

MEMORANDUM

To: Paula Scott & Hampden Environmental Trust
From: Matt Reynolds & Steve Rabasca
Date: August 21, 2019
Subject: Pine Tree Landfill –Post-Closure Monitoring Review & Update

This memorandum has been prepared to provide the Town with an overview of 2018 and April 2019 monitoring data and associated corrective actions and post-closure conditions at the Pine Tree Landfill (PTL). The review is based on information provided in the 2018 Annual Report and April 2019 water quality data provided by PTL's engineer Sevee & Maher Engineers, Inc. (SME).

This memorandum focuses on 2018 and early 2019 operations and data from PTL. Additional information on historical conditions, closure, etc. was provided to the Town in a memorandum dated November 21, 2016.

Figure 1-1 from Attachment C of the 2018 Annual Report (prepared by SME) is attached to this memorandum for reference and shows the configuration of the landfill and location of the monitoring points and other site features. Consistent with previous update memoranda, this update does not include detailed graphs and figures, however, we would be glad to prepare these if it would assist the Town and/or address specific questions.

I. Review of Landfill Closure Status

PTL completed closure of the landfill in 2010 in accordance with the October 2006 Schedule of Compliance agreed to by the Maine Department of Environmental Protection (MDEP) and the Town of Hampden. Since that time, monitoring of water quality, gas, settlement, etc. has continued in accordance with the Environmental Monitoring Plan (EMP) for the site. In 2016 (after 5 years of monitoring) several adjustments were made to the sampling frequency and parameters. Table 1 includes a summary of the current water quality monitoring regime.

In addition to the corrective action systems summarized in Section II, there are currently two active systems operating in association with the closed landfill.

1. Landfill gas containing methane is collected and used to fuel the Landfill Gas to Energy (GTE) facility constructed in 2007.
2. Additionally, some of the leachate collected by the leachate collection system and groundwater extracted from wells at the perimeter of the landfill has been recirculated into the landfill with the approval of the MDEP.

II. Corrective Action Summary

Prior to closure, corrective actions systems were implemented to control and/or mitigate impacts to groundwater and surface water. These include the following.

- Gas collection systems were installed in the Conventional Landfill and Secure Landfills to collect a portion of the landfill gas generated by decomposition of waste. Both gas collection systems are connected to the GTE plant.
- The Secure landfill liner system functions as a cover for the Conventional Landfill and the cover system for the Secure Landfills was completed in 2010;
- The perimeter drain (PDPS) borders the west, south and east sides of the Conventional Landfill and intercepts and collects some shallow groundwater;
- Six groundwater extraction wells have been installed near the edge of the landfill (shown as red symbols on Figure 1-1). Wells EW-2R and EW-3R are located adjacent to the southeast corner of the landfill. Wells EW-5R, EW-6R, EW-101 and EW-102 are located adjacent to the northeast corner of the landfill. The volume of leachate and groundwater extracted by these wells and the PDPS during 2013 to 2018 are summarized below.

Year	Northeast (EW-5R, -6R, -101, - 102)	South (EW-2R, -3R)	PDPS	Total (gallons)
2013	2,687,000	1,121,000	3,721,000	7,529,000
2014	1,857,000	506,000	3,802,000	6,165,000
2015	3,112,039	781,344	3,356,269	7,249,652
2016	2,328,767	475,324	2,705,609	5,509,700
2017	1,429,545	155,070	3,056,334	4,640,949
2018	1,771,445	265,776	4,097,318	6,134,539

After lower pumping in 2016 and 2017, PTL increased the total groundwater withdrawals from the extraction wells in 2018 to approximately the same volume as was withdrawn in 2014.

- PTL also collects gas migrating away from the landfill in collection wells located west and south of the landfill. This external landfill gas (LFG) collection system consists of 6 gas collection wells (shown as blue symbols on Figure 1-1) and a passive gas collection trench. The gas extracted from the collection wells during 2013 to 2018 is summarized below.

Year	PTGW08-1 (MMSCF/Tons)	PTGW08-11 (MMSCF/Tons)	PTGW08-12 (MMSCF/Tons)	PTGW08-13 (MMSCF/Tons)
2013	20.8/218	2.0/17	0.5/2	0.6/4
2014	19.7/220	2.6/22	0.1/0.3	0.4/6
2015	19.2/200	2.5/19	2.1/10	1.7/8
2016	13.9/144	2.8/18	1.1/2.6	0.1/0.2
2017	8.6/101	3.5/23	1.8/12	0.2/0.1
2018	12.6/138	7.1/49	5.5/33	3.7/17

Notes: 1. MMSCF = Million Standard Cubic Feet. Tons = Tons of Methane Extracted
 2. Estimate of Tons is Based on Volume Extracted and Percent Methane
 3. No Gas Was Extracted from PTGW08-3, -9 during 2013 to 2018 Due to Low Gas & Methane

The gas extraction in well PTGW08-1 increased in 2018 compared to 2017, but was generally lower than in previous years. In contrast, more gas was extracted from PTGW08-11, northwest of the landfill, in 2018 than in previous years. Similarly, more gas was extracted in PTGW08-12 and -13, southwest of the landfill, in 2018 compared to previous years. Since 2015 PTL has increased gas extraction at PTGW08-12 south of the landfill. This has generally resulted in lower dissolved methane concentrations in downgradient monitoring wells located southwest of the landfill (e.g., MW-03-802A, -802B, -803B) and the 2018 methane concentrations in these wells continued to be on the low end of the historical range.

III. Water Quality Target Criteria

The MDEP Closure Order identified 5 specific criteria for determining “successful corrective action” at PTL under the MDEP Solid Waste Regulations. These criteria incorporate the state Maximum Exposure Guideline (MEG) values and the federal Maximum Contaminant Level (MCL) and Ambient Water Quality Criteria (AWQC) values.

The five criteria are as follows.

- Groundwater Quality on the PTL Property:
 - Specific Conductance must be less than 500 umhos/cm
- Groundwater Quality off of the PTL Property:
 - Groundwater must be below the applicable MCLs and MEGs;
 - Specific Conductance must be less than 400 umhos/cm
 - Dissolved Methane must be below 700 ug/L

- Surface Water Quality:
 - Surface water quality must meet the federal AWQC and Maine water quality classification established in 38 MRSA Section 465 and 465-B.

These criteria must be met at the PTL monitoring locations before the end of the 30-year post-closure period for the MDEP to determine that corrective actions have been successful. The 30-year post-closure period began in 2010, so 2018 represents year 8 of 30. And while it is premature to expect that monitoring locations will meet these criteria after year 8, tracking data against these criteria allows PTL, the MDEP and the Town to judge whether the existing corrective actions will be sufficient to meet these criteria over time, or whether supplemental corrective actions may be necessary in the future.

IV. Water Quality Overview

In accordance with the Post-Closure Environmental Monitoring Plan, water quality is currently monitored two times each year at a network of sampling locations around PTL. These monitoring points are located in different regions around the landfill and include groundwater monitoring wells, residential wells and surface water. Table 1 summarizes the current sampling regime, specific conductance range and water quality trends for the data from 2014 to April 2019.

Table 1
PTL 2014 to April 2019 Water Quality Monitoring Summary

Monitoring Pt ³	2016-2020 Analysis ¹ (Frequency/yr)	Specific Cond. Range ² (umhos/cm)	Predominant Specific Cond. 5-Year Trend
South/Southwest			
200*	F, L (2)	362 - 691	None
641	F, L (2), M (1)	815 - 1368	None
MW-906B*	F, L (2)	364 - 513	Down
MW02-801A	F, L (2), M (1)	2381 - 3530	Down
MW02-801B	F (2)	1402 - 3700	Down
MW03-802A	F, L (2), M (1)	470 - 837	Down
MW03-802B	F, L [^] (2), M (1)	1004 - 1587	None
MW03-803A	F, L [^] (2), M (1)	1264 - 1867	Up
MW03-803B	F, L (2), M (1)	1157 - 1507	Up
West & North			
MW03-804A	F (2)	682 - 1070	Up
P-914A	F, L (2)	683 - 949	Up
P-914B	F (2)	589 - 918	Up
516B-B	F, L (2)	981 - 1169	Up
Northeast & East			
MW98-601A	F (2)	1969 - 2880	None
MW96-601B	F (2)	1176 - 1730	None
MW01-602B*	F (2)	259 - 679	None
MW97-123	F, L (2)	780 - 1414	None
509A	F (2)	800 - 1234	None
509B	F, L (2)	789 - 1249	Up
P-911B	F (2)	768 - 959	None
916	F, L (2), M (1)	257 - 1160	Up
917	F, L (2), M (1)	354 - 1042	None
Residential			
DW04-109*	F (2), L (1), M (2)	201 - 793	None
DW-103	F (2), L (1), M (2)	409 - 485	Up
Surface Water			
SW-A	F, L (2)	86 - 180	None
SW-C	F, L (2)	66 - 200	None
SW-D	F, L (2)	197 - 890	None
SW-E	F, L (2)	241 - 1046	None

Notes: 1. Analyses: F=Field Parameters, L=Laboratory Parameters, M= Methane, L[^]= Supplemental

2. SC Range Reflects Data from 2014 to April 2017

3. Wells in **BOLD*** are close to or below Corrective Action Criteria for Specific Conductance.

4. Values in RED Represent a New Low or High Concentration measured in 2018 or April 2019.

Comparison of Recent Data (2014 to April 2019) to the Target Criteria

- Prior to 2013, all on-site groundwater was above the 500 umhos/cm criteria. Since 2014, three on-site wells have begun to approach or meet the 500 umhos/cm criteria.

- MW-906B has had specific conductance below 500 since July 2014.
- MW-200 was below the 500 umhos/cm target criteria for 7 of the 13 sampling events since April 2014. In 2014 the specific conductance in MW-200 was below 500 in all three sampling events. Since then, this has occurred only one time per year.
- MW01-602B was below 500 umhos/cm for 7 of 11 sampling events since April 2014.
- MW-916, which is an off-site well with a target criteria of 400 umhos/cm, was below this concentration for 3 of 5 events in 2015 and 2016, but has been above 400 umhos/cm since 2016. There is an increasing trend of specific concentration in this well and October 2018 had a specific conductance of 1160 umhos/cm, which was highest since 2014. Well MW-917, which is also east of the landfill, also experienced a new 2014 to 2019 high specific concentration in October 2018.
- At MW-916, arsenic was below the MCL and MEG in 2018. At MW-917, groundwater was above the MCL and MEG for arsenic in 2018 and April 2019. Secondary drinking water criteria of iron and manganese are also exceeded at MW-916 and MW-917.
- Wells MW-917 and MW-917 were both below the 700 ug/L methane criterion in October 2018.
- Groundwater at off-site well DW04-109 was below the 400 umhos/cm target criteria during the 10 sampling rounds in since April 2015.
- At the off-site residential well DW-103, groundwater was below the MCL and/or MEG for arsenic in October 2018 but exceeded these criteria for sodium.
- Residential well DW-103 has been below the 700 ug/L methane off-site target criterion since April 2014. Well DW04-109 has been below this criterion since September of 2014.
- Surface water meets the applicable classification criteria and AWQC standards.

Discussion of Data Trends

As reflected in Table 1, over the past 5 years there has been a downward (improving) trend in specific conductance and related cations and anions in four of the monitoring locations included in the monitoring network at the PTL site. There were also new low specific concentrations measured at 8 locations in 2018 and April 2019. This improving trend has generally been gradual and at many locations, the specific conductance remains significantly above the target criteria of 500 umhos/cm.

The area where there has been a persistent upward trend in specific conductance has been to the southwest of landfill in wells MW03-802B and MW03-803A & B. New high concentrations were measured in the 803 wells in 2018. During 2018, PTL further increased gas extraction from gas PTGW08-12 and -13 in the vicinity of the 802 and 803 wells, but this has not yet resulted in significant water quality improvement. In June 2016, PTL discovered leachate leaking from a cover defect onto soils in this area. This condition was repaired promptly. However, this cover repair does not appear to have been sufficient to reverse the upward trend. Based on currently available information, it appears that the increasing trend is likely to be the result of a condition other than the 2016 leachate leak, but the cause is not known at this time.

The 2018 Annual Report notes that 2018 was the 8th year of the 30-year post-closure monitoring period and there has been discussion regarding whether the current correction action systems are adequate to reach the corrective action criteria by the end of the 30-year post-closure period. Obviously, for wells where the 5-year trend is upward, the recent data would not predict reaching the corrective action criteria by the end of the 30-year post-closure period.

Figure 2 shows the specific conductivity data and 2008 to April 2019 trend for three example monitoring wells at the PTL site where the 5-year trend is steady or downward. MW-02-801A and well 641 are south of the landfill and have exhibited moderate to strong decreasing trends that suggest the potential to reach the Corrective Action Criteria well before the end of the Post-Closure period in 2040. Review of Figure 2 also shows that data from well 641 from 2013 to 2019 has been more variable, with no statistical trend. However, the current specific concentration is low enough that slow improvement suggests that the criteria may be able to be achieved. Well 97-123 northeast of the landfill shows a more gradual downward trend that suggests the potential to remain above the Corrective Action Criteria after 30 years.

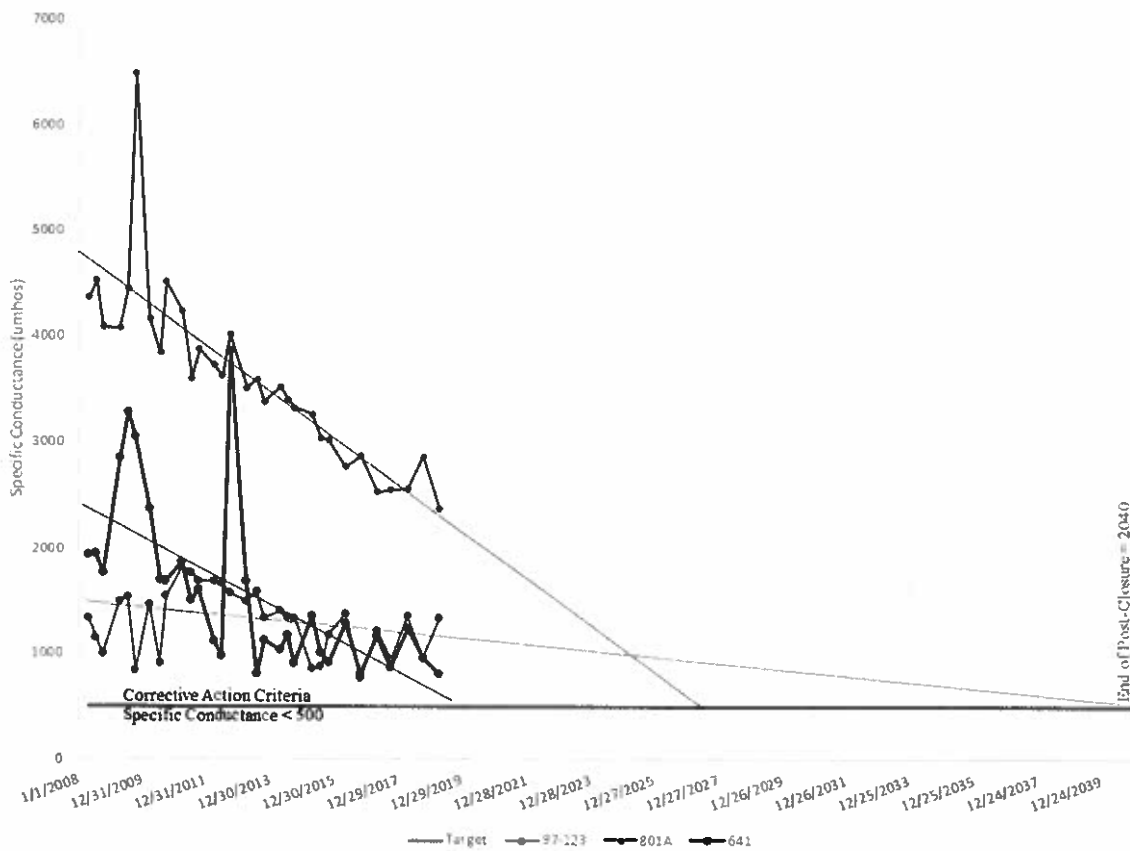


Figure 2 – Water Quality Trends

These examples suggest that with continued diligent operation of the Corrective Action systems, many wells at the PTL site have the potential to reach the criteria within the 30-year post-closure period, though many may take most of this period. However as shown in Table 1, there are wells in the southwest and west of the landfill where there are increasing trends that may require additional corrective actions in the future.

V. Geotechnical Monitoring

The geotechnical monitoring program for the landfill continued in 2018 and was summarized in a report prepared by Dr. Richard Wardwell, PE, dated April 2019. The primary purposes of the geotechnical monitoring are to assess if the internal waste mass and foundation soils are stable, and to assess if the cover system is performing as-designed.

Cover System Stability: The cover system stability is monitored by site observations and survey measurements of monitoring pins that were established within the liner system during the various closure phases. The periodic visual inspections made during 2018 did not reveal any obvious unusual deformations cracks or other issues that would indicate a liner instability, with one exception. Observations during the April 19, 2018 inspection indicated the need for repairs of surface water conveyance structures to improve drainage

from the Secure II and Secure III cover systems. There was damage to several pipe inlets collecting drainage from the top and side slopes of Secure III and a breach in the ripped lined surface water ditch that conveys water from the upper and northern side slopes of Secure II. Repairs were made in 2018.

The survey measurements of the monitoring pins continue to show movement of the pins at some locations in a downslope direction while other locations show relatively random movements. However, these horizontal movement plots do not indicate that there are serious large-scale deformations indicative of cover slope instability.

The drainage terraces that collect runoff and seepage that infiltrates through the cover soils, are periodically surveyed to check that there are no areas that have settled to the point where ponding may occur. Some sags in these terrace drains were noted, however it was concluded that the extent of the sagging would not result in flows over the top of the drainage berms or limit the terraces from draining. An additional survey of the drains will be made in 2019 to further monitor these structures.

Cover Strain Monitoring: The strain on the cover system is calculated based on the settlement component of the monitoring pins that were installed in the cover system during the several cover phases. The settlement data is plotted on individual plots then the strain is calculated based on the difference in vertical deformation between monitoring points. The settlement continues to show that the rate of settlement is lower than originally predicted. The calculations of liner strain continue to indicate that the measured strains are less than the originally predicted and is well within tolerable limits. There are no observations, from the survey monitoring or periodic visual observations that indicate liner instabilities or foundation instabilities.

Additionally, the overall slopes of the cover are gradually flattening. This flattening of the cover system improves the overall factor of safety for the liners, which were designed for the steeper slopes created when the landfill was closed.

Leachate Recirculation in 2018:

PTL continued the leachate recirculation program in 2018, but there was a large reduction in the total volume of leachate recirculated in 2018 compared to previous years. During 2018 317,000 gallons were recirculated in the two remaining collection trenches in the top of the landfill, and no leachate was recirculated in the extraction wells. This compares to a total of 1,296,000 gallons recirculated in 2017. The reduction was due to limited staffing and a lower demand for additional gas at the PTL GTE Facility. PTL indicated that 2019 recirculation volumes during the summer and winter of 2019 -2020 will be in the range of 3,400,00 gallons.

The leachate collection system pumping system volumes were evaluated in areas where the leachate recirculation system is operational to look for evidence that the recirculation program was having an adverse impact on overall leachate volumes which might lead to increased ponding on the liner system. Based on this review of system volumes, there

was no evidence that there were increased volume associated from the recirculation activities.

VI. Summary

Overall, the water quality monitoring data from PTL reflected in the 2018 Annual Report and April 2019 data summary indicate that there continues to be gradual improvement at some monitoring locations. Data from 2018 represents the 8th year of the 30-year post-closure monitoring period and is not required to meet the target criteria. However, there are three on-site locations that are close to or meet the corrective action criteria.

Despite the improving trend in some wells, there are nine monitoring wells that continue to have significantly elevated concentrations of landfill-related compounds and a TDS concentration above 1000 mg/L. Additionally, groundwater in several wells southwest of the landfill continue to exhibit increasing concentration trends. Increased gas collection and repair of the cover in this area and reduction of leachate recirculation in 2018 did not result in improved water quality in this area through 2018, suggesting that the cover defect detected and repaired in 2016 is unlikely to be the source of impact in this area.

As note previously, continued diligent operation of the existing corrective action systems (groundwater extraction and external gas extraction) will be necessary to maintain and extend the improvement observed to date. In 2018, PTL increased the volume of groundwater collected and gas extracted compared to 2017. If this increase in the control systems is continued, it may lead to improved water quality in 2019 or 2020.

If the trend of increasing conductivity in the MW03-802 and MW03-803 wells on the south side of the landfill continues through 2021 (year 10 of 30), it would also be appropriate for PTL to consider additional corrective actions in this area.

We hope that the information summarized in this memorandum is helpful to the Town. We would be glad to discuss any questions or comments that the Town may have.

