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October 17, 2023

VIA EMAIL ONLY

Mr. Steve Cassulo
Steven.Cassulo@WasteConnections.com
District Manager
Chiquita Canyon Landfill
29201 Henry Mayo Drive
Castaic, CA 91384

Subject: **CHIQUITA CANYON LANDFILL (SWIS No. 19-AA-0052)**
CALRECYCLE REVIEW OF THE ONGOING ODOR INCIDENT AT CHIQUITA CANYON LANDFILL

Dear Mr. Cassulo:

In response to significant increases in landfill gas production and emission, leachate, and odors at the Chiquita Canyon Landfill (CCL), the Los Angeles County Department of Public Health, Solid Waste Management Program, acting as the Local Enforcement Agency (LEA), requested CalRecycle to provide its technical expertise and assistance in determining the cause of these multiple serious issues. Please find the enclosed October 16, 2023 correspondence from CalRecycle that contains its analysis of the conditions that are causing these issues at the CCL.

As part of this analysis, CalRecycle conducted a comprehensive review of multiple years of CCL records. It focused its analysis on CCL's carbon monoxide concentrations, recent landfill gas temperatures at CCL, CCL's landfill gas control system operation, and other operational factors. The CalRecycle analysis determined that the CCL has sustained the following conditions during the past 18 months:

- Cover integrity issues;
- Increased temperatures and pressures in the landfill gas control systems and waste mass;
- Oxygen intrusion above 5% by volume;
- Landfill gas temperatures over 170°F;
- Landfill subsurface temperatures over 195°F;
- Decreased methane production;
- Elevated carbon monoxide concentration above 1000 ppmv;
- Unusual landfill settlement;
- Damaged gas wells;
- Poor gas well performance in and around the Reaction Settlement Area; and
- A heating/smoldering event that is expanding in size and intensity.

Importantly, CalRecycle concluded that these "conditions at the CCL are causing additional gas pressure, odors, elevated leachate temperatures, and damage to the gas extraction system." These are serious issues and have likely caused the many violations cited by the South Coast Air Quality Management District (SCAQMD) investigations this year. The CalRecycle analysis presents compelling evidence that the CCL needs to act promptly to address the current conditions for the protection of public health and the environment.

To address the multiple abnormal conditions being experienced at the CCL, CalRecycle has made the following recommendations to immediately address landfill gas control, emission, odor and leachate issues. CCL should implement the recommended mitigation measure and continue to work with the appropriate State and local agencies to resolve the odor nuisance and the serious conditions at the landfill.[1] If prompt steps are not taken, the condition is likely to worsen, and may threaten the integrity of the landfill, thereby compromising the landfill cover. (See, 27 California Code of Regulations ("CCR") §§ 20680 and §20700).

Accordingly, the LEA now expects CCL to take the following corrective and mitigation actions:

1. Repair cracks in the soil cover within 48 hours in and around the Reaction Settlement Area and any well showing signs of a reaction;
2. Place and compact a minimum cover of 24 inches of 1 x10-6 low permeability soil in and around the Reaction Settlement Area and a radius of 30 feet of soil around any well with temperatures over 160ºF or CO concentrations over 1,500 ppmv;

[1] California's environmental laws are enforced by state and local agencies, each responsible for enforcing the laws governing a specific media such as air, water, hazardous waste, solid waste, and pesticide laws. Therefore, regulations governing solid waste disposal in the State of California enforced by the LEA do not address air or water quality aspects of the environment that are regulated by other state or local agencies. (27 CCR § 20005(b); Public Resources Code § 43021).

3. Install well boots seals on all wells in and adjacent to the Reaction Settlement Area and any wells with temperatures over 160ºF or CO concentrations over 1,500 ppmv;
4. Replace all PVC wells that have been damaged, blocked, pinched, or that have gas temperatures over 145°F with steel wells;
5. Install additional steel wells in the Reaction Settlement Area and other areas where the gas extraction temperature exceeds 170°F to capture the additional gas generated by the incident;
6. Once additional gas extraction capacity is installed, remove all oxygen HOVs for interior gas wells and operate gas extraction wells with less than 3 percent oxygen where feasible. Use best management practices to keep oxygen below 5 percent in an interior well;
7. Measure the leachate temperate at the liner level and all sumps;
8. Sample the leachate for benzene and other volatile organic compounds. Past incidents similar to Chiquita Canyon in Bridgeton and Bristol have shown that heating event increases the levels of VOCs in the leachate;
9. Install temperature monitoring devices in and around the Reaction Settlement Area and other areas where gas temperatures exceed 170°F or CO over 1000 ppm. These devices should be installed within 25 ft. of a vertical LFG extraction well. These temperature devices should be able to sustain temperatures up to 750°F and be installed in boreholes up to 150 feet deep. The temperature devices should be spaced at 20-foot intervals and based on previous designs from SCS Engineering projects in Bridgton, San Diego, and Bristol. Since the temperature profiles were not successfully collected at the required enhanced gas wells C-55R, CV-1418, CV-1419, CV-1532, CV-2202, CV-2204, H-1561C, H-1561N, below-ground temperature devices should be first installed at these wells;
10. The landfill owner should review available internal manifests or other documents as far back as possible to ensure no reactive material was accepted at this landfill;
11. The landfill owner should hire an odor expert to determine which chemicals are causing the odor. A past expert at Bridgeton Landfill in Missouri identified a set of chemicals causing the greatest odor. Once the chemicals are identified, additional toxicological assessment can be performed;
12. Design and install a temporary geomembrane cover over the Reaction Settlement Area and other areas where gas temperatures have exceeded 170°F or CO over 1000 ppm once additional gas extraction capacity is operational;
13. Consider installing remote telemetry technology to continuously collect and analyze landfill gas data at the collection wells. The real-time data and control platform can instantaneously measure and report wellhead temperatures, pressures, O2, CO, and methane concentrations. Remote access to the real-time data should be provided to regulatory agencies, i.e., SCAQMD;
14. Consider utilizing a drone or land rover equipment with GPS, methane, and gas sensors to conduct daily instantaneous surface monitoring and provide real-time data throughout the

Reaction Settlement Area and adjacent areas of concern. This technology can facilitate immediate operational changes, including flagging hot spots, surface cracks, and fissures.

15. To better understand and communicate to the community if the heating/smoldering event is expanding or increasing in intensity, the CCL should submit monthly figures and data showing the reaction area, CO level, and temperature data.

The LEA requests that the CCL provide a written response and timeline to address the recent conditions sustained by the CCL in the prior 18 months and the 15 CalRecycle recommended corrective and mitigation actions by Friday, October 20, 2023. The LEA recognizes the CCL is experiencing a significant heating and smoldering event, which must be mitigated, controlled and corrected.

Thank you for your anticipated cooperation. Should you have any questions regarding the foregoing, please contact me.

Sincerely,

Karen Gork, Chief Environmental Health Specialist
Los Angeles County LEA

Enclosure

cc: (Via electronic correspondence only)

- Robert Ragland, Los Angeles County Department of Public Health
- Liza Frias, Los Angeles County Department of Public Health
- Nichole Quick, M.D., Los Angeles County Department of Public Health
- Shikari Nakagawa-Ota, Los Angeles County Department of Public Health
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- Wes Mindermann, CalRecycle (wes.mindermann@calrecycle.ca.gov)
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- Jeff Lindberg California Air Recourses Board (jeff.lindberg@arb.ca.gov)
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California Environmental Protection Agency

Department of Resources Recycling and Recovery

Gavin Newsom
California Governor
Amelia Yana Garcia Gonzalez
Secretary for Environmental Protection
Rachel Machi Wagoner
CalRecycle Director

October 16, 2023

Ms. Karen Gork, MPH, REHS
Chief Environmental Health Specialist
Solid Waste Management Inspection and Enforcement Program
Los Angeles County Department of Public Health – Environmental Health
5050 Commerce Drive
Baldwin Park, California 91706

Subject: Review of the Odor Incident at Chiquita Canyon Landfill (19-AA-0052)

Dear Ms. Gork:

CalRecycle staff are providing this letter in response to your request for technical assistance in reviewing the cause of the odor incident at the Chiquita Canyon Landfill (CCL). These emissions are causing significant impacts on people living and working near the landfill, as documented by South Coast Air Quality Management District (SCAQMD) investigations. As discussed later in this letter, you and your staff should work closely with SCAQMD and the Los Angeles Regional Water Quality Control Board (RWQCB) to address the issues at the site in a manner that will effectively reduce the impacts on the communities in the near term, leading to full resolution of the underlying problems in the long term.

The following comments are provided to the Local Enforcement Agency (LEA) as assistance to support the program in carrying out its responsibilities on permitted disposal sites. The final determination as to the comments to be provided to the responsible party is within the sole purview of the LEA, acting within the parameters of its discretion, in accordance with its vested authority under its certification as defined in Title 14, California Code of Regulations (14 CCR), Division 7, 27 CCR, Division 2, Subdivision 1 (Section 20005 et seq.), and Division 30 of the Public Resources Code.

For this technical request, I have reviewed the following documents submitted by the LEA:

- 2023 First Semi-Annual New Source Performance Standards (NSPS) and National Emissions Standards for Hazardous Air Pollutants (NESHAP) Report, Chiquita Canyon Landfill;
- 2022 First Semi-Annual NSPS and NESHAP Report, Chiquita Canyon Landfill;

- 2022 Second Semi-Annual NSPS and NESHAP Report, Chiquita Canyon Landfill;
- 2021 First Semi-Annual NSPS and Startup, Shutdown, and Malfunction (SSM) Report, Chiquita Canyon Landfill;
- 2021 Second Semi-Annual NSPS and SSM Report, Chiquita Canyon Landfill;
- 2020 First Semi-Annual NSPS and SSM Report, Chiquita Canyon Landfill;
- 2020 Second Semi-Annual NSPS and SSM Report, Chiquita Canyon Landfill;
- 2019 First Semi-Annual NSPS and SSM Report, Chiquita Canyon Landfill;
- 2019 Second Semi-Annual NSPS and SSM Report, Chiquita Canyon Landfill;
- 2018 First Semi-Annual NSPS and SSM Report, Chiquita Canyon Landfill;
- 2018 Second Semi-Annual NSPS and SSM Report, Chiquita Canyon Landfill;
- 2017 First Semi-Annual NSPS and SSM Report, Chiquita Canyon Landfill;
- 2017 Second Semi-Annual NSPS and SSM Report, Chiquita Canyon Landfill;
- 2016 First Semi-Annual NSPS and SSM Report, Chiquita Canyon Landfill;
- 2016 Second NSPS and SSM Report, Chiquita Canyon Landfill;
- South Coast Air Quality Management District (SCAQMD) Stipulated Order for Abatement for Chiquita Canyon Landfill, Case No. 6177-4;
- 2022 SCAQMD Annual Rule 1150.1 Compliance Plan Report, Chiquita Canyon Landfill, Castaic, California;
- 2021 SCAQMD Annual Rule 1150.1 Compliance Plan Report, Chiquita Canyon Landfill, Castaic, California;
- 2020 SCAQMD Annual Rule 1150.1 Compliance Plan Report, Chiquita Canyon Landfill, Castaic, California;
- 2019 SCAQMD Annual Rule 1150.1 Compliance Plan Report, Chiquita Canyon Landfill, Castaic, California;
- 2017 SCAQMD Annual Rule 1150.1 Compliance Plan Report, Chiquita Canyon Landfill, Castaic, California
- 2016 SCAQMD Annual Rule 1150.1 Compliance Plan Report, Chiquita Canyon Landfill, Castaic, California;
- Chiquita Canyon Landfill Well Data Feb 2022 - July 2023.xlsx;
- Various Well Temperature and Well Exceedance Data, Chiquita Canyon Landfill,
- Castaic, California;
- 2023 Chiquita Canyon LF Reaction Area Map.pdf;
- Chiquita Site Photos;
- Various laboratory analyses for carbon monoxide by EPA Method Alt-14, fixed gasses by ASTM-D1946-90, Total Sulfur Compounds by SCAQMD 307.91, toxic organic compounds by EPA Method TO-15 from October 2022 to July 2023;
- Monthly Report for Regular Variance (Case No. 6177-3), Chiquita Canyon;
- Landfill (Facility ID 119219), Castaic, California; and
- Various reports found on the Chiquita Canyon website https://chiquitacanyon.com/reports/landfill-reports/.

Background

The CCL is located at 29201 Henry Mayo Drive, Castaic, California, in northern Los Angeles County. The facility is a Class III non-hazardous municipal solid waste (MSW) landfill. The 639-acre landfill site began accepting waste in 1972. The landfill can receive up to 12,000 tons of MSW per day. The average daily tonnage in 2021 was reported to be 6,412 tons. The CCL only accepts non-hazardous solid waste for disposal, including municipal solid waste, green waste for composting or recycling, construction and demolition debris, and e-waste for recycling. The facility is prohibited from accepting hazardous waste that is ignitable, corrosive, reactive, or toxic. The landfill also does not accept biohazardous waste, household hazardous waste, radioactive materials, incinerator ash, sludge, automobile shredder waste, or liquid waste.

Recently, the CCL has experienced a significant increase in the number of odor complaints. In 2022, the CCL received only seven odor complaints directly; three were filed with the South Coast Air Quality Management District (SCAQMD). From January 1, 2023, to July 31, 2023, 869 odors were reported to the SCAQMD.

Regulatory Air Monitoring

The CCL has an extensive gas collection system operated under SCAQMD Permit No. G43917. The landfill gas (LFG) flares operate under SCAQMD Permit No. G73696 and the Permit to Construct Application No. 624296, while the LFG condensate collection and storage system operates under SCAQMD Permit No. G66132. The landfill site is permitted under the SCAQMD Title V permit (Facility ID No. 119219).

The LFG to Energy Facility (LFGTE) accepts LFG but is owned and operated by Ameresco Chiquita Canyon Energy LLC (Ameresco). The Ameresco facility operates under its own SCAQMD Title V permit.

The CCL is subject to the old and revised New Source Performance Standards (NSPS). The CCL submits semi-annual reports to the SCAQMD and the United States Environmental Protection Agency (USEPA) in compliance with 40 Code of Federal Regulations (CFR) Subpart WWW. In 2021, USEPA revised NSPS regulations and removed the oxygen limit for interior wells and the associated additional corrective action/enhanced monitoring requirements for oxygen under Subpart XXX/AAAA. However, the CCL continues to follow the oxygen limits under Subpart XXX because this rule is still referenced in the CCL's Title V Permit.

To evaluate the odor incident, the following sections of each NSPS semi-annual report were analyzed to understand the data trends and root cause:

- Prior Higher Operating Value Requests;
- Pressure requirements;

- Temperature and Oxygen Requirements;
- Corrective Action Analysis;
- Enhanced Monitoring;
- Surface Emission Monitoring;
- Cover Integrity;
- Additional Surface Emissions Monitoring;
- Well Expansion;
- Source Test – CO Emission Rate; and
- 24-Hour Temperature.

Higher Operating Values

The CCL has submitted several HOV requests to the SCAQMD for higher oxygen and temperature limits. On August 28, 2007, the CCL requested wells B-7, B-8, B-9, B-10, B-11, B-13, CV-22, D-6, D-7, D-8, D-9, D-10, D-11, P-1, P-2, P-3, P-4, P-5, P-12, P-13, P-14, P-22, P-23, P-24, P-56, P-78, and P-79 in the old unlined portion of the landfill be allowed to operate these wells at an oxygen limit of 10% to 15%.

On May 5, 2011, the CCL requested wells CV-90, H-39, CV-57D, CV-84D, CV-84S, and CV-85D be allowed to exceed the temperature limit of 131 Fahrenheit (°F) and operate at a temperature limit of 145°F.

On January 9, 2014 the SCAQMD approved these wells for higher temperature values and approved higher oxygen levels (i.e., 10 to 15%) in wells B-7, B-8, B-9, B-10, B-11, B-13, CV-22, D-6, D-7, D-8, D-9, D-10, D-11, P-1, P-2, P-3, P-4, P-5, P-12, P-13, P -14, P-22, P-23, P-24, P-56, P-78. On December 6, 2016, the SCAQMD approved additional higher temperature values of 131°F for wells CV-76, H-52A CV-100, CV-103, CV-104, CV-105, CV-50D, CV-50S, CV-51D, CV-51S, CV-52D, CV-52S, CV-53D, CV-53S, CV-54D, CV-54S, CV-55R, CV-56D, CV-57R, CV-74R, CV-79R, CV-107-56, CV-109-55, CV-1418, CV-1419, CV-1424, CV-1425, CV-1426, CV-1532, CV-1533, CV-108-52.

Possibly to account for where the odors are most likely being generated, the CCL used areas that settled one foot or more between June 19, 2023, and July 21, 2023. Figure 1 shows the reaction settlement area at the CCL.

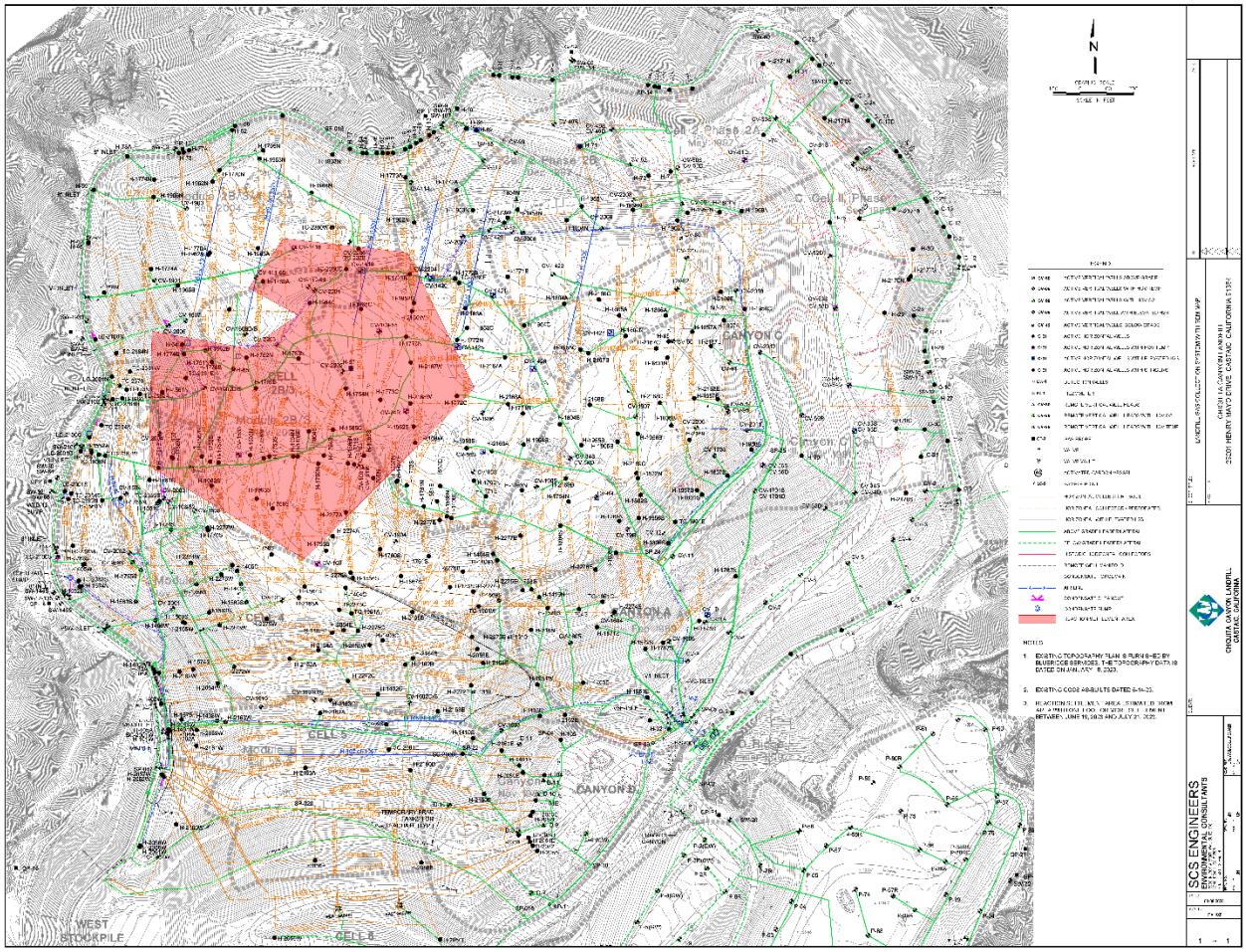

Figure 1. Reaction Settlement Area at the Chiquita Canyon Landfill. The red area was estimated using one foot or more settlement between June 19, 2023, and July 21, 2023.

Discussion

Determining if a landfill is experiencing a subsurface heating incident (i.e., gas temperatures above 145°F) involves the evaluation of the waste stream, LFG control system, landfill gas temperature and composition, carbon monoxide (CO) levels, physical evidence, odors, and accepted waste engineering practices. Heating incidents can occur from pre-combustion, combustion, post-combustion, and reactive wastes. Generally, to confirm a subsurface smoldering event (SSE), one must have visual confirmation or other physical conditions present. A smoldering event in municipal solid waste (MSW) can be confirmed by:

- Smoke emanating from the gas extraction well, sink hole, or landfill fissure;
- Combustion residue (i.e., carbon soot) in extraction wells, headers, or screens at the flare inlet;
- Black carbon tar-like substance along a fissure or crack in the area of concern;
- Unique MSW combustion odor;

- Substantial settlement over a short period (i.e., post-combustion indicator); and
- Landfill gas temperatures more than 176°F and/or levels of CO more than 1,500 parts per million by volume (ppmv) with one of the above indicators.

Several factors at a facility may affect the abovementioned parameters, including waste composition, moisture content, temperature, oxygen, compaction, landfill operations, leachate recirculation, LFG operations, cover properties, barometric pressures, waste cell construction, and other environmental issues.

A facility may also unknowingly accept reactive waste that may cause a fire or elevated temperature. Aluminum dross, incinerator ash, metal oxides, shredded tires, automobile shredder waste, sawdust, compost, pyrite, coal, or charcoal all have been shown to negatively impact the biological process with heat or directly cause a fire.

Excess oxygen can be introduced into the waste cell if a landfill's gas extraction system is not adjusted correctly or the cover and waste are not properly compacted. While high oxygen levels in a gas well do not directly correlate to a high temperature or an SSE, the more oxygen available in a gas well, the higher the risk of biological decomposition switching from anaerobic to aerobic and the greater the risk of subsurface fire.

These factors can lead to landfill temperatures above 165°F, including aerobic decomposition, pre-combustion, post-combustion, self-heating, partially extinguished surface fires, exothermic chemical reactions, spontaneous combustion, and smoldering combustion. MSW landfills have experienced elevated temperatures due to possible exothermic chemical reactions of industrial wastes, including aluminum production wastes, incinerator ash, and tires.

The most common types of landfill fires occur at the surface, where fuel and oxygen are abundant. These fires can burn between the surface and up to five feet below the ground level. Other subsurface fire events are initiated and develop deeper in the landfill and can extend past 50 feet or more below the ground level depending on geological and site conditions.

An operator can either increase or decrease the potential for a smoldering or heating event with how the waste is compacted and covered and how the landfill gas is controlled. A typical subsurface fire starts from overdrawing a gas collection system that allows oxygen to enter the waste prism. These fires start around or near a surface feature that allows oxygen to enter the waste mass and oxidize the organic matter. Most subsurface fires in gas collection systems are detected by elevated temperatures at the wellhead or by detecting CO or soot in the gas collection system. These fires are more likely to burn slowly without visible flame or large quantities of smoke and are characterized by rapid oxidation of organic waste. At times, combustion/oxidation will go undetected until a sinkhole (i.e., differential settlement) or smoke appears. Usually, an individual will not see actual flame or dark black smoke during smoldering events unless the subsurface fire is excavated or exposed to the atmosphere.

Carbon Monoxide

Smoldering combustion has been shown to produce CO concentrations of 1 to 10 percent (10,000 ppmv to 100,000 ppmv). In contrast, flaming combustion generally produces less than 0.02 percent (200 ppmv) CO. Other landfill fire literature uses CO concentrations as low as a few parts per million to 100 ppmv as a possible positive indicator of a landfill fire (Waste Age 1984; Environment Agency 2004; Industry Code of Practice 2008). Based on other landfill fire evaluations and case studies, other processes may produce CO at these concentrations. Therefore, one should use a higher CO concentration greater than 1,500 ppmv as the threshold value to prevent false assumptions.

After examining multiple CO results and data plots of CO versus menthane (CH4) from subsurface events, I concluded CO levels greater than or equal to 1,500 ppmv can still indicate an SSE if other indicators are observed. Typically, CO from active smoldering events ranges from 1,000 to 10,000 ppmv and has been documented to exceed 28,000 ppmv as the smoldering event breaks through the surface. Like landfill temperatures, CO readings should be examined, and trend plots should be developed over time. Like temperature, CO from a smoldering event will also reside in the waste prism LFG stream for an extended time. While elevated temperatures can remain over 18 to 24 months and longer, CO concentrations will begin to drop within 1 to 6 months as the smoldering event diminishes. Since the waste is not homogeneous and other waste management practices (e.g., compaction, leachate recirculation, types of waste, daily cover, waste cell size, access roads, gas extraction collection, and rates, etc.) may vary across the landfill, proximate monitoring points may indicate different readings. The entire suspected area and monitoring points should be examined continuously.

Temperature

It is also essential to understand that waste temperatures control the quality and quantity of LFG generated and are a factor in determining if an SSE is present. The NSPS requires each owner or operator to conduct enhanced monitoring and must include the results of all monitoring activities conducted during the period [§63.1961(a)(5) and (6)]. Enhanced monitoring is required at each well with a temperature greater than 145°F. Per §63.1958(c)(1) of the NSPS, once the landfill gas temperature measured at either the wellhead or at any point in the well is greater than or equal to 170°F and the carbon monoxide concentration measured is greater than or equal to 1,000 ppmv, the owner or operator must report the date, time, well identifier, temperature, and carbon monoxide reading via email to the Administrator within 24 hours.

Typically, I consider temperatures over 170°F an indicator of a heating event in MSW and not as confirmation of a fire. Around temperatures of 176°F, anaerobic biological decomposition ceases, and methane production drops significantly, approaching zero. Depending on site conditions and the time it takes to reach the upper threshold of 176°F, one should investigate the heating incident further. Figure 2 shows this trend at

the CCL.

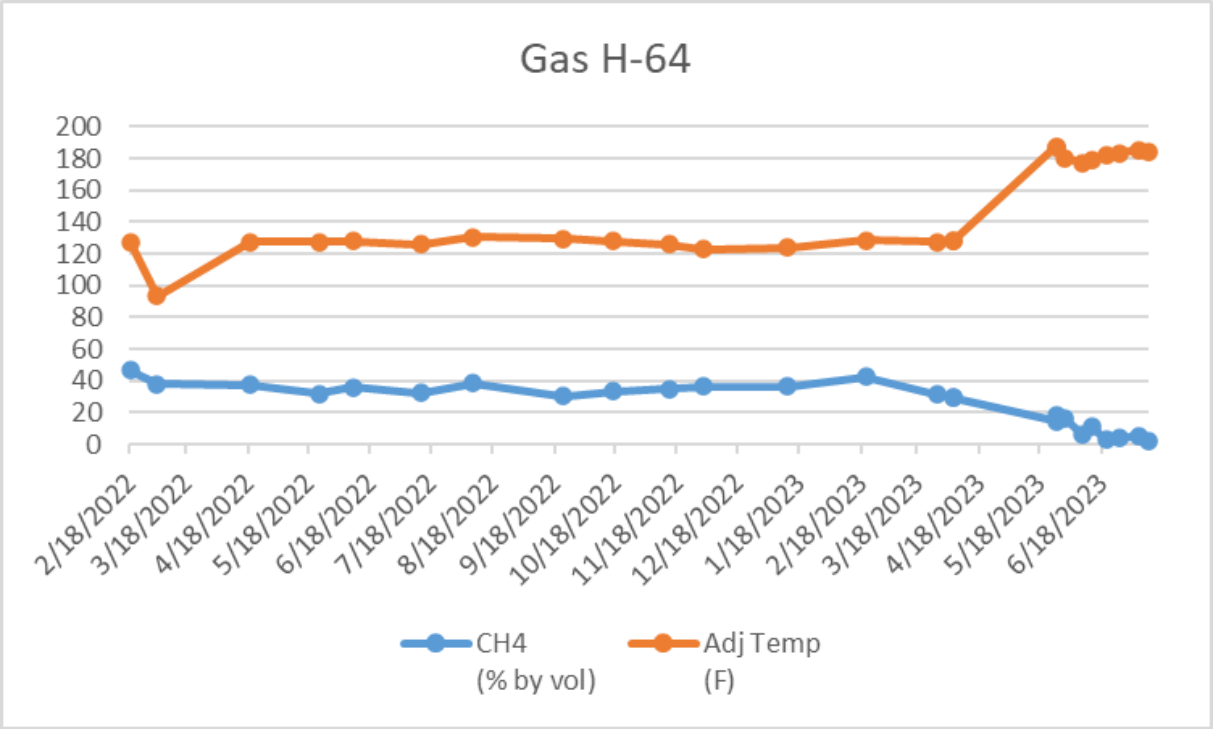

Figure 2. Gas Control Well H-64 – percent methane concentrations versus temperatures at Chiquita Canyon Landfill from February 2022 to July 2023.

If the temperature exceeds 200°F, significant damage can occur to the PVC well casings. PVC softens at 200°F and will begin to deform or become completely constricted as the temperature increases. The temperature at which PVC begins to degrade will vary depending on the specific grade and formulation used. Most video inspections can note if the well is damaged, pinched, collapsed, or blocked.

At 212°F, water and leachate will begin to boil. The transition from liquid to gas phase will cause an increase in volume (e.g., 1,700 times) and a resulting increase in pressure in the landfill. Additional leachate, gas, and odor have been observed in other landfills in the US when the temperature exceeds 212°F (e.g., Countywide Landfill in Ohio, Bridgeton Landfill in Missouri, Middle Point Landfill in Tennessee, and Bristol Landfill in Virginia).

Based on my experience, if temperatures exceed 350°F in an MSW and are reproducible, this temperature will confirm an SSE is occurring. Should landfill temperatures be below 350°F and above 212°F, then multiple parameters such as CO readings, physical evidence, or landfill gas ratios of CH4 to CO2 plots should be used to confirm SSE.

Volatile Organic Compounds (VOCs)

Smoldering combustion at waste facilities has also increased the concentration in some VOCs (e.g., benzene and methyl-ethyl ketone) one to two orders in magnitude. In general, gas concentrations of some VOCs emissions from Subtitle D landfills double with every 18°F temperature increase (ATSDR 2001). Benzene and methyl ethyl ketone are the two compounds that have consistently been found at elevated levels during landfill fire investigations. The presence of these compounds can be used to examine the likelihood of an SSE in conjunction with other parameters. According to the USEPA, benzene has also been shown to be the largest emission compound when household waste is burned.

Landfill Gas Control Systems Operation

All the smoldering events I evaluated have pre-indicators in the landfill gas control data. While the changes in the data might not initially be significant, cautionary trends can be observed when analysis is performed over a substantial period. The operator should closely monitor data for increasing oxygen and temperatures over time. The landfill operator should adjust their gas collection and control system both per the NSPS/Title V and their standard operating procedure when gas data indicates:

- Extraction system temperatures above 145°F;
- Excessive oxygen in gas collection wells greater than 5 percent; and/or
- Excessive nitrogen in gas collection wells greater than 20 percent.

The landfill operator should make additional adjustments to the landfill gas collection system and begin a heating/SSE evaluation when gas well data indicates the following trends:

- Extraction system temperatures exceeding 160°F;
- Upward temperature trend in gas collection wells greater than 5°F in less than one week;
- Dramatic downward trends in methane concentrations in less than one week;
- Methane concentrations dropping 20 percent within one month; and/or
- Excessive balance gas [e.g., primarily nitrogen (N2)] in the gas collection wells within one month.

The operator should take additional proactive steps when any of the following conditions occur:

- Extraction system temperatures exceeding 170°F;
- The melting, collapsing, or pinching of gas collection wells or leachate collection systems;
- Methane concentrations dropping below 30 percent in a short period;
- Orders of magnitude increases in benzene and/or methyl ethyl ketone

concentrations;
- Spike in nuisance odors;
- Change in gas composition;
- Increase in gas pressure and flow;
- Unusual rate of settlement; and/or
- Increase leachate volume and leachate outbreaks.

Findings

In this assessment, we examined parts of the old and new NSPS regulations to determine the efficiency and effectiveness of the gas collection system. Four key areas include landfill gas pressure, temperature, oxygen, and system integrity. The NSPS states that the owner shall operate the collection system with negative pressure at each wellhead except for (1) a fire or increased well temperature, (2) the use of a geomembrane or synthetic cover, and (3) a decommissioned well. New and old NSPS states that each interior wellhead in the collection system should operate with a temperature less than 131°F degrees (Subpart WWW and XXX) and 145°F (Subpart AAAA) with either a nitrogen level less than 20 percent or an oxygen level less than 5 percent (Subpart WWW only). I also examined SCAQMD Annual Rule 1150.1 Compliance Plan Reports and other CCL reports and data. To start the assessment, I sorted the CCL Well Data Excel file by the highest temperature to understand the current condition of the incident. I also reviewed other parts of the semi-annual reports to help determine if the heating/smoldering event is contracting, expanding, or holding constant over time.

Heating/Smoldering Event

From all the available information, the heating/smoldering event at CCL is occurring in MSW and not in reactive waste such as aluminum dross, incinerator ash, metal oxides, or other non-MSW that would cause a chemical reaction. The data reviewed did not reveal any documented slope instability that would cause gas wells to be blocked, damaged, plugged, or pinched. As of July 21, 2023, the Reaction Settlement Area is experiencing increasing temperature and CO levels and is expanding in size. The highest temperatures in the gas well field were recorded in July 2023. A trend analysis of the reported CO sampling results showed CO is increasing in nine wells, remaining stable in three wells, and decreasing in five wells. Figures 3, 4, and 5 show the CO concentration trend analysis in three monitoring wells required to undergo enhanced monitoring per the NSPS.

The heating/smoldering event appears to spread to gas wells CV-2003 and TC2382E. Well H-1561C was previously impacted but is showing a decrease in temperature over time. Also, wells H-1803N and CV-55R appear affected by elevated temperatures and CO readings. Well TC-2385A is new and not shown on the Reaction Settlement Area map, but it is also experiencing high temperatures.

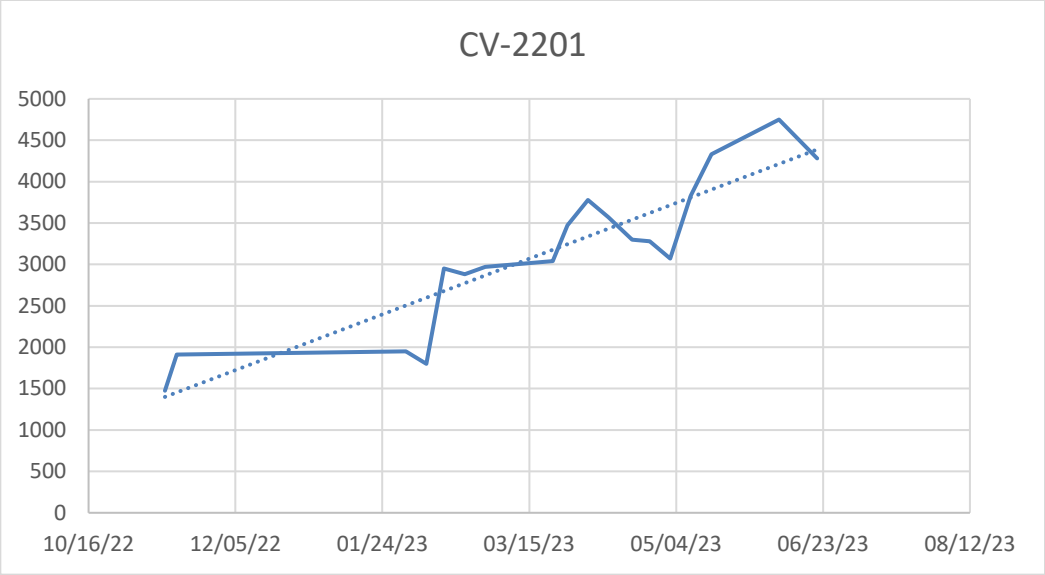

Figure 3. Enhanced Monitoring for Well CV-2201 with a positive CO trendline at the Chiquita Canyon Landfill.

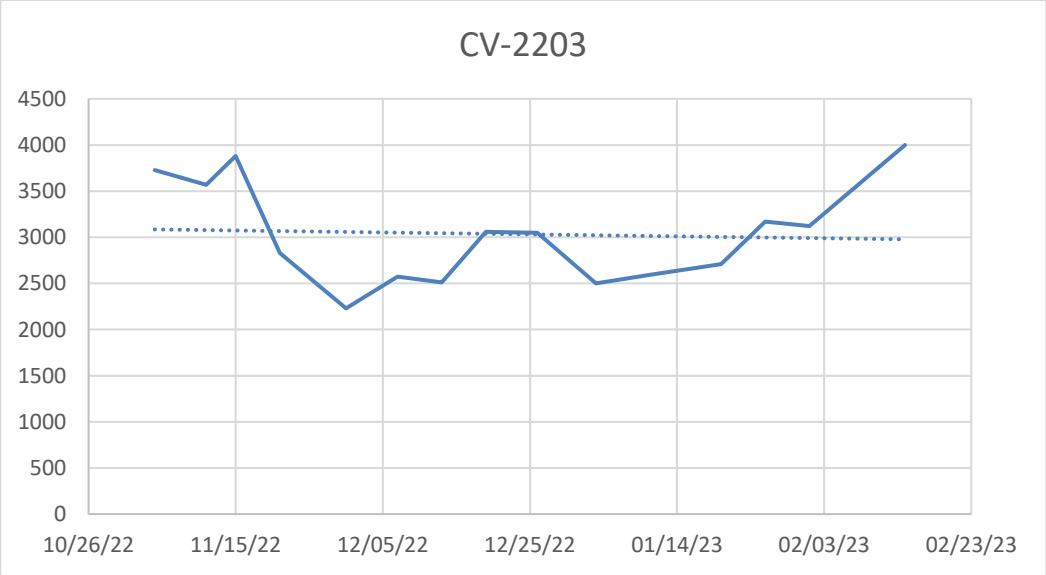

Figure 4. Enhanced Monitoring for Well CV-2203 with a neutral CO trendline at the Chiquita Canyon Landfill.

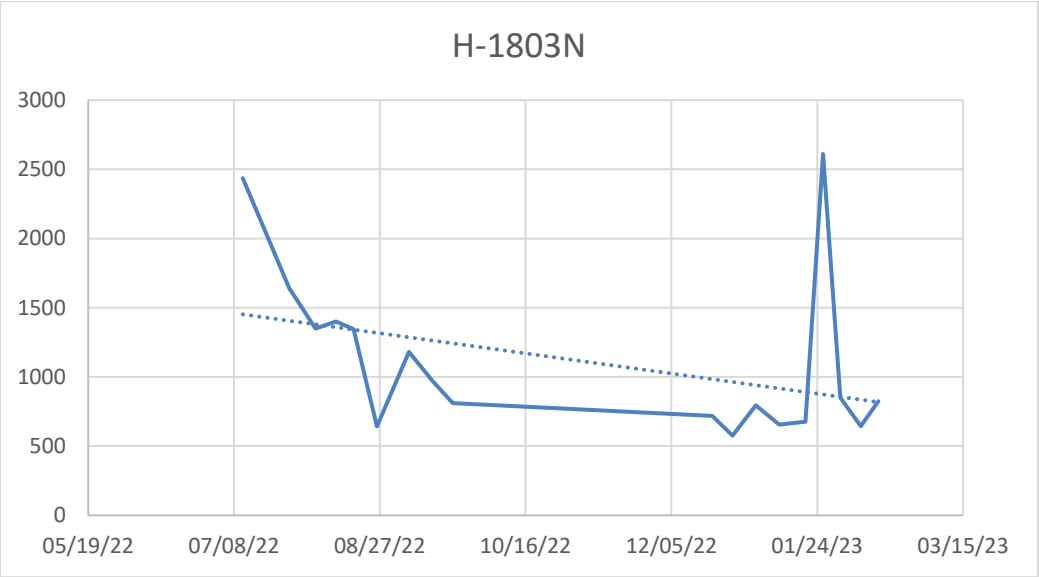

Figure 5. Enhanced monitoring for Well H1803 with a negative CO trendline at the Chiquita Canyon Landfill.

Point of Origin

Based on the available LFG data from February 1, 2022, to July 31, 2023, the pre-combustion/SSE incident may have started at gas control well CV-109-55 and spread to CV-1419 and then CV-1418. However, using the SCAQMD Annual Rule 1150.1 Compliance Plan Reports from 2016, 2017, 2019, 2020, 2021, and 2022, the CCL temporarily decommissioned or decommissioned several wells due to the concern for a potential subsurface oxidation. In 2017, only one well was decommissioned due to the pinched casing and high oxygen levels. No data was available for 2018, but in 2019, 31 wells were temporarily decommissioned or abandoned due to high oxygen levels and the concern for potential subsurface oxidation. In 2020, 69 wells were temporarily decommissioned or decommissioned due to high oxygen levels or poor gas generation and the concern for potential subsurface oxidation. In 2021, the number of wells temporarily decommissioned or decommissioned was 83; in 2022, it was 34. Also, in 2022, two unique events were noted in Appendix B of the report labeled "Flare Station Periods Offline for More Than One Hour." Two offline events occurred on April 6, 2022, and April 26, 2022, noting that the combustion air blower in FL-100 accumulated too much dirt and debris, causing a highly restricted airflow, resulting in FL-100 shut down due to low combustion airflow. Further information and photos should be collected on these two events to ensure this was not soot or particles resulting from a smoldering event.

Additional field gas data from January 2019 to January 2022 will be necessary to trace this incident further or to determine if multiple incidences have occurred. Table 1 provides the temperature data where the most significant temperature change occurred in February 2022.

Table 1. Possible location of initial pre-combustion/SSE incident location at Chiquita Canyon Landfill, 2022.

Well	Date/Temp	Date/Temp	Change in Temperature
CV-109-55	2/1 - 164°F	2/23 - 169°F	5°F
CV-1419	2/17 - 151°F	2/23 - 186°F	35°F
CV-1418	2/23 @ 10:51 am 101°F	2/23 @11:06 am 140°F	39°F

Temperatures

While one of the highest reported gas well temperatures occurred on July 18, 2023, in CV-1418 at 197°F, the SCAQMD reported the highest temperature to date was 201°F on September 26, 2023, at well CV-2393.

While gas wellhead temperatures can be a reliable data point, temperatures in the well can be up to 100 ºF lower than those measured deeper. Gas wellhead temperature can be diluted given the depth of the screen and volume of gas being extracted. For example, a gas well in Hawaii reported a temperature at the wellhead to be 128°F. However, the measured temperature at 80 feet below ground surface was 233°F. This 105°F swing in gas wellhead temperature can indicate other reactions are occurring.

Per NSPS §63.1958(c)(1) requirements, the CCL reported seventeen wells that were over 170°F or had CO measurements over 1,000 ppmv in the first semi-annual report of 2023. This regulation requires the operator to collect CO samples in the gas well and collect a temperature profile in the well. Several gas wells had higher temperatures in the well than at the wellhead. At CV-2201, the wellhead temperature was recorded at 135°F while the down well was 187°F. The 52°F temperature difference is a significant result. Temperature and carbon monoxide must be applied when determining which wells to perform a down well temperature survey every 10 feet. Two CCL wells were below the enhanced monitoring requirement temperature of 145°F at the wellhead but over the 170°F threshold in the down well temperatures. Table 2 provides the results of the wellhead temperature vs. actual below-ground temperatures at the CCL for July 2023.

Table 2. Enhanced monitoring down well temperatures (F) at Chiquita Canyon Landfill, July 2023 (Source: 2023 First Semi-Annual NSPS and NESHAP Report).

Enhanced Monitoring Down Well Temperatures (°F)				
Well	Wellhead Temp (°F)	Highest Temp (°F) in Well @ Depth		Comments from 2023 First Semi-Annual NSPS and NESHAP Report
CV-55R	148	166		Damage well casing at 20ft.
CV-1418	Not Collected			Tape got stuck and destroyed at 130ft. Total depth possibly not accurate.
CV-1419	Not Collected			4 meters suspect well is plugged/pinched.
CV-1532	153	153		Possible well casing damage. Unable to proceed past 20ft.
CV-1902D	141.5	**188***		(*Note: temp difference of 46.5°F)
CV-2003	154	179		
CV-2004	166	175		
CV-2201	135	**187***		(*Note: temp difference of 52°F)
CV-2202	Not Collected			Unable to monitor down well temp with sounder due to safety.
CV-2204	Not Collected			Unable to monitor down well temp with sounder due to safety.
H-1561C	146	153		Well likely damaged at 16ft. Casing leaning over.
H-1561N	168	180		Likely casing damage at 10ft.
H-1774A	173	172		
H-64	183	177		
H-67	173	158		
TC-2381W	129	128		New trench collector on West slope.
TC-2382E	173	172		New trench collector on West slope.

The number of temperatures exceeding 170°F in the gas wells may also pose a risk to the liner system at the CCL. Assessing temperature impacts on the service life of geomembrane (GM) liners can be a critical pathway for heating incidents if temperatures are observed in the leachate collection system above 130°F. Temperature plays the most crucial role in GMs' physical and chemical properties.

Carbon Monoxide

During the 2023 first semi-annual NSPS report, the CCL collected 224 CO samples from the LFG wells per the enhanced monitoring requirement provision of the revised NSPS. The results indicate that 154 out of 224 (or 68 percent) of the samples exceed 1,500 ppmv. The highest CO readings were at well CV-1419 (6,550 ppmv CO) and well CV-1902D (6,240 ppmv CO). In comparison, only one well was required to have enhanced monitoring in the first semi-annual report of 2022.

Using the previously discussed criteria, a map of the heating/smoldering event as of

July 2023 is shown in Figure 6. Wells with CO above 1,500 ppm (indicated by a green circle) and temperatures over 170°F (indicated by a blue circle) were plotted on the CCL's Reaction Settlement Area Map. Circles that share a boundary indicate the well has high CO and temperature.

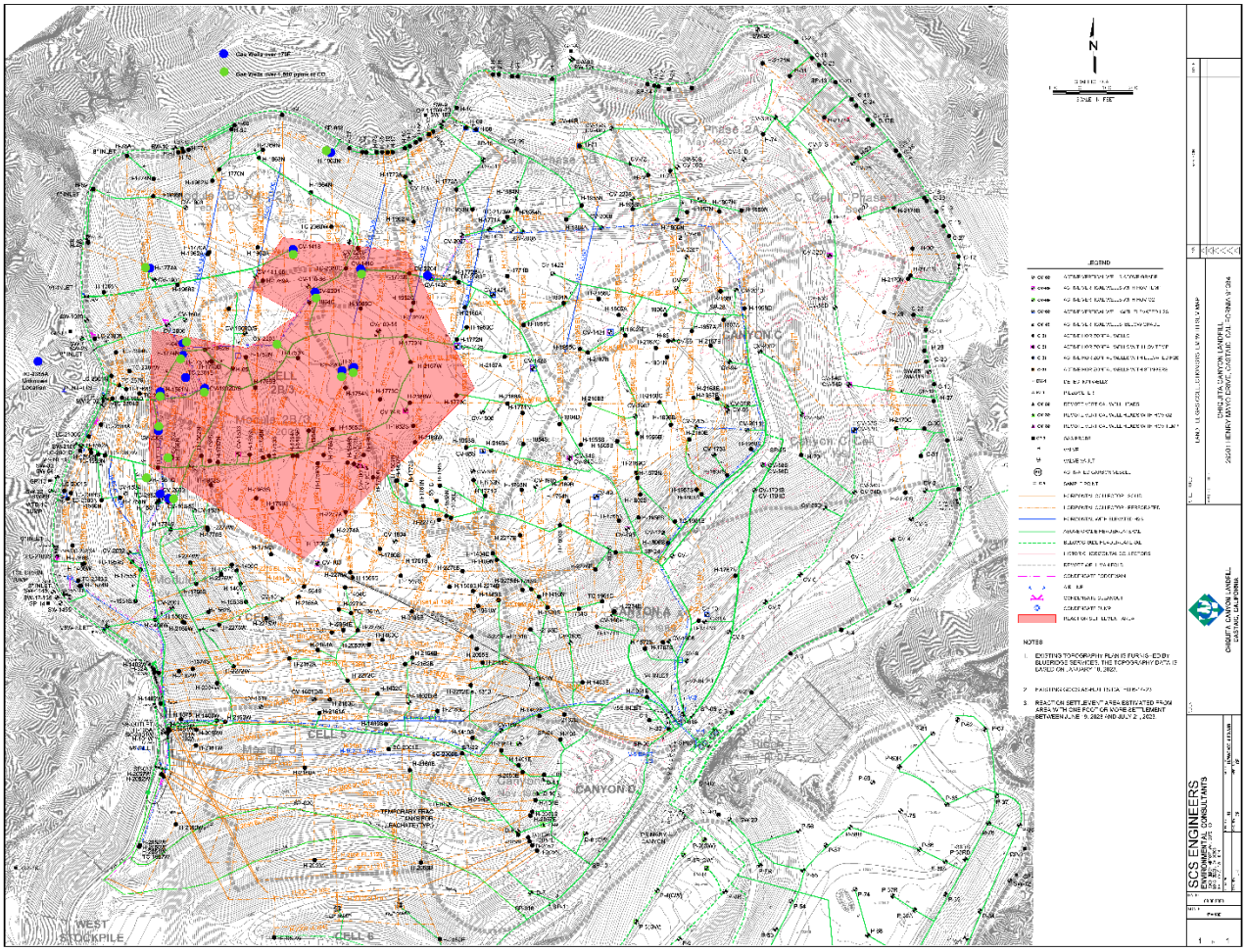

Figure 6. Gas Wellheads exceeding temperatures over 170°F and CO over 1,500 ppmv at the Chiquita Canyon Landfill, July 2023.

Landfill Gas Well Performance

While comparing landfill gas system performance from 2022 to the first half of 2023 is challenging, the Chiquita Canyon Landfill Well Data from February 2022 to July 2023 Excel file was used to develop a ratio of gas well data per day. The most significant result was that the number of positive pressure wells (initial static pressure) per day in 2023 doubled compared to 2022. If an extraction well has positive pressure, then gasses and odor are more likely to be released from the landfill in that area. To examine past performance, I picked six months in 2016 from the semi-annual report and found only one reported positive pressure event. Based on the odors and landfill gas performance data, the landfill gas control system is not effectively controlling LFG

emissions in areas where positive pressure is measured in wells. Additionally, the CCL landfill operations continue to overdraw oxygen above five percent, increasing the risk of an SSE. Table 3 summarizes the gas well performance for the amount of oxygen in each well, the number of wells with zero flow, and the number of wells with positive initial static pressure above 0.1 inches of water.

Table 3. Gas well performance at Chiquita Canyon Landfill, 2016, 2022, and 2023.

Gas Well Performance at CCL					
Gas Well Data	**2022 Data**	**# per day**	**2023 Data**	**# per day**	**2016 Data**
Wells with 0% Oxygen	4520	13.65	3175	17.63	
Oxygen from 0.1 to 5.0%	1630	4.92	4189	23.27	
Oxygen from 5.1 to 10.0%	218	0.65	111	0.61	Jan to
Oxygen from 10.1 to 15.0%	152	0.45	95	0.52	June
Oxygen from 15.1 to 20.0%	212	0.64	100	0.55	2016
Oxygen from 20.1 to 22.2%	66	0.19	80	0.44	
0.0 Initial Flow (scfm)	2225	6.72	1493	8.29	
Positive Initial Pressure > 0.1 in H2O	252	0.76	287	1.59	1
Number of Monitoring Days	331		180		181

Odors

The odors at the CCL are from a heating/smoldering incident in the waste. The doubling of positive wells from 2022 to 2023 is a concern and shows the gas collection system is not correctly capturing the gas and odors. Some temperatures in the reaction zone of the landfill are most likely above 200°F, causing additional gas pressure and damage to the gas extraction wells.

Data Discrepancies

The well data covered a period from February 1, 2022, to July 31, 2023. Data for some wells appeared missing for several reporting periods; however, all these discrepancies were explained in the semi-annual reports. These wells were either decommissioned due to filling operations, abandoned, or not placed in service. The well data file did have other discrepancies. There were 100 lines in the spreadsheet that had date and time field entries but no landfill gas data. Table 4 provides an example of the data discrepancies.

Table 4. An example of data discrepancies in the Chiquita Canyon Landfill Well Data Excel file where the gas data is missing, but data and time are logged.

CV-2203	12/13/2022 09:07	1.00	84.30	0.00	14.70	151.20	151.20	-18.89	-18.89	68.40	67.00	-26.14	Comments:No Adjustments Made,High Temp,Barely Open,Surging Liquid in Well (Watered In),,,,
CV-2203	12/13/2022 09:11												
CV-2203	12/13/2022 09:11												6.1% H2
CV-2203	12/19/2022 10:01												6.4% H2
CV-2203	12/19/2022 10:04	1.30	85.10	0.00	13.60	151.50	151.40	-22.80	-22.13	65.80	68.20	-25.17	Comments:NSPS/EG CAI,High Temp,Decreased Flow/Vacuum,Surging Liquid in Well (Watered In),,,,
CV-2203	12/19/2022 10:26												
CV-2203	12/21/2022 10:10	1.10	85.90	0.00	13.00	149.90	149.90	-16.56	-17.31	45.00	41.80	-19.13	Comments:NSPS/EG CAI,High Temp,Increased Flow/Vacuum,Surging Liquid in Header,,,,

Conclusion and Recommendations

Based on my professional experience, education, training, site documentation, available CCL reports, and personal knowledge of solid waste engineering with smoldering and heating events, I have determined with a reasonable degree of professional and scientific certainty that the CCL has sustained the following conditions during the past eighteen months:

- Cover integrity issues;
- Increased temperatures and pressures in the landfill gas control systems and waste mass;
- Oxygen intrusion above 5 percent by volume;
- Landfill gas temperatures over 170°F;
- Landfill subsurface temperatures over 195°F;
- Decreased methane production;
- Elevated carbon monoxide concentrations above 1000 ppmv;
- Unusually landfill settlement;
- Damage gas wells; and
- Poor gas well performance in and around the Reaction Settlement Area; and
- The heating/smoldering event is expanding in size and intensity.

These conditions at the CCL are causing additional gas pressure, odors, elevated leachate temperatures, and damage to the gas extraction system. The landfill gas generated in and around the reaction settlement area has exceeded the designed gas generation flow rate and caused increased emissions and odors. Since there are short-term and long-term environmental control issues, CalRecycle recommends working with SCAQMD and the RWQCB to address the gas control, emission, odors, and leachate issues.

To reduce the odors and better define the reaction, the CCL may want to consider the following actions:

1. Repair cracks in the soil cover within 48 hours in and around the Reaction Settlement Area and any well showing signs of a reaction;
2. Place and compact a minimum cover of 24 inches of 1 $x10^{-6}$ low permeability soil in and around the Reaction Settlement Area and a radius of 30 feet of soil around any well with temperatures over 160ºF or CO concentrations over 1,500 ppmv;
3. Install well boots seals on all wells in and adjacent to the Reaction Settlement Area and any wells with temperatures over 160ºF or CO concentrations over 1,500 ppmv;
4. Replace all PVC wells that have been damaged, blocked, pinched, or that have gas temperatures over 145°F with steel wells;
5. Install additional steel wells in the Reaction Settlement Area and other areas where the gas extraction temperature exceeds 170°F to capture the additional gas generated by the incident;
6. Once additional gas extraction capacity is installed, remove all oxygen HOVs for interior gas wells and operate gas extraction wells with less than 3 percent oxygen where feasible. Use best management practices to keep oxygen below 5 percent in an interior well;
7. Measure the leachate temperate at the liner level and all sumps;
8. Sample the leachate for benzene and other volatile organic compounds. Past incidents similar to Chiquita Canyon in Bridgeton and Bristol have shown that heating event increases the levels of VOCs in the leachate;
9. Install temperature monitoring devices in and around the Reaction Settlement Area and other areas where gas temperatures exceed 170°F or CO over 1000 ppm. These devices should be installed within 25 ft of a vertical LFG extraction well. These temperature devices should be able to sustain temperatures up to 750°F and be installed in boreholes up to 150 feet deep. The temperature devices should be spaced at 20-foot intervals and based on previous designs from SCS Engineering projects in Bridgton, San Diego, and Bristol. Since the temperature profiles were not successfully collected at the required enhanced gas wells C-55R, CV-1418, CV-1419, CV-1532, CV-2202, CV-2204, H-1561C, H-1561N, below-ground temperature devices should be first installed at these wells;
10. The landfill owner should review available internal manifests or other documents as far back as possible to ensure no reactive material was accepted at this landfill;
11. The landfill owner should hire an odor expert to determine which chemicals are causing the odor. A past expert at Bridgeton Landfill in Missouri identified a set of chemicals causing the greatest odor. Once the chemicals are identified, additional toxicological assessment can be performed;
12. Design and install a temporary geomembrane cover over the Reaction Settlement Area and other areas where gas temperatures have exceeded 170°F or CO over 1000 ppm once additional gas extraction capacity is operational;
13. Consider installing remote telemetry technology to continuously collect and analyze landfill gas data at the collection wells. The real-time data and control platform can instantaneously measure and report wellhead temperatures, pressures, O2, CO, and methane concentrations. Remote access to the real-time data should be provided to regulatory agencies;
14. Consider utilizing a drone or land rover equipment with GPS, methane, and gas

sensors to conduct daily instantaneous surface monitoring and provide real-time data throughout the Reaction Settlement Area and adjacent areas of concern. This technology can facilitate immediate operational changes, including flagging hot spots, surface cracks, and fissures.

15. To better understand and communicate to the community if the heating/smoldering event is expanding or increasing in intensity, the CCL should submit monthly figures and data showing the reaction area, CO level, and temperature data.

Please do not hesitate to contact me by telephone at (916) 341-6356 or by email at Todd.Thalhamer@Calrecycle.ca.gov if you have comments or questions.

Sincerely,

Todd Thalhamer, P.E.
Senior Waste Management Engineer
CalRecycle

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