NEW LFG MONITORING REQUIREMENTS IN CALIFORNIA: MORE STRINGENT AND EXPENSIVE

Patrick S. Sullivan, R.E.A., C.P.P.
SCS Engineers
Sacramento, California

Raymond H. Huff, R.E.A.
SCS Engineers
Long Beach, California

Cassandra B. Drotman
SCS Engineers
Long Beach, California

ABSTRACT

On September 20, 2008, all California landfills that did not close prior to Resource Conservation and Recovery Act (RCRA) Subtitle D implementation in 1989 must comply with a full set of new landfill gas (LFG) monitoring regulations. These requirements include elements for probe spacing, depths, construction details, location, monitoring, responses to exceedances, corrective action, and criteria for alternatives and exemptions. In addition, the enforcement of these requirements by the local enforcement agencies (LEAs) and/or the California Integrated Waste Management Board (CIWMB) has been very active, and the interpretations the agencies are making have been very stringent. There are many sites, whose previously compliant LFG monitoring probe networks are having to be replaced and/or new probes installed to meet the requirements. The cost of this compliance can be substantial, ranging from several hundred thousand of dollars to over a million dollars for some sites.

On top of this, the CIWMB recently completed a probe functionality study; the results of which will likely lead to additional regulations for probe testing, including down-hole camera surveys and periodic probe replacement schedules. This paper summarizes these new LFG regulations and the effects they are having on landfills in the state. Case studies are also provided detailing the types of requirements that are being imposed, how those differ from what is typically required or allowed under Subtitle D, and the cost for compliance. The results of the probe functionality study are also summarized as well as the likely effect it will have on future regulatory requirements and compliance costs for landfills.

INTRODUCTION

On September 20, 2007, the CIWMB promulgated a revised set of LFG regulations for gas monitoring and control at active and closed disposal sites, became effective. These regulations can be found in the California Code of Regulations (CCR) under Title 27, Division 2, Subdivision 1, Chapter 3, Subchapter 4, Article 6, Sections 20917-20939 (Article 6). Modifications to the existing regulation included (among other things) requirements for development of a monitoring program, formal inclusion of active sites in LFG regulations, compliance boundary modifications, probe network design and construction modifications, violation notification timing modifications, as well as a compliance deadline for the revised regulations. The history of these regulations is detailed below.

BACKGROUND/HISTORY

The recent revisions to Article 6 have been a work in progress since early 2003, consisting of technical advisory group (TAG) input, draft rulemaking, final rulemaking, as well as revision of final rulemaking. A summary of each step in this process, the revised regulations, as well as supplemental suggestive policies, which accompany the revised regulations, are presented below.

Technical Advisory Group

In 2003, the CIWMB convened a TAG tasked with reviewing the CIWMB's LFG Long-Term Violation (LTV) Policy and reviewing the existing LFG regulations in order to determine if they were adequate, or needed revisions. The TAG was comprised of representatives from the CIWMB, LEAs, landfill owners/operators, and solid waste consultants.

TAG discussions on the LTV Policy were concluded by mid-2003, at which time the group's full efforts shifted to modification of the existing LFG regulations. While individual opinions on the adequacy of these regulations differed, as of July 2003, the general consensuses of potential changes to the former Article 6 regulations were:

- Apply detailed landfill closure standards for LFG, which previously only applied to closed sites, to active sites

- Consistent timing is needed (5, 7, 10 days) for LEA notifications of LFG issues (§20919.5, 20937)
- Check for consistency with New Source Performance Standards (NSPS) regulations [§20921(a)(3)]
- Postclosure land use:
    - Look at potential conflict with local land use standards [§21190(b)]
    - Include CIWMB in review/approval for closed, illegal, abandoned (CIA) sites
- Change Lower Explosive Limit (LEL) threshold in structures from 25% LEL to 1.25% by volume for consistency (§20919.5)
- Require periodic testing of monitoring wells for functionality

The TAG was informally disbanded by the CIWMB in late 2003. Subsequently, in late 2005, the CIWMB released proposed text for the Article 6 LFG regulations that included a significant number of changes that had never been discussed by the TAG.

September 2007 Revised LFG Regulations

The revised Article 6 regulations were promulgated on September 20, 2007. The regulations require that operators of active and closed disposal sites to submit LFG gas monitoring control plans, which demonstrate compliance with the new LFG monitoring criteria. The plans must then be reviewed and approved from the LEA and reviewed with concurrence from the CIWMB. These Article 6 modifications also introduced an updated set of more stringent regulations with which California municipal solid waste (MSW) landfills must comply. The revised Article 6 regulations can be found at http://www.ciwmb.ca.gov/RuleArchive/2007/ActiveGas/default.htm. The major modifications to the Article 6 regulations are summarized below:

Section 20921 – CIWMB Gas Monitoring and Control:

This section was modified to include the requirement for a gas monitoring and control program to be submitted by the disposal site operator to the LEA and CIWMB for review and approval. In addition, this section currently stipulates that the CIWMB has a 60-day window to review plans following submittal, or they will be automatically approved.

Section 20921 was also modified to provide a compliance schedule for different configurations of landfills (active, closed, etc.).

1. New disposal sites or lateral expansions must comply with the regulations prior to receipt of waste in the expanded area.
2. Disposal sites, which have received their final shipment of waste, shall comply with these regulations immediately. Disposal sites, which are actively implementing final closure activities at the time these regulations become effective, shall comply with these regulations in accordance with the time schedule contained in the approved final closure plan.
3. Existing disposal sites, which have not yet received their final shipment of waste, shall comply with these regulations in accordance with the following schedule.
    A. Disposal sites, which are permitted to receive greater than 20 tons of waste per operating day, shall comply with these regulations by September 21, 2008.
    B. Disposal sites, which are permitted to accept less than or equal to 20 tons of waste per operating day, shall comply with these regulations by September 21, 2009.

This section was also modified to include inclusion of the implementation of the gas control program in the Joint Technical Document (JTD) as well as preliminary and final closure and postclosure maintenance plans for the site.

An additional modification to this section clarified that, for sites without a solid waste facility permit (SWFP), the disposal site permitted facility boundary is defined in the most recently approved closure/postclosure, or other appropriate documents.

Section 20923 – Monitoring: This section was modified to incorporate the disposal site facility boundary as a point of compliance (as opposed to landfill property boundary) and included a provision to consider the hydraulic conditions surrounding the disposal site when designing a monitoring network.

Section 20925 – Perimeter Monitoring Network:

Spacing Requirements – §20925(b) – This section was modified to ensure that wells are installed near the permitted facility boundary (as opposed to the property boundary) of a site and reinforces the 1,000-foot spacing rule that was in the previous version of the regulations. The modified regulation does not allow for a wider spacing unless the operator can demonstrate that, "there is no potential for adverse impacts to public health and safety and the environment," resulting from proposed wider spacing.

Well Depth Requirements – §20925(c) – This section was modified to stipulate that wells shall be installed to the maximum depth of the waste at the site, as opposed to the

previous requirements to install probes to the maximum depth of waste within 1,000 of the proposed probe location.

Section 20933 – Monitoring Frequency: This section was modified to include an allowance for a smaller disposal site (less than 20 tons per day disposed waste) to reduce monitoring frequency only after concurrence from both the LEA and CIWMB.

Section 20937 – Reporting and Control of Excessive Gas Concentrations: This section was modified to pertain specifically to reporting and control of gas readings in excess of compliance requirements, according to the following schedule:

1. Immediate action and notification to the LEA by telephone or electronic means.
2. Within seven days:
    a. Verify validity of results
    b. Place a description of the event in the operating record and notify LEA in writing.
3. Within 60 days, submit a remediation plan

February 2009 Re-Revised LFG Regulation

Following the promulgation of the September 2007 revised Article 6 regulations, the newly included active landfills in California were faced with a one year compliance deadline for not only the development of a monitoring control plan, but also its approval and installation. Considering the maximum 60-day review time allowed to the CIWMB staff (aside from the time allowed for LEA review and revision of the plan), at best, a landfill had 10 months to develop, revise, and implement these plans.

Subsequently, in August of 2008, the CIWMB directed staff to extend the compliance deadline set forth in §20921 to require only the submittal of a gas monitoring program by September 21, 2008, with the deadline for installation of an approved system extended until September 21, 2009. In addition, the re-revised §20921 includes a 60-day review window for the LEA (in addition to the 60-day window for CIWMB review) as well as providing for a longer extension of the implementation timeframe for a site, based on concurrence of the CIWMB and LEA.

This revision to §20921 was promulgated into law in February 2009. During the five month gap between the (then) existing regulations and the promulgation of the revised §20921, the CIWMB has created guidance for LEAs to retain their ability to enforce CIWMB regulations within their jurisdictions. Landfills, which accept over 20 tons of waste per day, still had to submit their gas monitoring and control programs plans by September 21, 2008, but the landfill operator does not need to fully implement the plans, as approved by the LEA and concurred with the CIWMB, until eight months after the effective date of the proposed regulation or September 21, 2009.

Probe Functionality Study

Concurrent with the development of the revised Article 6 LFG regulations and as recommended by the 2003 TAG, from 2006 to 2008; the CIWMB conducted a study of the functionality of gas monitoring probes at 20 landfills located throughout California (SCS, 2008). The intent of the study was to determine if the monitoring data collected is representative of the actual soil gas conditions in the vicinity of the screened portion of each probe. The CIWMB preselected 20 landfill sites in northern and southern California to be included in this study. The landfills were selected to include a variety of landfill sizes, geomorphic and geologic settings, and the presence of relatively deep gas probes (40 to 99 feet, or more). Ten probes at each landfill were selected by the CIWMB contract manager for functionality review and determination.

Prior to the implementation of the field portion of the Probe Functionality Study, a standardized approach to probe functionality assessment was developed. The standardized approach for probe assessment consisted of the following activities:

- Pre-Assessment Activities, which consisted of pre-notification of site owners/operators, on-site random selection of probes, and recording of ambient conditions (pressure, weather, etc.).
- Initial Condition Assessment, which consisted of reviewing the geographic location of the probe, reviewing the identification methodology for the probe, assessing the probehead assembly (fittings, piping, etc.), and conducting surface emissions monitoring in the vicinity of the probe.
- Gas Monitoring Assessment, which consisted of recording initial pressure readings, LFG monitoring, ambient oxygen analysis, depth trend analysis, and methane concentration analysis.
- Vacuum Testing of the probe, which consisted the application of a known vacuum to a probe and recording the probe response once the vacuum was stopped.
- Video Borescope Inspection, which consisted of verifying the probe construction by creating a video log of the inside of the probe using a small diameter borescope.
- Lithology Evaluation, which consisted of the evaluation of the adequacy of the placement of the screened section of a probe considering permeable and porous lithologies.

The May 2008 final report for this study concluded that although there is no single way in which to evaluate the functionality of a probe, the current approach to LFG perimeter migration monitoring probe design, construction, and installation is unsatisfactory. Further, the report recommended the following additional modifications to the probe network regulations contained in §20925:

1. Probes should be constructed with longer screened segments (as opposed to shorter, and such that screened sections do not overlap). A longer screened section reduces the possibility of blockages by bentonite, as well as the presence of dirt and roots.
2. Wherever possible, probes should be assembled using threaded coupling, as opposed to slip coupling and/or screwed together joints, or glued/solvent welded. This will ensure that gas samples are collected from the screened interval of a probe as opposed to areas where casing might leak due to a bad seal and/or screwed-together joints. It is understood that some portions of a probe (e.g., endcap and wellhead) cannot be preconstructed and thus, may require a slip-type fitting.
3. All probes should be constructed using a non-proprietary locking valve on the probehead assembly (labcock valve, quick connect valve, or similar). This will ensure that valid pressure readings can be obtained from the probe from on-site personnel as well as regulatory agencies.
4. Probes should be preferentially located as far away from surface vegetation as possible in order to avoid root intrusion into shallow probes.
5. Development of a standard probe specification and construction criteria.
6. Requirement for a professional geologist/engineer certification of installed/completed probes, including rationale for preferential placement of mid-depth probe(s) based on lithology.
7. Periodic functionality assessments should be initiated for all probes at every landfill site. One recommended implementation would be to perform a functionality assessment every ten years (following initial probe installation). The ten-year term is based on the average age of the probes evaluated in this study, which ranged from under five years to more than 25 years.

Best Management Practices for LFG Monitoring Well/Probe Construction

Following the presentation of the Probe Functionality Study to the CWIMB in July, 2008, its Board directed CIWMB staff to proceed with an informal rulemaking process to modify §20925 to provide additional requirements for LFG monitoring probe design, construction, and functionality assessment. The Board also directed staff to obtain input from stakeholders and the TAG into best management practices (BMPs) developed from the findings of the Probe Functionality Study.

Initial stakeholders, TAG, and CIWMB discussions focused around technical issues and clarification of portions of the existing regulations (e.g. explanation of "permanent low seasonal groundwater table, installation of probes in groundwater, etc.). Following these discussions, in October 2008 the CIWMB released the following BMPs for LFG monitoring well/probe construction:

- Probes should be constructed with longer screened segments (5-foot minimum).
- Probes should be assembled using material, and in a manner that, provides an adequate seal and does not interfere with sampling trace constituents.
- Minimize the number of probe pipe connections by using longer section of pipe.
- Probes should be constructed using a non-specialized valve on the probe head assembly.
- LFG wells and probes should be properly labeled and identified.
- LFG probes should be constructed to allow access by a bore monitor.
- The depth of the probe(s) in relation to the water table should be a design consideration.
- Probes should be preferentially located as far away from surface vegetation as possible in order to avoid root intrusion into shallow probes.
- A certified engineering geologist/registered civil engineer must "field design" the screened interval for the probes and certify installation/completion of well/probes in the as-built by the regulations.

The CIWMB web site denotes these BMPs as a "voluntary guidance" for landfill operators, consultants, and LEAs. The BMPs text can be located at (http://www.ciwmb.ca.gov/LEAcentral/LandfillGas/Monitoring/BMPWellConst.htm).

CIWMB Monitoring Program Plan Review Approach

In October 2008, the CIWMB published a review approach (RA) for gas monitoring probe plans submitted to LEAs and the CIWMB for review. The RA outlines the CIWMB's approach to review of these documents, submittal requirements, and discusses exemptions and alternatives for the revised regulations. The full text of the RA can be found at http://www.ciwmb.ca.gov/LEAcentral/LandfillGas/Monitoring/Plans/default.htm. The major components of the RA are summarized below.

The CIWMB Review Approach document states that the following "may" be included in a gas monitoring plan:

- LFG well/probe as-builts,
- Boring logs,
- Plot plans showing existing and proposed locations/spacing,
- A discussion and map regarding surrounding land uses,
- A drawing showing a typical LFG well/probe,
- Geologic cross sections and map,
- LFG monitoring results, and
- Any other pertinent evidence.

It has been the authors' experience that these items should be considered mandatory for the majority of landfills submitting gas monitoring plans.

In addition, the CIWMB is using all the criteria set forth in §20923(a)(2) for the evaluation of monitoring program plans (MPPs), particularly for any exemptions or alternatives. As stated in §20923(a)(2), the as monitoring plan needs to be designed to account for:

1. Local soil and rock conditions;
2. Hydrogeological conditions at the disposal site;
3. Hydraulic conditions surrounding the disposal site;
4. Location of buildings and structures relative to waste disposal area;
5. Adjacent land use, and inhabitable structures within 1,000 feet of the disposal site facility boundary;
6. Man-made pathways, such as underground construction; and
7. The nature and age of the waste and its potential to generate LFG.

The CIWMB has been evaluating alternative requests based on all of these factors combined since the regulation clearly says "and" for inclusion all of them. Thus, a landfill would need to address each of these components in any alternative request made to the CIWMB. We have first-hand experience of the CIWMB rejecting alternative requests that were sound in six of these seven areas, which were rejected simply because the seventh was not addressed. By addressing all of these issues in a single MPP submittal, there will be no room for CIWMB to reject based on not addressing all their concerns.

The operator's submittal should include LFG probe as-builts, boring lots, plans which display existing and proposed well locations and spacing, a discussion on surrounding land use, typical probe construction diagrams, geologic cross section, LFG monitoring results and any other pertinent evidence.

IMPLEMENTATION ISSUSES WITH REVISED REGULATIONS

When the revisions to the Article 6 LFG regulations were first proposed, the CIWMB touted them as a simple matter of making the requirements for close and active sites consistent. Closed sites, as defined in California regulations, had been subject to the more detailed LFG regulations for many years. As such, it seemed very logical that all landfills should be subject to the same set of requirements. Landfill owners and operators did not fear these revisions since they had many years of experience working under the same regulations, which included reasonable allowances for rule exemptions and alternatives. Further, the CIWMB projected in their rulemaking documentation that the average cost for active landfills to upgrade their LFG monitoring systems under the new regulations would be less than approximately $30,000 per site.

As it has turned out, the revised LFG regulations have had a more substantial compliance and economic impact than what was originally estimated. Several very subtle changes to the rules have turned out to be more of an issue than any landfill owner or operator imagined. To begin with, the CIWMB inserted themselves into the review and approval process for LFG plans, thereby necessitating their approval for any exemptions and alternatives. Previously, such allowances could be negotiated with LEAs, which had discretion to grant exemptions and alternatives. LEA discretion has been all but eliminated under the new regulatory structure, and the CIWMB has taken a very conservative approach to approving exemptions and alternatives, including many that were freely approved in the past.

Under §20925[c] relative to probe depth, the new regulations removed the requirement that probes should be installed to the depth of waste within 1000 feet of the probe and replaced it with a requirement that all probes must be installed at or near the maximum depth of waste anywhere on the site. This requirement has become a very expensive proposition for landfills where there are large surface elevation changes between different areas of the site (e.g., canyon fills). In some cases, these sites are being required to replace their entire probe network because it does not meet the depth criterion and/or was installed to the old criterion. Exemptions/alternatives are allowed in the regulation where "conditions limit the practicality or do not warrant the installation depth criteria;" however, the CIWMB has been unwilling to grant any even for the specific examples identified for possible exemption: filled pits, cut and trench, and canyon fills. Had the landfill industry known that no exemptions or alternatives would be granted, they may have taken a

harder stance on this change in the regulation during the TAG and rulemaking process.

The new regulations also deleted the 30-year time frame for post-closure monitoring for LFG, and instead, gave the discretion to the LEA and/or CIWMB to require post-closure gas monitoring for as long as directed by the agencies. Previously, landfills could end gas monitoring after 30 years as long as the LEA did not identify any issues. Under the current regulation, the burden of proof is on the landfill owner/operator to prove that it is acceptable to discontinue monitoring, which is likely to be difficult to accomplish given the CIWMB's conservative interpretations.

In addition to actual changes to the regulations, the CIWMB has also used the opportunity of the regulatory change to increase the stringency of their interpretation of various provisions of the rule. This is especially true in the areas of spacing and depth criteria for probes. Spacing exemptions and alternatives to the 1000-foot criterion were commonly granted in the past based on the presence of water bodies, the absence of inhabitable structures or receptors, geologic conditions, etc. As long as a site had a strong case for one of the criteria under §20923(a)(2), an approval could be obtained. However, the CIWMB is now suggesting that all of the criteria must be met, and there must be a strong case for each. This analysis has resulted in illogical and expensive interpretations where a landfill is being required to install probes at 1000-foot spacing along landfill perimeters adjacent to major bodies of water because the soil lithologic conditions were not optimal to meet the geologic criterion, completely forgoing the fact that the gas cannot migrate anywhere because of the water.

The net impact of the regulatory changes and new interpretations is that landfills in California are having to spend significantly more money than was estimated by the CIWMB to justify their rulemaking ($30,000). There have been several sites in California where full compliance as directed by the CIWMB would be near $1 million. Very few sites have spent less than $30,000. It would appear that the CIWMB has well understated the fiscal impact of their rule.

CASE STUDIES

Landfill #1

Landfill #1 is located within what is considered marsh land in Northern California. It began disposal operations in 1986 and has capacity beyond approximately 2030. The currently permitted disposal area is located entirely within a 320-acre parcel and includes 190 acres. An additional 160 acres has been approved as a landfill expansion area.

The original Preliminary Closure and Post Closure Maintenance Plan (PCPCMP) for the site proposed and justified a LFG probe spacing of 2,000 feet, which was subsequently approved by the CIWMB. In 2006, the CIWMB rescinded this 2000-foot spacing, noting only that the regulations require a minimum spacing of 1000 feet, but that the landfill owner could submit documentation for consideration of an alternative.

In 2007, a workplan for new probe installation was submitted to the LEA and CIWMB in order to comply with the September 2007 Article 6 requirements. This workplan included specific requests for alternatives for the spacing and depth criteria listed within the regulation. The spacing alternative (2000-foot spacing on three site perimeters bordered by grazing land) was justified based on the criteria in 27 CCR using similar arguments that were used and approved in the original PCPPCMP.

The CIWMB rejected this proposal on the grounds that not all of the seven criteria listed in §20923 had been met. When pressed, the CIWMB concurred that the proposal met all but one of the criteria, but was rejected because the site had too large a "potential to generate landfill gas." Their position was that only a very small, old landfill could ever qualify under this criterion and that it did not matter how well any of the other criteria were met. This position essentially means that only a very limited number of small, old landfills could ever qualify for spacing alternatives under the regulations.

The workplan also proposed depth alternatives based on the criteria in §20925(c):

- All probes shall be installed above the permanent low seasonal water table, above and below perched ground water, and above bedrock;
- Exclusions or modifications to depth criteria may be requested when conditions limit the practicality or do not warrant the installation depth criteria (e.g., filled pits, cut and trench, and canyon fills). The proposal must demonstrate to the satisfaction of the LEA and CIWMB that probes located at these depths are sufficient to detect migrating landfill gas and provide protection to public health and safety and the environment.

Landfill #1 has a portion of its perimeter, which is within a canyon area. Depth alternatives were proposed for this perimeter based on the presence of bedrock and the large elevation difference between the surface elevation at the top of the canyon and the depth of refuse at its lowest point. Also, where the probes would need to be placed is in an undeveloped canyon area, which is difficult to access for drilling equipment. The workplan proposed that any

new or replacement probes will be installed to one of the following depths: (1) equal to the maximum depth of refuse within 1,000 feet (the old 27 CCR standard) of the monitoring point, (2) above the permanent low seasonal water table, or (3) above bedrock.

The CIWMB rejected this argument, mandating that all probes be installed to the maximum depth of waste across the entire landfill. They have made it clear that the canyon fill scenario will not be accepted as justification for a depth alternative and that the accessibility criterion will also be rejected if a probe could be installed anywhere between the refuse and the facility boundary, regardless of cost. This decision necessitated drilling multiple probes to depths in excess of 250 feet, through bedrock material. A special drill rig had to be used to gain access to the drilling sites and get to the necessary depths. Also, the probe locations had to be moved directly adjacent to the refuse footprint due to accessibility, which will give the site no margin for error in terms of gas migration.

The projected cost estimate for probe installation under the original workplan, including proposed alternatives, was approximately $75,000. The ultimate cost for the probe installation project, after the CIWMB's rejection of the alternatives, was approximately $225,000.

Landfill #2

Landfill #2 is an active two phase landfill located in Northern California, with a river adjacent to the northeast. Phase I operated as a cut-and-cover fill between 1982 and 1991, and has a final in-place volume of approximately 800,000 cubic yards. Phase II is a canyon fill, which covers approximately 100 acres and is being developed in sub-phases over a period of 20-30 years.

Prior to the revision of the Article 6 regulations, Landfill #2 had been periodically monitoring lateral gas migration through installation of shallow, temporary bar-hole punches. No permanent probe network had been installed.

During the design of the monitoring well network for Landfill #2, information on the depth to groundwater, facility boundary, and topography were compiled. At Landfill #2, the estimated maximum depth of waste based on pre-fill topography, is approximately 960 feet above mean sea level (msl). The river, which runs along the northeastern boundary of Landfill #2 (within the permitted facility boundary), has an elevation which varies from 840 to 920 msl, an elevation lower than the maximum depth of refuse at Landfill #2.

In July 2008, a workplan for new probe installation was submitted to the LEA and CIWMB in order to comply with the September 2007 Article 6 requirements. This workplan included a prescriptive installation of a well network around the northern, western, and southern refuse footprint. An alternative spacing was requested along the northeastern boundary of Landfill #2, due to the presence of a riverbed at an elevation lower than the maximum depth of waste at the site.

The CIWMB rejected this proposal citing that the details provided were "inadequate." The CIWMB further requested "additional details to describe and justification on how the presence of river, which was stated as lower than the maximum depth of refuse, warrants the absence of perimeter migration probes." When pressed on this issue, CIWMB personnel stated that since the creek was located within the permitted facility boundary, LFG has the potential to travel down, vertically, under the river, then back up again, and migrate off-site. Therefore, Landfill #2 was given the option of installing probes across the river from the landfill (but not deeper than the depth of waste at the site), or to move the probes closer to the waste footprint.

Although the irony of assuming vertical migration below the maximum depth of waste at this landfill, and at no other sites, was pointed out the CIWMB, they still refused the alternative boundary request. The additional three probes required by the CIWMB resulted in a total of 210 feet of additional drilling for probes that will monitor the lateral migration of gas that would have to travel under a river to get to the perimeter of the site.

Landfill #3

Landfill #3 is a 324-acre, active MSW landfill located in located in Southern California. The site was located in an existing dry canyon. Portions of the site are unlined and have no as-built records as the landfill was constructed prior to Subtitle D regulations. The Site has an existing network of monitoring probes consisting of seven multi-depth and three single depth probes. The horizontal spacing of probes range from 800 to 1500 feet, with an average spacing of 989 feet. The western portion of the landfill does not currently have LFG probe coverage. The bottom elevation of the probes range from 412 to 618 feet msl. Pre-fill topography of the canyon indicates a base elevation of 600 feet msl. The probes are functioning as methane is occasionally detected in several probes. The landfill is beginning a phased expansion in the western portion of the site. The base elevation for the proposed expansion will be 430 feet.

The work plan to meet Article 6 was prepared and submitted for LEA and CIWMB review. The Plan outlined a phased approach, first by replacing five of the existing probes and constructing two additional probes.

The first phase would improve horizontal spacing and meet the new base elevation for the landfill expansion.

The horizontal spacing was reduced to average spacing of 929 feet. Four spacing intervals did exceed the 1000-foot requirement; two exceeded by 165 feet, one exceeded by 75 feet, and one exceeded by 44 feet. The request for a slight deviance in spacing was made because of limited access and the average spacing of 929 feet. These probes were placed prior to waste placement in an area, which is now a steep narrow cliff; the probes are functional. Deviations from the depth requirement were made for these limited access probes. These probes were placed to bottom elevation of 575 feet msl, which is below the depth of waste in the adjacent waste; these probes are functional.

The second phase would complete the landfill perimeter in the western area by constructing seven multi-depth probes to complete the landfill perimeter. The depth of these probes would range from 250 to 453 feet to meet the 430 feet msl base elevation and horizontal spacing requirements would be met. The timing of placement would occur after the landfill expansion and prior to waste placement. The phased expansion would be complete by 2011

The LEA found the workplan inadequate. The request for the slight horizontal spacing deviance was not accepted and all probes were required to meet the base elevation of 430 feet msl. The perimeter is required to be closed with the 1000 foot spacing by placing temporary probes in the landfill expansion excavation area. Subsequent discussions with the CIWMB have revealed a method to slightly modify the 1000-foot spacing with creative triangulation. This method may allow approval of one or more of the distance deviations; however, the regulatory review would direct the removal and replacement of functional probes to move them less than 200 feet. The deviations from probe depth requirements by basing probe depth to the depth of waste in the vicinity of the probe have been rejected. Probes must meet base elevation regardless of distance of that probe from that base elevation. The rejection of probe depth based on the depth of waste in the reasonable vicinity of the probes influence, creates an expensive depth requirement for canyon fill landfills.

Landfill #4

Landfill #4 is an active landfill located in the San Joaquin Valley in Central California. Landfill #4 occupies 440 acres of which 361 acres are utilized for waste disposal activities. Currently, wastes in-place occupy 148 acres of the site. Landfill #4 consists of three separate fill areas. The maximum depth of waste at the site is 145 feet msl, or 35-40 feet below grade. Shallow lithology beneath the site consists of silts and sands to a depth below the maximum depth of waste.

In 2008, a gas monitoring plan was submitted to the LEA and CIWMB in order to comply with the new CCR Article 6 requirements. This plan detailed an assessment of the existing 25 well perimeter monitoring network at Landfill #4 and recommended the augmentation of the existing network by replacing four multi-depth nested wells.

The CIWMB rejected this proposal citing that three of the 20 wells recommended to remain at the site were installed short of the bottom of the waste by between six to eight feet. Review of boring logs for these wells indicated that the boreholes had been drilled to the maximum depth of waste, but sloughing in the borehole had caused a collapse, which resulted in setting the probe approximately 3-4 feet shallower than intended. Note that §20925(c)(1)(C) states that, "the deep probe shall be set at, **or near** the depth of waste," (emphasis added).

In addition, the CIWMB stated in their review that the existing probes at the site (installed between 1999 and 2005), although approved at the time of construction by the LEA, were not constructed in accordance with the new BMPs as the probes consist of polyethylene tubing connected to a small metal screen at depth.

Currently, Landfill #4 is attempting to justify the construction of 20 probes that pre-date the creation of the "voluntary" BMPs, as well as to justify that a probe located within 6 feet of the base of waste (in a 40-foot deep hole). Landfill #4 is located "near" the depth of waste, per §20925(c)(1)(C). In the instance that the arguments are refused by the CIWMB, which is expected, an additional 20 wells (five times the replacement wells proposed) will need to be replaced, which could result in a cost over $70,000 more than anticipated.

Landfill #5

Landfill #5 is an active landfill located in Southern California, adjacent to a major river (adjacent to the north). It began disposal operations in 1963 and has capacity through approximately 2042. The currently permitted disposal area is located entirely within a 115-acre parcel.

The April 2008 JTD for the site proposed and justified the absence of LFG probes along the northern boundary of the site due to the presence of a river, with a 1,400-foot wide riverbed, with an airport located opposite Landfill #2 (across the riverbed).

In 2008, a gas monitoring plan was submitted to the LEA and CIWMB in order to comply with the new Article 6 requirements. This plan detailed an assessment of the existing perimeter probe network at Landfill #5, and requested an alternative spacing for only the northern boundary (located adjacent to the riverbed). The riverbed elevations vary across the site, but generally range from

approximately 1,185 feet msl (55 feet below the base waste elevation) along the eastern side, to 1,115 (15 feet above the base of waste elevation) at the extreme western portion of the site (note that this generally matches pre-landfill topography). The northern perimeter of the landfill is separated from the River by a levee constructed of concrete debris and earthen material. The monitoring plan also noted that access to the entire northern boundary of the site is restricted due to the conservation of Wooley-Star plant habitat preservation. In addition, there are no structures or other potential receptors within 1,000 feet in the area north of Landfill #5.

Therefore, an exemption from northern boundary probes was requested due to the limited practicality, access restrictions, levee construction which will restrict drilling efforts of installing probes along the levee (per §20925[c][2]), the lack of any potential receptors present within 4,000 feet of the site due to the river, and the periodic hydrologic barrier that the river creates when active during the wet season of the year.

The LEA/CIWMB rejected this proposal citing that additional information should be provided to describe the type of "soil and rock conditions" in the river levee to demonstrate how gas migration could not occur. Note that the statement, "soil and rock conditions," is a direct quotation from §20923(a)(2)(A). This is a significant issue because the riverbed is comprised of sands and gravels and the levee is comprised of concrete debris. This lithology will likely not meet the geologic criterion for being non-conducive to gas migration.

Based on the lack of access to the northern boundary area due to the protected river levee, Landfill #5 is still in the process of negotiating an implementable solution with the LEA and CIWMB.

CONCLUSIONS

As the case studies have shown, the CIWMB staff has used the recent revision of the Article 6 LFG regulations; to enforce a more stringent interpretation of the regulations than was originally intended by stakeholders, TAGs and as stated by CIWMB staff itself. In addition, sites were directly affected by the CIWMB's unwillingness to consider commonplace landfill management decisions and ignored what should be considered as practical during the assessment of LFG systems.

This "new take" on the Article 6 LFG regulations has resulted in excessive costs to the landfill owner/operator resulting from the most stringent interpretation of depth/spacing issues for monitoring wells, in addition to the revocation/non-consideration of previously approved exemptions by LEAs with more site-specific knowledge.

REFERENCES

Beizer, M., Bell, J., and Huff R., 2008, "Landfill Gas Monitoring Well Functionality at 20 California Landfills," California Integrated Waste Management Board Publication #IWMB-2008-022.