NLC on behalf of Loci Controls, Inc.

Summary of Comment:

Dear Mr. Flagg,

On behalf of Loci Controls, Inc. ("Loci"), I am writing to confirm Loci's strong support for the Department of Ecology's ("Ecology") proposed landfill methane regulation ("Proposed LMR"). Loci is a well-established and highly respected technology and service provider to the landfill industry. This comment letter ("Comment") provides recommendations regarding how Washington can achieve even greater greenhouse gas ("GHG") and criteria pollutant reductions at landfills than those provided by the Proposed LMR through a strategy that leverages Washington's Clean Fuel Standard ("CFS") to incentivize landfill emissions reductions that surpass those required by the Proposed LMR.

Loci's full comment is attached. We appreciate the opportunity to provide input to this process.

Best Regards,

Graham Noyes
Noyes Law Corporation
419 Broad Street, Suite E
Nevada City, CA 95959
www.fuelandcarbonlaw.com

December 11, 2023

Bill Flagg
Department of Ecology
Air Quality Program
(Comment submitted electronically)

RE: Comment on Landfill Methane Regulations, Chapter 173-408 WAC, RCW Chapter 70A.540

Dear Mr. Flagg,

On behalf of Loci Controls, Inc. ("Loci"), I am writing to confirm Loci's strong support for the Department of Ecology's ("Ecology") proposed landfill methane regulation ("Proposed LMR"). Loci is a well-established and highly respected technology and service provider to the landfill industry. This comment letter ("Comment") provides recommendations regarding how Washington can achieve even greater greenhouse gas ("GHG") and criteria pollutant reductions at landfills than those provided by the Proposed LMR through a strategy that leverages Washington's Clean Fuel Standard ("CFS") to incentivize landfill emissions reductions that surpass those required by the Proposed LMR.

Summary of Comment

Loci is a world leader in the development and deployment of Advanced Landfill Gas Control Systems ("Advanced LFG Control Systems"). Loci's patented cloud-connected real time data and automated gas collection control platform is comprised of four components: the Controller, the Sentry, WellWatcher® control dashboard, and Liquid Level Management. Loci's Advanced LFG Control System provides landfill gas collection system operators with data to improve operations, increase methane capture, and reduce landfill gas emissions. Loci's Controllers are wellhead-mounted products with an onboard sensor package that remotely monitor pressure, temperature, system vacuum, flow, oxygen, carbon dioxide, methane, and balance gas. To optimize gas-collection system efficiency, real time data is used to identify opportunities for gas collection system operators to improve gas collection, and more quickly identify and troubleshoot problems with the collection system such as air leaks, watered out wells, or loss of vacuum. Due to the continuous monitoring, precise and rapid adjustment and other system components, Loci's Advanced LFG Control Systems exceed the requirements of the Proposed LMR and typically deliver a 13-24% increase in LFG capture.

Loci is not recommending that the Proposed LMR be made more stringent to require Advanced LFG Control Systems but instead that Ecology leverage the existing CFS program that Ecology administers to incentivize additional LFG and criteria pollutant reductions.

Effective January 1, 2023, producers and suppliers of high carbon intensity fuels must meet the requirements of Washington's CFS for transportation fuels. As further described in this Comment, establishing Tier 2 pathways for LFG in the CFS program will effectively incentivize landfill operators to deploy Advanced LFG Control Systems, which will: 1) increase the supply of low carbon transportation fuels, 2) generate additional revenues for the lowest LFG emitting landfills, and 3) reduce GHG and criteria pollutant emissions in Washington.

Loci's Technology

Engineers from the Massachusetts Institute of Technology founded Loci in 2013 to develop an integrated system of proven technologies to increase landfill gas (LFG) collection capture, which results in significant reduction of methane emissions from landfills. Loci subsequently developed the Loci Automated Landfill Gas Collection system (the Loci Technology) and has since deployed the Loci Technology on 50 landfills in 21 states. A recent third-party analysis by PTP Informatics of operational data from four operating landfills found that the Loci Technology provided a performance improvement of 13-24% increase in methane capture or associated landfill gas to energy plant output.[1]

The American Carbon Registry (ACR) is a leading nonprofit carbon crediting program recognized for its strong standards for environmental integrity and its quest to innovate. ACR operates as a California Air Resources Board-approved compliance Offset Project Registry and Early Action Offset Program for the California carbon market. In June of 2021, ACR finalized its approval of a methodology for monitoring, reporting, and verifying methane and other greenhouse gases (GHG) collected using Loci's technology. With ACR approval, large landfills can now create projects using Loci's Automated Control Technology to improve gas collection over standard manual well-field tuning methods that meet regulatory requirements.

The ACR process was subject to both peer-review and public comment periods, as well as revisions to address the peer review and public feedback. Access the full ACR protocol development process is available via these links:

- American Carbon Registry Announcement RE: Approval of New Methodology to Reduce Methane Emissions from Large Landfills
- American Carbon Registry, "Methodology for the Quantification Monitoring, Reporting and Verification of Greenhouse Gas Emissions Reductions and Removals from Landfill Gas Destruction and Beneficial Use Projects, version 2.0"
- American Carbon Registry, Protocol Errata and Clarifications
- Methodology v2.0 Scientific Peer Review Comments and Responses
- Methodology v2.0 Public Comments and Responses
- Methodology v2.0 Public Comment Version
- Methodology v2.0 Summary of Changes

To further supplement this Comment, Loci also submits the attached Technical Paper that provides a case study of the implementation of Loci's automated landfill gas collection technology at the McCommas Bluff Landfill in Dallas, Texas. **Exhibit A**

[1] This third-party peer reviewed study is available upon request.

Washington's Clean Fuel Standard

The following summary of the Washington CFS provides an overview about the program and how it can be used to incentivize greater LFG emission reductions in the state in conjunction with the Proposed LMR. The Washington CFS generally applies to transportation fuels that are sold into Washington state with some limited exceptions. The CFS applies to a wide range of transportation fuels and technologies including liquid and gaseous fuels such as ethanol, biodiesel, hydrogen and biomethane, as well as electricity used in electric vehicles.

The CFS reduces GHG emissions by regulating the full life-cycle carbon intensity (CI) of transportation fuels used in Washington. The CI score of a fuel reflects not only GHG emissions created at the time of combustion, but also the GHG emissions associated with its extraction and refining, its transport to Washington, and any indirect land use change (ILUC) attributed to the feedstock based on GHG land use modeling. The CI score also reflects any GHG reductions the collection of the fuel provides such as avoided methane emissions. Regulated parties (petroleum refiners and importers) must meet an annual standard for CI, which decreases more rapidly in the later years of the program. In order to meet annual standards, regulated parties must either supply a sufficient quantity of low carbon fuels to the Washington market or buy credits from low carbon fuel producers. The increasingly difficult CI requirements and the ability to bank credits drive value for low carbon fuel producers who supply low CI fuels into Washington.

California and Oregon have programs very similar to the Washington CFS known as the California Low Carbon Fuel Standard and the Oregon Clean Fuels Program. All three programs are fundamentally consistent in terms of program structure and requirements.

In order to generate credits under the Washington CFS, a low carbon fuel producer must establish that it is supplying lower carbon intensity fuel to the Washington market. The specific CI score of the fuel is determined by Ecology based on a fuel pathway application that is submitted by the fuel producer. Depending on the life cycle analysis of the fuel, the low carbon fuel will receive a CI score. The lower the CI score, the more credits that the fuel will generate on a gasoline gallon equivalent basis.

Under the California and Oregon programs, there has been significant credit generation achieved through the use of LFG either in the form of renewable natural gas ("RNG") delivered through the pipeline to a compressed natural gas station ("CNG") to a CNG vehicle, or in the form of electricity supplied to an electric vehicle. In the case of RNG, the RNG may be transported by common carrier gas pipeline with the environmental attribute (the CI score of the RNG) transferred by contract. In the case of electricity, the LFG is utilized to generate power at the landfill site. Under program rules, the environmental attribute (the CI score of the electricity) can be transferred via renewable energy certificate ("REC"), sold to a fleet and matched with electricity supplied to an EV such as an electric bus or electric forklift fleet.

The necessary action for Washington to take to facilitate the usage of low-CI RNG and low-CI electricity derived from LFG is to develop a CFS pathway score for these fuels that can be utilized for landfills that utilize Advanced LFG Control Systems. Within the CFS program, there are two types of fuel pathways: Tier 1 and Tier 2 pathways. Tier 1 pathways have already been

created within the Washington CFS and are available for fuels that are well-recognized, have established CI scores and can be determined by existing Tier 1 calculators.[2]

Unfortunately, landfills are complex systems that cannot be easily modeled and thus the CI score of LFG from a landfill must be determined via a Tier 2 calculator. To date, Washington has not yet established any Tier 2 calculators and is not accepting novel Tier 2 pathway applications. At this stage, Washington is accepting only Tier 2 pathways that have already been approved by California and/or Oregon. Given that the Washington program started recently, this is a reasonable approach given that Tier 2 pathways are more complex and difficult to establish than Tier 1 pathways. Washington is scheduled to start accepting Tier 2 pathways on October 1, 2024.[3]

Even before the start date for Tier 2 pathway applications, Loci recommends that Ecology begin to undertake the necessary technical work to prepare to review pathway applications from landfills that now deploy or plan to deploy Advanced LFG Control Systems. The California Air Resources Board has undertaken this work and is potentially available as a resource to assist on it. This Comment is bringing this issue to Ecology's attention because of the complexity of modeling landfill gas emissions which is dependent on many variables including the size, location, age, temperature, nature of the waste material, and other factors. It is anticipated that it will take Ecology some time to make an analysis of what the baseline LFG emissions will be of a landfill that is compliant with the requirements established by the landfill methane regulation that Ecology approves in this rulemaking. This baseline is a necessary precursor to the determination of the CI score of a particular pathway because a crucial part of the pathway determination will be: ***How much additional LFG will an Advanced LFG Control System capture beyond the amount of LFG that would be captured by a control system that is simply compliant with the Washington landfill methane regulation?***

There is substantial value to Washington state and to Ecology in undertaking an analysis that will respond to this question as quickly as possible. The time pressure results from the structure of the Proposed LMR which will necessarily force landfill owners and operators to make decisions about how they will comply with the LMR within a specified time frame. For instance, WAC 173-408-080(2) provides in part that, "Design plan and installation: If a gas collection and control system that meets the requirements of either subsection (3), (4), or (5) of this section has not been installed, the owner or operator of a MSW landfill must submit a design plan to the department or local authority within one year after the effective date of this chapter, (…)"

Thus, depending on the status of the landfill methane control system of the landfills, landfill owners and operators will be required to make decisions quickly regarding the type of landfill methane control system they will choose to install. It is likely that the default approach will be to select the system that most cost-effectively meets the requirements of the regulation. However, the availability of a CFS revenue stream could substantially impact this calculation.

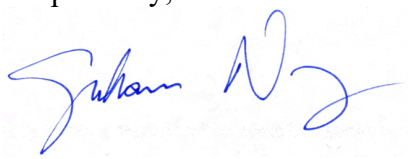
[2] See Ecology website, "Clean Fuel Standard Requirements for Participation," (section pertaining to Tier 1 is at bottom of page), at https://ecology.wa.gov/air-climate/reducing-greenhouse-gas-emissions/clean-fuel-standard/requirements
[3] Id. (section pertaining to Tier 2 is also at bottom of page).

Conclusion

Depending on the specific characteristics of the landfill and the costs of available control technologies, it may sometimes be the case that the additional revenue stream from CFS credits makes an Advanced LFG Control System more cost-effective in the long run than a "simple compliance" methane control system. It is for this reason that early action on establishing Tier 2 pathway lifecycle analysis methodologies by Ecology could accelerate opportunities for GHG and criteria emissions reductions in the State.

Loci is available with a substantial amount of data and knowledge to provide further input to this process and looks forward to working with Ecology in support of the fulfillment of Washington's goals.

Respectfully,



Graham Noyes
Representing Loci Controls, Inc.

EXHIBIT A

Automated Landfill Gas Collection Improves Operations and Increases Revenue for one of the Largest High-BTU Landfill-Gas-to-Energy Sites in the US

Technical Paper

Co-authored by:

Mark Messics, P.E.
Director – Field Optimization and Development, EPP Services
EnergyPowerPartners.com

Adam Andara
Operations & Maintenance Supervisor, EPP Services
EnergyPowerPartners.com

Nicole Neff
Landfill Gas Collection Project Manager, Loci Controls, Inc.
THE LEADER IN AUTOMATED LANDFILL GAS COLLECTION
LociControls.com

Abstract

Dallas Clean Energy McCommas Bluff, LLC ("DCEMB") operates one of the largest landfill gas-to-high-BTU projects in the United States at the McCommas Bluff Landfill in Dallas, Texas.

Loci Controls ("Loci") is the leader in automated landfill gas collection. Loci's products and services provide remote wellfield control through a cloud-based software application that maximizes landfill gas collection. Loci products have been installed at over 20 projects, including landfill gas-to-electricity projects, and Loci is currently providing automated landfill gas-collection services to six operational landfill gas to-high-BTU operations.

This paper highlights a case study where Loci provided automated landfill gas collection to DCEMB at the McCommas Bluff Landfill. In July 2017, Loci installed landfill gas-collection hardware, controlling 20% of DCEMB's gas flow and operated those 60 wells for a year. After reviewing the year's performance, the data on the aggregate flow was not consistent with the flow trends observed at the plant. The Loci wells were showing approximately 20% improvement in aggregate, but the plant was not reflecting this trend (in fact, DCEMB reported that they were seeing a decrease in flow at the plant). However, upon further investigation, it was discovered that operating only a small percentage of the wellfield, does not effectively manage the system's gas flow, and wells that are tuned more frequently with automated tuning may have been stealing gas from neighboring wells and not increasing the overall flow captured. Furthermore, with only this partial installation in place, it was unclear whether the overall gas collection on the remainder of the wellfield was trending in the right direction. Therefore, Loci and DCEMB agreed to run a trial on 75% or greater of the wellfield gas flow to see if that would deliver increased flow at the plant level. Loci installed landfill gas-collection hardware on 200 wells and began operating them in December 2018. As soon as Loci's automated gas-collection operation commenced on this larger scale, there was a marked improvement in gas collection when compared to the same month's performance the year prior, with a 24% average improvement in MMBTUs captured from December 2018 through March 2019. Following this latest trial, in April of 2019, DCEMB and Loci Controls entered into a 3-year agreement to continue operating the 200 wells, controlling approximately 75% of the wellfield's gas flow.

Background

Automated Landfill Gas Collection

Founded in 2013 by MIT engineers, Loci Controls is the first company to provide automated landfill gas collection. Loci utilizes patented and patent pending technology and control algorithms to monitor and control the landfill gas -collection process. Through continuous monitoring and control of the landfill gas-collection system, Loci increases gas-collection system efficiency. Loci increases methane collection, gas quality, and profits for landfill gas-to-energy project operators. Through the use of wellhead monitoring and automated control, both plant and employee productivity are also improved, and there is a significant reduction in man-hours spent manually tuning wells in vast wellfields. Loci's products and services are proven to improve gas-collection efficiency while reducing fugitive emissions and odors emanating from landfills.

The landfill gas-collection system consists of a large number of interconnected vertical gas-collection wells and horizontal pipes in trenches. Loci continuously monitors collection wells and makes continuous, incremental valve adjustments to maximize the collection of methane from the whole wellfield. Each Loci wellhead-mounted product includes a NIST traceable calibration gas bottle and on-demand pressure regulator, which allows for gas-composition sensor calibration on an automated, or on-demand basis. Additionally, Loci uses aggregate gas composition measurement equipment, such as gas chromatographs, and/or precision gas meters as top-level automation control. This ensures that aggregate gas quality meets the plant's processing requirements. While each landfill has a unique operating environment, Loci's automated gas-collection system has proven to increase gas collection by 10% or more, all while improving the productivity of plant and on-site personnel, and mitigating the environmental, health, and safety risks by reducing the number of wellfield technician man hours spent in the landfill, and associate

Loci's products and services use wellhead- and header-mounted hardware, connected via cellular networks to its WellWatcher® user interface and analytics platform. Working with personnel on site, Loci gas-collection analysts provide remote oversight of the landfill gas-collection process. In addition, Loci provides on-site support to help its customers optimize the overall gas-collection and gas-to-energy processes.

Loci Controllers and Guardians are wellhead-mounted products with an onboard sensor package that remotely monitors pressure, temperature, system vacuum, flow, oxygen, carbon dioxide, methane, and balance gas (calculated). The Controller unit is designed for high-flow wells (>15 SCFM) at LFG-to-high-BTU projects where the performance requirements and value of incremental gas collection is greatest and required precision with all measurements is down to tenths of a percent. The Guardian unit is designed for lower flowing wells at high-BTU projects or for collection wells on gas-to-electricity sites where the performance requires precision down to the percentage point. Both the Controller and the Guardian include an automated flow valve that regulates the flow at each individual well.

To optimize gas-collection system efficiency, algorithms are used to make fine-tuning adjustments on individual collection wells on an ongoing basis. Automation is also used to make simultaneous adjustments to multiple collection wells in response to changing gas composition as measured at the plant. In addition, Loci utilizes monitoring-only Sentry devices, which are mounted on individual gas headers to provide aggregate gas composition from sectional areas of the landfill.

Dallas Clean Energy McCommas Bluff, Dallas, Texas

The McCommas Bluff landfill in Dallas, Texas began accepting waste in 1980, is an open site, and has approximately 50 million tons of waste in place. The landfill is owned by The City of Dallas. Dallas Clean Energy McCommas Bluff, LLC (managed by Energy Power Partners and its affiliates), owns the landfill gas rights, the landfill gas-collection and control system (GCCS), and the landfill gas-to-high-BTU pipeline injection plant. The gas-collection project has been in operation since 2000. This project generates Renewable Identification Numbers (RINs) from the methane injected into the pipeline as part of the Renewable Fuel Standards Program.

The McCommas Bluff landfill has 390 vertical gas-collection wells and 80 horizontal gas collectors, for a total of 470 gas-collection points, with average LFG collection of 10,000 SCFM of landfill gas. The landfill has been manually tuned historically, with typical gas composition of the landfill gas at the inlet being no less than 55.2% methane. To meet pipeline injection requirements, a minimum of 950 BTU, <0.25% O_2, <1.5% Nitrogen, and <3% CO_2 is required.

The DCEMB plant does not have a Nitrogen Rejection Unit, so nitrogen must be controlled in the wellfield through the collection process. The plant uses a proprietary vacuum pressure swing adsorption (VPSA) system processing technology. At the plant, the LFG is compressed to over 100 PSIG and sent through a pretreatment system to remove moisture and trace constituents. The gas is then processed through the VPSA system to separate carbon dioxide from methane. In this highly automated process, the gas follows a sequence of adsorption, high-pressure rinse, depressurization, evacuation, and re-pressurization steps. The result is a gas stream of pipeline-quality methane.

The plant has the capacity to process over 15 million cubic feet of LFG into eight million cubic feet of pipeline-quality methane per day; enough to supply the needs of up to 20,000 homes. DCEMB delivers the gas into the Atmos Energy Pipeline Company distribution pipeline system.

Project
Automated Landfill Gas Collection on Majority Flow

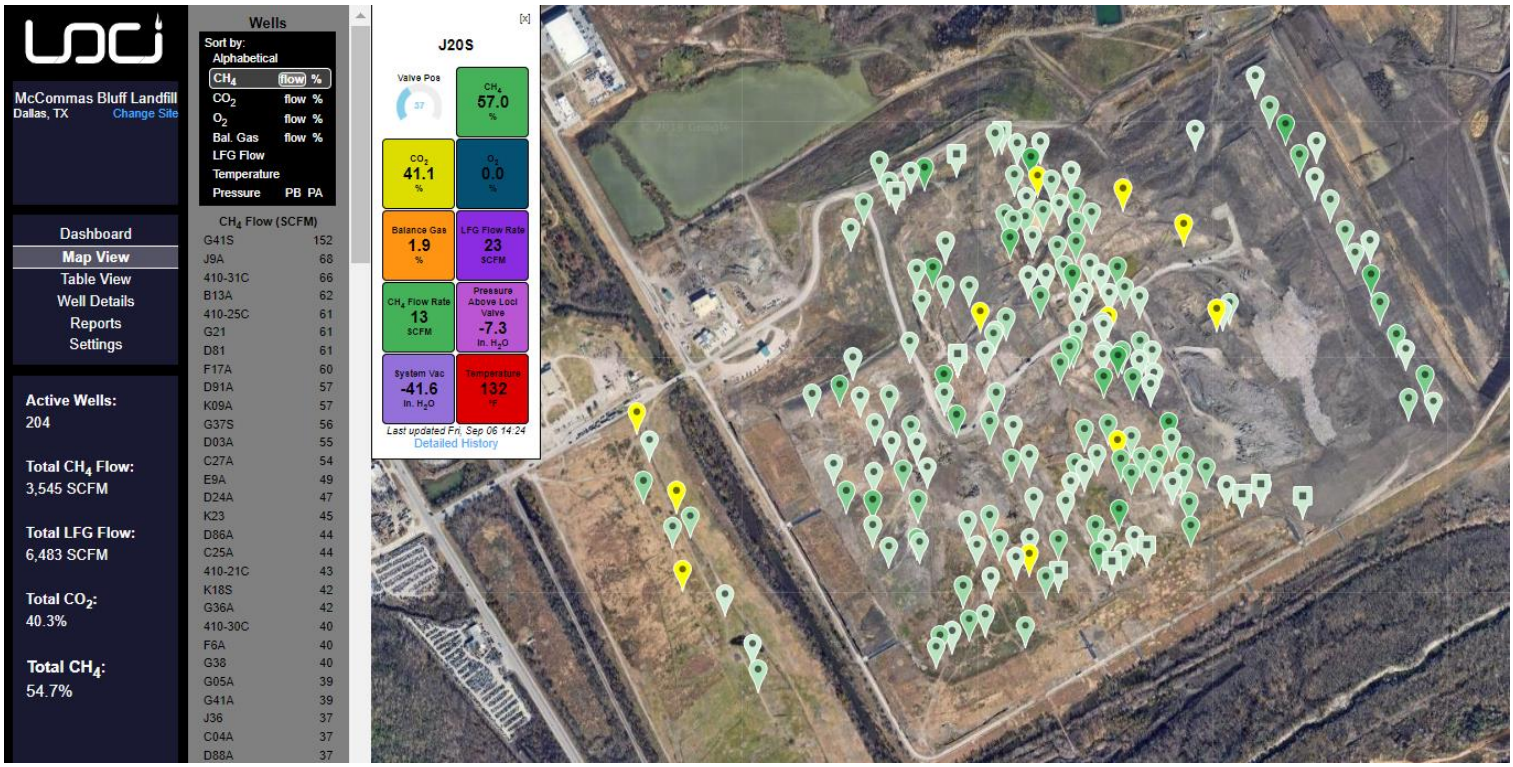
In the summer of 2017, Loci and DCEMB worked together to deploy an automated landfill gas-collection system at the McCommas Bluff Landfill in Dallas, TX. Loci deployed 60 Controllers, and 11 Sentry units to provide control of 20% of the total flow with the automated gas-collection system. Controllers were deployed on wells with historical performance above 15 SCFM of flow. Ten Sentry H units were installed on key header locations to monitor gas quality from sections of the

wellfield and aid in troubleshooting of air intrusions from wells on which Loci did not have Controllers installed. The remaining Sentry unit was deployed to monitor inlet gas by relaying the inlet GC readings in real time. The Sentry was used to make a direct connection to the ABB PGC 1000 Gas Chromatograph ("GC") at the EPP plant to monitor aggregate gas quality at the plant as a top-level control in the Gas Composition Threshold Automation. Installation on 75% of gas collection, plus the data connection to the GC at the DCEMB plant, allowed for optimal operation of the automated landfill gas-collection system.

Starting in October 2018, Loci automated landfill gas collection was expanded to 200 collection wells, representing 70% – 80% of the total gas collection from this landfill. The 10 Sentry header-monitoring products remain for this expanded installation.

Photo 1: Loci Controller unit on well at the McCommas Bluff landfill in 2018

Photo 2: Loci WellWatcher® Map of DCEMB wellfield with data shown for a sample well.



Large Site with Challenging Access

As one of the nation's largest landfill sites, and with the permitted area covering 965 acres, maintaining and tuning the gas-collection system at DCEMB has historically been challenging. It is a 2-mile drive to the far side of the landfill from the plant/flare station, with 470 collection points and an estimated 37 miles of gas-collection piping. The waste footprint currently covers approximately 480 acres, with another 53 acres of new cells ready to be placed into service. The landfill brings in ~6,000 tons per day via 1,800 trucks per day, so the work face and haul roads are constantly moving.

In addition to the sheer size of the site, the landfill design poses several management challenges. Most of the plateau surface of the landfill is flat, making it difficult to maintain adequate fall on the gas-collection piping, resulting in condensation buildup in the pipes. Older areas of the landfill that have settled is an ongoing process, requiring that landfill gas wells constantly need to be disconnected, raised, and later re-connected to the gas-collection and control system. This also entails frequently relocating the gas piping. Additionally, the landfill lacks a permanent cap, historic waste compaction is low, and the soil cover throughout is fairly porous, facilitating air intrusion. The flat plateau and porous cover also facilitate the infiltration of stormwater. With a highly permeable soil cover, gas quality is also very sensitive to changes in ambient atmospheric conditions, such as barometric pressure and temperature swings.

Prior to retaining Loci, DCEMB's internal goal was to manually tune each well twice per month. Unfortunately, DCEMB's technicians often get diverted to resolve emergencies encountered in the operations and maintenance of the gas-collection and control system due to the dynamic and expansive characteristics of the site. As a result, wells were often only tuned once per month, if subsequent extreme weather made accessing the wellfield impossible. Given the size and complexity of the site, DCEMB's staff also did not have the time or resources to analyze the historic manual well-tuning data, or spot trends and anomalies in the monthly well-tuning readings.

Gas Composition and Flow Tuning Challenges

Prior to retaining Loci, DCEMB's technicians would tune each well so that it would meet DCEMB's RNG plant's incoming gas spec during each and every hour up until the next tuning event. This effectively meant that each well was tuned to the worst-case condition that could historically be expected to occur during the next 720 hours (in the case of *monthly* tuning). As a result of this static tuning program, wells were often tuned to a lower flow setting in order to be conservative in terms of gas quality, meaning that a fair amount of additional "in spec" gas was not collected during many hours of the month when it was available.

During dynamic weather events, the impact of a static tuning regimen posed even greater challenges. In anticipation of a high-barometric front approaching the area — typical of the winter months — DCEMB would implement system-wide adjustments to the wellfield vacuum. This typically entailed simply dropping the vacuum at the plant and involved some guesswork. Because these changes were applied uniformly across the site and were implemented primarily based on manual estimations, flow drops were substantial, gas quality was inconsistent, and plant shutdowns were fairly frequent. In the three years prior to incorporating Loci's 200 units, DCEMB experienced significant total RNG plant downtime due to weather-induced poor incoming gas quality, with 17 hours of downtime in the 2015-2016 winter, 125 hours of downtime in the 2016-2017 winter, and 17 hours of downtime in the 2017-2018 winter (Nov-March).

Operational Challenges

The greater Dallas, TX area typically experiences a few rainy seasons throughout the year. These periods of significant rainfall cause huge areas of the (flat) plateau on the landfill to become inaccessible. Many of the access roads to the wells become impassable due to mud and deep ruts. DCEMB staff would often have to wait up to a week for the areas to dry out so that the wells could be reached.

Additionally, oxygen intrusions frequently resulted in a multi-day effort to find the source of the problem before field technicians could repair it. If a Fernco coupling or hose breaks loose on a wellhead, the ensuing oxygen intrusion will typically contaminate the entire gas flow and shut the RNG plant down. Similarly, air intrusions affecting gas-header pipes, lateral pipes, or other sections of the landfill gas-collection and control system would also lead to plant shutdowns. Prior to retaining Loci, the DCEMB staff would have to manually inspect all 470 wells and 37 miles of pipe spread over 500 acres in order to find the source of a problem. This effort frequently took many hours or days and was made even more difficult when such an incident occurred after dark.

Results

Automation of landfill gas collection on 200 wells, affecting approximately 75% of flow, has been in continuous operation since December 2018. The primary goals of the project for DCEMB are to increase overall CH_4 flow and MMBTU/sales, and to minimize plant downtime due to the landfill gas-collection system not meeting gas composition specifications. The results have been significant and compelling. Overall, MMBTUs/Day sold has increased by 16% from December 2018 – July 2019, compared to the same 8 months in the prior year. The total plant downtime due to landfill gas quality delivered to the plant not meeting specifications has been reduced to **zero** over the 2018-2019 winter.

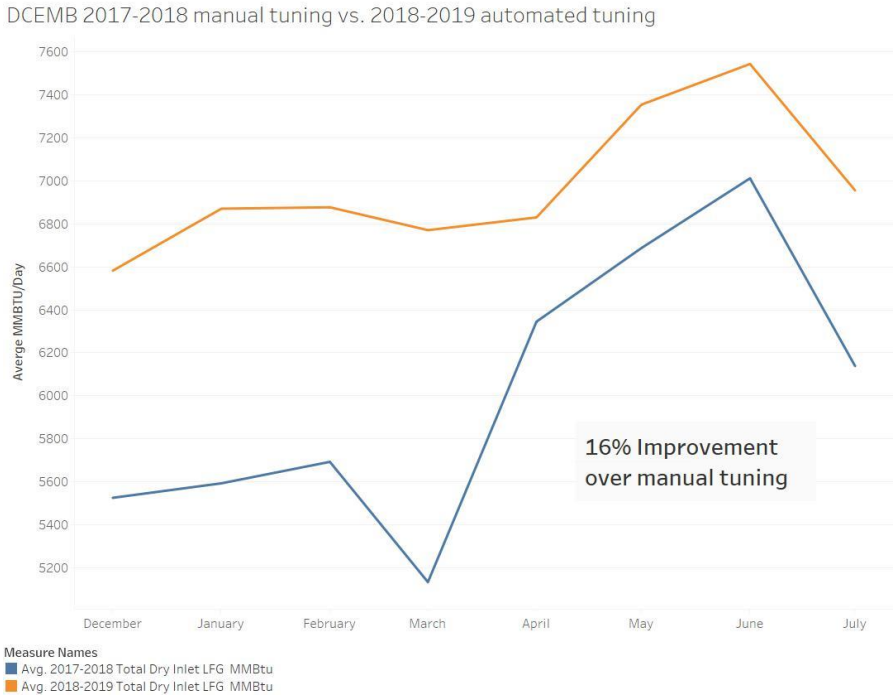


Figure 1. Sustained Increased LFG Collection Over Manual Tuning.

24/7/365 Monitoring and Control

With the Loci system now in place, site personnel can access data on the monitored wells at any time, freeing up technician time for higher value-added tasks and improving operations. DCEMB now only has to tune the wells not controlled by Loci approximately once per month, while Loci provides continuous monitoring and control of the Loci-controlled wells to maximize methane flow and maintain gas quality. DCEMB's technicians are now freed up to perform necessary wellfield operations and maintenance work without the fear of gas-quality deterioration leading to a potential shutdown of the RNG plant. DCEMB estimates the savings being the equivalent of two full-time landfill gas technicians (although they have not reduced their staff, nor do they plan to, as knowledgeable wellfield technicians are highly valuable and there remain plenty of other tasks to maintain the wellfield than wellfield tuning).

Additionally, Loci has been able to analyze the site data and make recommendations for improved performance and design. For example, Loci identified certain wells where the 2" wellheads were restricting the available gas flow. DCEMB replaced the 2" wellheads with 3" wellheads, thereby increasing the available gas flow and subsequent RNG sales. Loci and DCEMB also installed the appropriate orifice plates on wells that had very inconsistent and potentially inaccurate tuning readings. The proper orifice plates are now providing DCEMB with accurate and reliable data.

Increasing the wellhead size from a 2-inch wellhead to a 3 inch wellhead when the methane composition is above 56%, the oxygen and balance gas is low to none and the valve is mostly 100% open, allows the well to be operated at its flow potential. On average in these cases a well's flow can be increased another 10-15%, for example from 90 SCFM to 110 SCFM. Each well is unique and results very. The idea is to be able to increase flow to the point balance gas and oxygen as detected and so the well can be tuned at the appropriate position to control composition.

Gas Composition and Flow

Loci's original automated gas-collection algorithm uses frequent (hourly) gas-composition and flow measurements at each collection well to make small incremental valve adjustments. This automatic "fine tuning" of each collection well results in optimized CH_4 flow, while maintaining individual well-gas composition requirements within balance gas (N_2) and O_2 thresholds.
While the previous manual-tuning approach required tuning to worst-case conditions throughout the month in order to ensure high-quality gas for the duration of the month, Loci's automated tuning protocol has unlocked new potential in terms of gas flow while ensuring that composition thresholds are always maintained. With continuous tuning throughout the month, the automated tuning protocol can be much more responsive than manual tuning. The Loci automated control algorithms pull harder on a well when conditions allow for increased methane flow and acceptable gas composition, and then reduce the vacuum applied to the well when needed. As a result, DCEMB can maintain the gas quality with high precision to the required gas spec for the RNG plant and downstream sales gas pipeline specification.

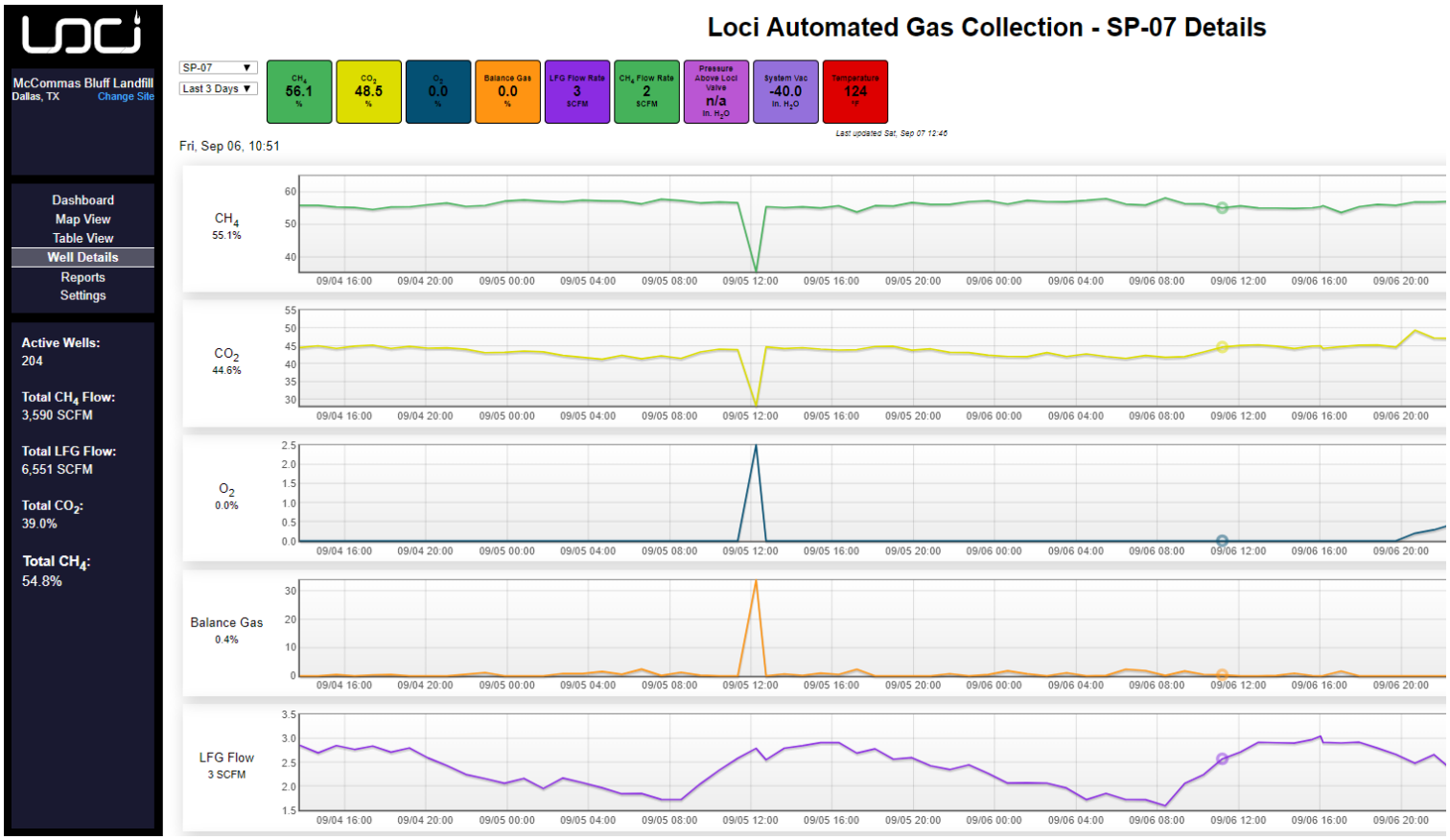
In addition to individual well readings, the Loci algorithm uses the plant GC data on aggregate gas composition from the entire wellfield, to optimize the landfill gas-collection process. Adjustments to valve positions on each individual collection well are weighted by gain factors, which reflect how responsive an individual well's gas composition is to a given valve adjustment. For some collection wells, small valve adjustments have a large impact on gas composition; for other collection wells, larger valve adjustments are required to change the gas quality. With full visibility into the plant's gas specs, the Loci algorithm can also make calculated trade-offs to increase flow from particular wells, because even if an individual well is temporarily "below-spec" on gas quality, Loci can maintain aggregate composite flow into the plant within spec and ensure the well is operating safely. By adopting this approach, DCEMB has thus eliminated a huge portion of the "factor of safety" buffer that it had previously incorporated into its process, which restricted the volume of sales gas.

Furthermore, the gas DCEMB was selling was oftentimes generously exceeding the minimum gas-quality standard that DCEMB is obligated to meet with the pipeline company with no financial upside. Loci's precision tuning approach has contributed to the recovery and sale of 0.5% to 35% of additional MMBTUs for a given day compared to the same day the prior year under DCEMB's prior manual-tuning program.

Loci has also used the aggregate gas composition readings to enable a rapid response algorithm to address changes in barometric pressure or other acute weather events. When the BTU value at the GC approaches either the high or low limits of a desired range, or process set points, Loci's automated system makes batch valve adjustments in the wellfield to stabilize the BTU values and maintain them within the optimal range. This has resulted in the ability to maintain gas quality specs at a much higher rate than the previous approach of manual adjustments to the full wellfield. During the first winter (Nov. 2018 – Mar. 2019) that Loci controlled the majority of the gas flow (with 200 units installed), DCEMB had zero hours of downtime due to weather-induced poor gas quality. This translated into increased RNG sales.

Operational Benefits

Loci's automated landfill gas-control system has provided new visibility into site operations, enabling both rapid problem solving in real-time, as well as new insights into the overall operating environment. Continuous well tuning is provided even during the worst weather conditions when manual tuning would be impossible. DCEMB can instantly see, on the real-time WellWatcher web screen, which collection well or group of wells has experienced a failure resulting in air intrusion so onsite staff can to go directly to that well to repair it. This translates into little-to-no plant downtime, as the Loci unit can also simultaneously start closing the control valves on other collection wells to compensate for a single struggling collector, until DCEMB staff arrives for the repair. This also provides savings in labor costs, as no time is wasted searching for the culprit well. Loci header monitors are located on the main subheaders and instantly notify DCEMB as to which area of the landfill they should focus their attention on. This translates into minimizing plant downtime and increasing RNG sales.



Graph: Example of quick identification and correction

In addition to these benefits from increased data and site visibility, the automated gas-collection and service package provides several additional benefits. A Loci employee provides on-site support and is an additional set of eyes/ears that might spot something awry in the wellfield that DCEMB staff may have missed. Loci service is available to address/monitor an unusual circumstance or event. Loci identifies and alerts DCEMB to variations in gas quality at a given well (where DCEMB technicians might never notice such on their own). Since Loci is controlling 75-80% of the total gas flow, DCEMB has found that they can get by only tuning the other "non-Loci" wells once per month, although the goal is to read all collector locations twice a month. This also translates into labor savings and frees up the DCEMB staff to work on more pressing O&M-related tasks. In addition, Loci provides more stability in the day-to-day gas flows than DCEMB staff could manually provide (as staff wouldn't have time to revisit wells after making tuning adjustments). The result is that the RNG operation is smoother and employee satisfaction has increased as consistency has improved, callouts have decreased, and problems are readily identifiable.

Conclusion

The use of automation to optimize landfill-gas collection and improve gas quality has lead to a significant ROI for DCEMB. Through constant monitoring and automatic well tuning, DCEMB's technicians are able to monitor the entire wellfield in real time and quickly respond to emergencies should they arise, drastically reducing labor costs. Plus, with a 24% average improvement in MMBTUs captured from December 2018 through March 2019, Loci's initial trial period was a resounding success. These results demonstrated a substantial value-add for DCEMB's business, leading to a 3-year commitment that promises to be profitable for Loci Controls and DCEMB alike.

About the Authors

Mark C. Messics, P.E., Director – Field Optimization and Development,
Mark has a B.S. in Civil Engineering and an MBA from Lehigh University. He has over 30 years of experience developing, permitting, constructing, and managing landfill gas-to-energy projects. He has worked at over 140 landfills, with prior employers including Waste Management, Inc., DTE Biomass Energy and PPL Renewable Energy. Mark has been with EPP Service Company since November 2015, when Energy Power Partners acquired the former PPL Renewable Energy power plants. His current focus is on optimizing landfill gas production at the City of Dallas' McCommas Bluff Landfill, where EPP operates the largest high-BTU plant in the country. He is a registered professional engineer in Pennsylvania and resides near Allentown, PA.

Adam Andara, Operations & Maintenance Supervisor
Adam brings a wealth of knowledge and 20 years of experience in the landfill gas industry with him to EPP Services. He got his start in 1999 at RSS Environmental managing SEM for landfills in Orange and San Bernardino Counties. In 2000, he accepted a role with GSF Energy as a welltech at Olinda Alpha Landfill in Brea, CA. As one of two technicians at the 565-acre site, he managed and operated a gas-collection system with over 400 gas-collection points. In 2009, while still with GSF Energy, Adam relocated to North Dallas, TX, where he helped start and manage a 2-engine Cat 3520 power generation site in McKinney, TX, before helping to start a SECOND similar site in Tulsa, OK — all while managing the gas-collection system at both plants. In 2016, he joined EPP Services as the Operations & Maintenance Supervisor overseeing wellfield and daily plant operations at the Dallas Clean Energy McCommas Bluff high BTU gas processing plant.

Nicole Neff, Landfill Gas Collection Project Manager and Sales
As the Landfill Gas Collection Project Manager for Loci Controls, Inc., Nicole is responsible for daily oversight of Loci's systems across the U.S. and has been instrumental in paving the way for remote and automated landfill gas collection and control. Nicole has worked in the management of environmental spatial analytics for 7 years. Loci's innovative approach to managing LFG collection is the perfect platform for applying her passion; she enjoys using spatial relationships with environmental data to maximize LFG collection and be a good steward of our environment. She holds a Master of Civil Engineering from Norwich University and a Bachelor of Environmental Science from the University of Washington.