BUNCOMBE COUNTY NORTH CAROLINA 2019 MID-YEAR BIOREACTOR PROGRESS REPORT

Buncombe County Landfill
81 Panther Branch Road
Alexander, NC 28701

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EXECUTIVE SUMMARY

Mid-Year Progress Report for 2019 has been updated with another year of operation of the bioreactor at the Buncombe County Landfill. The major issues for the County's solid waste program include the new transfer station, completion of the Construction & Demolition (C&D) landfill expansion, and the increase in the capacity of the municipal solid waste (MSW) landfill by increasing the slope angle of the sides of the disposal area. The slope construction has impacted the ability to recirculate leachate, so the County has temporarily ceased leachate injection. Once the side slope project progresses past certain areas of the landfill, portions of the injection program may be reactivated in the MSW facility.

Located in the mountains of western North Carolina, Buncombe County is a growing region of the state with the 2019 population estimated at 257,185. The City of Asheville is the County Seat. The landfill property is located north of the city and includes approximately 557 acres of area. The facility opened in 1997 as a transition to a Subtitle D classification MSW disposal landfill. The current planned MSW footprint is approximately 95 acres. A C&D landfill was permitted and constructed outside of the MSW planned footprint of the lined disposal area.

The intent of the Project XL program is to demonstrate that the environmental protection under a bioreactor operating in an alternative liner system can function equal to or better than the basic EPA liner system required under Subtitle D. The demonstration project has specific goals including impacts on the liner system, gas generation impacts, settlement due to enhanced degradation, and basic control of the injection program for leachate management.

One of the operational issues of landfills is the management of leachate generated and captured within the lined landfill. The wastewater treatment/holding facility on the Buncombe site cannot provide treatment to the level required for discharge into the French Broad River located close by to the site. The Municipal Service District (MSD) wastewater treatment facility is located approximately 6 miles from the site and serves to provide the final treatment of leachate. This requires transporting the liquid via tanker trucks to the MSD facility. This expensive process requires determining a more logical approach to management of the leachate. Injecting the liquid into the waste for recirculation helps in that effort and provides other benefits as well. Since the facility's disposal areas are designed as an alternative liner system, automatic permitting for recirculation was not available. However, the site was accepted as one of the Environmental Protection Agency's Project XL program as a full scale operation.

Under this program a leachate distribution/injection system was designed, installed, and operated within the deposited waste being expanded as the disposal areas are built and operated. The landfill also has a landfill gas collection system that directs the collected gas to a power generation system that is tied to the local grid. The current use of leachate may be supplemented in the future with other permitted liquids if the opportunity provides a reasonable management cost.

AIRSPACE GAINS/ENHANCED SETTLEMENT BENEFITS FROM BIOREACTOR OPERATIONS

One of the goals outlined in the Project XL agreement is enhanced settlement realized through recirculating leachate. Recirculating leachate increases microbial activity in the waste mass which in turn increases the decomposition rate for MSW. The faster the garbage decomposes the quicker the landfill settles and additional airspace can be gained for future disposal needs. Significant settlement and airspace gains have been realized from the leachate recirculation program at the Buncombe County Landfill through the Project XL agreement.

Ten Settlement plates were installed throughout the entire footprint of the MSW landfill. An average settlement of 1.84 ft. as shown in Figure 1 has occurred in Cells 1-5. There is a correlation between leachate recirculation locations relating to the settlement of the waste. Additionally, noticeable settlement areas have gained an advantage from stormwater that is captured on the flatter elevations that percolates through the waste.

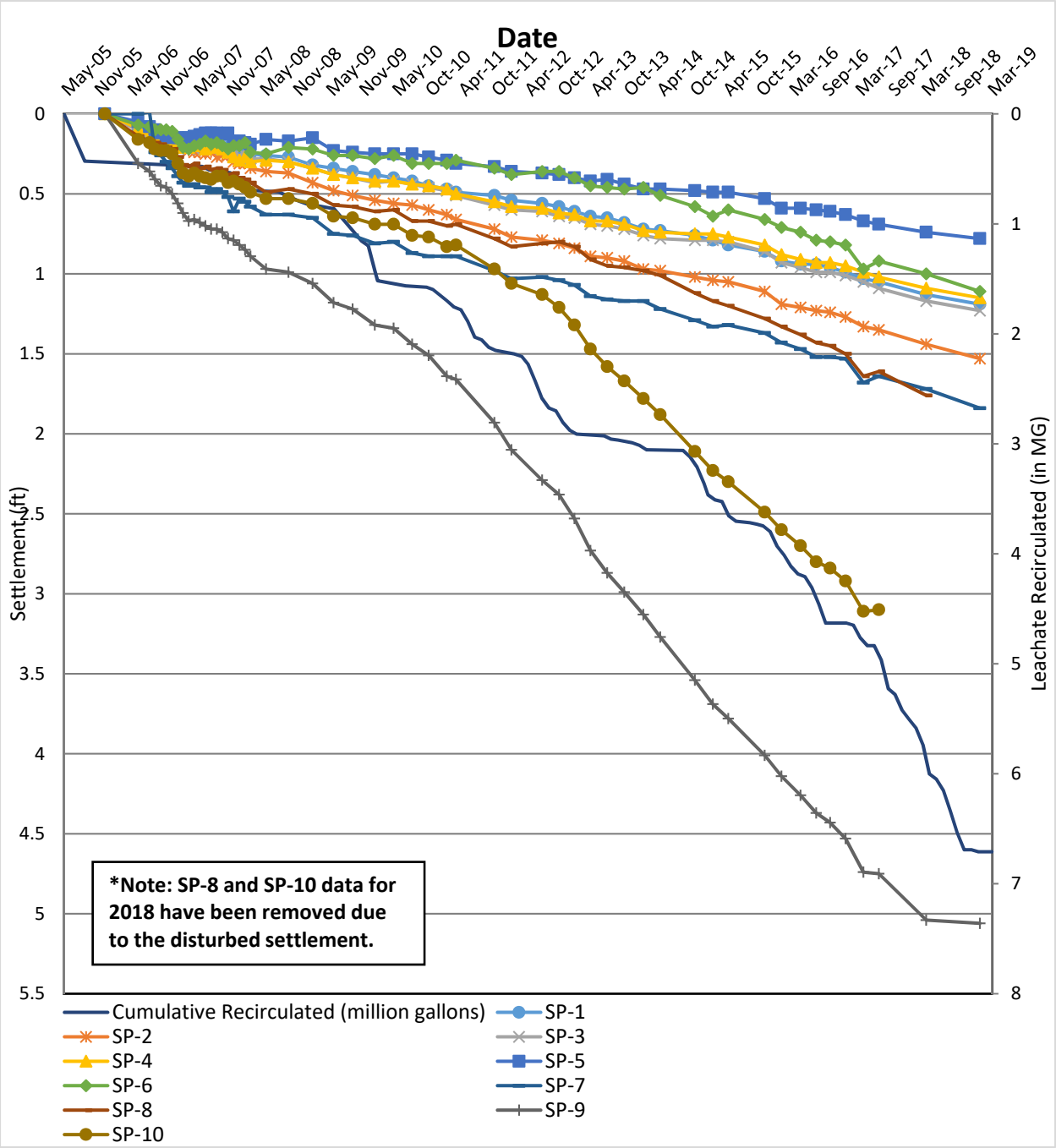

Figure 1. Cumulative Settlement (2006 – January 2019)

FUTURE LANDFILL DEVELOPMENT/OPERATIONS

The facility's long-term plans incorporate ten disposal units that are constructed separately but are under a continuously connected bottom liner system. The initial design for the filling of waste sequence called for the exterior side slopes of the landfill to be constructed at a 4:1 (horizontal:vertical) slope. The County has gained approval from the North Carolina Department of Environmental Quality (DEQ) to increase the slope to 3:1. This will provide a significant volume increase and will extend the life of the facility and spread out the costs of disposal unit additions without liner footprint expansion. This also allows airspace to be recaptured due to settlement from the bioreactor. Filling the sideslopes began on September 19, 2017. During the process, the recirculation program has been adjusted to fit the construction sequence. Injection will not be conducted in the vicinity of the slope construction until the fill sequence is complete in that area.

Buncombe County staff built the access road for the commercial haulers to access the sideslope disposal area, Figure 2. Utilizing our own Solid Waste Department's staff to build the access road and prepare the site for sideslope disposal saved the Solid Waste Department significant funds. Figure 3 & Figure 4 show the active disposal area prepared by staff. Additionally, Solid Waste staff completed all the excavation required around the bioreactor leachate injection/gas extraction lines, Figure 5.

Figure 2. Access road to side slope disposal area

Figure 3. Side slope Waste Placement

Figure 4. Waste Placement into sideslope disposal area

Figure 5. Excavation around Gas/Leachate Lines

RENEWABLE ENERGY BENEFITS OF THE BIOREACTOR PROGRAM

Bioreactor operation is utilized to produce renewable energy where landfill gas generation is applied. The renewable energy equivalent to the quantity of houses' electricity usage is shown in Table 1 below.

Table 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	8937	676
2013	9379	710
2014	8953	678
2015	9874	747
2016	7915	599
2017	9744	738
2018	8740	661
January – June 2019	4973	377

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

OPERATION OF CELL 6 HORIZONTAL INJECTION TRENCHES (HIT)

Early in the initial design and installation process the same pipe used to inject the liquid also collected the gas. Later, separate lines were used for each purpose to help maximize gas recovery. This approach is applied in the active disposal area of Cell 6. Horizontal Injection Trenches (HITs) 6A, 6D, and 6E have been observed to produce a high percentage of methane and a good steady flow rate. However, the periodic "watering in" of the collectors cause interruption of gas collection and monitoring. Gas collection will continue in the identified HIT's and continued leachate recirculation will occur in the other HIT's.

Based on operation experience, economic evaluation, and gas collection capabilities the County has opted to change the design of the gas collection by not installing horizontal gas collection piping in the next and future installations of the leachate injection distribution system. One of the lessons learned through the operations is that the horizontal piping tends to water-in thus reducing their effectiveness to collect gas as well as contributing to leachate breakouts on the side slopes. Vertical gas wells are more effective in collecting gas in a properly designed system and easier to de-water by utilizing vertical pumps, if necessary. In summary, the operation of the facility as a bioreactor has overall proven to be an advantage for Buncombe County.

LINER SYSTEM MONITORING AND PERFORMANCE

In order to ensure the performance of the liner system in the landfill, leak detection quality and quantity is monitored semiannually. Under the landfill at large monitoring program the leak detection liquid quality is also monitored with the semi-annual groundwater monitoring.

It was determined through leak detection data that the cells with alternative liner systems are functioning at a proportional level to those other 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 2 below shows that Cell 1-6 were presenting better outcomes than the industry standard.

Table 2. Leakage Rate in Cells 1-6 in Comparison to Industry Standard.

Cell	Area (acres)	Average Annual Leakage 2007 – Jan-June2019 (gal/acre/day)	Max Annual Leakage 2007 - Jan-June 2019 (gal/ac/year)	Industry Standard (gal/yr)	Liner Type
1	9.7	0.0	0.0	20	Subtitle D
2	3.1	0.1	0.1	20	Subtitle D
3	8.2	0.2	1.0	20	Alternative
4	4.1	0.0	0.0	20	Alternative
5	7.1	0.6	2.5	20	Alternative
6	22.7	0.3	1.3	20	Alternative

1. Peggs, Ian D. Geomembrane Liner Action Leakage Rates: What is Practical and What is Not? Land and Water Magazine. July/August 2009 Issue.

Liquids collected in the landfill cell detection sumps are tested against the North Carolina DEQ standards for groundwater. To reduce the potential of groundwater infiltrating the leak detection zones, the County has reassessed the design of Cells 7-10 leak detection zone (LDZ). The new design helps avoid groundwater from directly entering the detection sump areas. The County continues to look for better designs to address keeping contaminants contained in the leachate management system.

Leachate sump levels are also monitored and recorded during recirculation events to ensure sump levels don't 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 is operational as of April 2019 and the County was able to extract and collect the data on sump levels in Cell 6 from recirculation events shown in 0.

The following Mid-Year Bioreactor Progress Report summarizes the data collected through July 2019 for the Buncombe County Solid Waste Management Facility (Facility) as part of the United States Environmental Protection Agency's (USEPA's) Project XL Program.

1 INTRODUCTION

The Buncombe County (County) Solid Waste Management Facility was chosen to be a host site for a research project being conducted under USEPA Project XL Program. The objective of this Mid-Year Progress report is to demonstrate all the data gathered in January to June 2019. Kristy Smith – Buncombe County Bioreactor Manager, C. "Ed" Hilton Jr., PE – SCS Engineers, PC and Katherine Sun - SCS Engineers, PC prepared this document.

1.1 SITE DESCRIPTION

Buncombe County, North Carolina, is a growing community with a 2019 estimated population of 257,185. The County's Solid Waste Management Facility opened in 1997 and consist of approximately 557-acres. The site includes a MSW Subtitle D landfill, C&D

landfill, wood waste mulching facility, a residential drop-off, a household hazardous waste (HHW) facility, and a white good and tires recycling facility. See Figure 6 for the overall site layout.

Cells 1-10 of the MSW landfill are being constructed progressively over the approximated 30+ year life of the facility. The bottom liner system has been modified during expansions of the protective lined areas. The base original design for Cells 1 and 2 included the following, from bottom to top:

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

Cells 3-6 were constructed with the following bottom liner system from bottom to top:

- 18" soil barrier layer with a maximum hydraulic conductivity of $1x10^{-5}$ cm/sec
- Geosynthetic clay liner (GCL)
- 60-mil HDPE liner, and
- 24" rock drainage layer was constructed in Cells 3-6 as an alternative liner system.

Leachate detection systems were installed under the liner system. Since 2006, active MSW disposal operations have occurred in Cell 6 since Cells 1-5 capacity has reached their interim capacity.

Figure 6. 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. Having these requirements has been favorable in avoidance of the mitigation of potential groundwater contamination. The design guidelines for Subtitle D Landfills have been very successful in preventing groundwater contamination, however; the concept also creates a dry entombment for MSW of waste. This slows the process of degradation to stabilization but it remains the most common landfill type being operated since the regulations were instituted. The bioreactor landfill promotes the degradation process but challenges the stabilization process while the landfill is still being monitored. Liquids addition has favorable results at landfill sites in the United States. Bioreactor landfills use controlled methods of liquid addition to accelerate moisture build up and to enhance the decomposition of waste.

Subtitle D alternate liner systems are prohibited from operating as a bioreactor under solid waste management federal regulations. USEPA issued a final project agreement under their project excellence and leadership program also known as "Project XL" approving Buncombe County's proposal to associate a liquids addition process as an essential component of their landfill operation. This is done by providing the design and execution within a specific monitoring framework. The bioreactor project for Buncombe County provides for evaluation of impacts from the liquid addition for a different or alternate liner system that meets the Subtitle D criteria. The data gathered from this project may provide support for adaptation of federal regulations to allow liquids addition to MSW - alternative liner systems landfills.

1.3 PUBLIC AWARENESS

Raising public awareness has been an important part of the County's solid waste program, therefore the county staff has made presentations to diverse audiences, provided tours for local colleges and high schools, and exhibited a live interview at the bioreactor site for Buncombe County. The county website is also available where it is updated semi-annually with new compilation of data and other information and is available at https://bioreactor.buncombecounty.org/

Buncombe County holds periodic stakeholder meetings to generate feedback and report findings throughout the XL agreement. The first stakeholders meeting was held on September 10, 2008, and the last on November 10, 2016. The very first stakeholder meeting was attended by Western North Carolina Regional Air Quality Agency, NCDENR, University of Florida, Buncombe County Management, Engineers at CDM Smith, Inc., and EPA employees via teleconference. The stakeholders' session will not take place this year.

2 PROJECT DESCRIPTION

This project is under Project XL granting regulatory flexibility to add liquids to cells that are equipped with alternative liner systems. This also allows the County to add other liquids other than leachate to the waste mass. As of now, leachate has been the only liquid to be utilized as it is easily accessible onsite 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. Injection has currently been paused while the slope modifications are in process. It is noted that a leachate temperature of 50 °F should not be injected to the waste mass due to potential impact on the degradation process.

2.1 RETROFIT BIOREACTOR SYSTEM

2.1.1 Leachate Recirculation

The facility's bioreactor project began when Cells 1-5 were almost at capacity requiring the need to establish a retrofit system. The retrofit system was designed to utilize a combination of horizontal trenches (HIT) and Surficial Gravity Trenches (SGT) to recirculate leachate as shown in Figure 8.

There were a total of six HITs installed in the reconstructed area of the landfill. During the waste fill process at elevation of 2040, the first three HITs were installed as an anticipation of project's approval. They are placed 100 ft. apart, extending approximately 400 ft. south in the waste mass. Three more HITs were installed at 2080 elevation also using the same spacing but extending approximately 800 ft. east in the waste. To provide a more uniform distribution of leachate due to the placement issues, two pipes per trench were used – short pipe, to wet the first 400 feet, and long pipe to wet the remainder of the trench.

There are five SGTs that were installed on the side slopes ranging between 450-600 feet in length plus SGT1 at elevation 2030, SGT 2 and 4 at 2050, and SGT 3 and 5 at 2070. To prevent air intrusion, provide containment of the recirculated leachate, and to allow gas collection, the trenches were excavated 11 ft. into the waste and capped with a clayey soil. The SGTs are operated differently compared to the HITs. SGTs avoid leachate seeps as a gravity-feed system whereas the HITs provides greater lateral distribute by allowing it to be pressurized up to 10 psi.

To provide earlier implementations and thorough wetting, all future trenches will be initiated at vertical and horizontal separations during the waste fill sequence phase of the cells.

2.1.2 Gas Collection

Cells 1-5 have twenty-five vertical gas collection wells that were installed as shown in Figure 9 The gas collection components of the HIT and SGT were shut off when the new well field installation occurred. Landfill gas from the cleanouts of the leachate collection system of each cell was previously also gathered for additional data collection and has now been discontinued.

2.2 BUILD-AS-YOU-GO BIOREACTOR

Phase 2 is an infrastructure that is installed in stages as the waste is being placed. Thus, this process has been tagged as a "Build-As-You-Go Bioreactor." It allows a more pervasive wetting of the waste and early capture of landfill gas. The very first stage of the Phase 2 system was established in Cell 6 in 2012 and initiated operation in June 2014. The next stage will be installed at elevation 2100 will occur in November 2019.

2.2.1 Leachate Recirculation and Gas Collection

Cell 6 has five HITs for leachate recirculation and gas collection for the first phase as shown in Figure 10. Maintaining the injection process at an adequate distance from outer slope minimizes slope leachate seeps by installing a 100 foot section of solid wall pipe into the waste before the perforated pipe starts. The original intent of the pipe system was to drain the excess liquid to P-traps from which the leachate would drain to the leachate sump riser pipe allowing gas capture in between recirculation events. This had some impact because the leachate in the trench also drained to the surface on the slopes causing seeps that had to be managed. The next generation of HITs will drain inward into the center of the waste disposal area to alleviate the seeps. The gas collection portion of the HIT's will not be

installed in the next generation of HIT's. Leachate recirculation has been suspended due to sideslope fill operations and will resume as the construction progresses.

When liquids addition takes place, it is continuously supervised by the bioreactor manager. Each injection takes between two to six 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

Temperature probes are being used to monitor mesophilic bacteria since the bacteria becomes active in ranges between 80 °F and 115 °F, thus enhancing the decomposition of wastes. To get accurate results, thermocouples were placed in Cell 6 Phase 1 in July 2012, shown in Figure 11. These thermocouples are made up of a stainless-steel temperature sensors with a lead cable. Six thermocouples were placed in a 4-inch perforated PVC pipe backed with concrete and sand. To allow cable movement during settlement, the cable end of the pipe was left open which helps the sensors transfer data to a datalogger which was installed at the pump station control panel in Cell 6. These sensors are instrumental in assessing the impacts of leachate temperature during injection. As the ambient air temperatures drop in the winter, the leachate in the pond will get colder. The information is downloaded monthly for future analysis of the report.

The temperature of waste in Cell 6 is shown in Figure 7. Thermocouple T-5 and T-6 seem to have failed as evidenced by showing readings close to 300 degrees Fahrenheit and producing erratic jumps from negative to positive each monitored readings respectively. There are no temperature readings before April 2019 as the datalogger was sent back to the manufacturer for repair.

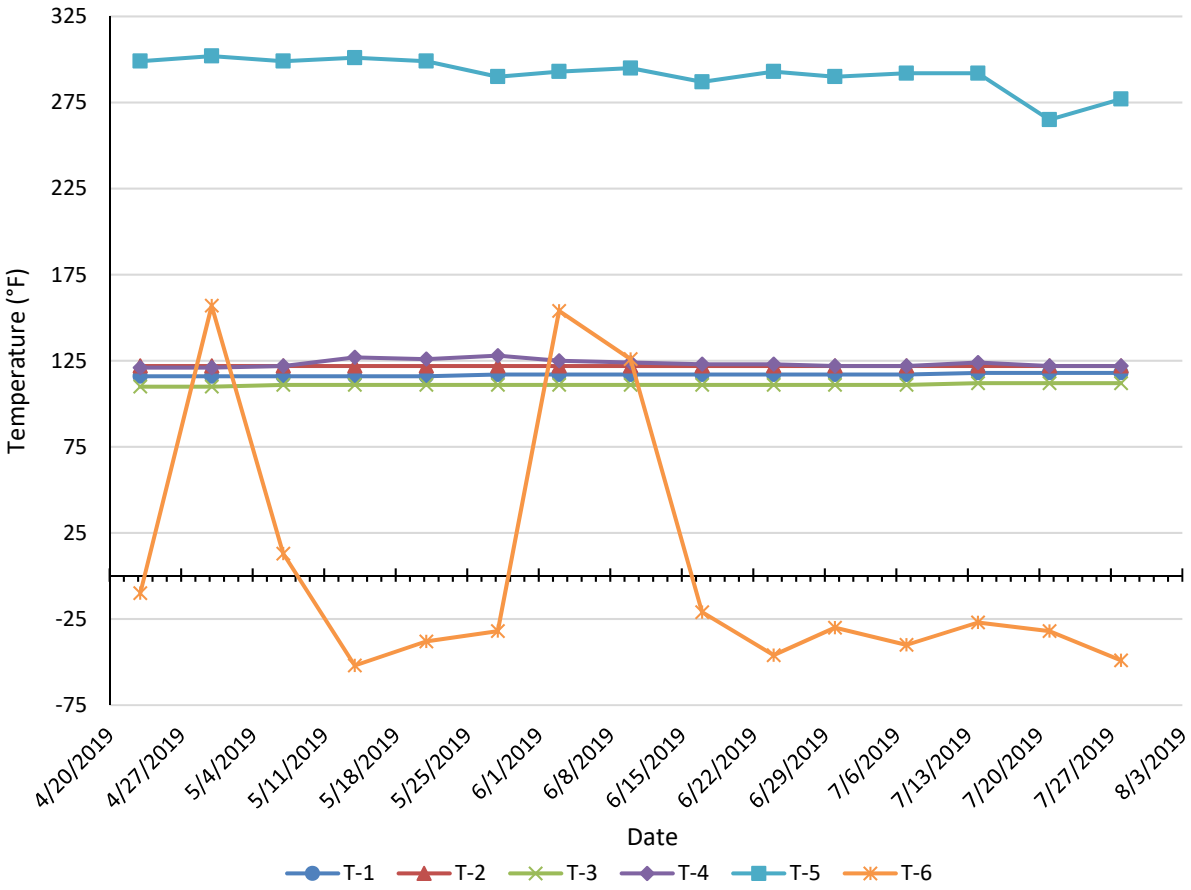

Figure 7. Waste Temperature Readings in Cell 6.

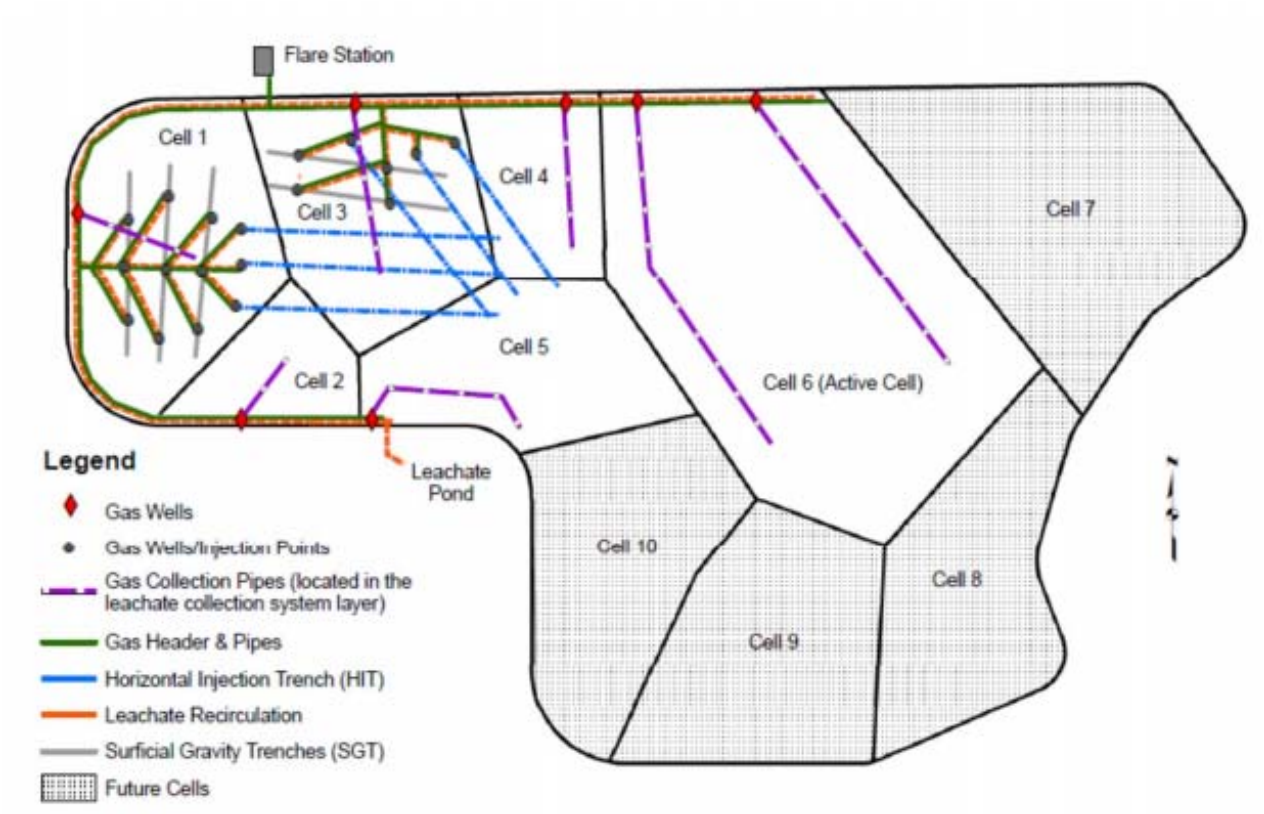

Figure 8. Retrofit Bioreactor System

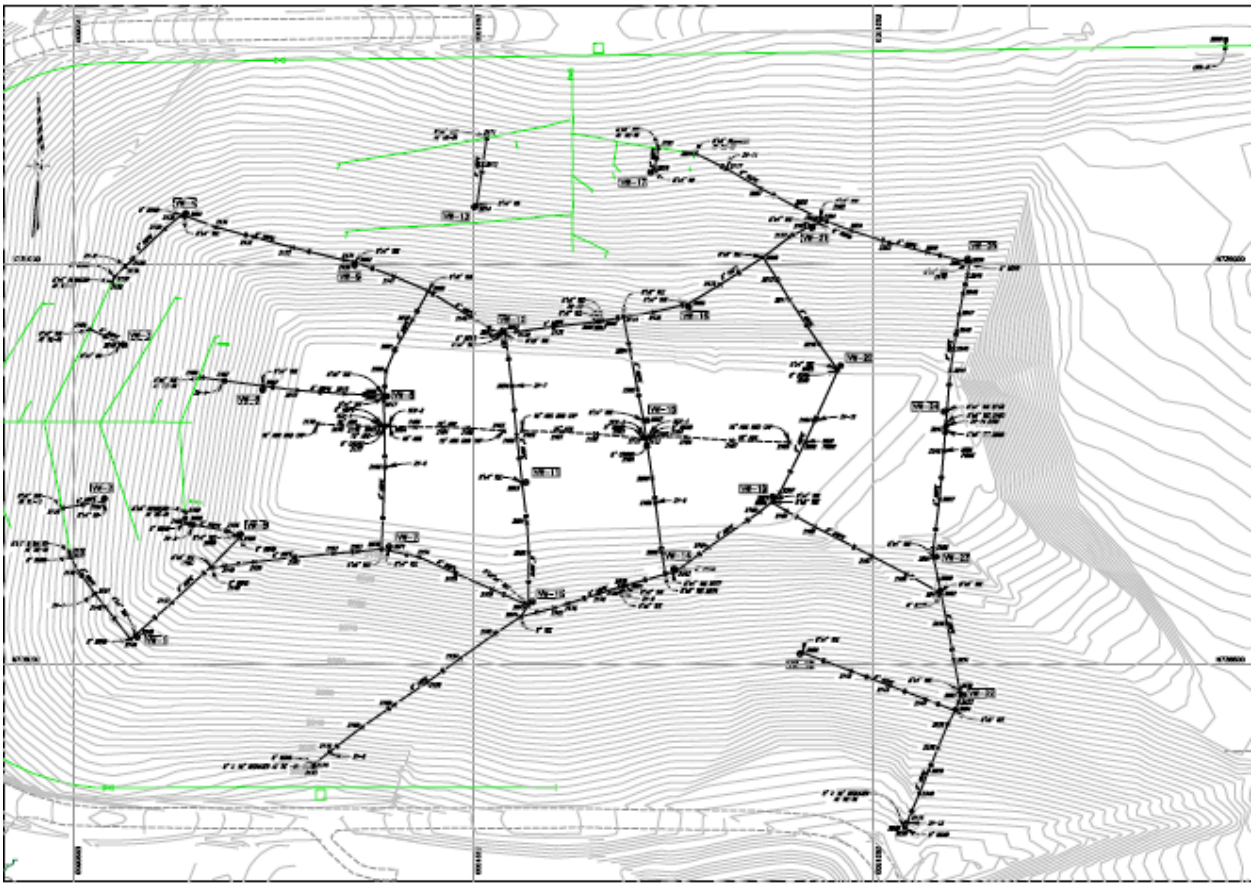

Figure 9. Vertical Gas Well Collection System in the Retrofit Area

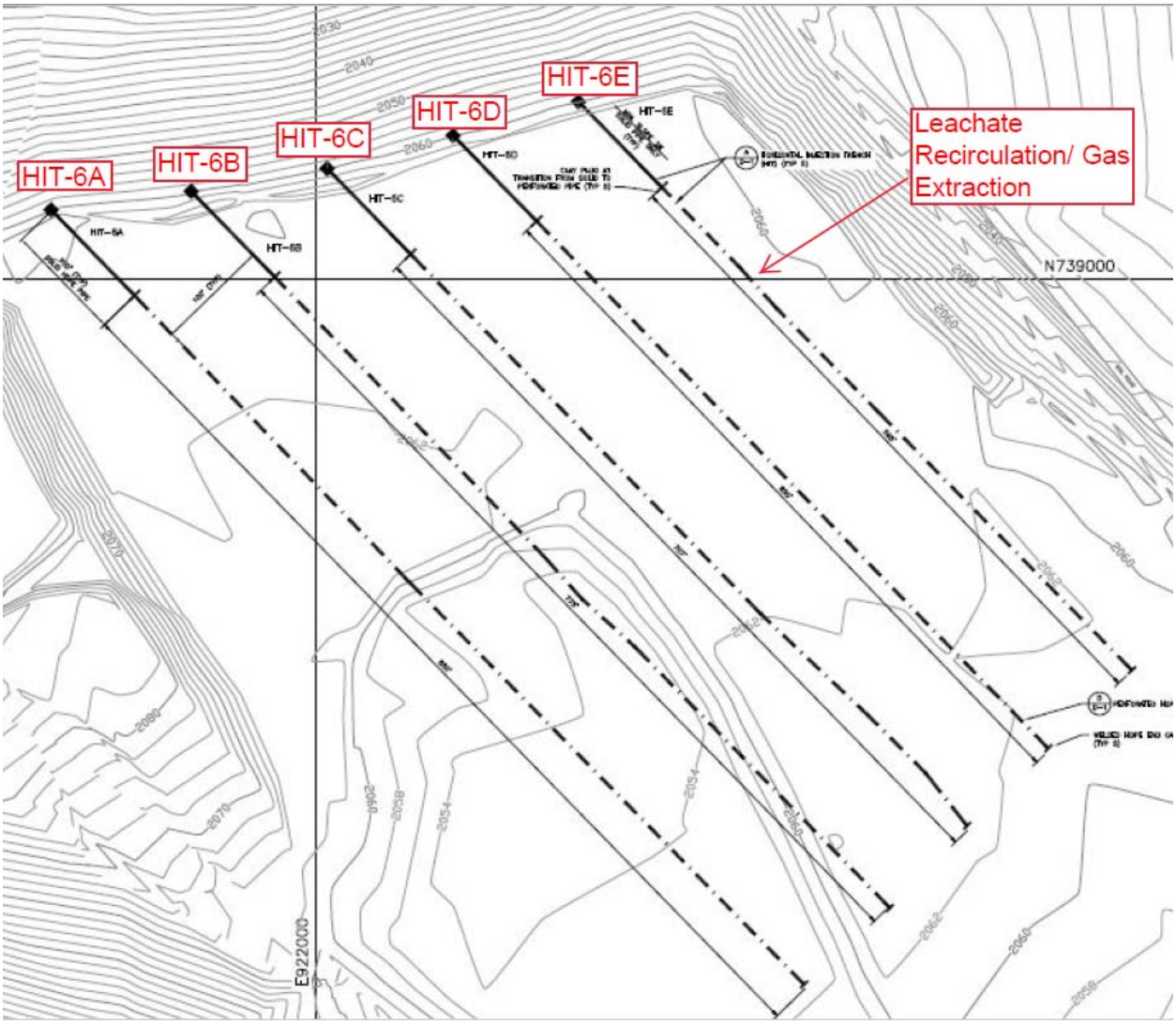

Figure 10. Build-As-You-Go Bioreactor System

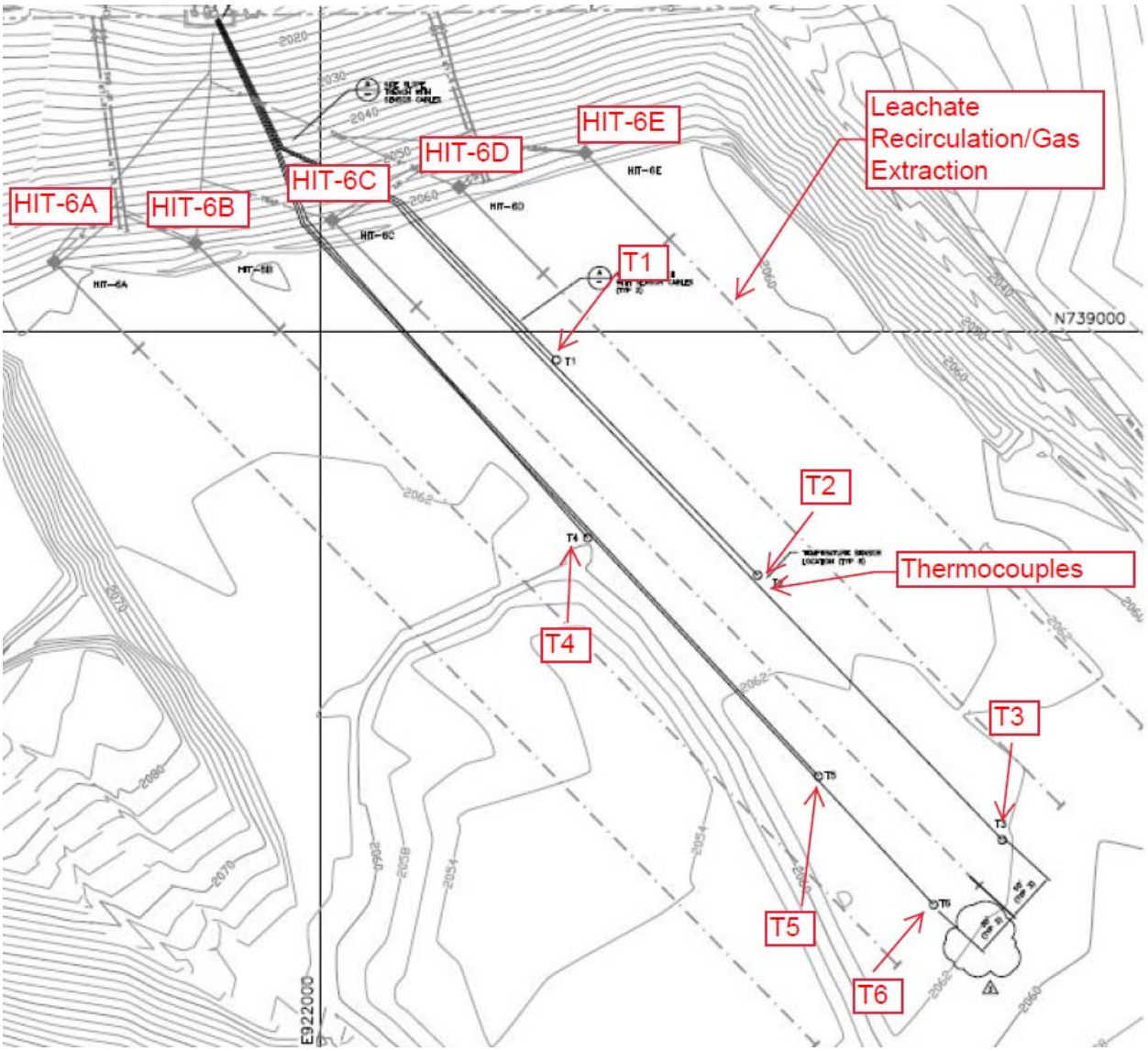

Figure 11. Temperature Sensors in Cell 6

3 MONITORING PROGRAM

3.1 PROGRAM OVERVIEW

The monitoring program for Buncombe County's Project XL EPA bioreactor agreement was developed with the stakeholders. Table 3 shows the monitoring parameters and frequency of data collection for the project.

As part of facility operation, Buncombe County also performs semi-annual testing of North Carolina Department of Environmental Quality (DEQ) established leak detection zones (LDZ), groundwater monitoring wells, leachate pond, and stormwater collection ponds for the 2L groundwater standards and for the surface water standards as appropriate. The data gathered from all these monitoring parameters is used to determine the performance of alternative liner system.

Table 3. Parameters and Frequency Events

Parameter	Frequency
Leak Detection Quantity	Semi-Annually
Leak Detection Quality	Semi-Annually
Leachate Quality	Semi-Annually
Leachate Quantity	Weekly
Leachate Recirculation Quantity	Ongoing
Gas Composition	Ongoing
Gas Volume and Flow Rates	Ongoing
Settlement Plates	Semi-annual
Settlement Survey	Annually
Waste Density	Annually
Waste Temperature	Ongoing
Cell 6 Sump Level	Ongoing

3.2 LEAK DETECTION SYSTEM

The landfill cells and leachate pond are equipped with leak detection zones (LDZ) located beneath the leachate collection system sumps. The LDZs are approximately one acre in size and are equipped with 60-mil HDPE geomembranes and a 24-inch rock drainage layer located three feet below the subgrade of the liner system. This geomembrane is designed to slope directly to a collection pipe that allow for the removal of any liquid that is collected in the detection zone.

For Cells 3-6 liquids that were collected in the LDZ are pumped out through vertical stand pipes that are located along the perimeter berm. Cells 1-2 utilizes gravity pipes to drain liquids to a collection point across the perimeter road. These drain pipes are equipped with gate valves that allows the operator to monitor the liquids being captured. There is no data recorded for the quantity in Cell 1 since it is evident that it appears to be impacted by a steady supply of groundwater from an underground spring.

If liquid is observed in the LDZ, it is collected and examined onsite using a water quality meter for oxidation reduction potential (ORP). The County has been experiencing issues with the water quality meter thus not being able to collect ORP readings. A new water quality meter has been purchased and these readings will resume. Furthermore, liquid samples collected are sent to Pace Analytical for analysis of BOD5 (Biological Oxygen Demand), pH, COD (Chemical Oxygen Demand), 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 COLLECTION SYSTEM

Each cell's quantity of leachate is collected on a weekly basis. Each cell is equipped with a leachate pump system with a flow meter that transmits and monitors 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. A Buncombe County staff member gathers and records the data onto a field form.

Leachate quality sampling from Cells 1-6 and Pond are taken from sampling ports at the leachate pump stations located in the valve vaults and occur semi-annually. These collected samples are sent to Pace Analytical for the examination of BOD5 (Biological Oxygen Demand), pH, COD (Chemical Oxygen Demand), Ammonia, and Specific Conductance. Sampling and testing of the combined cells leachate is also tested semi-annually from the leachate holding pond.

A water quality meter is used to perform on-site analysis of the leachate for ORP and TDS.

Currently, on-site analysis for ORP and TDS through Horiba U-22 water quality meter are not being performed since it has been malfunctioning. Continuing analysis of ORP and TDS will resume.

The Bioreactor Manager records all the sampling processes by gathering a recorded monitoring log.

3.4 LEACHATE RECIRCULATION

A magnetic flow meter is installed at the leachate pond pump station which records the quantity of leachate recirculated for each injection event. The Bioreactor Manager tracks the quantity of leachate injected and identifies the specific HIT/SGT used for the injection event. Leachate recirculation is currently suspended due to sideslope fill operations and it will resume as it progresses.

3.5 LANDFILL GAS

Gas composition and gas flow data has been steadily recorded and monitored since November 2011. Previously the gas was flared as a management tool. The development of the gas to energy facility has provided some benefit with the power being created by using the gas as the fuel for the engines that turn the turbines for electrical generation. This power is sold to the Duke Energy grid.

3.6 LANDFILL SETTLEMENT

There were 10 locations in the retrofit area where settlement plates were installed as shown in Figure 11. These plates were originally surveyed quarterly to monitor the rate of waste settlement. The settlement plate surveys now occur semi-annually. Figure 1 illustrates the impacts recirculation has on settlement across the landfill. Buncombe County is actively utilizing the enhanced settlement by going back over these areas with its sideslope fill operations. In addition to the settlement plates, on occasion, an annual topographic survey of Cells 1 through 5 is carried out using a 50-foot grid for taking measurements.

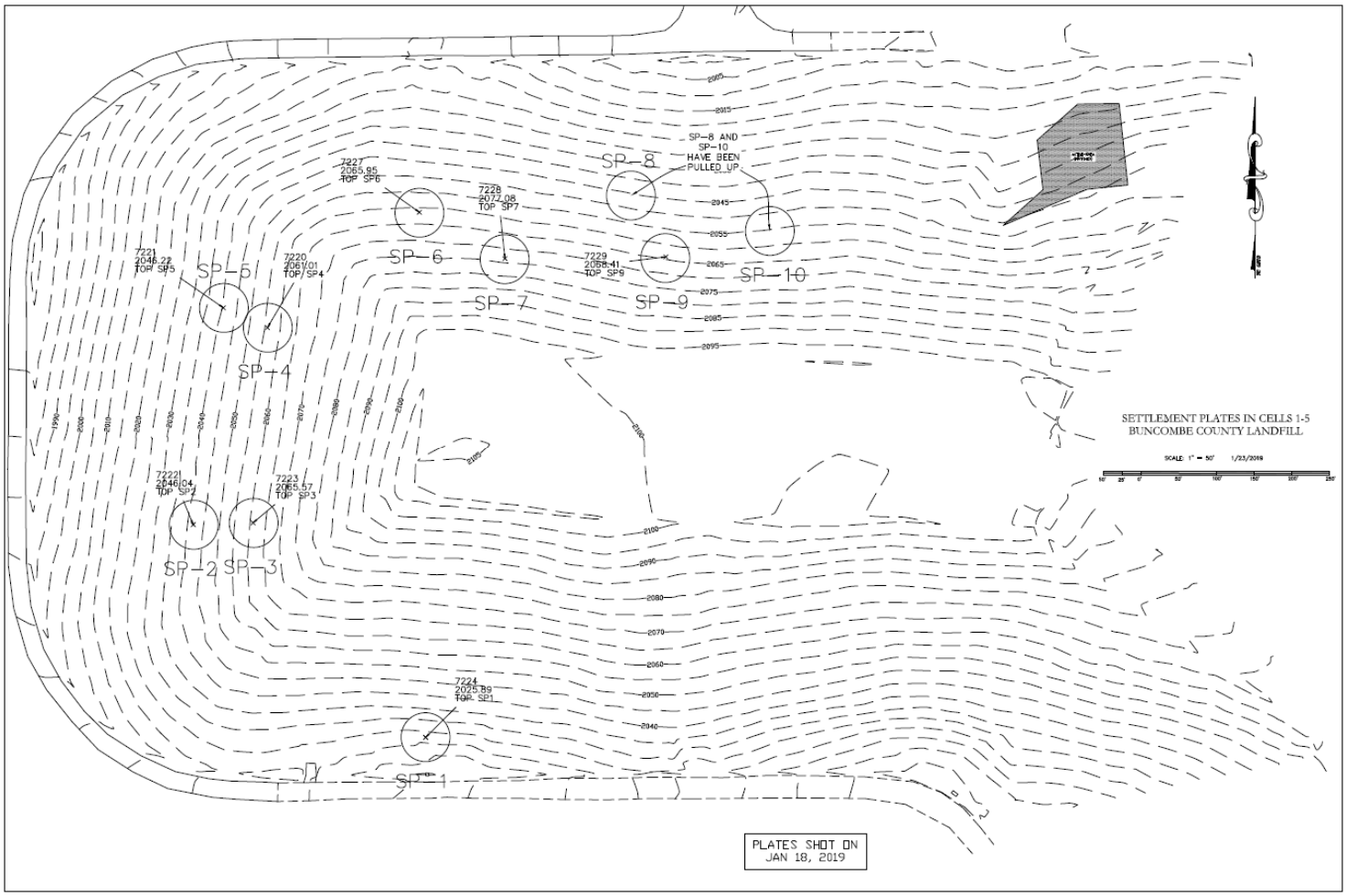

Figure 12. Settlement Plates in Cells 1-5

3.7 LANDFILL TEMPERATURE

Monitoring the temperature of the landfill has been ongoing since July 2012. Due to the fear that injecting a leachate colder than 50 °F into the waste mass may impact the biological activity, leachate recirculation is ceased if the temperature of the leachate falls below that value. Leachate recirculation during the winter months has occurred in Cell 6 HIT's. Utilizing the temperature probes allows the bioreactor operators to investigate if colder leachate has any impact on affecting the temperature of the waste in the landfill. To date, there has not been any significant temperature drops observed while recirculating during the winter.

3.8 EFFECTIVE WASTE DENSITY

Effective waste density was added to the monitoring program for Cell 6 to examine the impact of wetting on landfill capacity as settlement plates are problematic to maintain in active cells. In order to compute the volume of waste and cover soil in Cell 6 on a quarterly basis, a topographic survey was used. Recorded waste tonnage are used to determine the effective density of the waste which is defined as:

$$\frac{\text{The weight of disposed waste}}{\text{The combined volume of waste and cover soil}}$$

Actual density differs from effective density due to cover soils which are not weighted prior to placement.

3.9 CELL 6 LANDFILL GAS COLLECTION

All Cell 6 HIT's are being utilized for gas collection. No recirculation is occurring due to the ongoing sideslope project and it will resume as it progresses. All the information gathered from these data are being analyzed to determine if landfill gas collection should continue or if the HIT should be used just for recirculation. The upcoming expansion of the HIT system at a higher elevation in the waste fill sequence is planned to only inject the leachate not recover gas. The existing systems will continue to function as installed.

3.10 CELL 6 SUMP DATA

In order to continuously record the leachate level in Cell 6 sump, a datalogger is utilized. This allows the investigation of the impacts of recirculation on leachate generation and head on the liner system.

4 PROJECT ASSESSMENT & COLLECTED DATA

This section discusses the data collected from 2007 through June 2019. 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 leak detection zone, also known as "LDZ" is shown in Table 4. 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. Collected liquids from LDZ

Sample Year	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Yearly Total	Leachate Pond
	(gallons)	(gallons)	(gallons)	(gallons)	(gallons)	(gallons)	(gallons)	(gallons)
	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	3300	2040	5,898	0
2012	NA	115	530	1	1850	1220	3,716	3
2013	NA	80	500	0	850	1150	2,580	9
2014	NA	30	350	0	750	1325	2,455	45
2015	NA	136	400	0	875	2200	3,611	60
2016	NA	40	475	0	630	2050	3,195	28
2017	NA	25	200	0	150	450	825	15
2018	NA	80	600	0	550	2225	3,455	100
January – June 2019	NA	28	50	0	225	450	753	25
Cumulative	**NA**	**617**	**9,527**	**26**	**21,895**	**33,135**	**65,200**	**285**

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

Quarterly and semi-annual quantities of liquids collected from LDZ are shown in Figure 13 and Figure 14. Figure 15 through Figure 20 shows qualitative data from liquid testing such as pH, conductance, ORP, BOD5, COD, and ammonia parameters.

Semi-annual collections began in 2016.

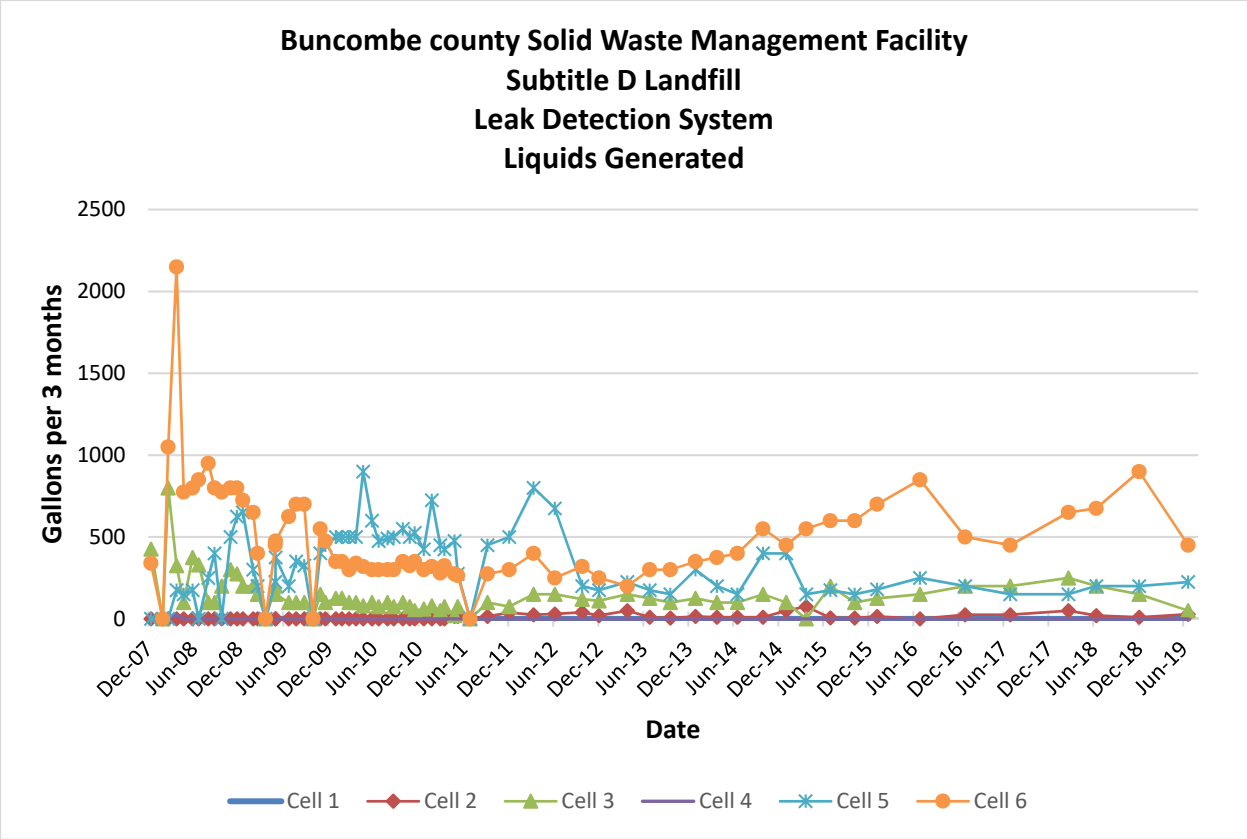

Figure 13. Liquids Generated (2007- June 2019)

*Note: Leak Detection Volumes was done quarterly until 2016.

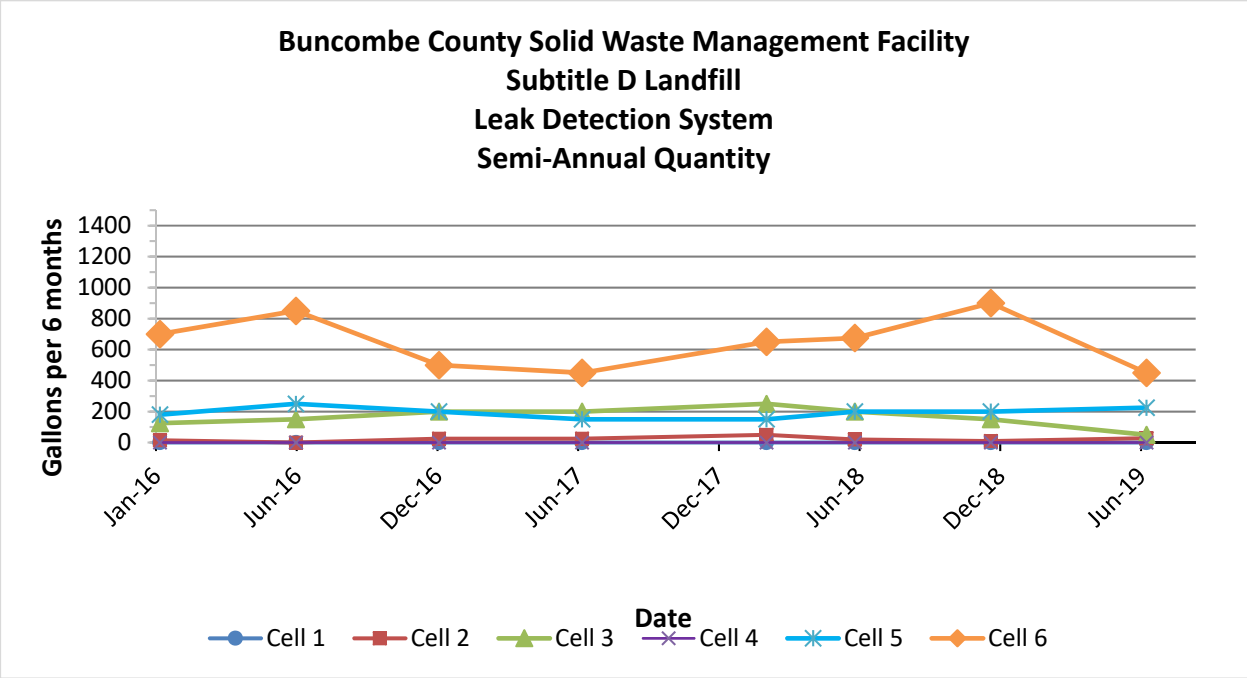

Figure 14. Semi-Annual Leak Detection Volumes (2016-Present)

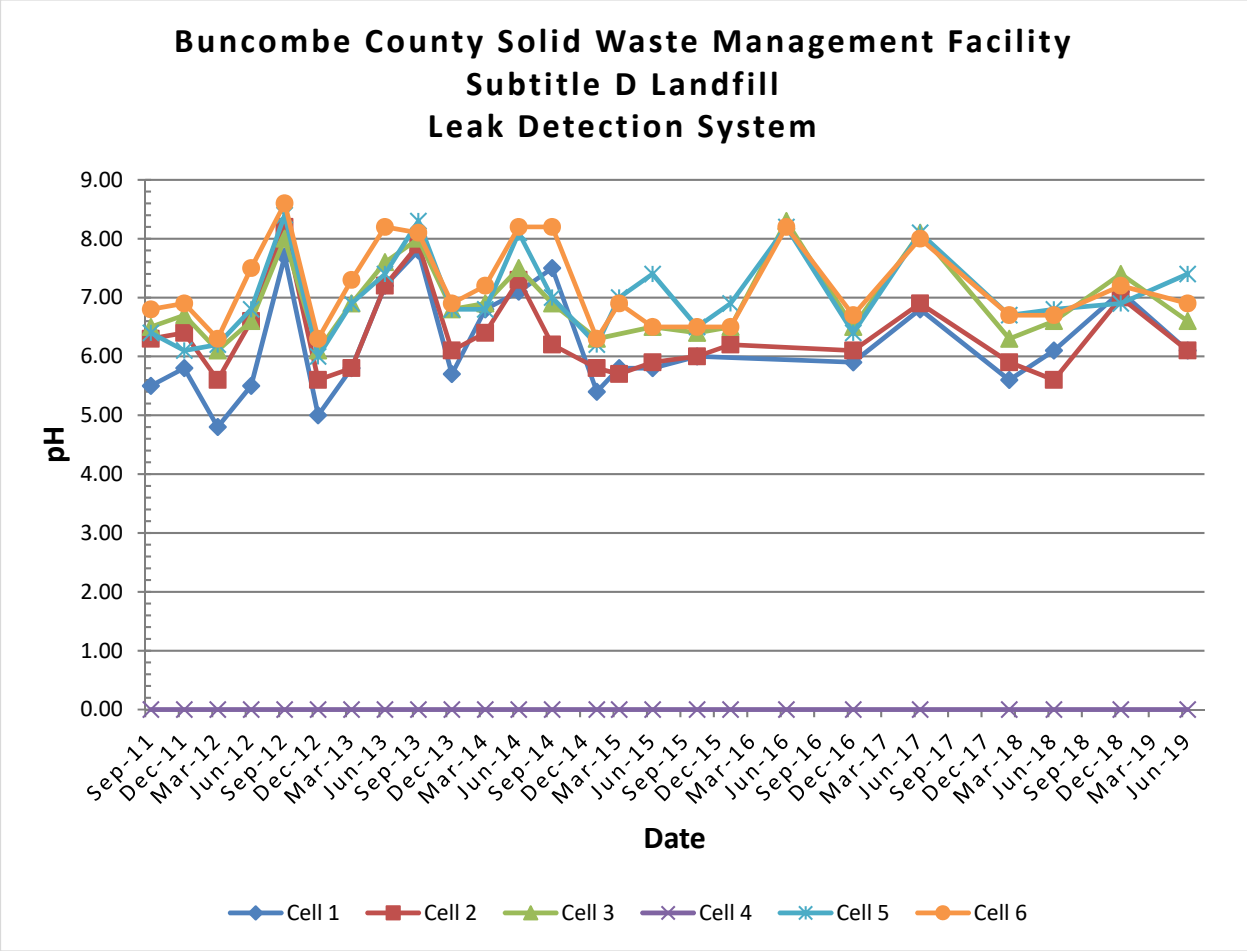

Figure 15. pH (2011 – June 2019)

*Note: Readings for December 2017 were taken in February 2018 due to weather conditions

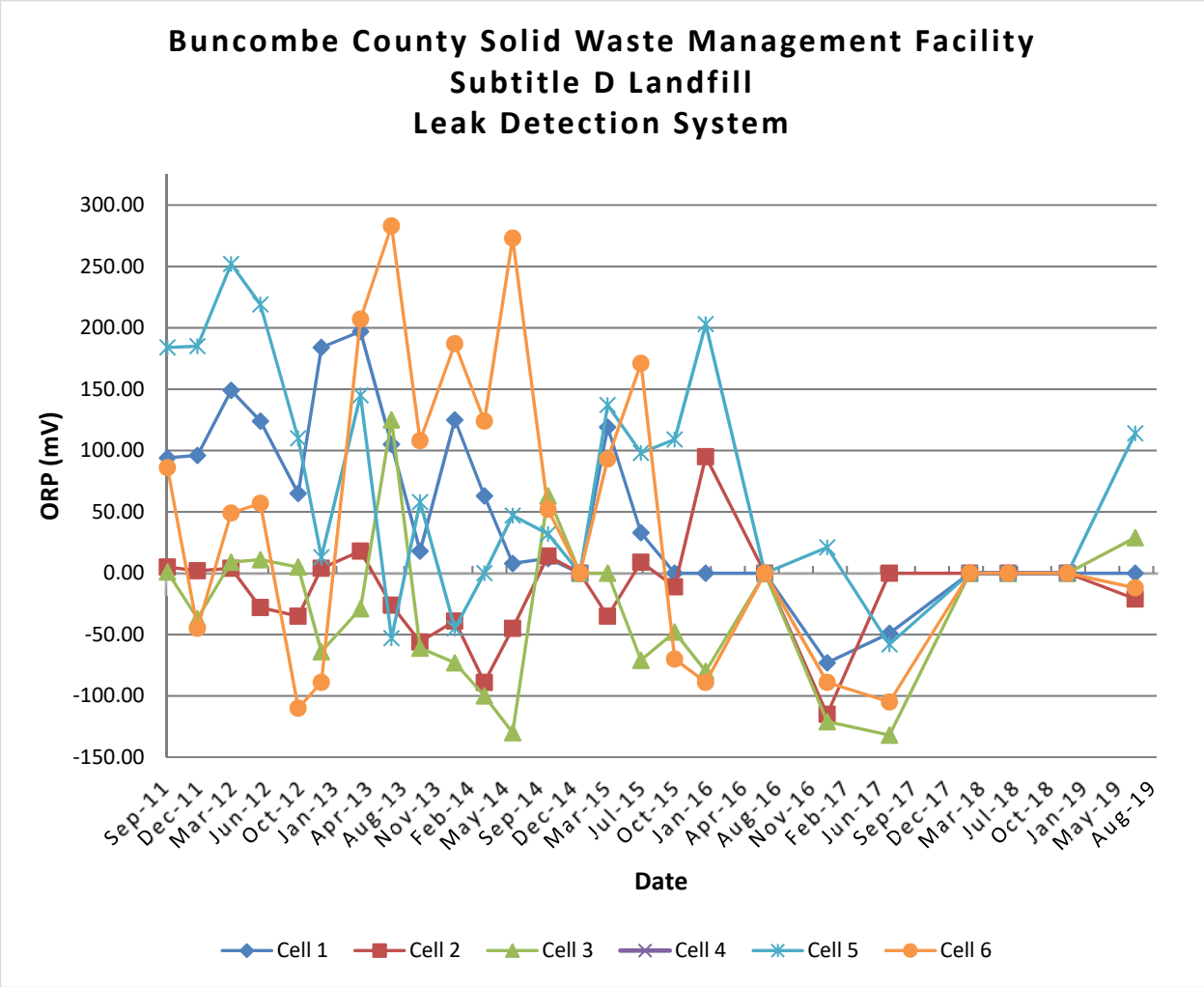

Figure 16. Oxidation Reduction Potential

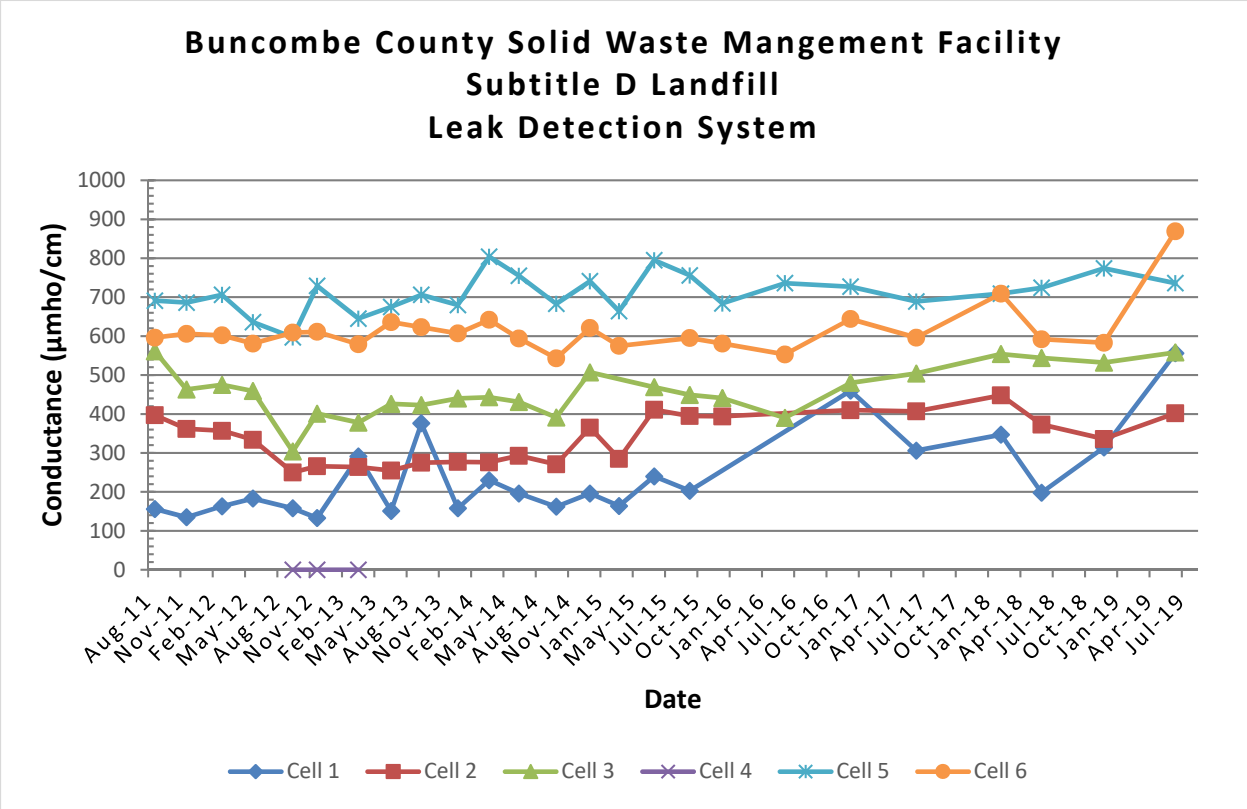

Figure 17. Specific Conductance

*Note: Readings for December 2017 were taken in February 2018 due to weather conditions

**No data readings for December 2018

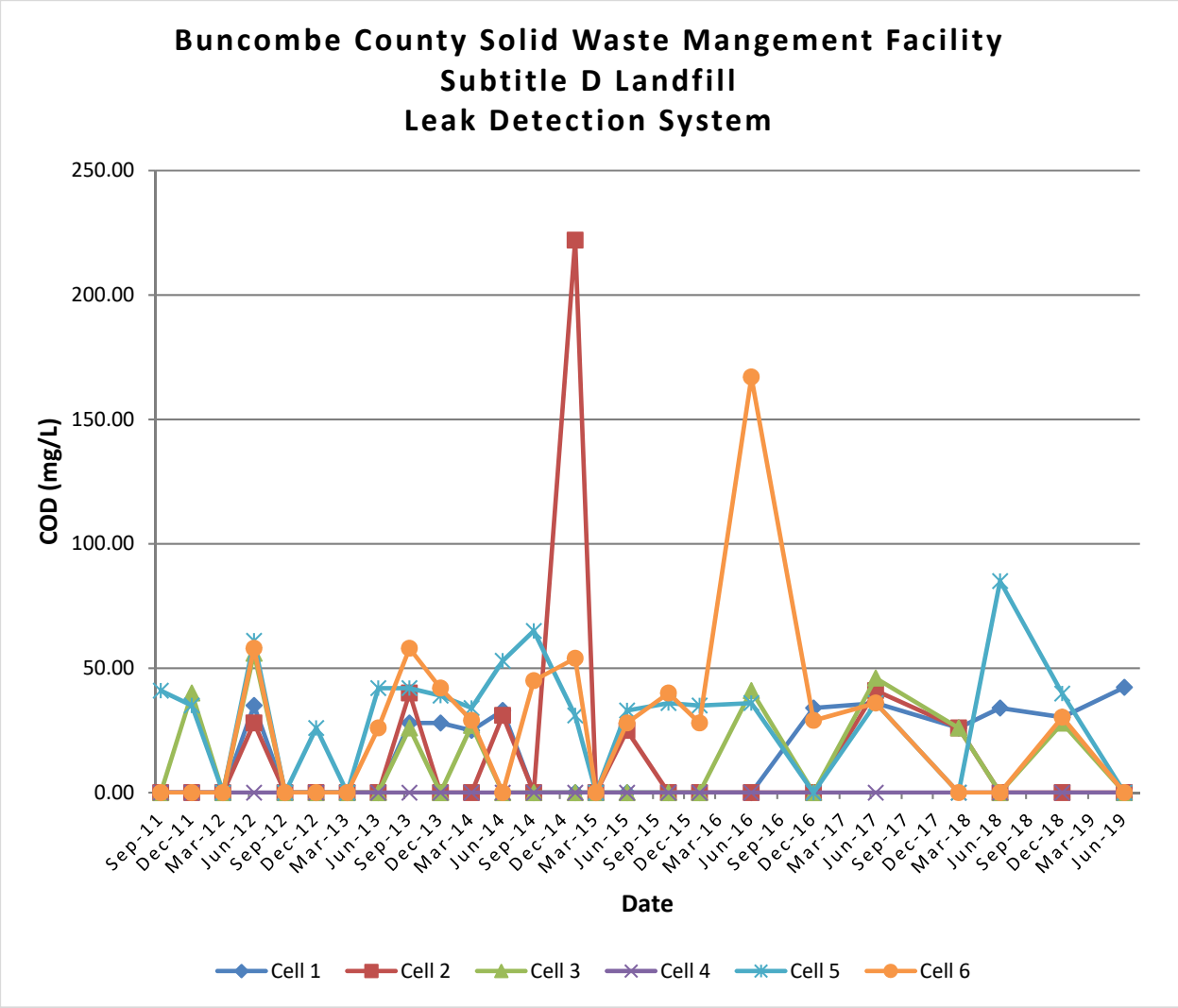

Figure 18. COD

*Note: Readings for December 2017 were taken in February 2018 due to weather conditions

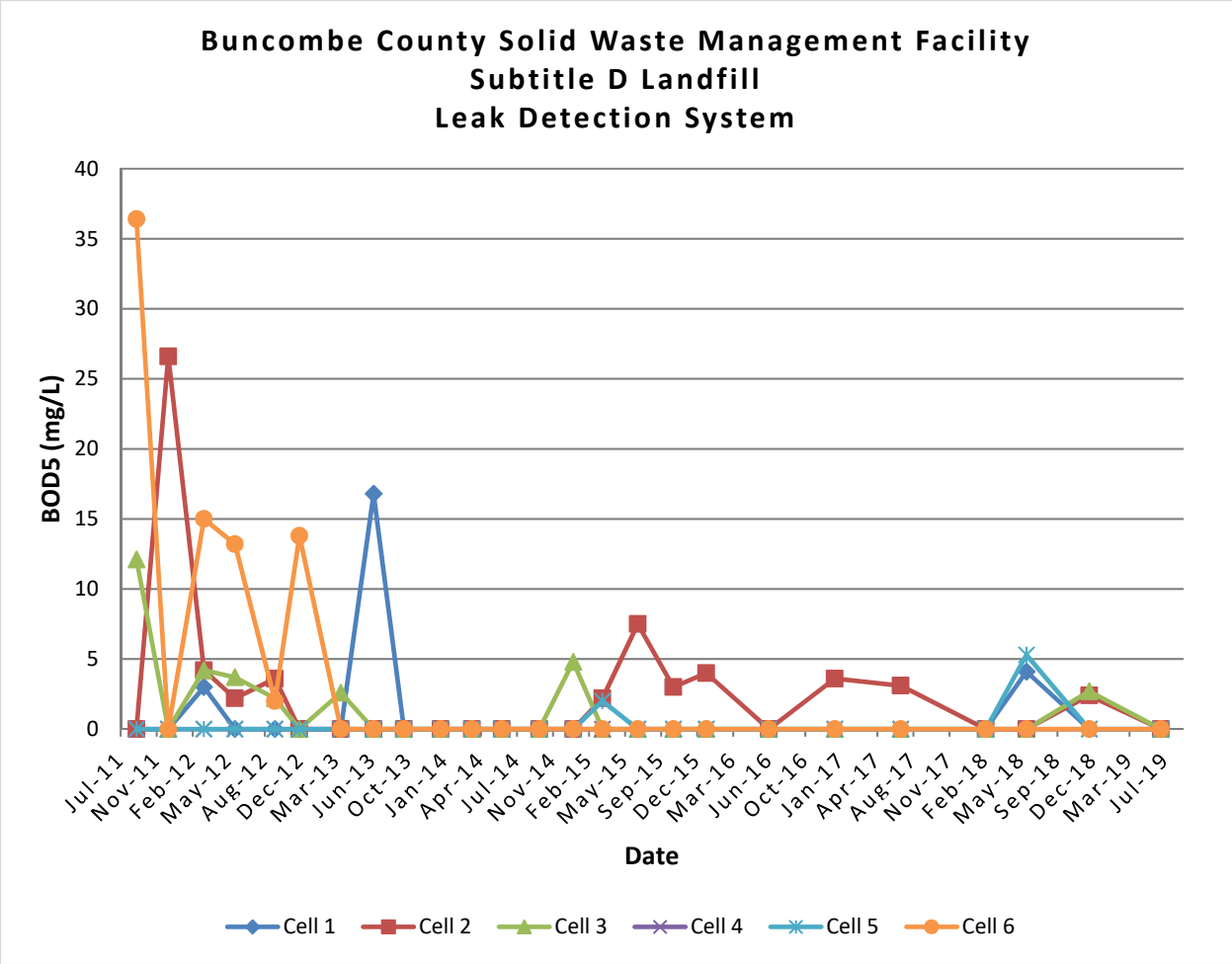

Figure 19. BOD5

*Note: Readings for December 2017 were taken in February 2018 due to weather conditions

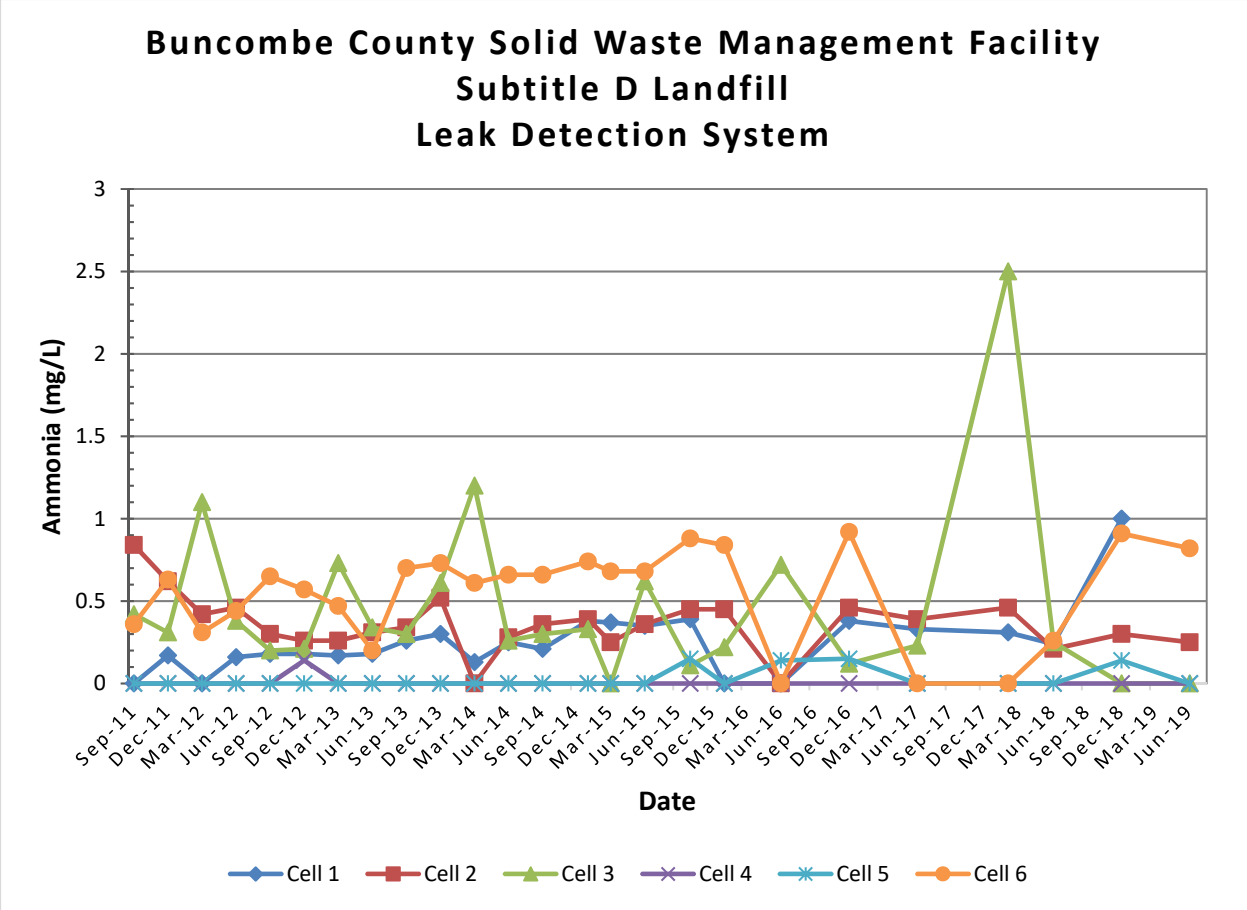

Figure 20. Ammonia

*Note: Readings for December 2017 were taken in February 2018 due to weather conditions
Reading in June 2019 for Cell 1 were taken out due to outlier.

4.2 LEACHATE COLLECTION SYSTEM

The quantity of leachate collected from each cell of the leachate collection system also known as "LCS" is shown on Table 5. Figure 21 shows the leachate generation vs. rainfall. Cells 1-6 and the leachate pond samples collected were analyzed and examined for BOD5, conductance, COD, ammonia, pH, temperature, and ORP, are shown in Figure 22 through Figure 27.

Table 5. Leachate Collected from Cells 1-6 from 2007- June 2019

	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Total	Rainfall
	(gallons)	(gallons)	(gallons)	(gallons)	(gallons)	(gallons)	(gallons)	(inches)
	Subtitle D Liner		Alternative Liner					
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
Jan. – June 2019	12,302	517,635	85,810	90,427	856,538	3,573,246	5,135,958	22
TOTAL	**1,876,009**	**2,720,095**	**1,908,660**	**2,795,448**	**9,764,652**	**67,621,171**	**83,686,035**	**448**

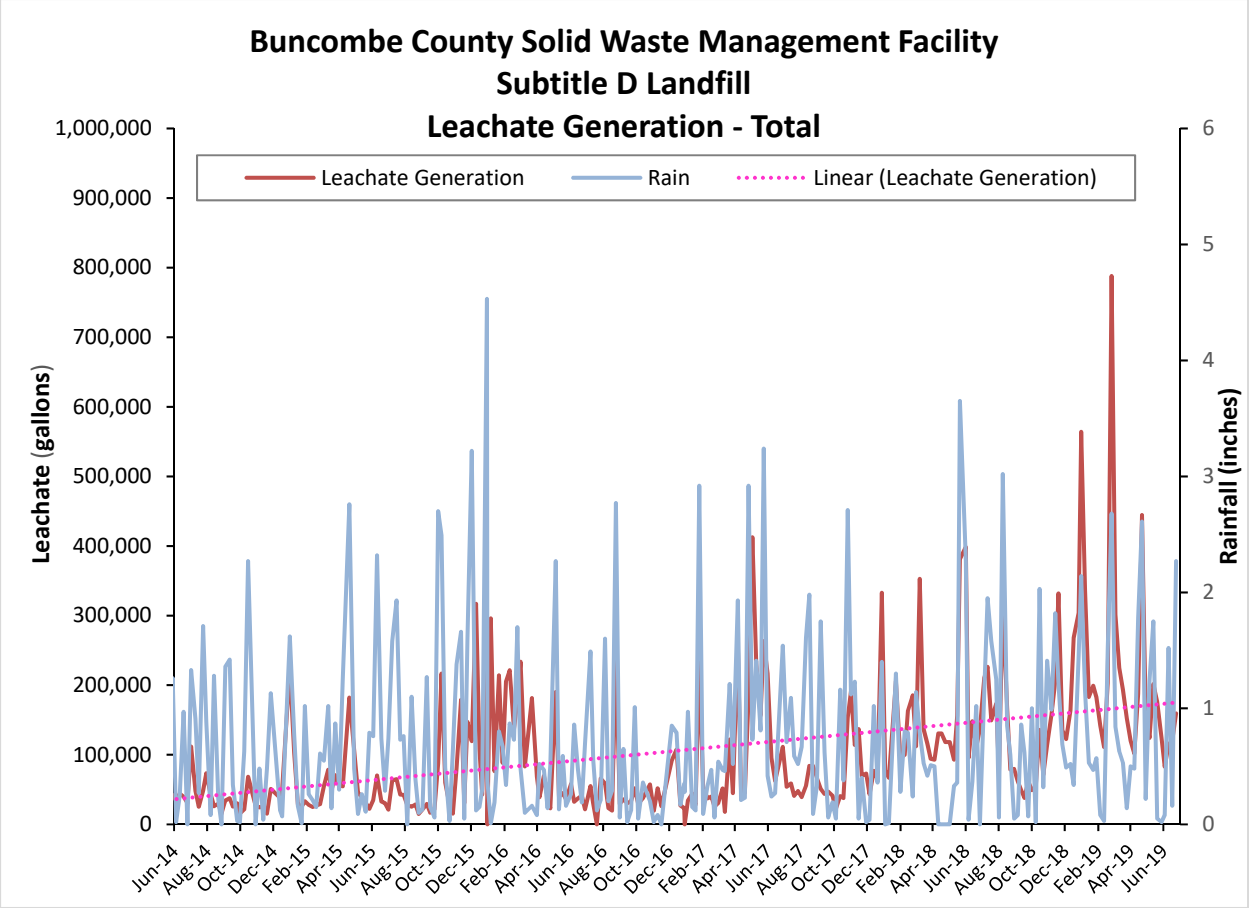

Figure 21. Leachate Generation vs. Rainfall

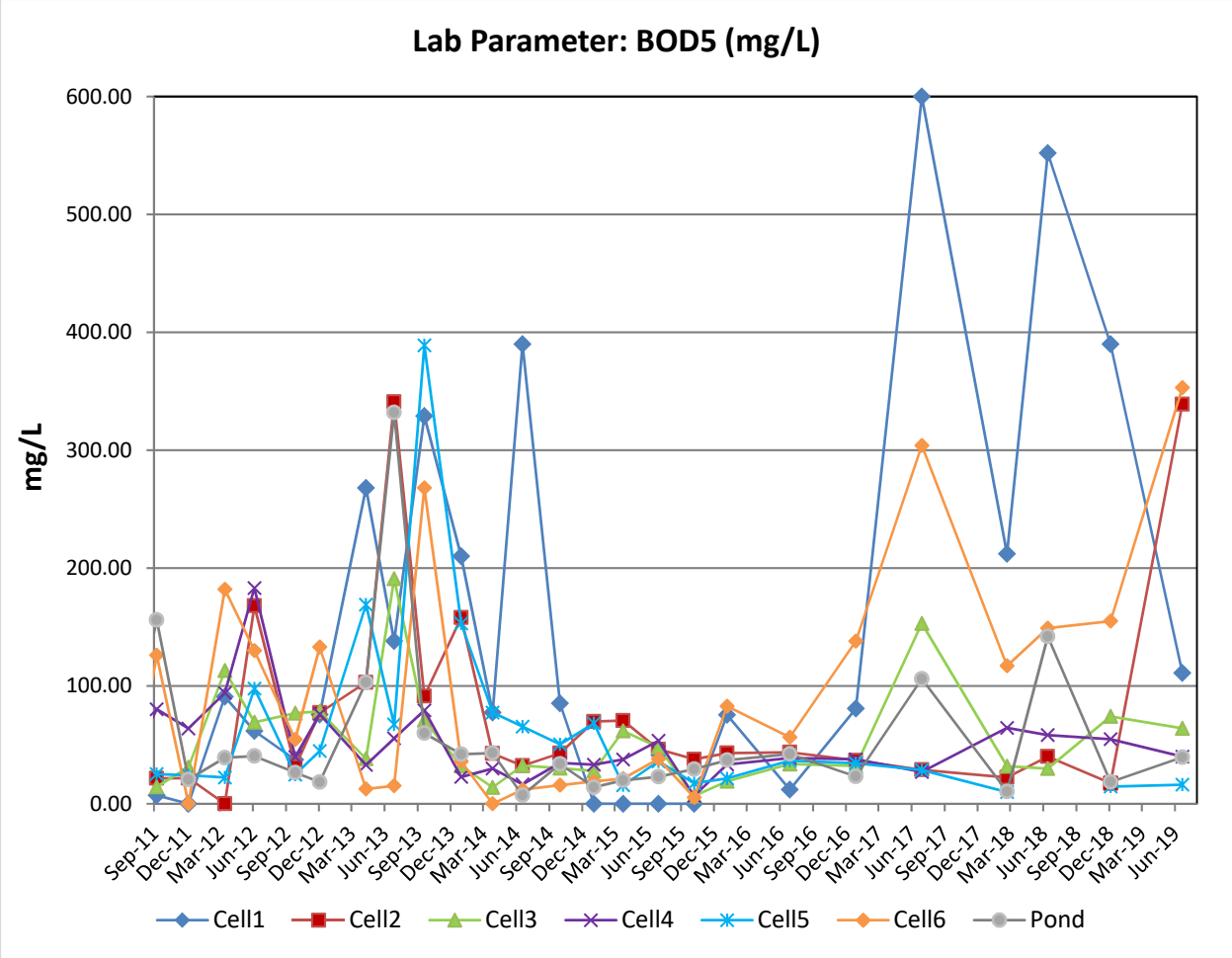

Figure 22. BOD5 of Leachate

*Note: No readings were taken in Cell 1 during the January-December 2015 period due to a clogged sampling port.

**December 2017 readings taken in February 2018 due to weather conditions.

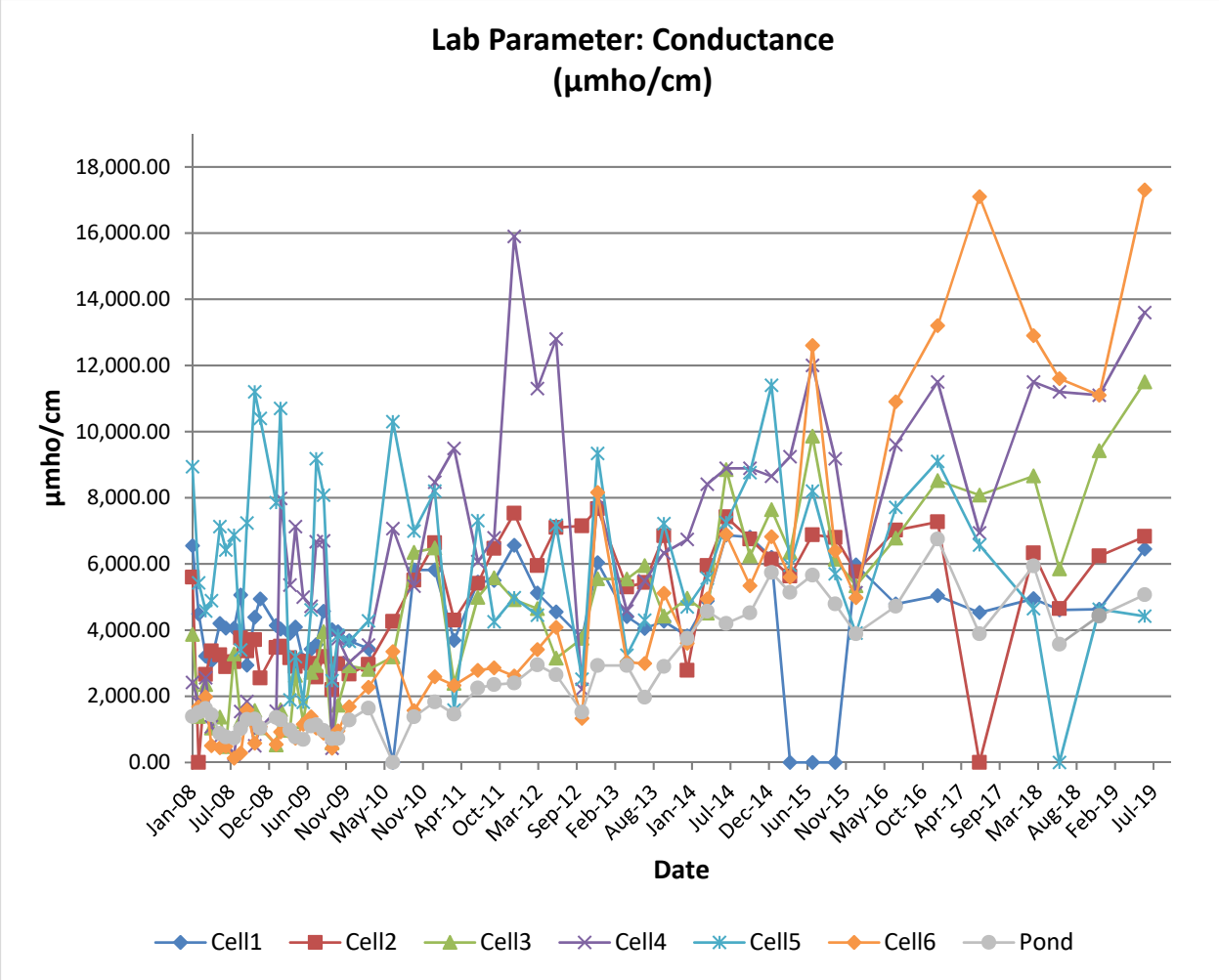

Figure 23. Specific Conductance of Leachate

*Note: No readings were taken in Cell 1 during the January-December 2015 period due to a clogged sampling port.

**December 2017 readings taken in February 2018 due to weather conditions.

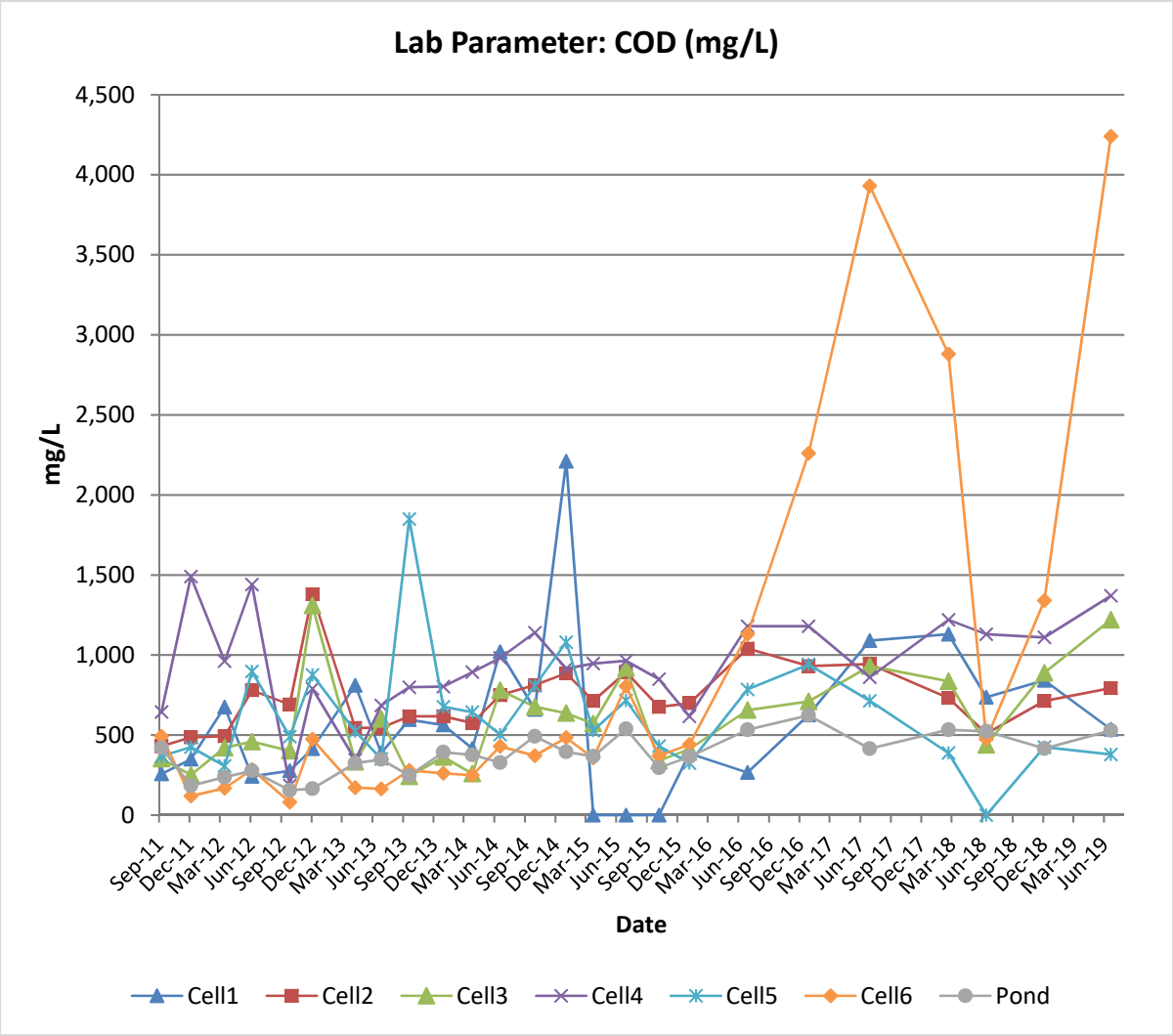

Figure 24. COD of Leachate

*Note: No readings were taken in Cell 1 during the January-December 2015 period due to a clogged sampling port.

**December 2017 readings taken in February 2018 due to weather conditions.

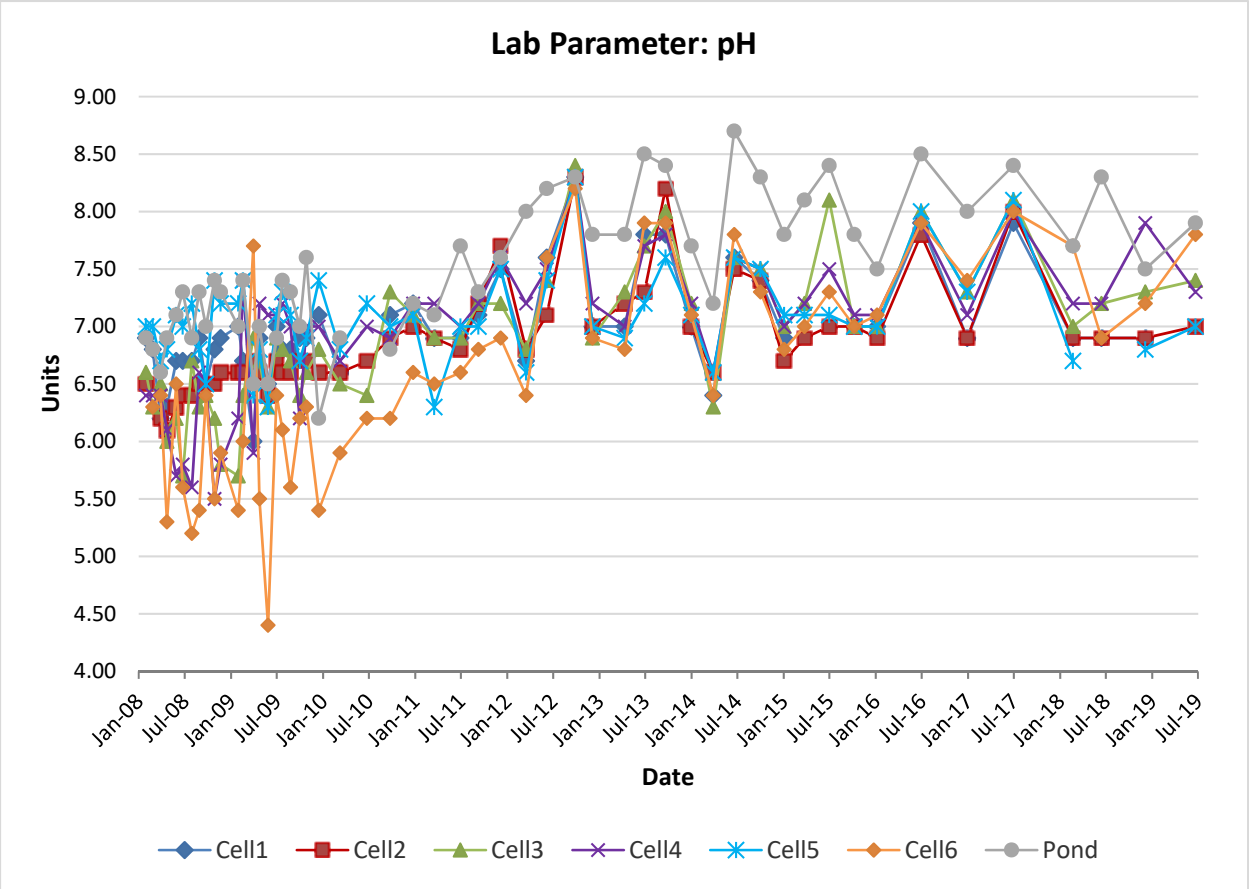

Figure 25. pH of Leachate

*Note: No readings were taken in Cell 1 during the January-December 2015 period due to a clogged sampling port.

**December 2017 readings taken in February 2018 due to weather conditions.

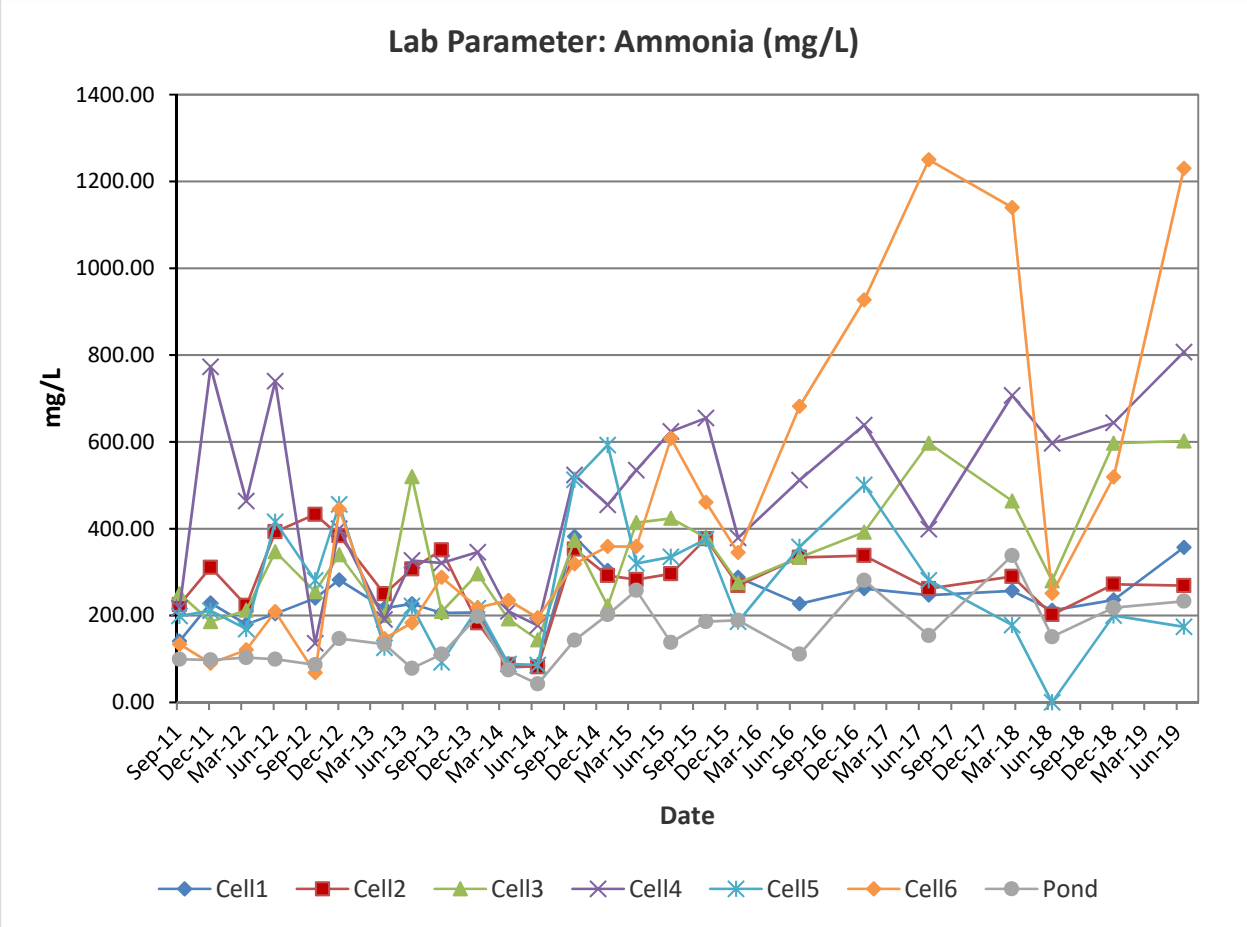

Figure 26. Ammonia of Leachate

*Note: No readings were taken in Cell 1 during the January-December 2015 period due to a clogged sampling port.

**December 2017 readings taken in February 2018 due to weather conditions

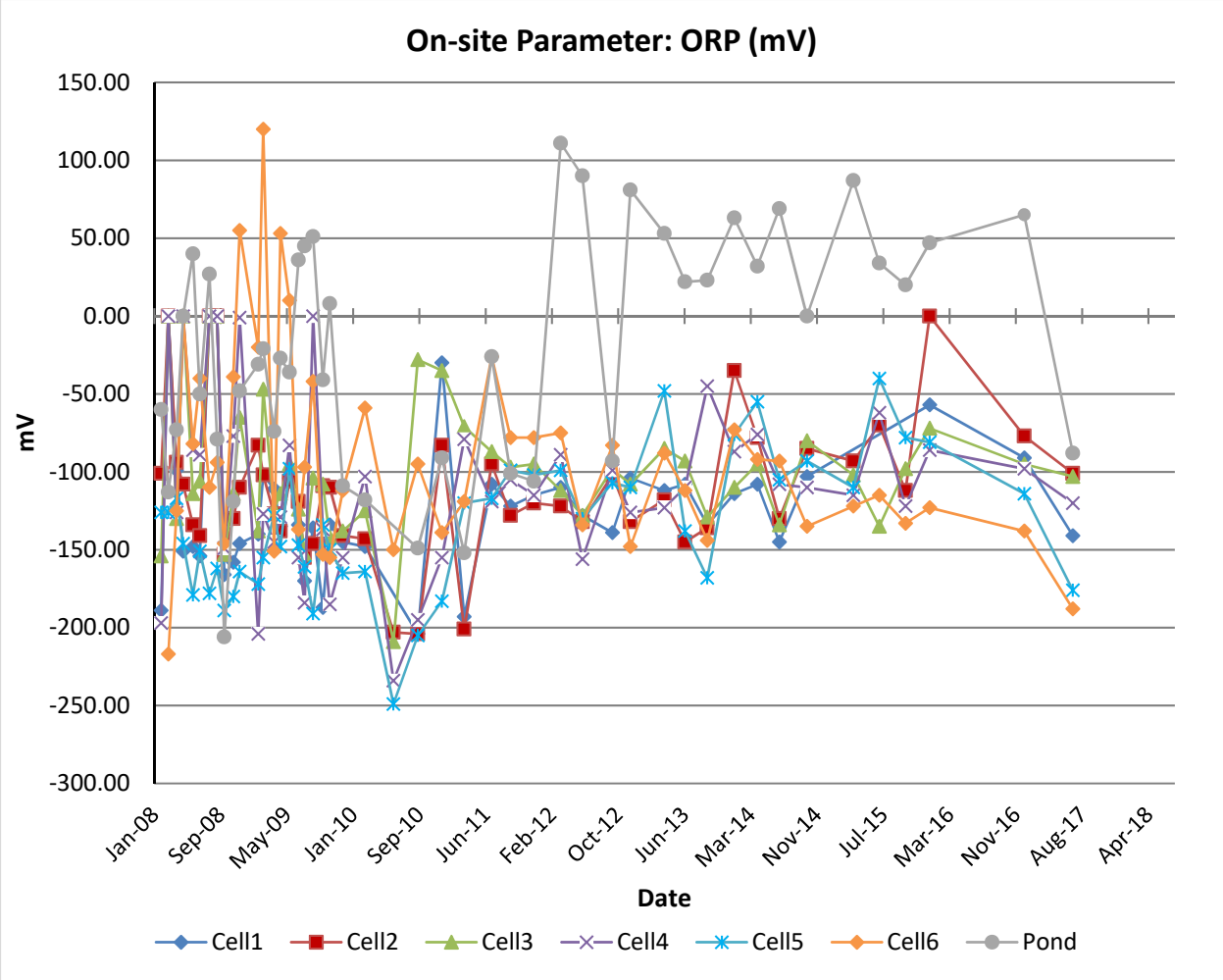

Figure 27. ORP of Leachate

*Note: No readings were taken in Cell 1 during the January-December 2015 period due to a clogged sampling port.

**December 2017 readings taken in February 2018 due to weather conditions.

***As of 2018, no readings were taken due to malfunction of the meter

4.3 LEACHATE RECIRCULATION

Table 6 presents the annual leachate recirculated. According to previous reports, the total approximation of 6.7 million gallons of leachate has been recirculated. The cumulative quantity of leachate recirculated from 2009 to 2017 is shown on Figure 28.

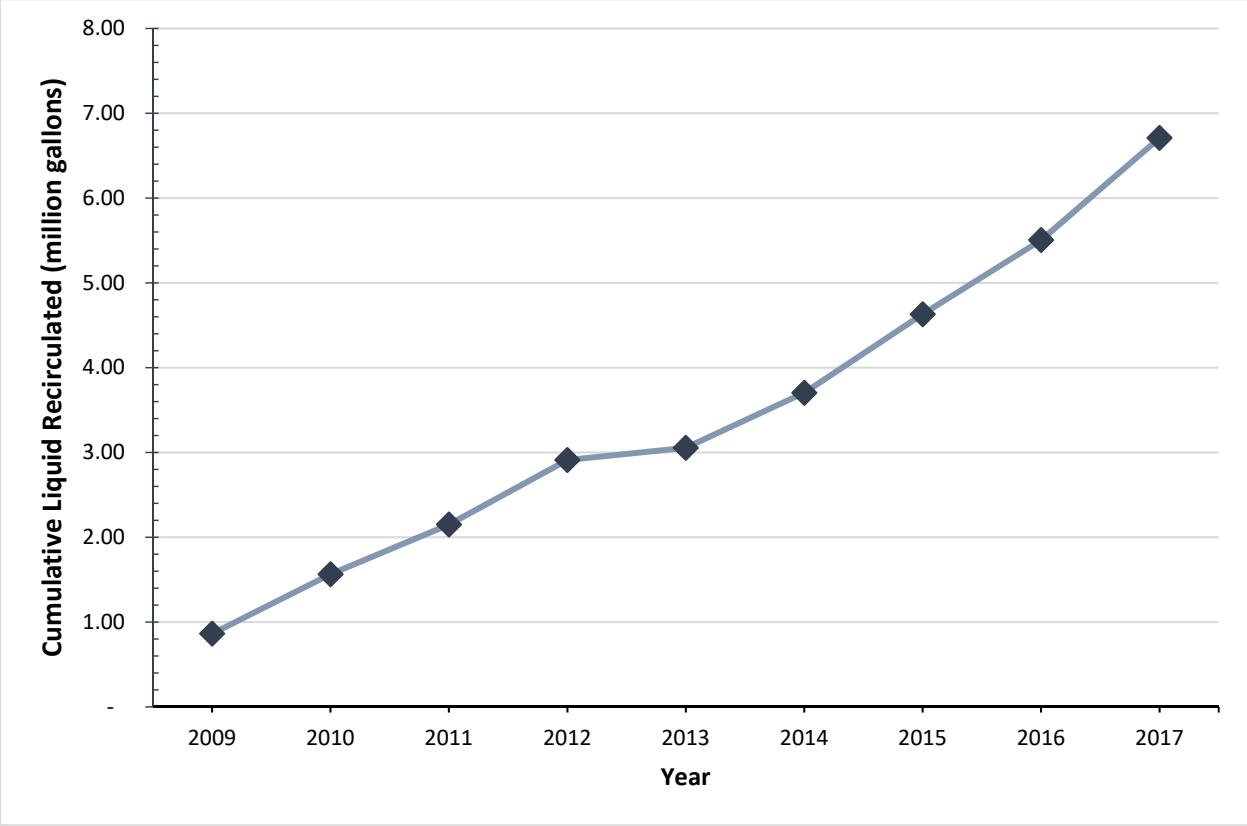

Figure 28. Cumulative Volume of Leachate Recirculation

*Note: Due to continuing sideslope fill operations, 2018 Leachate Recirculated was suspended.

Table 6. Leachate Recirculation Volumes

Date	HITs D, E, and F (gal)	SGTs 1A, B, and C (gal)	SGTs 2A, B, and C (gal)	SGTs 3A, B, and C (gal)	HITs A, B, and C (gal)	SGTs 4 and 4B (gal)	SGTs 5 and 5B (gal)	HITs 6A, 6B 6C, and 6E (gal)	Volume Recirculated (Gallons)	Cumulative Recirculated (Million Gallons)
2006	32,093.00	48,140.00	48,140.00	48,140.00	32,093.00	10,698.00	10,698.00		230,002.00	0.23
2007	27,907.00	41,860.00	41,860.00	41,860.00	27,907.00	9,302.00	9,302.00		199,998.00	0.43
2008	116,108.00	51,914.00	42,883.00	35,985.00	14,720.00	-	-		261,610.00	0.69
2009	48,210.00	3,670.00	1,720.00	3,590.00	105,330.00	8,510.00	-		171,030.00	0.86
2010	296,600.00	20,000.00	24,100.00	21,300.00	307,733.00	21,667.00	10,000.00		701,400.00	1.56
2011	298,490.00	14,129.00	27,654.00	21,867.00	161,068.00	32,922.00	29,690.00		585,820.00	2.15
2012	425,620.00	24,867.00	33,968.00	25,765.00	213,010.00	19,955.00	18,235.00		761,420.00	2.91
2013	87,820.00	5,730.00	12,485.00	12,195.00	20,420.00	2,180.00	2,050.00		142,880.00	3.05
2014	420,470.00	-	11,600.00	5,290.00	116,630.00	6,200.00	3,680.00	85,520.00	649,390.00	3.70
2015	622,921.00	-	-	-	86,100.00	-	-	217,160.00	926,181.00	4.63
2016	609,910.00	-	-	-	127,710.00	-	-	136,810.00	874,430.00	5.50
2017	691,254.00	-	-	-	83,960.00	-	-	429,770.00	1,204,984.00	6.71
Total	3,677,403.00	210,310.00	244,410.00	215,992.00	1,296,681.00	111,434.00	83,655.00	869,260.00	6,709,145.00	

*Note: Leachate Recirculation was suspended due to sideslope fill operations and it will resume as it progresses.

4.4 LANDFILL GAS

The total gas flow and methane percentage of the gas collected from the landfill is monitored continuously at the LFGTE facility as presented in Figure 29.

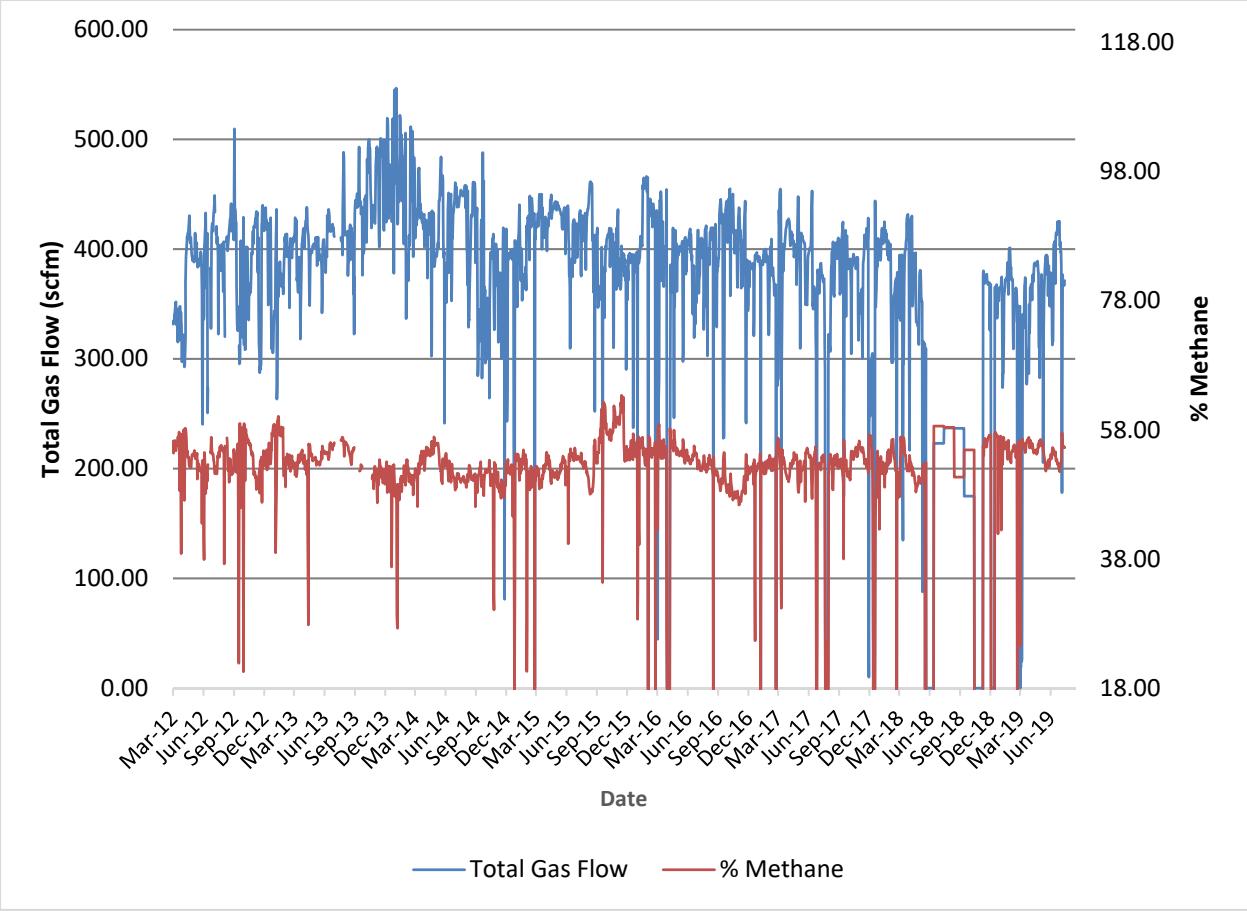

Figure 29. Total Gas Flow and Percent Methane at the LFGTE Facility

*Due to malfunctioning data logging equipment, monthly averages of methane and gas flow are represented in this graph for July 2018 through October 2018.

4.5 SETTLEMENT

There are ten settlement plates installed within the retrofit area as shown in Figure 12. Figure 1 shows the comparison between the measured settlements in the settlement Plates from 2006 through 2018 to the quantity of leachate recirculated in Cells 1-6. The latest survey was performed in January 2019. These cells were first surveyed in November 2010.

4.6 EFFECTIVE WASTE DENSITY

The County assesses the impact of liquids addition on compaction as part of the bioreactor project by tracking the effective waste density of the active cell. Density values for disposal for Fiscal Year 2019 were calculated at 0.83 tons/cy.

4.7 CELL 6 LANDFILL GAS COLLECTION

Data has been collected since from HITs 6A - 6E. Percent methane in each of the HITs and the flow rate in standard cubic feet per minute (SCFM) are shown in Figure 30 and Figure 31.

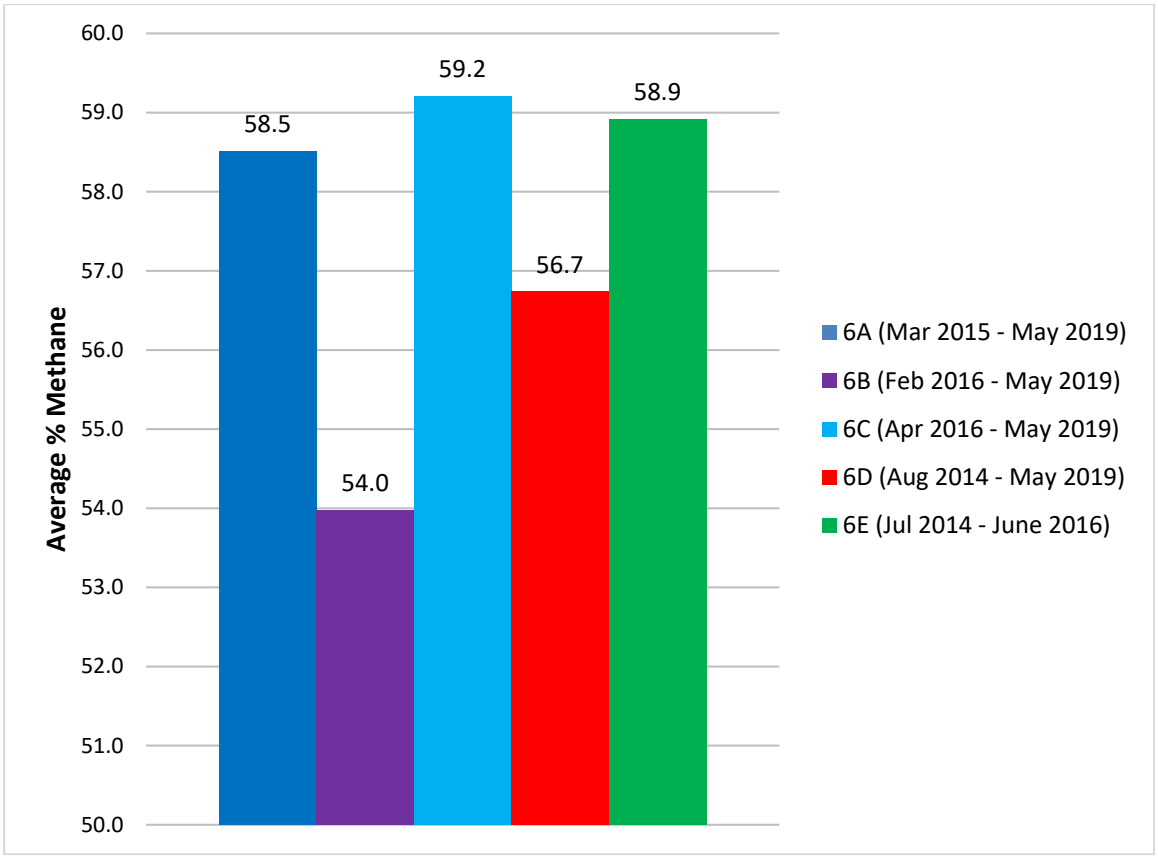

Figure 30. Average Percent Methane in HITs 6A, 6B, 6C, 6D, and 6E.

*Note: Readings are unavailable after May as the wellhead were raised for Buncombe County's sideslope expansion. Gas readings will resume as it progresses.

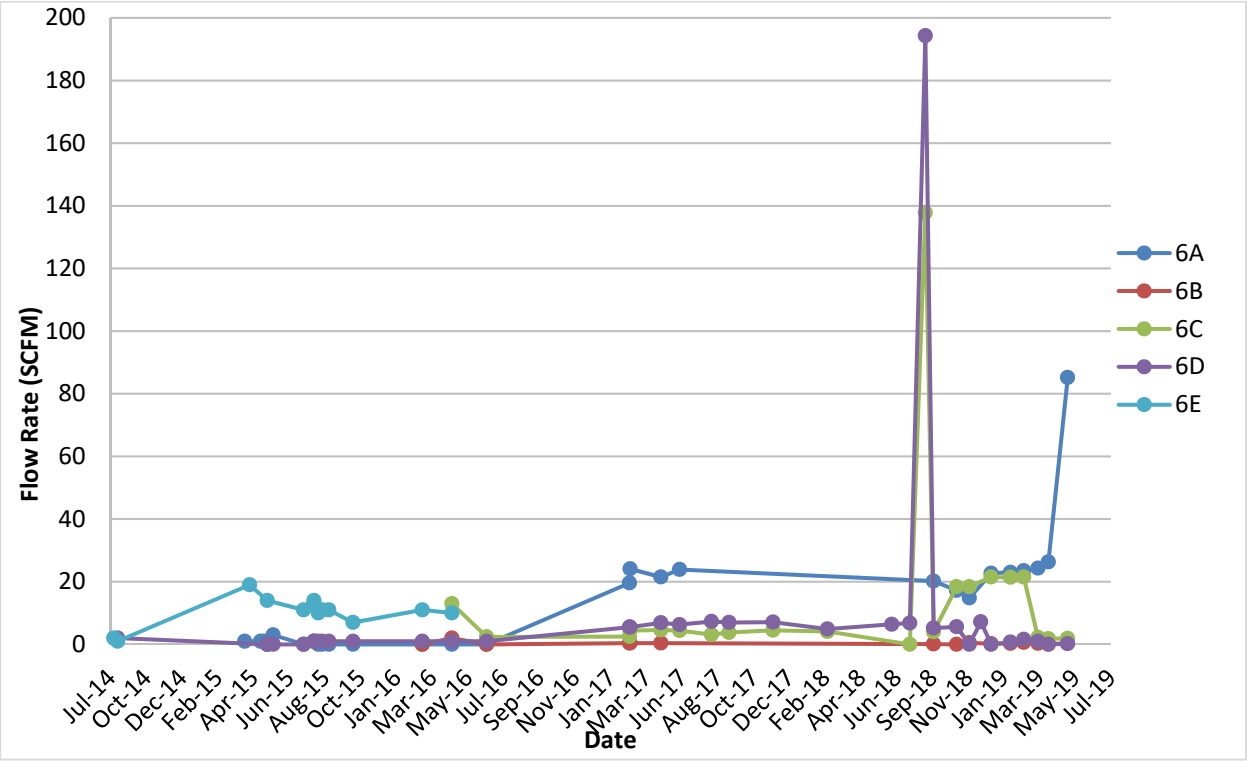

Figure 31. Flow Rate in HITs 6A, 6B, 6C, 6D, and 6E.

*Note: Readings are unavailable after May as the wellhead were raised for Buncombe County's sideslope expansion. Gas readings will resume as it progresses.

5 PROJECT GOALS UPDATE

5.1 ANALYSIS OF LEAK DETECTION AND COLLECTION SYSTEMS

5.1.1 Measurement of Liquid Source in the LDZ

Liquids observed in the LDZs that have percolated through the base liner system could be leachate, groundwater, or a combination of both. The LDZs are open on the sides and as a result subject to potential groundwater infiltration. The claim is reinforced by the LDZ in Cell 1 which is evident by the high quality of water during the sampling events in the underground springs. In determining the source of the liquid, comparison of test data between the LDZ, leachate and groundwater are examined. The proposed design for Cell 7 closes the open sides of the LDZs for future expansions.

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 800-5600 umho/cm compared to Cell 1 LDZ where it is in between 200-1200 umho/cm. The LDZ conductance and groundwater well samples in the area are tested and is shown in Figure 32.

Leachate often has a compound, toluene, present; toluene levels are found to be much lower in the LDZ tested samples. Figure 33 illustrates Toluene levels present in the groundwater testing results, which correlate closely with the LDZ samples.

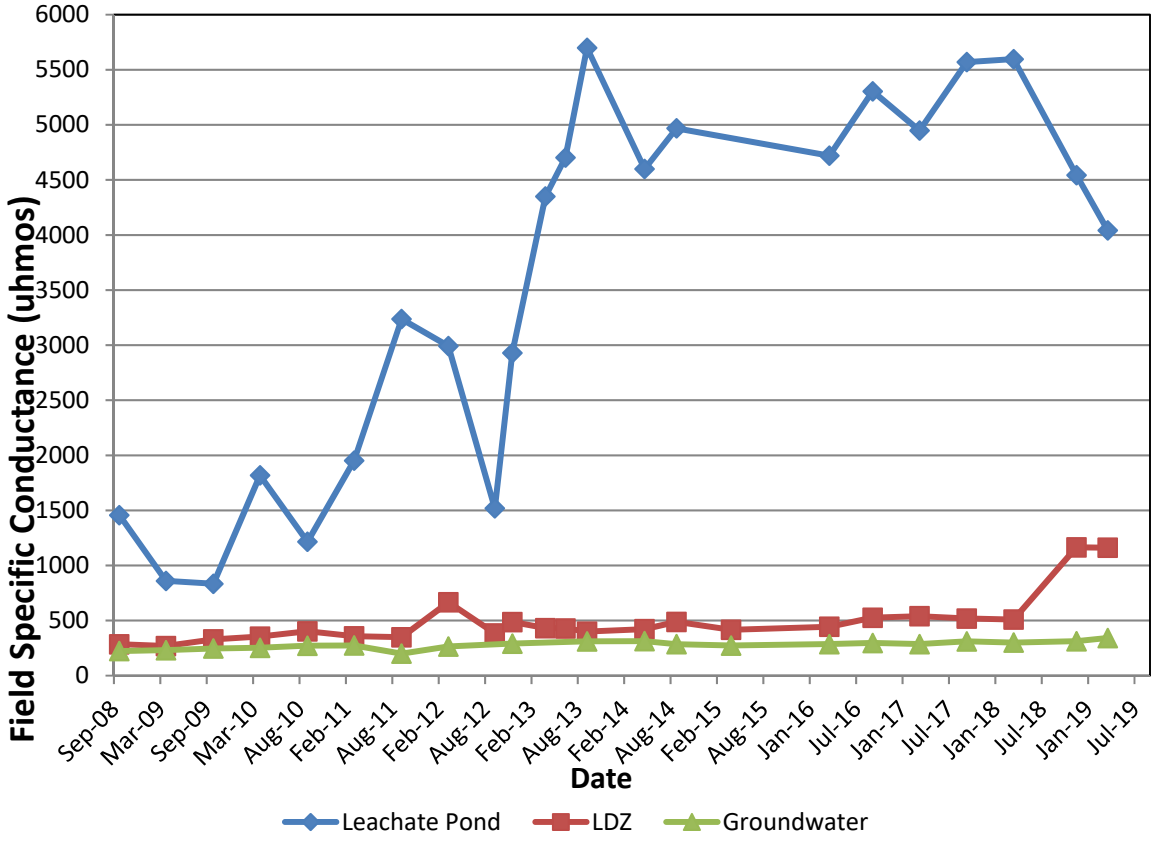

Figure 32. Comparison of conductance between Leachate Pond, LDZ, and Groundwater

*Note: values of Conductance are averages of testing results for Cells 1-6 and all Groundwater wells

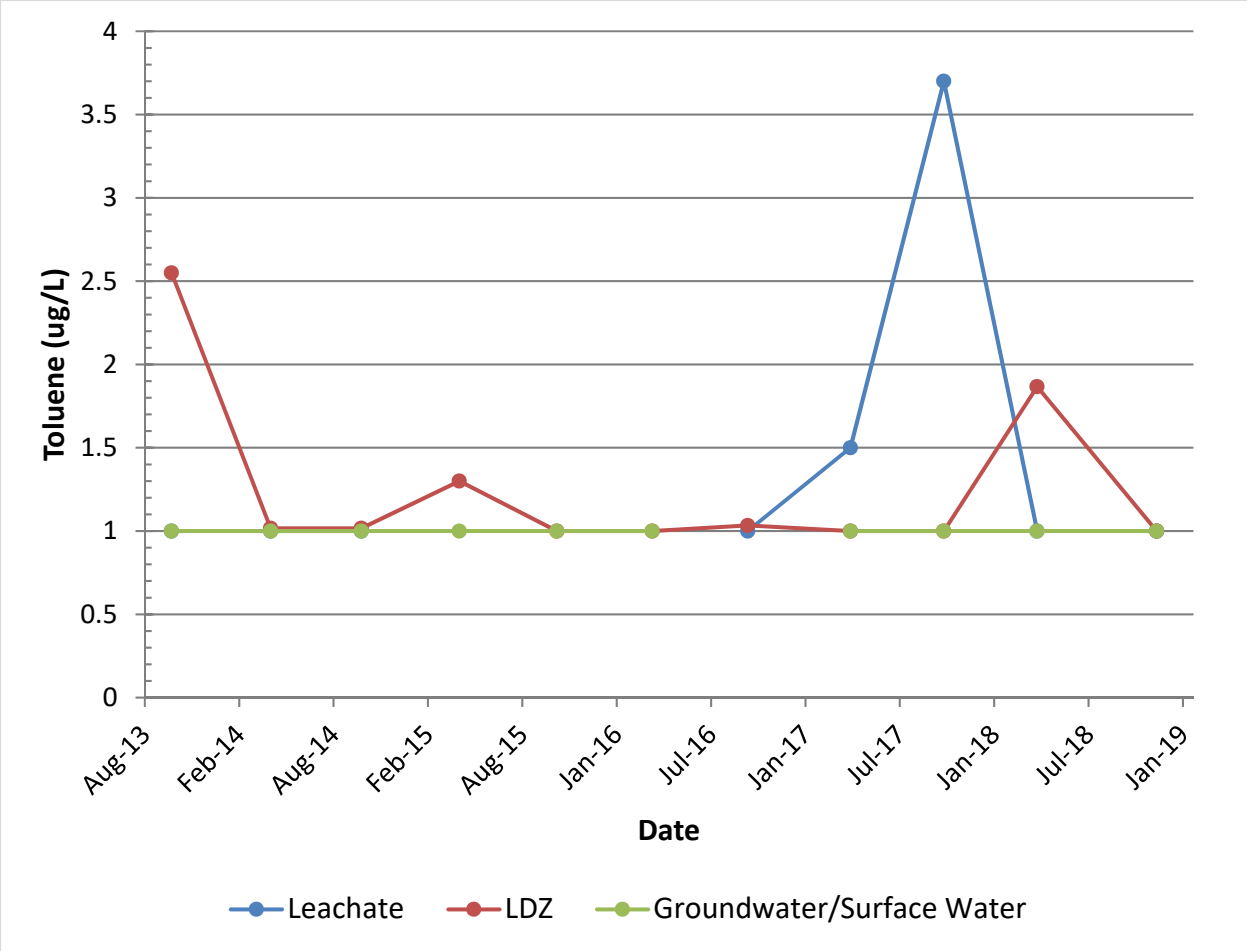

Figure 33. Toluene of Leachate, LDZ and GW/SW Samples

*Note: Values of toluene are averages of testing results for Cells 1-6 and all Groundwater/Surface water wells

.

5.2 CELL 6 SUMP LEVELS AND RECIRCULATION

Leachate recirculation in Cell 6 HITs 6B and 6C was instituted in June 2014. Approximately 16-34 feet of waste was placed on top of Cell 6 HITs. 452,894 gallons of leachate gallons injected in these two lines through 2017.

Leachate recirculation in August 2016 started in HIT 6A. The quantity of leachate that has been injected into this line amounted to 101,836 gallons through December 2017. HITs Other received leachate for recirculation and HITs 6A-D provided for landfill gas collection. Leachate recirculation has been suspended due to sideslope fill operations and will resume as the construction progresses.

5.3 STABILIZATION OF WASTE

By analyzing Figure 34 of BOD_5/COD ratio in Cells 1-6, the landfill leachate has dropped dramatically since 2007 which indicates that the organic waste fraction has stabilized.

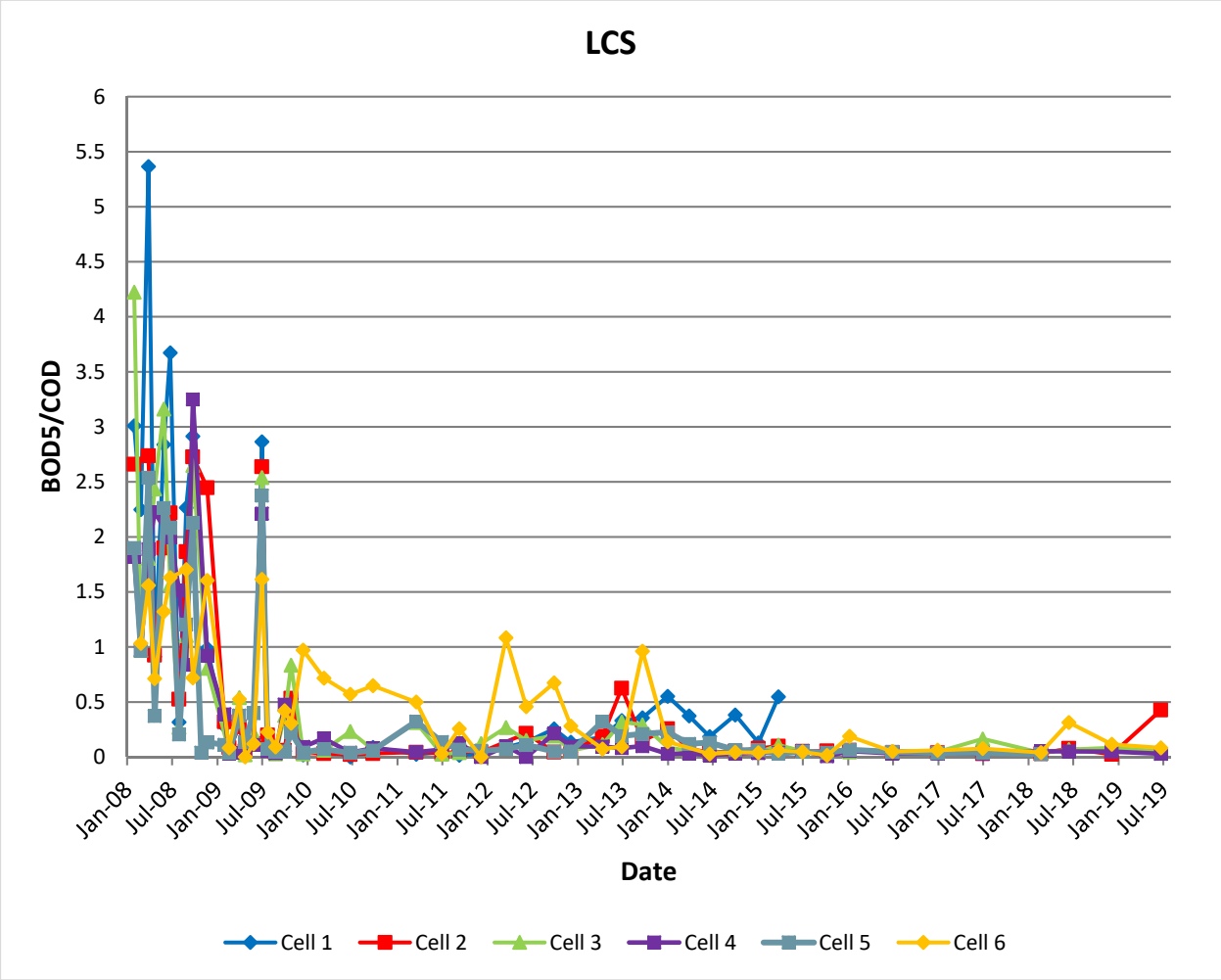

Figure 34. Ratio of LCS BOD5/COD in Cells 1-6

5.4 ALTERNATIVE COVER MATERIAL

By using an alternative cover material, the cover creates a uniformed wetting from the HIT, which allows the use of onsite borrow soils for the purpose of new cell and capping construction. It also uses less air space than soil. By analyzing the report, it is partially responsible for improving waste compaction. It is advised that alternative cover material be utilized overall in the continuing landfill operation.

North Carolina Department of Environmental Quality approved Buncombe County to utilize Posi-Shell as an alternative daily cover. Posi-shell has been utilized since 2008 as an alternative daily cover and as well as the primary daily cover for over five years.

6 RECOMMENDATIONS

6.1 MODIFICATIONS TO THE MONITORING PROGRAM

6.1.1 Assessment of Settlement

The 10 settlement plates (SP1-10) historically surveyed throughout the entire project period of the bioreactor program will continue to be monitored. Sideslope operations continue to generate new airspace. Other airspace is recouped from the rapid settlement experienced from Bioreactor operations throughout Cells 1-5. Settlement plates should be re-installed at new elevations to more accurately determine actual settlement after slope stabilization occurs in the sideslope operational areas.

6.1.2 Impacts of Leachate Recirculation to Head on Liner

As a result of the previous stakeholder meeting, DEQ and Buncombe 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 quantities added by the recirculation could reflect on impacts to the leachate collection if the values are significant. Changes in the levels are monitored, however, due to the construction activities on the slopes the recirculation has been temporarily stopped. Prior evaluation has not shown a significant change in the liquid levels during recirculation.

6.2 DESIGN AND OPERATION ADJUSTMENT

6.2.1 Design of the Leak Detection Zones

In order to reduce the possibility of groundwater percolation, Cells 7-10 LDZ design will be revised by eliminating the 3-foot separation between the LDZ and the bottom of the base liner system. Also, the secondary containment has been redesigned to avoid a lateral movement of groundwater into the liner detection sump. Other design alternatives will be considered as the possibilities are presented.

6.2.2 Plan of Action for Operation of the HITs in Cell 6

Regularly recirculating leachate in HITs 6B and 6C and temporarily collecting gas in HITs 6A, 6D, and 6E is the original plan. Gas flow rates of Cell 6 HITs has been steadily working, according to the landfill gas data obtained from 2014 through May 2019, HITs 6A, 6D, and 6E has a high percentage methane. Data are unavailable after May 2019 as the wellheads were raised due to sideslope expansion. Gas readings will resume as it progresses.

The collection of landfill gas data from Cell 6 HITs has been favorable. Recirculation in HIT 6E began in early 2017 and the rest of the HITs in Cell 6 were used to collect landfill gas. The wells have steady flow rates and presented methane contents ranging between 55% and 59%. The operation of collecting gas from HITs in Cell 6 that are not being used for recirculation and even the ones that were used for recirculation after they dried out should be continued. Collecting the data for this operation will help the assessment of whether the HITs should continue to be used in the long run for landfill gas collection.