Closure Cost Estimates for Standard Permits
Background Document - Option 5

Provide to Owners and Operators a Methodology That Can Be Used to Prepare Default Cost Estimates for Closure of Units Eligible to Use Standard Permits

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EPA Work Assignment Manager:	David A. Eberly
Telephone:	(703) 308-8645
Prepared by:	Tetra Tech EM Inc.
Tetra Tech Work Assignment Manager:	Arthur Glazer
Telephone:	(703) 287-8813

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1.0 INTRODUCTION

Tetra Tech EM Inc. (Tetra Tech) received Work Assignment (WA) No. R11018 from the U.S. Environmental Protection Agency's (EPA) Office of Solid Waste (OSW), Permits Branch, under Contract No. 68-W4-0007 (Resource Conservation and Recovery Act [RCRA] Enforcement, Permitting, and Assistance [REPA] Contract, Zone II). Under the WA, Tetra Tech will assist EPA in developing additional methods of estimating costs for closure of noncommercial container storage areas (CSA), tank systems,[1] and containment buildings that are regulated as hazardous waste treatment or storage units under subtitle C of RCRA. The methods developed are designed to reduce the financial, technical, and administrative burden on the regulated community of complying with requirements under Title 40 Code of Federal Regulations (CFR) parts 264.142 and 265.142 by enabling owners and operators of certain hazardous waste units to provide acceptable estimates of the costs of closure for those units without requiring those owners or operators to prepare full closure plans. After the methods have been developed, they will be proposed in conjunction with new regulations that will allow owners and operators to use standard permits for specified types of units.

Under this WA, Tetra Tech developed for EPA several preliminary options for estimating the costs of closure of units that are eligible for standard permits and proposed strategies for testing the accuracy of those options. Each of the options considered was designed to reduce the burden on owners and operators of developing such cost estimates. Among the preliminary options EPA selected for further development was an option to provide to owners or operators a methodology that could be used to develop default cost estimates for closure. This document provides information about the steps Tetra Tech took to develop that option and presents materials that owners or operators of hazardous waste management (HWM) units eligible to use standard permits can use to develop default cost estimates for closure of such units.

In developing this methodology, Tetra Tech attempted to gather amounts of unit-specific data for CSAs, tank systems, and containment buildings that were sufficient to support the development of this methodology. Unit-specific data from a sufficient number of CSAs and tank systems were available to support the development of this methodology for use with those units. However, because data were

[1] Tank systems include tanks used to store or treat hazardous waste and the ancillary equipment and containment systems associated with those tanks.

available for only three HWM facilities that had containment buildings, Tetra Tech lacked sufficient data to develop multipliers for those units.

Section 1.1 of this document presents background information about EPA's standard permit initiative. Section 2.0 of this document presents a methodology that can be used to prepare default cost estimates for closure of units eligible to use standard permits. Section 3.0 of this document describes how Tetra Tech developed the methodology. Section 4.0 presents a comparison of cost estimates generated through the use of the multipliers developed for this option with cost estimates prepared through the use of the CostPro© model. Appendix A of this document presents unit-specific data Tetra Tech used to develop multipliers for this methodology for CSAs. Appendix B presents the cost estimating worksheets Tetra Tech used to estimate the costs of closure of CSAs of different capacities. Appendix C presents unit-specific data Tetra Tech used to develop multipliers for this methodology for tank systems. Appendix D presents the cost estimating worksheets Tetra Tech used to estimate the costs of closure of tank systems of different capacities and under different closure scenarios. Appendix E presents data Tetra Tech used to derive multipliers for the costs of treatment and disposal of inventoried wastes at units eligible to use standard permits. Appendix F presents data Tetra Tech used in conducting a comparative analysis of cost estimates for CSAs. Appendix G presents data Tetra Tech used in conducting a comparative analysis of cost estimates for tank systems.

1.1 BACKGROUND INFORMATION

Currently, regulations under subtitle C of RCRA require owners and operators of all HWM facilities to comply with closure standards and establish financial assurance for closure. The standards for closure and financial assurance that apply to HWM facilities obtaining a hazardous waste permit (permit) are set forth under 40 CFR part 264 subparts G and H, respectively.[2]

Under subpart G, an owner or operator must close the facility in a manner that meets the general closure performance standard (section 264.111). The owner or operator must prepare a written closure plan and submit the plan with the permit application in accordance with regulations under part 270. The content

[2] In general, owners or operators of HWM facilities consisting of CSAs, tank systems, and containment buildings do not expect to close those units with waste in place. Therefore, standards set forth in the regulations for post-closure care and corresponding financial assurance for post-closure care usually do not apply to such facilities.

of the plan is specified by regulations under section 264.112. The closure plan must be approved by EPA or an authorized state program before the owner or operator may implement closure activities. In addition, the owner or operator must provide notice to EPA or the authorized state program before commencing closure activities.

Under subpart H, an owner or operator must establish financial assurance for closure. The owner or operator also must have a detailed written estimate, in current dollars, of the cost of closing the facility in accordance with the applicable closure requirements under subpart G. The requirements for preparation of the cost estimate are specified under section 264.142. The owner or operator must include the most recent closure cost estimate for the facility in the permit application (see section 270.14(b)(15)).

Under the current regulations, owners or operators must prepare facility-specific closure plans and closure cost estimates and include those materials with their permit applications. The preparation and review of facility-specific closure plans and cost estimates has proven to be time consuming and burdensome for owners or operators and regulatory authorities.

In 1994, EPA convened a special task force to study permitting activities under its various programs and to make specific recommendations for improving those programs. The task force, known as the Permit Improvement Team (PIT), worked for two years with EPA personnel, personnel of state agencies, representatives of industry, and representatives of environmental groups and associations to develop recommendations for the development of standard procedures for permitting. The PIT recommended that the processes for permitting HWM facilities be modified to make them commensurate with the complexity of the hazardous waste management activities conducted at certain facilities. The PIT recommended further that, to streamline the permitting process, EPA investigate the possibility of using "standardized" permits for those hazardous waste management units that: 1) are CSAs, tank systems, or containment buildings; 2) are used to conduct operations that are noncommercial in nature; and 3) will not be closed with wastes in place (that is, post-closure care will not be required).

EPA is investigating the possibility of proposing new regulations that would allow the use of standard permits for such units. Under the proposed rule, only owners and operators of noncommercial HWM facilities that have units that are classified as CSAs, tank systems, or containment buildings would be eligible to use standard permits, and then only for those specific units. Owners or operators of units that are eligible for standard permits would not be required, at the time of permitting, to prepare and submit to

the implementing agency a complete closure plan. However, owners or operators that use standard permits still would be required to prepare, at the time of permitting, a cost estimate for closure activities. They also would be required to prepare and submit to the implementing agency, before the initiation of final closure activities, a complete closure plan and cost estimate that meets requirements specified under 40 CFR 264.112. The owner or operator must obtain approval of the plan before implementing closure activities.

Under the proposed rule, owners or operators of facilities that have two or more units that are eligible for standard permits (for example, one facility might have both a CSA and an aboveground tank) would be allowed to permit all their units under a single standard permit. Owners or operators of facilities that have both units that are eligible for standard permits and units that are not (for example, one facility might have both a CSA and a waste pile) would have the option of permitting their eligible units under a standard permit and permitting their ineligible units separately under a traditional permit or of permitting all their units (both eligible and ineligible) under a single traditional permit.

To support the use of standard permits for certain types of units, EPA is developing several options that the agency believes will provide to owners and operators less burdensome methods of preparing cost estimates for closure of units that may be eligible to use standard permits. The options are designed to reduce the financial, technical, and administrative burdens on the regulated community of complying with requirements under 40 CFR parts 264.142 by enabling owners or operators to develop estimates that they and the permitting agency can accept as reasonably accurate, without the need to prepare an accompanying closure plan for the units of concern. Use of any such methods will be optional. If they prefer, owners or operators that are eligible for standard permits may follow the standard procedures currently established under the regulations to develop estimates of the costs of closure.

2.0 METHODOLOGY FOR PREPARING DEFAULT COST ESTIMATES FOR CLOSURE OF UNITS ELIGIBLE TO USE STANDARD PERMITS

Tetra Tech developed a methodology that owners or operators of units eligible to use standard permits can use to derive default cost estimates for closure of those units. The methodology consists of two sets of multipliers that represent the average costs per gallon of waste of conducting closure activities for different types of units under different closure scenarios. Use of the multipliers allows owners and operators to prepare default cost estimates for closure that require the use of only a minimum amount of unit-specific data. Use of the methodology described in this document would reduce the burden on the

regulated community significantly because it would simplify drastically the effort necessary to estimate the costs of closure of different types of HWM units under different closure scenarios.

The multipliers developed for this methodology are designed to be used on a unit-by-unit basis. For this methodology, a unit may be a single CSA or tank system or a group of CSAs or tank systems that are permitted as a single unit.

The data required to use the methodology are limited to:[3]

- Type of unit (CSA or tank system)[4]
- Maximum volume of waste that will be permitted to be managed at the unit
- Type and physical state of each waste that will be permitted to be managed at the unit

Under the methodology, the two sets of multipliers are used together to estimate the total costs of closure of units eligible to use standard permits. The first set of multipliers is used to estimate the costs of all closure activities, other than the treatment and disposal of inventoried wastes. The second set of multipliers is used to estimate the costs of treatment and disposal of all inventoried wastes. The estimates derived by application of the first set of multipliers are based on the amounts of waste (in gallons) that are permitted to be managed at a unit. The estimates derived by application of the second set of multipliers are based on the types of waste that are permitted to be managed at a unit.

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[3] The cost of closure that is derived through the use of the methodology will depend, in part, on the manner in which the unit will be closed. Therefore, in addition to the data specified for use with this methodology, owners or operators of certain facilities that wish to use the methodology must predict the manner in which the unit will be closed. For example, costs of closure of tank systems developed through application of the methodology will vary somewhat, depending on whether the unit will be closed with the tank left in place or removed during closure.

[4] As Section 3.0 of this report discusses, data from actual HWM facilities for which cost estimate evaluations had been performed for EPA were used in developing the multipliers used in the methodology. Because such data were available for only three HWM facilities that had containment buildings, Tetra Tech was able to develop only multipliers applicable to CSAs and tank systems.

Table 1 presents the multipliers that owners or operators of units eligible to use standard permits can use to estimate the costs of all closure activities, other than the treatment and disposal of inventoried wastes. To use the table, owners or operators must identify the types of units that will require closure (CSAs or tank systems) and the maximum amounts of wastes that are permitted to be managed at those units. In the case of tank systems, owners or operators also must determine whether the wastes managed in the tank are ignitible and whether the tank will be removed at the time of closure or left in place.

TABLE 1

MULTIPLIERS TO BE USED TO ESTIMATE THE COSTS OF ALL CLOSURE ACTIVITIES OTHER THAN THE TREATMENT AND DISPOSAL OF INVENTORIED WASTES
(Multipliers are Per Gallon)

Permitted Gallons of Waste Per Unit	Container Storage Areas	Tank Systems			
		Closed With Tank In Place		Closed With Tank Removed	
		Nonignitable Waste	Ignitable Waste	Nonignitable Waste	Ignitable Waste
1-500	20.64	23.41	23.52	23.71	23.81
501-1,000	10.82	13.08	13.15	13.29	13.52
1,001-5,000	3.25	4.58	4.61	4.77	4.80
5,001-10,000	2.33	3.67	3.70	3.85	3.88
10,001-15,000	2.11	3.38	3.41	3.57	3.60
15,001-20,000	2.02	3.19	3.22	3.38	3.41
20,001-25,000	1.95	3.14	3.17	3.32	3.35
25,001-30,000	1.91	3.09	3.12	3.27	3.30
30,001-35,000	1.89	3.05	3.08	3.23	3.26
35,001-40,000	1.90	2.98	3.01	3.16	3.19
40,001-45,000	1.88	2.96	2.99	3.14	3.17
45,001 and Up	1.86	2.95	2.98	3.13	3.16

Tables 2, 3, and 4 present the multipliers that owners or operators can use to estimate the costs of treatment and disposal of inventoried wastes. To use those tables, owners or operators must determine the maximum amounts of each type of waste that will be permitted to be managed at that unit, and

TABLE 2

MULTIPLIERS TO DERIVE COSTS OF TREATMENT AND DISPOSAL OF AQUEOUS WASTES BY TYPE OF WASTE (Multipliers are Per Gallon)

Type of Aqueous Waste	Handling Process	Multiplier
Hazardous because of inorganic toxicity characteristic	Drums	5.39
	Bulk	4.95
Hazardous because of organic toxicity characteristic (no pesticides)	Drums	5.06
	Bulk	4.51
Hazardous because of organic and inorganic toxicity characteristic (no pesticides)	Drums	6.05
	Bulk	5.06
Hazardous because of pesticides	Drums	7.71
	Bulk	5.83
Hazardous because of F001-F005 solvents (does not meet land disposal restrictions [LDR] standards)[5]	Drums	7.05
	Bulk	6.28
Hazardous because of P- and U-listed organic hazardous wastes[6] (does not meet LDR standards)	Drums	8.15
	Bulk	6.28
Hazardous because of P- and U-listed inorganic hazardous wastes (does not meet LDR standards)	Drums	7.82
	Bulk	6.28
Hazardous because of F006-F012, F019 wastes (does not meet LDR standards)	Drums	6.71
	Bulk	5.83
Contaminated leachate or runoff, moderately toxic wastes	Drums or bulk	1.44
Hazardous because of acidic or alkaline characteristic	Drums or bulk	0.72

[5] LDR standards are restrictions placed on the land disposal of hazardous wastes. "Land disposal" is defined as placement in a landfill, surface impoundment, waste pile, or land treatment unit. Land disposal also includes situations that involve "use constituting disposal," or the recycling of wastes by placing them on the land, such as use in fertilizers or asphalt.

[6] Basically, P- and U-listed wastes are unused chemical products that, when discarded, are hazardous wastes.

TABLE 3

MULTIPLIERS TO DERIVE COSTS OF TREATMENT AND DISPOSAL OF NONAQUEOUS WASTES BY TYPE OF WASTE (Multipliers are Per Gallon)

Type of Nonaqueous Waste	Special Characteristics	Multiplier
Hazardous because of inorganic toxicity characteristic	Free liquids present	9.12
	No free liquids present	6.37
Hazardous because of organic toxicity characteristic (no pesticides)	Free liquids present	10.33
	No free liquids present	6.89
Hazardous because of organic and inorganic toxicity characteristic (no pesticides)	Free liquids present	11.45
	No free liquids present	8.09
Hazardous because of pesticides	Free liquids present	14.29
	No free liquids present	14.11
Hazardous because of F001-F005 solvents	Free liquids present	13.60
	No free liquids present	8.09
Hazardous because of P- and U-listed organic hazardous wastes	Meets LDR standards	4.99
	Does not meet LDR standards	14.46
Hazardous because of P- and U-listed inorganic hazardous wastes	Meets LDR standards	4.99
	Does not meet LDR standards	12.39
Hazardous because of F006-F012, F019 wastes	Meets LDR standards	4.99

identify the hazardous characteristics of those wastes. Table 2 presents the multipliers that can be used to estimate the costs of treatment and disposal of aqueous wastes. Table 3 presents the multipliers that can be used to estimate the costs of treatment and disposal of nonaqueous wastes. Table 4 presents the multipliers that can be used to estimate the costs of treatment and disposal of sludge wastes.

In the case of aqueous wastes, owners or operators must determine whether the wastes at the unit will be managed in drums or in bulk and whether certain wastes at the unit meet the LDR standards established under RCRA. In the case of nonaqueous wastes, owners or operators must determine whether certain wastes at the unit contain free liquids and whether certain wastes at the unit meet the LDR standards established under RCRA. In the case of sludge wastes, owners or operators must determine whether the

TABLE 4

MULTIPLIERS TO DERIVE COSTS OF TREATMENT AND DISPOSAL OF SLUDGE WASTES BY TYPE OF WASTE (Multipliers are Per Gallon)

Type of Sludge Waste	Handling Process	Multiplier
Hazardous because of inorganic toxicity characteristic	Drums	5.94
	Bulk	5.39
Hazardous because of organic toxicity characteristic	Drums	7.16
	Bulk	6.83
Hazardous because of organic and inorganic toxicity characteristic	Drums	8.15
	Bulk	7.05
Hazardous because of F001-F005 solvents	Drums	9.25
	Bulk	7.49

wastes at the unit will be managed in drums or in bulk. The costs of treatment and disposal of certain wastes that do not meet the LDR standards established under RCRA will generally be greater than the costs for treatment and disposal of wastes that do meet those standards. The added costs of treatment and disposal of wastes that do not meet the LDR standards are reflected in the multipliers presented in Tables 2, 3, and 4.

The multipliers developed for this methodology are based on 1997 cost data and can be used to generate cost estimates stated in 1997 dollars. Therefore, to use this methodology in future years, owners or operators must adjust for inflation the cost estimates generated through application of the multipliers, through and including the year in which the methodology is used. Using inflation factors derived from annual implicit price deflators for gross national product (GNP), owners or operators can adjust the cost estimates to account for the effects of inflation. The method to be used to derive those inflation factors is described in 40 CFR 264.142(b)(1) and (2).[7] The Bureau of Economic Analysis, U.S. Department of Commerce publishes the implicit price deflators of GNP annually in its Survey of Current Businesses. The implicit price deflators of GNP also may be obtained through the Internet at *www.bea.doc.gov*.

[7] Per the RCRA Hotline Monthly Report for June 1994, inflation factors derived from annual implicit price deflators for gross domestic product (GDP) also may be used to adjust cost estimates for HWM facilities for inflation.

The following section presents a case study scenario that illustrates how the methodology could be used to derive default cost estimates for closure of CSAs eligible for permitting under standard permits.

2.1 Case Study Scenario for CSAs

Consider a CSA that is eligible for a standard permit and would be permitted to manage 10,000 gallons of hazardous waste. Assume that 5,000 gallons of the waste is aqueous waste and is hazardous because of inorganic toxicity characteristics. Further, assume that the remaining 5,000 gallons of waste also is aqueous waste and is hazardous because of organic and inorganic toxicity characteristics (but not pesticides). Because the unit is a CSA, all the waste at the unit will be managed in drums. To develop a default cost estimate for closure of the unit, the owner or operator first would use the multipliers in Table 1 to estimate the costs of all closure activities for the unit, other than the treatment and disposal of inventoried wastes. The owner or operator would multiply the maximum amount of waste to be managed at the unit (10,000 gallons) by the cost multiplier for CSAs permitted to manage from 5,001 to 10,000 gallons of waste (in this case, 2.33). The product, $23,300, represents the estimated cost of conducting all closure activities at the unit, other than the treatment and disposal of inventoried wastes.

The owner or operator next would use Table 2 to estimate the costs of treatment and disposal of all inventoried aqueous wastes at the unit. The owner or operator would multiply 5,000 gallons by the cost multiplier that corresponds to the estimated cost per gallon of treatment and disposal of waste in drums that is hazardous because of inorganic toxicity characteristics (in this case, 5.39). The product, $26,950, represents the estimated cost of treatment and disposal of that waste. The owner or operator then would multiply 5,000 gallons by the cost multiplier that corresponds to the estimated cost per gallon of treatment and disposal of waste in drums that is hazardous because of organic and inorganic toxicity characteristics (in this case, 6.05). The product, $30,250, represents the estimated cost of treatment and disposal of that waste.

To derive the total cost estimate for closure of the unit, the owner or operator would sum the estimated cost of all closure activities, other than the treatment and disposal of inventoried wastes, with the estimated costs of treatment and disposal of each type of waste that will be permitted to be managed at the unit. In this case, the total cost estimate for closure of the unit would be calculated as $80,500 ($23,300 + $26,950 + $30,250 = $80,500). Finally, the owner or operator would adjust the cost estimate to account for the effects of inflation through and including the year in which the methodology is used.

The following section presents a case study scenario that illustrates how the methodology could be used to derive default cost estimates for closure of tank systems eligible to use standard permits.

2.2 Case Study Scenario for Tank Systems

Consider a tank system that is eligible for a standard permit and would be permitted to manage 25,000 gallons of hazardous waste. Assume that 95 percent of the waste is aqueous, is hazardous because of F001-F005 solvents, and does not meet LDR standards. Also assume that 5 percent of the waste is sludge and is hazardous because of F001-F005 solvents. Assume further that the waste managed at the unit is not ignitable and that the unit will be closed with the tank left in place. Finally, assume that all the wastes at the unit will be managed in bulk.

To develop a default cost estimate for closure of the unit, the owner or operator first would use Table 1 to estimate the costs of all closure activities for the unit, other than the treatment and disposal of inventoried wastes. The owner or operator would multiply the maximum amount of waste managed at the unit (25,000 gallons) by the cost multiplier that corresponds to the estimated cost per gallon of tank systems permitted to manage from 20,001 to 25,000 gallons of non-ignitable waste when the unit will be closed with the tank left in place (in this case, 3.14). The product, $78,500, represents the estimated cost of conducting all closure activities at the unit, other than the treatment and disposal of inventoried wastes.

The owner or operator next would use Tables 2 and 4 to estimate the costs of treatment and disposal of the inventoried wastes at the unit. The owner or operator would multiply 23,750 gallons (or 95 percent of the maximum volume of waste that will be permitted to be managed at the unit) by the cost multiplier in Table 2 that corresponds to the estimated cost per gallon of treatment and disposal of bulk aqueous waste that is hazardous because of F001-F005 solvents and does not meet LDR standards (in this case, 6.28). The product, $149,150, represents the estimated cost of treatment and disposal of that waste. The owner or operator then would multiply 1,250 gallons (or 5 percent of the maximum permitted capacity of waste at the unit) by the cost multiplier in Table 4 that corresponds to the estimated cost per gallon of treatment and disposal of bulk sludge waste that is hazardous because of F001-F005 solvents (in this case, 7.49). The product, $9,363, represents the estimated cost of treatment and disposal of that waste.

To derive the total cost estimate for closure of the unit, the owner or operator would sum the estimated cost of all closure activities, other than the treatment and disposal of inventoried wastes, with the estimated costs of treatment and disposal of each type of waste that will be permitted to be managed at the unit. In this case, the total cost estimate for closure of the unit would be calculated as $237,013 ($78,500 + $149,150 + $9,363 = $237,013). Finally, the owner or operator would adjust the cost estimate to account for the effects of inflation through and including the year in which the methodology is used.

The following section describes how Tetra Tech developed the methodology described above.

3.0 DEVELOPMENT OF THE METHODOLOGY

In 1994, EPA Region 4 developed a comprehensive cost estimating model to assist EPA and state permit writers in evaluating the adequacy of cost estimates for closure and post-closure care that are prepared and submitted by owners or operators of HWM facilities. The model is discussed in detail in the document *Evaluating Cost Estimates for Closure and Post-Closure Care of RCRA Hazardous Waste Management Units*.[8] After that document had been developed, EPA Region 4 developed the CostPro© software.[9] That software was developed primarily to automate the model set forth in the document

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[8] EPA released the final version of the document on May 13, 1994. Because the document contains proprietary cost information, and because it has been superseded by various editions of the CostPro© software that provide more recent cost information, copies of the document currently are not available for distribution outside the agency. When development of this methodology has been completed, however, EPA will make one copy of the document available at the RCRA Information Center (RIC), Crystal Gateway I, First Floor, 1235 Jefferson Davis Highway, Arlington, Virginia 22202.

[9] EPA and Tetra Tech currently hold a joint copyright on the CostPro© software. The terms of the copyright allow EPA to distribute the software freely to all entities within the federal government that act on behalf of EPA. However, the software is sold commercially to all entities other than the federal government. EPA Region 4 maintains the CostPro© software and has updated it annually to incorporate current cost data. The cost data used in the CostPro© software is provided primarily by R.S. Means Company, Inc. (R.S. Means) and is published in the *Means Cost Guides*. Under special arrangement, R.S. Means has agreed to allow its cost data to be used in the CostPro© software. However, because the data provided by R.S. Means are proprietary, the R.S. Means data used in developing this option are not included in this background document. Persons who wish to obtain the CostPro© software may contact Mr. Steven Jeffords, Tetra Tech EM Inc., at (404) 225-5514 for more information.

identified above, thereby enhancing the ability of regulators to evaluate the adequacy of cost estimates for closure and post-closure care.

The CostPro© software provides numerous worksheets to be used in estimating the costs of closure and post-closure care activities for various types of TSDFs. Inventory worksheets are provided to be used in compiling the basic data about each unit that are necessary to develop cost estimates for that unit. Many other worksheets also are provided for use in estimating the costs of specific activities that typically are performed by owners or operators in conducting closure. Finally, summary worksheets are provided to accumulate the costs identified on all worksheets applicable to each type of unit.

In the case of CSAs and tank systems, data needed to use CostPro© include: 1) characteristics and physical states of each hazardous waste to be stored or treated at the unit; 2) maximum permitted capacities (in gallons) of each unit; 3) types of containers or tanks that will be used to store or treat hazardous wastes at the unit; 4) surface areas in square feet (ft^2) of all pads, berms, or other secondary containment structures at the unit; 5) interior surface area (in ft^2) of tank systems;[10] 6) length (in feet) and nominal diameter (in inches) of all ancillary piping;[10] 7) types of heavy equipment to be used during closure activities; 8) level of personal protective equipment (PPE) assumed to be required during closure activities; 9) methods of decontamination to be used for the unit and for heavy equipment; 10) number and types of samples to be taken and analytical procedures to be performed; 11) an estimation of whether tank systems will be closed with tanks in place or removed during closure;[10] 12) an estimation of whether the unit will be closed with the containment system in place or whether that system will be removed during closure; and 13) anticipated methods of treatment and disposal of all wastes removed and all residues generated in conducting closure activities.

The inventory worksheets are completed first, since the data entered on those worksheets are used to complete all activity worksheets for each unit. Depending on the activities to be conducted to close a unit, some of the information requested on the inventory worksheets may not be necessary or applicable. Therefore, the user is required to complete only those portions of the inventory worksheets that are applicable to anticipated closure activities at each unit.

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[10] This data point would apply only to the closure of tank systems.

Summary worksheets are provided to accumulate the costs derived through the use of all worksheets that are applicable to a unit. The summary worksheets list the name and number of each worksheet used to calculate the costs of closure for each unit. Along with worksheets for those activities that are conducted routinely during closure, the summary worksheet lists worksheets for certain additional activities that the owner or operator might choose to conduct to close the unit. Because not all of the activities listed may be conducted to close the unit, only the applicable portions of the summary worksheet are completed. When all worksheets that are applicable to each unit have been completed, the total cost of closure for that unit is calculated on the summary worksheet. Factors then are applied to that cost to account for management and engineering expenses and to allow for contingencies and unforeseen expenses.

Tetra Tech has used CostPro© since 1994 to evaluate for EPA cost estimates for numerous HWM facilities located throughout the United States. To conduct those evaluations, Tetra Tech reviewed the closure plans and Part B permit applications of each facility for which an evaluation was required and used the data obtained from those documents to derive independent estimates of the costs of closure of that facility. Tetra Tech compared the cost estimates generated through the use of CostPro© with those submitted by the owner or operator of each facility as part of its Part B permit application. Through application of that process, Tetra Tech was able to evaluate the overall adequacy of the owners' or operators' cost estimates and, in many cases, identify discrepancies in those estimates that provided regulating agencies justification to require adjustments of those estimates. Tetra Tech's findings for each facility were summarized in a cost estimate evaluation report for that facility.

In developing the multipliers used in this methodology, Tetra Tech used two primary sources of data. First, Tetra Tech obtained unit-specific data by reviewing a number of cost estimate evaluation reports for CSAs and tank systems that it had prepared previously for EPA. Second, Tetra Tech used cost estimating data incorporated into CostPro© in conjunction with the unit-specific data to generate estimates of the costs of specific closure activities for "average" CSAs and tank systems of various sizes.

Using the two sources of data identified above, Tetra Tech developed two sets of multipliers for use in this methodology. The first set of multipliers can be used to estimate the costs of all closure activities, other than the treatment and disposal of inventoried wastes, that would be conducted at those CSAs and tank systems that are eligible for standard permits. The second set of multipliers can be used to estimate the costs of treatment and disposal of inventoried wastes. Costs of treatment and disposal vary greatly, depending on the physical form and hazardous characteristics of wastes that are managed at HWM

facilities. Therefore, for this methodology, estimates of costs of treatment and disposal of inventoried wastes are generated separately from all other costs of closure.

3.1 Development of Multipliers for Estimating the Costs of All Closure Activities, Other Than the Treatment and Disposal of Inventoried Wastes

To develop the first set of multipliers used in the methodology, Tetra Tech reviewed cost estimate evaluation reports for 76 HWM facilities that had applied for or had already received permits under subtitle C of RCRA. Of those 76 HWM facilities, 40 had CSAs, 33 had tank systems, and three had containment buildings. From those reports Tetra Tech obtained key data about each unit that were needed to establish the "average" characteristics of those units. Data obtained for each unit included the maximum volume of waste permitted to be managed at that unit, the dimensions and surface areas of that unit, and the numbers and types of samples to be taken at that unit at the time of closure. Unit-specific data from a sufficient number of CSAs and tank systems were available to support development of multipliers for those units. However, because data were available for only three HWM facilities that had containment buildings, Tetra Tech lacked sufficient data to develop multipliers for those units.

Using the maximum permitted capacity of each unit, Tetra Tech calculated ratios to relate certain characteristics of each unit to the maximum number of gallons of waste that were permitted to be managed at that unit. For example, Tetra Tech calculated ratios of the surface areas of the secondary containment systems of each unit (in ft^2) to the maximum number of gallons of waste to be managed at that unit. In that way, Tetra Tech was able to restate the surface area of the secondary containment system of each unit in terms of the permitted capacity of that unit (number of ft^2 of surface area, per unit, per gallon of waste). The specific ratios Tetra Tech calculated for CSAs and for tank systems are described in sections 3.1.1 and 3.1.2 of this document, respectively.

Having derived ratios for all units for which the required data were available, Tetra Tech summed each group of ratios and divided that sum by the number of units from which the ratios were derived. The quotients represent the "average" characteristics of each type of unit relative to the number of gallons of waste managed at those units. Tetra Tech used those average ratios to derive specific values to be entered into CostPro©. In addition, Tetra Tech multiplied the average ratios it developed by different volumes of waste to prepare data for entry into CostPro© that could be used to estimate the costs of closure for units of varying permitted capacities.

CostPro© provides numerous worksheets that allow the user to estimate the cost of essentially any activity that might be associated with the closure or post-closure care of HWM facilities. In developing this methodology, however, Tetra Tech used only those portions of CostPro© that pertained to closure activities at units that would be eligible to use standard permits. For example, owners or operators that wish to use standard permits would be required to demonstrate that those units would not be closed with wastes in place. Because of that requirement, evidence of releases from the unit to the environment at the time of permitting probably would disqualify the unit from using a standard permit.

Previously, in evaluating cost estimates for EPA for certain HWM facilities that were used for this analysis, Tetra Tech used CostPro© to estimate the costs of demolishing and removing containment systems, removing contaminated soil, backfilling, installing groundwater monitoring wells, and conducting landfill closure and post-closure care activities. However, Tetra Tech did not use those portions of CostPro© in estimating the costs of closure of units for this methodology because conduct of such activities was assumed to indicate that releases of waste to the environment had occurred. If, at the time of permitting, an owner or operator were to recognize the need to conduct such activities to effect closure at a unit, that unit presumably would be ineligible for a standard permit.

Following the approach described above, Tetra Tech used CostPro© to prepare estimates of the costs of all closure activities, other than the treatment and disposal of inventoried wastes, for "average" CSAs and tank systems of various capacities. The cost estimates Tetra Tech derived were divided by the volumes of waste (in gallons) assumed for each unit to generate average costs per gallon for units of different sizes and derive multipliers that would account for the economies of scale that are inherent in conducting closure activities at units of various capacities. The average costs Tetra Tech derived through this process are represented by the multipliers presented in Table 1 of this document.

The following section describes how Tetra Tech developed multipliers for this methodology for CSAs.

3.1.1 Development of Multipliers for CSAs

Tetra Tech derived costs of closure for "average" CSAs, assuming conduct of the following closure activities at all units eligible to use standard permits: 1) decontamination,[11] 2) sampling and analysis,[12] 3) transportation of waste, 4) treatment and disposal of decontamination fluids,[13] and 5) certification of closure. Factors then were applied to the costs of those activities to account for management and engineering expenses and to allow for contingencies and unforeseen expenses. The costs of closure Tetra Tech derived for CSAs did not, however, include conduct of the following activities: 1) demolition and removal of containment systems, 2) removal of soil, 3) backfilling, 4) installing monitoring wells, and 5) conducting landfill closure and post-closure care activities. Tetra Tech did not include the costs of those activities in developing the multipliers for CSAs for this methodology because such activities were assumed to be inconsistent with closure activities conducted at CSAs eligible to use standard permits.

Using data on 40 HWM facilities that had CSAs, Tetra Tech calculated the average ratio values for those units that were needed to generate data for entry into CostPro© to develop the multipliers presented in this methodology. Appendix A of this document presents the unit-specific data used to generate those average ratio values.

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[11] Costs of "decontamination" include the costs of both decontamination of the unit by steam cleaning or pressure washing and decontamination of heavy equipment. For this methodology, decontamination of all surface areas at CSAs is assumed to be conducted at PPE level D. Because it is assumed for this methodology that the pad of the unit would be used to decontaminate any heavy equipment that is used on site, costs of the construction and demolition of a temporary decontamination area are not included in the costs of decontaminating heavy equipment.

[12] For this methodology, Tetra Tech assumed that a minimum of five samples would be taken for each unit at the time of closure. To estimate the cost of collecting subsurface soil samples, Tetra Tech assumed use of a 2.5-inch hollow-stem augur and a boring depth of three feet.

[13] For this methodology, Tetra Tech assumed that for treatment and disposal, all decontamination fluids generated during closure would be managed as bulk liquids.

The average ratio values Tetra Tech generated indicate that:

- The average surface area of the secondary containment systems of CSAs is 0.144773028 ft^2 per gallon of waste.
- The average number of samples collected at CSAs at the time of closure is 0.000599277 samples per gallon of waste.
- On average, of the samples collected at CSAs at the time of closure, 36.7 percent are aqueous samples, 29.2 percent are nonaqueous samples, 17.2 percent are wipe samples, 13.1 percent are concrete core samples, and 3.8 percent are subsurface soil samples.
- The average number of analyses conducted at CSAs for each sample collected at the time of closure is three.[14]

Tetra Tech used the above ratio values to derive data to be entered into CostPro© that were needed to generate estimates of the costs of all closure activities that would typically be conducted at CSAs that are eligible to use standard permits, other than the treatment and disposal of inventoried wastes.

For example, on the basis of the ratio values presented above, Tetra Tech determined that a CSA having a maximum permitted capacity of 10,000 gallons would have, on average, a secondary containment system pad with a surface area of 1,447.7 ft^2. Tetra Tech also determined that, for a CSA having a maximum permitted capacity of 10,000 gallons, an average of six samples would be collected at the time of closure. Further, two of those samples, on average, would be aqueous samples, two would be nonaqueous samples, one would be a wipe sample, and one would be a concrete core sample. In addition, Tetra Tech determined that an average of three analyses would be performed on each sample collected at that CSA at the time of closure. Finally, using standard-turnaround-time costs for conduct of laboratory analyses provided in CostPro© for 86 different types of analyses, Tetra Tech derived an average cost per analysis of $139.

Table 5 presents the costs Tetra Tech generated for CSAs for all closure activities, other than the treatment and disposal of inventoried wastes, and the corresponding multipliers for those activities. As the table shows, Tetra Tech developed multipliers for CSAs having maximum capacities of 500 gallons,

[14] For this methodology, Tetra Tech rounded the average number of analyses conducted per sample from 3.21 analyses per sample to 3 analyses per sample. Unlike other ratio values used in this methodology, Tetra Tech elected to round the number of analyses conducted per sample to the nearest whole number because such analyses are discrete units.

TABLE 5

AVERAGE COSTS FOR CSAs OF ALL CLOSURE ACTIVITIES OTHER THAN THE TREATMENT AND DISPOSAL OF INVENTORIED WASTES (Multipliers are Per Gallon)

Permitted Gallons of Waste	Estimated Cost of Closure ($)	Multiplier
500	10,321	20.64
1,000	10,819	10.82
5,000	16,253	3.25
10,000	23,334	2.33
15,000	31,631	2.11
20,000	40,414	2.02
25,000	48,800	1.95
30,000	57,413	1.91
35,000	66,221	1.89
40,000	76,046	1.90
45,000	84,407	1.88
50,000	92,952	1.86

1,000 gallons, 5,000 gallons, and capacities at increments of 5,000 gallons thereafter to a maximum capacity of 50,000 gallons. The worksheets Tetra Tech used to estimate the costs of closure of CSAs of different capacities have been purged of all proprietary cost data and are presented in Appendix B of this document.

The following section discusses how Tetra Tech developed multipliers for this methodology for tank systems.

3.1.2 Development of Multipliers for Tank Systems

Using data for 33 HWM facilities that had tank systems, Tetra Tech calculated the average ratio values for those units that were needed to generate data for entry into CostPro© to develop the multipliers

presented in this methodology. Appendix C of this document presents the unit-specific data Tetra Tech used to generate those ratio values.

The average ratio values generated by Tetra Tech indicate that:

- The average combined surface areas of the pads and berms of tank systems is 0.062854769 ft^2 per gallon of waste.
- The average length of ancillary piping of tank systems is 0.014195898 feet per gallon of waste.
- The average nominal diameter of the ancillary piping at tank systems is 2 inches.[15]
- The average number of samples collected at tank systems at the time of closure is 0.000426512 sample per gallon of waste.
- On average, of the samples collected at tank systems, 75.1 percent would be aqueous samples, 10.9 percent would be wipe samples, 7.9 percent would be nonaqueous samples, and 6.1 percent would be concrete core samples.
- The average number of analyses conducted at tank systems for each sample collected is three.[16]

Tetra Tech used the above ratio values to derive data to be entered into CostPro© that were needed to generate estimates of the costs of all closure activities conducted at tank systems, other than the treatment and disposal of inventoried wastes.

For example, on the basis of the ratio values presented above, Tetra Tech determined that the pad and berms of a tank system having a maximum permitted capacity of 20,000 gallons would have, on average, combined surface areas of 1,257.1 ft^2. Tetra Tech also determined that a tank system having a maximum permitted capacity of 20,000 gallons would have, on average, 283.9 linear feet of 2-inch-diameter ancillary piping. Tetra Tech determined that, for a tank system having a maximum permitted capacity of

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[15] For this methodology, Tetra Tech rounded the average nominal diameter of the ancillary piping from 2.15 inches to 2 inches. Unlike other ratio values used in this methodology, Tetra Tech elected to round the nominal diameter of the ancillary piping to the nearest half inch to be more consistent with the actual diameters of the piping used at tank systems.

[16] For this methodology, Tetra Tech rounded the average number of analyses conducted per sample for tank systems from 3.33 analyses per sample to 3 analyses per sample. Unlike other ratio values used in this methodology, Tetra Tech elected to round the number of analyses conducted per sample to the nearest whole number because such analyses are discrete units.

20,000 gallons, an average of 9 samples would be collected at the time of closure. Further, six of those samples, on average, would be aqueous samples, one would be a wipe sample, one would be a nonaqueous sample, and one would be a concrete core sample. In addition, Tetra Tech determined that an average of three analyses would be performed on each sample collected at the unit at the time of closure. Finally, using standard-turnaround-time costs for conduct of laboratory analyses provided in CostPro© for 86 different types of analyses, Tetra Tech derived an average cost per analysis of $139.

Tetra Tech used data provided in CostPro© to establish the interior surface areas of tanks of different capacities. For this methodology, Tetra Tech used the interior surface areas of vertical tanks to derive data for tanks of different capacities to be entered into CostPro©. Table 6 presents the data Tetra Tech used to establish the interior surface areas of tanks of different permitted capacities. According to the data presented in Table 6, a tank with a maximum permitted capacity of 20,000 gallons would have an interior surface area of approximately 1,060 ft^2.

TABLE 6

INTERIOR SURFACE AREAS OF VERTICAL TANKS OF VARIOUS CAPACITIES

Capacity in Gallons	Approximate Diameter (ft)	Approximately Height (ft)	Surface Area (ft^2)
500	4	5.5	94
1,000	5	7	149
5,000	9	10.5	424
10,000	11.5	13	677
15,000	13	15	878
20,000	15	15	1,060
25,000	16	17	1,257
30,000	17	18	1,415
35,000	18	18.5	1,555
40,000	19	19	1,701
45,000	19.5	20	1,822
50,000	20.5	20.5	1,980

Tetra Tech developed multipliers for tank systems for four closure scenarios. Those scenarios are: 1) closure of the tank system with the tank left in place (the tank did not contain ignitible wastes); 2) closure of the tank system with the tank left in place (the tank did contain ignitible wastes); 3) closure of the tank system with removal of the tank (the tank did not contain ignitible waste); and 4) closure of the tank system with removal of the tank (the tank did contain ignitible waste). Tetra Tech derived costs of closure for "average" tank systems of various capacities, assuming conduct of the following closure activities at all tank systems eligible for standard permits: 1) removal of waste, 2) flushing of the tank and piping,[17] 3) decontamination,[18] 4) sampling and analysis,[19] 5) transportation of waste, 6) treatment and disposal of decontamination fluids,[20] and 7) certification of closure.

Under those scenarios in which a tank system would be closed with removal of the tank, the cost of disassembling and loading the components of the tank was factored into the total cost of closure for the unit. Under those scenarios in which a tank system contained ignitible waste, the cost of purging the tank of vapors was factored into the total cost of closure for the unit. Under each scenario, factors were applied to the costs of all applicable closure activities to account for management and engineering expenses and to allow for contingencies and unforeseen expenses.

Regardless of the closure scenario, the costs of closure Tetra Tech derived for tank systems did not include conduct of the following activities: 1) demolition and removal of containment systems, 2) removal of soil, 3) backfilling, 4) installation of monitoring wells, and 5) conduct of landfill closure and post-closure care activities. Tetra Tech did not include costs of those activities in developing the

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[17] For this methodology, Tetra Tech assumed that, for treatment and disposal, all flushing solutions generated during closure would be managed as bulk liquids.

[18] For tank systems, costs of "decontamination" include decontamination of the unit by steam cleaning or pressure washing, but do not include decontamination of heavy equipment. For this methodology, decontamination of the interior surface areas of tanks is assumed to be conducted at PPE level B. Further, decontamination of pads and berms of tank systems is assumed to be conducted at PPE level D.

[19] For this methodology, Tetra Tech assumed that a minimum of five samples would be taken for each unit at the time of closure. To estimate the cost of collecting subsurface soil samples, use of a 2.5-inch hollow-stem augur and a boring depth of three feet is assumed.

[20] For this methodology, Tetra Tech assumed that, for treatment and disposal, all decontamination fluids generated during closure would be managed as bulk liquids.

multipliers for tank systems because such activities were assumed to be inconsistent with closure of units eligible for standard permits.

Table 7 presents the costs Tetra Tech generated for tank systems closed with the tank left in place for all closure activities, other than the treatment and disposal of inventoried wastes, and the corresponding multipliers for those activities. Table 8 presents the costs Tetra Tech generated for tank systems closed with removal of the tank for all closure activities, other than the treatment and disposal of inventoried wastes, and the corresponding multipliers for those activities. As the tables show, Tetra Tech developed multipliers for tank systems having maximum permitted capacities of 500 gallons, 1,000 gallons, 5,000 gallons, and capacities at increments of 5,000 gallons thereafter to a maximum capacity of 50,000 gallons. The worksheets Tetra Tech used to estimate the costs of closure of tank systems of different capacities have been purged of all proprietary cost data and are presented in Appendix D of this document.[21]

The following section discusses the development of multipliers to be used to estimate the costs of the treatment and disposal of inventoried wastes.

3.2 Development of Multipliers to Be Used to Estimate the Costs of Treatment and Disposal of Inventoried Wastes

Costs of treatment and disposal vary greatly, depending on the physical form and hazardous characteristics of wastes that are managed at HWM facilities. Therefore, for this methodology, estimates of costs of treatment and disposal of inventoried wastes are generated separately from all other costs of

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[21] All the worksheets Tetra Tech used to estimate the costs of closure of tank systems that did not contain ignitible waste and were closed with the tank left in place are presented in Appendix D of this document. To avoid duplication, however, worksheets for each of the other closure scenarios considered in this methodology for tank systems are provided only if they identify costs that differ from those for the closure scenario described above. Therefore, for tank systems that did contain ignitible waste and were closed with the tank left in place, only the summary worksheet and the tank system purging worksheets are provided. Similarly, for tank systems that did not contain ignitible waste and were closed with removal of the tank, only the summary worksheet and the excavation, disassembly, and loading worksheets are provided. Finally, for tank systems that did contain ignitible waste and were closed with removal of the tank, only the summary worksheet; the tank system purging worksheet; and the excavation, disassembly, and loading worksheets are provided.

TABLE 7

AVERAGE COSTS OF ALL CLOSURE ACTIVITIES OTHER THAN THE TREATMENT AND DISPOSAL OF INVENTORIED WASTES FOR TANK SYSTEMS CLOSED WITH THE TANK LEFT IN PLACE
(Multipliers are Per Gallon)

Permited Gallons of Waste	Non-Ignitible Waste		Ignitible Waste	
	Estimated Cost Of Closure ($)	Multiplier	Estimated Cost Of Closure ($)	Multiplier
500	11,706	23.41	11,759	23.52
1,000	13,084	13.08	13,146	13.15
5,000	22,901	4.58	23,063	4.61
10,000	36,692	3.67	36,996	3.70
15,000	50,738	3.38	51,206	3.41
20,000	63,858	3.19	64,468	3.22
25,000	78,509	3.14	79,280	3.17
30,000	92,711	3.09	93,624	3.12
35,000	106,817	3.05	107,872	3.08
40,000	119,182	2.98	120,400	3.01
45,000	133,170	2.96	134,531	2.99
50,000	147,527	2.95	149,051	2.98

closure. Tetra Tech used cost data for treatment and disposal activities that are incorporated into of those wastes. The cost data for treatment and disposal contained in CostPro© are obtained annually from several major waste brokers located throughout the United States. The cost data used by Tetra Tech in creating the cost multipliers to estimate the costs of treatment and disposal for this methodology are presented in Appendix E of this document.

In CostPro©, cost data for treatment and disposal are stated as cost per ton. To maintain consistency with the first set of multipliers generated for this methodology, Tetra Tech converted those costs to cost per gallon. To perform the conversion, Tetra Tech first divided each cost of treatment and disposal by 2,000

TABLE 8

AVERAGE COSTS OF ALL CLOSURE ACTIVITIES OTHER THAN THE TREATMENT AND DISPOSAL OF INVENTORIED WASTES FOR TANK SYSTEMS CLOSED WITH REMOVAL OF THE TANK
(Multipliers are Per Gallon)

Permitted Gallons of Waste	Non-Ignitible Waste		Ignitible waste	
	Estimated Cost Of Closure ($)	Multiplier	Estimated Cost Of Closure ($)	Multiplier
500	11,854	23.71	11,906	23.81
1,000	13,290	13.29	13,352	13.52
5,000	23,843	4.77	24,006	4.80
10,000	38,544	3.85	38,848	3.88
15,000	53,476	3.57	53,945	3.60
20,000	67,507	3.38	68,118	3.41
25,000	83,041	3.32	83,814	3.35
30,000	98,155	3.27	99,068	3.30
35,000	113,174	3.23	114,229	3.26
40,000	126,452	3.16	127,670	3.29
45,000	141,352	3.14	142,712	3.17
50,000	156,593	3.13	158,117	3.16

pounds to convert from cost per ton to cost per pound. Tetra Tech then used the approximate densities of each of the three major types of waste considered in this methodology to convert from cost per pound to cost per cubic yard (yd^3). For aqueous wastes, Tetra Tech used a density of 1,685.8 pounds per yd^3 to convert from cost per pound to cost per yd^3. For nonaqueous wastes, Tetra Tech used an average density of 2,632.5 pounds per yd^3 to convert from cost per pound to cost per yd^3. For sludge wastes, Tetra Tech used an average density of 2,025 pounds per yd^3 to convert from cost per pound to cost per yd^3. Next, Tetra Tech multiplied the cost per yd^3 of each waste by 4.951 times 10^{-3} to obtain the estimated cost per gallon of those wastes. Finally, to maintain consistency with other costs generated through the use of the CostPro© model, Tetra Tech applied factors to the cost per gallon of each type of waste considered in this

methodology to account for management and engineering expenses and to allow for contingencies and unforeseen expenses.

For this methodology, the multipliers provided to calculate costs for treatment and disposal are divided into three major groups of wastes: 1) aqueous wastes, 2) nonaqueous wastes, and 3) sludge wastes. Multipliers for aqueous wastes are subdivided into eight categories: 1) hazardous because of inorganic toxicity characteristic, 2) hazardous because of organic toxicity characteristic (no pesticides), 3) hazardous because of organic and inorganic toxicity characteristic (no pesticides), 4) hazardous because of pesticides, 5) hazardous because of F001-F005 solvents (does not meet LDR standards), 6) hazardous because of P- and U-listed organic hazardous wastes (does not meet LDR standards), 7) hazardous because of P- and U-listed inorganic hazardous wastes (does not meet LDR standards), and 8) hazardous because of F006-F012 or F019 wastes (does not meet LDR standards).[22] Multipliers for each category of aqueous wastes are subdivided further to provide costs for management of such wastes in drums or in bulk. The costs per gallon Tetra Tech derived for the treatment and disposal of various types of aqueous wastes are represented as the multipliers presented in Table 2 of this document.

Multipliers for nonaqueous wastes also are subdivided into eight categories: 1) hazardous because of inorganic toxicity characteristic, 2) hazardous because of organic toxicity characteristic (no pesticides), 3) hazardous because of organic and inorganic toxicity characteristic (no pesticides), 4) hazardous because of pesticides, 5) hazardous because of F001-F005 solvents, 6) hazardous because of P- and U-listed organic hazardous wastes, 7) hazardous because of P- and U-listed inorganic hazardous wastes, and 8) hazardous because of F006-F012 or F019 wastes.[22] Categories of certain nonaqueous wastes are subdivided to provide separate costs for treatment and disposal of such wastes when free liquids are or are not present. Other categories of nonaqueous wastes are subdivided to provide separate costs for treatment and disposal when such wastes meet or do not meet LDR standards**.** The costs per gallon Tetra Tech derived for the treatment and disposal of various types of nonaqueous wastes are represented as the multipliers presented in Table 3 of this document.

Multipliers for sludge wastes are subdivided into four categories: 1) hazardous because of inorganic toxicity characteristic, 2) hazardous because of organic toxicity characteristic, 3) hazardous because of organic and inorganic toxicity characteristic, 4) hazardous because of F001-F005 solvents.[22] Multipliers

[22] The categories of wastes used in this methodology are consistent with those used in CostPro©.

for each category of sludge wastes are subdivided further to provide costs for management of such wastes in drums or in bulk. The costs per gallon Tetra Tech derived for the treatment and disposal of various types of sludge wastes are represented as the multipliers presented in Table 4 of this document.

The following section presents the results of an analysis Tetra Tech conducted to compare cost estimates generated through the use of the multipliers with those prepared by using CostPro© for units at actual HWM facilities.

4.0 COMPARATIVE ANALYSIS OF COST ESTIMATES

To ensure that the multipliers created for this methodology could be used to generate reasonable cost estimates for closure of units eligible for standard permits, Tetra Tech conducted an analysis to compare cost estimates generated through the use of the multipliers with those prepared using CostPro© for units at actual HWM facilities. To conduct the comparison, Tetra Tech selected cost estimate evaluation reports that included complete cost estimate data for CSAs and tank systems. From those reports, Tetra Tech extracted the estimated costs of only those activities that would apply to the closure of units that would be eligible for standard permits. Tetra Tech applied factors to the costs of those activities to account for management and engineering expenses and to allow for contingencies and unforeseen expenses. In addition, to maintain consistency with the data in CostPro©, Tetra Tech adjusted for inflation the costs derived from the reports to express those costs in 1997 dollars.

Using the maximum capacities (in gallons) of each unit, Tetra Tech used the multipliers presented in Table 1 of this document to generate default estimates of the costs of all closure activities other than the treatment and disposal of inventoried wastes. In addition, on the basis of information in each unit's report about the characteristics of the wastes managed at that unit and the technologies proposed to treat or dispose of those wastes, Tetra Tech selected waste characteristics (and corresponding multipliers) from Tables 2, 3, and 4 of this document that were not incompatible with the types of wastes managed at the unit. Using the maximum capacities (in gallons) of each waste and the corresponding multiplier for that waste, Tetra Tech generated default estimates of the costs of treatment and disposal of the wastes managed at each unit. For each unit, Tetra Tech added the estimated costs of all closure activities, other than the treatment and disposal of inventoried wastes, and the estimated costs of treatment and disposal of the wastes managed at that unit to derive a total cost estimate for closure for that unit.

Tetra Tech recorded separately the estimated costs of all closure activities, other than the treatment and disposal of inventoried wastes, the estimated costs of treatment and disposal of inventoried wastes, and the total costs of all closure activities at each unit, as those costs were generated through the use of both CostPro© and the multipliers developed for this methodology. Tetra Tech then compared those cost estimates to determine whether the estimates generated through the use of the multipliers were comparable to those generated through the use of CostPro©.

The following section discusses the analysis conducted by Tetra Tech to compare the closure cost estimates for CSAs generated through the use of both CostPro© and the multipliers developed for this methodology.

4.1 Comparative Analysis of Cost Estimates for CSAs

Tetra Tech compared cost estimates generated through use of the multipliers created for this methodology with cost estimates generated through use of CostPro© for 35 CSAs. From cost estimates generated through use of CostPro©, Tetra Tech extracted the estimated costs of only those activities that would be conducted for the closure of CSAs that would be eligible for standard permits. For each CSA, Tetra Tech derived the estimated costs of all closure activities, other than the treatment and disposal of inventoried wastes, by adding the estimated costs generated through use of CostPro© for the following activities: 1) decontamination, 2) sampling and analysis, 3) transportation,[23] 4) treatment and disposal of decontamination fluids, and 5) certification of closure. However, the estimated costs of the following activities were not included with the costs listed above because they were assumed to be inconsistent with the closure activities to be conducted at CSAs eligible for standard permits: 1) demolition and removal of containment systems, 2) removal of soil, 3) backfilling, 4) installation of monitoring wells, and 5) landfill closure. For each CSA, Tetra Tech also extracted separately the estimated costs of treatment and disposal of inventoried wastes, as derived through the use of CostPro©.[24]

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[23] All costs attributable to the transportation of contaminated soil or components of containment systems or to any other closure activities that would be incompatible with the use of standard permits were excluded from the costs of closure Tetra Tech used in conducting this analysis.

[24] All costs attributable to the treatment or disposal of contaminated soil or components of containment systems or to the conduct of any other closure activities that would be incompatible with the use of standard permits were excluded from the costs of closure Tetra Tech used in conducting this analysis.

Tetra Tech applied factors to each of the above costs to account for management and engineering expenses and to allow for contingencies and unforeseen expenses. Tetra Tech also adjusted those costs for inflation to express them in 1997 dollars. Tetra Tech added the estimated costs of all applicable closure activities to derive a total cost estimate for closure for each CSA. Using the multipliers generated for this methodology, Tetra Tech also derived, for each CSA, estimated costs of all closure activities, other than the treatment and disposal of inventoried wastes, and estimated costs of the treatment and disposal of inventoried wastes. Tetra Tech added those costs to derive a total cost estimate for closure for each CSA.

Tetra Tech summed the total cost estimates for closure of all CSAs derived through use of CostPro© and summed the default cost estimates for closure for those same CSAs that were generated through use of the multipliers. To calculate average total costs of closure for those CSAs, Tetra Tech then divided each of those products by the number of CSAs for which cost estimates were developed. Tetra Tech then compared those average total costs of closure to determine whether the estimates generated through the use of the multipliers were comparable to those generated through the use of CostPro©. Through application of that approach, Tetra Tech determined that use of the multipliers developed for this methodology produced total cost estimates for closure for CSAs that were, on average, 23.2 percent higher than the estimates of the costs of closure derived through use of CostPro©. Appendix F of this document presents the data Tetra Tech compiled in conducting this analysis.

4.2 Comparative Analysis of Cost Estimates for Tank Systems

Tetra Tech compared cost estimates generated through use of the multipliers created for this methodology with cost estimates generated through use of CostPro© for 46 tank systems. From cost estimates generated through use of CostPro© Tetra Tech extracted the estimated costs of only those activities that would be conducted for closure of tank systems that would be eligible for standard permits. For each tank system, Tetra Tech derived the estimated costs of all closure activities, other than the treatment and disposal of inventoried wastes, by adding together the estimated costs generated through use of CostPro© for the following activities: 1) removal of waste, 2) flushing of the tank and piping,

3) purging of the tank system,[25] 4) disassembly and loading,[26] 4) decontamination, 5) sampling and analysis, 6) transportation,[27] 7) treatment and disposal of decontamination fluids, and 8) certification of closure. However, the estimated costs of the following activities were not included with the costs listed above because they were assumed to be inconsistent with the closure activities to be conducted at tank systems eligible for standard permits: 1) demolition and removal of containment systems, 2) removal of soil, 3) backfilling, 4) installation of monitoring wells, and 5) landfill closure. For each tank system, Tetra Tech extracted separately the estimated costs of treatment and disposal of inventoried wastes, as derived through the use of CostPro©.[28]

Tetra Tech applied factors to each of the above costs to account for management and engineering expenses and to allow for contingencies and unforeseen expenses. Tetra Tech also adjusted those costs for inflation to express them in 1997 dollars. Tetra Tech added the estimated costs of all applicable closure activities to derive a total cost estimate for closure for each tank system. Using the multipliers generated for this methodology, Tetra Tech also derived, for each tank system, estimated costs of all closure activities, other than the treatment and disposal of inventoried wastes, and estimated costs of the treatment and disposal of inventoried wastes. Tetra Tech added those costs to derive a total cost estimate for closure for each tank system.

Tetra Tech summed the total cost estimates of closure of all tank systems derived through use of CostPro© and summed the default cost estimates for closure for those same tank systems generated through use of the multipliers. To calculate average total costs of closure for those tank systems, Tetra Tech then divided each of those products by the number of tank systems for which cost estimates were

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[25] This activity would be performed during closure only if the tank had contained ignitible materials.

[26] This activity would be performed only if the tank was to be removed at the time of closure.

[27] All costs attributable to the transportation of contaminated soil or components of containment systems or to any other closure activities that would be incompatible with the use of standard permits were excluded from the costs of closure Tetra Tech used in performing this analysis.

[28] All costs attributable to the treatment or disposal of contaminated soil or components of containment systems or to the conduct of any other closure activities that would be incompatible with the use of standard permits were excluded from the costs of closure Tetra Tech used in performing this analysis.

developed. Tetra Tech then compared those average total costs of closure to determine whether the estimates generated through the use of the multipliers were comparable to those generated through the use of CostPro©. Through application of that approach, Tetra Tech determined that use of the multipliers developed for this methodology produced total cost estimates for closure for tank systems that were, on average, 37.6 percent higher than the estimates of the costs of closure derived through use of CostPro©. Appendix G of this document presents the data Tetra Tech compiled in conducting this analysis.

Closure Cost Estimates for Standard Permits
Background Document - Option 5

Provide to Owners and Operators a Methodology That Can Be Used to Prepare Default Cost Estimates for Closure of Units Eligible to Use Standard Permits

Appendices A Through G

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Work Assignment Number:	11018
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EPA Work Assignment Manager:	David A. Eberly
Telephone:	(703) 308-8645
Prepared by:	Tetra Tech EM Inc.
Tetra Tech Work Assignment Manager:	Arthur Glazer
Telephone:	(703) 287-8813