

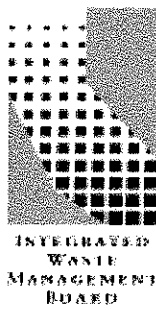
# *Contractor's Report to the Board*

## *Landfill Facility Compliance Study Phase II Report—Evaluation of Regulatory Effectiveness Based on a Review of 53 MSW Landfills*

*August 2004*

***Produced under contract by:***

***GeoSyntec Consultants, Inc.  
Oakland, California***



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The information contained herein is based on an interpretation by the contractor of comments provided by others and a review of existing documentation available on the topics discussed at the time the report was written. The statements and conclusions of this report are those of the contractor and not necessarily those of the Integrated Waste Management Board, its employees, or the State of California. The State makes no warranty, expressed or implied, and assumes no liability for the information contained in the succeeding text. Any mention of commercial products or processes shall not be construed as an endorsement of such products or processes.

# 1 Executive Summary

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This report presents the results of work completed by GeoSyntec Consultants, Inc. (GeoSyntec) under Tasks 4 and 5 of Phase II of the California Integrated Waste Management Board's (CIWMB) Landfill Facility Compliance Study. \* †The report will be referred to as the Phase II report. The purpose of Tasks 4 and 5 was to evaluate the effectiveness of the current California MSW landfill regulations in protecting the environment by using 53 selected MSW landfills as case studies. These 53 landfills were identified previously in the Phase I report (GeoSyntec, 2003, pp. 74-77), and the basis for their selection will be reiterated in this report. GeoSyntec undertook the actions listed below to satisfy the requirements of the Tasks 4 and 5 scopes of work. Items 1–3 below pertain to Task 4. Items 5–6 pertain to Task 5.

1. Assessed the Task 2 cross-media inventory and the results of the Task 3 multi-variable analyses to identify the environmental performance of the 53 landfills.
2. Reviewed documentation available through the Task 2 cross-media inventory to gain a better understanding of the environmental performance of the landfills.
3. Contacted landfill owners/operators and regulators (regional water quality control boards [RWQCB], local enforcement agencies [EA], and air quality management districts [AQMD] or air pollution control districts [APCD]) to collect more detailed information regarding the environmental performance of the 53 landfills and the application of the existing MSW regulations at those landfills.
4. Reviewed the results of the Task 4 in-depth review of the environmental performance of 53 MSW landfills, looking across all environmental media, for use in cross-site comparisons.
5. Evaluated the in-depth information and identified recurring issues related to unsatisfactory environmental performance that may be associated with deficiencies in the existing California landfill regulations.
6. Developed recommendations for changes to the existing California MSW landfill regulations based on the results of these evaluations that could lead to greater environmental protection.

This report: summarizes the results of the Task 5 analyses carried out on the environmental performance information gathered for Task 4. It also summarizes the role current MSW regulations play with regard to compliance and recommends regulatory changes that could result in greater environmental protection.

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\* A description of the Landfill Facility Compliance Study and progress updates may be found on the CIWMB's website at [www.ciwmb.ca.gov/Landfills/](http://www.ciwmb.ca.gov/Landfills/).

† The landfill study consists of two phases. Phase I includes Tasks 1–3 (compiling a checklist of pertinent environmental regulatory requirements, developing a cross-media database inventory of 224 California municipal solid waste (MSW) landfills, and assessing MSW landfill environmental performance for the time period from January 1998 through December 2001). Phase II consists of Tasks 4–8 (these tasks include assessing the effectiveness of current MSW regulatory requirements in controlling environmental impacts over time and identifying possible ways to improve regulations to provide for greater environmental protection).

Additionally, the report lists general findings from the in-depth landfill review (no. 4 above) and evaluates in detail six regulatory topics that were developed from these findings. From the six topics, four changes to the existing landfill regulations or practices are recommended. These include:

1. Either explicitly requiring landfill gas monitoring as part of the regulatory requirements for the detection monitoring program for water quality, or promoting this practice through the regulatory agencies.
2. Requiring in the regulations the same landfill gas monitoring and control requirements for the active life of the landfill as is currently required for post-closure care.
3. Promoting explosive gas monitoring closer to the waste mass at sites with large buffers, through encouragement by the regulatory agencies.
4. Either explicitly requiring all landfills to submit a winterization plan annually for review and approval by the EA with the concurrence of the regional water quality control board through a change to the regulations, or promoting this practice through the regulatory agencies.

These recommendations have been described in more detail in Section 4 and are summarized in Section 5.

## 2 Introduction

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As stated in the Executive Summary, this report (the “Phase II report”) presents the results of work completed by GeoSyntec Consultants, Inc. (GeoSyntec) under Tasks 4 and 5 of Phase II of the California Integrated Waste Management Board’s (CIWMB) Landfill Facility Compliance Study.<sup>† §</sup>

The purpose of Tasks 4 and 5 is to evaluate the effectiveness of the current California MSW landfill regulations in protecting the environment by using 53 selected MSW landfills as case studies. These 53 landfills were identified previously in the Phase I Report (GeoSyntec, 2003, pp. 74–77), and the basis for their selection will be reiterated in this report. Following are actions taken to satisfy the requirements of the Tasks 4 and 5 scope of work:

1. Assessed the Task 2 cross-media inventory and the results of the Task 3 multi-variable analyses to identify the environmental performance of the 53 landfills.
2. Reviewed documentation available through the Task 2 cross-media inventory to gain a better understanding of the environmental performance of the landfills.
3. Contacted landfill owners/operators and regulators (regional water quality control boards [RWQCB], local enforcement agencies [EA], and air quality management districts [AQMD] or air pollution control districts [APCD]) to collect more detailed information regarding the environmental performance of the 53 landfills and the application of the existing MSW regulations at those landfills.
4. Reviewed the results of the in-depth review of 53 MSW landfills’ environmental performance, looking across all environmental media, for cross-site comparisons.
5. Evaluated the in-depth information and identified recurring issues related to unsatisfactory environmental performance that may be associated with deficiencies in the existing California landfill regulations.
6. Developed recommendations for changes to the existing California MSW landfill regulations based on the results of these evaluations that could lead to greater environmental protection.

The Phase II report summarizes the results of the Task 5 analysis carried out on the Task 4 environmental performance information and the role current MSW regulations play with regard to compliance to better understand regulatory effectiveness in protecting the environment. The report also recommends regulatory changes that could result in greater environmental protection.

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<sup>†</sup> A description of the Landfill Facility Compliance Study and progress updates may be found on the CIWMB’s website at [www.ciwmb.ca.gov/Landfills/](http://www.ciwmb.ca.gov/Landfills/).

<sup>§</sup> Phase I includes Tasks 1–3 (compiling a checklist of pertinent environmental regulatory requirements, developing a cross-media database inventory of 224 California municipal solid waste (MSW) landfills, and assessing MSW landfill environmental performance for the time period from January 1998 through December 2001). Phase II consists of Tasks 4–8 (these tasks include assessing the effectiveness of current MSW regulatory requirements in controlling environmental impacts over time and identifying possible ways to improve regulations to provide for greater environmental protection).

## 2.1 Organization of This Report

Section 2.4 presents the basis for selecting the 53 MSW landfills that were evaluated in detail for Tasks 4 and 5. A description of the environmental performance variables used to evaluate the landfills and first defined in the Phase I report (*GeoSyntec, Phase I Report, 2003, pp. 23-31*) is presented in Section 2.5. Section 3 describes the process used for collecting the in-depth information on 53 MSW landfills in Task 4. Section 4 identifies and discusses topics related to environmental performance that were identified from a review of the in-depth information collected in Task 4, and provides recommendations, where appropriate. Conclusions and recommendations that could lead to greater environmental performance are summarized in Section 5.

## 2.2 Glossary and List of Acronyms

The following terms are used in this report. For purposes of this report, these terms have the following meanings:

**Emissions:** uncontrolled discharges of liquid, gas, or solid particles from a landfill to air, water, or land.

**Landfill gas:** a product of the anaerobic microbial decomposition of organic waste, consisting principally of approximately 50 percent methane, 50 percent carbon dioxide, and typically less than 5 percent nonmethane organic compounds.

**Lysimeter:** a field device containing a soil column and vegetation, used for measuring actual evapotranspiration.

**Prescriptive regulation / requirement:** a regulation or requirement in which the specifics for how a component is to be constructed are defined (for example, a requirement for a single composite liner system consisting of a compacted clay liner (CCL) and a geomembrane liner with defined minimum thickness and hydraulic conductivity would be a prescriptive requirement).

**Single composite liner:** landfill base containment consisting of a synthetic membrane barrier overlying a clay-based barrier layer that consists either of a compacted clay liner (CCL) or, where approved by the regional water quality control board (RWQCB), either a geosynthetic clay liner (GCL) or a combination of a GCL overlying a CCL. The synthetic membrane component is subject to a minimum thickness requirement. When used without a GCL component, the CCL must meet a requirement for minimum thickness and maximum allowable hydraulic conductivity. Where allowed by the RWQCB, the term includes an extra-thick synthetic membrane barrier overlying a prepared surface on native soil, for use only on steeply sloped portions of the landfill.

The following acronyms are used in this report.

**APCD:** Air pollution control district.

**AQMD:** Air quality management district.

**ARB:** Air Resources Board (California).

**BMP:** Best management practices.

**CCL:** Compacted clay liner.

**CCR:** California Code of Regulations.

**CFR:** Code of Federal Regulations.



**CIWMB:** California Integrated Waste Management Board.  
**EA:** Enforcement agency for the CIWMB.  
**ET:** Evapotranspiration.  
**GCL:** Geosynthetic clay liner.  
**GM:** Geomembrane  
**LCRS:** Leachate collection and removal system.  
**LEL:** Lower explosive limit.  
**LTGV:** Long-term gas violator.  
**MSW:** Municipal solid waste.  
**NOV:** Notice of violation of regulations/requirements.  
**NSPS:** New source performance standards for MSW Landfills.  
**NTC:** Notice to comply with regulations/requirements.  
**RWQCB:** Regional water quality control board.  
**SWFP:** Solid waste facility permit.  
**SWRCB:** State Water Resources Control Board (California).  
**Title 27 Prescriptive Cover:** Any site that has at least one unit covered with a final cover meeting the prescriptive standard found in section 21090 of Title 27 of the California Code of Regulations.  
**VOC:** Volatile organic compound.  
**WDR:** Waste discharge requirement.

### **2.3 California Regulations and Regulatory Agencies**

Regulation of California's MSW landfills is the responsibility of several regulatory bodies, including the CIWMB, the SWRCB, which promulgates water quality protection regulations, the nine RWQCBs, which apply the SWRCB's regulations, and the 35 local AQMDs and APCDs. California is currently enforcing regulations with respect to siting, design, operations, monitoring, post-closure, and landfill gas control, as set forth in Title 27 of the California Code of Regulations\*\* (27 CCR), Division 2, SWRCB Resolution Number 93-62, the federal Subtitle D<sup>††</sup> regulations (Title 40 of the Code of Federal Regulations [40 CFR], Part 258), and 40 CFR, Part 60, Subparts Cc and WWW.

The promulgation of the regulations in 27 CCR, Division 2 is divided between the CIWMB and the SWRCB. At the local level, EAs enforce CIWMB regulations and RWQCBs enforce SWRCB regulations.

In California, the 35 local AQMDs and APCDs have primary authority to regulate emissions from MSW landfills. Each district is responsible for developing and enforcing air quality regulations within its district. The ARB provides technical support to the

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\*\* GeoSyntec's source for information on Title 27 of the California Code of Regulations was the regulatory text approved by the Office of Administrative Law on June 18, 1997: "Combined SWRCB/CIWMB Regulations: Division 2, Title 27," California Integrated Waste Management Board, Sacramento, California. The text is available on CIWMB's website at [www.ciwmb.ca.gov/RuleArchive/1997/AB1220/](http://www.ciwmb.ca.gov/RuleArchive/1997/AB1220/) ("AB 1220 Regulations in Title 27").

<sup>††</sup> Also known as Subtitle D of the federal Resource Conservation and Recovery Act. Refers to requirements found in Title 40 Part 258 (40CFR Part 258) of the Code of Federal Regulations.

districts and oversees local district compliance with State and federal law. A complete discussion of California's regulatory requirements can be found in the Task 1 report [GeoSyntec, 2002].

## **2.4 Landfills Selected for Evaluation**

This section presents a list of 40 MSW landfills taken from the original study of 224 MSW landfills and recommended by GeoSyntec for the assessment of regulatory effectiveness (Phase II). GeoSyntec selected 37 landfills based on their general site characteristics. The CIWMB identified three additional landfills that might be impacted by regulations pertaining to very low waste acceptance levels that delay or avoid closure ("trickling waste") (27 CCR, Section 21110(b)). GeoSyntec included these landfills in the list of 40 landfills.

In addition to the 40 MSW landfills identified for assessment of regulatory effectiveness, the Phase II portion of the study also includes 13 MSW landfills that closed prior to 1993. The addition of these 13 landfills allowed the assessment of regulatory effectiveness to be more thorough by providing a longer closure period for review. The 13 landfills, which were selected by staff from the CIWMB, the SWRCB, and the ARB consist of the following landfills:

1. Mission Canyon (Unit 1) (Canyons 1-3)—Los Angeles County
2. Mission Canyon (Unit 2) (Canyons 4-7)—Los Angeles County
3. Mission Canyon (Unit 3) (Canyon 8)—Los Angeles County
4. Coastal/Santa Clara Landfill—Ventura County
5. East Third Avenue Landfill—San Mateo County
6. Adelanto Disposal Site—San Bernardino County
7. Madrone Landfill—Santa Clara County
8. Old Mount Shasta Dump—Siskiyou County
9. South Chollas Sanitary Landfill—San Diego County
10. Ballard Canyon Road—Santa Barbara County
11. Coyote Canyon Sanitary Landfill—Orange County
12. Buckeye Disposal Site—Shasta County
13. McCourtney Road Landfill —Nevada County

The 40 landfills from the Task 2 cross-media inventory selected for Phase II are shown in Table 2-A. Also included in this table are the site characteristics employed in making the selection. The geographic distribution of the landfills is shown in Figure 1.1. The number adjacent to each site marker corresponds to the site number listed in Table 2-A or in this section (2.4) for the 13 landfills closed prior to 1993. Four landfills—West Central Landfill, Billy Wright Disposal Site, South Coast Solid Waste Site, and Bakersfield Metropolitan (Bena) Sanitary Landfill—were included to provide a more representative geographic distribution. Figure 2.1 shows that the sample of 40 landfills appears relatively well distributed throughout the state, with the highest concentration in Los Angeles County.

**Table 2-A: Landfills Selected From Cross-Media Inventory for Further Study\***

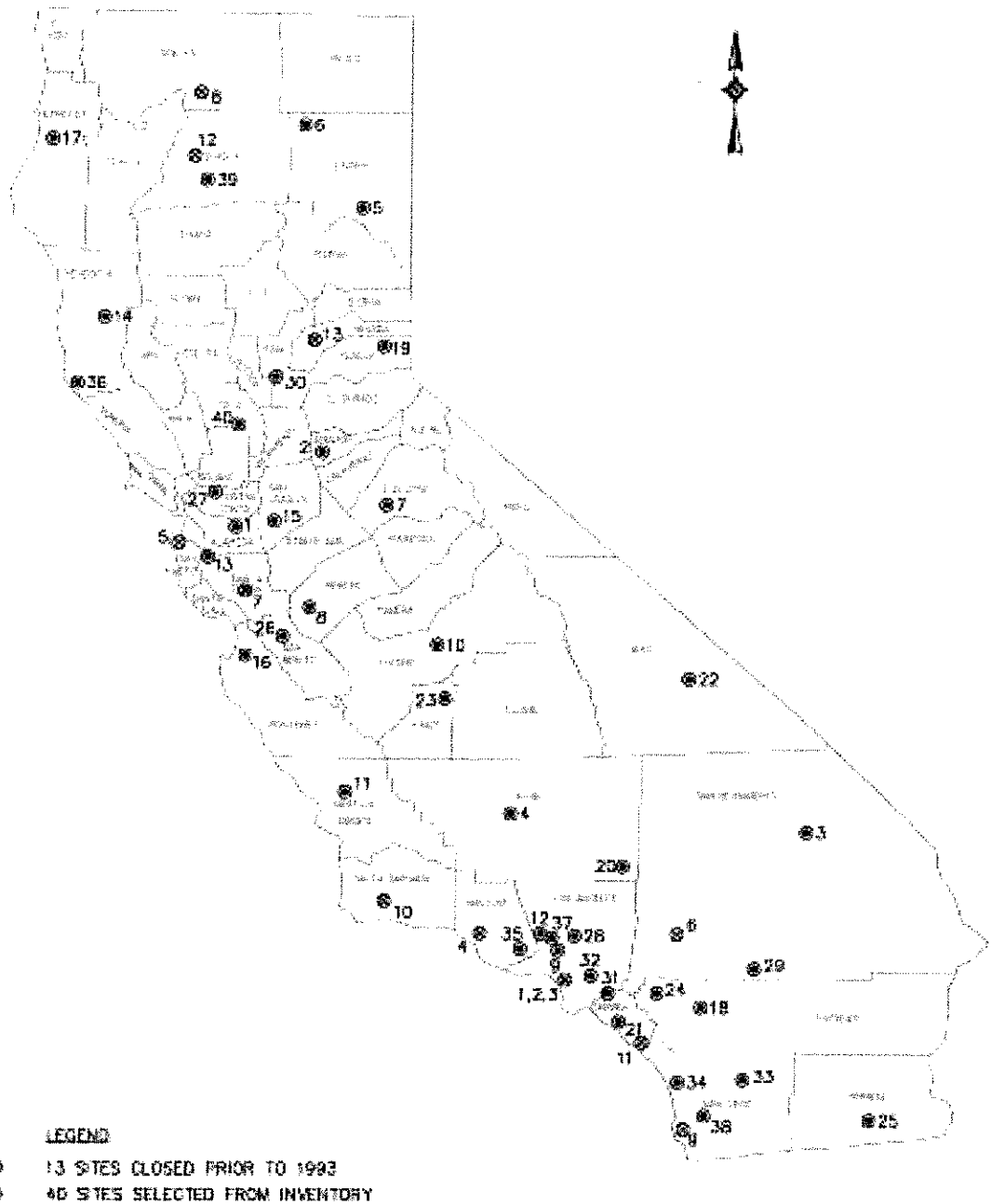
	<b>Landfill Name and County</b>	<b>Vertical Expansion Over Unlined Unit</b>	<b>Fully Subtitle D or Alternative Liner</b>	<b>"Typical" California MSW Landfill</b>	<b>Gas Extraction System</b>	<b>Gas-To-Energy System</b>	<b>Bioreactor, Leachate/Condensate Recirculation</b>	<b>Mechanical Pre-Treatment</b>	<b>Closed With GM cap</b>	<b>Closed With GCL Cap</b>	<b>Closed With Monofill or ET Cover</b>	<b>Title 27 Prescriptive Cover</b>	<b>"Tricking Waste" Site</b>
1	Altamont Landfill and Resource Recovery Facility (Alameda County)				X	X							
2	Amador County Landfill/Buena Vista Class II Landfill (Amador County)			X									
3	Baker Refuse Disposal Site (San Bernardino County)										X		
4	Bakersfield Metropolitan (Bena) Sanitary Landfill (Kern County)												
5	Bass Hill Landfill (Lassen County)			X									
6	Bieber Landfill (Lassen County)									X			
7	Big Oak Flat Landfill (Tuolumne County)												X
8	Billy Wright Disposal Site (Merced County)												
9	Bradley Landfill West and West Extension (Los Angeles County)				X	X							
10	Chateau Fresno Landfill (Fresno County)				X				X				
11	Chicago Grade Landfill (San Luis Obispo County)	X			X								
12	Chiquita Canyon Sanitary Landfill (Los Angeles County)				X						X		
13	City of Palo Alto Landfill				X	X							

	Landfill Name and County	Vertical Expansion Over Unlined Unit	Fully Subtitle D or Alternative Liner	"Typical" California MSW Landfill	Gas Extraction System	Gas-To-Energy System	Bioreactor, Leachate/Condensate Recirculation	Mechanical Pre-Treatment	Closed With GM cap	Closed With GCL Cap	Closed With Monofill or ET Cover	Title 27 Prescriptive Cover	"Trickling Waste" Site
	(Santa Clara County)												
14	City of Willits Disposal Site (Mendocino County)								X				
15	Corral Hollow Landfill (San Joaquin County)				X							X	
16	Crazy Horse Sanitary Landfill (Monterey County)				X	X							
17	Cummings Road Landfill (Humboldt County)				X								X
18	Double Butte Sanitary Landfill (Riverside County)				X								
19	Eastern Regional Landfill (Placer County)				X							X	
20	Edwards AFB Main Base Sanitary Landfill (Kern County)							X					
21	Frank R. Bowerman (Orange County)				X								
22	Furnace Creek Landfill (Inyo County)										X		
23	Hanford Sanitary Landfill (Kings County)				X					X			
24	Highgrove Sanitary Landfill (Riverside County)				X						X		
25	Holtville Disposal Site (Imperial County)												X
26	John Smith Road Class III Landfill (San Benito County)			X	X								
27	Keller Canyon Landfill (Contra Costa County)		X		X		X						
28	Lopez Canyon Sanitary				X	X					X	X	

	<b>Landfill Name and County</b>	<b>Vertical Expansion Over Unlined Unit</b>	<b>Fully Subtitle D or Alternative Liner</b>	<b>"Typical" California MSW Landfill</b>	<b>Gas Extraction System</b>	<b>Gas-To-Energy System</b>	<b>Bioreactor, Leachate/Condensate Recirculation</b>	<b>Mechanical Pre-Treatment</b>	<b>Closed With GM cap</b>	<b>Closed With GCL Cap</b>	<b>Closed With Monofill or ET Cover</b>	<b>Title 27 Prescriptive Cover</b>	<b>"Tricking Waste" Site</b>
	Landfill (Los Angeles County)												
29	Morongo Disposal Site (San Bernardino County)									X			
30	Norcal Waste Systems Ostrom Road Landfill (Sutter County)		X										
31	Olinda Alpha Sanitary Landfill (Orange County)				X	X							
32	Puente Hills Landfill (Los Angeles County)				X	X							
33	Ramona Landfill (San Diego County)			X	X								
34	San Marcos Landfill (San Diego County)	X			X	X			X				
35	Simi Valley Landfill & Recycling Center (Ventura County)	X			X								
36	South Coast Solid Waste Site (Mendocino County)												
37	Sunshine Canyon Sanitary Landfill County Extension (Los Angeles County)		X		X								
38	Sycamore Sanitary Landfill (San Diego County)				X	X							
39	West Central Landfill (Shasta County)												
40	Yolo County Central Landfill (Yolo County)				X	X	X						

\* List does not include 13 landfills closed prior to 1993.

Figure 2.1: Phase II Study Map



These 40 landfills selected from the Task 2 cross-media inventory, along with the 13 landfills closed prior to 1993, are evaluated in Phase II of the Landfill Facility Compliance Study.

## **2.5 Environmental Performance Variables as Basis for In-Depth Review of 53 MSW Landfills**

Typically, environmental performance for an MSW landfill can be assessed based on the measured properties of the groundwater, leachate, landfill gas, air, soil, and surface water, relative to some standard. However, to perform a quantitative comparison of the environmental performance of each of the original 224 landfills in the study would result in an extremely complex analysis that is beyond the scope of this project. Therefore, for purposes of the Phase I assessment of MSW landfill environmental performance, five variables were defined as indicators of environmental performance, based on the actions taken by the regulatory agencies (RWQCBs and EAs) at each landfill.<sup>‡‡</sup> These environmental performance variables are:

1. In Corrective Action.
2. Has Gas Inspection Report.
3. Has Gas Enforcement Action.
4. Has Surface Water Action.
5. Has Air Quality Violation.

The performance of each of the 224 landfills included in the Phase I report (GeoSyntec, *Phase I Report*, 2003) was evaluated in that report with respect to each of these variables, except “Has Air Quality Violation,” which was applicable to only the Bay Area AQMD and South Coast AQMD based on the data collected. For this Phase II report, all five variables were included in the analysis of the 53 MSW landfills, including the “Has Air Quality Violation” variable, since complete information was gathered for all 53 landfills.

Similarly, in this report the performance of each of the 53 MSW landfills identified in Section 2.4 is evaluated relative to these five environmental performance variables. This provides a framework for evaluating the performance of the existing regulations with respect to environmental protection. These five environmental performance variables serve as a basis for collecting in-depth information from the landfill owners/operators and regulators.

These five variables were originally developed to evaluate the environmental performance of the 224 landfills surveyed in Phase I of the Landfill Facility Compliance Study. In Phase II, these variables are not used to evaluate environmental performance of the landfills. Instead, they are used as a basis for evaluating the effectiveness of the regulations at the 53 landfills in protecting the environment. As such, the individual landfill’s “value” (“Yes” or “No”) with respect to each of the variables will not be presented as it was in the Phase I report. Rather, the appropriate value with respect to each of these variables was used solely as a trigger for determining whether to gather more in-depth information from owners/operators and regulatory agencies.

Because the Landfill Facility Compliance Study was designed as a cross-media study of landfill performance, the values of each of the five environmental performance variables were based on data included in the Task 2 cross-media inventory. The five environmental performance variables serve as indicators of each landfill’s environmental performance

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<sup>‡‡</sup> Details regarding the environmental performance variables derived from the RWQCB and EA information is presented in Section 3.3 of the Phase I Report (GeoSyntec, 2003).

with respect to groundwater, landfill gas, leachate, surface water, and air. The regulation of each landfill with respect to these media falls under the jurisdiction of different regulatory agencies. Table 2-B identifies the regulatory agencies responsible for oversight of each of the environmental performance variables. Section 3.3.2 of the Phase I report provides additional information on meanings of the “Yes” and “No” values for the environmental performance variables (GeoSyntec, *Phase I Report*, December 2003, pp. 25–30).

**Table 2-B: Regulatory Agencies That Oversee Environmental Performance**

Regulatory Agency Overseeing Environmental Performance		Environmental Performance Variable
State Oversight	Local Oversight	
State Water Resources Control Board	Regional Water Quality Control Board	In Corrective Action
California Integrated Waste Management Board	Enforcement Agency	Has Gas Inspection Report
		Has Gas Enforcement Action
		Has Surface Water Action
California Air Resources Board	Air Districts (AQMD or APCD)	Has Air Quality Violation*

\* This variable revised from Phase I report to be applicable to this phase of the study.

Limiting the evaluation of environmental performance to the five variables in Table 2-B excludes consideration of many potential impacts. For example, the EA inspects landfills for compliance with issues unrelated to the variables above, such as cover application, tonnage compliance, and vector control, all of which may impact the landfill’s environmental performance to some degree. These additional issues, however, are not considered in this report.

**Development of Air Quality Environmental Performance Variable**

The fifth indicator of environmental performance, “Has Air Quality Violation,” was chosen from the information provided by AQMDs and APCDs. Each district has established its own set of rules pertaining to landfills. These rules may vary slightly if the areas they are classified as attainment zone or non-attainment zone for ozone. The majority of these rules were adopted to implement the federal requirements for “new” and “existing” larger MSW landfills. Some district landfill rules also apply to smaller landfills in an effort to obtain further volatile organic compound (VOC) emission reductions.

Notices to comply (NTC) or notices of violation (NOV) can be issued by the AQMD or APCD for violation by the landfill of that district’s rules. NTCs or NOV’s issued by the AQMD or APCD for each landfill were combined as an indicator of environmental performance and a variable was established termed “Air Quality Violation.” The two possible values of this variable are shown in Table 2-C.



**Table 2-C: Possible Values of the “Has Air Quality Violation” Variable**

<b>Value</b>	<b>Meaning</b>
Yes	The AQMD / APCD issued the landfill at least one notice to comply or notice of violation since January 1, 1998.
No	The AQMD / APCD has not issued the landfill any notices to comply nor notices of violations since January 1, 1998.

### 3 Collection of In-Depth Information From 53 MSW Landfills

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The information used in this report for the assessment of current MSW landfill regulatory effectiveness in protecting the environment over time was collected in Task 4 of the landfill study. A consistent method was established for collecting the in-depth information for each of the 53 MSW landfills, which included the following process:

1. **Gathered initial information from Phase I portion of landfill study.** Five environmental performance variables (presented in Section 2.5 of this report) were defined in Phase I of the Landfill Facility Compliance Study. The value (“Yes” or “No”) for each of the environmental performance variables was defined as part of the Phase I statistical analyses for each of the 224 landfills included in the cross-media inventory (but not for the 13 landfills closed prior to 1993). For the 53 landfills (40 selected from the 224 plus the 13 that closed prior to 1993), the values of the environmental performance variables were defined by referencing the performance or compliance records included in the cross-media inventory for the period 1998 through 2001.

The values of the environmental performance variables for each of the 40 selected landfills were cross-checked against the performance/compliance records included in the cross-media inventory to verify the status of the landfills during the period 1998 through 2001. Because the landfills were selected for Task 4 based on criteria other than environmental performance, it is not surprising that some landfills are fully in compliance with environmental regulations and others are not.

2. **Gathered more in-depth information from landfill owners and regulators.** GeoSyntec developed a pertinent set of questions based on the value of each environmental performance variable to facilitate discussion when contacting landfill owners and regulators. Some questions were formulated to gather specific information regarding the landfills’ compliance status; other questions were formulated to discover general information about how effectively the regulations protect the environment at these landfills. The questions were developed to collect information about the following items:
  - a. Description of compliance issues, if applicable.
  - b. Details of monitoring and collection systems.
  - c. Causes for landfill’s non-compliance, if applicable.
  - d. Timeline for the landfill’s non-compliance and correction, if applicable.
  - e. Methods of corrective action employed, if applicable.
  - f. Relationship between the compliance issue and current regulations, if applicable.
  - g. Ability of the current regulations to address causes for non-compliance at the landfill.
  - h. Identification of methods of environmental protection employed at the landfill to ensure compliance.

Prior to contacting landfill owners and regulators, documentation available through the Task 2 cross-media inventory was reviewed to gain a better understanding of the site-specific conditions and to formulate site-specific questions for use during the collection of information from landfill owners and regulators.

Questionnaires were then sent to the regulators and the owner/operator for each of the 53 landfills. The regulatory agencies contacted for each landfill included the RWQCB, the EA, and the AQMD or APCD. The CIWMB provided the name of an initial contact person for each regulatory agency and landfill.

The questionnaire contained standardized questions to address the compliance issues at a particular landfill with respect to the area of authority of each contact. The RWQCB was contacted regarding compliance with groundwater monitoring regulations. The EA was contacted regarding compliance with landfill gas control, drainage control, erosion control and leachate control regulations. The AQMD / APCD was contacted regarding compliance with air quality regulations. The owner / operator was contacted regarding all of the aforementioned topics.

It should be recognized that several of the MSW landfills of the 53 have not been issued permits by the local AQMD/APCD. The AQMD/APCD was not contacted for these landfills.

Information was collected from the contacts in writing by e-mail or facsimile, or verbally by telephone.

3. **Compiled the information collected for each landfill, arranging results by each contributor (the landfill owner or operator and each regulator).** Information was deleted that could not be substantiated or was found not to be relevant to environmental performance at the landfill. The draft information collected for each landfill was distributed to the landfill owners/operators and regulators for comment, including AQMDs/APCDs that were not initially contacted because landfills in their areas were not required to be permitted. Regulators and owners/operators were given one week to provide comments. The comments were incorporated, where appropriate.

The final collected information for each of the 53 MSW landfills was posted on the CIWMB Landfill Facility Compliance Study website at [www.ciwmb.ca.gov/Landfills/ComplyStudy/](http://www.ciwmb.ca.gov/Landfills/ComplyStudy/).

The information collected under Task 4 for each of the landfills was reviewed to identify topics pertinent to the goals of this report. These topics are presented and evaluated in Section 4. It should be recognized that not all topics were discussed with the contacts for all landfills. The environmental performance conditions at a particular landfill guided the discussions with the individual contacts, and are reflected in the contents of the collected information.

## 4 Evaluation of Selected Regulatory Topics

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This section identifies and discusses topics related to environmental performance that were identified from the information collected in Task 4 of the Landfill Facility Compliance Study. The process used in the collection of the information is described in detail in Section 3.

The scope of this task includes examining the cross-media impacts by the 53 MSW landfills (identified in Section 2.4) to air, groundwater, and surface water and identifying recurring issues related to satisfactory or unsatisfactory environmental performance that may be related to existing MSW landfill regulations. In accordance with the scope of work, Task 4 identifies for further discussion those regulatory topics that were documented in the in-depth information collected on each landfill, discusses the role of the existing MSW regulations, and provides recommendations, where appropriate, for addressing the regulatory topic. The goal of these efforts is to improve or enhance California's multimedia MSW regulations, resulting therefore in greater environmental protection.

A direct quantitative evaluation of the impacts of a particular landfill regulation is beyond the scope of this study. Therefore, the evaluation and recommendation for changes to the regulations to provide additional protection of the environment, to result in incremental costs, or to be applied to conditions in California, is based primarily on the contractor's experience in the landfill industry, input from California regulators, and a review of the cross-media inventory (Task 2 of the Landfill Facility Compliance Study).

### 4.1 Selection of Topics for Further Discussion

As mentioned above, several regulatory topics have been selected for further evaluation in this section that are pertinent to the Task 5 scope of work.

Not all of the information collected for each of the landfills in Task 4 is discussed in detail in this report. For example, some of the information collected in Task 4 represents site-specific conditions that were included to gain more insight and a broader understanding of conditions at a particular landfill. Also, because some issues were identified for only one landfill, not enough broad-based information was available to recommend further discussion.

In addition, the recurrence of similar findings at multiple landfills discussed in this report may not be all-inclusive. For example, during the collection of information, researchers discovered that for four of the 53 landfills a buffer zone had helped the landfills comply with regulations limiting explosive gas concentrations at the property boundary. This is not to say that no other landfills in the list of 53 have large buffer zones; there may be other landfills with large buffer zones that have helped the landfills achieve compliance, but the landfills were not identified during the process of collecting information. Therefore, a general finding of the information-gathering process in Task 4 is:

*At least four of 53 landfills have either designed or purchased a buffer zone, which has helped the landfill to comply with regulations to limit explosive gas concentrations at the property boundary.*

## **4.2 Criteria for Evaluating Selected Regulatory Topics**

The selected regulatory topics are evaluated using a set of defined criteria for discussion. The potential impact of each of these criteria on the selected regulatory topics is discussed in detail in Sections 4.3 through 4.7. The criteria are described as follows:

### **Description of Compliance Issue**

This criterion identifies how the selected regulatory topic is manifesting itself in terms of environmental performance at the landfills included in the study. A brief description of the topic is provided, as well as whatever details are available.

### **Comparison to Cross-Media Inventory**

As appropriate, researchers reviewed the Task 2 cross-media inventory of California MSW landfills to provide additional pertinent information regarding the landfills where the regulatory topic may have affected environmental performance. The cross-media inventory is also used to identify landfills beyond the 53 in this study that have conditions similar to those at landfills where the topic has occurred. This exercise allows consideration of the applicability of any proposed changes to the regulations. While the cross-media inventory was not originally intended to be used as a basis for discussion in this report, some information is relevant to these discussions.

### **Current Regulatory Requirements**

For each selected topic, the existing regulation under consideration is summarized. The intent of the existing regulation is assessed, and any pertinent information regarding how the existing regulation is enforced is also provided.

### **Proposed Changes to Existing Regulations**

Where appropriate, changes to the existing regulations are proposed to address the selected regulatory topic. Suggestions on how the regulation could be worded to achieve greater environmental protection, and recommendations to obtain additional information that may be important to support a change, are provided.

### **Environmental Protection Benefit**

This criterion provides a qualitative assessment of expected environmental protection benefits of implementing changes to the regulations associated with each selected topic.

Proposed changes to the landfill regulations are expected to enhance or improve environmental protection through the implementation of either more restrictive (statewide) or more flexible (site-tailored) regulations. The types of environmental benefits expected are discussed for each selected regulatory topic.

### **Cost Impact**

This criterion provides a qualitative assessment of expected cost impacts of implementing changes to California's existing landfill regulations associated with each selected topic.

The costs associated with the implementation of proposed regulations are evaluated on a qualitative basis, discussing the anticipated relative impact to regulatory agencies, landfill owners, and the general public.

### **Design and Operational Considerations**

This subject provides a qualitative assessment of technological and analytical considerations and constraints that may affect the implementation of proposed regulatory changes, in California. For example, implementation of some regulations may require the use of technologies that are not yet proven or that pose excessive risk if not implemented properly. Similarly, implementation of some regulations may require a change in how landfills are designed.

A qualitative assessment of operational considerations and constraints that may affect the applicability of proposed regulatory changes to landfills in California is provided. For example, some proposed regulations may be difficult to implement at certain landfills because of site-specific operational constraints, which may also be closely related to cost impacts.

### **4.3 Landfill Containment Systems**

During the Task 4 collection of in-depth information, owners and regulators were questioned regarding the performance of unlined cells, base liner systems in lined cells, and final cover systems in closed cells. The following list presents general findings that were taken from the information collected in Task 4.

1. At least 2 of the 53 landfills have confirmed releases to groundwater from a single composite (Subtitle D) lined cell. For both landfills, a release was detected by a lysimeter below the cell. One landfill is currently developing a corrective action program; the other installed a landfill gas collection system and an automated sump pump. One of the landfills has also attributed the release to landfill gas migration across the geosynthetic anchor trench. The other may have had construction defects that have resulted in leaks. One of the two landfills indicated that a double liner system will be required for the construction of future cells at the landfill.
2. At least 1 of the 53 landfills has been required to submit a liner performance evaluation to the RWQCB prior to receiving approval of a prescriptive single composite (Subtitle D) base liner. While not in response to a problem at the site, the Central Valley and North Coast RWQCBs have in recent years required landfill owners to submit liner performance evaluations for new waste management units (even if they comply with prescriptive standards) to demonstrate sufficient protection.

Based on the information collected in Task 4 with respect to landfill containment systems, environmental performance, and the role of existing California MSW landfill regulations, there were no recurring findings indicative of a problem with the existing regulations on landfill containment systems. Therefore, no regulatory topics have been identified for evaluation, and no changes are recommended to the existing regulations.

### **4.4 Water Quality Monitoring**

During the Task 4 collection of in-depth information, owners and regulators were questioned about their site-specific experiences with water quality monitoring and the associated monitoring regulations enforced by the RWQCB. The following list presents findings that were taken from the information collected in Task 4.

1. Of the 53 landfills, 32 indicated that they are responding to impacts to groundwater caused by a release from the landfill.
2. At least 19 of the 53 landfills have likely experienced landfill gas impacts to groundwater.
3. At least 16 of the 53 landfills have installed or enhanced landfill gas collection systems as a corrective action for impacts to groundwater.
4. One landfill was identified as requiring subsurface landfill gas monitoring for VOCs as part of the monitoring conducted during a groundwater-related corrective action.

From these general findings, one regulatory topic was selected for further review in Section 4.4.1.

#### **4.4.1 Regulatory Topic: Subsurface Landfill Gas Monitoring as Part of Water Quality Detection Monitoring**

##### **Description of Compliance Issue**

Of the 53 landfills studied, 19 indicated landfill gas-related impacts to groundwater through subsurface migration of landfill gas from the landfill resulting in detections above concentration limits for groundwater. This represents approximately 59 percent of the 32 landfills where groundwater impacts were noted, and suggests that the potential for landfill gas to impact groundwater is significant.

Examining the Task 4 landfills, 16 of the 28 landfills that were in the category “In Corrective Action” at the time Task 4 was performed were required to include some form of gas control system to mitigate groundwater impacts. Once impacts to groundwater have occurred, the regulations require the operator to evaluate the source of the release and then address it through a corrective action. The regulatory trigger for gas control in these cases was evidence of impact to groundwater, rather than some measure of subsurface landfill gas migration through monitoring.

In addition, one landfill was identified as requiring subsurface landfill gas monitoring for VOCs as part of the monitoring conducted during a groundwater-related corrective action. Because the corrective action program included a gas control system, the subsurface landfill gas measurements are used in this case to assess the effectiveness of the corrective action and to help identify potential future landfill gas impacts to groundwater before they happen.

##### **Comparison to Cross-Media Inventory**

Based on a review of the Task 2 cross-media inventory, of the 19 landfills with landfill gas impacts to groundwater, the median depth to underlying groundwater was 26 feet. Nine of the sites are underlain with sand and/or gravel, eight are underlain by rock, and only two are underlain by silts or clays. About two-thirds of the sites received between 10 to 18 inches of precipitation per year. Nine of the sites are fully unlined, eight are partially lined, and two are fully lined. Eight of the 19 sites are fully closed with a variety of cover systems.

##### **Current Regulatory Requirements**

Under the existing regulatory framework for water quality detection monitoring, landfills must monitor groundwater, surface water, and the soil-pore liquid in the vadose zone.

California's groundwater, surface water, and vadose zone monitoring regulations for MSW landfills are contained in Division 2, Subchapter 3 of 27 CCR (sections 20380 through 20435). Under these regulations, landfill operators are required to establish a monitoring program to detect, at the earliest possible time, a release from the landfill that could threaten water quality and to report this information to the RWQCB.

The existing regulations require monitoring of subsurface landfill gas migration as methane at the facility boundary for active landfills (regulated by the CIWMB), but not explicitly as part of a groundwater detection monitoring (regulated by the SWRCB)<sup>§§</sup>. If the facility boundary is several hundred feet away from the source of the landfill gas while the groundwater is only 26 feet below the ground surface, the landfill gas impacts to groundwater may occur prior to exceeding concentration limits in the perimeter landfill gas probes.

### **Proposed Changes to Existing Regulations**

Because landfill gas impacts to groundwater were found to be prevalent in Task 4 and the current regulations do not explicitly require it, it is recommended that landfill gas monitoring should be either incorporated more explicitly into the regulations as part of the detection monitoring program for water quality or be more widely encouraged by the RWQCBs. Because the migration of landfill gas is a precursor to impacts to groundwater and landfill gas is easier to control than groundwater, such a monitoring philosophy would likely be beneficial in reducing future impacts to groundwater.

If such an approach is adopted, the location of such monitoring points and the constituents evaluated should be carefully considered. All landfills with active decomposition will generate landfill gas, and should require landfill gas monitoring as part of the groundwater monitoring program. Monitoring points located within or very close to the waste will likely have higher VOC concentrations than those located farther away. Site-specific conditions, including the location and age of the waste, presence of a liner system, subsurface geology, and proximity to groundwater should be used in designing a monitoring network. Any additional landfill gas monitoring should be coordinated with the EA in order to complement any ongoing explosive gas monitoring.

Note that there are added complexities with respect to monitoring gas migration that would make monitoring gas more complex than it is for water. For example, molecular diffusion through even a composite liner will result, in time, in the presence of detectable concentrations of VOCs in soil-pore gas immediately exterior to the landfill liner. This is not a release, given that it is not being driven by a pressure gradient, yet such a "hit" could result in a regulatory response. A means for avoiding false-positive indications resulting from molecular diffusion would need to be developed prior to implementation of the recommended approach.

### **Environmental Protection Benefit**

Provided that the issues listed above, such as avoiding false-positive indications, are addressed, incorporating landfill gas monitoring into the groundwater monitoring

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<sup>§§</sup> The SWRCB's unsaturated zone monitoring requirements are under section 20415(d) of 27 CCR. Although the primary focus of this regulation is on the recovery of soil-pore-liquid samples, section 20415 (d)(4) provides that "The RWQCB shall require complementary or alternative (non-liquid recovery or remote sensing) types of unsaturated zone monitoring to provide the best assurance of the earliest possible detection of a release from the Unit." Therefore, soil-pore-gas sampling is included in the SWRCB's regulations, albeit in an oblique fashion.



program may improve environmental performance by identifying conditions that could lead to groundwater impacts before they occur.

### **Cost Impact**

From a cost perspective, such a preventive measure would have significant impacts to the landfill operators, as another level of monitoring and report would be required. Time and money for sampling, testing, and reporting could be significant. Additionally, such a change would increase costs to the RWQCBs to review additional monitoring information. However, for landfills where a landfill gas release has already impacted groundwater and a corrective action is required, the cost to install and operate a landfill gas collection system can be large. Controlling landfill gas is often less expensive than remediating a groundwater impact, so for these landfills there could be a net cost savings to the operator for monitoring for landfill gas releases as part of groundwater monitoring.

### **Design and Operational Considerations**

From a design and operations perspective, a change in the regulations to include landfill gas monitoring as part of the groundwater monitoring program would likely have little effect on the existing monitoring systems but would require the design and operation of any new monitoring points.

## **4.5 Landfill Gas Monitoring and Control**

The monitoring and control of landfill gas falls, to some extent, under the jurisdiction of the SWRCB, the CIWMB, and local AQMDs and APCDs. As discussed in Section 4.4, the impacts of landfill gas on groundwater are often addressed by the SWRCB through corrective action. The potential impacts on human health and safety and the environment through the migration of landfill gas into structures and off of the landfill property are regulated by the CIWMB. The potential impacts of landfill gas on air quality are regulated by the AQMDs and APCDs. The impacts of landfill gas on groundwater were discussed in Section 4.4, and will not be discussed in this section. The discussion of landfill gas impacts on human health and safety and the environment will be discussed separately in this section from the impacts of landfill gas on air quality.

During the Task 4 collection of in-depth information, owners and regulators were questioned regarding their site-specific experiences with respect to air quality monitoring and control and the associated regulations enforced by the AQMD or APCD for the ARB. From the information gathered in Task 4, no general findings could be drawn regarding the efficacy of the regulations with respect to enhancing environmental performance.

During the Task 4 collection of in-depth information, owners and regulators were questioned regarding their site-specific experiences with respect to landfill gas monitoring and control and the associated landfill gas control regulations enforced by the EA for the CIWMB. The following list presents general findings that were taken from the information collected in Task 4.

1. Landfill gas control is not required by the regulations during the active life of the landfill. Therefore, unless a “hazard or nuisance” is identified, landfill gas can migrate unchecked through the subsurface to the landfill boundary.
2. Violations of the explosive gas concentration limits have occurred in perimeter monitoring probes of at least 5 of the 53 landfills because the waste limit is in close proximity to the property boundary.

3. At least 4 of the 53 landfills are performing monitoring of the vadose zone near the waste limit to detect releases of landfill gas as early as possible.
4. At least 3 of the 53 landfills have had difficulty complying with explosive gas concentration limits where gas monitoring probes had been installed closer to the waste mass than required. The landfill gas probes were moved in order to achieve compliance.
5. At least 4 of the 53 landfills have either designed or purchased a buffer zone, which has helped the landfill to comply with regulations to limit explosive gas concentrations at the property boundary.

From these general findings, three topics have been developed for further review. These three topics will be evaluated individually in Sections 4.5.1 through 4.5.3.

### **4.5.1 Regulatory Topic: Landfill Gas Monitoring and Control at Active Landfills**

#### **Description of Compliance Issue**

The five general findings listed above indicate that regulations regarding the specified minimum level of effort required for landfill gas monitoring and control during the active life of the landfill are inconsistent with those that relate to the post-closure care period. This issue has manifested itself at the studied landfills in that many active landfills have been required to install shallow monitoring probes (on the order of 20 feet deep) at the property boundary to comply with existing regulations, whereas multi-depth probes are required by regulations at the closed sites.

#### **Comparison to Cross-Media Inventory**

Based on the statistical analysis of the cross-media inventory described in the Phase I report, fully covered sites were found to be 7.3 times less likely than fully uncovered sites to be in the category “Has Gas Enforcement Action”<sup>\*\*\*</sup>. (GeoSyntec, *Phase I Report*, 2003). This finding suggests that landfills that have undergone closure and have been covered with a final cover are less prone to violating the State minimum standards for gas-related performance. While the performance standards for landfill gas control are the same for active and closed sites, it should be noted that under the current regulations, the regulatory requirements for landfill gas control and monitoring for active sites are less rigorous than those for closed sites.

#### **Current Regulatory Requirements**

With respect to the monitoring and control of gas at active and closed landfill sites, California’s existing regulations are presented in 27 CCR, Division 2, sections 20919 through 20937.<sup>†††</sup> The primary intent of the 27 CCR, Division 2 regulations is to protect

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<sup>\*\*\*</sup> Findings were based on a 90 percent significance level.

<sup>†††</sup> Note: Additional federal Clean Air Act requirements for landfill gas monitoring and control at landfills with certain size and emissions characteristics are not addressed in this report. (Title 40 of the Code of Federal Regulations, Part 70 provides for the establishment of comprehensive state air quality permitting systems consistent with the requirements of Title V of the Clean Air Act [Title 42, U.S. Code, section 7401, et seq.]. These regulations define the minimum elements required by the Clean Air Act for state operating permit programs and the corresponding standards and procedures by which U.S. EPA will approve, oversee, and withdraw approval of state operating permit programs.)

adjacent properties from the hazards associated with explosive gas. These regulations address monitoring and control of methane, with some consideration given to “trace gases,” providing monitoring criteria, concentration limits, and gas control requirements. By comparison, for groundwater protection, the SWRCB’s regulations provides for the RWQCB to require soil-pore gas monitoring (as non-soil-pore liquid monitoring, under 27 CCR, section 20415(d)(4)), and to require gas extraction as part of corrective action for a landfill that has a gas release to groundwater (see 27 CCR, section 20425(d)(3)). The existing CIWMB regulations are paraphrased and summarized, as follows.

1. **Gas Control (27 CCR, section 20919):** Monitoring and control of gas is required for landfills where a “hazard or nuisance” may be created by landfill gases. If monitoring indicates methane gas movement away from the site, the owner shall construct an approved gas control system. This requirement may be waived if adjacent properties are safe from the hazard or nuisance.
2. **Explosive Gas Control (27 CCR, 20919.5):** The concentration of methane gas generated by the MSW landfill must not exceed 25 percent of the lower explosive limit (LEL) in facility structures. The concentration of methane gas must not exceed the LEL at the property boundary. A site-specific routine methane monitoring program must be implemented to demonstrate compliance, with a minimum frequency of quarterly. If these limits are exceeded, the EA must be notified, steps must be taken to protect human health, and a remediation plan must be implemented. An alternative frequency may be approved for MSW landfills accepting less than 20 tons per day.
3. **Scope and Applicability During Closure and Post-Closure (27 CCR, section 20920):** Sections 20921 through 20937 are only applicable to closed solid waste disposal sites that did not commence complete closure prior to August 18, 1989, which was fully implemented by November 18, 1990, and to landfills implementing new post-closure activities that may jeopardize the integrity of previously closed landfills or pose a threat to public health and safety or the environment.
4. **Gas Monitoring and Control During Closure and Post-Closure (27 CCR, section 20921):** Landfill gases shall be controlled to ensure the concentration of methane gas does not exceed 1.25 percent by volume in air within site structures, the concentration of methane gas migrating from the landfill does not exceed 5 percent by volume in air at the property boundary or an approved alternative boundary, and trace gases are controlled to prevent exposure to toxic and/or carcinogenic compounds. The program shall continue 30 years or until authorized to discontinue by the EA.
5. **Monitoring During Closure and Post-Closure (27 CCR, section 20923):** A monitoring program and network shall be designed by a registered professional, which considers site-specific conditions.
6. **Perimeter Monitoring Network for Closure and Post-Closure (27 CCR, section 20925):** Perimeter monitoring wells shall be installed at or near the property boundary or alternate locations closer to the waste deposit (but not in waste) if site factors recommend it. If concentrations are exceeded at the alternate locations, additional monitoring locations are required closer to the property boundary.

Monitoring of the full perimeter may not be required if it can be demonstrated that geologic barriers prevent migration and there are no sensitive properties (inhabited

buildings or agricultural lands) within 1,000 feet of the boundary. Monitoring well spacing shall not exceed 1,000 feet, and shall be defined based on site features and as needed to protect persons and structures. Greater spacing may be approved by the EA based on site conditions.

Multi-depth probes are required, with a deep monitoring point installed at the maximum depth of the waste mass within 1,000 feet of the probe. A shallow monitoring point is required 5 to 10 feet below the surface, and intermediate monitoring is required at the half-depth of the waste mass. Actual depths shall be determined based on conditions encountered during drilling, to ensure that the monitoring points are located in materials conducive to flow. Monitoring points shall be installed above groundwater and bedrock. If the waste is less than 30 feet thick, only two monitoring depths are required. Alternative monitoring well designs will be considered for special conditions on a site-specific basis.

Monitoring wells shall be installed by a licensed contractor under the supervision of the design professional. The boring shall be logged by a professional using the American Society for Testing and Materials (ASTM) standard. A record for each monitoring well shall be maintained, including facility map, well log, and as-built description of well. A minimum 5-foot bentonite seal is required at the surface and between monitoring depths.

7. **Structure Monitoring During Closure and Post-Closure (27 CCR, section 20931):** The on-site monitoring network design shall include, but not be limited to, buildings, subsurface vaults, utilities, or any other areas where potential gas buildup would be of concern. Methods for monitoring may include, but are not limited to, periodic monitoring, utilizing either permanently installed monitoring probes, gas surveys, or continuous monitoring systems. Structures located on top of the waste disposal area shall be monitored on a continuous basis. When practical, structures shall be monitored after they have been closed overnight.
8. **Parameters Monitored During Closure and Post-Closure (27 CCR, section 20932):** All monitoring probes and site structures will be monitored for methane, and may need to be monitored for trace gases at the request of the EA.
9. **Monitoring Frequency During Closure and Post-Closure (27 CCR, section 20933):** Minimum quarterly monitoring is required. More frequent monitoring may be required based on site-specific conditions or at monitoring locations where landfill gas migration is occurring.
10. **Reporting During Closure and Post-Closure (27 CCR, section 20934):** If concentration limits are met, monitoring reports shall be submitted to the EA within 90 days of sampling. If concentration limits are not met, the conditions of section 20937 apply.
11. **Gas Control During Closure and Post-Closure (27 CCR, section 20937):** If concentration limits are exceeded, the EA must be notified, steps must be taken to protect human health, and a remediation plan must be implemented. The plan includes verifying exceedances by reviewing site data and conditions that may influence result, constructing an approved gas control system designed by a registered professional to prevent methane accumulation in structures, reducing methane concentrations at the property boundary to compliance levels, reducing trace gas concentrations, and collecting and treating and/or disposing of gas condensate.

Specific recommendations for systems components to control subsurface migration and accumulation in structures shall be provided. The gas control system shall be monitored and adjusted as needed. A maintenance program shall be developed and updated, as needed.

As is indicated by this summary, the existing CIWMB regulations focus considerably more regulatory attention on the monitoring and control of explosive gases after closure than during the active life of the landfill. Specific requirements for the monitoring system are detailed in the regulations for the post-closure care period, but not for the active life of the landfill. Likewise, there are no explicit requirements in the existing regulations regarding the detection of trace gases during the active life. The source of methane at the property boundary is not specified for compliance during the active life (section 20919.5(a)(2)). During post-closure, the source of gas is specified as “from the landfill” (section 20921(a)(2)).

#### **Proposed Changes to Existing Regulations**

Because the generation of landfill gas starts as soon as the waste is placed, it may be appropriate to require as comprehensive a landfill gas monitoring and control system during the active life of the landfill as is required by the existing regulations during post-closure care. To address the issues associated with this inconsistency, the existing regulations could be revised to require the same monitoring and control programs during the active life as are currently required for post-closure care.

#### **Environmental Protection Benefit**

The anticipated environmental protection benefit of implementing the same landfill gas monitoring and control requirements for the active life of the landfill as is currently required for post-closure care is that the potential for landfill gas to migrate off-site undetected through the subsurface is reduced prior to closure.

#### **Cost Impact**

The cost impact of these changes is expected to be associated with the installation and monitoring of multi-depth probes at the active landfills in the state, which are more expensive than the shallow probes that have been used at some landfills. Because multi-depth probes are already required at the time of closure, the installation costs would be incurred sooner than required by the current regulations.

Additional costs may also be incurred to monitor for trace gases at the property boundary of active sites, an activity that is not required by the current regulations.

#### **Design and Operational Considerations**

The proposed changes to the regulations would require more rigorous design than is currently required, but there would be no appreciable changes to landfill operations.

## **4.5.2 Regulatory Topic: Using Buffer Zones to Comply With Landfill Gas Regulations**

### **Description of Compliance Issue**

As indicated by some of the general findings listed in Section 4.5, several of the landfills included in this study have either designed or purchased a buffer zone. This has helped the landfills to comply with concentration limits for explosive gases at the property boundary. Several landfills have also had difficulty complying with explosive gas concentration limits because gas monitoring probes were installed closer to the waste mass than required. Those probes have been relocated to the property boundary to achieve compliance.

### **Comparison to Cross-Media Inventory**

Based on a review of the cross-media inventory and the Phase I report, a comparison of disposal area, facility area, and gas compliance was performed (“Has Gas Inspection Report” environmental performance variable). A ratio of permitted disposal area to permitted facility area was developed to represent the portion of the site that may be providing a buffer from adjacent facilities. Of the 224 existing California landfills included in the Task 2 cross-media inventory, 142 have a disposal area that is greater than 40 percent of the total facility area. Of these, 59 percent are in the category “Has Gas Inspection Report.” Of the 224 landfills, 78 have a disposal area less than 40 percent of the total facility area. Of these, 33 percent are in the category “Has Gas Inspection Report.” This demonstrates that having a buffer from adjacent properties may help landfills to be compliant with explosive gas concentration limits at the property boundary.

### **Current Regulatory Requirements**

The current landfill regulations regarding landfill gas monitoring and control are summarized in Section 4.5.1. The primary intent of these regulations is to protect adjacent properties from the hazards associated with explosive gas, with some consideration given to trace gases. There is no existing landfill regulation that prohibits a landfill from requesting a change to its solid waste facility permit (SWFP) to increase the size of the facility, and create a buffer, to provide additional protection to the surrounding properties as long as the landfill is in compliance with State minimum standards (27 CCR, section 21685). A landfill that has had repeated gas-related violations is not in compliance with the State minimum standards. However, the CIWMB has a policy procedure for considering changes to an SWFP if a landfill has been a long-term gas violator (LTGV). The California State Auditor has pointed out that this policy procedure may be in conflict with existing statute because it allows changes to the SWFP to be considered for landfills that are not meeting the State minimum standards (California State Auditor, 2000, pp. 16–18).

### **Proposed Changes to Existing Regulations**

The Board is proposing to codify into regulation its long-term gas violation policy. As proposed, 27 CCR, section 21685 would be amended to require a landfill owner/operator who has a long-term gas violation and is applying for a solid waste permit revision to meet nine additional requirements within the regulation in order to be considered consistent with State minimum standards. Expansion of the property boundary or footprint would be allowed if it is associated with other feasible and effective control measures. The proposed changes were presented at the CIWMB’s April 2004 Board

meeting, where staff was directed to initiate a 45-day public comment period. The draft text of this proposed change to the regulations is available at the following website:

[www.ciwmb.ca.gov/Agendas/MtgDocs/2004/04/00015964.doc](http://www.ciwmb.ca.gov/Agendas/MtgDocs/2004/04/00015964.doc)

Because the intent of the existing regulations is to protect human health and the environment at adjacent properties from the hazards associated with explosive gas, it follows that creating a buffer between the waste disposal area and adjacent properties would be an appropriate means for compliance. The information gained from the Task 2 cross-media inventory further suggests that existing facilities with sizable buffers are more often in compliance with gas-related regulations, supporting the idea that a buffer can help a landfill comply. Therefore, it seems that the proposed changes to the regulations (giving existing landfills with gas-related compliance issues a means to extend the property boundary) is an appropriate way to provide additional protection of human health and the environment on adjacent properties. No additional changes to the regulations are recommended.

However, it should be recognized that the proposed changes to the regulations, while they would allow the explosive gas issue to be further addressed, make no steps toward addressing other issues. These include trace gases or the potential for the gas release to transport VOCs to groundwater.

### **4.5.3 Regulatory Topic: Vadose Zone Monitoring for Landfill Gas Near the Waste Limit**

#### **Description of Compliance Issue**

It should be recognized that in some cases it may be more appropriate to locate probes inside the property boundary, based on a site-specific assessment of the potential for impacts from landfill gas migration. There are several landfills included in Task 4 of this study that indicated they are performing monitoring of the vadose zone near the waste limit to detect releases of landfill gas as early as possible, protecting against explosive gas migration and potential impacts to groundwater due to trace gases.

#### **Comparison to Cross-Media Inventory**

Of the four landfills identified that are performing vadose zone monitoring for early detection of landfill gas migration, three have relatively shallow groundwater (65 feet or less below ground surface). One site has very deep groundwater (greater than 320 feet below ground surface), but has installed a multi-depth probe to provide advance warning of migration. Of these four landfills, two are fully lined (Subtitle D- or Chapter 15<sup>†††</sup>-compliant liner), one is partially lined, and one is fully unlined. Only one of the four landfills is in the category “Has Gas Inspection Report” for gas-related compliance issues. While this information does not suggest any trends about when it may be appropriate to consider monitoring closer to the waste mass, it does provide general information about the sites that have implemented this program.

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<sup>†††</sup> Title 23, Chapter 15 of the California Code of Regulations refers to regulatory requirements that pertained to MSW landfills. In 1997, these regulations were moved to Title 27, Division 2.

### **Current Regulatory Requirements**

The current landfill regulations regarding landfill gas monitoring and control are summarized in Section 4.5.1. The primary intent of these regulations is to protect adjacent properties from the hazards associated with explosive gas by requiring compliance at the property boundary. The existing regulations do not specify the monitoring location for explosive gas during the active life and allow alternative monitoring locations on a site-specific basis during post-closure.

### **Proposed Changes to Existing Regulations**

It is recommended that the regulatory agencies promote monitoring for explosive gases in the vadose zone closer to the waste mass at sites with larger buffers. However, this would not include any changes to the existing regulations, and the compliance point remains at the property boundary.

To simplify landfill monitoring, it would be preferable that gas monitoring systems that detect landfill gas prior to impacting groundwater (recommended in Section 4.4) be combined with explosive gas monitoring systems, with the resulting monitoring results provided both to the EA and to the RWQCB. The depth and location of the monitoring locations (somewhere between the refuse boundary and the property boundary) would be defined on a site-specific basis, considering site subsurface conditions and depth and potential uses of groundwater. Approval of the system would require concurrence of both the local EA and the RWQCB.

There is, however, a difficulty if both systems are combined. The lower explosive limit (LEL) for methane is 5 percent by volume in air; however, the trace gases commonly found in landfill gas may reach toxic or carcinogenic levels in gas at a much lower concentration of methane than 5 percent. Therefore, a monitoring location may be in compliance for methane, but out of compliance for trace gases. The appropriate remediation would need to be selected to address the compliance issue, again with the concurrence of both the local EA and the RWQCB.

### **Environmental Protection Benefit**

Performing explosive gas monitoring closer to the waste mass allows the detection of landfill gas migration closer to the source, so that the landfill may implement the necessary controls to avoid landfill gas impacts to groundwater, human health and safety and the environment. The impacts of landfill gas on groundwater are discussed in detail in Section 4.4.

### **Cost Impact**

In terms of construction and monitoring costs, locating the gas monitoring probes closer to the waste mass may reduce the number of monitoring points and therefore reduce the total costs, since the maximum allowable spacing (without regulator variance) is 1,000 feet. Depending on the setback from the property line, the difference between the number of monitoring points at 1,000 feet spacing close to the waste mass could be much fewer than at the property boundary.

### **Design and Operational Considerations**

Access to the property boundary may also be difficult; whereas monitoring locations closer to the refuse boundary would likely be more accessible and simplify operations.



There are no appreciable changes in design expected for sites that monitor closer to the waste mass.

## **4.6 Other Control Systems**

During the collection of in-depth information for Task 4, owners/operators and regulators were questioned regarding their site-specific experiences with respect to other control systems, such as leachate control, surface water control, and dust control, and the associated regulations. The following list presents general findings that were taken from the information collected in Task 4.

1. At least 4 of 53 landfills identified the importance of winterization and surface water plans in complying with the existing surface water and leachate control regulations. A requirement for submittal of an annual winterization plan has been incorporated into the site-specific waste discharge requirements (WDR) of at least two of the four landfills.
2. At least 7 of the 53 landfills have had storm-related compliance issues with drainage and erosion control regulations or leachate control regulations.
3. At least 1 of the 53 landfills has stopped using porous alternative daily cover (ADC) during the winter months to reduce the potential for leachate seeps.

From these general findings, one regulatory topic has been developed for further review in the following section.

### **4.6.1 Regulatory Topic: Regulatory Requirement for Winterization**

#### **Description of Compliance Issue**

Four of the 53 landfills in Task 4 identified the importance of site winterization. At least two of these have had a requirement to submit an annual winterization plan included in the site-specific WDRs. This plan has provided guidance to the landfills in preparing the site for winter storms so that, as the landfills indicated, violations of erosion and drainage control regulations can be minimized. Likewise, many of the compliance issues related to surface water identified during Task 4 were also related to winter storms. Other landfills have not indicated that they have winterization plans, but have indicated that surface water best management plans (BMP) have helped them comply with surface water requirements.

#### **Comparison to Cross-Media Inventory**

A review of the cross-media inventory indicates that the four landfills that identified the importance of winterization have very different precipitation conditions, averaging 6, 16, 18, and 40 inches of precipitation per year. The landfills that have the winterization plans required in the WDRs have an average annual precipitation of 18 and 40 inches. Of the seven landfills that have had storm-related enforcement actions for erosion and drainage control issues or violations for leachate control issues, the average rainfall ranges from 5 to 35 inches per year with a mean value of 15 inches per year. Of the 237 California landfills included in the cross-media inventory, 96 (less than half) have a rainfall greater than 15 inches per year, suggesting that surface water compliance issues are not exclusively a problem at high precipitation sites.

It should be recognized that the problem is not always the total volume of precipitation, but the intensity of the precipitation. Some desert sites that get less than 6 inches of rain per year can get one-third to one-half of the yearly total in one short-duration storm.

### **Current Regulatory Requirements**

There are currently no landfill regulations specifically requiring the submission of an annual winterization plan. However, the RWQCB or EA can require them as part of permit conditions. The existing regulations for construction standards for precipitation and drainage controls are included in 27 CCR, section 20365. Control standards for erosion and drainage controls are included in 27 CCR, section 20820, and closure and post-closure maintenance standards for erosion and drainage controls are included in 27 CCR, section 21150. These regulations are summarized as follows.

1. **Construction Standards for Precipitation and Drainage Controls (27 CCR, section 20365)**: Waste units shall limit ponding, infiltration, inundation, erosion, slope failure, washout, and overtopping under the design storm conditions. Precipitation onto uncovered waste shall be managed in the leachate collection and removal system (LCRS), which will also be designed to accommodate design storm conditions. Diversion and drainage facilities shall be designed to (1) accommodate design storm conditions, (2) direct flow over the shortest distance to collection facilities, (3) prevent erosion, (4) control and intercept run-on, (5) consider the impacts of closed units, operating portions of units, and the regional watershed, and (6) preserve the system's function (system maintenance).
2. **Drainage and Erosion Control (27 CCR, section 20820)**: The drainage system shall be designed and maintained to (1) ensure integrity of roads, structures, and gas monitoring and control systems, (2) prevent safety hazards, and (3) prevent exposure of waste.
3. **Closure and Post-Closure Maintenance of Drainage and Erosion Control (27 CCR, section 21150)**: The drainage and erosion control system shall be designed and maintained to (1) ensure integrity of post-closure land uses, roads, and structures, (2) prevent public contact with waste and leachate, (3) ensure integrity of gas monitoring and control systems, (4) prevent safety hazards, and (5) prevent exposure of waste. In cases where the design storm is not adequate for the protection of public health and safety, the EA, in consultation with the RWQCB, may require the implementation of a more stringent design. Slopes not underlain by waste shall be stabilized to prevent soil erosion. Methods used to protect slopes and control erosion shall include, but are not limited to, terracing, contour furrows, and trenches.

The regulations in 27 CCR, section 20365 for design and construction standards are primarily enforced by the RWQCB. The regulations in 27 CCR, sections 20820 and 21150 for design and maintenance are primarily enforced by the EA, and regular inspections of these systems are performed by the EA. The winterization plan identified in this study, which is related to landfill operations and controls, has been required by the RWQCB in site-specific WDRs.

### **Proposed Changes to Existing Regulations**

A review of the existing regulations shows that there is no specific requirement for the submittal of a winterization plan at MSW landfills (although they can be required by the RWQCB or EA as part of the site's permit conditions). Winterization plans have been indicated to be helpful to achieve compliance. However, based on the findings of the

Task 4 in-depth analysis, these plans have been required at sites with higher rainfall. The results of Task 4 also indicate that stormwater compliance issues have been experienced by both high and low precipitation.

Therefore, it is recommended either that the regulations explicitly require annual submission of a winterization plan by all landfills to the EA for review and approval with concurrence from the RWQCB, or that the regulators more widely promote the practice. For sites with mild winters and low precipitation, it is expected that the plans will be simple. For sites with high precipitation, in the form of rain or snow, the plans may be more comprehensive. The level of detail required for a landfill may be defined on a site-specific basis by the EA, which would correct the overlap in regulatory oversight that has occurred with the inclusion of the requirement in the site-specific WDRs.

#### **Environmental Protection Benefit**

The potential environmental protection benefit associated with requiring a winterization plan is that landfills may be better prepared to handle winter storms. This could reduce the potential for erosion of cover, inundation of drainage features, and leachate control problems.

#### **Cost Impact**

The potential cost impacts associated with the addition of this regulation would be associated with the development of the plan by the owners and the review and approval of the plan by the EA. Regulators may experience potential cost benefits by simplifying the approval of erosion and drainage control systems with the submission of an annual plan. Owners may see cost benefits by reducing the likelihood of violations related to storm-related erosion and drainage control regulations and leachate control regulations.

#### **Design and Operational Considerations**

Requiring a winterization plan may result in a more rigorous design of the surface water control system and may result in more attention by the owner or operator to the implementation of control systems during winter months.

### **4.7 Landfill Closure and Post-Closure Care**

During the Task 4 collection of in-depth information, owners and regulators of closed sites, inactive sites, and sites nearing closure were questioned regarding their site-specific experiences with respect to landfill closure and post-closure care, and the associated regulations. The following list presents general findings that were taken from the information collected in Task 4.

1. At least 3 of the 53 landfills have delayed closure, despite reduced need for the landfill, due to a lack of funds for closure.
2. The issue of trickling waste has been addressed for at least 1 of the 53 landfills by the RWQCB specifying a closure date in the WDRs.

From these general findings, one regulatory topic has been developed for further review. This topic is discussed in the following section.

## 4.7.1 Regulatory Topic: Regulations Prohibiting “Trickling Waste” Sites

### Description of Compliance Issue

Trickling waste inflow to a landfill refers to a method used by some MSW landfill owners for delaying closure and postponing closure costs. This is accomplished by accepting very small amounts of waste annually to the site in order to maintain status as an active landfill. If the waste unit has not ceased accepting waste, the closure requirements in the regulations do not need to be initiated.

Several landfills were included in the list of 53 because trickling waste has been an issue. These landfills have been in compliance with existing regulations because a loophole in the regulations allowed them to avoid closing the landfill. In one case, the trickling waste issue was addressed by the RWQCB when it revised the WDRs to define a specific date for closure of the landfill. Other landfills identified in the study have not had sufficient funds to close, despite having previously demonstrated adequate closure funding<sup>§§§</sup>, and have been inactive for a long period. These landfills have not been in compliance with the regulations. The potential environmental risk associated with delaying closure indefinitely is that a final cover is not installed, possibly allowing infiltration to the waste mass and the generation of leachate that would not occur if a final cover were installed.

### Comparison to Cross-Media Inventory

The CIWMB has identified 17 of the 224 existing California MSW landfills that received waste after October 9, 1993, that may qualify as “trickling waste” sites by regulatory definition. Of these 17 landfills, 10 have had compliance issues related to either groundwater (2 landfills), gas (8 landfills), or surface water (3 landfills). All but one of these 17 landfills are in rural areas, and the maximum permitted disposal area ranges from 4 acres to 40 acres, with a median size of 21 acres.

### Current Regulatory Requirements

Recent changes by CIWMB to the landfill regulations have addressed the issue of trickling waste in 27 CCR, section 21110(b), which is quoted, in part, below.

1. **Closure Required at Trickling Waste Sites (27 CCR, section 21110 (b)(2)):**  
“If the average annual waste disposal rate to a solid waste landfill is reduced for two consecutive years to a rate equal to or less than thirty (30) percent of the average annual tonnage rate during the previous ten years (exclusive of the minimum and maximum tonnage years), the operator shall begin closure activities in accordance with the time frames specified in the closure plan unless granted an extension pursuant to ¶(b)(3).”
2. **Criteria for Receiving an Extension (27 CCR, section 21110 (b)(3)):** “Extensions beyond the deadline for beginning closure may be approved by the EA, for up to five years at a time, if all of the following conditions are met: (A) The operator demonstrates that the landfill has the capacity to receive additional wastes and is likely to receive additional wastes; (B) The operator demonstrates that the reduction in disposal tonnage is for a purpose other than the avoidance or delay of closure; (C)

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<sup>§§§</sup> Note that in instances where demonstrated closure funding includes a trust or enterprise fund, the funding level demonstrated while the landfill is in compliance with the regulations is likely insufficient to fully fund closure activities if the landfill closes prior to reaching full permitted capacity.

The operator has taken and will continue to take the steps necessary to prevent threats to public health and safety and the environment from the unclosed landfill;  
(D) CIWMB concurs with the EA-approved extension.”

**Proposed Changes to Existing Regulations**

These regulations appear to sufficiently address the issue of trickling waste, and no additional changes to the regulations are recommended. However, it should be recognized that there are other landfills in the state that would not be considered trickling waste sites but that have been inactive for long periods without closing, which is not allowed by the regulations. That these landfills remain out of compliance with the regulations is more of an enforcement issue than a regulatory one, and is outside the scope of this study.

## 5 Conclusions and Recommendations

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Section 4 presented a detailed discussion of six regulatory topics, which were identified for further discussion from the list of general findings also presented in Section 4. As discussed in Section 4.1, these topics were selected because they potentially impact environmental performance and are pertinent to the scope of work for this study. Recommendations were made in Section 4 with respect to each of these six topics. In this section, the conclusions and recommendations of this study will be summarized.

### 5.1 Proposed Changes to Existing Regulations

From the six topics discussed in Section 4, three changes to the existing regulations have been recommended. These changes fall under three regulatory categories—water quality monitoring, gas monitoring and control, and other control systems. No changes to the existing regulations are recommended in the categories of containment systems or closure and post-closure care. Some of the recommendations are interrelated and could be addressed with one revision, if it were worded appropriately.

A description of each of the recommended changes to the regulations within a given category and a brief summary of the basis for the recommendation is provided in the remainder of this section. In addition, one of the recommendations does not require an actual change in the regulations, but rather recommends that regulators promote systems that are beyond the regulatory minimums.

#### 5.1.2 Water Quality Monitoring

##### **Regulatory Topic: Subsurface Landfill Gas Monitoring as Part of Water Quality Detection Monitoring**

The existing water quality monitoring regulations allow for, but do not require, monitoring for releases of landfill gas. It is recommended that landfill gas monitoring be either explicitly incorporated into the regulations as part of the detection monitoring program for water quality or more widely encouraged by the RWQCBs. This change is recommended because:

1. The migration of landfill gas is a precursor to impacts to groundwater.
2. Landfill gas is easier to control than groundwater.
3. Fifty-nine percent of the landfills that have had impacts to groundwater have attributed those impacts at least in part to landfill gas migration.

#### 5.1.3 Landfill Gas Monitoring and Control

##### **Regulatory Topic: Landfill Gas Monitoring and Control at Active Landfills**

The existing regulations for landfill gas monitoring and control are significantly more comprehensive for the post-closure care period than they are for the active life of a landfill. It is recommended that the landfill gas monitoring and control regulations for the active life of the landfill be changed so that they are as comprehensive as the regulations for gas monitoring and control during the post-closure care period. This change is recommended because:

1. The generation of landfill gas starts as soon as waste is placed.
2. Active landfills are more likely to have gas-related compliance issues than closed landfills.

**Regulatory Topic: Vadose Zone Monitoring for Landfill Gas Near the Waste Limit.**

No change to the regulations is recommended per se, since current landfill regulations already allow alternative monitoring locations on a site-specific basis. However, it is recommended that the EAs promote monitoring for explosive gases in the vadose zone closer to the waste mass at sites with larger buffers. This change in practice is recommended because:

1. The migration of landfill gas is a precursor to impacts to groundwater.
2. The distance to the property boundary may be so large that monitoring at that boundary may not effectively identify the migration of explosive gases.

### **5.1.4 Other Control Systems**

**Regulatory Topic: Regulatory Requirement for Winterization**

The existing regulations have no explicit requirement for the submission of an annual winterization plan. It is recommended that annual submission of a winterization plan for review and approval by the EA with the concurrence of the RWQCB be either explicitly incorporated into the regulations or be more widely encouraged by the regulatory agencies. This change is recommended because:

1. Winterization plans have been indicated to be helpful in complying with surface water and leachate control requirements at sites with different climatic conditions.
2. Surface water and leachate control compliance issues have occurred at sites with different climate conditions.
3. The cost to implement and enforce the plans may be lower than the cost of responding to storm-related impacts to surface water.