# Fact Sheet for State Waste Discharge Permit No. ST0501318

## GWI Holdings, Inc. / GACO Western

### Date of Public Notice of Draft: February 9, 2021

## Purpose of this fact sheet

This fact sheet explains and documents the decisions the Department of Ecology (Ecology) made in drafting the proposed State Waste Discharge Permit for GACO Western that will allow discharge of wastewater to ground.

State law requires any industrial facility to obtain a permit before discharging waste or chemicals to waters of the state, which includes groundwater.

Ecology makes the draft permit and fact sheet available for public review and comment at least thirty (30) days before issuing the final permit. Copies of the fact sheet and draft permit for GACO Western, State Waste Discharge Permit No. ST0501318, are available for public review and comment from February 9, 2021 until the close of business on March 11, 2021. For more details on preparing and filing comments about these documents, please see **Appendix A - Public Involvement Information**.

GWI Holdings, Inc. / GACO Western reviewed the draft permit and fact sheet for factual accuracy. Ecology corrected any errors or omissions about the facility's location, history, product type or production rate, discharges or receiving water prior to publishing this draft fact sheet for public notice.

After the public comment period closes, Ecology will summarize substantive comments and our responses to them. Ecology will include our summary and responses to comments to this fact sheet as **Appendix E - Response to Comments**, and publish it when we issue the final State Waste Discharge Permit. Ecology generally will not revise the rest of the fact sheet. The full document will become part of the legal history contained in the facility's permit file.

## Summary

This state waste discharge permit authorizes the discharge of contaminated groundwater to ground for treatment under conditions specified in the permit. Based on previous results from pilot testing Phytoremediation Attached Growth Reactors (PhAGRs – selected trees placed in various in closed vessels containing combinations of soil and Perlite), this project will treat groundwater containing low levels of volatile organic compounds. The pilot test showed substantial decreases in contaminant concentrations. Contaminated groundwater is pumped to a holding tank that supplies a drip irrigation system applying this groundwater to a 6,750 square foot grove of poplar and willow trees called an EBuffer (US patent pending). These trees are selected for their specific remediation characteristics. The trees use the contaminated water for growth, and the pollutants are reduced in the root zone to nearly undetected amounts. Groundwater in the surficial aquifer is monitored up gradient, in the EBuffer, and down gradient to ensure pollutants do not exceed levels set in the permit. Soil moisture, pH, and other factors will be measured pursuant to permit requirements.

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# I. Introduction

The Legislature defined Ecology's authority and obligations for the wastewater discharge permit program in the Water Pollution Control law, chapter 90.48 RCW (Revised Code of Washington).

Ecology adopted rules describing how it exercises its authority:

- State waste discharge program (chapter 173-216 WAC).
- Water quality standards for ground waters of the state of Washington (chapter 173-200 WAC).
- Submission of plans and reports for construction of wastewater facilities (chapter 173-240 WAC).

These rules require any industrial facility owner/operator to obtain a State Waste Discharge Permit before discharging wastewater to state waters. They also help define the basis for limits on each discharge and for performance requirements imposed by the permit.

Under the State Waste Discharge Permit Program and in response to a complete and accepted permit application, Ecology generally prepares a draft permit and accompanying fact sheet, and makes it available for public review before final issuance. If the volume of the discharge has not changed or if the characteristics of the discharge have not changed, Ecology may choose not to issue a public notice. When Ecology publishes an announcement (public notice), it tells people where they can read the draft permit, and where to send their comments, during a period of thirty (30) days. (See **Appendix A – Public Involvement Information** for more detail about the public notice and comment procedures). After the public comment period ends, Ecology may make changes to the draft State Waste Discharge Permit in response to comment(s). Ecology will summarize the responses to comments and any changes to the permit in **Appendix E**.

# II. Background Information

### Table 1. General Facility Information

| Facility Information | |
|---|---|
| Applicant | GWI Holdings, Inc. |
| Facility Name and Address | GACO Western<br>18700 Southcenter Parkway<br>Tukwila, WA 98188 |
| Contact at Facility | Name: Brad Helland<br>Telephone #: 206-372-6806 |
| Responsible Official | Name: E. Bryant Hill<br>Title: VP Business Management<br>Address: 1000 First Ave, Suite 2201<br>Telephone #: 206-910-8240 |
| Industry Type | Independent clean-up action at an active dry goods warehouse |
| Cleanup Site Details | Site ID 2979 at Cleanup information |
| Type of Treatment | Phytoremediation (EBuffer, US Patent Pending) |
| SIC Codes | 4225 |
| NAICS Codes | 493110, 562910 |
| Facility Location | Latitude: 47.434575<br>Longitude: -122.2631667 |
| Legal Description of Application Area | Section, township, range SE ¼, SW ¼, Sec 35, T32N, R4E<br>Latitude: 47.434901<br>Longitude: -122.263069 |
| **Groundwater Monitoring Well Information** | |
| GWI_MW1<br>Westernmost MW | Ecology tag #: BLT941<br>Latitude: 47.43495315 (NAD83)<br>Longitude: -122.26348285 |
| GWI_MW2<br>Central MW | Ecology tag #: BLT942<br>Latitude: 47.43486775 (NAD83)<br>Longitude: -122.26301155 |
| GWI_MW3<br>Easternmost MW | Ecology tag #: BLT943<br>Latitude: 47.43470336 (NAD83)<br>Longitude: -122.26246584 |
| **Permit Status** | |
| Issuance Date of Permit | April 1, 2021 |
| Date of Ecology Acceptance of Application | September 25, 2018 |
| Permit fee category | Hazardous Waste – Leaking Underground Stroage Tank |

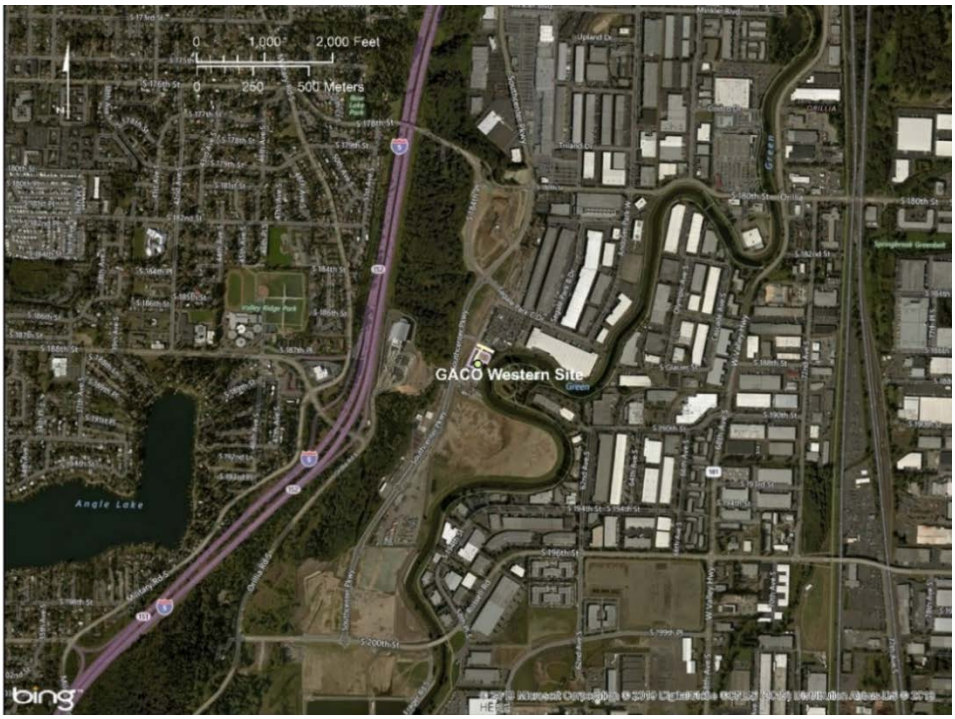


**Figure 1 Facility Location Map**


**Figure 2 Facility Map**

## A. Facility description

### *History*

This facility was a clean-up site in Ecology's Voluntary Cleanup Program (VCP) under the oversight of the Toxics Cleanup Program (TCP), but was later removed. The NW Region TCP responded to the VCP re-application finding the site was too complex for VCP and the application was rejected. Previous TCP investigations can be found here: Toxics Clean-up Program Site Information. The site is currently undergoing an independent cleanup action. Currently there are no industrial processes at the site. The site buildings function as general warehousing and storage with some office space (under renovation).

This permit authorizes discharges to ground after treating contaminated groundwater on-site by phytoremediation using a mix of poplar and willow species (EBuffer, US Patent Pending) to remove volatile organic compounds related to historic releases at the site.

The land treatment area is a small swath of trees specially selected to treat groundwater. Untreated contaminated groundwater will be distributed by drip irrigation. The operation was already used for the discharge of treated groundwater under a pilot program.

### *Wastewater treatment processes (prior to land treatment)*

The discharge applies contaminated groundwater to the installed EBuffer plot of trees. The treatment process reduces volatile organics in the groundwater through degradation of chemicals in the soil and root zone of the trees.

### *Land treatment and distribution system*

During the pilot test, effluent from the Phytoremediation Attached Growth Reactors (PhAGRs) was irrigated over 0.15 acres of trees planted for the purpose of phytoremediation. This provided information about treatment rates and other elements of the remediation system and additional treatment of groundwater during the pilot test.

After successful completion of the pilot test, the untreated groundwater will be discharged directly to the EBuffer. The EBuffer trees are planted at the north end of a parking area on property owned by the Permittee.

Soil in which the EBuffer trees are planted is a specially prepared mixture to enhance pollutant retention and uptake. The system will operate approximately nine months of the year (March through November). It is anticipated that any discharge not used by the trees during this period will be held in the soil column. Because of the narrow nature of the treatment area, which is surrounded by impervious surfaces, saturation by precipitation is not considered a major concern. Nevertheless, soil moisture will be monitored periodically.

If treated or untreated groundwater becomes insufficient to sustain the trees, supplemental non-potable water is available from hose connections at the warehouse.

*Solid wastes*

This discharge is not likely to generate any significant solid waste. EBuffer trees that die will be removed and replaced with new trees, as necessary. If needed, proper disposal of the removed trees and soil will be made at that time. When trees are trimmed, the trimmings will be chipped and distributed inside the EBuffer to provide additional carbon, reduce weed germination, and retain water.

## B. Description of the groundwater

Groundwater being treated by the system is contaminated with low levels of volatile organic compounds. These contaminants are related to historical releases at the site.

Permit writers in some cases must decide if the discharge of a pollutant onto the ground near a surface water is subject to an National Pollutant Discharge Elimination System (NPDES) Permit or State Waste Discharge Permit. Ecology believes the best guidance on this issue comes from the United States District Court Eastern District of Washington (Washington Wilderness Coalition v. Hecla Mining, 870 F. Supp 983, 990). The court held that since the goal of the Clean Water Act (CWA) is to protect the quality of surface waters, any pollutant, which enters such waters, whether directly or through groundwater, is subject to regulation by NPDES permit. The court went on to hold, “It is not sufficient to allege groundwater pollution, and then to assert a general hydrological connection between all waters. Rather, pollutants must be traced from their source to surface waters, in order to come within the purview of the CWA.”

The decision on hydraulic continuity depends upon the:

- Pollutant (type and mobility in soils)
- Pollutant loading
- Soils at the site
- Hydrology of the site

Ecology has determined that it should issue a State Waste Discharge Permit and not an NPDES Permit for this site because the discharge is small in comparison to the local groundwater. Although the site is within 100 meters of a dike containing the Green River, this system is specifically designed for pollutant uptake. It is therefore very unlikely that any contaminants from this discharge would be uniquely distinguishable from similar contaminants in the area.

## C. Wastewater characterization

GWI Holdings, Inc. / GACO Western reported the concentration of pollutants in the PhAGR pilot test discharge in the permit application. The tabulated data represents the quality of the wastewater discharged during pilot testing through December 2018. The wastewater after treatment is characterized as follows:

**Table 2. Wastewater Characterization**

| Parameter | Units | # of Samples | Average Value [a] | Maximum Value [a] |
|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | µg/L | 9 | 0.218 | < 1 [b] |
| 1,1-Dichloroethene | µg/L | 9 | 0.653 | 3 |
| 1,2-Dichloroethane | µg/L | 9 | 0.26 | < 1 |
| Acrylonitrile | µg/L | 9 | 1.21 | < 5 |
| Benzene | µg/L | 9 | 44.19 | 90.4 |
| cis-1,2-Dichloroethene | µg/L | 9 | 0.543 | 2.48 |
| Ethylbenzene | µg/L | 9 | 35.45 | 156 |
| Ethylene Dibromide | µg/L | 9 | 0.209 | < 1 |
| m, p-Xylene | µg/L | 9 | 172.72 | 543 |
| o-Xylene | µg/L | 9 | 27.01 | 88.3 |
| Tetrachloroethene | µg/L | 9 | 0.214 | < 1 |
| Toluene | µg/L | 9 | 5.88 | 17.6 |
| trans-1,2-Dichloroethene | µg/L | 9 | 0.217 | < 1 |
| Trichloroethene | µg/L | 9 | 0.218 | < 1 |
| Vinyl Chloride | µg/L | 9 | 1.07 | 4.02 |

| | |
|---|---|
| a | All values are in micrograms per liter (µg/L). |
| b | "<" symbol = less than the listed value. |

### D. State environmental policy act (SEPA) compliance

State law exempts the issuance, reissuance or modification of any wastewater discharge permit from the SEPA process as long as the permit contains conditions that are no less stringent than federal and state rules and regulations (RCW 43.21C.0383). The exemption applies only to existing discharges, not to new discharges.

To meet the intent of SEPA, new discharges must undergo SEPA review during the permitting process. The facility filed a SEPA checklist with Ecology on November 17, 2020, and Ecology issued a determination of non-significance for the project on Insert date.

## III. Proposed Permit Limits

State regulations require that Ecology base limits in a State Waste Discharge Permit on the:

- Technology and treatment methods available to treat specific pollutants (technology-based). Dischargers must treat wastewater using all known, available, reasonable methods of prevention, control, and treatment (AKART). Ecology has developed guidance describing technology-based (AKART) criteria for industrial/commercial systems that discharge to ground; (Ecology, 1993; 2004).
- Operations and best management practices necessary to meet applicable water quality standards to preserve or protect existing and future beneficial uses of the groundwaters.
- Ground water quality standards (Ecology, 1996).

- Applicable requirements of other local, state and federal laws.

Ecology applies the most stringent of technology and water quality-based limits to each parameter of concern and further describes the proposed limits below.

The limits in this permit reflect information received in the application and from supporting reports (engineering, hydrogeology, monitoring, and irrigation/crop management). Ecology evaluated the permit application and determined the limits needed to comply with the rules adopted by the state of Washington. Ecology does not develop effluent limits for all reported pollutants. Some pollutants are not treatable at the concentrations reported, are not controllable at the source, and are not listed in regulation.

Ecology does not usually develop permit limits for pollutants not reported in the permit application but may be present in the discharge. The permit does not authorize the discharge of the non-reported pollutants. During the five-year permit term, the facility's effluent discharge conditions may change from those conditions reported in the permit application. The facility must notify Ecology if significant changes occur in any constituent. Until Ecology modifies the permit to reflect additional discharges of pollutants, a permitted facility could be violating its permit.

## A. Technology-based effluent limits

Waste discharge permits issued by Ecology specify conditions requiring the facility to use AKART before discharging to waters of the state (RCW 90.48).

Ecology determined that the facility meets the minimum requirements demonstrating compliance with the AKART standard if the GWI Holdings, Inc. / GACO Western operates the treatment and disposal system as described in the permit application.

Ecology also evaluated the report for water quality-based requirements, which is described in the next section of the fact sheet.

### *Wastewater treatment (prior to land treatment) requirements*

Neither industrial category assigned to this site has technology-based water quality limits. Therefore, any limits derived will be based solely on the goal of meeting groundwater quality standards.

### *Land treatment requirements*

GWI Holdings, Inc. / GACO Western must meet the following permit limits to satisfy the requirements for AKART:

- Application of wastewater via drip irrigation must not exceed agronomic rates (as defined in Ecology's groundwater implementation guidance) for total nitrogen and water. Wastewater application rates for other wastewater constituents must protect the background groundwater quality.
- Apply water to the irrigated treatment site as approved in the permit.

- Operate the system to protect the existing and future beneficial uses of the groundwater and not degrade groundwater quality.

## B. Groundwater quality-based effluent limits

In order to protect existing water quality and preserve the designated beneficial uses of Washington's groundwater including the protection of human health, WAC 173-200-100 requires Ecology to condition discharge permits in such a manner as to authorize only activities that will not cause violations of the groundwater quality standards. The goal of the groundwater quality standards is to maintain the highest quality of the State's groundwater and to protect existing and future beneficial uses of the groundwater through the reduction or elimination of the discharge of contaminants to groundwater [WAC 173-200-010(4)]. Ecology achieves this goal by:

- Applying all known available and reasonable methods of prevention, control and treatment (AKART) to any discharge.
- Applying the antidegradation policy of the groundwater standards.
- Establishing numeric and narrative criteria for the protection of human health and the environment in the groundwater quality standards.

Ecology approved the engineering report as noted above in the technology based limits section. In addition, Ecology evaluated the report to ensure compliance with groundwater standards using the:

- *Guidance on Land Treatment of Nutrients in Wastewater, with Emphasis on Nitrogen, Ecology*, November 2004 Guidance on Land Treatment of Nutrients in Wastewater

### *Antidegradation policy*

The state of Washington's ground water quality standards (GWQS) require preservation of existing and future beneficial uses of groundwater through the antidegradation policy, which includes the two concepts of antidegradation and non-degradation. Antidegradation is not the same as non-degradation (see below).

### *Antidegradation*

Antidegradation applies to calculation of permit limits in groundwater when background (see below) contaminant concentrations are less than criteria in the GWQS. Ecology has discretion to allow the concentrations of contaminants at the point of compliance to exceed background concentrations but not exceed criteria in the GWQS. Ecology grants discretion through an approved AKART engineering analysis of treatment alternatives.

In this case, the existing groundwater concentrations are currently above the groundwater criteria. The goal of land treatment is to reduce the concentrations of contaminants already in the groundwater to levels acceptable under MTCA and the future use of the site. These clean-up levels may be above background groundwater quality.

*Non-degradation*

Non-degradation applies to permit limits in groundwater when background contaminant concentrations exceed criteria in the GWQS. Non-degradation means that discharges to groundwater must not further degrade existing water quality. In this case, Ecology considers the background concentrations as the water quality criteria and may impose the criteria as permit limits. To meet the antidegradation policy, the facility must prepare an AKART engineering analysis that demonstrates that discharges to groundwater will not result in increasing background concentrations. The AKART engineering analysis will be reviewed and approved by Ecology.

You can obtain more information on antidegradation and non-degradation by referring to the Implementation Guidance for the Ground Water Quality Standards (Implementation Guidance), Ecology Publication #96-02 (available at Implementation Guidance for the Ground Water Quality Standards).

*Background water quality*

Background water quality is determined by a statistical calculation of contaminant concentrations without the impacts of the proposed activity. The calculation requires an adequate amount of groundwater quality data and determining the mean and standard deviation of the data, as described in the Implementation Guidance. Following the procedure in the Implementation Guidance, Ecology then defines background water quality for most contaminants as the 95 percent upper tolerance limit. This means that Ecology is 95 percent confident that 95 percent of future measurements will be less than the upper tolerance limit. There are a few exceptions to the use of the upper tolerance limit. For pH, Ecology will calculate both an upper and a lower tolerance limit resulting in an upper and lower bound to the background water quality. If dissolved oxygen is of interest, Ecology will calculate a lower tolerance limit without an upper tolerance limit.

Applicable groundwater criteria as defined in chapter 173-200 WAC and in the *Implementation Guidance for the Groundwater Quality Standards* (Ecology, 2005) for this discharge include those in the following table:

**Table 3. Groundwater Quality Criteria**

| Parameter | Units | Groundwater Criteria | Maximum Reported Value | Percent of GWQS [a, b] |
|---|---|---|---|---|
| 1,1-Dichloroethene [c] | µg/L | 1 | 0.459 | 2 |
| 1,2-Dichloroethane | µg/L | 0.5 | 0.0325 (0.257) [d] | 6.5 |
| Acrylonitrile | µg/L | 0.07 | 0.5 | 71.4 |
| Benzene | µg/L | 1.0 | 0.934 (7.67) | **93.4** [e] |
| cis-1,2-Dichloroethene [f] | µg/L | 70 [g] | 0.2 | 0.029 |
| Ethylbenzene | µg/L | 700 [g] | 0.384 (4.49) | 0.055 |
| Ethylene Dibromide | µg/L | 0.001 | < 0.1 [h] | |
| Tetrachloroethene [i] | µg/L | 0.8 | < 0.2 | < 25 |
| Toluene | µg/L | 1,000 [g] | 0.2 (0.876) | 0.02 |

| Parameter | Units | Groundwater Criteria | Maximum Reported Value | Percent of GWQS [a, b] |
|---|---|---|---|---|
| trans-1,2-Dichloroethene [j] | µg/L | 100 [g] | < 0.2 | 0.02 |
| Trichloroethene [k] | µg/L | 3 | < 0.2 | 0.067 |
| Vinyl Chloride | µg/L | 0.02 | 0.111 (0.2) | **555** [e] |
| m, p-Xylene | µg/L | | 2.48 (25.4) | |
| o-Xylene | µg/L | | 0.2 (3.37) | |
| Xylene (Total) | µg/L | 10,000 [g] | 2.68 (28.77) | 0.027 |
| pH | SU [l] | 6.5 – 8.5 | -- [m] | |

| | |
|---|---|
| [a] | GWQS = Groundwater Quality Standard |
| [b] | Based on maximum reported value with statistical outliers removed. |
| [c] | Criteria is for 1,1-Dichloroethylene. |
| [d] | The maximum value with the statistical outliers removed is listed. The value in the parenthesis the maximum reported values, but are determined to be statistical outliers. |
| [e] | **Bold** values indicate the maximum concentration is near or above the groundwater quality standard. Average values are also greater than the standard. |
| [f] | Criterion is for cis-1,2-Dichloroethylene. |
| [g] | Values are Maximum Contaminant Levels for drinking water from WAC 246-290, as cited in the Implementation Guidance. |
| [h] | Method detection level of samples. |
| [i] | Criterion is for Tetrachloroethylene. |
| [j] | Criterion is for trans-1,2-Dichloroethylene. |
| [k] | Criterion is for Trichloroethylene. |
| [l] | SU = Standard Units |
| [m] | No pH data currently available. |

Ecology has reviewed existing records for the facility's land treatment site and is unable to determine background groundwater quality. However Ecology records demonstrate known groundwater and soil contamination for the chemicals listed above.

Maximum reported concentrations of benzene and vinyl chloride in the proposed discharge exceed groundwater quality criteria. The proposed permit establishes early warning values (EWVs) based on current data. The permit depends on wastewater application limits and EWVs to ensure reduction of contaminants. Additional limits or monitoring can be imposed in the future if necessary.

Ecology established groundwater EWVs to protect the quality of the groundwater based on the current concentrations in the discharge and groundwater quality standards. The proposed groundwater EWVs establish the quality of the wastewater that GWI Holdings, Inc. / GACO Western may apply or discharge to the approved infiltration area.

The table below includes the groundwater EWVs for the discharge. Two consecutive exceedances of an EWV for the same parameter at the same well means additional actions may be taken to determine the cause of the exceedance.

### Table 4. Groundwater Quality-Based Early Warning Values

| Parameter | Background Water Quality [a] | Groundwater Early Warning Value [b, c] |
|---|---|---|
| 1,2-Dichloroethane | 1 µg/L | 0.05 µg/L |
| Benzene | 90.4 µg/L | 3.70 µg/L |
| cis-1,2-Dichloroethene | 2.48 µg/L | 0.14 µg/L |
| Ethylbenzene | 156 µg/L | 3.72 µg/L |
| m,p-Xylene | 543 µg/L | 10.72 µg/L |
| o-Xylene | 88.3 µg/L | 2.84 µg/L |
| Vinyl Chloride | 4.02 µg/L | 0.125 µg/L |

| | |
|---|---|
| [a] | Values are the maximum reported concentration with statistical outliers removed. |
| [b] | Values are for Daily Maximum concentration at the 95th percent confidence level, unless otherwise noted. |
| [c] | Two consecutive exceedances of an EWV for the same parameter at the same well may lead to additional actions being taken. |
| [d] | µg/L = micrograms per liter. |
| [e] | Value is the 95th percentile of the combined final data. |

| Parameter | Daily Minimum | Daily Maximum |
|---|---|---|
| pH | 6.5 standard units | 8.5 standard units |

# IV. Monitoring Requirements

Ecology requires monitoring, recording, and reporting (WAC 173-216-110) to verify that the treatment process functions correctly, the discharge meets groundwater criteria and that the discharge complies with the permit's effluent limits.

If a facility uses a contract laboratory to monitor wastewater, it must ensure that the laboratory uses the methods and meets or exceeds the method detection levels required by the permit. The permit describes when facilities may use alternative methods. It also describes what to do in certain situations when the laboratory encounters matrix effects. When a facility uses an alternative method as allowed by the permit, it must report the test method, detection level (DL), and quantitation level (QL) on the discharge monitoring report or in the required report.

## A. Lab accreditation

Ecology requires that facilities must use a laboratory registered or accredited under the provisions of chapter 173-50 WAC, Accreditation of Environmental Laboratories, to prepare all monitoring data (with the exception of certain parameters).

## B. Wastewater monitoring

Ecology details the proposed monitoring schedule under Special Condition S2.A. Specified monitoring frequencies take into account the quantity and variability of the discharge, the treatment method, past compliance, significance of pollutants, and cost of monitoring.

## C. Groundwater monitoring

Ecology requires groundwater monitoring at the site in accordance with the Ground Water Quality Standards, chapter 173-200 WAC. This facility has three wells monitoring the land application area. Well MW-1 is the up gradient well and provides background groundwater concentrations. Wells MW-2 and MW 3 are down gradient and monitor groundwater for constituent concentrations potentially impacted by land application.

Ecology has determined through the MTCA process that groundwater at this site is contaminated with pollutants. This discharge is intended to reduce pollutant levels in the groundwater. Monitoring is required to verify the treatment system is reducing pollutant levels in the groundwater. Pumping the existing groundwater has a potential to move the pollutants in groundwater. Therefore, the facility must evaluate the impacts on groundwater quality. Ecology considers monitoring of the groundwater at the site boundaries and within the site an integral component of such an evaluation. Ecology details the proposed monitoring schedule under Special Condition S2.B.

## D. Vadose zone monitoring

Ecology details the proposed monitoring schedule under Special Condition S2.C. Ecology will use this data to ensure irrigated wastewater does not move below the root zone and to demonstrate compliance with the agronomic rate limit in Special Condition S1.

## E. Effluent limits which are near detection or quantitation levels

The water quality-based effluent concentration values that are near the limits of current analytical methods to detect or accurately quantify. The method detection level (MDL) also known as detection level (DL) is the minimum concentration of a pollutant that a laboratory can measure and report with a 99 percent confidence that its concentration is greater than zero (as determined by a specific laboratory method). The quantitation level (QL) is the level at which a laboratory can reliably report concentrations with a specified level of error. Estimated concentrations are the values between the DL and the QL. Ecology requires permitted facilities to report estimated concentrations. When reporting maximum daily effluent concentrations, Ecology requires the facility to report “less than X” where X is the required detection level if the measured effluent concentration falls below the detection level.

# V. Other Permit Conditions

## A. Reporting and record keeping

Ecology based Special Condition S3 on its authority to specify any appropriate reporting and recordkeeping requirements to prevent and control waste discharges (WAC 173-216-110).

## B. Operations and maintenance

Ecology requires dischargers to take all reasonable steps to properly operate and maintain their wastewater treatment system in accordance with state regulations (WAC 173-240-080 and WAC 173-216-110). The facility must prepare and submit of an operation and maintenance (O&M) manual for the wastewater facility.

Implementation of the procedures in the operation and maintenance manual ensures the facility's compliance with the terms and limits in the permit and ensures the facility provides AKART to the waste stream.

## C. Non-routine and unanticipated wastewater

Occasionally, this facility may generate wastewater that was not characterized in the permit application because it is not a routine discharge and was not anticipated at the time of application. These wastes typically consist of waters used to pressure-test storage tanks or fire water systems or of leaks from drinking water systems.

The permit authorizes the discharge of non-routine and unanticipated wastewater under certain conditions. The facility must characterize these wastewaters for pollutants and examine the opportunities for reuse. Depending on the nature and extent of pollutants in this wastewater and on any opportunities for reuse, Ecology may:

- Authorize the facility to discharge the wastewater.
- Require the facility to treat the wastewater.
- Require the facility to reuse the wastewater.

## D. Industrial storm water discharge

In accordance with 40 CFR 122.26, the permit includes a requirement for the facility to apply for Ecology's Industrial Stormwater General Permit for authorization to discharge storm water that is exposed to industrial activities that require coverage under that permit, if applicable. The current use at the site does not require this coverage.

Most of the storm water generated at this site is discharged to ground and infiltrates. However, there is a potential for storm water from the land treatment area to enter surface water. The permittee must manage storm water by preventing exposure of sources of pollution, infiltrating storm water or a combination of both. Storm water has potential to enter the Green River if it reaches a catch basin.

GACO Western Inc previously had coverage under Industrial Stormwater permit SO30000113D for SIC code 2851 (Paint and Allied Products). Coverage was terminated at the end of 2009. Ecology last inspected for this permit in 2006. The industrial operations that required this permit coverage ceased by 2010.

## E. Best management practices – land treatment site

Best management practices (BMPs) are the actions identified to manage, prevent contamination of storm water/ groundwater. BMPs include schedules of activities, prohibitions of practices, maintenance procedures, and other physical, structural and/or managerial practices to prevent or reduce the pollution of waters of the state. BMPs also include treatment systems, operating procedures, and practices used to control plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage. The list below describes best management practices applicable for land treatment sites.

The Permittee must:

1. Not allow spray irrigation practices to result in runoff of wastewater to any surface waters of the state or to any land not owned by or under its control.
2. Use recognized good practices, and all available and reasonable procedures to control odors from the land application system.
3. Implement measures to reduce odors to a reasonable minimum when notified by Ecology.
4. Not apply wastewater to the irrigation lands in quantities that would:
    a. Significantly reduce or destroy the long-term infiltration rate of the soil.
    b. Cause long-term anaerobic conditions in the soil.
    c. Cause ponding of wastewater and produce objectionable odors or support insects or vectors.
    d. Cause leaching losses of constituents of concern beyond the treatment zone or in excess of the approved design. Constituents of concern are constituents in the wastewater, partial decomposition products, or soil constituents that would alter groundwater quality in amounts that would affect current and future beneficial uses.
5. Maintain all irrigation agreements for lands not owned for the duration of the permit cycle. Any reduction in irrigation lands by termination of any irrigation agreements may result in permit modification or revocation.
6. Immediately inform Ecology in writing of any proposed changes to existing irrigation agreements.
7. Meet the leaching requirement using precipitation and/or fresh water whenever leaching is required to control soil salinity.
8. Reduce wastewater application during the months of November to March to ensure plant uptake during the dormant season is not exceeded.

### F. General conditions

Ecology bases the standardized general conditions on state law and regulations. They are included in all individual industrial state waste discharge permits issued by Ecology.

# VI. Permit Issuance Procedures

### A. Permit modifications

Ecology may modify this permit to impose numerical limits, if necessary, to comply with water quality standards for groundwater, based on new information from sources such as inspections, effluent monitoring, outfall studies, and effluent mixing studies.

Ecology may also modify this permit to comply with new or amended state regulations.

### B. Proposed permit issuance

This proposed permit meets all statutory requirements for Ecology to authorize a wastewater discharge. The permit includes limits and conditions to protect human health and aquatic life, and the beneficial uses of waters of the state of Washington. Ecology proposes to issue this permit for a term of 5 years.

# VII. References for Text and Appendices

Gavlak, R., D. Horneck , R.O. Miller, and J. Kotuby-Amacher.

3rd edition 2005. Soil, Plant And Water Reference Methods For The Western Region Soil, Plant And Water Reference Methods For The Western Region

GWI Holdings, Inc.
August 2018. Application for a State Waste Discharge Permit to Discharge Industrial Wastewater to Ground Water by Land Treatment or Application.

Washington State Department of Ecology.

1993. Guidelines for Preparation of Engineering Reports for Industrial Wastewater Land Application Systems, Ecology Publication Number 93-36. 20 pp. Guidelines for Preparation of Engineering Reports for Industrial Wastewater Land Application Systems

Laws and Regulations (Regulations-Permits)

Permit and Wastewater Related Information (Water Quality Permits)

Revised October 2005. *Implementation Guidance for the Ground Water Quality Standards*, Ecology Publication Number 96-02. Implementation Guidance for the Ground Water Quality Standards

December 2011. *Permit Writer's Manual*, Publication Number 92-109 (Permit Writer's Manual)

February 2007. *Focus Sheet on Solid Waste Control Plan, Developing a Solid Waste Control Plan for Industrial Wastewater Discharge Permittee*s, Publication Number 07-10-024. Focus Sheet on Solid Waste Control Plan, Developing a Solid Waste Control Plan for Industrial Wastewater Discharge Permittees

November 2004. *Guidance on Land Treatment of Nutrients in Wastewater, with Emphasis on Nitrogen*, Ecology Publication #04-10-081; Guidance on Land Treatment of Nutrients in Wastewater, with Emphasis on Nitrogen

# Appendix A--Public Involvement Information

Ecology proposes to issue a permit to GWI Holdings, Inc. / GACO Western. The permit includes wastewater discharge limits and other conditions. This fact sheet describes the facility and Ecology's reasons for requiring permit conditions.

Ecology will place a Public Notice of Draft on February 9, 2021 in the Seattle Times to inform the public and to invite comment on the proposed draft State Waste Discharge permit and fact sheet.

The notice:

- Tells where copies of the draft Permit and Fact Sheet are available for public evaluation
  (a local public library, the closest Regional or Field Office, posted on our website).
- Offers to provide the documents in an alternate format to accommodate special needs.
- Urges people to submit their comments, in writing, before the end of the Comment Period.
- Tells how to request a public hearing of comments about the proposed state waste discharge permit.
- Explains the next step(s) in the permitting process.

Ecology has published a document entitled Frequently Asked Questions about Effective Public Commenting, which is available on our website at Frequently Asked Questions about Effective Public Commenting.

You may obtain further information from Ecology by telephone, 425-649-7201, or by writing to the address listed below.

Water Quality Permit Coordinator
Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452

The primary author of this permit and fact sheet is Christopher Martin.

# Appendix B--Your Right to Appeal

You have a right to appeal this permit to the Pollution Control Hearing Board (PCHB) within thirty (30) days of the date of receipt of the final permit. The appeal process is governed by chapter 43.21B RCW and chapter 371-08 WAC. "Date of receipt" is defined in RCW 43.21B.001(2) (see glossary).

To appeal, you must do the following within thirty (30) days of the date of receipt of this permit:

- File your appeal and a copy of this permit with the PCHB (see addresses below). Filing means actual receipt by the PCHB during regular business hours.
- Serve a copy of your appeal and this permit on Ecology in paper form - by mail or in person. (See addresses below.) E-mail is not accepted.

You must also comply with other applicable requirements in chapter 43.21B RCW and chapter 371-08 WAC.

## ADDRESS AND LOCATION INFORMATION

| Street Addresses | Mailing Addresses |
|---|---|
| Department of Ecology<br>Attn: Appeals Processing Desk<br>300 Desmond Drive SE<br>Lacey, WA 98503 | Department of Ecology<br>Attn: Appeals Processing Desk<br>PO Box 47608<br>Olympia, WA 98504-7608 |
| Pollution Control Hearings Board<br>1111 Israel RD SW<br>STE 301<br>Tumwater, WA 98501 | Pollution Control Hearings Board<br>PO Box 40903<br>Olympia, WA 98504-0903 |

# Appendix C--Glossary

**AKART --** The acronym for "all known, available, and reasonable methods of prevention, control and treatment." AKART is a technology-based approach to limiting pollutants from wastewater discharges, which requires an engineering judgment and an economic judgment. AKART must be applied to all wastes and contaminants prior to entry into waters of the state in accordance with RCW 90.48.010 and 520, WAC 173-200-030(2)(c)(ii), and WAC 173-216-110(1)(a).

**Alternate point of compliance --** An alternative location in the groundwater from the point of compliance where compliance with the groundwater standards is measured. It may be established in the groundwater at locations some distance from the discharge source, up to, but not exceeding the property boundary and is determined on a site-specific basis following an AKART analysis. An "early warning value" must be used when an alternate point is established. An alternate point of compliance must be determined and approved in accordance with WAC 173-200-060(2).

**Ambient water quality --** The existing environmental condition of the water in a receiving water body.

**Average monthly discharge limit --** The average of the measured values obtained over a calendar months' time.

**Background water quality --** The concentrations of chemical, physical, biological or radiological constituents or other characteristics in or of groundwater at a particular point in time up gradient of an activity that has not been affected by that activity [WAC 173-200-020(3)]. Background water quality for any parameter is statistically defined as the 95% upper tolerance interval with a 95% confidence based on at least eight hydraulically upgradient water quality samples. The eight samples are collected over a period of at least one year, with no more than one sample collected during any month in a single calendar year.

**Best management practices (BMPs) --** Schedules of activities, prohibitions of practices, maintenance procedures, and other physical, structural and/or managerial practices to prevent or reduce the pollution of waters of the state. BMPs include treatment systems, operating procedures, and practices to control: plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. BMPs may be further categorized as operational, source control, erosion and sediment control, and treatment BMPs.

**$BOD_5$ --** Determining the five-day Biochemical Oxygen Demand of an effluent is an indirect way of measuring the quantity of organic material present in an effluent that is utilized by bacteria. The $BOD_5$ is used in modeling to measure the reduction of dissolved oxygen in receiving waters after effluent is discharged. Stress caused by reduced dissolved oxygen levels makes organisms less competitive and less able to sustain their species in the aquatic environment. Although $BOD_5$ is not a specific compound, it is defined as a conventional pollutant under the federal Clean Water Act.

**Bypass --** The intentional diversion of waste streams from any portion of a treatment facility.

**Clean water act (CWA) --** The federal Water Pollution Control Act enacted by Public Law 92-500, as amended by Public Laws 95-217, 95-576, 96-483, 97-117; USC 1251 et seq.

**Compliance inspection-without sampling --** A site visit for the purpose of determining the compliance of a facility with the terms and conditions of its permit or with applicable statutes and regulations.

**Compliance inspection-with sampling --** A site visit for the purpose of determining the compliance of a facility with the terms and conditions of its permit or with applicable statutes and regulations. In addition it includes as a minimum, sampling and analysis for all parameters with limits in the permit to ascertain compliance with those limits; and, for municipal facilities, sampling of influent to ascertain compliance with the 85 percent removal requirement. Ecology may conduct additional sampling.

**Composite sample --** A mixture of grab samples collected at the same sampling point at different times, formed either by continuous sampling or by mixing discrete samples. May be "time-composite" (collected at constant time intervals) or "flow-proportional" (collected either as a constant sample volume at time intervals proportional to stream flow, or collected by increasing the volume of each aliquot as the flow increased while maintaining a constant time interval between the aliquots).

**Construction activity --** Clearing, grading, excavation, and any other activity, which disturbs the surface of the land. Such activities may include road building; construction of residential houses, office buildings, or industrial buildings; and demolition activity.

**Continuous monitoring --** Uninterrupted, unless otherwise noted in the permit.

**Date of receipt –** This is defined in RCW 43.21B.001(2) as five business days after the date of mailing; or the date of actual receipt, when the actual receipt date can be proven by a preponderance of the evidence. The recipient's sworn affidavit or declaration indicating the date of receipt, which is unchallenged by the agency, constitutes sufficient evidence of actual receipt. The date of actual receipt, however, may not exceed forty-five days from the date of mailing.

**Detection limit --** The minimum concentration of a substance that can be measured and reported with 99 percent confidence that the pollutant concentration is above zero and is determined from analysis of a sample in a given matrix containing the pollutant.

**Early warning value --** The concentration of a pollutant set in accordance with WAC 173-200-070 that is a percentage of an enforcement limit. It may be established in the effluent, groundwater, surface water, the vadose zone or within the treatment process. This value acts as a trigger to detect and respond to increasing contaminant concentrations prior to the degradation of a beneficial use.

**Enforcement limit --** The concentration assigned to a contaminant in the groundwater at the point of compliance for the purpose of regulation, [WAC 173-200-020(11)]. This limit assures that a groundwater criterion will not be exceeded and that background water quality will be protected.

**Engineering report --** A document that thoroughly examines the engineering and administrative aspects of a particular domestic or industrial wastewater facility. The report must contain the appropriate information required in WAC 173-240-060 or 173-240-130.

**Grab sample --** A single sample or measurement taken at a specific time or over as short a period as is feasible.

**Groundwater --** Water in a saturated zone or stratum beneath the surface of land or below a surface water body.

**Maximum daily discharge limit --** The highest allowable daily discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. The daily discharge is the maximum discharge of a pollutant measured during a calendar day.

**Method detection level (MDL) --** See Detection Limit.

**National pollutant discharge elimination system (NPDES) --** The NPDES (Section 402 of the Clean Water Act) is the federal wastewater permitting system for discharges to navigable waters of the United States. Many states, including the state of Washington, have been delegated the authority to issue these permits. NPDES permits issued by Washington State permit writers are joint NPDES/State permits issued under both state and federal laws.

**pH --** The pH of a liquid measures its acidity or alkalinity. It is the negative logarithm of the hydrogen ion concentration. A pH of 7 is defined as neutral and large variations above or below this value are considered harmful to most aquatic life.

**Point of compliance --** The location in the groundwater where the enforcement limit must not be exceeded and a facility must comply with the Ground Water Quality Standards. Ecology determines this limit on a site-specific basis. Ecology locates the point of compliance in the groundwater as near and directly down gradient from the pollutant source as technically, hydrogeologically, and geographically feasible, unless it approves an alternative point of compliance.

**Quantitation level (QL) --** Also known as Minimum Level of Quantitation (ML) – The lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. It is equivalent to the concentration of the lowest calibration standard, assuming that the lab has used all method-specified sample weights, volumes, and cleanup procedures. The QL is calculated by multiplying the MDL by 3.18 and rounding the result to the number nearest to (1, 2, or 5) x $10^n$, where n is an integer (64 FR 30417).
ALSO GIVEN AS:
The smallest detectable concentration of analyte greater than the Detection Limit (DL) where the accuracy (precision & bias) achieves the objectives of the intended purpose. (Report of the Federal Advisory Committee on Detection and Quantitation Approaches and Uses in Clean Water Act Programs Submitted to the US Environmental Protection Agency, December 2007).

**Reasonable potential --** A reasonable potential to cause a water quality violation, or loss of sensitive and/or important habitat.

**Responsible corporate officer --** A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation, or the manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or have gross annual sales or expenditures exceeding $25 million (in second quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures (40 CFR 122.22).

**Sample Maximum --** No sample may exceed this value.

**Soil scientist --** An individual who is registered as a Certified or Registered Professional Soil Scientist or as a Certified Professional Soil Specialist by the American Registry of Certified Professionals in Agronomy, Crops, and Soils or by the National Society of Consulting Scientists or who has the credentials for membership. Minimum requirements for eligibility are: possession of a baccalaureate, masters, or doctorate degree from a U.S. or Canadian institution with a minimum of 30 semester hours or 45 quarter hours professional core courses in agronomy, crops or soils, and have 5,3,or 1 years, respectively, of professional experience working in the area of agronomy, crops, or soils.

**Solid waste --** All putrescible and non-putrescible solid and semisolid wastes including, but not limited to, garbage, rubbish, ashes, industrial wastes, swill, sewage sludge, demolition and construction wastes, abandoned vehicles or parts thereof, contaminated soils and contaminated dredged material, and recyclable materials.

**State waters --** Lakes, rivers, ponds, streams, inland waters, underground waters, salt waters, and all other surface waters and watercourses within the jurisdiction of the state of Washington.

**Stormwater --** That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes, and other features of a stormwater drainage system into a defined surface water body, or a constructed infiltration facility.

**Technology-based effluent limit --** A permit limit based on the ability of a treatment method to reduce the pollutant.

**Total dissolved solids --** That portion of total solids in water or wastewater that passes through a specific filter.

**Total suspended solids (TSS) --** Total suspended solids is the particulate material in an effluent. Large quantities of TSS discharged to a receiving water may result in solids accumulation. Apart from any toxic effects attributable to substances leached out by water, suspended solids may kill fish, shellfish, and other aquatic organisms by causing abrasive injuries and by clogging the gills and respiratory passages of various aquatic fauna. Indirectly, suspended solids can screen out light and can promote and maintain the development of noxious conditions through oxygen depletion.

**Upset --** An exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limits because of factors beyond the reasonable control of the Permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, lack of preventative maintenance, or careless or improper operation.

**Water quality-based effluent limit --** A limit imposed on the concentration of an effluent parameter to prevent the concentration of that parameter from exceeding its water quality criterion after discharge into receiving waters.

# Appendix D--Technical Calculations

## Determination of Permit Limits

Ecology has specialized tools available to assist with the calculation of limits for inclusion in permits. Each tool uses a slightly different method of calculation to arrive at a unique limit value and each tool has certain strengths and weaknesses. Two of the methods available (PermitCalcDec2016V1.1_GW [PermitCalc] and TSDCalc11 for GW [TSDCalc]) use data for effluent, receiving water, and water quality criteria; while the third method (TSD for WQ Limits) is a direct calculation method using all available effluent or groundwater data. PermitCalc and TSDCalc were originally written for discharges to surface water, but have been modified to calculate groundwater limits. Modifications include adding parameters with groundwater quality standards to the list of available parameters and changing values for existing parameters from the surface water to the groundwater standard; changing the calculation of dilution factor from that used for a surface water mixing zone to one used for groundwater; removal of "acute" and "chronic" criteria and substitution with a single line for groundwater criteria; and changing units from micrograms per liter (µg/L) to milligrams per liter (mg/L). The strength of both PermitCalc and TSDCalc are that they use information from the receiving waters to arrive at a limit value. A weakness for both is that they assume a log-normal distribution for the data set.

The TSD for WQ Limits tool's strength lies in the fact that it uses all available data to calculate a limit and allows for the application of the any normality distribution. The weakness lies with the fact that the limit value calculated from effluent values reflects only current wastewater treatment, and may not be protective of groundwater. This is due to using only effluent data in the calculations, thus there is no opportunity to add a dilution factor or perform a comparison to ambient groundwater conditions.

Because of the different strengths and weaknesses of the tools, both PermitCalc and TSDCalc are used to determine which constituents show a reasonable potential to exceed groundwater limits. TSD for WQ Limits is used to calculate limits and early warning values for groundwater. Groundwater limits and early warning values are normally calculated using receiving water data. However in this case, data is for discharge from the pilot project PhAGRs, and background groundwater data is from well MW-9.

Before any limit calculations are conducted, the entire data set is subjected to basic descriptive statistical analyses. Because there have been only a limited number of sampling events during the pilot project results from individual PhAGRs have been combined into their three main containment groups as shown in Table D-5.

### Table D-5. PhAGR Containments

| Containment No. | PhAGR No. | Number of Samples | Description |
|---|---|---|---|
| CW-1 | 1 | 5 | 2-yr old trees in perlite. |
| | 2 | 7 | 2-yr old trees in perlite. |
| | 3 | 5 | 2-yr old trees in perlite. |
| | 4 | 4 | 2-yr old trees in perlite. |
| | CW-1 | 3 | 2-yr old trees in perlite. |
| CW-2 | 5 | 5 | Newly planted trees in site soil. |
| | 6 | 3 | Soil blank. |

| Containment No. | PhAGR No. | Number of Samples | Description |
|---|---|---|---|
| | 7 | 2 | Soil blank. |
| | 8 | 3 | Newly planted trees in site soil. |
| | 9 | 3 | Newly planted trees in site soil. |
| | CW-2 | 3 | Newly planted trees in site soil. |
| CW-3 | 10 | 0 | Newly planted trees in perlite. |
| | 11 | 2 | Perlite blank. |
| | 12 | 3 | Newly planted trees in perlite. |
| | 13 | 4 | Newly planted trees in perlite. |
| | 14 | 4 | Newly planted trees in perlite. |
| | 15 | 7 | Newly planted trees in perlite. |
| | CW-3 | 3 | Newly planted trees in perlite. |
| MW-9 | MW-9 | 5 | Groundwater monitoring well. |
| | T-2 | 7 | Groundwater holding tank. |

Each parameter for each containment (CW-1, CW-2, CW-3, and MW-9) is first evaluated for statistical outliers, seasonality, normality, and equality of variance. Basic descriptive statistics (mean [average], minimum, maximum, median, standard deviation, variance, and 95$^{th}$ percentile) are calculated for the three containment data sets both with and without outliers removed. The PermitCalc worksheet also requires calculation of the geometric mean, and 50$^{th}$ and 90$^{th}$ percentiles. All statistics are done using the Sanitas statistical software program by Sanitas Technologies, and the methods detailed in the EPA 530/R-09-007, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*, March 2009 (Unified Guidance).

Outliers are determined by the method set out in EPA G-89-00018, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities Interim Final Guidance*, April, 1989. Outlier normality is tested using the Shapiro-Francia method (Shapiro-Wilk if n <= 10) with an alpha of 0.1. Seasonality is tested using the Kruskal-Wallis test and the default of four seasons. If the calculated Kruskal-Wallis statistic is greater than the tabulated Chi-squared value, then seasonality is confirmed. If a parameter is determined to have seasonality, the software program automatically deseasonalizes before conducting any analysis. Normality of the data set is tested using the Ladder of Powers again at an alpha of 0.1. The Ladder of Powers allows for testing of multiple statistical distributions at one time. Statistical distributions include normal, log-normal, square-root normal, cube-root normal, square normal, cube normal, $x^4$ normal, $x^5$ normal, and $x^6$ normal. Equality of variance is tested using Levene's Equality of Variance method.

Seasonality is not found in any of the data due to insufficient seasonal data (data spans only six months, July to December).

Each containment was tested for 15 parameters; 1,1,2,2-tetrachloroethane, 1,1-dichloroethene, 1,2-dichloroethene, acrylonitrile, benzene, cis-1,2-dichloroethene, ethylbenzene, ethylene dibromide, m,p-xylene, o-xylene, tetrachloroethene, toluene, trans-1,2-dichloroethene, trichloroethene, and vinyl chloride. Of these only seven (1,2-dichloroethene, benzene, ethylbenzene, m,p-xylene, o-xylene, toluene, and vinyl chloride) had sufficient detections above the reporting limit to allow meaningful statistical analysis.

Outliers are determined for each of the seven parameters for each containment. Outliers are determined in CW-1 for 1,2 dichloroethane, toluene, and vinyl chloride. CW-2 has only outliers for ethylbenzene and o-xylene, while CW-3 has outliers for 1,2 dichloroethane, o-xylene, and toluene. MW-9 has outliers for ethylbenzene, o-xylene, toluene, and vinyl chloride.

To obtain the greater statistical power the three containments are combined. Before this was done inter-containment analyses were done for the pairings of CW-1 and CW-2, CW-1 and CW-3, and CW-2 and CW-3. A Levene's test of equivalence of variance, a standard analysis of variance (ANOVA), and a Mann-Kendell test were done for each parameter for each of the three pairings. If a particular pairing showed a variation for any of the three statistical tests then the values associated with one of the containments was not combined in the final data set. The best example is for benzene, where the pairings CW-1 – CW-2 and CW-1 – CW-3 show a variance and the pairing CW-2 – CW-3 does not, the values for CW-1 are not used in the final combined data set. Table D-6 shows the results of the inter-containment testing.

## Table D-6. Containment Pairing Statistical Analysis Results

| Parameter | Pairing | Statistical Test | Notes |
|---|---|---|---|
| Benzene | CW-1 – CW-2 | Levene's [a] | No outliers removed. |
| | | Levene's | Seven CW-1 and three CW-2 outliers removed. |
| | | ANOVA [a] | Seven CW-1 and three CW-2 outliers removed. |
| | | Mann-Kendall [c] (95%) [d] | Seven CW-1 and three CW-2 outliers removed. |
| Ethylbenzene | | Levene's | Two CW-2 outliers removed. |
| | | Mann-Kendall (80%) [d] | No outliers removed. |
| o-xylene | | Mann-Kendall (80%) | No outliers removed. |
| Toluene | | Levene's | No outliers removed. |
| | | Levene's | Three CW-1 outliers removed. |
| Vinyl Chloride | | Levene's | Three CW-1 outliers removed. |
| | | Mann-Kendall (80%) [d] | Three CW-1 outliers removed. |
| Benzene | CW-1 – CW-3 | Levene's | No outliers removed. |
| m,p-xylene | | Levene's | Four CW-1 and one CW-3 outliers removed. |
| o-xylene | | ANOVA | No outliers removed. |
| | | Mann-Kendall (98%) | No outliers removed. |
| Toluene | | Mann-Kendall (80%) [d] | No outliers removed. |
| | | Mann-Kendall (80%) [d] | Three CW-1 outliers removed. |
| Vinyl Chloride | | Levene's | Three CW-1 outliers removed. |
| | | Mann-Kendall (80%) [d] | Three CW-1 outliers removed. |
| Benzene | CW-2 – CW-3 | Levene's | No outliers removed. |
| Ethylbenzene | | Levene's | Two CW-2 outliers removed. |
| | | Mann-Kendall (90%) [d] | No outliers removed. |
| | | Mann-Kendall (80%) [d] | Two CW-2 outliers removed. |

| | |
|---|---|
| [a] | Levene's = Levene's test for equality of variance. |
| [b] | ANOVA = Analysis of variance between means. All are non-parametric tests. |
| [c] | Mann-Kendall = A non-parametric test of equivalence of means. |
| [d] | Value in parenthesis is the confidence level of the test. As an example an 80% confidence is not as strong a significance as a 95% confidence. |

Based on these results, the values from CW-1 for benzene, toluene, and vinyl chloride were not included in the final combined data set. Values for ethylbenzene in CW-2 also not included in the final combined data set.

Statistical analysis was also conducted on the final combined data set. Two outliers are identified for 1,2-dichloroethane and one outlier for toluene. Additional investigation into suspect results lead to the identification of six benzene values, five ethylbenzene values, eight m,p-xylene values, seven o-xylene values, and three additional toluene value.

Through the Ladder of Powers normality testing all parameters were identified as non-normal in the final combined data set. Normality's to be used by the TSD for WQ workbook are determined by reviewing a closeness of fit of residuals on a probability plot for each parameter. This method yielded a natural log distribution best fit for 1,2-dichloroethane, benzene, and m, p-xylene. Ethylbenzene, o-xylene, and toluene have a best fir with an $x^6$ (sixth power) distribution. Vinyl chloride best fit is a cubed distribution.

Tables D-8 through D-10 show the descriptive statistcal results for the individual containments. Table D-11 lists the descriptive statistics for the combined data set, while Table D-12 presents to the statistics for the source water. Table D-13 shows the normality results for the final combined data set from the Shapiro-Francia outlier test and the Ladder of Powers test, and what distribution was used for final calculations.

# Determination of Groundwater Early Warning Values

This facility has three wells monitoring the land treatment area. Well MW-1 is the up gradient well and provides background groundwater concentrations. Wells MW-2 and MW-3 are down gradient and monitor groundwater for constituent concentrations potentially impacted by land application.

Groundwater early warning values are determined using the scenarios shown in Table D-7 to determine what constituents, if any, have a reasonable potential to contaminate groundwater.

To account for processes that occur in the soil column and dilution in the aquifer a dilution attenuation factor (DAF) is used in PermitCalc. The method used to calculate the DAF is from the EPAs soil screening guidance document (EPA, 1996). It uses site-specific soils information in the following equation:

$$DAF = 1 + \frac{Kid}{IL}$$

Where: DAF = Dilution Attenuation Factor (unit less)

K = Aquifer hydraulic conductivity (feet/year)

i = Hydraulic gradient (feet/foot)

d = Mixing zone depth (feet)

I = Infiltration rate (feet/hour), and

L = Source length measured parallel to groundwater flow (feet).

Mixing zone depth is determined from many of the same parameters as follows:

$$d = \sqrt{(0.0112 * L^2)} + d^a * \left\{1 - \exp\left[{}^{(-LI)}/_{(Kid_a)}\right]\right\}$$

Where d = Mixing zone depth (feet)

$d_a$ = Aquifer thickness (feet), and

other variables as above.

For this permit the following values are used:

$d_a$ = 17 ft.

K = 517.32 ft/yr

i = 0.0007 ft/ft

I = 9.58 ft/hr

L = 248.94 ft, and

d = 44.496 ft.

Values for $d_a$ is the average aquifer thickness from the monitoring well logs in the area, *K* is estimated from a 2011 Landau Associates report for TCP and an on-site pump test, *i* is the average gradient across the application area determined from the piezometric map in the Landau report, *I* is the infiltration rate of the dominant soil in the application area from National Resources Conservation Service data, and *L* is the length of the application area measured parallel to groundwater flow. It should be noted that *I* is based on the reported saturated hydraulic conductivity of the soil. To convert this to a vertical rate the value is multiplied by 0.04 (4 %).

Two constituents, trans-1,2-dichloroethylene and trichloroethylene, show a reasonable potential for exceeding the groundwater standards. Only trichloroethylene showed a reasonable potential to exceed a humand health limit. These two are not considered for EWVs as the detection level is the same as the groundwater quality standard.

When compared to the groundwater quality standards 1,1-dichloroethane, 1,2-dichloroethane, acryolnitrile, benzene, trichloroethylene, and vinyl chloride show a reasonable potential to pollute. Results showed most combinations yielded very similar values. Determination of which constituents to propose for groundwater EWVs in the permit were determined through a combination of reviewing the various scenarios from PermitCalc and TSDCalc.

Using the review rationale stated above groundwater early warning values are proposed for 1,1-dichloroethene, 1,2-dichloroethene, acrylonitrile, benzene and vinyl chloride. Ethylbenzene, m,p-xylene, and toluene will be monitored, but current detectable levels and calculated EWVs are below their respective groundwater quality standards. Even though the workbook shows a potential human health impact from acrylonitrile and trichloroethylene to date these values have been below their reporting limits.

Groundwater EWVs are derived using the TSD for WQ Limits spreadsheet. The reason for not using PermitCalc is that Ecology determined both PermitCalc and TSDCalc spreadsheets tend to overestimate the resulting limit values when compared to the TSD for WQ spreadsheet. The TSD for WQ Limits spreadsheet calculates both a daily maximum and a monthly average. For the EWVs the monthly average value at the 95% confidence level is used. Tables D-14 through D-16 are examples of the PermitCalc workbook. Specifically they show the maximum, 95%,

and 50% effluent concentrations with the groundwater standards as the receiving water. Tables D-17 and D-18 provide the TSD for WQ calculation definitions and the calculations for the groundwater ealry warning parameters, resepctively.

## Table D-7. Early Warning Value Reasonable Potential Calculation Scenarios

| Effluent [A] | Receiving Water [B] | Water Quality Criteria 1 [C] | Water Quality Criteria 2 [D] | Other | Table No. [E] |
|---|---|---|---|---|---|
| Combined Max | Combined 90th Percentile | Combined 95th Percentile | GWQS [F] | Default CV [G, H] | |
| Combined Max | Combined 90th Percentile | Combined 95th Percentile | GWQS | Calculated CV [I] | |
| Combined Max | GWQS 90th Percentile | GWQS 95th Percentile | GWQS | Calculated CV | D-14 |
| Combined 95th Percentile | Combined 90th Percentile | Combined 95th Percentile | GWQS | Default CV | |
| Combined 95th Percentile | Combined 90th Percentile | Combined 95th Percentile | GWQS | Calculated CV | |
| Combined 95th Percentile | GWQS 90th Percentile | GWQS 95th Percentile | GWQS | Calculated CV | D-15 |
| Combined 50th Percentile | Combined Geometric Mean | Combined 95th Percentile | GWQS | Default CV | |
| Combined 50th Percentile | Combined Geometric Mean | Combined 95th Percentile | GWQS | Calculated CV | |
| Combined 50th Percentile | GWQS 90th Percentile | GWQS 95th Percentile | GWQS | Calculated CV | D-16 |

| | |
|---|---|
| A | Effluent ≡ value used for the effluent concentration. Scenarios are run using the combined maximum, 95th percentile, and 50th percentile of data from July to December 2018. |
| B | Receiving Water ≡ value used for receiving water in calculations. Equal to the geometric mean when number of samples is greater than 10 (n > 10). |
| C | Water Quality Criteria 1 ≡ the 95th percentile of the data from July to December 2018 for each parameter. |
| D | Water Quality Criteria 2 ≡ the groundwater quality standard. |
| E | Table No. refers to the tables below with that PermitCalc scenario. |
| F | GWQS ≡ Groundwater Quality Standard |
| G | CV ≡ Coefficient of Variance. |
| H | Default CV ≡ the default CV value in the PermitCalc worksheet of 0.6. |
| I | Calculated CV ≡ CV value calculated for each parameter using the equation CV = $\bar{X}/\sigma$, where $\bar{x}$ is the sample mean and σ is the sample standard deviation. |

## Table D-8. Descriptive Statistics for CW-1 [A]

| Parameter | Count | Average [B] | Minimum | Maximum | Median | Geomean | Std Dev [C] | Variance | CV [D] | Percentile | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 50th | 90th | 95th |
| 1,1,2,2-Tetrachloroethane [E] | 24 | 0.0275 | 0.2 | 0.02 | 0.02 | 0.02201 | 0.03674 | 0.00135 | 1.34 | 0.02 | 0.02 | 0.02 |
| 1,1-Dichloroethene [F] | 24 | 0.0458 | 0.459 | 0.02 | 0.02 | 0.02508 | 0.09536 | 0.00909 | 2.08 | 0.02 | 0.02 | 0.173 |
| 1,2-Dichloroethane [G] | 24 | 0.0291 | 0.257 | 0.0129 | 0.01935 | 0.02056 | 0.04886 | 0.00239 | 1.68 | 0.01935 | 0.02863 | 0.0297 |
| Acrylonitrile [H] | 24 | 0.0779 | 0.5 | 0.05 | 0.05 | 0.05904 | 0.10048 | 0.01010 | 1.29 | 0.05 | 0.05 | 0.237 |
| Benzene [I] | 25 | 3.34 | 32.8 | 0.02 | 0.164 | 0.22086 | 8.92 | 79.48 | 2.67 | 0.164 | 7.94 | 26.8 |
| cis-1,2-Dichloroethene [J] | 24 | 0.0347 | 0.2 | 0.0134 | 0.02 | 0.02466 | 0.04639 | 0.00215 | 1.34 | 0.02 | 0.0445 | 0.1485 |
| Ethylbenzene [K] | 24 | 0.5999 | 4.49 | 0.0474 | 0.2 | 0.22265 | 1.195 | 1.43 | 1.99 | 0.2 | 2.23 | 3.296 |
| Ethylene Dibromide [L] | 24 | 0.0138 | 0.1 | 0.01 | 0.01 | 0.01101 | 0.01837 | 0.00034 | 1.34 | 0.01 | 0.01 | 0.01 |
| m, p-Xylene [M] | 25 | 4.01 | 25.4 | 0.0522 | 0.4 | 0.56488 | 8.56 | 73.304 | 2.14 | 0.4 | 21.5 | 23.9 |
| o-Xylene [N] | 24 | 0.4859 | 3.37 | 0.0361 | 0.2 | 0.24078 | 0.88553 | 0.78416 | 1.82 | 0.2 | 0.9094 | 2.88 |
| Tetrachloroethene [O] | 24 | 0.0275 | 0.2 | 0.02 | 0.02 | 0.02201 | 0.03674 | 0.00135 | 1.34 | 0.02 | 0.02 | 0.02 |
| Toluene [P] | 24 | 0.3061 | 1.33 | 0.0771 | 0.2 | 0.23697 | 0.31330 | 0.09816 | 1.02 | 0.2 | 0.6263 | 1.08 |
| trans-1,2-Dichloroethene [Q] | 24 | 0.0273 | 0.2 | 0.0144 | 0.02 | 0.02171 | 0.03681 | 0.00135 | 1.35 | 0.02 | 0.02 | 0.02 |
| Trichloroethene [R] | 24 | 0.0275 | 0.2 | 0.02 | 0.02 | 0.02201 | 0.03674 | 0.00135 | 1.34 | 0.02 | 0.02 | 0.02 |
| Vinyl Chloride [S] | 24 | 0.0686 | 0.869 | 0.0141 | 0.02 | 0.02994 | 0.17483 | 0.03056 | 2.55 | 0.02 | 0.07532 | 0.1834 |

| | |
|---|---|
| A | Statistical outliers are noted on the footnotes. But are included in the statistical calculations. |
| B | All values are in micrograms per liter (µg/L). |
| C | Std Dev ≡ Standard Deviation. |
| D | CV ≡ Coefficient of Variation. |
| E | One statistical outlier identified for 1,1,2,2-Tetrachloroethane; <0.2 on 11/13/2018 (11/15/2018 in the data set). |
| F | Two statistical oultiers identified for 1,1-Dichloroethene; 0.0459 on 07/27/2018 and <0.2 on 11/13/2018 (07/29 and 11/15/2018 in the data set). |
| G | One statistical outlier identified 1,2-Dichloroethane; 0.257 on 11/13/2018 (11/15/2018 in the data set). |
| H | Two statistical oultiers identified for Acryonitrile; 0.027 on 07/27/2018 and <0.5 on 11/13/2018 (07/29 and 11/15/2018 in the data set). |
| I | Four statistical outliers identified Benzene; 32.8 and 31.4 on 07/27/2018, 8.4 and 7.24 on 11/13/2018 (07/29, 07/30, 11/14, and 11/15/2018, respectively, in the data set). |
| J | Four statistical outliers identified cis-1,2-Dichloroethene; 0.165 on 07/27/2018, <0.2, 0055 on 11/13/2018, and 0.0134 on 12/13/2018 (07/29, 11/14, 11/15, and 12/15/2018, respectively, in the data set). |
| K | Three statistical outliers identified Ethylbenzene; 4.49 on 07/27/2018, 3.31 and 3.33 on 11/13/2018 (07/29, 11/14, 11/15/208, respectively, in the data set. |

| Parameter | Count | Average [B] | Minimum | Maximum | Median | Geomean | Std Dev [C] | Variance | CV [D] | Percentile | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 50th | 90th | 95th |
| L | One statistical outlier identified for Ethylene Dibromide; <0.1 on 11/13/2018 (11/15/2018 in the data set). | | | | | | | | | | | |
| M | Four statistical outliers identified for m,p-Xylene; 25.4 and 24.4 on 07/27/2018, 20.9 and 21.9 on 11/13/2018 (07/29, 07/30, 11/14, and 11/15, respectively, in the data set | | | | | | | | | | | |
| N | Four statistical outliers identified for o-Xylene; 1.21 on 07/27/2018, 0.208, 3.18, and 3.37 on 11/13/2018 (07/29, 11/13, 11/14, and 11/15, respectively, in the data set). | | | | | | | | | | | |
| O | One statistical outlier identified for Tetrachloroethene; <0.2 on 11/13/2018 (11/15/2018 in the data set). | | | | | | | | | | | |
| P | Three statistical outliers identified for Toluene; 0.809 on 07/27/2018, 1.13 and 1.33 on 11/13/2018 (07/29, 11/14, and 11/15/2018, respectively, in the data set). | | | | | | | | | | | |
| Q | Two statistical outliers identified for trans-1,2-Dichloroethene; 0.0144 on 07/27/2018, and <0.2 on 11/13/2018 (07/29 and 11/15/2018 in the data set). | | | | | | | | | | | |
| R | One statistical outlier identified for Trichloroethene; <0.2 on 11/13/2018 (11/15/2018 in the data set). | | | | | | | | | | | |
| S | Three statistical outliers identified for Vinyl Chloride; 0.869 and 0.0893 on 07/27/2018, and < 0.2 on 11/13/2018 (07/29, 07/30, and 11/15, respectively, in the data set. | | | | | | | | | | | |

## Table D-9. Descriptive Statistics for CW-2 [A]

| Parameter | Count | Average [B] | Minimum | Maximum | Median | Geomean | Std Dev [C] | Variance | CV [D] | Percentile | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 50th | 90th | 95th |
| 1,1,2,2-Tetrachloroethane [E] | 19 | 0.0186 | 0.00653 | 0.02 | 0.01783 | 0.00419 | 0.00002 | 0.02 | 0.2254 | 0.02 | 0.02 | 0.02 |
| 1,1-Dichloroethene [F] | 19 | 0.0239 | 0.00773 | 0.02 | 0.02148 | 0.01422 | 0.00020 | 0.0654 | 0.5944 | 0.02 | 0.0283 | 0.06189 |
| 1,2-Dichloroethane | 19 | 0.0207 | 0.0123 | 0.0214 | 0.01979 | 0.00606 | 3.671E-05 | 0.0298 | 0.2925 | 0.0214 | 0.027 | 0.02944 |
| Acrylonitrile [G] | 19 | 0.0508 | 0.05 | 0.05 | 0.05073 | 0.00362 | 0.00001 | 0.0658 | 0.0713 | 0.05 | 0.05 | 0.05158 |
| Benzene | 19 | 1.25 | 7.67 | 0.0163 | 0.123 | 0.14615 | 2.503 | 6.26 | 1.998 | 0.123 | 4.404 | 7.63 |
| cis-1,2-Dichloroethene [I] | 19 | 0.0272 | 0.0102 | 0.02 | 0.02250 | 0.02398 | 0.00058 | 0.0995 | 0.88319 | 0.02 | 0.034 | 0.09095 |
| Ethylbenzene [J] | 19 | 0.3891 | 1.93 | 0.0411 | 0.2 | 0.24402 | 0.53792 | 0.28935 | 1.38 | 0.2 | 0.72 | 1.867 |
| Ethylene Dibromide | 19 | 0.01 | 0.01 | 0.01 | 0.01 | 1.78E-18 | 3.18E-36 | 0.01 | 1.78E-16 | 0.01 | 0.01 | 0.01 |
| m, p-Xylene [K] | 19 | 2.3998 | 17.8 | 0.0852 | 0.4 | 0.59721 | 5.37 | 28.801 | 2.24 | 0.4 | 5.42 | 17.26 |
| o-Xylene [L] | 19 | 0.3479 | 1.86 | 0.0483 | 0.2 | 0.21571 | 0.51393 | 0.26412 | 1.48 | 0.2 | 0.508 | 1.75 |
| Tetrachloroethene | 19 | 0.02 | 0.02 | 0.02 | 0.02 | 3.565E-18 | 1.271E-35 | 0.02 | 1.78E-16 | 0.02 | 0.02 | 0.02 |
| Toluene | 19 | 0.2306 | 0.0857 | 0.2 | 0.20585 | 0.13597 | 0.01849 | 0.615 | 0.5898 | 0.2 | 0.2782 | 0.5934 |
| trans-1,2-Dichloroethene | 19 | 0.0162 | 0.00507 | 0.02 | 0.01474 | 0.00593 | 0.00004 | 0.02 | 0.3654 | 0.02 | 0.02 | 0.02 |
| Trichloroethene [M] | 19 | 0.02001 | 0.02 | 0.02 | 0.02001 | 0.00002 | 5.263E-10 | 0.0201 | 0.0011 | 0.02 | 0.02 | 0.02001 |
| Vinyl Chloride | 19 | 0.0424 | 0.02 | 0.02 | 0.02940 | 0.04573 | 0.00209 | 0.154 | 1.08 | 0.02 | 0.1168 | 0.1414 |

| | |
|---|---|
| A | Statistical outliers are noted on the footnotes. But are included in the statistical calculations. |
| B | All values are in micrograms per liter (µg/L). |
| C | Std Dev ≡ Standard Deviation. |
| D | CV ≡ Coefficient of Variation. |
| E | Two statistical outliers identified for 1,1,2,2-Tetrachloroethane; 0.00653 and 0.00688 on 12/13/2018 (12/12, and 12/13/2018, respectively, in the data set). |
| F | Three statistical outliers identified for 1,1-Dichloroethene; 0.0654 and 0.0615 on 07/27/2018 and 0.00773 on 12/12/2018 (07/27, 07/28, and 12/12 in the data set). |
| G | One statistical outlier identified for Acryonitrile; 0.0658 on 12/13/2018 (12/12 in the data set). |
| H | Five statistical outliers identified for cis-1,2-Dichloroethene; 0.0179 and 0.0183 on 07/27, and 0.0995, 0.09, and 0.0102 on 12/12/2018 (07/27, 07/28, 12/12, 12/13/, and 12/19/2018, respectively, in the data set. |
| I | Two statistical outliers identified for Ethylbenzene; 1.86 and 1.93 on 12/12/2018 (12/12 and 12/13 in the data set). |
| J | Two statistical outliers identified for m,p-Xylene; 17.2 and 17.8 on 12/12/2018 (12/12 and 12/13 in the data set). |

| Parameter | Count | Average [B] | Minimum | Maximum | Median | Geomean | Std Dev [C] | Variance | CV [D] | Percentile | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 50th | 90th | 95th |
| K | Five statistical outliers identified for o-Xylene; 0.125 and 0.13 on 07/27/2018 and 1.74, 1.86 and 0.106 on 12/12/2018 (07/27, 07/28, 12/12, 12/13, and 12/15/2018 in the data set. | | | | | | | | | | | |
| L | One statistical outlier identified for Trichloroethane; <0.2 on 11/13/2018 (11/15 in the data set). | | | | | | | | | | | |

## Table D-10. Descriptive Statistics for CW-3 [A]

| Parameter | Count | Average [B] | Minimum | Maximum | Median | Geomean | Std Dev [C] | Variance | CV [D] | Percentile | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 50th | 90th | 95th |
| 1,1,2,2-Tetrachloroethane [E] | 23 | 0.0278 | 0.02 | 0.2 | 0.02 | 0.02211 | 0.03753 | 0.00141 | 1.35 | 0.02 | 0.02 | 0.02 |
| 1,1-Dichloroethene [F] | 23 | 0.0289 | 0.02 | 0.2 | 0.02 | 0.02292 | 0.03767 | 0.00142 | 1.301 | 0.02 | 0.02 | 0.04322 |
| 1,2-Dichloroethane [G] | 23 | 0.0302 | 0.25 | 0.0124 | 0.0226 | 0.02154 | 0.04831 | 0.00233 | 1.5998 | 0.0226 | 0.03122 | 0.03248 |
| Acrylonitrile [H] | 23 | 0.0696 | 0.05 | 0.5 | 0.05 | 0.05526 | 0.09383 | 0.0088 | 1.35 | 0.05 | 0.05 | 0.05 |
| Benzene | 23 | 0.7297 | 5.48 | 0.02 | 0.216 | 0.22366 | 1.501 | 2.25 | 2.06 | 0.216 | 0.9196 | 4.899 |
| cis-1,2-Dichloroethene [I] | 23 | 0.0259 | 0.00663 | 0.2 | 0.02 | 0.01833 | 0.03873 | 0.0015 | 1.496 | 0.02 | 0.02008 | 0.04314 |
| Ethylbenzene | 23 | 0.3787 | 2.69 | 0.0403 | 0.173 | 0.17507 | 0.72239 | 0.52184 | 1.91 | 0.173 | 0.3814 | 2.39 |
| Ethylene Dibromide [J] | 23 | 0.0139 | 0.01 | 0.1 | 0.01 | 0.01105 | 0.01877 | 0.00035 | 1.35 | 0.01 | 0.01 | 0.01 |
| m, p-Xylene [K] | 23 | 1.99 | 17.6 | 0.0752 | 0.4 | 0.5221 | 4.75 | 22.53 | 2.39 | 0.4 | 1.57 | 14.83 |
| o-Xylene [L] | 23 | 0.3696 | 0.0469 | 2.49 | 0.2 | 0.20696 | 0.65198 | 0.42508 | 1.76 | 0.2 | 0.2176 | 2.16 |
| Tetrachloroethene [M] | 23 | 0.0278 | 0.02 | 0.2 | 0.02 | 0.02211 | 0.03753 | 0.00141 | 1.35 | 0.02 | 0.02 | 0.02 |
| Toluene [N] | 23 | 0.2323 | 0.876 | 0.0405 | 0.2 | 0.17925 | 0.20803 | 0.04327 | 0.896 | 0.2 | 0.2 | 0.7913 |
| trans-1,2-Dichloroethene [O] | 23 | 0.0278 | 0.02 | 0.2 | 0.02 | 0.02211 | 0.03753 | 0.00141 | 1.35 | 0.02 | 0.02 | 0.02 |
| Trichloroethene [P] | 23 | 0.0278 | 0.02 | 0.2 | 0.02 | 0.02211 | 0.03753 | 0.00141 | 1.35 | 0.02 | 0.02 | 0.02 |
| Vinyl Chloride | 23 | 0.0416 | 0.00845 | 0.2 | 0.02 | 0.0299 | 0.0429 | 0.001842 | 1.03 | 0.02 | 0.0750 | 0.1057 |

| | |
|---|---|
| A | Statistical outliers are noted on the footnotes. But are included in the statistical calculations. |
| B | All values are in micrograms per liter (µg/L). |
| C | Std Dev ≡ Standard Deviation. |
| D | CV ≡ Coefficient of Variation. |
| E | One statistical outlier identified for 1,1,2,2-Tetrachloroethane; <0.2 on 11/13/2018 (11/18/2018 in the data set). |
| F | Two statistical outliers identified for 1,1-Dichloroethene; 0.0458 on 07/27/2018 and <0.2 on 11/13/2018 (07/27 and 11/15/2018 in the data set). |
| G | One statistical outlier identified for 1,2-Dichloroethene; 0.25 on 11/13/2018 (11/18/2018 in the data set). |
| H | One statistical outlier identified for Acryonitrile; <0.5 on 11/13/2018 (11/15/2018 in the data set). |
| I | One statistical outlier identified for cis-1,2-Dichloroethene; <0.2 on 11/13/2018 (11/15/2018 in the data set). |
| J | One statistical outlier identified for Ethylene Dibromide; <0.1 on 11/13/2018 (11/15/2018 in the data set). |
| K | Two statistical outliers identified for m,p-Xylene; 17.6 and 16.3 on 11/13/2018 (11/17 and 11/18/2018, respectively, in the data set). |
| L | Eleven statistical outlier identified for o-Xylene; 0.0469 on 07/27/2018, 2.49 and 2.37 on 11/13/2018, 0.156, 0.222, 0.177, 0.193, 0.0731, 0.129, 0.14, 0.104 on 12/13/2018 (07/27, 11/14, 11/15, 12/14 thru 12/21/2018 in the data set). |

| Parameter | Count | Average [B] | Minimum | Maximum | Median | Geomean | Std Dev [C] | Variance | CV [D] | Percentile | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 50th | 90th | 95th |
| M | One statistical outlier identified for Tetrachloroethene; <0.2 on 11/13/2018 (11/15/2018 in the data set). | | | | | | | | | | | |
| N | Two statistical outliers identified Toluene; 0.857 and 0.876 on 11/13/2018 (11/14 and 11/15/2018 in the data set, respectively). | | | | | | | | | | | |
| O | One statistical outlier identified for trans-1,2-Dichloroethene; <0.2 on 11/13/2018 (11/15/2018 in the data set). | | | | | | | | | | | |
| P | One statistical outlier identified for Trichloroethene; <0.2 on 11/13/2018 (11/15/2018 in the data set). | | | | | | | | | | | |

## Table D-11. Descriptive Statistics for Final Combined Data [A]

| Parameter | Count | Average [B] | Minimum | Maximum | Median | Geomean | Std Dev [C] | Variance | CV [D] | Percentile | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 50th | 90th | 95th |
| 1,1,2,2-Tetrachloroethane [E] | 47 | 0.02766 | 0.2 | 0.02 | 0.02 | 0.02206 | 0.03673 | 0.001349 | 1.33 | 0.02 | 0.02 | 0.02 |
| 1,1-Dichloroethene [F] | 42 | 0.026677 | 0.2 | 0.00773 | 0.02 | 0.022256 | 0.02927 | 0.000857 | 1.097 | 0.02 | 0.02 | 0.06072 |
| 1,2-Dichloroethane [G] | 66 | 0.02707 | 0.257 | 0.0123 | 0.02105 | 0.02067 | 0.04076 | 0.001661 | 1.51 | 0.02105 | 0.02915 | 0.03168 |
| Acrylonitrile [H] | 42 | 0.06109 | 0.5 | 0.05 | 0.05 | 0.05316 | 0.06942 | 0.006482 | 1.14 | 0.05 | 0.05 | 0.05 |
| Benzene [I] | 42 | 0.96628 | 7.67 | 0.0163 | 0.1395 | 0.18450 | 2.01 | 4.03 | 2.08 | 0.1395 | 3.59 | 5.47 |
| cis-1,2-Dichloroethene [J] | 43 | 0.03138 | 0.2 | 0.0102 | 0.02 | 0.02368 | 0.03794 | 0.001439 | 1.21 | 0.02 | 0.048 | 0.09855 |
| Ethylbenzene [K] | 47 | 0.49163 | 4.49 | 0.0403 | 0.2 | 0.19794 | 0.98823 | 0.97660 | 2.01 | 0.2 | 1.27 | 2.98 |
| Ethylene Dibromide [L] | 66 | 0.01273 | 0.1 | 0.01 | 0.01 | 0.01072 | 0.01555 | 0.000242 | 1.22 | 0.01 | 0.01 | 0.01 |
| m, p-Xylene [M] | 67 | 2.86 | 25.4 | 0.0522 | 0.4 | 0.55856 | 6.55 | 42.84 | 2.29 | 0.4 | 16.66 | 19.97 |
| o-Xylene [N] | 42 | 0.35977 | 2.49 | 0.0469 | 0.2 | 0.21087 | 0.58666 | 0.34417 | 1.63 | 0.2 | 0.2198 | 1.85 |
| Total Xylene | 66 | 21.25 | 1,235.4 | 0.1534 | 0.6 | 0.8812 | 151.87 | 2.306E4 | 7.15 | 0.6 | 10.64 | 19.98 |
| Tetrachloroethene [O] | 66 | 0.02545 | 0.2 | 0.02 | 0.02 | 0.02145 | 0.03109 | 0.000967 | 1.22 | 0.02 | 0.02 | 0.02 |
| Toluene [P] | 42 | 0.23153 | 0.876 | 0.0405 | 0.2 | 0.19083 | 0.17703 | 0.03134 | 0.7646 | 0.2 | 0.2 | 0.6138 |
| trans-1,2-Dichloroethene [Q] | 47 | 0.02754 | 0.2 | 0.0144 | 0.02 | 0.02191 | 0.03676 | 0.001351 | 1.33 | 0.02 | 0.02 | 0.02 |
| Trichloroethene [R] | 66 | 0.02546 | 0.2 | 0.02 | 0.02 | 0.02145 | 0.03109 | 0.000967 | 1.22 | 0.02 | 0.02 | 0.02 |
| Vinyl Chloride [S] | 42 | 0.04196 | 0.2 | 0.00845 | 0.02 | 0.02968 | 0.04367 | 0.001907 | 1.04 | 0.02 | 0.1082 | 0.13855 |

| | |
|---|---|
| A | Statistical outliers are noted on the footnotes. But are included in the statistical calculations. |
| B | All values are in micrograms per liter (µg/L). |
| C | Std Dev ≡ Standard Deviation. |
| D | CV ≡ Coefficient of Variation. |
| E | Two statistical outliers identified for 1,1,2,2,-Tetrachloroethane; < 0.2 on 11/13/2018 (11/10 and 11/19/2018 in the data set). |
| F | Five statistical outliers identified for 1,1-Dichloroethene: 0.0654, 0.0615, and 0.0458 on 07/27/2018; <0.2 on 11/13/2018; and 0.00773 on 12/12/2018 (07/13, 07/14, 07/21, 11/19, and 12/01/2018 in the data set, respectively). |
| G | Two statistical outliers identified for 1,2-Dichloroethane; 0.257 and 0.25 on 11/13/2018 (11/10/2018 and 11/19/2018 in the data set, respectively). |
| H | Two statistical outliers identified for Acrylonitrile; <0.5 on 11/13/2018, and 0.0658 on 12/14/2018 (11/10 and 12/02/2018 in the data set, respectively). |
| I | No statistical outliers were identified for Benzene in the data set. |

| Parameter | Count | Average [B] | Minimum | Maximum | Median | Geomean | Std Dev [C] | Variance | CV [D] | Percentile | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 50th | 90th | 95th |
| J | Eleven statistical outliers identified for cis-1,2-Dichloroethene: 0.165, 0.0179, and 0.0183 on 07/27/2018; <0.2 (x2), 0.055, and 0.0457 on 11/13/2018; and 0.0995, 0.09, 0.102, and 0.0134 on 12/14/2018 (07/06, 07/14, 07/13, 11/10, 11/19, 11/09, 11/18, 12/01, 12/02, 12/08, and 12/11/2018 in the data set, respectively). | | | | | | | | | | | |
| K | No statistical outliers were identified for Ethylbenzene in the data set. | | | | | | | | | | | |
| L | Two statistical outliers identified for Ethylene Dibromide; < 0.1 on 11/13/2018 (11/10 and 11/19/2018 in the data set). | | | | | | | | | | | |
| M | No statistical outliers were identified for m,p-Xylene in the data set. | | | | | | | | | | | |
| N | Sixteen statistical outliers identified for o-Xylene: 0.0469, 0.125, and 0.13 on 07/27/2018; 2.49 and 2.37 on 11/13/2018; 1.86, 1.74, 0.0731, 0.104, 0.106, 0.129, 0.14, 0.156, 0.177, and 0.222 on 12/14/2018 (07/21, 07/13, 07/14, 11/18, 11/19, 12/02, 12/01, 12/20, 12/23, 12/04, 12/21, 12/22, 12/16, 12/18, and 12/17/2018 in the data set, respectively). | | | | | | | | | | | |
| O | No statistical outliers were identified for Tetrachloroethene in the data set. | | | | | | | | | | | |
| P | Two statistical outliers identified for Toluene; < 2 (x2) on 11/13/2018 (11/10 and 11/19/2018 in the data set, respectively). | | | | | | | | | | | |
| Q | Three statistical outliers identified for trans-1,2-Dichloroethene; and 0.0144 on 07/27/2018, < 0.2 (x2) on 11/13/2018 (07/06, 11/10, and 11/19/2018 in the data set, respectively). | | | | | | | | | | | |
| R | Three statistical outliers identified for Trichloroethene; < 0.2 (x2) on 11/13/2018, and 0.0201 on 12/14/2018 (11/10, 11/19, and 12/03/2018 in the data set, respectively). | | | | | | | | | | | |
| S | No statistical outliers were identified in the Vinyl Chloride data set. | | | | | | | | | | | |

## Table D-12. Descriptive Statistics for MW-9 (Source Groundwater)

| Parameter | Count | Average [A] | Minimum | Maximum | Median | Geomean | Std Dev [B] | Variance | CV [C] | Percentile | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 50th | 90th | 95th |
| 1,1,2,2-Tetrachloroethane | 12 | 0.6567 | 0.02 | 2 | 0.2 | 0.1888 | 0.8521 | 0.7261 | 1.298 | 0.2 | 2 | 2 |
| 1,1-Dichloroethene | 12 | 0.6949 | 0.02 | 2 | 0.2 | 0.2460 | 0.8310 | 0.6905 | 1.196 | 0.2 | 2 | 2 |
| 1,2-Dichloroethane | 12 | 0.7338 | 0.0182 | 2.53 | 0.2 | 0.2116 | 0.9871 | 0.9744 | 1.35 | 0.2 | 2.33 | 2.44 |
| Acrylonitrile | 12 | 2.29 | 0.05 | 10 | 1 | 0.9948 | 2.98 | 8.86 | 1.299 | 1 | 5 | 7.25 |
| Benzene | 13 | 42.71 | 6.9 | 90.4 | 43 | 34.52 | 24.08 | 579.81 | 0.5638 | 43 | 73.4 | 83.2 |
| cis-1,2-Dichloroethene | 12 | 0.7297 | 0.0759 | 2 | 0.2045 | 0.3981 | 0.8042 | 0.6468 | 1.102 | 0.2045 | 2 | 2 |
| Ethylbenzene [D] | 12 | 17.04 | 24.9 | 4.23 | 18.3 | 15.61 | 6.17 | 38.102 | 0.3621 | 18.3 | 23.55 | 24.24 |
| Ethylene Dibromide | 12 | 0.445 | 0.01 | 2 | 0.2 | 0.1260 | 0.6056 | 0.3667 | 1.36 | 0.2 | 1 | 1.45 |
| m, p-Xylene | 13 | 103.72 | 23.1 | 166 | 105 | 89.11 | 47.33 | 2,239.95 | 0.4563 | 105 | 156 | 160 |
| o-Xylene [E] | 12 | 14.44 | 24.4 | 1.12 | 15.7 | 11.91 | 6.49 | 42.18 | 0.4498 | 15.7 | 20.6 | 22.42 |
| Tetrachloroethene | 12 | 0.6567 | 0.02 | 2 | 0.2 | 0.1888 | 0.8521 | 0.7261 | 1.298 | 0.2 | 2 | 2 |
| Toluene [F] | 12 | 8.47 | 13.2 | 0.0702 | 9.755 | 5.19 | 4.504 | 20.28 | 0.5318 | 9.76 | 12.97 | 13.09 |
| trans-1,2-Dichloroethene | 12 | 0.6552 | 0.0104 | 2 | 0.2 | 0.1718 | 0.8533 | 0.7281 | 1.302 | 0.2 | 2 | 2 |
| Trichloroethene | 12 | 0.6567 | 0.02 | 2 | 0.2 | 0.1888 | 0.8521 | 0.7261 | 1.298 | 0.2 | 2 | 2 |
| Vinyl Chloride [G] | 12 | 0.874083 | 2 | 0.02 | 0.719 | 0.516708 | 0.744635 | 0.5544814 | 0.8519 | 0.719 | 2 | 2 |

| | |
|---|---|
| A | All values are in micrograms per liter (µg/L). |
| B | Std Dev ≡ Standard Deviation. |
| C | CV ≡ Coefficient of Variation. |
| D | One statistical outlier identified from the Ethylbenzene data set; 4.23 on 07/27/2018. |
| E | One statistical outlier identified from the o-Xylene data set; 1.12 on 07/27/2018. |
| F | Three statistical outliers identified from the Toluene data set; 0.0702 on 07/27/2018, < 10 on 07/04/2018, and 0.736 on 07/27/2018. |
| G | One statistical outlier identified from the Vinyl Chloride data set; < 0.02 on 07/27/2018. |

## Table D-13. Statistical Distributions for Final Combined Data Set

| Parameter | Outlier Statistic [A] | Ladder of Powers [B] | Statistic Used[C] |
|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | Unknown [D] | Non-normal [E] | $x^6$ [F] |
| 1,1-Dichloroethene | Unknown | Non-normal | Normal [G] |
| 1,2-Dichloroethane | Unknown | Non-normal | ln(x) [H] |
| Acryonitrile | Unknown | Non-normal | $x^6$ |
| Benzene | Unknown | Non-normal | ln(x) |
| cis-1,2-Dichloroethene | Unknown | Non-normal | $x^6$ |
| Ethylbenzene | Unknown | Non-normal | $x^6$ |
| Ethylene Dibromide | Unknown | Non-normal | Normal |
| m,p-Xylene | Unknown | Non-normal | ln(x) |
| o-Xylene | Unknown | Non-normal | $x^6$ |
| Tetrachloroethene | Unknown | Non-normal | Normal |
| Toluene | Unknown | Non-normal | $x^6$ |
| trans-1,2-Dicholoethene | Unknown | Non-normal | Normal |
| Trichloroethene | Unknown | Non-normal | Normal |
| Vinyl Chloride | Unknown | Non-normal | $x^3$ [I] |

| | |
|---|---|
| A | Outlier Statistic ≡ Data set normality for the outlier analyses used the Shapiro-Francia method at an alpha level of 0.01. |
| B | Ladder of Powers ≡ Calculation of normality for multiple data transformation. Transformations include: No transformation (normal distribution), natural log, square-root, cube-root, square ($x^2$), cube ($x^3$), $x^4$, $x^5$, and $x^6$. |
| C | Statistic Used ≡ Data set normality was selected using a probability plot. |
| D | Unknown ≡ The data set has a non-normal distribution (non-parametric). |
| E | Non-Normal ≡ None of the ladder of powers transformations returned a positive result. |
| F | $x^6$ ≡ the data set fits an sixth power transformation distribution. |
| G | Normal ≡ The data set is normally distribution. |

| Parameter | | Outlier Statistic [A] | Ladder of Powers [B] | Statistic Used[C] |
|---|---|---|---|---|
| H | ln(x) ≡ The data set has a log-normal distribution. | | | |
| I | $x^3$ ≡ the data set fits an sixth power transformation distribution. | | | |

## Table D-14. PermitCalcDec2016V1.1_GW – Effluent (max effluent / Calculated CV / GWQS)

**Effluent Reasonable Potential Calculation**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Facility** | GACO Western | | | | | | Dilution Attenuation Factors: | | | | | |
| **Water Body Type** | Groundwater | | | | | | Background Groundwater | | | | | 1.01 |
| **Rec. Water Hardness** | | | | | | | Human Health Carcinogenic | | | | | 1.01 |
| | | | | | | | Human Health Non-Carcinogenic | | | | | 1.01 |

| Pollutant, CAS No. & NPDES Application Ref. No. | | 1,1-DICHLOROETHANE (75-34-3) 14V | 1,2 DICHLOROETHANE (Ethylene chloride) 107062 15V | ACRYLONITRILE 107131 2V | BENZENE 71432 3V | cis 1,2-DICHLOROETHYLENE 156-59-2 | ETHYLBENZENE 100414 19V | XYLENE (TOTAL) 1330-20-7 | TOLUENE 108883 25V | trans 1,2-DICHLOROETHYLENE 156-60-5 | TRICHLOROETHYLENE 79016 29V | VINYL CHLORIDE 75014 31V |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Effluent Data (Outfall 1/Pond)** | # of Samples (n) | 66 | 66 | 66 | 42 | 43 | 47 | 67 | 42 | 47 | 66 | 42 |
| | Coefficient of Variation (Cv) | 1.84 | 1.51 | 1.22 | 2.08 | 1.21 | 2.01 | 2.93 | 0.766 | 1.33 | 1.22 | 1.04 |
| | Effluent Concentration, µg/L (95th Percentile) | 0.459 | 0.26 | 0.50 | 7.67 | 0.2 | 4.49 | 25.61 | 0.876 | 0.2 | 0.2 | 0.2 |
| | Calculated 50th percentile Effluent Conc. (when n>10) | | | | | | | | | | | |
| **Receiving Water Data** | 90th Percentile Conc. µg/L | 0.9 | 0.45 | 0.063 | 0.9 | 63 | 630 | 9,000 | 900 | 90 | 2.7 | 0.018 |
| | Geo Mean, µg/L | | | | | | | | | | | |
| **Water Quality Criteria** | 95th Percentile Background Groundwater µg/L | 0.95 | 0.475 | 0.0665 | 0.95 | 66.5 | 665 | 9,500 | 950 | 95 | 2.85 | 0.019 |
| | GWQ Criteria for Protection of Human Health, µg/L | 1 | 0.5 | 0.07 | 1.0 | 70 | 700 | 10,000 | 1,000 | 100 | 3 | 0.02 |
| | Metal Criteria Translator, decimal | - | - | - | - | - | - | - | - | - | - | - |
| | Carcinogen? | - | Y | Y | Y | - | N | - | N | - | Y | Y |

## Table D-14. PermitCalcDec2016V1.1_GW – Effluent (Max / calc) (continued)

**Effluent Reasonable Potential Calculation**

| Pollutant, CAS No. & NPDES Application Ref. No. | 1,1-DICHLOROETHANE (75-34-3) 14V | 1,2 DICHLOROETHANE (Ethylene chloride) 107062 15V | ACRYLONITRILE 107131 2V | BENZENE 71432 3V | cis 1,2-DICHLOROETHYLENE 156-59-2 | ETHYLBENZENE 100414 19V | XYLENE (TOTAL) 1330-20-7 | TOLUENE 108883 25V | trans 1,2-DICHLOROETHYLENE 156-60-5 | TRICHLOROETHYLENE 79016 29V | VINYL CHLORIDE 75014 31V |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reasonable Potential** | | | | | | | | | | | |
| Effluent percentile value | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| s $\sigma^2 = \ln(CV^2 + 1)$ | 1.217 | 1.088 | 0.953 | 1.292 | 0.949 | 1.272 | 1.504 | 0.678 | 1.011 | 0.956 | 0.857 |
| $P_n$ $P_n = (1 - \text{confidence level})^{1/n}$ | 0.956 | 0.956 | 0.956 | 0.931 | 0.933 | 0.938 | 0.956 | 0.931 | 0.938 | 0.956 | 0.931 |
| Multiplier | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 95th Percentile concentration (µg/L) | 0.46 | 0.26 | 0.50 | 7.62 | 0.62 | 8.69 | 88.99 | 6.91 | 0.80 | 0.22 | 0.20 |
| **Reasonable Potential? Limit Required?** | **NO** | **NO** | **YES** | **YES** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | **YES** |

## Effluent Reasonable Potential Calculation

| Pollutant, CAS No. & NPDES Application Ref. No. | 1,1-DICHLOROETHANE (75-34-3) 14V | 1,2 DICHLOROETHANE (Ethylene chloride) 107062 15V | ACRYLONITRILE 107131 2V | BENZENE 71432 3V | cis 1,2-DICHLOROETHYLENE 156-59-2 | ETHYLBENZENE 100414 19V | XYLENE (TOTAL) 1330-20-7 | TOLUENE 108883 25V | trans 1,2-DICHLOROETHYLENE 156-60-5 | TRICHLOROETHYLENE 79016 29V | VINYL CHLORIDE 75014 31V |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Groundwater Quality Standard Reasonable Potential** | | | | | | | | | | | |
| s $\sigma^2 = \ln(CV^2 + 1)$ | 1.22 | 1.09 | 0.953 | 1.29 | 0.949 | 1.27 | 1.504 | 0.678 | 1.01 | 0.956 | 0.857 |
| $P_n$ $P_n = (1 - \text{confidence level})^{1/n}$ | 0.956 | 0.956 | 0.956 | 0.931 | 0.933 | 0.938 | 0.956 | 0.931 | 0.938 | 0.956 | 0.931 |
| Multiplie | 0.364 | 0.433 | 0.509 | 0.321 | 0.504 | 0.332 | 0.231 | 0.657 | 0.470 | 0.508 | 0.556 |
| Dilution Attenuation Factor | 1.0068 | 1.0068 | 1.0068 | 1.0068 | 1.0068 | 1.0068 | 1.0068 | 1.0068 | 1.0068 | 1.0068 | 1.0068 |
| Maximum concentration (µg/L) | 0.166 | 0.111 | 0.253 | 2.443 | 0.100 | 1.480 | 5.887 | 0.571 | 0.093 | 0.101 | 0.110 |
| **Reasonable Potential? Limit Required?** | **NO** | **NO** | **YES** | **YES** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | **YES** |

**Comments/Notes:**

| | |
|---|---|
| YES | Parameter has a potential to impact groundwater. Value is above both background and groundwater quality standards. |
| YES* | Parameter exceeds groundwater quality standards, but not the background concentration. |
| YES** | Parameter has a potential to impact groundwater. Value is the above the background value, but not above the groundwater quality standards. |

**References:** WAC 173-200-040

## Table D-15. PermitCalcDec2016V1.1_GW – Effluent (95% / Calculated CV/ GWQS)

**Effluent Reasonable Potential Calculation**

| | |
|---|---|
| **Facility** | GACO Western |
| **Water Body Type** | Groundwater |
| **Rec. Water Hardness** | |

**Dilution Attenuation Factors:**

| | |
|---|---|
| Background Groundwater | 1.01 |
| Human Health Carcinogenic | 1.01 |
| Human Health Non-Carcinogenic | 1.01 |

| **Pollutant, CAS No. & NPDES Application Ref. No.** | | **1,1-DICHLOROETHANE (75-34-3) 14V** | **1,2 DICHLOROETHANE (Ethylene chloride) 107062 15V** | **ACRYLONITRILE 107131 2V** | **BENZENE 71432 3V** | **cis 1,2-DICHLOROETHYLENE 156-59-2** | **ETHYLBENZENE 100414 19V** | **XYLENE (TOTAL) 1330-20-7** | **TOLUENE 108883 25V** | **trans 1,2-DICHLOROETHYLENE 156-60-5** | **TRICHLOROETHYLENE 79016 29V** | **VINYL CHLORIDE 75014 31V** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Effluent Data (Outfall 1/Pond)** | # of Samples (n) | 66 | 66 | 66 | 42 | 43 | 47 | 67 | 42 | 47 | 66 | 42 |
| | Coefficient of Variation (Cv) | 1.84 | 1.51 | 1.22 | 2.08 | 1.21 | 2.01 | 2.93 | 0.7659 | 1.33 | 1.22 | 1.04 |
| | Effluent Concentration, µg/L (95th Percentile) | 0.0644 | 0.0317 | 0.0619 | 5.47 | 0.0986 | 2.98 | .6 | 0.6138 | 0.02 | 0.02 | 0.1386 |
| | Calculated 50th percentile Effluent Conc. (when n>10) | | | | | | | | | | | |
| **Receiving Water Data** | 90th Percentile Conc. µg/L | 0.9 | 0.45 | 0.063 | 0.9 | 63 | 630 | 9,000 | 900 | 90 | 2.7 | 0.018 |
| | Geo Mean, µg/L | | | | | | | | | | | |
| **Water Quality Criteria** | 95th Percentile Background Groundwater µg/L | 0.95 | 0.475 | 0.0665 | 0.95 | 66.5 | 665 | 9,500 | 950 | 95 | 2.85 | 0.019 |
| | GWQ Criteria for Protection of Human Health, µg/L | 1 | 0.5 | 0.07 | 1.0 | 70 | 700 | 10,000 | 1,000 | 100 | 3 | 0.02 |
| | Metal Criteria Translator, decimal | - | - | - | - | - | - | - | - | - | - | - |
| | Carcinogen? | - | Y | Y | Y | - | N | - | N | - | Y | Y |

## Table D-15. PermitCalcDec2016V1.1_GW – Effluent (95% / Calc CV/ GWQS) (continued)

**Effluent Reasonable Potential Calculation**

| Pollutant, CAS No. & NPDES Application Ref. No. | 1,1-DICHLOROETHANE (75-34-3) 14V | 1,2 DICHLOROETHANE (Ethylene chloride) 107062 15V | ACRYLONITRILE 107131 2V | BENZENE 71432 3V | cis 1,2-DICHLOROETHYLENE 156-59-2 | ETHYLBENZENE 100414 19V | XYLENE (TOTAL) 1330-20-7 | TOLUENE 108883 25V | trans 1,2-DICHLOROETHYLENE 156-60-5 | TRICHLOROETHYLENE 79016 29V | VINYL CHLORIDE 75014 31V |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reasonable Potential** | | | | | | | | | | | |
| Effluent percentile value | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| s $\sigma^2 = \ln(CV^2 + 1)$ | 1.217 | 1.088 | 0.953 | 1.292 | 0.949 | 1.272 | 1.504 | 0.678 | 1.011 | 0.956 | 0.857 |
| $P_n$ $P_n = (1 - \text{confidence level})^{1/n}$ | 0.956 | 0.956 | 0.956 | 0.931 | 0.933 | 0.938 | 0.956 | 0.931 | 0.938 | 0.956 | 0.931 |
| Multiplier | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 95th Percentile concentration (µg/L) | 0.07 | 0.03 | 0.06 | 5.44 | 0.52 | 7.19 | 61.01 | 6.65 | 0.62 | 0.04 | 0.14 |
| **Reasonable Potential? Limit Required?** | **NO** | **NO** | **NO** | **YES** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | **YES** |

## Effluent Reasonable Potential Calculation

| Pollutant, CAS No. & NPDES Application Ref. No. | 1,1-DICHLOROETHANE (75-34-3) 14V | 1,2 DICHLOROETHANE (Ethylene chloride) 107062 15V | ACRYLONITRILE 107131 2V | BENZENE 71432 3V | cis 1,2-DICHLOROETHYLENE 156-59-2 | ETHYLBENZENE 100414 19V | XYLENE (TOTAL) 1330-20-7 | TOLUENE 108883 25V | trans 1,2-DICHLOROETHYLENE 156-60-5 | TRICHLOROETHYLENE 79016 29V | VINYL CHLORIDE 75014 31V |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Groundwater Quality Standard Reasonable Potential** | | | | | | | | | | | |
| s $\sigma^2 = \ln(CV^2 + 1)$ | 1.217 | 1.088 | 0.953 | 1.292 | 0.949 | 1.272 | 1.504 | 0.678 | 1.011 | 0.956 | 0.857 |
| $P_n$ $P_n = (1 - \text{confidence level})^{1/n}$ | 0.956 | 0.956 | 0.956 | 0.931 | 0.933 | 0.938 | 0.956 | 0.931 | 0.938 | 0.956 | 0.931 |
| Multiplier | 0.364 | 0.433 | 0.509 | 0.321 | 0.504 | 0.332 | 0.231 | 0.657 | 0.470 | 0.508 | 0.556 |
| Dilution Attenuation Factor | 1.007 | 1.007 | 1.007 | 1.007 | 1.007 | 1.007 | 1.007 | 1.007 | 1.007 | 1.007 | 1.007 |
| Maximum concentration (µg/L) | 0.023 | 0.014 | 0.031 | 1.743 | 0.049 | 0.982 | 0.138 | 0.400 | 0.009 | 0.010 | 0.077 |
| **Reasonable Potential? Limit Required?** | **NO** | **NO** | **NO** | **YES** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | **YES** |

**Comments/Notes:**

| | |
|---|---|
| YES | Parameter has a potential to impact groundwater. Value is above both background and groundwater quality standards. |
| YES* | Parameter exceeds groundwater quality standards, but not the background concentration. |
| YES** | Parameter has a potential to impact groundwater. Value is the above the background value, but not above the groundwater quality standards. |

**References:** WAC 173-200-040

## Table 16. PermitCalcDec2016V1.1_GW – Effluent (50% / Calc CV/ GWQS)

**Effluent Reasonable Potential Calculation**

| | |
|---|---|
| **Facility** | GACO Western |
| **Water Body Type** | Groundwater |
| **Rec. Water Hardness** | |

**Dilution Attenuation Factors:**

| | |
|---|---|
| Background Groundwater | 1.01 |
| Human Health Carcinogenic | 1.01 |
| Human Health Non-Carcinogenic | 1.01 |

| Pollutant, CAS No. & NPDES Application Ref. No. | | 1,1-DICHLOROETHANE (75-34-3) 14V | 1,2 DICHLOROETHANE (Ethylene chloride) 107062 15V | ACRYLONITRILE 107131 2V | BENZENE 71432 3V | cis 1,2-DICHLOROETHYLENE 156-59-2 | ETHYLBENZENE 100414 19V | XYLENE (TOTAL) 1330-20-7 | TOLUENE 108883 25V | trans 1,2-DICHLOROETHYLENE 156-60-5 | TRICHLOROETHYLENE 79016 29V | VINYL CHLORIDE 75014 31V |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Effluent Data (Outfall 1/Pond)** | # of Samples (n) | 66 | 66 | 66 | 42 | 43 | 47 | 67 | 42 | 47 | 66 | 42 |
| | Coefficient of Variation (Cv) | 1.84 | 1.51 | 1.22 | 2.08 | 1.21 | 2.01 | 2.93 | 0.765 | 1.33 | 1.22 | 1.04 |
| | Effluent Concentration, µg/L (95th Percentile) | | | | | | | | | | | |
| | Calculated 50th percentile Effluent Conc. (when n>10) | 0.02 | 0.021 | 0.05 | 0.1395 | 0.02 | 0.2 | 0.6 | 0.2 | 0.02 | 0.02 | 0.02 |
| **Receiving Water Data** | 90th Percentile Conc. µg/L | | | | | | | | | | | |
| | Geo Mean, µg/L | 0.5 | 0.25 | 0.035 | 0.5 | 35 | 350 | 5,000 | 500 | 50 | 1.5 | 0.01 |
| **Water Quality Criteria** | 95th Percentile Background Groundwater µg/L | 0.95 | 0.475 | 0.0665 | 0.95 | 66.5 | 665 | 9,500 | 950 | 95 | 2.85 | 0.019 |
| | GWQ Criteria for Protection of Human Health, µg/L | 1 | 0.5 | 0.07 | 1.0 | 70 | 700 | 10,000 | 1,000 | 100 | 3 | 0.02 |
| | Metal Criteria Translator, decimal | - | - | - | - | - | - | - | - | - | - | - |
| | Carcinogen? | - | Y | Y | Y | - | N | - | N | - | Y | Y |

## Table 16. PermitCalcDec2016V1.1_GW – Effluent (Outliers Removed) (continued)

**Effluent Reasonable Potential Calculation**

| Pollutant, CAS No. & NPDES Application Ref. No. | 1,1-DICHLOROETHANE (75-34-3) 14V | 1,2 DICHLOROETHANE (Ethylene chloride) 107062 15V | ACRYLONITRILE 107131 2V | BENZENE 71432 3V | cis 1,2-DICHLOROETHYLENE 156-59-2 | ETHYLBENZENE 100414 19V | XYLENE (TOTAL) 1330-20-7 | TOLUENE 108883 25V | trans 1,2-DICHLOROETHYLENE 156-60-5 | TRICHLOROETHYLENE 79016 29V | VINYL CHLORIDE 75014 31V |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reasonable Potential** | | | | | | | | | | | |
| Effluent percentile value | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| s $\sigma^2 = \ln(CV^2 + 1)$ | 1.22 | 1.09 | 0.953 | 1.29 | 0.949 | 1.27 | 1.504 | 0.678 | 1.01 | 0.956 | 0.857 |
| $P_n$ $P_n = (1 - \text{confidence level})^{1/n}$ | 0.956 | 0.956 | 0.956 | 0.931 | 0.933 | 0.938 | 0.956 | 0.931 | 0.938 | 0.956 | 0.931 |
| Multiplier | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 95th Percentile concentration (µg/L) | 0.02 | 0.02 | 0.05 | 0.14 | 0.25 | 2.55 | 34.16 | 3.55 | 0.36 | 0.03 | 0.02 |
| **Reasonable Potential? Limit Required?** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | **YES** |

## Effluent Reasonable Potential Calculation

| Pollutant, CAS No. & NPDES Application Ref. No. | 1,1-DICHLOROETHANE (75-34-3) 14V | 1,2 DICHLOROETHANE (Ethylene chloride) 107062 15V | ACRYLONITRILE 107131 2V | BENZENE 71432 3V | cis 1,2-DICHLOROETHYLENE 156-59-2 | ETHYLBENZENE 100414 19V | XYLENE (TOTAL) 1330-20-7 | TOLUENE 108883 25V | trans 1,2-DICHLOROETHYLENE 156-60-5 | TRICHLOROETHYLENE 79016 29V | VINYL CHLORIDE 75014 31V |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Groundwater Quality Standard Reasonable Potential** | | | | | | | | | | | |
| s $\sigma^2 = \ln(CV^2 + 1)$ | 1.22 | 1.09 | 0.953 | 1.29 | 0.949 | 1.27 | 1.504 | 0.678 | 1.01 | 0.956 | 0.857 |
| $P_n$ $P_n = (1 - \text{confidence level})^{1/n}$ | 0.956 | 0.956 | 0.956 | 0.931 | 0.933 | 0.938 | 0.956 | 0.931 | 0.938 | 0.956 | 0.931 |
| Multiplier | 0.364 | 0.433 | 0.509 | 0.321 | 0.504 | 0.332 | 0.231 | 0.657 | 0.470 | 0.508 | 0.556 |
| Dilution Attenuation Factor | 1.0068 | 1.0068 | 1.0068 | 1.0068 | 1.0068 | 1.0068 | 1.0068 | 1.0068 | 1.0068 | 1.0068 | 1.0068 |
| Maximum concentration (µg/L) | 0.023 | 0.023 | 0.050 | 0.142 | 0.255 | 2.55 | 34.16 | 3.55 | 0.355 | 0.030 | 0.020 |
| **Reasonable Potential? Limit Required?** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | **YES**** |

**Comments/Notes:**

| | |
|---|---|
| **YES** | Parameter has a potential to impact groundwater. Value is above both background and groundwater quality standards. |
| **YES*** | Parameter exceeds groundwater quality standards, but not the background concentration. |
| **YES**** | Parameter has a potential to impact groundwater. Value is the above the background value, but not above the groundwater quality standards. |

**References:** WAC 173-200-040

**Table 17. Key to TSD Workbook Terms**

| HEADER | DESCRIPTION | EQUATION | COMMENTS |
|---|---|---|---|
| WELL | The well number to which the data is associated. | | |
| DATE | The collection date for each sample value. | | |
| PARAMETER | The constituent being evaluated. | | |
| Value ($x_i$) | The reported constituent result. | | |
| Units | Units of the constituent result. | | |
| Flag | Any associated flag or qualifiers to the constituent result. | | |
| D | The minimum reported value. | | May be a method detection limit, practical quantitation limit, or a reporting limit. Used for constituents with non-detects. |
| Outlier | Type of outlier. | | Note as to the type of outlier (verified, suspect, other). |
| Value | Value of the outlier. | | (So it doesn't get lost when removed from the Value ($x_i$) column.) |
| $y_i$ = ln(x) | The calculated natural log of the constituent result ($x_i$). | IF((D12 = ""), "", LN(D12)) | Calculated by the EXCEL function ln(number). Set-up with an If/Then statement so that empty value cells are not calculated (**IF((D12 = ""), "", LN(D12))**). |
| $y_i$ (- NDs) | Same as Column J. | IF((D12 = ""), "", (IF((F12 = "U"), "", LN(D12)))) | But set-up with an If/Then statement so that empty value cells AND non-detect values are not calculated (**IF((D12 = ""), "", (IF((F12 = "U"), "", LN(D12))))**). |
| k | Total number of results. | COUNT(D2:D44) | Calculated using the EXCEL function COUNT(value1, value2, …). In the worksheet counts results in Column D. |
| NDs | Assignment of non-detects. | IF((F2 = "U"), "Y", "") | If/Then statement used to determine the number of non-detects (**IF((F2 = "U"), "Y", "")**). The equation yields a "Y"es for non-detects and leaves all others blank. Note that the flag value ("U") should equal whatever is used for designation of a non-detect in the data set (U, ND, etc.). |
| r | Total number of non-detects. | COUNTIF(M2:M44,"Y") | Calculated using the EXCEL function COUNTIF(range, criteria). In the worksheet counts results in Column M (COUNTIF(M2:M44,"Y")). |
| k - r | Total number of detected values. | L2 - N2 | The total number of results minus the total number of non-detects. |
| δ = r / k | Sample proportion of non-detects. | N2 / L2 | The total number of non-detects divided by the total number of results. |
| $\mu^y$ | Estimated mean. | AVERAGE(D2:D44) | Uses the EXCEL function **Average(number1, number2,...)** to calculate the arithmetic mean of the data. This is the short version of $\mu = \Sigma(xi) / k$, $1 \le i \le k$. |
| $\sigma^{2y}$ | Estimated variance. | VAR(D2:D44) | Uses the EXCEL function **Var.s(number1, number2,...)** to calculate the variance of the data. This is the short version of $\sigma^2 = \Sigma[(x_i - \mu)^2] / (k - 1)$, $1 \le i \le k$. |
| $\sigma^y$ | Estimated standard deviation. | STDEV(D2:D44) | Uses the EXCEL function **stdev.s(number1, number2,...)** to calculate the standard deviation of the data. This is the short version of $\sigma = (\sigma^2)^{½}$ aka the square root of the variance. |
| 1 - δ | Term used in calculation of other values. | 1 - P2 | |
| E(X) | Daily average. | EXP(Q2 + (R2/2)) | EXCEL equation for $\exp(\mu + \sigma_y^2 / 2)$. The exponent (exp) is used to convert the natural log transformed values back to regular values. |
| V(X) | Variance. | EXP(((2 * Q2) + R2)) * (EXP(R2) - 1) | EXCEL equation for $\exp(2\mu + \sigma_y^2 / 2) [\exp(\sigma_y^2) - 1]$. The exponent (exp) is used to convert the natural log transformed values back to regular values. |
| cv(X) | Estimated coefficient of variation. | SQRT(EXP(R2) - 1) | EXCEL equation for $\exp[(\sigma_y^2) - 1]^{½}$. The exponent (exp) is used to convert the natural log transformed values back to regular values. |
| Ê(X*) | Daily average for data with non-detects. | (P2 * G3) + (T2 * EXP(Q2 + (0.5 * R2))) | EXCEL equation for $\delta D + (1 - \delta) \exp(\mu + \sigma_y^2 / 2)$. The exponent (exp) is used to convert the natural log transformed values back to regular values. |
| V^(X*) | Variance for data with non-detects. | (T2 * (EXP((2 * Q2) + R2)) * (EXP(R2) - T2)) + (P2 * T2 * (G3 * (G3 - (2 * EXP(Q2 + (0.5 * R2)))))) | EXCEL equation for $(1 - \delta) \exp(2\mu + \sigma_y^2 / 2) [\exp(\sigma y2) - (1 - \delta)] + \delta(1 - \delta)D[D - 2\exp(\mu + \sigma_y^2 / 2)]$. The exponent (exp) is used to convert the natural log transformed values back to regular values. |

**Table 17. Key to TSD Workbook Terms (continued)**

| HEADER | DESCRIPTION | EQUATION | COMMENTS |
|---|---|---|---|
| cv(X*) | Estimated coefficient of variation for data with non-detects. | (SQRT(Y2)) / X2 | EXCEL equation for [V(X*)]½ divided by E(X*). The exponent (exp) is used to convert the natural log transformed values back to regular values. |
| $Z^*_{(0.95)}$ | 95 percent z-score value from table of standard percentiles. | (0.95 - P2) / (1 - P2) | For distributions WITHOUT non-detects this value is 1.6449. For distributions WITH non-detects the percentile (P) is calculated from the equation **(0.95 - P2) / (1 - P2)**, and the z-score value is selected from the standard percentile table. |
| $Z^*_{(0.99)}$ | 99 percent z-score value from table of standard percentiles. | (0.99 - P2) / (1 - P2) | For distributions WITHOUT non-detects this value is 2.3263. For distributions WITH non-detects the percentile (P) is calculated from the equation **(0.99 - P2) / (1 - P2)**, and the z-score value is selected from the standard percentile table. |
| Daily Max ($X_{0.95}$) | Daily Maximum Limit (at the 95th percentile) | Q2 + (1.6449 * S2) **OR** EXP(Q2 + (1.6449 * S2)) | For distributions WITHOUT non-detects the first equation is used. For distributions WITH non-detects the second equation is used. The exponent (exp) is used in the second equation to convert the natural log transformed values back to regular values. |
| Daily Max ($X_{0.99}$) | Daily Maximum Limit (at the 99th percentile) | Q2 + (2.3263 * S2) **OR** EXP(Q2 + (2.3263 * S2)) | For distributions WITHOUT non-detects the first equation is used. For distributions WITH non-detects the second equation is used. The exponent (exp) is used in the second equation to convert the natural log transformed values back to regular values. |
| Daily Max ($X_{0.95}$) (w NDs) | Daily Maximum Limit (at the 95th percentile) | EXP(Q2 + (0.9863 * S2)) | Used ONLY For distributions WITH non-detects. **NOTE:** The value of 0.9863 is an example only. Actual value is taken from standard table of percentiles using result from Column Z. The exponent (exp) is used in the second equation to convert the natural log transformed values back to regular values. |
| Daily Max ($X_{0.99}$) (w/ NDs) | Daily Maximum Limit (at the 99th percentile) | EXP(Q2 + (1.8522 * S2)) | Used ONLY For distributions WITH non-detects. **NOTE:** The value of 1.8522 is an example only. Actual value is taken from standard table of percentiles using result from Column Z. The exponent (exp) is used in the second equation to convert the natural log transformed values back to regular values. |
| Daily Max 0.95 Variability Factor | Daily maximum 95th percentile variability. | AC2 / Q2 **OR** AC2 / U2 OR AE2 / X2 | Equations are for 1) normal distribution with no non-detects; 2) log-normal distribution with no non-detects; and 3) log-normal distribution with non-detects. |
| Daily Max 0.99 Variability Factor | Daily maximum 99th percentile variability. | AD2 / Q2 **OR** AD2 / U2 OR AF2 / X2 | Equations are for 1) normal distribution with no non-detects; 2) log-normal distribution with no non-detects; and 3) log-normal distribution with non-detects. |
| n | Average number of samples per month | AVERAGE(AI2:AI44) | The average number of samples per year. |
| $\sigma^{2n}$ | Variance of distribution of the n-day monthly average. | R2 / AK4 **OR** LN((1 - (P2^AK4)) * (1 + AK2 + AL2 + AM2)) | Equations are for 1) normal distribution with no non-detects; and 2) log-normal distribution with non-detects. Value is not required for log-normal distributions WITHOUT non-detects. |
| $\mu^n$ | Mean of distribution of the n-day monthly average. | Q2 **OR** LN((SQRT(AJ2)) / (1 - (P2^AK4))) - (AN2 / 2) | Equations are for 1) normal distribution with no non-detects; and 2) log-normal distribution with non-detects. Value is not required for log-normal distributions WITHOUT non-detects. |
| $\sigma^n$ | Standard deviation of distribution of the n-day monthly average. | SQRT(AN2) | Equation is for 1) normal distribution with no non-detects; and 2) log-normal distribution with non-detects. Value is not required for log-normal distributions WITHOUT non-detects. |
| $E(X_n)$ | Daily average of distribution of n-day monthly average. | U2 **OR** EXP(AP2 + (AO2 / 2)) | Equation is for 1) log-normal distribution with no non-detects; and 2) log-normal distribution with non-detects. Value is not required for normal distributions WITHOUT non-detects. |
| $V(X_n)$ | Variance for data with non-detects. | V2 / AK4 **OR** (EXP((2 * AO2) + AN2)) * (EXP(AN2) - 1) | Equation is for 1) log-normal distribution with no non-detects; and 2) log-normal distribution with non-detects. Value is not required for normal distributions WITHOUT non-detects. |

| HEADER | DESCRIPTION | EQUATION | COMMENTS |
|---|---|---|---|
| $X_n$ | Term used in calculation of cv($X_n$). | AVERAGE(AJ9:AJ44) | Random variable representing the average of distribution of n-day monthly averages. Value is not required for normal distributions WITHOUT non-detects. |
| | Calculation of values for $X_n$. | AVERAGE(J2:J9) **OR** AVERAGE(K2:K9) | Equations are for 1) log-normal distribution with no non-detects; and 2) log-normal distribution with non-detects. |
| cv($X_n$) | Variance of the n-day monthly average. | AP2 / AO2 **OR** (SQRT(AR2)) / AS2 **OR** AQ2 / AR2 | Equation is for 1) normal distribution with no non-detects; and 2) log-normal distribution with non-detects. Value is not required for log-normal distributions WITHOUT non-detects. |
| Average Monthly 0.95 ($X_{0.95(n)}$) | Monthly Average 95$^{th}$ percentile. | AO2 + (1.6449 * AP2) **OR** AQ2 + (1.6449 * SQRT(AR2))) | Equations are for 1) normal distribution with no non-detects; and 2) log-normal distribution with no non-detects. The exponent (exp) is used to convert the natural log transformed values back to regular values. |
| Average Monthly 0.99 ($X_{0.99(n)}$) | Monthly Average 99$^{th}$ percentile. | AO2 + (2.3263 * AP2) **OR** AQ2 + (2.3263 * SQRT(AR2))) | Equations are for 1) normal distribution with no non-detects; and 2) log-normal distribution with no non-detects. The exponent (exp) is used to convert the natural log transformed values back to regular values. |
| Average Monthly 0.95 ($X_{0.95(n)}$) (w/ NDs) | Monthly Average 95$^{th}$ percentile. | AQ6 + (0.9863 * (SQRT(AR6))) | Equation is for log-normal distribution WITH non-detects. **NOTE:** The value of 0.9863 is an example only. Actual value is taken from standard table of percentiles using result from Column Z. The exponent (exp) is used to convert the natural log transformed values back to regular values. |
| Average Monthly 0.99 ($X_{0.99(n)}$) (w/ NDs) | Monthly Average 99$^{th}$ percentile. | AQ6 + (1.8522 * (SQRT(AR6))) | Equation is log-normal distribution WITH non-detects. **NOTE:** The value of 1.8522 is an example only. Actual value is taken from standard table of percentiles using result from Column Z. The exponent (exp) is used to convert the natural log transformed values back to regular values. |
| Normality | Calculation Normality | | The normality of calculations used for that parameter. |

**Table 18. TSD for WQ Limits – Groundwater Early Warning Values [A]**

| Well | Start_Date | Parameter_Name | Value | Units | Qlf | PQL | Outlier | Value | $y_i = \ln(x)$ | $y_i$ (- NDs) | k | NDs | r | k - r | δ = r / k | $\mu^y$ | $\sigma^{2y}$ | $\sigma^y$ | 1 - δ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Combined | 07/27/2018 | 1,2-Dichloroethane | 0.0137 | µg/L | J | 0.02 | | | 6.4E-11 | | 66 | | 5 | 61 | 0.07576 | -3.88 | 0.313681 | 0.560072 | 0.9242424 |
| Combined | 07/27/2018 | Benzene | 3.53 | µg/L | B | 0.02 | Possible | 3.53 | 1.26 | 1.26 | 42 | | 6 | 36 | 0.142857 | -1.32 | 2.797 | 1.67 | 0.857143 |
| Combined | 07/27/2018 | cis-1,2-Dichloroethene | 0.02 | ug/L | U | 0.02 | | | 6.4E-11 | | 43 | Y | 34 | 9 | 0.790698 | 2.41E-06 | 4.451E-11 | 6.6714E-06 | |
| Combined | 07/27/2018 | Ethylbenzene | 0.2 | µg/L | U | 0.2 | | | 0.000064 | | 47 | Y | 23 | 24 | 0.489362 | 464.15 | 2.82E+06 | 1,679.233 | |
| Combined | 07/27/2018 | m, p-Xylene | 0.124 | µg/L | J | 0.4 | | | -2.09 | -2.09 | 67 | | 23 | 44 | 0.343284 | -0.35297 | 3.62 | 1.902 | 0.656716 |
| Combined | 07/27/2018 | o-Xylene | 0.2 | µg/L | U | 0.2 | | | 0.000064 | | 66 | Y | 45 | 21 | 0.68182 | 142.23 | 144,046.13 | 379.53 | |
| Combined | 07/27/2018 | Vinyl Chloride | 0.111 | µg/L | J | 0.02 | | | 0.00137 | 0.00137 | 42 | | 27 | 15 | 0.642857 | 0.000773 | 1.21E-06 | 0.001102 | |

| Well | Start_Date | Parameter_Name | E(X) | V(X) | cv(X) | Ê(X*) | V^(X*) | cv(X*) | $Z^*_{(0.95)}$ | $Z^*_{(0.99)}$ | Daily Max ($X_{0.95}$) | Daily Max ($X_{0.99}$) | Daily Max ($X_{0.95}$) (w NDs) | Daily Max ($X_{0.99}$) (w/ NDs) | Daily Max 0.95 Variability Factor | Daily Max 0.99 Variability Factor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Combined | 07/27/2018 | 1,2-Dichloroethane | | | | 0.023921 | 0.0002014 | | 0.946 | 0.989 | | | 0.05098 | 0.074742 | 2.13 | 3.12 |
| Combined | 07/27/2018 | Benzene | | | | 0.929982 | 15.57 | | 0.942 | 0.988 | | | 3.701 | 11.64 | 3.98 | 12.52 |
| Combined | 07/27/2018 | cis-1,2-Dichloroethene | | | | | | | 0.761 | 0.952 | | | 0.13878 | 0.15434 | 1.198 | 1.33 |
| Combined | 07/27/2018 | Ethylbenzene | | | | | | | 0.902 | 0.980 | | | 3.72 | 3.97 | 1.34 | 1.43 |
| Combined | 07/27/2018 | m, p-Xylene | | | | 2.96 | 442.68 | | 0.924 | 0.985 | | | 10.72 | 43.62 | 3.63 | 14.76 |
| Combined | 07/27/2018 | o-Xylene | | | | | | | 0.843 | 0.969 | | | 2.84 | 3.08 | 1.24 | 1.35 |
| Combined | 07/27/2018 | Vinyl Chloride | | | | | | | 0.860 | 0.972 | | | 0.125212 | 0.14225 | 1.36 | 1.55 |

| Well | Start_Date | Parameter_Name | n | $\sigma^2_n$ | $\mu^n$ | $\sigma_n$ | $E(X_n)$ | $V(X_n)$ | $X_n$ | $cv(X_n)$ | Average Monthly 0.95 ($X_{0.95(n)}$) | Average Monthly 0.99 ($X_{0.99(n)}$) | Average Monthly 0.95 ($X_{0.95(n)}$) (w/ NDs) | Average Monthly 0.99 ($X_{0.99(n)}$) (w/ NDs) | Normality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Combined | 07/27/2018 | 1,2-Dichloroethane | | | | | 0.023921 | 3.66E-05 | -3.73 | -0.001624 | | | 0.03365 | 0.03778 | Natural log w/ NDs |
| Combined | 07/27/2018 | Benzene | | | | | 0.93 | 2.97 | -1.441 | -1.19 | | | 3.64 | 4.82 | Natural log w/ NDs |
| Combined | 07/27/2018 | cis-1,2-Dichloroethene | | 8.28E-12 | 2.41E-06 | 2.88E-06 | | | | 1.19 | | | 0.12827 | 0.13897 | $x^6$ w/ NDs |
| Combined | 07/27/2018 | Ethylbenzene | | 479,969.81 | 464.15 | 692.799 | | | | 1.49 | | | 3.33 | 3.52 | $x^6$ w/ NDs |
| Combined | 07/27/2018 | m, p-Xylene | | | | | 2.96 | 26.43 | -0.01362 | -377.45 | | | 10.32 | 14.11 | Natural log w/ NDs |
| Combined | 07/27/2018 | o-Xylene | | 26,190.205 | 142.23 | 161.83 | | | | 1.14 | | | 2.59 | 2.76 | $x^6$ w/ NDs |
| Combined | 07/27/2018 | Vinyl Chloride | | 2.31E-07 | 0.0007731 | 0.000481 | | | | 0.6218989 | | | 0.10893 | 0.11916 | $x^3$ w/ NDs |
| A | Calculations were preformed for all constituents. Only those with less than 20 percent non-detects or constituents of concern are shown. | | | | | | | | | | | | | | |

# Appendix E--Response to Comments

[Ecology will complete this section after the public notice of draft period.]