

Memorandum

Date: December 14, 2004

To: Dave Finley, Administrator Solid and Hazardous Waste Division

From: Jan Lydigsen, Solid and Hazardous Waste Division

Subject: Landfill Remediation Cost Estimate

DEQ estimates the following number of landfills is likely to require groundwater remediation:

Size category	Number of Wyoming landfills in each size category	Number of Wyoming landfills predicted to require groundwater remediation, based on DEQ projections	Percentage of Wyoming landfills predicted to require groundwater remediation
Large (>15 acres)	23	19	~90%
Medium (5-15 acres)	20	15	~80%
Small (1-5 acres)	37	18	~50%
Very small (<1 acre)	50	6	~12%
Total	130	58	~45%

What will it cost to address a problem of this magnitude?

DEQ's original projection was that the total remediation cost at 65 of Wyoming's 130 landfills would equal \$184 million. That cost projection has been revised to incorporate new cost data and to reduce the overall number of landfills projected to be affected to 58. DEQ's projections and the basis for these projections, are as follows:

Cost category: Screening investigations \$1,980,000

A screening investigation is needed to determine if any of the 109 landfills without documented groundwater impacts are currently impacting groundwater. A screening investigation includes installation of an average of three to four wells, and a single round of groundwater sampling. The average cost of this screening investigation is estimated to be \$30,000. Performance of the screening investigations would be prioritized based on size of landfills, aquifer sensitivity areas, and number of wells within one mile of the landfill. Since there is a universe of 109 landfills without documented groundwater contamination, and 43 of those landfills have monitor well systems in place, there is a need to conduct a screening investigation at 66 landfills.

DEQ's original cost projection assumed a need for 109 screening investigations, at a cost of \$3.27 million. The original cost projection did not account for the existence of groundwater monitor systems at 43 landfills. The revised cost projection, 66 landfills at \$30,000 each, or \$1.98 million, is lower than the former projection by \$1.29 million.

Cost category: Supplemental groundwater investigations: \$7,800,000

Supplemental groundwater investigations are needed at those landfills with indications of groundwater impacts, to serve two purposes: first, wells are needed to determine the nature (how bad) and extent (how far) of any groundwater contamination; and second, wells are needed to assess the type of corrective action systems that would be effective at the site.

Costs were developed for the four size-based categories of landfills that exist in Wyoming: very small, small, medium and large. DEQ chose to assess costs for supplemental groundwater investigations based on landfill size, since it costs more to investigate larger areas than smaller ones. In DEQ's original estimate, only costs for small, medium and large landfills were developed. Each supplemental investigation project is anticipated to take one year. Project management costs were estimated at two hours of project manager time per week at \$100/hour.

Development of an investigation work plan was estimated to be more complex at larger sites than smaller ones. Junior (\$50/hour) and senior (\$100/hr) personnel are expected to develop the work plan. The hours required for work plan development are estimated at:

Large	100 hours
Medium	60 hours
Small	40hours
Very small	30hours

The number of wells is estimated to vary by size of landfill, and a well drilling and completion cost of \$3500/well was used. Depending on the geologic conditions, some well installation costs will be more and some less. The following number of wells was projected to be necessary:

Large	16 wells
Medium	12 wells
Small	8 wells
Very small	4 wells

The number of hours required for the original field work and quarterly monitoring was estimated to vary by the size of the landfill:

has operated in Minnesota for more than a decade. In that program, the average cost for a cap and gas mitigation at landfills in communities with populations of about 24,000 is \$550,000. This cost was used as an average cost for capping a typical landfill in Wyoming, since an average community population of 24,000 was believed to be reasonable for Wyoming.

DEQ has now revised its estimate for the cost of capping and gas mitigation. The cost to cap a landfill is not only dependent on the size of a landfill but also on whether suitable capping materials are available nearby. Mobilization/demobilization costs will be higher per acre for smaller landfills than larger landfills. Cap design can affect costs as well. Two basic capping options exist: a cap based on use of clay or other impermeable material to limit the infiltration of precipitation, and a cap based on use of natural soils with sufficient water-holding ability to store precipitation and allow plants to use the water. Clay caps are referred to as 'prescriptive' caps, and natural soil caps are referred to as 'evapotranspiration', or 'ET' caps.

To prepare this estimate of the costs of capping affected landfills, DEQ reviewed the data available in its files on currently operating landfills from worksheets prepared by operators to calculate the amount of financial assurance required for closure. These worksheets estimate the total acreage at each landfill that has been affected by landfilling operations. It is this total acreage that would need to be capped, if a cap were installed. For closed landfills, the landfill size was estimated by DEQ based upon a file review, and individual staff knowledge about these sites. The costs for capping landfills were refined based this information.

Costs for installing a 'prescriptive' cap and costs for an 'ET' cap have been developed by the City of Casper for closure of its existing landfill, which will reach capacity in several years. The cost estimate for the construction phase of the 'prescriptive' cap was \$42,000/acre and for the 'ET' cap \$95,000/acre. These do not include engineering and design costs so it is reasonable to assume that actual costs would be higher. However it is also reasonable to assume that the State will focus on ways to minimize costs. An average capping cost of \$95,000 per acre is reasonable.

Capping costs are estimated to be required for 55.5 acres of closed, leaking landfills. There are also 248 acres of closed landfills which are not known to be leaking at this time. It is likely that during the screening and or investigation phase, the State will decide that some landfills should be capped as a preventive measure. Also, during the screening and investigation phase, it may be discovered that some of these landfills are leaking. To cap the 303.5 acres of closed leaking and closed, potentially leaking landfills would cost approximately \$28.9 million, assuming a capping cost of \$95,000/acre.

For landfills which are already capped, and which are either leaking or have the potential to leak, supplemental capping may be recommended. It is estimated that supplemental capping will cost less than \$20,000/acre. To provide supplemental capping/gas

mitigation at all 1057 acres of currently active landfills would cost approximately \$20 million..

Capping and gas mitigation costs are estimated at \$49 million. This is lower than the original estimate because acres of closed landfills were estimated from file information rather than estimating a general cost for all landfills. This estimate also assumes that capping costs for currently active landfills would be limited to supplemental capping costs.

Cost Category: Remediation \$103,000,000

The original estimate assumed that half the landfills would require groundwater remediation. Costs for groundwater remediation projects were estimated for large, medium and small landfills. I also assumed that some projects would last 10 years, some 20 years and some 30 years. From these estimates, I generated an average cost and assumed this average cost for 65 landfills.

In the current estimate, I modified this based on the revised classification of landfills into very small, small, medium and large. The project size varied from monitoring only to pump and treat. The time to completion also varied from 10 years to 30 years.

Based on the new assumption that ~90% of large landfills will leak and ~80% of medium landfills will leak the cost estimate for remediation was also revised for the number of landfills in each size category that are anticipated to leak.

Of the known 21 leaking landfills and the assumed additional 37 that are anticipated to leak, an estimated 14 are known or expected to be in a high aquifer sensitivity area, eight in medium to high aquifer sensitivity areas, and sixteen in medium aquifer sensitivity areas. The remainder are estimated to be in medium/low to low aquifer sensitivity areas.

For cost estimation purposes, I assumed that all leaking landfills in the medium/low to low aquifer sensitivity areas will require monitoring only. I also assumed that one half the leaking landfills in medium aquifer sensitivity would require monitoring only. These landfills will be equally divided between 10, 20 and 30 year monitoring programs. The average cost of 10/20/30 year monitoring-only programs for landfills based on size is:

Large	\$1,606,000
Medium	\$1,123,000
Small	\$ 804,000
Very Small	\$ 503,400

Therefore the cost for monitoring only is estimated at:

	Number of landfills	Cost
Large	10	\$16.0 Million

Medium	8	\$ 9.0 Million
Small	11	\$ 8.8 Million
Very Small	3	<u>\$ 1.5 Million</u>
		\$35.3 Million

I assumed landfills in areas of high aquifer sensitivity would require an active, 30-year system:

	Number of landfills	Cost
Large	3.5	\$16.6 Million
Medium	3.5	\$12.8 Million
Small	4	\$10.5 Million
Very Small	1	<u>\$ 1.9 Million</u>
		\$41.8 Million

The remaining sixteen landfills in medium/high to medium aquifer sensitivity, I assumed would require an average in-situ, remediation program, with an equal distribution of 10, 20 and 30 year projects:

	Number of landfills	Cost
Large	5.5	\$ 13.7 Million
Medium	3.5	\$ 6.7 Million
Small	3	\$ 4.0 Million
Very Small	2	<u>\$ 1.9 Million</u>
		\$ 26.3 Million

Under this scenario, the estimated groundwater remediation cost for 58 leaking landfills is \$103 million. A spreadsheet showing the assumptions used for remediation costs is attached.

This is approximately \$2 million less than the original estimate.

DEQ Administration costs over 30 years are estimated at \$10.5 million.

The overall, revised cost estimate is \$172 million. This is somewhat less than the original estimate of \$184 million.

Screening Investigations	\$ 1.98 million
Full Groundwater Investigation	\$ 7.80 million
Capping and Gas Mitigation	\$ 49.00 million
Remediation	\$103.00 million
DEQ Administration	<u>\$ 10.50 million</u>
	\$172.3 million

**Cost Estimate
Landfill Investigation, Capping and Remediation**

	Costs per year	Costs for first 25 years
Program Administration - WDEQ		
1. a. Program development (estimate one year to set up program) Develop technical program (guidance/rules)	\$75,000	NA
Total Cost - one time	\$75,000	\$75,000
b. Manage Fee Collection (estimate \$10,000 to develop database to track fees)	\$10,000	\$250,000
Total Costs - Annual and after 25 years	First year \$20,000	\$260,000
2. Manage technical program		
Manage contractors	\$331,618	\$8,290,443
Total cost - annually and after 25 years	\$331,618	\$8,290,443
3. Administer Contracts and Program Management		
	\$75,000	\$1,875,006
Total cost - annually and after 25 years	\$75,000	\$1,875,006
	\$406,618	\$10,500,450

Screening, Investigation, Capping, and Remediation				
	\$/landfill	No. of landfills	total cost	\$ for first 25years
4 Screening Site Investigation landfill (66 landfills with no information as to whether or not they are leaking)	\$30,000	66	\$1,980,000	\$1,980,000
5. Site Investigation for the 58 landfills which are leaking or are anticipated to leak, Assumes LFs now leaking have begun the investigation		58	\$7,800,000	\$7,800,000
6. Capping and Gas Mitigation Assume currently closed landfills will require a cap Assume landfills which are leaking may require supplemental capping			\$49,000,000	\$49,000,000
7. Remediate Groundwater (assume 58 of landfills will require groundwater remediation)		58	\$103,000,000	\$103,000,000
8. Annual O&M required beyond 25 years at 10% of landfills requiring groundwater cleanup	per landfill \$100,000	6	one year \$580,000	10 more years \$5,800,000

Total costs for first 25 years	\$172,280,450
Average Annual Cost	\$6,891,218
Annual cost for years 25 through 35	\$580,000

Groundwater Remediation

Very Small	No. of	30 yrs			
4. Site Remediation	years	O&M	totals	totals	totals
project Management			for 10 years	for 20 years	for 30 years
\$10,400					
Project Implementation					
qtrly monitoring	\$3,200				
reporting	\$4,000				
			\$50,400	\$106,400	\$162,400
ODCs	\$800				
work plan	\$9,000				
first year analysis	\$20,000				
Monitoring Only	\$0		\$263,400	\$503,400	\$743,400
In-situ / Simple (ie SVE)					
Capital Cost	50,000				
Annual O&M	\$11,300	30	\$339,000	\$426,400	\$779,400
\$1,132,400					
In-situ / medium (SVE/sparge)					
Capital Cost	75,000				
Annual O&M	\$19,000	30	\$570,000	\$528,400	\$958,400
\$1,388,400					
In-situ / complex (PRB)					
Capital Cost	100,000				
Annual O&M	\$26,700	30	\$801,000	\$630,400	\$1,137,400
\$1,644,400					
ex-situ(ie p&T)					
Capital Cost	125,000				
Annual O&M	\$37,000	30	\$1,110,000	\$758,400	\$1,368,400
\$1,978,400					

Quarterly Monitoring assume 2 people1 day to sample wells
 In-situ/simple - O&M assume 3 hours per week, \$20 wk misc, and \$2500/year other expense
 In-situ/medium - O&M assume 5 hours per week, \$20 wk misc, and \$5000/year other expense
 In-situ/complex - O&M assume 7 hours per week, \$20 wk misc, and \$7500/year other expense
 Ex-situ/ - O&M assume 10 hours per week, \$20 wk misc, and \$10,000/year other expense
 4 wells
 First time analysis cost is \$1250 per sample
 Quarterly Monitoring costs are assumed to be \$350/sample

Monitor only average	\$503,400
High aq sens cleanups	\$1,978,400
Monitor only LFs	\$1,510,200
Average insitu cost	\$958,400
Rem med AQ sens LFs	\$1,916,800.0

Small	No. of	30 yrs			
4. Site Remediation	years	O&M	totals	totals	totals
project Management			for 10 years	for 20 years	for 30 years
\$15,600					
Project Implementation					
initial field work					
qtrly monitoring	\$3,200				
reporting	\$4,000				
			\$126,000	\$266,000	\$406,000
ODCs	\$1,000				
work plan	\$12,000				
first year analysis	\$50,000				
Monitoring Only	\$0		\$426,000	\$804,000	\$1,182,000
In-situ / Simple (ie SVE)					
Capital Cost	50,000				
Annual O&M	\$14,900	30	\$447,000	\$625,000	\$1,152,000
\$1,679,000					
In-situ / medium (SVE/sparge)					
Capital Cost	75,000				
Annual O&M	\$23,100	30	\$693,000	\$732,000	\$1,341,000
\$1,950,000					
In-situ / complex (PRB)					
Capital Cost	100,000				
Annual O&M	\$30,800	30	\$924,000	\$834,000	\$1,520,000
\$2,206,000					
ex-situ(ie p&T)					
Capital Cost	125,000				
Annual O&M	\$44,700	30	\$1,341,000	\$998,000	\$1,019,000
\$2,648,000					

Quarterly Monitoring assume 2 people1 day to sample wells
 In-situ/simple - O&M assume 4 hours per week, \$20 wk misc, and \$3500/year other expense
 In-situ/medium - O&M assume 6 hours per week, \$20 wk misc, and \$6500/year other expense
 In-situ/complex - O&M assume 8 hours per week, \$20 wk misc, and \$9,000/year other expense
 Ex-situ/ - O&M assume 12 hours per week, \$20 wk misc, and \$12,500/year other expense
 10 wells
 First time analysis cost is \$1250 per sample
 Quarterly Monitoring costs are assumed to be \$350/sample

Monitor only average	\$804,000
High aq sens cleanups	\$10,592,000
Monitor only LFs	\$8,844,000.0
Average insitu cost	\$1,337,667
Rem med AQ sens LFs	\$4,013,000.0

Groundwater Remediation

Medium	No. of years	30 yrs O&M	totals for 10 years	totals for 20 years	totals for 30 years
4. Site Remediation					
project Management	\$20,800				
Project Implementation					
qtrly monitoring	\$6,400				
reporting	\$3,000				
analysis			\$189,000	\$399,000	\$609,000
ODCs	\$1,500				
first year analysis	\$75,000				
work plan	\$15,000				
Capping &Monitoring Only	\$0		\$596,000	\$1,123,000	\$1,650,000
In-situ / Simple (ie SVE)					
Capital Cost	75,000				
Annual O&M	\$22,900	30	\$687,000	\$900,000	\$1,656,000
In-situ / medium (SVE/sparge)					
Capital Cost	100,000				
Annual O&M	\$31,900	30	\$957,000	\$1,015,000	\$1,861,000
In-situ / complex (PRB)					
Capital Cost	125,000				
Annual O&M	\$47,400	30	\$1,422,000	\$1,195,000	\$2,196,000
ex-situ(ie p&T)					
Capital Cost	150,000				
Annual O&M	\$61,500	30	\$1,845,000	\$1,361,000	\$2,503,000

Quarterly Monitoring assume 2 people 2 days to sample wells
 In-situ/simple - O&M assume 6.5 hours per week, \$20 wk misc, and \$5000/year other expense
 In-situ/medium - O&M assume 9 hours per week, \$20 wk misc, and \$7500/year other expense
 In-situ/complex - O&M assume 14 hours per week, \$20 wk misc, and \$10,000/year other expense
 Ex-situ/ - O&M assume 17.5 hours per week, \$25 wk misc, and \$15,000/year other expense
 15 wells
 First time analysis cost is \$1250 per sample
 Quarterly Monitoring costs are assumed to be \$350/sample

Monitor only average	\$1,123,000
Monitor only LFs	\$8,984,000.0
High aq sens cleanups	\$12,757,500
Average insitu cost	\$1,904,333
Rem med AQ sens LFs	\$6,665,166.7

Large	No. of years	30 yrs O&M	totals for 10 years	totals for 20 years	totals for 30 years
4. Site Remediation					
project Management	\$31,200				
Project Implementation					
qtrly monitoring	\$9,600				
reporting	\$5,000				
analysis			\$252,000	\$532,000	\$812,000
ODCs	\$2,000				
work plan	\$18,000				
first year analysis	\$100,000				
Monitoring Only	\$0		\$848,000	\$1,606,000	\$2,364,000
In-situ / Simple (ie SVE)					
Capital Cost	100,000				
Annual O&M	\$26,950	30	\$808,500	\$1,217,500	\$2,245,000
In-situ / medium (SVE/sparge)					
Capital Cost	125,000				
Annual O&M	\$37,250	30	\$1,117,500	\$1,345,500	\$2,476,000
In-situ / complex (PRB)					
Capital Cost	150,000				
Annual O&M	\$48,750	30	\$1,462,500	\$1,485,500	\$2,731,000
ex-situ(ie p&T)					
Capital Cost	175,000				
Annual O&M	\$73,500	30	\$2,205,000	\$1,758,000	\$3,251,000

Quarterly Monitoring assume 2 people 3 days to sample wells
 In-situ/simple - O&M assume 7 hours per week, \$25 wk misc, and \$7500/year other expense
 In-situ/medium - O&M assume 10 hours per week, \$25 wk misc, and \$10000/year other expense
 In-situ/complex - O&M assume 12.5 hours per week, \$25 wk misc, and \$15,000/year other expense
 Ex-situ/ - O&M assume 20 hours per week, \$30 wk misc, and \$20,000/year other expense
 20 wells
 First time analysis cost is \$1250 per sample
 Quarterly Monitoring costs are assumed to be \$350/sample

Monitor only average	\$1,606,000
Monitor only LFs	\$16,060,000.0
High aq sens cleanups	\$16,604,000
Average insitu cost	\$2,484,000
Rem med AQ sens LFs	\$13,662,000.0
avg total	\$26,256,966.7
total	\$103,587,067