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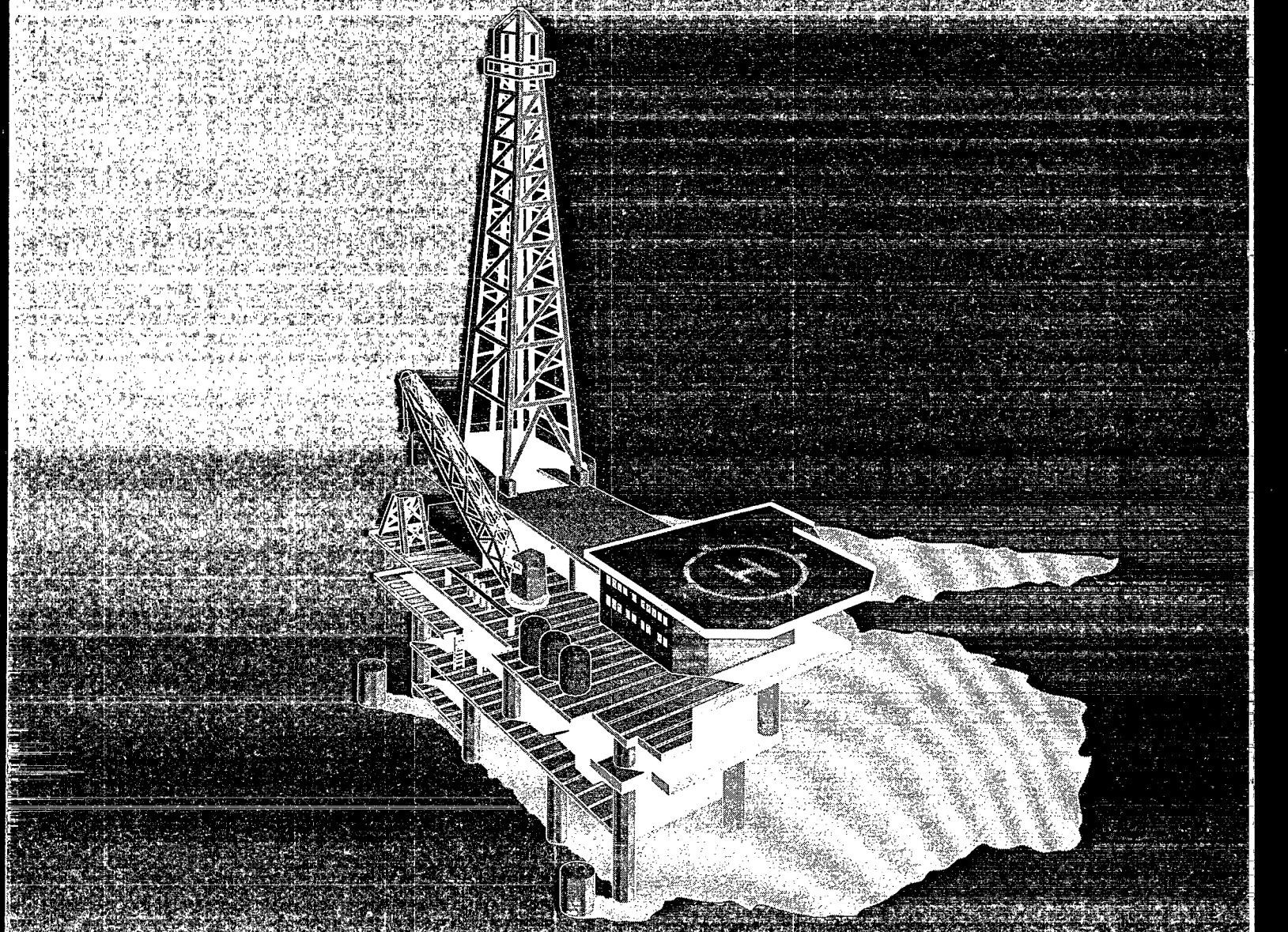
EPA

Cost Effectiveness Analysis of Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category



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SECTION ONE

INTRODUCTION

This report supports the Effluent Limitations Guidelines and Standards for the Coastal Oil and Gas Industry ("Coastal Guidelines"). The report analyzes the cost-effectiveness of five regulatory options for three wastestreams organized into two wastestream groups under the current regulatory baseline and under an alternative baseline. In this document, EPA compares the total annualized cost of each regulatory option to the corresponding effectiveness of that option in reducing the discharge of pollutants for each wastestream. EPA evaluates the effectiveness in terms of costs per pound of pollutant removed, weighted by the relative toxicity of the pollutant. The rationale for this measure, referred to as "pound equivalents removed," is described later in this document.

Section Two discusses EPA's cost-effectiveness methodology and identifies the pollutants included in the analysis. This section also presents EPA's toxic weighting factors for each pollutant and considers the removal efficiency of each option. Section Three presents the results of an analysis comparing the considered options to the current regulatory baseline (see the Final Economic Impact Analysis [FEIA]).[1] Section Four compares the options considered to an alternative baseline (see the FEIA, Chapter Ten). In Section Five, cost-effectiveness values for selected coastal options are compared to cost-effectiveness values for other promulgated rules. Appendix A presents data on pollutants and pollutant removals and Appendix B presents data on annualized costs for each of the regulatory options. Appendix C presents an analysis of cost-effectiveness using total annualized dollar losses as calculated in the FEIA. These total dollar losses incorporate the values of all production losses as well as compliance costs for all affected producing units that do not shut in in the baseline or first year.

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[1] U.S. Environmental Protection Agency. 1996. Economic Impact Analysis for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. October.

SECTION TWO

BACKGROUND METHODOLOGY

The cost-effectiveness (CE) of the Coastal Guidelines is evaluated as the average and incremental annualized cost of a pollution control option in an industry or industry subcategory per total and incremental pound equivalent of pollutant (i.e., pound of pollutant adjusted for toxicity) removed by that control option. The cost-effectiveness analysis primarily enables EPA to compare the removal efficiencies of regulatory options under consideration for a rule. A secondary and less effective use is to compare the cost-effectiveness of the options for the Coastal Guidelines to that of Effluent Guidelines for other industries. By ranking the options in order of decreasing cost-effectiveness (higher cost per pound equivalent removed), EPA can identify the point at which options cease to be cost-effective.

EPA ranks options in order of decreasing cost-effectiveness (increasing cost per pound equivalent removed) in order to identify the point at which increased removal of pollutants is no longer cost-effective. Generally, EPA determines this to be where costs (per pound equivalent removed) increase sharply, that is, where relatively few incremental pounds are removed for steady increases in cost. The accompanying figure (Figure 2-1) shows this point as Point A, where the cost-effectiveness curve becomes nearly vertical. Increases in removals beyond this point come only at relatively high unit costs, which, in many cases, EPA will determine exceeds the benefit of the increased removals to society.

A number of steps must be undertaken before a cost-effectiveness analysis can be performed. There are five steps that define the analysis or generate data for use in the cost-effectiveness calculation:

- Determine the wastewater pollutants of concern (priority and other pollutants).
- Estimate the relative toxic weights (the adjustments to pounds of pollutants to reflect toxicity) of the pollutants of concern.
- Define the regulatory pollution control options.
- Calculate pollutant removals for each pollution control option.
- Determine the annualized cost of each pollution control option.

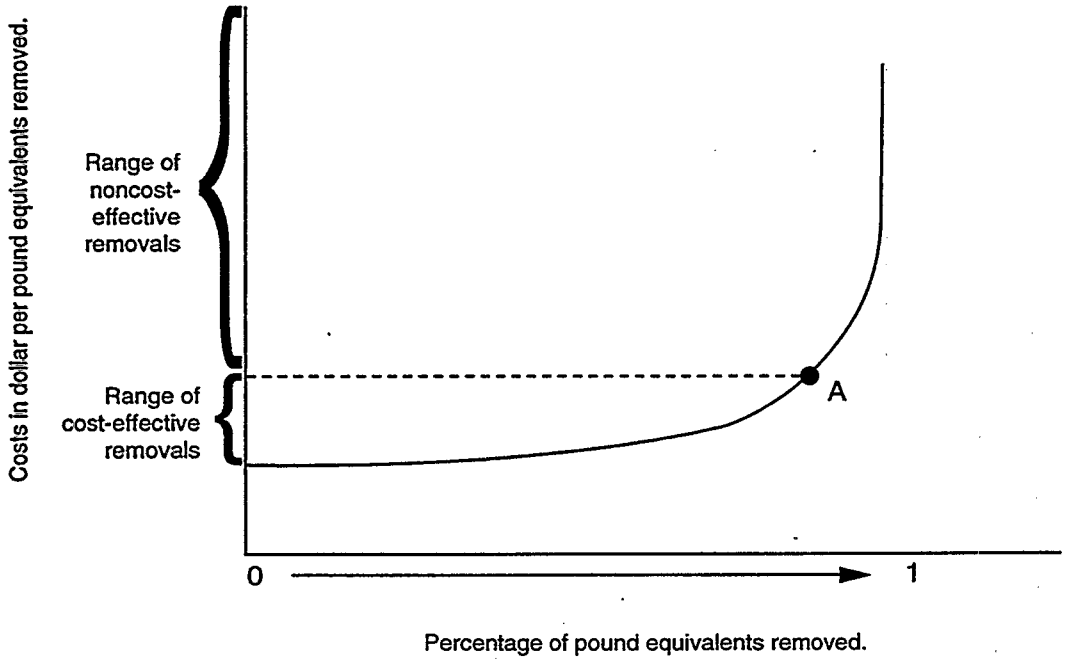

Figure 2-1. Cost effectiveness

All of these factors are used in the calculation of the cost-effectiveness values, which can then be compared for each regulatory option under consideration. The following sections discuss the five preliminary steps and the cost-effectiveness calculation and comparison methodologies.

2.1 POLLUTANTS OF CONCERN

Under the Effluent Limitation Guidelines and Standards for the Coastal Oil and Gas Industry, a number of priority and other nonconventional pollutants are regulated. Some of the factors considered in selecting pollutants for regulation include toxicity, frequency of occurrence in wastestream effluent, and amount of pollutant in the wastestream. The list of regulated pollutants for each regulatory option is presented in Appendix A.

2.2 TOXIC WEIGHTING FACTORS

Cost-effectiveness analyses account for differences in toxicity among the pollutants using toxic weighting factors. These factors are necessary because different pollutants have different potential effects on human and aquatic life. For example, a pound of zinc in an effluent stream has a significantly different effect than a pound of PCBs. Toxic weighting factors for pollutants are derived using ambient water quality criteria and toxicity values. For most industries, toxic weighting factors are derived from chronic freshwater aquatic criteria. In cases where a human health criterion has also been established for the consumption of fish, then the sum of both the human and aquatic criteria are used to derive toxic weighting factors. The factors are standardized by relating them to a "benchmark" toxicity value that was based on the toxicity of copper when the methodology was developed.[2] Appendix A presents the toxic weighting factors used for the regulated pollutants in the cost-effectiveness analysis of the coastal oil and gas industry. Where possible, EPA derived toxic weighting factors

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[2] Although the water quality criterion has been revised (to 12.0 ug/l), all cost-effectiveness analyses for effluent guideline regulations continue to use the "old" criterion of 5.6 ug/l as a benchmark so that cost-effectiveness values can continue to be compared to those for other effluent guidelines. Where copper is present in the effluent, the revised higher criterion for copper results in a toxic weighting factor for copper of 0.467 rather than 1.0.

for pollutants discharged to saltwater, since most discharges by the industry are to salt or brackish waters.[3] In general, saltwater toxic weighting factors are lower (i.e., less toxic) for pollutants in saltwater than in freshwater. Only where no saltwater toxic weighting factors are available are freshwater factors used.

Examples of the effects of different aquatic and human health criteria on freshwater toxic weighting factors are presented in Table 2-1. As shown in this table, the toxic weighting factor is the sum of two criteria-weighted ratios: the "benchmark/old" copper criterion divided by the human health criterion for the particular pollutant and the "benchmark/old" copper criterion divided by the aquatic chronic criterion. For example, using the values reported in Table 2-1, 11 pounds of the benchmark chemical (copper) pose the same relative hazard in freshwater as one pound of cadmium because cadmium has a freshwater toxic weight 11 times as large as the toxic weight of copper (5.16/0.467=11.05).

2.3 POLLUTION CONTROL OPTIONS

This cost-effectiveness analysis was performed on pollution control options proposed for two wastestream groups: 1) produced water/treatment, workover, and completion fluids (TWC); and 2) drilling wastes. The produced water/TWC measures include both costs and loadings for produced water and TWC, which were treated separately at proposal. Table 2-2 presents a summary of the options proposed by wastestream. In all there are five separate options: three produced water/TWC options and two drilling waste options under two regulatory baselines. For all wastestreams, a zero-discharge option is considered. New Source Performance Standards (NSPS) options are not specifically covered because they are identical to Best Available Technology (BAT) options. The relative cost-effectiveness for new sources will not be different than that shown for the BAT options. Pretreatment Standards for Existing Sources (PSES) and Pretreatment Standards for New Sources (PSNS) options identical to NSPS options are also proposed. Because no PSES or PSNS projects are anticipated, however, the cost-effectiveness of these options is not discussed.

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[3] This is true for Main Passes and Cook Inlet as well as for discharges associated with the alternative baseline (See Section Four.)

TABLE 2-1

EXAMPLES OF TOXIC WEIGHTING FACTORS BASED ON COPPER FRESHWATER CHRONIC CRITERIA

Pollutant	Human Health Criteria (µg/l)	Aquatic Chronic Criteria (µg/l)	Weighting Calculation	Toxic Weighting Factor
Copper	---	12.0	5.6/12.0	0.467
Cadmium	84	1.1	5.6/84 + 5.6/1.1	5.16
Naphthalene	41,026	370	5.6/41,026 + 5.6/370	0.015

Notes: Human health and aquatic chronic criteria are maximum contamination thresholds. Units for criteria are micrograms of pollutant per liter of water.

Source: Versar, Inc. 1991. Toxic Weighting Factors for Oil and Gas Extraction Industry Pollutants. Prepared for U.S. Environmental Protection Agency, Office of Water, October 1992.

TABLE 2-2

REGULATORY OPTIONS CONSIDERED IN THE COST-EFFECTIVENESS ANALYSIS

Type of Wastestream	Option	Description
Produced Water/TWC	Option #1	Zero discharge except eight outfalls of produced water into deltaic passes of the Mississippi River and Cook Inlet — discharge limitations
	Option #2	Zero discharge all except Cook Inlet — discharge limitations
	Option #3	Zero discharge all
Drilling Wastes	Option #1	Discharge limitations
	Option #2	Zero discharge all

2.4 POLLUTANT REMOVALS

The pollutant loadings have been calculated for each facility under each regulatory option for comparison with baseline (i.e., current practice, without the regulation) loadings. The postregulatory removals for each wastestream affected under each regulatory option are presented in Appendix A.

Pollutant removals are calculated directly as the difference between current and post-treatment discharges. Removals are then weighted using the toxic weighting factors and are reported in pound equivalents (see Appendix A for pound equivalent removals for all pollutants by wastestream and option). Total removals for each option are then calculated by summing the removals for all pollutants under each option. Total pollutant and pound equivalent removals estimated to be achieved under each regulatory option are presented by wastestream in Table 2-3.

2.5 ANNUALIZED COSTS OF COMPLIANCE

Under each regulatory option, annualized costs of compliance have been developed (see the FEIA). The derivation of these costs is summarized briefly below.

For produced water and TWC, EPA derived the pretax costs (including the state and federal governments' share of compliance costs)[4] of purchasing, installing, and operating injection wells or improved gas flotation systems, or alternatively, transportation and disposal at a commercial facility, depending on size of operation for each of the treatment facilities not yet required to meet zero discharge in 1996 in the Gulf of Mexico and for each of the treatment facilities in Cook Inlet. Where capital costs are incurred, EPA annualized them at 7 percent[5] over 10 years (the estimated realistic worst-case lifetime of production) and added to the annual costs of operating the pollution control equipment. Commercial disposal costs were computed on the basis of barrels per year disposed.

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[4] Every dollar spent on compliance can be applied against a firm's taxable income. Due to various tax mechanisms such as accelerated depreciation, this reduction means that firms face only about 60 to 70 percent of compliance costs post-tax.

[5] Source of real cost of capital: Office of Management and Budget. Economic Analysis of Federal Regulations Under Executive Order 12866. January 11, 1996.

TABLE 2-3

TOTAL POLLUTANT REMOVALS BY REGULATORY OPTION
CURRENT REGULATORY BASELINE

Type of Wastestream	Option	Total Annual Pollutant Removals	Total Pound Equivalent Removals
Produced Water/TWC	Option #1	5,165,181	489,305
	Option #2	1,497,541,244	712,335
	Option #3	2,552,583,264	1,213,725
Drilling Waste	Option #1	0	0
	Option #2	25,287,965	8,536

For drilling wastes (which are only of concern in Cook Inlet), EPA estimated the costs of landfilling (in an existing landfill, so to accrue annual costs only) versus using dedicated disposal wells (including the capital costs of installing wells and retrofitting platforms). Based on a drilling schedule supplied by Cook Inlet operators, EPA distributed operating costs over time. EPA then derived the net present value of this uneven stream of capital and operating cost outlays annualized at 7 percent over a 7-year period of drilling.

The aggregate annual costs by option are presented in Table 2-4. Appendix B presents the calculations used to arrive at the aggregate annual costs figures. Appendix C presents costs and cost-effectiveness for an alternative analysis incorporating production losses into the cost of regulatory compliance.

2.6 CALCULATION OF THE COST-EFFECTIVENESS VALUES

Cost-effectiveness values are calculated separately for each wastestream. This approach leads to the following two analytical groupings: produced water/TWC options and drilling waste options. Within each of these groups, the options are ranked in ascending order of pound equivalents of pollutants removed. Under each of these analytical groupings, the incremental cost-effectiveness value for a particular control option is calculated as the ratio of the incremental annual cost to the incremental pound equivalents removed. Average cost-effectiveness values are calculated as total dollars divided by total pound equivalents. The incremental effectiveness may be viewed primarily in comparison to the baseline scenario and to other regulatory options. Cost-effectiveness values are reported in units of dollars per pound equivalent of pollutant removed.

For the purpose of comparing cost-effectiveness values of options under review to those of other promulgated rules, compliance costs used in the cost-effectiveness analysis are adjusted to 1981 dollars using *Engineering News Record*'s Construction Cost Index (CCI). This adjustment factor is calculated as follows:

Adjustment factor = 1981 CCI/1995 CCI = 3,535/5,471 = 0.646

TABLE 2-4

AGGREGATE ANNUAL COSTS BY REGULATORY OPTION
CURRENT REGULATORY BASELINE
(1981 $)

Type of Wastestream	Option	Aggregate Annual Cost
Produced Water/TWC	Option #1	$2,386,206
	Option #2	$10,081,484
	Option #3	$30,935,664
Drilling Wastes	Option #1	$0
	Option #2	$5,969,728

The equation to calculate incremental cost-effectiveness is:

$$CE_k = \frac{ATC_k - ATC_{k-1}}{PE_k - PE_{k-1}}$$

where:

CE_k=	Cost-effectiveness of Option k
ATC_k=	Total annualized treatment cost under Option k
PE_k=	Pound equivalents removed by Option k

The numerator of the equation, ATC_k minus ATC_{k-1}, is simply the incremental annualized treatment cost in going from Option k-1 (an option that removes fewer pound equivalent pollutants) to Option k (an option that removes more pound equivalent pollutants). The denominator is similarly the incremental removals achieved in going from Option k-1 to k. Thus, cost-effectiveness measures the incremental unit cost of pollutant removal of Option k (in pound equivalents) in comparison to Option k-1.

Average cost-effectiveness values can also be derived by setting ATC_{k-1} to zero and by setting the pollutant loadings (PE_{k-1}) to the current loading. These values can be used, with caution, to compare an option to previously promulgated effluent limitations guidelines.

2.7 COMPARISONS OF COST-EFFECTIVENESS VALUES

Because the options are ranked in ascending order of pound equivalents of pollutants removed, any option that has higher costs but lower removals than another option immediately can be identified (the cost-effectiveness value for the next option becomes negative). When negative values are computed for Option k, Option k-1 will be noted as "dominated" (having a higher cost and lower removals than Option k). Option k-1 is then removed from the cost-effectiveness calculations, and all cost-effectiveness values within a regulatory grouping are then recalculated without the "dominated" option. This process continues until all "dominated" options are eliminated. The remaining options can then be presented in terms of their incremental cost-effectiveness values and are considered viable options for regulatory consideration.

SECTION THREE

CURRENT REGULATORY BASELINE RESULTS

The cost-effectiveness analysis is based on the Agency's estimates of the cost of compliance and wastewater pollution removals associated with five BAT options for two wastestream groups—produced water/TWC and drilling waste. NSPS options are also established but are not separately investigated because they are the same as BAT options and the relative cost-effectiveness is the same. A total of five options organized into the two wastestream groups under the current regulatory baseline are analyzed (see Section Two for more details).

The following sections present a brief description of the technologies used in each of the regulatory groupings, and, for each grouping, cost-effectiveness data and results are presented in a table. Note that the incremental data for the first option in each group is determined against baseline values (i.e., no removals and no cost). Cost-effectiveness results are presented for priority and other nonconventional pollutants combined.

3.1 PRODUCED WATER/TWC BAT OPTIONS

Three BAT options were evaluated for produced water/TWC. Option #1 requires oil and grease limits based on the use of improved gas flotation technology (currently required of all offshore oil and gas operations). Option #2 requires all operations to achieve zero discharge, with the exception of Cook Inlet and main pass operations, where limits based on improved gas flotation must be achieved. Option #3 requires all coastal oil and gas operations to achieve zero discharge, regardless of location.

Table 3-1 presents the cost-effectiveness data and results under the current regulatory baseline. As shown in the table, the incremental cost-effectiveness values range from $5 to $42 per pound equivalent removed.

The selected option is Option #2, zero discharge with improved gas flotation in Cook Inlet. The incremental cost-effectiveness of this option is $35 per pound equivalent removed and the average cost-effectiveness is $14 per pound equivalent removed.

TABLE 3-1

CURRENT REGULATORY BASELINE

COST-EFFECTIVENESS FOR PRODUCED WATER AND TREATMENT, WORKOVER, AND COMPLETION COMBINED MAIN PASS AND COOK INLET OPERATIONS

Option	Total Annual		Incremental		Incremental Cost Effectiveness (1981 $) ($/lb equiv.)	Average Cost Effectiveness (from BPT) (1981 $) ($/lb equiv.)
	Pound Equivalents Removed (lbs)	Cost (1981 $)	Pound Equivalents Removed (lbs)	Cost (1981 $)		
Option 1: Zero Discharge Gulf/ Discharge Limitations Main Pass and Cook Inlet	489,305	$2,386,206	489,305	$2,386,206	$5	$5
Option 2: Zero Discharge Gulf/ Discharge Limitations Cook Inlet	712,335	$10,081,484	223,030	$7,695,278	$35	$14
Option 3: Zero Discharge All	1,213,725	$30,935,664	501,390	$20,854,180	$42	$25

3.2 DRILLING WASTE BAT OPTIONS

Drilling waste requirements only apply to Cook Inlet because the remainder of the subcategory is subject to zero discharge. Two BAT options were evaluated for drilling waste. Option #1 specifies zero discharge in all coastal areas and offshore oil and gas industry limitations for Cook Inlet. This option corresponds to current practices. Option #2 requires zero discharge in all regions.

Table 3-2 presents the cost-effectiveness data and results for this group of options. The incremental cost-effectiveness values range from $0 to $699 per pound equivalent removed.

EPA selected Option #1. As shown in Table 3-2, this option has no costs or loading reductions associated with it.

TABLE 3-2

CURRENT REGULATORY BASELINE

COST-EFFECTIVENESS FOR DRILLING WASTE
COMBINED GULF OF MEXICO AND COOK INLET

Option	Total Annual		Incremental		Incremental Cost Effectiveness (1981 $) ($/lb equiv.)	Average Cost Effectiveness (from BPT) (1981 $) ($/lb equiv.)
	Pound Equivalents Removed (lbs)	Cost (1981 $)	Pound Equivalents Removed (lbs)	Cost (1981 $)		
Option #1: Discharge Limitations	0	$0	0	$0	$0	$0
Option #2: Zero Discharge All	8,536	$5,969,728	8,536	$5,969,728	$699	$699

SECTION FOUR

ALTERNATIVE BASELINE RESULTS

Under the current regulatory baseline, EPA assumes that only certain operators discharging to the major passes of the Mississippi River and operators in Cook Inlet are affected by the regulation. Under the alternative baseline, EPA assumes that, in addition to those dischargers affected under the current regulatory baseline, operators defined as Louisiana Open Bay Dischargers and Texas Individual Permit Applicants also are affected by the regulation (see the FEIA).

Table 4-1 shows the total pollutants removed under the alternative regulatory baseline and Table 4-2 shows the aggregate annualized costs. The results are presented in Tables 4-3 and 4-4. As Table 4-3 shows, the incremental cost-effectiveness values for the produced water/TWC BAT options under the alternative baseline range from $22 to $42. EPA selected Option #2, zero discharge with limits based on improved gas flotation in Cook Inlet. The incremental cost-effectiveness of this option is $42 per pound equivalent removed and the average cost-effectiveness is $26 per pound equivalent removed.

Table 4-4 presents the cost-effectiveness data and results for the drilling waste BAT options. The cost-effectiveness for drilling waste options is the same for the current regulatory baseline and the alternative baseline. Therefore, as in the results presented previously, the incremental cost-effectiveness values for the alternative baseline range from $0 to $699 per pound equivalent removed. The selected option is Option #1. As shown in Table 4-4, this option has no costs or loading reductions associated with it.

TABLE 4-1

TOTAL POLLUTANT REMOVALS BY REGULATORY OPTION
ALTERNATIVE BASELINE

Type of Wastestream	Option	Total Annual Pollutant Removals	Pound Equivalent Removals
Produced Waste/TWC	Option #1	3,114,043,653	1,091,754
	Option #2	4,606,419,716	1,314,784
	Option #3	5,661,461,736	1,816,174
Drilling Waste	Option #1	0	0
	Option #2	25,287,965	8,536

TABLE 4-2

AGGREGATE ANNUAL COSTS BY REGULATORY OPTION
ALTERNATIVE BASELINE
(1981 $)

Type of Wastestream	Option	Aggregate Annual Cost
Produced Water/TWC	Option #1	$24,502,620
	Option #2	$33,781,413
	Option #3	$54,635,592
Drilling Wastes	Option #1	$0
	Option #2	$5,969,728

TABLE 4-3

ALTERNATIVE BASELINE

COST-EFFECTIVENESS FOR PRODUCED WATER AND TREATMENT, WORKOVER, AND COMPLETION COMBINED MAIN PASS, COOK INLET, LOUISIANA OPEN BAY, AND TEXAS INDIVIDUAL PERMIT OPERATIONS

Option	Total Annual		Incremental		Incremental Cost Effectiveness (1981 $) ($/lb equiv.)	Average Cost Effectiveness (from BPT) (1981 $) ($/lb equiv.)
	Pound Equivalents Removed (lbs)	Cost (1981 $)	Pound Equivalents Removed (lbs)	Cost (1981 $)		
Option 1: Zero Discharge Gulf/ Discharge Limitations Main Pass and Cook Inlet	1,091,754	$24,502,620	1,091,754	$24,502,620	$22	$22
Option 2: Zero Discharge Gulf/ Discharge Limitations Cook Inlet	1,314,784	$33,781,413	223,030	$9,278,793	$42	$26
Option 3: Zero Discharge All	1,816,174	$54,635,592	501,390	$20,854,180	$42	$30

TABLE 4-4

ALTERNATIVE BASELINE

COST-EFFECTIVENESS FOR DRILLING WASTE
COMBINED GULF OF MEXICO AND COOK INLET

Option	Total Annual		Incremental		Incremental Cost Effectiveness (1981 $) ($/lb equiv.)	Average Cost Effectiveness (from BPT) (1981 $) ($/lb equiv.)
	Pound Equivalents Removed (lbs)	Cost (1981 $)	Pound Equivalents Removed (lbs)	Cost (1981 $)		
Option #1: Discharge Limitations	0	$0	0	$0	$0	$0
Option #2: Zero Discharge All	8,536	$5,969,728	8,536	$5,969,728	$699	$699

SECTION FIVE

COMPARISON OF COST-EFFECTIVENESS VALUES WITH PROMULGATED RULES

Table 5-1 presents the cost-effectiveness values for Effluent Limitations Guidelines and Standards issued for direct dischargers under BAT in other industries. The numbers presented here for this rulemaking are pretax costs, whereas many of the numbers presented for other effluent guidelines are post-tax costs—that is, the costs actually faced by the firms, not the total cost of the equipment (which is subsidized by reductions in taxable income). Thus direct comparisons between this rulemaking and others cannot be made easily. An equivalent post-tax cost, however, might be at least 60 to 70 percent of pretax costs. The number reported for the Coastal Oil and Gas Industry is for the selected produced water option, the most costly drilling waste option, and the most costly TWC option listed separately. As the table shows, the $35 per pound equivalent removed for produced water/TWC is well within the range of cost-effectiveness values seen for other rules. For drilling waste, BAT is zero discharge in the coastal subcategory, except in Cook Inlet, where BAT is equal to current practice (BAT limits established in permits on a best professional judgment basis) and thus results in no costs.

TABLE 5-1

INDUSTRY COMPARISON OF BAT COST-EFFECTIVENESS FOR DIRECT DISCHARGERS
(Toxic and Nonconventional Pollutants Only; Copper-Based Weights[a]; 1981 $)

Industry		PE Currently Discharged (thousands)	PE Remaining at Selected Option (thousands)	Cost-Effectiveness of Selected Option(s) ($/PE removed)
Aluminum Forming		1,340	90	121
Battery Manufacturing		4,126	5	2
Canmaking		12	0.2	10
Coal Mining		BAT=BPT	BAT=BPT	BAT=BPT
Coastal Oil and Gas Produced Water/TWC[b] Drilling Waste		951 BAT=Current Practice	239 BAT=Current Practice	35 BAT=Current Practice
Coil Coating		2,289	9	49
Copper Forming		70	8	27
Electronics I		9	3	404
Electronics II		NA	NA	NA
Foundries		2,308	39	84
Inorganic Chemicals I		32,503	1,290	<1
Inorganic Chemicals II		605	27	6
Iron and Steel		40,746	1,040	2
Leather Tanning		259	112	BAT=BPT
Metal Finishing		3,305	3,268	12
Nonferrous Metals Forming		34	2	69
Nonferrous Metals Manufacturing I		6,653	313	4
Nonferrous Metals Manufacturing II		1,004	12	6
Offshore Oil and Gas		3,628	2,218	34[c]
OCSPSF[d]		54,225	9,735	5
Pesticides		2,461	371	15
Petroleum Refining		BAT=BPT	BAT=BPT	BAT=BPT
Pharmaceuticals[e]	A/C	897	47	47
	B/D	90	0.5	96
Plastics Molding and Forming		44	41	BAT=BPT

TABLE 5-1 (continued)

Industry	PE Currently Discharged (thousands)	PE Remaining at Selected Option (thousands)	Cost-Effectiveness of Selected Option(s) ($/PE removed)
Porcelain Enameling	1,086	63	6
Pulp and Paper[f]	1,330	748	18
Textile Mills	BAT=BPT	BAT=BPT	BAT=BPT

[a]Although toxic weighing factors for priority pollutants varied across these rules, this table reflects the cost-effectiveness at the time of regulation.

[b]TWC loadings and reductions are for Gulf of Mexico only. Produced water loadings and reductions include TWC discharges in Cook Inlet.

[c]For produced water only; for produced sand and drilling fluids and drill cuttings under Offshore Oil and Gas, BAT=NSPS.

[d]Reflects costs and removals of both air and water pollutants.

[e]Proposed.

[f]PCB control for Deink subcategory only.

APPENDIX A

SUPPORTING DOCUMENTATION FOR COST-EFFECTIVENESS ANALYSIS: POLLUTANT LOADINGS ANALYSIS

TABLE A-1

Pollutant Loadings Analysis for Produced Water
Gulf of Mexico Main Pass, Option 1: Discharge Limitations Based on Improved Gas Flotation

Pollutant Name	Annual Pounds Removed	TWF	Pound Equivalents
Conventional Pollutants			
Oil and Grease	14,833	0.00E+00	0
TSS	531,100	0.00E+00	0
Total Conventionals	**545,933**		**0**
Priority Organic Pollutants			
2,4-Dimethylphenol	0	2.40E-03	0
Benzene	19,015	1.60E-02	304
Ethylbenzene	229	1.30E-01	30
Naphthalene	440	4.70E-02	21
Phenol	895	2.20E-01	197
Toluene	16,661	1.10E-03	18
Total Priority Organics	**37,240**		**570**
Priority Pollutants Metals			
Cadmium	81	6.70E-01	55
Chromium	0	1.10E-01	0
Copper	0	1.90E+00	0
Lead	2,876	6.60E-01	1,898
Nickel	0	6.80E-01	0
Silver	0	6.10E+00	0
Zinc	1,570	6.50E-02	102
Total Priority Metals	**4,528**		**2,055**
Non-Conventional Pollutants			
Aluminum	6,508	6.40E-02	416
Ammonia	0	8.10E-03	0
Barium	82,484	2.00E-03	165
Benzoic acid	0	3.30E-04	0
Boron	30,269	1.80E-01	5,448
Calcium	0	2.80E-05	0
Chlorides	0	2.40E-05	0
Cobalt	0	5.60E-01	0
Hexanoic Acid	0	3.40E-04	0
2-Hexanone	0	1.30E-04	0
Iron	66,286	2.10E-03	139
Magnesium	0	8.70E-04	0
Manganese	7,683	5.60E-01	4,303
2-Methylnaphthalene	0	9.30E-02	0
Molybdenum	0	2.00E-01	0
n-Decane	0	1.10E-04	0
n-Dodecane	0	4.30E-03	0
n-Eicosane	0	4.30E-03	0
n-Hexadecane	0	4.30E-03	0
n-Octadecane	0	4.30E-03	0
n-Tetradecane	0	4.30E-03	0
o-Cresol	0	5.70E-03	0
p-Cresol	0	1.80E-04	0
Strontium	0	5.50E-06	0
Sulfur	0	5.60E-06	0
Tin	0	3.00E-01	0
Titanium	188	2.90E-02	5
m-Xylene	0	1.70E-02	0
o+p-Xylene	0	3.30E-02	0
Vanadium	0	6.20E-01	0
Yttrium	0	0.00E+00	0
Total Non-Conventionals	**193,419**		**10,477**
Radionuclides			
Lead 210	0	0.00E+00	0
Radium 226	0	1.50E+05	0
Radium 228	0	3.50E+08	0
Total Radionuclides			**0**
Total Reduction	**781,119**		**13,102**

a = Concentrations in this column are from the Offshore Development Document unless otherwise noted.
b = For the purpose of regulatory analysis, these concentrations are substituted using the settling effluent concentrations either because no data were available in the Offshore Development document or because the offshore gas flotation value was greater than the settling effluent value.

Source for Annual Pounds Removed: U.S. Environmental Protection Agency. 1996. Development Document for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. September.

Source for TWF: Versar, Inc. 1994. Toxic Weighting Factors for Coastal Subcategory of the Oil and Gas Extraction Industry Proposed Effluent Guidelines. November.

TABLE A-2

Pollutant Loadings Analysis for Produced Water
Gulf of Mexico Main Pass, Options 2 and 3: Zero Discharge

Pollutant Name	Annual Pounds Removed	TWF	Pound Equivalents
Conventional Pollutants			
Oil and Grease	589,983	0.00E+00	0
TSS	1,265,335	0.00E+00	0
Total Conventionals	**1,855,319**		**0**
Priority Pollutants Organics			
2,4-Dimethylphenol	3,622	2.40E-03	9
Benzene	49,018	1.60E-02	784
Ethylbenzene	1,751	1.30E-01	228
Naphthalene	2,692	4.70E-02	127
Phenol	14,013	2.20E-01	3,083
Toluene	36,921	1.10E-03	41
Total Priority Pollutants Organics	**108,018**		**4,271**
Priority Pollutants Metals			
Cadmium	436	6.70E-01	292
Chromium	4,405	1.10E-01	485
Copper	5,776	1.90E+00	10,974
Lead	5,932	6.60E-01	3,915
Nickel	3,696	6.80E-01	2,513
Silver	8,786	6.10E+00	53,597
Zinc	4,846	6.50E-02	315
Total Priority Metals	**33,877**		**72,091**
Non-Conventional Pollutants			
Aluminum	7,730	6.40E-02	495
Ammonia	1,025,481	8.10E-03	8,306
Barium	952,817	2.00E-03	1,906
Benzoic acid	131,183	3.30E-04	43
Boron	433,456	1.80E-01	78,022
Calcium	60,941,494	2.80E-05	1,706
Chlorides	1,404,836,049	2.40E-05	33,716
Cobalt	2,864	5.60E-01	1,604
Hexanoic Acid	27,167	3.40E-04	9
2-Hexanone	844	1.30E-04	0
Iron	143,287	2.10E-03	301
Magnesium	14,709,172	8.70E-04	12,797
Manganese	9,498	5.60E-01	5,319
2-Methylnaphthalene	1,902	9.30E-02	177
Molybdenum	2,961	2.00E-01	592
n-Decane	3,720	1.10E-04	0
n-Dodecane	7,049	4.30E-03	30
n-Eicosane	1,929	4.30E-03	8
n-Hexadecane	7,734	4.30E-03	33
n-Octadecane	1,929	4.30E-03	8
n-Tetradecane	2,912	4.30E-03	13
o-Cresol	3,720	5.70E-03	21
p-Cresol	4,014	1.80E-04	1
Strontium	7,024,180	5.50E-06	39
Sulfur	298,589	5.60E-06	2
Tin	10,524	3.00E-01	3,157
Titanium	298	2.90E-02	9
m-Xylene	3,598	1.70E-02	61
o+p-Xylene	2,692	3.30E-02	89
Vanadium	3,304	6.20E-01	2,049
Yttrium	864	0.00E+00	0
Total Non-Conventionals	**1,490,602,961**		**150,513**
Radionuclides			
Lead 210	1.34E-05	0.00E+00	0
Radium 226	4.67E-03	1.50E+05	701
Radium 228	2.39E-05	3.50E+08	8,369
Total Radionuclides	**4.71E-03**		**9,070**
Total Removals	**1,492,600,175**		**235,945**

Source for Annual Pounds Removed: U.S. Environmental Protection Agency. 1996. Development Document for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. September.

Source for TWF: Versar, Inc. 1994. Toxic Weighting Factors for Coastal Subcategory of the Oil and Gas Extraction Industry Proposed Effluent Guidelines. November.

TABLE A-3

Pollutants Leadings Analysis for Produced Water
Cook Inlet, Options 1 and 2: Discharge Limitations

Pollutant Name	Annual Pounds Removed	TWF	Pound Equivalents
Conventional Pollutants			
Oil and Grease	205,975	0.00E+00	0
TSS	649,079	0.00E+00	0
Total Conventionals	**855,054**		**0**
Priority Organic Pollutants			
2,4-Dimethylphenol	4,582	2.40E-03	11
Anthracene	309	3.50E-01	108
Benzene	37,391	1.60E-02	598
Benzo(a)pyrene	102	4.20E+03	429,639
Ethylbenzene	1,654	1.30E-01	215
Naphthalene	14,566	4.70E-02	685
Phenol	0	2.20E-01	0
Toluene	11,764	1.10E-03	13
Total Priority Organics	**70,367**		**431,269**
Priority Pollutants Metals			
Cadmium	141	6.70E-01	95
Copper	2,771	1.90E+00	5,265
Lead	1,216	6.60E-01	802
Nickel	10,627	6.80E-01	7,226
Zinc	0	6.50E-02	0
Total Priority Metals	**14,755**		**13,388**
Non-Conventional Pollutants			
Aluminum	486	6.40E-02	31
Barium	346,227	2.00E-03	692
Boron	160,392	1.80E-01	28,871
Iron	30,632	2.10E-03	64
Manganese	722	5.60E-01	404
Titanium	44	2.90E-02	1
n-Alkanes	17,047	4.30E-03	73
Steranes	805	4.30E-03	3
Triterpanes	810	4.30E-03	3
Total Xylenes	2,847	1.70E-02	48
Radium 226	0	1.50E+05	0
Radium 228	0	3.50E+08	0
Total Non-Conventionals	**560,011**		**30,193**
Total Removals	**1,500,186**		**474,849**

Source for Annual Pounds Removed: U.S. Environmental Protection Agency. 1996. Development Document for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. September.

Source for TWF: Versar, Inc. 1994. Toxic Weighting Factors for Coastal Subcategory of the Oil and Gas Extraction Industry Proposed Effluent Guidelines. November.

TABLE A-4

Pollutant Loadings Analysis for Produced Water
Cook Inlet, Option 3: Zero Discharge

Pollutant Name	Annual Pounds Removed	TWF	Pound Equivalents
Conventional Pollutants			
Oil and Grease	612,731	0.00E+00	0
TSS	1,168,343	0.00E+00	0
Total Conventionals	**1,781,074**		**0**
Priority Pollutants Organic			
2,4-Dimethylphenol	8,909	2.40E-03	21
Anthracene	437	3.50E-01	153
Benzene	58,610	1.60E-02	938
Benzo(a)pyrene	183	4.20E+03	767,679
Ethylbenzene	2,730	1.30E-01	355
Naphthalene	16,158	4.70E-02	759
Phenol	7,469	2.20E-01	1,643
Toluene	26,092	1.10E-03	29
Total Priority Organics	**120,587**		**771,577**
Priority Pollutants Metals			
Cadmium	392	6.70E-01	262
Chromium*	3,116	1.10E-01	343
Copper	7,697	1.90E+00	14,623
Lead	3,377	6.60E-01	2,229
Nickel	29,519	6.80E-01	20,073
Silver*	6,214	6.10E+00	37,905
Zinc	775	6.50E-02	50
Total Priority Metals	**51,089**		**75,485**
Non-Conventional Pollutants			
Aluminum	1,350	6.40E-02	86
Ammonia*	725,238	8.10E-03	5,874
Barium	961,742	2.00E-03	1,923
Benzoic acid*	92,775	3.30E-04	31
Boron	445,532	1.80E-01	80,196
Calcium*	43,098,875	2.80E-05	1,207
Chlorides*	993,524,272	2.40E-05	23,845
Cobalt*	2,025	5.60E-01	1,134
Hexanoic Acid*	19,213	3.40E-04	7
2-Hexanone*	597	1.30E-04	0
Iron	85,088	2.10E-03	179
Magnesium*	10,402,580	8.70E-04	9,050
Manganese	2,006	5.60E-01	1,123
2-Methylnaphthalene*	1,345	9.30E-02	125
Molybdenum*	2,094	2.00E-01	419
n-Alkanes	17,873	4.30E-03	77
o-Cresol*	2,631	5.70E-03	15
p-Cresol*	2,839	1.80E-04	1
Steranes	1,341	4.30E-03	6
Strontium*	4,967,621	5.50E-06	27
Sulfur*	211,167	5.60E-06	1
Tin*	7,443	3.00E-01	2,233
Titanium	121	2.90E-02	4
Triterpanes	1,350	4.30E-03	6
Total Xylenes	9,389	1.70E-02	160
Vanadium*	2,337	6.20E-01	1,449
Yttrium*	611	0.00E+00	0
Radium 226	4.59E-05	1.50E+05	7
Radium 228	5.19E-07	3.50E+08	182
Total Non-Conventionals	**1,054,589,456**		**129,176**
Total Reduction	**1,056,542,206**		**976,239**

Source for Annual Pounds Removed: U.S. Environmental Protection Agency. 1996. Development Document for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. September.

Source for TWF: Versar, Inc. 1994. Toxic Weighting Factors for Coastal Subcategory of the Oil and Gas Extraction Industry Proposed Effluent Guidelines. November.

TABLE A-5

Pollutant Loadings Analysis for Treatment and Workover for Existing Sources, Option 1:
Main Pass Operators = Improved Gas Flotation;
Others = Zero Discharge Via Injection or Commercial Disposal

Pollutant Name	Annual Pounds Removed	TWF	Pound Equivalents
Conventional Pollutants			
Oil & Grease	14,957	0.00E+00	0
Solids, Total Suspended	33,711	0.00E+00	0
Total Conventional	**48,668**		**0**
Priority Pollutants: Organics			
Benzene	81	1.60E-02	1
Ethylbenzene	75	1.30E-01	10
Methyl Chloride (Chloromethane)	2	2.20E-03	0
Toluene	54	1.10E-03	0
Fluorene	4	5.60E-01	2
Naphthalene	34	4.70E-02	2
Phenanthrene	4	1.90E+01	76
Phenol	16	2.20E-01	4
Total Priority Pollutants: Organics	**270**		**83**
Priority Pollutants: Metals			
Antimony	2	1.30E-02	0
Arsenic	11	4.20E+00	46
Beryllium	1	4.20E+00	4
Cadmium	2	6.70E-01	1
Chromium	37	1.10E-01	4
Copper	17	1.90E+00	32
Lead	89	6.60E-01	59
Nickel	7	6.80E-01	5
Selenium	3	7.90E-02	0
Silver	0	6.10E+00	0
Thallium	1	2.60E-02	0
Zinc	23	6.50E-02	1
Total Priority Pollutants: Metals	**193**		**153**
Non-Conventional Pollutants			
Aluminum	421	6.40E-02	27
Barium	29	2.00E-03	0
Boron	902	1.80E-01	162
Calcium	616,483	2.80E-05	17
Cobalt	1	5.60E-01	1
Cyanide, Total	3	1.10E+00	3
Iron	25,001	2.10E-03	53
Manganese	335	5.60E-01	188
Magnesium	302,863	8.70E-04	263
Molybdenum	4	2.00E-01	1
Sodium	1,132,137	5.50E-06	6
Strontium	8,556	5.50E-06	0
Sulfur	14,705	5.60E-06	0
Tin	2	3.00E-01	1
Titanium	5	2.90E-02	0
Vanadium	69	6.20E-01	43
Yttrium	3	0.00E+00	0
Acetone	432	5.60E-04	0
Methyl Ethyl Ketone (2-Butanone)	4	4.50E-04	0
Total Xylenes	172	1.70E-02	3
4-Methyl-2-Pentanone	181	1.20E-04	0
Dibenzofuran	8	2.00E-02	0
Dibenzothiophene	6	4.60E-02	0
N-Decane (N-C10)	17	1.10E-04	0
N-Docosane (N-C22)	46	1.10E-04	0
N-Dodecane (N-C12)	34	4.30E-03	0
N-Eicosane (N-C20)	14	4.30E-03	0
N-Hexacosane (N-C26)	29	8.20E-05	0
N-Hexadecane (N-C16)	24	4.30E-03	0
N-Octacosane (N-C28)	13	8.20E-05	0
N-Octadecane (N-C18)	64	4.30E-03	0
N-Tetracosane (N-C24)	48	8.20E-05	0
N-Tetradecane (N-C14)	75	4.30E-03	0
P-Cymene	5	4.30E-02	0
Pentamethylbenzene	4	2.90E-01	1
1-Methylfluorene	5	8.90E-02	0
2-Methylnaphthalene	49	9.30E-02	5
Total Non-Conventional Pollutants	**2,102,749**		**776**
Total Removals	**2,151,598**		**1,012**

Source for Annual Pounds Removed: U.S. Environmental Protection Agency. 1996. Development Document for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. September.

Source for TWF: Versar, Inc. 1994. Toxic Weighting Factors for Coastal Subcategory of the Oil and Gas Extraction Industry Proposed Effluent Guidelines. November.

TABLE A-6

Pollutant Loadings Analysis for Completion for Existing Sources, Option 1:
Main Pass Operators = Improved Gas Flotation;
Others = Zero Discharge Via Injection or Commercial Disposal

Pollutant Name	Annual Pounds Removed	TWF	Pound Equivalents
Conventional Pollutants			
Oil & Grease	5,074	0.00E+00	0
Solids, Total Suspended	11,437	0.00E+00	0
Total Conventional	**16,511**		**0**
Priority Pollutants Organics			
Benzene	28	1.60E-02	0
Ethylbenzene	25	1.30E-01	3
Methyl Chloride (Chloromethane)	1	2.20E-03	0
Toluene	19	1.10E-03	0
Fluorene	1	5.60E-01	1
Naphthalene	12	4.70E-02	1
Phenanthrene	1	1.90E+01	19
Phenol	6	2.20E-01	1
Total Priority Pollutants Organics	**93**		**25**
Priority Pollutants Metals			
Antimony	1	1.30E-02	0
Arsenic	4	4.20E+00	17
Beryllium	0	4.20E+00	0
Cadmium	1	6.70E-01	1
Chromium	13	1.10E-01	1
Copper	6	1.90E+00	11
Lead	30	6.60E-01	20
Nickel	3	6.80E-01	2
Selenium	1	7.90E-02	0
Silver	0	6.10E+00	0
Thallium	0	2.60E-02	0
Zinc	8	6.50E-02	1
Total Priority Pollutants Metals	**67**		**53**
Non-Conventional Pollutants			
Aluminum	143	6.40E-02	9
Barium	10	2.00E-03	0
Boron	307	1.80E-01	55
Calcium	209,725	2.80E-05	6
Cobalt	0	5.60E-01	0
Cyanide, Total	1	1.10E+00	1
Iron	8,481	2.10E-03	18
Manganese	114	5.60E-01	64
Magnesium	103,033	8.70E-04	90
Molybdenum	1	2.00E-01	0
Sodium	385,148	5.50E-06	2
Strontium	2,910	5.50E-06	0
Sulfur	5,003	5.60E-06	0
Tin	1	3.00E-01	0
Titanium	2	2.90E-02	0
Vanadium	24	6.20E-01	15
Yttrium	1	0.00E+00	0
Acetone	147	5.60E-04	0
Methyl Ethyl Ketone (2-Butanone)	1	4.50E-04	0
Total Xylenes	58	1.70E-02	1
4-Methyl-2-Pentanone	62	1.20E-04	0
Dibenzofuran	3	2.00E-02	0
Dibenzothiophene	2	4.60E-02	0
N-Decane (N-C10)	6	1.10E-04	0
N-Docosane (N-C22)	16	1.10E-04	0
N-Dodecane (N-C12)	12	4.30E-03	0
N-Eicosane (N-C20)	5	4.30E-03	0
N-Hexacosane (N-C26)	10	8.20E-05	0
N-Hexadecane (N-C16)	8	4.30E-03	0
N-Octacosane (N-C28)	5	8.20E-05	0
N-Octadecane (N-C18)	22	4.30E-03	0
N-Tetracosane (N-C24)	17	8.20E-05	0
N-Tetradecane (N-C14)	25	4.30E-03	0
P-Cymene	2	4.30E-02	0
Pentamethylbenzene	1	2.90E-01	0
1-Methylfluorene	2	8.90E-02	0
2-Methylnaphthalene	17	9.30E-02	2
Total Non-Conventional Pollutants	**715,325**		**264**
Total Removals	**731,996**		**342**

Source for Annual Pounds Removed: U.S. Environmental Protection Agency. 1996. Development Document for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. September.

Source for TWF: Versar, Inc. 1994. Toxic Weighting Factors for Coastal Subcategory of the Oil and Gas Extraction Industry Proposed Effluent Guidelines. November.

TABLE A - 7

Pollutant Loadings Analysis for Treatment and Workover for Existing Sources
Gulf of Mexico Main Pass, Options 2 and 3: Zero Discharge

Pollutant Name	Annual Pounds Removed	TWF	Pounds Equivalent
Conventional Pollutants			
Oil & Grease	15,237	0.00E+00	0
Solids, Total Suspended	34,068	0.00E+00	0
Total Conventional	**49,305**		**0**
Priority Pollutants Organics			
Benzene	96	1.60E-02	2
Ethylbenzene	75	1.30E-01	10
Methyl Chloride (Chloromethane)	2	2.20E-03	0
Toluene	64	1.10E-03	0
Fluorene	4	5.60E-01	2
Naphthalene	35	4.70E-02	2
Phenanthrene	5	1.90E+01	95
Phenol	19	2.20E-01	4
Total Priority Pollutants Organics	**300**		**114**
Priority Pollutants Metals			
Antimony	2	1.30E-02	0
Arsenic	11	4.20E+00	46
Beryllium	1	4.20E+00	4
Cadmium	2	6.70E-01	1
Chromium	44	1.10E-01	5
Copper	20	1.90E+00	38
Lead	90	6.60E-01	59
Nickel	8	6.80E-01	5
Selenium	3	7.90E-02	0
Silver	0	6.10E+00	0
Thallium	1	2.60E-02	0
Zinc	25	6.50E-02	2
Total Priority Pollutants Metals	**287**		**161**
Non-conventional Pollutants			
Aluminum	421	6.40E-02	27
Barium	36	2.00E-03	0
Boron	1,081	1.80E-01	195
Calcium	738,935	2.80E-05	21
Cobalt	1	5.60E-01	1
Cyanide, Total	4	1.10E+00	4
Iron	25,038	2.10E-03	53
Manganese	335	5.60E-01	188
Magnesium	363,021	8.70E-04	316
Molybdenum	5	2.00E-01	1
Sodium	1,357,013	5.50E-06	7
Strontium	10,255	5.50E-06	0
Sulfur	17,626	5.60E-06	0
Tin	2	3.00E-01	1
Titanium	5	2.90E-02	0
Vanadium	83	6.20E-01	51
Yttrium	3	0.00E+00	0
Acetone	518	5.60E-04	0
Methyl Ethyl Ketone (2-Butanone)	4	4.50E-04	0
Total Xylenes	177	1.70E-02	3
4-Methyl-2-Pentanone	218	1.20E-04	0
Dibenzofuran	10	2.00E-02	0
Dibenzothiophene	8	4.60E-02	0
N-Decane (N-C10)	20	1.10E-04	0
N-Docosane (N-C22)	55	1.10E-04	0
N-Dodecane (N-C12)	41	4.30E-03	0
N-Eicosane (N-C20)	16	4.30E-03	0
N-Hexacosane (N-C26)	35	8.20E-05	0
N-Hexadecane (N-C16)	29	4.30E-03	0
N-Octacosane (N-C28)	15	8.20E-05	0
N-Octadecane (N-C18)	77	4.30E-03	0
N-Tetracosane (N-C24)	58	8.20E-05	0
N-Tetradecane (N-C14)	89	4.30E-03	0
P-Cymene	5	4.30E-02	0
Pentamethylbenzene	4	2.90E-01	1
1-Methylfluorene	6	8.90E-02	1
2-Methylnaphthalene	59	9.30E-02	5
Total Non-Conventionals	**2,515,388**		**976**
Total Removals	**2,565,130**		**1,152**

Source for Annual Pounds Removed: U.S. Environmental Protection Agency. 1996. Development Document for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. September.

Source for TWF: Versar, Inc. 1994. Toxic Weighting Factors for Coastal Subcategory of the Oil and Gas Extraction Industry Proposed Effluent Guidelines. November.

TABLE A-8

Pollutant Loadings Analysis for Completion for Existing Sources
Gulf of Mexico Main Pass, Options 2 and 3: Zero Discharge

Pollutant Name	Annual Pounds Removed	TWF	Pounds Equivalent
Conventional Pollutants			
Oil & Grease	5,169	0.00E+00	0
Solids, Total Suspended	11,557	0.00E+00	0
Total Conventionals	**16,360**		**0**
Priority Pollutants Organics			
Benzene	32	1.60E-02	1
Ethylbenzene	26	1.30E-01	3
Methyl Chloride (Chloromethane)	1	2.20E-03	0
Toluene	22	1.10E-03	0
Fluorene	2	5.60E-01	1
Naphthalene	12	4.70E-02	1
Phenanthrene	2	1.90E+01	30
Phenol	6	2.20E-01	1
Total Priority Pollutants Organics	**107**		**36**
Priority Pollutant Metals			
Antimony	1	1.30E-02	0
Arsenic	4	4.20E+00	16
Beryllium	0	4.20E+00	1
Cadmium	1	6.70E-01	0
Chromium	15	1.10E-01	2
Copper	7	1.90E+00	13
Lead	31	6.60E-01	20
Nickel	3	6.80E-01	2
Selenium	1	7.90E-02	0
Silver	0	6.10E+00	0
Thallium	0	2.60E-02	0
Zinc	8	6.50E-02	1
Total Priority Pollutants Metals	**74**		**55**
Non-Conventional Pollutants			
Aluminum	143	6.40E-02	9
Barium	12	2.00E-03	0
Boron	367	1.80E-01	66
Calcium	251,069	2.80E-05	7
Cobalt	0	5.60E-01	0
Cyanide, Total	1	1.10E+00	1
Iron	8,493	2.10E-03	18
Manganese	114	5.60E-01	64
Magnesium	123,344	8.70E-04	107
Molybdenum	2	2.00E-01	0
Sodium	461,074	5.50E-06	3
Strontium	3,484	5.50E-06	0
Sulfur	5,989	5.60E-06	0
Tin	1	3.00E-01	0
Titanium	2	2.90E-02	0
Vanadium	28	6.20E-01	17
Yttrium	1	0.00E+00	0
Acetone	176	5.60E-04	0
Methyl Ethyl Ketone (2-Butanone)	1	4.50E-04	0
Total Xylenes	60	1.70E-02	1
4-Methyl-2-Pentanone	74	1.20E-04	0
Dibenzofuran	3	2.00E-02	0
Dibenzothiophene	3	4.60E-02	0
N-Decane (N-C10)	7	1.10E-04	0
N-Docosane (N-C22)	19	1.10E-04	0
N-Dodecane (N-C12)	14	4.30E-03	0
N-Eicosane (N-C20)	6	4.30E-03	0
N-Hexacosane (N-C26)	12	8.20E-05	0
N-Hexadecane (N-C16)	10	4.30E-03	0
N-Octacosane (N-C28)	5	8.20E-05	0
N-Octadecane (N-C18)	26	4.30E-03	0
N-Tetracosane (N-C24)	20	8.20E-05	0
N-Tetradecane (N-C14)	30	4.30E-03	0
P-Cymene	2	4.30E-02	0
Pentamethylbenzene	1	2.90E-01	0
1-Methylfluorene	2	8.90E-02	0
2-Methylnaphthalene	20	9.30E-02	2
Total Non-Conventionals	**857,222**		**297**
Total Removals	**875,763**		**389**

Source for Annual Pounds Removed: U.S. Environmental Protection Agency. 1996. Development Document for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. September.

Source for TWF: Versar, Inc. 1994. Toxic Weighting Factors for Coastal Subcategory of the Oil and Gas Extraction Industry Proposed Effluent Guidelines. November.

TABLE A-9

Louisiana Open Bay PW Pollutant Removals for Zero Discharge

Volume = 329814.4 bbl/day

Pollutant Parameter	Concentration (ug/l)		Loading (Pounds)		Incremental Removal (pounds)	Toxic Weighting Factor	Removal (lb-equiv.)
	Settling Effluent	Zero Discharge	Settling Effluent	Zero Discharge			
Oil and Grease	26,600.00	0.00	1,122,453	0	1,122,453	0.00E+00	0
TSS	141,000.00	0.00	5,949,845	0	5,949,845	0.00E+00	0
Total Conventionals			7,072,298	0	7,072,298		0
Priority Organic Pollutants							
2,4-Dimethylphenol	148.00	0.00	6,245	0	6,245	2.40E-03	15
Benzene	5,200.00	0.00	219,427	0	219,427	1.60E-02	3,511
Ethylbenzene	110.00	0.00	4,642	0	4,642	1.30E-01	603
Naphthalene	184.00	0.00	7,764	0	7,764	4.70E-02	365
Phenol	723.00	0.00	30,509	0	30,509	2.20E-01	6,712
Toluene	4,310.00	0.00	181,871	0	181,871	1.10E-03	200
Total Priority Organics			450,458	0	450,458		11,406
Priority Metal Pollutants							
Cadmium	31.50	0.00	1,329	0	1,329	6.70E-01	890
Chromium	180.00	0.00	7,596	0	7,596	1.10E-01	836
Copper	236.00	0.00	9,959	0	9,959	1.90E+00	18,922
Lead	726.00	0.00	30,635	0	30,635	6.60E-01	20,219
Nickel	151.00	0.00	6,372	0	6,372	6.80E-01	4,333
Silver	359.00	0.00	15,149	0	15,149	6.10E+00	92,409
Zinc	462.00	0.00	19,495	0	19,495	6.50E-02	1,267
Total Priority Metals			90,535	0	90,535		138,876
Non-Conventional Pollutants							
Aluminum	1,410.00	0.00	59,498	0	59,498	6.40E-02	3,808
Ammonia	41,900.00	0.00	1,768,075	0	1,768,075	8.10E-03	14,321
Barium	52,800.00	0.00	2,228,027	0	2,228,027	2.00E-03	4,456
Benzoic acid	5,360.00	0.00	226,179	0	226,179	3.30E-04	75
Boron	22,800.00	0.00	962,103	0	962,103	1.80E-01	173,179
Calcium	2,490,000.00	0.00	105,071,735	0	105,071,735	2.80E-05	2,942
Chlorides	57,400,000.00	0.00	2,422,135,577	0	2,422,135,577	2.40E-05	58,131
Cobalt	117.00	0.00	4,937	0	4,937	5.60E-01	2,765
Hexanoic Acid	1,110.00	0.00	46,839	0	46,839	3.40E-04	16
2-Hexanone	34.50	0.00	1,456	0	1,456	1.30E-04	0
Iron	17,000.00	0.00	717,357	0	717,357	2.10E-03	1,506
Magnesium	601,000.00	0.00	25,360,688	0	25,360,688	8.70E-04	22,064
Manganese	1,680.00	0.00	70,892	0	70,892	5.60E-01	39,700
2-Methylnaphthalene	77.70	0.00	3,279	0	3,279	9.30E-02	305
Molybdenum	121.00	0.00	5,106	0	5,106	2.00E-01	1,021
n-Decane	152.00	0.00	6,414	0	6,414	1.10E-04	1
n-Dodecane	288.00	0.00	12,153	0	12,153	4.30E-03	52
n-Eicosane	78.80	0.00	3,325	0	3,325	4.30E-03	14
n-Heptadecane	316.00	0.00	13,334	0	13,334	4.30E-03	57
n-Octadecane	78.80	0.00	3,325	0	3,325	4.30E-03	14
n-Tetradecane	119.00	0.00	5,022	0	5,022	4.30E-03	22
o-Cresol	152.00	0.00	6,414	0	6,414	5.70E-03	37
p-Cresol	164.00	0.00	6,920	0	6,920	1.30E-04	1
Strontium	287,000.00	0.00	12,110,678	0	12,110,678	5.50E-06	67
Sulfur	12,200.00	0.00	514,809	0	514,809	5.60E-06	3
Tin	430.00	0.00	18,145	0	18,145	3.00E-01	5,444
Titanium	43.80	0.00	1,848	0	1,848	2.90E-02	54
m-Xylene	147.00	0.00	6,203	0	6,203	1.70E-02	105
o+p-Xylene	110.00	0.00	4,642	0	4,642	3.30E-02	153
Vanadium	135.00	0.00	5,697	0	5,697	6.20E-01	3,532
Yttrium	35.30	0.00	1,490	0	1,490	0.00E+00	0
Total Non-Conventionals			2,571,382,167	0	2,571,382,167		333,844
Total Non-Conventionals less Ca, Cl, Mg			18,814,167	0	18,814,167		
Radionuclides							
Lead 210	5.49E-07	0.00	2.32E-05	0	2.32E-05	0.00E+00	0
Radium 226	1.91E-04	0.00	8.06E-03	0	8.06E-03	1.50E+05	1,209
Radium 228	9.77E-07	0.00	4.12E-05	0	4.12E-05	3.50E+08	14,429
Total Radionuclides					8.12E-03		15,638
Total Reduction			2,578,995,458	0	2,578,995,458		499,765

Source: Development Document, 1996.

TABLE A-10

Texas Open Bay PW Pollutant Removals for Zero Discharge

Volume = 67764 bbl/day

Pollutant Parameter	Concentration (ug/l)		Loading (Pounds)		Incremental Removal (pounds)	Toxic Weighting Factor	Removal (lb–eqniv.)
	Settling Effluent	Zero Disch	Settling Effluent	Zero Disch			
Oil and Grease	26,600.00	0.00	230,620	0	230,620	0.00E+00	0
TSS	141,000.00	0.00	1,222,461	0	1,222,461	0.00E+00	0
Total Conventionals			1,453,081	0.00	1,453,081		0
Priority Organic Pollutants							
2,4–Dimethylphenol	148.00	0.00	1,283	0	1,283	2.40E–03	3
Benzene	5,200.00	0.00	45,084	0	45,084	1.60E–02	721
Ethylbenzene	110.00	0.00	954	0	954	1.30E–01	124
Naphthalene	184.00	0.00	1,595	0	1,595	4.70E–02	75
Phenol	723.00	0.00	6,268	0	6,268	2.20E–01	1,379
Toluene	4,310.00	0.00	37,367	0	37,367	1.10E–03	41
Total Priority Organics			92,551	0	92,551		2,343
Priority Metal Pollutants							
Cadmium	31.50	0.00	273	0	273	6.70E–01	183
Chromium	180.00	0.00	1,561	0	1,561	1.10E–01	172
Copper	236.00	0.00	2,046	0	2,046	1.90E+00	3,887
Lead	726.00	0.00	6,294	0	6,294	6.60E–01	4,154
Nickel	151.00	0.00	1,309	0	1,309	6.80E–01	890
Silver	359.00	0.00	3,113	0	3,113	6.10E+00	18,989
Zinc	462.00	0.00	4,006	0	4,006	6.50E–02	260
Total Priority Metals			18,602	0	18,602		28,536
Non–Conventional Pollutants							
Aluminum	1,410.00	0.00	12,225	0	12,225	6.40E–02	782
Ammonia	41,900.00	0.00	363,270	0	363,270	8.10E–03	2,942
Barium	52,800.00	0.00	457,773	0	457,773	2.00E–03	916
Benzoic acid	5,360.00	0.00	46,471	0	46,471	3.30E–04	15
Boron	22,800.00	0.00	197,675	0	197,675	1.80E–01	35,582
Calcium	2,490,000.00	0.00	21,588,145	0	21,588,145	2.80E–05	604
Chlorides	57,400,000.00	0.00	497,654,424	0	497,654,424	2.40E–05	11,944
Cobalt	117.00	0.00	1,014	0	1,014	5.60E–01	568
Hexanoic Acid	1,110.00	0.00	9,624	0	9,624	3.40E–04	3
2–Hexanone	34.50	0.00	299	0	299	1.30E–04	0
Iron	17,000.00	0.00	147,389	0	147,389	2.10E–03	310
Magnesium	601,000.00	0.00	5,210,633	0	5,210,633	8.70E–04	4,533
Manganese	1,680.00	0.00	14,565	0	14,565	5.60E–01	8,156
2–Methylnaphthalene	77.70	0.00	674	0	674	9.30E–02	63
Molybdenum	121.00	0.00	1,049	0	1,049	2.00E–01	210
n–Decane	152.00	0.00	1,318	0	1,318	1.10E–04	0
n–Dodecane	288.00	0.00	2,497	0	2,497	4.30E–03	11
n–Eicosane	78.80	0.00	683	0	683	4.30E–03	3
n–Hexadecane	316.00	0.00	2,740	0	2,740	4.30E–03	12
n–Octadecane	78.80	0.00	683	0	683	4.30E–03	3
n–Tetradecane	119.00	0.00	1,032	0	1,032	4.30E–03	4
o–Cresol	152.00	0.00	1,318	0	1,318	5.70E–03	8
p–Cresol	164.00	0.00	1,422	0	1,422	1.80E–04	0
Strontium	287,000.00	0.00	2,488,272	0	2,488,272	5.50E–06	14
Sulfur	12,200.00	0.00	105,773	0	105,773	5.60E–06	1
Tin	430.00	0.00	3,728	0	3,728	3.00E–01	1,118
Titanium	43.80	0.00	380	0	380	2.90E–02	11
m–Xylene	147.00	0.00	1,274	0	1,274	1.70E–02	22
o+p–Xylene	110.00	0.00	954	0	954	3.30E–02	31
Vanadium	135.00	0.00	1,170	0	1,170	6.20E–01	725
Yttrium	35.30	0.00	306	0	306	0.00E+00	0
Total Non–Conventionals			528,318,780	0	528,318,780		68,591
Total Non–Conventionals less Ca, Cl, Mg			3,865,578	0	3,865,578		
Radionuclides							
Lead 210	5.49E–07	0.00	4.76E–06	0	4.76E–06	0.00E+00	0
Radium 226	1.91E–04	0.00	1.66E–03	0	1.66E–03	1.50E+05	248
Radium 228	9.77E–07	0.00	8.47E–06	0	8.47E–06	3.50E+08	2,965
Total Radionuclides					1.67E–03		3,213
Total Reduction			529,883,014		529,883,014		102,684

Source: Development Document, 1996.

TABLE A-11

Pollutant Loadings Analysis for Drilling Waste
Cumulative Reduction in Pollutant Loadings for Operators in Cook Inlet, Alaska
Zero Discharge Option

Pollutant Name	Annual Pounds Removed	TWF	Pound Equivalents
Conventional Pollutants			
TSS (Associated with Muds)	8,264,001.0	0.00E+00	0.0
TSS (Associated with Cuttings)	15,820,788.9	0.00E+00	0.0
TSS (Total)	24,084,789.9		0.0
Total Oil (In Muds+Cuttings)	4,368.4	0.00E+00	0.0
Total Conventional	**24,089,158.3**		**0.0**
Priority Pollutants Organics			
Naphthalene	0.3	4.70E-02	0.0
Fluorene	4.1	5.60E-01	2.3
Phenanthrene	0.6	1.90E+01	11.7
Total Priority Pollutants Organics	**5.0**		**14.0**
Priority Pollutants Metals			
Cadmium	9.1	6.70E-01	6.1
Mercury	0.8	2.60E+02	214.9
Antimony	47.1	1.30E-02	0.6
Arsenic	58.7	4.20E+00	246.4
Beryllium	5.8	4.20E+00	24.3
Chromium	1,983.4	1.10E-01	218.2
Copper	154.5	1.90E+00	293.6
Lead	290.1	6.60E-01	191.4
Nickel	111.6	6.80E-01	75.9
Selenium	9.1	7.90E-02	0.7
Silver	5.8	6.10E+00	35.3
Thallium	9.9	2.60E-02	0.3
Zinc	1,656.9	6.50E-02	107.7
Total Priority Pollutants Metals	**4,342.7**		**1,415.4**
Non-Conventional Pollutants			
Aluminum	74,953.7	6.40E-02	4,797.0
Barium	991,680.1	2.00E-03	1,983.4
Iron	126,805.3	2.10E-03	266.3
Tin	120.7	3.00E-01	36.2
Titanium	723.1	2.90E-02	21.0
Alkylated benzenes	154.0	5.60E-03	0.9
Alkylated naphthalenes	2.5	6.20E-02	0.2
Alkylated fluorenes	8.9	8.90E-02	0.8
Alkylated phenanthrenes	1.0	1.40E-01	0.1
Total biphenyl	10.0	3.70E-02	0.4
Total dibenzothiophenes	0.0	4.60E-02	0.0
Total Non-Conventional Pollutants	**1,194,459.4**		**7,106.2**
Total Removals	**25,287,965.4**		**8,535.6**

Source for Annual Pounds Removed: U.S. Environmental Protection Agency. 1996. Development Document for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. September.

Source for TWF: Versar, Inc. 1994. Toxic Weighting Factors for Coastal Subcategory of the Oil and Gas Extraction Industry Proposed Effluent Guidelines. November.

APPENDIX B

SUPPORTING DOCUMENTATION FOR COST-EFFECTIVENESS ANALYSIS: COST ANALYSIS

TABLE B - 1

ANNUAL COSTS
PRODUCED WATER: COOK INLET AND GULF OF MEXICO COMBINED
CURRENT REGULATORY BASELINE

Costs	Option 1	Option 2	Option 3
Capital Cost Gulf (1995 $)	$1,818,604	$23,089,994	$23,089,994
Capital Cost Cook (1995 $)	$9,232,461	$9,232,461	$96,956,093
Total Capital Cost (1995 $)	$11,051,065	$32,322,455	$120,046,087
Annual O&M Cost Gulf (1995 $)	$286,259	$9,165,013	$9,165,013
Annual O&M Cost Cook (1995 $)	$1,168,826	$1,168,826	$20,960,966
Total Annual O&M Cost (1995 $)	$1,455,085	$10,333,839	$30,125,979
Total Annualized Capital Cost (1995 $)	$1,573,423	$4,601,990	$17,091,862
Total Annual Cost (1995 $)	$3,028,508	$14,935,829	$47,217,841
Deflator (c)	0.646	0.646	0.646
Total Cost (1981 $)	$1,956,416	$9,648,546	$30,502,725

Source for Annual Pounds Removed: U.S. Environmental Protection Agency. 1996 Development Document for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. September.

TABLE B - 2

ANNUAL COSTS
PRODUCED WATER: COOK INLET AND GULF OF MEXICO COMBINED
ALTERNATIVE BASELINE

Costs	Option #1	Option #2	Option #3
Capital Cost Gulf (1995 $)	$1,818,604	$27,150,372	$27,150,372
Capital Cost Cook (1995 $)	$9,232,461	$9,232,461	$96,956,093
Total Capital Cost (1995 $)	$11,051,065	$36,382,833	$124,106,465
Annual O&M Cost Gulf (1995 $)	$286,259	$11,038,169	$11,038,169
Annual O&M Cost Cook (1995 $)	$1,168,826	$1,168,826	$20,960,966
Total Annual O&M Cost (1995 $)	$1,455,085	$12,206,995	$31,999,135
Total Annualized Capital Cost (1995 $)	$1,573,423	$5,180,097	$17,669,969
Total Annual Cost (1995 $)	$3,028,508	$17,387,092	$49,669,104
Deflator (c)	0.646	0.646	0.646
Total Cost (1981 $)	$1,956,416	$11,232,061	$32,086,241

Source for Annual Pounds Removed: U.S. Environmental Protection Agency. 1996. Development Document for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. September.

TABLE B-3

ANNUAL COSTS
TREATMENT, WORKOVER, AND COMPLETION FLUIDS
COOK INLET AND GULF OF MEXICO COMBINED

Costs	Option 1	Option 2	Option 3
Annual Cost (1995 $)	$665,310	$670,183	$670,183
Deflator	0.646	0.646	0.646
Annual Cost (1981 $)	$429,790	$432,938	$432,938

Source for Annual Pounds Removed: U.S. Environmental Protection Agency. 1996. Development Document for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. September.

TABLE B-4

ANNUAL COSTS
PRODUCED WATER/TWC: LOUISIANA OPEN BAY AND TEXAS INDIVIDUAL PERMIT OPERATORS

Costs	Option 1	Option 2	Option 3
Capital Cost LA (1995 $)	$49,864,657	$49,864,657	$49,864,657
Capital Cost TX (1995 $)	$12,379,593	$12,379,593	$12,379,593
Total Capital Cost (1995 $)	$62,244,250	$62,244,250	$62,244,250
Annual O&M Cost LA (1995 $)	$21,021,582	$21,021,582	$21,021,582
Annual O&M Cost TX (1995 $)	$4,352,171	$4,352,171	$4,352,171
Total Annual O&M Cost (1995 $)	$25,373,753	$25,373,753	$25,373,753
Total Annualized Capital Cost (1995 $)	$8,862,181	$8,862,181	$8,862,181
Total Annual Cost (1995 $)	$34,235,934	$34,235,934	$34,235,934
Deflator (c)	0.646	0.646	0.646
Total Cost (1981 $)	$22,116,413	$22,116,413	$22,116,413

Source for Annual Pounds Removed: U.S. Environmental Protection Agency. 1996. Development Document for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. September.

TABLE B-5

ANNUAL COSTS FOR DRILLING FLUIDS

Costs	Option 1	Option 2
Annual Cost (1995 $)	$0	$9,241,065
Deflator	0.646	0.646
Annual Cost (1981 $)	$0	$5,969,728

Source for Annual Pounds Removed: U.S. Environmental Protection Agency. 1996. Development Document for Final Effluent Limitation Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category. September.

APPENDIX C

COST-EFFECTIVENESS RESULTS INCLUDING PRODUCTION LOSSES IN COMPLIANCE COST ESTIMATES

APPENDIX C

COST-EFFECTIVENESS RESULTS INCLUDING PRODUCTION LOSSES IN COMPLIANCE COST ESTIMATES

In this appendix, EPA assesses the cost-effectiveness of the Coastal Guidelines using the total dollar losses calculated for each modeled well, facility, or platform in the economic impact analysis (see the FEIA) for produced water/TWC options. (Drilling options are not associated with production losses and thus are not addressed here.) These losses include capital and O&M expenditures on compliance equipment among production units that do not shut in in the baseline or first year (these production units would not install the equipment), the tax shields on that equipment (taxes foregone by state and federal governments), the value of production losses to the firm and state and federal governments (income and severance taxes), and mineral rights owners (royalties).

The pollutant loadings remain the same, but the annual costs of compliance in some cases tend to be less (leading to an overall slightly lower annual cost over all options) because the production loss modeling is more sophisticated than the approach used to calculate total compliance costs. Using the production loss model (described in the FEIA), EPA can determine which operators will choose to install equipment and produce and which operators will choose to shut in and incur production losses instead of incurring compliance costs, thereby reducing their total losses. In many cases, the total value of production lost is less than the cost of compliance. Table C-1 shows the present value losses (costs) in 1995 dollars, the annualized cost, and the annualized cost in 1981 dollars for all options under the current regulatory baseline and the alternative regulatory baseline.

Table C-2 presents the cost-effectiveness using total dollar losses under the current regulatory baseline. As shown in the table, the incremental cost-effectiveness values range from $5 to $41 per pound equivalent removed. EPA selected Option #2, zero discharge with improved gas flotation in Cook Inlet. The incremental cost-effectiveness of this option is $31 per pound equivalent removed and the average cost-effectiveness is $13 per pound equivalent removed.

Table C-3 presents the cost-effectiveness using total dollar losses under the alternative regulatory baseline. As shown in the table, the incremental cost-effectiveness values range from $20 to $44 per pound

TABLE C-1

TOTAL COST OF LOSSES
(PRODUCTION LOSSES AND COMPLIANCE COSTS)

Cost ($000)	Option 1	Option 2	Option 3
Current Regulatory Baseline			
Present Value Cost (1995 $)	$22,460	$98,522	$320,689
Annualized Cost (1995 $)	$3,863	$14,698	$46,329
Annualized Cost (1981 $)	$2,496	$9,495	$29,929
Alternative Baseline			
Present Value Cost (1995 $)	$230,246	$319,484	$560,095
Annualized Cost (1995 $)	$33,447	$46,158	$80,415
Annualized Cost (1981 $)	$21,607	$29,818	$51,948

Note: TWC costs are not included in present value costs but are included in annualized costs for 1995 and 1981.

TABLE C-2

CURRENT REGULATORY BASELINE

COST-EFFECTIVENESS FOR PRODUCED WATER AND TREATMENT, WORKOVER, AND COMPLETION COMBINED MAIN PASS AND COOK INLET OPERATIONS PRODUCTION LOSSES INCLUDED

Option	Total Annual		Incremental		Incremental Cost Effectiveness (1981 $) ($/lb equiv.)	Average Cost Effectiveness (from BPT) (1981 $) ($/lb equiv.)
	Pound Equivalents Removed (lbs)	Cost (1981 $)	Pound Equivalents Removed (lbs)	Cost (1981 $)		
Option 1: Zero Discharge Gulf/ Discharge Limitations Main Pass and Cook Inlet	489,305	$2,495,568	489,305	$2,495,568	$5	$5
Option 2: Zero Discharge Gulf/ Discharge Limitations Cook Inlet	712,335	$9,494,585	223,030	$6,999,016	$31	$13
Option 3: Zero Discharge All	1,213,725	$29,928,587	501,390	$20,434,002	$41	$25

TABLE C-3

ALTERNATIVE BASELINE

COST-EFFECTIVENESS FOR PRODUCED WATER AND TREATMENT, WORKOVER, AND COMPLETION COMBINED MAIN PASS, COOK INLET, LOUISIANA OPEN BAY, AND TEXAS INDIVIDUAL PERMIT OPERATIONS PRODUCTION LOSSES INCLUDED

Option	Total Annual		Incremental		Incremental Cost Effectiveness (1981 $) ($/lb equiv.)	Average Cost Effectiveness (from BPT) (1981 $) ($/lb equiv.)
	Pound Equivalents Removed (lbs)	Cost (1981 $)	Pound Equivalents Removed (lbs)	Cost (1981 $)		
Option 1: Zero Discharge Gulf/ Discharge Limitations Main Pass and Cook Inlet	1,091,754	$21,658,464	1,091,754	$21,658,464	$20	$20
Option 2: Zero Discharge Gulf/ Discharge Limitations Cook Inlet	1,314,784	$29,817,756	223,030	$8,159,292	$37	$23
Option 3: Zero Discharge All	1,816,174	$51,948,161	501,390	$22,130,405	$44	$29

equivalent removed. The selected option is Option #2, zero discharge with improved gas flotation in Cook Inlet. The incremental cost-effectiveness of this option is $37 per pound equivalent removed and the average cost-effectiveness is $23 per pound equivalent removed.