Level 1 Nitrate Balance Instructions for Large On-site Sewage Systems

Washington State Department of HEALTH

Instructions for Department of Health (SOH) Level 1 Nitrate Balance

DOH uses the Level 1 Nitrate Balance as a screening tool to identify LOSS which may have potential impacts to an unconfined or semi-confined surface aquifer. DOH may require a more comprehensive Nitrate Balance at sites where the Level 1 analysis indicates a potential moderate or significant impact to ground water. In general, a moderate impact is an increase greater than 2 mg/L above background. You can use the nitrate balance as a tool to understand the sensitivity of your LOSS on groundwater quality by varying values for effluent quality, effluent volume, and drainfield orientation. The equation used to build the Level 1 Nitrate Balance Excel spreadsheet is shown in Appendix A.

When you fill out the Nitrate Balance Excel spreadsheet use the most reliable site-specific information you can find. Always list your information source on the spreadsheet or on a separate reference sheet if you need more room. Provide a copy of the information source or an on-line link to the source. Sources of information can include field measurements, pump test data, well logs, literature reviews, a local or regional study, and state or local databases. DOH will generally consider a nitrate balance supported by field measurements to be more reliable than one completed with literature values.

Based on the parameters you provide, the spread sheet will calculate the estimated nitrate concentration in the groundwater at the point of compliance. The default point of compliance is the downgradient edge of the drainfield. DOH may approve an alternative point of compliance up to but not exceeding the property boundary.

In your supporting information, identify and include all drainfields associated with the project or located on the property in the nitrate balance. One nitrate balance must be performed that includes all active drainfields unless the drainfields are separated by a groundwater boundary condition that would result in different points of compliance. For those cases, a separate nitrate balance should be performed for each drainfield.

As explained below, several parameters must be shown on a topographic map of 1:7200 scale or less. The parameters are drainfield area, point of compliance, alternative point of compliance (if applicable), aquifer width, hydraulic gradient, and the property boundary. The map MUST be readable at a printable size of 11”x17” or smaller. An example map is shown in Appendix B.

The nitrate balance(s) and supporting information can be submitted as a hard copy or electronically submitted as a PDF file.

For more information call 360-236-3330 or wastewatermgmt@doh.wa.gov.

DOH 337-069 September 2023

Input Values

Nitrate Concentration in Precipitation: Precipitation in Washington State contains a small amount of nitrates from both natural and man-made sources.

Instructions: Use the default vale of 0.24 mg/L

Total Nitrogen Concentration in Wastewater: This is the concentration of total nitrogen in the effluent measured at the end of the pipe before it enters the drainfield. Residential strength effluent can range from 30 to 100 mg/L. High strength effluent, such as RV waste, can have total nitrogen concentrations greater than 500 mg/L.

Instructions: Use the default value of 60 mg/L for residential strength effluent. This value is for systems that do not have advanced treatment and are not treating high strength waste. Any value other then 60 mg/L must be supported by sampling data or a supporting reference.

Soil Denitrification: Denitrification in the soil can reduce the amount of nitrates that reach groundwater. Denitrification occurs when soil oxygen is depleted and the microbes must obtain oxygen from another source. Microbes obtain oxygen from soil compounds in the following general order: 02>N03->Mn+4>Fe+3>SO4-2 >CO2. The amount of denitrification is difficult to quantify and depends on several variables including soil carbon, soil moisture, soil temperature, and soil pH. In general, a coarse well drained soil will have less denitrification than a fine poorly drained soil.

Instructions: Use the default value of 10% denitrification. If you use a denitrification rate greater than 10%, you must provide site specific data or a supporting reference.

NOTE: The nitrate balance does not have a specific value for plant uptake. Some LOSS using shallow drip systems may qualify for an additional percent reduction in soil nitrates due to plant uptake. To qualify, your site must have a nutrient management plan that includes soil sampling and vegetation management. If you are taking a nitrate reduction for plant uptake, add the reduction to your denitrification value. Clearly identify which portion of the reduction is for plant uptake.

Aquifer Thickness: This value is used to calculate nitrate dilution in the upper-most aquifer through vertical mixing of the nitrate and groundwater.

Instructions: Use the default value of 20 feet or the actual aquifer thickness, whichever is less. Aquifer thickness can be estimated from a well log.

Drainfield Area: This is the area of the primary drainfield and does not include the reserve area except when part of the reserve area is being used. The area of the drainfield is used to calculate how much dilution is received from infiltrating precipitation (recharge). The down gradient edge of the drainfield is the default point of compliance (POC) for the nitrate concentration in groundwater.

Instructions: For a new LOSS, calculate the area of the primary drainfield based on the estimated drainfield size including the area between trenches. For an existing LOSS, field measure the area of the existing drainfield. Be sure to take credit if you use or plan to use 50% of the reserve area in addition to the primary ("150% of the primary"). Show the drainfield area on the nitrate balance map.

Distance from the drainfield to the property boundary: The LOSS owner may request an alternative POC and DOH may approve an alternative POC up to but not exceeding the property boundary. An alternative POC can sometimes help dilute the nitrate in the groundwater to an acceptable level. If there is a well, spring, or surface water before the property boundary, then use that point for the distance instead of the property boundary for the alternative POC.

Instructions: The nitrate balance must first always be calculated with a zero value for the distance to the property boundary. This allows the spreadsheet to calculate the POC at the downgradient edge of the drainfield. A second nitrate balance can then be completed for an alternative POC (if applicable) using the distance between the down gradient edge of the drainfield and the property boundary or other receptor such as a well, spring or surface water. Measure the distance in the direction of the groundwater flow. Show both the default POC at the edge of the drainfield and the alternate POC on the nitrate balance map.

Aquifer Width: The width of the aquifer is the width of the gross area of the drainfield (not the width of the property) perpendicular to the groundwater flow.

Instructions: Measure the primary drainfield perpendicular to the direction of groundwater flow. Similar to measuring the drainfield area, be sure to consider the additional width if you use or plan to use 50% of the reserve area. Place a dotted line on the nitrate balance map to show where you measured the drainfield width.

Hydraulic conductivity of aquifer (K): Hydraulic conductivity is a measurement of an aquifer's ability to transmit water. Hydraulic conductivities can range from greater than 10,000 ft/day to less than 1 ft/day. A well sorted gravel aquifer has high conductivity, whereas a poorly sorted sand aquifer has a lower conductivity. A high conductivity results in greater dilution and lower nitrate concentrations.

Instructions: Use the most site specific value available. Pump test or slug test data from a nearby well is preferred. Many public supply wells will have a pump test on record with the county that will contain a value for hydraulic conductivity. Other options include drawdown data on well logs from nearby wells, values in a technical report for the local area, or literature values for hydraulic conductivity based on aquifer materials. The table below shows typical literature values. If you are using the table, follow these steps:

1. Based on a geotechnical report or the nearest well logs, determine the materials of the upper-most aquifer (this may not be the aquifer where the well is completed).
2. Find the materials on the table that best matches the well log description and select a K value in the mid to lower range for that material. Input K using ft/day.

Hydraulic Conductivity Table

<table>
<tr><td>K (cm/s)</td><td>10^{2}</td><td>10^{1}</td><td>$10^{0}=1$</td><td>10^{-1}</td><td>10^{-2}</td><td>10^{-3}</td><td>10^{-4}</td><td>10^{-5}</td><td>10^{-6}</td><td>10^{-7}</td><td>10^{-8}</td><td>10^{-9}</td><td>10^{-10}</td></tr>
<tr><td>K (ft/day)</td><td>10^{5}</td><td>10,000</td><td>1,000</td><td>100</td><td>10</td><td>1</td><td>0.1</td><td>0.01</td><td>0.001</td><td>0.0001</td><td>10^{-5}</td><td>10^{-6}</td><td>10^{-7}</td></tr>
<tr><td>Relative Permeability</td><td colspan="4">Pervious</td><td colspan="4">Semi-Pervious</td><td colspan="5">Impervious</td></tr>
<tr><td>Aquifer</td><td colspan="5">Good</td><td colspan="4">Poor</td><td colspan="4">None</td></tr>
<tr><td>Unconsolidated Sand & Gravel</td><td colspan="2">Well Sorted Gravel</td><td colspan="3">Well Sorted Sand or Sand & Gravel</td><td colspan="4">Very Fine Sand, Silt, Loess, Loam</td><td colspan="4"></td></tr>
<tr><td>Unconsolidated Clay & Organic</td><td colspan="4"></td><td colspan="2">Peat</td><td colspan="3">Layered Clay</td><td colspan="4">Unweathered Clay</td></tr>
<tr><td>Consolidated Rocks</td><td colspan="4">Highly Fractured Rocks</td><td colspan="3">Oil Reservoir Rocks</td><td colspan="2">Fresh Sandstone</td><td colspan="2">Fresh Limestone, Dolomite</td><td colspan="2">Fresh Granite</td></tr>
</table>

Modified from J. Bear, 1972

Hydraulic gradient: This is the “slope” of the groundwater. Hydraulic gradients are generally less than three percent. The gradient, hydraulic conductivity, width of the aquifer, and depth of the mixing zone determine the aquifer flow under the drainfield.

Instructions: Water table elevations may be found on a water table map if one is available or can be calculated using water table elevations from nearby wells. Use a default value of 0.001 if the gradient is unknown. Place an arrow on the nitrate balance map to show the direction of groundwater flow.

Recharge: The rate of recharge is the amount of inches per year of rainfall that infiltrate into the ground surface. Recharge is a percentage of the annual precipitation. This value is converted to gallons per day (gpd) in the nitrate balance equation.

Instructions: Some counties have groundwater recharge rates available. Where recharge is unknown, use a default is 35% of annual rainfall in western Washington and 20% of annual rainfall in eastern Washington.

Nitrate concentration of up-gradient groundwater: This is the nitrate concentration upgradient of the primary drainfield.

Instructions: Use site specific groundwater quality data for this value. Provide two or more sample results from nearby wells preferably on or upgradient of the project property. The sample must come from the surface aquifer. If you are unable to get a sample, you may use recent data from nearby public drinking water wells, county records, or hydrogeology reports in the local area. If you know the name or location of the public water system you can find sample data at https://fortress.wa.gov/doh/eh/portal/odw/si/Intro.aspx. If you use well data, show the location of the wells on the nitrate balance map.

Wastewater Volume: For a new LOSS, the volume of wastewater is the daily operating capacity of the LOSS. The operating capacity is the design flow without a peaking factor. Use actual flow volumes if you have an existing LOSS with a reliable history of flow monitoring.

Instructions: For a new LOSS, determine the daily operating capacity from the pre-design report. For an existing LOSS use flow data if available or estimate the flow using information in Section-06150 of WAC 246-272B (the LOSS rule).

Appendix A - Nitrogen Balance Equation

$$N_{GW} = \frac{\overbrace{(Q \times N_B)}^{\text{Upgradient}} + \overbrace{(V_W \times N_W(1-d))}^{\text{Effluent}} + \overbrace{(V_R \times N_r)}^{\text{Recharge}}}{Q + V_W + V_r}$$

N_{GW} = nitrate concentration in groundwater (mg/L) at the selected point of compliance

$Q = KibW_A (7.48)$

- Q = aquifer flow (gallons/day)
- i = gradient (ft/ft)
- b =depth of mixing in Aquifer (feet)
- W_A = width of aquifer (measured as width of drainfield) (feet)

N_B = background (upgradient) ground water nitrate concentration (mg/L)

V_W = volume of wastewater (gallons/day)

N_W = nitrogen concentration in wastewater (mg/L)

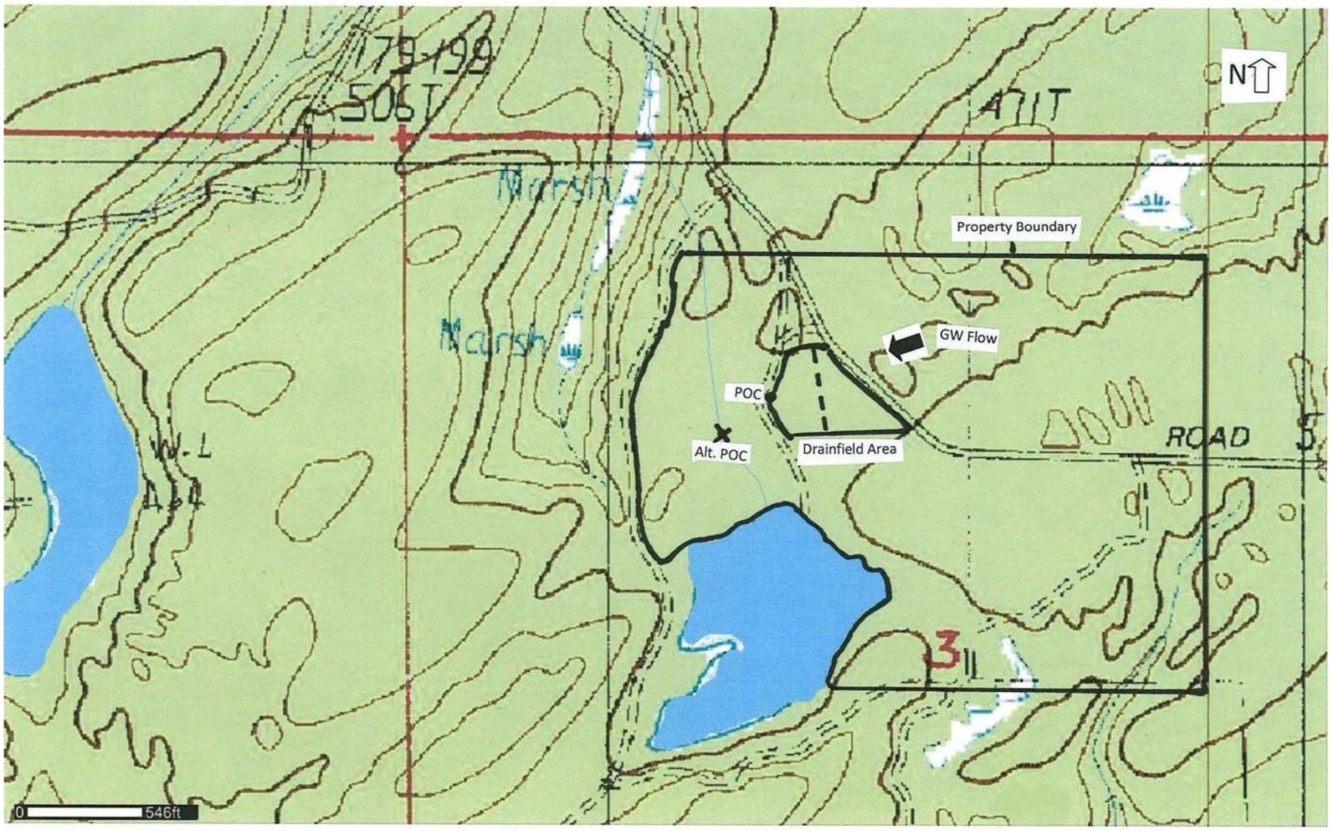
d = denitrification rate in soil and vadose zone (unitless)

$V_R = A_D \times R \times 0.0017$

- V_R = volume of recharge over drainfield (gallons/day)
- A_D = area of drainfield (ft^2)
- R = recharge (in/yr)

N_r = nitrate concentration in precipitation (mg/L)

Appendix B – Level One Nitrate Balance Sample Map



Darling's Acres Proposed LOSS 2/5/2011

To request this document in another format, call 1-800-525-0127. Deaf or hard of hearing customers, please call 711 (Washington Relay) or email civil.rights@doh.wa.gov.