



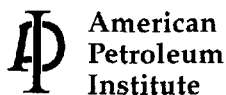
TEMPORARY TREATMENT OPTIONS FOR PETROLEUM DISTRIBUTION TERMINAL WASTEWATERS

REGULATORY AND SCIENTIFIC AFFAIRS
PUBLICATION NUMBER 4688
NOVEMBER 1999



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Temporary Treatment Options for Petroleum Distribution Terminal Wastewaters

Regulatory and Scientific Affairs

API PUBLICATION NUMBER 4688

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NOVEMBER 1999



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PREFACE

The American Petroleum Institute's (API's) Health and Environmental Sciences Department, through its Water Technology Task Force (Task Force), has been conducting a multi-year research program to identify and evaluate practical and environmentally sound technologies for wastewater treatment at petroleum facilities. The Task Force has also been sponsoring research to assist petroleum facilities and government agencies in improving regulations and attaining compliance. The results of this program are intended to provide both industry and regulatory agencies with the requisite technical information for making informed decisions on appropriate wastewater treatment alternatives for individual petroleum marketing and distribution facilities.

The Task Force has sponsored and published a significant number of research reports in prior years. A listing of some key published reports is provided below. The goal of this study was to identify options for the temporary treatment of wastewaters at marketing distribution terminals. Contaminated waters from distribution terminals can be generated intermittently, such as hydrostatic test waters or tank bottom waters, frequently in small volumes that can be stored. In many cases, these waters can be returned to refineries or other oil recyclers for oil recovery and reuse. The water portion of this material is treated at the receiving site. In other cases, it may be economical to install permanent facilities to treat the waters or to pretreat them for discharge and final treatment in POTWs (publicly owned treatment works, such as sewage treatment plants).

The trend toward highly automated distribution terminals, requiring minimal on-site staff, makes attractive temporary or mobile treatment facilities managed by contractors. Moreover, temporary treatment is often the preferred option for handling wastewater from the growing number of groundwater remediation projects at petroleum facilities. This report assists facility personnel in selecting appropriate temporary treatment technologies, competent contractors, and effective implementation options at petroleum product distribution and pipeline terminals. The information may also be applicable to other petroleum facilities that have a need for temporary treatment of wastewaters.

This report covers typical contaminated waters at terminals, permitting issues, treatment technology selection processes, contractor selection, oversight, and case studies.

The Task Force greatly acknowledges and appreciates the fine work performed by ENSR, Acton, Massachusetts, in preparing this document.

Studies Sponsored by the Water Technology Task Force

Publ. 4665 - Analysis and Reduction of Toxicity in Biologically Treated Petroleum Product Terminal Tank Bottoms Water, April 1998.

Publ. 4664 - Mixing Zone Modeling and Dilution Analysis for Water-Quality-Based NPDES Permit Limits, April 1998.

Publ. 1612 - Guidance Document for Discharging of Petroleum Distribution Terminal Effluents to Publicly Owned Treatment Works, November 1996.

Publ. 4602 - Minimization, Handling, Treatment, and Disposal of Petroleum Product Terminal Wastewaters, September 1994.

Publ. 4606 - Source Control and Treatment of Contaminants Found in Petroleum Product Terminal Tank Bottoms, August 1994.

Publ. 4582 - Comparative Evaluation of Biological Treatment of Petroleum Product Terminal Wastewater by the Sequencing Batch Reactor Process and the Rotating Biological Contactor Process, June 1993.

Publ. 4581 - Evaluation of Technologies for the Treatment of Petroleum Product Marketing Terminal Wastewater, June 1993.

ABSTRACT

This document provides terminal operators and engineers with an evaluation process for selecting temporary systems for treatment of wastewater generated at petroleum distribution terminals. Some of the variables that must be considered include the characteristics of the wastewater, the permitting process, and contractor experience. The four steps in the process are:

- problem definition
- technology selection
- contractor selection
- implementation

In problem identification, the operator/engineer collects information on the wastewater and terminal site, as well as 1) the constraints of the site, such as location, size and access to utilities, and 2) the applicable permits (e.g., RCRA, NPDES, and air). Once the problem is defined, the next step is to evaluate and select the appropriate treatment technology. This is done by first identifying the contaminants, based on the wastewater characteristics and site/permit limitations defined earlier. In selecting an appropriate treatment technology, the terminal operator/engineer uses information on available temporary treatment technologies, including their efficiencies in treating specific contaminants, and their capital and operating costs. Once the treatment technology is chosen, the terminal operator/engineer selects a competent contractor, taking into account such considerations as contractor experience, level of service, warranties, and cost.

CONTENTS

EXECUTIVE SUMMARY	ES-1
1.0 INTRODUCTION	1-1
1.1 Purpose of the Document.....	1-1
1.2 Why Consider Mobile Treatment?	1-1
1.3 When to Use Mobile Treatment (Comparison to Other Alternatives)	1-1
1.4 Document Overview	1-3
2.0 PROBLEM DEFINITION.....	2-1
Overview	2-1
2.1 Wastewater Characterization	2-1
2.1.1 Sources, Quality, and Volume of Typical Terminal Effluents.....	2-1
2.1.2 Characterization of Specific Wastewater Streams	2-3
2.2 Identification of Permitting Constraints	2-10
2.2.1 RCRA Considerations.....	2-10
2.2.2 Discharge Options	2-14
2.2.3 Agency Relations.....	2-15
2.3 Identification of Site Constraints	2-16
3.0 TREATMENT TECHNOLOGY SELECTION PROCESS	3-1
Overview	3-1
3.1 Selection Process Description.....	3-1
3.2 Treatment Technologies.....	3-2
3.3 Cost Evaluation Procedures	3-3
4.0 CONTRACTOR SELECTION PROCESS.....	4-1
Overview	4-1
4.1 Mobile Treatment Contractor Checklist.....	4-1
4.2 Experience	4-1
4.2.1 References	4-3
4.2.2 Current Activities	4-3
4.3 Financial Qualifications.....	4-3

4.3.1	Cost.....	4-3
4.3.2	Warranty.....	4-4
4.3.3	Alternatives to Warranty	4-5
4.4	Residuals	4-5
4.5	Permitting Services	4-5
4.6	Analytical Services	4-6
4.7	Health and Safety.....	4-6
5.0	CONTRACTOR OVERSIGHT	5-1
	Overview	5-1
5.1	Treatability Testing	5-1
5.2	Performance Verification	5-2
5.3	Process Control Instrumentation	5-2
5.4	Setup Logistics	5-3
5.5	Startup/Shutdown Procedures.....	5-4
5.6	SOPs.....	5-4
5.7	Operator Certification	5-5
5.8	Spill Control.....	5-5
5.9	Contingencies.....	5-6
5.10	Case Studies.....	5-6
6.0	IDENTIFICATION OF CONCERNS/PITFALLS	6-1
	Introduction	6-1
6.1	Control of Contractor	6-1
6.2	Regulatory Changes.....	6-2
6.3	Emergencies	6-3
6.4	Accumulation Storage	6-3
7.0	SUMMARY	7-1
	GLOSSARY	G-1
	REFERENCES	R-1

LIST OF TABLES

1-1	Comparison of Mobile Treatment to Permanent Treatment and Off-Site Transportation	1-2
2-1	Petroleum Products Terminals Wastewater and Likely Contaminants	2-2
2-2	Terminal Wastewater Quality	2-4
2-3	Common Petroleum Industry Wastewater Analyses	2-6
3-1	Contaminants and Appropriate Treatments	3-4
3-2	Treatment Technology Description	3-5
5-1	Summary of Case Studies - Mobile Treatment of Terminal Wastewater	5-8

LIST OF FIGURES

2-1	RCRA Guide for TCLP Hazardous Wastewater	2-12
4-1	Mobile Treatment Contractor Checklist	4-2
7-1	Summary Checklist	7-2



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EXECUTIVE SUMMARY

This document provides guidance to terminal operators and engineers in evaluating mobile treatment systems for wastewater generated at petroleum distribution terminals. Some of the variables that must be considered include the characteristics of the wastewater, the permitting process, and contractor experience. This executive summary provides an overview of the evaluation process; the gray highlight boxes identify the sections in the document for further discussion. The four steps in the process are:

- problem definition
- technology selection
- contractor selection
- implementation

The first step in the evaluation process is to define the treatment problem. The operator/engineer should start by collecting information on the wastewater and terminal site. The wastewater is characterized by:

- Consideration of typical wastewater sources, and
- Sampling and analysis of the terminal's wastewater to define its quality and volume/flow rate.

Identifying the constraints of the site (such as location, size and access to utilities) and the applicable permits (e.g., RCRA, NPDES, and air) completes the problem definition.

PROBLEM DEFINITION

- Identify and Characterize the Wastewater (Section 2.1)
- Identify Site and Permit Constraints (Sections 2.2 and 2.3)

Once the problem is defined, the next step is to evaluate and select the appropriate treatment technology. This is done by first identifying the contaminants, based on the wastewater characteristics and site/permit limitations defined earlier. The terminal operator/engineer should use information on the available mobile treatment technologies and their efficiencies in treating specific contaminants (see Tables 3-1 and 3-2) to select an appropriate treatment technology.

The operator/engineer should consider the economic ramifications such as the capital, operation, and maintenance costs as well as the technical feasibility of each technology.

TECHNOLOGY SELECTION

(Flow Chart, Figure 3-1)

- Select Technologies Based on Technical Feasibility (Tables 3-1 and 3-2)
- Evaluate Technologies Based on Economic Feasibility (Section 3.3)

Once the treatment technology is chosen, the terminal operator/engineer should select a competent contractor to mobilize and operate the treatment system. In Section 4.0, there is a checklist (Figure 4-1) that identifies the essential elements of contractor selection. The issues to consider in contractor selection are:

- Experience (references and information on current projects)
- Cost (including mobilization, treatment and demobilization)
- Warranty (including liability for pilot tests and permitting)
- Residuals (handling, treatment and disposal)
- Additional services (including analytical and permitting services)

CONTRACTOR SELECTION

(Checklist, Figure 4-1)

- Review Experience (Section 4.2)
- Review Financial Qualifications (Section 4.3)
- Review Liability Issues (Sections 4.4, 4.5, 4.6, and 4.7)

Prior to selecting the contractor, the operator/engineer should evaluate the proposed implementation of the mobile treatment system. Also, he/she should review the contractor's past performance and proposed methodology for performing:

- Treatability testing
- Performance verification
- Process control instrumentation
- Startup/shutdown procedures
- Standard Operating Practices (SOPs)
- Operator certification and training (including health and safety)
- Spill control
- Contingencies

Before committing to a mobile treatment system and contractor, the terminal operator/engineer should assess potential pitfalls such as:

- Control of the contractor
- Regulatory changes
- Emergencies
- Accumulation storage (RCRA)

IMPLEMENTATION ISSUES

- Review Oversight Issues (Section 5.0)
- Assess Potential Pitfalls (Section 6.0)

This document provides sufficient information to guide an operator/engineer through evaluation of mobile treatment systems, including problem definition, treatment technology selection, contractor selection and implementation. Additional information and guidance should also be obtained from in-house technical and legal staff, or outside consultants.

1.0 INTRODUCTION

1.1 Purpose of the Document

This document provides guidance to terminal operators and engineers in evaluating and selecting mobile treatment systems for wastewater generated at petroleum distribution terminals.

1.2 Why Consider Mobile Treatment?

Three reasons for terminal personnel to consider the use of mobile treatment include:

- wastewater does not meet final disposal requirements (e.g., NPDES permit limits)
- wastewater flow is of short duration (less than 3 months per year) and can have significant volume (more than 10,000 gallons)
- resources (labor, time, and capital budget) are limited

Mobile treatment systems may not be appropriate for all wastewater streams at a petroleum terminal. In some cases, transportation to an off-site treatment facility or construction of a permanent treatment system is a better choice.

1.3 When to Use Mobile Treatment (Comparison to Other Alternatives)

As indicated on Table 1-1, mobile treatment systems have distinct advantages over other alternatives. Mobile treatment is often more appropriate than on-site permanent treatment or transportation off-site. First of all, mobile treatment requires little or no capital improvements to implement. Treatment can begin rapidly because the mobilization and installation are so quick. Mobile treatment technologies are flexible so that they can be easily moved from site to site to treat flows that occur over a short time period. In addition, the labor and expertise to install and operate a mobile system are supplied by the contractor - a critical consideration when the terminal's resources are limited.

There are some limits, however, to using mobile treatment. Even though capital costs are generally small (e.g., utility hookup), long-term operating costs, and the costs of mobilization and demobilization, should be considered. Residual disposal and treatment costs will also increase the operation and maintenance cost. Another disadvantage of mobile treatment is the liability incurred by having contractor personnel and equipment on site for a period of time.

TABLE 1-1
Comparison of Mobile Treatment to
Permanent Treatment and Off-Site Transportation

	Mobile Treatment	Permanent Treatment	Transportation to Off-Site Treatment
Advantages	Minimal Capital Investment Treats Periodic Flow Labor & Expertise Included	Equipment Always Available Treats Continuous Flow	No Capital Investment Required Treats Periodic Flow Minimal Oversight Required Minimal Permitting Administrative Burden
Disadvantages	Cumulative O&M Cost Contractor Liability Oversight Required Size Limited to Mobile Platform Hookups Required	High Capital Cost Labor & Expertise Required	High Transportation Cost for Distant Treatment Facility Expensive for Volumes Above 10,000 Gallons Liability Increased by Transportation Dependent on Acceptance by Treatment Facility

Another drawback is the required time to manage the contractor (e.g., initial negotiations, setup, and oversight).

When considering the use of mobile treatment, weigh the benefits and drawbacks of mobile treatment in relation to the other two alternatives on Table 1-1. The specific characteristics of the terminal (wastewater and location) will affect selection of the most appropriate alternative for the petroleum terminal. In general, mobile treatment should be used if there is a large volume (>10,000 gallons) of wastewater and flow is periodic and of short duration. On the other hand, permanent treatment should be implemented if the wastewater stream is continuous and the flow rate is relatively large. As a rule of thumb, off-site treatment should be used if the wastewater volume is small (<10,000 gallons) and flow is periodic.

1.4 Document Overview

This document addresses the four-step process for evaluating and selecting a mobile treatment system and contractor. Section 2.0 summarizes the problem definition process that includes characterization of the wastewater and identification of permitting and site constraints. Section 3.0 summarizes the treatment technology selection process. Section 4.0 describes the contractor selection process. Sections 5.0 and 6.0 summarize the implementation issues to consider prior to project initiation.

2.0 PROBLEM DEFINITION

Overview

The first step in the evaluation process is to define the treatment problem. Start by collecting information on the wastewater and terminal site. The wastewater is characterized by:

- Consideration of typical wastewater sources, and
- Sampling and analysis of the terminal's wastewater to define its quality and volume/flow rate.

The second step is to identify the problem constraints (e.g., applicable permits and site constraints).

2.1 Wastewater Characterization

2.1.1 Sources, Quality, and Volume of Typical Terminal Effluents

Sources: The primary sources of wastewater at a typical terminal are tank bottoms water (which may be a product, if petroleum hydrocarbons are recovered from it), water collected from secondary containment areas and storm water. Tank bottoms water collects in the bottom of bulk storage tanks. It results from water included in outside deliveries, tank breathing and condensation of moisture in the air, and rain water leaking through floating roof seals. Spill containment wastewater includes all the water that collects in the loading rack spill collection system including minor amounts of oil from drips, leaks and spills. Table 2-1 summarizes the typical sources and likely contaminants in petroleum terminal wastewater.

Quality: Typical marketing terminal wastewater contains dissolved organic matter measured as biochemical oxygen demand (BOD₅), chemical oxygen demand (COD), total organic carbon (TOC), and the soluble fraction of oil and grease, which may include benzene, toluene, ethylbenzene and xylenes (BTEX), phenols, oxygenates, surfactants, and naphthenic acids. Most terminal wastewater will contain oily contaminants including oil and grease, total petroleum hydrocarbons (TPH), and the oily fraction of BOD₅, COD, and TOC (e.g., aliphatics and polynuclear aromatic hydrocarbons [PAHs]). Terminal wastewater usually contains suspended solids and settleable material that can contribute to BOD₅, COD and TOC.

TABLE 2-1

Petroleum Products Terminals Wastewater and Likely Contaminants

Wastewater Type	Oil & Grease	TPH	BOD	COD	TOC	Ammonia	pH high, low	TSS
Tank bottoms water	H	H	H	H	H	H	M	H
Spill containment wastewater	H	H	L	L	L	0	0	H
Truck wash water	H	H	M	M	M	0	H	H
Truck maintenance wastes	H	H	H	H	H	0	L	0
Ballast water	H	H	M	M	M	0	0	M
Produced groundwater	M	M	L	L	L	0	0	0
Vapor recovery water	H	H	M	M	M	0	0	0
Haulback material water bottoms	H	H	M	M	M	0	0	L
Hydrostatic test water	L/0	L/0	L/0	L/0	L/0	0	0	0
Boiler blowdown	0	0	0	0	0	0	H	L
Steam condensate	0	0	0	0	0	0	H	0
Laboratory wastes	M	M	M	M	M	?	?	?
Sanitary wastes	0	0	H	H	H	?	0	H
Detergents	L	L	H	H	H	?	H	H

Wastewater Type	Sulfide	Phenols	TDS	Naphthenic Acids	BTEX	Surfactants	Metals	Toxicity After Treat
Tank bottoms water	M	H	H	H	H	H	L	M
Spill containment wastewater	0	0	0	0	H	0	0	0
Truck wash water	0	0	M	0	0	H	0	M
Truck maintenance wastes	0	0	L	0	0	0	0	H
Ballast water	L	0	H/L	0	?	0	?	M
Produced groundwater	?	0	?	0	H	0	?	L
Vapor recovery water	0	0	0	0	H	0	0	0
Haulback material water bottoms	0	0	0	0	H	0	0	L
Hydrostatic test water	0	0	L	0	0	0	0	0
Boiler blowdown	0	0	H	0	0	0	?	L
Steam condensate	0	0	0	0	0	0	0	0
Laboratory wastes	?	?	?	0	?	?	M	?
Sanitary wastes	M	0	L	0	0	M	L	?
Detergents	0	0	H	0	0	H	0	M

H = High concentration or probability
 M = Medium concentration or probability
 L = Low concentration or probability
 0 = Very low concentration or probability
 ? = Unknown concentration or probability

(Source: Texaco Inc. 1994)

Note: Toxicity refers to the toxic effects of wastewater on aquatic life as measured by acute or chronic bioassays.

Table 2-2 presents research data on the concentration of parameters commonly found in terminal wastewater.

Volume: Wastewater volume at petroleum terminals varies considerably and should be characterized, if possible, at each terminal prior to treatment. The volume of the wastewater, and the time frame during which the wastewater must be treated, determine the flow rate. This flow rate is required to properly size the storage, equalization and treatment units. Based on previous surveys, terminal effluent is produced at a rate of approximately 1000 gallons per week (Texaco, 1994). Yearly wastewater production at terminals can range from 10,000 to 100,000 gallons (Brown and Caldwell, 1986). Tank bottoms water makes up a small portion of the wastewater flow, but contains recoverable product. Storm water collected in loading rack spill containment systems (spill containment wastewater) makes up a larger portion of the flow. Hydrostatic test water, on the other hand, may result in high flow rates because the large volume (from a bulk storage tank or pipeline) is released over a short time period.

Flow characterization data determine the size of feed, equalization, or effluent storage tanks for continuous wastewater treatment. Wastewater flows from a feed tank through the treatment units and into an effluent collection tank. If feed water and effluent storage tanks are provided, feed water and effluent can be characterized prior to treatment and discharge. The treatment technology can be adjusted to feed water characteristics and compliance with permit limits can be demonstrated. These advantages often justify the cost of the storage tanks. Once the wastewater characteristics are consistent and the technology is proven, effluent discharge without collection may be more economical. As a rule of thumb, it is impractical and expensive to collect effluents of greater than approximately 50,000 gallons.

2.1.2 Characterization of Specific Wastewater Streams

Identification of Contaminants of Concern: Contaminants of concern are those chemical parameters that are limited by a discharge permit or those that limit the effectiveness of potential treatment technologies. These compounds can be identified by reviewing existing characterization data, considering which parameters may be in the water as a result of operations, and reviewing existing permits. Once the parameters are identified, appropriate analyses can be defined. Table 2-3 describes the analyses for compounds commonly regulated in discharge permits for the petroleum industry.

TABLE 2-2
Terminal Wastewater Quality*

Contaminant	Units	Gasoline Tank Bottoms(9)			Diesel/Fuel Oil Tank Bottoms(2)			Terminal Wastewater(4)		
		Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum
BOD	ppm	4369	7177	1961	1305	1617	982	1412	2600	570
COD	ppm	27778	58000	8075	8688	9175	8200	3935	6000	1700
TOC	ppm	5936	12760	2741	1786	2381	1191	999	1980	290
Oil & Grease	ppm							100	240	25
TPH	ppm							42	250	2
Ammonia	ppm	1650	4300	16	1635	2500	770	22.7	116	0.1
Benzene	ppm							5.3	11	0.8
Toluene	ppm							9.3	19	0.11
Xylenes	ppm							5.6	14	0.011
Ethyl Benzene	ppb							2397	6200	180
MTBE	ppm							105	290	8.5
Methanol	ppm							143	630	<1
Ethanol	ppm							4	12	<1
Phenols	ppm							10	52	0.4
2,4 Dimethyl Phenol	ppb							603	1300	97
MBAS	ppm							6.1	16.2	1.1
CTAS	ppm							5.4	14	0.2
TSS	ppm							195	768	45
TDS	ppm							1893	3660	646
Conductivity								2260	4000	1013
Sulfide	ppm							<0.5	2	<0.01
Cyanide	ppm							<0.01	<0.01	<0.005
Arsenic	ppb	6073	20794	381	101	195	6	167	430	28
Cadmium	ppb		<3	<3	<3	<3	<3		14	<5
Chromium	ppb		62	<5		<5			90	<10
Copper	ppb	3576	8028	179	1478	2235	720		550	<20
Lead	ppb		1669	<1		<1			550	<60
Mercury	ppb		1	<0.2		<0.2				
Nickel	ppb	345	779	30	66	100	31			
Zinc	ppb	2153	9696	126	246	445	47	492	1700	20