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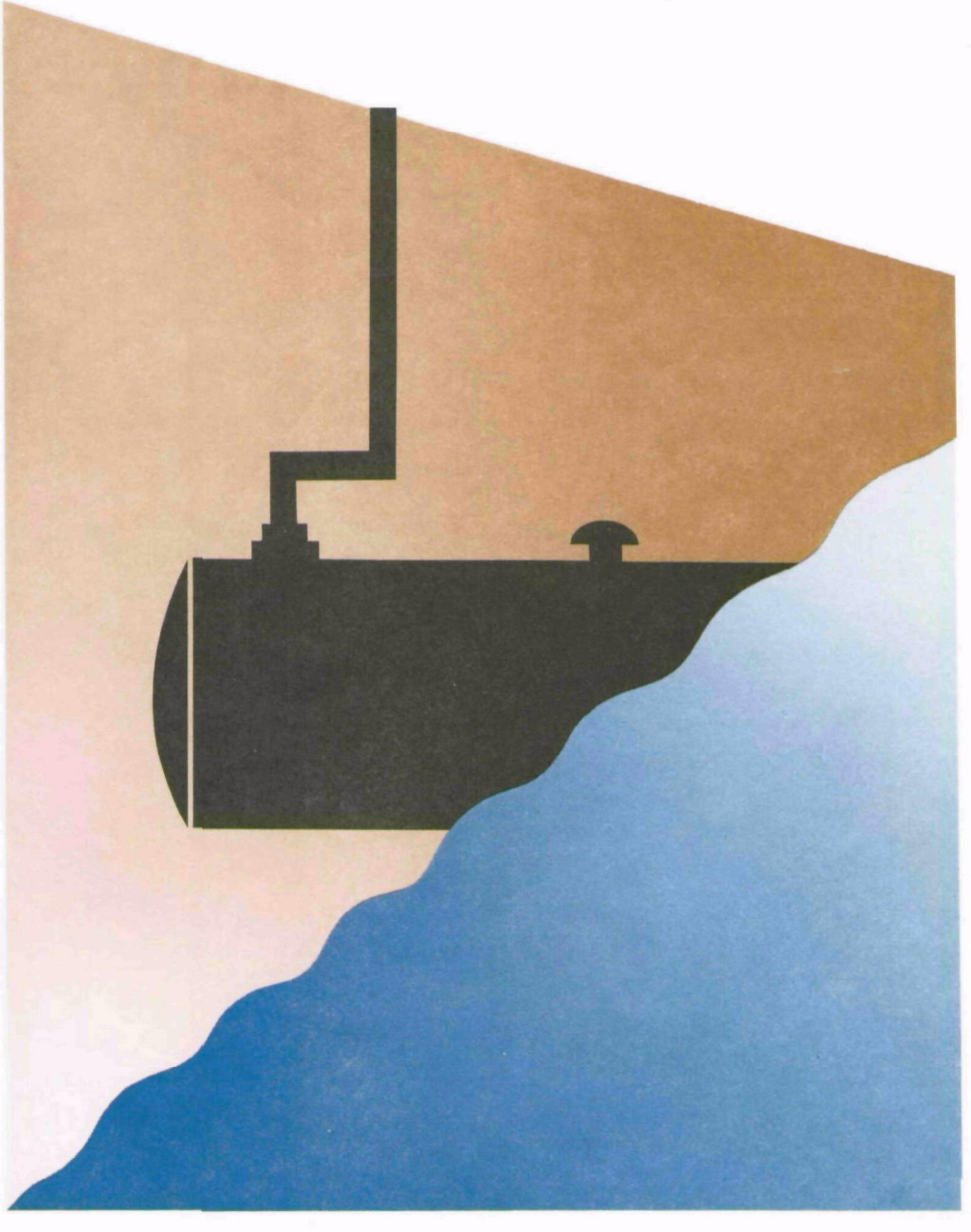
Cost Guide For Remediation Equipment At UST Sites



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COST GUIDE

FOR

REMEDIATION EQUIPMENT

AT

UST SITES

JULY 1993

United States Environmental Protection Agency

Office Of Underground Storage Tanks

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§1. INTRODUCTION

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Section 1. Introduction

INTRODUCTION

The Cost Guide for Remediation Equipment at UST Sites provides comprehensive, current information on the costs for certain equipment (i.e., equipment currently being manufactured) that is used during the cleanup of petroleum hydrocarbons from soil and groundwater at the site of a release from an underground storage tank (UST). The remediation technologies represented in this *Cost Guide* are influenced significantly by many site-specific characteristics. Specific contaminant types, containment levels, site geology and hydrogeology, remediation goals, and many other factors contribute to a fluctuation in actual costs from one site to another. While Dataquest made significant efforts to ensure total accuracy, the variable nature of the information and its sources precludes any warranties.

The rates in this *Cost Guide* represent an average allowance that equipment owners should charge in order to recoup their ownership and operating costs. Because this manual is based upon average costs, use discretion in applying the data to evaluate costs at specific sites. The rates are derived from cost formulas and data developed from research and from analytic methods used in the equipment industry. Generally, these methods consider purchase price, depreciation, maintenance and repair costs, indirect equipment costs, and average annual use hours. Specific market conditions (e.g., local supply and demand) are not considered. These rates are not a listing of rates being charged nationally by rental companies.[1]

How This *Cost Guide* Is Organized

This *Cost Guide* is divided into four sections: Section 1 is the Introduction, Section 2 contains the Remediation Equipment Tables, Section 3 contains Appendices A through F, and Section 4 is a Glossary. Pages are numbered by section.

- The Introduction explains how to calculate rate structures, how to adjust rates found in this *Cost Guide*, and how to use the *Cost Guide*. The following three topics are covered in the remainder of the Introduction:
  - Rate Structure: Definitions and Methodology outlines the methodology used to calculate total, annual, monthly, weekly, and hourly ownership and operating costs.
  - How To Use The *Cost Guide* describes how the Remediation Equipment Tables are organized and explains how to use them.
  - How To Adjust The Rates In This *Cost Guide* shows how to use the Rate Element and Rate Adjustment Tables in Appendix A when calculating

[1] The publication of these rates is not intended to influence the rental market of remediation equipment as a whole. To enter into agreement, combination, understanding, or action with any person or party with intent to establish rental rates at specific levels in this or any other publication may constitute a violation of Fair Trade Practices.

adjustments for equipment age and various job elements (e.g., standby, job severity, duplication of costs, discounts).

- The Remediation Equipment Tables outline annual, monthly, weekly, daily, and hourly ownership costs of specific equipment and systems and include equipment specifications and performance data where available.

- The Appendices supply detailed technical information (e.g., chemical conversion factors, weight and measure equivalencies) that can be used to compare specifications or performance data that are otherwise not directly comparable. Other information in the Appendices (e.g., pumping power requirements) can be useful for selecting equipment that is appropriate for specific environmental conditions.

- The Glossary contains definitions of the technical terms used in this *Cost Guide*.

Rate Structure: Definitions And Methodology

The rates in this *Cost Guide* are based on the ownership and operating costs for contractor-owned equipment. Profit, project overhead, and general company overhead costs (e.g., office facilities, supplies) are not included.

Ownership Costs

Total ownership costs are the sum of the costs of depreciation, indirect equipment, facilities capital, and major repair. Each of these costs is explained below.

- **The cost of depreciation.** In this *Cost Guide*, "depreciation" means the straight line, even accrual of funds over the established economic life of a piece of equipment; it does not refer to any of the other methods of determining depreciation (i.e., for taxation or other accounting purposes). Depreciation is used to offset the purchase price.

  Depreciation costs are based on the purchase price plus sales tax and original freight costs minus the cost of a set of new tires (if tire mounted) and minus an allowance for salvage value at the end of the economic life of a piece of equipment. The purchase price used in this *Cost Guide* is the last or most recent manufacturers' suggested list price available at the time this document was researched. No discount is applied to this list price.

- **The indirect costs of equipment.** Allowances are made for indirect costs that result directly from equipment ownership. These costs include normal risk and liability insurance, property taxes, storage, licenses, recordkeeping costs, security, and worker's supervision. Insurance allowance does not include pollution insurance.

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Indirect costs are sometimes recovered in project or general company overhead. If any of these costs need to be eliminated from the basic rates in this *Cost Guide*, refer to the Rate Element Tables in Appendix A and the accompanying explanation for these tables in this section under the heading, *Use The Rate Element Tables To Adjust For Standby, Job Severity, Duplication Of Costs, And Discounts*.

- **The cost of facilities capital.** The cost of facilities capital (CFC) is an allowance for the cost of money invested in equipment, whether the equipment is purchased in cash or financed over time. CFC is not the same as interest charges. CFC is calculated by using the following formula:

$$CFC = \frac{[(N - 1) \times (1 + S) + 2] \times CMR \times P}{2 \times N}$$

Where:

N = Economic life of piece of equipment in years
S = Salvage value percentage
CMR = Cost of money rate (as set by the Treasury Department each January 1 and July 1)
P = Purchase price of the piece of equipment
CFC = Annual cost of facilities capital

- **The cost of major repair.** The ownership rates in this *Cost Guide* include an allowance for the major repair costs necessary to keep a piece of equipment functional throughout its economic life. This allowance covers the periodic rebuilding of major equipment components.

The life-cycle ownership costs (i.e., depreciation, indirect costs, cost of facilities capital, and major repair) are annualized and then adjusted to reflect the average annual working season in order to develop a monthly ownership rate. Weekly, daily, and hourly rates are derived from the monthly rate. Rates for shorter periods are increased to account for lost availability and productivity.

The weekly ownership rate is approximately 28 percent of the monthly rate. This percentage presumes the loss of roughly 32 hours during a month when equipment is used on a weekly basis.

The daily ownership rate is approximately 25 percent of the weekly rate, based on the loss of roughly 60 hours during a month when the equipment is used on a daily basis.

The hourly ownership rate is approximately 15 percent of the daily rate, based on the loss of about 80 hours during a month when the equipment is used on an hourly basis.

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Operating Costs

Total operating costs are based on the costs of labor and parts, expendables, and extraordinary expendables. Each of these costs is explained below.

- **The cost of labor and parts** needed for routine, daily servicing of the equipment. This includes repairing and/or replacing small components (e.g., pumps, injectors, filters, gaskets, and worn lines).

- **The cost of operating expendables** include fuel (computed in accordance with price, horsepower, and average load factors); lubrications (including filters, oil, and grease); and tires. Tire costs are calculated by average tire life factors and take into consideration typical discounts from list prices. Electrical costs are not included.

- **The cost of extraordinary operating expendables.** The Estimated Operating Cost per Hour may not include all operating expenses. Ground-engaging components (e.g., drill bits) are normally excluded because of their highly variable wear patterns, and operators' wages are not included. These costs should be recovered separately.

How To Use The *Cost Guide*

Familiarize yourself with both the Contents page (so that you can find the information you need) and the Introduction (so that you can use the information effectively). Then learn how this *Cost Guide* presents information, for example:

Oil/Water Separators

Maximum Capacity	Inlet/Outlet	Oil Outlet	Discharge
10 gpm	2.0"	3.0"	Gravity
10 gpm	2.0"	3.0"	½ HP Pump
20 gpm	2.5"	3.0"	Gravity
20 gpm	2.5"	3.0"	½ HP Pump
30 gpm	2.5"	3.0"	Gravity
30 gpm	2.5"	3.0"	½ HP Pump

Gasoline, diesel, air, and electrically powered units are listed separately for some equipment. Other specifications (e.g., flow rate, dimensions) are given to help identify equipment. Note the following:

- When horsepower is shown, it is the horsepower used for calculating estimated operating costs per hour or for identifying variations in like models from the same

manufacturer. Whenever possible, flywheel horsepower is used based upon manufacturers' ratings. For motors, it is 1.341 times the kilowatt rating or as listed by the manufacturer for a given rpm.

- Rates are given by the month, week, day, and hour for each piece of equipment.

Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
$115.00	$36.25	$10.20	$1.50	$1.50
$130.00	$42.00	$11.80	$1.75	$1.90
$165.00	$52.50	$14.70	$2.20	$2.30

- When applicable, the rates should be modified by the Rate Adjustment Table (Appendix A) factors to reflect a depreciation allowance indexed to the year a piece of equipment was originally manufactured and sold.

- To calculate the total cost for owning and operating a piece of equipment, add the following items:

  - Rental rate for equipment (plus modifications from the Rate Adjustment Tables when applicable)
  - Rate for attachments (when applicable)
  - Estimated operating cost
  - Operators' wages (including fringe benefits)
  - Additional costs for any operating or maintenance personnel who may be required.

The total cost suggested here is a guideline. It is not meant to define the actual rate that a lessor may charge. The actual rate may be increased or decreased by factors not taken into account in this *Cost Guide* (e.g., severe conditions on the job). Please note that the operator's wages and additional costs for operating or maintenance personnel are not included in the cited rates.

How To Adjust The Rates In This *Cost Guide*

The Rate Adjustment Tables and the Rate Element Tables are in Appendix A.

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Use The Rate Adjustment Tables To Adjust For Differences In Age Of Equipment

Allowances for depreciation costs, which are one of four kinds of ownership costs in these rates, represent a percentage of the total rate. Depreciation allowances are based on current or latest price levels for a given piece of equipment. The Rate Adjustment Tables list depreciation costs according to the year a piece of equipment was originally manufactured. (When this document was written, analysts used the Producer Price Index, published by the U.S. Department of Labor, Bureau of Labor Statistics, and manufacturers' price literature to determine historical and current price levels.) The adjustments ensure that the rates in this *Cost Guide* comply with federal cost principles.

The factors in the Rate Adjustment Tables apply only to the basic ownership rates; they do not apply to the Estimated Operating Cost per Hour or repair costs. The 1993 Rate Adjustment Tables can only be applied to 1993 rates.

To adjust the rate for a piece of equipment that carries a current model number:

1. Determine the year your piece of equipment was manufactured. (You may need to refer to an equipment serial number guide.) For example, let's say you have a 500 CFM Thermal Oxidizer manufactured in 1990.

2. Decide which table you should use. There are two tables: Table 1 contains data for years 1993-1984, and Table 2 contains data for years 1983-1974. Find the rate adjustment factor for your piece of equipment and the year it was manufactured. For our example, you would look in Table 1 (because your oxidizer was manufactured in 1990), and you would discover that the factor is .981.

3. Multiply the published rate by the adjustment factor for the year your equipment was manufactured. In our example,

   $1,350 is the monthly published rate for 500 CFM Thermal Oxidizer
   x .981 is the adjustment factor for 1990
   $1,325 is the adjusted monthly rate for 1990 vintage 500 CFM Thermal Oxidizer

Use The Rate Element Tables To Adjust For Standby, Job Severity, Duplication Of Costs, And Discounts

The Rate Element Tables (Appendix A) help you adjust the rates for standby, job severity, duplication of costs, and discounts. The basic rate contains allowances for depreciation, major repairs, cost of facilities capital (CFC), and indirect equipment costs.

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The Rate Element Tables show the average percentage of the total rate that each cost allowance comprises. For example, the tables list the following data for thermal oxidizers.

Equipment Type	Depreciation	Major Overhaul	CFC	Indirect Costs
Oxidizers	.40	.14	.14	.32

- **Standby rates.** A piece of equipment is in a "standby" situation when it is on the job and available for work but is not put into operation until needed. Under certain circumstances (e.g., during forced or legal standby), contractors may be entitled to payments for their equipment on standby. These payments reimburse the contractor for fixed costs (e.g., depreciation, cost of facilities capital, and indirect equipment costs).

  No industry standard exists for computing standby rates. However, data in the Rate Element Tables can help users identify an appropriate standby rate. Let's use thermal oxidizers again. Calculate "standby" for them as follows: Add the factors for depreciation, cost of facilities capital, and indirect costs to obtain a total percent of the ownership rate.

  .40 = Depreciation
  .14 = CFC
  ± .32 = Indirect costs
  .86(or 86 percent of ownership rate) = Standby rate

  The above example is not meant to establish a correct way of determining standby rates. Determining the specific amounts and cost allowances used in the calculation of standby rates is the responsibility of the contracting parties.

- **Job Severity.** Rates in this *Cost Guide* are based on the assumption that equipment is working mostly under normal job conditions, with occasional light and severe applications. In some cases, equipment may work consistently in severe job conditions, which may increase actual repair costs. The Rate Element Tables isolate the allowance for major repair and adjust it for severity. For example, if severe job conditions are expected to increase major repair by 10 percent, then you can increase the ownership rate by adding 10 percent to the repair portion. In the Oxidizer tables, repair is .14, or 14 percent, of the ownership rate. Multiplying this by 10 percent gives you 1.4 percent, which is the amount of increase in the total ownership rate. Remember that prolonged applications in severe job conditions may affect other cost allowances by decreasing the economic life of a piece of equipment; therefore, other adjustments may be necessary.

- **Duplication of costs.** If costs that are included in the rates are handled through other procedures, these costs should be deducted from the published rate. For example, if indirect costs are included in project overhead, then deduct that portion of the ownership rate. Using the tables for Oxidizers, this means that one would deduct 32 percent from the ownership rate to avoid duplicating the allowance for Indirect Costs.

- **Discounts.** As stated earlier in this Introduction, the ownership rates in this guide do not include an allowance for a discount from the manufacturer's suggested price. If it is necessary to account for a discounted purchase price, reduce the depreciation portion of the ownership rate by an amount equal to the discount percentage. With Thermal Oxidizers, for example, if the buyer receives a 15 percent discount, reduce the ownership rate by subtracting 15 percent of 40 percent (the depreciation portion); in this case, 6 percent.

Use One Of Two Ways To Adjust For Multiple Shifts

Depending on the agreement, you may charge multiple shifts (overtime) in one of the following ways:

- At 1/8th the daily rate for each hour in excess of 8 hours, 1/40th of the weekly rate for each hour in excess of 40 hours, and 1/176th of the monthly rate for each hour in excess of 176 hours within a 30-day period.

- At 150 percent of the base rate for double shifts; 200 percent of the base rate for triple shifts. For example,

Single shift (8 hours)	=	$100 per day (base rate)
Double shift (16 hours)	=	$150 per day
Third shift (24 hours)	=	$200 per day

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REMEDIATION EQUIPMENT

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UST SITES

§2, REMEDIATION EQUIPMENT

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REMEDIATION EQUIPMENT

LIQUID PHASE CARBON ADSORBERS

(All rates include carbon cannister, initial carbon supply, and internal piping. Carbon cannisters are made of steel and internally lined with an epoxy coating. Pumps, transfer piping, accessory instrumentation, shipping costs, and electricity costs are not included. Rates are based on one month carbon change-out. Actual carbon life is highly site specific and will vary greatly.)

Height	*Diameter*	*Maximum Flow Rate*	*Carbon Capacity*	*Monthly*	*Weekly*	*Daily*	*Hourly*	*Estimated Operating Cost/Hr.*
Manual Powered								
30 in	20 in	3 gpm	110 lbs	$ 24.00	$ 7.00	$ 2.00	$ .30	$ .15
40 in	30 in	6 gpm	180 lbs	45.00	13.00	3.00	.45	.15
36 in	22 in	15 gpm	180 lbs	70.00	20.00	5.00	.75	.15
40 in	26 in	10 gpm	250 lbs	66.00	18.00	5.00	.75	.15
40 in	26 in	20 gpm	250 lbs	110.00	31.00	8.00	1.00	.15
75 in	21 in	12 gpm	300 lbs	200.00	56.00	14.00	2.00	.15
43 in	29 in	25 gpm	350 lbs	145.00	41.00	10.00	2.00	.15
46 in	32 in	15 gpm	400 lbs	210.00	59.00	15.00	2.00	.15
71 in	38 in	35 gpm	650 lbs	350.00	98.00	25.00	4.00	.20
87 in	36 in	33 gpm	800 lbs	360.00	100.00	25.00	4.00	.20
72 in	44 in	45 gpm	1,000 lbs	350.00	98.00	25.00	4.00	.20
78 in	47 in	50 gpm	1,000 lbs	485.00	135.00	34.00	5.00	.25
86 in	45 in	50 gpm	1,500 lbs	445.00	125.00	31.00	5.00	.20
86 in	45 in	60 gpm	2,000 lbs	545.00	155.00	39.00	6.00	.25
91 in	57 in	75 gpm	2,000 lbs	755.00	210.00	53.00	8.00	.30
97 in	68 in	100 gpm	3,000 lbs	875.00	245.00	61.00	9.00	.30
112 in	85 in	200 gpm	6,000 lbs	1,605.00	450.00	115.00	17.00	.50

REMEDIATION EQUIPMENT

VAPOR PHASE CARBON ADSORBERS

(All rates include carbon cannister, internal piping and initial carbon supply. Carbon cannisters are made of steel and internally lined with an epoxy coating. Pumps, transfer piping, accessory instrumentation, shipping costs and electricity costs are not included. Rates are based on one month carbon change-out. Actual carbon life is highly site specific and will vary greatly.)

Height	*Diameter*	*Maximum Flow Rate*	*Carbon Capacity*	*Monthly*	*Weekly*	*Daily*	*Hourly*	*Estimated Operating Cost/Hr.*
Manual Powered								
31 in	20 in	50 cfm	100 lbs	$ 50.00	$ 14.00	$ 4.00	$ .60	$ .15
30 in	19 in	30 cfm	100 lbs	30.00	8.00	2.00	.30	.15
36 in	24 in	60 cfm	175 lbs	50.00	14.00	4.00	.60	.15
36 in	24 in	300 cfm	175 lbs	81.00	23.00	6.00	.90	.15
36 in	24 in	100 cfm	200 lbs	77.00	22.00	6.00	.90	.15
40 in	26 in	75 cfm	250 lbs	78.00	22.00	6.00	.90	.15
41 in	27 in	150 cfm	300 lbs	130.00	36.00	9.00	1.00	.15
46 in	32 in	125 cfm	400 lbs	125.00	35.00	9.00	1.00	.15
43 in	33 in	250 cfm	400 lbs	165.00	46.00	12.00	2.00	.15
51 in	38 in	200 cfm	650 lbs	210.00	59.00	15.00	2.00	.15
72 in	38 in	400 cfm	700 lbs	415.00	115.00	29.00	4.00	.20
72 in	44 in	250 cfm	1,000 lbs	325.00	91.00	23.00	3.00	.20
87 in	47 in	600 cfm	1,000 lbs	510.00	145.00	36.00	5.00	.25
87 in	47 in	600 cfm	1,500 lbs	720.00	200.00	50.00	8.00	.30
89 in	47 in	500 cfm	1,500 lbs	750.00	210.00	53.00	8.00	.30
92 in	57 in	1,000 cfm	2,500 lbs	1,220.00	340.00	85.00	13.00	.40
98 in	68 in	1,500 cfm	4,500 lbs	2,215.00	620.00	155.00	23.00	.60
113 in	85 in	2,000 cfm	6,000 lbs	2,495.00	700.00	175.00	26.00	.70

TRAY AERATORS

Number of Trays	Flow Rate	Blower Capacity	Blower Horsepower	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered								
3	10 gpm	150 cfm	3	$ 235.00	$ 66.00	$ 17.00	$ 3.00	$ 1.00
3 (Includes sump pump.)	10 gpm	150 cfm	3	305.00	85.00	21.00	3.00	1.10
4	10 gpm	150 cfm	3	280.00	78.00	20.00	3.00	1.10
4 (Includes sump pump)	10 gpm	150 cfm	3	350.00	98.00	25.00	4.00	1.20
3	15 gpm	175 cfm	3	280.00	78.00	20.00	3.00	1.10
3 (Includes sump pump.)	15 gpm	175 cfm	3	350.00	98.00	25.00	4.00	1.20
4	15 gpm	175 cfm	3	315.00	88.00	22.00	3.00	1.15
4 (Includes sump pump.)	15 gpm	175 cfm	3	385.00	110.00	28.00	4.00	1.25
6	15 gpm	175 cfm	3	350.00	98.00	25.00	4.00	1.20
6 (Includes sump pump.)	15 gpm	175 cfm	3	420.00	120.00	30.00	5.00	1.30
3	20 gpm	250 cfm	5	365.00	100.00	25.00	4.00	1.20
3 (Includes sump pump.)	20 gpm	250 cfm	5	435.00	120.00	30.00	5.00	1.35
4	20 gpm	250 cfm	5	405.00	115.00	29.00	4.00	1.25
4 (Includes sump pump.)	20 gpm	250 cfm	5	475.00	135.00	34.00	5.00	1.40

TRAY AERATORS

Number of Trays	Flow Rate	Blower Capacity	Blower Horsepower	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered, Continued								
6	20 gpm	250 cfm	5	$ 495.00	$ 140.00	$ 35.00	$ 5.00	$ 1.40
6 (Includes sump pump.)	20 gpm	250 cfm	5	565.00	160.00	40.00	6.00	1.55
3	25 gpm	300 cfm	5	450.00	125.00	31.00	5.00	1.35
3 (Includes sump pump.)	25 gpm	300 cfm	5	540.00	150.00	38.00	6.00	1.50
4	25 gpm	300 cfm	5	525.00	145.00	36.00	5.00	1.45
4 (Includes sump pump.)	25 gpm	300 cfm	5	615.00	170.00	43.00	6.00	1.60
3	50 gpm	600 cfm	5	625.00	175.00	44.00	7.00	1.60
3 (Includes sump pump.)	50 gpm	600 cfm	5	720.00	200.00	50.00	8.00	1.75
4	50 gpm	600 cfm	5	720.00	200.00	50.00	8.00	1.75
4 (Includes sump pump.)	50 gpm	600 cfm	5	815.00	230.00	58.00	9.00	1.90

PACKED TOWER AIR STRIPPERS

(Includes blower, demister, sump pump, fiberglass reinforced plastic tower, initial supply of tower packing, and (for trailer mounted units) tandem axle trailer. Electricity costs not included.)

Tower Diameter	*Tower Height*	*Water Flow Rate*	*Maximum Air Flow*	*Monthly*	*Weekly*	*Daily*	*Hourly*	*Estimated Operating Cost/Hr.*
Electric Powered								
12"	18'0"	10 gpm	350 cfm	$ 145.00	$ 41.00	$ 10.00	$ 2.00	$ .65
12" (Trailer mounted)	18'0"	10 gpm	350 cfm	180.00	50.00	13.00	2.00	.70
18"	18'0"	25 gpm	500 cfm	165.00	46.00	12.00	2.00	.70
18" (Trailer mounted)	18'0"	25 gpm	500 cfm	205.00	57.00	14.00	2.00	.75
24"	18'0"	50 gpm	750 cfm	195.00	55.00	14.00	2.00	.75
24" (Trailer mounted)	18'0"	50 gpm	750 cfm	230.00	64.00	16.00	2.00	.80
30"	18'0"	75 gpm	900 cfm	240.00	67.00	17.00	3.00	.80
30" (Trailer mounted)	18'0"	75 gpm	900 cfm	280.00	78.00	20.00	3.00	.90
36"	18'0"	125 gpm	1,250 cfm	280.00	78.00	20.00	3.00	.90
36" (Trailer mounted)	18'0"	125 gpm	1,250 cfm	335.00	94.00	24.00	4.00	1.00

PUGMILL MIXERS

(Pugmill Mixers include mix elevator, screening unit and tandem axle trailer.)

HP	Mixer Size	Mixer Type	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered							
140	50" X 6'	Paddle	$ 4,630.00	$ 1,295.00	$ 325.00	$ 49.00	$ 10.30
165	50" X 8'	Paddle	5,105.00	1,430.00	360.00	54.00	10.90
190	50" X 10'	Paddle	5,260.00	1,475.00	370.00	56.00	11.10
195	60" X 8'	Paddle	6,970.00	1,950.00	490.00	74.00	13.35
245	60" X 10'	Paddle	7,790.00	2,180.00	545.00	82.00	14.45

BINS

Capacity	Material	Type	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Manual Powered							
5 GAL	Polyethylene	Cylindrical Storage	$ .90	$ .25	$ .05	$ .00	$ .00
5 GAL	Polypropylene	Cylindrical Storage	1.00	.30	.10	.00	.00
5 GAL	HDPE	Rectangular	1.00	.30	.10	.00	.00
5 GAL	Polypropylene	Rectangular	1.00	.30	.10	.00	.00
7 GAL	HDPE	Rectangular	1.00	.30	.10	.00	.00
7 GAL	Polypropylene	Rectangular	2.00	.55	.15	.00	.00
10 GAL	Polyethylene	Cylindrical Storage	1.00	.30	.10	.00	.00
10 GAL	Polypropylene	Cylindrical Storage	2.00	.55	.15	.00	.00
10 GAL	HDPE	Rectangular	2.00	.55	.15	.00	.00
10 GAL	Polypropylene	Rectangular	2.00	.55	.15	.00	.00

BINS

Capacity	Material	Type	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Manual Powered, Continued							
15 GAL	Polyethylene	Cylindrical Storage	$ 2.00	$ .55	$ .15	$ .00	$ .00
15 GAL	Polypropylene	Cylindrical Storage	2.00	.55	.15	.00	.00
15 GAL	HDPE	Rectangular	2.00	.55	.15	.00	.00
15 GAL	Polypropylene	Rectangular	3.00	.85	.20	.05	.00
25 GAL	Polyethylene	Cylindrical Storage	2.00	.55	.15	.00	.00
25 GAL	Polypropylene	Cylindrical Storage	3.00	.85	.20	.05	.00
25 GAL	HDPE	Rectangular	3.00	.85	.20	.05	.00
25 GAL	Polypropylene	Rectangular	3.00	.85	.20	.05	.00
35 GAL	HDPE	Rectangular	3.00	.85	.20	.05	.00
35 GAL	Polypropylene	Rectangular	5.00	1.00	.25	.05	.00
50 GAL	HDPE	Utility-Dry	1.00	.30	.10	.00	.00
50 GAL	HDPE	Utility-Wet	2.00	.55	.15	.00	.00
55 GAL	Cross-linked PE	Cylindrical Storage	3.00	.85	.20	.05	.00
55 GAL	Polyethylene	Cylindrical Storage	3.00	.85	.20	.05	.00
55 GAL	Polypropylene	Cylindrical Storage	4.00	1.00	.25	.05	.00
55 GAL	HDPE	Rectangular	5.00	1.00	.25	.05	.05
55 GAL	Polypropylene	Rectangular	7.00	2.00	.50	.10	.05
65 GAL	HDPE	Utility-Dry	1.00	.30	.10	.00	.00
65 GAL	HDPE	Utility-Wet	2.00	.55	.15	.00	.00
75 GAL	Cross-linked PE	Cylindrical Storage	6.00	2.00	.50	.10	.05
75 GAL	Polyethylene	Cylindrical Storage	5.00	1.00	.25	.05	.05
75 GAL	Polypropylene	Cylindrical Storage	7.00	2.00	.50	.10	.05

BINS

Capacity	Material	Type	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Manual Powered, Continued							
75 GAL	HDPE	Rectangular	$ 6.00	$ 2.00	$ .50	$ .10	$ .05
75 GAL	Polypropylene	Rectangular	9.00	3.00	.75	.10	.05
80 GAL	HDPE	Utility-Dry	2.00	.55	.15	.00	.00
80 GAL	HDPE	Utility-Wet	3.00	.85	.20	.05	.00
100 GAL	Cross-linked PE	Cylindrical Storage	8.00	2.00	.50	.10	.05
100 GAL	Polyethylene	Cylindrical Storage	6.00	2.00	.50	.10	.05
100 GAL	Polypropylene	Cylindrical Storage	8.00	2.00	.50	.10	.05
100 GAL	HDPE	Rectangular	9.00	3.00	.75	.10	.05
100 GAL	Polypropylene	Rectangular	12.00	3.00	.75	.10	.05
100 GAL	HDPE	Utility-Dry	2.00	.55	.15	.00	.00
100 GAL	HDPE	Utility-Wet	3.00	.85	.20	.05	.00
130 GAL	HDPE	Utility-Dry	2.00	.55	.15	.00	.00
130 GAL	HDPE	Utility-Wet	4.00	1.00	.25	.05	.00
150 GAL	Cross-linked PE	Cylindrical Storage	9.00	3.00	.75	.10	.05
150 GAL	Polyethylene	Cylindrical Storage	8.00	2.00	.50	.10	.05
150 GAL	Polypropylene	Cylindrical Storage	10.00	3.00	.75	.10	.05
160 GAL	HDPE	Utility-Dry	3.00	.85	.20	.05	.00
160 GAL	HDPE	Utility-Wet	4.00	1.00	.25	.05	.00
200 GAL	Cross-linked PE	Cylindrical Storage	10.00	3.00	.75	.10	.05
200 GAL	Polyethylene	Cylindrical Storage	9.00	3.00	.75	.10	.05
200 GAL	Polypropylene	Cylindrical Storage	11.00	3.00	.75	.10	.05
250 GAL	Cross-linked PE	Cylindrical Storage	13.00	4.00	1.00	.15	.05

BINS

Capacity	Material	Type	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr
Manual Powered, Continued							
250 GAL	Polyethylene	Cylindrical Storage	$ 12.00	$ 3.00	$ .75	$ .10	$ .05
250 GAL	Polypropylene	Cylindrical Storage	17.00	5.00	1.00	.15	.05
350 GAL	Cross-linked PE	Cylindrical Storage	18.00	5.00	1.00	.15	.05
350 GAL	Polyethylene	Cylindrical Storage	16.00	4.00	1.00	.15	.05
350 GAL	Polypropylene	Cylindrical Storage	21.00	6.00	2.00	.30	.05
500 GAL	Cross-linked PE	Cylindrical Storage	24.00	7.00	2.00	.30	.05
500 GAL	Polyethylene	Cylindrical Storage	22.00	6.00	2.00	.30	.05
500 GAL	Polypropylene	Cylindrical Storage	34.00	10.00	3.00	.45	.10
700 GAL	Polyethylene	Cylindrical Storage	33.00	9.00	2.00	.30	.10
1,000 GAL	Polyethylene	Cylindrical Storage	43.00	12.00	3.00	.45	.10

OIL/WATER SEPARATORS

(Coalescing plate-type)

Maximum Capacity	Inlet/Outlet	Oil Outlet	Discharge	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr
Manual Powered								
4 gpm	1.5"	2"	Gravity	$ 59.00	$ 17.00	$ 4.00	$ .60	$ .30
8 gpm	2"	2"	Gravity	115.00	32.00	8.00	1.00	.35
10 gpm	2"	3"	Gravity	135.00	38.00	10.00	2.00	.40
20 gpm	2.5"	3"	Gravity	185.00	52.00	13.00	2.00	.40
30 gpm	2.5"	3"	Gravity	260.00	73.00	18.00	3.00	.50
40 gpm	3"	3"	Gravity	300.00	84.00	21.00	3.00	.55
60 gpm	3"	3"	Gravity	370.00	105.00	26.00	4.00	.60

OIL/WATER SEPARATORS

(Coalescing plate-type)

Maximum Capacity	Inlet/Outlet	Oil Outlet	Discharge	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered								
10 gpm	2"	3"	1/2 HP Pump	$ 285.00	$ 80.00	$ 20.00	$ 3.00.	$ 60
20 gpm	2.5"	3"	1/2 HP Pump	335.00	94.00	24.00	4.00	.65
30 gpm	2.5"	3"	1/2 HP Pump	405.00	115.00	29.00	4.00	.75
40 gpm	3"	3"	1 HP Pump	455.00	125.00	31.00	5.00	.80
60 gpm	3"	3"	1 HP Pump	525.00	145.00	36.00	5.00	.90

BLOWERS

Maximum Flow Rate	Maximum Pressure	RPM	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered							
0–25 cfm	28 "H20	3,500	$ 15.00	$ 4.00	$ 1.00	$ .15	$ .05
26–50 cfm	45 "H20	3,500	18.00	5.00	1.00	.15	.05
51–100 cfm	52 "H20	3,500	20.00	6.00	2.00	.30	.05
101–150 cfm	65 "H20	3,500	26.00	7.00	2.00	.30	.05
151–200 cfm	65 "H20	3,500	38.00	11.00	3.00	.45	.10
201–300 cfm	90 "H20	3,500	62.00	17.00	4.00	.60	.10
301–500 cfm	105 "H20	3,500	73.00	20.00	5.00	.75	.15
501–800 cfm	90 "H20	3,500	95.00	27.00	7.00	1.00	.15

GENERAL PURPOSE CONVEYORS

HP	Belt Length	Belt Width	Capacity	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr
Electric Powered								
5	30'	18"	150 tph	$ 820.00	$ 230.00	$ 58.00	$ 9.00	$ 2.00
5	50'	18"	150 tph	960.00	270.00	68.00	10.00	2.20
7	30'	24"	300 tph	890.00	250.00	63.00	9.00	2.20
10	40'	24"	300 tph	990.00	275.00	69.00	10.00	2.35
10	50'	24"	300 tph	1,065.00	300.00	75.00	11.00	2.45
15	30'	30"	500 tph	1,015.00	285.00	71.00	11.00	2.40
15	40'	30"	500 tph	1,065.00	300.00	75.00	11.00	2.45
20	50'	30"	500 tph	1,160.00	325.00	81.00	12.00	2.60
20	30'	36"	750 tph	1,100.00	310.00	78.00	12.00	2.50
20	40'	36"	750 tph	1,175.00	330.00	83.00	12.00	2.60
25	50'	36"	750 tph	1,200.00	335.00	84.00	13.00	2.65
30	60'	36"	750 tph	1,275.00	355.00	89.00	13.00	2.75
25	40'	42"	1,100 tph	1,440.00	405.00	100.00	15.00	4.00
25	50'	42"	1,100 tph	1,470.00	410.00	105.00	16.00	4.05
30	60'	42"	1,100 tph	1,515.00	425.00	105.00	16.00	4.10

REMEDIATION EQUIPMENT

BELT FEEDERS

Belt Length	Belt Width	Horsepower	Type	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered								
4'	18"	2	Belt	$ 310.00	$ 87.00	$ 22.00	$ 3.00	$ .50
6'	18"	2	Belt	335.00	94.00	24.00	4.00	.50
4'	24"	3	Belt	330.00	92.00	23.00	3.00	.50
6'	24"	3	Belt	350.00	98.00	25.00	4.00	.50
4'	30"	3	Belt	335.00	94.00	24.00	4.00	.50
6'	30"	3	Belt	380.00	105.00	26.00	4.00	.55
4'	36"	5	Belt	360.00	100.00	25.00	4.00	.55
6'	36"	5	Belt	405.00	115.00	29.00	4.00	.55
4'	42"	7	Belt	405.00	115.00	29.00	4.00	.55
6'	42"	7	Belt	435.00	120.00	30.00	5.00	.60
4'	48"	10	Belt	460.00	130.00	33.00	5.00	.60
6'	48"	10	Belt	470.00	130.00	33.00	5.00	.60

VIBRATING GRIZZLY FEEDERS

Deck Length	Screen Size	Horsepower	Number of Decks	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered								
14'	30"	25	1	$ 1,785.00	$ 500.00	$ 125.00	$ 19.00	$ 3.45
17'	30"	25	1	1,940.00	545.00	135.00	20.00	3.65
14'	35"	30	1	1,820.00	510.00	130.00	20.00	3.50
17'	35"	30	1	2,070.00	580.00	145.00	22.00	3.75

VIBRATING GRIZZLY FEEDERS

Deck Length	Screen Size	Horsepower	Number of Decks	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered, Continued								
20'	35"	30	1	$ 2,180.00	$ 610.00	$ 155.00	$ 23.00	$ 3.90
14'	42"	35	1	1,850.00	520.00	130.00	20.00	3.55
17'	42"	35	1	1,980.00	555.00	140.00	21.00	3.65
20'	42"	35	1	2,210.00	620.00	155.00	23.00	3.90
17'	52"	40	1	2,235.00	625.00	155.00	23.00	3.95
20'	52"	40	1	2,540.00	710.00	180.00	27.00	4.25
24'	52"	40	1	4,345.00	1,215.00	305.00	46.00	6.20
24'	62"	60	1	4,655.00	1,305.00	325.00	49.00	6.55
30'	62"	60	1	5,470.00	1,530.00	385.00	58.00	7.40
14'	30"	25	2	1,830.00	510.00	130.00	20.00	3.90
17'	30"	25	2	1,975.00	555.00	140.00	21.00	4.05
14'	35"	30	2	1,870.00	525.00	130.00	20.00	3.95
17'	35"	30	2	2,105.00	590.00	150.00	23.00	4.20
20'	35"	30	2	2,205.00	615.00	155.00	23.00	4.35
14'	42"	35	2	1,910.00	535.00	135.00	20.00	4.00
17'	42"	35	2	2,030.00	570.00	145.00	22.00	4.15
20'	42"	35	2	2,250.00	630.00	160.00	24.00	4.40
17'	52"	40	2	2,275.00	635.00	160.00	24.00	4.40
20'	52"	40	2	2,565.00	720.00	180.00	27.00	4.75
24'	52"	40	2	4,260.00	1,195.00	300.00	45.00	6.70
24'	62"	60	2	4,555.00	1,275.00	320.00	48.00	7.05
30'	62"	60	2	5,320.00	1,490.00	375.00	56.00	7.95

APRON FEEDERS

Belt Length	Belt Width	Horsepower	Type	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered								
10'	30"	5	Double Chain	$ 1,665.00	$ 465.00	$ 115.00	$ 17.00	$ 1.90
12'	30"	5	Double Chain	1,795.00	505.00	125.00	19.00	2.00
6'	30"	5	Double Chain	1,390.00	390.00	98.00	15.00	1.70
8'	30"	5	Double Chain	1,520.00	425.00	105.00	16.00	1.80
10'	36"	5	Double Chain	1,715.00	480.00	120.00	18.00	1.95
12'	36"	5	Double Chain	1,850.00	520.00	130.00	20.00	2.05
6'	36"	5	Double Chain	1,440.00	405.00	100.00	15.00	1.75
8'	36"	5	Double Chain	1,570.00	440.00	110.00	17.00	1.85
10'	36"	5	Triple Chain	1,845.00	515.00	130.00	20.00	10.30
6'	36"	5	Triple Chain	1,535.00	430.00	110.00	17.00	8.55
8'	36"	5	Triple Chain	1,685.00	470.00	120.00	18.00	9.40
10'	42"	7	Triple Chain	2,010.00	565.00	140.00	21.00	11.30
6'	42"	7	Triple Chain	1,675.00	470.00	120.00	18.00	9.35
8'	42"	7	Triple Chain	1,840.00	515.00	130.00	20.00	10.30
10'	48"	10	Triple Chain	2,150.00	600.00	150.00	23.00	12.10
6'	48"	10	Triple Chain	1,960.00	550.00	140.00	21.00	11.00

REMEDIATION EQUIPMENT

SCALPING SCREENS

Screen Width	Screen Length	HP	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr
Electric Powered							
3'0"	8'0"	7	$ 340.00	$ 95.00	$ 24.00	$ 4.00	$ .00
3'6"	8'0"	7	380.00	105.00	26.00	4.00	.00
4'0" (Double Deck)	10'0"	15	485.00	135.00	34.00	5.00	.00

DRUM DEHEADERS

Type	Cutter Diameter	Drum Gauge	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr
Manual Powered							
Hand Operated	N/A	All	$ 13.00	$ 4.00	$ 1.00	$ .15	$ .00
Electric Powered							
Powered	1 in	18/20	240.00	67.00	17.00	3.00	.15
Air Powered							
Powered	1 in	18/20	265.00	74.00	19.00	3.00	.15

WALK-BEHIND ROTOTILLERS

HP	Drive	Till Width	Rotor Diameter	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr
Gasoline Powered								
5	Mechanical	18"	7"	$ 62.00	$ 17.00	$ 4.00	$ .60	$ .40
11	Hydraulic	24"	14"	205.00	57.00	14.00	2.00	.75
16	Hydraulic	30"	14"	270.00	76.00	19.00	3.00	1.05

REMEDIATION EQUIPMENT

SELF-PROPELLED RIDE-ON ROTOTILLERS

HP	Drive	Till Width	Rotor Diameter	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Gasoline Powered								
12	Manual Reversing	36"	14"	$ 375.00	$ 105.00	$ 26.00	$ 4.00	$ 1.25
12	Manual Reversing	36"	7"	360.00	100.00	25.00	4.00	1.25
12	Manual Reversing	42"	14"	380.00	105.00	26.00	4.00	1.25
12	Manual Reversing	42"	17"	400.00	110.00	28.00	4.00	1.25
19	Manual Reversing	42"	14"	460.00	130.00	33.00	5.00	1.70
19	Manual Reversing	42"	17"	480.00	135.00	34.00	5.00	1.70
19	Manual Reversing	50"	17"	480.00	135.00	34.00	5.00	1.70
24	Hydrostatic	50"	17"	570.00	160.00	40.00	6.00	2.10
24	Hydrostatic	50"	20"	585.00	165.00	41.00	6.00	2.10
24	Hydrostatic	60"	17"	580.00	160.00	40.00	6.00	2.10
24	Hydrostatic	60"	20"	600.00	170.00	43.00	6.00	2.10

LOW TEMPERATURE THERMAL DESORBERS

(All units include primary feed hopper and screens, soil conveying equipment, secondary feed hoppers and mixing equipment, controlled weigh batchers, scalping screen, primary desorber unit, secondary vapor treatment (thermal oxidizer), cloth baghouse, treated soil conveying equipment, and control house. Capacity is based on 12% soil moisture content. Maximum BTU rating is based on both desorber and oxidizer burners. Fuel costs will vary with contaminant type and amount. (For example, 10,000/ppm BTEX can reduce fuel requirement by as much as four gallons propane per ton of soil.) Fuel costs assume no recycling of contaminant vapors for use as fuel.)

Drum Diameter	Drum Length	Capacity	Maximum BTU	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Liquid Propane Gas Powered (Operating cost will fluctuate due to seasonality of propane costs.)								
5'6"	25'0"	25-50 tph	37,500,000	$ 26,065.00	$ 7,300.00	$ 1,825.00	$ 275.00	$ 270.10
7'6"	35'0"	50-75 tph	75,000,000	32,290.00	9,040.00	2,260.00	340.00	506.05
9'6"	55'0"	75-110 tph	120,000,000	37,190.00	10,415.00	2,605.00	390.00	785.90

REMEDIATION EQUIPMENT

LOW TEMPERATURE THERMAL DESORBERS

(All units include primary feed hopper and screens, soil conveying equipment, secondary feed hoppers and mixing equipment, controlled weigh batchers, scalping screen, primary desorber unit, secondary vapor treatment (thermal oxidizer), cloth baghouse, treated soil conveying equipment, and control house. Capacity is based on 12% soil moisture content. Maximum BTU rating is based on both desorber and oxidizer burners. Fuel costs will vary with contaminant type and amount. (For example, 10,000/ppm BTEX can reduce fuel requirement by as much as four gallons propane per ton of soil.) Fuel costs assume no recycling of contaminant vapors for use as fuel.)

Drum Diameter	*Drum Length*	*Capacity*	*Maximum BTU*	*Monthly*	*Weekly*	*Daily*	*Hourly*	*Estimated Operating Cost/Hr*
Diesel Powered								
5'6"	25'0"	25-50 tph	37,500,000	$ 26,065.00	$ 7,300.00	$ 1,825.00	$ 275.00	$ 321.00
7'6"	35'0"	50-75 tph	75,000,000	32,290.00	9,040.00	2,260.00	340.00	606.20
9'6"	55'0"	75-110 tph	120,000,000	37,190.00	10,415.00	2,605.00	390.00	948.25
Natural Gas Powered								
5'6"	25'0"	25-50 tph	37,500,000	26,065.00	7,300.00	1,825.00	275.00	310.50
7'6"	35'0"	50-75 tph	75,000,000	32,290.00	9,040.00	2,260.00	340.00	589.00
9'6"	55'0"	75-110 tph	120,000,000	37,190.00	10,415.00	2,605.00	390.00	921.45

SOIL VAPOR EXTRACTION SYSTEMS

(Includes moisture separator, automatic shut-off device, air filter, and inlet manifold. Skid mounted. Flow instrumentation and electricity costs not included.)

Vacuum Pump Capacity	*Horsepower*	*Intake Diameter*	*Maximum Vacuum*	*Monthly*	*Weekly*	*Daily*	*Hourly*	*Estimated Operating Cost/Hr*
Electric Powered								
75 cfm (With 20 gallon moisture separator)	1	2"	48 "H20	$ 115.00	$ 32.00	$ 8.00	$ 1.00	$ .30
75 cfm (With 40 gallon moisture separator)	1	2"	48 "H20	120.00	34.00	9.00	1.00	.30
150 cfm (With 20 gallon moisture separator)	2	2"	60 "h20	125.00	35.00	9.00	1.00	.30
150 cfm (With 40 gallon moisture separator)	2	2"	60 "h20	130.00	36.00	9.00	1.00	.30

REMEDIATION EQUIPMENT

SOIL VAPOR EXTRACTION SYSTEMS

(Includes moisture separator, automatic shut-off device, air filter, and inlet manifold. Skid mounted. Flow instrumentation and electricity costs not included.)

Vacuum Pump Capacity	Horsepower	Intake Diameter	Maximum Vacuum	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered (Continued)								
250 cfm (With 20 gallon moisture separator.)	5	2"	90 "H20	$ 185.00	$ 52.00	$ 13.00	$ 2.00	$ .35
250 cfm (With 40 gallon moisture separator.)	5	2"	90 "H20	190.00	53.00	13.00	2.00	.35
400 cfm (With 20 gallon moisture separator.)	10	2"	90 "H20	310.00	87.00	22.00	3.00	.45
400 cfm (With 40 gallon moisture separator.)	10	2"	90 "H20	315.00	88.00	22.00	3.00	.45

BAGHOUSES

Air Flow	Number of Bags	Horsepower	Number of Axles	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered								
20,000 CFM	280	80	2	$ 7,130.00	$ 1,995.00	$ 500.00	$ 75.00	$ 12.45
25,000 CFM	280	100	2	7,310.00	2,045.00	510.00	77.00	12.60
35,000 CFM	336	170	2	8,825.00	2,470.00	620.00	93.00	16.60
50,000 CFM	560	210	3	11,355.00	3,180.00	795.00	120.00	18.95
55,000 CFM	704	230	3	13,470.00	3,770.00	945.00	140.00	24.80
65,000 CFM	704	270	3	13,300.00	3,725.00	930.00	140.00	27.45
75,000 CFM	800	280	3	14,510.00	4,065.00	1,015.00	150.00	28.65

REMEDIATION EQUIPMENT

WET SCRUBBERS

Air Flow	Horsepower	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered						
20,000 CFM	120	$ 2,410.00	$ 675.00	$ 170.00	$ 26.00	$ 5.20
30,000 CFM	180	3,100.00	870.00	220.00	33.00	5.85
40,000 CFM	230	6,390.00	1,790.00	450.00	68.00	12.90
55,000 CFM	350	6,825.00	1,910.00	480.00	72.00	13.30
70,000 CFM	450	7,405.00	2,075.00	520.00	78.00	13.80

LOCATORS

Type	Receiver Output	Transmitter Output	Power Source	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered								
Magnetic	40 HZ	N/A	C-Cell Batteries	$ 62.00	$ 17.00	$ 4.00	$ .60	$ .15
Magnetic and Cable	40 HZ	82 KHZ	C-Cell Batteries	175.00	49.00	12.00	2.00	.25

SKIMMERS

(Electric models include product bladder pump and controller.)

Diameter	Type	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Manual Powered						
1 in	Downhole	$ 75.00	$ 21.00	$ 5.00	$ .75	$ .05
3 in	Downhole	91.00	25.00	6.00	.90	.05
Electric Powered						
1 in	Downhole	245.00	69.00	17.00	3.00	.40

REMEDIATION EQUIPMENT

DOWNHOLE FILTER-SEPARATORS

(Includes product pump and controller.)

Pump Diameter	Recovery Rate	Control Panel	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered							
4 in	.30 gpm	NEMA 3	$ 310.00	$ 87.00	$ 22.00	$ 3.00	$ .55
4 in	.30 gpm	NEMA 7	365.00	100.00	25.00	4.00	.60
6 in	.60 gpm	NEMA 3	355.00	99.00	25.00	4.00	.60
6 in	.60 gpm	NEMA 7	405.00	115.00	29.00	4.00	.65

SURFACE FILTER-SEPARATORS

Recovery Rate	Buoy Diameter	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered						
5 gpm	18 in	$ 350.00	$ 98.00	$ 25.00	$ 4.00	$ .50

BLADDER PUMPS

Maximum Flow Rate	Pump Diameter	Length	Depth Capacity	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Air Powered								
2 gpm (Stainless steel)	1 in	36 in	100'	$ 115.00	$ 32.00	$ 8.00	$ 1.00	$ .40
2 gpm (Stainless steel)	1 in	36 in	25'	105.00	29.00	7.00	1.00	.35
2 gpm (Stainless steel)	1 in	36 in	50'	105.00	29.00	7.00	1.00	.40
2 gpm (Teflon)	1 in	36 in	100'	120.00	34.00	9.00	1.00	.40

REMEDIATION EQUIPMENT

BLADDER PUMPS

Maximum Flow Rate	Pump Diameter	Length	Depth Capacity	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Air Powered, Continued								
2 gpm (Teflon)	1 in	36 in	25'	$ 110.00	$ 31.00	$ 8.00	$ 1.00	$ .40
2 gpm (Teflon)	1 in	36 in	50'	110.00	31.00	8.00	1.00	.40
4 gpm (Stainless steel)	1 in	98 in	100'	125.00	35.00	9.00	1.00	.40
4 gpm (Stainless steel)	1 in	98 in	25'	110.00	31.00	8.00	1.00	.40
4 gpm (Stainless steel)	1 in	98 in	50'	115.00	32.00	8.00	1.00	.40
4 gpm (Teflon)	1 in	98 in	100'	130.00	36.00	9.00	1.00	.45
4 gpm (Teflon)	1 in	98 in	25'	115.00	32.00	8.00	1.00	.40
4 gpm (Teflon)	1 in	98 in	50'	120.00	34.00	9.00	1.00	.40

CENTRIFUGAL PUMPS

HP	Size	Capacity	Mounting	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Gasoline Powered								
3	2"	115 gpm	Skid	$ 75.00	$ 21.00	$ 5.00	$ .75	$ .35
3	2"	115 gpm	Trailer	89.00	25.00	6.00	.90	.40
5	2"	135 gpm	Skid	83.00	23.00	6.00	.90	.55
5	2"	135 gpm	Trailer	100.00	28.00	7.00	1.00	.55
7	2"	165 gpm	Skid	120.00	34.00	9.00	1.00	.80
7	2"	165 gpm	Trailer	150.00	42.00	11.00	2.00	.80

REMEDIATION EQUIPMENT

CENTRIFUGAL PUMPS

HP	Size	Capacity	Mounting	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Diesel Powered, Continued								
3	1.5"	85 gpm	Skid	$ 72.00	$ 20.00	$ 5.00	$ .75	$ .35
3	1.5"	85 gpm	Trailer	87.00	24.00	6.00	.90	.40
7	3"	250 gpm	Skid	155.00	43.00	11.00	2.00	.85
7	3"	250 gpm	Trailer	170.00	48.00	12.00	2.00	.85
10	3"	300 gpm	Trailer	390.00	110.00	28.00	4.00	1.25
Diesel Powered								
5	2"	135 gpm	Trailer	190.00	53.00	13.00	2.00	.50
10	3"	300 gpm	Trailer	360.00	100.00	25.00	4.00	.90

CHEMICAL METERING PUMPS

Maximum Pressure	Drive	Maximum Flow Rate	Wetted Parts	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered								
50 psi	Direct Current	50–500 ML/MIN	Ceramic	$ 38.00	$ 11.00	$ 3.00	$ .45	$ .10
100 psi	Direct Current	50–500 ML/MIN	Ceramic	49.00	14.00	4.00	.60	.10
100 psi	High Speed	50–500 ML/MIN	Ceramic	44.00	12.00	3.00	.45	.10
100 psi	Low Speed	0–50 ML/MIN	Ceramic	52.00	15.00	4.00	.60	.10
100 psi	Synchronous	0–50 ML/MIN	Ceramic	63.00	18.00	5.00	.75	.15
50 psi	Variable Speed	500–1000 ML/MIN	Ceramic	64.00	18.00	5.00	.75	.15
100 psi	Variable Speed	50–500 ML/MIN	Ceramic	70.00	20.00	5.00	.75	.15
Air Powered								
100 psi	Pneumatic	0–200	Ceramic	68.00	19.00	5.00	.75	.15

DIAPHRAGM PUMPS

Discharge Size	Motor Material	Capacity	Ball/Diaphragm	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr
Air Powered								
3/4"	Aluminum	30 gpm	Neoprene	$ 27.00	$ 8.00	$ 2.00	$ .30	$ .15
3/4"	Aluminum	30 gpm	Teflon	38.00	11.00	3.00	.45	.15
1"	Aluminum	40 gpm	Neoprene	29.00	8.00	2.00	.30	.15
1"	Aluminim	40 gpm	Teflon	47.00	13.00	3.00	.45	.15
1-1/4"	Aluminum	50 gpm	Neoprene	35.00	10.00	3.00	.45	.15
1-1/4"	Aluminum	50 gpm	Teflon	53.00	15.00	4.00	.60	.15
1/2"	Aluminum	15 gpm	Neoprene	17.00	5.00	1.00	.15	.10
1/2"	Aluminum	15 gpm	Teflon	21.00	6.00	2.00	.30	.10
2"	Aluminum	150 gpm	Neoprene	69.00	19.00	5.00	.75	.20
2"	Aluminum	150 gpm	Teflon	87.00	24.00	6.00	.90	.20
3"	Aluminum	220 gpm	Neoprene	80.00	22.00	6.00	.90	.20
3"	Aluminum	220 gpm	Teflon	110.00	31.00	8.00	1.00	.25

REMEDIATION EQUIPMENT

SUBMERSIBLE PUMPS

Pump Size	Horsepower	Maximum Capacity	Discharge Size	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr
Electric Powered								
2"	2.00	9 gpm	1/2"	$ 155.00	$ 43.00	$ 11.00	$ 2.00	$ .15
4"	.50	7 gpm	1"	99.00	28.00	7.00	1.00	.15
4"	1.00	7 gpm	1"	115.00	32.00	8.00	1.00	.15
4"	1.50	7 gpm	1"	145.00	41.00	10.00	2.00	.15
4"	.50	14 gpm	1-1/4"	100.00	28.00	7.00	1.00	.15
4"	1.00	14 gpm	1-1/4"	120.00	34.00	9.00	1.00	.15
4"	1.50	14 gpm	1-1/4"	140.00	39.00	10.00	2.00	.15
4"	.50	20 gpm	1-1/4"	99.00	28.00	7.00	1.00	.15
4"	1.00	20 gpm	1-1/4"	110.00	31.00	8.00	1.00	.15
4"	1.50	20 gpm	1-1/4"	130.00	36.00	9.00	1.00	.15
4"	.50	32 gpm	1-1/2"	99.00	28.00	7.00	1.00	.15
4"	1.00	32 gpm	1-1/2"	110.00	31.00	8.00	1.00	.15
4"	1.50	32 gpm	1-1/2"	130.00	36.00	9.00	1.00	.15

THERMAL OXIDIZERS

Temperature Range (F)	Maximum Air Flow	Retention Time	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr
Electric Powered							
1400-1500 (Skid mounted)	1,000 cfm	1 Second	$ 1,705.00	$ 475.00	$ 120.00	$ 18.00	$ 2.70
1400-1500 (Trailer mounted)	1,000 cfm	1 Second	1,820.00	510.00	130.00	20.00	2.85

THERMAL OXIDIZERS

Temperature Range (F)	Maximum Air Flow	Retention Time	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr
Electric Powered (Continued)							
1400-1500 (Skid mounted)	250 cfm	1 Second	$ 1,185.00	$ 330.00	$ 83.00	$ 12.00	$ 2.15
1400-1500 (Trailer mounted)	250 cfm	1 Second	1,270.00	355.00	89.00	13.00	2.25
1400-1500 (Skid mounted)	500 cfm	1 Second	1,350.00	380.00	95.00	14.00	2.35
1400-1500 (Trailer mounted)	500 cfm	1 Second	1,445.00	405.00	100.00	15.00	2.45

CATALYTIC OXIDIZERS

(Operating costs do not include catalyst replacement.)

Temperature Range (F)	Maximum Air Flow	Catalyst	Inlet Diameter	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr
Electric Powered								
400–900 (Skid mounted)	250 cfm	Platinum Coated	4"	$ 1,465.00	$ 410.00	$ 105.00	$ 16.00	$ 6.65
400–900 (Trailer mounted)	250 cfm	Platinum Coated	4"	1,545.00	435.00	110.00	17.00	7.00
400-900 (Skid mounted)	500 cfm	Platinum Coated	4"	1,855.00	520.00	130.00	20.00	8.25
400-900 (Trailer mounted)	500 cfm	Platinum Coated	4"	1,945.00	545.00	135.00	20.00	8.60

REMEDIATION EQUIPMENT

FIXED FILM BIOREACTORS

(External piping, pump, blower, bacteria and electricity costs are not included.)

Diameter	Height	Maximum Air Flow	Maximum Water Flow	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Electric Powered								
48"	7'	15 cfm	7 gpm	$ 450.00	$ 125.00	$ 31.00	$ 5.00	$ .70
60"	8'	20 cfm	12 gpm	665.00	185.00	46.00	7.00	.80
72"	9'	30 cfm	30 gpm	870.00	245.00	61.00	9.00	.90
108"	9'	65 cfm	65 gpm	1,025.00	285.00	71.00	11.00	1.00
132"	10'	95 cfm	95 gpm	1,145.00	320.00	80.00	12.00	1.05

ROTARY AUGER DRILLS FOR TRUCK MOUNTING

HP	Maximum Torque	Maximum Pulldown	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Gasoline Powered							
65	3,500 Ft-lbs	10,000 lbs	$ 2,435.00	$ 680.00	$ 170.00	$ 26.00	$ 9.05
80	6,250 Ft-lbs	25,000 lbs	2,840.00	795.00	200.00	30.00	10.55
95	10,000 Ft-lbs	30,000 lbs	4,700.00	1,315.00	330.00	50.00	13.30
Diesel Powered							
74	3,500 Ft-lbs	10,000 lbs	2,660.00	745.00	185.00	28.00	7.95
95	6,250 Ft-lbs	25,000 lbs	2,810.00	785.00	195.00	29.00	8.90
100	10,000 Ft-lbs	30,000 lbs	4,925.00	1,380.00	345.00	52.00	10.85
275	20,000 Ft-lbs	35,000 lbs	8,440.00	2,365.00	590.00	89.00	20.55

REMEDIATION EQUIPMENT

TRAILER MOUNTED ROTARY AUGER DRILLS

HP	Maximum Torque	Maximum Pulldown	Trailer	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Gasoline Powered								
30	1,500 Ft-lbs	4,500 lbs	Tandem Axle	$ 980.00	$ 275.00	$ 69.00	$ 10.00	$ 4.20
Diesel Powered								
50	1,500 Ft-lbs	4,500 lbs	Tandem Axle	1,070.00	300.00	75.00	11.00	4.10

SMALL GENERATORS

HP	Output	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Gasoline Powered						
1	900 W	$ 50.00	$ 14.00	$ 4.00	$ .60	$ .30
1	1,000 W	52.00	15.00	4.00	.60	.35
2	1,400 W	55.00	15.00	4.00	.60	.40
2	1,500 W	58.00	16.00	4.00	.60	.50
3	1,800 W	60.00	17.00	4.00	.60	.55
3	2,000 W	62.00	17.00	4.00	.60	.60
3	2,100 W	67.00	19.00	5.00	.75	.60
3	2,400 W	82.00	23.00	6.00	.90	.65
4	2,500 W	84.00	24.00	6.00	.90	.65
4	3,000 W	92.00	26.00	7.00	1.00	.70
5	3,500 W	100.00	28.00	7.00	1.00	.80
5	4,000 W	115.00	32.00	8.00	1.00	.85
7	5,000 W	125.00	35.00	9.00	1.00	1.00
7	5,500 W	140.00	39.00	10.00	2.00	1.15

REMEDIATION EQUIPMENT

SMALL GENERATORS

HP	Output	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Gasoline Powered (Continued)						
8	6,000 W	$ 145.00	$ 41.00	$ 10.00	$ 2.00	$ 1.25
10	7,500 W	175.00	49.00	12.00	2.00	1.50
13	9,000 W	205.00	57.00	14.00	2.00	1.80
14	10,000 W	255.00	71.00	18.00	3.00	2.05
17	12,000 W	290.00	81.00	20.00	3.00	2.40
17	12,500 W	310.00	87.00	22.00	3.00	2.45
21	15,000 W	380.00	105.00	26.00	4.00	2.90
28	20,000 W	565.00	160.00	40.00	6.00	4.00
Diesel Powered						
5	2,500 W	115.00	32.00	8.00	1.00	.50
5	3,000 W	215.00	60.00	15.00	2.00	.60
6	4,500 W	260.00	73.00	18.00	3.00	.70
8	6,000 W	370.00	105.00	26.00	4.00	.90
60	17,500 W	605.00	170.00	43.00	6.00	4.15

LARGE GENERATORS

HP	Output	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Gasoline Powered						
30	20 KW	$ 430.00	$ 120.00	$ 30.00	$ 5.00	$ 4.30
36	25 KW	445.00	125.00	31.00	5.00	5.00
42	30 KW	495.00	140.00	35.00	5.00	5.70
50	35 KW	535.00	150.00	38.00	6.00	6.55
57	40 KW	555.00	155.00	39.00	6.00	7.40

REMEDIATION EQUIPMENT

LARGE GENERATORS

HP	Output	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Gasoline Powered (Continued)						
64	45 KW	$ 605.00	$ 170.00	$ 43.00	$ 6.00	$ 8.15
70	50 KW	630.00	175.00	44.00	7.00	8.85
78	55 KW	675.00	190.00	48.00	7.00	10.00
85	60 KW	705.00	195.00	49.00	7.00	10.75
92	65 KW	760.00	215.00	54.00	8.00	11.55
99	70 KW	815.00	230.00	58.00	9.00	12.45
106	75 KW	865.00	240.00	60.00	9.00	13.20
121	85 KW	895.00	250.00	63.00	9.00	14.85
142	100 KW	955.00	265.00	66.00	10.00	17.25
164	115 KW	1,435.00	400.00	100.00	15.00	20.50
178	125 KW	1,430.00	400.00	100.00	15.00	22.05
Diesel Powered						
28	20 KW	560.00	155.00	39.00	6.00	2.65
43	30 KW	710.00	200.00	50.00	8.00	3.55
57	40 KW	750.00	210.00	53.00	8.00	4.35
64	45 KW	860.00	240.00	60.00	9.00	4.80
85	60 KW	920.00	260.00	65.00	10.00	6.20
107	75 KW	1,075.00	300.00	75.00	11.00	7.50
128	90 KW	1,120.00	315.00	79.00	12.00	8.65
143	100 KW	1,140.00	320.00	80.00	12.00	9.50
160	110 KW	1,250.00	350.00	88.00	13.00	10.90
178	125 KW	1,385.00	390.00	98.00	15.00	11.95
214	150 KW	1,420.00	400.00	100.00	15.00	13.95
250	175 KW	1,455.00	405.00	100.00	15.00	15.90

REMEDIATION EQUIPMENT

LARGE GENERATORS

HP	Output	Monthly	Weekly	Daily	Hourly	Estimated Operating Cost/Hr.
Diesel Powered (Continued)						
285	200 KW	$ 1,510.00	$ 425.00	$ 105.00	$ 16.00	$ 17.85
320	225 KW	1,780.00	500.00	125.00	19.00	20.65
357	250 KW	1,910.00	535.00	135.00	20.00	22.75
385	270 KW	1,975.00	555.00	140.00	21.00	24.30
428	300 KW	2,060.00	575.00	145.00	22.00	26.70
520	365 KW	2,475.00	695.00	175.00	26.00	32.00
570	400 KW	2,760.00	775.00	195.00	29.00	34.90
640	450 KW	3,175.00	890.00	225.00	34.00	41.70
713	500 KW	3,650.00	1,020.00	255.00	38.00	46.00
855	600 KW	4,475.00	1,255.00	315.00	47.00	54.35
900	625 KW	4,505.00	1,260.00	315.00	47.00	57.80
930	660 KW	4,645.00	1,300.00	325.00	49.00	59.55
1,050	750 KW	4,835.00	1,355.00	340.00	51.00	66.15
1,125	800 KW	4,925.00	1,380.00	345.00	52.00	70.30
1,175	840 KW	5,215.00	1,460.00	365.00	55.00	73.30
1,250	900 KW	5,360.00	1,500.00	375.00	56.00	77.45
1,425	1,000 KW	6,065.00	1,700.00	425.00	64.00	87.45

COST GUIDE

FOR

REMEDIATION EQUIPMENT

AT

UST SITES

§3, APPENDICES

JULY 1993

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Section 3: Appendices

APPENDIX A

RATE ADJUSTMENT TABLES

Table 1

(1984-1993)

EQUIPMENT TYPES	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
ADSORBERS	.852	.869	.884	.896	.908	.928	.958	.982	.998	1.000
AERATORS	.901	.913	.923	.931	.939	.952	.972	.988	.999	1.000
MIXERS	.925	.933	.941	.947	.953	.963	.979	.991	.999	1.000
BINS/TANKS	.907	.918	.927	.935	.942	.955	.974	.989	.999	1.000
BLOWERS & FANS	.920	.929	.938	.944	.950	.961	.977	.990	.999	1.000
CONVEYORS	.931	.937	.943	.948	.960	.960	.973	.980	.992	1.000
DRUM DEHEADERS	.944	.950	.956	.960	.965	.972	.984	.993	.999	1.000
ENHANCED VOLITALIZATION	.927	.935	.943	.948	.954	.964	.979	.991	.999	1.000
DUST COLLECTION	.913	.921	.921	.924	.928	.940	.956	.969	.985	1.000
LOCATORS, PIPE/VALVE/CABLE	.873	.888	.901	.911	.921	.938	.964	.984	.998	1.000
OIL SKIMMERS	.880	.894	.906	.916	.925	.941	.966	.985	.999	1.000
PUMP	.852	.857	.859	.865	.879	.907	.940	.955	.979	1.000
OXIDIZERS	.933	.941	.948	.953	.958	.967	.981	.992	.999	1.000
BIOREACTORS	.888	.901	.912	.921	.930	.945	.968	.986	.999	1.000
WELL DRILLING EQUIPMENT	.912	.913	.913	.915	.915	.927	.947	.971	.991	1.000
GENERATORS	.910	.915	.923	.924	.935	.954	.978	.992	.997	1.000

APPENDIX A

RATE ADJUSTMENT TABLES

Table 2

(1974-1983)

EQUIPMENT TYPES	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
ADSORBERS	.428	.473	.530	.554	.583	.619	.665	.732	.793	.833
AERATORS	.618	.648	.686	.703	.722	.746	.777	.821	.862	.889
MIXERS	.709	.732	.761	.773	.788	.806	.830	.864	.895	.915
BINS/TANKS	.641	.670	.705	.721	.738	.761	.790	.832	.870	.895
BLOWERS & FANS	.691	.715	.746	.759	.775	.794	.819	.855	.888	.910
CONVEYORS	.693	.724	.742	.757	.773	.789	.835	.860	.901	.921
DRUMS DEHEADERS	.781	.799	.820	.830	.841	.855	.872	.898	.921	.936
ENHANCED VOLITALIZATION	.716	.738	.767	.779	.793	.811	.834	.867	.897	.917
DUST COLLECTION	.795	.802	.814	.829	.843	.860	.883	.902	.908	.908
LOCATORS, PIPE/VALVE/CABLE	.509	.547	.596	.617	.642	.673	.713	.770	.822	.857
OIL SKIMMERS	.537	.573	.619	.639	.662	.692	.729	.783	.832	.865
PUMP	.675	.684	.696	.711	.730	.751	.806	.839	.848	.843
OXIDIZERS	.742	.762	.788	.799	.812	.828	.849	.879	.906	.925
BIOREACTORS	.567	.601	.644	.663	.684	.712	.747	.797	.843	.874
WELL DRILLING EQUIPMENT	.788	.798	.803	.832	.843	.847	.876	.897	.910	.912
GENERATORS	.736	.764	.779	.795	.803	.818	.833	.863	.886	.892

APPENDIX A

RATE ELEMENT TABLE

Table 3

The Rate Element Table is designed to allow for greater accuracy when adjusting *Cost Guide* rates and identifying specific cost allowances contained in the rates. The basic *Cost Guide* rate contains allowances for depreciation, major overhaul repairs, cost of facilities capital (Cfc), and indirect costs. These tables show the percentage of the total *Cost Guide* rate that each cost allowance comprises. See section 1, "INTRODUCTION," for a complete explanation of the Rate Element Table and sample applications.

Equipment Types	Depreciation	Major Overhaul	Cfc	Indirect Costs
ADSORBERS	.89	.00	.06	.05
AERATORS	.60	.09	.10	.21
MIXERS	.46	.25	.10	.19
BINS/TANKS	.50	.05	.16	.29
BLOWERS & FANS	.51	.22	.10	.17
CONVEYORS	.43	.36	.08	.13
DRUMS DEHEADERS	.41	.32	.11	.16
ENHANCED VOLITALIZATION	.26	.13	.18	.43
DUST COLLECTION	.37	.34	.10	.19
LOCATORS, PIPE/VALVE/CABLE	.75	.04	.10	.11
OIL SKIMMERS	.71	.05	.10	.14
PUMP	.55	.21	.10	.14
OXIDIZERS	.40	.14	.14	.32
BIOREACTORS	.68	.12	.08	.12
WELL DRILLING EQUIPMENT	.39	.26	.12	.23
GENERATORS	.37	.28	.14	.21

APPENDIX B

Unit Price Information For Materials Purchased For One Time Use

Bailers

TEFLON

Standard Top, 1.875" O.D	$40.50
Point Sampling Top, 1.875" O.D	$67.50
12" Extension Tube, 350 cc, 1.75" O.D	$42.40
24" Extension Tube, 700 cc, 1.75" O.D	$83.80
36" Extension Tube, 1.050 cc, 1.75" O.D	$98.20
Extension Coupling	$18.75
Standard Bottom, 1.875" O.D	$37.40
Bottom Emptying Bottom, 1.875" O.D	$56.00
Control Flow Bottom, 1.875" O.D	$68.90
.75" O.D. x 1', 60 cc, complete bailer	$129.30
.75" O.D. x 3', 180 cc, complete bailer	$164.60
1" O.D. x 1', 80 cc, complete bailer	$180.30
1" O.D. x 3', 240 cc, complete bailer	$211.00
Economy bailer, 1.75" O.D. x 1', complete	$53.50
Economy bailer, 1,75" O.D. x 3', complete	$89.90

(Economy bailers include a lifting cap and standard bottom.)

Teflon suspension cord	$1.10/foot

PVC

Standard Bailer, 1.66" O.D. x 12", 300 cc	$18.20
Standard Bailer, 1.66" O.D. x 24", 600 cc	$19.25
Standard Bailer, 1.66" O.D. x 36", 900 cc	$22.00
Standard bailer, 3.5" O.D. x 12", 1,450 cc	$42.00
Standard bailer, 3.5" O.D. x 24", 2,900 cc	$45.20
Standard bailer, 3.5" O.D. x 36", 4,350 cc	$48.00

(Standard bailers include PVC lifting cap and standard bottom.)

PVC valve bottom emptying device, 1.66" O.D.	$28.50
PVC valve bottom emptying device, 3.5" O.D.	$90.40
Teflon valve bottom emptying device, 3.5" O.D.	$138.00

APPENDIX B

Unit Price Information For Materials Purchased For One Time Use

Well Supplies

Cement

Ready Mix Concrete, 90# bag $3.25
Portland Cement, 90# bag $7.00

Grout

Bentonite Grout, 50# bag $22.50
Bentonite Chips, 50# bag $7.50
Bentonite, granular, 50# bag $6.25
Bentonite Donuts, package of four $115.00
Bentonite Tablets, 50# bag $31.00

Grouting Tremie Pipes
5' PVC, 1.3" I.D. x 1.05" O.D. $7.25
10' PVC, 1.3" I.D. x 1.05" O.D. $10.95

Manholes

CAST IRON
6" O.D. x 7" deep $49.25
8" O.D. x 8" deep $55.35
12" O.D. x 12" deep $77.35

Sand

Monterey Sand, 4 x 12 Mesh, 100# bag $6.12
Monterey Sand, 8 x 20 Mesh, 100# bag $4.75
Monterey Sand, 20 x 40 Mesh, 100# bag $4.35

Silica Sand, All Mesh, 100# bag $3.55

Well Caps

PLASTIC
2", Locking $15.45
4", Locking $18.15
6", Locking $35.75

APPENDIX B

Unit Price Information For Materials Purchased For One Time Use

Well Caps

CAST ALUMINUM

2", W/ Padlock	$16.75
4", W/ Padlock	$18.75
6", W/ Padlock	$25.50
8", W/ Padlock	$34.50

Well Casing

PVC SCHEDULE 40

1" I.D x 10'	$10.90
1.5" I.D. x 10'	$13.50
2" I.D. x 10'	$17.00
4" I.D. x 10'	$42.10
5" I.D. x 10'	$58.50
6" I.D. x 10'	$92.15

PVC SCHEDULE 80

.75" I.D. x 10'	$11.00
1" I.D. x 10'	$11.25
2" I.D. x 10'	$23.55
4" I.D. x 10'	$58.80

PVC SCHEDULE 80

5" I.D. x 10'	$95.80
6" I.D. x 10'	$129.20

STAINLESS STEEL TYPE 304

2" I.D. x 10'	$108.50
4" I.D. x 10'	$260.00
5" I.D. x 10'	$415.00
6" I.D. x 10'	$610.00
8" I.D. x 10'	$850.00

STAINLESS STEEL TYPE 316

2" I.D. x 10'	$165.00
4" I.D. x 10'	$310.00

APPENDIX B

Unit Price Information For Materials Purchased For One Time Use

Well Casing

TEFLON SCHEDULE 40

2" I.D. x 10'	$301.00
4" I.D. x 10'	$925.00

TEFLON SCHEDULE 80

2" I.D. x 10'	$395.00
4" I.D. x 10'	$1,145.00

Well Covers

STEEL

4" x 5', W/Padlock	$56.50
6" x 5', W/ Padlock	$76.40
8" x 5', W/ Padlock	$114.15
10" x 5', W/ Padlock	$152.25
12" x 5', W/ Padlock	$162.75

Well Screen

PVC SCHEDULE 40

1" I.D. x 10'	$19.70
1.5" I.D. x 10'	$25.25
2" I.D. x 10'	$27.90
4" I.D. x 10'	$64.05
5" I.D. x 10'	$85.00
6" I.D. x 10'	$108.10

PVC SCHEDULE 80

.75" I.D. x 10'	$20.15
1" I.D. x 10'	$21.50
2" I.D. x 10'	$40.85
4" I.D. x 10'	$97.25
5" I.D. x 10'	$120.10
6" I.D. x 10'	$152.40

STAINLESS STEEL TYPE 304

2" I.D. x 10'	$302.50
4" I.D. x 10'	$450.00
5" I.D. x 10'	$580.00
6" I.D. x 10'	$845.00
8" I.D. x 10'	$1,545.00

APPENDIX B

Unit Price Information For Materials Purchased For One Time Use

Well Screen

STAINLESS STEEL TYPE 316

2" I.D. x 10'	$425.00
4" I.D. x 10'	$590.00

TEFLON SCHEDULE 40

2" I.D. x 10'	$390.00
4" I.D. x 10'	$1,154.50

TEFLON SCHEDULE 80

2" I.D. x 10'	$517.00
4" I.D. x 10'	$1,386.00

Miscellaneous Supplies

Drum Accessories

FILLING FUNNELS

21.5" O.D.	$33.10
21.5" O.D. W/ Flash arrestor	$121.10
13.5" O.D.	$30.35
9" O.D.	$7.95
9" O.D W/ Flash arrestor	$108.80

Tower Packing

POLYPROPYLENE

1", 0-25 cubic feet	$45.00/cubic foot
1", 26-100 cubic feet	$42.75/cubic foot
1", 101-500 cubic feet	$33.75/cubic foot
2", 0-50 cubic feet	$18.65/cubic foot
2", 51-1,000 cubic feet	$14.90/cubic foot
2", 1,001-2,000 cubic feet	$12.65/cubic foot
3", 0-50 cubic feet	$10.90/cubic foot
3", 51-1,500 cubic feet	$9.90/cubic foot
3", 1,501-3,500 cubic feet	$8.50/cubic foot

APPENDIX C

Chemical Conversion Factors

Constituents	mg/liter to epm	epm to mg/liter	gpg to epm	epm to gpg	mg/liter to mg/liter $CaCo_3$
Calcium	0.0499	20.04	0.853	1.172	2.497
Iron	0.0358	27.92	0.612	1.633	1.792
Magnesium	0.0822	12.16	1.406	0.711	4.115
Potassium	0.0256	39.10	0.437	2.286	1.280
Sodium	0.0435	23.00	0.743	1.345	2.176
Bicarbonate	0.0164	61.01	0.280	3.568	0.820
Carbonate	0.0333	30.00	0.570	1.754	1.668
Chloride	0.0282	35.46	0.482	2.074	1.411
Hydroxide	0.0588	17.01	1.005	0.995	2.926
Nitrate	0.0161	62.01	0.276	3.626	0.807
Phosphate	0.0316	31.67	0.540	1.852	1.580
Sulphate	0.0208	48.04	0.356	2.809	1.042
Calcium bicarbonate	0.0123	81.05	0.211	4.740	0.617
Calcium carbonate	0.0200	50.04	0.342	2.926	1.000
Calcium chloride	0.0180	55.50	0.308	3.246	0.902
Calcium hydroxide	0.0270	37.05	0.461	2.167	1.351
Calcium sulphate	0.0147	68.07	0.251	3.981	0.735
Ferrous bicarbonate	0.0112	88.93	0.192	5.201	0.563
Ferrous carbonate	0.0173	57.92	0.295	3.387	0.864
Ferrous sulphate	0.0132	75.96	0.225	4.442	0.659
Magnesium bicarbonate	0.0137	73.17	0.234	4.279	0.684
Magnesium carbonate	0.0237	42.16	0.406	2.465	1.187
Magnesium chloride	0.0210	47.62	0.359	2.785	1.051
Magnesium hydroxide	0.0343	29.17	0.586	1.706	1.715
Magnesium sulphate	0.0166	60.20	0.284	3.520	0.631
Potassium chloride	0.0134	74.56	0.229	4.360	0.671
Sodium bicarbonate	0.0119	84.01	0.203	4.913	0.596
Sodium carbonate	0.0189	53.00	0.323	3.099	0.944
Sodium chloride	0.0171	58.46	0.292	3.419	0.856
Sodium hydroxide	0.0245	40.01	0.427	2.340	1.251
Soidium nitrate	0.0118	85.01	0.201	4.971	0.589
Sodium phosphate	0.0183	54.67	0.313	3.197	0.915
Sodium sulphate	0.0141	71.04	0.241	4.154	0.704

epm = equivalent parts per million
gpg = grains per gallon = 17.1 mg/liter
mg/liter = milligrams per liter
mg/liter $CaCo_3$ = milligrams per liter of $CaCo_3$

APPENDIX D1

Weight and Measure Equivalencies

Measure of Length

1 Mile = 1,760 yds. = 5,280 ft. = 63,360 Inches
1 Mile = 8 Furlongs = 80 Chains
1 Furlong = 10 Chains = 220 Yds.
1 Chain = 4 Rods = 22 Yds. = 66 Ft. = 100 Links
1 Rod = 5.5 Yds. = 16.5 Ft.

Measure of Length—English to Metric

1 Mile = 1.609 Kilometer
1 Yard = 0.9144 Meter
1 Foot = 0.03048 Meter = 304.8 Millimeters
1 Inch = 2.54 Centimeters = 25.4 Millimeters

Measure of Length—Metric to English

1 Kilometer = 0.6214 Mile
1 Meter = 39.37 Inch = 3.2808 Ft. = 1.0936 Yd.
1 Centimeter = 0.3937 Inch
1 Millimeter = 0.03937 Inch

Square Measure

1 Sq. Mile = 640 Acres = 6,400 Sq. Chains
1 Acre = 10 Sq. Chains = 4,840 Sq. Yds. = 43,560 Sq. Ft.
1 Sq. Chain = 16 Sq. Rods = 484 Sq. Yds. = 4,356 Sq. Ft.
1 Sq. Rod = 30.25 Sq. Yds. = 272.25 Sq. Ft. = 625 Sq. Links
1 Sq. Yd. = 9 Sq. Ft.
1 Sq. Ft. = 144 Sq. Inches
An Acre is equal to a Square 208.7 Feet per Side

Square Measure—English to Metric

1 Sq. Mile = 2.5899 Sq. Kilometers
1 Acre = 0.4047 Hectare = 40.47 Acres
1 Sq. Yard = 0.836 Sq. Meters
1 Sq. Foot = 0.0929 Sq. Meters = 929 Sq. Centimeters
1 Sq. Inch = 6.452 Sq. Centimeters = 645.2 Sq. Millimeters

Square Measure—Metric to English

1 Sq. Kilometer = 0.3861 Sq. Mile = 247.1 Acres
1 Hectare = 2.471 Acres = 107,640 Sq. Ft.
1 Acre = 0.0247 Acre = 1,076.4 Sq. Ft.
1 Sq. Meter = 10.764 Sq. Ft. = 1.196 Sq. Yd.
1 Sq. Centimeter = 0.155 Sq. Inch
1 Sq. Millimeter = 0.00155 Sq. Inch

APPENDIX D1

Weight and Measure Equivalencies

Cubic Measure

1 Cubic Yd. = 27 Cu. Ft.
1 Cubic Ft. = 1,728 Cu. Inches
1 Cord = 128 Cu. Ft.
1 Gallon = 0.1137 Cu. Ft. = 231 Cu. Inches
1 Cubic Ft. = 7.48 U.S. Gallons
1 U.S. Gallon = 0.83268 Imperial Gallon
1 Imperial Gallon = 1.2009 U.S. Gallons

Cubic Measure—English to Metric

1 Cubic Yd. = 0.7646 Cubic Meters
1 Cubic Ft. = 28.316 Liters
1 Cubic Inch = 16.38 Cubic Centimeters
1 U.S. Gallon = 3.785 Liters
1 U.S. Quart = 0.946 Liters
1 U.S. Pint = 0.473 Liters
1 Imperial Gallon = 4.542 Liters

Cubic Measure—Metric to English

1 Cubic Meter = 35.314 Cu. Ft. = 1.308 Cu. Yd. = 264.2 U.S. Gallons
1 Cubic Centimeter = 0.061 Cu. Inch
1 Liter = 0.0353 Cu. Ft. = 61.023 Cu. Inches
1 Liter = 0.2642 U.S. Gallon = 1.0567 U.S. Quart

Measures of Weight—English and Metric

1 Long Ton = 2,240 Lbs. = 1016.05 Kilograms
1 Short Ton = 2,000 Lbs. = 907.18 Kilograms
1 Metric Ton = 2204.6 Lbs.
1 Kilogram = 2.2046 Lbs.
1 Lb. = 0.45359 Kilograms

Equivalents of Pressure—English and Metric

1 Lb. per Sq. Inch = 0.0703 Kg. per Sq. Centimeter
1 Kg. per Sq. Centimeter = 14.244 Lbs. per Sq. Inch

Weights of Diesel Fuel

1 U.S. Gallon = 7 lbs. average.
1 U.S. Gallon = 3.17 kilograms.

APPENDIX D2

Energy Equivalencies

Unit	Equivalent[1,2]					
	British thermal unit	foot-pound	horsepower-hour	joules	calorie	kilowatt-hour
British thermal unit	1	777.9	3.929×10^{-4}	1,055	252	2.93×10^{-4}
foot-pound	1.285×10^{-3}	1	5.051×10^{-7}	1.356	0.3239	3.766×10^{-7}
horsepower-hour	2,545	1.98×10^{6}	1	2.685×10^{6}	6.414×10^{5}	0.7457
joules	9.481×10^{-4}	0.7376	3.725×10^{-7}	1	0.2389	2.778×10^{-7}
calorie	3.968×10^{-3}	3.087	1.559×10^{-6}	4.186	1	1.163×10^{-6}
kilowat-hour	3,413	2.655×10^{6}	1.341	3.6×10^{6}	8.601×10^{5}	1

APPENDIX D3

Mechanical-Electrical Equivalencies

Power

1 horsepower (hp)	=	550 foot-pounds (ft.-lb.) per second (sec)
	=	33,000 ft.-lb. per minute (min.)
	=	1,980,000 ft.-lbs. per hour (hr.)
	=	.275 ft.-tons per sec.
	=	16.5 ft.-tons per min.
	=	990 ft.-tons per. hr.
1 horsepower-second (hp-sec)	=	550 ft.-lb.
	=	.275 ft.-tons
1 horsepower-minute (hp-min)	=	33,000 ft.-lb.
	=	16.5 ft.-tons
1 horsepower-hour (hp-hr)	=	1,980,000 ft.-lb.
	=	990 ft.-tons
1 horsepower (hp)	=	746 watts (w)
	=	.746 kilowatts (kw)

Energy

1 horsepower-hour	=	2,544 BTU
	=	.746 KW-hr.
1 Kilowatt-hour	=	3,413 BTU

Pressure

1 lb. per sq. in.	=	2.0360" of mercury at 32° F.
	=	27.71" of water at 32° F.
	=	2.3091 ft. of water at 60° F.
	=	144 lb. per sq. ft.
1 in. of mercury	=	.491 lb. per sq. in.
1 in. of water	=	5.2 lb. per sq. ft.
	=	.0361 lb. per sq. in.

APPENDIX E

Power Required for Pumping

Gals per Min.	Theoretical Horsepower Required to Raise Water (at 60 F) To Different Heights											
	5 ft.	10 ft.	15 ft.	20 ft.	25 ft.	30 ft.	35 ft.	40 ft.	45 ft.	50 ft.	60 ft.	70 ft.
5	0.006	0.013	0.019	0.025	0.032	0.038	0.044	0.051	0.057	0.063	0.076	0.088
10	0.013	0.025	0.038	0.051	0.063	0.076	0.088	0.101	0.114	0.126	0.152	0.177
15	0.019	0.038	0.057	0.076	0.095	0.114	0.133	0.152	0.171	0.190	0.227	0.265
20	0.025	0.051	0.076	0.101	0.126	0.152	0.177	0.202	0.227	0.253	0.303	0.354
25	0.032	0.063	0.095	0.126	0.158	0.190	0.221	0.253	0.284	0.316	0.379	0.442
30	0.038	0.076	0.114	0.152	0.190	0.227	0.265	0.303	0.341	0.379	0.531	0.531
35	0.044	0.088	0.133	0.177	0.221	0.265	0.310	0.354	0.398	0.442	0.531	0.619
40	0.051	0.101	0.152	0.202	0.253	0.303	0.354	0.404	0.455	0.505	0.606	0.707
45	0.057	0.114	0.171	0.227	0.284	0.341	0.398	0.455	0.512	0.568	0.682	0.796
50	0.063	0.126	0.190	0.253	0.316	0.379	0.442	0.505	0.568	0.632	0.758	0.884
60	0.076	0.152	0.227	0.303	0.379	0.455	0.531	0.606	0.682	0.758	0.910	1.061
70	0.088	0.177	0.265	0.354	0.442	0.531	0.619	0.707	0.796	0.884	1.061	1.238
80	0.101	0.202	0.303	0.404	0.505	0.606	0.707	0.808	1.910	1.011	1.213	1.415
90	0.114	0.227	0.341	0.455	0.568	0.682	0.796	0.910	1.023	1.137	1.364	1.592
100	0.126	0.253	0.379	0.505	0.632	0.758	0.884	1.011	1.137	1.263	1.516	1.768
125	0.158	0.316	0.474	0.632	0.790	0.947	1.105	1.263	1.421	1.579	1.895	2.211
150	0.190	0.379	0.568	0.758	0.947	1.137	1.326	1.516	1.705	1.895	2.274	2.653
175	0.221	0.442	0.663	0.884	1.105	1.326	1.547	1.768	1.990	2.211	2.653	3.095
200	0.253	0.505	0.758	1.011	1.263	1.516	1.768	2.021	2.274	2.526	3.032	3.537
250	0.316	0.632	0.947	1.263	1.579	1.895	2.211	2.526	2.842	3.158	3.790	4.421
300	0.379	0.758	1.137	1.516	1.895	2.274	2.653	3.032	3.411	3.790	4.548	5.305
350	0.442	0.884	1.326	1.768	2.211	2.653	3.095	3.537	3.979	4.421	5.305	6.190
400	0.505	1.011	1.516	2.021	2.526	3.032	3.537	4.042	4.548	5.053	6.063	7.074
500	0.632	1.263	1.895	2.526	3.158	3.790	4.421	5.053	5.684	6.316	7.579	8.842

Note: For fluids other than water, multiply table values by specific gravity. In pumping liquids with a viscosity considerably higher than that of water, the pump capacity and head are reduced. To calculate the horsepower for such fluids, pipe friction head must be added to the elevation head to obtain the total head.

APPENDIX E

Power Required for Pumping

Gals per Min.	Theoretical Horsepower Required to Raise Water (at 60 F) To Different Heights										
	80 fth	90 ft	100 ft	125 ft	150 ft	175 ft	200 ft	250 ft	300 ft	350 ft	400 ft.
5	0.101	0.114	0.126	0.158	0.190	0.221	0.253	0.316	0.379	0.442	0.505
10	0.202	0.227	0.253	0.316	0.379	0.442	0.505	0.632	0.758	0.884	1.011
15	0.303	0.341	0.379	0.474	0.568	0.663	0.758	0.947	1.137	1.326	1.516
20	0.404	0.455	0.505	0.632	0.758	0.884	1.011	1.263	1.516	1.768	2.021
25	0.505	0.568	0.632	0.790	0.947	1.105	1.263	1.579	1.895	2.211	2.526
30	0.606	0.682	0.758	0.947	1.137	1.326	1.516	1.895	2.274	2.653	3.032
35	0.707	0.796	0.884	1.105	1.326	1.547	1.768	2.211	2.653	3.095	3.537
40	0.808	0.910	1.011	1.163	1.516	1.768	2.021	2.526	3.032	3.537	4.042
45	0.910	1.023	1.137	1.421	1.705	1.990	2.274	2.842	3.411	3.979	4.548
50	1.011	1.137	1.263	1.579	1.895	2.211	2.256	3.158	3.790	4.421	5.053
60	1.213	1.364	1.516	1.895	2.274	2.653	3.032	3.790	4.548	5.305	6.063
70	1.415	1.592	1.768	2.211	2.653	3.095	3.357	4.421	5.305	6.190	7.074
80	1.617	1.819	2.021	2.526	3.302	3.537	4.042	5.053	6.063	7.074	8.084
90	1.819	2.046	2.274	2.842	3.411	3.979	4.548	5.684	6.821	7.958	9.095
100	2.021	2.274	2.526	3.158	3.790	4.421	5.053	6.316	7.579	8.842	10.11
125	2.526	2.842	3.158	3.948	4.737	5.527	6.316	7.895	9.474	11.05	12.63
150	3.032	3.411	3.790	4.737	5.684	6.632	7.759	9.474	11.37	13.26	15.16
175	3.537	3.979	4.421	5.527	6.632	7.737	8.842	11.05	13.26	15.47	17.68
200	4.042	4.548	5.053	6.316	7.579	8.842	10.11	12.63	15.16	17.68	20.21
250	5.053	5.684	6.316	7.895	9.474	11.05	12.63	15.79	18.95	22.11	25.26
300	6.063	6.821	7.579	9.474	11.37	13.26	15.16	18.95	22.74	26.53	30.32
350	7.074	7.958	8.842	11.05	13.26	15.47	17.68	22.11	26.53	30.95	35.37
400	8.084	9.095	10.11	12.63	15.16	17.68	20.21	25.26	30.32	35.37	40.42
500	10.11	11.37	12.63	15.79	18.95	22.11	25.26	31.58	37.90	44.21	50.53

Note: For fluids other than water, multiply table values by specific gravity. In pumping liquids with a viscosity considerably higher than that of water, the pump capacity and head are reduced. To calculate the horsepower for such fluids, pipe friction head must be added to the elevation head to obtain the total head.

APPENDIX F

Variables for Pumping Applications

Effect of Speed and Impeller Diameter on Centrifugal Pumps

Within certain limitations, there are three rules governing the operation of centrifugal pumps:

1. Capacity increases proportionately as the speed or the impeller diameter increases.
2. Head varies as the square of the speed or the square of the impeller diameter.
3. Power varies as the cube of the speed or the cube of the impeller diameter.

Atmospheric Pressure

Atmospheric pressure at sea level is approximately 14.7 pounds per square inch. This pressure with a perfect vacuum will maintain a column of mercury 29.9 inches high or a column of water 33.9 feet high. Neglecting vapor pressure of the water (see the section on pumping warm water, page 10), this is the theoretical height to which water may be drawn by suction. The practical limit to which cold water (60°F.) can be drawn by suction at sea level is 25 ft., and common sense dictates that the suction line should be kept just as short as the circumstances will permit. It should be understood that it is the pressure or weight of the air that pushes the water up the suction line. In addition, this air pressure must impart velocity to the water to get it into the pump and must overcome the friction resulting from the flow of water in the suction line. Thus, the lower the suction lift, the greater will be the percentage of the air pressure that is available for imparting velocity to the water and overcoming the suction line friction. For this reason, the lower the suction lift, the more water the pump will get.

Flow of Liquid in Pipe or Hose

Horsepower Formula

One horsepower = 33,000 ft.-lbs. per minute

$$\text{theoretical liquid horsepower} = \frac{\text{GPM x total head (feet) x sp. gr.}}{3{,}960}$$

$$\text{theoretical water horsepower} = \frac{\text{GPM x total head (feet)}}{3{,}960}$$

$$\frac{\text{GPM x lbs. per sq. in.}}{1{,}715}$$

$$\text{brake horsepower} = \frac{\text{theoretical water horsepower}}{\text{pump efficiency}}$$

To determine the area of the required pipe to discharge a given volume (gallons) in a fixed time (minutes) at a given velocity:

$$\text{velocity (ft/sec)} = \text{GPM x } .408 = .321 \text{ x GPM}$$
$$\text{(dia. in inches}^2\text{) Area (sq. in.)}$$

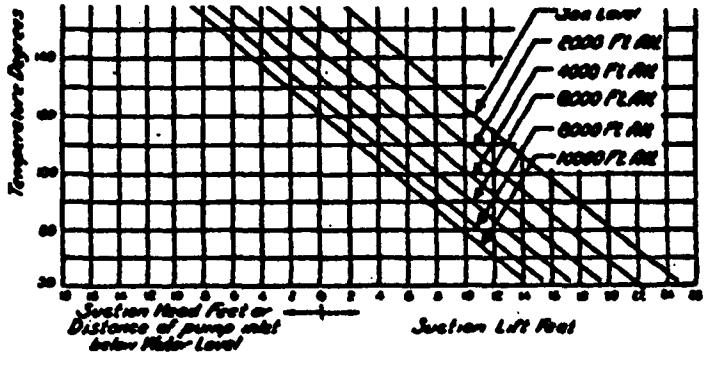
$$\text{pipe area (sq. in.)} = .321 \text{ x gallons}$$
$$\text{T x Vel. (ft/sec)}$$

APPENDIX F

Doubling the diameter of a pipe or cylinder increases its capacity four times. For the same diameter, friction of liquids in pipe or hose increases approximately as the square of the velocity.

Pumping Warm Water

For a particular temperature, the actual theoretical height that water can be drawn by suction by a perfect vacuum at sea level is obtained by subtracting the vapor pressure (in feet) of water at that temperature from 33.9 feet. For example, at room temperature (72°F.), this theoretical limit becomes 33 feet, and at 160°F., this limit is 22.9 feet. Since proper allowance must be made for water velocity and friction, the practical limits are less than the theoretical. If the water is not hot enough, it is necessary to place the pump below the level of the water so that there is an actual head on the suction. The following chart gives practical suction lifts and suction heads for pumping water of different temperatures and at different elevations.



Effect of Altitude on Pumps

When a pump is operated at elevations above sea level, the lower atmospheric pressures encountered have a double effect on the pump performance.

1. The lower atmospheric pressure cannot support as high a column of water so that the maximum practical suction lift decreases.

2. The lower atmospheric pressure reduces the horsepower output of the gas engine, thus causing it to lose speed which results in a loss of capacity and discharge head of the pump.

At elevations above sea level, the suction lift on the pump should be reduced accordingly to insure that the same amount of water can get into the pump as would get in at the equivalent sea level lift. The following table gives equivalent suction lifts for various elevations.

APPENDIX F

Equivalent Suction Lifts for Various Elevations

Altitude	*Suction Lifts in Feet*			
Sea Level	10.0	15.0	20.0	25.0
2,000 ft.	8.8	13.2	17.6	22.0
4,000 ft.	7.8	11.7	15.6	19.5
6,000 ft.	6.9	10.4	13.8	17.3
8,000 ft.	6.2	9.3	12.4	15.5
10,000 ft.	5.7	8.6	11.4	14.3

When a gas engine driven pump is operated at elevations of 4,000 ft. or over, the engine should be equipped with a high altitude head. However, even with a special cylinder, there is still a power loss of approximately 3% for every 1,000 ft. of elevation. This will result in a loss of speed and a loss of pump performances. The following table gives the loss in performance that can be expected at various elevations.

Loss of Performance at Various Elevations

Altitude	*Discharge*	*Head*
Sea Level	100%	100%
2,000 ft.	97%	95%
4,000 ft.	95%	91%
6,000 ft.	93%	87%
8,000 ft.	91%	83%
10,000 ft.	88%	78%

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GLOSSARY

Activated Carbon: A granular material produced by the roasting of cellulose base substances, such as wood or coconut shells, in the absence of air. It has an extremely porous structure and is highly adsorbent; it is used to remove organic matter and certain dissolved gases from contaminated groundwater.

Aeration: The process of bringing air into contact with water, usually by bubbling air through the water to remove dissolved gases.

Air Sparging: A process that involves injecting air under pressure below the surface of groundwater (into the saturated zone) to produce bubbles that rise and carry dissolved volatile contaminants from the groundwater into unsaturated soils above. These volatile contaminants may then be removed from the soils using a vapor extraction system.

Air Stripping: A process in which air and contaminated water are brought into contact in an engineered unit to allow the volatile contaminants to diffuse from the water into the air.

Annulus: The space between the drill string or casing and the wall of the borehole or outer casing.

Backwash: The process in which filter beds are subjected to water flow opposite to the service flow direction to loosen the bed and flush solid materials accumulated on the resin bed to waste.

Baghouses: Dust collection device used primarily in soil treatment, such as low temperature thermal desorption. Air flows into the baghouse and is distributed across the "bags," which are fabric filters that allow for filtration of the air stream.

Barite: Natural finely ground barium sulfate used for increasing the density of drilling fluids.

Bedrock: A general term for the rock, usually solid, that underlies soil or other unconsolidated material.

Bentonite: A colloidal clay, usually made up of the mineral sodium montmorillonite.

Bioreactor: A vessel constructed specifically to promote the growth of microorganisms that can degrade the contaminants dissolved in the groundwater. Such factors as oxygen levels, temperature, and nutrient levels can be controlled to optimize the efficiency with which microorganisms degrade the contaminants.

Bladder Pumps: Also known as squeeze pumps, bladder pumps operate by the compression of a flexible bladder housed inside the pump. Water enters the bladder

through a check valve. Once the bladder is filled, it is squeezed by compressed air that has been injected into the housing surrounding the bladder. Water cycles through the bladder in evenly-spaced pulses.

Blowers: Used for a wide variety of applications in soil and ground water remediation, blowers can provide positive air flow as well as vacuum force. Most blowers are electrically driven impellers which, turning at high speed, create high rates of air flow. Blowers normally have filters on them to minimize the potential damage caused by dust and debris that can be trapped between the impeller and its housing.

Cable Locators: Battery powered units designed to locate underground cable through the use of a receiver and a transmitter. The transmitter is applied to an exposed portion of the cable and sends a signal along the cable. This signal can then be located by the receiver, thereby identifying the exact location of the underground portion of the cable. The transmitter can also send a signal across the cable without actually contacting the cable if the location of a portion of the cable is known with accuracy. Some cable locators include a magnetic field detection function that also allows for pipe location. See also, Pipe Locators.

Capillary Fringe: The zone at the bottom of the vadose zone where groundwater is drawn upward by capillary force.

Carbon Adsorption - Vapor: The use of activated carbon (usually granular) to adsorb vapor-phase organic compounds from an airstream. Typically used to control off-gas emissions in air stripping and other groundwater remediation techniques as well as in soil vapor extraction systems.

Carbon Adsorption - Liquid: The use of activated carbon (usually granular) to adsorb organic compounds from a liquid stream. As the water filters through the carbon, the organics adsorb onto the carbon thus cleansing the water.

Catalytic Oxidizers: Similar to thermal oxidizers but operated at lower temperatures and with the aid of a chemical catalyst that enhances the oxidation of the organic compound in the vapor stream.

Cementing: See Grouting.

Centrifugal Pumps: Centrifugal pumps operate through the use of an impeller spinning at high numbers of revolutions per minute (rpm's). The spinning impeller creates centrifugal force which pumps water in the housing out the outlet while simultaneously creating suction, drawing water in. Centrifugal pumps are commonly used for dewatering and as

transfer pumps to move liquid from one storage area, such as a sump, to another. See also, **Electric Submersible Pumps.**

Chemical Metering Pumps: Used to measure the rate at which nutrients are introduced into bioreactors. Chemical metering pumps operate through a positive displacement piston which, through tight housing tolerances, creates suction on the intake and then forces the fluid (or gas) through the outlet port on the downstroke.

Colloid: Extremely small solid particles, 0.0001 to 1 micron in size, which will not settle out of a solution; intermediate between a true dissolved particle and a suspended solid which will settle out of solution.

Cone of Depression: A depression in the groundwater table that has the shape of an inverted cone and develops around a well from which water is being withdrawn. It defines the area of influence of a well.

Diaphragm Pumps: Diaphragm pumps are used to pump fluids that may contain sediment or other granular material that could damage a centrifugal pump and its impeller. Diaphragm pumps operate with two check valves separated by a diaphragm that moves up and down, creating pressure and suction in the same manner as a piston. As suction is created, one check valve is lifted off its seat while the other is pulled against its seat, allowing for water to flow into a chamber. As the diaphragm comes down, the first valve reseats and the second is pushed off its seat, allowing the water to flow out of the chamber and through the system.

Downhole Filter-Separators: Used to remove hydrocarbons from groundwater, filter-separators employ an oleophilic (oil-absorbing) - hydrophobic (water-repelling) filter which allows hydrocarbons to enter a collection chamber but repels water. Recovered product typically has less water mixed in with it than when using downhole skimmers. Filter separators also permit the effective recovery of free product when the water table is fluctuating significantly.

Drawdown: The distance between the static water level and the surface of the cone of depression.

Drill Collar: A length of extremely heavy steel tube. It is placed in the drill string immediately above the drill bit to minimize bending caused by the weight of the drill pipe.

Drilling Fluid: A fluid used in well drilling operations to remove cuttings from the hole, to clean and cool the bit, to reduce friction between the drill string and the sides of the hole, and to seal the borehole.

GLOSSARY

Drum Deheaders: Essentially large can openers, drum deheaders are tools for cutting off the tops of drums. Powered units and manual units are available to cut both inside and outside the chime, depending on the need to reuse the drum.

Effluent: A waste liquid byproduct from a manufacturing or treatment process, in its natural state or partially or completely treated, that is discharged into the environment.

Electric Submersible Pumps: Electric submersible pumps are used for purging and dewatering of wells and, more recently, for sampling of monitor wells. Because the pumps are capable of being submerged in wells, the pump's energy can be fully devoted to moving the water up instead of to creating a vacuum to prime the pump. Electric submersible pumps utilize impellers to create centrifugal force that creates the water flow in and out of the pump housing.

Filter Cake: The suspended solids that become deposited on a porous medium as a solution is filtered.

Filter Pack: Sand or gravel that is smooth, uniform, clean, well-rounded, and siliceous. It is placed in the annulus of the well between the borehole wall and the well screen to prevent geologic formation material from entering the screen.

Fixed Film Bioreactors: Enclosed chamber with fixed surfaces for the growth of bacteria, a pumping system for the throughput of contaminated water, and an inlet for nutrients required for bacterial cultures. The contaminated water is filtered through the bacteria which digest the hydrocarbons.

Flocculation: The agglomeration of finely divided suspended solids into larger, usually gelatinous, particles; the development of a "floc" after treatment with a coagulant by gentle stirring or mixing.

Foaming Agent: See surfactant.

Formation Stabilizer: Sand or gravel placed in the annulus of a well between the borehole wall and the well screen to provide temporary or long-term support for the borehole.

Fouling: The accumulation of undesirable foreign matter in filtration media, such as in a packed tower or an ion exchanger, which results in inhibited or retarded flow through the media or reduced operational efficiency of the packed tower or ion exchanger.

Groundwater Table: The surface between the zone of saturation and the zone of aeration; the surface of an unconfined aquifer.

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Grout: A mixture of cement and water used to fill spaces. Various additives, such as sand, bentonite, and/or hydrated lime, may be included in the mixture to meet certain requirements.

Grouting: The placing of grout between the casing and sides of a well bore to a predetermined height above the bottom of the well. This process secures the casing in place and excludes water and other fluids from entering the well bore.

Head: Energy contained in a water mass, produced by the water's elevation, pressure, or velocity.

Hydration: The taking up of water by a substance through absorption and/or adsorption.

Interference: The condition occurring when the area of influence of a water well comes into contact with or overlaps that of a neighboring well, as when two wells are pumping from the same aquifer or are located near each other.

Kelly: Hollow steel bar to which power is directly transmitted from a rotary table; its purpose is to rotate the drill pipe and bit.

Leachate: Liquid that has percolated through and dissolved soluble components of solid waste.

Low Profile Diffuser Aerators: Mechanically simple aeration devices used for treating water contaminated with VOCs. The devices are comprised of holding tanks that are frequently separated into compartments by baffles, and a series of diffusers running along the bottom of the tanks. (A diffuser is a device that reduces the velocity of, and increases the static pressure of, a fluid or gas passing through a system.) As contaminated water flows into each compartment of the tank, it is aerated by air pumped through the diffusers, effecting mass transfer and stripping the VOCs. The water flows out of the system in a finished state, and the VOC-contaminated vapor is captured and sent to a vapor treatment system, usually an oxidizer or carbon treatment vessel.

Low Profile Tray Aerators: Used for treating water contaminated with VOCs. Similar to packed towers, low-profile tray aerators employ a series of trays stacked on top of each other. Each tray has small holes in it that allow pressurized air to flow upward through the holes in the trays and into a stream of contaminated water, creating aeration and enhancing transfer of the VOCs out of the water. The VOC-contaminated vapor flows into a vapor treatment system, such as an oxidizer or a carbon treatment station.

Low Temperature Thermal Desorption Systems: A soil remediation technique in which contaminated soils are heated at relatively modest temperatures (200 to 500 degrees C),

typically within a treatment unit, using direct heat, heated air, or steam to volatilize organic constituents and separate them from the soils. The separated or desorbed organic compounds are subsequently collected in a vacuum, then treated or destroyed by a variety of processes.

Oil Skimmers - Downhole: Used to remove free-floating hydrocarbon product from the surface of groundwater by skimming. Downhole skimmers are inserted by line into a well and skim free floating hydrocarbons from the top of the water table through the use of a traveling buoy and screen that move with the fluctuation of the water table. When the skimmer has collected its capacity of hydrocarbon, it is emptied by pumping the collected product to a surface storage bin or oil water separator.

Oil/Water Separators: Closed boxes used to separate petroleum hydrocarbons from water. Coalescing plates attract the hydrocarbons, enhancing their separation and subsequent flotation. Weirs installed in the unit allow the floating hydrocarbons to spill over into a storage tank, while the water flows under a baffle and out through an effluent outlet. Depending on the level of contaminant removal required, the separated water either may be considered fully treated or may need to be piped to a carbon filtration unit for further treatment. The separated hydrocarbons can frequently be salvaged and reused.

Packed Tower Air Strippers: Used to strip volatile organic compounds from a water stream. Influent is pumped to the top of the tower where it is diffused or sprayed over the tower packing. As the water cascades down through the packing material, high pressure air is blown up from underneath the packing. This aeration of the water results in mass transfer of the VOCs from liquid-phase to vapor-phase. The water flows down to a sump in the bottom of the tower, then flows out via either a gravity feed or a pumping system. The VOC-contaminated vapor is routed to a vapor treatment system, usually an oxidizer or a carbon treatment station.

Pipe Locators: Battery powered units designed to identify the magnetic field of underground ferrous and nonferrous objects. See also, **Cable Locators.**

Pugmill Mixers: Large paddle mixing units used to mix additives or nutrients into contaminated soil prior to thermal desorption or bioremediation. Usually electrically driven by a motor on one end of a tub with a discharge outlet at the other end.

Radius of Influence: The radial distance from the center of a well bore to the point where there is no lowering of the water table (the edge of its cone of depression).

Recharge: The addition of water to the zone of saturation; also, the amount of water added.

GLOSSARY

Redox: A chemical reaction in which an atom or molecule loses electrons to another atom or molecule. Also called oxidation-reduction. Oxidation results from a loss of electrons, while reduction results from a gain in electrons.

Residual Drawdown: The difference between the original static groundwater level and the depth to groundwater at a given instant during the remediation process.

Rototiller: Soil mixing device used in land farming. Operated like a lawnmower, it is gas- or diesel-powered and is used to till earth and/or mix in additives. Ride-on versions include a small tractor with a turning till either on the rear or mounted in the middle of the chassis.

Sieve Analysis: Determination of the particle-size distribution of a soil, sediment, or rock by measuring the percentage of the particles that will pass through standard sieves of various sizes.

Soil Vapor Extraction Systems: A process in which vacuum extraction wells are used to induce air flow through unsaturated soils to vaporize and strip any volatile organic compounds from the soils into induced air streams. The compounds are then captured in the extraction wells and subsequently vented, or they are treated in a vapor treatment system.

Static Water Level: The level of water in a well that is not being affected by withdrawal of groundwater.

Steam Stripping: An adjunct to soil vapor extraction, steam stripping is the process of injecting pressurized steam in and around an extraction well's zone of influence. The steam aids in desorbing organic compounds from soil pores and so functions as an in situ soil wash or rinse. The steam vapor and moisture, along with any stripped organics, are then extracted by a soil vapor extraction system. See also, **Air Sparging.**

Surface Filter-Separators: Typically used in trench and pond recovery, surface filter-separators operate in the same manner as downhole types except that they are larger in diameter and can recover floating product at a faster pace. See also, **Downhole Filter-Separators.**

Surfactant: A substance capable of reducing the surface tension of a liquid in which it is dissolved. Used in air-based drilling fluids to produce foam and during well development to disaggregate clays.

Thermal Oxidizers: High temperature burners used for destroying VOCs in the vapor phase.

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Total Dissolved Solids (TDS): The quantity of dissolved material in a sample of water, usually expressed in milligrams per liter (mg/l). It is either a measure of the residue produced by the evaporation of the water sample at 356 degrees Fahrenheit, or for waters that contain more than 1,000 mg/l of dissolved solids, a measure of the sum of the chemical constituents.

Trench Liners: Impermeable materials used to prevent contaminated water from percolating back into the soil. Liners are also used as protection in landfills against contaminants leaching out of the refuse and seeping into the soil and groundwater. While usually made of polyethylene, other materials, such as compacted bentonite, can be used as liners as well.

Vadose Zone: The zone containing water under pressure less than that of the atmosphere, including soil water, intermediate vadose water, and capillary water. This zone is bounded by the surface of the land and the surface of the zone of saturation (the water table).

Volatile Organic Compounds (VOCs): Carbon containing compounds that readily vaporize (that is, change from a liquid to a gas) at normal temperatures and pressures.

Water Table: The surface between the vadose zone and groundwater; that surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere.

Well Screen: A filtering device used to keep sediment from entering a water well.

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