

APPENDIX N

GRAY WATER NITROGEN AND PHOSPHORUS LOADING RATES

A gray water system may affect the loading values in the nondegradation review (gray water is defined in ARM 17.36 sub-chapter 1). This appendix provides nitrogen and phosphorus loading values for use in a gray water system nondegradation review. Due to the different configurations of gray water systems (seasonal use versus year-round use and use of waste segregation systems), several different nitrogen and phosphorus loads/concentrations are provided in this appendix. A waste segregation system, as defined in department Circular DEQ-4, includes sewage flow that does not contain industrial chemicals, hazardous wastes, or wastewater from toilets. When waste segregation is not used the kitchen waste is combined with toilet waste in the blackwater. Blackwater is defined in department Circular DEQ-4 and includes any wastewater that has some toilet waste.

The values below in Table 1 for “Percent Volume of Household Use” and Table 2 for “Percent Nitrogen Load” are based on Tables 3-3 and 3-8 of the USEPA Onsite Wastewater Treatment Systems Manual (USEPA, 2002). Table 3-3 (USEPA, 2002) does not provide a specific volume for the kitchen, therefore kitchen use in Tables 1 and 2 was estimated as 10 percent based on the average use of all household faucets (15.7%) and dishwasher volume (1.4%) in Table 3-3.

The wastewater loading and concentration values in Tables 1 and 2 are based on a single living unit with 2 to 5 bedrooms that has an average nondegradation flow of 200 gal/day (Section 2.7.1.3).

NITROGEN

Discharge rates and nitrogen concentrations for two gray water configurations are provided in Table 1. Concentrations in Table 1 are based on the average nitrogen concentration in combined wastewater (gray water, kitchen, and blackwater) for a conventional subsurface wastewater treatment system (SWTS), 50 mg/L. Due to the varying wastewater strength and potential seasonality in gray water systems, the applicability of level 2, 3 and 4 treatment systems shall be determined by the reviewing authority based on the specifics of the application including the seasonality of the discharges (see Section 2.7.1.3) and the wastewater strengths.

Seasonal discharges are estimated to create steady-state conditions at the end of the mixing zone and are treated as constant annual discharges for purposes of conducting the nitrate sensitivity analysis (NSA). Therefore, the annual discharge rate shall be used for any of the discharges in Table 1 for both seasonal and continuous discharges, except when the reviewing authority approves reducing the annual discharge rate for seasonal use according to the criteria described in Section 2.7.1.3.

Wastewater discharge rates provided in Table 1 will need to be adjusted proportionally for systems with lower or higher discharge rates.

Table 1. Annual Nitrogen Concentration and Loading for Gray Water Systems for 2-5 bedroom single living unit. Columns A and B are provided for reference, columns C and D are used in the nitrate sensitivity analysis.

Wastewater Configuration	Percent Household Volume ⁽¹⁾	Percent Nitrogen Load ⁽¹⁾	Wastewater Discharge Rate (gal/day) ⁽²⁾	Nitrogen Discharge Concentration (mg/L) ⁽³⁾
	A	B	C	D
Option 1 – Typical Combined Wastewater				
Gray water + Kitchen + Blackwater (toilet only)	100	100	200	50
Option 2 – Waste Segregation				
Gray water + Kitchen	73	22	146	15.1
Blackwater (toilet only) ⁽⁴⁾	27	78	54	144.4
Option 3 – No Waste Segregation				
Gray water only	63	17	126	13.5
Blackwater (toilet only) + Kitchen	37	83	74	112.2

Notes:

1. Values based on USEPA (2002).
2. The wastewater discharge rate (C) is calculated by multiplying the percentage of household volume (A) by 200 gal/day. 200 gal/day is the nondegradation flow rate for a single living unit with 2-5 bedrooms; for discharges with different flow rates the values in column (C) shall be adjusted proportionally.
3. Nitrogen discharge concentration (D) is calculated by multiplying the ratio of percent nitrogen load (B) to the percent household volume (A) by 50 mg/L. 50 mg/L is the average nitrogen concentration used for residential strength wastewater.
4. This row is only provided for reference; the blackwater in a waste segregation is not discharged via an absorption system.

PHOSPHORUS

Discharge rates and phosphorus concentrations for two gray water configurations are provided in Table 2. Concentrations in Table 2 are based on the average phosphorus concentration in combined wastewater (gray water, kitchen, and blackwater), 10.6 mg/L.

For seasonal discharges, phosphorus is addressed differently than nitrogen because phosphorus breakthrough is based on the absorption capacity of soils as opposed to the groundwater dilution method used for nitrogen. For phosphorus the wastewater discharge rate in Table 2 can be adjusted to an average annual discharge for systems that discharge seasonally (see also Section 3.7.2).

Wastewater discharge rates provided in Table 2 will need to be adjusted proportionally for systems with lower or higher discharge rates.

Table 2. Annual Phosphorus Concentration and Loading for Gray Water Systems for 2-5 bedroom single living unit. Columns A and B are provided for reference, columns C and D are used in the phosphorus breakthrough calculations.

Wastewater Configuration	Percent Household Volume ⁽¹⁾	Percent Phosphorus Load ⁽¹⁾	Wastewater Discharge Rate (gal/day) ⁽²⁾	Phosphorus Discharge Conc. (mg/L) ⁽³⁾
	A	B	C	D
Option 1 – Typical Combined Wastewater				
Gray water + Kitchen + Blackwater (toilet only)	100	100	200	10.6
Option 2 – Waste Segregation				
Gray water + Kitchen	73	41	146	5.95
Blackwater (toilet only) ⁽⁴⁾	27	59	54	23.2
Option 3 – No Waste Segregation				
Gray water only	63	37	126	6.2
Blackwater (toilet only) + Kitchen	37	63	74	18.0

Notes:

1. Values based on USEPA (2002).
2. The wastewater discharge rate (C) is calculated by multiplying the percentage of household volume (A) by 200 gal/day. 200 gal/day is the nondegradation flow rate for a single living unit with 2-5 bedrooms; for discharges with different flow rates the values in column (C) shall be adjusted proportionally.
3. Phosphorus discharge concentration (D) is calculated by multiplying the ratio of percent phosphorus load (B) to the percent household volume (A) by 10.6 mg/L. 10.6 mg/L is the average phosphorus concentration used for residential strength wastewater.
4. This row is only provided for reference; the blackwater in a waste segregation is not discharged via an absorption system.

REFERENCES

USEPA, February 2002. Onsite Wastewater Treatment Systems Manual. EPA/625/R-00/008.
https://cfpub.epa.gov/si/si_public_record_Report.cfm?Lab=NRMRL&dirEntryID=55133