SOLID WASTE
FINANCIAL ASSURANCE PROGRAM REPORT

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY
WASTE MANAGEMENT DIVISION

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ACKNOWLEDGMENT

Cardinal Engineering, Inc. would like to acknowledge and thank the numerous agencies, individuals and entities who provided input, oversight, and cost data to complete this study. We hope the results of this study help landfill and state agencies to better estimate and utilize fair and uniform cost estimates for closure and post-closure of landfills. Don Barrett, Kelly Dixon, Jon Roberts, and Catherine Sharp of the Oklahoma Department of Environmental Quality; Chris Varga of the Arizona Department of Environmental Quality; Casey Elliott of the Okmulgee Landfill; Ralph Triplett of the Woodward County Landfill; and Jerry Ihler of the City of Lawton provided oversight and guidance to complete this study. Jim Warram provided necessary leadership to successfully complete this study. Cost estimates generated by the Arkansas Department of Environmental Quality, Louisiana Department of Environmental Quality, New Mexico Environment Department, Texas Natural Resource Conservation Commission, Iowa Department of Natural Resources, Kansas Department of Health and Environment, Missouri Department of Natural Resources, Nebraska Department of Environmental Quality, Colorado Department of Health and Environment, Montana Department of Environmental Quality, South Dakota Department of Environment and Natural Resources, Utah Department of Environmental Quality, Wyoming Department of Environmental Quality, Minnesota Pollution Control Agency, Oklahoma Conservation Commission, Oklahoma Corporation Commission, Oklahoma Department of Environmental Quality, Oklahoma Department of Mines, Oklahoma Department of Transportation, Environmental Protection Agency, and R.S. Means Company were examined to complete this study. Twenty-seven businesses associated with drilling companies, environmental labs, publicly owned treatment works, geosynthetic companies, plumbers, and landfills provided cost estimates. The project's primary goals were to develop and document procedures to help landfills and regulatory agencies better estimate and utilize fair and uniform cost estimates for calculating landfill closure and post-closure costs. The cooperation and input from those mentioned above has been crucial in successfully achieving these goals.

LIMITATIONS

Cardinal Engineering has made every effort to assure the information contained in this report is accurate and an accurate estimate of costs which may be expected under the circumstances indicated. However, since actual closure and post-closure costs are determined by competitive bidding and negotiations, the actual closure and post-closure costs for a landfill may vary.

EXECUTIVE SUMMARY

Oklahoma solid waste regulations govern the permitting, construction, operation, and closure of three different types of solid waste landfills; municipal solid waste landfills (MSWLFs), construction and demolition (C&D) landfills, and nonhazardous industrial solid waste (NHISW) landfills. Since 1991, landfills have been required to provide financial assurance for completing closure and post-closure activities. Each facility's financial assurance amount must receive Department of Environmental Quality (DEQ) approval. The underlying motivation for posting financial assurance is the landfill owner may not physically or financially be able to complete closure and post-closure obligations. In this instance, the DEQ becomes financially responsible for all tasks and services associated with closure and post-closure of the landfill. The landfill conditions under which the cost estimate is computed may differ significantly from the conditions anticipated by the owner or operator at the end of the normal landfill life. The current estimates for completing final closure activities and post-closure monitoring of the 64 Oklahoma landfills are over $100 million. If the DEQ's solid waste financial assurance program inaccurately estimates the necessary monies for closure and post-closure, sufficient funds will not be available and the financial responsibility is transferred to the State of Oklahoma and it's citizens. Therefore, the solid waste financial assurance program must accurately identify and define the tasks and services for closure and post-closure activities and present defensible unit costs to ensure sufficient funds are available.

To aid landfill owners and operators in interpreting and applying the regulatory requirements, the DEQ developed a guidance document for calculating final closure and post-closure cost estimates. Recent scrutiny by the regulated community prompted the DEQ to review the guidance document and perform a thorough analysis of financial assurance calculation procedures through commissioning of this project.

The project's objective is to provide a solid waste financial assurance procedure that adequately addresses and documents costs for final closure and post-closure activities necessary to properly close and monitor a landfill. Successfully completing this project will help ensure correct and fair financial obligations are available to perform closure and post-closure requirements without posing a financial burden to the State of Oklahoma nor landfill owner/operators.

Determining legitimate third-party costs is difficult due to the number of cost variables associated with closing a landfill and monitoring during the post-closure period. Closure and post-closure costs for a solid waste landfill can range significantly depending on the landfill type, final cover design, geographical location, and other variables. Evaluating and developing a financial assurance program with justifiable unit costs accounting for these variables must begin with a thorough understanding of the regulations combined with practical experience of performing these tasks and services at actual operating landfills. Through knowledge, research, and input from the regulated community, this report develops a comprehensive list of tasks and services for closure and post-closure activities. The research encompassed surveying agencies in 16 different states performing similar regulatory missions as the DEQ in the central United States region, other Oklahoma state agencies, landfill owner/operators, and service providers. After identifying the closure and post-closure tasks and services, legitimate third-party unit costs were ascertained from researching the regulated community, vendors, service providers, and standard

references. A successful financial assurance program must use unit costs from identifiable resources that are capable of being validated. Recognizing some costs fluctuate with geographical location, a mechanism was developed to adjust for regional variations. Other adjustments account for landfills having designed operational lives measured in decades and regulatory post-closure monitoring requirements ranging from eight to 30 years. Facilities operating over such long periods of time will witness new developments and changes in the regulations that govern their operation. Mechanisms were developed to account for inflation, changing regulatory requirements, changes in applicable tasks or services, and periodic review and re-verification of unit costs. The report presents a subsection for each closure and post-closure task and service unit cost that:

- describes and defines the task and service;
- determines if the task or service is subject to regional variation;
- identifies units of measurement;
- identifies and explains constants and conversion factors;
- explains assumptions;
- presents associated unit cost; and
- and evaluates whether changes in regulatory language is necessary to support including task or service in calculating financial assurance.

The report concludes with a detailed procedure to calculate final closure and post-closure cost estimates for posting financial assurance. The procedure presents brief and concise explanations for each identified task and service along with the associated unit cost. The tasks and services included in this procedure are based on the more complex closure and post-closure requirements for MSWLFs. C&D and NHISW landfills will find each task and service they require is included in this procedure. However, not every task and service included is required for C&D and NHISW landfills. Owners/operators of C&D and NHISW landfills should determine which unit costs are applicable to calculate closure and post-closure cost for their facility. Users of the procedure are able to input site specific information to calculate the necessary financial assurance. The procedure is contained in Chapter 5 of the report and contains sufficient information to stand alone as a guidance document available to owners and operators to calculate the necessary financial assurance amount.

TABLE OF CONTENTS

List of Tables

List of Figures

Attachments

Chapter 1 - Introduction

1.1 Report Summary

The report is divided into the following five chapters:

Chapter 1 Introduction
Chapter 2 State and Federal Solid Waste Financial Assurance Programs
Chapter 3 Comprehensive List of Tasks and Services
Chapter 4 Unit Costs
Chapter 5 Procedure for Calculating Final Closure and Post-Closure Costs

Chapter 1 provides background information on solid waste financial assurance, historical perspective on Oklahoma financial assurance regulations, and discussions on different types of facilities and final cover designs.

Chapter 2 summarizes research of other states' solid waste regulatory agencies' and the United States Environmental Protection Agency's (USEPA's) solid waste financial assurance programs.

Chapter 3 develops comprehensive lists of tasks and services necessary for conducting final closure and post-closure activities at a landfill. This chapter also discusses how tasks and services can be modified due to technical or regulatory changes.

Chapter 4 identifies and documents legitimate third-party unit costs for variable and non-variable tasks and services determined in Chapter 3. Development of unit costs will be completed by research of regulated community, vendors, service providers, and standard references. Mechanisms are presented for adjusting unit costs for inflation, changes in required tasks or services, and periodic review and re-verification.

Chapter 5 presents the procedure for calculating final closure and post-closure cost estimates. The procedure will present brief and concise explanations for each identified task and service along with the associated unit cost. Users will be able to input site specific information to calculate the necessary financial assurance. This chapter contains sufficient information to stand alone as a guidance document available to owners and operators to calculate the necessary financial assurance. A recommendation section will be included that identifies potential regulatory language changes to support the solid waste financial assurance program.

1.2 Objectives

Determining legitimate third-party costs is difficult due to the number of cost variables associated with closing a landfill and monitoring during the post-closure period. Closure and post-closure costs for a solid waste landfill can range significantly, depending on the primary variables identified in Table 1.1.

Table 1.1 Primary Variables Affecting Closure and Post-Closure Costs for Landfills

VARIABLE	RANGE
Landfill Type	MSWLF, Nonhazardous Industrial Solid Waste Landfill, and Construction & Demolition
Final Cover	Clay, Composite, or Permit Specific
Geographical Location	Altus to Oologah Broken Bow to Woodward Elk City to Sallisaw
Developed Disposal Area	5 acres or 150 acres
Condition of Landfill	Well maintained and operated or poorly maintained and operated
Leachate Collection System	Yes or No, if Yes - leachate removal system and leachate treatment/disposal method
Availability of Clay	On-site or Off-site, if Off-site what is hauling distance
Availability of Topsoil	On-site or Off-site, if Off-site what is hauling distance
Availability of Water	On-site or Off-site, if Off-site what is hauling distance

Developing unit costs for different landfill types, final cover designs, geographical locations, and the other variables listed in Table 1.1 presents many obstacles. Obstacles initially identified for the solid waste financial assurance project are presented below.

- Limited examples or information from researching programs in other states;
- Wide range for specific unit costs;
- Regional and facility variations;
- Documentation of actual third-party unit costs
- Documented unit costs becoming obsolete; and
- Lack of supporting regulatory language.

Therefore, the objective is to provide a solid waste financial assurance report that adequately addresses and documents costs of the final closure and post-closure activities necessary to properly close and monitor a landfill. Providing defensible unit costs to the DEQ and owner/operators will help ensure adequate funds are available to conduct final closure and post-closure activities without posing a financial liability to the State of Oklahoma and it's citizens.

1.3 Background and Purpose

Oklahoma Statutes Title 27A, §2-10-701 requires certain disposal sites determine real third-party costs for closure and post-closure care of their facilities. The costs represent what the Oklahoma Department of Environmental Quality (DEQ) would expend if it were to oversee and ensure proper closure and post-closure monitoring of a landfill, presuming the owner was unable to do so. The landfill conditions under which the cost estimate is predicated may differ significantly from the conditions anticipated by the owner or operator at the end of the normal landfill life.

Given the underlying presumption that the owner will not be physically or financially able to complete closure and post-closure obligations, the DEQ becomes financially responsible for all tasks and services associated with closure and post-closure of the landfill. Required closure and post-closure tasks and services are derived from applicable statutes and regulations. Municipal solid waste landfills (MSWLF) must estimate costs to complete regulatory requirements in Oklahoma Administrative Code (OAC) 252:510. Nonhazardous industrial solid waste landfills (NHISW) and construction and demolition landfills (C&D) must estimate costs to complete regulatory requirements in OAC 252:520.

The current estimates for completing final closure activities and post-closure monitoring of all the landfills in Oklahoma are over $100 million. A solid waste financial assurance program that accurately identifies and defines the tasks and services for closure and post-closure activities and presents defensible unit costs is important in ensuring correct financial assurances are available. If the DEQ's solid waste financial assurance program inaccurately estimates the necessary monies for closure and post-closure sufficient funds will not be available and the financial responsibility is transferred to the State of Oklahoma and it's citizens.

The purpose of this project is to develop correct unit costs for calculating financial assurance, assist the DEQ in implementing the financial assurance regulation and help landfill owners and operators prepare cost estimates that satisfy these regulations. In particular, this project:

- identifies and describes the tasks and services involved in proper closure and post-closure care of solid waste landfills in Oklahoma;
- identifies and validates third-party unit costs for variable and non-variable tasks and services;
- describes and defines the procedure for calculating financial assurance;
- provides procedure for updating or adjusting costs;
- reviews applicable regulations and makes recommendations for language supporting the financial assurance requirement; and
- provides a guidance document to assist the DEQ and regulated community in calculating closure and post-closure cost estimates.

Successfully completing this project will help ensure correct and fair unit costs are available to complete closure and post-closure requirements while not posing a financial burden to the State of Oklahoma nor landfill owner/operators.

1.4 Historical Perspective

The Oklahoma Solid Waste Management Act (SWMA) was first enacted in March 17, 1970. The Solid Waste Management Act's purpose is to regulate the collection, transportation, processing, and disposal of solid waste in Oklahoma. Implementation of the SWMA is accomplished through solid waste regulations. The history of Oklahoma solid waste regulations is outlined in Table 1.2.

Table 1.2 History of Oklahoma Solid Waste Regulations

Date	Title	Citation
July 1, 1969	Sanitary Landfill Operation	O.D.H. Engineering Bulletin No. 0523
June 13, 1971	The Oklahoma Solid Waste Management Act of 1970 with Rules and Regulations	O.D.H. Engineering Bulletin No. 0524
July 1, 1973	The Oklahoma Solid Waste Management Act of 1970 with Rules and Regulations	O.D.H. Bulletin No. 0524
March 27, 1982	Solid Waste Management Rules and Regulations Including Sludge Management Rules and Regulations	OSDH Bulletin No. 0524
July 25, 1985	Regulations Governing Solid Waste and Sludge Management	OSDH Bulletin No. 0524
April 2, 1987	Regulations Governing Solid Waste and Sludge Management	OSDH Bulletin No. 0524
October 24, 1991	Regulations Governing Solid Waste and Sludge Management	OSDH Bulletin No. 0524
December 31, 1991	Solid Waste and Sludge Management	OAC 310:360
October 9, 1993	Municipal Solid Waste Landfills	OAC 252:510
May 26, 1994	Solid Waste Management	OAC 252:500
November 4, 1995	Solid Waste Management	OAC 252:520
Pending	Solid Waste Management	OAC 252:530

A review of solid waste regulations listed in the above history reveals financial assurance for landfills was not required until the October 24, 1991 amendments to OSDH Bulletin No. 0524, Regulations Governing Solid Waste and Sludge Management. Subsequent regulations ending with the currently applicable regulations, OAC 252:510 and OAC 252:520, have all retained the financial assurance requirement.

Since landfill owner/operators were required to provide financial assurance in 1991, the regulatory agency developed guidance documents to assist owner/operators with calculating closure and post-closure costs. Based on the closure and post-closure requirements in OAC 310:360, the first financial assurance guidance document was developed and dated July 8, 1992 (see Attachment 1a). The purpose was to illustrate how landfills should calculate cost estimates for final closure and post-closure activities. The guidance document provided brief descriptions of each task and an associated unit cost. The guidance document was reviewed, updated, and reissued on December 8, 1994 (see Attachment 1b). The following tables illustrate the changes in tasks/services and unit costs between the two guidance documents for closure and post-closure, respectively.

Table 1.3 Comparison of Final Closure Task/Services and Unit Costs from Previous Agency Guidance Documents

Final Closure Task/Service		Unit Costs	
		July 8, 1992	December 8, 1994
1	Control Grading	$500.00 per acre	$500.00 per acre
2	Clay Cover	$3.00 per cubic yard	$3.00 per cubic yard
3	Top Soil	$6.00 per cubic yard	$6.00 per cubic yard
4	Vegetation	$1,500.00 per acre	$500.00 per acre
5	Temporary Building	$3,500.00 lump sum	$3,500.00 lump sum
6	Equipment	$2,000.00 lump sum	$2,000.00 lump sum
7	Surface Drainage Ditches	$3.50 per linear foot	$3.50 per linear foot
8	Replace Defective Groundwater Monitoring Wells	$2,500.00 each	$2,500.00 each
9	Plug Defective Groundwater Monitoring Wells	$1,000.00 each	$1,000.00 each
10	Soil Sampling	No unit cost provided	Deleted†
11	Air Sampling	No unit cost provided	Deleted†
12	Gas Sampling	$35.00 per probe	Deleted‡
13	Groundwater Monitoring Well Sampling and Analysis	$2,000.00 per well	Deleted‡
14	Surface Water Sampling and Analysis	$85.00 per sample	Deleted‡
15	Collection Costs	$500.00 per day-2 days	Deleted‡
16	Final Closure Survey	$75.00 per hour-2 man crew for 24 hrs	$4,000.00 lump sum
17	Drafting	$45.00 per hour-24 hrs	Included in Item 16
18	Leachate Collection System Installation and/or Sedimentation and Drainage Control	$0.40 per square foot	Deleted‡
19	Leachate Treatment	$0.15 per gallon	Deleted‡
20	Administrative Costs	20%	20%
21	Contingency Costs	10%	10%

† Identified as a contingency item with an unassigned unit cost and therefore was deleted from the guidance document.

‡ Identified as an item already addressed in calculating post-closure costs and therefore was deleted from the guidance document.

Table 1.4 Comparison of Post-Closure Task/Services and Unit Costs from Previous Agency Guidance Documents

Post-Closure Task/Service		Unit Costs	
		July 8, 1992	December 8, 1994
1	Routine Inspection	$500.00 per inspection	$500.00 per inspection
2	Maintenance of On-site Improvements	$2,000.00 per acre	$2,000.00 per acre
3	Final Plugging of Groundwater Monitoring Wells	$1,000.00 each	$1,000.00 each
4	Maintaining Vegetation	$250 per acre	$250 per acre
5	Repairing Final Cover	$6.00 per cubic yard	Included in Item 2
6	Maintaining Surface Drainage Structures	$3.50 linear foot	$3.50 linear foot
7	Replace Defective Groundwater Monitoring Wells	$2,500.00 per well	$2,500.00 per well
8	Plug Defective Groundwater Monitoring Wells	$1,000 per well	$1,000 per well
9	Air Sampling	No unit cost provided	Deleted†
10	Soil Sampling	No unit cost provided	Deleted†
11	Gas Sampling	$35.00 per probe	$35.00 per probe
12	Groundwater Monitoring Well Sampling and Analysis	$2,000.00 per well	$1,000.00 per well
13	Surface Water Sampling and Analysis	$85.00 per sample	$100.00 per sample
14	Collection Costs	$500 per day - 2 days	Included in Items 11, 12, and 13
15	Leachate System Maintenance	Not identified*	$0.25 per linear foot
16	Leachate Management	$0.15 per gallon	$0.15 per gallon
17	Administrative Costs	10%	10%
18	Contingency Costs	10%	10%

† Identified as a contingency item with an unassigned unit cost and therefore was deleted from the guidance document.

* Item was not identified as a task or service.

Comparing the tasks and services included in the 1992 and 1994 documents demonstrates how the DEQ worked at simplifying closure and post-closure activities. One area of simplification was the deletion of post-closure monitoring items included in both the closure and post-closure lists and contingency items such as soil and air testing. This simplification benefited landfill owner/operators by removing redundant and ambiguous tasks or services. Comparing the unit costs between the two documents shows the DEQ lowered several different unit costs. Although preservation of supporting documentation is limited, the revised unit costs were based on internal research conducted by the DEQ to determine realistic and current third-party costs.

As discussed above, Oklahoma landfills were first required to calculate cost estimates for financial assurance in 1991. To aid landfill owners and operators in interpreting and applying the regulatory requirements, guidance documents were developed for calculating final closure and post-closure cost estimates. These guidance documents have become institutional by both the regulated community and regulators. However, recent scrutiny by the regulated community has prompted the DEQ to perform a more broad and thorough analysis of calculating financial assurance. The first step in evaluating or developing a financial assurance program with defendable unit costs must be a thorough understanding of the regulations combined with the practical experience of performing these tasks and services at actual operating landfills. Therefore, the unit costs for a comprehensive list of tasks and services must consider the different types of facilities and cover designs, and must allow input from the regulated community.

1.5 Facility Types

Oklahoma Administrative Code (OAC) 252:510 and OAC 252:520 govern the permitting, construction, operation, and closure of three different types of solid waste landfills. Municipal solid waste landfills (MSWLFs) are regulated under OAC 252:510. Construction & demolition (C&D) landfills and nonhazardous industrial solid waste (NHISW) landfills are regulated under OAC 252:520. All regulated solid waste landfills, processing facilities except transfer stations, and composting facilities that principally manage municipal solid waste must provide financial assurance. The June 2000 DEQ solid waste inventory of operating facilities lists 40 MSWLFs, 18 NHISW landfills, and four C&D landfills. Comparing the July 1999 DEQ solid waste financial assurance inventory list to the operating facility list finds 41 MSWLFs, 18 NHISW landfills, and four C&D landfills have provided financial assurance.

As of June 2000, the DEQ database listed 50 processing facilities, of which 38 are transfer stations. Processing facilities include municipal solid waste incinerator, biomedical autoclave, tire recycling facility, composting facility, and recycling facility. The variation in different types of processing facilities and employed processes makes establishing a list of tasks and services for a set financial assurance program infinite. Therefore, this report does not address financial assurance for processing facilities. However, a specific unit cost described herein may be applicable for a particular facility design or operation. In those instances, the financial assurance procedure described in this report may be used.

OAC 252:510-19 and OAC 252:520-23 describe closure and post-closure tasks for MSWLFs and NHISW landfills and C&D landfills, respectively. Table 1.5 compares current closure tasks for MSWLFs, NHISW landfills, and C&D landfills. Table 1.6 compares current post-closure tasks for MSWLFs, NHISW landfills, and C&D landfills. Both table 1.5 and 1.6 include relevant regulatory citations.

Table 1.5 Comparison of Current Closure Tasks for Different Types of Landfills with Regulatory Citation

TASK		MSWLF OAC 252:510-19	NHISW OAC 252:520-23	C&D OAC 252:520-23
1	Amending Closure Plan	2(b)	7(3)(c)	7(3)(c)
2	A description of the final cover and the methods and procedures to be used to install it	3(1)	ns	ns
3	An estimate of the largest area of the landfill ever requiring a final cover during the active life	3(2)	ns	ns
4	An estimate of the maximum inventory of wastes ever on-site over the active life of the site	3(3)	ns	ns
5	A schedule for completing all activities	3(4)	ns	ns
6	The cost of contracting for technical and professional services	3(5)	8(b)(1)	8(b)(1)
7	The cost of providing administrative overhead for oversight and record keeping (12)	3(6)	8(b)(2)	8(b)(2)
8	A plan for identifying temporary buildings and other improvements not designated as permanent in the permit application and removing each from the site (5)	3(7)	8(b)(3)	8(b)(3)
9	A plan for identifying all equipment to be removed from the site after closure has been certified as complete (6)	3(8)	8(b)(4)	8(b)(4)
10	A plan for reworking or replacing any defective groundwater monitor wells and other defective monitoring equipment, monitoring ground and surface water, and collecting and analyzing soil and water samples (8 & 9)	3(9)	8(b)(5)	8(b)(5)
11	A procedure for disposing of final wastes and affected soil	3(10)	8(c)(2)	8(c)(2)
12	A plan for maintaining site security and access control	3(11)	8(b)(6)	8(b)(6)
13	A plan for redesigning final closure in accordance with existing site conditions and applicable regulations	3(12)	8(c)(1)	8(c)(1)
14	A description of the final cover construction, including a calculation of the amount of material needed for each phase of closure, the identification of the soil type and location to be used for the final cover, analysis of the proposed cover material's permeability, and the schedule and method of placement of the final cover	3(13)	8(c)(3)	8(c)(3)
15	A method for obtaining, hauling and placing soil for final cover (1, 2, & 3)	3(14)	8(c)(4)	8(c)(4)
16	A schedule for grading, planting, fertilizing and establishing vegetation on disturbed areas and final cover (4)	3(15)	8(c)(5)	8(c)(5)

	TASK	MSWLF OAC 252:510-19	NHISW OAC 252:520-23	C&D OAC 252:520-23
17	A plan for constructing additional or reworking existing surface drainage and erosion control measures as necessary (7)	3(16)	8(c)(6)	8(c)(6)
18	A plan for remedying all former improper closure at the site	3(17)	8(c)(7)	8(c)(7)
19	A procedure for collecting, treating and properly disposing of leachate	3(18)	8(c)(8)	8(c)(8)
20	A plan for preparing final closure certification and other final closure reports and notices required	3(19)	8(b)(7)	8(b)(7)
21	A proposal for performing any other tasks necessary to achieve complete and final closure of the site (14)	3(20)	8(b)(8)	8(b)(8)
22	Conducting the final closure survey (10)	ns	8(b)(9)	8(b)(9)

NOTE: Tasks in bold are included in the December 8, 1994 Closure and Post-Closure Guidance Document with respective item number.

ns - Not specifically listed in the regulations

Table 1.6 Comparison of Current Post-Closure Tasks for Different Types of Landfills with Regulatory Citation

	TASK	MSWLF OAC 252:510-19	NHISW OAC 252:520-23	C&D OAC 252:520-23
1	Amending Post-Closure Plan	2(b)	7(3)(c)	7(3)(c)
2	A plan to comply with all applicable technical requirements	ns	14(e)(1)	14(e)(1)
3	The cost of contracting for technical and professional services	6(1)	14(e)(2)	14(e)(2)
4	The cost of providing administrative overhead for oversight and recordkeeping (13)	6(2)	14(e)(12)	14(e)(12)
5	The schedule for inspecting site routinely (1)	6(3)	14(e)(3)	14(e)(3)
6	The procedures for repairing and maintaining all on-site permanent improvements and equipment (2)	6(4)	14(e)(5)	14(e)(5)
7	The procedures for repairing and maintaining surface drainage structures	6(5)	14(e)(7)	14(e)(7)
8	The procedures for reworking or replacing any defective required groundwater monitor wells and other defective monitoring equipment and installing new wells and equipment as required (4, 5, & 6)	6(6)	14(e)(8)	14(e)(8)
9	The protocol for collecting and analyzing soil and water samples as required (7, 8, & 9)	6(7)	14(e)(9)	14(e)(9)

	TASK	MSWLF OAC 252:510-19	NHISW OAC 252:520-23	C&D OAC 252:520-23
10	The methods to be used to properly collect, treat and dispose of leachate (10 & 11)	6(8)	14(e)(4)	14(e)(4)
11	The methods for maintaining site security and access control	6(9)	17	17
12	The methods for maintaining vegetation and other erosion controls in permitted areas	6(10)	14(e)(6)	14(e)(6)
13	The procedures to be used to repair erosion and maintain final cover (3)	6(11)	14(e)(10)	14(e)(10)
14	The schedule for mowing and fertilizing final cover vegetation and other areas as needed (3)	6(12)	14(e)(11)	14(e)(11)
15	The outline for preparing annual maintenance and monitoring post-closure report	6(13)	14(e)(13)	14(e)(13)
16	The requirements for preparing post-closure certification	6(14)	14(e)(14)	14(e)(14)
17	A description of any other tasks necessary to accomplish adequate post-closure care (15)	6(15)	14(e)(15)	14(e)(15)

NOTE: Tasks in bold are included in the December 8, 1994 Closure and Post-Closure Guidance Document with respective item number.

ns - Not specifically listed in the regulations

Comparing closure and post-closure requirements for MSWLFs, NHISW landfills, and C&D landfills listed in Table 1.5 and Table 1.6 illustrates different landfills must complete very similar activities.

1.6 Landfill Final Cap Designs

Landfills in Oklahoma must install a final cap after completing filling operations. The final cap designs differ depending on the type of landfill. Municipal solid waste landfills in Oklahoma can be subdivided into two landfilling categories: (1) Placing waste on soil liner or (2) Placing waste on composite liner. OAC 252:510-19-4 specifies final cover systems have permeabilities less than or equal to the permeability of any bottom liner system, or natural subsoils present, or a permeability no greater than $1x10^{-5}$ cm/sec, whichever is less. Therefore, Category 1 MSWLFs are only required to install a soil cap and Category 2 MSWLFs must install a composite cap. Regulations allow alternative cover designs that technically demonstrate equivalent performance.

Cap design for NHISW landfills must comply with OAC 252:520-23, which allows flexibility for different cap types appropriate for the specific landfill. These cap designs range from placing topsoil and vegetation to using a composite cap similar to that required by MSWLFs. OAC 252:520-9-11(7) specifies C&D landfills construct soil caps. Table 1.7 illustrates the different landfills and cap designs.

Table 1.7 Different Cap Designs for Different Landfills

LANDFILL TYPE	CAP DESIGN
Category 1 MSWLF (soil liner)	Clay cap (3 feet of clay)
Category 2 MSWLF (composite liner)	Composite cap (2 feet of clay, flexible membrane liner, and 1 foot soil)
NHISW landfill	Ranges between topsoil and composite cap with different thicknesses
C&D landfill	Clay cap (3 feet of clay)

Category 2 MSWLFs cap design requirements are the most technically complex. Defining tasks and services for a MSWLF and determining defendable unit costs produces the most comprehensive financial assurance procedure for the three different landfills. NHISW landfill and C&D landfill financial assurance is calculated from including only the applicable tasks and services with unit costs presented for MSWLFs.

Chapter 2 - State and Federal Solid Waste Financial Assurance Programs

The purpose of this chapter is to document research into surrounding states' solid waste financial assurance programs and collect pertinent data. Chapter 2 also documents research into guidance documents produced by the United States Environmental Protection Agency (USEPA) for determining closure and post-closure cost estimates.

2.1 State Solid Waste Financial Assurance Programs

State agencies performing similar regulatory missions as the Oklahoma Department of Environmental Quality may have information and data beneficial to the goals of this project. Useful information includes:

- Identification of which landfill types are required to provide financial assurance;
- At what point in facility operations financial assurance is required;
- Regulatory language specifically identifying necessary tasks and services for closure and post-closure activities;
- Guidance documents illustrating the necessary tasks and services for closure and post-closure activities and associated unit costs;
- Regulatory language addressing the source and use of unit costs;
- When, why, and how closure and post-closure cost estimates must be adjusted; and
- Acknowledgment of regional variations.

2.1.1 State Regulatory Agencies

Research and data collection scope definition was necessary to accomplish two goals (1) create sufficient probability of acquiring information and (2) be completed in a reasonable amount of time to maintain project schedule at reasonable expense. Contacting all 50 states would result in the greatest probability of finding information, but the data from the most distant states may not be as relevant as adjacent states. All states within a USEPA's regional area for states contiguous to Oklahoma was the selection criteria and produced a target group consisting of states in USEPA's Region VI, VII, and VIII. One additional, Minnesota, which is in Region V, was added because the state regulatory agency is directly involved with closing 106 landfills with the Minnesota Closed Landfill Program. Table 2.1 lists the target contact states and associated regulatory agency.

TABLE 2.1 List of Identified State Regulatory Agencies

	REGION/STATE	REGULATORY AGENCY
	Region VI	
1	Arkansas	Department of Pollution Control and Ecology
2	Louisiana	Department of Environmental Quality
3	New Mexico	Environment Department
4	Oklahoma	Department of Environmental Quality
5	Texas	Natural Resource Conservation Commission
	Region VII	
6	Iowa	Department of Natural Resources
7	Kansas	Department of Health and Environment
8	Missouri	Department of Natural Resources
9	Nebraska	Department of Environmental Quality
	Region VIII	
10	Colorado	Department of Public Health and Environment
11	Montana	Department of Environmental Quality
12	North Dakota	Department of Health
13	South Dakota	Department of Environmental and Natural Resources
14	Utah	Department of Environmental Quality
15	Wyoming	Department of Environmental Quality
	Region V	
16	Minnesota	Pollution Control Agency

2.1.2 Landfill Financial Assurance Program Survey

A survey form was developed using the information identified in Section 2.1. The survey was distributed to contacts at each agency identified in Table 2.1. Multiple surveys were sent to regulatory agencies if the solid and hazardous waste programs were administered separately. The states that received two surveys were Arkansas, Iowa, Missouri, and Nebraska. A copy of the survey is presented in Table 2.2 and the form letter and complete mailing list are in Attachment 2.

TABLE 2.2. State Regulatory Agency Survey

LANDFILL FINANCIAL ASSURANCE PROGRAM SURVEY

Please answer each question thoroughly and attach supporting documentation where requested.

Region/State: _____

Agency: _____

Person Completing Survey: _____

Telephone Number: _____

Address: _____

E-mail Address _____

Municipal Solid Waste Landfill = MSWLF
Nonhazardous Industrial Solid Waste Landfill = NHISWLF
Construction & Demolition Landfill = C&D landfill

1. Do the regulations require the following landfills provide financial assurance for completing final closure and post-closure activities?

		Final Closure		Post-Closure	
a.	MSWLF:	☐Yes	☐No	☐Yes	☐No
b.	NHISWLF:	☐Yes	☐No	☐Yes	☐No
c.	C&D Landfills:	☐Yes	☐No	☐Yes	☐No

2. When is a facility required to provide financial assurance? (i.e. before receiving final permit, before receiving waste, or some other trigger mechanism)

3. Do the regulations specifically state what tasks and services must be performed for final closure? ☐Yes ☐No
   If "YES", Please provide regulatory citation for each landfill type
   If "NO", Please explain how owner/operators and state agree on list of tasks and services (attach applicable guidance document(s), if available)

4. Do the regulations specifically state what tasks and services must be performed for post-closure? ☐Yes ☐No
   If "YES", Please provide regulatory citation for each landfill type
   If "NO", Please explain how owner/operators and state agree on list of tasks and services (attach applicable guidance document(s), if available)

5. Does the State use a guidance document for determining unit costs? ☐Yes ☐No
   If "YES", Please attach a copy of the guidance document.

6. Do the regulations specifically state unit costs for individual closure and post-closure tasks and services? ☐Yes ☐No
   If "YES", Please provide regulatory citation for each landfill type _____
   If "NO", Does the State use unit prices published by other state or federal agencies? ☐Yes ☐No
   If "YES", please provide a list of acceptable state and federal agencies that publish unit prices_____
   If "NO", Explain how owner/operators determine unit costs acceptable to the regulatory agency _____

7. Do the regulations require periodic (i.e. annual) adjustments to the financial assurance amount? ☐Yes ☐No
   If "YES", Please explain when financial assurance must be adjusted and how to perform adjustment(s) _____

8. Does the State acknowledge regional variations in unit costs? ☐Yes ☐No
   If "YES", Please explain how regions are identified and how specific unit costs are derived for each region (attach supporting documentation)

9. Please provide a copy of the regulations containing the citations identified above or provide an internet address where they are available for downloading. _____

10. Would you like a copy of the survey results? ☐Yes ☐No

2.1.3 Summary of State Regulatory Agency Survey Responses

The regulatory agencies governing landfill activities in 16 states were contacted to gather information on closure and post-closure tasks and services and associated unit costs. In addition to the actual survey mailed to each agency, respondents were given the opportunity to complete the survey at Cardinal Engineering's webpage. Of the 20 surveys sent to 16 states, 12 were completed and returned, three were electronically submitted, and four of the four separate hazardous waste regulatory groups responded by stating information would be provided by the solid waste group. The replies represent a response rate of 95%. Submitted surveys and attached reference materials are contained in Attachment 3 and sorted by state. Attachment 4 lists information on how to contact each respondent. Table 2.3 summarizes the survey data from the 15 states and Section 2.1.4 discusses the individual state response.

TABLE 2.3 Summary of State Regulatory Agency Survey Responses

Number of States Recieving Survey Questionare			16
Number of States Responding to Survey			15
Number of States Requiring Financial Assurance for Final Closure	MSWLF	NHISWLF	C&D Landfill
Before receiving permit	4	4	3
Before receiving waste	11	9	9
Not required or other trigger method	0	2	3
Number of States Requiring Financial Assurance for Post-Closure	MSWLF	NHISWLF	C&D Landfill
Before receiving permit	4	4	3
Before receiving waste	11	7	7
Not required or other trigger method	0	4	5
Number of States Using Guidance Documents with Unit Costs			4
Number of States Using Guidance Documents without Unit Costs			1
Number of States Not Using Guidance Documents			10
Number of States Using Statutory or Regulatory Defined Unit Costs			1
Number of States Requiring Annual Adjustments to Financial Assurance			
Increase/Decrease in Closure Costs			10
Increase/Decrease in Post-Closure Costs			10
Inflation (based on GDP)			5

Inflation (based on GNP)	2
Inflation (based on CPI)	0
Inflation (method not specified)	7
Acknowledging Regional Variation	
Using Site Specific Unit Costs	9
Not Acknowledged	6
Number of States Requesting Copy of Results	12

2.1.4 State Regulatory Agency Survey Data

2.1.4.1 Arkansas

The Arkansas Department of Environmental Quality's regulations require the following landfills provide financial assurance before receiving the final permit.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☒ Yes	☐ No	☐ Yes	☒ No
C&D Landfills:	☒ Yes	☐ No	☒ Yes	☐ No

Current regulations provide only general descriptions of tasks and services to include in closure and post-closure plans. Owner/operators must provide detailed closure and post-closure plans for state review and approval. Arkansas does not use a guidance document for determining a landfill's financial assurance amount. Nor does Arkansas use regulatorily defined unit costs or unit costs published by other state or federal agencies. Unit costs used in calculating the facility's financial assurance are typically developed by professional engineers. The Solid Waste Division maintains a unit cost database for comparison with submitted costs.

State required annual adjustments must account for inflation. Regulations do not prescibe an accounting method for calculating the inflation rate. Arkansas DEQ does acknowledge some slight variations in costs based on soil availability and mobilizations costs across the state. Applicable state regulations can be found on the Internet at http://www.adeq.state.ar.us.

2.1.4.2 Louisiana

The Louisiana Department of Environmental Quality's regulations require the following landfills provide financial assurance before receiving the final permit.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☒ Yes	☐ No	☒ Yes	☐ No
C&D Landfills:	☒ Yes	☐ No	☒ Yes	☐ No

Current regulations provide only general descriptions of tasks and services to include in closure and post-closure plans. Owner/operators must provide detailed closure and post-closure plans for state review and approval. Louisiana does not use a guidance document for determining a landfill's financial assurance amount. Nor does Louisiana use regulatorily defined unit costs or unit costs published by other state or federal agencies. Unit costs used in calculating the facility's financial assurance are negotiated with the Louisiana DEQ.

State required annual adjustments must account for inflation. Inflation is adjusted annually using an inflation factor derived from the Implicit Price Deflator for the Gross Domestic Product (GDP). Louisiana DEQ does not acknowledge in-state regional variations in unit costs. Applicable state regulations can be found on the Internet at http://www.deq.state.la.us.

2.1.4.3 New Mexico

The New Mexico Environment Department's regulations require the following landfills provide financial assurance before receiving waste.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☒ Yes	☐ No	☒ Yes	☐ No
C&D Landfills:	☒ Yes	☐ No	☒ Yes	☐ No

Current regulations provide only general descriptions of tasks and services to include in closure and post-closure plans. Owner/operators must provide closure and post-closure plans for state review and approval. New Mexico does not use a guidance document for determining a landfill's financial assurance amount. Nor does New Mexico use regulatorily defined unit costs or unit costs published by other state or federal agencies. Unit costs used in calculating the facility's financial assurance are determined by the owner/operator and must have documentation justifying a unit cost if it is significantly lower than those for other facilities.

State required annual adjustments must account for increases or decreases in cost estimates due to operational changes and inflation. Regulations do not prescribe an accounting method for calculating the rate of inflation. New Mexico does not acknowledge in-state regional variations in unit costs. Applicable state regulations can be found at http://www.nmenv.state.nm.us.

2.1.4.4 Oklahoma

The Oklahoma Department of Environmental Quality's regulations require the following landfills provide financial assurance before receiving waste.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☒ Yes	☐ No	☒ Yes	☐ No
C&D Landfills:	☒ Yes	☐ No	☒ Yes	☐ No

Current regulations provide only general descriptions of tasks and services to include in closure and post-closure plans. Owner/operators must provide closure and post-closure plans for state review and approval. Oklahoma does use a guidance document for determining a landfill's financial assurance amount (See Attachment 3). Oklahoma does not use regulatorily defined unit costs. Unit costs used in calculating the facility's financial assurance were determined using cost estimates provided by companies that perform similar work and/or state agency that records unit cost for similar task. Owner/operators can also provide reference sources to justify using a unit cost different than the one provided in the guidance document. Table 2.4 contains the current unit costs listed in Oklahoma's guidance document.

TABLE 2.4 Oklahoma Closure and Post-Closure Unit Cost Data

TASK/SERVICE (unit)	UNIT COST	RESOURCE
FINAL CLOSURE		
Control Grading (acre)	$500.00	Departmental estimate
Recompacted clay cover (CY)	$3.00	Departmental estimate and ODOT data
Top soil (CY)	$6.00	Departmental estimate and ODOT data
Vegetation (acre)	$500.00	Departmental estimate
Remove temporary buildings (lump sum)	$3,500.00	Departmental estimate
Remove equipment (lump sum)	$2,000.00	Departmental estimate
Surface drainage ditches (LF)	$3.50	Departmental estimate
Replace defective groundwater monitoring well (well)	$2,500.00	Departmental estimate and information from drilling company(s)
Plug defective groundwater monitoring well and final plugging (well)	$1,000.00	Departmental estimate and information from drilling company(s)
Final closure topographic map (each)	$4,000.00	Departmental estimate
Administrative closure costs (lump sum)	20%	Departmental estimate
Contingency closure costs	10%	Departmental estimate

POST-CLOSURE		
Routine inspections (each)	$500.00	Departmental estimate
Maintenance of on-site improvements (lump sum)	$2,000.00	Departmental estimate
Maintaining vegetation (acre)	$250.00	Departmental estimate
Gas sampling (probe)	$35.00	Departmental estimate
Groundwater monitoring well sampling and analysis (well)†	$1,000.00	Departmental estimate and information from certified laboratories
Surface water sampling and analysis (sample point)‡	$100.00	Departmental estimate and information from certified laboratories
Leachate System Maintenance (LF)	$0.25	Departmental estimate
Leachate Management (gallon)	$0.15	Departmental estimate and information from POTWs
Post-closure administrative cost (lump sum)	10%	Departmental estimate
Post-closure contingency cost (lump sum)	10%	Departmental estimate

† Analysis includes: pH, COD, specific conductance, chloride, sulfate, calcium, magnesium, nitrates, sodium, carbonates, potassium, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, nickel, selenium, silver, thallium, vanadium, zinc, and 47 volatile organics in USEPA Report SW-846 Test Method 8260.
‡ Analysis includes: pH, chemical oxygen demand (COD), conductivity, dissolved oxygen (DO), and turbidity.

Annual adjustments must account for increases or decreases in cost estimates due to operational changes and inflation. Regulations do not prescribe an accounting method for calculating the inflation rate. Accounting for regional variations is accomplished through the use of bids or other actual cost estimates for that specific site. Applicable state regulations can be found on the Internet at http://www.deq.state.ok.us.

2.1.4.5 Texas

The Texas Natural Resource Conservation Commission's (TNRCC's) regulations require the following landfills provide financial assurance 60 days before receiving waste.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☒ Yes	☐ No	☒ Yes	☐ No
C&D Landfills:	☒ Yes	☐ No	☒ Yes	☐ No

Current regulations provide only general descriptions of tasks and services to include in closure and post-closure plans. Owner/operators must provide closure and post-closure plans for state review and approval. TNRCC does not use a guidance document for determining a landfill's financial assurance amount. Nor does TNRCC use regulatorily defined unit costs or unit costs published by other state or federal agencies. Unit costs used in calculating financial assurance are

determined by the owner/operator and must be signed and sealed by a Texas registered professional engineer.

Annual adjustments must account for increases or decreases in cost estimates due to operational changes and inflation. Inflation is adjusted annually using an inflation factor derived from the Implicit Price Deflator for the Gross National Product (GNP). Texas does not acknowledge in-state regional variations in unit costs. Applicable state regulations can be found on the Internet at http://www.tnrcc.state.tx.us.

2.1.4.6 Iowa

The Iowa Department of Natural Resources' (DNR's) regulations require the following landfills provide financial assurance before the initial receipt of solid waste.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☐ Yes	☒ No	☐ Yes	☒ No
C&D Landfills:	☐ Yes	☒ No	☐ Yes	☒ No

Current regulations provide only general descriptions of closure and post-closure requirements. Owner/operators must develop tasks and services in accordance with the approved closure and post-closure plans. Iowa does not use a guidance document for determining financial assurance amount. Nor does Iowa use regulatorily defined unit costs or unit costs published by other state or federal agencies. Unit costs used in calculating financial assurance are determined by the owner/operator and do not have to be approved by the Iowa DNR. Instead the Iowa DNR must be notified when the cost estimate has been placed in the facility files. Iowa requires annual adjustments for inflation and changes in the closure and post-closure plans. Regulations do not prescribe an accounting method for calculating the rate of inflation. In-state regional variations are not acknowledged in unit costs. Applicable state regulations can be found on the Internet at http://www.iac.legis.state.ia.us.

2.1.4.7 Kansas

The Kansas Department of Health and Environmental's regulations require the following landfills provide financial assurance before receiving waste.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☒ Yes	☐ No	☒ Yes	☐ No
C&D Landfills:	☒ Yes	☐ No	☐ Yes	☒ No

Current regulations provide only general descriptions of tasks and services to include in closure and post-closure plans. Owner/operators must provide closure and post-closure plans with specific tasks and services for state review and approval. Kansas does use a guidance document for determining a landfill's financial assurance amount (See Attachment 3). However, the guidance document does not use regulatorily defined unit costs or unit costs published by other state or federal agencies. Unit costs used in calculating the facility's financial assurance are determined using R.S. Means Cost Guides, state-wide averages of previously submitted third-party estimates, and actual contractor supplied bids. R.S. Means estimates are multiplied by a factor of 0.85 to adjust national averages to locations in Kansas. Not all tasks and services have assigned unit costs and owner/operators must determine applicable unit costs if one is not provided. Owner/operators can also provide reference sources to justify using a unit cost different than the one provided in the guidance document. Table 2.5 contains the current unit costs listed in Kansas' guidance document.

TABLE 2.5 Kansas Closure and Post-Closure Unit Cost Data

TASK/SERVICE(unit)	UNIT COST	RESOURCE
FINAL CLOSURE		
Final Grading (acre)	$53.75	R.S. Means
Soil-compacted, off-site (CY)	$5.63	State-wide average + R.S. Means
Soil-compacted, on-site (CY)	$2.20	State-wide average + R.S. Means
Drainage material, sand (CY)	$11.00	State-wide average
Drainage material, geogrid (sq. yd.)	$4.18	State-wide average
Geomembrane (sq. yd.)	$3.90	State-wide average
Vegetative soil, off-site and cover repair (CY)	$5.20	State-wide average + R.S. Means
Vegetative soil, on-site and cover repair (CY)	$1.77	State-wide average
Seeding and mulching (acre)	$1,500.00	State-wide average
Terraces (l.f.)	$0.55	U.S. Natural Resources Conservation Service
Grass ditching/channels (LF)	$9.00	R.S. Means
Riprap ditching/channels (LF)	$13.00	R.S. Means
Gas Vents (LF)	not specified	not applicable
Passive Gas System or Active Gas System	not specified	not applicable
Professional Services (Lump Sum)	not specified	not applicable
Administration and Contingency	10%	not applicable
POST-CLOSURE		
Cover Repair 5% of Landfill - Soil off-site (CY)	$5.20	State-wide average + R.S. Means

Cover Repair 5% of Landfill - Soil on-site (CY)	$1.77	State-wide average
Reseeding 5% of Landfill (acre)	$1,500.00	State-wide average
Operation and Maintenance of Leachage Collection System (year)	not specified	not applicable
Leachate Hauling (trip)	not specified	not applicable
Leachate Treatment (gallon)	not specified	not applicable
Leachate Management and Treatment On-site (lump sum)	not specified	not applicable
Leachate Sampling (trip)	not specified	not applicable
Leachate Analysis (event)	not specified	not applicable
Landfill Gas Monitoring (event)	not specified	not applicable
Reinstallation of Gas Vents (LF)	not specified	not applicable
Operation and Maintenance of Gas Extration System (Million CU FT)	not specified	not applicable
Groundwater sampling personnel labor (hr)	$35.00	Medium hourly rate for ten (10) KDHE leaking underground storage tanks contractors who perform work in the state
Groundwater sampling event mobilization (mile)	$0.40	Medium hourly rate for ten (10) KDHE leaking underground storage tanks contractors who perform work in the state
Groundwater monitoring analytical costs† (2/year)	blank - industrial landfills $165.00 - small arid MSWLF $220.00 - MSWLF	State-wide average + 10%
Groundwater monitoring well maintenance (well/year)	$13.00	Cost includes replacement of well pads and padlocks. Price is prorated over 30 years
Groundwater monitoring well replacement (sum of total well footage)	$0.20	Cost includes replacing 30% of the groundwater wells during the 30-year post-closure period at an installation rate of $20/ft
Inspections and Recordkeeping (lump sum)	not specified	not applicable
Remedial System Operations (lump sum)	not specified	not applicable
Administration and Contingency	10%	KDHE prescribed

NOTE: CY = cubic yard
sq. yd. = square yard
LF = linear feet

† Small Arid MSWLF analysis includes: benzene, 1,2-dichloroethane, 1,1-Dichloroethene, ethylbenzene, styrene, tetrachloroethene, toluene, 1,1,1-trichloroethane, trichloroethene, vinyl chloride, total xylenes, cadmium, and chromium.
MSWLF analysis includes: Alkalinity, Calcium, Chemical Oxygen Demand (COD), Chloride, Nitrogen (Ammonia), Pottasiu (dissolved), Sodium (dissolved), Sulfate, Total Dissolved Solids (TDS), Acetone, Benzene, Bromodichloromethane, Bromomethane, Bromoform, 2-Butanone, Carbon Disulfide, Carbon tetrachloride, Chlorobenzene, Chlorethane, 2-Chloroethylinyl ehter, Chloroform, Chloromethane, Dibromochloromethane, 1,1-Dichloroethane, 1,2-Dichloroethane, 1,1-Dichloroethene, trans-1,2-Dichloroethene, 1,2-Dichloropropane, cis-1,3-Dichloropropene, Trans-1,3-Dichloropropene, Ethylbenzene, 2-Hexanone, 4-Methyle-2-pentanone, Methylene chloride, Styrene, Tetrachlorethene, Toluene, Total Xylenes, 1,1,2,2-Tetrachloroethane, 1,1,1-Trichloroethane, 1,1,2-Trichloroethane, Trichloroethene, Vinyl acetate, Vinyl chloride, MCL promulgated.

State required annual adjustments must account for increases or decreases in cost estimates resulting from operational changes. Inflation is adjusted annually using an inflation factor derived from the Implicit Price Deflator for the Gross Domestic Product. Accounting for regional

variations is accomplished on a case-by-case basis if a facility believes the standard unit cost is significantly different from the local cost. Applicable state regulations can be found on the Internet at http://www.kdhe.state.ks.us.

2.1.4.8 Missouri

The Missouri Department of Natural Resources' regulations require the following landfills provide financial assurance. Closure estimates are due during permit review and post-closure estimates are required before any waste is deposited for MSWLF only.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☒ Yes	☐ No	☐ Yes	☒ No
C&D Landfills:	☒ Yes	☐ No	☐ Yes	☒ No

Current regulations provide only general descriptions of tasks and services to include in closure and post-closure plans. Owner/operators must provide closure and post-closure plans with specific tasks and services for state review and approval. Missouri does not use a guidance document for determining a landfill's financial assurance amount. Unit costs used in calculating the facility's financial assurance are determined on a site specific basis and reviewed by the Missouri DNR. Missouri does not use regulatorily defined unit costs or unit costs published by other state or federal agencies. Annual adjustments must account for increases or decreases in cost estimates resulting from operational changes. Inflation is adjusted annually using an inflation factor derived from the Implicit Price Deflator for the Gross Domestic Product. In-state regional variations are not acknowledged in unit costs. Applicable state regulations can be found on the Internet at http://www.dnr.state.mo.us.

2.1.4.9 Nebraska

The Nebraska Department of Environmental Quality's regulations require the following landfills provide financial assurance before receiving final permit.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☒ Yes	☐ No	☒ Yes	☐ No
C&D Landfills:	☒ Yes	☐ No	☒ Yes	☐ No

Current regulations provide only general descriptions of tasks and services to include in closure and post-closure plans. Nebraska uses a guidance document with ranges of unit costs for determining the financial assurance amount. The guidance document describes the necessary individual tasks and services (See Attachment 3). However, the guidance document does not use regulatorily defined unit costs or unit costs from other state or federal agencies. Unit costs used in calculating the facility's financial assurance were determined using cost estimating references such as R.S. Means, United States Environmental Protection Agency documents, actual construction costs for closing landfills, the state-wide Solid Waste Management Plan, and cost estimates from owner/operators. Facilities must still submit site specific unit costs with documentation showing breakdown of labor, equipment, materials, etc. However, if the unit cost is within the guidance document range no additional documentation is necessary before agency approval. If the unit cost is outside the guidance document range then additional information is required before agency approval. Table 2.6 lists the current unit costs listed in Nebraska's guidance document.

TABLE 2.6 Nebraska Closure and Post-Closure Unit Cost Data

TASK/SERVICE (unit)	UNIT COST RANGE	RESOURCE
FINAL CLOSURE		Unit costs were calculated using cost estimating references like R.S. Means (labor, equipment, and materials), United States Environmental Protection Agency (USEPA) documents, actual construction costs for closing landfills, the state-wide Solid Waste Management Plan, and cost estimates from owner/operators.
Infiltration layer (CY)	$2.16 - $4.66	
Erosion layer (CY)	$1.23 -$2.00	
Flexible membrane liner (sq. ft.)	$0.30 - $0.80	
Filter fabric (sq. ft.)	$0.28 - $0.56	
Venting layer (CY)	$13.50	
Drainage layer (CY)	$13.50	
Final grading (acre)	$1,700 - $2,000	
Surface water control structures (LF)	$8.50 - $25.00	
Seeding, mulching, fertilizer (acre)	$915 - $1,982	
Gas venting system (acre)	$500	
Engineering - closure	15%	
Legal and administration - closure	5%	
Other direct costs - closure	1%	
Contingency - closure	10%	

TABLE 2.6 Nebraska Closure and Post-Closure Unit Cost Data (continued)

TASK/SERVICE (unit)	UNIT COST RANGE	RESOURCE
POST-CLOSURE		
Groundwater monitoring sampling (event)	$500 - $1,200	Unit costs were calculated using cost estimating references like R.S. Means (labor, equipment, and materials), United States Environmental Protection Agency (USEPA) documents, actual construction costs for closing landfills, the state-wide Solid Waste Management Plan, and cost estimates from owner/operators.
Groundwater monitoring analytical (well/year)†	$1,056 - $1,288	
Groundwater monitoring data assessment (event)	$500	
Groundwater monitoring well replacement (well)	$2,500	
Leachate management - sampling & analysis (year)	$900	
Leachate management - maintenance & inspections (year)	$1,000	
Leachate management - pumping, removal, & disposal (gallon - mile)	$0.12/gallon & $2.50/mile	
Leachate management - pump replacement (each/10years)	$2,000	
Gas monitoring - sampling & analysis (quarter)	$150 - $240	
Gas monitoring - maintenance & inspections (year)	$500 - $1,500	
Gas monitoring - replacement & repair (year)	$500	
Site inspection (year)	$300 - $1,200	
Final cover repair (CY)	$2.00 - $4.00	
Seeding repair (acre)	$1,000 - $1,500	
Mowing (acre)	$25.00	
Rodent, weed, & tree control (acre)	$75.00	
Surface water control (year)	$300	
Fence repair (year)	$500 - $1,000	
Gate and sign replacement (year)	$120	
Post-closure recordkeeping and administration (year)	$1,200 - $1,600	
Contingency - post-closure	10%	
Other direct costs - post-closure	1%	

† Analysis includes: pH, COD, specific conductance, chloride, sulfate, calcium, magnesium, nitrates, sodium, carbonates, potassium, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, nickel, selenium, silver, thallium, vanadium, zinc, and 47 volatile organics in USEPA Report SW-846 Test Method 8260.

State required annual adjustments must account for inflation. Inflation is adjusted annually using an inflation factor derived from the Implicit Price Deflator for the Gross Domestic Product. Accounting for regional variations is accomplished through the use of bids or other actual cost estimates for that specific site. Applicable state regulations can be found on the Internet at http://www.deq.state.ne.us.

2.1.4.10 Colorado

The Colorado Department of Health and Environment's regulations require the following landfills provide financial assurance 60 days before receiving waste.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☒ Yes	☐ No	☒ Yes	☐ No
C&D Landfills:	☒ Yes	☐ No	☒ Yes	☐ No

Current regulations provide only general descriptions of tasks and services to include in closure and post-closure plans. Owner/operators must provide closure and post-closure plans for state review and approval. Colorado does not use a guidance document for determining a landfill's financial assurance amount. Nor does Colorado use regulatorily defined unit costs or unit costs published by other state or federal agencies. Unit costs used in calculating financial assurance are determined by values published in R.S. Means, or a facility may provide documentation from contractors and suppliers for site specific unit costs.

State required annual adjustments must account for inflation. Inflation is adjusted annually using an inflation factor derived from the Implicit Price Deflator for the Gross Domestic Product. Accounting for regional variations is accomplished through the use of bids or other actual cost estimates for that specific site. Applicable state regulations can be found on the Internet at http://www.cdphe.state.co.us.

2.1.4.11 Montana

The Montana Department of Environmental Quality's regulations require the following landfills provide financial assurance before receiving waste.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☐ Yes	☒ No	☐ Yes	☒ No
C&D Landfills:	☒ Yes	☐ No	☒ Yes	☐ No

Current regulations provide only general descriptions of tasks and services to include in closure and post-closure plans. Owner/operators must provide closure and post-closure plans for state review and approval. Montana does not use a guidance document for determining a landfill's financial assurance amount. Nor does Montana use regulatorily defined unit costs or unit costs published by other state or federal agencies. Unit costs used in calculating the facility's financial assurance are determined on a site specific basis, where costs are compared to previous work completed at the site and nearby sites or experience with other areas of Montana. State required annual adjustments mirror annual adjustments specified in 40 CFR 258 that require annual adjustments for inflation and changes in closure and post-closure plans. Regulations do not

prescribe an accounting method for calculating the rate of inflation. Accounting for regional variations is accomplished through the use of site specific closure and post-closure tasks and services and unit costs.

2.1.4.12 North Dakota

No response was submitted.

2.1.4.13 South Dakota

The South Dakota Department of Environment and Natural Resources' (DENR's) regulations require the following landfills provide financial assurance as a condition of the permit, but not necessarily before receiving waste.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☒ Yes	☐ No	☒ Yes	☐ No
C&D Landfills:	☐ Yes	☒ No	☐ Yes	☒ No

Current regulations provide only general descriptions of tasks and services to include in closure and post-closure plans. Owner/operators must provide closure and post-closure plans for state review and approval. South Dakota does not use a guidance document for determining a landfill's financial assurance amount. Nor does South Dakota use regulatorily defined unit costs or unit costs published by other state or federal agencies. Unit costs used in calculating financial assurance are determined by the owner/operator or engineering consultant. The necessity of adjustments are determined by the facility owners. Annual reviews are required with South Dakota DENR oversight. Accounting for regional variations is accomplished through the use of site specific closure and post-closure unit costs. Applicable state regulations can be found on the Internet at http://www.state.sd.us/denr.

2.1.4.14 Utah

The Utah Department of Environmental Quality's regulations require the following landfills provide financial assurance before receiving waste.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☒ Yes	☐ No	☒ Yes	☐ No
C&D Landfills:	☒ Yes	☐ No	☒ Yes	☐ No

Current regulations provide only general descriptions of tasks and services to include in closure and post-closure plans. Owner/operators must provide closure and post-closure plans for state review and approval. Utah does use a guidance document for determining a landfill's financial assurance amount (See Attachment 3). The guidance document identifies all the closure and

post-closure tasks and services, as shown in Tables 2.7 and 2.8, respectively. However, the guidance document does not provide unit costs nor does it use regulatorily defined unit costs or unit costs published by other state or federal agencies.

TABLE 2.7 Utah Closure Tasks and Services

Item	Unit Measure	Cost/Unit	No. Units	Total Cost
1.0 Engineering				
1.1 Topographic Survey				
1.2 Boundary Survey				
1.3 Site Evaluation				
1.4 Development of Plans				
1.5 Contract Administration, Bidding, and Award				
1.6 Administrative Costs for Certification of Final Cover and Closure Notice				
1.7 Project Management; Construction Observation and Testing				
1.8 Monitor Well Consultant Cost				
1.9 Other Environmental Permit Costs				
2.0 Construction				
2.1 Final Cover System				
2.1.1 Completion of Sidewall Liner				
2.1.1a Soil Placement				
2.1.1b Soil Processing				
2.1.1c Soil Amendment				
2.1.1d Soil Purchase				
2.1.1e Soil Transportation				
2.1.2 Drainage Layer on Sidewall				
2.1.2a Geotextile Filter Fabric				
2.1.2b Geonet/Geotextile Composite				
2.1.2c Geomembrane Sidewall Liner				
2.2 Completing of Top Cover				
2.2.1 Infiltration Layer				
2.2.1a Soil Placement				
2.2.1b Soil Processing				
2.2.1c Soil Amendment				
2.2.1d Soil Purchase				

Item	Unit Measure	Cost/Unit	No. Units	Total Cost
2.2.1e Soil Transportation				
2.2.2 Flexible Membrane Cover				
2.2.2a Drainage Layer on Top				
2.2.2b Sand Layer				
2.2.2c Geotextile Filter Fabric				
2.2.3 Drainage Layer				
2.2.3a Geonet/Geotextile				
2.2.3b Collection Pipe				
2.2.3c Soil Cover				
2.2.3d Geonet/Geotextile Composite				
2.3 Erosion Layer Placement				
2.4 Revegetation				
2.4.1 Seeding				
2.4.2 Fertilizer				
2.4.3 Mulch				
2.5 Site Grading and Drainage				
2.6 Site Fencing and Security				
2.7 Leachate Collection System Completion				
2.8 Completion of Gas Monitoring System				
3.0 Gas Collection System				
3.1 System Design				
3.2 Equipment and Installation				
4.0 Monitor Well Installation Cost				
4.1 Monitoring Well Installation				
4.2 Piezometer and Monitoring Well Plugging				
10% Contingency				
Contract Performance Bond				
Legal Fees (0% to 25%)				

TABLE 2.8 Utah Post-Closure Tasks and Services

Item	Unit Measure	Cost/Unit	No. Units	Total Cost
1.0 Engineering Costs				
1.1 Post-Closure Plan				

Item	Unit Measure	Cost/Unit	No. Units	Total Cost
1.2 Site Inspection and Recordkeeping (annual)				
1.3 Correctional Plans and Specifications (annual)				
1.4 Site Monitoring (semiannual)				
1.4.1 Ground Water Monitoring				
1.4.1a Ground Water Sample Collection				
1.4.1b Ground Water Sample Analysis				
1.4.1c Ground Water Sample Analysis Review and Reporting				
1.4.2 Landfill Gas Monitoring				
1.4.2a Gas Monitoring Data Collection				
1.4.2b Gas Monitoring Data Review and Reporting				
2.0 Maintenance Costs				
2.1 Cover Maintenance Costs				
2.1.1 Soil Replacement				
2.1.2 Vegetation Reseeding				
2.2 Equipment Maintenance				
2.2.1 Ground Water Well Maintenance and Replacement				
2.2.2 Gas Collection System Operation				
2.2.3 Gas Collection System Maintenance and Repair				
2.2.4 Leachate Collection System Operation				
2.2.5 Leachate Collection System Repair and Maintenance				
3.0 Leachate Disposal				
4.0 Site Maintenance				
4.1 Repair of Surface Water Diversion Structures				
4.2 Repair of Fences and Gates				
4.3 Other Site Maintenance				
10% Contingency				

Unit costs used in calculating the facility's financial assurance are determined on a site specific basis, where costs are obtained from third-party bid or other available cost data. State required annual adjustments must account for increases or decreases in cost estimates but does not define accounting method to adjust for inflation. Design changes could change total closure and post-closure costs and are addressed with the modification request. Accounting for regional variations is accomplished through the use of bids or other actual cost estimates for that specific site. Applicable state regulations can be found on the Internet at http://www.deq.state.ut.us.

2.1.4.15 Wyoming

The Wyoming Department of Environmental Quality's regulations require the following landfills provide financial assurance before receiving final permit.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☒ Yes	☐ No	☒ Yes	☐ No
C&D Landfills:	☒ Yes	☐ No	☒ Yes	☐ No

Current regulations provide only general descriptions of tasks and services to include in closure and post-closure plans. Owner/operators must provide closure and post-closure plans with task and services for state review and approval. Wyoming does not use a guidance document for determining a landfill's financial assurance amount. Wyoming does use regulatorily defined unit costs for a number of tasks and accepts unit costs published by R.S. Means (See Attachment 3). Owner/operators can submit third-party contractor bids for DEQ review and approval. Published data must be updated every four years and third-party bids must be updated every year. Table 2.9 presents current regulatory unit costs listed in Chapter 7, Section 9 of the Solid Waste Rules.

TABLE 2.9 Wyoming Closure and Post-Closure Unit Cost Data

TASK/SERVICE (unit)	UNIT COST	RESOURCE
FINAL CLOSURE		
Final cover, seeding, fertilizer, and mulching (acres)	$10,200	Chapter 7, Section 9(d)(I)(A)
Building demolition, removal, and disposal (sq. ft.)	$6.00	Chapter 7, Section 9(d)(I)(B)
Install new groundwater monitoring well (well)	$2,400	Chapter 7, Section 9(d)(I)(C)
Install new methane gas probe (probe)	$1,300	Chapter 7, Section 9(d)(I)(C)
Disposal of stored solid waste (CY)	$10.00	Chapter 7, Section 9(d)(I)(D)
Perimeter fencing (LF)	$13.00	Chapter 7, Section 9(d)(I)(E)
Final facility survey (lump sum)	$3,600	Chapter 7, Section 9(d)(I)(F)
Surface water diversion structures (LF)	$1.00	Chapter 7, Section 9(d)(I)(G)
Closure contingency	15%	Chapter 7, Section 9(d)(I)(H)
POST-CLOSURE		
Annual post-closure inspections (lump sum)	$733.33	Chapter 7, Section 9(d)(ii)(A)
Annual groundwater monitoring well sampling & analysis - Type I (well)†	$400	Chapter 7, Section 9(d)(ii)(B)(I)

Annual groundwater monitoring well sampling & analysis - Type II (well)††	$150	Chapter 7, Section 9(d)(ii)(B)(II)
Perimeter fence maintenance and replacement (LF)	$12.00	Chapter 7, Section 9(d)(ii)(C)
Remove and dispose perimeter fence (LF)	$2.00	Chapter 7, Section 9(d)(ii)(D)
Annual Methane gas monitoring (probe)	$240	Chapter 7, Section 9(d)(ii)(E)
Maintain surface water diversion structures (LF)	$1.00	Chapter 7, Section 9(d)(ii)(F)
Post-closure contingency	15%	Chapter 7, Section 9(d)(ii)(G)

† Type I analysis includes: pH, COD, specific conductance, chloride, sulfate, calcium, magnesium, nitrates, sodium, carbonates, potassium, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, nickel, selenium, silver, thallium, vanadium, zinc, and 47 volatile organics in USEPA Report SW-846 Test Method 8260.
††Type II analysis includes: total dissolved solids, chlorides, ammonia as nitrogen, iron, hardness, total organic carbon, water temperature, specific conductance, pH.

For the purpose of estimating closure and post-closure costs for facilities electing to participate in Wyoming's state guarantee trust account, the cost factors listed in Table 2.9 are expressed in 1993 dollars. Any closure and post-closure cost estimate resulting from the use of these cost factors must be adjusted to account for inflation. The inflation factor shall be derived from the most recent implicit price deflator for Gross National Product published by the US Department of Commerce. Inflation is adjusted when closure and post-closure costs are adjusted, either annually or every four years. Wyoming does not acknowledge in-state regional variations. Applicable state regulations can be found on the Internet at http://deq.state.wy.us.

2.1.4.16 Minnesota

The Minnesota Pollution Control Agency's (MPCA's) regulations require the following landfills provide financial assurance before receiving final permit or permit re-issuance.

	Final Closure		Post-Closure	
MSWLF:	☒ Yes	☐ No	☒ Yes	☐ No
NHISWLF:	☒ Yes	☐ No	☒ Yes	☐ No
C&D Landfills:	☐ Yes	☒ No	☐ Yes	☒ No

Current regulations provide only general descriptions of tasks and services to include in closure and post-closure plans. Owner/operators must provide closure and post-closure plans with tasks and services for state review and approval. Minnesota does not use a guidance document for determining a landfill's financial assurance amount. Nor does Minnesota use regulatorily defined unit costs or unit costs published by other state or federal agencies. Owner/operators can submit third-party contractor cost estimates or the facility can use data maintained as part of the Closed Landfill Program. Attachment 3 contains project costs sheets for several landfills the MPCA is managing.

The Closed Landfill Program was created by the 1994 Landfill Cleanup Act. The program is an alternative to Superfund for closed landfills and the first of its kind in the nation. Under the program MPCA is authorized to initiate cleanup actions, complete closures, take over long-term operation and maintenance and reimburse eligible parties for past clean-up costs at the 106 qualified closed state-permitted landfills. Funding for the program has or will come from the following five sources.

- Solid Waste Assessment fees;
- Up to $90 million in state general obligation bonds;
- Funds transferred from the financial assurance accounts of closed landfills;
- A one-time transfer of funds from the Metropolitan Landfill Contingency Action Trust Fund; and
- Future settlements from landfill-related insurance policies.

At the end of the 1998 fiscal year, the program had 27 construction projects underway or completed and another 30 construction designs underway or completed. A copy of the 1998 annual report is contained in Attachment 3.

State required annual adjustments must account for increases or decreases in cost estimates but does not define an accounting method to adjust for inflation. Accounting for regional variations is accomplished through the use of bids or other actual cost estimates for that specific area of the state. Applicable state regulations can be found on the Internet at http://www.pca.state.mn.us.

2.2 United States Environmental Protection Agency Research

The United States Environmental Protection Agency's document database maintained at its webpage was researched for reports and guidance documents pertaining to financial assurance and closure and post-closure cost estimates. Research applicability screening identified the following described in Table 2.10.

TABLE 2.10 USEPA Reference Documents

	USEPA Reference Document
1	Guidance Manual: Cost Estimates for Closure and Post-Closure Plans (Subparts G and H) Volume II - Land Disposal Facilities, November 1986
2	Guidance Manual: Cost Estimates for Closure and Post-Closure Plans (Subparts G and H) Volume III - Unit Costs, November 1986
3	Guidance Manual: Cost Estimates for Closure and Post-Closure Plans (Subparts G and H) Volume IV - Documentation, November 1986
4	RCRA Guidance Manual for Subpart G Closure and Post-Closure Care Standards and Subpart H Cost Estimating Requirements, January 1987
5	Requirements for Hazardous Waste Landfill Design, Construction, and Closure, August 1989

6	Solid Waste Disposal Facility Criteria - Technical Manual, November 1993
7	Design, Operation, and Closure of Municipal Solid Waste Landfills, September 1994

2.2.1 Guidance Manual: Cost Estimates for Closure and Post-Closure Plans

Subpart H of 40 CFR Part 264 and Part 265 of the RCRA Subtitle C regulations requires owner/operators of all hazardous waste treatment, storage, and disposal facilities (TSDFs) to prepare an estimate of the cost for closing the facility in accordance with regulations. In addition to the closure cost estimates, TSDF owner/operators are to prepare estimates of the cost of post-closure care for those facilities. The cost estimates are based on closure and post-closure plans required by Subpart G of 40 CFR Part 264 and Part 265. Financial assurance must be established for closure and post-closure, the amount of which is based on these cost estimates. Reviewers of closure and post-closure cost estimates need to be able to determine whether the cost estimates are reasonable in order to assess the adequacy of the closure and post-closure financial assurance. This involves consideration both of the closure and post-closure plans and of the unit costs and calculations used to develop the cost estimates.

Although there are many construction and operational differences between Subtitle C and Subtitle D facilities, the obligation to develop closure and post-closure plans and provide defendable unit costs exists for both facility types. The corresponding federal regulations are 40 CFR Part 258 Subpart F - Closure and Post-Closure Care and Subpart G - Financial Assurance Criteria. Based on the similarities between the respective regulations, the methods and procedures of determining unit costs developed for some Subtitle C facilities provide a framework to evaluate methods and procedures of determining unit cost for solid waste landfills. Volume I of the guidance document addressed treatment and storage facilities and therefore was not reviewed. Volume II that addressed land disposal facilities, Volume III that covered unit costs, and Volume IV that provided documentation for unit costs developed in Volume III were reviewed. A summary of findings for each volume is presented in the following subsections respectively.

2.2.1.1 Volume II - Land Disposal Facilities

The purpose of this volume is to provide a framework for developing the closure and post-closure cost estimates for land disposal technologies. Volume II is divided into six major chapters addressing closure cost estimating for waste piles, surface impoundments, land treatment facilities, and landfills, post-closure cost estimating, and summary worksheets. For purpose of this project, Chapters 5 and 6 were reviewed for pertinent information, procedures, and methods for identifying and determining closure and post-closure unit costs.

Chapter 5 addresses landfills and identifies tasks and services necessary to complete final closure. The calculation worksheets are very detailed. Chapter 6 addresses post-closure cost estimates and is also very detailed. Both sets of worksheets are included in Attachment 5 for review. The worksheets contain unit costs for some tasks and services. Discussion on unit costs is covered in Volume III.

Since the guidance document was published in November 1986, the unit costs have to be updated before being applied to an Oklahoma facility. The guidance document shows how to complete a detailed breakdown of tasks and services to include in calculating closure costs. Defining such detail creates a complicated procedure for calculating closure costs, with many items subject to different interpretation and disagreement. The goal of this project is to develop a procedure that is easy to implement and comply with, therefore a less complicated and subjective approach to calculating closure and post-closure costs will be developed.

2.2.1.2 Volume III - Unit Costs

Volume III is the companion to the Volume II closure and post-closure calculation sheets. Volume III contains information and guidance on unit cost ranges, typical unit costs, and how the unit costs are applied to different facilities in calculating closure and post-closure cost estimates. The unit costs were developed from cost information obtained through cost-estimating manuals, USEPA reports, technical publications, contractor's bid estimates, equipment vendor specifications and contracts, and site surveys. All reported costs are in 1986 dollars and represent third-party costs. The cost estimating procedure used in Volume III consists of the following steps:

- Identify tasks and subtasks to be performed;
- Determine appropriate labor categories;
- Estimate hours to complete each task and subtask for each labor category;
- Determine appropriate equipment necessary to complete each task and subtask;
- Estimate operating time to complete each task and subtask;
- Select a unit cost for each item identified in Steps 1 through 5; and
- Calculate cost for each task and subtask.

Chapters 2 through 9 provide extensive detail in determining tasks, subtasks, and associated assumptions. For example, the cost for moving a cubic yard of soil is calculated after deciding the cost associated with the type of equipment, engine horsepower, size of bucket, distance to move material, specific soil classification, and mobilization/demobilization. This method presents many different possible scenarios for calculating one unit cost item. Using this method would create difficulties in calculating consistent and defendable unit costs for the different landfills located across Oklahoma. The method would be very time consuming for both the owner/operator and reviewing authority. Furthermore, the method would require extensive explanation and supporting documentation for each assumption. Although the guidance document is detailed in describing the tasks and subtasks, the result is an impracticable and time-consuming procedure for calculating a specific unit cost. Rather, the guidance document is useful as a reference for aggregating similar activities into one unit cost.

Another useful item in Volume III is the discussion on additional project costs that are percentages of the total project cost. The discussion in Chapter 10 is helpful in identifying appropriate values for additional cost percentages for closure and post-closure cost estimates. The reported value or range is presented in Table 2.11.

TABLE 2.11 Closure and Post-Closure Indirect Costs

Indirect Cost Category		Additional Cost Ranges
1	Engineering and supervision	5% - 15%
2	Contractor's fee	15% - 50%
3	Contingency fee	10% - 30%
	Landfill Closure Contingency	25%
	Landfill Post-Closure Contingency	15%

2.2.1.3 Volume IV - Documentation

Volume IV contains the documentation for the unit costs presented in Volume III. The purpose of
Volume IV is to present information on the source(s) used for each unit cost, provide examples of any computations performed in developing a unit cost, and describe any assumptions made in developing the unit costs. The discussion and calculations presented in Chapters 2 through 10 are very thorough and the interested reader is directed to the specific document for questions and inquiries. A concise summary of reference resources reported in Volume IV and used in Volume III are presented in Table 2.12.

TABLE 2.12 USEPA Unit Cost Primary Reference Resources

Unit Cost Category		Primary Reference Resources
1	Laboratory analysis (soil and water)	USEPA Contract Laboratories
2	Inspection and Maintenance	R.S. Means, Minnesota Department of Transportation, and vendors
3	Inventory and Residual Management	R.S. Means, Department of Energy, City of St. Paul Water Department, USEPA Reports, and vendors
4	Equipment and Facility Decontamination	R.S. Means and vendors
5	Protective clothing and safety equipment	Lab Safety Supply Company
6	Demolition and Excavation	R.S. Means and consultants
7	Final Cover and Revegetation	R.S. Means, vendors, Engineering News Record (ENR)
8	Labor Categories and Rates	R.S. Means, consultants, and attorney
9	Closure and Post-closure Indirect Costs	R.S. Means, National Construction Estimator, USEPA Reports, and cost engineering texts

2.2.2 RCRA Guidance Manual for Subpart G Closure and Post-Closure Care Standards and Subpart H Cost Estimating Requirements

The purpose of this guidance manual is to assist the USEPA and state regulatory agencies in implementing the closure and post-closure care and cost estimate regulations and to help owners and operators prepare plans and costs estimates. The manual addresses four broad topics:

- Clarifies the intent and scope of regulations;
- Provides examples of information to include in closure and post-closure plans and cost estimate;
- Discusses site-specific factors that may affect closure and post-closure; and
- Provides closure and post-closure plan checklists.

After the introduction chapter, Chapters 2 and 3 list and explain the regulatory language for closure and post-closure. Due to space limitations, these discussions are not valuable in the context of this project. The last Chapter, Chapter 4, provides instructions for preparing cost estimates. Interesting conclusions presented include:

- Cost estimates should not include the cost of responding to highly unusual contingencies, unless such circumstances exist at the time of preparing or updating the closure and post-closure cost estimates;
- Cost estimates must be based on the owner/operator hiring a third-party to conduct the activities. Parent companies or subsidiaries of the owner/operator cannot be considered third-parties;
- Cost estimates cannot account for salvage value of equipment or material or sale of recyclable materials present at the site. These items shall have a zero value;
- Some examples of when cost estimates may increase:
    - The facility increases in size or capacity;
    - Change in regulatory requirements;
    - More extensive or frequent groundwater monitoring due to new data, groundwater usage change; and
    - Extension in the post-closure monitoring period.
- Some examples of when cost estimates may decrease:
    - Reduction in the size needing closure due to phased closure; and
    - Reduction in the post-closure monitoring period.
- A facility may account for inflation by completely redoing closure and post-closure costs using current year dollars or by calculating an adjustment factor using the Implicit Price Deflator for the Gross National Product that is published in the Survey of Current Business.
- Documentation for cost estimates should clearly delineate all the activities and subactivities consistent with those described in the closure and post-closure plans and include the fully loaded costs. Fully loaded costs account for labor, materials, equipment, and contingency. Five sources identified in the manual are: Guidance Manual: Cost Estimates for Closure and Post-Closure Plans (Subpart G and H), owner/operator experience, contractor estimate, cost estimating handbooks, and accounting worksheets and workups.

2.2.3 Requirements for Hazardous Waste Landfill Design, Construction, and Closure

This publication outlines in detail the provisions of the minimum technology guidance and regulations, and offers practical and detailed information on the construction of hazardous waste facilities. Although Chapter 5 discusses elements of closure systems for landfills and Chapter 9 presents an overview of long-term care considerations, the document does not provide valuable discussion or detail on calculating closure and post-closure cost estimates.

2.2.4 Solid Waste Disposal Facility Criteria - Technical Manual

This technical manual was developed by the USEPA to assist municipal solid waste landfill owner/operators in achieving compliance with 40 CFR Part 258. Chapter 6 specifically addresses 40 CFR Part 258 Subpart F - Closure and Post-Closure. Subsections address individual regulatory requirements, such as technical considerations for final cover design, including infiltration layer, erosion layer, drainage layer, gas vent layer, biotic layer, settlement and subsidence, and slope stability. Subsection 6.4 addresses the closure plan and includes a provision whereby the closure cost estimate must account for the portions of the landfill that have received waste but not final cover. Some steps identified in the subsection include:

- Determining the area to receive final cover;
- Developing the closure schedule;
- Preparing construction contract documents and securing a contractor;
- Hiring an independent registered professional engineer to observe closure activities and provide certification;
- Securing borrow material;
- Constructing the cover system;
- Obtaining signed certificate and placing it in operating record; and
- Recording notation in deed to land or other similar instrument.

Subsection 6.6 addresses post-closure care requirements, specifically identifying the operation and maintenance performance criteria that targets the final cover system, leachate collection system, groundwater monitoring system, and gas monitoring system.

Unit cost discussions are absent from the technical manual. However, the discussions on closure and post-closure expectations are useful in identifying closure and post-closure tasks. For example, in order to determine the area to receive final cover, a site inspection and topographic survey will have to be performed prior to commencing construction. Additionally post-closure performance activities can be categorized into three groups.

Inspections - necessary to determine site conditions and equipment performance;

Operations - collecting and analyzing samples, removing and disposing leachate, operating gas collection system, and performing necessary recordkeeping and reporting; and

Maintenance - correcting erosion and settlement of final cover, maintaining vegetative cover, maintaining drainage structures, maintaining monitoring equipment (monitoring wells, methane gas probes, and piezometers), and maintaining access control.

2.2.5 Design, Operation, and Closure of Municipal Solid Waste Landfills

The purpose of this publication, when published in 1994, was to provide people with state-of-the-art information on the proper design, construction, operation, and closure of municipal solid waste landfills. Chapter 7 deals with closure and post-closure while an earlier chapter addressed other design, construction, and operational topics. The information provided on closure activities is summarized in the following paragraphs.

Final cover should include an interim layer of soil, gas venting layer, low permeability layer, drainage layer, and erosion control layer. The USEPA document further recommends the installation of one passive gas vent per acre of cover. These are necessary to prevent the buildup of gas pressure beneath the final cover. Passive vents may not be necessary for landfills that do not install a composite cap or landfills that operate and maintain an active gas extraction system.

Post-closure requirements are summarized into the monitoring plan, maintenance plan, emergency plan and contacts, and description of the end-use plan for the site. Specific maintenance items discussed included: routine vegetation management (mowing and planting), subsidence repair, run-on/run-off control, inspection and repair of sedimentation basins and drainage channels, cleaning and maintaining the leachate collection system, and inspecting and maintaining methane gas probes, passive gas vents, and groundwater monitoring wells.

Chapter 8 addresses financial assurance and provides cost estimates for specific construction, operation, and maintenance tasks. The unit cost source(s) and some of the calculation assumptions were not disclosed. These tasks and cost estimates are summarized in Table 2.13.

TABLE 2.13 USEPA Estimating Final Cover and Post-Closure Care Costs

DESCRIPTION		UNIT COST
FINAL CLOSURE		
1	Infiltration Layer	
	Geomembrane	$0.20-$0.80/square foot
	Placing and compacting soil	$4-$6/CY
	Transporting soil to the site	$0.15-$0.25/ton/mile
2	Drainage Layer	
	6-inch sand layer	$12-$20/ton
	Bonded geonet	$0.55-$0.70/square foot

3	Erosion Control Layer	
	Soil	$8-$14/ton
	Fertilizing, seeding, and hydro mulching	$1,200-$1,800/acre
	Drainage swales	$1,100-$2,000/acre
4	Passive Gas Venting Layer	
	Venting wells	$3,000-$8,000/well
	Surface trench collectors	$2,000/each
	POST-CLOSURE	
5	Long-term Maintenance of Final Cover	$1,500-$3,000/acre
6	Leachate Management	
	Maintenance and operation	$10,000-$25,000/year
	Leachate treatment	$0.15-$0.25/gallon
7	Groundwater Monitoring	
	Installation of replacement well	$50-$100/foot
	Annual sampling and analysis (40 CFR Part 258, Appendix I, Constituents)	$2,500-$3,200/well
8	Gas Monitoring System	
	Gas monitoring	$1,000-$1,600/year
	Methane gas probe repair	$1,000/year

Chapter 3 - Comprehensive List of Tasks and Services

While the regulations establish broad categories of tasks and services, a more specific list of these items must be established for landfills to calculate the amount of financial assurance. Chapter 3 develops the comprehensive lists of tasks and services necessary for conducting final closure and post-closure activities at a landfill. Tasks and services are identified based on regulatory requirements and modified based on research and technical information obtained in Chapter 2. This chapter also describes how tasks and services can be modified due to technical or regulatory changes.

3.1 Evaluation of Closure Tasks and Services

The development of closure tasks and services begins with review of existing regulatory requirements completed in Chapter 1 and presented in Table 1.5. Table 1.5 illustrates the regulatory language defining closure requirements for MSWLFs, NHISW landfills, and C&D landfills is very similar. Regulatory language can be ambiguous and the use of Table 1.5 for calculating closure costs estimates would be difficult for a specific site. Research of surrounding states' and the United States Environmental Protection Agency's solid waste financial assurance programs presented in Chapter 2 provided valuable information to consider in modifying the tasks and services listed in Table 1.5.

Based on the information in Chapter 1 and research completed for Chapter 2, the closure tasks and services listed in Table 1.5 were evaluated to answer these questions:

- Does the regulatory task or service require clarification before it is able to be implemented?
- Are there separate tasks and services that from a practical engineering and construction perspective would be completed as a single task or service?
- Can one or more tasks or services be combined to simplify the cost estimating procedure and still comply with the regulations?
- Can a unit cost be precisely described or defined for the task or service?

Discussion and examples of the evaluation process are presented in the following subsections.

3.1.1 Regulatory Clarification

The regulatory language for closure activities, presented in Table 1.5, identifies closure tasks but does not describe the tasks in sufficient detail to allow a landfill to list specific closure task(s) to calculate a cost estimate. Therefore, the procedure for calculating closure costs must clarify how a specific landfill will implement the regulation. The difficulty of implementing some of the regulations is illustrated by Task109 in Table 1.5, which quotes regulatory language stating the landfill closure plan must include "(a) plan for reworking or replacing any defective groundwater monitor wells and other defective monitoring equipment, monitoring ground water and surface water, and collecting and analyzing soil and water samples." Although the regulation identifies a task, the language format is not specific enough for a landfill to determine a cost estimate. A C&D landfill or NHISW landfill may only have groundwater monitoring wells, while a MSWLF

may have groundwater monitoring wells, methane gas probes, and a landfill gas extraction system. Task 15 in Table 1.5 quotes regulatory language stating the landfill closure plan must include "(a) method for obtaining, hauling and placing soil for final cover." Once again, the regulation may be interpreted and implemented differently at the different types of landfills. A NHISW landfill may only be required to construct a final cover with a specific thickness of topsoil. A MSWLF operating on an existing footprint or C&D landfill may only be required to construct a final cover with specific thickness of clay cap and topsoil. And a composite lined MSWLF may be required to construct a final cover with a clay cap, gas venting layer, passive gas vents, flexible membrane liner, drainage layer, filter fabric, and topsoil. Therefore, development of specific closure tasks and services must reflect the landfill type and specific site.

3.1.2 Aggregate Tasks and Services Based on Engineering or Construction Practices

The regulatory language for closure activities presented in Table 1.5 lists the necessary tasks and services for completing final closure. However, based on standard engineering or construction practices, several individual tasks or services may be aggregated together. The point is illustrated by Tasks 1, 2, and 5 in Table 1.5. Amending the site specific closure plan, preparing construction documents, completing the bidding process, and providing a construction schedule are inter-related tasks that are better aggregated together. Combining regulatory tasks like these also simplifies the closure cost calculation by reducing the number of items. Ultimately it was determined that nine items would best be combined to form the closure category, Technical and Professional Services, that now include:

- Amend closure plan;
- Prepare construction documents with final cover description and installation procedures;
- Prepare schedule for completing all activities;
- Technical and professional services;
- Plan for redesigning final closure in accordance with existing site conditions and applicable regulations;
- A description of the final cover construction, including a calculation of the amount of material needed for each phase of closure, the identification of the soil type and location to be used for the final cover, analysis of the proposed cover material's permeability, and the schedule and method of placement of final cover;
- A plan for remedying all former improper closure at the site;
- A plan for preparing final closure certification and other final closure reports and notices required; and
- Conducting the final closure survey.

3.1.3 Aggregate Tasks and Services Based on Procedure Simplification

The regulatory language for closure activities, presented in Table 1.5, lists the necessary tasks and services for completing final closure, including several general categories. Task 6, 7, and 21 list general categories "Technical and Professional Services", "Administrative Services", and "Final Closure Contingency". "Technical and Professional Services" may include activities such as evaluating existing site conditions and redesigning final closure accordingly; identifying, testing, evaluating, and specifying all the construction materials necessary for completing

closure; conducting a topographic survey to validate former proper disposal and former closure activities; and completing all construction quality assurance activities. “Administrative Services” may include administrating the various construction and service contracts, managing the funds for completing closure, conducting review of construction activities, completing necessary recordkeeping, and performing necessary legal actions associated with completing closure. “Final Closure Contingency” may include activities such as remedying improperly closed areas and waste placed outside the permit boundaries, installing a groundwater remediation system or gas control system, and other possible, but unforeseen, problems at the landfill. Separately describing, defining, and determining cost estimates for the numerous activities associated with each of these categories would create a very complicated and unquantifiable procedure for calculating closure costs. Therefore, creating general categories for “Technical and Professional Services”, “Administrative Services”, and “Final Closure Contingency” allows landfills to comply with all the regulatory closure requirements and simplify the overall procedure.

3.1.4 Determination of Precise Unit Costs

The regulatory language for closure activities, presented in Table 1.5, lists the necessary tasks and services for completing final closure. However, some descriptions are impractical to assign a precise unit cost to the task or service. In instances where concise unit costs could not be practically determined from the regulatory language, the task or service was divided to more clearly define necessary items and allow development of concise unit costs. Task 17 in Table 1.5 illustrates the problem created when a concise unit cost cannot be determined. Task 17 requires landfills construct additional or rework existing surface drainage and erosion control measures. Erosion control measures could include terraces and let-down channels. Assigning a unit cost that would apply to surface drainage ditches, terraces, and let-down channels is impractical. Therefore, regulatory compliance is better achieved by separating the task into three subtasks. Individual unit costs for drainage ditches, terraces, and let-down channels can be reasonably determined. Therefore, dividing some ambiguous tasks and services allows landfills to achieve regulatory compliance and determine concise unit costs.

3.2 Identification of Closure Tasks and Services

The evaluation procedures discussed in Section 3.1 and applied to Table 1.5 are tabulated in Attachment 6 and list closure tasks and services according to regulatory citation. Table 3.1 presents a practical format and lists tasks and services chronologically and task-wise according to closure construction activities and represents the tasks and services for owner/operators to estimate third-party closure costs. Because there are differences between the types of landfills and specific permit requirements, not all items in the comprehensive list of closure tasks and services will be applicable to all landfills. Instead the list is intended to identify all closure tasks and services. Each individual landfill will use those items applicable to their site.

TABLE 3.1 Comprehensive Final Closure Cost Estimation Task and Services

FINAL CLOSURE COST ESTIMATION TASK and SERVICE	
1	**PRELIMINARY SITE WORK**
a	Conduct Site Evaluation
b	Dispose Final Wastes
c	Remove Temporary Building(s)
d	Remove Equipment
e	Repair/Replace Perimeter Fencing
f	Clean Leachate Line(s)
2	**MONITORING EQUIPMENT**
a	Rework/Replace Monitoring Well(s)
b	Plug Abandoned Monitoring Well(s)
c	Rework/Replace Methane Probe(s)
d	Plug Abandoned Methane Probe(s)
e	Rework/Replace Remediation Equipment and/or Gas Control Equipment
3	**CONSTRUCTION**
a	Complete Site Grading
b	Construct Final Cap (Clay or Geosynthetic Clay Liner (GCL)
c	Construct Landfill Gas Venting Layer
d	Install Passive Landfill Gas Vents
e	Install Flexible Membrane Liner
f	Drainage Layer (Sand or Geonet)
g	Install Geotextile Filter Fabric
h	Place Topsoil
I	Establish Vegetative Cover
4	**DRAINAGE/EROSION CONTROL**
a	Construct Terraces
b	Construct Letdown Channels
c	Clean Perimeter Drainage Ditches

5	**ADMINISTRATIVE SERVICES**
6	**TECHNICAL and PROFESSIONAL SERVICES**
7	**FINAL CLOSURE CONTINGENCY**

Chapter 4 will address each task and service identified in Table 3.1, including a detailed description, determination whether task or service is subject to regional variation, units of measurement, constants, conversion and adjustment factors, assumptions, and documented unit cost.

3.3 Evaluation of Post-Closure Tasks and Services

The development of post-closure tasks and services begins with review of existing regulatory requirements completed in Chapter 1 and presented in Table 1.6. Table 1.6 illustrates the regulatory language defining post-closure requirements for MSWLFs, NHISW landfills, and C&D landfills is very similar. Regulatory language can be ambiguous and the use of Table 1.6 for calculating post-closure costs estimates would be difficult. Research of surrounding states' solid waste regulatory agency's and the United States Environmental Protection Agency's solid waste financial assurance programs presented in Chapter 2 provided valuable information to consider in modifying the tasks and services listed in Table 1.6.

Based on the information in Chapter 1 and research completed in Chapter 2, the regulatory post-closure tasks and services listed in Table 1.6 were evaluated to answer these questions:

- Does the regulatory task or service require clarification before it is able to be implemented?
- Are there separate tasks and services that from a practical engineering and construction perspective would be completed as a single task or service?
- Can one or more tasks or services be combined to simplify the cost estimating procedure and still comply with the regulations?
- Can a unit cost be precisely described or defined for the task or service?

Discussion and examples of the evaluation process are presented in the following subsections.

3.3.1 Regulatory Clarification

The regulatory language for post-closure activities, presented in Table 1.6, clearly identifies post-closure tasks but does not describe the tasks in sufficient detail to allow a landfill to list specific post-closure task(s) to calculate a cost estimate. Therefore, the procedure for calculating post-closure costs must clarify how a specific landfill will implement the regulation. The difficulty of implementing some of the regulations is illustrated by Task 8 in Table 1.6, which quotes regulatory language stating the landfill post-closure plan must include "procedures for reworking or replacing any defective required groundwater monitor wells and other defective monitoring equipment and installing new wells and equipment as required." Although the regulation clearly identifies a task, the language format is not concise enough for a landfill to

determine a cost estimate. A C&D landfill or NHISW landfill may only have groundwater monitoring wells, while a MSWLF may have groundwater monitoring wells, methane gas probes, and a landfill gas extraction system. Therefore, development of specific post-closure tasks and services must demonstrate compliance with the regulations and relevance to the landfill type and specific site.

3.3.2 Aggregate Tasks and Services Based on Engineering or Construction Practices

The regulatory language for post-closure activities presented in Table 1.6 lists the necessary tasks and services for completing post-closure. However, based on standard engineering or construction practices, several individual tasks or services may be aggregated. The point is illustrated by Tasks 1 and 2 in Table 1.6. Amending the site specific post-closure plan and completing a plan to comply with all applicable technical requirements are inter-related tasks that are better aggregated together. Another example is Tasks 6 and 7. These tasks require repair and maintenance of on-site improvement, structures, and drainage structures. From a practical construction perspective, these tasks would be completed by the same contractor and should be aggregated together. Combining regulatory tasks like these also simplifies the post-closure cost calculation by reducing the items. Ultimately it was determined that six items would best be combined to form the post-closure category: Technical and Professional Services, that now include:

- Amending closure plan;
- A plan to comply with all applicable technical requirements;
- Technical and professional services;
- Protocol for collecting and analyzing soil and water samples as required;
- Preparing annual maintenance and monitoring post-closure reports; and
- Preparing post-closure certification.

3.3.3 Aggregate Tasks and Services Based on Procedure Simplification

The regulatory language for post-closure activities, presented in Table 1.6, lists the necessary tasks and services for completing post-closure, including several general categories. Task 3, 4, and 17 list general categories “Technical and Professional Services”, “Administrative Services”, and “Post-Closure Contingency”. “Technical and Professional Services” may include activities such as conducting statistical analysis on groundwater data, preparing annual reports, and completing post-closure certification. “Administrative Services” may include administrating the various maintenance and service contracts, managing the funds for completing post-closure, conducting review of maintenance and monitoring activities, completing necessary record keeping, and performing necessary legal actions associated with completing post-closure. “Post-Closure Contingency” may include activities such as correcting structural failure of the cap, and correcting a failed leachate collection system, and installing a groundwater remediation system or gas control system, and other possible, but unforeseen, problems at the landfill. Describing, defining, and determining cost estimates for the numerous activities associated with each of these categories would create a very complicated and unquantifiable procedure for calculating post-closure costs. Therefore, creating general categories for “Technical and Professional Services”, “Administrative Services”, and “Post-Closure Contingency” allows landfills to comply with all

the regulatory post-closure requirements and simplify the post-closure cost estimate calculation procedure.

3.3.4 Determination of Precise Unit Costs

The regulatory language for post-closure activities, presented in Table 1.6, presents the necessary tasks and services for completing post-closure. However, some descriptions are impractical to assign a concise unit cost to the task or service. In instances where precise unit costs could not be practically determined from the regulatory language, the task or service was divided to more clearly define necessary items and allow development of concise unit costs. Task 8 in Table 1.6 illustrates the problem created when a concise unit cost cannot be determined. Task 8 requires landfills have a "protocol for collecting and analyzing soil and water samples, as required." Since different types of landfills have different requirements, a precise and concise unit cost cannot be determined. A C&D landfill may only have groundwater monitoring wells. While a NHISW landfill may have some surface water sampling points and groundwater monitoring wells, a MSWLF may have surface water sampling points, groundwater monitoring wells, and methane gas probes. Assigning a unit cost that would apply to all these facilities and monitoring requirements is impractical. Therefore, regulatory compliance is better achieved by separating the task into three subtasks. Individual unit costs for groundwater monitoring wells, methane gas probes, and surface water sampling points can be reasonably determined. Therefore, dividing some complicated tasks and services allows landfills to achieve regulatory compliance and determine concise unit costs.

3.4 Identification of Post-Closure Tasks and Services

The evaluation procedures discussed in Section 3.3 and applied to Table 1.6 are tabulated in Attachment 7 and list post-closure tasks and services according to regulatory citation. Table 3.2 presents a practical format and lists tasks and services chronologically and task-wise according to post-closure monitoring and maintenance activities and represents the tasks and services for owner/operators to estimate third-party post-closure costs. Due to differences between the types of landfills and specific permit requirements, not all items in the comprehensive list of post-closure tasks and services will be applicable to all landfills. Instead, the list is intended to identify all the post-closure tasks and services. Each individual landfill will use those items applicable to their site.

TABLE 3.2 Comprehensive Post-Closure Cost Estimation Task and Services

POST-CLOSURE COST ESTIMATION TASK and SERVICES	
1	**SITE MAINTENANCE**
a	Site Inspections
b	General Maintenance
c	Remediation and/or Gas Control Equipment
2	**MONITORING EQUIPMENT**
a	Rework/Replace Monitoring Well(s)
b	Plug Abandoned Monitoring Well(s)
c	Final Plugging of Monitoring Wells

POST-CLOSURE COST ESTIMATION TASK and SERVICES	
d	Rework/Replace Methane Probe(s)
e	Plug Abandoned Methane Probe(s)
f	Final Plugging of Methane Probes
g	Final Plugging of Piezometer(s)
4	**SAMPLING and ANALYSIS**
a	Groundwater Monitoring Wells
b	Methane Gas Probes
c	Surface Water Monitoring Points
d	Leachate
5	**FINAL COVER MAINTENANCE**
a	Mow and Fertilize Vegetative Cover
b	Repair Erosion, Settlement, and Subsidence
c	Re-seed Vegetative Cover
6	**LEACHATE MANAGEMENT**
a	Clean Leachate Line(s)
b	Maintain Leachate Collection System and Equipment
c	Collect, Treat, Transport, and Dispose Leachate
7	**ADMINISTRATIVE SERVICES**
8	**TECHNICAL and PROFESSIONAL SERVICES**
9	**POST-CLOSURE CONTINGENCY**

Chapter 4 will address each task and service identified in Table 3.2, including a detailed description, determination whether the task or service is subject to regional variation, units of measurement, constants, conversion and adjustment factors, assumptions, and documented unit cost.

3.5 Procedures for Amending Closure and Post-Closure Tasks and Services

3.5.1 Amending Closure and Post-Closure Tasks and Services Due to Technical Requirements or Corrective Action

All facilities must develop closure and post-closure tasks and services and compute cost estimates in order to providing financial assurance. Each facility must then receive DEQ approval. Oklahoma Administrative Code (OAC) 252:510-21-2, OAC 252:510-21-3, and OAC 252:520-23-40 require landfills annually adjust closure and post-closure cost estimates to account for inflation and operational changes. Examples of operational changes include constructing new disposal cells or constructing final cover over completed areas. Facilities may also need to adjust closure or post-closure cost estimates due to changes in technical

requirements or the development of corrective action at the facility. For example, technical requirements change for a Title V landfill when non-methane gas emissions exceed 50 Megagrams per year (Mg/yr). Under current regulations these landfill would have to install a gas extraction system. Another possible scenario would be changes in the units or conversion factors used in calculating cost such as when a facility receives DEQ directive under OAC 252:510-19-11 or OAC 252:520-23-20 to lengthen the post-closure monitoring period. Development of corrective action might include the discovery of groundwater contamination or landfill gas levels exceeding regulatory limits. In all cases, a facility will modify the closure and post-closure plans and adjust cost estimates accordingly.

The procedure for adjusting closure and/or post-closure cost estimates due to changes in technical requirements or development of corrective action includes:

- Changing the unit or conversion factor in the specific calculation, if applicable;
- Adding specific task or service item to address the new technical requirement or corrective action, if applicable;
- Determining appropriate and documented unit cost(s);
- Recomputing closure and/or post-closure cost estimate(s) maintaining previously identified task and services; and
- Submitting revised closure and/or post-closure plan(s) and cost estimates to the DEQ.

3.5.2 Amending Closure and Post-Closure Tasks and Services Due to Regulatory Requirements

Landfills have designed operational lives measured in decades and regulatory post-closure monitoring requirements ranging from eight to 30 years. Facilities operating over such long periods of time will witness new developments and changes in the regulations that govern their operation. Therefore, a procedure is necessary to address how existing landfills adjust closure and post-closure cost estimates to comply with changing regulations.

The procedure for adjusting closure and/or post-closure cost estimates due to regulatory changes includes:

- During the rule making process, the DEQ identifies if a rule change affects calculating closure or post-closure cost estimates;
- After passage of the rule(s), in the case of adding new rule(s), the DEQ shall develop a description of tasks and services and determine appropriate standard unit cost(s). In the case of removing an existing rule, the DEQ shall determine which tasks or services associated with the rule are removed. After these determinations, the DEQ shall notify all facilities whose cost estimates will be affected by the rule(s);
- Owner/operators adds or deletes the appropriate task or service from the closure and/or post-closure cost estimating worksheets and recomputes the cost estimates; and
- Owner/operators submit revised closure and/or post-closure plan(s) and cost estimates to the DEQ.

Chapter 4 -Unit Costs

The purpose of this chapter is to identify and document legitimate third-party unit costs for tasks and services determined in Chapter 3. Development of unit costs has been completed by research of regulated community, vendors, service providers, and standard references. A determination will be made as the susceptibility of task and service unit costs variation due to geographical location across the state. Mechanisms are presented for adjusting unit costs for inflation, changes in required tasks or services, and periodic review and re-verification.

4.1 Unit Cost Resources

Chapter 1 discussed the necessity for determining legitimate third-party unit costs. Successful financial assurance programs must use unit costs that come from identifiable resources and are capable of being validated. Identifiable resources are specific entities, agencies, or institutions that because of their operation provide services and information on the cost of activities associated with landfill final closure and post-closure tasks and services. This project identified the following resources for use in determining legitimate third-party unit costs:

- Environmental regulatory agencies in other states;
- Existing landfills operating in Oklahoma;
- Companies providing environmental drilling services;
- Laboratories providing environmental analysis services;
- Companies providing geosynthetic construction materials;
- Public facilities providing wastewater treatment services;
- Companies providing leachate line cleaning services;
- Oklahoma Department of Transportation;
- Oklahoma Department of Mines;
- Oklahoma Farm Agency/Natural Resource Conservation Service;
- Oklahoma Conservation Commission;
- Oklahoma Corporation Commission; and
- R.S. Means Company, Inc.

In order to reference an entity, agency, or institution, the resource must maintain a means to validate the unit cost. Chapter 2 summarizes the procedures and methods for determining or using unit costs employed by the states surveyed. States using specific unit costs for their financial assurance program can be referenced and periodically re-examined. Landfills operating in Oklahoma may have performed or may be performing an identified task or service at an existing facility. Using operating landfills as a resource provides the opportunity for the financial assurance program to compare actual expenses to proposed unit costs. Therefore, a survey including the tasks and services identified in Tables 3.1 and 3.2 was distributed to managers of 33 MSWLF, 13 NHISW landfills, and 4 C&D landfills operating in Oklahoma. The survey provided landfills the opportunity to share actual unit cost data with the DEQ. Fourteen of the 50 landfills responded to the survey. The data obtained from the operating landfills is incorporated in the following subsections.

Companies providing services specifically related to landfill final closure and post-closure, such as environmental drilling companies, environmental laboratories, geosynthetic materials manufacturers, wastewater treatment plants, and service companies with equipment to clean leachate lines, are resources that can provide specific unit cost information. The validation process for unit cost from these sources is reproducible by the DEQ and landfill owner/operators. Research of Oklahoma businesses identified eight environmental drilling companies and nine environmental laboratories. Attachments 8a and 8b, respectively, provide reference information on each company surveyed. Figures 4.1 and 4.2 show the geographical relationship between the landfill locations and environmental drilling companies and laboratories, respectively. Figure 4.1 shows the drilling companies are sufficiently distributed across the state so the distance between them and any given landfill is only about 75 miles. Figure 4.2 shows the laboratories are located in the larger metropolitan areas across the state. The typical distance from a laboratory to landfill is 120 miles.

The manufacturing of geosynthetic materials is a global industry with a limited number of companies. Research for this project targeted three major manufacturers. Attachment 8c provides reference information on each company surveyed. Unit cost information from these companies is described in specific task and service unit cost discussions presented in the following subsections.

Using publicly owned treatment works (POTWs) can be one of the easiest method of disposal and treatment of leachate. No special equipment or construction is necessary at the landfill. Tanker trucks pump the leachate out and haul it to the POTW for disposal. Choosing this method would mean the DEQ would not have the responsibility of operating or maintaining an on-site leachate treatment and disposal system. POTWs across the state were contacted based on the geographical locations of landfills. Figure 4.3 depicts the geographical relationship between landfills and POTWs showing the typical hauling distance is 70 miles. Attachment 8d provides reference information on each POTW surveyed.

Figure 4.1 Geographical Relationship Between Landfills and Environmental Drilling Companies

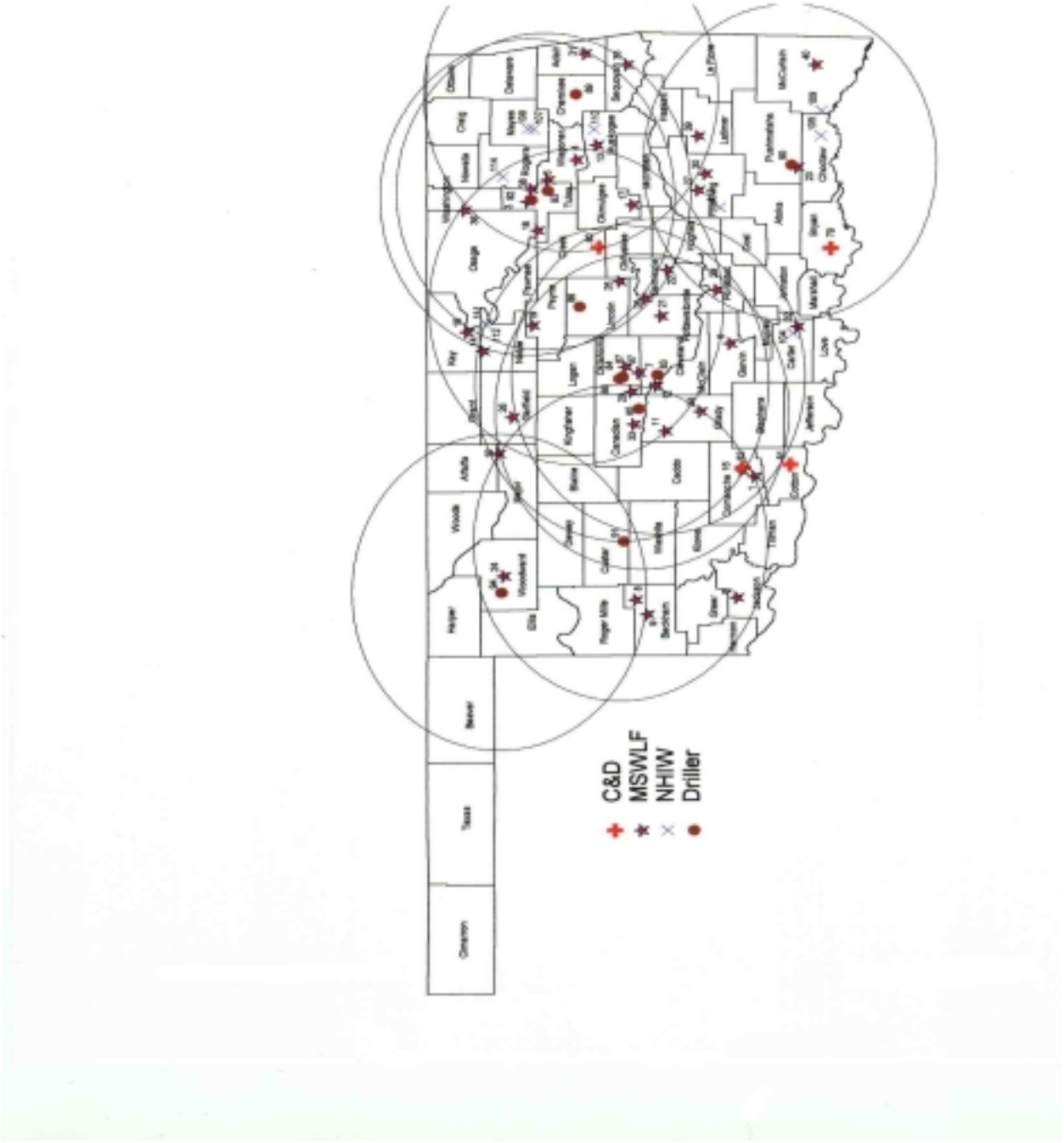


Figure 4.2 Geographical Relationship Between Landfills and Laboratories

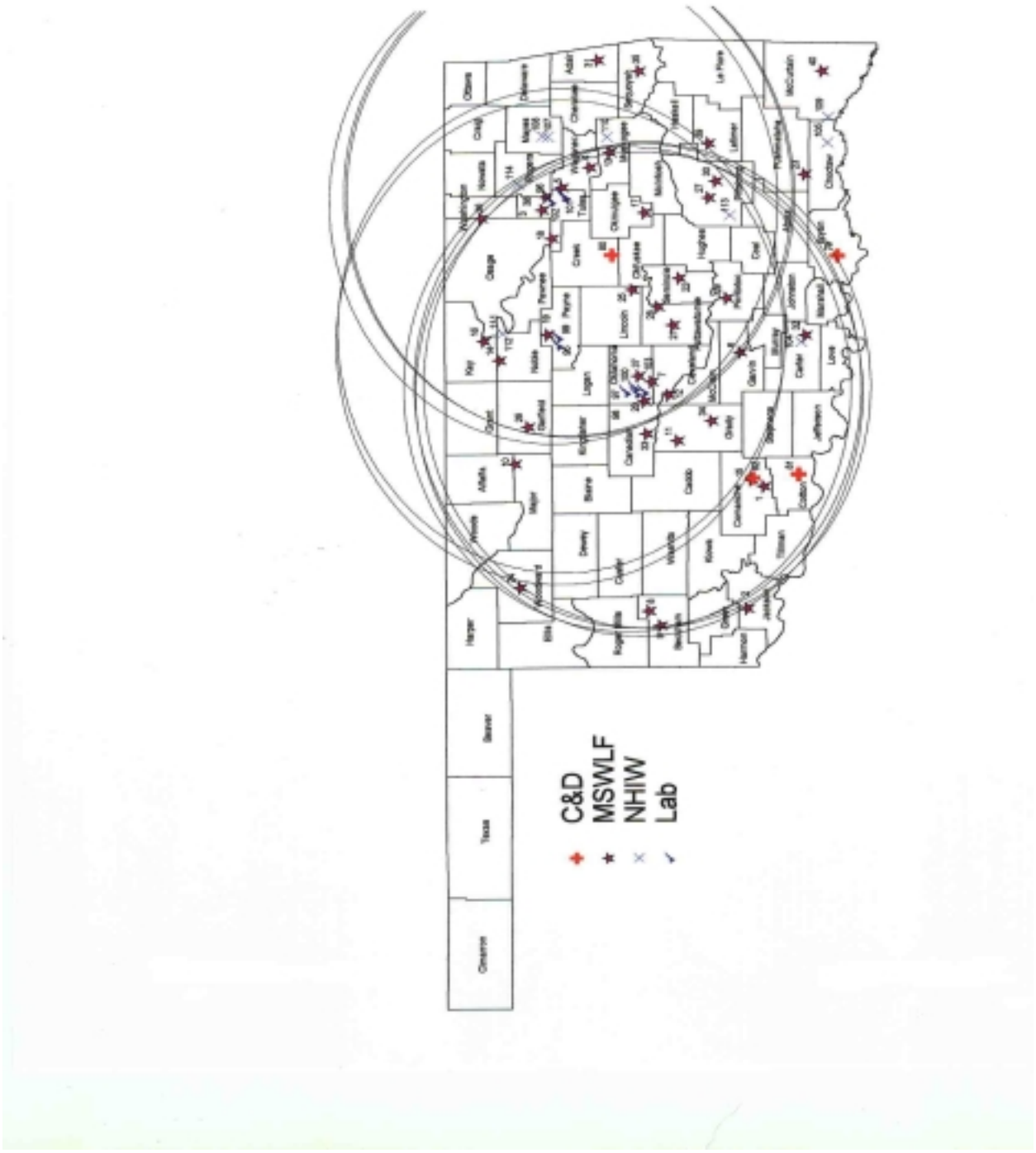
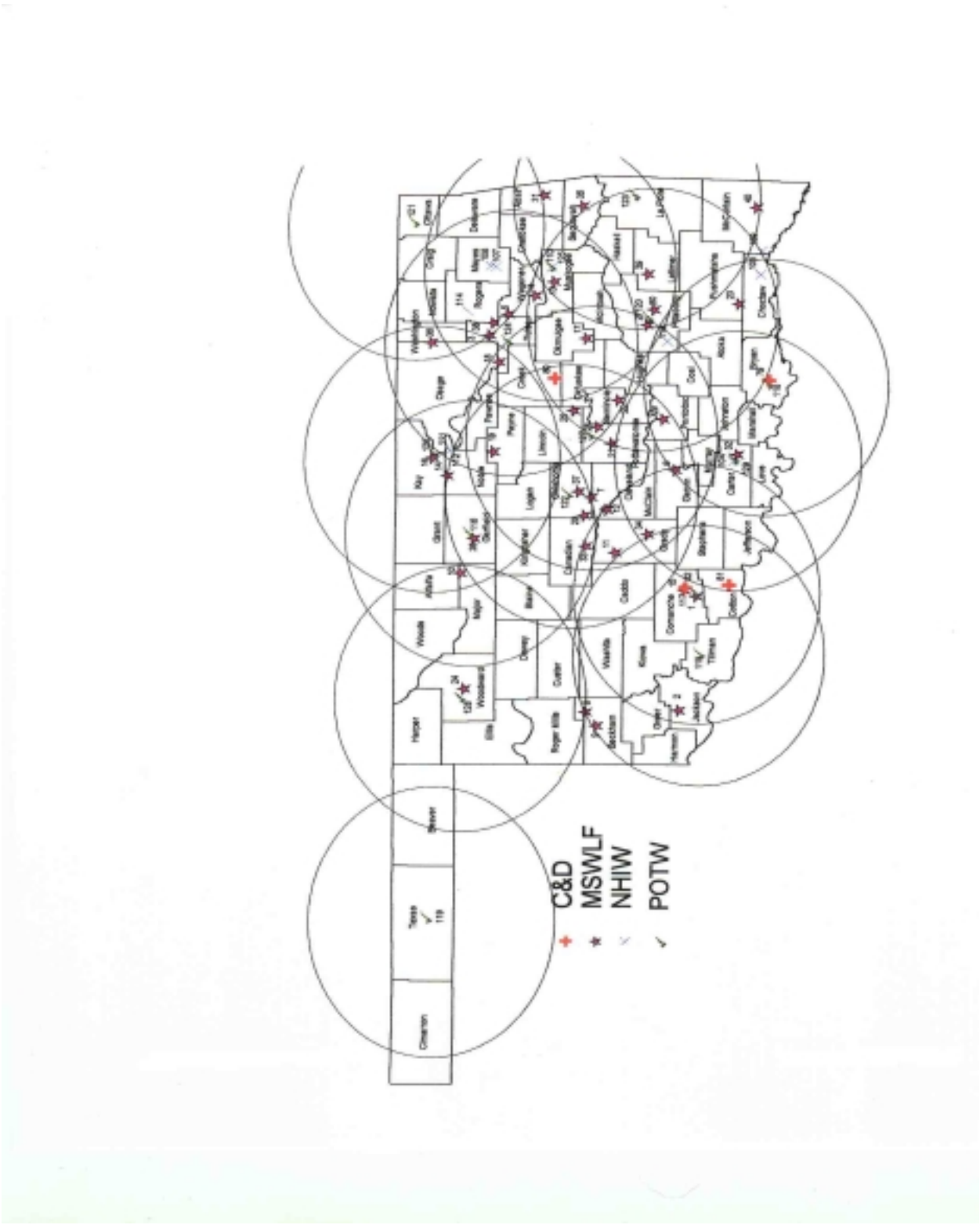


Figure 4.3 Geographical Relationship Between Landfills and POTWs



4.2 Financial Assurance Programs from Other Oklahoma Agencies

The DEQ is the regulatory agency responsible for final closure and post-closure activities at landfills in Oklahoma. However, the DEQ has not been the responsible party for actually completing final closure or post-closure activities. The survey of other state environmental regulatory agencies presented in Chapter 2 found that Minnesota appears to have the most experience in actually completing closure and post-closure activities for landfills through its Closed Landfill Program. Agencies in Oklahoma that do perform or supervise activities adaptable to landfill final closure and post-closure activities are the Department of Transportation, Department of Mines, and Corporation Commission.

The Oklahoma Department of Transportation (ODOT) oversees the majority of transportation related construction projects within the state. ODOT is comprised of eight regional divisions, housing specialists in construction, maintenance, design and management. Each regional division is comprised of a main office and numerous maintenance yards and construction residences. ODOT's central management offices are located at 200 NE 21st Street, Oklahoma City, Oklahoma. Figure 4.4 is a map representing the boundaries of each of the eight regional divisions. Attachment 9 lists addresses for the regional division offices and the central offices.

ODOT utilizes and maintains BAMS/PES, a massive database of unit cost items associated with transportation related projects. The BAMS/PES database is comprised of 20,000+ unit cost items. All construction and maintenance projects overseen by ODOT utilize the BAMS/PES established unit costs for development of engineering estimates and contractor bid forms. From quarterly, statewide bid lettings, ODOT tracks engineers' estimates and actual bids for BAMS/PES unit costs identified within the project. These unit costs are accumulated and reported on bid tabulation forms available from the office of the ODOT Office Engineer in Oklahoma City.

The vast majority of the BAMS/PES unit costs are not related to aspects of landfill closure. Review of the 20,000+ unit costs produced ten unit cost categories trackable against the listed unit costs monitored by the ODEQ for landfill financial assurance. These ten trackable categories are:

- Top Soil
- Salvaged Top Soil
- Sand
- Riprap
- Fencing
- Solid Slab Sodding
- Broadcast Sprigging
- Mulch Sodding
- Vegetative Mulching
- Mowing

Targeting the ten identified categories, all the bid tabs for ODOT projects between March 1998 and October 1999 were reviewed. A summary is provided for each category in Table 4.1.

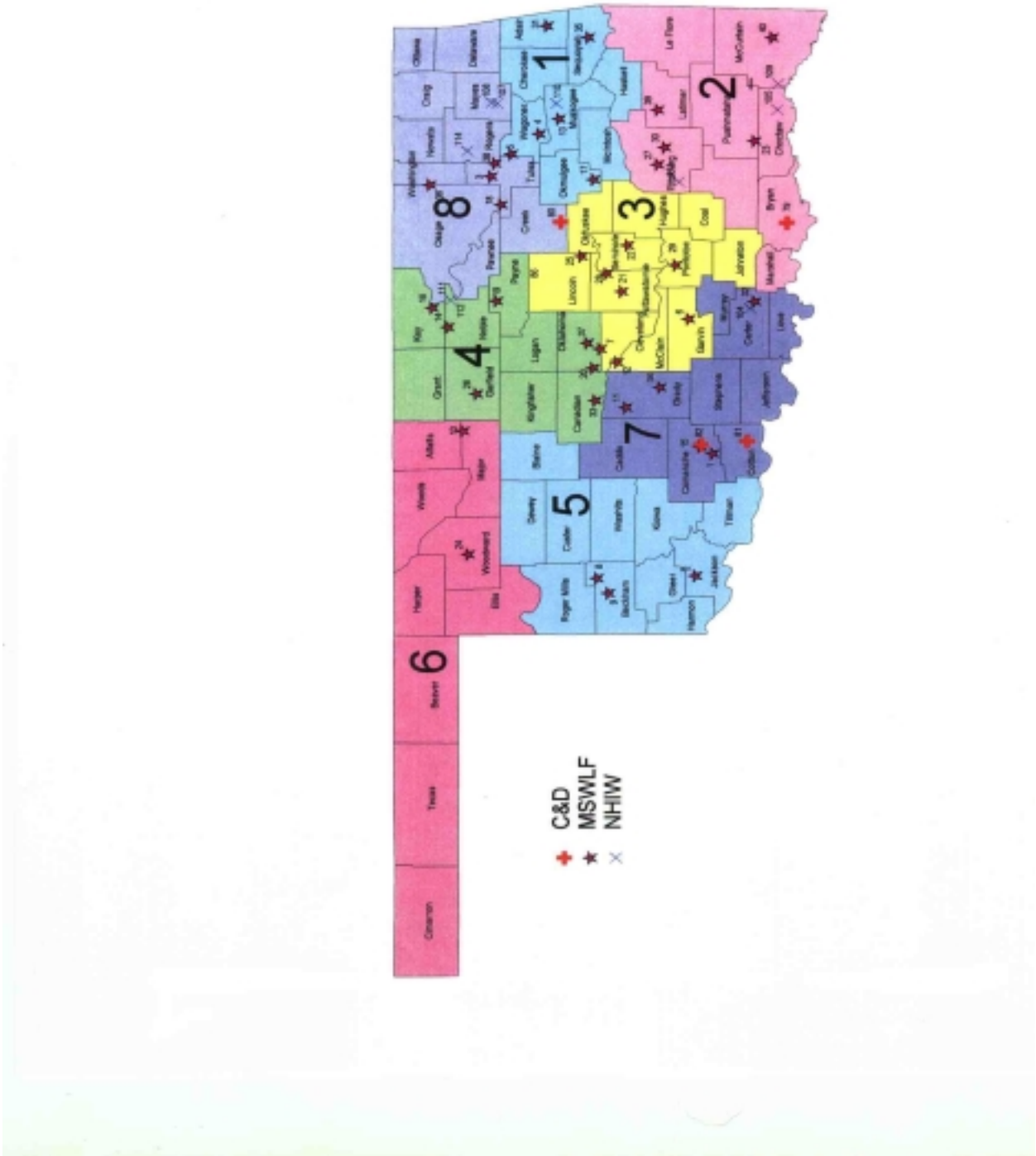
TABLE 4.1 ODOT Unit Costs

	Category	Minimum	Maximum	Average	Median
1	Topsoil				
	Quantity (CY)	65	6,703	1,989	1,343
	Unit Cost ($/CY)	$4.93	$114.69	$16.14	$13.76
2	Salvaged Topsoil				
	Quantity (CY)	3,996	70,388	36,595	26,865
	Unit Cost ($/CY)	$1.00	$10.00	$3.58	$3.03
3	Sand				
	Quantity (tons)	28	620	222	180
	Unit Cost ($/ton)	$13.54	$165.00	$24.42	$22.00
4	Riprap				
	Quantity (tons)	132	2,290	848	765
	Unit Cost ($/ton)	$17.00	$75.00	$26.13	$25.00
5a	Fencing (4-Strand Barbwire)				
	Quantity (LF)	66	1,640	1,036	1,210
	Unit Cost ($/LF)	$1.22	$10.67	$3.52	$2.98
5b	Fencing (5-Strand Barbwire)				
	Quantity (LF)	26	91,086	18,920	15,495
	Unit Cost ($/LF)	$0.59	$10.25	$2.74	$2.20
5c	Fencing (4-foot Chain-link)				
	Quantity (LF)	262	1,429	577	444
	Unit Cost ($/LF)	$2.70	$12.00	$7.93	$9.07
5d	Fencing (6-foot Chain-link)				
	Quantity (LF)	36	5,755	1,328	757
	Unit Cost ($/LF)	$6.50	$30.48	$13.67	$13.00

6	Solid Slab Sodding				
	Quantity (SY)	17	241,889	14,151	5,877
	Unit Cost ($/SY)	$0.85	$16.20	$2.35	$2.00
7	Broadcast Sprigging				
	Quantity (SY)	32,396	356,366	198,446	185,556
	Unit Cost ($/SY)	$0.07	$0.55	$0.18	$0.13
8	Mulch Sodding				
	Quantity (SY)	1,267	295,810	67,767	17,000
	Unit Cost ($/SY)	$0.53	$3.89	$1.35	$1.22
9	Vegetative Mulching				
	Quantity (acres)	0.44	241.98	17.39	4.20
	Unit Cost ($/acres)	$40.50	$2,632.50	$653.75	$555.80
10	Mowing				
	Quantity (acres)	1.85	160.00	39.18	30.00
	Unit Cost ($/acres)	$10.00	$300.00	$47.96	$40.00

Evaluation of the applicability of determining appropriate unit costs from the BAMS/PES for the above referenced items provides a variety of positive and negative aspects as outlined in Table 4.2. From a positive viewpoint, BAMS/PES allows for a determination of regional cost variations. Over the active life of the BAMS/PES database a large volume of unit cost data has been recorded for projects located within all 77 counties. This factor along with the BAMS/PES unit costs availability and overall volume of data points should benefit the calculation of landfill financial assurance unit costs along with their regional variations.

Figure 4.4 Oklahoma Department of Transportation's Regional Divisions



Inherent in the evaluation of the BAMS/PES unit cost applicability are several negatives. The BAMS/PES database is set up to record unit costs as they relate to transportation projects. Therefore, of the 20,000+ unit costs items tracked, a low percentage actually can be applied to landfill closure assurance. Also, estimating practices of roadway contractors versus landfill closure contractors must be accounted for in evaluation of BAMS/PES unit costs. These estimating practices are mostly affected by the operating environment of the project. These operating environments are established by the standard specifications provided for each project by the engineer-of-record. One would, therefore, assume a higher unit cost to achieve the elevated standard. A third negative factor to consider is the manipulation of bid processes by a contractor for his advantage. Many factors can influence the unit cost for a specific item that a contractor may bid on certain projects. A contractor may undervalue or exaggerate a specific unit cost to achieve higher payout during the early stages of construction, eliminate a stored surplus of material or multiple other reasons.

Utilization of BAMS/PES unit cost figures will require an in-depth study of each individual data point and utilization of statistical analysis to account for the multiple variables affecting each like data point. If a landfill does use any BAMS/PES unit costs they must account for negative and positive factors as outlined in Table 4.2.

TABLE 4.2 Negative and Positive Factors Associated with ODOT BAMS/PES

NEGATIVES	POSITIVES
Roadway contractors	Regional reference
Different project specification	Extensive/historic database
Bid manipulation	Readily available
Project sizes vary	
Bid items not summarized in database	
Requirements vary between projects, up to design engineer	
Most unit costs not related to landfill closure activities	

The Oklahoma Department of Mines is responsible for assuring that depleted surface mine sites are restored to useful purposes at the conclusion of mining operations. During the strip mining process, large quantities of soil are excavated, stockpiled, replaced and re-vegetated, and thus have a distinct similarity to landfill activities. Generally both the Department of Mines and the applicant calculate the bond value and negotiate a sum agreeable to both parties.

Since coal strip mines are the most complex type to restore, the following discussion is based on coal strip mine bonds. The calculation process involves a thorough review of the mining plan, to determine the worst case scenario where the maximum area of unrestored mine pits are likely to be exposed. The surface mining process involves removal and stockpiling of topsoil, and excavation of trenches to expose the coal. Overburden soil is stockpiled adjacent to the initial

trench. After the first trench is depleted, another is started parallel to the first, and soil is placed into the first trench. After mining equipment has moved several trenches distant, the previous trench areas are re-graded and compacted to an acceptable degree and topsoil is replaced. Seeding and fertilization to establish acceptable cover completes the process. In addition to the mining itself, sediment collection ponds are constructed to retain runoff, and haul roads are constructed from the mined areas to coal pad (stockpile) locations where it is loaded for off-site transport. The mining process is dynamic. In theory, as mining proceeds, restoration work follows, with a relatively uniform volume of disturbed area between. Typically the pits at strip mine sites are not completely uniform and at some point, there is a maximum exposed area. This is the basis for bond size determination.

A Department of Mines Bond is calculated to provide sufficient funding to properly close a site if the mining company defaults on its responsibility. The bond calculation is based on the cost of employing an outside engineer and contractor to restore the site. Costs are determined for categories as described in Table 4.3.

TABLE 4.3 Department of Mines Financial Assurance Calculation Categories

1.0	**DIRECT COSTS**
1.1	Earth moving which includes:
a	Backfilling of the pits
b	Removal of haul roads
c	Restoration of coal pads
1.2	Seed and Fertilize Restored Areas
1.3	Maintenance Costs
a	Area to maintain until vegetative cover is complete
b	Temporary stormwater ponds
c	Permanent stormwater ponds
2.0	**Indirect Costs Necessary to Complete Restoration**
2.1	Mobilization and Demobilization by contractor
2.2	Engineering by outside consultant
2.3	Reclamation Management
2.4	Contingencies
2.5	Profit and Overhead

Determination of direct costs is performed as a series of line item calculations, usually with assistance of a spreadsheet computer program. For each item the actual quantity of work to be

completed, such as material to be moved, distance of haul, difficulty of mobility and other field related costs, is entered into the spread sheet program. Local labor and fuel cost adjustment factors are entered into the spreadsheet to better estimate the actual cost. Highly localized items such as seed and fertilizer spreading are based on prior local experience.
The computer program most often used by the Department of Mines is the Fleet Production Cost (FPC), developed by Caterpillar Corporation of Peoria, Illinois. Table 4.4 uses the FPC model to calculate closure costs for a typical mine. This program is based on equipment type, operational efficiency, site conditions, and maintenance data included in the Caterpillar Performance Hand Book, (latest edition). This hand book is revised on an almost annual basis. Local labor costs are derived from the Oklahoma Wage Report publications of the Oklahoma Employment Security Division. This report is updated annually. Fuel costs are adjusted based on current prices or projections.

The program user enters the site characteristics, equipment type, haul distance and volume of material handled and adjustment factors (for labor, fuel etc.) into the spread sheet, then the program searches the data bank and calculates the time required and cost to complete the project. When used with professional judgement, this program prepares estimates which are within a reasonable range.
Indirect costs are calculated as a percentage of direct costs based on prior experience and data included in Bonding Workshop, Student Notebook published by the US Department of the Interior, Office of Surface Mines: Reclamation and Enforcement Branch Training and Technical Information.

Table 4.4 Oklahoma Department of Mines Bond Calculation

Company: Phoenix Coal Company	Permit #4260	Increment 1	1/12/1998
Summary Calculations of Earthmoving Costs			
Equipment Type	Cost $/Hour	Labor($/hr)	Total Hours	
CAT D10N Dozer	$119.11	$10.77	52	$6,753.76
CAT D8N Dozer	$69.43	$10.77	10	$802.00
CAT 637E Scraper	$147.69	$10.77	18	$2,852.28
CAT 14G Grader	$41.55	$10.77	3	$156.96
Water Wagon (10K gal)	$58.24	$10.77	18	$1,242.18
Fuel/Service	$30.49	$10.77	18	$742.68
			Total Earthmoving Costs	$12,549.86
Seed and Fertilize (Total Top soiled Area)				
Seed and Fertilize	4 Acres @	$300.00	Per Acre	$1,200.00

Maintenance Cost (Total Permit Disturbance)				
Area to Maintain	56.5 Acres @	$200.00	Per Acre	$11,300.00
Temporary Ponds/FPI	3 Ponds @	$1,500.00	Per Pond	$4,500.00
Permanent Ponds	0 Ponds @	$500.00	Per Pond	$0.00
			Total Maintenance Cost	$15,800.00
			Total Direct Reclamation Costs	$29,549.86
Indirect Costs in Percentages of Reclamation Costs				
Mobilization and Demobilization		5.00%		$1,477.49
Contingencies		10.00%		$2,954.99
Engineering		9.00%		$2,659.49
Profit and Overhead		13.60%		$4,018.78
Reclamation Management		6.50%		$1,920.74
			Total Indirect Costs	$13,031.49
			Total Bond Amount Required	$42,581.35

The Oklahoma Conservation Commission is responsible for closure of abandoned mine sites. Commission staff perform technical services such as engineering design for each project. All other associated restoration tasks and contracts are administered by the Oklahoma Department of Central Services (DCS), except re-vegetation. The DCS contracts cover tasks associated with the major earthmoving and restoration work. Once restoration earthwork has been completed the sites are re-vegetated by discing, mulching, and planting. The discing, mulching and planting is performed under contracts negotiated between the Conservation Commission and the local county conservation districts at a rate of approximately $400.00 per acre.

The Farm Service Agency (FSA) acts as the administration agency for the Natural Resource Conservation Service (NRCS). There are 17 NRCS field office teams covering Oklahoma, as shown on Figure 4.5.

Figure 4.5 National Resource Conservation Service Regions

NRCS has a cost sharing program (Environmental Quality Incentives Program) to assist farmers with conservation projects such as erosion control structures, farm ponds, and planting of drainage ways. For each district office, FSA maintains a listing of unit costs per task for every project during the year. Each year the district offices submit a cost report to the Oklahoma State Farm Service Agency which prepares a state wide report. This annual report sets the basis for the district unit cost reimbursement for the next year. Table 4.5 lists the unit costs for the Logan-Oklahoma county Farm Service District Agency District for the year.

Table 4.5 Practices/Component Report for Environmental Quality Incentives Program

PRACTICES & COMPONENTS	UNIT TYPE	UNIT COST
CRITICAL AREA PLANTING - 342		
Alkali Sacaton CA (GASA)	AC	$46.92
Bahlagrass (GBH)	PIP	$1.35
Bermudagrass Mulch Sod (GBGMS)	SY	$1.00
Bermudagrass Solid Sod (GBGSS)	SY	$4.90
Bermudagrass Sprigs CA (GBGS)	AC	$109.00
Erosion Control Blanket (ECB)	SY	$51.25
Fertilizer CA <1 acre (FTC1)	ITEM	$61.00
Fertilizer CA >1 acre (FTC2)	AC	$45.00
Guymon Bermudagrass CA (GGBGA)	AC	$101.20
Gypsum (GYP)	TON	$42.00
Liming (per ton ECCE) (LIME)	TON	$23.32
Native Mixture CA (GNMA)	AC	$99.04
Old World Bluestem CA (GOWBA)	AC	$69.76
Shaping and Filling Gullies (GFS)	AC	$400.00
Smooth Bromegrass CA (GSBA)	AC	$37.34
Switchgrass CA (GSGA)	AC	$49.84
Tall Fescue CA (GTFA)	AC	$43.04
Trees &/or Shrubs-barerooted (TSB)	EACH	$0.49
Vegetation <1 acre (VEG)	ITEM	$150.00
Weeping Lovegrass CA (GLGA)	AC	$30.40
Western Wheatgrass CA (GWWGA)	AC	$132.00

PRACTICES & COMPONENTS	UNIT TYPE	UNIT COST
RESIDUE MANAGEMENT, SEASONAL - 344		
Residue Management, Seasonal (RMS)	AC	$0.00
SEDIMENT BASIN - 350		
Anti-vortex Baffle (AVB)	SP	$3.55
Barrel &/or Riser - CSP<=12ga (BR12)	DIFT	$1.47
Barrel &/or Riser - CSP>=14ga (BR14)	DIFT	$1.29
Barrel &/or Riser - Plastic (BRP)	DIFT	$0.86
Barrel &/or Riser - Steel (BRS)	DIFT	$1.38
Concrete - Reinforced/Formed (CON1)	CY	$164.00
Drainage Pipe & Filter (PDF)	DIFT	$1.20
Excavation &/or Embankment (EM)	CY	$1.02
Fly Ash (FA)	TON	$24.00
Gypsum (GYP)	TON	$42.00
Hydrated Lime (HL)	TON	$15.00
Principal Spillway Drainage Diaphragm Filter (PSDDF)	CY	$23.00
Riprap and Filter (RRF)	CY	$30.00
Trash Guard (TG)	EACH	$200.00
WELL DECOMMISSIONING - 351		
Water Well Plugging (WWP)	NO	$1300.00
DIKE - 356		
Ridge and/or Chanel (RC)	CY	$0.85
Riprap and Filter (RRF)	CY	$30.00
WASTE TREATMENT LAGOON - 359		
Bentonite Liner (BL)	CY	$5.70
Clay Liner (CL)	CY	$3.00
Concrete - Reinforced/Formed (CON1)	CY	$164.00
Corrugated Steel Pipe (PCS)	DIFT	$1.29
Excavation &/or Embankment (EM)	CY	$1.02
Plastic Pipe (PP)	DIFT	$0.86
Pumping Facility (PF)	NO	$1000.00

PRACTICES & COMPONENTS	UNIT TYPE	UNIT COST
DIVERSION - 362		
Ridge and/or Channel (RC)	CY	$0.85
POND - 378		
Anti-vortex Baffle (AVB)	SF	3.55
Barrel &/or Riser - CSP<=12ga (BR12)	DIFT	1.47
Barrel &/or Riser - CSP>=14ga (BR14)	DIFT	1.29
Barrel &/or Riser - Plastic (BRP)	DIFT	0.86
Barrel &/or Riser - Steel (BRS)	DIFT	1.38
Blanket Material (BM)	CY	15.00
Clay Liner (CL)	CY	3.00
Concrete - Reinforced/Form (CON1)	CY	164.00
Drainage Pipe & Filter (PDF)	DIFT	
Excavation &/or Embankment (EM)	CY	1.02
Fly Ash (FA)	TON	24.00
Gypsum (GYP)	TON	42.00
Hydrated Lime (HL)	TON	15.00
Principal Spillway Drainage Diaphragm Filter (PSDDF)	CY	23.00
Riprap and Filter (RRF)	CY	30.00
Splashboard Riser - 18 inch and less (SR18)	DIFT	1.50
Splashboard Riser - 24 inch and greater (SR24)	DIFT	2.50
Trash Guard (TG)	EACH	200.00
WINDBREAK/SHELTERBELT ESTABLISHMENT - 380		
Geotextile Fabric (GEOTF)	LF	$0.45
Seedbed Preparation (SP)	AC	$30.00
Trees &/or Shrubs-barerooted (TSB)	EACH	$0.49
Trees &/or Shrubs-potted (TSP)	EACH	$1.05

Pumping Facility - 75% of actual cost not to exceed a specified maximum payment of $1,000.00.

The Oklahoma Corporation Commission (OCC), through management of the Indemnity Fund Program, has historically established specific unit costs for tasks performed for investigation and remediation of leaking underground storage tank (LUST) sites. Initially, the OCC developed "Reasonable Rates Paid by Indemnity Fund" (1992) internally with some consultation with local service providers and published national guideline sources . These unit cost guidelines were revised on a sporadic basis.

The OCC, with assistance of the Storage Tank Advisory Council, is in the process of reviewing and revising the cost guidelines. The Advisory Council is composed of representatives of consulting companies, analytical laboratories, drilling contractors and equipment suppliers who are active in the local remediation industry. This committee has evaluated the established unit costs and recommended changes which reflect current local economics. The unit costs summarized on Table 4.6 represent the reasonable value of tasks for reimbursement under the Oklahoma Leaking Storage Tank Facilities program. The information in this table is effective as of April 10, 1999.

TABLE 4.6 Recommended Reimbursement Guidelines for Oklahoma Leaking Storage Tank Facilities

TASK		UNIT COST
Professional Hourly Rates		
A	Principal	$100.00/hr
B	Senior Hydrologist/Engineer	$85.00/hr
C	Project Manager	$75.00/hr
D	Senior Technician/Staff Hydrologist	$55.00/hr
E	Draftsman/Field Technician	$45.00/hr
F	Clerical/General Laborer	$35.00/hr
Units and Costs		
A	Bailers	$10.00/bailer
B	Barricades (rental)	$7.00/each
C	Base Map (standard time = 4 hours)	$75.00/hr
D	Data Logger and Trans (rental)	$200.00/day
E	Decon Unit (rental)	$10.00/day
F	Develop/Sample/Survey(2 people)/Disposal (standard time = 6 hours)	$45.00/hr
G	Diaphragm Pump (rental)	$45.00/day
H	Drums	$30.00/drum

TASK		UNIT COST
I	FID (rental)	$80.00/day
J	Historical Research/Site Visit/Safety Plan (standard time = 6 hours)	$75.00/hr
K	Monitoring Well (2" or 4")	$32.00/ft
L	Oil/Water Interface Probe (rental)	$45.00/day
M	ORBCA Maps/Logs (drafting - standard time = 10 hours)	$45.00/hr
N	Organic Vapor Monitor (rental)	$80.00/day
O	OVA (rental)	$80.00/day
P	OWRD Search (standard time = 4 hours)	$75.00/hr
Q	PID (rental)	$80.00/day
R	Research (Public Notification - Staff Hydro - standard time = 1 hour)	$55.00/hr
S	Risk Analysis Report (Tier 1/1A - standard time = 30 hours)	$75.00/hr
T	Risk Analysis Report (Tier 2 - standard time = 24 hours)	$75.00/hr
U	Sensitive Receptive Survey (660' - standard time = 6 hours)	$55.00/hr
V	Sign (Public Notification)	$150.00/each
W	Site Sketch (drafting - standard time = 1 hour)	$45.00/hr
X	Site Sketch (hydrologist - standard time = 2 hours)	$55.00/hr
Y	Survey Equipment (rental)	$25.00/day
Z	Water Depth Gauge (rental)	$40.00/day
Mileage Rates		
A	Car	$0.31/mile
B	Truck (½ ton)	$0.40/mile
C	Truck (¾ ton)	$0.55/mile
D	Truck (1 ton)	$1.00/mile

In an effort to assure future costs remain realistic, the Council and OCC Staff have recommended adoption of a proprietary software program to determine reasonable remediation costs. This software, titled “Tank RACER 99” was developed by Talisman Partners, Ltd. of Englewood, Colorado, specifically for underground storage and petroleum-related assessments and remediation efforts. While this program is focused on UST type projects and not suitable to landfill final closure and post-closure activities, individual cost items are often provided by the same consultants and companies which also serve the landfill business. While Cardinal does not specifically endorse this software for landfill use, it conceptually offers a procedure to assure unit costs are current.

This software was developed nationally with the assistance of the United States Environmental Protection Agency Office of Underground Storage Tanks and representatives of oil companies and distributors, cleanup contractors, state fund administrators and regulatory agencies. The program's foundation for unit cost information is the data published in R.S. Means Company's *Environmental Cost Data - Unit Price and Environmental Remediation Cost Data - Assemblies* reference books.

The OCC's Petroleum Division - Pollution Abatement Department has jurisdiction over operation and closure of commercial drilling mud disposal pits. The Pollution Abatement Department closure regulations for commercial drilling mud disposal pits require soil cover and re-establishment of native vegetation. The regulations further require the operator to provide sufficient financial assurance to complete final closure of the disposal pits.

A typical mud disposal pit is constructed to the maximum depth of ten feet. Mud placement into the pit is allowed to a maximum depth of seven feet with a freeboard of three feet. During construction, the topsoil and sufficient soil for three feet of final restoration cover is required to be stockpiled adjacent to the pit. When the pit has been filled to the maximum height, it is allowed to surface dry until it can be backfilled with stockpiled soil and topsoil. Final seeding and grading complete closure. Three monitoring wells constructed at the site are plugged at completion of the closure.

The financial assurance amount for final closure has been established by the Pollution Abatement Department at $10,000 per acre. This value is based on experience and is not updated on any particular schedule. Disposal pits are not required to excavate and stockpile the soil necessary for final closure so the appropriateness of using $10,000 per acre closure amount is disputable. However, the final closure is based on experience and can serve as a useful reference to compare with site specific cost estimates submitted from landfills.

Presuming the landfill will not perform the final closure and post-closure activities, the DEQ will have to issue contracts with third-party entities to perform the work. The contracts will have to competitively bid. Successful bidders must provide the bonds and insurances listed in Table 4.7.

TABLE 4.7 State Requirements for Issuing Contracts†

1	Bid Bond	5% of bid amount
2	Workers Compensation Insurance	State set limit
3	General Liability Insurance	≥ $100,000.00
4	Automobile Insurance	≥ $300,000.00
5	Performance Bond	100% of bid amount
6	Defect Bond	100% of bid amount
7	Payment Bond	100% of bid amount

† Items 5, 6, and 7 are only required on contracts exceeding $15,000.00.

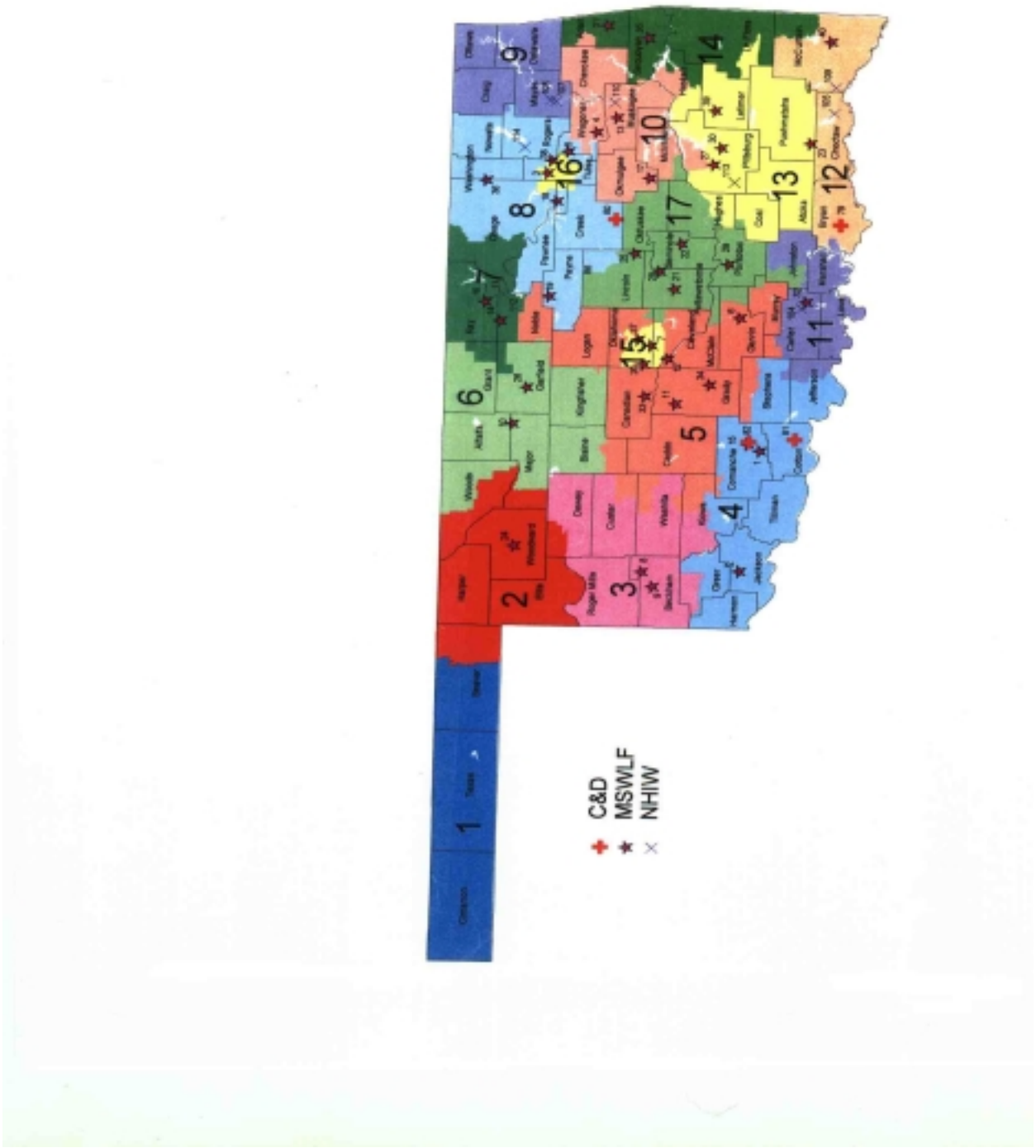
Alternative bid prices and unit costs presented to the DEQ should account for the proposed contractor being able to comply with the above state requirements.

The R.S. Means Company is nationally recognized as a reliable reference for determining environmental remediation, building construction, heavy construction, and site work/landscape projects costs. Research of state financial assurance programs discussed in Chapter 2 found four states either use or specifically reference R.S. Means as the source for unit cost data. Ten other states allow landfills to propose unit costs for approval. Typically these estimates are prepared by professional engineers, who may use R.S. Means as a resource. This chapter references unit costs from R.S. Means "Environmental Remediation Cost Data 2000, 6th Edition." As discussed above, the OCC is implementing a new software program that uses R.S. Means data for unit cost information. The unit cost data published by R.S. Means represents national averages for a specific assembly or item. Adjusting for regional variation in local economies is accomplished through localization factors established for individual zip code zones. Figure 4.6 shows the different zip code zones, 2000 R.S. Means localization factors for Oklahoma, and location of existing landfills. Table 4.8 lists the individual localization factors and shows that averaging the reported localization factors produces an Oklahoma average adjustment factor of 0.80.

TABLE 4.8 R.S. Means Localization Factors

ZONE	ZIP CODE	LOCALIZATION FACTOR	ZONE	ZIP CODE	LOCALIZATION FACTOR
1	739__	0.69	10	744__	0.74
2	738__	0.81	11	734__	0.82
3	736__	0.82	12	747__	0.81
4	735__	0.83	13	745__	0.78
5	730__	0.83	14	749__	0.81
6	737__	0.82	15	731__	0.83
7	746__	0.81	16	741__	0.82
8	740__	0.82	17	748__	0.81
9	743__	0.83	**AVERAGE INDEX**		**0.80**

FIGURE 4.6 Localization Factors for Oklahoma



4.3 Description of Closure Tasks and Services

Estimating closure costs for a landfill is achieved by calculating costs associated with tasks and services listed in Table 3.1. Each closure task and service requires a unit cost. The following closure task and service subsections define each task and service; determine if task or service is subject to regional variation; identify units of measurement; identify and explain constants and conversion factors; explain assumptions; determine associated unit cost; and evaluate whether changes in regulatory language are necessary to support including task or service in calculating closure costs.

4.4 Preliminary Site Work

4.4.1 Conduct Site Evaluation

Description: Presuming the owner will not be physically or financially able to complete closure and post-closure obligations, the DEQ becomes responsible for all tasks and services associated with closure of the landfill. Before initiating any closure activities the site will have to be inspected by an individual experienced in landfill operations and construction to evaluate and document existing conditions.

The site evaluation should inspect and document existing conditions for the following:

- Evaluate site security and access control features, such as fencing and gates used to restrict access to the site;
- Inventory, evaluate, and document all equipment, buildings, and other structures (i.e. fuel storage facilities, scales, recycling areas, and citizen convenience areas) present at the site;
- Inspect, determine integrity, and document condition of all groundwater monitoring wells, methane gas probes, and other monitoring equipment present at the site;
- Inspect and document condition of existing perimeter drainage structures and erosion control measures (i.e. terraces, let-down channels, sedimentation ponds, drainage pipes, and inlet/outlet structures);
- Inspect and document condition of leachate collection system and appurtenances (i.e. access and clean-out pipes, pumps, manholes, lift stations, surface impoundments, storage tanks and secondary containment, treatment systems); and
- Determine other site features that may not be in compliance with the permit.

Regional Variation: Not subject to regional variation.

Units of Measurement: Lump Sum.

Constants or Conversions: None.

Reference Unit Costs:

	Reference	Unit Cost
1	2000 R.S. Means Environmental Remediation Cost Data	
a	Project Engineer (33-22-0105)	$26.51/hr
b	Office Overhead	200%
c	General & Administrative Overhead	75%
d	Profit	5%
2	Subtotal	$100.74/hr
3	Average Localization Factor for Oklahoma	0.80
4	Total	$80.59/hr

Unit Cost Calculation Assumption(s):

	Assumption	Quantity	Units	Unit Cost	Total
1	Project/facility Review	8	hrs	$80.59	$ 644.72
2	Site Evaluation	8	hrs	$80.59	$ 644.72
3	Report of Finding and Recommendations	16	hrs	$80.59	$ 1,289.44
4	Mileage (round-trip)	200	miles	$0.32	$ 64.00
5	Miscellaneous Project Expenses	1	lump sum	$100.00	$ 100.00
6	**TOTAL**				**$ 2,742.88**

Unit Cost: $2750.00

Regulatory Changes: No recommendations.

4.4.2 Dispose Final Waste

Description: OAC 252:510-19-3(10) and OAC 252:520-23-8(c)(2) require a procedure for disposing of final wastes and affected soil. Immediately after a landfill owner/operator ceases operation, there will be some amount of waste that was not properly disposed. This waste may be uncovered waste at the working face, waste abandoned in trailers and containers on-site, or un-processed recyclable materials. Before final closure can proceed, all waste on-site must be properly managed and disposed. The activities associated with this task include:

- Transport all on-site waste to the working face;
- Properly compact and dispose all waste; and
- Excavate, haul, and apply daily cover.

Regional Variation: Subject to regional variation since the amount of waste will depend on the facility's average daily waste flow and current disposal cost.

Units of Measurement: Tons per day (tpd) and dollars per ton ($/ton).

Constants or Conversions: In order to determine the quantity, one will have to determine the average daily flow (tons per day). Average daily flow is based on the previous years reported total tonnage divided by 312 (52 weeks * 6 days/week) operating days per year.

Reference Unit Costs for Disposal:

Reference		Unit Cost
1	Wyoming Statutes (Solid Waste)	$10/CY
2	2000 R.S. Means Environmental Remediation Cost Data	
a	Nonhazardous Solid Waste (33-19-7269)	$77.17/ton
b	Average Localization Factor for Oklahoma	0.80
c	Total	$61.74/ton

Unit Cost Calculation Assumption(s):

Assumption	
1	Five days of waste has accumulated and/or is un-processed at each landfill
2	Daily cover soil is available on-site

Unit Cost: Varies Regionally - use the current posted disposal cost ($/ton) at the particular landfill.

Regulatory Changes: No recommendations.

4.4.3 Remove Temporary Buildings/Structures

Description: OAC 252:510-19-3(7) and OAC 252:520-23-8(b)(3) require facilities remove buildings and structures which include, but are not limited to: office/administrative buildings, scale houses, citizen convenience centers, recycling facilities, maintenance buildings, storage sheds, equipment sheds, and fuel storage facilities. Removal can be accomplished by demolishing buildings and structures and disposing in the working face. Actual buildings and structures present at a given landfill will be determined during the "Site Evaluation" and vary from site to site.

Regional Variation: Not subject to regional variation.

Units of Measurement: Lump sum.
Constants or Conversions: None.

Reference Unit Costs for Removing Building(s) and Structures:

Reference					Unit Cost
1	Wyoming Statutes (demolition, removal, and disposal)				$6.00/sq. ft.
2	Oklahoma Guidance Document				$3,500 lump sum
3	2000 R.S. Means Environmental Remediation Cost Data				
	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
a	D6 Dozer (17-03-0704)	10	HR	$100.08	$1,000.80
b	12 CY Dump Truck (17-03-0285)	10	HR	$65.26	$652.60
c	926, 2 CY Wheel Loader (17-03-0222)	10	HR	$69.38	$693.80
d	Equipment mobilization (99-06-0201)	1	LS	0.15%	$352.08
e	Equipment demobilization (99-06-0501)	1	LS	0.15%	$352.08
f	Subtotal				$3,051.36
g	Average Localization Factor for Oklahoma				0.8
h	Total				$2,441.09

Unit Cost Calculation Assumption(s):At least one office or administrative building, one building used for maintenance or storage, and one above-ground fuel storage tank facility.

Unit Cost: $2,450.00

Regulatory Changes: No recommendations.

4.4.4 Remove Equipment

Description: OAC 252:510-19-3(8) and OAC 252:520-23-8(b)(4) require facilities remove site equipment which includes but is not limited to: compactors, bulldozers, scrapers, front-end loaders, backhoes, graders, water trucks, dump trucks, and truck scale. Actual equipment present at a given landfill will be determined during the “Site Evaluation” and will vary from site to site.

Regional Variation: Not subject to regional variation.

Units of Measurement: Lump sum.

Constants or Conversions: None. A facility cannot adjust the closure costs by assigning a salvage value to equipment.

Reference Unit Costs:

Reference		Unit Cost
1	Oklahoma Guidance Document	$2,000 - lump sum
2	2000 R.S. Means Environmental Cost Data	
a	Equipment Demobilization (99-06-0501)	0.15 - 3.0% of construction costs
3	Landfill D	$1,000 - lump sum

Unit Cost Calculation Assumption(s): At least four pieces of equipment on-site and one set of truck scales.

Unit Cost: 0.15% of final closure costs or $2,000.00, whichever is more.

Regulatory Changes: No recommendations.

4.4.5 Repair/Replace Perimeter Fencing

Description: OAC 252:510-19-3(11) and OAC 252:520-23-8(b)(6) require facilities to maintain site security and access control. All facilities have some form of site security and access control, typically perimeter fencing and gates. Fencing can range from three strand barbed wire set with T-posts to ten foot high galvanized chain-link with three strand barbed wire. The "Site Evaluation" will determine the type and condition of a facility's site security and access control.

Regional Variation: Subject to regional variation because the unit cost is a published national unit cost. Adjust unit cost according to site location and factors shown in Figure 4.6.

Units of Measurement: Linear feet of fencing.

Constants or Conversions: Multiply the total linear feet of perimeter fencing around the facility by 25%.

Reference Unit Costs:

Reference		Unit Cost
1	Nebraska Guidance Document - Fence Repair	$500-$1000/year
2	Nebraska Guidance Document - Gate and Sign Replacement	$120/year
3	Wyoming Statutes - New Perimeter Fencing (1993 Dollars)	$13/LF
4	2000 R.S. Means Environmental Remediation Cost Data	
a	Security Fence, 10' Galvanized with 3 strands barbed wire (18-04-0101)	$30.81/LF
b	Barbed wire Fencing, 3 strand (18-04-0110)	$2.18/LF
5	Oklahoma Department of Transportation	
a	4-Strand Barbwire Fence	$2.98/LF
b	5-Strand Barbwire Fence	$2.20/LF
c	4-foot Chain-link Fence	$9.07/LF
d	6-foot Chain-link Fence	$13.00/LF
6	Landfill C (6-foot high chain link fence including barbed wire and gate)	$8.00/LF

Unit Cost Calculation Assumption(s): Cost of repairing or replacing a gate is accounted for in the amount set aside for repairing and replacing perimeter fencing. Landfills install barbed-wire fencing.

Unit Cost: $2.2/LF based on ODOT five strand barbwire fence

Regulatory Changes: No recommendations.

4.4.6 Clean Leachate Line(s)

Description: OAC 252:510-19-3(18), and OAC 252:520-23-8(c)(8) require a procedure for collecting, treating and properly disposing of leachate. OAC 252:510-15-4 requires cleaning of the leachate lines after placing protective cover and again after placing the first lift of waste across the disposal cell. Current regulations do not require regular cleaning of the leachate lines during the landfill's operational period. OAC 252:510-15-4 does require the leachate line sump be inspected quarterly to determine the leachate collection system is operating properly. Final closure activities can commence from a few years to decades after the initial cleaning of the leachate lines. Therefore, successful implementation of this required procedure begins with cleaning the leachate collection lines.

Current best management practice for cleaning leachate collection lines is hydro-jetting. Hydro-jetting uses water pressure delivered through hosing and a special nozzle to clean pipes.

Regional Variation: A limited number of companies offer hydro-jetting services in Oklahoma. Therefore this item is not considered subject to regional variation.

Units of Measurement: Mobilization/Demobilization - Lump Sum
Cleaning Leachate Collection Line(s) - Linear Feet (LF)

Constants or Conversions: Not applicable.

Reference Unit Costs:

Reference		Unit Cost
1	Oklahoma Guidance Document - Leachate System Maintenance	$0.25/LF
2	Nebraska Guidance Document - Leachate Maintenance and Inspections	$1,000.00/yr
3	Vendor A	$137.50/hr
4	Vendor B	$125.00/hr $1.25/mi
5	Landfill G	$875.00/each
6	Landfill I	$0.50/LF

* See Data in Attachment 8e

Unit Cost Calculation Assumption(s): Landfill uses a hydro-jet for cleaning leachate lines. Unit cost based on Vendor B for eight hours and 200 miles travel.

Unit Cost: $1,250.00

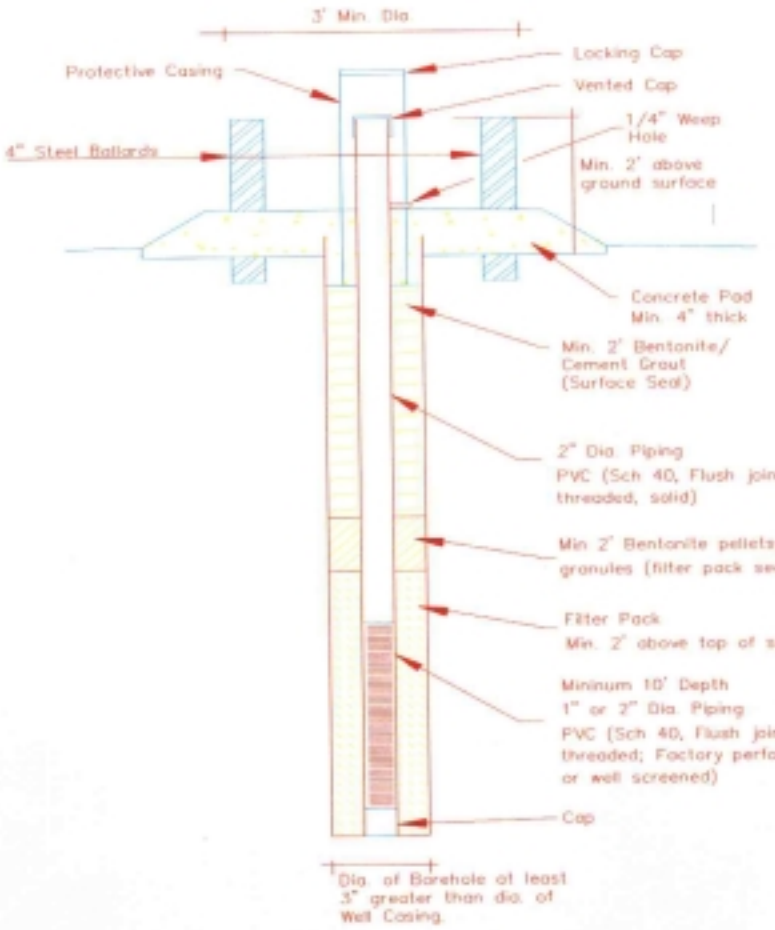
Regulatory Changes: No recommendations.

4.5 Monitoring Equipment

4.5.1 Rework/Replace Monitoring Well(s)

Description: OAC 252:510-19-3(9) and OAC 252:520-23-8(b)(5) require facilities rework or replace any defective groundwater monitoring equipment. The number of groundwater monitoring wells at a specific landfill will be determined during the "Site Evaluation" and will vary from site to site. Groundwater monitoring wells must be constructed in accordance with OAC 252:510-11-5 and OAC 252:520-9-7, depending on the type of landfill. Figure 4.7 represents a schematic of a typical groundwater monitoring well.

FIGURE 4.7 Typical Groundwater Monitoring Well



Regional Variation: Groundwater monitoring wells must be installed in the uppermost aquifer beneath the site. Since depth to the uppermost aquifer varies from site to site depending on the landfill's geographical location and design, this item is subject to regional variation.

Units of Measurement: Mobilization/Demobilization - Lump Sum
Install Monitoring Well - Dollar per Foot of Boring ($/ft)
Construct Surface Protection - Well

Constants or Conversions: Multiply the total depth for all groundwater monitoring wells by 25%.

Reference Unit Costs:

Reference		Unit Cost
1	Oklahoma Guidance Document - Replace Groundwater Monitoring Well	$2,500/well
2	Kansas Guidance Document - Groundwater Monitoring Well Replacement	$20/VLF
3	Nebraska Guidance Document - Groundwater Monitoring Well Replacement	$2,500/well
4	Wyoming Statutes - Install New Groundwater Monitoring Well (1993 Dollars)	$2,400/well
5	USEPA Reference Document 7 - Installation of Replacement Well	$50-$100/VLF
6	Oklahoma Corporation Commission - Monitoring well (2" or 4")	$32/VLF
7	2000 R.S. Means Environmental Remediation Cost Data	
a	Drill and Install 2" PVC Monitoring Well, 11-20 feet (33-23-2502)	$26.50/VLF
b	Drill and Install 2" PVC Monitoring Well, 21-30 feet (33-23-2503)	$26.59/VLF
c	Drill and Install 2" PVC Monitoring Well, 31-40 feet (33-23-2504)	$25.88/VLF
d	Drill and Install 2" PVC Monitoring Well, >40 feet (33-23-2505)	$25.42/VLF
e	Steel Protective Cover, 4"x4"x5', Lockable (33-23-2215)	$229.90/EA
f	Concrete Surface Pad (4'x4'x4") (33-23-1502)	$158.58/EA
g	5' Guard Posts (33-23-2301)	$48.35/EA
8	Driller A	
a	Mobilization/Demobilization	$300.00
b	Monitoring Well Construction (hollow-stem auger or air-rotary)	$32.00/VLF
c	Monitoring Well Protection	$150.00/well
d	Well Development	$75.00/well
9	Driller B	
a	Mobilization/Demobilization	$300.00

b	Monitoring Well Construction (hollow-stem auger)	$32.00/VLF
c	Monitoring Well Construction (air-rotary)	$35.00/VLF
d	Monitoring Well Protection	$300.00/well
e	Well Development	$115.00/well
10	Driller C	
a	Mobilization/Demobilization	$400.00
b	Monitoring Well Construction (air-rotary)	$36.00/VLF
c	Monitoring Well Protection	$350.00/well
d	Well Development	$175.00/well
11	Landfill A	
a	Groundwater Monitoring Well Replacement (complete)	$3,795/well
12	Landfill C	
a	Groundwater Monitoring Well Replacement (complete)	$50.00/VLF
13	Landfill D	
a	Groundwater Monitoring Well Replacement (complete)	$25.00/VLF

VLF = Vertical Linear Foot

- Unit Cost Calculation Assumptions:
- Mobilization/Demobilization: 75-miles one-way (See Figure 4.1);
- Groundwater Monitoring Well Construction (See Figure 4.7);
  - Total well depth will range between 20 and 150 feet;
  - Borehole diameter shall be at least three inches larger than nominal casing diameter;
  - Well casing extends at least two feet above ground surface;
  - Between 15 and 145 feet of two inch diameter threaded PVC well casing;
  - Ten feet of two inch diameter threaded PVC factory-slotted well screen;
  - Filter pack entire depth of screen plus two feet;
  - Two feet of bentonite pellets or chips; and
  - Bentonite/cement grout to surface;
- Monitoring Well Protection (See Figure 4.7);
  - Expandable plug for PVC casing;
  - Protective steel casing with locking cap; and
  - Concrete pad (3'x3'x4") with four steel bollards;
- Well Development;
- Perform Logging/Reporting;
- Provide Drilling Log report for each monitoring well;
- Complete and file OWRB Well Completion Report; and
- Oklahoma Water Resources Board licensed.

Unit Cost: $32/ft +($150 mobilization +$150 protection +$75 development) /40 foot well
$41.40/ft using low driller quote by Driller A.

Regulatory Changes: No recommendations.

4.5.2 Plug Abandoned Monitoring Well(s)

Description: OAC 252:510-11-6 and OAC 252:520-9-8 require proper plugging of all groundwater monitoring wells. Therefore, groundwater monitoring wells needing replacement as identified in subsection 4.5.1 will need plugging.

Regional Variation: Monitoring well plugging will vary regionally because this task is a function of groundwater monitoring wells subject to regional variation, as described in subsection 4.5.1.

Units of Measurement: Mobilization/Demobilization - Lump Sum
Plug Monitoring Well - Dollar per Foot of Boring ($/ft)
Remove/Dispose Surface Protection - Well

Constants or Conversions: Multiply the total depth for all groundwater monitoring wells by 25%.

Reference Unit Costs:

Reference		Unit Cost
1	Oklahoma Guidance Document - Plug Groundwater Monitoring Well	$1,000/well
2	NRCS Farm Service District Agency - Plug Groundwater Monitoring Well	$1,300/well
3	2000 R.S. Means Environmental Remediation Cost Data	
a	Well Abandonment, 2" well (33-23-1822)	$12.36/VLF
b	Well Abandonment, 4" well (33-23-1823)	$21.21/VLF
4	Driller A	
a	Mobilization/Demobilization	$300.00
b	Plugging	$15.00/VLF
5	Driller B	
a	Mobilization/Demobilization	$300.00
b	Plugging	$14.00/VLF
6	Driller C	
a	Mobilization/Demobilization	$350.00
b	Plugging	$15.00/VLF

7	Landfill D	
a	Mobilization/Demobilization	not given
b	Plugging	$1.00/VLF

Unit Cost Calculation Assumption(s):

- Mobilization/Demobilization: 75-miles one-way (See Figure 4.1);
- Materials - Unless otherwise specified, borings shall be plugged with one of the following:
  - Bentonite enhanced cement consisting of five percent sodium bentonite and 95% Portland Cement;
  - Neat Portland cement-grout mixed at six gallons of water to one sack of cement with an admixture of powdered aluminum to compensate for shrinkage; or
  - Bentonite pellets or chips hydrated in place may be used from the bottom of the boring to a depth of ten feet below land surface for uncontaminated borings. Either the bentonite enhanced cement or neat Portland cement referenced above shall be placed from ten feet below the surface to land surface;
- Groundwater Monitoring Well Plugging - Monitoring wells shall be plugged by removing the protective bollards and concrete apron. The surface seal and well casing shall be removed by one of the following methods:
  - Extracting the casing by over-drilling; or
  - Perforating the bottom cap and filling the casing with plugging material specified above as the casing is being pulled from the borehole; or
  - In areas where all or part of the well's casing and other components of the well cannot be plugged and abandoned in accordance with previously stated methods, the well will be plugged and abandoned by the installation of a cement-bentonite grout inside the well's casing, from the bottom of the well to the ground surface, provided that the annular seal is demonstrated to be adequately sealed;
- Complete and file OWRB Plugging Report; and
- Oklahoma Water Resources Board licensed.

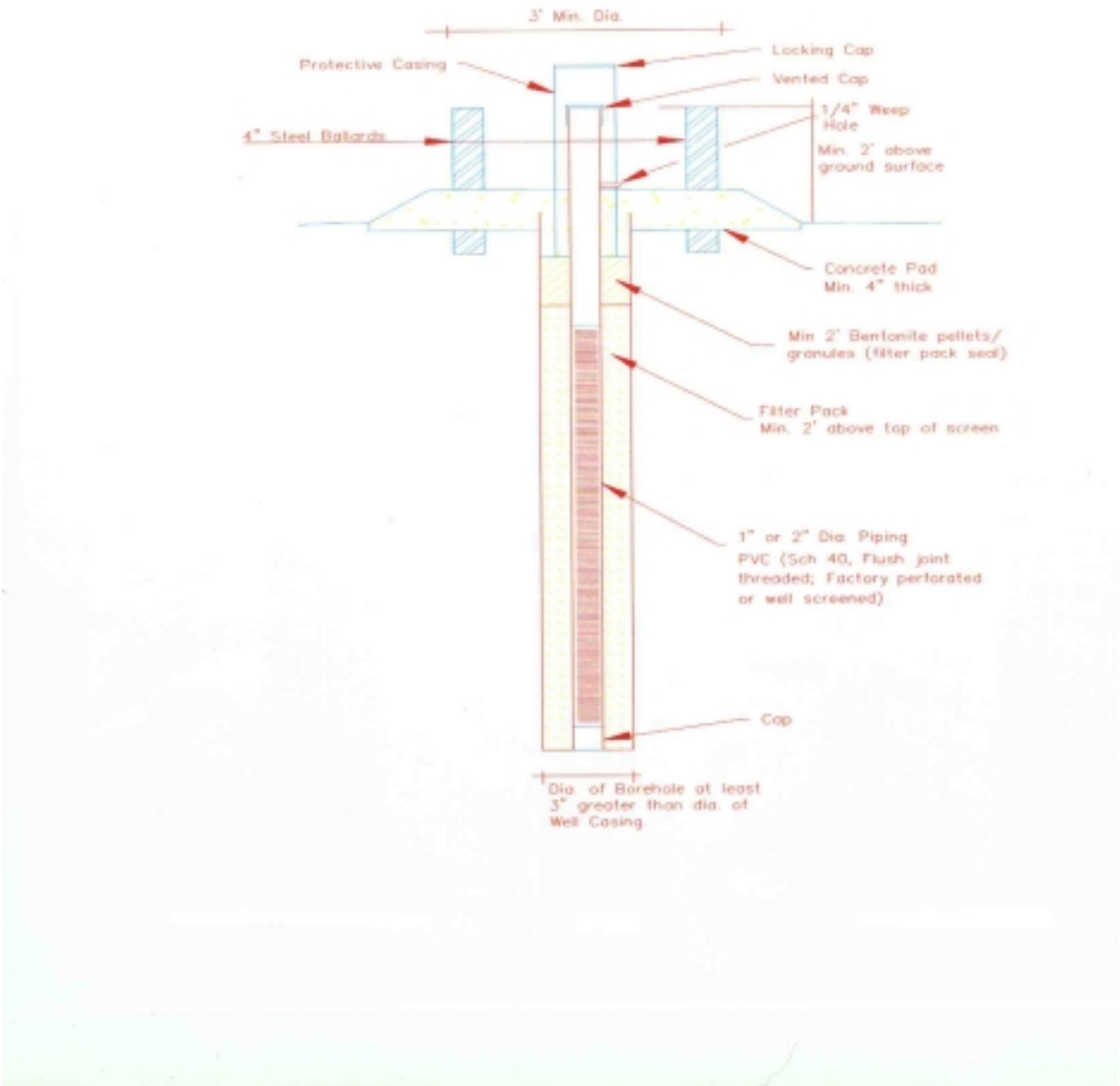
Unit Cost: $14/ft well +$150(demobilization)/(40ft/well)
$17.75/ft using low driller quote by Driller B.

Regulatory Changes: No recommendations.

4.5.3 Rework/Replace Methane Gas Probe(s)

Description: OAC 252:510-19-3(9) and OAC 252:520-23-8(b)(5) require facilities rework or replace any defective monitoring equipment. The number of methane gas probes at a specific landfill will be determined during the "Site Evaluation" and will vary from site to site. Construction and demolition landfills and nonhazardous industrial solid waste landfills typically do not have methane gas probes, in which case the reported quantity can be zero. Figure 4.8 represents a schematic of a typical methane gas probe.

FIGURE 4.8 Typical Schematic of Methane Gas Probe



Regional Variation: Methane gas probes must be drilled to the deepest placement of waste or the top of the groundwater table, whichever is shallower. Since depth of waste placement and depth to groundwater vary from site to site depending on the landfill's geographical location and design, this item is subject to regional variation.

Units of Measurement: Mobilization/Demobilization - Lump Sum
Install Methane Gas Probe - Dollar per Foot of Boring ($/ft)
Construct Surface Protection - Probe

Constants or Conversions: Add the total depth for all methane gas probes. Multiply the total depth by 25%.

Reference Unit Costs:

	Reference	Unit Cost
1	Nebraska Guidance Document - Gas Monitoring Replacement and Repair	$500/year
2	Wyoming Statutes - Install New Methane Gas Probe (1993 Dollars)	$1,300/probe
3	USEPA Reference Document 7 - Methane Gas Probe Repair	$1,000/year
4	2000 R.S. Means Environmental Remediation Cost Data	
a	Drill and Install 2" PVC Monitoring Well, 11-20 feet (33-23-2502)	$26.50/VLF
b	Drill and Install 2" PVC Monitoring Well, 21-30 feet (33-23-2503)	$26.59/VLF
c	Drill and Install 2" PVC Monitoring Well, 31-40 feet (33-23-2504)	$25.88/VLF
d	Drill and Install 2" PVC Monitoring Well, >40 feet (33-23-2505)	$25.42/VLF
e	Steel Protective Cover, 4"x4"x5', Lockable (33-23-2215)	$229.90/EA
f	Concrete Surface Pad (4'x4'x4") (33-23-1502)	$158.58/EA
g	5' Guard Posts (33-23-2301)	$48.35/EA)
5	Driller A	
a	Mobilization/Demobilization	$300.00
b	Methane Gas Probe Construction (15-50 VLF, 1" and 2" diameter, and hollow-stem	$32.00/VLF
c	Methane Gas Probe Protection	$150.00/probe
6	Driller B	
a	Mobilization/Demobilization	$300.00
b	Methane Gas Probe Construction (15-50 VLF, 1" diameter, and hollow-stem auger)	$25.00/VLF
c	Methane Gas Probe Construction (15-50 VLF, 2" diameter, hollow-stem and auger)	$28.00/VLF

d	Methane Gas Probe Construction (15-50 VLF, 1" diameter, and air-rotary)	$28.00/VLF
e	Methane Gas Probe Construction (15-50 VLF, 2" diameter, and air-rotary)	$31.00/VLF
f	Methane Gas Probe Protection	$300.00/probe
7	Driller C	
a	Mobilization/Demobilization	$400.00
d	Methane Gas Probe Construction (15-50 VLF, 1" diameter, and air-rotary)	$34.00/VLF
e	Methane Gas Probe Construction (15-50 VLF, 2" diameter, and air-rotary)	$36.00/VLF
f	Methane Gas Probe Protection	$350.00/probe
8	Landfill C - Methane Gas Probe Construction (complete)	$35.00/VLF
9	Landfill E	
a	Drilling Borehole for Methane Gas Probe	$464.29/probe
b	Methane Gas Probe Construction	not given
10	Landfill K - Methane Gas Probe Construction (complete)	$1,725.00/probe
11	Landfill L - Methane Gas Probe Construction (complete)	$1,191.00/probe

Unit Cost Calculation Assumption(s):

- Mobilization/Demobilization: 75 miles one way (See Figure 4.1);
- Methane Gas Probe Construction (See Figure 4.8);
  - Total probe depth will range between 15 and 50 feet;
  - Borehole diameter shall be a minimum of three inches larger than the nominal casing diameter;
  - Well casing extends at least two feet above ground surface;
  - Five feet of one inch (or two inch) diameter threaded PVC well casing;
  - Between 10 and 40 feet of one inch (or two inch) diameter threaded PVC factory-slotted well screen;
  - Filter pack entire depth of screen plus two feet; and
  - One foot of bentonite pellets or chips;
- Methane Probe Protection (See Figure 4.8);
  - Expandable plug for PVC casing;
  - Protective steel casing with locking cap; and
  - Concrete pad (3'x3'x4") with four steel bollards;
- Perform Logging/Reporting;
- Provide Drilling Log report for each probe;
- Complete and file OWRB Well Completion Report;
- Oklahoma Water Resources Board licensed; and
- Methane gas probe is two inch diameter PVC for purpose of using R.S. Means.

Unit Cost: $32 per well +$150(protection)/40ft well
Mobilization and demobilization paid for as part of monitoring well unit cost
$35.75per foot using low driller quote by Driller A.

Regulatory Changes: No recommendations.

4.5.4 Plug Abandoned Methane Gas Probe(s)

Description: OAC 252:510-11-6 and OAC 252:520-9-8 require proper plugging of all borings. Therefore, methane gas probes needing replacement as identified in subsection 4.5.3 will need plugging.

Regional Variation: Methane probe plugging will vary regionally because this task is a function of methane gas probes that are subject to regional variation, as described in subsection 4.5.3.

Units of Measurement: Mobilization/Demobilization - Lump Sum
Plug Methane Gas Probe - Dollar per Foot of Boring ($/ft)
Remove/Dispose Surface Protection - Probe

Constants or Conversions: Add the total depth for all methane gas probes. Multiply the total depth by 25%.

Reference Unit Costs:

Reference		Unit Cost
1	2000 R.S. Means Environmental Remediation Cost Data	
a	Well Abandonment, 2" well (33-23-1822)	$12.36/VLF
b	Well Abandonment, 4" well (33-23-1823)	$21.21/VLF
2	Driller A	
a	Mobilization/Demobilization	$300.00
b	Plugging	$15.00/VLF
3	Driller B	
a	Mobilization/Demobilization	$300.00
b	Plugging	$14.00/VLF
4	Driller C	
a	Mobilization/Demobilization	$350.00
b	Plugging	$15.00/VLF

5	Landfill D	
a	Mobilization/Demobilization	not given
b	Plugging	$1.00/VLF

Unit Cost Calculation Assumption(s):

- Mobilization/Demobilization: 75 miles one way (See Figure 4.1);
- Materials - Unless otherwise specified, borings shall be plugged with one of the following:
  - Bentonite enhanced cement consisting of five percent sodium bentonite and 95% Portland Cement;
  - Neat Portland cement-grout mixed at six gallons of water to one sack of cement with an admixture of powdered aluminum to compensate for shrinkage; or
  - Bentonite pellets or chips hydrated in place may be used from the bottom of the boring to a depth of ten feet below land surface for uncontaminated borings. Either the bentonite enhanced cement or neat Portland cement referenced above shall be placed from ten feet below the surface to land surface;
- Groundwater Monitoring Well Plugging - Monitoring wells shall be plugged by removing the protective bollards and concrete apron. The surface seal and well casing shall be removed by one of the following methods:
  - Extracting the casing by over-drilling; or
  - Perforating the bottom cap and filling the casing with plugging material specified above as the casing is being pulled from the borehole; or
  - In areas where all or part of the well's casing and other components of the well cannot be plugged and abandoned in accordance with previously stated methods, the well will be plugged and abandoned by the installation of a cement-bentonite grout inside the well's casing, from the bottom of the well to the ground surface, provided that the annular seal is demonstrated to be adequately sealed;
- Methane Gas Probe Plugging - The procedure for plugging methane gas probes shall be the same as for monitoring wells, except that the surface seal and well casing shall be removed from the borehole and a tremie pipe shall be used to fill the hole from the bottom of the hole to four feet below the ground surface;
- Complete and file OWRB Plugging Report;
- Oklahoma Water Resources Board licensed; and
- Methane gas probed is constructed with two inch diameter piping for purpose of using R.S. Means.

Unit Cost: $14/ft

Mobilization and demobilization paid for as part of monitoring well unit cost $14/ft using low driller quote by Driller B.

Regulatory Changes: No recommendations.

4.5.5 Rework/Replace Remediation Equipment and/or Gas Control Equipment

Description: OAC 252:510-19-3(9) and OAC 252:520-23-8(b)(5) require landfills to rework or replace any defective monitoring equipment. Providing financial assurance for this final closure item is only applicable to landfills with approved remediation plans and landfills with installed gas control equipment. Landfills not operating remediation and/or gas control equipment do not need to provide financial assurance for this final closure task. However, if a landfill must implement and/or install remediation and/or gas control equipment during the landfills operational life or post-closure monitoring period, the final closure cost estimate shall be adjusted to account for those liabilities.

Regional Variation: Not subject to regional variation.

Units of Measurement: Lump Sum.

Constants or Conversions: Multiply the total remediation and/or gas control equipment capital cost by a percentage.

Reference Unit Costs: None

Unit Cost Calculation Assumption(s): Operations and Maintenance costs are five percent of total equipment capital cost.

Unit Cost: 5% of total equipment capital cost.

Regulatory Changes: No recommendations.

4.6 Construction

4.6.1 Site Grading

Description: OAC 252:510-19-3(10) and OAC 252:520-23-8(c)(2) require landfills have procedures for disposing final wastes and affected soil. OAC 252:510-19-3(12) and OAC 252:520-23-8(c)(1) require landfills have plans for redesigning final closure in accordance with existing site conditions and applicable regulations. OAC 252:510-19-3(17) and OAC 252:520-23-8(c)(7) require landfills develop a plan for remedying all former improper closure at the site. And OAC 252:510-19-3(14) and OAC 252:520-23-8(c)(4) require landfills have a method for obtaining, hauling, and placing soil for final cover. An inherent but silent task common to the listed regulatory requirements is grading. A landfill must engage in various levels of grading across the site as part of completing final closure. Site grading will include grading the disposal areas, borrow areas, and any other area disturbed by landfill operations.

Regional Variation: Subject to regional variation.

Units of Measurement: Acre.

Constants or Conversions: Not applicable.

Reference Unit Costs:

Reference		Unit Cost
1	Oklahoma Guidance Document - Control Grading	$500/acre
2	Kansas Guidance Document - Final Grading	$53.75/acre
3	Nebraska Guidance Document - Final Grading	$1,700-$2,000/acre
4	R.S. Means Environmental Remediation Cost Data	
a	Rough Grading, D6 Dozer (17-03-0101)	$15,488.00/acre
b	Fine Grading, 12G, 2 Passes (17-03-0106)	$1,403.60/acre

Unit Cost Calculation Assumption(s):

Assumption	
1	Grading activities will be conducted over the entire permitted area.
2	80% * $1403.60 (RS Means) = $1122.88

Unit Cost: $1122/Acre

Regulatory Changes: No recommendations.

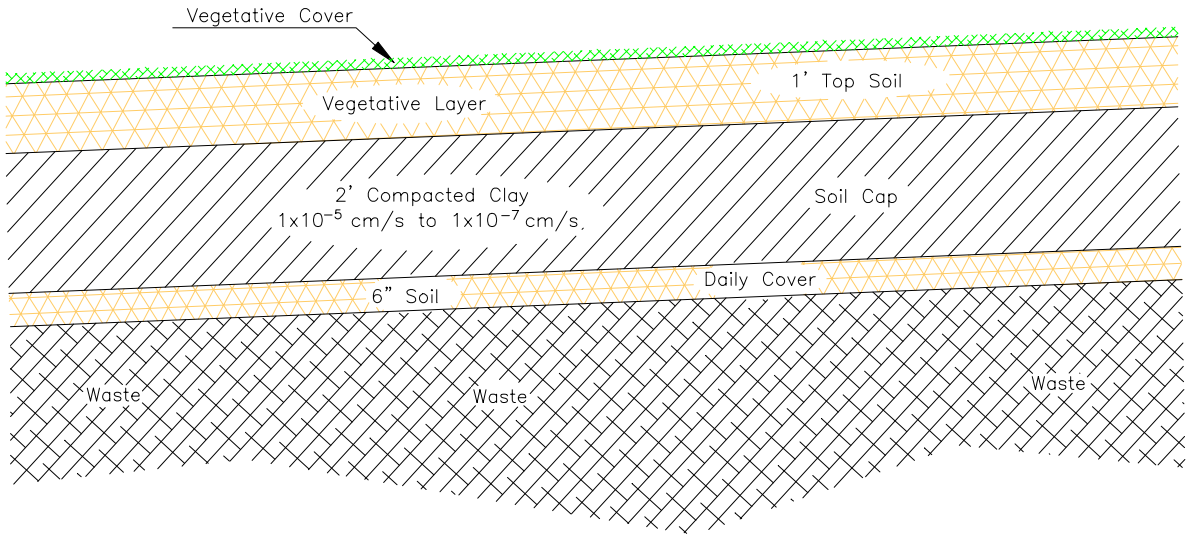
4.6.2 Infiltration Layer

OAC 252:510-19-4(a) and OAC 252:520-9-11(7) require landfills have cover material equivalent to the liner material. Therefore, landfills with composite liners will require composite caps, while landfills with soil liners will require soil caps. Installing a composite cap creates long-term maintenance obligations not experienced by clay capped landfills. Landfills generate gas through the biological decomposition of the waste mass. Unless these gases are allowed to vent, pressure will accumulate under the flexible membrane liner causing it to "bubble". At best, "bubbles" require correction and re-installation of the topsoil and vegetative cover. At worst, "bubbles" can result in catastrophic slope failures of the cap. As recommended in the USEPA's *Design, Operation, and Closure of Municipal Solid Waste Landfills* document, landfills with composite caps should construct a gas venting layer beneath the flexible membrane liner. The gas venting layer is connected to gas vents operating passively or actively with the use of vacuum pumps.

A second engineering and design consideration with composite caps is excessive pore water above the flexible membrane liner. Preventing water from infiltration by installing the flexible membrane liner will create excess pore water in the soil. Pressure from the excess pore water weakens the soils strength and decreases the friction forces holding the soil on the slopes. The result are veneer slope failures at the soil and geosynthetic interface. A drainage layer is necessary to allow the excess water to drain off the cap.

The two basic final cap designs are illustrated in Figure 4.9 and Figure 4.10. These figures show landfill final caps are divided into two basic components, an infiltration layer and a vegetative layer. Composite landfills have a complex infiltration layer and soil lined landfills have a relatively simple infiltration layer. Subsection 4.6.2.1 documents tasks and service unit costs for soil cap landfills and subsection 4.6.2.2 documents tasks and service unit costs for composite cap landfills.

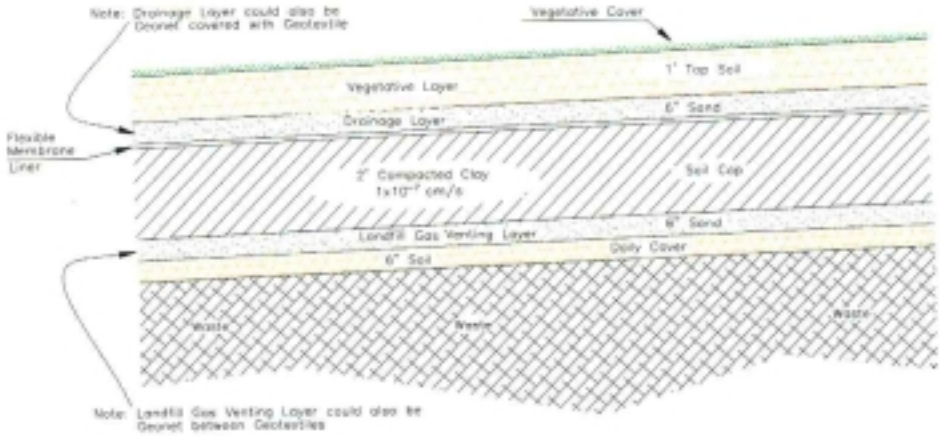
FIGURE 4.9 Soil Cap for Landfills



A. Infiltration Layer for Soil Final Caps

Description: OAC 252:510-19-3(14) and OAC 252:520-23-8(c)(4) require landfills have a method for obtaining, hauling, and placing soil for final cover. Obtaining final cover material can be accomplished by either having suitable material available on-site and dedicating the borrow areas to the DEQ for use in closing the landfill or by purchasing the material from an adjacent or nearby resource. The method of hauling is dependent on the source material. Scrapers or an excavator with dump trucks would be suitable for on-site materials. Hauling off-site material requires compliance with federal, state, and local weight limits and road conditions (low overpasses, narrow roads, and bridges with weight limits). In this case, the material would be excavated and transported in "belly dump" tractor-trailers. The placing of the final cap would be performed using a bulldozer, compactor, tractor with plowing discs, and water truck. The factors in determining a unit cost for a compacted cubic yard include material cost, hauling cost, and placement costs.

FIGURE 4.10 Composite Cap for Landfills



Regional Variation: Subject to regional variation.

Units of Measurement: Compacted Cubic Yard (CCY).

Constants or Conversions: Not applicable.

Reference Unit Costs:

Reference		Unit Cost
1	Oklahoma Guidance Document - Recompacted clay cover	$3.00/CCY
2	Kansas Guidance Document - Soil-compacted, off-site	$5.63/CCY
3	Kansas Guidance Document - Soil-compacted, on-site	$2.20/CCY
4	Nebraska Guidance Document - Infiltration layer	$2.16-$4.66/CY
5	Wyoming Guidance Document - Final cover, seeding, fertilizer, and mulching	$10,200/acre
6	USEPA Reference Document 7 - Infiltration Layer	
a	Placing and compacting soil	$4.00-$6.00/CY
b	Transporting soil to the site	$0.15-$.25/ton/mile

7	R.S. Means Environmental Remediation Cost Data	
a	Compacted clay, off-site (17-03-0428) $13.20 - testing ($0.73)	$12.47/CY
b	Compacted clay, on-site (17-03-0429) $9.54 - testing ($0.86)	$8.68/CY
8	R.S. Means Environmental Remediation Cost Data, Off-Site Clay	
a	Material (assumed)	$1.00/CY
b	Excavate (R.S. Means 17-03-0278)	$2.33/CY
c	Haul, 26 CY Truck, 5-miles, 40 MPH, 1.9 Cycles/hour (R.S. Means 17-03-0288)	$1.70/CY
d	Haul, 26 CY Truck, 10-miles, 40 MPH, 1.3 Cycles/hour (R.S. Means 17-03-0288)	$2.49/CY
e	Haul, 26 CY Truck, 15-miles, 40 MPH, 0.9 Cycles/hour (R.S. Means 17-03-0288)	$3.60/CY
f	Spread/Compact (R.S. Means17-03-0517)	$0.66/CY
g	Off-site clay, compacted, 5-mile haul (8a+b+c+f)	$5.69/CCY
h	Off-site clay, compacted, 10-mile haul (8a+b+d+f)	$6.46/CCY
i	Off-site clay, compacted, 15-mile haul (8a+b+e+f)	$7.56/CCY
9	Geosynthetic Vendor A (Geosynthetic Clay liner-GCL)	$0.39/SF
10	Geosynthetic Vendor B (Geosynthetic Clay liner)	$0.38/SF
11	Geosynthetic Vendor C (Geosynthetic Clay liner)	$0.40/SF

Unit Cost Calculation Assumption(s):

	Assumption
1	On-site clay = $2.33 (excavation) + $1.00 (haul) + $0.66 (compact) * .80 (Oklahoma factor) = 3.20/CY
2	Off-site clay = 6.46 (item 8h) * .80 (Oklahoma factor) = $5.17/CY

Unit Cost: $3.20/CY Clay On-site
$5.17/CY Clay Off-site
$0.38/SF GCL (Geosynthetic Vendor B)

Regulatory Changes: No recommendations.

B. Infiltration Layer for Composite Cap Landfills

4.6.2.1 Landfill Gas Venting Layer

Description: The gas venting layer must be a porous, highly permeable system to collect gases and transport to the gas vents. Thickness of granular material may vary depending on the material. Acceptable construction materials include washed gravel, washed coarse sand, geonet, tire chips, or other equivalent material. Design and construction of a gas venting layer is similar to the design and construction of the cap drainage layer.

Regional Variation: Subject to regional variation.

Units of Measurement: Compacted Cubic Yard (CCY).

Constants or Conversions: Not applicable.

Reference Unit Costs:

Reference		Unit Cost
1	Kansas Guidance Document - Drainage material, sand	$11.00/CY
2	Kansas Guidance Document - Drainage material, geogrid	$4.18/SY
3	Nebraska Guidance Document - Venting Layer	$13.50/CY
4	Wyoming Guidance Document - Final cover, seeding, fertilizer, and mulching	$10,200/acre
5	USEPA Reference Document 7 - Drainage Layer	
a	6-inch sand layer	$12.00-$20.00/ton
b	Bonded geonet	$0.55 - $0.70/SF
6	Oklahoma Department of Transportation - sand	$22.00/ton

†Cost of material testing identified with item has been subtracted.

Unit Cost Calculation Assumption(s):

Assumption	
1	Granular material (gravel or sand) layer thickness equals six inches
2	Tire chip layer thickness equals 12 inches
3	Loose sand density 90#/cf. Dense sand density 100#/cf
4	Sand compaction factor of 1.25

Unit Cost: $29.70/cy
$29,937/acre - ODOT sand

Regulatory Changes: No recommendations.

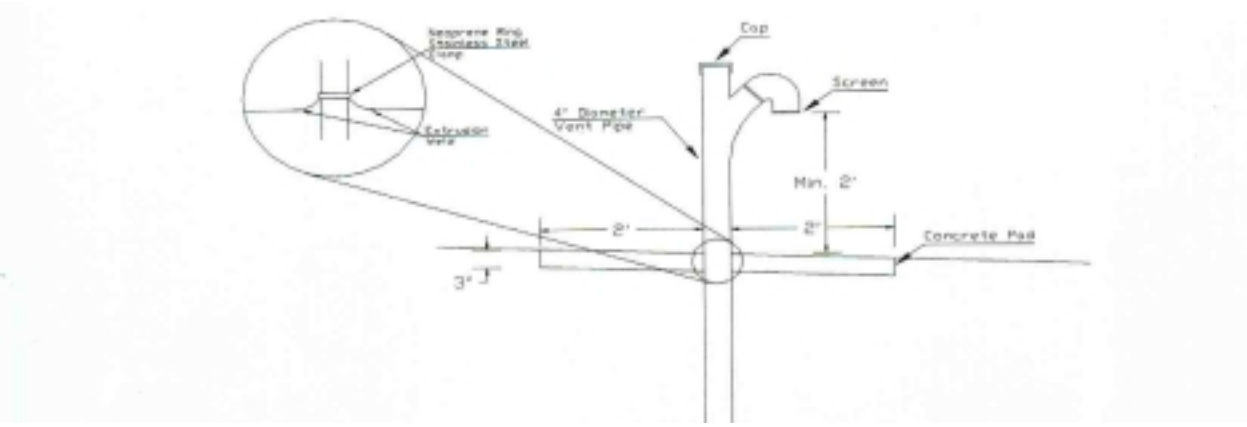
4.6.2.2 Soil Cap

Description: The soil cap component for composite caps is the same as the infiltration layer for soil cap landfills. Unit cost documentation for this task and service is covered in subsection 4.6.2.1.

4.6.2.3 Install Passive Gas Vents

Description: The gas venting layer discussed in subsection 4.6.2.1 requires the installation of gas vents to transport landfill gas through the final cap. The gas vents will operate passively on a spacing of one vent per acre. The vents are incorporated with the gas venting layer and consist of perforated pipe located in the venting layer, a solid gas vent pipe extending through the final cover, and a protective cap that vents gas but prevents vermin and precipitation from entering the gas venting system. Figure 4.11 represents a typical schematic of a passive gas vent.

FIGURE 4.11 Typical Passive Gas Vent



Regional Variation: Not subject to regional variation.

Units of Measurement: Vent.

Constants or Conversions: Not applicable.

Reference(s):

Reference		Unit Cost
1	Nebraska Guidance Document - Gas Venting System	$500/acre
2	USEPA Reference Document 7 - Passive Gas Venting Layer	
a	Venting wells	$3,000-$8,000/well
b	Surface trench collectors	$2,000/each

Unit Cost Calculation Assumption(s): One passive vent per acre.

Unit Cost: $500/acre

Regulatory Changes: No recommendations.

4.6.2.3.1 Install Flexible Membrane Liner

Description: OAC 252:510-19-4(a)(1) and OAC 252:520-9-11(7) require landfills construct final covers equivalent to the liner constructed under the landfill. Therefore, landfills with composite liners will construct composite caps. The flexible membrane liner used for the final cover must be long-lasting and must tolerate anticipated subsidence induced strains. Materials with high biaxial strengths more easily withstand the differential settling that can occur after closure. A second concern with flexible membrane liner in landfill caps is slope failure. Materials must demonstrate high angles of friction at interfaces to reduce shear failures on slopes.

Regional Variation: Not subject to regional variation.

Units of Measurement: Installed Square Foot (SF)

Constants or Conversions: Non applicable.

Reference(s):

Reference		Unit Cost
1	Kansas Guidance Document - Geomembrane	$3.90/SY or $0.43/SF
2	Nebraska Guidance Document - Flexible membrane liner	$0.30-$0.80/SF

3	Wyoming Guidance Document - Final cover, seeding, fertilizer, and mulching	$10,200/acre
4	USEPA Reference Document 7 - Infiltration Layer	
a	Geomembrane	$0.20-$0.80/SF
5	Landfill B (60-mil HDPE liner 138,920 SF)	$0.3965/SF
6	Landfill C (60-mil HDPE liner 470,800 SF)	$0.39/SF
7	Landfill K (60-mil HDPE liner 60,600 SF)	$0.543/SF
8	Landfill L (60-mil HDPE liner 118,800 SF)	$0.465/SF
9	Geosynthetic Vendor A (40-mil HDPE textured liner)	$0.30/SF
10	Geosynthetic Vendor B (40-mil HDPE smooth liner)	$0.33/SF
11	Geosynthetic Vendor C (40-mil HDPE textured liner, double sided	$.032/SF

Unit Cost Calculation Assumption(s):

	Assumption
1	Unit cost includes all labor, materials, and manufacturing QA documentation costs for installing flexible membrane liner
2	40-mil very high density polyethylene (VHDPE) flexible membrane liner textured on both sides

Unit Cost: $0.32/SF, Vendor C

Regulatory Changes: No recommendations.

4.6.2.3.2 Install Drainage Layer

Description: The drainage layer serves the engineering purpose of releasing the excess pore water in the vegetative layer. Unless the final cover design incorporates a mechanism to transport soil pore water away from the soil liner interface, excess pore water pressure will de-stabilize the soil component and lead to excessive erosion and/or failure of the final cap. Consideration of a drainage layer may not be applicable under certain alternative final cover designs and must be evaluated on an individual basis. The design and construction of a drainage layer is similar to the gas venting layer. Therefore the unit cost discussion in subsection 4.6.2.1 is applicable to this task and service also.

Regional Variation: May be subject to regional variation.

Units of Measurement: Lump Sum

Constants or Conversions: Non applicable.

Reference(s):

Reference		Unit Cost
1	Geosynthetic Vendor A (Geonet, 6oz Geotextile Filter Fabric)	$0.27/SF
2	Geosynthetic Vendor B (Geonet, 6oz Geotextile Filter Fabric)	$0.30/SF
3	Geosynthetic Vendor C (Double Sided Geonet/Geotextile composite)	$.038/SF

Unit Cost Calculation Assumption(s): The vegetative layer consisting of topsoil and vegetative cover are installed above the drainage layer.

Unit Cost: $29.70/CY, $29,937/Acre - ODOT Sand
$0.27/SF, $11,761/Acre-Geonet and geotextile filter fabric

Regulatory Changes: No recommendations.

4.6.3 Vegetative Layer

Description: The vegetative layer is a fertile topsoil layer suitable for sustaining growth of a vegetative cover.

Regional Variation: Subject to regional variation.

Units of Measurement: Cubic Yard (CY)

Constants or Conversions: Compute the number of acres requiring a vegetative layer and convert from acres to square feet (43,560 SF/acre). Multiply by the layer thickness of one foot. Cubic feet are converted to cubic yards by dividing by 27. Although the vegetative layer is not intentionally compacted to a design specification, some compaction will occur during placement. The calculated quantity must be addressed to account for shrinkage. Assume a soil shrinkage factor of 25%.

Reference(s):

Reference		Unit Cost
1	Oklahoma Guidance Document - Top soil	$6.00/CY
2	Kansas Guidance Document	$4.18/SY
a	Vegetative soil, off-site	$5.20/CY
b	Vegetative soil, on-site	$1.77/CY
3	Nebraska Guidance Document - Erosion layer	$1.23-$2.00/CY

4	Wyoming Guidance Document - Final cover, seeding, fertilizer,	$10,200/acre
6	USEPA Reference Document 7 - Erosion Control Layer	
a	Soil	$8.00-$14.00/ton
7	R.S. Means Environmental Remediation Cost Data	
a	Topsoil, 6" lifts, off-site (18-05-0301)	$24.45/CY
b	Topsoil, 6" lifts, on-site (18-05-0302)	$6.59/CY †
8	Oklahoma Department of Transportation	$---- - $-----
a	Topsoil	$13.76/CY
b	Salvaged Topsoil	$3.03/CY
9	Landfill B (topsoil, on-site, 9,031 CY)	$1.80/CY
10	Landfill D (topsoil, on-site, 11,132 CY)	$1.50/CY
11	Landfill F (topsoil, ----------, 16,000 CY)	$12.00/CY

†Cost of material testing identified with item has been subtracted.

Unit Cost Calculation Assumption(s):

	Assumption
1	Vegetative layer thickness is one foot
2	Soil shrinkage factor equals 25%
3	Vegetative layer consists of topsoil or an amended soil mixture capable of sustaining vegetative growth

Unit Cost: On-site $1.50/CY (Landfill D)
Off-site $12.00/CY (Landfill F)

Regulatory Changes: No recommendations.

4.6.4 Vegetative Cover

Description: Establishing a vegetative cover reduces the extent and degree of erosion on the vegetative layer. Successfully establishing a vegetative cover means the topsoil must be tested for nutrients to determine necessary soil amendments and fertilizers for the specific species of vegetation at a particular landfill. The vegetative cover can be established with seeds, sprigs, or sod. Seeding can be performed by either broadcast spreading, drilling, or hydro-mulching. The type and method of planting will vary from site to site and will depend on geographical location, season, and the regional climate. For instance, the Oklahoma panhandle receives an average of less than 16 inches of precipitation each year and southeastern Oklahoma receives an average of greater than 52 inches of precipitation each year according to the Oklahoma Climeotogical Survey.

Regional Variation: Subject to regional variation.

Units of Measurement: Acre.

Constants or Conversions: Non applicable.

Reference(s):

Reference		Unit Cost
1	Oklahoma Guidance Document - Vegetation	$500.00/acre
2	Kansas Guidance Document - Seeding and mulching	$1,500.00/acre
3	Nebraska Guidance Document - Seeding, mulching, fertilizer	$915.00-$1,982.00/acre
4	Wyoming Guidance Document - Final cover, seeding, fertilizer, and	$10,200/acre
6	USEPA Reference Document 7 - Erosion Control Layer	
a	Fertilizing, seeding, and hydro-mulching	$1,200.00-$1,800.00/acre
7	R.S. Means Environmental Remediation Cost Data	
a	Seeding, 67% Level & 33% Slope, Hydoseeding	$477.91/acre
b	Seeding, vegetative cover (18-05-0402)	$2,033.00/acre
c	Sodding, Average Continental U.S. (18-05-0404)	$21,849.00/acre
d	Fertilizer, Hydro Spread (18-05-0408)	$140.79/acre
e	Fertilize, 800 lbs/acre, Push Rotary (18-05-0409)	$80.47/acre
f	Fertilize, 800 lbs/acre, Spray from Truck (18-05-0410)	$137.69/acre
g	Crushed Limestone, pH adjustment, 800 lbs/acre (18-05-0411)	$97.58/acre
h	Purchase & Spread Dry Granular Limestone for pH Control (18-05-0412)	$193.60/acre
I	Watering with 3,000-gallon Tank Truck, per pass (18-05-0413)	$55.63/acre
j	Vegetative Cover (a, e, g, and I)	$693.72/acre
8	Oklahoma Department of Transportation	
a	Solid Slab Sodding	$9,680/acre
b	Broadcast Sprigging	$629.20/acre
c	Mulch Sodding	$5,904.80/acre
d	Vegetative Mulching	$555.80/acre

9	Oklahoma Department of Mines - Seed/Fertilize	$300.00/acre
10	Oklahoma Conservation Commission - Disc/Mulch/Plant	$400.00/acre
11	Landfill B (Bermuda grass sod, 314,900 SF)	$7840.80/acre
12	Landfill C	
a	Sodding (23.35 acres)	$7018.00/acre
b	Seeding and mulching (28.93 acres)	$2178.00/acre
13	Landfill D	$325.00/acre

Unit Cost Calculation Assumption(s): Unit cost includes all costs associated with analyzing soil, planting vegetation, and necessary fertilizers and soil amendments.

Unit Cost: $400 from the Oklahoma Conservation Commission. The Average of 1, 2, 3, 7j, 8b, 9, 10 is $826. The average of $826 is higher than the existing Oklahoma Guidance Document and Oklahoma Conservation Commission.

Regulatory Changes: No recommendations.

4.7 Drainage/Erosion Control

4.7.1 Construct Terraces

Description: OAC 252:510-19-3(16) and OAC 252:520-23-8(c)(6) require landfills construct additional or rework existing erosion control measures. Landfills completing final covers above existing grade must incorporate some sort of terrace and let-down channel system to control run-off and minimize erosion. Landfill final covers can either construct terraces across the side slopes or construct slope benches. Slope benches result in the side slope resembling a set of stairs. Benching side slopes decreases a landfills total disposal capacity more than terraces, but are easier to construct and maintain. Side slope benches must be constructed during normal landfill operations. Constructing benches after completing a side slope requires removing large quantities of waste to cut the bench.

Regional Variation: Subject to regional variation.

Units of Measurement: Linear Feet (LF).

Constants or Conversions: Non applicable.

Reference(s):

Reference		Unit Cost
1	Kansas Guidance Document - Terraces	$0.55/LF
2	Nebraska Guidance Document - Surface water control structures	$8.50-$25.00/LF
3	USEPA Reference Document 7 - Erosion Control Layer	
a	Drainage swales	$1,100.00-$2,000.00/acre
4	R.S. Means Environmental Remediation Cost Data	
a	10' Wide Grass Drainage Swale (33-05-0801)	$7.24/LF

Unit Cost Calculation Assumption(s): Slope benches were not constructed. Construct terraces during construction of final cover.

Unit Cost: $7.24.LF - R.S. Means, adjust for region.

Regulatory Changes: No recommendations.

4.7.2 Construct Letdown Channels

Description: OAC 252:510-19-3(16) and OAC 252:520-23-8(c)(6) require landfills construct additional or rework existing erosion control measures. Landfills completing final covers above existing grade must incorporate some sort of terrace and let-down channel system to control run-off and minimize erosion. Landfill final covers can either construct terraces across the side slopes or construct slope benches as discussed in subsection 4.7.1. In either case, run-off water collected and controlled must be transported to the slope bottom in a mean that minimizes slope erosion.

Transporting stormwater down slopes can be accomplished with the use of above-grade piping (elephant pipe) or let-down channels. Elephant pipe requires the construction and maintenance of inlet structures along the slope. Let-down channels must be constructed with material that dissipates energy and minimizes final cover undercutting.

Regional Variation: Subject to regional variation.

Units of Measurement: Linear Feet (LF)

Constants or Conversions: Non applicable.

Reference(s):

Reference		Unit Cost	Unit Cost
1	Kansas Guidance Document - Riprap ditching/channels	$13.00/LF	$13.00/LF
2	R.S. Means Environmental Remediation Cost Data		

a	Rock Cover, riprap, medium (10-200 lb pieces)(18-05-0203)	$20.80/CY	$7.70/LF
b	Channel (20' wide by 3' deep)	$45.27/LF	$45.27/LF
3	Oklahoma Department of Transportation - Riprap	$25.00/ton	$16.20/LF
4	Landfill C		
a	Riprap (D50=18") installed	$15.00/CY	$5.55/LF
b	Riprap (D50=12") installed	$16.00/CY	$5.92/LF

Unit Cost Calculation Assumption(s):

	Assumption
1	Let-down channels are constructed with riprap and are about 20-feet wide and 3-feet deep. Assuming 6 " deep and 20 feet of surface area, there would 10 sf or rip rap per linear feet of ditch.
2	3500lb/cy for rip rap

Unit Cost: $5.55/lf - Landfill C

Regulatory Changes: No recommendations.

4.7.3 Clean Perimeter Drainage Ditches

Description: OAC 252:510-19-3(16) and OAC 252:520-23-8(c)(6) require landfills construct additional or rework existing surface drainage structures. Surface water at landfills is collected and controlled through the use of drainage ditches. Some landfills may incorporate sedimentation basins with the drainage ditches. At the time of final closure the drainage ditches and sedimentation basins may require routine maintenance. Ongoing maintenance during the post-closure monitoring period is addressed in the post-closure section.

Regional Variation: Subject to regional variation.

Units of Measurement: Linear Feet (LF)

Constants or Conversions: The existing perimeter drainage ditches will not all require cleaning. Therefore multiply the total linear feet of existing ditch by 50% to determine the quantity for this task and service.

Reference(s):

Reference		Unit Cost
1	Oklahoma Guidance Document - Surface drainage ditches	$3.50/LF
2	Kansas Guidance Document - Grass ditching/channels	$9.00/LF
3	Kansas Guidance Document - Riprap ditching/channels	$13.00/LF
4	Nebraska Guidance Document - Surface water control structures	$8.50-$25.00/LF
5	Wyoming Guidance Document - Surface water diversion structures	$1.00/LF
6	R.S. Means Environmental Remediation Cost Data	
a	New Grass Ditching, 5' bottom, 5' deep, 4:1 side slopes (33-05-0803)	$40.49/LF
	$40.49/LF * 0.8 (adjustment for Oklahoma region)	$32.39/LF
7	Landfill D	$1.50/LF

Unit Cost Calculation Assumption(s): Only 50% of the existing ditches will require cleaning.

Unit Cost: $4.7/LF, average of Oklahoma, Kansas ($9.00/LF), Nebraska ($8.50/LF), Wyoming, Landfill D costs

Regulatory Changes: No recommendations.

4.8 Administrative Services

Description: OAC 252:510-19-3(6) and OAC 252:520-23-8(b)(2) require landfill final closure cost estimates include the cost of providing administrative overhead for oversight and recordkeeping. The administrative tasks and services associated with completing final closure include:

- Recordkeeping;
- Contracting for technical and professional services;
- Administrative project and facility oversight;
- Review of all maintenance and monitoring reports;
- Contracting for general contractor(s) to perform post-closure activities and project supervision;
- Legal cost associated with post-closure activities and contract administration; and
- Cost of bonds

Regional Variation: Not subject to regional variation.

Units of Measurement: Lump Sum

Constants or Conversions: A percentage of total final closure construction costs.

Reference(s):

Reference		Unit Cost
1	Kansas Guidance Document - Administrative & Contingency	10%
2	Oklahoma Guidance Document	20%
2	Nebraska Guidance Document - Legal & Administrative	5%
3	Nebraska Guidance Document - Other Direct Costs	1%
4	Utah Guidance Document - Legal Fees	25%
5	USEPA Reference Document 2 - Closure and Post-Closure Indirect Costs	
a	Engineering & Supervision	5% - 15%
b	Contractors Fee	15% - 50%
6	R.S. Means Environmental Remediation Cost Data 1999	
a	Administrative Cost Overhead	6% - 10%

Unit Cost Calculation Assumption(s): All administrative costs are a percentage of the total construction costs.

Unit Cost: 10% of total final closure construction costs.

Regulatory Changes: No recommendations.

4.8.1 Technical and Professional Services

Description: OAC 252:510-19-3(5) and OAC 252:520-23-8(b)(1) require landfill final closures cost estimates include the cost of contracting for technical and professional services. The technical and professional tasks and services associated with final closure include:

- Complete topographic map of existing site;
- Verify proper waste placement and former closure areas;
- Redesign final cover based on existing site conditions;
- Determine/evaluate final cover material (amount of soil, soil type, location, and test material for physical properties). For composite caps the type and specifications for geosynthetic materials must be determined and evaluated (including, flexible membrane liners, geonets, and geotextiles);
- Prepare construction bid documents with final cover description and installation procedure;
- Evaluate acceptable bids and assist in selecting contractor(s);
- Prepare final cover construction schedule;
- Conduct construction quality assurance inspections and testing required to properly close

the landfill;

- Complete topographic map of final cover and site closure;
- Complete final closure certification and other final closure reports;
- Prepare and file a deed notice to the property with the appropriate county courthouse; and
- Other technical and professional tasks and services associated with completing post-closure monitoring.

Regional Variation: Not subject to regional variation.

Units of Measurement: Lump Sum

Constants or Conversions: a percentage of total final closure construction costs.

Reference Unit Costs:

Reference		Unit Cost
1	Nebraska Guidance Document - Engineering Fees	15%
2	Nebraska Guidance Document - Legal & Administrative	5%
3	Nebraska Guidance Document - Other Direct Costs	1%
4	Utah Guidance Document - Legal Fees	25%
5	USEPA Reference Document 2 - Closure and Post-Closure Indirect Costs	
a	Engineering & Supervision	5% - 15%
b	Contractors Fee	15% - 50%
6	R.S. Means Environmental Remediation Cost Data 1999	
a	Professional Labor - Remedial Action Construction	5% - 25%
7	Oklahoma Department of Mines - Engineering	9%
8	Landfill H	7%-12%

Unit Cost Calculation Assumption(s): All technical and professional fees are a percentage of the total construction costs.

Unit Cost: 12% of total final closure construction costs, not including final closure administrative services.

Regulatory Changes: No recommendations.

4.8.2 Final Closure Contingency

Description: OAC 252:510-19-3(20) and OAC 252:520-23-8(b)(8) require landfills prepare proposals for accomplishing any other tasks necessary to achieve complete and final closure of the site. Examples of possible contingency items include:

- Previously placed waste improperly disposed;
- Areas claimed to have final cover that is inadequate;
- Groundwater contamination;
- Surface water contamination;
- Methane gas migrating off-site in concentrations exceeding regulatory limits;
- NMOC concentrations exceeding regulatory limits triggering NSPS Title V requirements;
- Liner or waste containment failure;
- Clean up and remediation associated with a petroleum release from underground or above-ground storage tanks; or
- Other unforeseen tasks requiring correction to achieve final closure.

Regional Variation: Not subject to regional variation.

Units of Measurement: Lump Sum.

Constants or Conversions: a percentage of final closure construction costs.

Reference Unit Costs:

Reference		Unit Cost
1	Kansas Guidance Document - Administrative & Contingency	10%
2	Oklahoma Guidance Document - Contingency	10%
3	Nebraska Guidance Document - Contingency	10%
4	Utah Guidance Document - Contingency	10%
5	Wyoming Guidance Document - Contingency	15%
6	USEPA Reference Document 2 - Closure and Post-Closure Indirect Costs	
a	Contingency	25%

Unit Cost Calculation Assumption(s): All unforseen or unexpected costs associated with completing final closure are covered under a percentage of the total construction costs.

Unit Cost: 10% of total final closure construction costs, not including final closure administrative services or technical and professional services.

Regulatory Changes: No recommendations.

4.9 Description of Post-Closure Tasks and Services

Estimating post-closure costs for a landfill is achieved by calculating costs associated with tasks and services listed in Table 3.2. Each post-closure task and service requires a unit cost. The following post-closure task and service subsections describe and define each task and service; determine if task or service is subject to regional variation; identify units of measurement; identify and explain constants and conversion factors; explain assumptions; determine associated unit cost; and evaluate whether changes in regulatory language is necessary to support including task or service in calculating post-closure costs.

4.10 Site Maintenance

4.10.1 Site Inspections

Description: OAC 252:510-19-6(3) and OAC 252:520-23-14(e)(3) require landfills inspect the site routinely during the post-closure monitoring period. OAC 252:510-17-8(c) and OAC 252:520-9-11(13)(A) stipulates landfills must comply with pollution discharge elimination system permit. Adopted by reference, the National Pollution Discharge Elimination System (NPDES) section L(3)(a)(3)(d)(ii) mandates quarterly inspections for inactive landfills with NPDES permits.

Regional Variation: Not subject to regional variation.

Units of Measurement: Each

Constants or Conversions: Inspections will be conducted on a quarterly basis.

Reference Unit Costs:

Reference		Unit Cost
1	Oklahoma Guidance Document - Site Inspections	$250/inspection
2	Nebraska Guidance Document - Site Inspections	$300-$1,200/year
3	Wyoming Guidance Document - Post-closure inspections (1993 dollars)	$733.33/year

Unit Cost Calculation Assumption(s): Inspections conducted quarterly at $60/hour * 8 hours/day * 4 inspections/year = $1920.

Unit Cost: $2000

Regulatory Changes: No recommendations.

4.10.2 General Maintenance

Description: OAC 252:510-19-6(4) and OAC 252:520-23-14(e)(5) require landfills repair and maintain all on-site permanent improvements and equipment. General maintenance and repair activities should be performed on the following:

- Site security and access control features, such as signs, fencing and gates used to restrict access to the site;
- Permanent structures, such as equipment sheds or storage buildings, lighting and lamp poles, and utilities (water, sewer, electricity)
- Site access roads;
- Surface water control structures, such as, ditches, terraces, berms, let-down channels, sedimentation ponds, culverts, and weirs; and
- Other on-site permanent improvements and equipment.

Regional Variation: Not subject to regional variation.

Units of Measurement: Lump Sum.

Constants or Conversions: None.

Reference Unit Costs:

Reference		Unit Cost
1	Oklahoma Guidance Document - Maintenance of on-site improvements	$2,000/yr
2	Nebraska Guidance Document	
a	Fence repair	$500-$1,000/year
b	Gate and sign replacement	$120/year
3	Wyoming Guidance Document	
a	Perimeter fence maintenance and replacement	$12.00/LF
b	Remove and dispose perimeter fence	$2.00/LF
c	Maintain surface water diversion structures	$1.00/LF

Unit Cost Calculation Assumption(s):

Assumption	
1	Gate and sign replacement - $150/yr
2	Fence replacement - $2.20/lf * 200 = $440
3	Maintain surface water diversion structures - $4.7/lf * 200 lf = $840

Unit Cost: $1500

Regulatory Changes: No recommendations.

4.10.3 Remediation and/or Gas Control Equipment

Description: OAC 252:510-19-6(6) and OAC 252:520-23-14(e)(8) require landfills rework or replace any defective monitoring equipment. Providing financial assurance for this post-closure item is only applicable to landfills with approved remediation plans and landfills with installed gas control equipment. Landfills not operating remediation and/or gas control equipment do not need to provide financial assurance for this post-closure task. However, if a landfill must implement and/or install remediation and/or gas control equipment during the landfills operational life or post-closure monitoring period then the post-closure cost estimate shall be adjusted to account for those liabilities.

Regional Variation: Not subject to regional variation.

Units of Measurement: Lump Sum.

Constants or Conversions: Multiply the total remediation capital cost by a percentage.

Reference Unit Costs: None

Unit Cost Calculation Assumption(s): Operation and maintenance costs are five percent of total equipment capital costs.

Unit Cost: Dependent on five percent of total remediation equipment capital cost. If there is no remediation equipment, this cost would be zero. It is assumed that the cost of operating and maintaining the gas control equipment would be less than the revenue from selling the gas.

Regulatory Changes: No recommendations.

4.11 Monitoring Equipment

4.11.1 Rework/Replace Monitoring Well(s)

Description: OAC 252:510-19-6(6) and OAC 252:520-23-14(e)(8) require landfills post-closure plan develop a procedure for reworking or replacing monitoring wells that may become damaged or nonfunctional during the post-closure monitoring period.

Regional Variation: Groundwater monitoring wells must be installed in the uppermost aquifer beneath the site. Since depth to the uppermost aquifer varies from site to site depending on the landfill's geographical location and design, this item is subject to regional variation.

Units of Measurement: Mobilization/Demobilization - Lump Sum
Install Monitoring Well - Dollar per Foot of Boring ($/ft)
Construct Surface Protection - Well

Constants or Conversions: Add the total depth for all existing groundwater monitoring wells. Multiply the total depth by 25%.

Reference Unit Costs: Refer to documentation in subsection 4.5.1.

Unit Cost Calculation Assumption(s): Refer to documentation in subsection 4.5.1.

Unit Cost: $41.4/ft.

Regulatory Changes: No recommendations.

4.11.2 Plug Abandoned Monitoring Well(s)

Description: OAC 252:510-11-6 and OAC 252:520-9-8 require proper plugging of all groundwater monitoring wells. Therefore, groundwater monitoring wells needing replacement as identified in subsection 4.12.1 will need plugging.

Regional Variation: Monitoring well plugging will vary regionally because this task is a function of groundwater monitoring wells that are subject to regional variation, as described in subsection 4.12.1.

Units of Measurement: Mobilization/Demobilization - Lump Sum
Plug Monitoring Well - Dollar per Foot of Boring ($/ft)
Remove/Dispose Surface Protection - Well

Constants or Conversions: Add the total depth for all groundwater monitoring wells. Multiply the total depth by 25%.

Reference Unit Costs: Refer to documentation in subsection 4.5.2.

Unit Cost Calculation Assumption(s): Refer to documentation in subsection 4.5.2.

Unit Cost: $17.75/ft.

Regulatory Changes: No recommendations.

4.11.3 Final Plugging of Monitoring Wells

Description: OAC 252:510-11-6 and OAC 252:520-9-8 require proper plugging of all groundwater monitoring wells. Therefore, at the conclusion of the post-closure monitoring period all groundwater monitoring wells must be properly plugged.

Regional Variation: Monitoring well plugging will vary regionally because this task is a function of groundwater monitoring wells that are subject to regional variation, as described in subsection 4.12.1.

Units of Measurement: Mobilization/Demobilization - Lump Sum
Plug Monitoring Well - Dollar per Foot of Boring ($/ft)
Remove/Dispose Surface Protection - Well

Constants or Conversions: None.

Reference Unit Costs: Refer to documentation in subsection 4.5.2.

Unit Cost Calculation Assumption(s): Refer to documentation in subsection 4.5.2.

Unit Cost: $17.75/ft.

Regulatory Changes: No recommendations.

4.11.4 Rework/Replace Methane Probe(s)

Description: OAC 252:510-19-6(6) and OAC 252:520-23-14(e)(8) require landfill's post-closure plan develop a procedure for reworking or replacing monitoring wells that may become damaged or nonfunctional during the post-closure monitoring period. The number of methane gas probes at a specific landfill will be determined during the "Site Evaluation" and can vary from site to site. Construction and demolition landfills and nonhazardous industrial solid waste landfills typically do not have methane gas probes, in which case the reported quantity can be zero.

Regional Variation: Methane gas probes must be drilled to the deepest placement of waste or the top of the groundwater table, whichever is shallower. Since depth of waste placement and depth to groundwater vary from site to site depending on the landfill's geographical location and design, this item is subject to regional variation.

Units of Measurement: Mobilization/Demobilization - Lump Sum
Install Methane Gas Probe - Dollar per Foot of Boring ($/ft)
Construct Surface Protection - Probe

Constants or Conversions: Add the total depth for all methane gas probes. Multiply the total depth by 25%.

Reference Unit Costs: Refer to documentation in subsection 4.5.3.

Unit Cost Calculation Assumption(s): Refer to documentation in subsection 4.5.3.

Unit Cost: $35.75/ft.

Regulatory Changes: No recommendations.

4.11.5 Plug Abandoned Methane Probe(s)

Description: OAC 252:510-11-6 and OAC 252:520-9-8 require proper plugging of all borings. Therefore, methane gas probes needing replacement as identified in subsection 4.12.2 will need plugging.

Regional Variation: Methane probe plugging will vary regionally because this task is a function of methane gas probes that are subject to regional variation, as described in subsection 4.12.2.

Units of Measurement: Mobilization/Demobilization - Lump Sum
Plug Methane Gas Probe - Dollar per Foot of Boring ($/ft)
Remove/Dispose Surface Protection - Probe

Constants or Conversions: Add the total depth for all methane gas probes. Multiply the total depth by 25%.

Reference Unit Costs: Refer to documentation in subsection 4.5.4.

Unit Cost Calculation Assumption(s): Refer to documentation in subsection 4.5.4.

Unit Cost: $14/ft.

Regulatory Changes: No recommendations.

4.11.6 Final Plugging of Methane Probes

Description: OAC 252:510-11-6 and OAC 252:520-9-8 require proper plugging of all borings. Therefore, at the conclusion of the post-closure monitoring period, all methane gas probes must be properly plugged.

Regional Variation: Methane gas probe well plugging will vary regionally because this task is a function of methane gas probes that are subject to regional variation, as described in subsection 4.12.4.

Units of Measurement Mobilization/Demobilization - Lump Sum
Plug Methane Gas Probe - Dollar per Foot of Boring ($/ft)
Remove/Dispose Surface Protection - Probe

Constants or Conversions: None.

Reference Unit Costs: Refer to documentation in subsection 4.5.4.

Unit Cost: $14/ft.

Regulatory Changes: No recommendations.

4.11.7 Final Plugging of Piezometer(s)

Description: OAC 252:510-11-6 and OAC 252:520-9-8 require proper plugging of all borings. Therefore, at the conclusion of the post-closure monitoring period, all piezometers must be properly plugged.

Regional Variation: Piezometer plugging will vary regionally because this task is a function of depth to groundwater that is subject to regional variation as described in subsection 4.12.1.

Units of Measurement: Mobilization/Demobilization - Lump Sum
Plug Piezometer - Dollar per Foot of Boring ($/ft)
Remove/Dispose Surface Protection - Piezometer

Constants or Conversions: None.

Reference Unit Costs: Piezometer plugging must follow the same procedures for plugging monitoring wells. Therefore, refer to documentation in subsection 4.5.2.

Unit Cost Calculation Assumption(s): Piezometer plugging must follow the same procedures for plugging monitoring wells. Therefore, refer to documentation in subsection 4.5.2.

Unit Cost: $14/ft.

Regulatory Changes: No recommendations.

4.12 Sampling and Analysis

4.12.1 Groundwater Monitoring Wells

Description: OAC 252:510-19-6(7) and OAC 252:520-23-14(e)(9) require landfills collect and analyze groundwater samples. OAC 252:510-19-7 and OAC 252:520-23-14(c) stipulates sampling

must be conducted on a semi-annual basis. Landfills must analyze groundwater monitoring well samples for the constituents in Table 4.9, at a minimum.

TABLE 4.9 Groundwater Monitoring Constituents

LANDFILL TYPE	CONSTITUENTS
MSWLF	USEPA SW-846 Test Method 8260, total metals (antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, lead, magnesium, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and, zinc), pH, chemical oxygen demand (COD), specific conductivity, chloride, sulfate, nitrates, and carbonates

NHISW	varies - site specific
C&D	pH, chemical oxygen demand (COD), and specific conductivity

Regional Variation: Not subject to regional variation.

Units of Measurement: Well.

Constants or Conversions: None.

Reference Unit Costs:

Reference		Unit Cost
1	Oklahoma Guidance Document - MSWLF groundwater monitoring well	$1,000/well/event
2	Kansas Guidance Document - Groundwater sampling personnel labor	$35.00/HR
3	Kansas Guidance Document - Groundwater sampling event mobilization	$0.40/mile
4	Kansas Guidance Document - Groundwater monitoring analytical costs,	$165.00/well/event
5	Kansas Guidance Document - Groundwater monitoring analytical costs,	$220.00/well/event
6	Nebraska Guidance Document - Groundwater monitoring sampling	$500-$1,200/event
7	Nebraska Guidance Document - Groundwater monitoring analytical	$1,056-$1,288/well/event
8	Wyoming Guidance Document - Groundwater monitoring well sampling	$400.00/well/year
9	Wyoming Guidance Document - Groundwater monitoring well sampling	$150.00/well/year
10	USEPA Reference Document 7 - Annual sampling and analysis	$2,500-$3,200/well/year
11	Landfill A	$390/well
12	Landfill B	$400/well
13	Landfill D - analysis	$380/well
14	Landfill D - sampling	$200/event
15	Landfill E - analysis	$669/well
16	Landfill F	$500/well
17	Landfill G	$417.19/well
18	Landfill K	$450/well
19	Landfill L	$386/well

Analysis		Unit Cost					
		Lab A	**Lab B**	**Lab C**	**Lab D**	**Lab E**	**DEQ LAB**
1	Sample collection	$320	$700	$520	-	-	-
2	USEPA 8260	$630	$180	$150	$200	$143	$200
3	METALS						
a	Antimony	$12	$15	$15	$15	$12	$12
b	Arsenic	$12	$15	$15	$15	$12	$12
c	Barium	$12	$15	$15	$10	$12	$12
d	Beryllium	$12	$15	$15	$10	$12	$12
e	Cadmium	$12	$15	$15	$10	$12	$12
f	Calcium	$12	$15	$15	$10	$12	$12
g	Chromium	$12	$15	$15	$10	$12	$12
h	Cobalt	$12	$15	$15	$10	$12	-
I	Copper	$12	$15	$15	$10	$12	$12
j	Lead	$12	$15	$15	$10	$12	$12
k	Magnesium	$12	$15	$15	$10	$12	$12
l	Nickel	$12	$15	$15	$10	$12	$12
m	Potassium	$12	$15	$15	$10	$12	$12
n	Selenium	$12	$15	$15	$15	$12	$12
o	Silver	$12	$15	$15	$10	$12	$12
p	Sodium	$12	$15	$15	$10	$12	$12
q	Thallium	$12	$15	$15	$15	$12	$12
r	Vanadium	$12	$15	$15	$15	$12	-
s	Zinc	$12	$15	$15	$10	$12	$12
4	OTHERS						
a	pH	$5	$10	$8	$10	$5	$3
b	Chemical Oxygen Demand	$16	$25	$30	$25	$20	$29
c	Specific Conductance	$16	$10	$10	$15	$10	$3

d	Chloride	$16	$15	$10	$15	$10	$3
e	Sulfate	$16	$10	$20	$15	$10	$3
f	Nitrates	$16	$15	$20	$15	$10	$5
g	Carbonates	$16	$10	$10	$10	$10	$6
5	ANALYSIS TOTALS†						
a	MSWLF	$959	$560	$543	$520	$446	$456
b	NHISW Landfill	varies	varies	varies	varies	varies	varies
c	C&D Landfill	$37	$45	$48	$50	$35	$35

† Analysis totals do not include costs associated with sample collection.

Unit Cost Calculation Assumption(s):

	Assumption(s)
1	Sampling collection cost is the rounded average of estimates provided and are based on four monitoring wells and 100 mile one way travel distance.
2	Sample collection cost is equally divided between four wells and added to the laboratory cost
3	Sample cost = ((8 hours * $45/hour) + ($0.30*200))/4 wells=$105/well
2	Use low lab cost for analysis, Lab E

Unit Cost: $ 105 + 446 = $551 MSWLF
$ utilize MSWLF cost of $551 - NHISW Landfill
$ 105 + $35 = $136 - C&D Landfill

Regulatory Changes: No recommendations.

4.12.2 Methane Gas Probes

Description: OAC 252:510-19-6(7) and OAC 252:520-23-14(e)(9) require landfills collect and analyze samples, as required. OAC 252:510-19-7 stipulates methane gas probes must sampled on

a semi-annual basis. OAC 252:520 determines the necessity of methane gas probes based on the type of facility and proposed or permitted waste.

Regional Variation: Not subject to regional variation.

Units of Measurement: Probe.

Constants or Conversions: None.

Reference Unit Costs:

Reference		Unit Cost
1	Oklahoma Guidance Document - Gas sampling	$35/probe/event
2	Nebraska Guidance Document - Gas monitoring - sampling & analysis	$150-$240/quarter
3	Wyoming Guidance Document - Methane gas monitoring	$240/probe/year
4	USEPA Reference Document 7 - Gas monitoring	$1,000-$1,600/year
5	Landfill A	$40/probe
6	Landfill D	$35/probe
7	Landfill G	$125/event

Unit Cost Calculation Assumption(s): Sampling cost includes all related time, materials, equipment, travel, and reporting costs.

Unit Cost: $ 35/probe, Landfill D cost

Regulatory Changes: No recommendations.

4.12.3 Surface Water Monitoring Points

Description: OAC 252:510-19-6(7) and OAC 252:520-23-14(e)(9) stipulates landfills collect and analyze water samples, as required. OAC 252:510-19-7 specifies sampling must be conducted on a semi-annual basis. OAC 252:520-23-14(e)(9) specifies sampling must be conducted as required. Landfills must analyze surface water sampling locations for the constituents in Table 4.10, at a minimum.

TABLE 4.10 Surface Water Sampling Requirements

LANDFILL TYPE	CONSTITUENTS
MSWLF	pH, chemical oxygen demand (COD), specific conductivity, dissolved oxygen (DO), and turbidity
NHISW	varies - site specific
C&D	varies - site specific

Regional Variation: Not subject to regional variation.

Units of Measurement: Sample Point.

Constants or Conversions: None.

Reference Unit Costs:

Reference		Unit Cost
1	Oklahoma Guidance Document - surface water sampling and analysis	$100/point/event
2	Landfill A	
	Collection cost	$50/event
	Analysis	$40/point

Analysis		Unit Cost†					
		Lab A	Lab B	Lab C	Lab D	Lab E	DEQ LAB
1	CONSTITUENTS						
a	pH	$5	$10	$8	$10	$5	$3
b	Chemical Oxygen Demand	$16	$25	$30	$25	$20	$29
c	Specific Conductance	$16	$10	$10	$15	$10	$3
d	Dissolved oxygen (DO)	$16	$15	$10	$15	$10	$3
e	Turbidity	$16	$10	$20	$15	$10	$5
2	ANALYSIS TOTAL						
a	MSWLF	$69	$70	$78	$80	$55	$43
b	NHISW Landfill	varies	varies	varies	varies	varies	varies
c	C&D Landfill	varies	varies	varies	varies	varies	varies

† Laboratory costs do not include costs associated with collecting the sample.

Unit Cost Calculation Assumption(s):

Assumption(s)	
1	Sampling collection cost includes all related time, materials, equipment, travel, and reporting costs.
2	Utilize landfill A cost of $50/event/2 points + $40/point = $65/point

Unit Cost: $65 - MSWLF
$ varies - NHISW Landfill
$ varies - C&D Landfill

Regulatory Changes: No recommendations.

4.12.4 Leachate

Description: OAC 252:510-19-6(8) and OAC 252:520-23-14(e)(4) requires landfills develop methods for properly collecting, treating, and disposing leachate generated during the post-closure monitoring period. Proper treatment and disposal cannot be achieved until the leachate is characterized. Leachate characteristics determine which treatment and disposal options are viable. Batch analysis of collected leachate is considered uneconomical because landfills can generate leachate daily. A grab sample collected and analyzed annually is considered sufficient. The analysis should mirror the analysis required under municipal wastewater treatment plant pre-treatment programs. Based on interviews with publicly owned treatment works across the state, the most common requested parameter analysis to determine acceptability was compiled and listed in Table 4.11.

TABLE 4.11 POTW Leachate Screening Analysis

POTW		Screening Analysis Parameters
1	POTW - A	BOD, TSS, pH, As, Ba, Cd, Cr, Pb, Se, Ag, Hg
2	POTW - B	BOD, COD, Alk Group, Chloride, Ammonia
3	POTW - C	BOD, TSS
4	POTW - D	40 CFR Part 122, Appendix D, Table II and III

Regional Variation: Not subject to regional variation.

Units of Measurement: Each.

Constants or Conversions: None.

Reference Unit Costs: Nebraska Guidance Document, Leachate management, sampling and analysis is $900/year.

Analysis		Unit Cost					
		Lab A	Lab B	Lab C	Lab D	Lab E	DEQ LAB
1	CONSTITUENTS						
a	pH	$5	$10	$8	$10	$5	$3
b	Chemical Oxygen Demand	$16	$25	$30	$25	$20	$29
c	Specific Conductance	$16	$10	$10	$15	$10	$3
d	Dissolved oxygen (DO)	$16	$15	$10	$15	$10	$3
e	Turbidity	$16	$10	$20	$15	$10	$5

2	ANALYSIS TOTAL						
a	MSWLF	$69	$70	$78	$80	$55	$43
b	NHISW Landfill	varies	varies	varies	varies	varies	varies
c	C&D Landfill	varies	varies	varies	varies	varies	varies

Unit Cost Calculation Assumption(s):

	Assumption(s)
1	Sampling collection cost includes all related time, materials, equipment, travel, and reporting costs.
2	Utilize Landfill A collection cost from 4.10.3 of $50/event + Lab E cost of $55/event

Unit Cost: $ 105/event - MSWLF, NHISW Landfill, and C&D Landfill

Regulatory Changes: No recommendations.

4.13 Final Cover Maintenance

4.13.1 Mow and Fertilize Vegetative Cover

Description: OAC 252:510-19-6(12) and OAC 252:520-23-14(e)(11) require landfills establish a schedule for mowing and fertilizing final cover vegetation and other areas, as needed.

Regional Variation: Subject to regional variation.

Units of Measurement: Acre.

Constants or Conversions: None.

Reference Unit Costs:

	Reference	Unit Cost
1	Oklahoma Guidance Document - Maintaining Vegetation	$250/acre
2	Nebraska Guidance Document - Mowing	$25/acre
3	USEPA Reference Document 7 - Long-term Maintenance of Final Cover	$1,500-$3,000/acre
4	1999 R.S. Means Environmental Cost Data	
	Mowing (18-05-0415)	$27.20/acre
5	ODOT- mowing	$40.00/acre
6	Oklahoma Department of Mines - Maintenance	$200.00/acre

Unit Cost Calculation Assumption(s):

	Assumption(s)
1	Entire permitted site has vegetative cover requiring mowing and fertilizing.
2	Mow 3 times/yr + fertilize 1 time/yr at odot rate of $40/acre

Unit Cost: $ 160/acre

Regulatory Changes: No recommendations.

4.13.2 Repair Erosion, Settlement, and Subsidence

Description: OAC 252:510-19-6(11) and OAC 252:520-23-14(e)(10) require landfills establish procedures to repair erosion and maintain the final cover. A landfill final cover may experience localized settlement and subsidence over the post-closure period requiring maintenance.

Regional Variation: Subject to regional variation.

Units of Measurement: Cubic Yards.

Constants or Conversions: Multiply total acres in post-closure by two cubic yards per acre to determine number of cubic yards.

Reference Unit Costs:

	Reference	Unit Cost
1	Oklahoma Guidance Document - Maintenance of On-site Improvements	$2,000/acre
2	Kansas Guidance Document - Cover repair, soil off-site	$5.20/CY
3	Kansas Guidance Document - Cover repair, soil on-site	$1.77/CY
4	Nebraska Guidance Document - Final cover repair	$2.00-$4.00/CY
5	USEPA Reference Document 7 - Long-term Maintenance of Final Cover	$1,500-$3,000/acre

Unit Cost Calculation Assumption(s): Over the post-closure period, repairs will average two cubic yards per acre.

Unit Cost: $2.00/cy Onsite
$12.00/cy Off-site from Section 4.6.3

Regulatory Changes: No recommendations.

4.13.3 Re-seed Vegetative Cover

Description: OAC 252:510-19-6(11) and OAC 252:520-23-14(e)(10) require landfills establish procedures to maintain the final cover. The maintenance routine will include re-seeding the vegetative cover over repaired areas and other bare or thin areas.

Regional Variation: Subject to regional variation.

Units of Measurement: Acre.

Constants or Conversions: Non applicable.

Reference(s):

Reference		Unit Cost
1	Oklahoma Guidance Document - Vegetation	$500.00/acre
2	Kansas Guidance Document - Seeding and mulching	$1,500.00/acre
3	Nebraska Guidance Document - Seeding, mulching, fertilizer	$915.00-$1,982.00/acre
4	Wyoming Guidance Document - Final cover, seeding, fertilizer, and	$10,200/acre
6	USEPA Reference Document 7 - Erosion Control Layer	
a	Fertilizing, seeding, and hydro-mulching	$1,200.00-$1,800.00/acre
7	USEPA Reference Document 7 - Long-term Maintenance of Final Cover	$1,500-$3,000/acre
8	R.S. Means Environmental Remediation Cost Data	
a	Seeding, 67% Level & 33% Slope, Hydoseeding	$477.91/acre
b	Seeding, vegetative cover (18-05-0402)	$14,134.00/acre
c	Sodding, Average Continental U.S. (18-05-0404)	$21,849.00/acre
d	Fertilizer, Hydro Spread (18-05-0408)	$140.79/acre
e	Fertilize, 800 lbs/acre, Push Rotary (18-05-0409)	$80.47/acre
f	Fertilize, 800 lbs/acre, Spray from Truck (18-05-0410)	$137.69/acre
g	Crushed Limestone, pH adjustment, 800 lbs/acre (18-05-0411)	$97.58/acre
h	Purchase & Spread Dry Granular Limestone for pH Control (18-05-0412)	$193.60/acre
i	Watering with 3,000-gallon Tank Truck, per pass (18-05-0413)	$55.63/acre
j	Vegetative Cover (a, e, g, and I)	$693.72/acre

9	Landfill B (Bermuda grass sod, 314,900 SF)	$7840.80/acre
10	Landfill C	
a	Sodding (23.35 acres)	$7018.00/acre
b	Seeding and mulching (28.93 acres)	$2178.00/acre
11	Landfill D	$325.00/acre

Unit Cost Calculation Assumption(s): On average, during the post-closure period, re-seeding will be necessary over 20% of the final cover area.

Unit Cost Calculation Assumption(s): Refer to documentation in subsection 4.6.4.

Unit Cost: $400/acre, Section 3i, Establish vegetative cover

Regulatory Changes: No recommendations.

4.14 Leachate Management

4.14.1 Clean Leachate Line(s)

Description: OAC 252:510-15-4(b) and OAC 252:520-23-14(e)(4) require MSWLFs annually clean the leachate collection lines and establish methods to properly collect leachate. Leachate lines must be clean in order to remove leachate for treatment and disposal.

Regional Variation: A limited number of companies offer hydro-jetting services in Oklahoma. Therefore this item is not considered subject to regional variation.

Units of Measurement: Mobilization/Demobilization - Lump Sum
Cleaning Leachate Collection Line(s) - Linear Feet (LF)

Constants or Conversions: None.

Reference Unit Costs: Refer to documentation in section 4.4.6.

Unit Cost Calculation Assumption(s): Refer to section 4.4.6.

Unit Cost: $1250

Regulatory Changes: No recommendations.

4.14.2 Maintain Leachate Collection System and Equipment

Description: OAC 252:510-19-6(8) and OAC 252:520-23-14(e)(4) require landfills properly collect, treat, and dispose of leachate. In order to properly collect, treat, and dispose of leachate the leachate collection system and associated equipment must be maintained.

Regional Variation: Not subject to regional variation.

Units of Measurement: Lump Sum.

Constants or Conversions: None.

Reference Unit Costs:

Reference		Unit Cost
1	Oklahoma Guidance Document - Leachate System Maintenance	$0.25/LF
2	Nebraska Guidance Document - Leachate management - maintenance & inspections	$1,000/year
3	Nebraska Guidance Document - Leachate management - pump replacement	$2,000/each/10years
4	USEPA Reference Document 7 - Leachate Management - Maintenance and operation	$10,000-$25,000/year

Unit Cost Calculation Assumption(s): Cost will cover all expenses associated with maintaining and replacing equipment and appurtenances used to collect, treat, and dispose of leachate.

Unit Cost: $2000/year

Regulatory Changes: No recommendations.

4.14.3 Collect, Treat, Transport, and Dispose Leachate

Description: OAC 252:510-19-6(8) and OAC 252:520-23-14(e)(4) require landfills collect, treat, and dispose of leachate. Using POTWs can be one of the easiest methods of disposal and treatment of leachate. Calculating the associated cost for treating and disposing leachate needs to include transportation costs from the landfill to the POTW.

Regional Variation: Not subject to regional variation.

Units of Measurement: Gallon.

Constants or Conversions: None.

Reference Unit Costs:

Reference		Unit Cost
1	Oklahoma Guidance Document - Leachate Management	$0.15/gallon
2	Nebraska Guidance Document - Leachate Management - pumping, removal, & disposal	$0.12/gallon & $2.50/mile
3	USEPA Reference Document 7 - Leachate treatment	$0.15-$0.25/gallon
4	POTW	$0.15-$0.38/gallon

Unit Cost Calculation Assumption(s):

Assumption(s)	
1	Landfill determines amount of leachate generated per acre per year using the HELP model.
2	Leachate is transported by tanker truck to POTW

Unit Cost: $0.10/gallon transportation + POTW-$0.15/gallon for treatment at lowest priced POTW

Regulatory Changes: No recommendations.

4.15 Post-Closure Administrative Services

Description: OAC 252:510-19-6(2) and OAC 252:520-23-14(e)(12) require landfill post-closure cost estimates include the cost of providing administrative overhead for oversight and recordkeeping. The administrative tasks and services associated with completing post-closure include:

- Recordkeeping;
- Contracting for technical and professional services;
- Administrative project and facility oversight;
- Review of all maintenance and monitoring reports;
- Contracting for general contractor(s) to perform post-closure activities and project supervision; and
- Legal cost associated with post-closure activities and contract administration.

Regional Variation: Not subject to regional variation.

Units of Measurement: Lump Sum

Constants or Conversions: A percentage of post-closure monitoring and maintenance costs.

Reference(s):

Reference		Unit Cost
1	Oklahoma Guidance Document	10%
2	Kansas Guidance Document - Administrative & Contingency	10%
3	Nebraska Guidance Document - Recordkeeping & Administrative	$1,200 - $1,600/year
4	Nebraska Guidance Document - Other Direct Costs	1%/year
5	USEPA Reference Document 2 - Closure and Post-Closure Indirect Costs	
a	Engineering & Supervision	5% - 15%
b	Contractors Fee	15% - 50%
6	R.S. Means Environmental Remediation Cost Data 1999	
a	Administrative Cost Overhead	6% - 10%

Unit Cost Calculation Assumption(s): All administrative costs are a percentage of the total monitoring and maintenance costs.

Unit Cost: 6% of total post-closure monitoring and maintenance costs.

Regulatory Changes: No recommendations.

4.16 Post-Closure Technical and Professional Services

Description: OAC 252:510-19-6(1) and OAC 252:520-23-14(e)(2) require landfill post-closure cost estimates include the cost of contracting for technical and professional services. The technical and professional tasks and services associated with post-closure include:

- Complete and submit annual maintenance and monitoring reports;
- Review and evaluate all monitoring data, including performing statistical analysis of groundwater data;
- Complete and submit annual NMOC Emission Rate Report, including documenting when NMOC emission rates drop below 50Mg/year;
- Maintain/Renew Title V permits, as required during NSPS control period;
- Submit control equipment removal report and complete activities to remove control equipment, meeting requirements in 40 CFR 60.757(e);
- Complete any necessary re-design of structures at the landfill;
- Complete and submit final post-closure certification and other final post-closure reports; and
- Other technical and professional tasks and services associated with completing post-closure monitoring.

Regional Variation: Not subject to regional variation.

Units of Measurement: Lump Sum

Constants or Conversions: A percentage of post-closure monitoring and maintenance costs.

Reference Unit Costs:

Reference		Unit Cost
1	Nebraska Guidance Document - Engineering Fees	15%
2	Nebraska Guidance Document - Legal & Administrative	5%
3	Nebraska Guidance Document - Other Direct Costs	1%
4	Utah Guidance Document - Legal Fees	25%
5	USEPA Reference Document 2 - Closure and Post-Closure Indirect Costs	
a	Engineering & Supervision	5% - 15%
b	Contractors Fee	15% - 50%
6	R.S. Means Environmental Remediation Cost Data 1999	
a	Professional Labor - Remedial Action Construction	5% - 25%
7	Landfill H	7%-12%

Unit Cost Calculation Assumption(s): All technical and professional fees are a percentage of the total monitoring and maintenance costs.

Unit Cost: 7% of total post-closure monitoring and maintenance costs, not including post-closure administrative services.

Regulatory Changes: No recommendations.

4.17 Post-Closure Contingency

Description: OAC 252:510-19-6(15) and OAC 252:520-23-14(e)(15) require landfills account for monies to complete any other tasks necessary to accomplish adequate post-closure. Examples of possible contingency tasks and services include:

- Groundwater contamination;
- Surface water contamination;
- Methane gas migrating off-site in concentrations exceeding regulatory limits;
- NMOC concentrations exceeding regulatory limits triggering NSPS Title V requirements;
- Installation of a gas control system;
- Liner, cap, or waste containment failure; or
- Other unforeseen tasks requiring correction to achieve final post-closure.

Regional Variation: Not subject to regional variation.

Units of Measurement: Lump Sum.

Constants or Conversions: a percentage of post-closure monitoring and maintenance costs.

Reference Unit Costs:

Reference		Unit Cost
1	Oklahoma Guidance Document	10%
2	Kansas Guidance Document - Administrative & Contingency	10%
3	Nebraska Guidance Document - Contingency	10%/year
4	Utah Guidance Document - Contingency	10%
5	Wyoming Guidance Document - Contingency	15%
6	USEPA Reference Document 2 - Closure and Post-Closure Indirect Costs	
a	Contingency	15%

Unit Cost Calculation Assumption(s): All unforseen or unexpected costs associated with completing post-closure monitoring and maintenance are covered under a percentage of the total monitoring and maintenance costs.

Unit Cost: 10% of total post-closure monitoring and maintenance costs, not including post-closure administrative services or technical and professional services.

Regulatory Changes: No recommendations.

Chapter 5 - Procedure for Calculating Final Closure and Post-Closure Costs

The purpose of this chapter is to present the procedure for calculating final closure and post-closure cost estimates. The procedure will present brief and concise explanations for each identified task and service along with the associated unit cost. The tasks and services included in this procedure are based on the more complex closure and post-closure requirements for MSWLFs. C&D and NHISW landfills will find each task and service they require is included in this procedure. However, not every task and service included is required for C&D and NHISW landfills. Owners/Operators of C&D and NHISW landfills should determine which unit costs are applicable to calculate closure and post-closure cost for their facility. Users will be able to input site specific information to calculate the necessary financial assurance. This chapter contains sufficient information to stand alone as a guidance document available to owners and operators to calculate the necessary financial assurance.

5.1 Site Data

All site data necessary to calculate estimates of closure and post closure costs can be gathered by completing Table 5.1. Data from Table 5.1 should be inserted into Tables 5.2 and 5.3 to complete calculations.

Table 5.1 Site Data
FACILITY NAME:
PERMIT NUMBER:

DESCRIPTION	QUANTITY	UNITS
Total Permitted Area		acres
Active Portion		
Composite Lined		acres
Soil Lined		acres
Final Cover Area		
Composite Lined		acres
Soil Lined		acres
Perimeter Fencing		linear feet
Groundwater Monitoring Wells		linear feet
Methane Gas Probes		linear feet
Terraces		linear feet
Letdown Channels		
Perimeter Drainage Ditches		linear feet

5.2 Calculating Closure Costs

Table 5.2 can be used to calculate closure cost estimates for landfills for which site specific data are available. The table is designed to be executed as a computer spreadsheet, but will work equally as well using hand calculations.

The following procedures may be utilized to reach the estimated closure cost:

- Input site specific quantities from Table 5.1 into Table 5.2, making sure the requisite units are used. Some quantities are already given by the table.
- Multiply the value input for quantity by the multiplier and unit cost given by the table, and enter the resultant value in the subtotal column to compute values for Tasks/Services listed in Items 1 through 4.
- Add subtotals for Task/Service Items 1 through 4 to determine a Subtotal for Task/Services, and enter the sum as the value Item 5.
- Compute Administrative Services, Technical and Professional Services and Closure Contingency costs, Items 6, 7 and 8, by multiplying the Subtotal (Item 5) by the multiplier for each respective Item. Enter the resultant values.
- Compute the sum of Items 5,6,7,and 8 and enter the resultant as a value for Total Final Closure, Item 9. The value for Total Final Closure is the estimated Closure Cost for the facility for which data was entered.

Table 5.2 Closure Cost Estimate
FACILITY NAME:
FACILITY TYPE:
FACILITY LOCATION:

	Task/Service	Quantity	Units	Multiplier	Unit Cost	Subtotal
1	**PRELIMINARY SITE WORK**					
a	Conduct Site Evaluation		lump sum	1	$2,750.00	
b	Dispose Final Wastes					
	Average Daily Flow		tons/day			
	Disposal Cost		$/ton	5 days of waste		
c	Remove Temporary Building(s)	1	lump sum	1	$2,450.00	
d	Remove Equipment	1	lump sum	1	$2,000.00	$2,000.00
e	Repair/Replace Perimeter Fencing		linear feet	25% of fencing	$2.20	
f	Clean Leachate Line(s)	1	lump sum	1	$1,250.00	$1,250.00
2	**MONITORING EQUIPMENT**					
a	Rework/Replace Monitoring Well(s)		VLF	25% of wells	$41.40	
b	Plug Abandoned Monitoring Well(s)		VLF	25% of wells	$17.75	
c	Rework/Replace Methane Probe(s)		VLF	25% of probes	$35.75	

d	Plug Abandoned Methane Probe(s)		VLF	25% of probes	$14.00	
e	Rework/Replace Remediation and/or Gas Control Equipment	5% of equipment capital cost	lump sum	1		
3	**CONSTRUCTION**					
a	Complete Site Grading		acres	1	$1,122.00	
b	Construct Final Cap					
	Compacted On-site Clay Cap or		cubic yards	1	$3.20	
	Compacted Off-site Clay Cap or		cubic yards	1	$5.17	
	Install Geosynthetic Clay Liner Cap		square feet	1	$0.38	
c	Construct Landfill Gas Venting Layer					
	Place Sand or		acres	1	$30,000.00	
	Install Net and Geotextile		square feet	1	$0.27	
d	Install Passive Landfill Gas Vents		acres	1	$500.00	
e	Install Flexible Membrane Liner		square feet	1	$0.32	
f	Drainage Layer					
	Place Sand or		acres	1	$30,000.00	
	Install Net and Geonet		square feet	1	$0.27	
g	Place On-site Topsoil		cubic yards	1	$1.50	
	Place Off-site Topsoil		cubic yards	1	$12.00	
h	Establish Vegetative Cover		acres	1	$400.00	
4	**DRAINAGE/EROSION CONTROL**					
a	Construct Terraces		linear feet	1	$7.24	
b	Construct Letdown Channels		linear feet	1	$5.55	
c	Clean Perimeter Drainage Ditches		linear feet	50% of ditches	$4.70	
5	**SUBTOTAL**					
6	**ADMINISTRATIVE SERVICES**	1	lump sum	1	10%	
7	**TECHNICAL and PROFESSIONAL SERVICES**	1	lump sum	1	12%	
8	**CLOSURE CONTINGENCY**	1	lump sum	1	10%	
9	**TOTAL FINAL CLOSURE**					

5.3 Calculating Post-Closure Costs

Table 5.3 can be used to estimate Post-Closure Costs. Table 5.3 may be utilized in the same manner as Table 5.2.

The following procedures may be utilized to reach the estimated post-closure cost:

- Input site specific quantities from Table 5.1 into Table 5.3 making sure the requisite units are used. Some quantities are already given by the table.
- Multiply the value input for quantity by the multiplier and unit cost given by the table, and enter the resultant value in the subtotal column to compute values for Tasks/Services listed in Items 1 through 5.
- Add subtotals for Task/Service Items 1 through 5 to determine a Subtotal for Task/Services, and enter the sum as the value Item 6.
- Compute Administrative Services, Technical and Professional Services and Closure Contingency costs, Items 7,8, and 9, by multiplying the Subtotal (Item 6) by the multiplier for each respective Item. Enter the resultant values.
- Compute the sum of Items 6, 7, 8, and 9 and enter the resultant as a value for Total Post Closure, Item 10. The value for Total Post Closure is the estimated Post-Closure Cost for the facility for which data was entered.

Table 5.3 Post Closure Estimate
FACILITY NAME:
FACILITY TYPE:
FACILITY LOCATION:

	Task/Service	Quantity	Units	Multiplier*	Unit Cost	Subtotal
1	**SITE MAINTENANCE**					
a	Site Inspections	4	per year	30 yrs	$500.00	
b	General Maintenance	1	lump sum	30 years	$1,500.00	
c	Remediation and/or Gas Control Equipment	5% of equipment capital cost	lump sum	one per 5 yrs for 30 years		
2	**MONITORING EQUIPMENT**					
a	Rework/Replace Monitoring Well(s)		VLF	25% of wells	$41.40	
b	Plug Abandoned Well(s)		VLF	25% of wells	$17.75	
c	Final Plugging of Monitoring Wells		VLF	1	$17.75	
d	Rework/Replace Methane Probe(s)		VLF	25% of probes	$35.75	
e	Plug Abandoned Probe(s)		VLF	25% of probes	$14.00	
f	Final Plugging of Methane Probes		VLF	1	$14.00	
g	Final Plugging of Piezometer(s)		VLF	1	$14.00	

3	**SAMPLING and ANALYSIS**					
a	Groundwater Monitoring Wells		wells	2/yr for 30 years	$551.00	
b	Methane Gas Probes		probes	2/yr for 30 years	$35.00	
c	Surface Water Monitoring Points		points	2/yr for 30 years	$65.00	
d	Leachate		sample	2/yr for 30 years	$ 105.00	
4	**FINAL COVER MAINTENANCE**					
a	Mow and Fertilize Vegetative Cover		acres	30 years	$160.00	
b	Repair Erosion, Settlement, and Subsidence for On-site Soils		acres	2 CY/acre for 30 years	$2.00	
	Repair Erosion, Settlement, and Subsidence for Off-site Soils		acres	2 CY/acre for 30 years	$12.00	
c	Re-seed Vegetative Cover		acres	20% of area for 30 years	$400.00	
5	**LEACHATE MANAGEMENT**					
a	Clean Leachate Line(s)	1	lump sum	30 years	$1,250.00	
b	Maintain Leachate Collection System and Equipment	1	lump sum	30 years	$2,000.00	
c	Collect, Treat, Transport, and Dispose Leachate		gallons/year	30 years	$0.25	
6	**SUBTOTAL**					
7	**ADMINISTRATIVE SERVICES**		lump sum	1	6%	
8	**TECHNICAL and PROFESSIONAL SERVICES**		lump sum	1	7%	
9	**POST-CLOSURE CONTINGENCY**		lump sum	1	10%	
10	**TOTAL POST CLOSURE**					

5.4 Adjusting for Inflation

Since unit costs for tasks and services given in Tables 5.2 and 5.3 are given in current dollars they should be updated periodically to account for rises in inflation and other market influences. To provide accurate closure and post closure cost estimates it is recommended that quick and easy inflation adjustments be made annually. A more thorough but time consuming reassessment of unit costs should be conducted after every fifth year. Steps for accomplishing both annual adjustments and comprehensive reassessments are given below.

5.4.1 Annual Adjustment

Currently in accordance with OAC 252:510-21-2 (c) and 3(c), MSWLF owners and operators must annually adjust their final closure and post-closure costs for inflation. OAC 252:510-21-2(c) and 21-3(c), though not yet adopted as permanent regulation, describe how to perform inflation adjustment calculations using an inflation factor.

The inflation factor is derived from the most recent annual "Implicit Price Deflator for Gross National Product" or the "Implicit Price Deflator for Gross Domestic Product" published by the U.S. Department of Commerce in its *Survey of Current Business* in the year for which the adjustment is being made. The inflation factor is the result of dividing the latest published annual Deflator by the Deflator for the previous year.

The first annual adjustment should occur the first year after this document is published. The first adjustment should be made by multiplying the unit costs given in Tables 5.2 and 5.3 by the inflation factor. The adjusted values should then be used to calculate closure and post closure costs estimates. Subsequent adjustments should be made annually by multiplying the latest values for unit costs by the latest inflation factor. This process of adjustment should be utilized until the unit costs are more thoroughly reassessed after year five.

5.4.2 Comprehensive Reassessment

After five years, a more comprehensive adjustment of unit costs should be performed. This can be accomplished by re-tracing some of the steps taken in Chapter Four of this document. Those resources consulted in Chapter Four, members of the regulated community, vendors service providers, and standard references, could provide current unit costs for tasks and services. For instance, labs would be asked to submit current price lists, and ODOT bid tabs for the previous year could be reviewed to determine the costs of topsoil and salvaged topsoil. Attachments 8 through 11 contain all the necessary contact information for those agencies and companies submitting information used to determine the original unit costs used in this document.

Tables 5.2 and 5.3 should be revised when new values for unit costs have been determined. At this point, MSWLF owners and operators should recalculate closure and post closure costs using the revised tables. Annual adjustments, as described in 5.4.1, should now resume and continue until the next comprehensive five year adjustment occurs.

5.5 Utilization of Closure and Post-Closure Cost Estimates

After exhaustive research of numerous resources including other states, the EPA, cost estimate publications such as R.S. Means, and the owner/operators of the regulated landfills in Oklahoma, the comprehensive list of tasks and services and unit costs are presented in this chapter. It is recommended that the list of tasks and services and unit costs be utilized in the State of Oklahoma to calculate adequate costs estimates for closure and post-closure activities. It is recommended that these unit costs be updated periodically to account for inflation and other market influences as discussed in this chapter.