

CEDAR HILLS REGIONAL LANDFILL 2018 ANNUAL REPORT



King County

Department of
Natural Resources and Parks
Solid Waste Division

Waste
Prevention

Resource
Recovery

Waste
Disposal

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April 2019

2018 ANNUAL REPORT CEDAR HILLS REGIONAL LANDFILL

APRIL 2019

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SECTION 1 - OVERVIEW

The King County Solid Waste Division (KCSWD) owns and operates the Cedar Hills Regional Landfill (CHRLF) in eastern King County for the disposal of municipal solid waste generated in the County, exclusive of the cities of Seattle and Milton. It is a 920-acre site located at 16645 228th Avenue Southeast, off Cedar Grove Road, approximately three miles north of Maple Valley, six miles east of the City of Renton and four miles south of the City of Issaquah. In addition to the landfill, the site contains Passage Point, a transitional housing facility; a landfill gas-to energy facility owned and operated by Bio Energy Washington, LLC (BEW); a right-of-way for a natural gas pipeline and numerous power transmission line rights-of-way.

Filling operations are continuing in Area 7, which is anticipated to have capacity through mid-2019. Construction of Area 8 began in 2017 and is anticipated to be completed in the spring of 2019.

An Area 7 construction contract was executed in 2017 to be completed over two years (2017 and 2018) and includes final cover and interim cover sections over finished faces of Area 7. A final construction contract for completion of final cover and interim cover over the South Face of Area 7 will be executed in 2019 and completed in 2020.

This report includes a compilation of activity summaries and system evaluations associated with the following:

- Landfill capacity;
- Financial assurance cost estimates for closure and post-closure;
- Changes to landfill operations; and,
- Environmental monitoring program, including a summary of groundwater, stormwater, leachate, and landfill gas monitoring results and exceedances.

This annual report is submitted pursuant to the provisions of the Washington State Criteria for Municipal Solid Waste Landfills, Operating Criteria - Annual Reports (WAC 173-351-200(11)) and the Cedar Hills Regional Landfill Operating Permit, Section XII - Reporting Requirements, Part B - Annual Report and Permit Renewal Application. A ten year permit application was submitted to Public Health – Seattle & King County (PHSKC) on December 27, 2018. A copy of the first page of this application form is included in Appendix A.

SECTION 2 - FACILITY INFORMATION

The Washington Department of Ecology (WDOE) form, titled “Annual Report Municipal Solid Waste Landfill” that is required for submittal of this report is included in Attachment B.

Significant facility activities which occurred in 2018:

- Construction of Area 8 began in 2017. Approximately 1.8 million cubic yards of soil were excavated and stockpiled on site (1.5 million in 2017 and the remainder in 2016 and 2018). Liner and drainage layer material placement occurred in 2018 and completion and commissioning will occur in 2019. Construction is anticipated to be completed in the spring of 2019.
- Stage 3 Final and Interim Cover over exterior slopes of Area 7 was placed in 2017 and Stage 4 Final and Interim Cover was placed in 2018. The last stage of cover, Stage 5, will be placed in 2020.

SECTION 3 - LANDFILL CAPACITY AND DEVELOPMENT STATUS

Cedar Hills has built capacity remaining in three areas (Area 5 – 1,203,000 cubic yards, Area 6 – 1,226,000 cubic yards, and Area 7 – 1,003,000 cubic yards). These capacities are based upon the difference between existing landfill contours and a design surface at completion. Attachment D contains documentation for calculating capacity.

Efforts are underway to optimize the use of this remaining built capacity. These include decreasing the amount of airspace consumed by disposal and recovering airspace gained due to settlement, and recycling efforts.

The amount of airspace available for disposal is impacted by airspace consumed by daily cover and road construction. The use of tarps for alternative daily cover, and the recovery of rock used for roads increases the airspace available for disposal. Additionally, mechanical compaction increases the airspace available for disposal.

As the landfill ages, it settles. Airspace from settlement can be recovered for disposal. Settlement occurs due to consolidation and to loss of mass from leachate and more importantly gas production. As gas is collected, it is removed from the landfill. The airspace once occupied by gas consolidates and the landfill settles. Soil surcharge is used to accelerate settlement. Areas 5 and 6 both have areas of soil stockpiled over them to accelerate settlement. This soil will be recovered later for other uses.

CHRLF has a planned capacity addition of 7,840,000 cubic yards for Area 8. Area 8 construction is anticipated to be completed in late spring 2019.

The table below presents current and planned capacity in cubic yards and tons by area, as of September 2, 2018. It is based upon an airspace utilization of 1,600 pounds of refuse disposed per cubic yard of air space consumed, and an average yearly tonnage of 1,100,000 tons (forecasted between 2018 and 2028). 1,600 pounds per cubic yard is the airspace utilization achieved in Area 7

using current operational practices (compaction, daily cover usage, and rock recovery). See Attachment D for details.

Area	Capacity (cubic yards)	Capacity (tons)	Remaining Capacity (years)
7	1,003,000	802,000	0.8
8	7,840,000	6,272,000	6.0
5	1,203,000	962,000	0.8
6	1,226,000	980,000	0.9
Total	11,272,000	9,016,000	8.5

The development status of the landfill is summarized in the table below. Closed Areas are Refuse Areas closed in accordance with pertinent regulatory requirements and not currently scheduled to receive additional waste. The Area 5 and Area 6 top surfaces have interim covers that will be maintained until the completion of the last remaining lifts.

STATUS OF LANDFILL AREAS

Landfill Area	Area Specific Information	
Main Hill	Status	Closed
	Exposed Surface Area	84.4 acres
South Solid Waste Area	Waste was removed from this area and relocated to Area 7.	
Southeast Pit	Status	Closed
	Exposed Surface Area	9.6 acres
Central Pit	Status	Closed
	Exposed Surface Area	9.6 acres
Area 2/3	Status	Closed
	Exposed Surface Area	22.2 acres
Area 4	Status	Closed
	Exposed Surface Area	22.2 acres
Area 5	Status	Interim closure
	Final Cover Surface Area	9.2 acres
	Top Deck Intermediate Cover Area	31.4 acres
Area 6	Status	Interim closure
	Final Cover Surface Area	25.2 acres
	Top Deck Intermediate Cover Area	30.1 acres
	Volume in Place	6,800,000 cubic yards
Area 7	Status	Active
	Final Cover Surface Area in Place	9.1 acres
	Side Slope Intermediate Cover Area in Place	17.4 acres
	Open Area	36 acres
	Volume in Place	8,070,000 cubic yards
Area 8	Status	Construction & Permitting
	Liner Footprint Area	31.4 acres

Note: Areas are net final cover plan view surfaces or as otherwise noted.

SECTION 4 - FINANCIAL ASSURANCE ANALYSIS

The KCSWD maintains a Landfill Reserve Fund (LRF) account for new area development, closure, post-closure, and corrective action in accordance with WAC 173-351-600. The LRF receives monthly transfers from the KCSWD operating fund, which obtains about 94% of its revenue each year from customers paying the waste disposal fee for MSW brought into the KCSWD solid waste system. The transfer amount is set during the disposal rate approval process and adjusted annually. New Rates were adopted in 2018. The 2018 LRF contribution was \$18.00 per ton and the 2019 contribution remains \$18.00. In addition to the requirements of Washington Administrative Code 173-351-600 requiring the LRF to provide financial assurance for closure and post-closure care, King County Code (4A.200.390) requires the LRF to include funding for new area development costs.

The current LRF rate is based on projected expenditures forecast when the current rate was adopted in 2018 and is subject to change based on approval of planning documents. The details upon which the LRF contribution were based in the rate are included in Attachment E.

In 2019 we will assess the following items and calculate a new LRF contribution for 2020.

- [a] Updated tonnage forecast;
- [b] The current interest rate set by the King County Office of Economic and Financial Analysis (OEFA);
- [c] Updated projected costs in each future year for Closure, New Area Development, and Facility Improvements;
- [d] Updated assumptions for future capacity development of the site and updated post closure maintenance estimates.
- [e] Updated Post Closure Maintenance Estimate.

The post-closure maintenance estimate is updated annually. The updated estimate is based on current costs for maintenance of the systems, and considered whether there have been changes to the environmental control systems that would lead to changes in maintenance costs and any changes to current costs of maintenance.

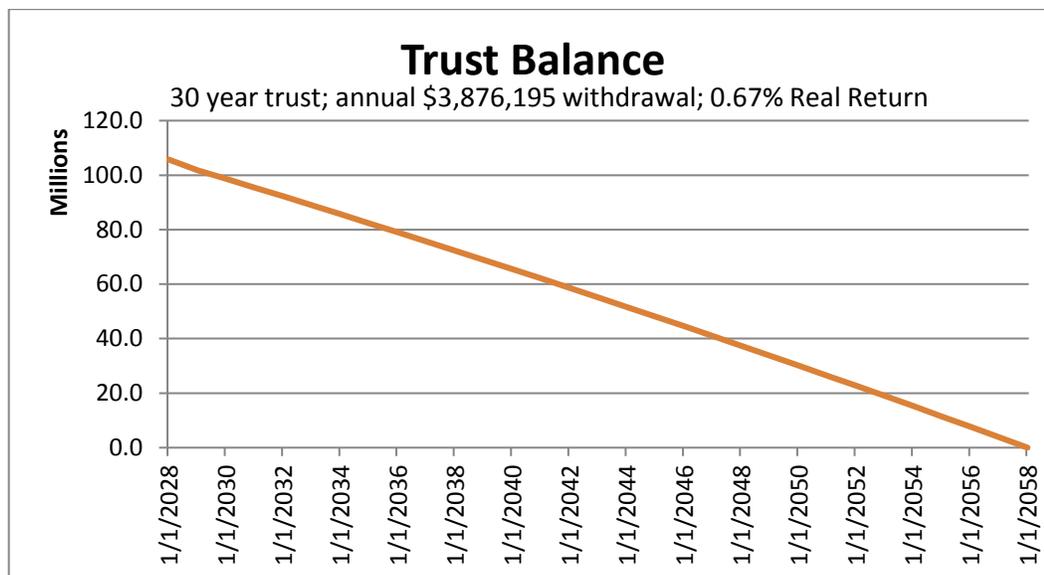
Based on a recommendation from the King County Auditor's Office, the KCSWD uses the King County Office of Economic and Financial Analysis (OEFA) forecast for the both inflationary assumptions, and likely future investment return interest rates. The current¹ direction is to use a real (after inflation) long term rate of return of 0.67%.

This year's estimate is that \$3,876,195 (2018 dollars) per year will be required to maintain the landfill for 30 years for a total of \$116.3 million in expenses over the closure period. The background for this

¹ March, 2019 forecast
Cedar Hills Regional Landfill
Annual Report - 2018

year's estimate is included in Attachment E. The \$116.3 million in total spending can be sustained over a 30-year period with a trust fund of about \$105.7 million invested in government-backed securities paying a real (after inflation) rate of return of 0.67%.

This updated estimate will be used in calculating the LFR fund contribution for 2020.



SECTION 5 - WASTE DISPOSAL QUANTITIES

The CHRLF received 888,503 tons of municipal solid waste in 2018. Detailed information can be found in Attachment B.

SECTION 6 - SUMMARY OF 2018 GROUNDWATER, STORMWATER, LEACHATE AND LANDFILL GAS MONITORING PROGRAM AND 2019 PROPOSED ENVIRONMENTAL MONITORING PROGRAM

6.1 Summary of Groundwater Monitoring Program

Groundwater monitoring is conducted in accordance with WAC 173-351-410 and reported here in compliance with WAC 173-351-415(1). A summary of groundwater data collected during the reporting year is presented in Part 7 of Attachment F.

The Groundwater Monitoring Program is described in detail in the *Environmental Monitoring Sampling and Analysis Plan for Cedar Hills Regional Landfill* (SAP), and in Attachment F of this annual report. Twenty nine (29) groundwater monitoring wells are used for monitoring groundwater elevations and geochemical sampling in the regional aquifer, and four (4) for monitoring the perched saturated zones. Twelve (12) additional wells in the regional aquifer and nineteen (19) additional wells in the perched zones are monitored only for groundwater elevations. Detection monitoring wells

are located downgradient of, or lateral to, waste placement areas. Background characterization wells are located up-gradient of waste placement areas.

6.2 Summary of Stormwater Monitoring Program

The stormwater monitoring program is described in the SAP. The goals of this program include these elements:

- Monitor the effectiveness of Best Management Practices (BMPs) per the Stormwater Pollution Prevention Plan (SWPPP) for CHRLF; and
- Evaluate compliance with the Industrial Stormwater General Permit (ISGP).

Stormwater discharges associated with industrial activities at CHRLF are covered by the ISGP, which establishes monitoring requirements and benchmark values for several parameters. Three (3) discharge locations are monitored quarterly for compliance with the ISGP. Permit compliance monitoring locations are at N4 at the north end of the landfill, GS1 at the south end, and SL3 at the discharge of the bioswale along 228th Avenue Southeast.

Besides routine monitoring conducted in accordance with the ISGP, KCSWD maintains several contingency surface water monitoring stations. The purpose of the contingency monitoring stations is to allow additional surface water monitoring if ISGP monitoring results exceed applicable benchmarks and broader surface water monitoring is warranted.

In 2018, KCSWD also had a Construction Stormwater General Permit (CSGP) - permit number WAR305034 with WDOE - for the Area 8 construction activities. A separate SWPPP was created for this CSGP permit. Permit coverage took effect in 2017, is still active, and will be in effect through the duration of the construction project.

Four discharge locations are monitored weekly for compliance with the CSGP in accordance with the SWPPP. The construction contractor also monitors the construction site BMPs and the CSGP monitoring locations daily during construction activities. The four monitoring locations are as follows: C-1 at the northwest end of the site downstream of the northwest siltation pond; C-2 at the northeast end of the site, downstream of the north stormwater pond; C-3 at the southeast part of the site, downstream of the south stormwater lagoon and upstream of the bioswale; and C-4 at the southwest part of the site, downstream from the southwest siltation pond.

Copies of required stormwater reports submitted to WDOE are included in Attachment H.

6.3 Summary of Leachate Monitoring Program

KCSWD collects two types of leachate samples at CHRLF: characterization and compliance. Leachate characterization is a critical component of the on-going groundwater contamination detection monitoring that is performed at the landfill. Leachate characterization also serves to assess pretreatment needs prior to discharge, and to evaluate the effectiveness of pretreatment. Characterization includes all analytes that groundwater is analyzed for plus several analytes

specifically related to wastewater characterization and treatment. Monthly characterization samples are collected at four monitoring locations: LEPS, LAPI, PS-2A, and MH-46N.

Compliance samples refer to those collected to support compliance with Wastewater Discharge Permits No. 7842-02, which expired October 25, 2018, and 7842-03 from October 26 through December 31, 2018. Monthly compliance samples collected from LEPS are analyzed for all permit-specified parameters. Sample analyte concentrations and leachate discharge flow data are used to calculate permit analyte loadings. Compliance is determined by comparing results to allowable limits specified in permits no. 7842-02 and 7842-03.

Self-monitoring discharge permit reports are generated monthly and submitted to the King County Wastewater Treatment Division, Industrial Waste Program (KCIW).

During 2018, KCSWD also operated under a temporary permit modification from KCIW due to repair work being performed on one of the wastewater lagoons. This permit modification allowed for an increase in metals loading and a decrease in discharge volume during “contingency discharge” events. Additional field monitoring, sample collection and analysis, and reporting also were required during “contingency discharge” events. The permit modification went into effect September 6, 2017 and ended January 31, 2018. “Contingency discharge” events began October 16, 2017 and continued periodically throughout the permit modification time frame.

In February 2018, SWD began an additional investigation that added four new monthly characterization locations, including leachate flows from different landfill areas (PS1A, PS4, and MH5), and the seasonal flow from the recently relocated contaminated stormwater (CSW) lagoon. These additional locations were analyzed solely for total and dissolved metals, with the goal of determining the source(s) of elevated total arsenic and chromium in the leachate effluent currently discharged from the landfill.

In October 2018, modifications were made to the leachate conveyance system due to the construction of Area 8 of the landfill. These modifications resulted in the decommissioning of monitoring location LAPI. Vault 1A was established as the replacement monitoring location. MH-LIF is monitored as a leachate confluence point.

Field and analytical leachate data are included in Part 7 of Attachment F.

6.4 Summary of Landfill Gas Monitoring Program

Landfill gas (LFG) monitoring is performed in accordance with provisions of WAC 173-351-200(4). A network of LFG monitoring probes has been installed at strategic locations and elevation intervals below the ground surface to monitor the potential presence of LFG in the subsurface vadose zone outside of the footprint of the landfill refuse (see Attachment G).

According to WAC 173-351-200 (4)(a), the concentration of methane gas generated by the facility shall not exceed:

- Twenty-five (25) percent of the lower explosive limit (LEL) for methane (or 12,500 parts per million [ppm]) in facility structures, excluding LFG control or recovery system
- The LEL for methane (or 50,000 ppm) at the facility property boundary or beyond
- 100 ppm in off-site structures

There are two categories (defined by function) of LFG probes at the CHRLF:

- Migration Monitoring Probes
- Interior Monitoring Probes

Migration Monitoring Probes are primarily intended to verify that methane concentrations at the property boundary do not exceed 50,000 ppm in the subsurface vadose zone. There are 36 Migration Monitoring Probes at CHRLF. The installation history of the LFG monitoring probes at the CHRLF was described in the 2005 CHRLF Annual Report. These probes are either single or multiple completion probes installed at different depths depending on subsurface geological formation. Information on the location, elevation, installation date, and a description of each probe is provided in the Monitoring Plan figure in Attachment G.

Interior Probe Network: Interior Monitoring Probes are used to evaluate and manage the performance of the LFG collection system with respect to LFG composition (methane, oxygen and carbon dioxide) and vacuum radius of influence. This information is used to adjust the LFG collection and conveyance system to minimize the potential for LFG migration outside of the refuse footprint. There are 25 Interior Monitoring Probes at CHRLF. The installation history of the LFG monitoring probes at the CHRLF was described in the 2005 CHRLF Annual Report. The probes are either single or multiple completion probes installed at different depths depending on subsurface geological formation. Information on the location, elevation, installation date, and a description of each probe is provided in the Monitoring Plan figure in Attachment G.

Migration and interior probe monitoring are performed quarterly for compliance with WAC 173-351, and monthly for operational indicators. Monitoring results are included in Attachment G. Results from LFG migration monitoring for 2018 are discussed in Section 8.4 of this report.

6.5 Environmental Monitoring Program for 2019

Effective January 1, 2016, KCSWD began implementing the *Environmental Monitoring Sampling and Analysis Plan for Cedar Hills Regional Landfill* (December 31, 2013), as approved by PHSKC and WDOE in 2015. The SAP outlines current monitoring programs designed to comply with the requirements of Chapter 173-351 WAC and other applicable environmental regulations and permits, including wastewater discharge permits and stormwater permits.

If and when changes to the SAP are deemed appropriate, KCSWD will seek approval of such changes from PHSKC and WDOE.

SECTION 7 - SUMMARY OF LANDFILL PERSONNEL TRAINING PROGRAM

The KCSWD implements a Landfill Training Program that ensures that landfill personnel comply with the Certification requirements of WAC 173-300-060. Employees with valid SWANA Landfill Certification as Manager of Landfill Operations (MOLO) are listed below in the table below.

MOLO Certifications

NAME	TITLE	DATE OF CERTIFICATION
John Hills	Lead Equipment Operator	Certified through April 2021
Rusty Bogart	Landfill Gas Operator	Certified through October 2021
Nigel White	Special Projects Manager	Certified through October, 2019
Scott Barden	Landfill Operations Manager	Certified through October 2020
Bill Berni	Operations Manager	Certified through July 2020
Kris Burgin	Operations Supervisor	Certified through May 2019
Jason Gonzales	Lead Equipment Operator	Certified through May 2019
Mark Hammer	Assistant Operations Manager	Certified through May 2019
Anthony Slaughter	Operations Supervisor	Certified through May 2019

SECTION 8 - EVALUATION REPORTS

8.1 Summary of Emergency or Corrective Actions Taken in 2018

8.1.1 Stormwater Corrective Action

When stormwater monitoring indicates exceedances of benchmark limits established in the ISGP, the permittee must take corrective actions to remain in compliance with the permit. In 2018, the benchmark limits of our ISGP were not exceeded. In regards to our Area 8 CSGP, sampling results in 2018 indicated select benchmark limits were exceeded. In response to turbid stormwater discharges associated with the Area 8 construction project, KCSWD worked with contractors responsible for temporary erosion and sediment control to improve water quality of construction discharges. Additional details regarding exceedances and corrective actions are contained in the Discharge Monitoring Reports and Annual Report included in Attachment H.

8.1.2 Wastewater Discharge Permit Corrective Action

During January 2018, KCSWD continued to discharge wastewater in accordance with a temporary permit modification issued by KCIW in fall 2017. This temporary modification, which was in effect from September 6, 2017 to January 31, 2018, was granted to accommodate repair work being performed on one of the wastewater lagoons. This permit modification allowed for a temporary increase in metals loading and a decrease in discharge volume during “contingency discharge” events. Additional field monitoring, sample collection and analysis, and reporting also were required during “contingency discharge” events. KCSWD had volume discharge exceedances of our temporary permit modification in January 2018. Corrective actions taken included improved discharge management and improved business processes related to timely reporting of permit exceedances. KCSWD had metals loading exceedances in October, November, and December. Corrective actions include improved discharge management. Due to a misunderstanding of the permit language, metals loading reported to KCWTD as exceedances in April, May, and June were incorrect and were not reportable exceedances. In July 2018, KCSWD received a Notice of Violation from KCWTD for permit discharges and reporting violations that occurred between October 2, 2013 and May 14, 2018. A subsequent Assessment of Penalty and Compliance Order was issued by KCIW on December 21, 2018. KCSWD’s response included an explanation of the cause of the violations, and planned corrective actions to respond to the violations intended to help ensure a return to compliance. KCSWD initiated actions to determine the source, mitigate metals loading in the short-term, and to mitigate metals loading in the long-term. KCSWD also received a Notice of Violation dated December 5, 2018 from KCWTD indicating results of their sampling violated the discharge limits of our permit. KCSWD responded by completing the additional monitoring and reporting as required in the Notice of Violation. No other corrective actions occurred in 2018 with regards to the wastewater discharge permit.

8.1.3 PHSKC Inspection Reports and Corrective Actions

In 2018, PHSKC inspected CHRLF six (6) times. Corrective actions taken in response to inspection reports included routine maintenance activities such as litter collection, safety issues, recordkeeping, and soils coverage management. There were no permit violations.

8.1.4 Title V Air Operating Permit Deviation Reports

KCSWD submitted a deviation report for the month of February 2018 due to Flare #1 burning at temperatures less than the permitted 1,493 degrees Fahrenheit for 3.5 hours on February 17, 2018. There were no other deviation reports in 2018.

8.1.5 Independent Remedial Action

KCSWD is proceeding with an Independent Remedial Action in the East Perched Zone (EPZ) under the Model Toxics Control Act (MTCA) in accordance with WAC 173-340-510 and 173-340-515. KCSWD issued a Remedial Investigation/Feasibility Study (RI/FS) in December of 2016 and is implementing the EPZ Phase 1 Interim Actions. Work completed in 2018 included groundwater and landfill gas well decommissioning and installation.

8.1.6 Leachate Release Response and Corrective Actions

CHRLF experienced three releases of leachate into the natural environment in 2018. One release was a pipe break in Area 8 before the liner was constructed, thus leachate was released into the native soil. The second release resulted from a tear in the bottom liner of the west leachate lagoon when cleaning out the bottom of the lagoon after repair, and some residual leachate/wastewater liquids were released into the native soil beneath the liner. The third incident also was a release of leachate into the native soils near the southwest corner of Area 7 due to misidentification of piping. All three releases were reported to PHSKC and WDOE, were contained on the CHRLF site, were cleaned up promptly and thoroughly, and were followed up with confirmation sampling.

8.2 Evaluation of Stormwater Monitoring Data

Under the ISGP, quarterly sampling is required for the following twelve (12) parameters: biological oxygen demand, total suspended solids, ammonia (total as N), alpha terpineol, benzoic acid, p-Cresol (4-methylphenol), phenol, zinc (total), pH, turbidity, copper (total), and oil sheen. Field and analytical stormwater data are included in Part 7 of Attachment F.

Monitoring station N4 monitors discharges to an unnamed tributary to McDonald Creek, which ultimately flows into Issaquah Creek. Monitoring station SL3 monitors discharges to a series of roadside ditches along 228th Avenue SE and Cedar Grove Road. While the ditches ultimately connect to the Cedar River, the underlying geology is highly infiltrative, resulting in the infiltration of

stormwater discharging from CHRLF long before it reaches the Cedar River. Monitoring station GS1 monitors discharges to a designated King County wetland with palustrine forested, palustrine open water, and palustrine emergent wetland classes. The wetland does not contain key aquatic life uses.

There were no exceedances of ISGP benchmarks or applicable effluent limits in 2018.

The CHRLF also has a CSGP for the Area 8 construction activities. Four (4) discharge points are monitored in compliance with the CSGP. The four monitoring locations are: C-1 at the northwest end of the site downstream of the northwest siltation pond; C-2 at the northeast end of the site, downstream of the north stormwater pond; C-3 at the southeast part of the site, downstream of the south stormwater lagoon and upstream of the bioswale; and C-4 at the southwest part of the site, downstream from the southwest siltation pond. All CSGP monitoring points discharge into the ISGP monitoring locations.

Under the CSGP, inspections of all areas disturbed the construction activities, all BMPs, and all stormwater discharge points are performed at least once every calendar week and within twenty-four (24) hours of any discharge from the site. Monitoring is required for turbidity. Monitoring for pH is required if more than 1000 cubic yards of concrete is poured (no monitoring for pH occurred in 2018).

Exceedances of the CSGP for 2018 are summarized in the table below.

**SUMMARY OF 2018 STORMWATER MONITORING DATA
THAT EXCEEDED CSGP CRITERIA**

Date	NTU Measurement by Monitoring Location			
	C1	C2	C3	C4
1/17	<25 or NS	<25 or NS	<25 or NS	106
1/18	<25 or NS	<25 or NS	<25 or NS	86
1/19	<25 or NS	<25 or NS	<25 or NS	109
1/23	<25 or NS	<25 or NS	<25 or NS	64
1/29	<25 or NS	<25 or NS	<25 or NS	65.8
1/30	50.5	<25 or NS	<25 or NS	65.9
1/31	29.7	<25 or NS	<25 or NS	73.5
2/1	<25 or NS	<25 or NS	38.4	86.8
2/2	<25 or NS	<25 or NS	190	99.2
2/05	<25 or NS	<25 or NS	<25 or NS	79.3
2/7	<25 or NS	<25 or NS	<25 or NS	30.3
3/26	56.1	<25 or NS	<25 or NS	<25 or NS
3/27	47.6	<25 or NS	<25 or NS	<25 or NS
3/29	30.1	<25 or NS	<25 or NS	<25 or NS
4/09	89.9	<25 or NS	<25 or NS	<25 or NS
4/10	29.8	<25 or NS	<25 or NS	<25 or NS
4/11	27.5	<25 or NS	<25 or NS	<25 or NS
4/12	38.4	<25 or NS	<25 or NS	<25 or NS
4/13	47	<25 or NS	<25 or NS	<25 or NS
4/16	40.7 (avg)	<25 or NS	<25 or NS	146.5 (avg)
4/17	137	<25 or NS	<25 or NS	101
4/18	32.8<25	<25 or NS	<25 or NS	91.1
4/19	30.7<25	<25 or NS	<25 or NS	28
10/29	102	<25 or NS	39.7	51.7
10/30	<25 or NS	<25 or NS	<25 or NS	33.1
10/31	<25 or NS	<25 or NS	<25 or NS	27.5
11/05	114	<25 or NS	<25 or NS	<25
11/13	27.8	<25 or NS	<25 or NS	<25 or NS
11/27	<25 or NS	<25 or NS	63.8	<25 or NS
11/28	115	<25 or NS	107	26.6
11/29	<25 or NS	<25 or NS	<25 or NS	41.1
11/30	<25 or NS	<25 or NS	<25 or NS	46.5
12/10	<25 or NS	<25 or NS	54	<25 or NS
12/11	<25 or NS	<25 or NS	49.3	<25 or NS
12/12	85.6	<25 or NS	96.2	<25 or NS
12/13	42.8	<25 or NS	143	<25 or NS
12/14	30.3	<25 or NS	93.1	<25 or NS
12/18	<25 or NS	<25 or NS	61.8	<25 or NS
12/19	51.7	<25 or NS	59.8	<25 or NS

NTU = Nephelometric turbidity unit
 NS = Not Sampled
 = criteria exceeded

Field and analytical stormwater data are included in Part 7 of Attachment F.

When turbidity exceedances occurred, the effectiveness of the existing stormwater BMPs were evaluated and modifications were made to improve erosion and sediment controls.

8.3 Groundwater Monitoring Data

Groundwater at the CHRLF occurs both in a regional aquifer and in perched zones. The regional aquifer flows through advance outwash and deeper deposits and is separated from the base of waste placement areas by over 200 feet of unsaturated sands and gravels. Perched groundwater occurs in onsite till, ice-contact deposits and recessional outwash. No laterally or vertically extensive perched zones have been identified, leaving the regional aquifer beneath the landfill as the earliest target hydraulic pathway for groundwater contaminant detection.

Attachment F contains a detailed analysis of groundwater monitoring results. Sections 8.3.1 and 8.3.2 give a summary of the conclusions of the Annual Groundwater Monitoring Report certified in Attachment F.

8.3.1 Regional Aquifer

The regional aquifer beneath CHRLF is recharged entirely by precipitation. A local recharge area is located immediately south of the landfill within the Queen City Farms (QCF) property, and is centered north of the Main Gravel Pit Lake. In general, groundwater flow in the regional aquifer is radial from the recharge area. Beneath the landfill, regional flow is to the north in the south and central portions of the landfill site. Flow direction in the northern part of the site turns northeasterly as recharge from the McDonald Creek drainage affects flow patterns. Regional aquifer flow is physically separated from the Cedar River and likely discharges to Issaquah Creek. There is no significant seasonal variation in horizontal groundwater flow paths. Horizontal gradients are influenced by infiltrating precipitation in the recharge area. Vertical hydraulic gradients are demonstrated by head differences in adjacent wells screened at different depths and related to hydraulic conductivity of the aquifer materials. A flow path analysis has been completed for the site and indicates a complex flow regime in the landfill vicinity.

A monitoring network is in place consisting of thirty nine (39) regional monitoring wells located to characterize groundwater flow and to obtain representative samples for water quality characterization. Downgradient flow converges into a high transmissivity zone which provides excellent monitoring coverage for all flow paths within the potential source area.

An extensive list of chemical analytes and field parameters are analyzed and the results are evaluated by a variety of graphical and statistical methods. The groundwater data analyses presented in this report describe onsite groundwater elevations, flow direction and velocity, and summarizes the evaluation of groundwater quality to determine if chemical concentrations have changed over time or differ between well locations. This report determines if these findings are indicative of impacts to groundwater quality by surface activities.

Upgradient groundwater quality, especially in wells nearest the southern recharge zone, is profoundly affected by conditions and activities that have occurred on the adjoining QCF property. Upgradient groundwater quality is variable and subject to surface activities occurring near the recharge zone.

Increasing trends for several key water quality indicator parameters began in 2011, coincidental with major clearing and grading activities on the QCF property, and have continued through 2018.

As flow continues into areas beneath the landfill footprint, changes are discernible as groundwater encounters and equilibrates to different oxidation-reduction conditions, soil gas/groundwater interface conditions, and solvent/solute interactions. Flow paths under the landfill footprint and immediately downgradient of waste cells are influenced by the presence of LFG in the unsaturated strata. Flow paths in the north landfill area are also notably higher in chloride concentrations. The data are consistent with an input from onsite, overlying infrastructure in the north end. Concentrations have declined and stabilized since maximum levels were reached in 2008-2010. Dispersion along the flow-path is apparent in other wells.

Downgradient groundwater quality is also highly variable and displays temporal trends. Much as recharge effects are dampened with distance from the source, the concentrations of many analytes are attenuated by processes such as dispersion, dilution, sorption, and degradation as groundwater flows beneath the landfill. The highest concentrations of certain analytes occur in upgradient wells. Groundwater quality in the regional aquifer leaving the site remains consistent with historical data.

The data indicate that CHRLF acts as an attenuation zone for upgradient impacts, allowing a reduction in the concentration of chlorinated volatile organic compounds (CVOCs).

Site hydrogeological reports and supporting documentation identify the regional aquifer is the first continuously saturated zone beneath the landfill and serves as the earliest path for detection monitoring. Recent water quality evaluations of QCF groundwater are available in *Fifth Five-Year Review Report for Queen City Farms* (2018).

8.3.2 Perched Zones

Perched groundwater occurs in onsite till, ice-contact deposits and recessional outwash. No laterally or vertically extensive perched zones have been identified. Recharge is by precipitation with possible hydraulic continuity to surface streams.

Impacts from past landfilling practices have previously been recognized in several perched zones. Site improvements and engineered facilities have been effective in reducing contaminant concentrations attributable to past practices. Declining or stable long term trends for many contaminants are apparent in these wells.

The East Main Hill perched zone is undergoing an independent clean up action led by KCSWD. Recent investigation findings for this zone are presented in the *East Perched Zones Remedial Investigation and Feasibility Study*, December 2016. A discussion of conditions in the perched zone near the former South Solid Waste Area are available in the *Technical Memoranda Results of Groundwater Sampling and Fate and Transport Analysis South Solid Waste Area Perched Zone Assessment*, April 2010.

8.4 Evaluation of Gas Monitoring Data

No methane was detected in any of the 36 migration monitoring probes at CHRLF, with the exception of one probe. Migration monitoring probe ATC-3D had a methane concentration of 2,000 ppm on June 19, 2018, only. This concentration is one order of magnitude (25 times) smaller than the 50,000 parts per million (ppm) regulatory limit. All subsequent methane measurements at migration monitoring probe ATC-3D were non-detect.

No methane was detected in 12 of 25 interior monitoring probes at CHRLF. Methane was detected in 7 interior monitoring probes at concentrations below 50,000 ppm. Methane was detected in 6 interior monitoring probes (GP-46, GP-47, GP-48, GP-55, GP-57 and GP-59) at concentrations above 50,000 ppm. Based on these readings, adjustments were made in more than 300 LFG wells inside the footprint of the landfill refuse, upgradient from the above-referenced interior monitoring probes. These adjustments were made twice a month to ensure the containment of LFG within the footprint of landfill refuse. These adjustments were successful in preventing potential migration of LFG outside of the landfill refuse footprint, as demonstrated by the methane readings in the 36 migration monitoring probes.

Furthermore, no methane was detected inside any of the CHRLF facilities, or in offsite facilities (Passage Point) at concentrations above 100 ppm. All LFG monitoring data for 2018 for the perimeter compliance probes, interior probes, and building monitoring are included in Attachment G.

8.5 Evaluation of Wastewater Monitoring Data and Volumes Generated

Leachate collected throughout the landfill is routed to the onsite leachate lagoons where it mixes with other sources of wastewater at CHRLF (e.g., contaminated stormwater, gray water, sewage, and BEW process water). Following aeration, the combined wastewater discharges to the King County sewerage system pursuant to a Waste Discharge Permit issued to KCSWD by KCIW (permits 7842-02 and 7842-03).

8.5.1 Wastewater Volumes

The recorded volumes of wastewater discharged from the leachate aeration basins by way of the Leachate Effluent Pumping Station (LEPS) are stated in the table below. The actual leachate volume generated within the landfill is not measured directly.

Temporary modifications to permit 7842-02 decreased the daily maximum discharge volume to 1.5 million gallons per day (MGD), during contingency discharge events. During January 2018, KCSWD exceeded the temporary maximum discharge volume of 1.5 MGD during “contingency discharge” as follows:

- January 3, 2018 – 1.9 MGD,
- January 10, 2018 – 2.0 MGD,
- January 12, 2018 – 1.9 MGD,
- January 14, 2018 – 2.1 MGD,
- January 16, 2018 – 1.9 MGD,
- January 18, 2018 – 1.9 MGD,
- January 21, 2018 – 2.1 MGD,
- January 24, 2018 – 1.9 MGD,
- January 26, 2018 – 2.8 MGD,
- January 27, 2018 – 1.2 MGD, and
- January 30, 2018 – 2.1 MGD.

The maximum daily discharge volume for permits 7842-02 and 7842-03 was 2.7 MGD. During the months of February thru December 2018, there was one exceedance of this 2.7 MGD discharge limit: on April 17, 2018 the discharge volume was 3.3 MGD. There were no other exceedances of the discharge volume in 2018.

8.5.2 *Wastewater Monitoring Data*

A compilation of leachate monitoring data is included in Part 7 of Attachment F. In 2018, the total loading limits of arsenic at 0.27 pounds per day (lbs/day) and chromium at 1.2 lbs/day were exceeded as follows:

- September 11, 2018 – 0.513 lbs/day of arsenic
- October 1, 2018 – 0.293 lbs/day of arsenic
- November 06, 2018 – 1.35 lbs/day of arsenic
- November 20, 2018 – 0.893 lbs/day of arsenic
- December 04, 2018 – 0.4995 lbs/day of arsenic
- December 18, 2018 – 0.834 lbs/day of arsenic
- December 24, 2018 – 0.586 lbs/day of arsenic
- December 31, 2018 – 0.5617 lbs/day of arsenic

All other wastewater monitoring results indicated compliance with permit-specified effluent limits in 2018.

8.6 Landfill Settlement

Settlement Monitoring at CHRLF began in 1992, and by 2005 seven (7) monitoring locations had been established. More stations were added in 2007, while others have been abandoned as a result of operational impacts, including one station that was covered with Area 8 excavation soils in the summer of 2017. The total number of stations is currently eight (8). Annual Settlement, which is in part dependent on refuse thickness as well as time, has historically varied in a range of 0% to nearly 4% of refuse thickness for different settlement monitoring locations over time. Settlement at all stations monitored in 2018 was minimal with the highest rate being 0.06% of the underlying refuse thickness. It is anticipated that landfill settlement will continue, with older landfill areas settling at a comparatively lower rate to newer areas of disposed refuse.

SECTION 9 - ATTACHMENTS

Attachment A – Permit Renewal Application

Attachment B – Tonnage Report

Attachment C – Disposal Fees

Attachment D – Landfill Capacity Documentation

Attachment E – Financial Assurance Documentation

Attachment F – Annual Summary of Groundwater Monitoring Results

Attachment G – Landfill Gas Probe Monitoring Results

Attachment H – Stormwater Reports