

CEDAR HILLS REGIONAL LANDFILL 2017 ANNUAL REPORT



King County

Department of
Natural Resources and Parks
Solid Waste Division

Waste
Prevention

Resource
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Disposal

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2017 ANNUAL REPORT CEDAR HILLS REGIONAL LANDFILL

MARCH 2018

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CONTENTS

1.	Overview	1
2.	Facility Information	2
3.	Landfill Capacity and Development Status	2
4.	Financial Assurance Analysis	4
5.	Waste Disposal Quantities	5
6.	Summary of Groundwater, Stormwater, Leachate, and Landfill Gas Monitoring Results and 2018 Proposed Environmental Monitoring Program	6
6.1	Summary of the Groundwater Monitoring Program	6
6.2	Summary of the Stormwater Monitoring Program	6
6.3	Summary of the Leachate Monitoring Program	7
6.4	Summary of the Landfill Gas Monitoring Program	7
6.5	Environmental Monitoring Program for 2018	8
7.	Summary of Landfill Personnel Training Program	9
8	Evaluation Reports	10
8.1	Summary of Emergency or Corrective Actions Taken in 2017	10
8.2	Evaluation of Stormwater Monitoring Data	11
8.3	Groundwater Monitoring Data	14
8.4	Evaluation of Gas Monitoring Data	16
8.5	Evaluation of Wastewater Monitoring Data and Volume Generated	16
8.6	Landfill Settlement	18
9.	Attachments	19
	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 Monitoring Results	
	Attachment H – Stormwater Reports	

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. Area 7 is anticipated to have capacity through early 2019. Area 8 is under construction. Construction began in 2017 and is anticipated to be completed in the fall of 2018.

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.

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. For 2018 there is no Permit Renewal Application; Attachment A therefore is being held in reserve for future use.

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 2017:

- Construction of Area 8 began in 2017. Approximately 1.5 million cubic yards of soil were excavated and stockpiled. Additional excavation, and liner and drainage layer material placement will occur in 2018. Construction is anticipated to be completed in the early fall of 2018.
- Stage 3 Final and Interim Cover over exterior slopes of Area 7 was placed in 2017 and Stage 4 Final and Interim Cover will be placed in 2018.
- A landfill gas delivery pipeline along a new alignment from the North Flare Station to the Bio Energy Washington Facility was completed in 2017. The new pipeline and associated blowers were commissioned in March 2017.

In 2015, an electro-resistivity survey of the leachate basins identified anomalies, indicating potential leaks in the liner. The anomalies identified in the west leachate basin were patched in 2017.

SECTION 3 - LANDFILL CAPACITY AND DEVELOPMENT STATUS

Cedar Hills has built capacity remaining in three areas (Area 5 – 1,923,000 cubic yards, Area 6 – 1,367,000 cubic yards, and Area 7 – 2,070,000 cubic yards). These capacities are based upon the difference between existing landfill contours and a design surface at completion. Attachment D contains design surfaces at completion, and additional 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.

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 gas once occupied consolidates and the landfill settles. Soil surcharge can be 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 7,842,000 cubic yards for Area 8. Area 8 is under construction and is planned to be completed in the early fall of 2018.

In addition to Area 8, a topping lift over Areas 7 and 8 with a capacity of 1,061,000 cubic yards is planned to bring Areas 7 and 8 to a permitted maximum design surface of 800 feet. Attachment D contains the contours used to calculate Area 8 capacity and the capacity of the top lift.

The table below presents current and planned capacity in cubic yards and tons by area, as of September 2, 2017. 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)	Capacity (years)
7	2,070,000	1,656,000	1.5
8	7,842,000	6,273,600	5.7
5	1,923,000	1,538,400	1.4
6	1,367,000	1,093,600	1
7 & 8 Top Lift	1,061,000	848,800	0.8
Total	14,263,000	11,410,400	10.4

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 AREAS¹

Landfill Area	Closed Area Size (acres)	Open Area Size (acres)
Main Hill	84.4	0.0
Southeast Pit	9.6	0.0
Central Pit	5.5	0.0
Area 2/3	22.2	0.0
Area 4	60.4	0.0
Area 5	9.2 ² 37.1 ³	31.4
Area 6	25.18 ² 37.4 ³	30.1
Area 7	6.9 ² 13.2 ³	50.1
Area 8	Not Developed	Not Developed
1. Areas are net final cover plan view surfaces or as otherwise noted. 2. Final cover surface area. 3. Interim final cover surface area.		

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 2017. The 2017 LRF contribution was \$18.00 per ton and the 2018 contribution will remain \$18.00 per ton. 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 2017. The details upon which the LRF contribution were based in the rate are included in Attachment E.

In 2018, KCSWD will assess the following items and calculate a new LRF contribution for 2019.

- [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 that waste receipt will stop in March of 2028, and final closure completed in 2030;
- [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.

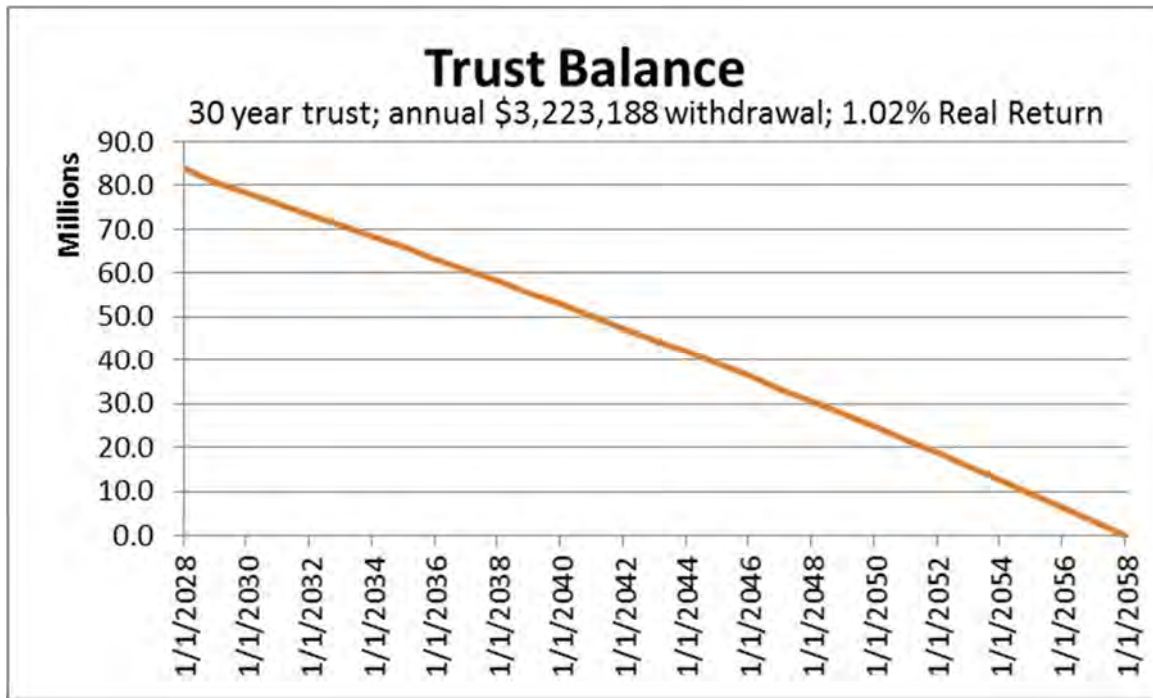
Based on a recommendation from the King County Auditor's Office, the KCSWD uses the King County Office of Economic and Financial Analysis (OEFA) forecast for the both inflationary assumptions, and likely future investment return interest rates. The current¹ direction is to use a real (after inflation) long term rate of return of 1.02%.

This year's estimate is that \$3,223,188 (2017 dollars) per year will be required to maintain the landfill for 30 years for a total of \$96.7 million in expenses over the closure period. The background for this year's estimate is included in Attachment E. The \$96.7 million in total spending can be sustained over

¹ March, 2018 forecast
Cedar Hills Regional Landfill
Annual Report - 2017

a 30-year period with a trust fund of about \$83.8 million invested in government-backed securities paying a real (after inflation) rate of return of 1.02%.

This updated estimate will be used in calculating the LFR fund contribution for 2019.



SECTION 5 - WASTE DISPOSAL QUANTITIES

The CHRLF received an average of 2,526 tons of municipal solid waste a day in 2017. Detailed information can be found in Attachment B.

SECTION 6 - SUMMARY OF 2017 GROUNDWATER, STORMWATER, LEACHATE AND LANDFILL GAS MONITORING PROGRAM AND 2018 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 six (6) 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 down-gradient 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 2017, 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. This permit 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 Permit No. 7842-02. 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 permit no. 7842-02.

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

During 2017 KCSWD received a temporary permit modification from the King County Wastewater Treatment Division 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, which included two time extensions and a modification, went into effect September 6, 2017 and ended January 31, 2018. “Contingency discharge” events began October 16 and continued periodically through the end of 2017, into early 2018.

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 measure LFG composition and pressure (see Attachment G). There are two categories (defined by function) of probes at the CHRLF: Migration Monitoring Probes and Interior Monitoring Probes.

Migration Monitoring Probes are primarily intended to verify that methane concentrations at the property boundary are not exceeding the lower explosive limit (LEL) for methane (typically 5 percent, by volume) and whether subsurface LFG is migrating into surrounding native soils.

Interior LFG Monitoring Probes are used to evaluate and manage the performance of the LFG collection system and will indicate if any operational adjustments to the system are required.

Monitoring Probe Network: 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. Information on the location, elevation, and installation date, and a description of each probe is provided in the Monitoring Plan figure in Attachment G. Parameters typically measured at the LFG monitoring probes include methane, oxygen and carbon dioxide concentrations and static pressure. Monitoring is performed quarterly for compliance with WAC 173-351, and monthly for operational indicators. Monitoring data results are included in Attachment G. Results from LFG migration monitoring for 2017 are discussed in Sections 8.1 and 8.3 of this report.

6.5 Environmental Monitoring Program for 2017

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 Public Health of Seattle and King County (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 WSDOE.

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 earned 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 2018
Lenny Kuzaro	Equipment Operator	Certified through April 2018
Rusty Bogart	Landfill Gas Operator	Certified through October 2018
Nigel White	Special Projects Manager	Certified through October, 2019
Wally Grant	Landfill Gas Supervisor	Certified through May, 2019
Shawn Carter	Transportation Supervisor	Certified through October 2017
Scott Barden	Landfill Operations Manager	Certified through October 2020
Bill Berni	Operations Manager	Certified through July 2018
Kris Burgin	Operations Supervisor	Certified through May 2019
Jason Gonzales	Lead Equipment Operator	Certified through May 2019
Lynn Walters	Operations Supervisor	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 2017

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 2017, the benchmark limits of our ISGP were not exceeded. In regards to our Area 8 CSGP, sampling results in 2017 indicated select benchmark limits were exceeded; KCSWD undertook the following corrective actions:

<i>Trigger</i>	<i>Corrective Action</i>
Turbid stormwater discharges associated with the Area 8 construction project.	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

KCSWD had volume discharge and metals loading exceedances of our temporary permit modification in October and December of 2017. Corrective actions taken included improved discharge management. No corrective actions were taken nor required regarding a hydrogen sulfide exceedance that occurred in March 2017.

No other corrective actions occurred in 2017 with regards to the wastewater discharge permit.

8.1.3 PHSKC Inspection Reports and Corrective Actions

In 2017, PHSKC inspected CHRLF ten (10) times. Corrective actions taken in response to inspection reports included routine maintenance activities such as litter collection, recordkeeping, and soils coverage management. There were no permit violations.

PHSKC also inspected the Area 8 construction contractor (Scarsella Brothers, Inc.) work activities once in August, 2017. Corrective actions taken by the contractor in response to the inspection report included earth moving equipment maintenance and leak repair, recordkeeping, and health and safety concerns (e.g. inspecting personal protective equipment).

8.1.4 Title V Air Operating Permit Deviation Reports

KCSWD reports deviations from the Title V Air Operating Permit by submitting Deviation Reports to the Puget Sound Clean Air Agency (PSCAA) if they occur. The Title V Air Operating Permit requires that flare stack testing be performed to establish flare operating temperatures which meet destruction efficiency requirements for hazardous air pollutants. A stack test was performed in 2015 for each flare. The test established 1,493 degrees Fahrenheit as the lowest operating temperature for

Flare #1. On October 22, 2017, Flare #1 operated at approximately 1,200 degrees Fahrenheit for approximately seven hours.

8.1.5 Independent Remedial Action

KCSWD is proceeding with an Independent Remedial Action in the East Perched Zone 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. Data collected during this effort is not presented or discussed in this annual report.

8.1.6 Leachate Aeration Basin Anomaly Investigation

In the summer of 2016, the leachate aeration basins were partially drawn down to try to expose and investigate certain anomalies that had been detected in a 2015 electro-resistivity survey. A mechanical issue was encountered that prohibited complete draw down of the basins. An anomaly in the west basin was exposed (a small dimple on the geomembrane – no holes or tears), and a patch installed over the area in 2016.

Note: In the 2016 Annual Report the basin patched was mistakenly identified as the **east** basin and is corrected here to accurately identify the **west** pond.

In 2017, the basins were drawn down again and the malfunctioning valve that prevented complete drawdown of the basins was repaired, along with patches to bottom liner anomalies and a side-slope anomaly in the east basin that were observed. No visible holes or tears were observed during this event.

8.2 Evaluation of Stormwater Monitoring Data

The CHRLF operates under a National Pollutant Discharge Elimination System (NPDES) ISGP, number WAR000756. Three (3) discharge points are monitored in compliance with the ISGP. These points are N4 to the north, GS1 in the south, and SL3 along 228th Avenue SE.

Under the ISGP, quarterly sampling is required for the following twelve (12) parameters: BOD, 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.

Exceedances of the ISGP for 2017 are summarized in the table below.

**SUMMARY OF 2017 STORMWATER MONITORING DATA
THAT EXCEEDED ISGP CRITERIA**

Sample Period	Sample Result	Unit	Criteria		
			Benchmark	Effluent Limit	
			Quarterly Average	Monthly Average	Daily Maximum
Sample Location: N4					
Q1			No exceedances		
Q2			No exceedances		
Q3			No exceedances		
Q4			No Exceedances		
Sample Location: GS1					
Q1			No exceedances		
Q2			No exceedances		
Q3			No exceedances		
Q4			Noe exceedances		
Sample Location: SL3					
Q1			No exceedances		
Q2			No exceedances		
Q3			No exceedances		
Q4			No exceedances		

- | | | | |
|---|--------------------------|------|--------------------------------|
|  | = criteria exceeded | ug/L | = micrograms per liter |
| TSS | = total suspended solids | mg/L | = milligrams per liter |
| Turb | = turbidity | NTU | = Nephelometric turbidity unit |
| Cu | = copper | -- | = not defined |
| Zn | = zinc | | |

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 2017).

Exceedances of the CSGP for 2017 are summarized in the table below.

**SUMMARY OF 2017 STORMWATER MONITORING DATA
THAT EXCEEDED CSGP CRITERIA**

Date	NTU Measurement by Monitoring Location			
	C1	C2	C3	C4
10/20	<25	<25	<25	37
10/21	<25	<25	<25	52
10/22	<25	<25	<25	205
10/23	45	<25	<25	87
10/24	39	<25	<25	<25
11/06	<25	<25	<25	63
11/07	<25	<25	<25	38
11/08	<25	<25	<25	116
11/09	<25	<25	<25	40
11/14	52	<25	<25	30
11/20	<25	<25	<25	43
11/21	<25	<25	<25	45
11/22	<25	<25	<25	46
11/26	<25	<25	<25	88
11/27	<25	<25	<25	107
11/28	<25	<25	<25	91
11/29	37	<25	<25	86
11/30	30	<25	<25	77
12/01	<25	<25	<25	80
12/08	<25	<25	<25	79
12/11	<25	<25	<25	56
12/12	<25	<25	<25	47
12/14	<25	<25	<25	45
12/19	109	<25	<25	<25
12/20	60	<25	<25	<25
12/23	52	<25	<25	58

NTU = Nephelometric turbidity unit = criteria exceeded

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

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 entirely recharged 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) 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 parameters began in 2011 coincidental with major clearing and grading activities on the QCF property.

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 (aligned along MW-66, MW-74, MW-75 and MW-85) are 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 in MW-74. 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 *Fourth Five-Year Review Report for Queen City Farms* (2013).

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

Per 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 in facility structures (excluding gas control or recovery system components), exceed the LEL for methane at the facility property boundary or beyond, or exceed 100 parts per million (ppm) by volume of methane in off-site structures.

On July 19, 2017 methane was detected at a concentration of 5.5% by volume at GP-44A. The probe was monitored daily for two weeks. Concentration dropped to 4% on July 21, 2017 and remained below the 5% threshold.

Cedar Hills Buildings and Passage Point Buildings were also routinely monitored for methane detections in 2017. No readings of methane above 5 ppm were detected in 2017 (regulatory limit of 100 ppm).

All LFG monitoring data for 2017 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 Leachate Effluent Pump Station (LEPS) where it mixes with other, smaller sources of wastewater at CHRLF (e.g., contaminated stormwater, gray water, 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 the King County Industrial Waste Program (KCIW) (permit no. 7842-02).

8.5.1 Wastewater Volumes

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

LEACHATE DISCHARGE DATA AND EXCEEDANCES FOR 2017

Month	Flow (million gallons)	Daily Max Discharge Volume Exceedances (limit = 2.7 million gallons per day)
January	18.6857	None
February	31.8889	None
March	38.3446	None
April	19.8448	None
May	14.8619	None
June	9.5796	None
July	7.3421	None
August	6.65	None
September	5.5544	None
October	11.4732	None
November	28.2231	None
December	25.7279	None
Total	218.1762	0
Average/Month	18.18135	0

Temporary permit 7842-02 decreased the daily maximum discharge volume to 1.5 million gallons per day (MGD), during contingency discharge. During the last quarter of 2017 KCSWD exceeded the temporary maximum discharge volume during of 1.5 MGD during “contingency discharge” as follows:

- October 20, 2017 – 1.527 MGD,
- October 21, 2017 – 1.6876 MGD,
- December 03, 2017 – 1.6135 MGD,
- December 20, 2017 – 2.0577 MGD,
- December 22, 2017 – 1.9255 MGD,
- December 29, 2017 – 1.86259 MGD, and
- December 31, 2017 – 2.01342 MGD.

8.5.2 Wastewater Monitoring Data

A compilation of leachate monitoring data is included in Part 7 of Attachment F. All wastewater discharges from the LEPS in 2017 were in compliance with permit-specified effluent limits. As previously stated, Temporary Permit 7842-02 increased the total loading limits of arsenic to 2.8 pounds per day (lbs./day) and chromium to 2.0 lbs./day during “contingency discharge”. All

wastewater discharge from the LEPS during “contingency discharge” were in compliance with the temporary permit-specific limits, with the exception of the three discharges described below:

- On October 16, 2017, wastewater discharged from CHRLF contained a total of 2.03 pounds of chromium, an exceedance of the 2.0 pound limit specified in modifications to permit no. 7842-02.
- On October 20, 2017, wastewater discharged from CHRLF contained a total of 2.389 pounds of chromium, an exceedance of the 2.0 pound limit specified in modifications to permit no. 7842-02. On October 21, 2017, wastewater discharged from the CHRLF contained a total of 2.094 pounds of chromium, an exceedance of the 2.0 pound limit specified in modifications to permit no. 7842-02.

All other wastewater monitoring results indicated compliance with permit-specified effluent limits in 2017.

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 0.1% to nearly 4% of refuse thickness for different settlement monitoring locations over time. Settlement at all stations monitored in 2017 was minimal with the highest rate being 0.38% 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