Assessment of Arsenic Monitoring Results for the Water Treatment Plant General Permit: September 2016 through August 2017

Water Quality Program
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1.0 Background and Purpose

The Washington State Department of Ecology (Ecology) has managed the National Pollutant Discharge Elimination System (NPDES) Water Treatment Plant General Permit (WTPGP) since 1997, and has issued four versions at approximately 5-year intervals to date. Water Treatment Plants (WTPs) that employ water treatment filtration processes generate wastewater from filter backwashing, sedimentation/pre-sedimentation basin washdown, sedimentation/clarification, and/or filter-to-waste. Treatment of that wastewater has included settling it over time to reduce the concentration of suspended particulates. Final discharge of the treated wastewater occurs intermittently depending on the frequency of filter backwashing and the volume of wastewater produced. The WTPGP authorizes certain WTPs to discharge treated filter backwash wastewater.

During preparation of the current WTPGP, Ecology considered an internal study ("Investigation of Discharges from Water Treatment Plant Filter Backwash"), which included chemical analyses of filter backwash wastewater generated by 15 small WTPs, none of which were covered by the general permit, at various locations in Washington State. The results of the total arsenic analyses for 11 of the 15 WTPs were "non-detect." However, the reporting limit for those arsenic analyses was 60 micrograms per liter (μg/L), which is much greater than the water quality criterion for protection of human health (inorganic arsenic: 0.018 μg/L), the primary drinking water standard maximum contaminant level (total arsenic: 10 μg/L), and the Washington State groundwater quality standard (total arsenic: 0.05 ug/L). The total arsenic results for three of the remaining WTP discharges ranged from 140 to 190 μg/L. Two of the WTPs with greater concentrations employed aeration or another method to oxidize arsenic, iron, and manganese, and filtration to remove those contaminants from the treated water. The treatment method used by the third WTP was unknown. The total arsenic concentration in the remaining WTP filter backwash was 6.9 ug/L. Although the data from this study was limited, it suggested a potential that filter backwash wastewaters from some types of WTPs may have a reasonable potential to exceed human health criteria for both surface water and groundwater. While the data was not sufficient to support the imposition of discharge limits in the current permit, it provided a starting point for this study and better informed calculations.

For the current permit term beginning in 2014, Ecology required that existing and current Permittees collect and analyze for total and dissolved arsenic a representative set of treated filter backwash discharges during the third year of the permit cycle (from September 2016 through August 2017). Ecology believed that one year of monthly sampling and analysis by the 32 WTP Permittees would provide sufficient data to determine whether:

- Additional monitoring is required of the Permittees.
- Certain water treatment processes are more or less likely to produce wastewater excessively contaminated with arsenic.
- Monitoring and discharge limits for arsenic or other parameters are required for reissuance of the general permit in 2019.

The purpose of this study was to address these topics.

2.0 Methods

The current WTPGP required Permittees to collect representative samples of effluent from September 2016 through August 2017 and report monthly analytical results for the following four parameters:

Total Arsenic	Total Daily Volume of Discharge
Dissolved Arsenic	Total Daily Number of Discharge Events

The names of the 30 WTP Permittees who were to provide data are listed in Table 1, and their approximate locations are shown in Figure 1. (The other two WTPs were no longer covered by the WTPGP, and thus provided no data.)

2.1 Data Gathering and Cleanup

On September 27, 2017, Ecology extracted from its Permitting and Reporting Information System (PARIS) database the reported monitoring results for the four parameters plus pH, total residual chlorine, settleable solids, and turbidity for the 1-year study period (September 2016 through August 2017). While the WTPGP required the 30 WTP Permittees to have submitted the data no later than September 15, 2017, several of them needed reminders from Ecology, and some of those were able to submit some of their missing data prior to September 27. Although required by the general permit, the following data was **not** reported:

- 16 Permittees did not report at least one of the 12 required monthly total arsenic results, and 5 of the Permittees reported only between 1 to 5 total arsenic results for the entire year-long study period.

- 18 Permittees did not report at least 1 of the 12 required monthly dissolved arsenic results, and 5 of the Permittees reported only between 1 to 5 dissolved arsenic results for the entire year-long study period. One Permittee failed to report any results for dissolved arsenic.

- 11 Permittees did not report effluent discharge volume data for at least 1 of the 12 months required, and 4 Permittees reported volume data for fewer than 5 months. One Permittee failed to report any volume data.

- 8 Permittees did not report at least some of their arsenic results to the required sensitivity (quantitation level of 0.5 μg/L).

Only 11 of the 30 Permittees fully complied with the required monitoring and reporting of total and dissolved arsenic concentrations and discharge flow events.

Ecology then “cleaned up” the data extracted from the PARIS database. Data cleanup included the following actions:

1. Deleted null and replicated records.

2. Deleted records containing “calculated” results, e.g., monthly averages.

3. Except for when calculating summary statistics, replaced anomalously low (<0.01 ug/L) arsenic non-detect (ND) results (sometimes referred to as “censored data”) with reasonable values up to 0.1 ug/L (more details in Section 3.1).

Ecology acquired two in-house sets of historical ambient arsenic concentrations. Ecology’s publication “Natural Background Groundwater Arsenic Concentrations in Washington State” (Ecology, 2015) described the geographic extent and amounts of arsenic typically present in the sources of raw groundwater used by certain WTPs. The Ecology Environmental Information Management (EIM) database provided historical ambient concentrations of arsenic present in surface waters located around the State near the 30 subject WTPs to represent both their sources of raw water and the waterbodies that received the WTPs’ wastewater discharges.

Ecology also acquired data from two other government agencies. The Washington State Department of Health (DoH) provided data files that Ecology used to confirm information provided by the Permittees directly to Ecology. The U.S. Geological Survey provided average and low flow rates of the waterbodies that received discharges from 14 of the Permittees.

2.2 Statistical Evaluations of the Data and Other Calculations

Ecology determined the basic summary statistics listed below for total and dissolved arsenic using monthly data for each WTP individually and all WTPs combined. Ecology applied the nonparametric Kaplan-Meier method, which used a flipped survival function that accounted for censored data (as described by Helsel, 2005, pp. 63-68, and Helsel, 2012). The basic summary statistics were:

- Mean
- Standard deviation
- Coefficient of variation
- 50th Percentile (Median)
- 95th Percentile

Where possible, Ecology estimated prorated discharge volumes for those WTPs who failed to provide volume data for each month.

Ecology manipulated the data and performed all statistical calculations with Excel using the equations provided by the references cited in this section. “Significant” was defined with α = 0.05.

Ecology prepared two sets of plots along the 12 months of the study period; one for the combined results of the 26 permitted WTPs located in Western Washington, and another for the four permitted WTPs in Eastern Washington. The plots illustrated total and dissolved arsenic concentrations, discharge volumes, and the monthly ratios of dissolved arsenic to total arsenic. The purpose of these plots was to assess whether the data showed obvious trends over time.

Ecology determined whether significant correlations existed between the monthly arsenic concentrations and monthly averages of the following five potential surrogate parameters. Ecology conducted these evaluations using a Mann-Kendall test for trends, which accounted for multiple observations per time period, censored data, and ties (Gilbert, 1987; Hollander and Wolfe, 1973).

- Total volume discharged per day
- Volume discharged per discharge event
- Settleable solids
- Total residual chlorine
- Turbidity

Ecology summarized the average arsenic concentrations for each WTP along with each WTP's source of raw water, the nearby ambient arsenic concentrations, and the main water treatment methods employed by each WTP. Ecology identified each WTP's source of raw water and treatment methods from permit application and renewal information provided by the WTPs, along with available updates to that information. A search of the Ecology EIM database provided ambient concentrations of arsenic in nearby surface waters located within approximately 13 miles of or directly upstream from each of the WTPs.

Finally, Ecology assessed the likelihood that WTP wastewater discharges would cause exceedances of arsenic water quality criteria. A discussion of that assessment is presented in Section 4.0 below.

2.3 Assumptions and Limitations

The two main assumptions upon which this assessment is based and their potential consequences are identified below.

1. *The data reported by the WTP Permittees were derived honestly and objectively.*

   Although the WTP Permittees were unlikely to intentionally falsify their monitoring results, they may have injected an unconscious systematic bias into the results through decisions such as whether to collect samples earlier or later during discharge events, during periods of greater or lesser flow, or from the center, edge, top, or bottom of the discharge stream. The consequences of this assumption may be inaccurately reported pollutant concentrations or apparent, but non-existent, trends in the concentrations over time or correlations between parameters.

2. *The grab samples were representative of the wastewater discharges throughout an entire monitoring period (for arsenic usually a month).*

   A grab sample of treated filter backwash discharge may not provide results representative of the actual average wastewater discharge quality within a given monitoring period. The consequences of this assumption may include inaccurate characterizations of wastewater discharges or a false belief that a trend occurred when it had not or that correlations existed when there were none.

3.0 Results

Figure 1 is a map of the approximate locations of the 30 WTPs covered by the current WTPGP, which were the subjects of this assessment. The monitoring data reported by the WTPs is available from the Ecology Permitting and Reporting Information System (PARIS) database at https://fortress.wa.gov/ecy/paris/PermitLookup.aspx.

3.1 Summary Statistics

The reported concentrations of total and dissolved arsenic varied considerably among the WTPs. Many of the WTPs reported that their treated backflush wastewater contained no detectable total or dissolved arsenic (15 WTPs for total arsenic, and 16 for dissolved arsenic). One of the WTPs failed to report any dissolved arsenic results. Table 1 presents summary statistics for each WTP and all 30 WTPs combined.

Unfortunately, meeting the required sensitivity of 0.5 µg/L was also problematic for many of the WTPs. Eight of the WTPs reported analytical reporting limits for arsenic that ranged from 1.0 to 5.0 µg/L. Twelve of the WTPs reported analytical reporting limits for arsenic much less than reasonably expected, ranging from 0.00003 to 0.01 µg/L. Since the normal laboratory detection limit for arsenic is 0.1 µg/L, the extremely low reported results were likely errors due to a unit conversion failure. Therefore, for purposes other than determining summary statistics, Ecology adjusted those unrealistically low results to reasonable values up to 0.1 ug/L. The method that Ecology used to calculate summary statistics, itself, accounted for censored data without adjustment.

Both the mean and median total arsenic values for the individual WTPs ranged from non-detect to 3.48 µg/L. For dissolved arsenic, the means and medians for the individual WTPs ranged from non-detect to 1.16 µg/L, and from non-detect to 0.75 µg/L, respectively. When the results from all 30 WTPs were combined, the mean and median values for total arsenic were 0.26 µg/L and non-detect, respectively. For dissolved arsenic, the mean and median values were 0.11 µg/L and non-detect, respectively.

3.2 Temporal Plots

Inspection of the time plots (Figures 2 and 3) found no obvious temporal patterns in the discharged volumes of or arsenic concentrations in the WTP's treated wastewater. The large variability of the Eastern Washington plots was likely due to the small number of WTPs in Eastern Washington and incomplete reporting by the Permittees. Incomplete reporting by the Permittees statewide caused approximately 16% of the expected monthly volume values and approximately 20% of the expected monthly total arsenic values to be missing. Dissolved arsenic results showed a similar pattern.

For Western Washington, the monthly average volume of reported treated wastewater discharges ranged from about 34 to 48 thousand gallons per month. The average month-to-month concentrations of total arsenic ranged from 0.15 to 0.41 μg/L. Dissolved arsenic concentrations averaged across all 30 WTPs were generally 30 to 75 % of the total concentrations. However for individual WTPs, dissolved-to-total ratios ranged from approximately <0.05 to 7.0. Since the amount of dissolved arsenic in a sample can be no greater than the amount of total arsenic (i.e., a maximum ratio of 1.0), these results suggest errors in sampling, analysis, and/or reporting. The temporal plots of monthly arsenic concentrations in Western Washington showed no apparent pattern through the seasons.

3.3 Correlating Arsenic with Other Parameters

Correlation tests between total and dissolved arsenic and each of the five potential surrogate parameters showed little to no correspondence. Given a total of 273 statistical tests, only 17 tests showed significant matches between arsenic and the other parameters. These matches accounted for about 6.2% of the tests, which is approximately the same as the expected rate of random correlations given the criterion for significance of $p = 0.05$. Table 2 summarizes the results of these correlation tests.

Table 3 shows a comparison of total and dissolved average arsenic concentrations of WTP wastewaters with the source of the raw water (surface or underground), nearby ambient concentrations of arsenic, and three of the main methods the Permittees had reported they use to treat their raw water in addition to settling (pH adjustment, chlorination, and addition of organic polymer). No obvious correspondence was apparent among these parameters. Note that the nearby ambient total arsenic concentrations may or may not have been measured in the actual source or receiving waterbodies of the WTPs.

4.0 Discussion of Arsenic's Potential to Pollute

4.1 Protection of Aquatic Life

The existing EPA-approved water quality criteria for arsenic (WAC 173-201A-240) are:

Aquatic Life Water Quality Criteria	Dissolved Arsenic (ug/L)	
	Acute	Chronic
Freshwater	360.0	190.0
Marine Water	69.0	36.0

Since the greatest reported concentration of total arsenic was only 7.22 ug/L, no reasonable potential appeared to exist for the dissolved arsenic in treated filter backwash wastewater to exceed any of the aquatic life criteria.

4.2 Protection of Human Health

The existing EPA-approved water quality criteria for arsenic (WAC 173-201A-240) are:

Human Health Water Quality Criteria	Inorganic Arsenic (ug/L)
Water & Organisms (Freshwater)	0.018
Organisms Only (Marine water)	0.14

The U.S. EPA-approved method (1991) for determining whether a reasonable potential exists for a discharge to exceed surface water quality criteria for human health includes the assumption that the discharge occurs continuously during "critical conditions," when the receiving water flow is low. Since WTPs discharge treated filter backwash wastewater only intermittently, that method is not applicable. Additional data regarding the duration of discharge events could enable calculation of reasonable potential for individual permittees.

However, Ecology did assess the likelihood that the actual intermittent WTP wastewater discharges would cause exceedances of those criteria using the following method. Table 4 summarizes the readily available data for average and minimum-flow conditions of the reported receiving surface waterbodies. Where data was sufficient, Ecology compared those daily minimum flows with the daily wastewater discharge volumes reported by each of the 30 permitted WTPs. Only 14 of the WTPs had data sufficient to calculate both meaningful receiving waterbody flows and discharge volumes. Of those 14 WTPs, the ratio of the smallest receiving waterbody flow to the average wastewater discharge ranged from 18 to almost 350,000. The WTP with the lowest ratio (18) reported no detectable total arsenic at a reporting limit of 0.5 ug/L. The WTP with the second-lowest ratio (161) reported 12 months of data yielding a 95th percentile concentration of 0.60 ug of total arsenic/L. The concentration of total arsenic divided by the ratio (161) gives 0.004 ug of total arsenic/L, still well below the human health criterion of 0.018 ug of inorganic arsenic/L.

As a crosscheck, Ecology reviewed the dilution factors cited in the current WTPGP Fact Sheet. These dilution factors, shown below, are based on the assumption of continuous discharge. The ratios identified in Table 4 appear reasonable, thus indicating little-to-no reasonable potential to pollute.

Receptor	Mixing Zone Dilution Factor	
	Acute	Chronic
Aquatic Life	3.5	26
Human Health, Carcinogen	not applicable	26

5.0 Conclusions and Recommendations

1. **WTP backflush wastewater effluent contained quite variable concentrations of arsenic.** Half of the WTPs had no detectable arsenic, while the average total arsenic concentrations from the others ranged from 0.11 to 3.48 μg/L, with a maximum single sample value of 7.22 ug/L (Table 1). Coefficients of variation ranged from 0.10 to 1.39 for individual WTPs, but 2.50 for all 30 WTPs considered together. Where calculable, the ratios of dissolved arsenic to total arsenic ranged from approximately 0.2 to 2.0 (Figures 2 and 3). The locations of WTPs that discharged relatively higher arsenic concentrations did not appear grouped into specific areas of the state (Figure 1) or to correspond with nearby ambient surface water concentrations (Table 3).

   Recommendation: Since naturally-occurring arsenic is likely present in the source water of several WTPs, any future discharge limits for arsenic discharged from WTPs should account for the ambient arsenic load.

2. **The reported arsenic data did not correspond with specific water treatment processes, the sources of raw water, or other monitored parameters.** Additional data may validate or refute this conclusion.

   Recommendation: Prior to developing the Notice of Intent application form for the next version of the WTPGP, Ecology should consider modifying the form to require each WTP to identify (a) Its source(s) of raw water and any seasonal variations of the percent mix for cases with multiple sources; and (b) Details of its treatment processes and any seasonal variations that may contribute to the chemical or physical characteristics of its treated backflush wastewater.

3. **The dissolved arsenic data indicated that WTP backflush wastewater effluent did not present a reasonable potential to exceed water quality criteria for protecting aquatic life. Based upon the low concentration of arsenic and the intermittent nature of effluent discharges, a reasonable potential to exceed the human health criterion is also unlikely.**

Recommendation: Based on the absence of a reasonable threat from arsenic in permitted WTP discharges to aquatic life or human health, Ecology should not create a discharge limit or require monitoring for arsenic at this time where AKART and adaptive management processes are implemented.

In any case, the Clean Water Act requires the use of analytical methods (40 CFR 136) that are not capable of detecting small exceedances of the EPA-required human health water quality criterion for arsenic. If necessary, prior to issuing the next version of the WTPGP Ecology should apply the reasoning in Ecology's draft policy background statement included in Appendix B to the extent it may apply to general permits. Considerations should also include the typical technical capabilities of State-accredited laboratories and the actual concentrations of arsenic in source and receiving waters.

6.0 References

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Tables

Table 1. Summary of Available Data for Finished Water Production and Wastewater Discharges by All 30 Permitted Water Treatment Plants.

Water Treatment Plant	Permit Number	Source Waterbody	Receiving Waterbody	Finished Water Production		Wastewater Discharge	Total Arsenic (ug/L)				Dissolved Arsenic (ug/L)			
				Max Capacity (Kgal/mo)	Actual Average (Kgal/mo)	Actual Average (N) (Kgal/mo)	Actual Average (N, SD)	Coefficient of Variation	95th Percentile	50th Percentile	Actual Average (N, SD)	Coefficient of Variation	95th Percentile	50th Percentile
Total of All 30 WTPs	na	na	na	na	na	na	0.26 (294, 0.65)	2.50	1.50	<0.01	0.11 (278, 0.25)	2.27	0.69	<0.01
Aberdeen	WAG641026	Wishka R.	trib. To Wishka R.	180,000	96,000	9,824 (12)	<0.5 (11, nc)	nc	nc	<0.5	<0.5 (11, nc)	nc	nc	<0.5
Anacortes	WAG643002	Skagit R.	Skagit R.	1,260,000	630,000	509 (2)	<0.5 (2, nc)	nc	nc	<0.5	<0.5 (2, nc)	nc	nc	<0.5
Arlington	WAG647003	Haller Bridge Wellfield	Stillaguamish R.	73,800	29,400	2,313 (12)	0.71 (12, 0.62)	0.87	2.00	0.50	0.08 (12, 0.03)	0.38	0.10	<0.07
Castle Rock	WAG641025	Cowlitz R.	Cowlitz R.	60,000	11,610	233 (11)	0.25 (10, 0.23)	0.92	0.69	0.23	0.24 (10, 0.20)	0.83	0.69	0.14
Cathlamet	WAG641009	Elochoman R.	Elochoman R.	680	212	12.8 (12)	<0.5 (11, nc)	nc	nc	<0.5	<0.5 (11, nc)	nc	nc	<0.5
Chehalis	WAG641012	Coal Creek	Coal Creek	135,000	51,000	1,236 (12)	<0.1 (12, nc)	nc	nc	<0.1	<0.1 (12, nc)	nc	nc	<0.1
Chinook Water Distr.	WAG641027	Freshwater Creek	Freshwater Creek	15,000	3,000	150 (12)	<0.5 (12, nc)	nc	nc	<0.5	<0.5 (12, nc)	nc	nc	<0.5
Clallam Cnty PUD #1	WAG641010	Morse Creek	Morse Creek	30,000	10,500	NR	0.40 (5, 0.20)	0.50	0.70	0.30	0.40 (3, 0.10)	0.25	0.50	0.40
Cusick	WAG647000	Pend Oreille R.	Pend Oreille R.	15,000	3,000	558 (4)	1.08 (4, 0.11)	0.10	1.16	1.16	1.16 (4, 0.32)	0.28	1.63	<1.0
Everett	WAG643009	Spada Resvr (Sultan R.)	Lake Chaplain	4,230,000	1,500,000	12,562 (12)	0.36 (12, 0.13)	0.36	0.60	0.30	0.32 (12, 0.17)	0.53	0.60	0.30
Friday Harbor	WAG643005	Trout Lake	trib. to Margos Lake	30,000	13,500	1,524 (10)	<0.1 (10, nc)	nc	nc	<0.1	<0.1 (10, nc)	nc	nc	<0.1
Hoquiam, Outfall 1	WAG641000	W.F. Hoquiam R.	W.F. Hoquiam R.	103,800	34,560	744 (9)	<5 (7, nc)	nc	nc	<5	<5 (7, nc)	nc	nc	<5
Hoquiam, Outfall 2	WAG641000	W.F. Hoquiam R.	W.F. Hoquiam R.	---	---	452 (7)	<0.5 (5, nc)	nc	nc	<0.5	<0.5 (5, nc)	nc	nc	<0.5
Ilwaco	WAG641001	Indian Creek	Bear Creek	41,070	12,000	2,099 (12)	0.23 (12, 0.15)	0.65	0.57	0.17	0.10 (9, 0.01)	0.10	0.12	<0.1
Kalama	WAG641023	Ranney Wells/Kalama R.	Kalama R.	77,760	24,000	5.3 (12)	3.48 (1, nc)	nc	nc	3.48	0.65 (1, nc)	nc	nc	0.65
Leavenworth	WAG645001	Icicle Creek	Icicle Creek	60,000	22,500	673 (12)	2.10 (10, 1.82)	0.87	7.22	<1.4	<1.4 (10, nc)	nc	nc	<1.4
LISECC, Inc.	WAG643004	Dickinson Lake	No Name Creek	2,760	750	50.2 (12)	<0.01 (12, nc)	nc	nc	<0.01	<0.01 (12, nc)	nc	nc	<0.01
Long Beach	WAG641019	surface water	Mountain Spring Resvr	45,000	13,500	838 (12)	0.13 (12, 0.07)	0.54	0.33	<0.1	0.12 (12, 0.03)	0.25	0.20	<0.1
Lynden	WAG643003	Nooksack R.	Nooksack R.	120,000	54,000	659 (12)	0.46 (12, 0.64)	1.39	2.00	<0.14	0.12 (12, 0.23)	1.92	0.70	0.05
McNeil Island Stp.	WAG643008	Butterworth Resvr	Eden Creek	30,000	6,000	217 (10)	0.63 (10, 0.41)	0.65	1.80	<0.5	0.54 (10, 0.14)	0.26	0.90	<0.5
Morton	WAG641016	Connelly Creek	Tilton R.	30,000	10,500	643 (12)	<0.5 (12, nc)	nc	nc	<0.5	<0.5 (12, nc)	nc	nc	<0.5
Pasco	WAG647001	Columbia R.	Columbia R.	720,000	360,000	10,326 (11)	0.42 (12, 0.37)	0.88	1.00	0.20	0.24 (12, 0.19)	0.79	0.70	0.30
Raymond	WAG641007	S.F. Willapa R.	S.F. Willapa R.	60,000	15,000	970 (12)	<0.1 (12, nc)	nc	nc	<0.1	<0.1 (12, nc)	nc	nc	<0.1
Richland	WAG645000	Columbia R.	Columbia R.	1,080,000	335,293	2,913 (6)	<0.5 (6, nc)	nc	nc	<0.5	<0.5 (6, nc)	nc	nc	<0.5
Ryderwood	WAG641011	Campbell Creek	Campbell Creek	4,320	2,850	49.7 (11)	<1 (11, nc)	nc	nc	<1	<1 (11, nc)	nc	nc	<1.0
South Bend	WAG641008	Martin & Electric Creeks	Martin Creek	25,920	10,800	1,767 (12)	<0.1 (12, nc)	nc	nc	<0.1	NR	NR	NR	NR
Stevenson	WAG641020	LaBong Creek	Rock Creek	30,000	7,500	408 (12)	1.54 (12, 0.60)	0.39	2.60	1.50	0.72 (12, 0.14)	0.19	0.94	0.75
Vader	WAG641004	Cowlitz R.	Olequa Creek	2,748	2,406	121 (11)	<0.1 (11, nc)	nc	nc	<0.1	<0.1 (11, nc)	nc	nc	<0.1
Whatcom Cnty PUD #1	WAG643006	Nooksack R.	Nooksack R.	NR	NR	104 (3)	<0.1 (2, nc)	nc	nc	<0.1	<0.1 (3, nc)	nc	nc	<0.1
Willapa Valley Water	WAG641013	Stringer Creek	Stringer Creek	15,000	6,000	239 (12)	0.11 (12, 0.03)	0.27	0.20	<0.1	0.10 (12, 0.02)	0.20	0.15	<0.1
Woodland	WAG641021	Lewis R.	Lewis R.	90,000	21,930	2,987 (12)	1.07 (11, 0.52)	0.48	2.20	0.95	0.29 (11, 0.31)	1.07	1.10	0.14

Kgal/mo = Thousands of gallons per month.
ug/L = Micrograms per liter.
N = Number of months for which the permittee provided data.
For "Total of All 30 WTPs," N = Total number of numeric results.
SD = Standard deviation.

na = Not applicable.
nc = Data were insufficient for the calculation.
NR = Not reported by the permittee.
--- = Values for total water production at the Hoqiam WTP are shown in only the record for Outfall 1.

Permittees provided the data summarized in this table except as noted below.

Source and Receiving Waterbody data were from permittees' Notices of Intent, with adjustments based on water supply system data from the State Department of Health.

Table 1. Summary of Available Data for Finished Water Production and Wastewater Discharges by All 30 Permitted Water Treatment Plants.

Water Treatment Plant	Permit Number	Source Waterbody	Receiving Waterbody	Finished Water Production		Wastewater Discharge	Total Arsenic (ug/L)				Dissolved Arsenic (ug/L)			
				Max Capacity (Kgal/mo)	Actual Average (Kgal/mo)	Actual Average (N) (Kgal/mo)	Actual Average (N, SD)	Coefficient of Variation	95th Percentile	50th Percentile	Actual Average (N, SD)	Coefficient of Variation	95th Percentile	50th Percentile

Max Production Capacity and Actual Average Production data were from permittees' Notices of Intent.

Actual Average Discharge and Arsenic data were calculated from data provided by the permittees for the year September 2016 through August 2017 using the Kaplan-Meier method.

Table 2. Correspondence between Arsenic Concentrations and Other Parameters.

Water Treatment Plant		Total Volume Discharged per Day	Volume Discharged per Event	Settleable Solids	Total Residual Chlorine	Turbidity
		Based on Monthly Averages				
Total of All 30 WTPs	Total Arsenic	No significant match	No significant match	No significant match	Significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Aberdeen	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Anacortes	Total Arsenic	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
	Dissolved Arsenic	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Arlington	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Castle Rock	Total Arsenic	No significant match	Significant match	Insufficient data	Insufficient data	Insufficient data
	Dissolved Arsenic	No significant match	No significant match	Insufficient data	Insufficient data	Insufficient data
Cathlamet	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Chehalis	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Chinook Water District	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Clallam County PUD #1	Total Arsenic	Insufficient data	Insufficient data	No significant match	No significant match	No significant match
	Dissolved Arsenic	Insufficient data	Insufficient data	No significant match	Insufficient data	Insufficient data
Cusick	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Everett	Total Arsenic	No significant match	No significant match	Significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	Significant match	Significant match	No significant match
Friday Harbor	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Hoquiam, Outfall 1	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match

Table 2. Correspondence between Arsenic Concentrations and Other Parameters.

Water Treatment Plant		Total Volume Discharged per Day	Volume Discharged per Event	Settleable Solids	Total Residual Chlorine	Turbidity
		Based on Monthly Averages				
Hoquiam, Outfall 2	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Ilwaco	Total Arsenic	No significant match	No significant match	Significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	Significant match	No significant match	No significant match
Kalama	Total Arsenic	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
	Dissolved Arsenic	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Leavenworth	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
LISECC, Inc.	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Long Beach	Total Arsenic	No significant match	No significant match	Significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	Significant match	No significant match	No significant match
Lynden	Total Arsenic	No significant match	No significant match	Significant match	Significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	Significant match	No significant match	No significant match
McNeil Island Stewardship	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Morton	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Pasco	Total Arsenic	No significant match	No significant match	No significant match	Significant match	No significant match
	Dissolved Arsenic	Significant match	No significant match	No significant match	Significant match	No significant match
Raymond	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Richland	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Ryderwood	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match

Table 2. Correspondence between Arsenic Concentrations and Other Parameters.

Water Treatment Plant		Total Volume Discharged per Day	Volume Discharged per Event	Settleable Solids	Total Residual Chlorine	Turbidity
		Based on Monthly Averages				
South Bend	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Stevenson	Total Arsenic	No significant match	No significant match	No significant match	No significant match	Significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	Significant match	No significant match
Vader	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Whatcom County PUD #1 Plant 1	Total Arsenic	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
	Dissolved Arsenic	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Willapa Valley Water District	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
Woodland	Total Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match
	Dissolved Arsenic	No significant match	No significant match	No significant match	No significant match	No significant match

Note: Evaluations of significant correlations were conducted with a Mann-Kendall test for trends.

Table 3. Raw Water Sources, Nearby Arsenic Background, and Treatment Methods.

Water Treatment Plant	Arsenic in Wastewater (ug/L)			Source of Raw Water	Nearby Natural Background (a) Total Arsenic (ug/L)	Known Treatment Methods		
		Mean	Standard Deviation			Adjust pH	Chlorination	Organic Polymer
Aberdeen	Total	<0.5	nc	Surface	0.27	No data	No data	No data
	Dissolved	<0.5	nc					
Anacortes	Total	<0.5	nc	Surface	No data	Yes	Yes	No data
	Dissolved	<0.5	nc					
Arlington	Total	0.71	0.62	Ground (≥90%)	0.77 to 1.48	Yes	Yes	No data
	Dissolved	0.08	0.03					
Castle Rock	Total	0.25	0.23	Surface	0.15 to 0.52	No data	No data	No data
	Dissolved	0.24	0.20					
Cathlamet	Total	<0.5	nc	Surface Elochoman R	0.15	No data	Yes	Yes
	Dissolved	<0.5	nc					
Chehalis	Total	<0.1	nc	Surface	0.25 to 0.38	Yes	Yes	No data
	Dissolved	<0.1	nc					
Chinook Water District	Total	<0.5	nc	Surface Freshwater Creek	No data	No data	Yes	No data
	Dissolved	<0.5	nc					
Clallam County PUD #1	Total	0.40	0.20	Surface Morse Creek	0.31 to 1.69	No data	No data	No data
	Dissolved	0.40	0.10					
Cusick	Total	1.08	0.11	Surface Pend Oreille R	0.88	No data	No data	No data
	Dissolved	1.16	0.32					
Everett	Total	0.36	0.13	Surface Sultan R Basin	0.54 to 3.49	Yes	No data	Yes
	Dissolved	0.32	0.17					
Friday Harbor	Total	<0.1	nc	Surface Trout Lake	No data	Yes	Yes	No data
	Dissolved	<0.1	nc					
Hoquiam, Outfall 1	Total	<5	nc	Surface West fork, Hoquiam R	0.27	No data	Yes	Yes
	Dissolved	<5	nc					
Hoquiam, Outfall 2	Total	<0.5	nc	Surface West fork, Hoquiam R	0.27	No data	Yes	Yes
	Dissolved	<0.5	nc					
Indian Creek	Total	0.23	0.15	Surface Indian Creek	No data	Yes	Yes	Yes
	Dissolved	0.10	0.01					
Kalama	Total	3.48	nc	Ranney Wells Kalama R.	0.22 to 0.52	No data	Yes	No data
	Dissolved	0.65	nc					
Leavenworth	Total	2.10	1.82	Surface Icicle Creek	0.08	No data	Yes	No data
	Dissolved	<1.4	nc					
LISECC, Inc.	Total	<0.01	nc	Dickinson Lake	0.54 to 0.97	No data	Yes	No data
	Dissolved	<0.01	nc					

Table 3. Raw Water Sources, Nearby Arsenic Background, and Treatment Methods.

Water Treatment Plant	Arsenic in Wastewater (ug/L)			Source of Raw Water	Nearby Natural Background (a) Total Arsenic (ug/L)	Known Treatment Methods		
		Mean	Standard Deviation			Adjust pH	Chlorination	Organic Polymer
Long Beach	Total	0.13	0.07	Surface	No data	Yes	No data	No data
	Dissolved	0.12	0.03					
Lynden	Total	0.46	0.64	Surface Nooksack R	0.59 to 0.97	Yes	Yes	Yes
	Dissolved	0.12	0.23					
McNeil Island Stewardship	Total	0.63	0.41	Surface Butterworth Reservoir	0.48 to 3.64	Yes	Yes	Yes
	Dissolved	0.54	0.14					
Morton	Total	<0.5	nc	Surface Connelly Creek	No data	Yes	Yes	Yes
	Dissolved	<0.5	nc					
Pasco	Total	0.42	0.37	Surface Columbia R	1.81 to 2.17	No data	Yes	No data
	Dissolved	<0.13	nc					
Raymond	Total	<0.1	nc	Surface	0.27	Yes	Yes	Yes
	Dissolved	<0.1	nc					
Richland	Total	<0.5	nc	Surface Columbia R	1.41 to 5.42	No data	Yes	No data
	Dissolved	<0.5	nc					
Ryderwood	Total	<1	nc	Suface Campbell Creek	0.20 to 0.38	Yes	No data	Yes
	Dissolved	<1	nc					
South Bend	Total	<0.1	nc	Surface Martin and Electric Creeks	0.27	No data	No data	No data
	Dissolved	NR	NR					
Stevenson	Total	1.54	0.60	Surface LaBong Creek	1.36	No data	Yes	No data
	Dissolved	0.72	0.14					
Vader	Total	<0.1	nc	Surface Cowlitz R	0.30 to 0.38	Yes	Yes	Yes
	Dissolved	<0.1	nc					
Whatcom County PUD #1 Plant 1	Total	<0.1	nc	Surface Nooksack R	0.54 to 0.97	No data	No data	No data
	Dissolved	<0.1	nc					
Willapa Valley Water District	Total	0.11	0.03	Surface Stringer Creek	0.27	No data	Yes	Yes
	Dissolved	0.10	0.02					
Woodland	Total	1.07	0.52	Surface Lewis R	0.72	Yes	Yes	Yes
	Dissolved	0.29	0.31					

(a) = Based upon historical data from the Ecology Environmental Information Management database for surface water locations within approximately 13 miles of or directly upstream from the water treatment plant. **Locations may not include the waterbody that actually provides raw source water to or receives discharge from the water treatment plant.**

nc = Data were insufficient for the calculation.

NR = Not reported by the Permittee.

Table 4. Ratios between Receiving Water Flow Rates and Average Wastewater Discharge Rates

Water Treatment Plant	Permit Number	Receiving Waterbody			Wastewater Discharge		Ratio of Lowest Receiving Waterbody Flow to Average Wastewater Daily Discharge
		Receiving Waterbody	Annual Daily Mean Flow (cu ft / sec)	Lowest-Flow Month Daily Minimum Flow (million gal/day)	Avg Number of Events per Day	Avg Volume per Event (gal)	
Aberdeen	WAG641026	trib. To Wishkah R.	101 [d]	5.8	12.3	26,290	18
Anacortes	WAG643002	Skagit R.	18,128 [e]	3,935.8	0.7	133,214	42,910
Arlington	WAG647003	Stillaguamish R.	2,211 [e]	146.7	5.2	14,741	1,929
Castle Rock	WAG641025	Cowlitz R.	11,733 [e]	2,375.7	2.9	2,934	283,489
Cathlamet	WAG641009	Elochoman R.	488 [e]	17.3	0.6	699	41,276
Chehalis	WAG641012	Coal Creek	nra	nra	0.7	59,782	nc
Chinook Water Distr.	WAG641027	Freshwater Creek	nra	nra	15.3	321	nc
Clallam Cnty PUD #1	WAG641010	Morse Creek	nra	nra	NR	NR	NR
Cusick	WAG647000	Pend Oreille R.	nra	nra	3.9	13,940	nc
Everett	WAG643009	Lake Chaplain	179 [e]	66.6	1.4	292,149	161
Friday Harbor	WAG643005	unamed stream to Margos Lake	nra	nra	14.1	4,255	nc
Hoquiam, Outfall 1	WAG641000	W.F. Hoquiam R.	nra	nra	1.3	25,721	nc
Hoquiam, Outfall 2	WAG641000	W.F. Hoquiam R.	nra	nra	1.1	23,088	nc
Ilwaco	WAG641001	Bear Creek	nra	nra	6.2	11,143	nc
Kalama	WAG641023	Kalama R.	1,253 [c]	60.1	0.1	2,765	344,932
Leavenworth	WAG645001	Icicle Creek	722 [e]	56.5	1.0	54,925	1,014
LISECC, Inc.	WAG643004	No Name Creek	nra	nra	1.0	1,650	nc
Long Beach	WAG641019	Mountain Spring Reservoir	nra	nra	45.5	606	nc
Lynden	WAG643003	Nooksack R.	3,908 [e]	378.7	0.3	83,300	17,468
McNeil Island Stp.	WAG643008	Eden Creek	nra	nra	0.1	144,800	nc
Morton	WAG641016	Tilton R.	121 [a]	6.5	3.0	7,201	301
Pasco	WAG647001	Columbia R.	11,742 [e]	1,776.0	5.3	75,363	4,449
Raymond	WAG641007	S.F. Willapa R.	173 [b]	17.4	0.6	51,996	547
Richland	WAG645000	Columbia R.	11,742 [e]	1,776.0	0.9	208,065	9,298
Ryderwood	WAG641011	Campbell Creek	nra	nra	0.8	2,100	nc
South Bend	WAG641008	Martin Creek	nra	nra	53.6	1,083	nc
Stevenson	WAG641020	Rock Creek	nra	nra	2.3	5,843	nc
Vader	WAG641004	Olequa Creek	nra	nra	1.5	2,634	nc
Whatcom Cnty PUD #1	WAG643006	Nooksack R.	nra	nra	0.1	250,000	nc
Willapa Valley Water	WAG641013	Stringer Creek	nra	nra	0.2	31,832	nc
Woodland	WAG641021	Lewis R.	3,908 [e]	378.7	1.4	70,700	3,856

Table Corrected 11/13/2018

Table 4. Ratios between Receiving Water Flow Rates and Average Wastewater Discharge Rates

Annual Daily Mean Flows values were from the U.S. Geological Survey (https://waterdata.usgs.gov/nwis).

Time period represented by the Annual Daily Mean Flow:

[a] = October 1950 through September 1971.
[b] = October 1965 through September 1972.
[c] = January through September 1975; October through December 1980.
[d] = October 2008 through September 2009.
[e] = October 2016 through September 2017.

cu ft / sec = Cubic feet per second.
gal = Gallons.
million gal / day = Million gallons per day.
nc = Not calculated due to insufficient data.
NR = Not reported by the permittee.
nra = Data were not readily available.

Permittees identified their Receiving Waterbody data in their Notices of Intent, and provided wastewater information via their discharge monitoring reports.

Figures

Figure 1. Location Map of All 30 Water Treatment Plants

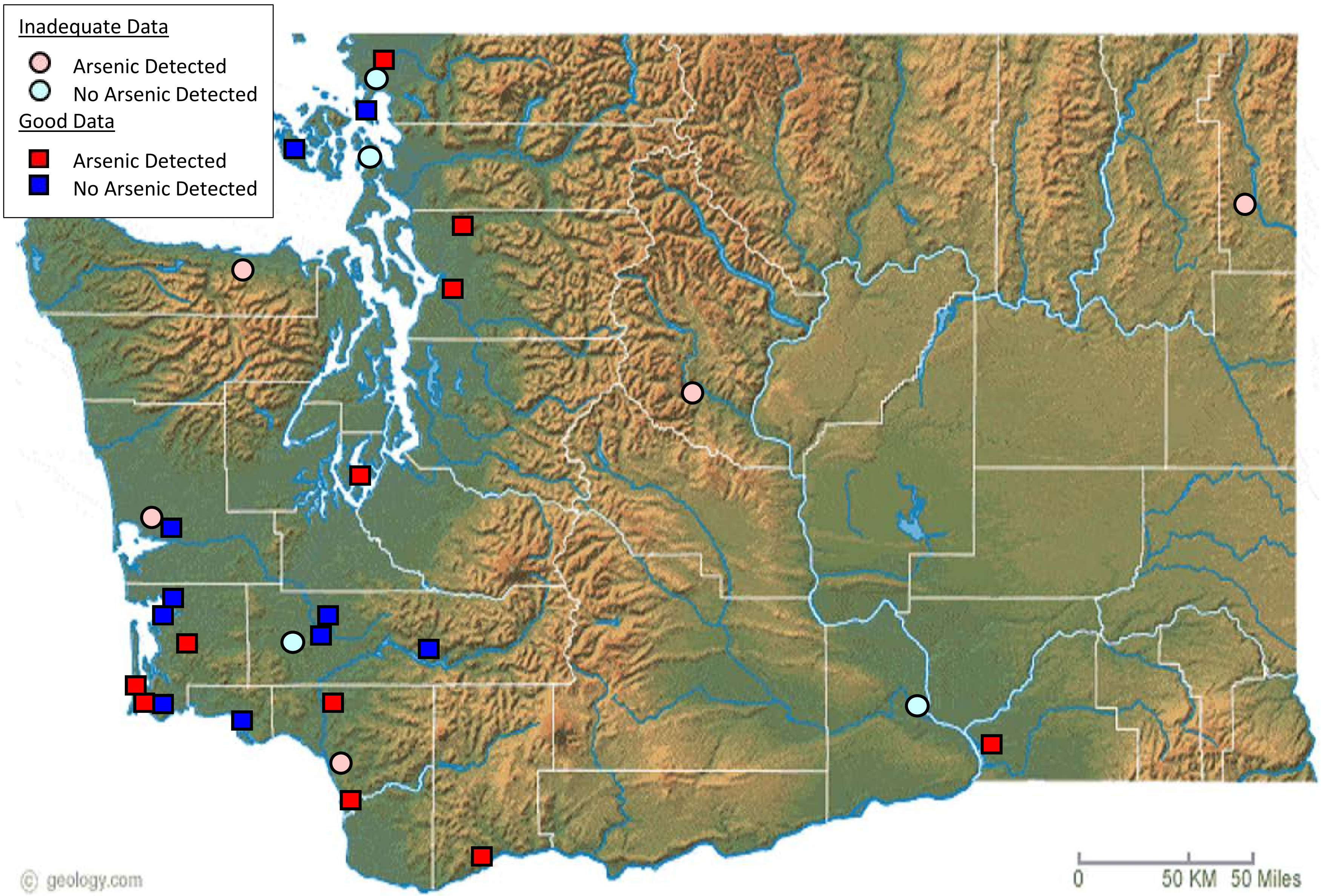
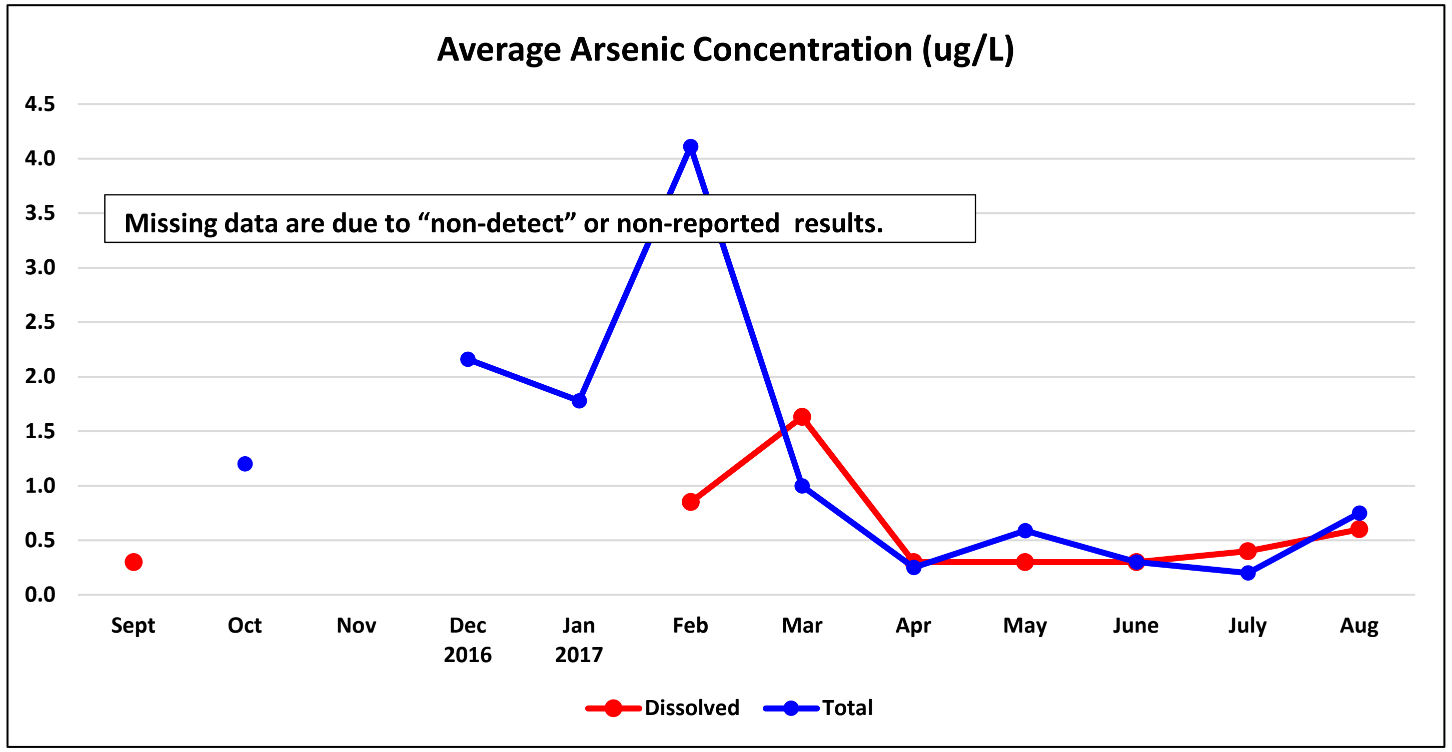
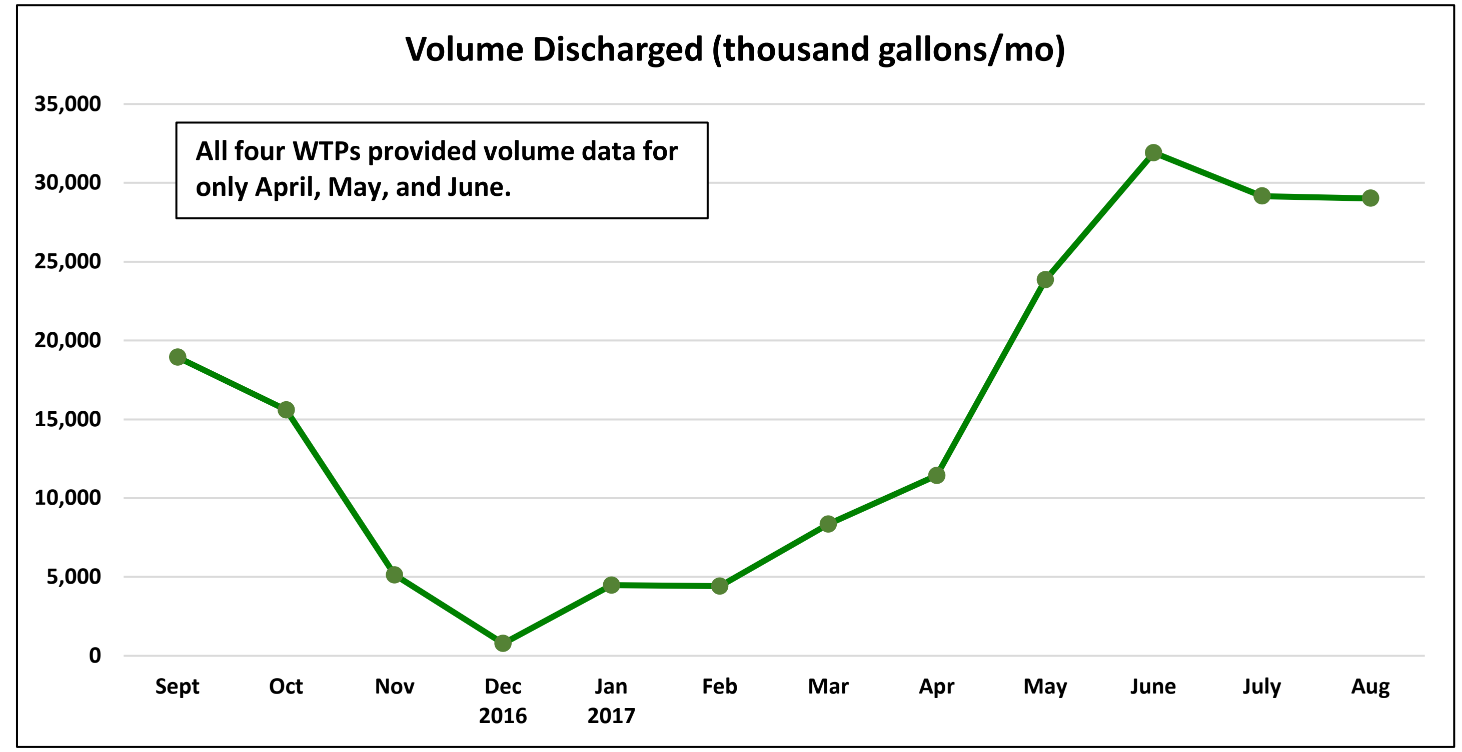


Figure 2. Time Plots for All 4 Eastern Washington Water Treatment Plants





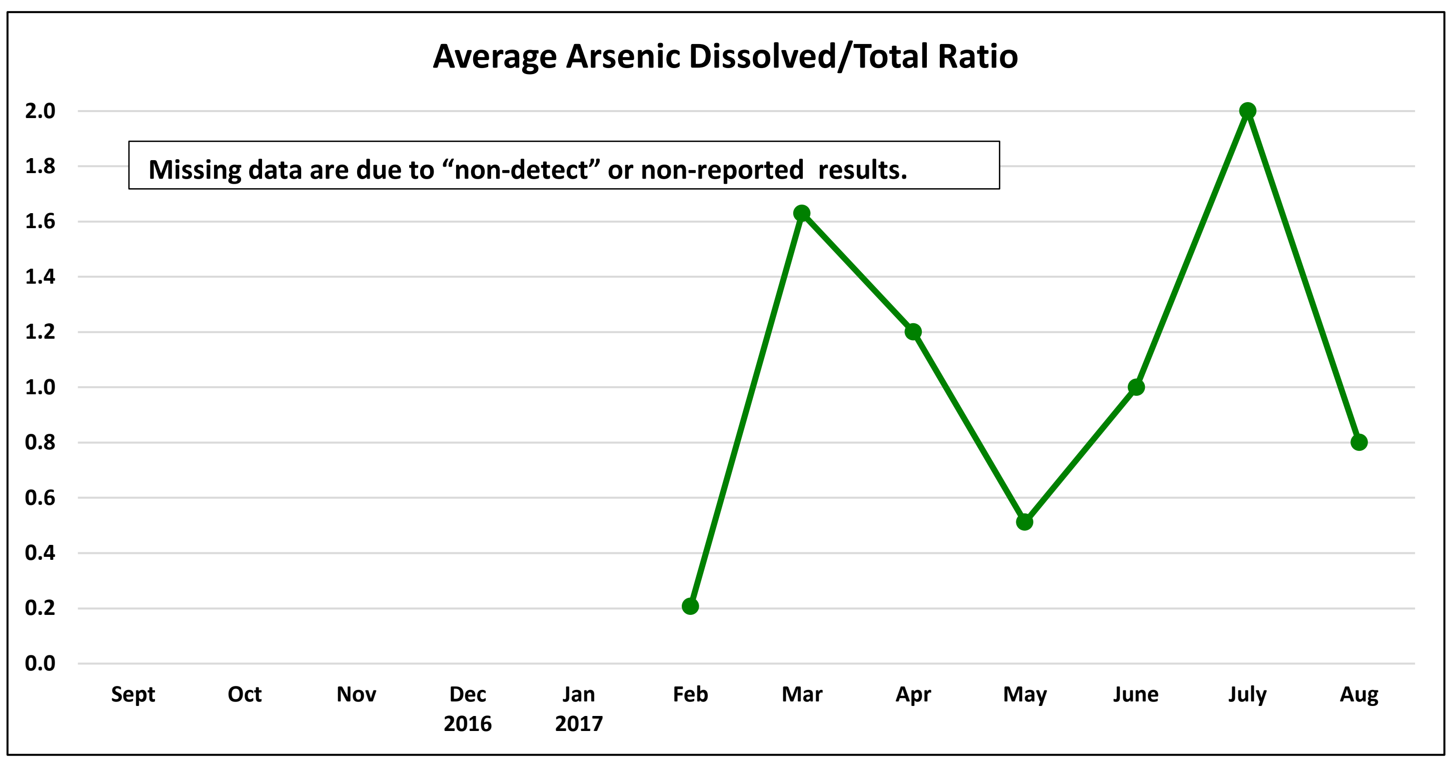
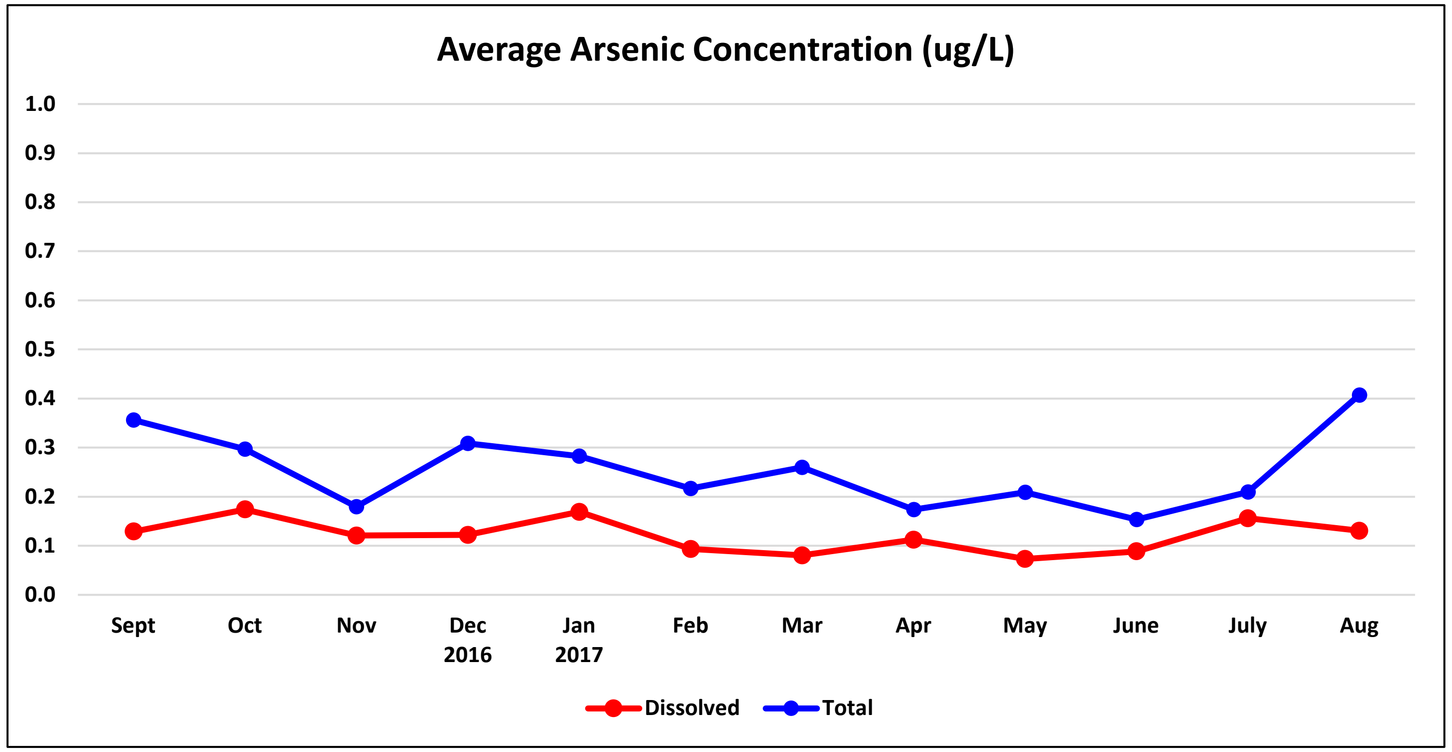
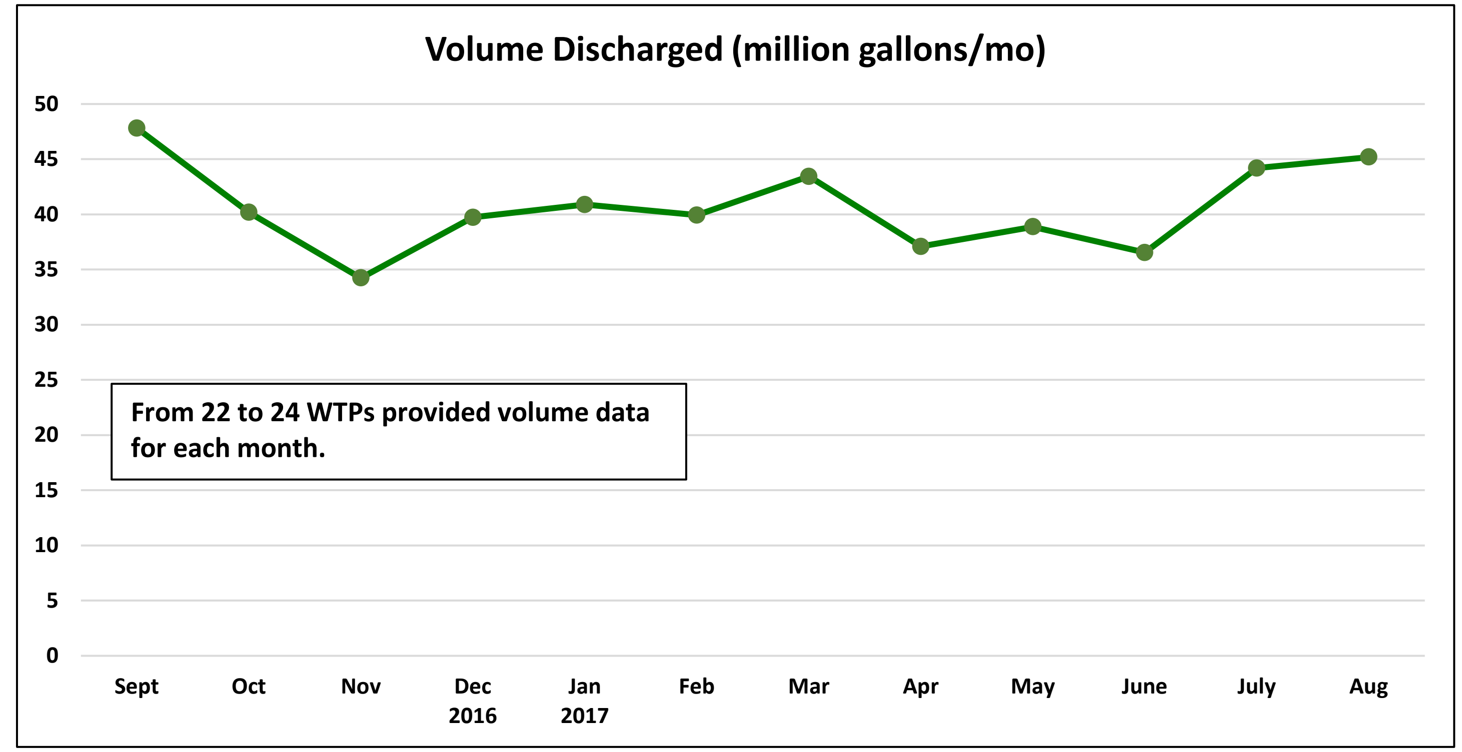
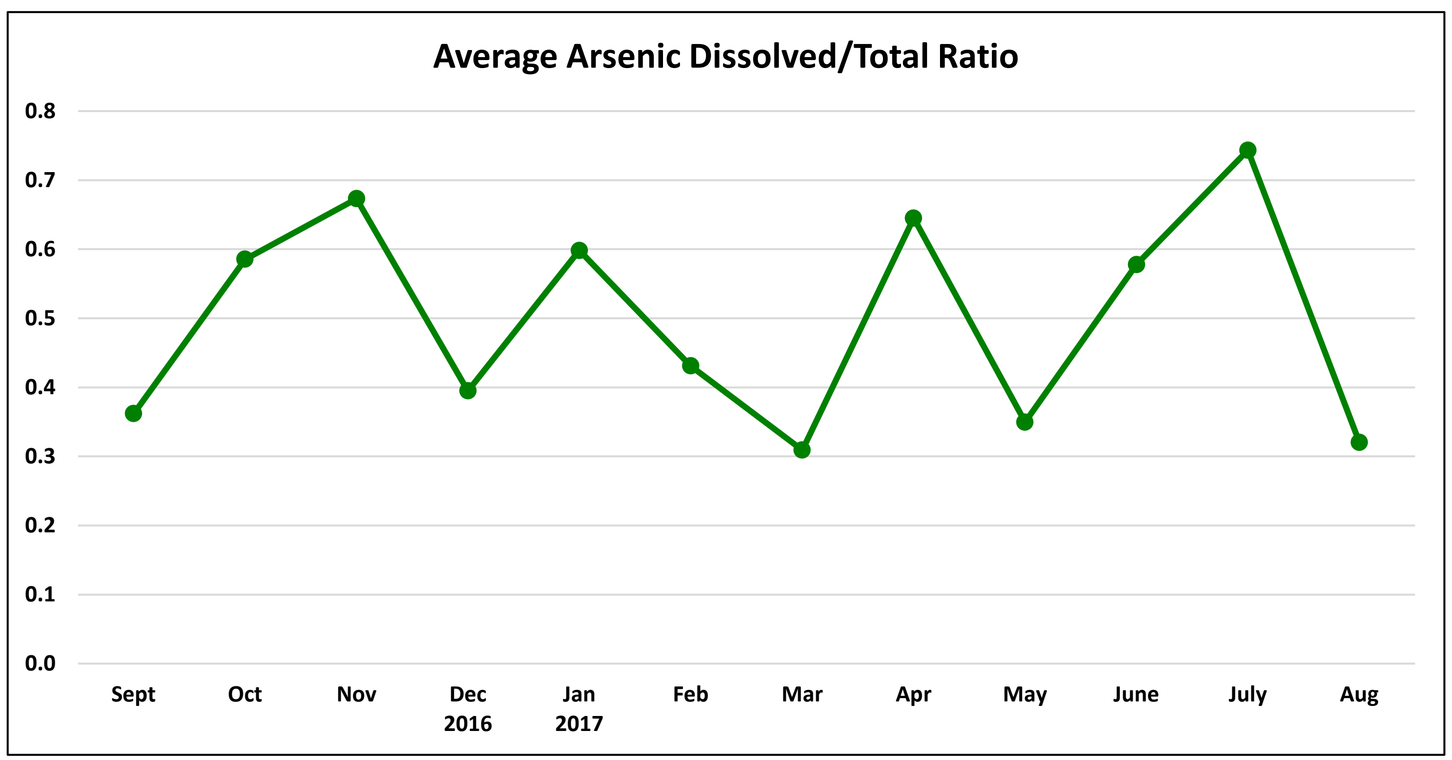


Figure 3. Time Plots for All 26 Western Washington Water Treatment Plants







Appendix A

Acronyms, Units of Measure, and Definitions

Acronym	Meaning
AKART	All known and reasonable treatment technologies
BMP	Best management practice
CFR	Code of Federal Regulations
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
EPA	Environmental Protection Agency
MCL	Maximum contaminant level
na	Not applicable
nc	Not calculated due to insufficient data
ND	Non-detect
NPDES	National Pollutant Discharge Elimination System
NR	Not reported by the Permittee
NTR	National Toxics Rule
PARIS	Permitting and Reporting Information System
U.S.	United States
WTP	Water treatment plant

Unit of Measure	Meaning
cu ft/sec	Cubic feet per second
gal/mo	Gallons per month
Kgal/mo	Thousands of gallons per month
μg/L	Micrograms per liter

Appendix A - Definitions

Ambient
The existing or typical environmental condition that exists at or surrounding a particular location.

Criteria
The numeric values and the narrative standards that represent contaminant concentrations which are not to be exceeded in the receiving environmental media (surface water, ground water, sediment) to protect beneficial uses. *See Surface water.*

Discharge (the noun form is the same as Effluent)
1. To release or add material to waters of the State of Washington.
2. The material discharged, including surface runoff that has been collected or channeled by man.

Effluent (same as the noun form of Discharge)
Material (usually an aqueous liquid) added or released to waters of the State of Washington, including surface runoff that has been collected or channeled by man.

Effluent limit (same as Discharge limit)
Any restriction, including schedules of compliance, established by the local government, the Washington State Department of Ecology, or the U.S. Environmental Protection Agency on quantities, rates, and/or concentrations of biological, chemical, physical, radiological, and/or other characteristics of material discharged from point sources into any site including, but not limited to, waters of the State of Washington. *See Discharge.*

General permit
A single permit that covers multiple characteristically similar dischargers of a point source category within a designated geographical area, in lieu of many individual permits that are issued separately to each discharger. *See Permit.*

Grab sample
An individual sample collected on a one-time basis from a continuous or intermittent stream without consideration of flow or time. For the water treatment plant general permits, the total collection time should occur over as short a period of time as is feasible.

Groundwater
The water located in a saturated zone or stratum beneath the surface of the land or below a surface water body. Groundwater is a water of the State of Washington and includes interflow, which is a type of perched water, and water in all other saturated soil pore spaces and rock interstices, whether perched, seasonal, or artificial. Although underground water within the vadose zone (unsaturated zone) also is a type of groundwater, the Washington State groundwater quality standards do not specifically protect soil pore water or soil moisture located in the vadose zone. *See Surface water and Water quality standard.*

Maximum contaminant level (MCL)
The maximum concentration of a contaminant established by the U.S. Environmental Protection Agency under the Federal Safe Drinking Water Act (42 U.S.C. 300f) and published in 40 CFR 141, as presently promulgated or as subsequently amended or repromulgated. A maximum contaminant level is an enforceable health-based standard which reflects the effects of certain risk management factors, such as laboratory confidence limits and economics.

National Pollutant Discharge Elimination System (NPDES)
The Federal wastewater permitting system for discharges of pollutants from point sources to the navigable waters of the United States authorized under Section 402 of the Clean Water Act. The U.S. Environmental Protection Agency has authorized the State of Washington to issue and administer NPDES permits for non-Federal point sources within the State. *See Discharge and Pollutant.*

Permit
An authorization, license, or equivalent control document issued by a formally constituted legal body, such as the Washington State Department of Ecology, to a facility, activity, or entity to treat, store, dispose, or discharge materials or wastes, specifying the waste treatment and control requirements and waste discharge conditions. Unless the context requires differently, "permit" refers to individual and general permits authorized under the National Pollutant Discharge Elimination System program. *See Discharge, General permit, National Pollutant Discharge Elimination System, Treatment, and Waste.*

Permittee
The entity that has applied to Ecology and been issued coverage under this general permit for a discharge of pollutants to waters of the State of Washington. Each general permit may have specific requirements describing who is eligible to be a permittee. *See Discharge, General permit, and Pollutant.*

pH
A measure of the acidity or alkalinity of water. A pH of 7.0 is defined as neutral. Large variations above or below 7.0 are harmful to most aquatic life. Mathematically, pH is the negative logarithm of the activity of the hydronium ion (often expressed as the negative logarithm of the molar concentration of the hydrogen ion). The analytical procedure for determining this amount is typically Standard Methods for the Examination of Water and Wastewater, Method 4500-H^+B.

Pollutant (in water)
Any discharged substance or pathogenic organism that would: (1) Alter the biological, chemical, physical, radiological, or thermal properties of any water of the State of Washington, (2) Would be likely to create a nuisance or render such water harmful, detrimental, or injurious (a) to the public health, safety, or welfare, (b) to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (c) to any animal or plant life, either terrestrial or aquatic, either directly from the environment or indirectly by ingestion through the food chain. Pollutants may include, but are not limited to, the following: solid waste, incinerator residue, garbage, sewage, sewage sludge, filter backwash, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, dredged spoil, rock, sand, cellar dirt, and other industrial, municipal, and agricultural wastes.

Pollutant does **not** mean: (1) Sewage from marine vessels or a discharge incidental to the normal operation of a vessel of the Armed Forces, within the meaning of Section 312 of the Clean Water Act (CWA); (2) Dredged or fill material discharged in accordance with a permit issued under Section 404 of the CWA; or (3) Water, gas, or other material which is injected into a well to facilitate production of oil or gas, or water derived in association with oil or gas production and disposed of in a well, if the well used either to facilitate production or for disposal is approved by authority of the Washington State Department of Ecology (Ecology), and if Ecology determines that such injection or disposal will not result in the degradation of ground- or surface water resources. *See Discharge, Permit, and Pollutant.*

Reasonable potential
A probability calculated or projected as likely that an effluent or discharge will cause an excursion of a pollutant beyond a water quality criterion at the point of compliance in the receiving water, based on several factors including, as a minimum, the four factors listed in 40 CFR 122.44(d)(1)(ii). *See Effluent, Pollutant, Receiving water, and Water quality.*

Receiving water
The waterbody at the point of discharge, whether that discharge is through a point source or via sheet flow. If the discharge is to a stormwater conveyance system, either surface or subsurface, the receiving water is the waterbody to which the stormwater conveyance system discharges. Systems designed for groundwater drainage, redirecting stream natural flows, or conveyance of irrigation water/return flows that coincidentally convey stormwater, are considered the receiving water. Receiving waters may also be groundwater to which surface runoff is directed by infiltration.

Reporting limit (RL)
The minimum concentration at which detection of an analyte is reported, usually chosen by the laboratory and usually greater than the method detection limit.

Representative sample
A sample that yields data that accurately characterizes the nature of a discharge or other sampled matrix for the parameters of concern. A representative sample should account for the factors that contribute to the variability of the parameters, such as the quantity of the discharge, the date and time of the sampling event, and whether the particular sampling location or associated physical events may affect the material sampled. Combining grab samples collected from multiple outfalls from a designated area of the facility during a certain time range to create a flow-weighted composite sample may be required to obtain a representative sample.

A random sample **may not** be a representative sample. Representative sampling schemes should vary based on the population distribution and variability. For a relatively constant discharge, a grab sample is representative. For a discharge that varies greatly over time or space, a grab sample would likely not be representative. *See Discharge and Grab sample.*

Settleable solids
The material that settles out of suspension within a certain timespan measured volumetrically. The analytical procedure for determining this amount is typically Standard Methods for the Examination of Water and Wastewater, Method 2540 F.

Surface water
Lakes, rivers, ponds, streams, inland waters, wetlands, marine waters, estuaries, and all other fresh or brackish waters and water courses, plus drainages to those water bodies. Surface waters do not include hatchery ponds, raceways, pollution abatement ponds, and wetlands constructed solely for wastewater treatment. *See Treatment.*

Total residual chlorine
The amount of chlorine remaining in water or wastewater, which is equivalent to the sum of the combined residual chlorine (non-reactive) and the free residual chlorine (reactive). The analytical procedure for determining this amount is typically Standard Methods for the Examination of Water and Wastewater, Method 4500-Cl B through G.

Treatment
1. The intentional application of a pesticide or other chemical to the water, vegetation, or soil to control or eradicate a target organism or species; to remove or inactivate bioavailable phosphorus; or to regulate some other ecosystem process.
2. The removal of a pollutant from wastewater or stormwater, or some other manipulation of wastewater or stormwater, to reduce or control the adverse effects of a pollutant therein. *See Pollutant.*

Turbidity
The optical property of water that causes light to be scattered and absorbed rather than transmitted in a straight line. Turbidity in water is caused by suspended matter, such as clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, and plankton and other microscopic organisms. Turbidity is a measure of water clarity using a calibrated turbidimeter according to the analytical procedure described typically by Standard Methods for the Examination of Water and Wastewater, Method 2130 B.

Waste
Any discarded, abandoned, unwanted, or unrecovered material, except the following are not waste materials for the purposes of this permit: (1) Discharges into the ground or ground water of return flow, unaltered except for temperature, from a ground-water heat pump used for space heating or cooling, provided that such discharges do not have significant potential, either individually or collectively, to affect ground-water quality or uses; and (2) Discharges of stormwater that is not contaminated or potentially contaminated by industrial or commercial sources. *See Discharge, Permit, and Water quality.*

Water quality (WQ)
The biological, chemical, physical, and radiological characteristics of water, usually with respect to its suitability for a particular purpose.

Water quality standard (WQS)
Numerical or narrative criterion meant to protect the beneficial uses of the waters of the State of Washington. WQSs may be found in 40 CFR 131; and Chapters 173-200, 173-201A, and 173-204 of the Washington Administrative Code.

Appendix B

Draft Policy Regarding Arsenic Water Quality Criteria

Human Health Arsenic Fact Sheet Language
April 2018

Ecology submitted newly adopted state Human Health Water Quality Criteria to the EPA for Clean Water Act review and approval in August 2016. Parts of that submittal to EPA were new total arsenic criteria of 10 µg/L for both marine and freshwaters. Additional requirements in the new state rule included pollutant minimization requirements for anthropogenic inputs of arsenic from both indirect and direct discharges. The state's new total arsenic criteria match the EPA's Safe Drinking Water Act maximum contaminant level (MCL) used in Washington State for drinking water protection. The state's new arsenic criteria took into account existing scientific data, high concentrations of naturally occurring arsenic in the State of Washington, and EPA's CWA approval of 10 µg/L total arsenic criteria in almost all other western states.

Ecology intended the new total arsenic criteria to supersede the inorganic arsenic human health criteria adopted for the State of Washington by the EPA in the 1992 National Toxics Rule (NTR; 40 CFR 131.36). The EPA's 1992 risk based human health criterion for marine waters is 0.14 µg/L inorganic arsenic, and is based on exposure from fish and shellfish tissue ingestion. The freshwater criterion is 0.018 µg/L, and is based on exposure from fish and shellfish tissue and surface water ingestion. The 2016 arsenic criteria adopted by Ecology eliminated uncertainties associated with the cancer potency factor used by the EPA in the 1992 NTR arsenic standards. However, the EPA disapproved Ecology's proposed total arsenic criteria in November 2016 and retained the inorganic arsenic human health criteria set in the 1992 NTR. The EPA's Technical Support Document for the approval/disapproval of Washington's Human Health Water Quality Criteria states that the federal agency intends to conduct a toxicological review of inorganic arsenic in 2017. The work has not yet been completed. This toxicological review could lead to an opportunity for Ecology to participate in a national dialogue associated with the update of the arsenic criteria in section 304(a) of the Clean Water Act. Until the EPA inorganic arsenic review is completed, scientific information is updated, and Washington State adopts into rule EPA CWA-approvable new total or inorganic arsenic criteria, the EPA's existing marine and freshwater inorganic arsenic criteria remain in effect at 0.14 and 0.018 µg/L.

The EPA's disapproval of Washington's new total arsenic criteria continues to create several difficulties in the wastewater discharge permitting process. One issue, as mentioned above, involves natural background concentrations of both marine and freshwaters that exceed the criteria. This can be particularly problematic for groundwater-sourced drinking waters with arsenic concentrations above 0.018 µg/L, which then pass through wastewater treatment plants after initial use. In this situation, no implementation tool exists to account for the naturally occurring element in the drinking water source. Intake credits do not apply in this situation because the source water and the receiving water must be the same body of water or proven to be hydraulically connected. Another issue is the lack of a 40 CFR 136-approved analytical method for inorganic arsenic that can be used for compliance assessment. Evaluation of point source discharges for effluent limit compliance must use 40 CFR 136 methods. The current 40 CFR 136-approved method for arsenic measures the total recoverable portion of the metal, and does not differentiate the inorganic portion. The lack of federally approved translators for inorganic-to-total recoverable arsenic in discharges increases the difficulty in assigning an effluent limitation for discharges to surface waters.

Attainment of Washington's inorganic arsenic criteria remains challenging if not improbable. At best, current treatment technologies may be capable of arsenic removal to approximate concentrations ranging from 0.5- 1 μg/L. The difference between the best available treatment technology and numeric effluent limits based on the criteria creates difficulty for both existing and proposed discharges. Ecology intends to continue to pursue a solution to the regulatory issue of groundwater sources with high arsenic concentrations that would cause treatment plant effluent to exceed effluent limits based on the numeric criteria.

Where numeric effluent limits are infeasible, 40 CFR 122.44(k) provides for the use of best management practices (BMPs) to control or abate the discharge of pollutants. This provision in the federal regulations provides the basis for Ecology's permitting strategy for inorganic arsenic until the EPA revisits their criteria development procedures and develops site specific total-to-inorganic arsenic translators for individual dischargers. Components of Ecology's permitting strategy include permit requirements to monitor for total recoverable arsenic, implementation of source control BMPs, and an adaptive management process to refine BMPs for continuous pollutant minimization. While numeric effluent limits based on the human health inorganic arsenic criteria remain infeasible, Washington NPDES permits will continue to contain numeric effluent limits for arsenic based on best available treatment technology and aquatic life-based criteria as appropriate.

Notes:
This language is to be used only when the permit writer finds reasonable potential to exceed the HHC.

Permit writers should require monitoring for total recoverable arsenic only. Development of a site specific translator to inorganic arsenic varies both temporally and spatially. Therefore, requiring both inorganic and total recoverable arsenic monitoring will not lead to a scientifically defensible translator between the two forms. Ecology has not yet determined a defensible process for this translation.

- If no arsenic is detected in the previous permit cycle and there are no site specific triggers, you may conclude no RP exists. Do not use this fact sheet language.
- Do not use PermitCalc to determine RP for exceedance of the As human health criteria. A site evaluation including a review of all data and available dilution should be conducted in lieu of the traditional RPA process. Document this review in the fact sheet and include this optional fact sheet language when RP to exceed is found. PWG is working on a screening tool to help with this evaluation procedure.