Appendix M

Calculation of Cumulative Phosphorous Impacts (part 1/2)

If any part of two or more drainfields overlap, as measured in the direction of ground-water flow, cumulative impacts calculations shall be conducted (the 5° dispersion widening in ARM 17.30.517(1)(d) is not accounted for when determining overlap of drainfields for cumulative effects analysis). To determine the cumulative effects for multiple drainfields aligned in the direction of ground water flow, the phosphorus breakthrough shall be completed using the "Cumulative Effects Calculation" tab in **Appendix L**.

Two examples for using the Cumulative Effects Calculation tab are provided later in this Appendix. When using the Cumulative Effects Calculation tab some important features and requirements are listed below:

- The amount of overlap between two or more drainfields is not used in the calculations; whether that overlap is a fraction of the drainfields width or the entire drainfield width, cumulative impacts must be evaluated. The full length of each drainfield as measured perpendicular to groundwater flow (variable "Lg") shall be used. The values for length (L) and width (W) shall also be based on the full dimensions of each drainfield;
- The spreadsheet requires the same user inputs as the single drainfield calculation spreadsheet with one difference; the value for distance to surface water (D), is changed to distance to the adjacent downgradient drainfield for each drainfield in the calculations except for the drainfield closest to the receiving surface water (drainfield #1). For drainfield #1 (D) remains as distance to receiving surface water;
- The spreadsheet includes the flexibility to analyze drainfields with different flow rates. This is noted in the spreadsheet where the description of the "Yup" and "Ydown" variables indicates that they are normalized to a load of 6.44 lb/yr. 6.44 lb/yr is the phosphorus load for a 2-5 bedroom single family home, which is the most common source used in the phosphorus analysis;
- The spreadsheet calculates if there is sufficient soil to provide at least 50 years of adsorption for drainfield #1 and for each successive upgradient drainfield (#2, #3, etc). Each drainfield upgradient of drainfield #1 is able to use the cumulative number of years of excess soil from all the downgradient drainfields; the "Yup" value in the spreadsheet represents that excess soil that is available to the next upgradient drainfield; and
- The final row in the spreadsheet ("P/F") is automatically calculated and populated in the spreadsheet for each drainfield. Only one drainfield in the cumulative effects needs to "Fail" for the cumulative effects analysis to fail as a whole. When sufficient soil exists for drainfields upgradient of a failed drainfield the spreadsheet will show "Pass" for those upgradient drainfields only to assist the user in determining how to reorganize the drainfields to pass the cumulative effects analysis.

Two examples are provided below for the **Appendix L** calculations and how to determine distances between cumulative drainfields.

EXAMPLE 1

Example 1 demonstrates the cumulative effects calculations for 2 or more drainfields; refer to the diagram on part 2 of **Appendix M** and the "Example 1" tab in the **Appendix L** spreadsheet.

Appendix M

STEP 1: The drainfield #1 breakthrough to surface water is over 50 years (72.88 years) and it passes. The “Yup” value for this example would be 22.88 years (72.88-50). “Yup” is the number of years over 50 (22.88 years) calculated for drainfield #1 that is then available for drainfield #2 to meet its 50-year breakthrough.

STEP 2: The breakthrough from drainfield #2 to drainfield #1 is 28.87 years which is 21.13 years less than the needed 50 years. The 21.13 years is the “Ydown” value in the “Example 1” tab and represents the number of years drainfield #2 needs from downgradient soil to pass the 50-year breakthrough. In Step 1 the ‘Yup” was 22.88 years available from drainfield #1, 22.88 plus 28.87 is greater than 50 years and therefore enough years available for drainfield #2 to pass. Subtracting 21.13 years (“Ydown” from drainfield #2) from 22.88 (“Yup from drainfield #1) provides 1.75 years which is the new ‘Yup” value that is available to drainfields upgradient of drainfield #2.

STEP 3: The breakthrough from drainfield #3 to drainfield #2 is 26.31 years, which is 23.69 years less than the needed 50 years. There are 1.75 years available (the “Yup” value from Step 2) from the two downgradient drainfields (#1 and #2). 26.31 plus 1.75 years does not provide enough years to meet the 50-year breakthrough and therefore the cumulative effects fail and is significant degradation.

EXAMPLE 2

Example 2 (refer to part 2 of **Appendix M**) demonstrates the distances to use in calculations for drainfields in a more complicated situation than example 1.

The flow path that provides the worst-case scenario of the overlapping drainfields shall be used for the analysis. In this example, flow path #1 is likely not the worst case because only two of the three drainfields overlap compared to flow paths #2 and #3. Flow path #2 is not the worst-case because the distances between drainfields and surface water are longer (providing more soil for phosphorus adsorption) than flow path #3. In this example flow path #3 is the worst-case scenario. In cases where the worst-case flow line is not obvious, multiple scenarios may need to be calculated to determine the worst-case. Also note that the flow line with the most drainfields overlapping is not necessarily the worst case; distances to surface water, distance between drainfields, drainfield size/orientation, soil profiles, and effluent rate also affect the results.