

Completing Discharge Monitoring Reports (DMRs)

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Quality



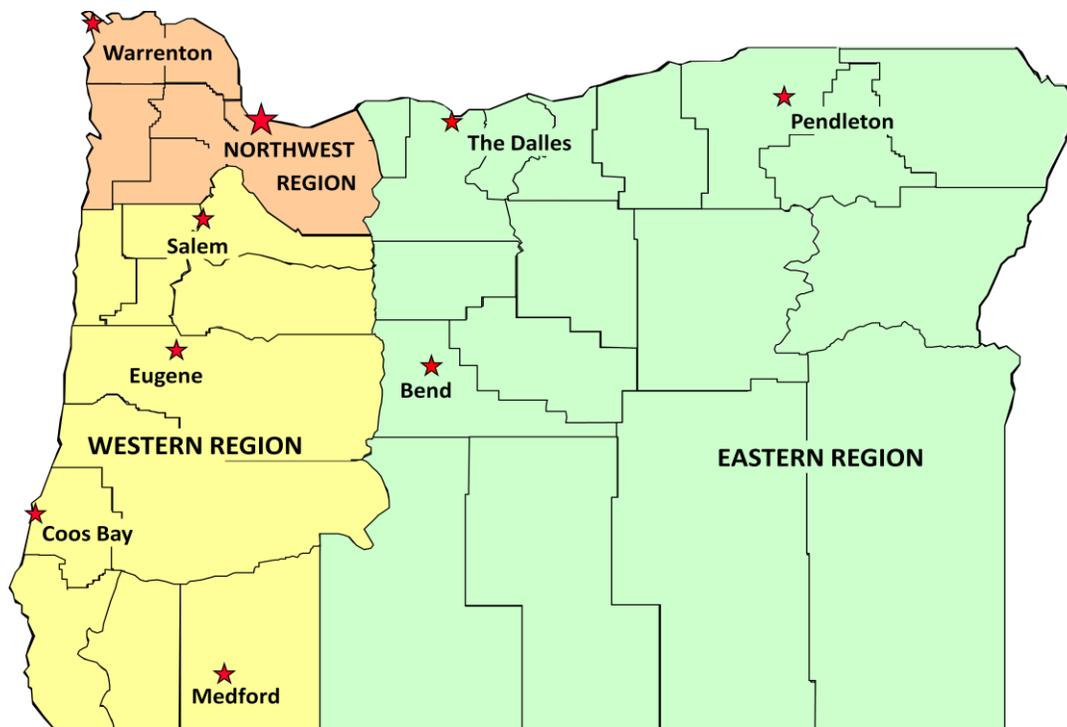
This report prepared by:

Oregon Department of Environmental Quality
811 SW 6th Avenue
Portland, OR 97204
1-800-452-4011
www.oregon.gov/deq

This document provides procedural information on how to complete **Discharge Monitoring Reports**. This information is intended as guidance for wastewater treatment plant operators and should be interpreted and used in a manner fully consistent with the state's environmental laws and implementing rules. This document does not constitute rulemaking by the Oregon Environmental Quality Commission and may not be relied on to create a right or benefit, substantive or procedural, enforceable at law or in equity, by any person, including DEQ employees.

Do You Have Comments or Suggestions for Improving this Guidance? Please let us know! Send comments and suggested changes to the: Oregon DEQ, Surface Water Management Program, 811 SW 6th Ave., Portland, OR 97201 or contact DEQ at one of the offices listed in this guide.

Completing Discharge Monitoring Reports



Northwest Region Offices	Western Region Offices	Eastern Region Offices
<p>Portland 2020 SW 4th Ave., Suite 400 Portland, OR 97201 Phone: 503-229-5263 Fax: 503-229-6945 TTY: 503-229-5471</p> <p>North Coast Branch Office 65 N Highway 101, Suite 202 Warrenton, OR 97146 Phone: 503-861-3280 Fax: 503-861-3259</p>	<p>Salem 750 Front St NE, #120 Salem, OR 97301-1039 Phone: 503-378-8240 Toll free in Oregon: 800-349-7677 Fax: 503-373-7944 TTY: 503-378-3684</p> <p>Eugene 165 East 7th Ave., Suite 100 Eugene, OR 97401 Phone: 541-686-7838 Toll free in Oregon: 800-844-8467 Fax: 541-686-7551 TTY: 541-687-5603</p> <p>Coos Bay 381 N Second St Coos Bay, OR 97420 Phone: 541-269-2721 Fax: 541-269-7984</p> <p>Medford 221 Stewart Ave., Suite 201 Medford, OR 97501 Phone: 541-776-6010 Fax: 541-776-6262 Toll free in OR: 877-823-3216</p>	<p>The Dalles 400 E Scenic Drive, Building 2 The Dalles, OR 97058 Phone: 541-298-7255 Fax: 541-298-7330</p> <p>Bend 475 NE Bellevue, Suite 110 Bend, OR 97701 Phone: 541-388-6146 Fax: 541-388-8283</p> <p>Pendleton 700 SE Emigrant, #330 Pendleton, OR 97801 Phone: 541-276-4063 Fax: 541-278-0168 Toll free in OR: 800-304-3513 Fax: 541-567-4741</p>

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1 Introduction

1.1 Purpose

This manual is intended to help wastewater treatment plant operators in completion and submittal of monitoring and reporting as required by their permit. The use and reference of this manual may help avoid reporting errors and permit noncompliance. Please note, however, that if any conflicts arise between this document and Oregon rules, regulations or the permit, then the applicable rules, regulations, and/or permit take priority over this document.

1.2 Content

This manual contains instructions for completing Discharge Monitoring Reports and sample calculations. A separate document regarding laboratory test methods, calculations, and procedures titled Quality Assurance (QA) Guidance for Self Monitoring Laboratories has been prepared and is available online at:

<http://www.deq.state.or.us/lab/techrpts/docs/NPDESWPCF.pdf>

1.3 Permit Basis

The Department of Environmental Quality (DEQ) regulates domestic wastewater systems under two types of permits. National Pollutant Discharge Elimination System (NPDES) permits are for systems that may discharge to surface waters, and Water Pollution Control Facilities (WPCF) permits are issued to systems that do not discharge to surface waters.

A permit is a legally enforceable agreement between the permit holder (permittee) and the DEQ, as the permit issuer. Permits are issued to systems based on their site-specific conditions and types of treatments. A permit includes discharge and disposal limits, requirements for monitoring and reporting, testing and compliance schedules, and other operational requirements. It is important for the permittee to read and understand their permit in order to meet all permit requirements.

1.4 Discharge Monitoring Reports

Permits require the permittee to regularly submit a Wastewater Treatment Plant Monitoring Report, more commonly referred to as a Discharge Monitoring Report or DMR, to the DEQ. The DMR reflects system operating conditions and is evidence of compliance or non-compliance with the terms and conditions of the permit. DMRs are evaluated by DEQ as part of the agency's compliance assurance and pollution prevention activities. Monitoring data helps the operator control and optimize system performance and allows operators and the DEQ to be more fully responsive to pollution prevention issues.

The permit details the minimum information that must be included in a DMR. If analyses are performed more frequently than the permit specified, these additional analyses must also be reported. Often, additional parameters are reported to better describe the discharge and operational conditions, and to provide information on the receiving stream. Failure to comply with the minimum monitoring and reporting requirements in the permit is a violation of Oregon

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Administrative Rules (OARs). Under OAR Chapter 340, Division 12, failing to submit a complete DMR is a Class III violation. Failure to monitor any Schedule B item or parameter is a Class I violation. Class I violations are considered to be the most serious violations; Class III violations are the least serious.

The DMR is a matter of public record and available for inspection by citizens, consultants, attorneys, the Environmental Protection Agency (EPA), and other interested parties. Therefore, it is important that DMRs are submitted in a timely manner, that they are legible, and that they contain complete and accurate information that has been validated by a permittee's QA procedures.

2 Instructions for Completing Discharge Monitoring Reports

2.1 General Instructions

2.1.1 DMR Forms

Discharge Monitoring Reports must be submitted on DEQ-approved forms. A DEQ-developed DMR form is available for use and can be found online at:

<http://www.deq.state.or.us/wq/wqpermit/dmrformsindy.htm>. A permittee may use a form of its own design if it includes all required information and has been approved by DEQ.

2.1.2 Legibility

DMRs must be legible (do not use pencil or red ink) using blue or black ink. Please do not use “white-out” to make a correction. Errors should be left visible, struck with a line, and initialed. Any subsequent reporting of DMR errors or missing data should be clearly identified as a ‘Corrective Report’.

2.1.3 Permit Information

Schedule A of the permit contains waste discharge limitations and conditions. Minimum monitoring and reporting requirements and related general conditions are found in Schedule B of the permit. Every item or parameter under Schedule B must be reported on the DMR.

2.1.4 Significant Figures

Results must be reported using the same number of significant figures as the permit limit. For a complete discussion on the use of significant figures and rounding conventions in permitting, refer to: <http://www.deq.state.or.us/wq/pubs/imds/SigFigsIMD.pdf>

2.1.5 Sampling Frequency

Schedule B defines a minimum frequency of analysis for each parameter. A week is defined in Schedule F Section E Definitions as a calendar week beginning on Sunday and ending on Saturday. Any variation in the definition of a week will be defined in the facility’s permit. If a parameter is sampled on a quarterly basis, check the permit for the defined quarters and when quarterly data is to be reported.

2.1.6 Reporting Units

Data must be converted and reported in proper units (e.g. flow in MGD, concentrations in mg/L, ug/L, loading in lbs per day, etc.). The units are shown just below the parameters in the DEQ DMR form. In general, BOD, TSS, ammonia, chlorine, nutrients, oil & grease, and dissolved oxygen are reported in mg/L. Metals and organics are typically reported in ug/L.

2.1.7 Quality Assurance

All data gathered to meet monitoring and reporting requirements must be accurate, based on DEQ approved analytical methods, and validated by QA procedures. DEQ approved analytical methods are defined in (the General Conditions) the permit. Unless otherwise noted in the permit, NPDES permit holders must use EPA approved methods listed in the most recent publication of 40 CFR Part 136. Please note that not all methods in Standard Methods for the Examination of Water and Wastewater are included in 40 CFR Part 136. Data from any additional monitoring of a required parameter that is based on approved analytical methods must also be included on the DMR.

2.1.8 QA/QC Failure

Monitoring data not validated by QA procedures must be reported (and clearly noted), but not used to calculate weekly and monthly averages, to calculate pollutant loadings, or determine compliance with a pollutant limit. In these cases, the DMR must include a note about the QA/QC failure and what corrective actions have been or will be taken.

2.1.9 Verification of Compliance or Non-Compliance

The yes or no questions regarding effluent limits, sampling frequencies, overflows, and upset conditions must be answered. Any permit exception or non-compliance during a reporting period needs to be identified on the DMR. A brief explanation describing the cause and corrective actions taken should also be included.

2.1.10 Due Date

The completed, signed (by licensed operator) original DMR must be submitted (postmarked) by no later than the 15th day of the month following the reporting period, unless otherwise stated in the permit. Reporting periods are generally calendar months (refer to the permit). Note that unless the permit specifically states otherwise, a DMR must be submitted even when no discharge occurs.

2.2 Completing DMR Heading Information

2.2.1 Facility Name

The facility name is reported on all pages of the DMR.

2.2.2 Phone Number

Please provide a contact phone number in the event that DEQ needs to contact the facility regarding questions about the DMR or facility.

2.2.3 Month/Year

The period (month and year) covered by the report is reported on all pages of the DMR. Reporting periods are generally calendar months (refer to the permit). Note that subsequent corrective reports submitted to the DEQ should be clearly marked "Corrected Report".

2.2.4 DEQ Permit No.

The Permit Number can be found on the first page of the permit. This is reported on all pages of the DMR.

2.2.5 DEQ File No./ Facility ID

The File Number can be found in the header information of the permit. This is reported on all pages of the DMR.

2.2.6 EPA Reference No.

Please provide the EPA Reference No., which can be found on the first page of the permit.

2.2.7 Plant Type

Include the type of wastewater treatment used (i.e. activated sludge, trickling filter, lagoon with aeration etc.). The type of treatment should be consistent with the facility type listed on the permit.

2.2.8 County

Please include the county where the facility is located.

2.2.9 Population Served

Please provide the service area population. Do not use census population if that number is not representative of the total service area population. Where sewers extend beyond city limits and/or there are large numbers of 'second homes', seasonal recreational and tourism use, reliance on a census number may result in gross under-estimating.

For a system without significant industrial users, a best estimate may be one that is based on a 'per person' equivalent pollutant load known as a Population Equivalency (PE). If this number has not already been established through planning/design, it may be calculated based on 70 gallons per person per day average dry weather flow (ADWF) or 0.17 pounds BOD5 per person per day, whichever is greater [(See OAR 340-049-0010(13)].

Calculation using ADWF Method:

$$PE = \frac{ADWF \text{ (gallons/day)}}{70 \text{ gallons/day} \cdot \text{person}}$$

Calculation using BOD5 Method:

$$PE = \frac{\text{Total average influent BOD (lbs/day)}}{0.17 \text{ lbs/day} \cdot \text{person}}$$

2.2.10 Operator Certification

The Collection System Class and Treatment System Class designations can be found on the first page of the permit. In accordance with OAR 340 Division 49, wastewater systems must be supervised by one or more operators who hold a valid certificate for the type of system (treatment or collection) at a grade equal to or greater than the system classification. Report the name, certification number and grade of the operator for the treatment and collection systems.

2.3 Influent Data

2.3.1 Influent Parameters

Specific parameters, monitoring frequencies, types of samples, and sampling location(s) are outlined in Schedule B of the permit. Required influent data may include temperature (if reporting, designate Celsius or Fahrenheit by checking the appropriate box), pH, flow, BOD and/or CBOD, and TSS. For BOD/CBOD and TSS, record concentration in mg/L on the line for the date sampled, not on date when the test was completed. **Note:** Report required influent parameters even when there is no discharge (see permit).

If influent flow is monitored, daily reporting is to represent a 24-hour operating period unless the permit specifically authorizes abbreviated on-site operation (weekends, holidays, etc.). Such exceptions are typically full-telemetry and / or non-discharging systems, where the daily flow may be derived from data graphs or totalizer averaging.

Generally, only concentration values (mg/L) for influent BOD / CBOD and TSS will need to be reported. If the permit requires loading values (lbs), they may need to be calculated. See the example calculations section for examples.

2.4 Effluent Data

2.4.1 Outfall Identification

The permit may require reporting of multiple outfall discharge data or a 'zero discharge' statement (see Schedule A of the permit). This may require a separate DMR for each outfall. Be sure to clearly identify which outfall the effluent data represents by permit assigned number or description (i.e. 001, 002, 'XYZ' River, land irrigation, combined sewer overflow, etc.)

2.4.2 Effluent Parameters

Specific parameters, monitoring frequencies, types of samples, and sampling location(s) are outlined in Schedule B of the permit. Report appropriate data (as specified in the permit), which may include the following:

Temperature: If reporting, designate Celsius or Fahrenheit by checking the appropriate box.

pH: Report measured pH value.

Flow: It is desirable to monitor effluent flows influenced by recycle streams, controlled discharge, seepage, evaporation, and rainfall, as with lagoons or ponds.

DO: Report the measured dissolved oxygen concentration in mg/L

BOD or CBOD (5 day): Record concentration in mg/L on the line for the date sampled, not on date when the test was completed. Data for mass loading (lbs) is calculated based on flow data for the date sampled. See the example calculations section for examples. **Note:** Use of nitrification inhibited BOD (CBOD) data for compliance purposes requires DEQ authorization (refer to permit).

TSS: Reporting follows the same method as for BOD.

Removal Efficiency: Determining percent removal helps in evaluating plant efficiency and is required to determine compliance with the secondary treatment standards in 40 CFR Part 133. Required reporting for percent removal values for BOD/CBOD and TSS are generally monthly values based on monthly average influent and effluent concentration values (see the example calculations section). Percent removal is defined in 40 CFR Part 133 as follows:

“Percent removal. A percentage expression of the removal efficiency across a treatment plant for a given pollutant parameter, as determined from the 30-day average values of the raw wastewater influent pollutant concentrations to the facility and the 30-day average values of the effluent pollutant concentrations for a given time period.”

When preliminary treatment occurs within septic tanks prior to reaching the treatment facility, the permit can allow assumed 200 mg/L influent BOD5 and TSS concentrations to be used in the calculation of the percent removal efficiency.

Nutrients: Record as required by permit.

Chlorine Used: If chlorine scales are used, record the daily amount used as calculated from scale readings (difference in weight). If Sodium Hypochlorite is used, report pounds based on liquid volume and available chlorine concentration.

Total Residual Chlorine (TRC): TRC must be tested at the same time that coliform samples are taken, and the result must be entered on the sampling record (lab data sheet).

UV: Report as required by permit. UV monitoring typically requires reporting UV dose (mJ/cm²), but may also include parameters such as UV intensity (mW/cm²), UV transmittance (%) or lamp life (hours). UV dose is calculated based on the residence time in the reactor and the UV intensity:

$$UV \text{ Dose} = \text{Residence Time (RT)} \times UV \text{ Intensity (UVI)}$$

The UV system manufacturer should provide the relationship between the flow and the residence time (RT Coefficient). This relationship may be used in the following equation:

$$UV \text{ Dose} \left(\frac{mJ}{cm^2} \right) = \text{Flow (MGD)} \times RT \text{ Coef.} \left(\frac{seconds}{MGD} \right) \times UVI \left(\frac{mW}{cm^2} \right)$$

Turbidity: Typically required for Class A recycled water systems. Please see DEQ’s Internal Management Directive on Recycled Water Use for more information.

Coliform: Refer to the permit to determine whether *E. coli*, Fecal Coliform, Enterococci, and/or Total Coliform sampling is required. Record values for the date sampled. Test method may be the Membrane Filter (MF) procedure or the Most Probable Number (MPN) method. Identify either MF or MPN method on the DMR by checking the appropriate box under the Coliform heading, above the type (*E. coli*, Fecal, enterococci, or Total) monitored.

Note: For *E. coli* sampling only (not applicable for Fecal or Total Coliform), if a single sample exceeds 406 organisms per 100 mL, the facility may resample by taking five consecutive re-samples at four-hour intervals beginning within 48 hours after the original sample was taken. If the geometric mean of the five re-samples is less than or equal to 126 organisms per 100 mL, a violation is not triggered. However, all values need to be reported on the DMR. The original high

value sample can be reported with an asterisk (*) to signal that it will not be included in the monthly calculation. See the example calculations section for explanation of geometric mean.

2.4.3 Special Situations

2.4.3.1 Daily Average

The following procedures should be followed when more than one sample is taken in a day (midnight to midnight):

1. **Bacteria:** report the maximum value for the day, but use all values to calculate and report the geometric mean.
2. **pH:** report the 90th percentile.
3. **Temperature:** report the maximum temperature for the day.
4. **All other parameters:** report the average of the samples.

2.4.3.2 Intermittent Discharges

DEQ recognizes the difficulty of monitoring intermittent discharges. To the maximum extent possible, the facility should manage the discharge so that the monitoring requirements in the permit can be met. In general, the facility should follow an established monitoring schedule (e.g., Monday, Wednesday, Friday). However, if the discharge is intermittent, there may be no discharge on the scheduled sampling day. In these cases, DEQ expects that at least one sample per month and recommends the following guidelines for discharges that last less than one week:

Table 1: Sampling Guidelines for Intermittent Discharges

Discharge Period	Guidelines
Discharge begins Sunday through Thursday and ends prior to Saturday	Sampling should be performed as typically scheduled during the week until the discharge ceases. After the discharge ceases, no further sampling is required for the week.
Discharge begins Friday through Saturday and ends prior to the following Friday	Sampling should be performed as typically scheduled during the week until the discharge ceases. However, weekly averages should include data from Friday through the date that the discharge ceases.
Discharge begins before or after normal working hours (generally 8-5, 5 days a week)	The daily sample from the day before or day after may be considered representative of the discharge during the partial day discharge. If discharge only occurs outside of normal working hours, the facility must make arrangements for off hours monitoring and at least one sample per week is expected.

2.4.3.3 Analytical Results Less Than Quantitation Level

Unless the Department instructs the Permittee in writing to do otherwise, the following procedures are to be used for analytic results that are less than the quantitation level:

A. Sample result at or below detection level

If a sample result is at or below the detection level, report the result as less than the specified detection level. For example, if the detection level is 1.0 ug/L and the result is non-detect, report “<1.0 ug/L” on the DMR.

B. Sample result above detection level but below quantitation level:

If a sample result is above the detection level but below the quantitation level, report the result as the detection level preceded by the DEQ data code “e”. This code identifies the result as being between the detection level and quantitation level. For example, if the detection level is 1 ug/L and the quantitation level is 5 ug/L and the sample result is 4 ug/L, report “e1 ug/L” on the DMR.

Arithmetic average: If a sample result is below the detection limit, use zero for that sample in the calculation of the arithmetic average. If the sample result is greater than the detection limit, but less than the quantitation limit, use the detection limit value for that sample in the calculation of the arithmetic average.

Geometric mean: Values of zero cannot be used to calculate a geometric mean. If a sample result is below the detection limit, one-half the detection limit should be used in the calculation of the geometric mean for all pollutants except bacteria. For bacteria results less than the detection limit, use the detection limit value for that sample to calculate the geometric mean.

2.5 Receiving Stream Data

DEQ evaluates water quality and DMR information by watershed / receiving stream to determine pollutant load. Refer to the permit to determine if in-stream monitoring (upstream or downstream) is required and report data accordingly.

2.6 Summary Statistic Values

Summary statistic values (such as daily maximum, monthly average and weekly average) are:

- Reported in the rows near the bottom of the form, below the reported monitoring data.
- Calculated when parameters are monitored more than once a month or week.
- If the permit specifies a parameter to be monitored a minimum of once per month and only one sample is taken, this single value serves as summary statistic. For example, if only one BOD sample is analyzed, then this value is reported as the daily maximum, the weekly average maximum, and the monthly average maximum.

At least one summary statistic value is needed for every parameter monitored. For the parameters with effluent limits, a summary statistic is needed for each limit. For instance, if BOD has monthly average, weekly average, and daily maximum effluent limits, then these summary statistic values should be reported. For parameters without effluent limits, a monthly average and daily maximum should be reported.

2.6.1 Total

Report totals for flow (in million gallons) and loads (in pounds). Calculate and enter the sum of the figures in the column.

2.6.2 Daily Minimum

This is the lowest sample result for a day occurring in the reporting period. Determine and record the smallest single figure in the column.

2.6.3 Daily Maximum

This is the highest sample result for a day occurring in the reporting period. Determine and record the largest single figure in the column.

2.6.4 Weekly Average Maximum

A week is defined as a calendar week beginning on Sunday and ending on Saturday in Schedule F, Section E (Definitions) of the permit. Any variation in the definition of a week will be defined in the facility's permit. Refer to Schedule A of the permit to determine which parameters have weekly average discharge limitations. For those parameters, calculate weekly averages (see discussion of calculating averages below) for each week and record the highest value calculated. If a calendar week falls between two reporting months, the weekly average is still calculated once all of the data is available. The value may be reported in the month's DMR that has the majority of days from the week that spans the two months.

2.6.5 Monthly Average

Except for bacteria, pH, and percent removal, an arithmetic average is used to report the monthly average value. An average is not obtained by adding the minimum and maximum figures in a column and dividing by two. Calculate by taking the total sum of all the figures in the column and dividing by the number of figures reported. For example, if a three day/week discharge results in 12 entries for a reporting period, add the 12 values to get a total sum. Then divide the total sum by 12 to obtain the average.

The monthly summary statistic for bacteria (except for recycled water) is a geometric mean. See section 3.7, p. 17, for an example of a monthly geometric mean calculation.

pH: Monthly average values are not reported for pH.

BOD/CBOD and TSS: Monthly values for percent removal (BOD/CBOD and TSS) are calculated based on the monthly average influent and effluent concentration values of the parameter (see the example calculations section). While it might appear that the monthly average of the percent removals calculated on a daily basis would be the same, the results are actually different. Therefore, to avoid confusion, DEQ recommends leaving the spaces in the DMR for the daily percent removal blank.

Note: Always track and calculate averages for compliance determination if average limits are in the permit. More frequent sampling may help a facility avoid or mitigate a violation of permit limits that would otherwise be based solely on one or two non-compliant test results.

2.6.6 Recycled Water

The recycled water rules have special summary statistics regarding total coliform results. Class A,

B, and C recycled water requires the calculation and reporting of a “median based on results of the last seven days that analyses have been completed”. The rule also establishes the minimum monitoring frequency (e.g. once per week for Class C). Therefore, if a facility monitors Class C water at the minimum frequency, compliance is based over multiple monthly DMRs. If a facility collects samples more frequently than required in Schedule B, compliance is still based on the last 7 representative daily samples. If multiple samples are collected on a single day, report the median of the samples collected on a single day as one of the 7 samples. Report the maximum median in the “weekly average maximum” row of the DMR.

Class C recycled water also requires reporting if “two consecutive samples” exceed 240 organisms per 100 ml. This review will also be based over multiple monthly DMRs. If two consecutive samples exceed 240, the operator should note this in the comments section of the DMR.

2.7 Permit Limits

The rows at the bottom of the form provide space to list the daily, weekly, and monthly limits as set by the permit, Schedule A. To assist both DEQ and the permittee in determining compliance with permit limits, record the permit limits on the DMR. Some permits contain different monitoring parameters and limits for various times of the year and/or specific identified outfalls, such as for effluent reuse. Be sure to enter the correct limits for the reporting period and outfall.

2.8 Operational Information

2.8.1 Daily Log

This column is intended to record important information for the collection and treatment system, such as equipment breakdown, repairs, odors, complaints, bypasses, etc. **Note:** Identification of system upsets and bypassed under this ‘Daily Log’ section does not relieve the requirement to submit a written report.

2.8.2 Process Data

Columns for process and operational data are provided on the second page of the DMR. The permit may have additional monitoring requirements such as depth of blanket, lagoon levels, etc.

2.8.3 Upset Event Conditions

Columns are provided to record flow and duration conditions for overflow and bypass events. See below regarding bypass, upset, and emergency reporting.

2.8.4 Recycled Water

Columns are provided to record the quantity of irrigated water.

2.8.5 Rainfall

Recording the amount of rainfall helps a facility to gage its performance during storm events and verify that the facility has the hydraulic and treatment capacity for design storms. It also provides an indication of whether Infiltration and Inflow (I/I) may be a problem in the collection system.

2.8.6 Operator(s) Time on Site

This column is used to record the hours spent onsite operating the facility, which should include maintenance, monitoring, repairs or any other activities related to operation of the facility.

2.9 Permit Non-Compliance

The permittee is responsible for continually evaluating compliance with permit limits and conditions. Any permit exception or non-compliance (violation) incident during a reporting period must be identified on the DMR. Some situations also require immediate notice (telephone) and/or a 5-day written report, see Schedule F General Conditions Section D Reporting Requirements for details. Indicate permit compliance or non-compliance by circling yes or no for the three questions on the right side of the form on the second page.

2.9.1 Non-Compliance Incidents / Corrective Action Reporting

Circle or otherwise identify on the DMR (by date of incident) non-compliance with permit established limitations. Also, identify non-compliance with minimum frequency for monitoring and reporting, compliance schedules / conditions, special conditions, and general conditions.

Provide a statement on (or attached to) the DMR describing each incident, its cause, duration and time corrected (or to be), and steps taken to reduce, eliminate, and prevent a recurrence of non-compliance. DEQ may request additional information and/or take further action as appropriate.

2.9.2 SSO, Bypass, Upset, and Emergency Reporting

Any unanticipated bypass or upset condition which exceeds permit effluent limits and/or endangers health or the environment must be reported orally to the Oregon Emergency Response System (OERS) within 24 hours at 1-800-452-0311.

In addition, a bypass of raw untreated sewage from a collection or treatment system or sanitary sewer overflow (SSO) must now be reported in accordance with DEQ's SSO Internal Management Directive (IMD) and SSO reporting form, both of which can be found at: <http://www.deq.state.or.us/wq/pubs/pubs.htm#forms> . A copy of the fillable form should be readily available on the facility's computer. This report must be submitted to the appropriate DEQ Regional office within 5 days of the time the permittee becomes aware of the event.

The facility must also have an emergency response and public notification plan that contains specific emergency operations, including public notification.

2.10 Signature

For the DMR to be considered complete, it must be properly signed by an authorized person or representative. This may be a principal executive officer or ranking elected official or their designated representative(s). The date of signature and clearly printed name must also be included. The person signing the DMR is accountable for assuring that the information submitted has been properly gathered and evaluated and certifies it is true, accurate, and complete to the best of their knowledge. Be aware that there are significant penalties for knowingly submitting false information.

A person is a duly authorized representative only if the authorization is made in writing to DEQ, and the authorization specifies an individual or position having responsibility for the overall operation of the system, such as plant manager, supervisor, superintendent or equivalent

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responsibility. When an authorization is no longer accurate because a different individual or position has responsibility for the overall operation of the system, a new authorization must be submitted to DEQ.

3 Example Calculations

3.1 Flow in MGD

Flows are typically reported in Million Gallons per Day (MGD)

$$MGD = \frac{\text{gallons per day}}{1,000,000}$$

Example: A facility records 124,567 gallons of flow in a day. To report the flow on the DMR, the value should be converted to units of MGD.

$$MGD = \frac{124567}{1000000} = 0.12 \text{ MGD}$$

The result is reported to two significant figures, consistent with the level of accuracy associated with most flow measurement devices. For example:

1,000,000 gallons per day = 1.0 MGD
100,000 gallons per day = 0.10 MGD
10,000 gallons per day = 0.010 MGD

3.2 Loading

The term loading as presented in the permit and reported in the DMR refers to the total amount of a pollutant entering the facility or discharged in the effluent. It is calculated by knowing the amount of flow, the concentration, and the density of water. Results should be rounded off and expressed with the same number of significant figures as the permit limit. If the permit does not explicitly state how many significant figures are associated with the permit limit, it can usually be assumed to be two.

$$\text{Loading (lbs/day)} = \text{flow (MGD)} \times \text{concentration (mg/L)} \times 8.34 \frac{\text{lbs/MG}}{\text{mg/L}}$$

The equation may be shown as:

$$\text{Mass Loading} = Q \times C \times 8.34$$

Where: Mass Loading is in lbs/day
Q = flow in MGD
C = concentration in mg/L
8.34 is the unit conversion for the weight of water*

* If the concentration units are in ug/L for the water quality parameter, the following unit conversion for the weight of water would be used in the above equation to calculate a daily loading.

$$8.34 \frac{\text{lbs/MG}}{\text{mg/L}} \times \frac{1 \text{ mg}}{1000 \text{ ug}} = 0.00834 \frac{\text{lbs/MG}}{\text{ug/L}}$$

Example: For a given day, a facility discharged 500,000 gallons of treated water that had a BOD5 concentration of 15 mg/L. To calculate the effluent BOD5 loading:

First convert the flow to MGD -> 500,000/1,000,000 = 0.50 MGD

Now, using the above equation:

$$\text{Loading} = 0.50 \text{ MGD} \times 15 \text{ mg/L} \times 8.34 \frac{\text{lbs/MG}}{\text{mg/L}} = 63 \text{ lb/day}$$

The calculated result of 62.6 lb/day has been rounded off to 63 lb/day, or two significant figures. This is consistent with the number of significant figures associated with most permit limits. For more information, consult DEQ's internal management directive on the use of significant figures and rounding conventions at: <http://www.deq.state.or.us/wq/pubs/imds/SigFigsIMD.pdf>.

Because the value is reported for one distinct day, it is reported in lbs on the DMR.

3.3 Percent Removal

To determine monthly percent removal, the monthly average influent and effluent concentrations should be used. This calculation is not an average of daily percent removal values.

$$\% \text{ Removal} = \frac{\left[\frac{\text{Monthly avg influent conc. in mg/L}}{\text{Monthly avg influent conc. in mg/L}} \right] - \left[\frac{\text{Monthly avg effluent conc. in mg/L}}{\text{Monthly avg influent conc. in mg/L}} \right]}{\text{Monthly avg influent conc. in mg/L}} \times 100\%$$

Example: A facility has calculated the monthly average influent TSS concentration as 250 mg/L. The monthly average effluent TSS concentration was calculated as 20 mg/L.

$$\% \text{ Removal} = \frac{(250 \text{ mg/L}) - (20 \text{ mg/L})}{(250 \text{ mg/L})} \times 100\% = 92\%$$

3.4 Percent Volatile Solids (VS) Reduction

Percent volatile solids reduction may be a required monitoring parameter for sludge (biosolids). This value is calculated differently than percent removal, and care should be taken so as not to confuse the two values.

$$\% VS Reduction = \frac{(VS_{in} - VS_{out})}{VS_{in} - (VS_{in} \times VS_{out})} \times 100$$

Example: If a facility has 79% VS in raw sludge and 54% VS in digested sludge:

$$\% VS Reduction = \frac{(0.79 - 0.54)}{0.79 - (0.79 \times 0.54)} \times 100 = 69\%$$

3.5 Arithmetic Average

For parameters other than pH, percent removal, and coliform, the weekly and monthly averages are calculated by arithmetic average or arithmetic mean. For a given parameter, add all of the sample values to determine the total sum and then divide by the number of samples taken.

Example: A facility samples for effluent BOD three times a week, resulting in 12 samples for the reporting month. The sample values they obtained in mg/L were:

Week 1: 22, 18, 23
 Week 2: 28, 25, 19
 Week 3: 22, 24, 29
 Week 4: 31, 28, 26

$$Week\ 4\ Avg. = \frac{31 + 28 + 26}{3} = 28\ mg/L$$

$$Monthly\ Avg. = \frac{22 + 18 + 23 + 28 + 25 + 19 + 22 + 24 + 29 + 31 + 28 + 26}{12} = 25\ mg/L$$

3.6 Median

The permit may require reporting a median value of Total Coliform in some cases such as for effluent reuse. A median value is not the same as an average or mean value. A median is defined as the middle measurement when all measurements are ranked in order of magnitude (size).

Example: The following data has been ranked in ascending order.

Data:	2	2	4	10	20	20	22
Rank:	1	2	3	4	5	6	7
Median	^						

This example is for an odd number of samples with a reported median of 10. For an even-numbered data set, the median is the arithmetic average of the two middle numbers.

3.7 Geometric Mean (for weekly and monthly average values for coliform)

Weekly and monthly averages for coliform values are calculated using a geometric mean. Geometric means can be calculated using two different methods. The two methods will be shown using the following example data set (data in counts/100ml):

Example Data Set		
Result type	Data Reported	Data for Calculation
No colony growth	<4	4
# of colonies <20	15 est.	15
Colonies between 20-60	40	40
Colonies > 60	150 est.	150
Colonies TNTC	>6000	6000

TNTC = too numerous to count

Procedure 1: Calculate the n^{th} root of the results.

$$\text{Geometric Mean} = \bar{X}_g = \sqrt[n]{X_1 \times X_2 \times X_3 \times \dots \times X_n}$$

Where: n = the number of values observed / analyzed
 X_1, X_2, \dots, X_n = the sample results or values

For example data set:

$$\bar{X}_g = \sqrt[5]{4 \times 15 \times 40 \times 150 \times 6000} = \sqrt[5]{2,160,000,000} = 74 \text{ counts/100 ml}$$

Procedure 2: Calculate the antilog of the log average.

$$\text{Geometric Mean} = \bar{X}_g = \text{Log}^{-1} \frac{[\log X_1 + \log X_2 + \log X_3 + \dots + \log X_n]}{n}$$

For example data set:

$$\bar{X}_g = \text{Log}^{-1} \frac{[\log(4) + \log(15) + \log(40) + \log(150) + \log(6000)]}{5}$$

$$\bar{X}_g = \text{Log}^{-1} \frac{(0.06 + 1.18 + 1.60 + 2.18 + 3.78)}{5} = \text{Log}^{-1}(1.868) = 74 \text{ counts/100 ml}$$

Do not report weekly and monthly average coliform values based on arithmetic average calculations. In this example, the arithmetic average would be $6209/5 = 1242$ and reported as 1,200, which would result in a violation.

Note: For *E. coli* sampling only (not applicable for Fecal or Total Coliform), if a single sample exceeds 406 organisms per 100 mL, the facility may resample by taking five consecutive re-samples at four-hour intervals beginning within 48 hours after the original sample was taken. If the geometric mean of the five re-samples is less than or equal to 126 organisms per 100 mL, a violation is not triggered. When calculating weekly or monthly averages, the original high sample will not be included, but the individual resample values will be included as distinct sample values in the calculations.