Riverside Park
Water Reclamation Facility
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June 29, 2017

Diana Washington
Water Quality Program
Washington State Department of Ecology
Eastern Regional Office
4601 N Monroe Street
Spokane, WA 99205-1295

Dear Ms. Washington

Enclosed please find the City of Spokane's Annual Assessment of flow and waste load for 2016 as required by Section S4.E (Waste Load Assessment) of NPDES Permit No. WA992447-3. The report is the thirtieth in a series of assessments that began in 1986.

Based on the design standards listed in section S4.A of the permit (effective July 1st, 2011), the reclamation facility remained under 85 percent design capacity for all of the loading parameters except for peak hour flow. This exceedance is discussed further in the report. The facility has been and is currently under construction to increase capacity and treatment capability.

If you have questions, comments or require additional information on the enclosed material, feel free to contact me at: jdonovan@spokanecity.org or 509-625-4638.

Sincerely,

Jeff Donovan
Environmental Analyst, RPWRF Laboratory

Enclosure

cc: Mike Hepp, Department of Ecology, ERO
Scott Simmons, Utilities Director
Chuck Conklin, Director, Wastewater Treatment Facility
Catherine Olsen, Environmental and Sustainability Manager, Environmental Programs
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2016 Annual Assessment

City of Spokane
Riverside Park Water Reclamation Facility

Chuck Conklin
Director

Mike Coster
Plant Manager

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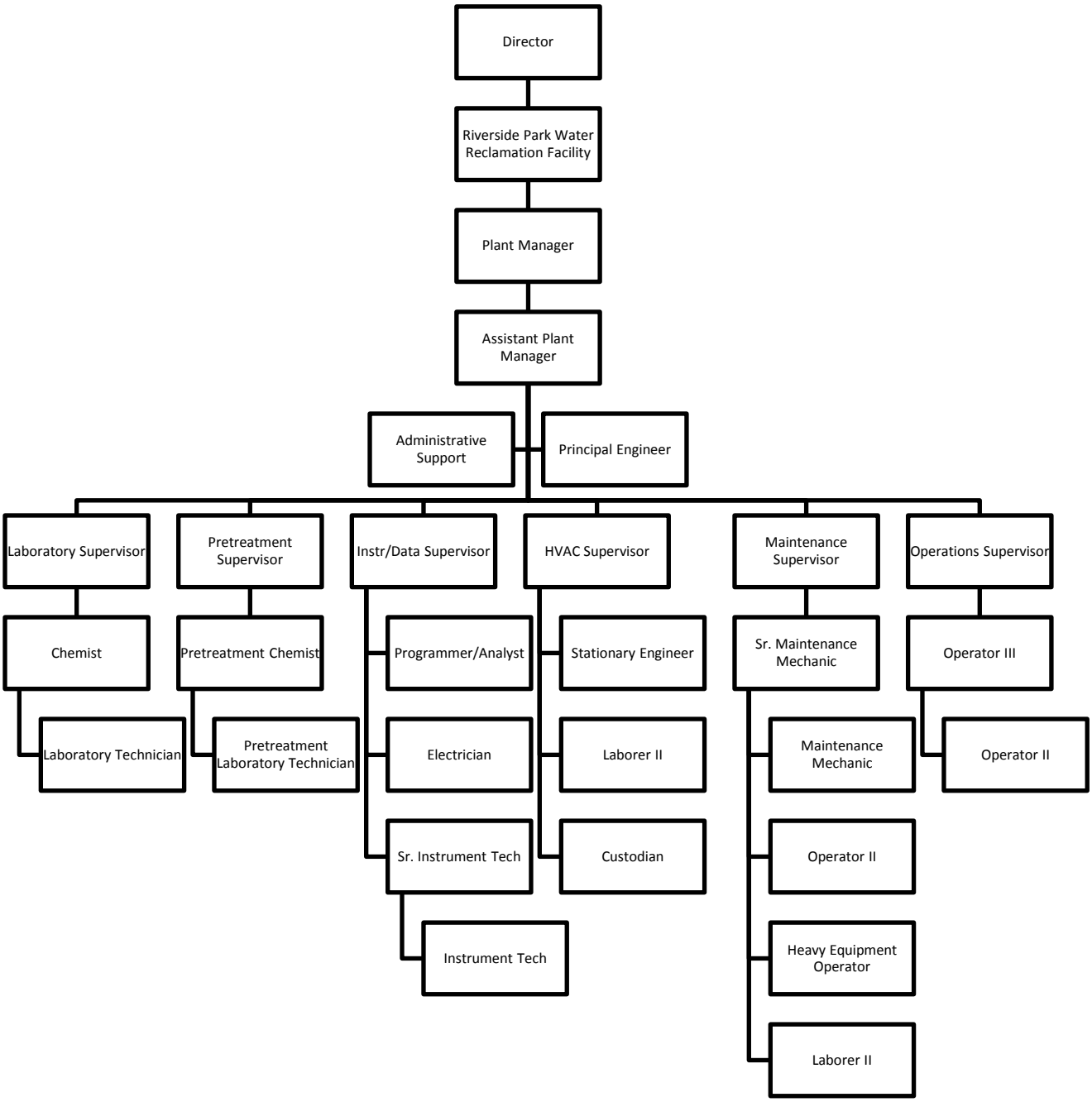
INTRODUCTION

The following report was assembled in accordance with requirements specified in National Pollutant Discharge Elimination System (NPDES) Waste Discharge Permit Number WA-002447-3. The report is written in response to section S4.E of the permit. Section S4.E requires the City of Spokane to provide a Waste Load Assessment report to the Washington State Department of Ecology annually by July 1st. Included in this report are elements of the Riverside Park Water Reclamation Facility (RPWRF) budget, a comparison of plant loading and design capacity, and a discussion of compliance or noncompliance with the permit effluent limitations.

Waste load assessments are conducted as plans to aid municipalities in maintaining adequate capacity within their treatment systems. The waste load assessment process gives a clear picture of existing pollutant loadings versus the design capacity of a given wastewater facility. When flows and/or loadings on municipal treatment facilities reach 85% of NPDES permit design capacity or when projected increases in a parameter is expected to exceed 85% within five years, whichever occurs first, the municipality must furnish the Department of Ecology with a plan for maintaining adequate capacity.

ORGANIZATION CHART



RIVERSIDE PARK WATER RECLAMATION FACILITY BUDGET

During 2016, the costs incurred by the Spokane facility were $31,544,754. This included items such as personnel costs, chemicals, electrical power, supplies, general and miscellaneous, and capital expenditures. A general line by line description follows:

Reclamation Facility Operating Costs:

1)	Wages and Personnel services	$	10,494,431
2)	Chemicals:		
	(a) Phosphorus (alum)		568,710
	(b) Sludge dewatering/CEPT (polymers)		380,749
	(c) Sodium Hypochlorite		160,218
	(d) Sodium Bisulfite		114,990
	(e) Magnesium Hydroxide		420,734
	(f) Other		304,098
3)	Power and Natural Gas:		
	(a) BOD removal		638,389
	(b) Suspended solids		490,216
	(c) Other		256,186
	(d) Natural Gas		53,960
4)	Supplies: Lab, grease, parts, etc.		309,422
5)	Insurance		95,855
6)	General and Miscellaneous		3,419,005
7)	Capital expenditures		526,277
8)	Billing and collection		247,368
9)	Interfund		1,893,104
10)	Taxes		1,290,586
11)	Depreciation and Amortization		9,880,456
TOTAL		**$**	**31,544,754**

Costs incurred for personnel include wages and employee benefits. Chemical costs arise from chemicals used in primary and secondary processes such as alum used in treatment for phosphorus removal and polymers used for solids thickening, sludge dewatering and chemically enhanced primary treatment (CEPT). Magnesium Hydroxide is used to ensure compliance with the effluent pH limits and to support nitrification. Sodium Hypochlorite is used in the disinfection process. Sodium Bisulfite is used to dechlorinate the final effluent and thus remove chlorine toxicity.

Power costs were allocated into four general areas: (a) pumping, recirculation, and diffusion for BOD removal; (b) pumping, dewatering equipment and settling basins for suspended solids removal; (c) plant lighting and miscellaneous power consumption; and (e) natural gas usage. As noted by the figure above, the remaining costs can be grouped into eight categories: (4) Supplies; (5) Insurance; (6) General and Miscellaneous; (7) Capital expenditures; (8) Billing; (9) Interfund payments; (10) Taxes; and (11) Depreciation and Amortization.

Supplies includes all minor purchase items necessary for day to day operations such as office supplies, laboratory supplies, maintenance supplies, etc. The City is currently self-funded as far as Insurance is concerned. The category General and Miscellaneous includes minor equipment and supplies not included in the Supplies and Capital Equipment sections. Capital Expenditures include most items with

a purchase price greater than $5,000. The eighth category covers Billing and Collection costs incurred by the Utilities Billing Department. The ninth category, Interfund payments, contains costs resulting from intracity transactions. The final two categories contain taxes the City pays, and Depreciation and Amortization.

Appendix II depicts the above expenditures and their relationship to the total treatment plant operating budget.

Cost of Personnel by Department

During 2016, the personnel costs were $10,494,431. The budget was apportioned to six departments. (Also see Appendix II)

Operations	$3,133,930
Maintenance	2,812,444
Administration	1,043,588
Facility HVAC	919,765
Laboratory	1,369,183
Instrumentation/Data	1,215,522
TOTAL	**$10,494,431**

Operations personnel costs include all direct operating and support crew personnel costs.
Maintenance personnel costs include all personnel costs associated with the biosolids program, pump station maintenance, and general plant maintenance functions. Administrative personnel costs include: Engineering, Director, Plant Manager, Assistant Plant Manager, and clerical staff. Laboratory personnel costs are associated with general laboratory work as well as work associated with the Pretreatment program. Instrumentation personnel maintain the electrical and data collection equipment/instruments at the plant, pump stations, and CSOs. HVAC Personnel operate the boiler, natural gas, and digester gas systems. Janitorial and grounds maintenance activities are also overseen by the HVAC department.

Cost of Chemicals

The reclamation facility uses five major chemicals for operation of plant processes: Alum, Polymers, Sodium Hypochlorite, Sodium Bisulfite and Magnesium Hydroxide. Their costs for 2016 are as follows:

Alum	$ 568,710
Polymers	380,749
Sodium Hypochlorite	160,218
Sodium Bisulfite	114,990
Magnesium Hydroxide	420,734
TOTAL	**$ 1,645,401**

Additional usage of alum, polymers, and magnesium hydroxide has occurred due to the use of Chemically Enhanced Primary Treatment (CEPT) which began in spring 2011. See also Figure 3.

Cost of Power

Power costs were allocated based on the treatment function they accomplished. The total power cost during 2016 was $1,384,791. Based on usage in the clarification (TSS Removal) and aeration (BOD removal) processes, the cost of power for each function was (also see Figure 4):

BOD removal	$ 638,389
Suspended solids removal	490,216
Other	256,186
TOTAL	**$1,384,791**

DESIGN CRITERIA

The City of Spokane's Riverside Park Water Reclamation Facility is located at 4401 North Aubrey L. White Parkway on Waterway Segment No. 24-54-1 and discharges into the Spokane River at Latitude 47° 41' 43" and Longitude 117° 28' 26". The approved design criteria for this facility, as stated in the NPDES permit section S4.A and referenced Engineering Report are shown below.

Design Flows and Facility Loading

	Dry Season *(May– Oct)*	**Wet Season** *(Nov–Apr)*
Average flow, MGD	55.9	60.6
Maximum Monthly flow, MGD	59.6	79.8
Maximum Daily flow, MGD	103.9	129.5
Peak Hour flow, MGD	130	130
BOD_5 influent loading, lb./day		
Annual Average	85,100	
Maximum Month	102,120	
Maximum Day	170,200	
TSS influent loading, lb./day		
Annual Average	85,100	
Maximum Month	102,120	
Maximum Day	170,200	
TKN influent loading, lb./day		
Annual Average	16,300	
Maximum Month	19,560	
Maximum Day	32,600	
TP influent loading, lb./day		
Annual Average	2,270	
Maximum Month	2,570	
Maximum Day	3,630	

Comparison between Design and Existing Flows

	2015 Flow (MGD)	2016 Flow (MGD)	% Change from 2015	Design Criteria (MGD)	2016 % Design
Avg. Flow (May-Oct)	25.81	28.56	10.6%	55.9	51.1%
Avg. Flow (Nov-Apr)	28.39	31.85	12.2%	60.6	52.6%
Max Monthly Flow (May-Oct)	26.30	34.37	30.7%	59.6	57.7%
Max Monthly Flow (Nov-Apr)	30.78	35.81	16.3%	79.8	44.9%
Max Daily Flow (May-Oct)	33.36	67.95	103.7%	103.9	65.4%
Max Daily Flow (Nov-Apr)	60.22	53.89	-10.5%	129.5	41.6%
Peak Hour Flow (May-Oct)	66.37	124.11	87.0%	130	95.5%
Peak Hour Flow (Nov-Apr)	129.21	109.42	-15.3%	130	84.2%

As shown in the table above, all flows to the Plant were below the established design criteria. Flows were generally higher in 2016 than in 2015. Higher than normal precipitation was the main contributor to the increased flows. Precipitation recorded at the Spokane airport in 2016 was 18.3 inches. This compares to 14.1 inches of precipitation during 2015. More rainfall directly translates to more flow through the CSO portion of the collection system and consequently more flow to RPWRF. River flows were also slightly higher in 2016, with average and maximum river flows of 6,102 and 17,900 CFS, respectively. This compares to respective average and maximum river flows for 2015 of 4,728 and 22,495 CFS, respectively. Inflow and infiltration becomes an issue as the flow at the Spokane Gage of the river increases.

The RPWRF NPDES permit requires, as per section S4.B, a formal submittal of plans to maintain adequate capacity when either:

1. Any of the flows or waste loads exceed 85% of the design criteria for three consecutive months; or
2. A projected increase in loading/flow would cause the plant to reach the design capacity within five years.

All but one of the flow categories for 2016 were below the 85% design criteria threshold. Peak hour flow for May-Oct reached 95.5% due to a heavy rain event that occurred on 10/30/2016 through 10/31/2016. Since flows are projected to increase only slightly over the next 5 years, a formal plan to maintain adequate capacity is not required at this time. Ongoing work in the sewer system to reduce inflow and infiltration should, over time, help stabilize flows reaching RPWRF.

Comparison between Design and Existing Pollutant Mass Loadings

	2016 Loading (Lb./day)	2015 Loading (Lb./day)	% Change from 2015	Design Criteria (Lb./day)	2016 % Design
Annual Average BOD_5	46,359	43,963	5.5%	85,100	54.5%
Maximum Monthly BOD_5	52,319	48,176	8.6%	102,120	51.2%
Maximum Daily BOD_5	117,396	70,281	67.0%	170,200	69.0%
Annual Average TSS	41,599	40,824	1.9%	85,100	48.9%
Maximum Monthly TSS	46,263	45,187	2.4%	102,120	45.3%
Maximum Daily TSS	116,176	88,971	30.6%	170,200	68.3%
[1]Annual Average Ammonia	4,495	4,059	10.7%	9,829	45.7%
[1]Maximum Monthly Ammonia	4,823	4,596	5.0%	11,795	40.9%
[1]Maximum Daily Ammonia	5,755	5,765	-0.2%	19,658	29.3%
Annual Average TP	995	967	2.9%	2,270	43.8%
Maximum Monthly TP	1,038	999	3.9%	2,570	40.4%
Maximum Daily TP	1,776	1,795	-1.0%	3,630	48.9%

The pollutant loadings to RPWRF in 2016 were mostly in line with 2015. All of the pollutant loadings were below the 85% design criteria threshold.

Equivalent Population Served and Growth Projection

Based on the average influent BOD loading during 2016 and the standard population equivalent of 0.2 lbs BOD/person/day, the equivalent population served by RPWRF was 231,800 individuals. Using the annual average design BOD criteria, the design population equivalent is 425,500 individuals. Using these figures, the treatment plant was loaded at 54.5% of capacity during 2016.

The most recent estimate of growth was conducted by CH2M Hill as part of a draft Facility Plan Amendment 3 for RPWRF in 2014. This document projects BOD loading to the plant to reach an annual average of 57,637 lbs/day in 2030, a 1.6% year-over-year increase from 2013. TSS loading is projected to be an annual average of 59,223 lbs/day in 2030, a 1.7% year-over-year increase. Both of these figures represent a more conservative estimate than the previous two facility plan amendments. Based on these growth estimates and the averages for 2016, BOD loading would surpass the approved design criteria after 2054 and TSS would surpass the design criteria after 2058.

The water reclamation facility is currently under construction to address increasing regulatory requirements, growth and maintenance issues.

[1] The approved design criteria for nitrogen were developed for TKN whereas the Waste Load Assessment requires a comparison between design and existing loading of ammonia. The design criteria listed in the table for ammonia was determined by taking the TKN design criteria and multiplying it by the average ratio of NH3-N/TKN for the RPWRF influent over the 2010-2016 period (0.603).

POLLUTANT REMOVAL PERFORMANCE

BOD

BOD loading in mg/L and lbs/day for the plant is listed below (a more detailed description follows in the appendices):

BOD LOADING

(Daily Averages 2016)

	Primary Influent	Primary Effluent	Secondary Influent	Secondary Effluent	Sec Effluent Removal
mg/L	189	97	81	8	95.6%
lbs/day	46,433	24,153	20,047	2,006	44,444

The effluent limitations for BOD are a monthly average of 30 mg/L (10,759 lbs/day), and a weekly average of 45 mg/L (16,138 lbs/day). For 2016, the maximum daily discharge from Spokane's facility was 23 mg/L and 5,256 lbs/day; 77% and 49% of the more stringent monthly average limits, respectively. Effluent BOD loading to the Spokane River increased 18% from 2015 to 2016.

Suspended Solids

Suspended solids loading in mg/L and lbs/day for the plant is listed below (a more detailed description follows in the appendices):

TSS LOADING

(Daily Averages 2016)

	Primary Influent	Primary Effluent	Secondary Influent	Secondary Effluent	Sec Effluent Removal
mg/L	168	51	60	9	94.1%
lbs/day	41,634	12,835	15,066	2,326	39,308

The effluent limitations for TSS are a monthly average of 30 mg/L (10,759 lbs/day), and a weekly average of 45 mg/L (16,138 lbs/day). For 2016, the maximum daily discharge was 23 mg/L and 8,402 lbs/day; 77% and 78% of the more stringent monthly average limits, respectively. Effluent TSS loading to the river increased 22% from 2015 to 2016.

Phosphorus

Total phosphorus loading in mg/L and lbs/day during the removal season (April 15th through October 15th for 2016) is listed below (a more detailed description follows in the appendices):

PHOSPHORUS LOADING

(Removal Season Daily Averages 2016)

	Primary Influent	Primary Effluent	Secondary Influent	Secondary Effluent	Sec Effluent Removal
mg/L	4.27	1.80	2.02	0.37	91.2%
lbs/day	985	416	467	86	898

The effluent limits for seasonal phosphorus discharge are 0.63 mg/L (monthly average, total phosphorus) and 0.95 mg/L (weekly average, total phosphorus). For the period of April 15th through October 15th, the 7-day rolling average maximum for effluent phosphorus was 0.852 mg/L, 90% of the weekly limit. The 30-day rolling average maximum for the same period was 0.489 mg/L, 78% of the monthly limit.

The coefficient of variation (CV) for effluent phosphorus (mg/L) during the removal season was 40%. This compares with a CV for influent phosphorus (mg/L) of 11% during the same period.

Effluent phosphorus mass loading to the river during the removal season increased 1% from 2015 to 2016.

Ammonia

The current permit has ammonia limitations for the period of July through October. These are 3.1 mg/L and 1,112 lbs/day for a monthly average and 7.5 mg/L and 2,960 lbs/day for a daily maximum. During 2016, the effluent had a maximum daily concentration of 2.02 mg/L and a maximum daily loading to the river of 537 lbs/day. These were below both the daily and monthly limits listed above.

Effluent ammonia mass loading to the river decreased 39% from 2015 to 2016. Loading of ammonia to the plant in mg/L and lbs/day is listed below (the appendices give a more detailed description of Ammonia treatment in 2016):

AMMONIA LOADING

(Daily Averages 2016)

	Primary Influent	Primary Effluent	Secondary Influent	Secondary Effluent	Sec Effluent Removal
mg/L	18.21	16.70	21.69	0.04	99.8%
lbs/day	4,494	4,122	5,354	11.2	4,482

Nitrates

The conversion of aquatically toxic ammonia to relatively benign nitrates is the intended result of nitrification through extended aeration. There are currently no effluent limitations for nitrates. Loading of nitrates to the plant in mg/L and lbs/day are listed below:

NITRATE LOADING

(Daily Averages 2016)

	Primary Influent	Primary Effluent	Secondary Influent	Secondary Effluent	Sec Effluent Increase
mg/L	1.07			25.13	2256%
lbs/day	254			6,221	5,962

The appendices show a more detailed description of nitrate concentrations and mass loading during 2016.

PERMIT COMPLIANCE

A list is shown below of violations that resulted in exceedances of effluent limitations for 2016:

Parameter	*Date(s) of Violation*	*Effluent Concentration/mass*	*Effluent Limit*
Total Residual Chlorine	Oct 4, 2016	32.9 ug/L	22.2 ug/L – Daily Max
Total Residual Chlorine	Dec 30, 2016	35.6 ug/L	22.2 ug/L – Daily Max

Both of the chlorine violations arose due to issues with the sodium bisulfite delivery system used to dechlorinate the effluent. Operational and maintenance changes were made to reduce the likelihood of dechlorination issues in the future.

The above issues were reported promptly to Ecology once identified.

LOADING DISCUSSION

Flow

Projecting wastewater flow is generally a difficult task. While population in Spokane County is expected to increase at approximately 1% per year into 2040,[1] estimating the flow contribution from changes in Inflow, infiltration, and water conservation efforts are less predictable. Draft Facility Plan Amendment 3, which was completed in January, 2014, is the most current source of flow estimates for RPWRF. Typical flows projected in Draft Facility Plan Amendment 3 are as follows:

	2018 (MGD)	2024 (MGD)	2030 (MGD)
Annual Average	34.3	35.3	36.5
Critical Season (Mar 1 – Nov 1)			
Season Average	34.2	35.3	36.4
Maximum-Month	40.6	41.9	43.1
Maximum-Week	47.8	49.1	50.3
Maximum-Day	66.9	68.2	69.4
Non-Critical Season (Nov 1 – Mar 1)			
Season Average	34.3	35.4	37.1
Maximum-Month	39.3	40.5	41.8
Maximum-Week	47.6	48.8	50.1
Maximum-Day	72.3	73.5	74.8

Previous facility plan amendments estimated that annual average flows during 2030 would be 48 MGD. Total flows for the previous 20 years have remained relatively stable with decreases in 2012 due to other regional facilities coming online. It is apparent from historic trends that flows to our facility are not increasing at the rate projected by the previous facility plan amendments and that those flows proposed in the 2014 amendment are likely more reasonable.

The following table displays influent flow characteristics from 1997 through 2016. The left column illustrates annual average influent flow in millions of gallons. The next two columns illustrate maximum and minimum average flow rates (MGD) for the same period. The next column displays storm flow. Storm flow is flow that reaches the plant and is contained in the CSO clarifiers but is not discharged to the river through the primary treating CSO system at the plant. The next column illustrates flow receiving only primary treatment through the plant CSO clarifiers. The final column indicates total flows that were diverted to the primary treating CSO system (both contained events and overflows).

Flows in this table are highly variable and are strongly influenced by precipitation duration and intensity. Flows and treatment strategies were closely examined by the liquid phase study of the treatment plant that was initiated in July of 1999. Standard operating

[1] 2040 OFM County Growth Management Population Projections
http://www.ofm.wa.gov/pop/gma/projections12/GMA_2012_county_pop_projections.pdf

procedures (SOP's) now include operation of all treatment units and a new instantaneous peaking factor of 100 MGD. When one unit is out of service, the instantaneous peak flow when secondary treatment is provided is reduced to 75 MGD. In cases where flow exceeds 100 MGD, flow is diverted to storm/CSO clarifiers No. 5 and No. 6 where 4 MG of storage exists. Flow that is able to be stored is returned to headworks for full treatment after the high flows have subsided. In rare cases where the storage capacity is exceeded, storm flow will only receive primary treatment plus disinfection from the CSO clarifiers.

INFLUENT FLOW CHARACTERISTICS 1997-2016

	P.INF. FLOW MGD	PEAK FLOW MGD	MIN FLOW (MGD)	MG CSO SYSTEM (MG)	MG CSO OVERFLOW (MG)	MG TOTAL CSO FLOW TO PLANT
1997	45.54	59.00	30.00	10.98	238.71	249.69
1998	38.31	52.00	23.00	28.78	94.33	123.11
1999	39.51	52.93	24.31	17.57	36.54	54.11
2000	40.61	54.00	26.00	4.47	9.14	13.61
2001	37.73	58.00	22.00	0.11	2.10	2.21
2002	39.36	61.70	22.35	2.62	0.22	2.84
2003	38.32	61.70	21.48	1.23	0.22	1.45
2004	37.27	59.00	21.48	0.11	0.11	0.22
2005	36.38	57.00	21.00	33.09	2.89	35.98
2006	41.33	61.00	25.00	29.66	1.41	31.07
2007	37.22	48.90	22.20	11.47	0.00	11.47
2008	39.48	52.00	23.00	27.00	0.00	27.00
2009	38.96	54.00	23.00	21.82	4.10	25.92
2010	38.11	54.73	21.89	64.30	0.00	64.30
2011	40.77	57.68	24.54	24.00	0.00	24.00
2012	33.75	50.18	19.43	19.40	0.00	19.40
2013	28.46	41.85	15.37	19.40	0.00	19.40
2014	29.01	45.55	15.87	13.00	0.00	13.00
2015	27.09	39.77	14.77	7.70	0.00	7.70
2016	30.17	44.51	17.43	6.10	0.11	6.21
MIN	27.09	39.77	14.77	0.11	0.00	0.22
MAX	45.54	61.70	30.00	64.30	238.71	249.69
AVG	36.87	53.27	21.71	17.14	19.49	36.64

Biochemical Oxygen Demand

BOD loading has generally increased over time since 1996. However, loading in 2012 dropped off significantly due to the other regional treatment facilities coming online. According to the approved design criteria listed in the NDPES permit, RPWRF will be able to treat daily influent BOD loading of 85,100 pounds and a peak daily load of 170,200 pounds. Projected influent loadings from the 2014 draft facility plan amendment 3 are summarized below.

Year	Average Annual BOD (lbs/day)	Maximum Day BOD (lbs/day)
2018	50,456	100,912
2024	53,953	107,905
2030	57,637	115,273
Design Criteria (2011 NPDES Permit)	85,100	170,200

The table that follows illustrates BOD loading for the period 1997 through 2016 and includes loading to the secondary system. During 2016 BOD loading to the secondary system averaged 20,047 lbs/day, a decrease of 52% from the peak in average annual secondary loading which occurred in 2007. Aeration basins 1 through 4 were determined in the original 1999 facility plan to have an average annual capacity for BOD of 51,030 lbs/ day. Based on this original design criterion, the plant was only loaded at 39% of the 1999 secondary loading capacity. In addition to less loading coming into the plant, the implementation of Chemically Enhanced Primary Treatment (CEPT) from 2011-2016 led to decreased loading to the secondary system. The addition of AB 6 in 2004 has led to a design capacity for BOD in the secondary system which is approximately 68,000 lbs/day with all units in service.[1] The capacity remains at 51,030 lbs/day with AB 6 out of service and at roughly 55,000 lbs/day with any of the other four ABs out of service.

While BOD levels in the secondary influent dropped off significantly during 2012, on a longer scale they are still expected to trend upward. The table also shows that the effluent levels are relatively stable and that the plant is below design levels for BOD loading to the secondary portion of the facility (see also Graph 3).

[1] This is the estimated design capacity for the entire aeration system with all units in operation and is based solely upon the increase volume of sludge under aeration. AB 6 has a capacity of 4 MG whereas ABs 1 through 4 are 3 MG units.

BIOCHEMICAL OXYGEN DEMAND LOADING 1997-2016

(Annual Average Loading, lbs/day)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	STORM EFFLUENT	SECONDARY REMOVAL (%)	Design 30% Primary Removal	PRIMARY INFLUENT (mg/L)	SECONDARY EFFLUENT (mg/L)
1997	53,088	30,015	29,897	3,089	814	94.18	37,162	151	9
1998	47,166	27,239	26,976	3,218	7,810	93.18	33,016	124	8
1999	50,693	30,398	30,019	3,773	8,443	92.56	35,485	159	12
2000	56,178	33,478	33,978	2,753	2,147	95.10	39,325	170	8
2001	56,383	32,929	35,133	2,807	15,985	95.02	39,468	166	8
2002	59,935	36,132	36,156	3,659		93.90	41,955	190	12
2003	59,139	37,455	33,821	3,348		94.34	41,397	180	10
2004	59,809	37,853	41,538	3,191		94.66	41,866	187	10
2005	58,112	36,785	39,598	3,056		94.74	40,678	187	10
2006	57,737	35,956	40,257	3,056		94.71	40,416	167	9
2007	60,775	38,732	41,899	2,617		95.69	42,543	196	8
2008	62,721	38,915	40,063	3,441		94.51	43,905	190	10
2009	58,153	35,741	36,561	2,823		95.15	40,707	179	9
2010	60,607	39,528	39,009	3,438		94.36	42,425	191	11
2011	57,139	31,676	34,137	2,908		94.23	39,997	174	9
2012	48,269	19,777	21,354	2,729		93.99	33,788	177	10
2013	45,077	20,482	19,984	2,196		95.07	31,554	192	9
2014	44,137	22,855	20,465	2,021		95.45	30,896	186	8
2015	43,963	20,786	19,627	1,701		96.07	30,774	197	8
2016	46,433	24,153	20,047	2,006		95.64	32,503	189	8
MIN	43,963	19,777	19,627	1,701	814	92.56	30,774	124	8
MAX	62,721	39,528	41,899	3,773	15,985	96.07	43,905	197	12
AVG	54,276	31,544	32,026	2,892	7,040	94.63	37,993	178	9

Total Suspended Solids

Influent TSS loading has remained fairly stable over the last ten years with a significant decrease in 2012 due to other regional facilities coming online. The following table shows total suspended solids loading for the period 1997 through 2016.

TOTAL SUSPENDED SOLIDS LOADING 1997-2016

(Annual Average Loading, lbs/day)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	STORM EFFLUENT	SECONDARY REMOVAL (%)	PRIMARY INFLUENT (mg/L)	SECONDARY EFFLUENT (mg/L)
1997	57,504	19,648	18,269	2,605	3,069	95.47	151	7
1998	52,234	15,320	15,200	2,597	1,823	95.03	163	8
1999	55,811	16,506	17,024	3,086	1,130	94.47	169	9
2000	65,054	20,079	22,032	2,497	1,246	96.16	192	7
2001	64,903	19,583	21,655	3,275	458	94.95	206	10
2002	61,763	21,777	23,704	4,071		93.41	188	12
2003	59,961	22,552	25,380	3,743		93.76	188	12
2004	60,646	21,428	27,246	3,883		93.60	195	12
2005	57,769	20,525	24,165	5,232		90.94	190	17
2006	60,101	23,434	28,277	4,344		92.77	174	13
2007	63,311	23,876	28,719	3,304		94.78	204	11
2008	61,739	22,443	27,475	3,662		94.07	188	11
2009	55,227	20,701	23,952	3,119		94.35	170	10
2010	57,672	20,849	22,734	3,566		93.82	181	11
2011	58,554	22,125	25,997	3,126		94.23	178	10
2012	49,179	12,752	17,138	2,925		93.99	178	10
2013	41,926	10,041	13,124	2,622		93.66	176	11
2014	41,444	10,780	13,072	2,526		93.73	172	10
2015	40,824	10,095	12,880	1,901		95.29	182	8
2016	41,634	12,835	15,066	2,326		94.12	168	9
MIN	40,824	10,041	12,880	1,901	458	90.94	151	7
MAX	65,054	23,876	28,719	5,232	3,069	96.16	206	17
AVG	55,363	18,367	21,155	3,221	1,545	94.13	181	11

Phosphorus

The Facility Plan, experience and special studies have indicated that 0.6 mg/L total Phosphorus can be consistently achieved in the final effluent under normal secondary treatment plant operating conditions using chemical precipitation with alum to remove Phosphorus. The preliminary results from implementation of CEPT that began in 2011 appear to indicate that further reduction in effluent phosphorus can be achieved by the addition of alum and polymer prior to primary treatment. The seasonal average for effluent phosphorus was 0.37 mg/L during the 2016 removal season.

Extensive and long term filtration pilot studies were conducted from 2009 to 2010 to investigate the best way to remove phosphorus from effluent prior to discharge to the river. Based on the results of this pilot testing, draft facility plan amendment 3 has recommended the selection of membrane filtration technology to meet future, more stringent, phosphorus limits. Further pilot testing in 2015 and 2016 resulted in the selection of a pressurized membrane system manufactured by Pall Corporation for final construction to meet 2021 effluent limits.

Influent Phosphorus loading has been relatively steady over the period of 1996 through 2008. Since 2008, influent phosphorus loading has shown significant decline. Causes for

the decline are likely a combination of the phosphorus detergent and fertilizer bans and the Spokane County Plant coming online.

Phosphorus levels have fluctuated in the effluent. Effluent Phosphorus values were at a minimum level in 2015 and peaked in 2007. Effluent loading has decreased 63% from 230 lbs/day in 2007 to 86 lbs/day in 2016 (See Graphs 7 and 8). There have been no storm effluent flows during the growing seasons since 1997.

The following table depicts Phosphorus loading for the period 1997 through 2016.

GROWING SEASON PHOSPHORUS LOADING 1997-2016

(Seasonal Average Loading, lbs/day)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	STORM EFFLUENT	SECONDARY REMOVAL (%)	PRIMARY INFLUENT (mg/L)	SECONDARY EFFLUENT (mg/L)
1997	1,581	1,096	1,164	173	85	89.06	4.16	0.46
1998	1,537	1,080	1,120	168		89.07	4.81	0.53
1999	1,656	1,133	1,244	132		92.03	5.03	0.40
2000	1,867	1,166	1,253	140		92.50	5.51	0.41
2001	1,526	1,064	1,148	146		90.43	4.85	0.46
2002	1,614	1,148	1,209	117		92.75	4.92	0.36
2003	1,638	1,204	1,234	147		91.03	5.13	0.46
2004	1,729	1,175	1,348	172		90.05	5.56	0.55
2005	1,729	1,170	1,274	217		87.45	5.70	0.72
2006	1,641	1,173	1,276	206		87.45	4.91	0.64
2007	1,625	1,200	1,361	230		85.85	5.29	0.68
2008	1,713	1,189	1,311	187		89.08	4.87	0.57
2009	1,532	1,039	1,119	149		90.27	4.79	0.49
2010	1,342	979	1,093	141		89.51	4.47	0.47
2011	1,359	823	988	121		90.57	4.12	0.36
2012	1,056	355	446	89		91.56	3.94	0.32
2013	926	318	419	103		88.87	3.95	0.44
2014	977	378	433	97		90.07	4.07	0.40
2015	966	402	467	86		91.08	4.47	0.40
2016	985	416	467	86		91.16	4.27	0.37
MIN	926	318	419	86	85	85.85	3.94	0.32
MAX	1,867	1,204	1,361	230	85	92.75	5.70	0.72
AVG	1,450	925	1,019	145	85	89.99	4.74	0.47

Ammonia

Primary influent ammonia loading increased steadily prior to peaking in 2008. Since then, loading has decreased. Secondary effluent ammonia levels declined sharply after 1998 and have remained low since 2003. The table below depicts the relationship between ammonia loading in the influent and effluent during the period 1997 through 2016.

The main projects that have taken place in recent years to enhance Ammonia removal have been the installation of fine bubble diffusers in the aeration basins and the addition of aeration basin #6 (See Graphs 9 and 10).

AMMONIA LOADING 1997-2016

(Annual Average Loading, lbs/day)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	STORM EFFLUENT	SECONDARY REMOVAL (%)	PRIMARY INFLUENT (mg/L)	SECONDARY EFFLUENT (mg/L)
1997	6,242	5,220	7,052	408	215	93.46	16.43	1.07
1998	4,422	4,033	5,168	1,205	180	72.75	13.84	3.77
1999	4,813	4,307	5,415	401	204	91.67	14.61	1.22
2000	5,161	4,514	5,728	101		98.04	15.24	0.30
2001	5,381	4,454	5,810	107		98.01	17.10	0.34
2002	5,632	5,267	5,850	93		98.35	17.16	0.28
2003	5,826	5,653	5,990	55		99.06	18.23	0.17
2004	5,823	5,079	5,738	58		99.00	18.73	0.19
2005	6,005	4,402	5,845	56		99.07	19.79	0.18
2006	6,214	5,098	6,042	57		99.08	18.03	0.17
2007	6,065	5,021	5,833	27		99.55	19.54	0.09
2008	6,406	5,143	6,113	46		99.28	19.46	0.10
2009	6,282	5,473	6,437	35		99.44	19.33	0.11
2010	5,757	5,473	6,877	42		99.27	18.12	0.13
2011	5,567	5,328	6,697	35		99.40	16.82	0.10
2012	4,615	4,220	5,577	37		99.18	17.13	0.16
2013	4,488	3,990	5,346	11		99.75	19.12	0.05
2014	4,415	4,081	5,169	50		98.92	18.56	0.18
2015	4,059	3,909	5,012	18		99.54	18.19	0.08
2016	4,494	4,122	5,354	11		99.76	18.21	0.04
MIN	4,059	3,909	5,012	11	180	72.75	13.84	0.04
MAX	6,406	5,653	7,052	1,205	215	99.76	19.79	3.77
AVG	5,383	4,739	5,853	143	200	97.13	17.68	0.44

Summary

Flow

RPWRF is attempting to manage and minimize storm flow to the river through the fifth and sixth clarifiers. Peak flows through the secondary portion of the plant has been increased from 77 mgd to 100 mgd with four secondary clarifiers in service. Increasing the flow through the secondary portion of the plant has resulted in less storm overflow because secondary treatment is provided to higher rates of flow. Graphs 1 and 2 depict the relationship between flows (1986-2016).

Biochemical Oxygen Demand

The reclamation facility was loaded at 54.5% design capacity during 2016 on an annual average basis. BOD loading to the plant increased 5.5% during 201. Graphs 3 and 4 depict the relationships between BOD loading and discharge to the river (1986-2016).

Total Suspended Solids

The water reclamation facility reached 48.9% capacity for total suspended solids loading in 2016 on an annual average basis. Several improvements to the primary, secondary and solids handling facilities have been implemented in recent years to address and accommodate the increased loading. Graphs 5 and 6 depict TSS loading (1986-2016).

Phosphorus

Historical loading levels to the river have averaged 145 lbs/day during the growing season for the period from 1997-2016. Discharge levels peaked in 2007 and were at minimum levels in 2016. Graphs 7 and 8 depict phosphorus loading (1986-2016).

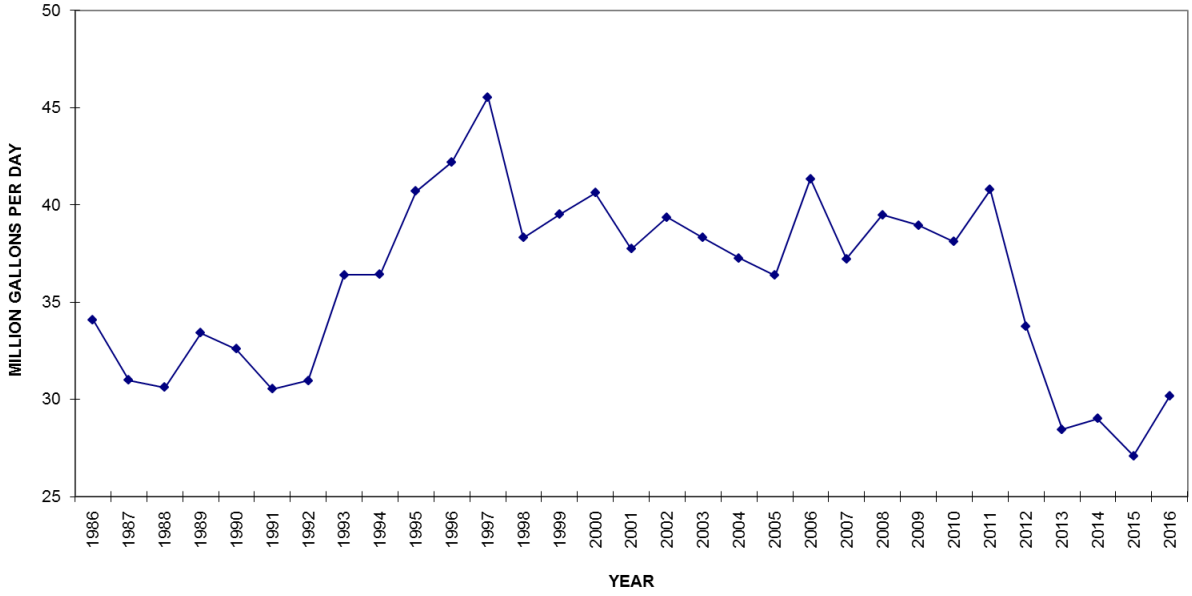
Ammonia

The reclamation facility discharged Ammonia at an average annual rate of 11 lbs/day during 2016. Ammonia discharge levels averaged 143 lbs/day during the period from 1997 to 2016. During recent years, Ammonia discharge levels have been less than 60 lbs/day. Graphs 9 and 10 depict Ammonia loading (1986-2016).

FIGURES AND APPENDICES

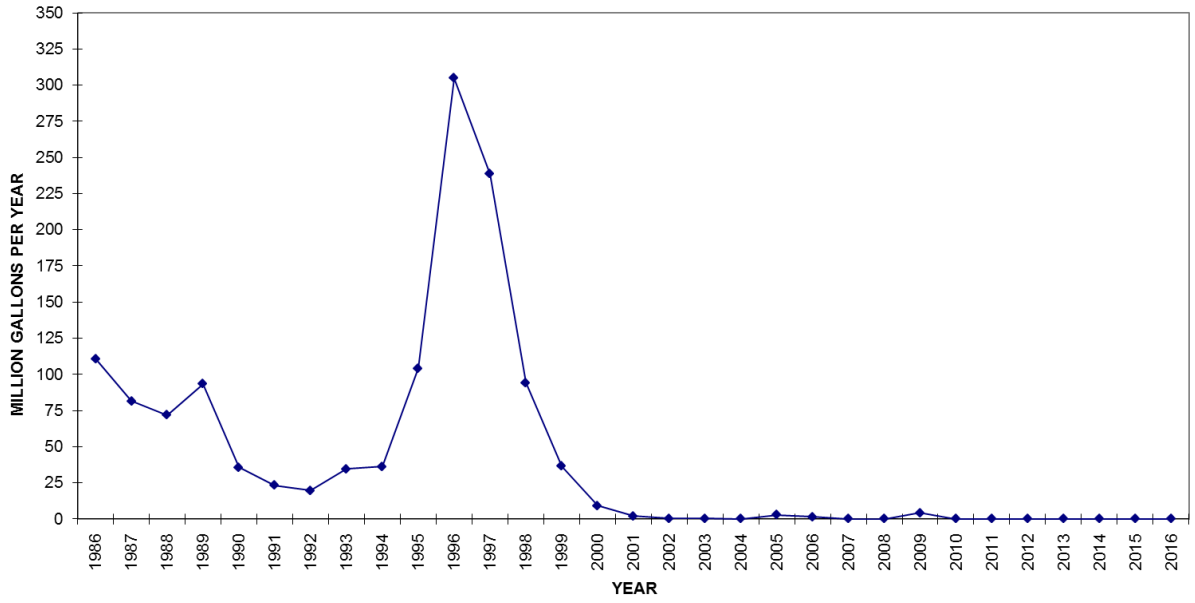
Appendix I: Loading Graphs

GRAPH 1
RPWRF INFLUENT FLOW



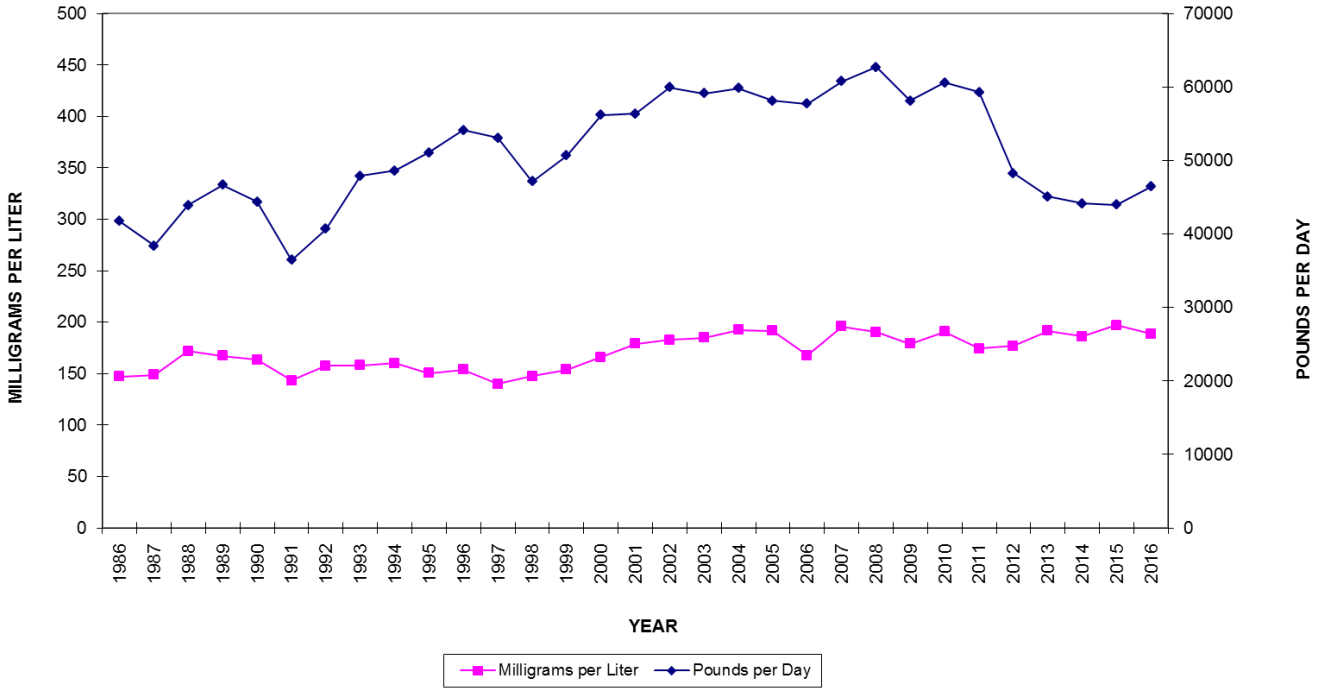
GRAPH 2

TREATED CSO DISCHARGE VOLUME

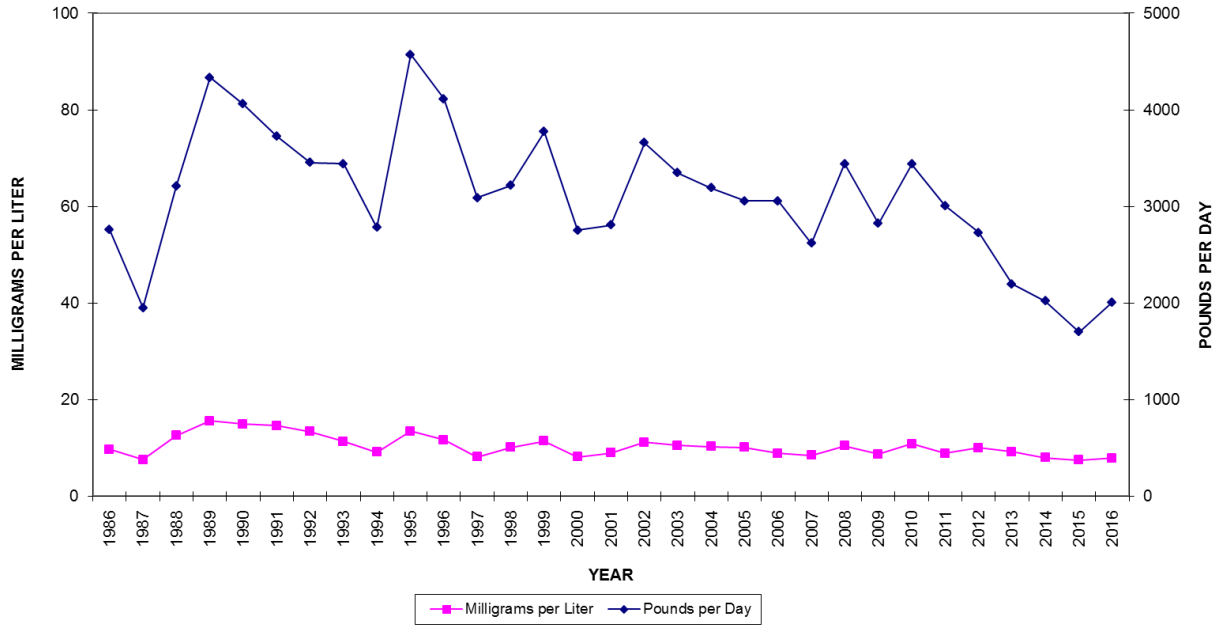


GRAPH 3

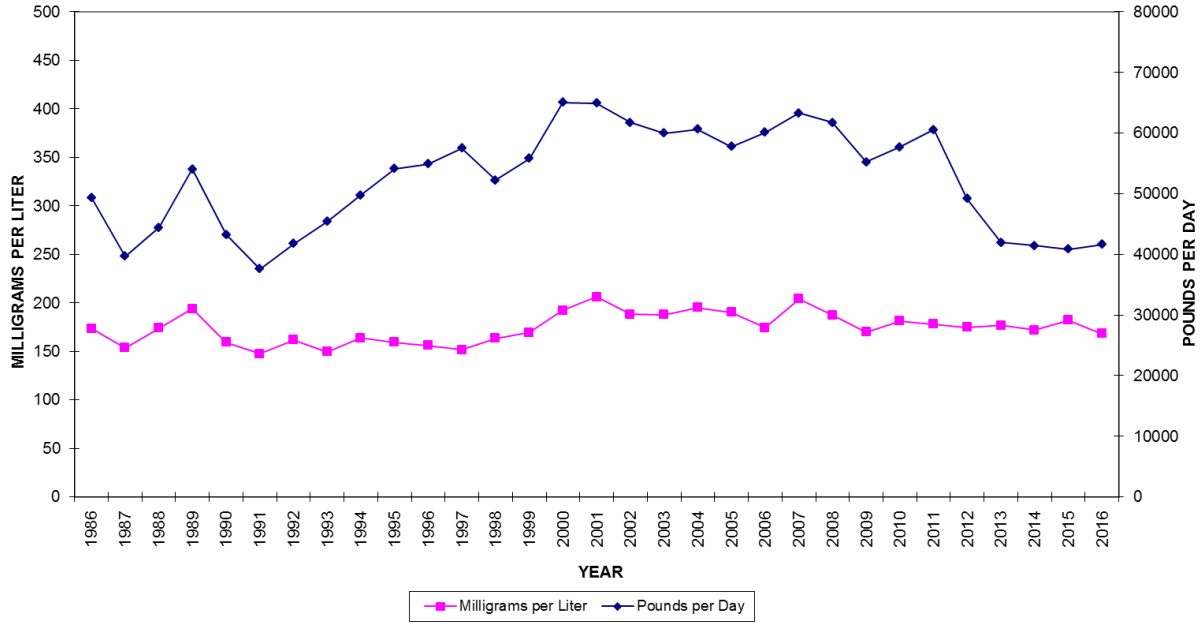
RPWRF BOD LOADING



GRAPH 4
RPWRF BOD DISCHARGED

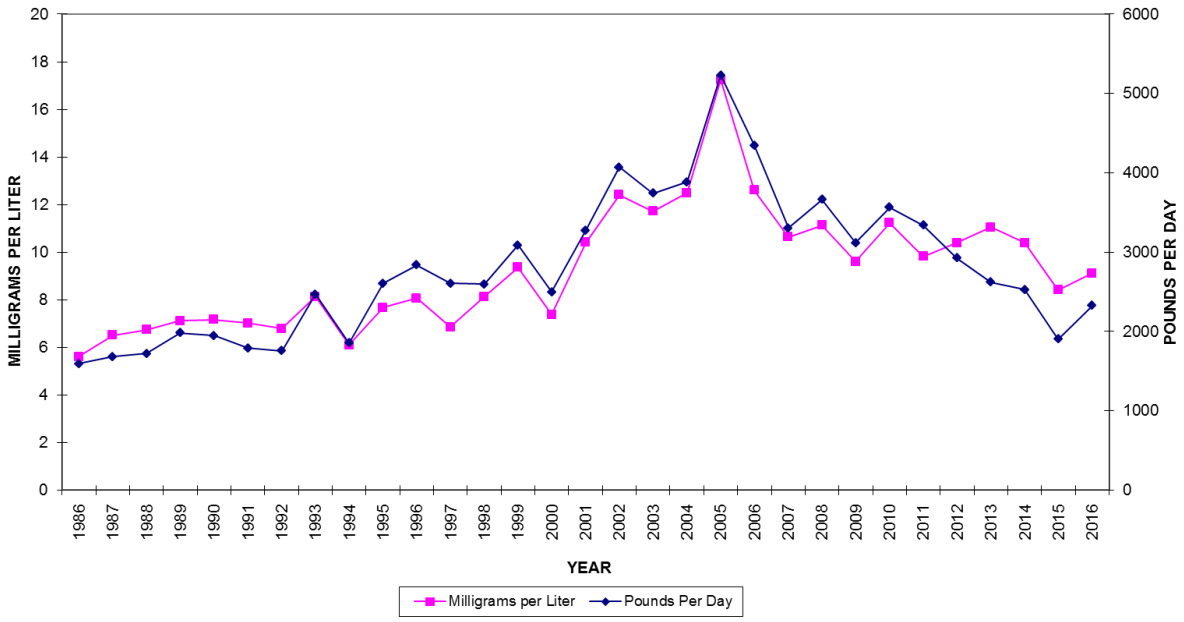


GRAPH 5
RPWRF TOTAL SUSPENDED SOLIDS LOADING



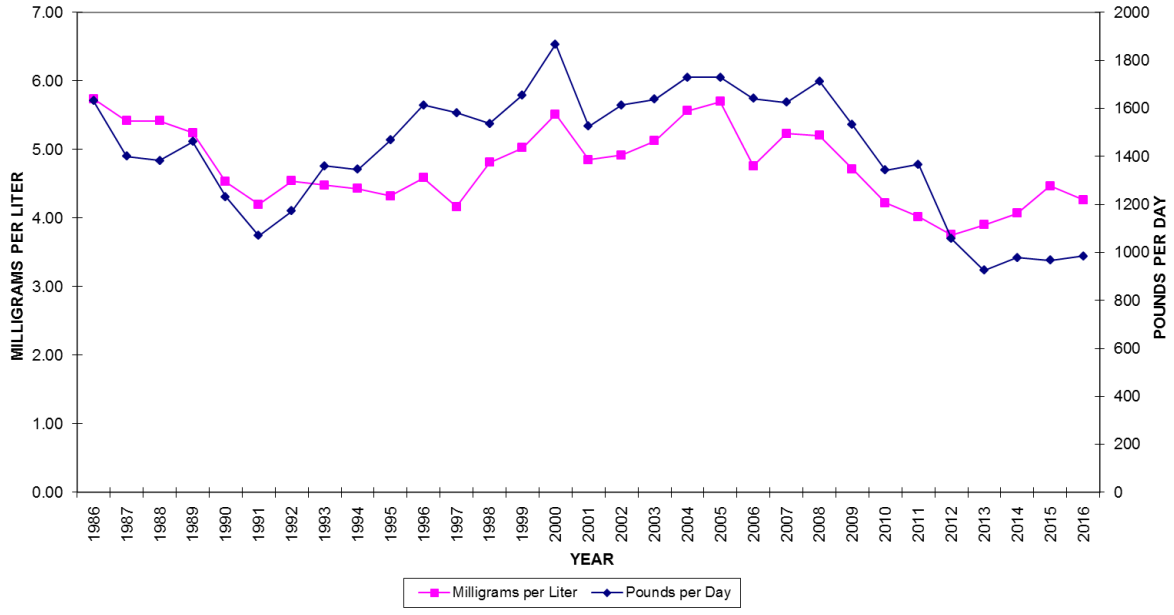
GRAPH 6

RPWRF TOTAL SUSPENDED SOLIDS DISCHARGED



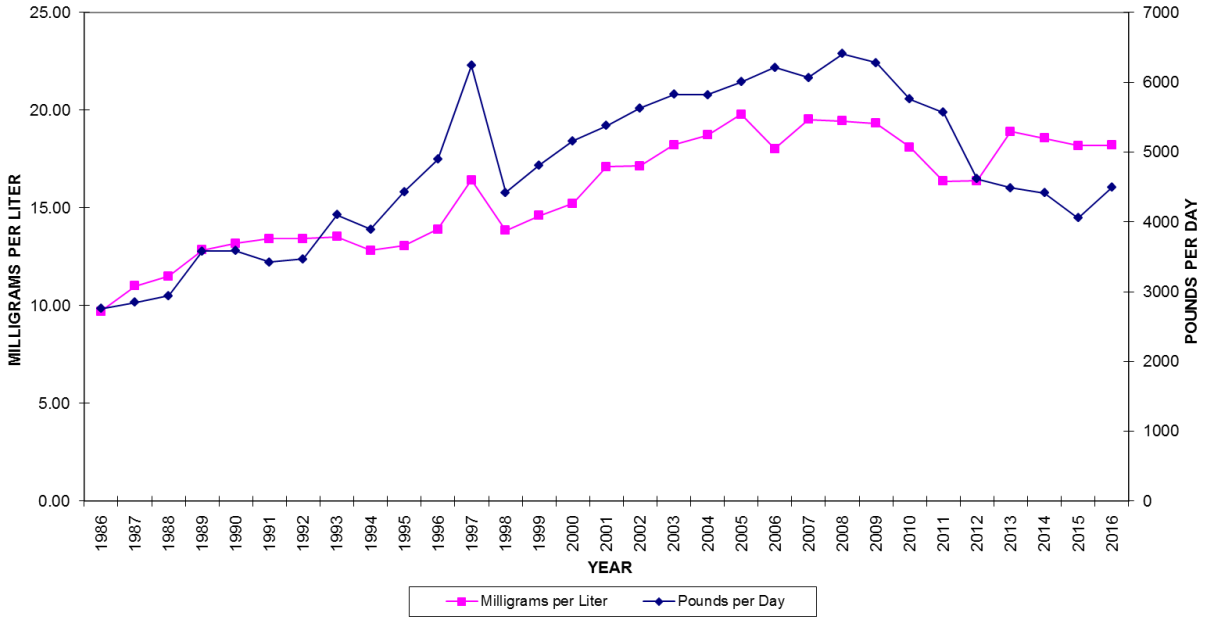
GRAPH 7

RPWRF SEASONAL PHOSPHORUS LOADING



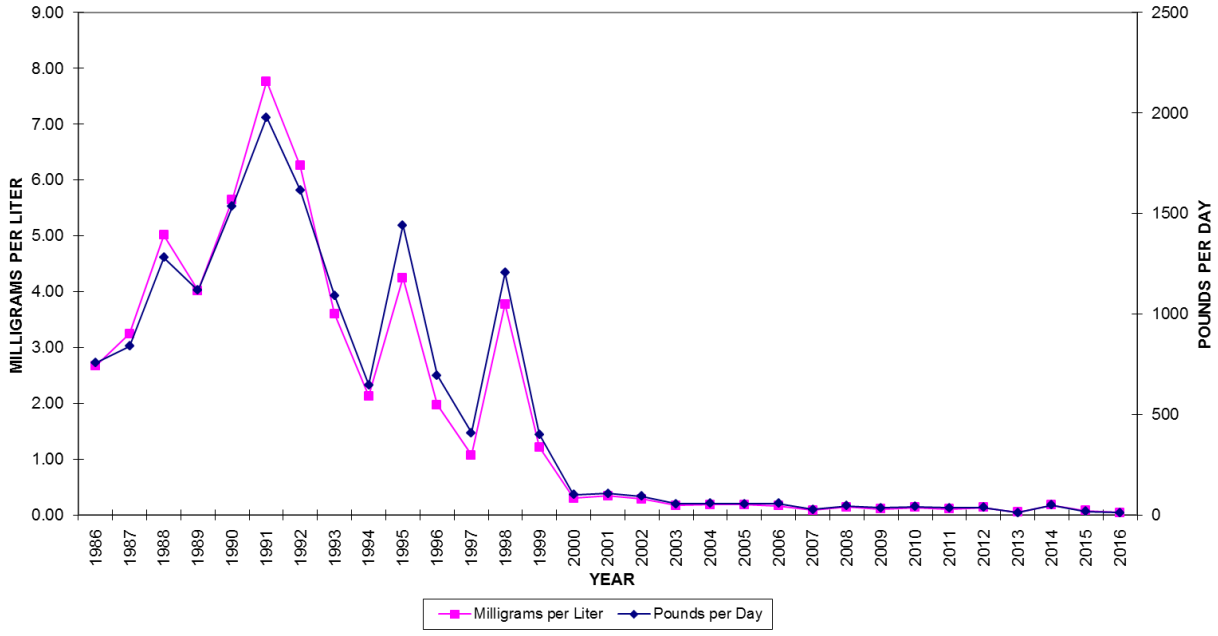
GRAPH 8
RPWRF PHOSPHORUS DISCHARGED

GRAPH 9
RPWRF AMMONIA LOADING

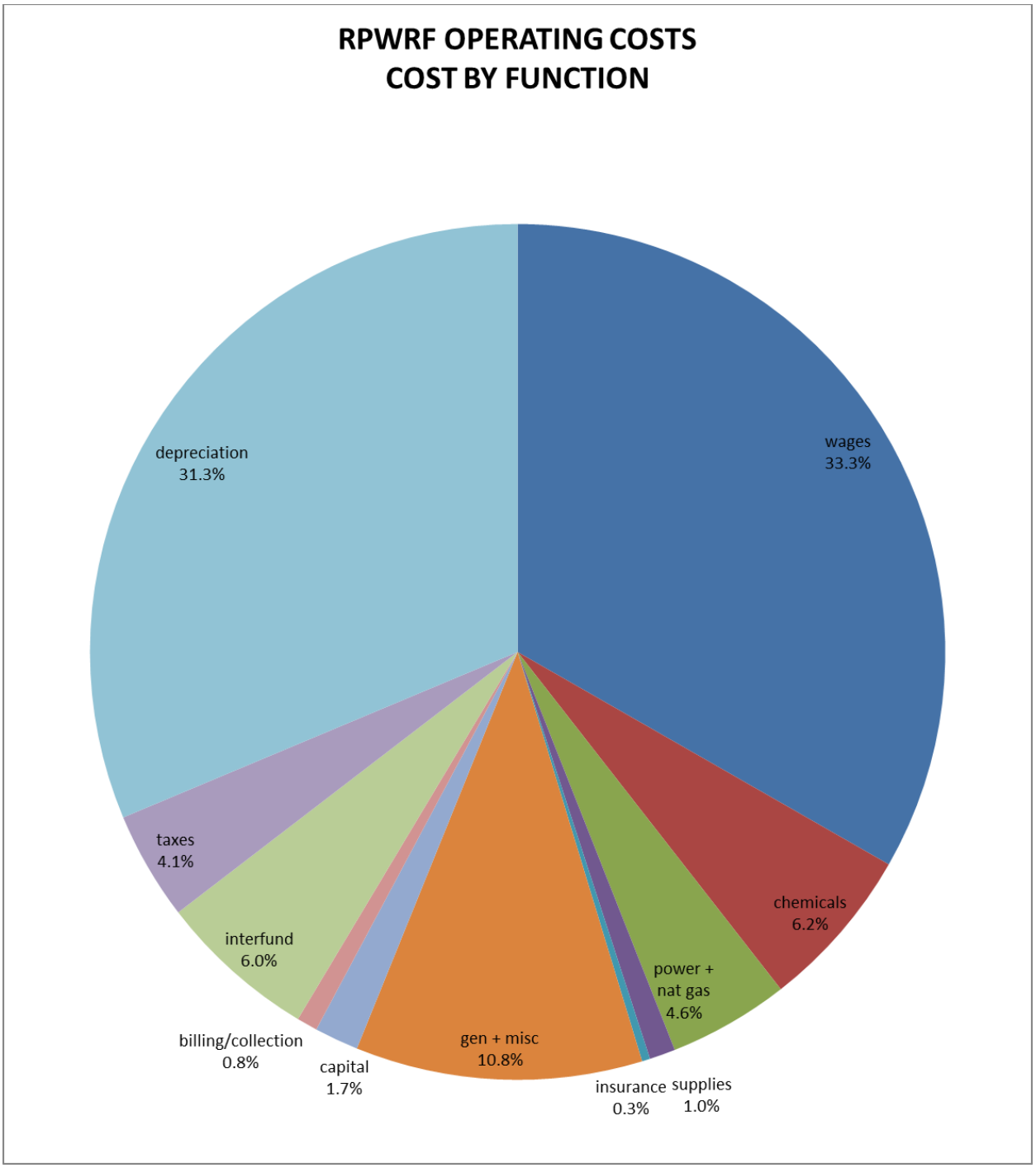


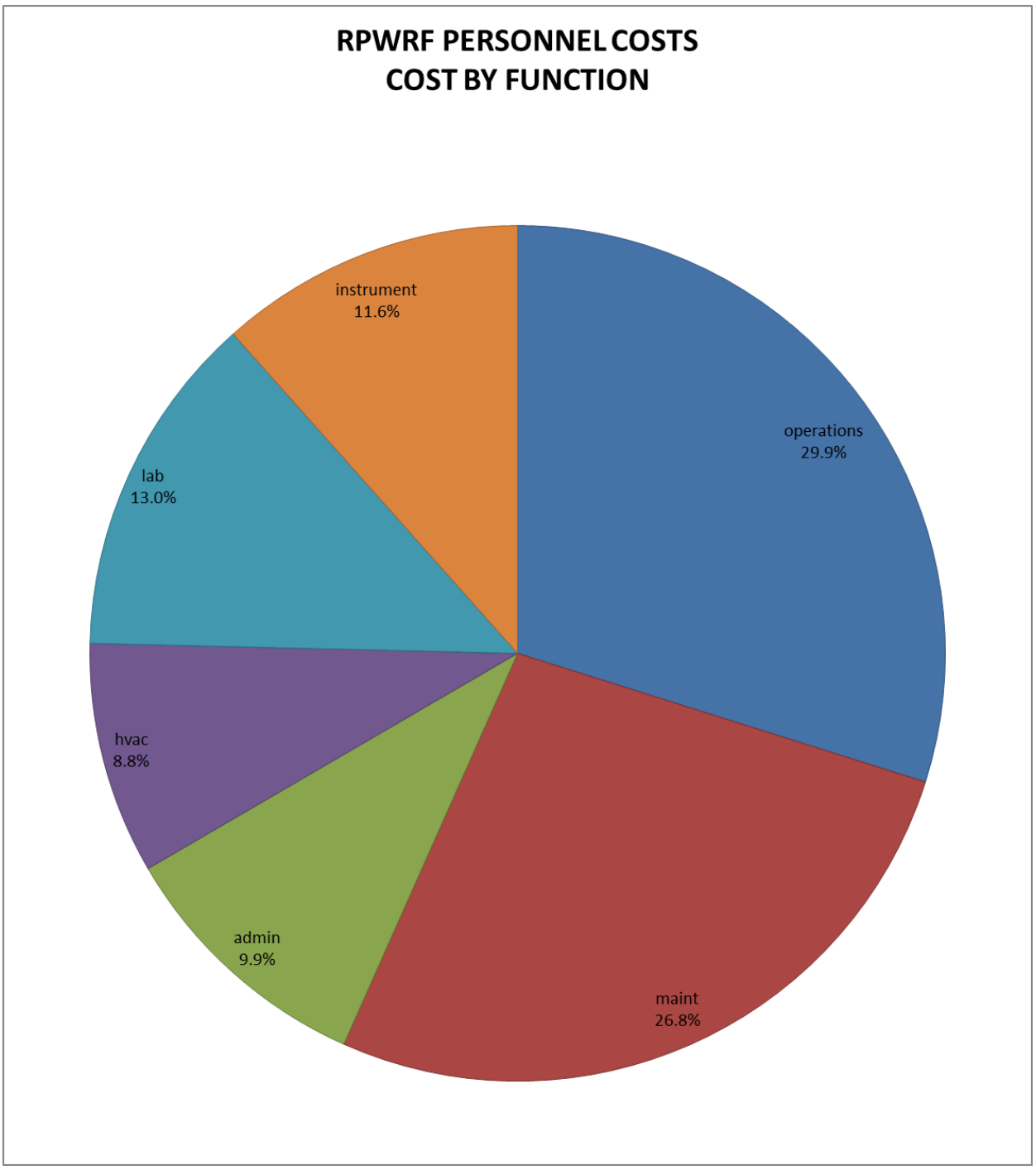
GRAPH 10

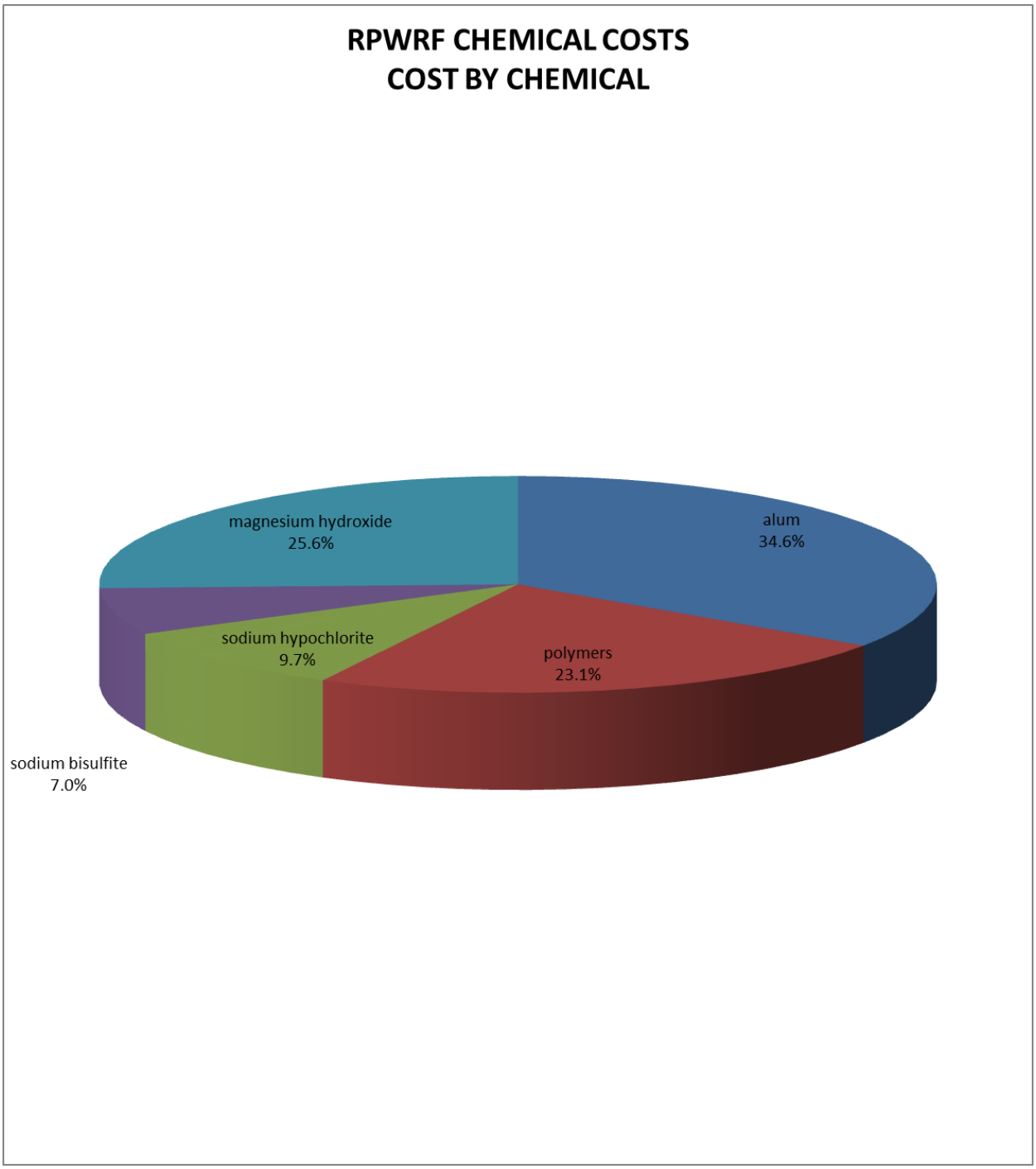
RPWRF AMMONIA DISCHARGED

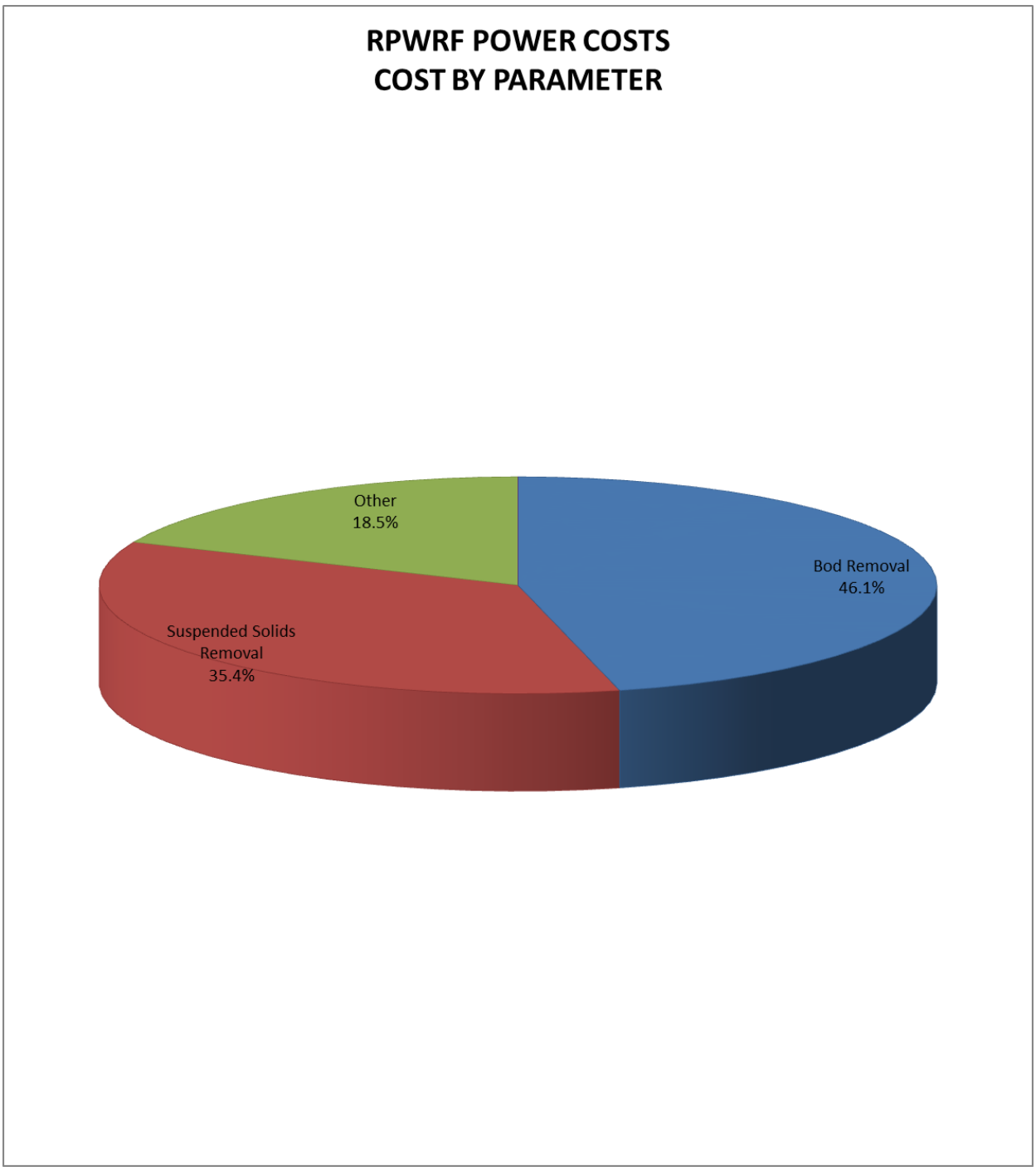


Appendix II: Budget Figures




RPWRF PERSONNEL COSTS
COST BY FUNCTION
instrument
11.6%
operations
29.9%
lab
13.0%
hvac
8.8%
admin
9.9%
maint
26.8%


RPWRF CHEMICAL COSTS
COST BY CHEMICAL
magnesium hydroxide
25.6%
alum
34.6%
sodium hypochlorite
9.7%
polymers
23.1%
sodium bisulfite
7.0%


RPWRF POWER COSTS
COST BY PARAMETER
Other
18.5%
Bod Removal
46.1%
Suspended Solids
Removal
35.4%

Appendix III – Loading and Removal Tables and Graphs

CITY OF SPOKANE RPWRF
FLOW CHARACTERISTICS 2016

	P.INF. FLOW (MGD)	PEAK FLOW (MGD)	MIN FLOW (MGD)	AVG FLOW CSO SYSTEM	MG CSO SYSTEM	MG CSO DISCHARGED
JANUARY	34.88	51.79	20.41	0.000	0.00	0.00
FEBRUARY	30.56	42.18	18.05	0.000	0.00	0.00
MARCH	35.81	56.07	21.26	0.000	0.00	0.00
APRIL	30.50	44.90	17.74	0.007	0.20	0.00
MAY	28.64	42.25	16.00	0.019	0.60	0.00
JUNE	27.82	39.28	15.92	0.057	1.70	0.00
JULY	27.03	37.84	15.66	0.000	0.00	0.00
AUGUST	27.05	38.69	14.97	0.000	0.00	0.00
SEPTEMBER	26.05	37.79	13.53	0.000	0.00	0.00
OCTOBER	34.37	59.32	19.65	0.116	3.60	0.11
NOVEMBER	31.04	45.15	19.09	0.000	0.00	0.00
DECEMBER	28.17	38.34	16.80	0.000	0.00	0.00
MINIMUM	24.51	31.81	7.34	0.00	0.00	0.00
MAXIMUM	67.95	127.01	44.00	2.10	2.10	0.11
DAILY AVG	30.17	44.51	17.43	0.02	0.02	0.00
MONTH AVG	30.16	44.47	17.42	0.017	0.51	0.01
TOTAL	11,043				6.10	0.11
COUNT	366	366	366	366	366	366

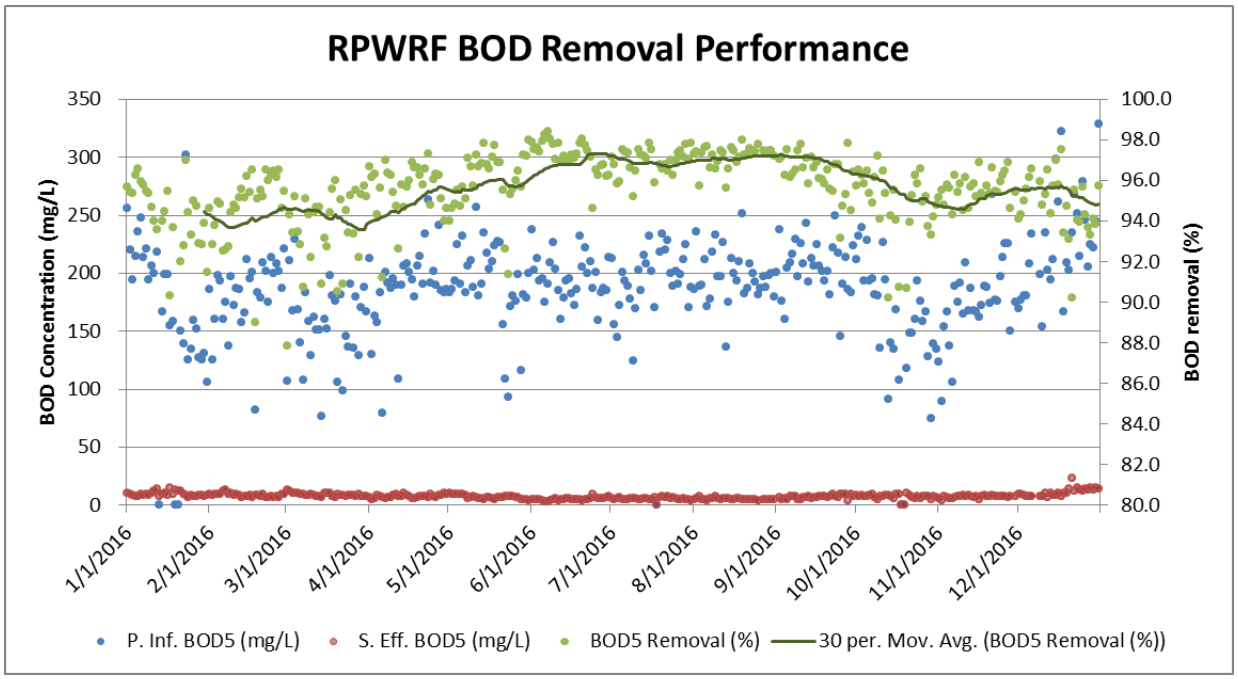
CITY OF SPOKANE RPWRF
BIOCHEMICAL OXYGEN DEMAND LOADING 2016

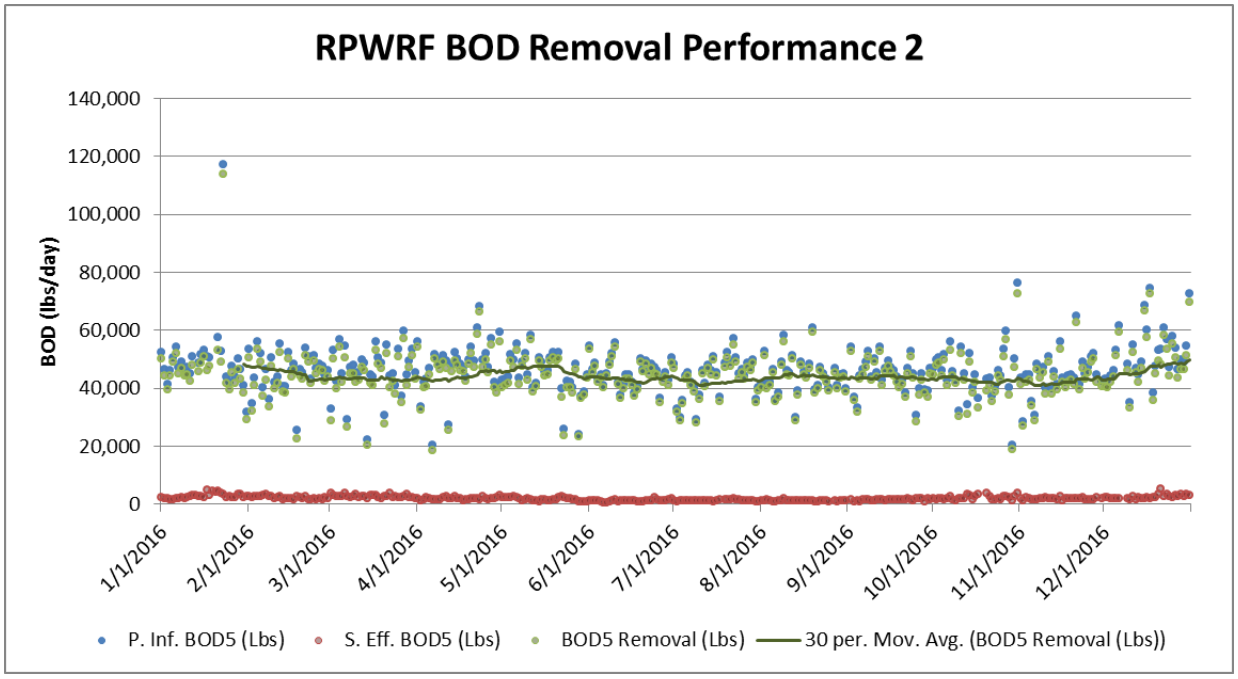
(AVERAGE LOADING mg/L)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	PERCENT SECONDARY REMOVAL
JANUARY	184	84	74	10	94.63
FEBRUARY	182	108	87	9	95.04
MARCH	156	111	92	9	94.00
APRIL	189	102	81	8	95.79
MAY	192	111	82	7	96.20
JUNE	197	104	76	5	97.27
JULY	195	97	92	6	97.00
AUGUST	197	90	72	5	97.27
SEPTEMBER	206	96	82	7	96.43
OCTOBER	166	74	65	8	95.18
NOVEMBER	176	81	68	8	95.70
DECEMBER	223	110	98	11	95.00
DAILY MINIMUM	75	31	36	3	87.85
DAILY MAXIMUM	329	161	195	23	98.43
DAILY AVG	189	97	81	8	95.64
MONTH AVG	189	97	81	8	95.79
JUL-OCT AVG	191	90	78	7	96.35
NOV-JUN AVG	187	101	82	8	95.28
JUL-OCT MEDIAN	195	92	73	6	96.63
NOV-JUN MEDIAN	189	101	82	8	95.51

(AVERAGE LOADING lbs/day)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	SECONDARY REMOVAL
JANUARY	50,344	22,872	20,243	2,879	47,592
FEBRUARY	46,021	27,141	22,168	2,311	43,710
MARCH	45,998	32,892	27,182	2,795	43,203
APRIL	48,083	25,856	20,667	2,027	46,056
MAY	45,145	26,320	19,566	1,757	43,388
JUNE	45,563	24,185	17,599	1,250	44,313
JULY	43,957	21,934	20,804	1,317	42,640
AUGUST	44,758	20,343	16,351	1,229	43,529
SEPTEMBER	44,744	20,941	17,851	1,607	43,137
OCTOBER	45,803	20,682	17,876	2,304	43,499
NOVEMBER	44,837	20,547	17,092	1,942	42,895
DECEMBER	51,590	25,555	22,833	2,620	48,970
DAILY MINIMUM	20,247	10,727	9,468	706	18,508
DAILY MAXIMUM	117,396	51,043	44,436	5,256	113,897
DAILY AVG	46,433	24,153	20,047	2,006	44,444
MONTH AVG	46,404	24,106	20,019	2,003	44,411
JUL-OCT AVG	44,808	20,978	18,205	1,608	43,199
NOV-JUN AVG	47,243	25,715	20,953	2,202	45,064
JUL-OCT MEDIAN	45,048	20,802	17,014	1,429	43,727
NOV-JUN MEDIAN	46,881	24,339	20,159	2,113	42,212


RPWRF BOD Removal Performance
BOD Concentration (mg/L)
BOD removal (%)
350
300
250
200
150
100
50
0
100.0
98.0
96.0
94.0
92.0
90.0
88.0
86.0
84.0
82.0
80.0
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016
P. Inf. BOD5 (mg/L)
S. Eff. BOD5 (mg/L)
BOD5 Removal (%)
30 per. Mov. Avg. (BOD5 Removal (%))


RPWRF BOD Removal Performance 2
BOD (lbs/day)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016
P. Inf. BOD5 (Lbs)
S. Eff. BOD5 (Lbs)
BOD5 Removal (Lbs)
30 per. Mov. Avg. (BOD5 Removal (Lbs))

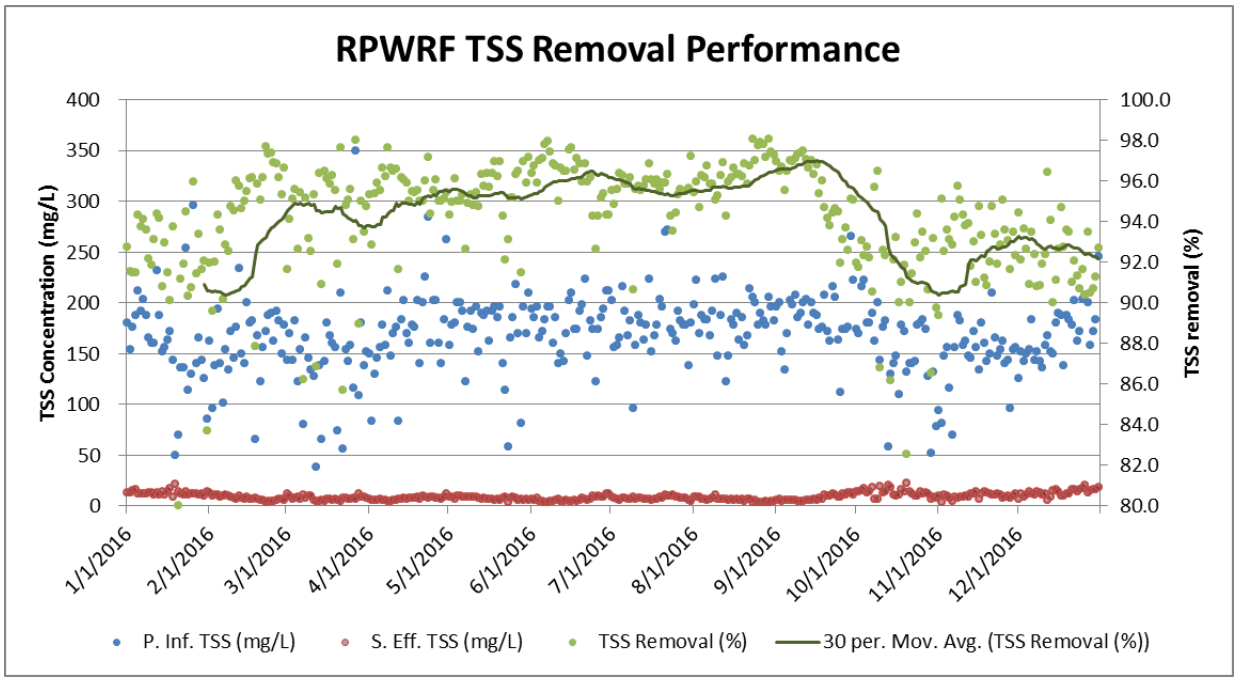
CITY OF SPOKANE RPWRF
TOTAL SUSPENDED SOLIDS LOADING 2016

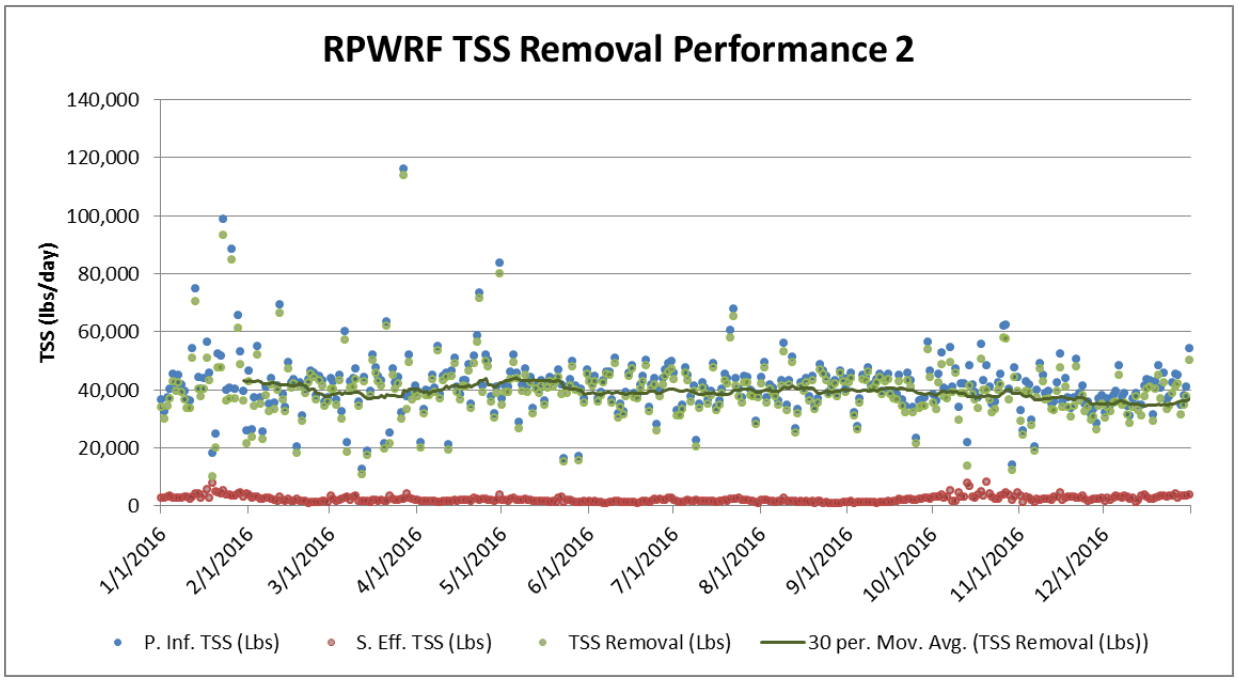
(AVERAGE LOADING mg/L)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	PERCENT SECONDARY REMOVAL
JANUARY	162	45	58	13	92.10
FEBRUARY	160	58	60	8	95.05
MARCH	144	64	62	8	94.62
APRIL	174	58	59	7	95.71
MAY	172	55	57	8	95.50
JUNE	181	50	52	7	96.23
JULY	181	47	64	8	95.64
AUGUST	185	45	53	6	96.50
SEPTEMBER	187	49	61	8	95.69
OCTOBER	155	41	58	13	91.44
NOVEMBER	148	43	60	10	93.23
DECEMBER	170	62	76	13	92.27
DAILY MINIMUM	38	20	26	4	56.00
DAILY MAXIMUM	350	82	136	23	98.06
DAILY AVG	168	51	60	9	94.12
MONTH AVG	168	51	60	9	94.50
JUL-OCT AVG	177	45	59	9	94.53
NOV-JUN AVG	164	54	61	9	93.91
JUL-OCT MEDIAN	178	46	56	8	95.60
NOV-JUN MEDIAN	166	54	60	9	94.68

(AVERAGE LOADING lbs/day)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	SECONDARY REMOVAL
JANUARY	46,263	12,437	16,309	3,732	42,531
FEBRUARY	40,435	14,796	15,288	2,042	38,393
MARCH	42,548	19,052	18,625	2,315	40,233
APRIL	44,496	14,660	15,025	1,905	42,591
MAY	40,565	13,078	13,594	1,857	38,708
JUNE	41,891	11,663	12,170	1,581	40,309
JULY	40,965	10,538	14,536	1,791	39,174
AUGUST	41,696	10,119	12,060	1,460	40,236
SEPTEMBER	40,609	10,576	13,303	1,735	38,874
OCTOBER	42,587	11,719	16,448	3,793	38,793
NOVEMBER	37,694	10,860	15,402	2,575	35,119
DECEMBER	39,235	14,467	17,974	3,032	36,203
DAILY MINIMUM	12,566	6,479	7,046	882	10,142
DAILY MAXIMUM	116,176	25,717	39,551	8,402	113,853
DAILY AVG	41,634	12,835	15,066	2,326	39,308
MONTH AVG	41,582	12,830	15,061	2,318	39,264
JUL-OCT AVG	41,471	10,739	14,093	2,198	39,273
NOV-JUN AVG	41,717	13,895	15,559	2,391	39,326
JUL-OCT MEDIAN	41,496	10,389	13,141	1,781	39,266
NOV-JUN MEDIAN	41,358	13,297	14,812	2,184	39,147


RPWRF TSS Removal Performance
TSS Concentration (mg/L)
TSS removal (%)
400
350
300
250
200
150
100
50
0
100.0
98.0
96.0
94.0
92.0
90.0
88.0
86.0
84.0
82.0
80.0
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016
P. Inf. TSS (mg/L)
S. Eff. TSS (mg/L)
TSS Removal (%)
30 per. Mov. Avg. (TSS Removal (%))


RPWRF TSS Removal Performance 2
TSS (lbs/day)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016
P. Inf. TSS (Lbs)
S. Eff. TSS (Lbs)
TSS Removal (Lbs)
30 per. Mov. Avg. (TSS Removal (Lbs))

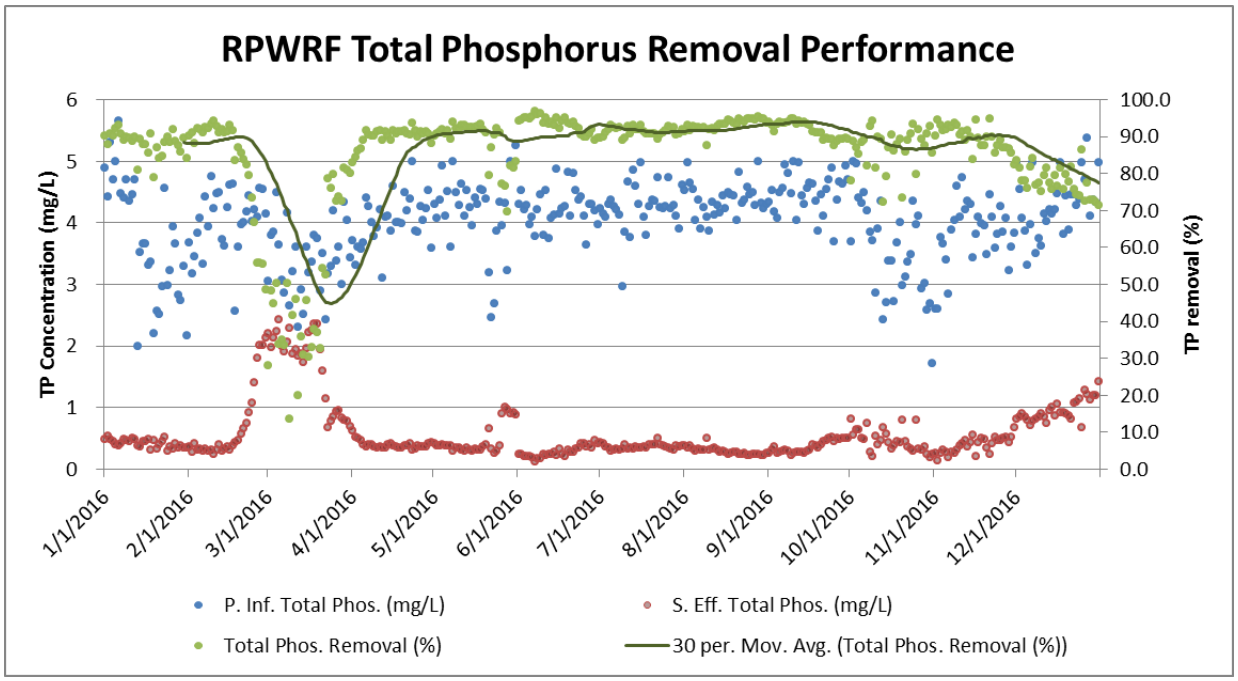
CITY OF SPOKANE RPWRF
TOTAL PHOSPHORUS LOADING 2016

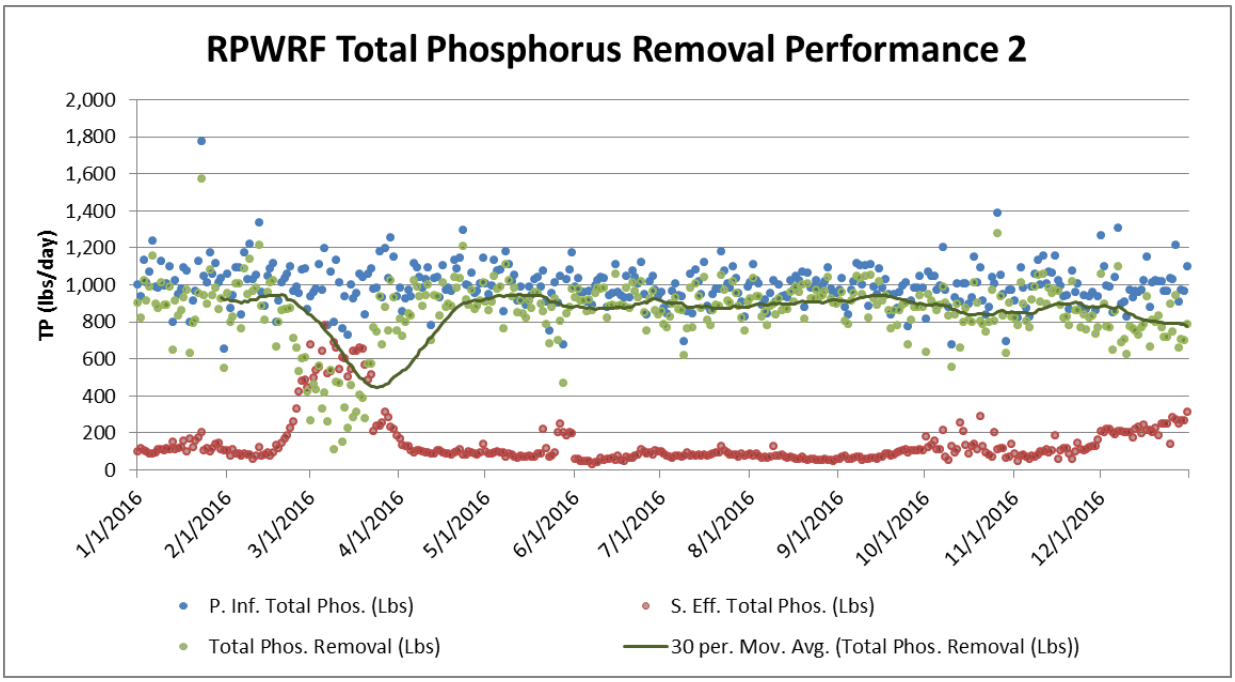
(AVERAGE LOADING mg/L)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	PERCENT SECONDARY REMOVAL
JANUARY	3.75	1.63	1.81	0.42	88.84
FEBRUARY	4.04	2.43	2.39	0.68	83.09
MARCH	3.39	2.67	2.73	1.67	50.89
APRIL	4.02	1.96	2.17	0.40	90.16
MAY	4.21	1.94	2.07	0.47	88.93
JUNE	4.24	1.84	1.85	0.28	93.44
JULY	4.26	1.71	2.30	0.36	91.43
AUGUST	4.37	1.68	1.80	0.29	93.35
SEPTEMBER	4.50	1.91	2.07	0.37	91.87
OCTOBER	3.56	1.54	1.67	0.46	87.09
NOVEMBER	3.82	1.68	1.81	0.39	89.87
DECEMBER	4.30	2.50	2.73	0.95	77.85
DAILY MINIMUM	1.71	0.72	0.90	0.30	13.58
DAILY MAXIMUM	5.65	4.75	3.28	0.52	96.77
DAILY AVG	4.04	1.96	2.12	0.56	85.28
MONTH AVG	4.04	1.96	2.12	0.56	85.57

(AVERAGE LOADING lbs/day)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	POUNDS SECONDARY REMOVAL
JANUARY	1,038	441	494	120	919
FEBRUARY	1,024	610	601	167	857
MARCH	1,000	786	803	491	508
APRIL	1,021	499	551	101	920
MAY	992	460	490	110	882
JUNE	983	426	430	65	918
JULY	960	386	517	82	878
AUGUST	985	380	406	66	920
SEPTEMBER	978	414	450	79	899
OCTOBER	978	421	456	129	849
NOVEMBER	977	426	457	99	879
DECEMBER	1,005	586	634	219	786
DAILY MINIMUM	654	273	246	29	108
DAILY MAXIMUM	1,776	1,264	1,124	779	1,574
DAILY AVG	995	486	525	145	850
MONTH AVG	995	486	524	144	851


RPWRF Total Phosphorus Removal Performance
TP Concentration (mg/L)
TP removal (%)
0
1
2
3
4
5
6
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016
P. Inf. Total Phos. (mg/L)
S. Eff. Total Phos. (mg/L)
Total Phos. Removal (%)
30 per. Mov. Avg. (Total Phos. Removal (%))


RPWRF Total Phosphorus Removal Performance 2
TP (lbs/day)
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016
P. Inf. Total Phos. (Lbs)
S. Eff. Total Phos. (Lbs)
Total Phos. Removal (Lbs)
30 per. Mov. Avg. (Total Phos. Removal (Lbs))

CITY OF SPOKANE RPWRF
PHOSPHORUS REMOVAL SEASON LOADING 2016
APRIL 15TH THROUGH OCTOBER 15TH
(AVERAGE LOADING mg/L)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	PERCENT SECONDARY REMOVAL	ALUM GALLONS	ALUM (MG/L)
JANUARY	3.75	1.63	1.81	0.42	88.84	3544	66
FEBRUARY	4.04	2.43	2.39	0.68	83.09	1517	31
MARCH	3.39	2.67	2.73	1.67	50.89	659	11
APRIL (1-14)	3.84	2.15	2.19	0.42	88.94	2532	53
APRIL (15-30)	4.18	1.79	2.15	0.38	90.94	2798	60
MAY	4.21	1.94	2.07	0.47	88.93	2676	60
JUNE	4.24	1.84	1.85	0.28	93.44	2704	63
JULY	4.26	1.71	2.30	0.36	91.43	2515	60
AUGUST	4.37	1.68	1.80	0.29	93.35	2511	60
SEPTEMBER	4.50	1.91	2.07	0.37	91.87	2395	62
OCTOBER (1-15)	3.88	1.63	1.88	0.53	85.68	3384	32
OCTOBER (16-31)	3.26	1.46	1.47	0.39	87.73	3986	38
NOVEMBER	3.82	1.68	1.81	0.39	89.87	2389	49
DECEMBER	4.30	2.50	2.73	0.95	77.85	1306	32
APR 15 - OCT 15 MIN	2.42	1.02	1.04	0.12	69.81	1477	22
APR 15 - OCT 15 MAX	5.25	3.41	4.99	1.01	96.77	5039	72
APR 15 - OCT 15 AVG	4.27	1.80	2.02	0.37	91.16	2648	59
APR 15 - OCT 15 MEDIA	4.30	1.75	1.90	0.34	92.04	2546	60
APR 15 - OCT 15 ST DE	0.46	0.32	0.51	0.15	4.02	408	9
APR 15 - OCT 15 CV*	0.11	0.18	0.25	0.40	0.04	0.15	0.15
OFF SEASON MIN	1.71	0.72	0.70	0.14	13.58	0	0
OFF SEASON MAX	5.65	4.75	4.37	2.42	94.70	6532	78
OFF SEASON AVG	3.80	2.12	2.22	0.76	79.33	2119	39
OFF SEASON MEDIAN	3.86	2.10	2.23	0.48	86.27	2170	40

(AVERAGE LOADING lbs/day)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	POUNDS SECONDARY REMOVAL	ALUM POUNDS	POUNDS ALUM/P RATIO*
JANUARY	1,038	441	494	120	919	19,066	41
FEBRUARY	1,024	610	601	167	857	8,163	16
MARCH	1,000	786	803	491	508	3,548	5
APRIL (1-14)	992	556	567	108	884	13,624	24
APRIL (15-30)	1,046	449	537	94	952	15,052	29
MAY	992	460	490	110	882	14,399	30
JUNE	983	426	430	65	918	14,548	34
JULY	960	386	517	82	878	13,529	29
AUGUST	985	380	406	66	920	13,511	34
SEPTEMBER	978	414	450	79	899	12,884	30
OCTOBER (1-15)	969	409	475	138	832	18,206	19
OCTOBER (16-31)	986	432	438	122	865	21,444	30
NOVEMBER	977	426	457	99	879	12,855	31
DECEMBER	1,005	586	634	219	786	7,040	12
APR 15 - OCT 15 MIN	674	273	246	29	471	7,946	9
APR 15 - OCT 15 MAX	1,293	784	1,124	252	1,210	27,110	45
APR 15 - OCT 15 AVG	985	416	467	86	898	14,247	30
APR 15 - OCT 15 MEDIA	985	403	433	78	901	13,695	32
APR 15 - OCT 15 ST DE	92	75	121	38	97	2,193	7
APR 15 - OCT 15 CV*	0.09	0.18	0.26	0.44	0.11	0.15	0.24
OFF SEASON MIN	654	283	300	44	108	0	0
OFF SEASON MAX	1,776	1,264	1,025	779	1,574	35,142	89
OFF SEASON AVG	1,006	557	583	204	802	11,401	22
OFF SEASON MEDIAN	1,002	529	570	130	828	11,672	19

*CV = coefficient of variation = (average)/(standard deviation)

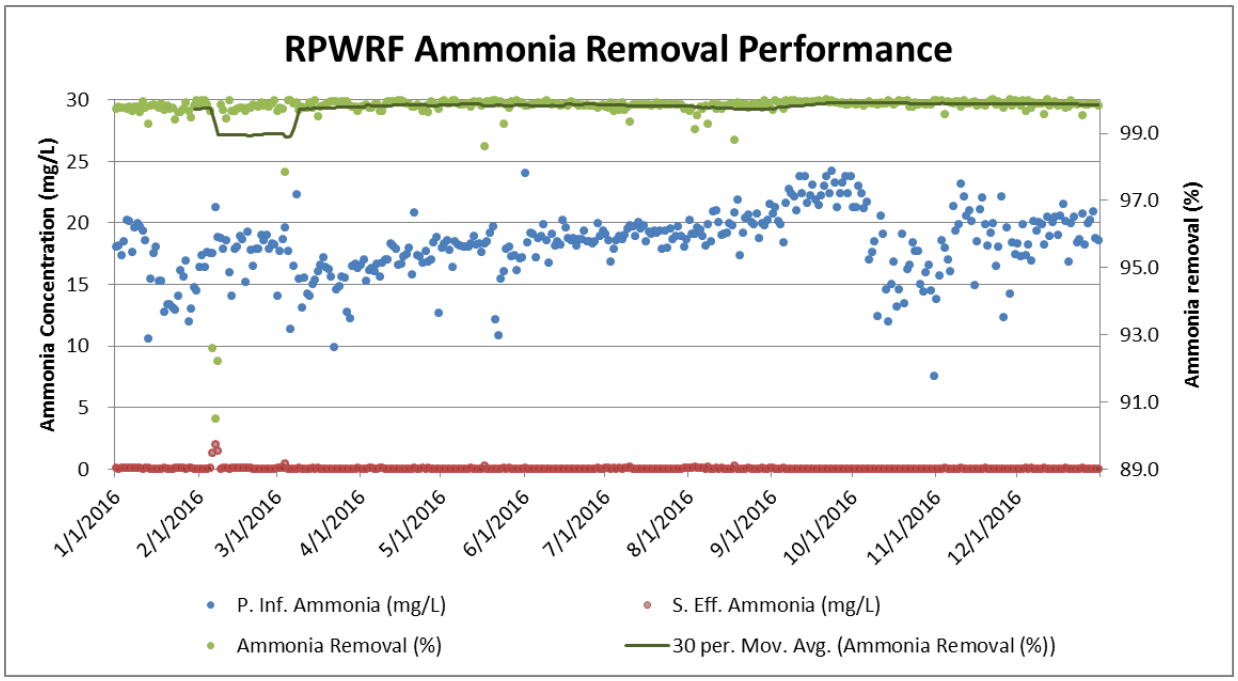
CITY OF SPOKANE RPWRF
AMMONIA NITROGEN LOADING 2016

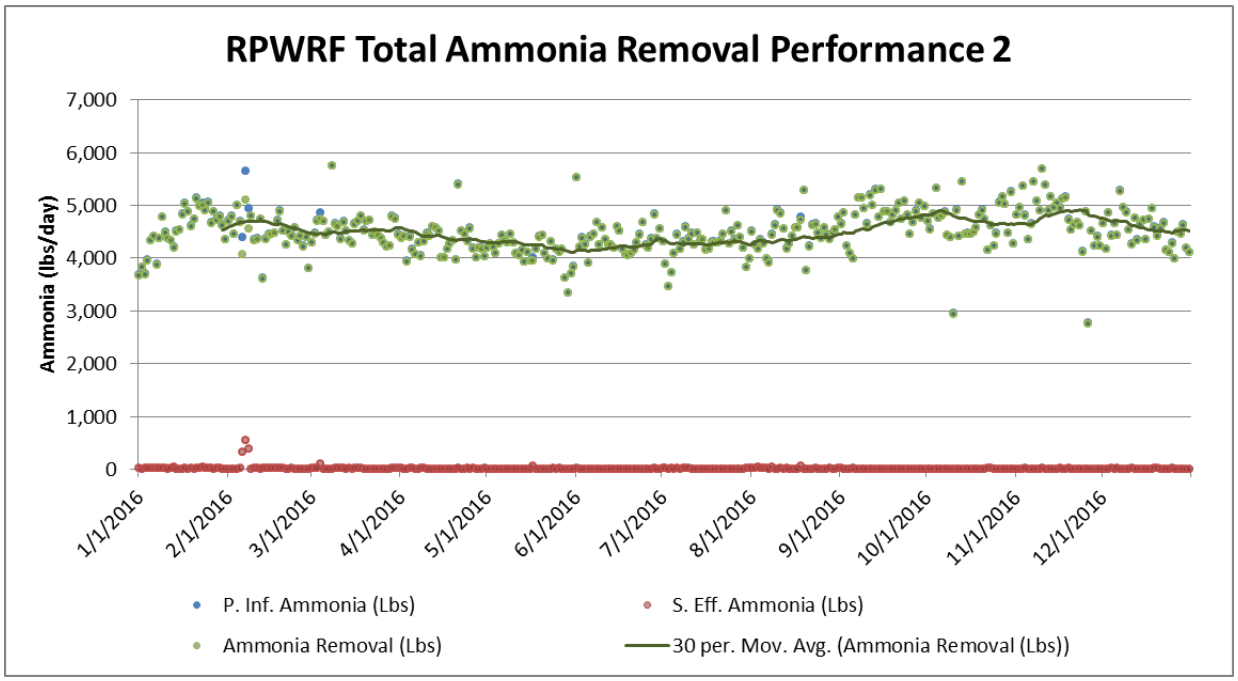
(AVERAGE LOADING mg/L)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	PERCENT SECONDARY REMOVAL
JANUARY	16.18	15.66	18.65	0.04	99.74
FEBRUARY	17.82	15.94	20.14	0.22	98.77
MARCH	15.59	14.52	18.17	0.04	99.72
APRIL	16.99	15.97	20.74	0.03	99.83
MAY	17.43	16.67	21.03	0.03	99.82
JUNE	18.89	17.83	21.98	0.03	99.85
JULY	18.93	17.11	23.14	0.04	99.81
AUGUST	19.77	17.21	23.39	0.05	99.73
SEPTEMBER	22.20	20.29	26.54	0.02	99.90
OCTOBER	16.95	15.65	21.08	0.02	99.87
NOVEMBER	18.62	16.23	21.93	0.02	99.88
DECEMBER	19.30	17.39	23.59	0.03	99.84
DAILY MINIMUM	7.55	6.18	9.03	0.00	90.49
DAILY MAXIMUM	24.16	21.79	30.67	2.02	99.99
DAILY AVG	18.21	16.70	21.69	0.04	99.76
MONTH AVG	18.22	16.71	21.70	0.05	99.73
JUL-OCT AVG	19.44	17.54	23.51	0.03	99.83
NOV-JUN AVG	17.59	16.27	20.77	0.05	99.72
JUL-OCT MEDIAN	19.51	17.48	23.80	0.03	99.86
NOV-JUN MEDIAN	18.01	16.56	21.02	0.03	99.85

(AVERAGE LOADING lbs/day)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	POUNDS SECONDARY REMOVAL
JANUARY	4,527	4,049	5,115	51	4,475
FEBRUARY	4,571	4,261	5,334	11	4,560
MARCH	4,309	4,052	5,267	7	4,302
APRIL	4,112	3,935	4,973	6	4,106
MAY	4,380	4,133	5,098	6	4,373
JUNE	4,270	3,858	5,218	8	4,261
JULY	4,462	3,885	5,281	12	4,450
AUGUST	4,823	4,405	5,764	4	4,819
SEPTEMBER	4,646	4,275	5,774	5	4,641
OCTOBER	4,771	4,152	5,606	5	4,765
NOVEMBER	4,539	4,097	5,554	7	4,533
DECEMBER	4,495	4,123	5,355	11	4,483
DAILY MINIMUM	2,769	2,404	2,522	0.4	2,762
DAILY MAXIMUM	5,755	5,313	7,517	536.5	5,749
DAILY AVG	4,494	4,122	5,354	11.2	4,482
MONTH AVG	4,492	4,102	5,362	11.3	4,481
JUL-OCT AVG	4,548	4,103	5,507	7.4	4,541
NOV-JUN AVG	4,466	4,131	5,277	13.1	4,453
JUL-OCT MEDIAN	4,507	4,112	5,527	6.3	4,496
NOV-JUN MEDIAN	4,427	4,142	5,280	6.6	4,424


RPWRF Ammonia Removal Performance
Ammonia Concentration (mg/L)
Ammonia removal (%)
30
25
20
15
10
5
0
99.0
97.0
95.0
93.0
91.0
89.0
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016
P. Inf. Ammonia (mg/L)
S. Eff. Ammonia (mg/L)
Ammonia Removal (%)
30 per. Mov. Avg. (Ammonia Removal (%))


RPWRF Total Ammonia Removal Performance 2
Ammonia (lbs/day)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016
P. Inf. Ammonia (Lbs)
S. Eff. Ammonia (Lbs)
Ammonia Removal (Lbs)
30 per. Mov. Avg. (Ammonia Removal (Lbs))

CITY OF SPOKANE RPWRF
NITRATE NITROGEN LOADING 2016

(AVERAGE LOADING mg/L)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	PERCENT SECONDARY INCREASE
JANUARY	1.43			24.81	1,631
FEBRUARY	1.40			24.78	1,674
MARCH	1.25			22.96	1,740
APRIL	1.42			25.62	1,698
MAY	1.20			25.81	2,044
JUNE	1.62			25.16	1,454
JULY	1.03			26.22	2,451
AUGUST	0.55			25.84	4,568
SEPTEMBER	0.75			25.23	3,285
OCTOBER	1.14			23.21	1,928
NOVEMBER	0.37			25.29	6,728
DECEMBER	0.71			26.65	3,645
DAILY MINIMUM	0.021			18.67	943
DAILY MAXIMUM	2.24			32.76	131,622
DAILY AVG	1.07			25.13	2,256
MONTH AVG	1.07			25.13	2,242

(AVERAGE LOADING lbs/day)

	PRIMARY INFLUENT	PRIMARY EFFLUENT	SECONDARY INFLUENT	SECONDARY EFFLUENT	POUNDS SECONDARY INCREASE
JANUARY	360			6,779	5,885
FEBRUARY	424			6,246	7,173
MARCH	277			7,597	6,281
APRIL	225			6,557	6,091
MAY	369			6,316	5,348
JUNE	222			5,717	5,538
JULY	99			5,760	5,599
AUGUST	157			5,722	5,215
SEPTEMBER	302			5,372	5,822
OCTOBER	98			6,124	6,268
NOVEMBER	166			6,366	6,049
DECEMBER	254			6,215	5,962
DAILY MINIMUM	4.4			4,845	4,473
DAILY MAXIMUM	712			8,385	8,193
DAILY AVG	254			6,221	5,962
MONTH AVG	246			6,231	5,936