46
Dissolved Air Flotation			
100,000 Gallons	$286,884	$529	287.00
1,000,000 Gallons	$286,884	$529	28.70
10,000,000 Gallons	$286,884	$5,908	2.93
Ultra Violet Oxidation			
100,000 Gallons	$423,976	$544	424.00
1,000,000 Gallons	$423,976	$544	42.40
10,000,000 Gallons	$423,976	$8,976	4.33

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