BUNCOMBE COUNTY
BIOREACTOR PROJECT
USEPA PROJECT XL

YEAR END 2020 PROGRESS REPORT

Buncombe County
Solid Waste Management Facility
81 Panther Branch Road
Alexander, North Carolina 28701

SCS ENGINEERS, PC

SCS Project No. 02219304.01 | March 1, 2021

3801 Lake Boone Trail, Suite 430
Raleigh, North Carolina 27607
(919) 662-3015

Table of Contents

Table of Contents

Section Page

Figures

Table of Contents

Section Page

Tables

EXECUTIVE SUMMARY

PROGRESS REPORT UPDATES

The 2020 Year End Bioreactor Progress Report will provide updates to previous reports and project milestones. The Buncombe Bioreactor Project XL made significant improvements during 2020. A major project milestone was reached with the installation of the Phase II Horizontal Injection Trenches (HITs) leachate injection lines into the active MSW landfill Cell 6 area. These new HITs will increase recirculation capacity, allowing significant reduction in leachate tanker truck haul trips to the wastewater treatment plant (WWTP); reducing the carbon footprint and greenhouse gas emissions from the landfill facility. Updated drawings are included in Section 2.

Temperature readings installed with the Phase I HITs will no longer be taken as discussed in the 2020 Mid-Year Progress Report.

Due to the side slope filling operations, the settlement plates will not be used to monitor settlement and the County will use topographic surveys.

Also in 2020, the County abandoned the surficial gravity trenches (SGTs). Leachate recirculation in these features began in 2006 and thusly, after over a decade, they have reached their service life.

BACKGROUND

The Buncombe County Solid Waste Management Facility is located in the mountains of western North Carolina, approximately 9 miles north of the City of Asheville. The 557-acre solid waste management facility opened in 1997 with a Subtitle D landfill that comprises approximately 100 acres. Under the United States Environmental Protection Agency's (EPA) Project XL, Buncombe County (County) is operating a combined leachate recirculation and landfill gas (LFG) recovery system at its Subtitle D landfill.

The purpose of the project is to determine if liquids addition has any adverse effects on alternative liner systems. The County is also monitoring the effects of liquids addition on waste density and settlement to determine if an increase in landfill life and LFG generation for energy production is being realized.

This project differs from other Project XL projects in that it is a full-scale project that is being operated over an extended period of time. This project was granted regulatory flexibility to apply water sources other than leachate to the waste and to apply water sources to the waste in landfill cells with alternative liners. To date, only leachate has been used since there has been adequate leachate available on-site to meet the needs of the project. Although application at the working face is allowed, it has not been employed in the bioreactor operation; and there are no plans for future application. Additional water sources may be required after the build-as-you-go system is in full operation due to the additional leachate capacity.

The intent of the Project XL program is to demonstrate that operating a bioreactor landfill with an alternative liner system can function equal to the basic EPA liner system required under Subtitle D.

CELLS 1-6 SLOPE CHANGES

The County received approval to steepen the slopes from 4 to 1 (horizontal to vertical) to 3 to 1 in Cells 1 through 6 and all future cells. Filling on sideslopes began in September 2017, and this has allowed airspace to be recaptured due to settlement from bioreactor operations. During the filling process, recirculation has been suspended.

BIOREACTOR PROGRAM BENEFITS

Leachate Recirculation

Approximately 6.85 million gallons of leachate has been recirculated since the program began, resulting in 1,370 less truck trips to the WWTP. That has provided a savings of over $520,000 in avoided hauling costs as shown in **Figure ES-1**. In addition, the reduction of truck trips has reduced the County's carbon footprint. With continued leachate recirculation system expansions, the amount of recirculated leachate that can be significantly increased.

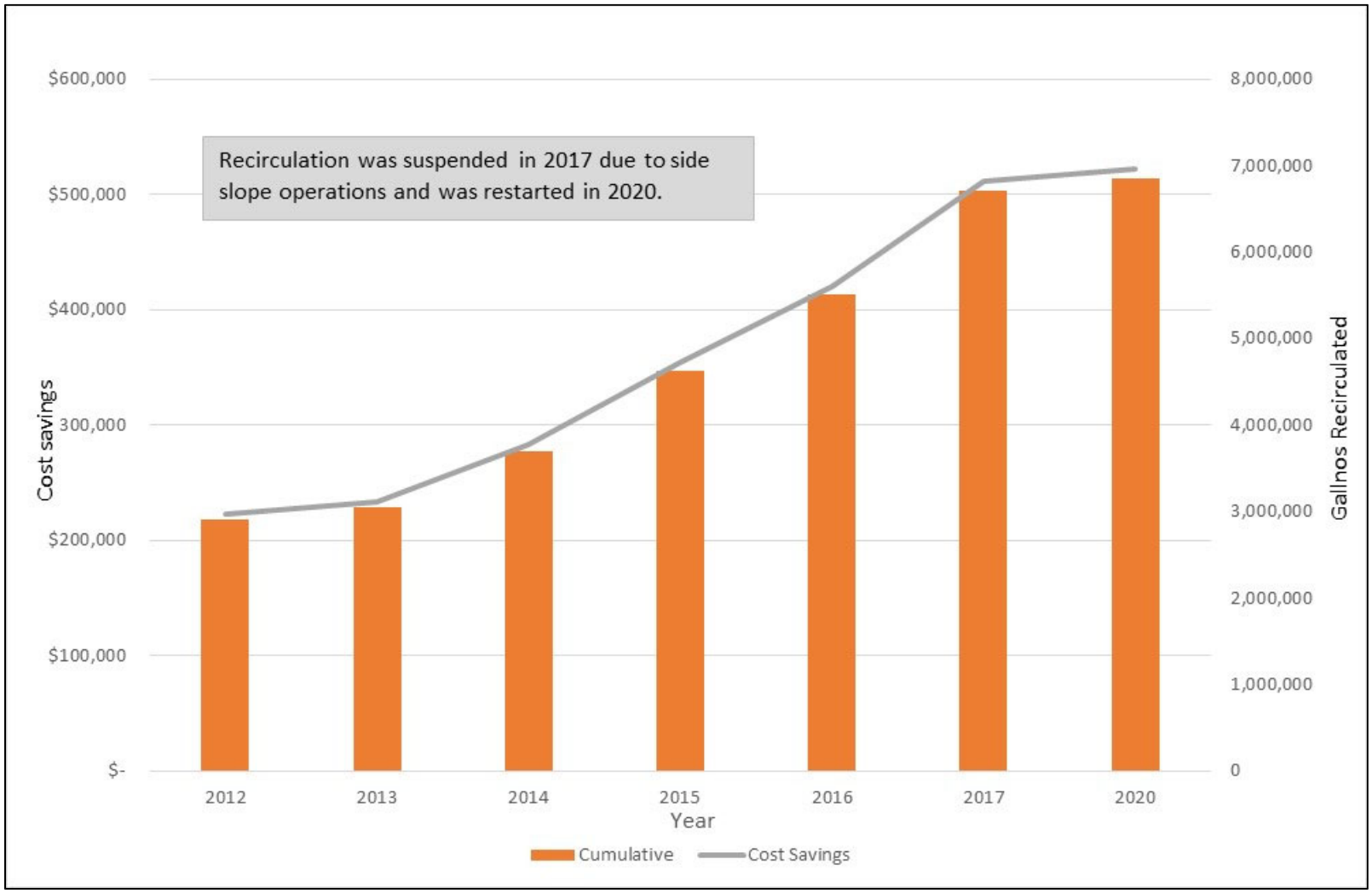

Figure ES-1: Cost Savings by Recirculation

Landfill Settlement

One of the goals outlined in the Project XL agreement is increasing settlement through leachate recirculation. Recirculating leachate increases microbial activity in the waste mass, which in turn increases the decomposition rate. The faster the waste decomposes, the quicker the landfill settles and additional airspace can be gained for future disposal needs.

The topographic survey comparison for Cells 1 through 5 were updated from 2010 to December 2020 as shown in **Figure ES-2**. The majority of the settled areas have been filled during side slope operations. Settled areas are present on the south slope of the landfill. The approximate settlement is 23,900 cubic yards.

For comparison, **Figure ES-3** presents settlement of Cells 1 through 5 taken in 2010 and 2016. This figure illustrates the settlement prior to recapturing those areas with the side slope filling operations.

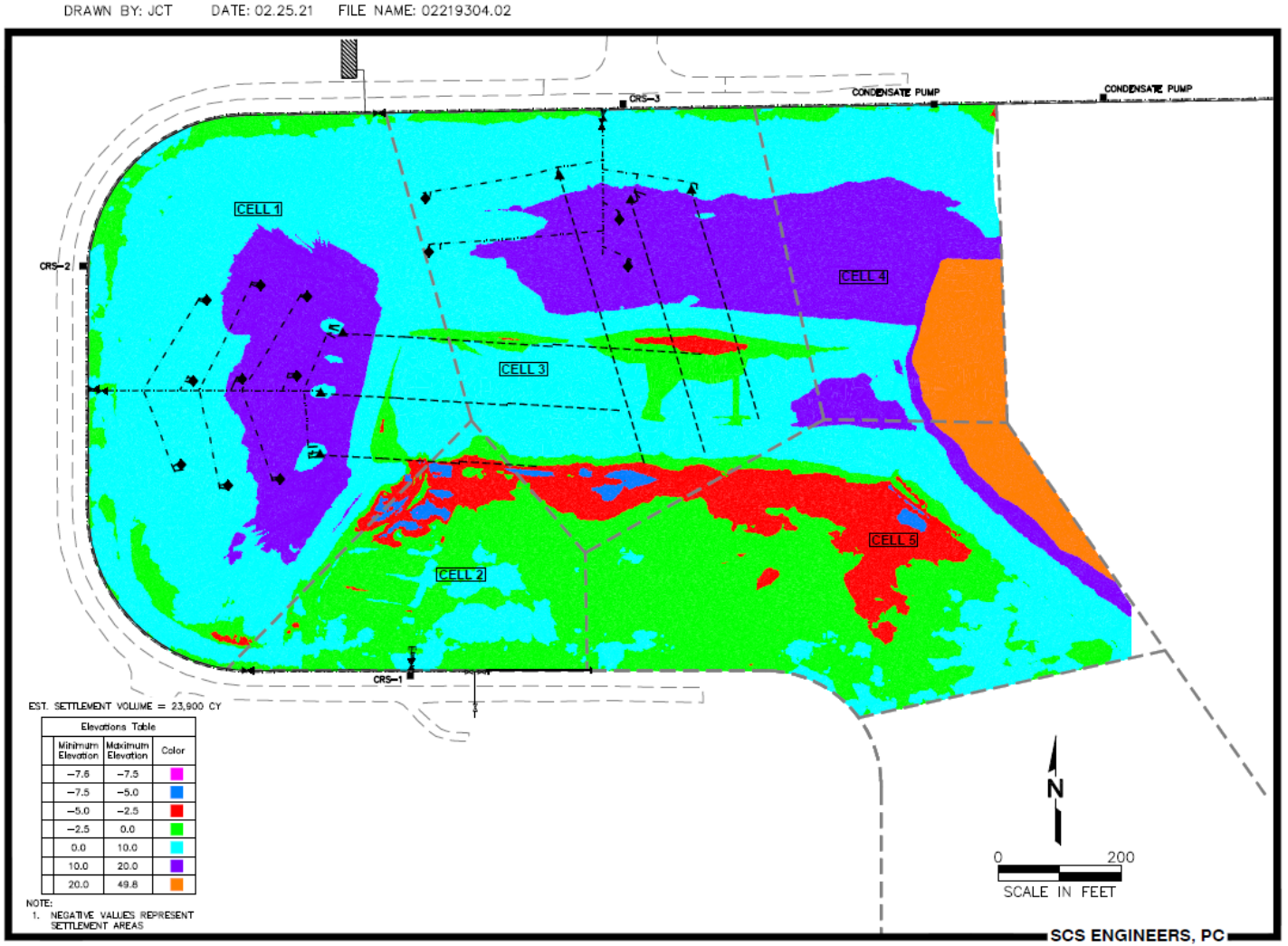

Figure ES-2: Settlement in Cells 1 through 5 (2010 to 2020)

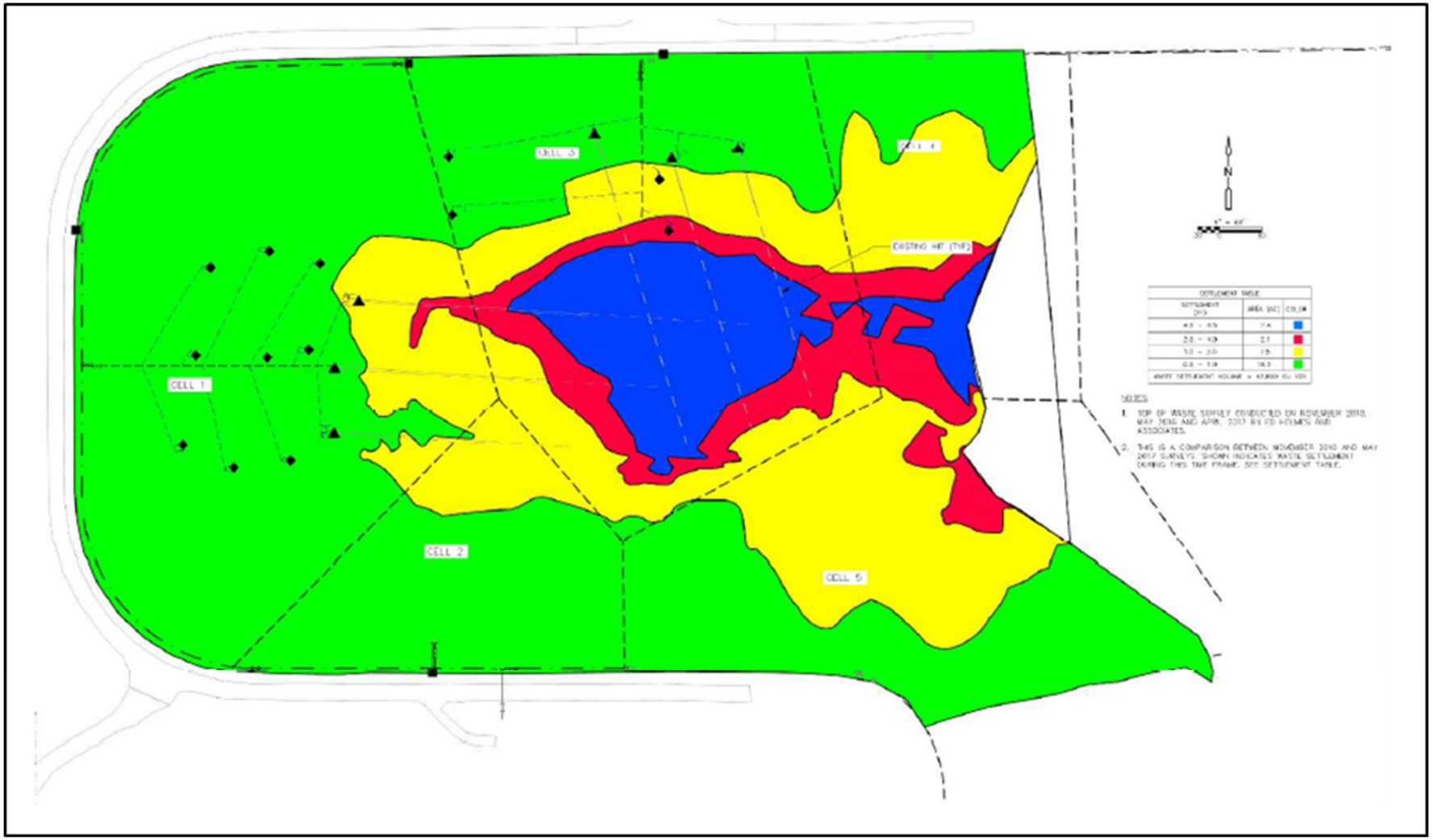

Figure ES-3: Settlement in Cells 1 through 5 (2010 to 2016)

Renewable Energy

Bioreactor operation accelerates landfill gas generation and can increase renewable energy production. The renewable energy equivalent to the quantity of houses' electricity usage is shown in Table ES-1.

Table ES-1: Renewable Energy Generated Converted to Equivalent Houses

Year	Annual Energy Generated by LFGTE (Mega-Watt Hours)	Households With Similar Energy Consumption[1]
2011	498	38
2012	8,937	676
2013	9,379	710
2014	8,953	678
2015	9,874	747
2016	7,915	599
2017	9,744	738
2018	8,740	661
2019	8,187	620
2020	7,302	553

[1]Calculated using U.S. Energy Information Administrated under the State of North Carolina residential energy data.

OPERATION OF CELL 6 HORIZONTAL INJECTION TRENCHES

At the beginning of the program, the HIT design used the same pipe to inject leachate and collect LFG. As the program progressed, separate, dedicated pipes were used to maximize LFG recovery. This approach is applied in the active Cell 6 disposal area. HITs 6A, 6D, and 6E have been observed to produce a high percentage of methane and steady LFG flow rate.

Based on operational experience, economic evaluation, and LFG collection capabilities, the County has elected to dedicate new HITs to leachate recirculation for future installations. One of the lessons learned through operations is that HITs tend to water-in thus reducing their effectiveness to collect LFG.

System HIT Designs

The two different HIT designs that the County has incorporated are retrofit and build-as-you-go approaches.

The most recent addition to the build-as-you-go HIT system occurred in early 2020 when three of the Phase II HITs were installed at Elevation 2100 NGVD. HITs 6F, 6G, and 6H range in length from 400 to 500 feet and will be for leachate injection only. Commencement of operations is to be determined and may not occur until sufficient waste mass has been placed above the lines.

The retrofit HIT system was installed into the Cells 1 through 5 waste mound after the cells were filled to capacity. The retrofit system includes shallow, wetting/gas collection trenches that have been in operation since April 2007.

The build-as-you-go system includes infrastructure installed in phases as the waste is being placed. This provides better wetting of the waste, earlier capture of landfill gas, and increased gas generation for energy production. The first stage (Phase I) of the build-as-you-go system was installed in Cell 6 at Elevation 2060 National Geodetic Vertical Datum (NGVD) in July 2012, and began operation in June 2014 after the trenches were completely covered by a 10-foot minimum layer of waste.

Phase I included installing five HITs identified as HITs 6A, 6B, 6C, 6D, and 6E and ranging in length from 700 to 950 feet. Six temperature sensors were installed in strategic locations between the trenches to monitor the extent of wetting and the impact of cold weather wetting on the biological processes. In 2020, the temperature sensors were abandoned due to faulty readings and service life.

LINER SYSTEM MONITORING AND PERFORMANCE

In order to ensure the performance of the landfill liner system, leak detection quality and quantity is monitored semi-annually.

It was determined through leak detection data that the cells with alternative liner systems are functioning at a proportional level to those cells with Subtitle D liner systems. In addition, according to *"Geomembrane Liner Action Leakage Rates: What is Practical and What is Not,"* the industry standard is 20 gallons/acre/day, a value that all cells have been compared to. Table ES-2 below shows that Cells 1 through 6 are performing better than the industry standard.

Table ES-2: Cells 1 through 6 Leakage Rate Comparison

Cell	Area (acres)	Average Annual Leakage 2007 – 2020 (gal/acre/day)	Max Annual Leakage 2007 – 2020 (gal/acre/year)	Industry Standard (gal/acre/year)	Liner Type
1	9.7	0	0	20	Subtitle D
2	3.1	0.1	0.6	20	Subtitle D
3	8.2	0.4	3.3	20	Alternative
4	4.1	0	0	20	Alternative
5	7.1	1.2	8.7	20	Alternative
6	22.7	0.6	4.3	20	Alternative

While liquids have been observed in the leak detection zones (LDZ) in nearly all of the landfill cells, testing of the liquids indicate it is groundwater. For Cells 7 through 10, it is recommended that the design of the LDZ be revised to eliminate the 3-foot separation between the LDZ and the bottom of the base liner system, as this will greatly reduce the potential for groundwater infiltration.

Leachate sump levels are monitored and recorded during recirculation events to ensure sump levels do not increase as a result of recirculation. A datalogger was installed in Cell 6 several years ago to continuously monitor sump levels before, during, and after recirculation events. The datalogger has been operational as of April 2019.

STAKEHOLDER MEETINGS

Stakeholder meetings are held at the discretion of the County to discuss project status and potential issues. Coordinating a multi-faceted stakeholder meeting take considerable time, resources, and commitment; therefore, meetings typically occur as needed.

The project stakeholders generally include Buncombe County, NCDEQ, USEPA, WNCRAQA, the Engineer of Record and the University of Florida.

The first stakeholder meeting was held in September 2012 and established new criteria for determining liner performance. Leachate levels in the sump of Cell 6 are being recorded in 1-minute intervals to see if head on the liner ever increases more rapidly during periods of leachate recirculation. Rapid increases in leachate levels in the sump would indicate abnormal head build-up on the liner system, which could lead to higher rates of leakage. Results, to date, show no impact on head on the liner due to the recirculation of leachate.

The last stakeholder meeting was held in November 2016. This meeting reviewed the operational results of the bioreactor system demonstrating that the recirculation has helped re-capture airspace and has had no impact on the pumping or liner systems.

At the time of this progress report, a stakeholder meeting has not been scheduled or planned.

This text report provides an update of the Buncombe County Bioreactor Program. To view this report and historical reports, please visit the project website at: https://bioreactor.buncombecounty.org/.

1 INTRODUCTION

The Buncombe County Solid Waste Management Facility is a host site for a research project being conducted under the USEPA Project XL Program. The purpose of this Year End Progress Report is to present the data collected during 2020. This report was prepared by:

- Kristy Smith – Buncombe County Bioreactor Manager
- Kenton Yang, PE – SCS Engineers, PC

1.1 SITE DESCRIPTION

The Buncombe County Solid Waste Management Facility is located in the mountains of western North Carolina, approximately 9 miles north of the City of Asheville. The 557-acre solid waste management facility (refer to **Figure 1-1**) opened in 1997 and comprises of a Subtitle D landfill, construction and demolition (C&D) landfill, wood waste mulching facility, convenience center for residential drop-off, a household hazardous waste (HHW) facility, and a white goods and tires holding facility.

Cells 1 through 10 of the Subtitle D landfill are being constructed progressively over the approximated 30-year life of the facility. The County has developed Cells 1 through 6. The base liner system for Cells 1 and 2 included the following (from bottom to top):

- 24-inch soil barrier layer with a maximum hydraulic conductivity of $1x10^{-7}$ cm/sec
- 60-mil high density polyethylene (HDPE) liner, and
- 24-inch rock drainage layer.

Cells 3 through 6 were constructed with the following base liner system (from bottom to top):

- 18-inch soil barrier layer with a maximum hydraulic conductivity of $1x10^{-5}$ cm/sec
- Geosynthetic clay liner (GCL)
- 60-mil HDPE liner, and
- 24-inch rock drainage layer.

Leachate leak detection systems were installed below the base liner systems. Current disposal operations are either on the sideslopes of Cells 1 through 5 or within the Cell 6 limits.

Figure 1-1: Buncombe County Solid Waste Management Facility

1.2 PROJECT GOALS

Subtitle D of the Resource Conservation and Recovery Act (RCRA) provides technical guidelines, which require that MSW landfills be designed with impermeable base liners and caps. The design guidelines for Subtitle D landfills have been successful in limiting potential groundwater contamination; however, the approach creates a dry entombment of waste. This slows the process of waste degradation to stabilization, but it remains the most common landfill type being operated since the regulations were instituted. Some concern has been raised regarding the long-term containment of undecomposed waste and the potential for leachate releases after the post-closure monitoring period ends (typically 30 years) in the event the liner systems fail.

One approach to addressing this concern is to operate MSW landfills as bioreactors. A bioreactor landfill uses controlled methods of liquids addition to increase waste moisture content as a means for promoting decomposition of waste. The goal of a bioreactor operation is to achieve a stabilized condition while the landfill is still being monitored. Liquids addition has been applied at numerous landfill sites in the United States with favorable results.

Federal regulations governing solid waste management restrict liquids addition to only those landfills equipped with prescriptive Subtitle D liner systems. The Buncombe County Bioreactor Project seeks to determine what impact, if any, liquids addition has on alternative liner systems by comparing the performance of the prescriptive Subtitle D liner system in Cells 1 and 2 to the alternative liner systems in Cells 3 through 10. The data obtained from this project may provide support for modifying federal regulations to allow liquids addition in MSW landfills equipped with alternative liner systems. A Final Project Agreement (FPA) was issued by the USEPA under the Project Excellence and Leadership Program (Project XL) approving Buncombe County's proposal to incorporate a liquids addition process as an integral part of their landfill operation and providing the design, execution, and monitoring framework developed for the project.

1.3 PUBLIC AWARENESS

Public awareness has been an important part of the County's solid waste program; therefore, the County staff have given presentations to various groups, led tours for local area colleges and high schools, and performed a live interview at the bioreactor site for Buncombe County Television. The County website is available to the public to learn about the project. The website is updated semi-annually with new monitoring data and other information and is accessible at https://bioreactor.buncombecounty.org/.

Buncombe County holds periodic stakeholder meetings to generate feedback and report findings through the Project XL Agreement. The first stakeholder meeting was held on September 10, 2008 and the last on November 10, 2016.

Coordinating a multi-faceted stakeholder meeting takes considerable time, resources, and commitment; therefore, meetings typically occur as needed. At the time of this progress report, a stakeholder meeting has not been scheduled or planned.

2 PROJECT DESCRIPTION

This project was granted regulatory flexibility under Project XL to add leachate or other liquids to cells with alternative liner systems. To date, leachate has been the only liquid to be utilized as it is easily accessible on-site to meet the needs of the project. Leachate recirculation may be suspended during colder weather to avoid any adverse impact that may affect the decomposition. Leachate recirculation has currently been suspended while the sideslopes are being filled.

The project team, in consultation with the project academic advisors, Dr. Morton Barlaz of North Carolina State University, Dr. Timothy Townsend of University of Florida, and Dr. Debra Reinhart of University of Central Florida, established a minimum temperature of 50°F for the recirculation operation as measured at the leachate pond.

2.1 RETROFIT BIOREACTOR SYSTEM

2.1.1 Leachate Recirculation

The Bioreactor Program began when Cells 1 through 5 were nearing capacity requiring the need to install a retrofit system. The retrofit system is equipped to recirculate leachate using a combination of HITs and surficial gravity trenches (SGT) as shown in **Figure 2-1**.

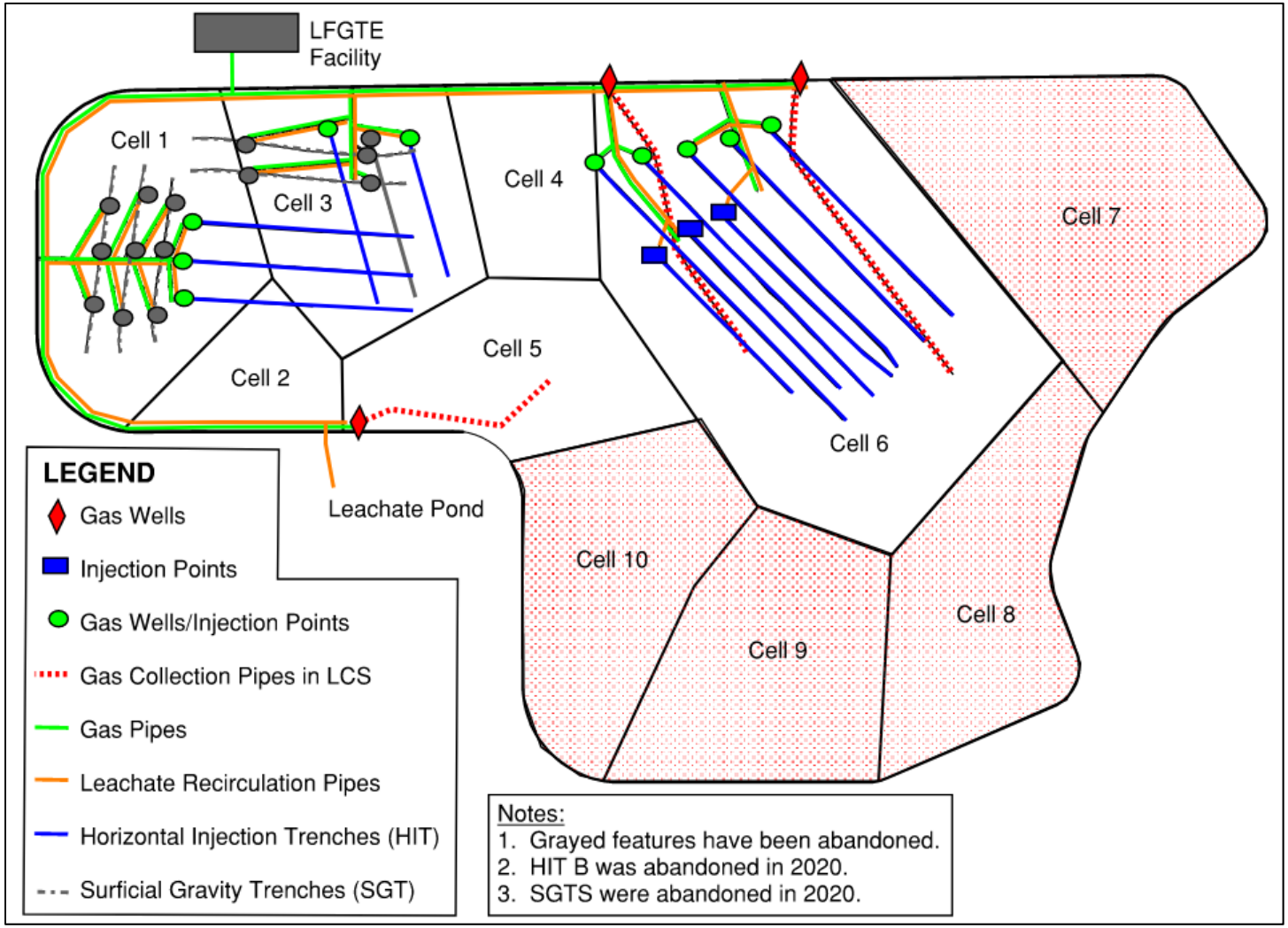

Figure 2-1: Retrofit Bioreactor System

Six HITs were installed in the retrofit area. During the waste fill process at Elevation 2040, the first three HITs were installed as an anticipation of project's approval. They are placed 100 feet apart, extending approximately 400 feet south in the waste mass. Three more HITs were installed at Elevation2080 using the same spacing but extending approximately 800 feet east in the waste. To provide a more uniform leachate wetting distribution, two pipes per trench were used – a short pipe to wet the first 400 feet and a long pipe to wet the remainder (the far end) of the trench.

Five SGTs were installed on the sideslopes ranging between 450 to 600 feet in length (SGT1 at Elevation 2030, SGT 2 and 4 at Elevation 2050, and SGT 3 and 5 at Elevation 2070). In 2020, the SGTs were at the end of their service life and abandoned.

To provide earlier implementations and thorough wetting, all future HITs will be installed during cell operations.

2.1.2 Landfill Gas Collection

Twenty-five vertical LFG collection wells were installed in Cells 1 through 5 as shown in **Figure 2-2**. At the time of the well field installation, the LFG collection components of the HIT and SGT was deactivated. LFG from the leachate collection system cleanouts for each cell was previously collected but has been discontinued.

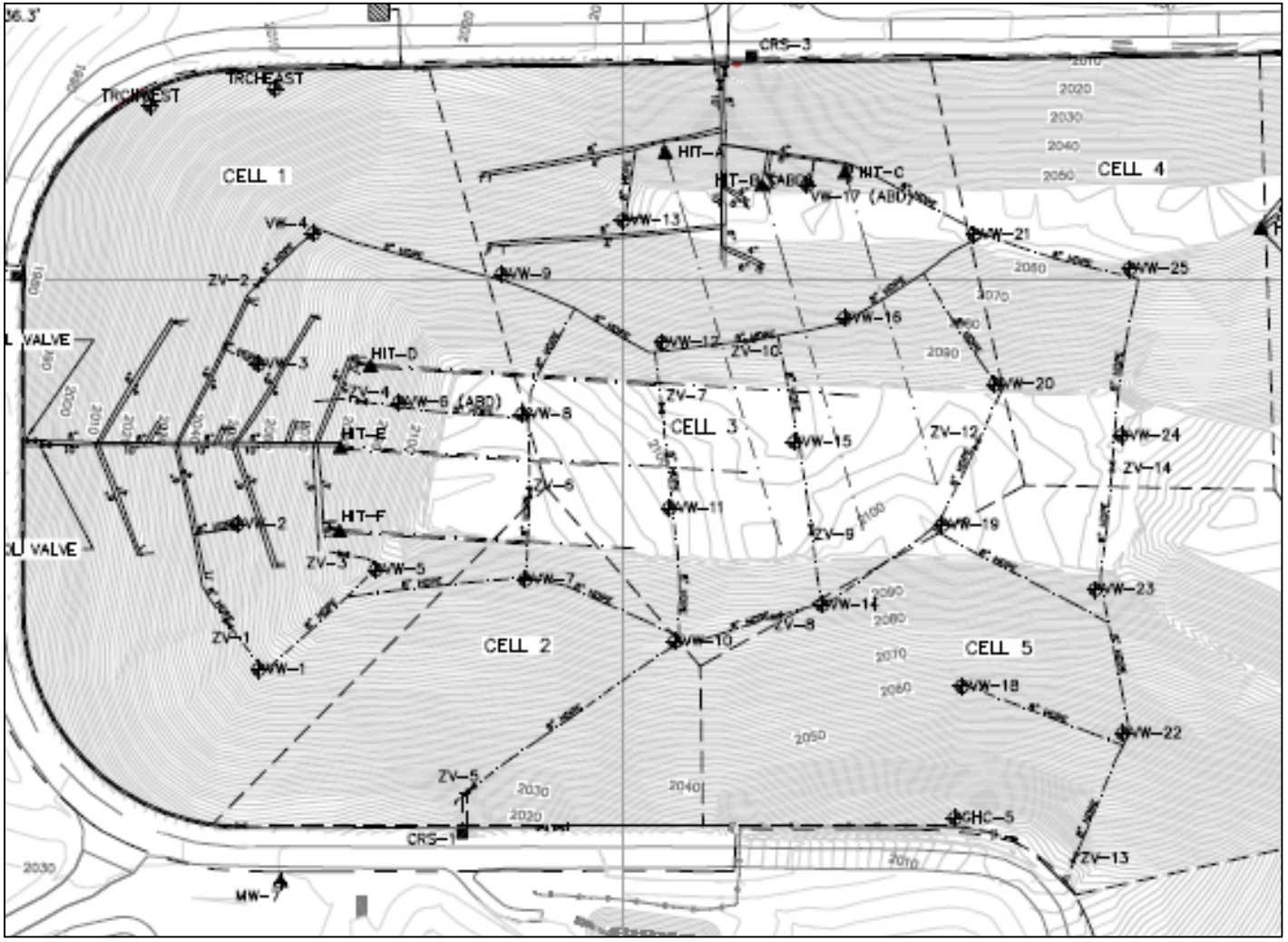

Figure 2-2: Vertical Landfill Gas Well Collection System in the Retrofit Area

2.2 BUILD-AS-YOU-GO BIOREACTOR

The build-as-you-go bioreactor system means that the infrastructure is installed in stages as the waste is being placed. The build-as-you-go approach allows for more extensive wetting of the waste and earlier capture of LFG. The first stage was installed in Cell 6 in 2012 and began operation in June 2014. The next stage was installed at Elevation 2100 in early 2020.

2.2.1 Leachate Recirculation and LFG Collection

Cell 6 has five HITs for leachate recirculation and gas collection (HIT-6A through HIT-6E) and three HITs for leachate recirculation (HIT-6F through HIT-6H) as shown in Figure 2-3. A 100-foot solid section of pipe was used for the front portion of the HIT to provide adequate distance from injection to the outer slope to minimize seeps.

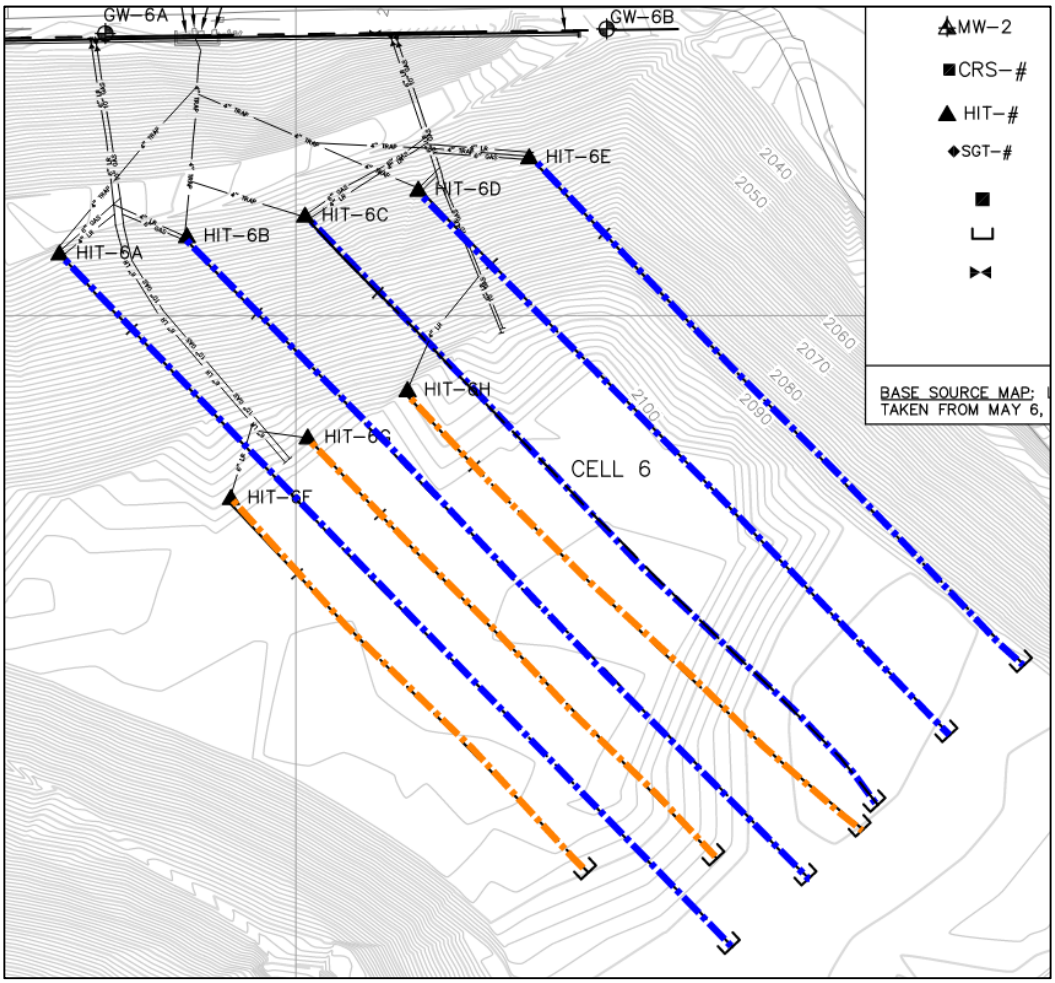

Figure 2-3: Build-As-You-Go Bioreactor System

For HIT-6A through HIT 6E, the solid pipe sections are sloped 3 percent to drain towards the outer slope of the landfill. P-traps were installed at the head of each HIT and drain down the slope to the leachate sump riser pipe to allow excess recirculated leachate to be removed from the HIT after injection events. This is intended to prolong LFG collection capability of the system. Unfortunately, leachate in the trench also drained to the slopes, causing seeps that had to be managed.

For HIT-6F through HIT-6H, the solid pipe drains inward, into the center of the waste disposal area, to minimize seeps. In addition, the LFG collection portion of the HITs were not installed.

When liquids addition takes place, it is continuously supervised by the bioreactor manager. Each injection takes between 2 to 6 hours. A rotation schedule makes it possible to account for differences in times between injection and drainage. It is adjusted dynamically to reflect the differences between HIT and SGT. During rainfall season, the leachate recirculation is reduced or postponed until the area has been sufficiently dried out. During and after each injection event, the side slopes of the landfill are carefully inspected for leachate seeps.

2.2.2 Temperature Probes

Due to their service life and faulty readings, the temperature probes have been abandoned and will no longer be monitored.

3 MONITORING PROGRAM

3.1 PROGRAM OVERVIEW

The monitoring program for Project XL was developed with the stakeholders. Table 3-1 shows the monitoring parameters and frequency of data collection.

As part of facility operations, the County performs semi-annual testing of the leak detection zones (LDZ), groundwater monitoring wells, leachate pond, and stormwater collection points for the 2L groundwater standards established by NCDEQ. The data is used to assess the performance of the alternative liner system.

Table 3-1: Monitoring Parameters and Frequencies

Parameter	Frequency
Leak Detection Quantity	Semi-Annually
Leak Detection Quality	Semi-Annually
Leachate Quality	Semi-Annually
Leachate Quantity	Weekly
Settlement Survey	Annually
Waste Temperature	Continuous
Cell 6 Sump Level	Continuous
Removed from Monitoring Program in 2020	
Settlement Plates	
Waste Temperatures	

3.2 LEAK DETECTION LIQUIDS

The landfill cells and leachate pond are equipped with LDZs located beneath the leachate collection system sumps. The LDZs are approximately 1 acre in size and are equipped with a 60-mil HDPE geomembrane and a 24-inch rock drainage layer located 3 feet below the subgrade of the liner system. The geomembrane is sloped directly to a collection pipe that allows for the removal of any liquid that is collected in the detection zone.

Cells 1 and 2 utilize gravity pipes to drain liquids to a collection point across the landfill perimeter road. For Cells 3 through 6, liquids that are collected in the LDZ are pumped out through vertical stand pipes that are located along the perimeter berm. The drain pipes are equipped with gate valves that allows the operator to monitor the liquids being captured. Quantity data is not recorded for Cell 1 since it appears to be impacted by a steady supply of groundwater from an underground spring.

If liquid is observed in the LDZs, it is collected and examined on-site using a water quality meter for oxidation reduction potential (ORP).

Furthermore, liquid samples collected are sent to Pace Analytical for analysis of biological oxygen demand (BOD5), pH, chemical oxygen demand (COD), ammonia, and specific conductance. The

samples of the liquids are also collected and tested as a component of the semi-annual groundwater, surface water, and leachate testing.

3.3 LEACHATE

The quantity of leachate collected is recorded for each cell on a weekly basis. Each cell is equipped with a leachate pump system with a flow meter that transmits the number of operating hours for the installed pumps, the quantity of leachate pumped, and the level of the leachate in the sumps at the time the monitoring occurred. County staff records the data onto a field form.

Leachate quality sampling from Cells 1 through 6 are taken from sampling ports at the leachate pump stations located in the valve vaults and occurs semi-annually. These collected samples are sent to Pace Analytical for the examination of BOD5, pH, COD, ammonia, and specific conductance. Sampling and testing of the combined cells leachate is also tested semi-annually from the leachate holding pond.

Currently, on-site analysis for ORP is performed using an YSI Professional Plus water quality meter.

The sampling process is dated and recorded in a monitoring log by the Bioreactor Manager.

3.4 LEACHATE RECIRCULATION

A magnetic flow meter, installed at the leachate pond pump station, records the quantity of leachate recirculated for each event. The Bioreactor Manager tracks the quantity of leachate injected and identifies the specific HIT used for the injection event.

3.5 LANDFILL GAS

LFG composition and flow data have been recorded and monitored since November 2011.

3.6 LANDFILL SETTLEMENT

Settlement is measured and monitored using topographic surveys.

3.7 LANDFILL/LEACHATE TEMPERATURE

Temperature has been monitored in Cell 6 since July 2012. Historically, there has not been significant temperature drops observed while recirculating during the winter. In 2020, the temperature probes were abandoned due to service life and faulty readings.

3.8 CELL 6 LANDFILL GAS COLLECTION

Cell 6 HIT-6A through -6E are being utilized for LFG collection. LFG collection data is being monitored to determine if LFG collection should continue or if the HITs should be used for recirculation.

HIT-6F through -6H were constructed to inject leachate and not recover LFG. The existing systems will continue to function as installed.

3.9 CELL 6 SUMP DATA

A datalogger is used to record the leachate level in the Cell 6 sump every minute. The data is being analyzed and compared with recirculation events and daily rainfall data to evaluate impacts of recirculation on leachate generation and head on the liner system.

4 PROJECT ASSESSMENT AND COLLECTED DATA

This section discusses the data collected from 2007 through 2020. A complete compilation of all data collected can be found on this website: https://bioreactor.buncombecounty.org/

4.1 LEAK DETECTION

Annual quantity of liquid collected from the LDZs is shown in **Table 4-1**. Although liquids have been found in the Cell 1 LDZ, the project team is unable to measure the quantity due to the remote location of the discharge and influence of a spring beneath the cell.

Table 4-1: Collected Liquids from LDZ (Gallons)

Sample Year	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Yearly Total	Leachate Pond
	Subtitle D Liner			Alternative Liner				Subtitle D Liner
2007	NA	NA	427	0	0	340	767	0
2008	NA	NA	3,105	25	2,925	10,475	16,530	0
2009	NA	NA	1,375	0	3,325	5,375	10,075	0
2010	NA	NA	1,040	0	6,465	3,835	11,340	0
2011	NA	83	475	0	3,300	2,040	5,898	0
2012	NA	115	530	1	1,850	1,220	3,716	3
2013	NA	80	500	0	850	1,150	2,580	9
2014	NA	30	350	0	750	1,325	2,455	45
2015	NA	136	400	0	875	2,200	3,611	60
2016	NA	40	475	0	630	2,050	3,195	28
2017	NA	25	200	0	150	450	825	15
2018	NA	80	600	0	550	2,225	3,455	100
2019	NA	81	125	0	500	1,750	2,456	65
2020	NA	85	225	0	600	2,500	3,410	60
Cumulative	**NA**	**755**	**9,827**	**26**	**22,770**	**36,935**	**70,313**	**385**

[1]Leachate Pond is not included for the yearly total.
NA – unable to measure quantity of liquids from LDZ.

Liquid volumes collected from the LDZs are presented in **Figure 4-1**. Qualitative liquid testing data for pH, conductance, ORP, BOD5, COD, and ammonia are presented in **0s 4-2** through **4-7.**

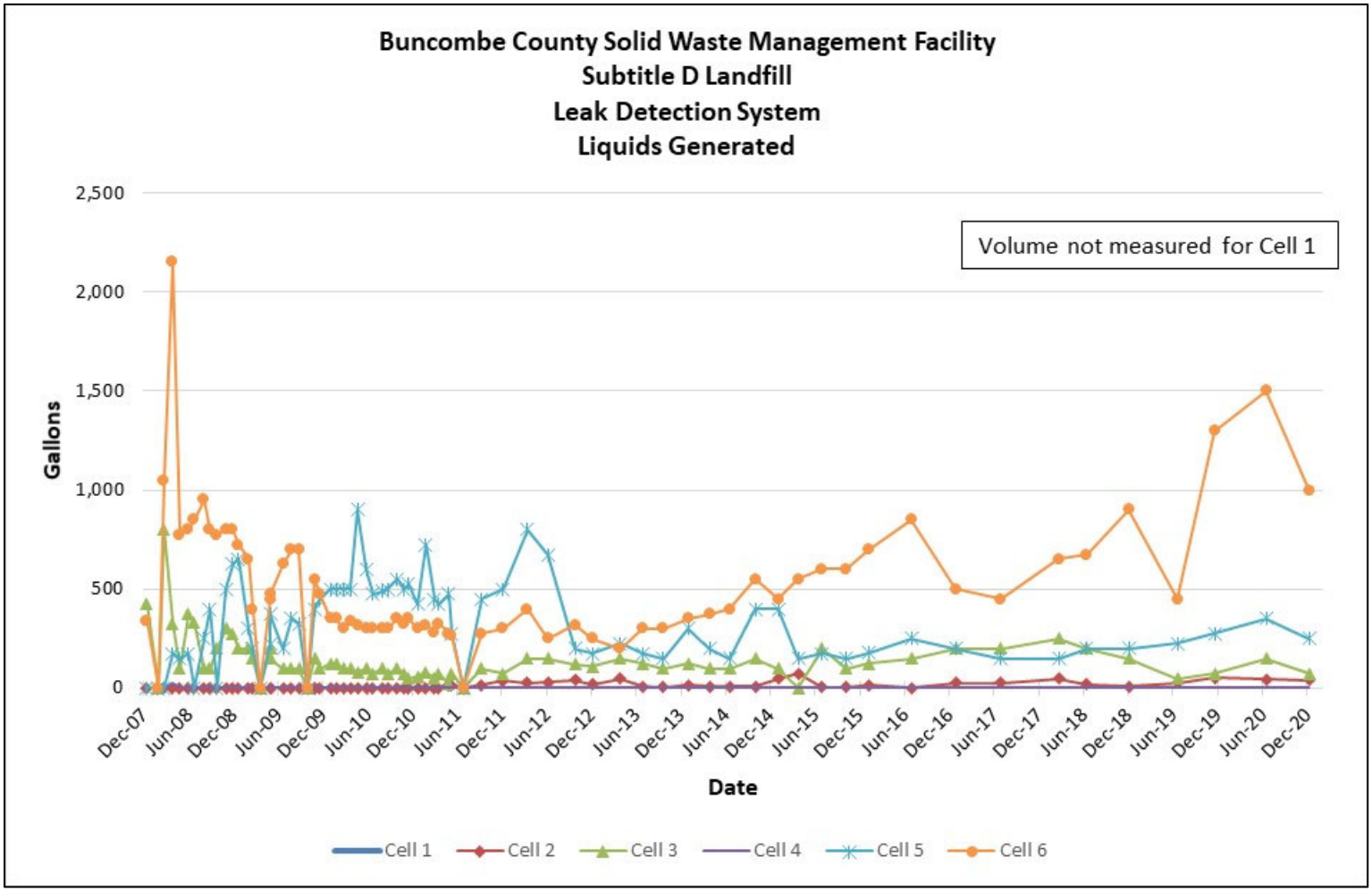

Figure 4-1: Liquids Generated

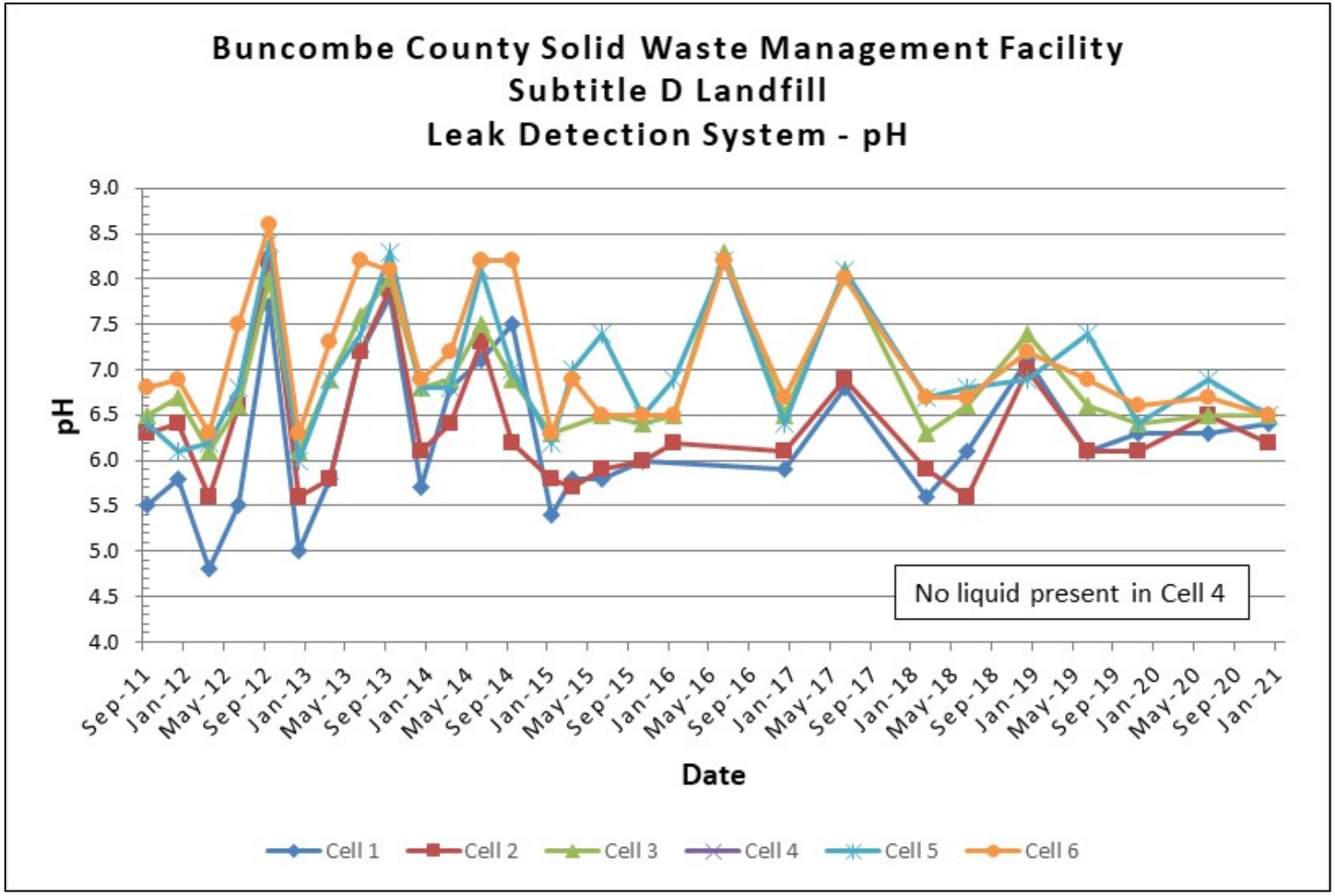

Figure 4-2: Leak Detection - pH

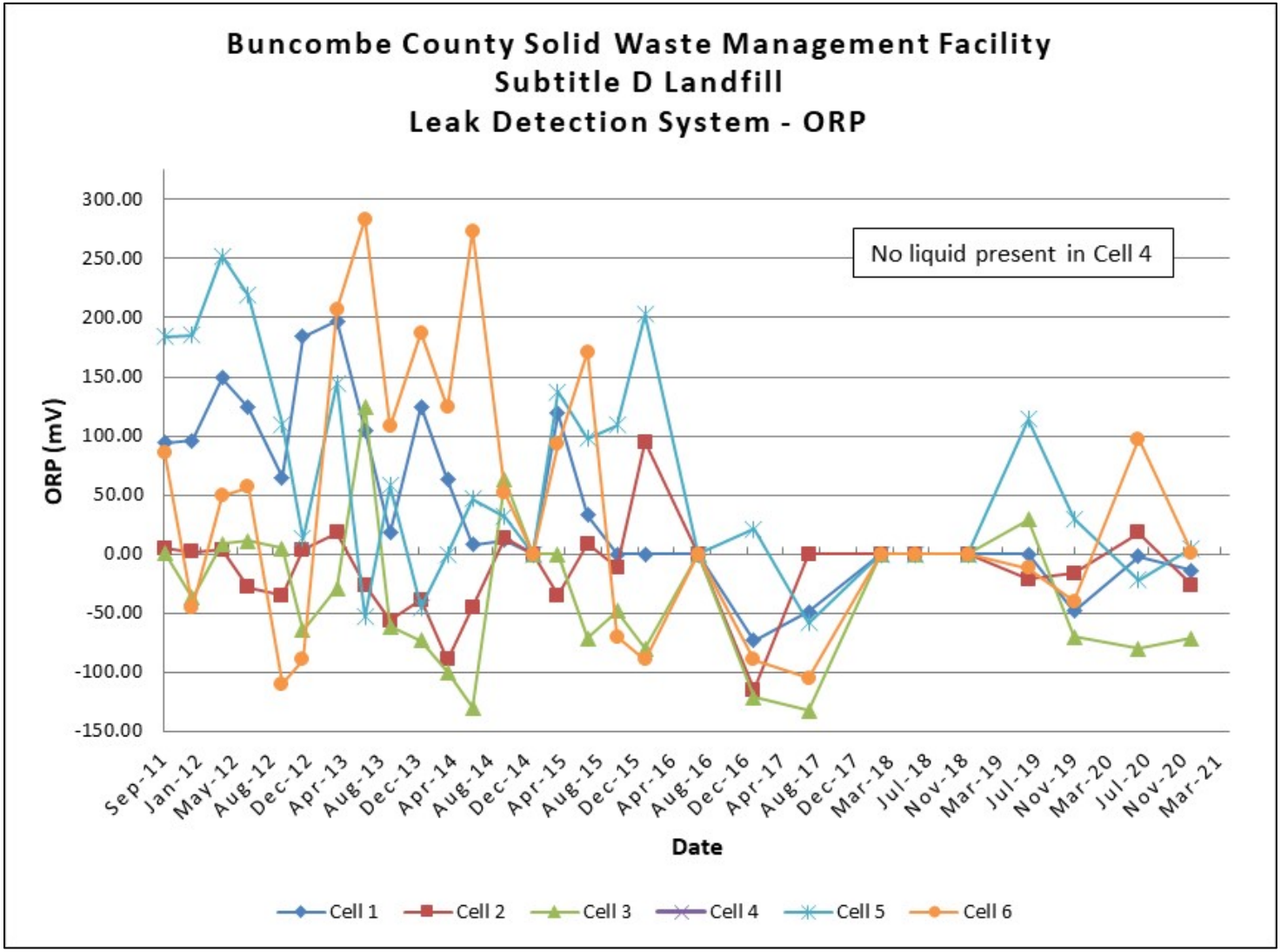

Figure 4-3: Leak Detection - Oxidation Reduction Potential

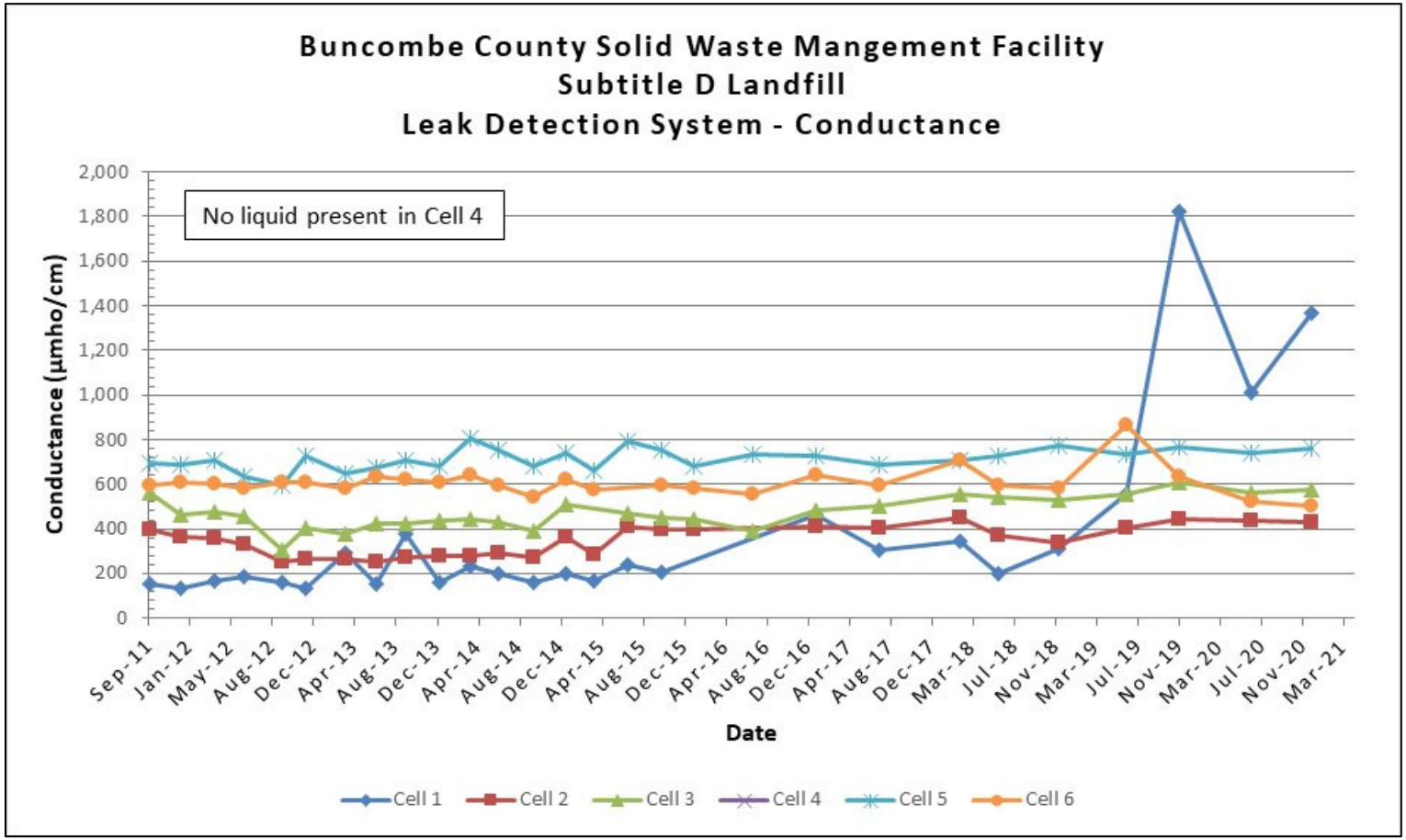

Figure 4-4: Leak Detection - Specific Conductance

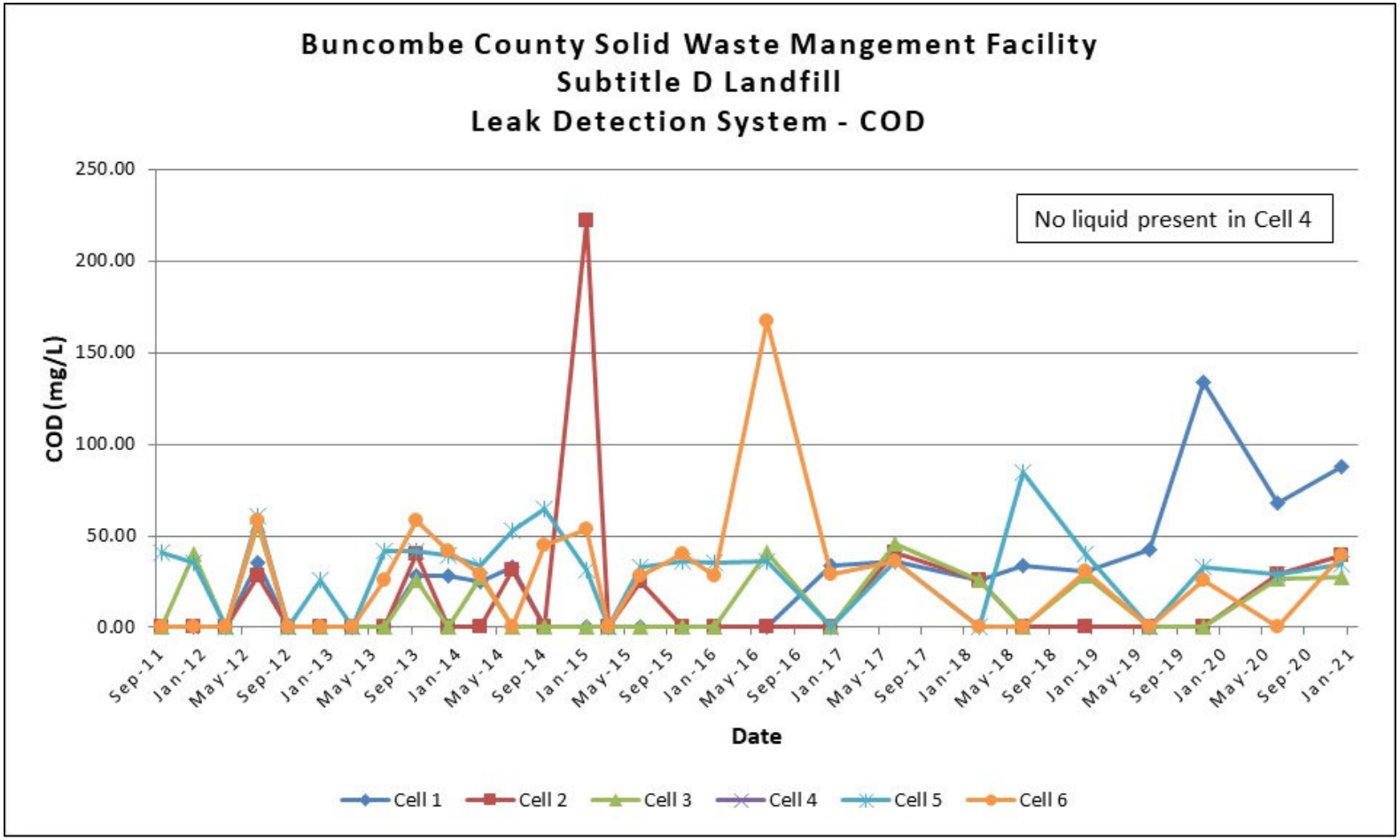

Figure 4-5: Leak Detection – COD

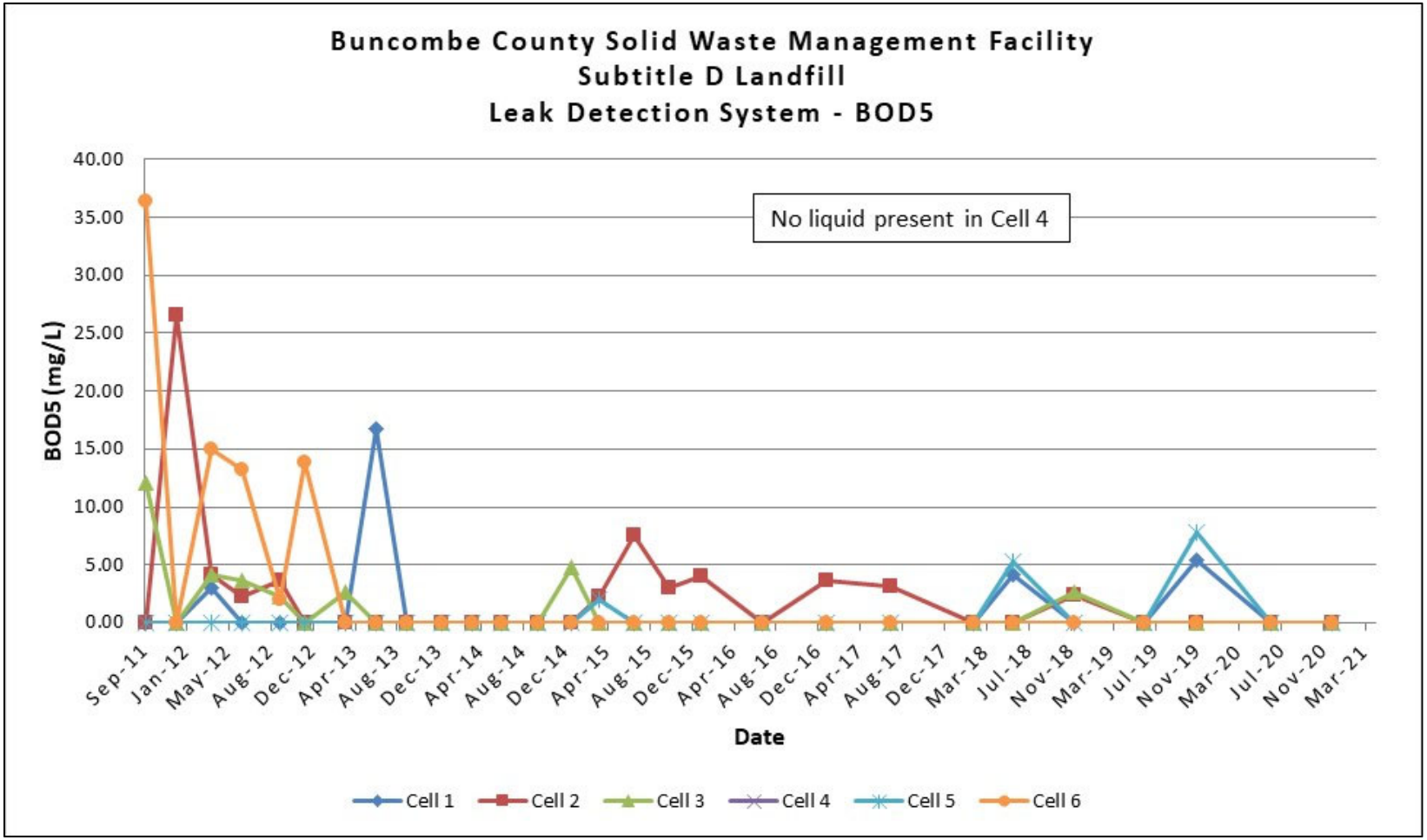

Figure 4-6: Leak Detection - BOD5

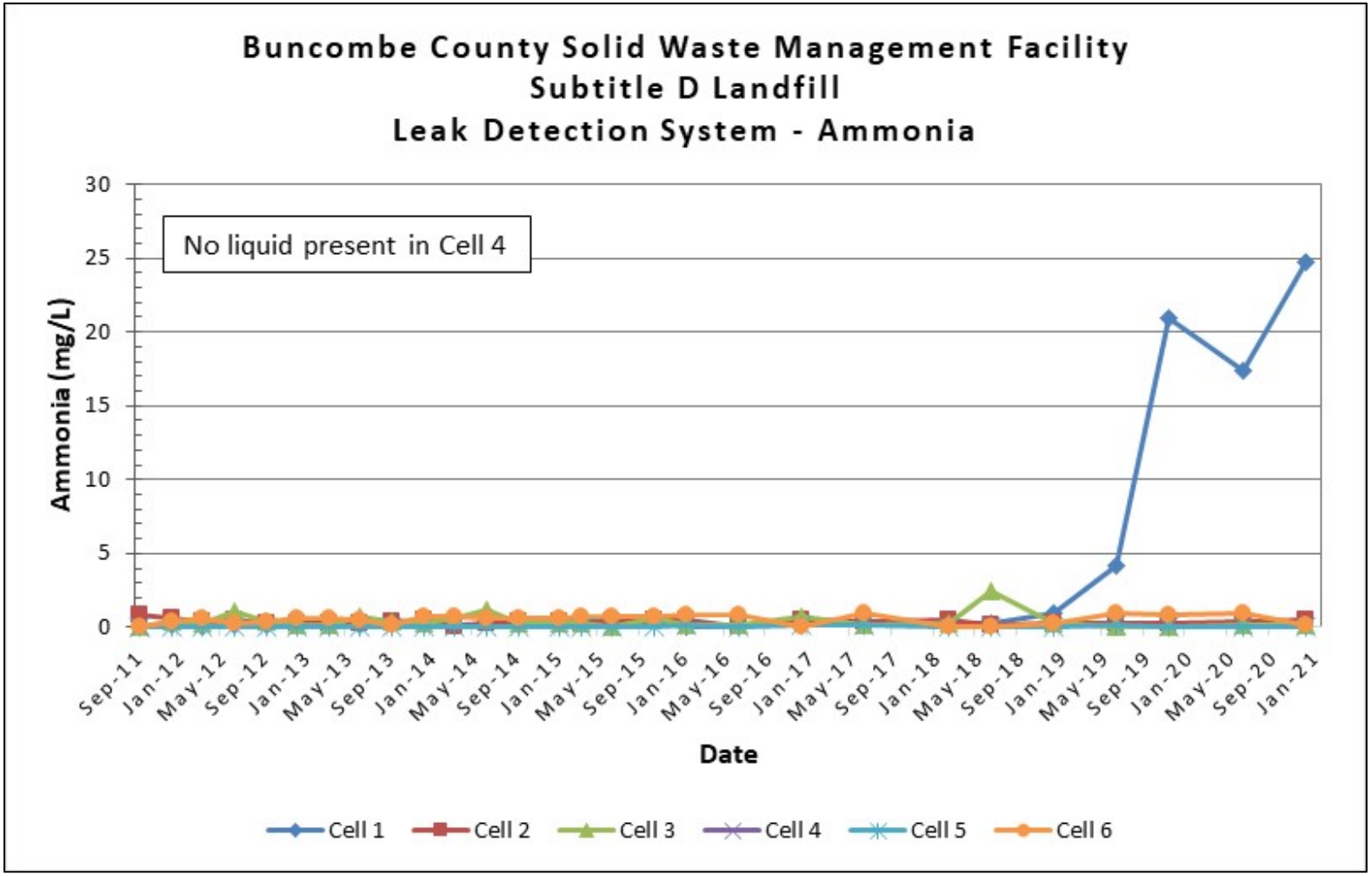

Figure 4-7: Leak Detection - Ammonia

4.2 LEACHATE COLLECTION SYSTEM

Table 4-2 shows the quantity of leachate collected from each cell's leachate collection system (LCS). Figure 4-8 shows the quantity of leachate generated in comparison to the rainfall. Leachate samples from Cells 1 through 6 and the leachate pond were analyzed for BOD5, conductance, COD, pH, ammonia and ORP are shown in Figures 4-9 through 4-14.

Table 4-2. Leachate Collected from Cells 1 through 6

	Cell 1 (gallons)	Cell 2 (gallons)	Cell 3 (gallons)	Cell 4 (gallons)	Cell 5 (gallons)	Cell 6 (gallons)	Total (gallons)	Rainfall (inches)
Nov. – Dec. 2007	9,723	487	20,898	11,382	11,675	981,305	1,035,470	
2008	288,526	8,860	94,705	173,647	164,467	8,904,461	9,634,666	33
2009	101,777	35,102	103,371	333,067	356,580	14,610,720	15,540,617	43
2010	173,878	34,813	283,867	419,454	124,095	7,097,590	8,133,697	33
2011	156,900	36,027	44,096	124,478	402,831	6,589,437	7,353,769	37
2012	191,608	71,821	92,225	355,101	332,049	5,441,508	6,484,312	40
2013	374,081	239,328	413,068	659,838	987,974	4,791,339	7,465,628	54
2014	184,767	329,346	111,053	82,890	481,695	1,458,189	2,647,940	31
2015	46,104	270,968	145,390	99,538	533,353	2,150,375	3,345,728	45
2016	215,590	289,412	121,855	92,718	625,964	2,457,079	3,802,618	26
2017	84,384	258,117	234,156	206,322	563,471	3,575,850	4,922,300	42
2018	36,369	628,179	158,166	146,586	1,223,960	5,990,072	8,183,332	42
2019	18,862	914,087	159,780	185,911	1,187,580	5,139,010	7,605,500	39
2020	14,204	900,371	196,699	210,021	1,384,935	5,887,982	8,594,212	48
TOTAL	**1,896,773**	**4,016,918**	**2,179,329**	**3,100,953**	**8,480,899**	**75,074,917**	**94,749,789**	**513**

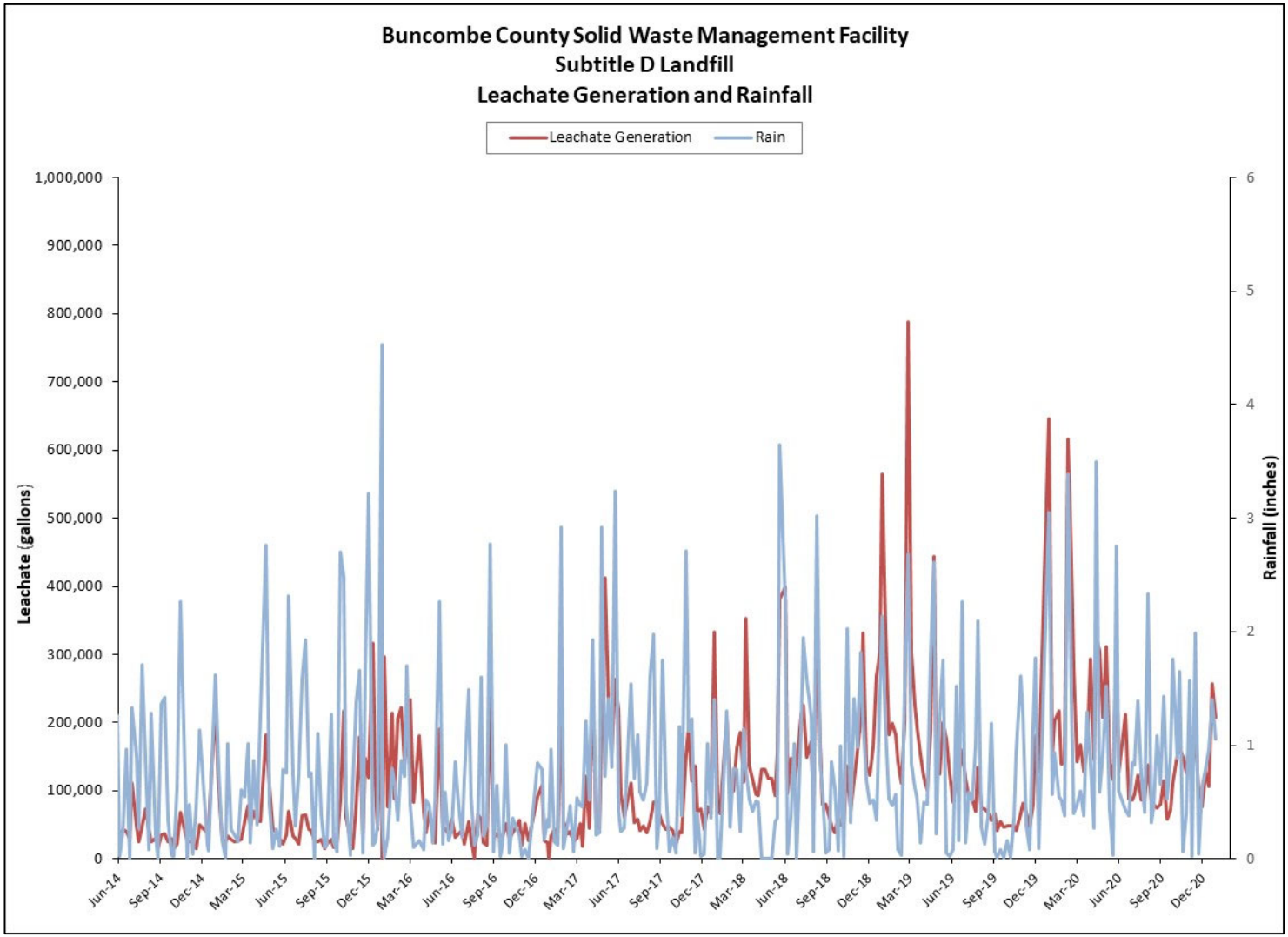

Figure 4-8: Leachate Generation versus Rainfall

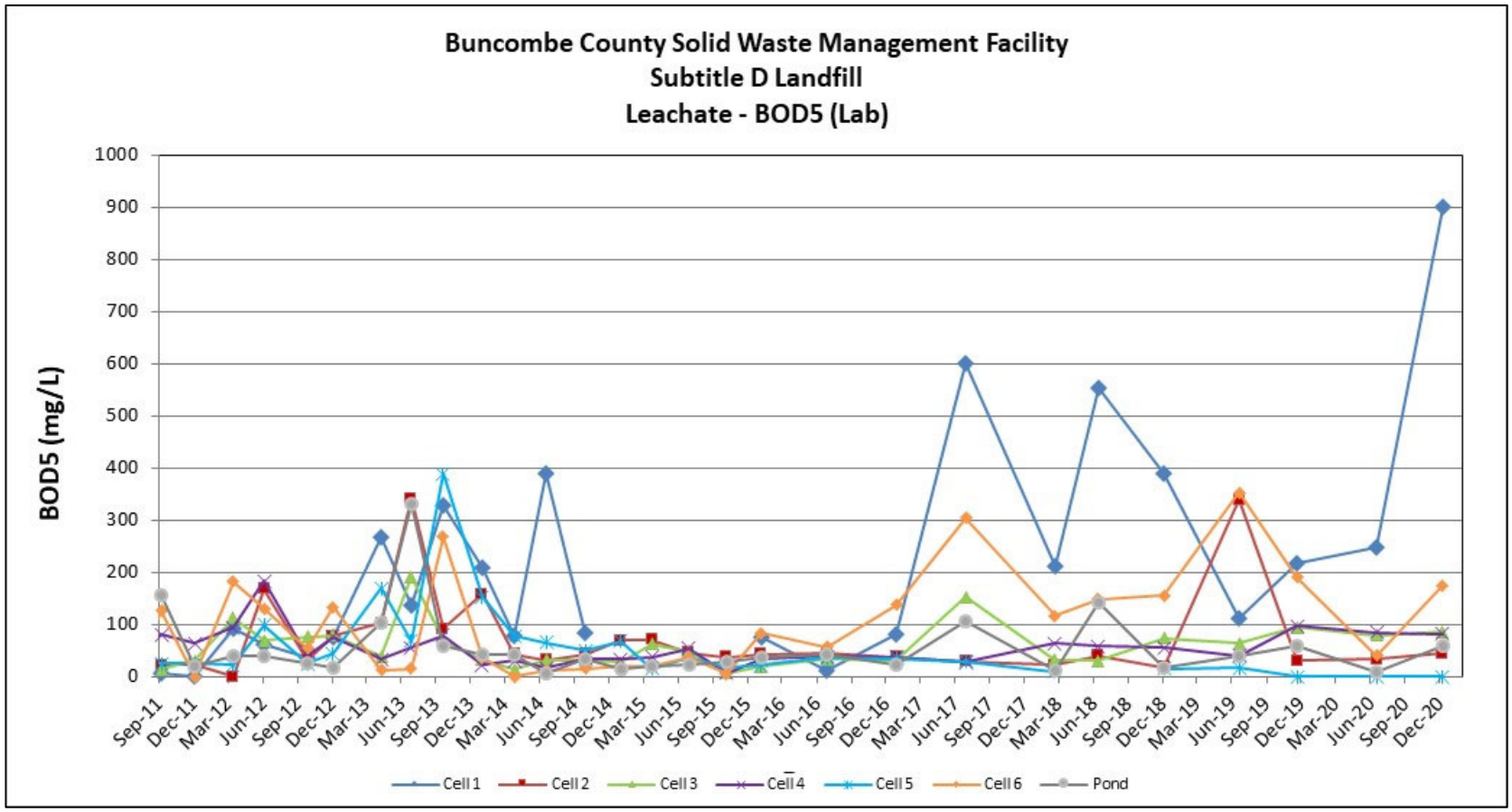

Figure 4-9: Leachate - BOD5 (Lab)

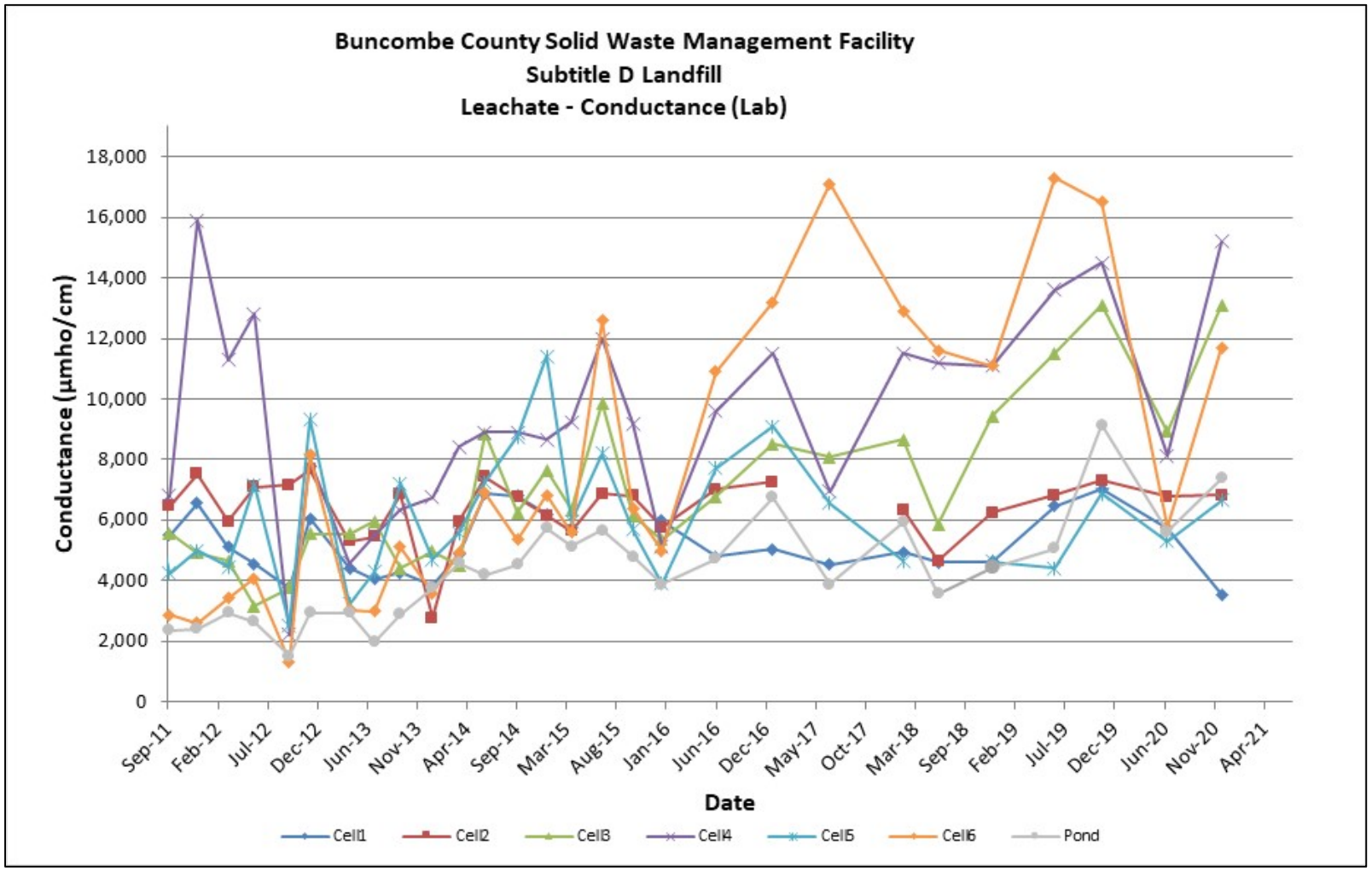

Figure 4-10: Leachate - Specific Conductance (Lab)

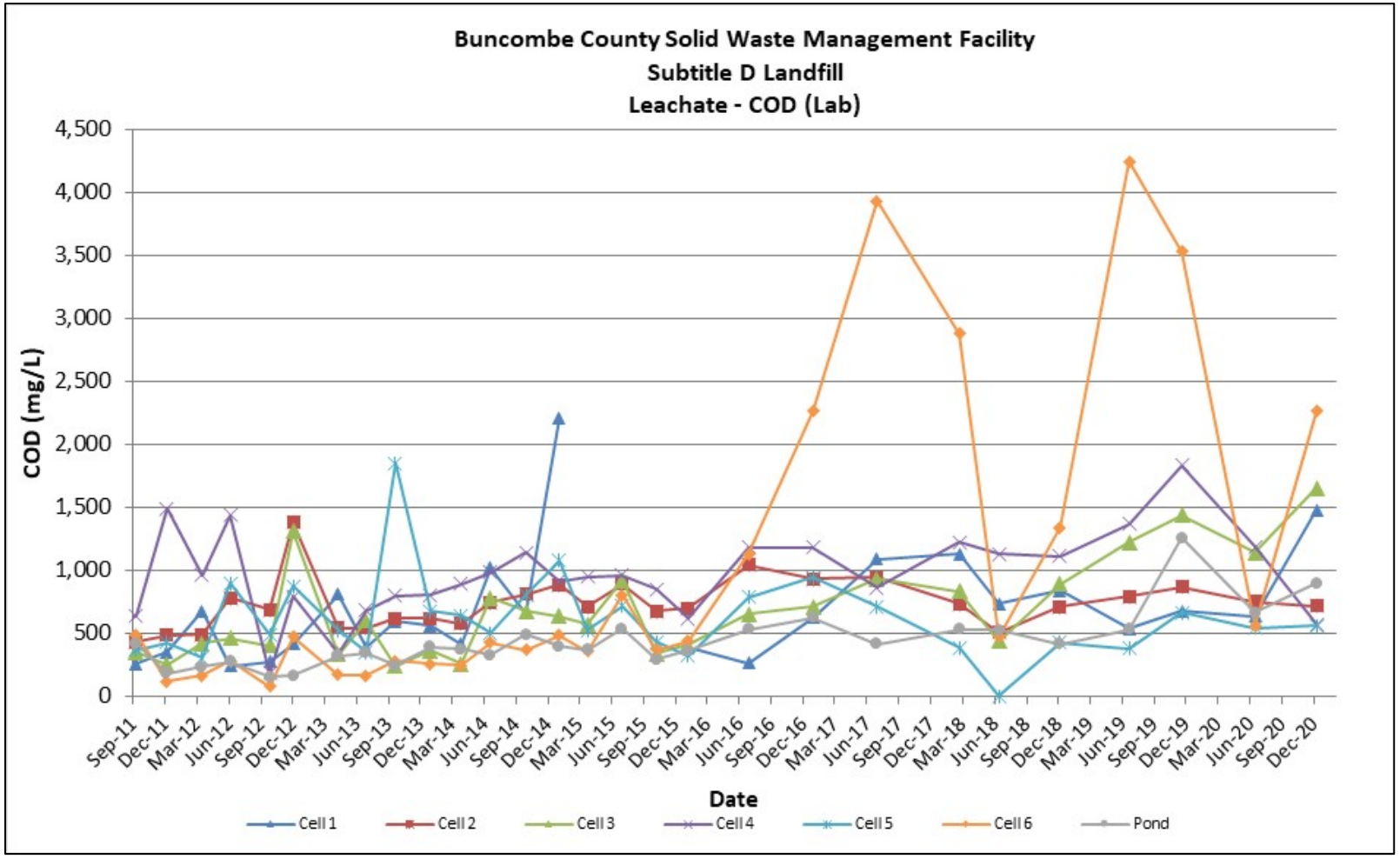

Figure 4-11: Leachate - COD (Lab)

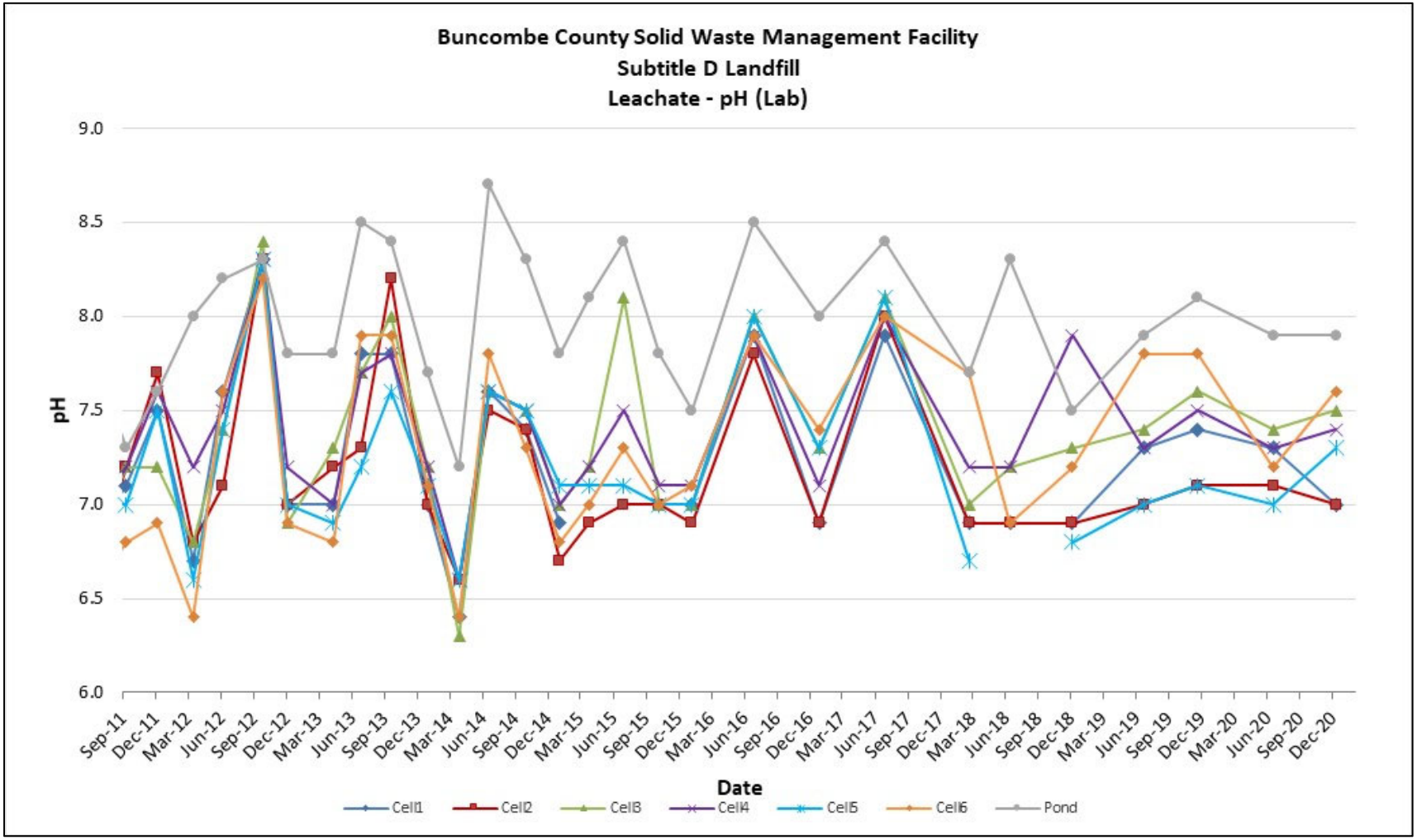

Figure 4-12: Leachate - pH (Lab)

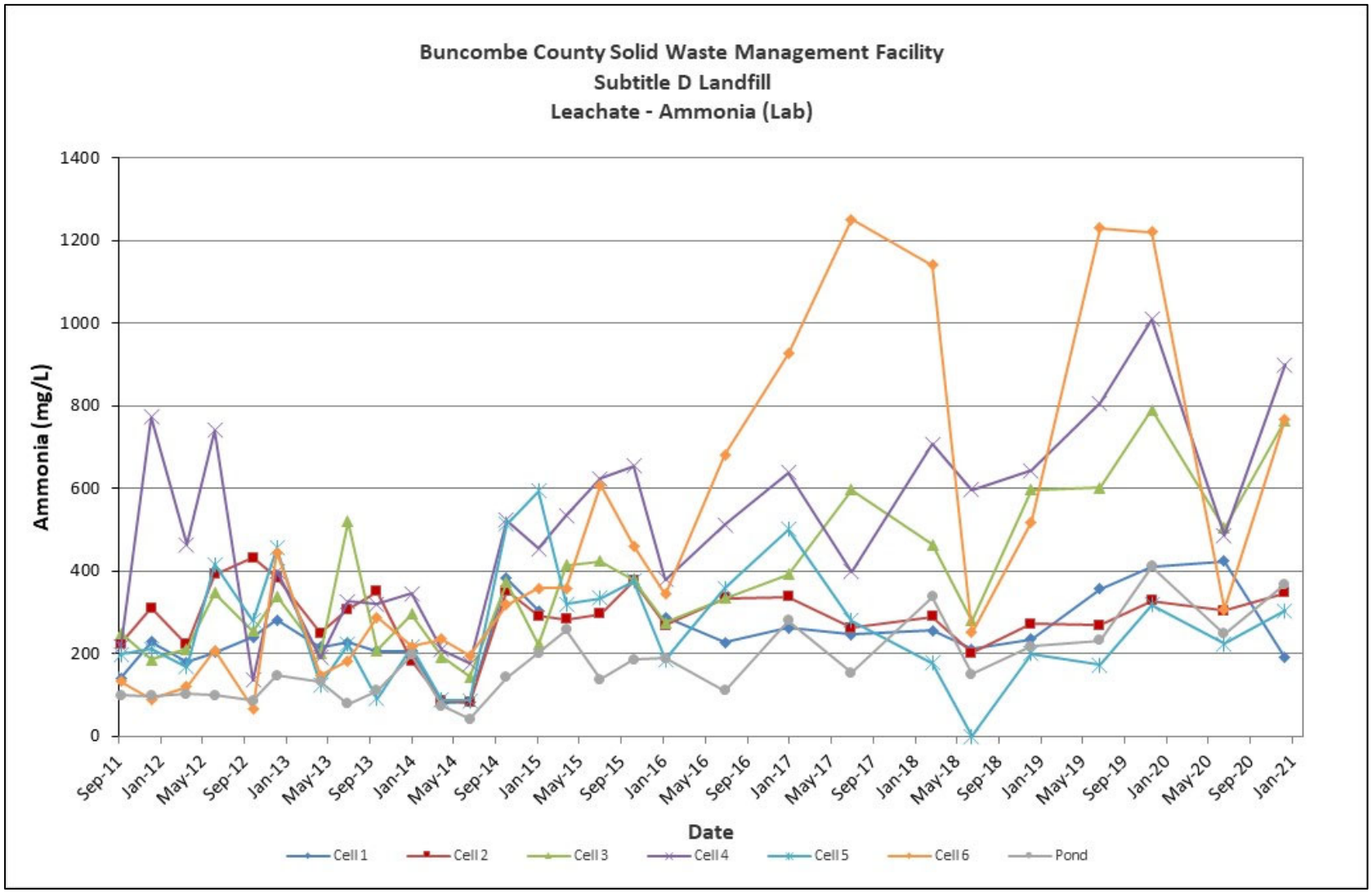

Figure 4-13: Leachate - Ammonia (Lab)

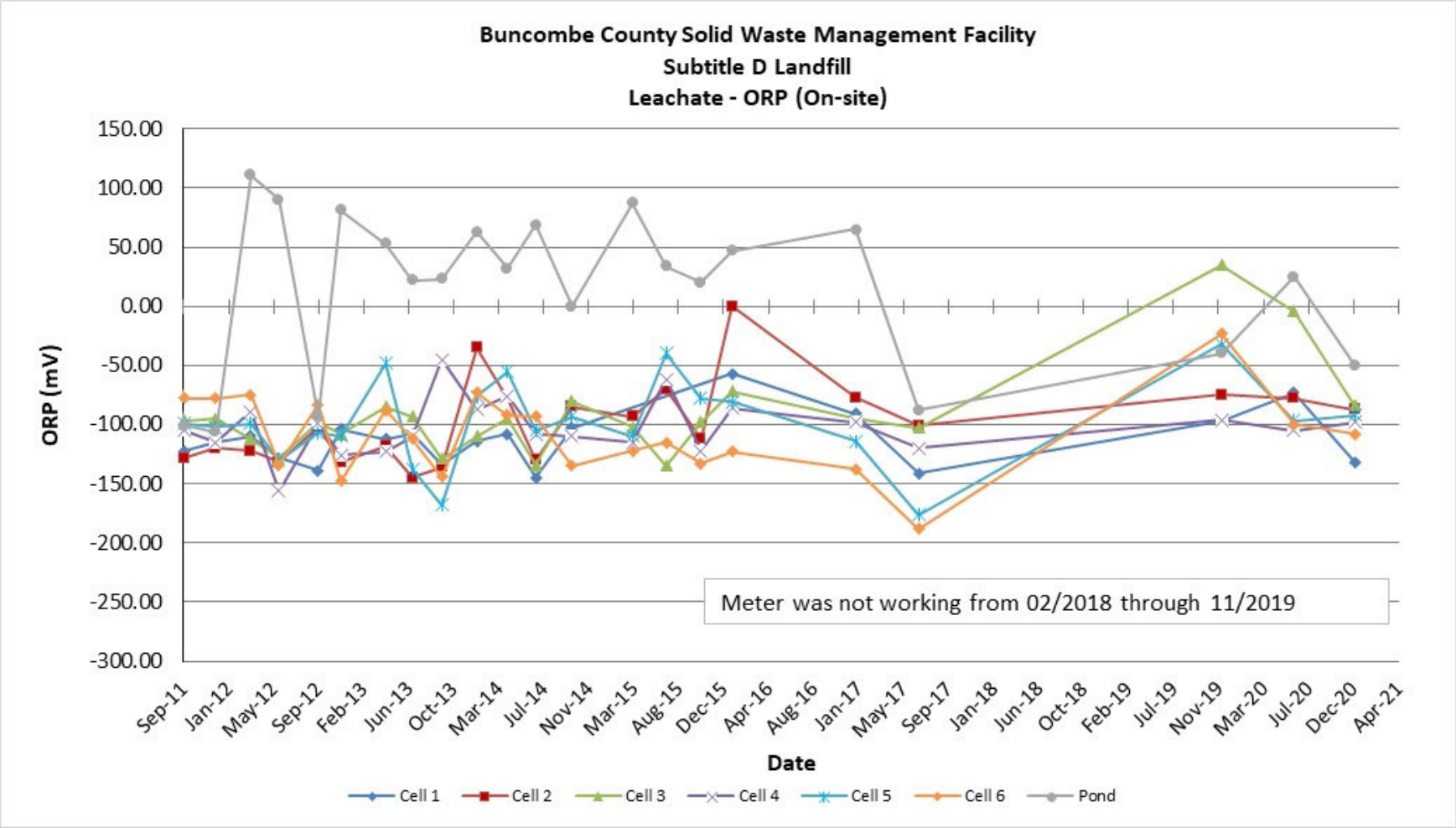

Figure 4-14: Leachate – ORP (On-Site)

4.3 LEACHATE RECIRCULATION

Table 4-3 presents the annual leachate recirculated. Leachate recirculation was suspended in 2017 due to the sideslope fill operations and recommenced in 2020. Approximately 6.85 million gallons of leachate have been recirculated. Figure 4-15 shows the cumulative leachate recirculation volume from 2009 to 2020.

Table 4-3. Leachate Recirculation Quantities

Year	Cells 1 through 5							Cell 6		Total
	SGTs					HITs				
	1A-1C	2A-2C	3A-3C	4A-4B	5A-5B	A-C	D-F	6A-6E	6F-6H	
2006	48,140	48,140	48,140	10,698	10,698	32,093	32,093	--	--	230,002
2007	41,860	41,860	41,860	9,302	9,302	27,907	27,907	--	--	199,998
2008	51,914	42,883	35,985	0	0	14,720	116,108	--	--	261,610
2009	3,670	1,720	3,590	8,510	0	105,330	48,210	--	--	173,039
2010	20,000	24,100	21,300	21,667	10,000	307,733	296,600	--	--	701,400
2011	14,129	27,654	21,867	32,922	29,690	161,068	298,490	--	--	585,820
2012	24,867	33,968	25,765	19,955	18,235	213,010	425,620	--	--	761,420
2013	5,730	12,485	12,195	2,180	2,050	20,420	87,820	--	--	142,880
2014	0	11,600	5,290	6,200	3,680	116,630	420,470	85,520	--	649,390
2015	0	0	0	0	0	86,100	622,921	217,160	--	926,181
2016	0	0	0	0	0	127,710	609,910	136,810	--	874,430
2017	0	0	0	0	0	83,960	691,254	429,770	--	1,204,984
2018	0	0	0	0	0	0	0	0	--	0
2019	0	0	0	0	0	0	0	0	--	0
2020	0	0	0	0	0	0	23,660	115,220	0	138,880
TOTAL	210,310	244,410	215,992	111,434	83,655	1,296,681	3,701,063	984,480	0	6,850,034

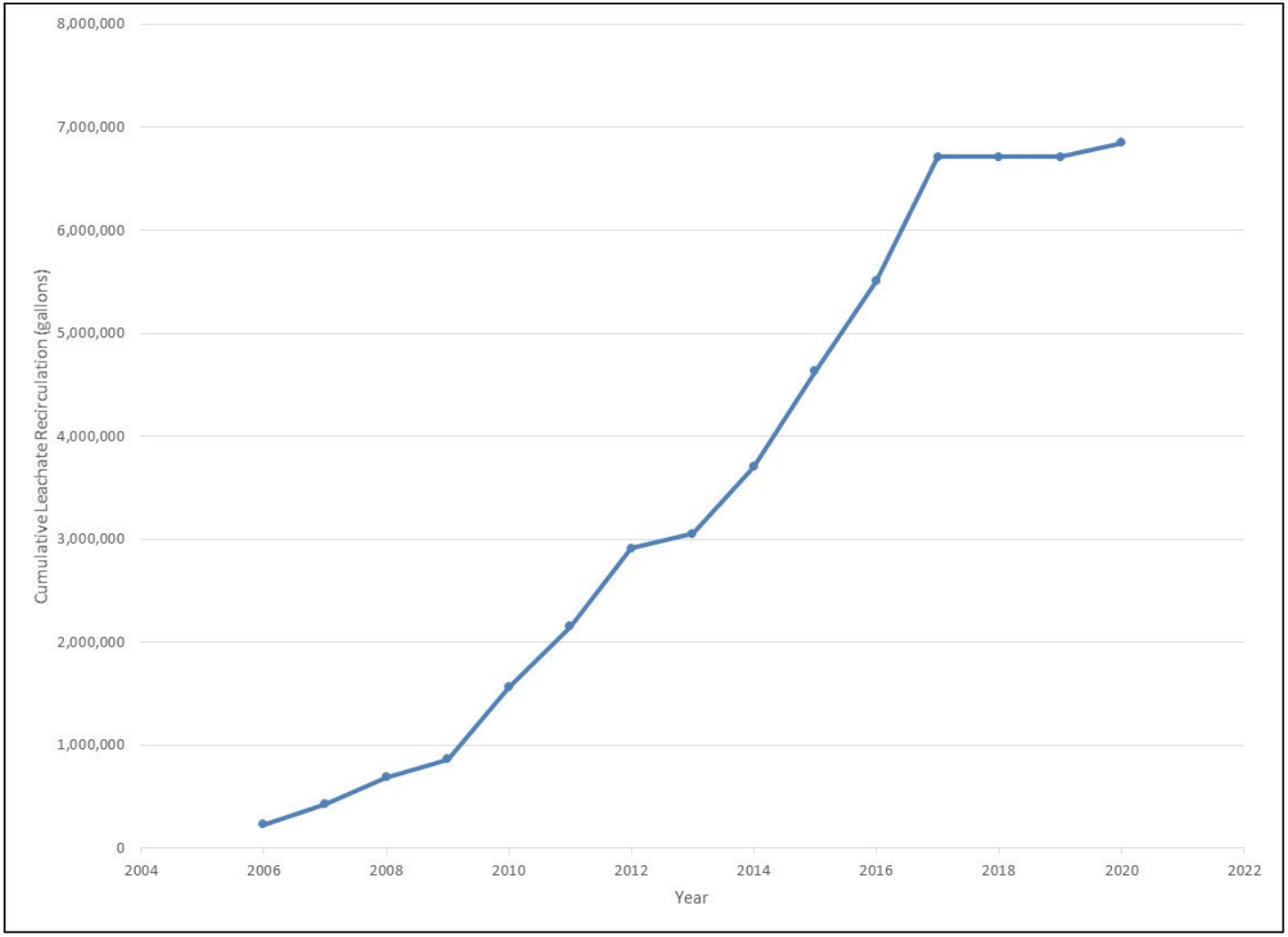

Figure 4-15: Cumulative Leachate Recirculation Volume

4.4 LANDFILL GAS

The LFG flow and methane percentage from the landfill is monitored continuously at the LFGTE facility as presented in 0 4-16.

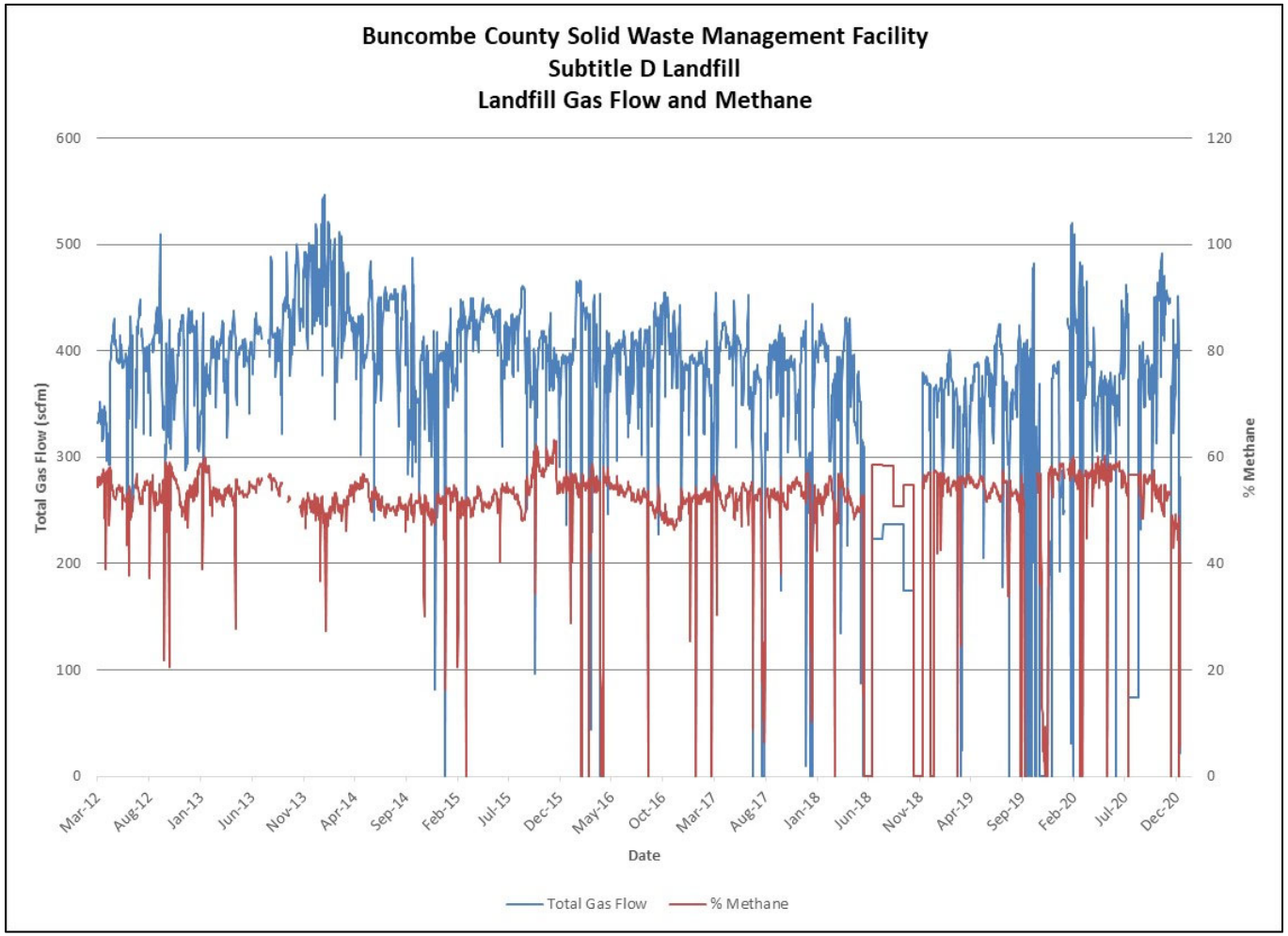

Figure 4-16: Landfill Gas Flow and Percent Methane

*Due to malfunctioning data logging equipment, monthly averages of methane and gas flow are shown from July 2018 through October 2018.

4.5 SETTLEMENT

As stated above, landfill settlement is measured using topographic surveys. Figure 4-17 presents a topographic survey comparison for Cells 1 through 5 from 2010 to December 2020.

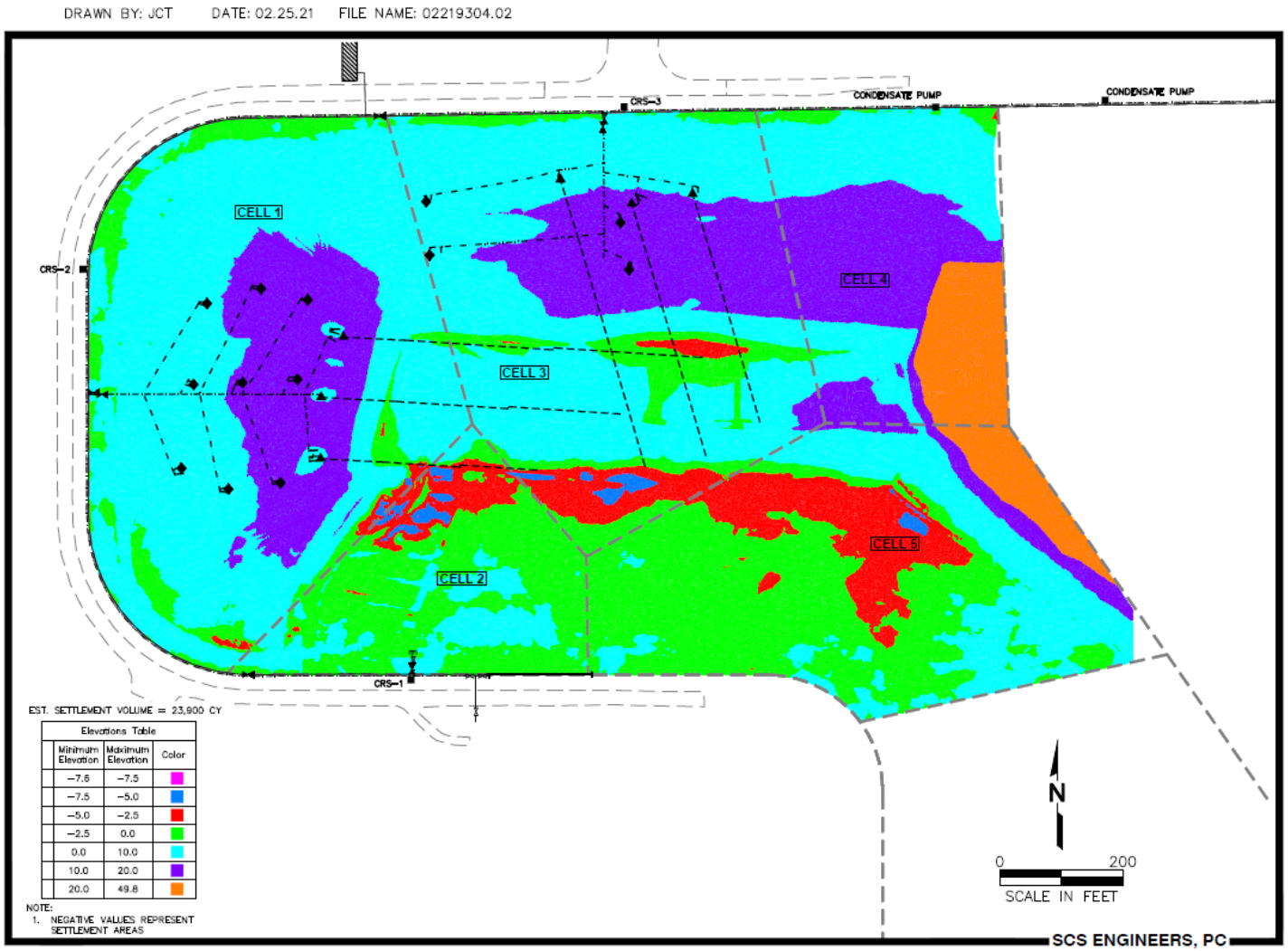

Figure 4-17: Settlement

4.6 CELL 6 LANDFILL GAS COLLECTION

Percent methane and LFG flow rate in each of the HIT are measured and are shown in **Figure 4-18**.

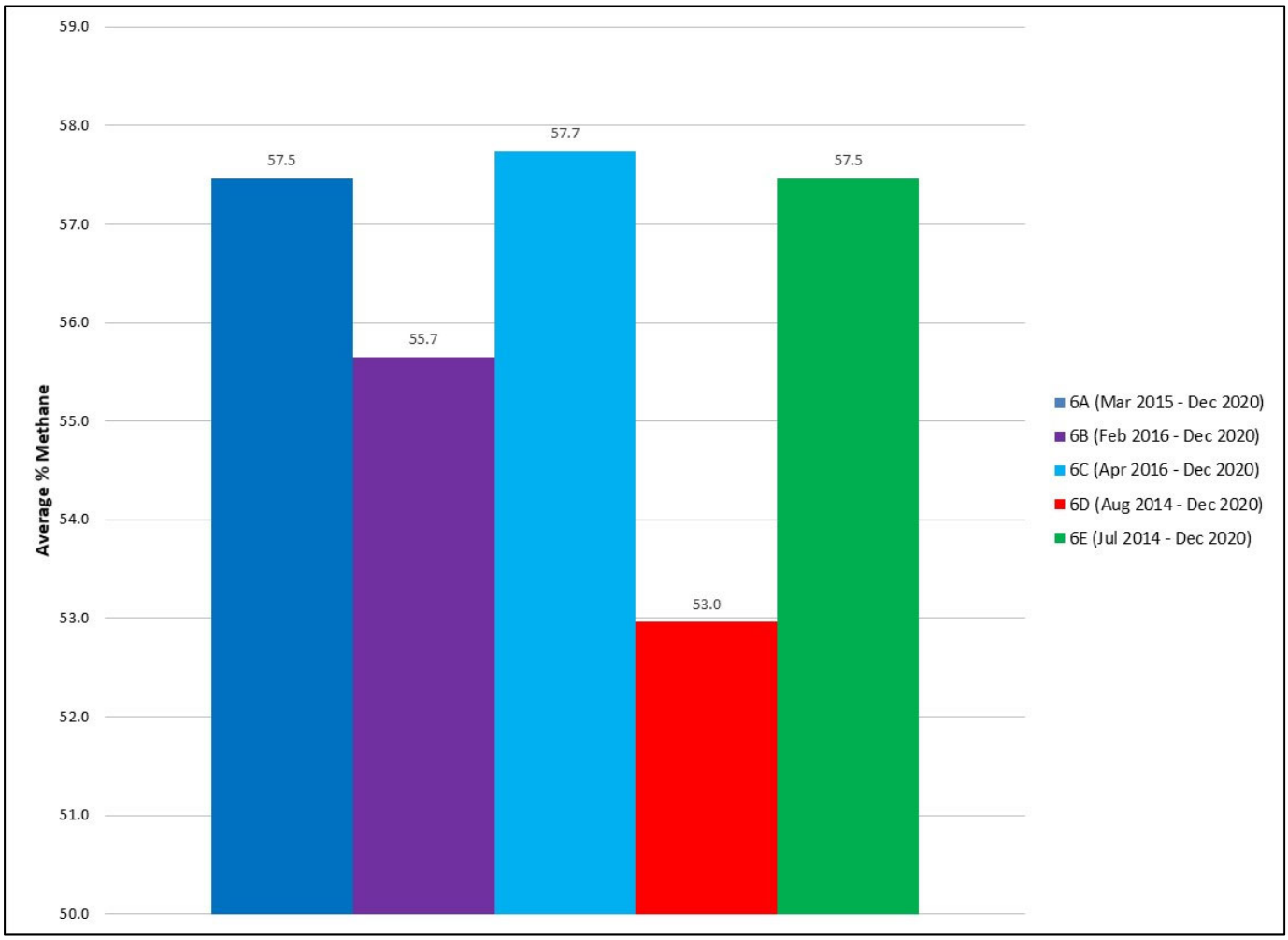

Figure 4-18: Cell 6 HITs - Average Percent Methane

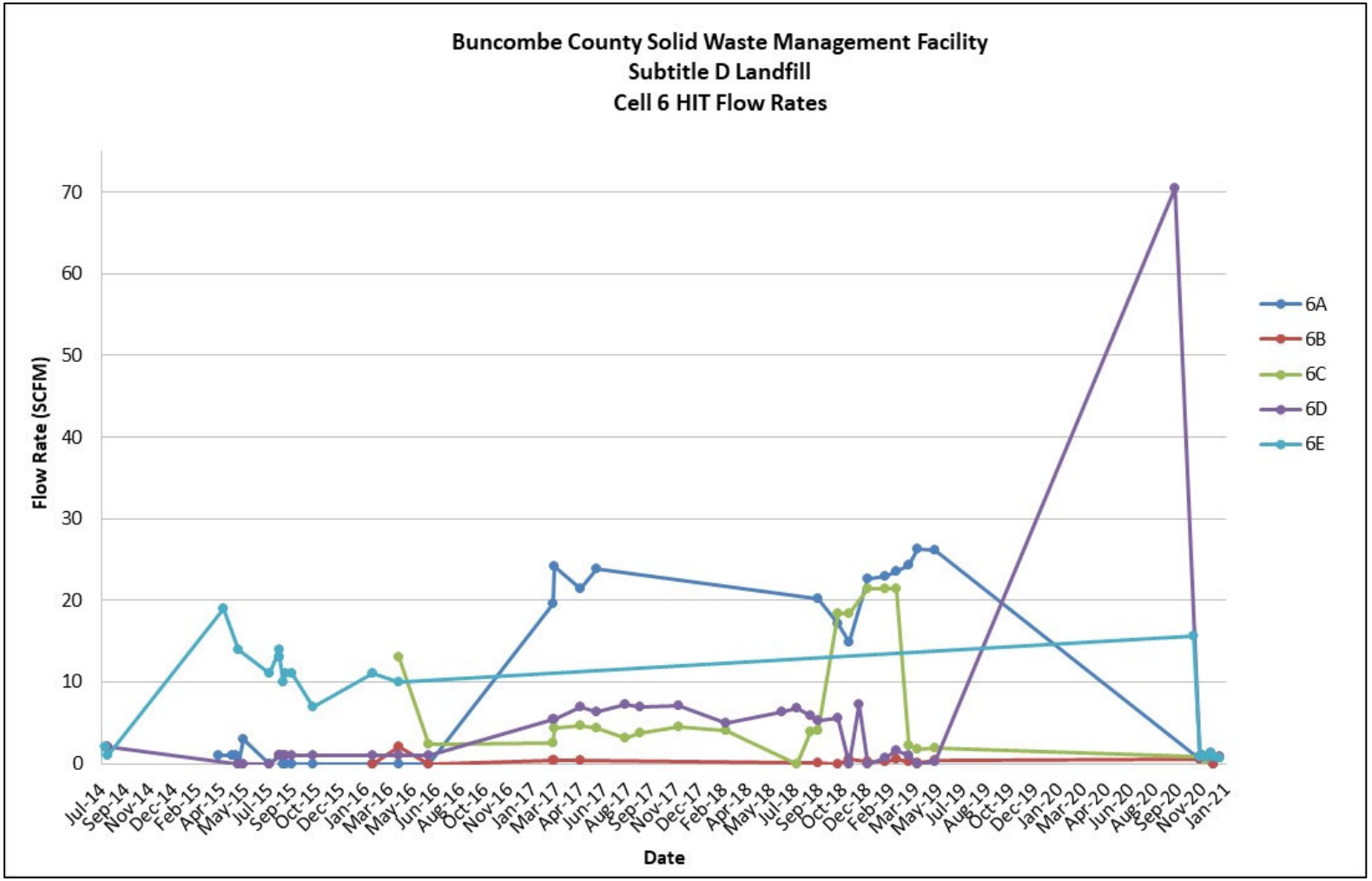

Figure 4-19: Cell 6 HITs - Flow Rate

5 PROJECT GOALS UPDATE

5.1 LIQUIDS MONITORING ANALYSIS

5.1.1 Determination of Liquid Source in the LDZ

Liquids present in the LDZs could be leachate that has leaked through the base liner system, groundwater – or a combination of both. The LDZs are open on the sides and as a result, subject to potential groundwater infiltration. This is particularly evident in Cell 1 where it appears that the LDZ is being impacted by an underground spring based on the amount of flow witnessed during sampling events and the high quality of the samples.

Comparison of test data between the LDZ, leachate and groundwater was made in an effort to determine the source of the liquid. The proposed Cell 7 and future expansions design encloses the open sides of the LDZs to minimize groundwater impacts.

The conductance levels for leachate are much higher than the samples analyzed for the Cell 1 LDZ. The conductance for leachate is in the range of 800 to 8,700 μmho/cm compared to Cell 1 LDZ where it is in between 200 to 1,000 μmho/cm. The LDZ conductance and groundwater well samples in the area are tested and shown in **Figure 5-1**.

Toluene is often present in leachate and was found to be much lower in the LDZ tested samples. **Figure 5-2** illustrates toluene levels present in the groundwater testing results, which correlate closely with the LDZ samples.

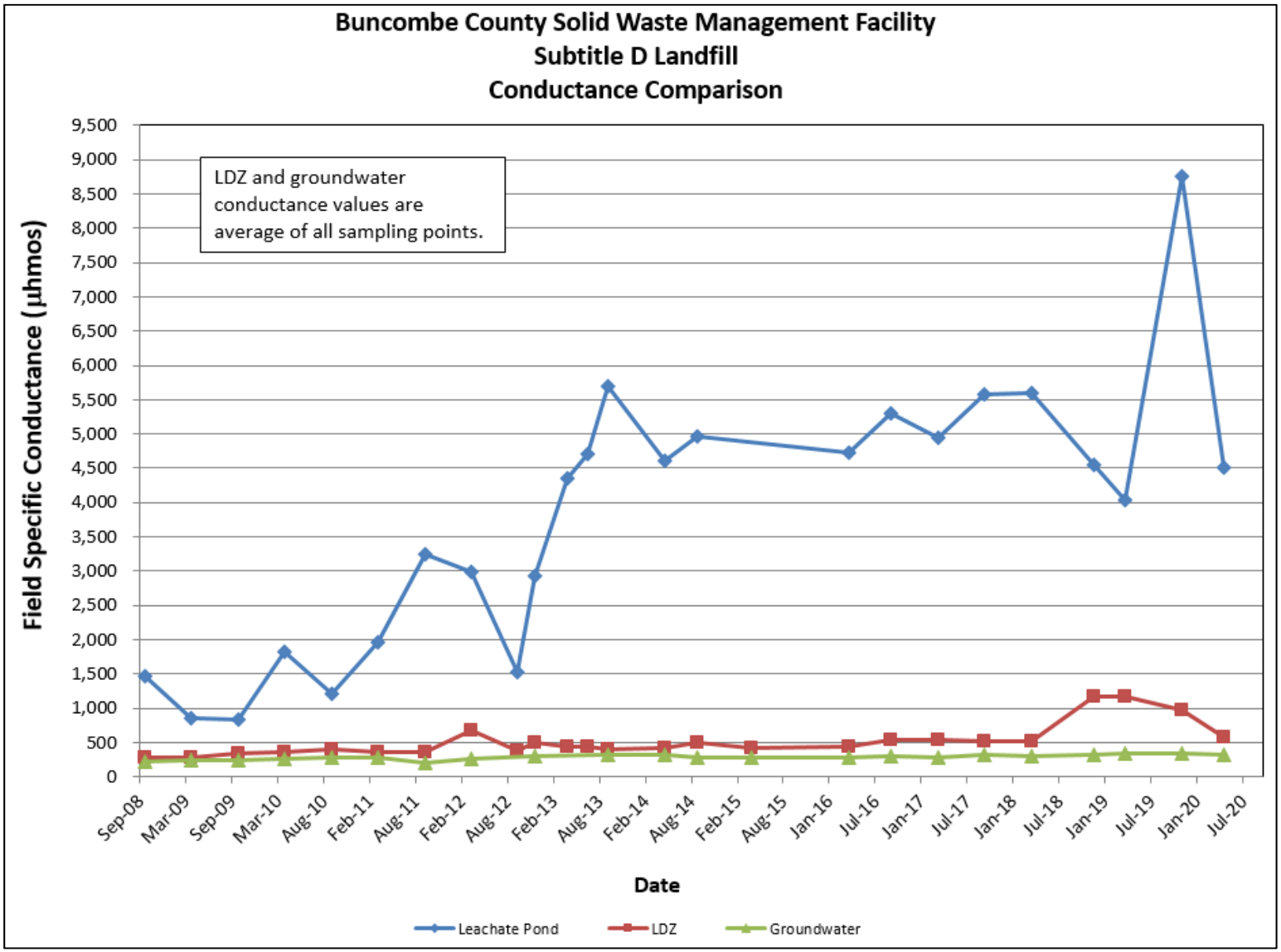

Figure 5-1: Conductance Comparison

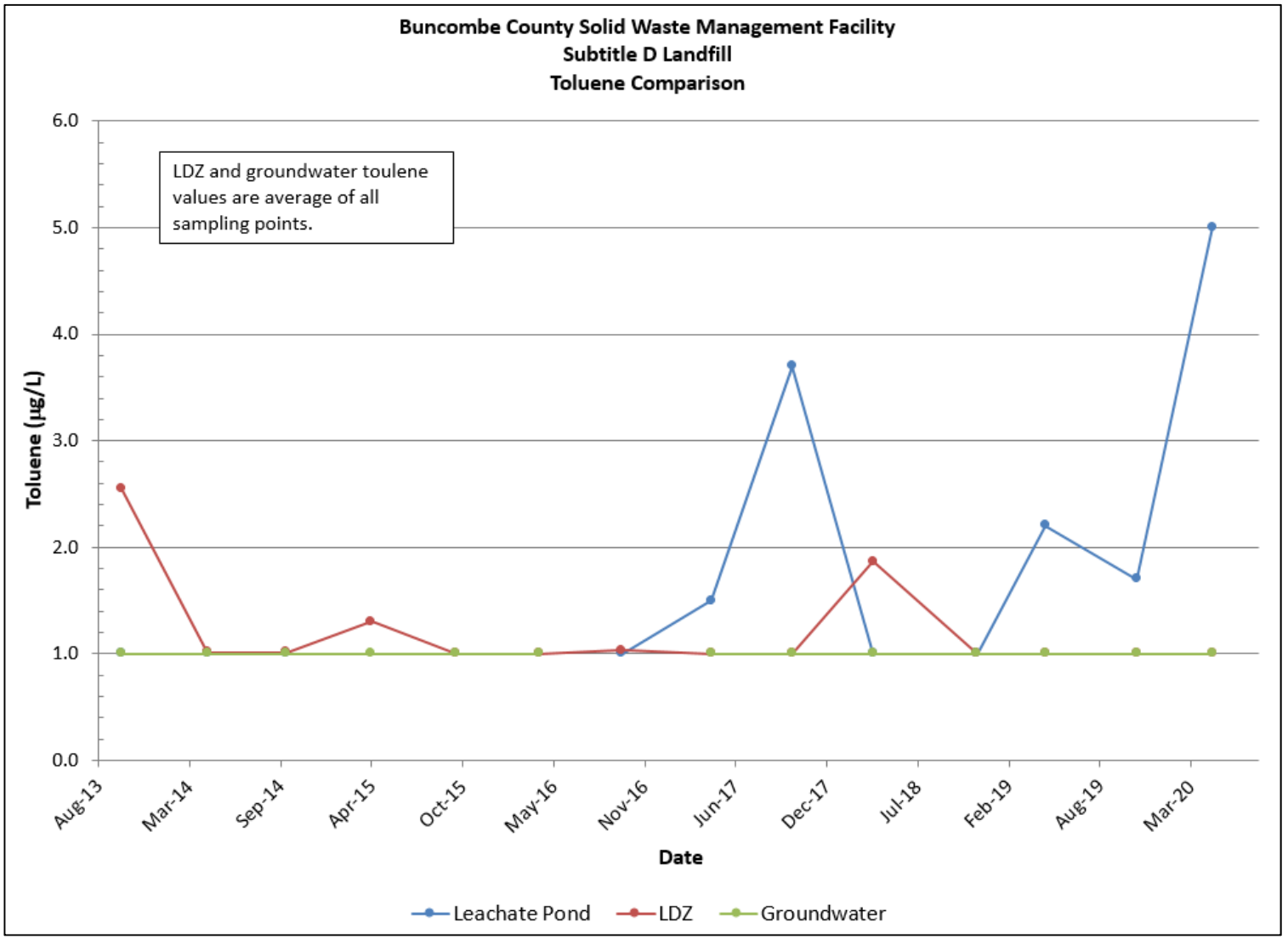

Figure 5-2: Toluene Comparison

5.2 WASTE SETTLEMENT IN CELLS 1 THROUGH 5

Approximately 6.85 million gallons of leachate has been recirculated in the landfill from 2006 through 2020.

Figure 4-17 presents a comparison of the 2010 and December 2020 topographic surveys. Side slope filling has recapture the majority of settlement. Settlement from recirculation is still apparent on the south slopes of the landfill.

5.3 CELL 6 SUMP LEVELS AND RECIRCULATION

Leachate recirculation in HITs 6B and 6C started in June 2014. Approximately 16 to 34 feet of waste was placed on top of those HITs and approximately 452,894 gallons of leachate were injected through 2017. Leachate recirculation in HIT 6A began in August 2016. The total leachate recirculated was approximately 101,836 gallons through December 2017.

Leachate sump levels are monitored and recorded during recirculation events to ensure sump levels do not increase as a result of recirculation.

Leachate recirculation was suspended in 2017 due to sideslope fill operations but in late 2020, marginal recirculation began.

5.4 WASTE STABILIZATION

The BOD5/COD ratio in Cells 1 through 6 leachate has decreased since 2007, which indicates that the organic waste fraction has stabilized (see **Figure 5-3**).

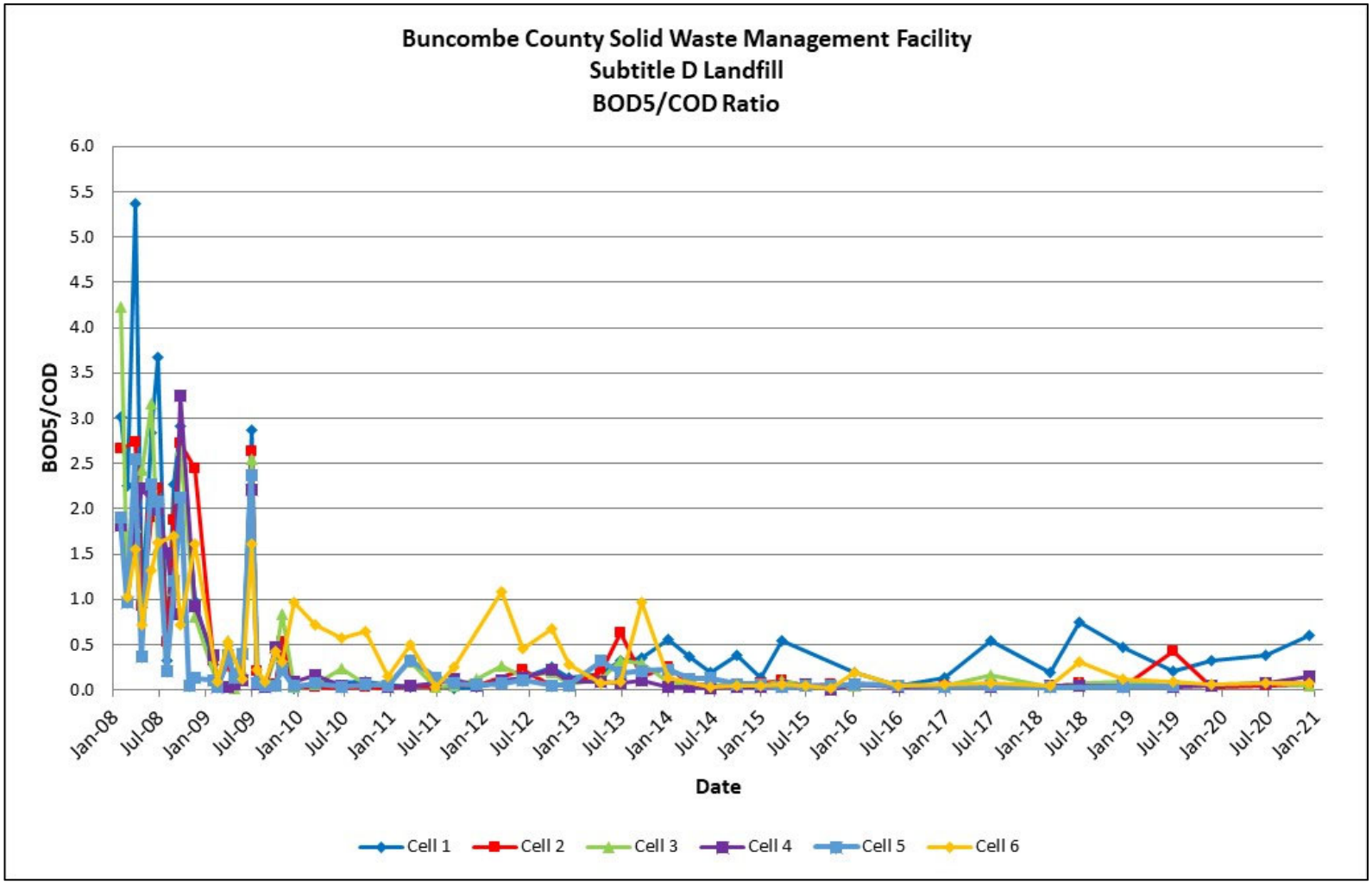

Figure 5-3: BOD5/COD Leachate Ratio

5.5 ALTERNATIVE COVER MATERIAL

The use of alternative daily cover improves HIT wetting distribution, uses less airspace than soil, and allows the on-site borrow soils to be dedicated for new cell and capping construction. It may also contribute to improved compaction of waste. It is recommended that alternative cover material be used to the largest extent possible during landfill operation.

The County received approval from NCDEQ to use Posi-Shell as an alternative daily cover at the Buncombe County landfill. This material has been used as an alternative daily cover and primary daily cover material since 2008.

6 RECOMMENDATIONS

6.1 MODIFICATIONS TO THE MONITORING PROGRAM

6.1.1 Assessment of Settlement

Settlement will be monitoring using annual topographic surveys in lieu of settlement plates.

6.1.2 Impacts of Leachate Recirculation to Head on Liner

As a result of the previous stakeholder meetings, NCDEQ and the County decided to monitor and record levels of the leachate in Cell 6 sump during recirculation events. By collecting and analyzing the information, the relationship of recirculation and leachate sump levels could provide insight. Changes in the levels are monitored; however, due to the construction activities on the slopes, recirculation has been suspended. Prior evaluation has not shown a significant change in the sump leachate levels during recirculation.

6.1.3 Temperature Probes

Temperature probes have been abandoned and will no longer be monitored. Historical data indicates that recirculation during winter months does not impact waste heat and decomposition.

6.2 DESIGN AND OPERATION ADJUSTMENT

6.2.1 Design of the Leak Detection Zones

In order to reduce the possibility of groundwater infiltration, future Cells 7 through 10 LDZ design will be revised by eliminating the 3-foot separation between the LDZ and the bottom of the base liner system. In addition, the secondary containment will be redesigned to avoid a lateral movement of groundwater into the liner detection sump. Other design revisions may be considered.

6.2.2 Plan of Action for Cell 6 HIT Operation

The Cell 6 HITs are currently being used for LFG extraction exclusively while sideslope filling operations take place in the area. Once that filling sequence has ended, the HITs with the highest LFG flow and ideal quality will continue to be used for LFG extraction and the remaining HITs will be used for leachate recirculation.

Future Cell 6 HITs will be installed and used for leachate recirculation only and the original Cell 6 HITs (6A through 6E) will be used for LFG collection.

The retrofit HITs will continue to be used for leachate recirculation in the future.

The retrofit SGTs have been abandoned during sideslope filling operations, and all SGTs will eventually be abandoned as sideslope filling operations progress. The SGTs worked well for over 10 years; however, they are no longer performing as well and will be abandoned.