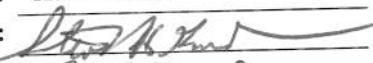


**WATER QUALITY
PERMITS**

Policy No: WQP-26
Initiated By: Kenan Diker
Approved By: 
Effective Date: 2-25-08
Revision No.:
Revision Date:

Policies & Procedures

**Methodology for Determining
Agronomic Rates for the
Beneficial Use of Biosolids**

Purpose: To provide guidance to Division personnel, domestic wastewater treatment facilities, land appliers, farmers and others in determining the agronomic rate of application for biosolids in order to comply with the Nutrient Management section of the Colorado Department of Public Health and Environment Biosolids Regulation No. 64, which states in part:

“No person shall apply biosolids for beneficial use to agricultural land such that the nitrogen application exceeds the agronomic rate for the crop or vegetation cultivated...”

**Policy/
Procedures:**

Nitrogen in Biosolids

This policy defines the required procedures for determining the agronomic rate of biosolids. As noted in the regulation, the following equation shall be used to determine the amount of nitrogen required per acre for the relevant crop:

$$\text{Biosolids PAN} = (m) (\text{Organic N}) + (v) (\text{NH}_4\text{-N}) + \text{NO}_3\text{-N}$$

Where:

- PAN = Plant Available Nitrogen (lbs per dry ton of biosolids)
- m = Mineralization Factor
- v = Volatization Factor
- Organic N = organic nitrogen in biosolids (%)
- NH₄-N = Ammonia-nitrogen in biosolids (%)
- NO₃-N = Nitrate-nitrogen in biosolids (%)

Mineralization and volatilization factors can be found as attachments to this document and may be updated as needed. Organic nitrogen can be calculated by subtracting the ammonia-nitrogen from the Total Kjeldahl Nitrogen (TKN).

These parameters are to be based upon representative samples of the biosolids to be land applied for beneficial use.

The PAN calculation will provide a number that represents the pounds of plant available nitrogen in a dry ton of biosolids.

Estimated Yield

A projected yield goal must be determined in order to calculate the amount of nitrogen to apply for a given crop. Verbal or written farmer / farm manager input should initially be sought. Yield goals should be recorded, dated, and kept on file by the biosolids land applicator. If a yield goal (verbal or written) can not be obtained from the farmer / farm manager, the county average yield for at least the last 3 cropping years (for the crop to be planted) should be used. Applicators are encouraged to use a larger average county yield dataset (greater than the last 3 years) for a more representative yield goal.

County yields can be obtained from the following web site:

http://www.nass.usda.gov/Statistics_by_State/Colorado/index.asp

(When using the above listed website, users can download data for a given crop and selected years, and calculate an average yield.)

Colorado State University Fertilizer Guide

The following fact sheets (See Fact sheets 0.534 through 0.544) can be used to determine crop nitrogen requirement based on soil test NO₃-N concentrations and soil organic matter content. The fact sheets can be obtained from the following web site:

<http://www.ext.colostate.edu/pubs/crops/pubcrop.html>

Additional Fertilizer Recommendations

Other professional agronomic resources using recent methods can provide acceptable recommendations for various crops.

Mineralization/Volatilization Charts

Estimated first year net N mineralization rates can be based on Colorado State Findings (Barbarick and Ippolito, 2000) which showed 25 to 32% mineralizable N. This may also be based on a more generalized table, found in the additional attachments. Volatilization rates for various types of application can also be found in the additional attachments. Other mineralization and volatilization rates can be used if approved by the State.

Barbarick, K.A., and J.A. Ippolito. 2000. Nitrogen Fertilizer Equivalency of Sewage Biosolids Applied to Winter Wheat. *Journal of Environmental Quality*, 29:1345-1351.

Worksheet

A worksheet is attached to use as a basis for these calculations.

Background/ Rationale:

To provide a consistent method for Colorado generators, applicators, farmers, regulators and citizens to interpret the Biosolids Regulation section that requires application at the agronomic rate based on the N requirement of the crop to be grown. Historically, this was left to the generator for interpretation. This formula and policy will allow for all interested parties to easily understand how to calculate plant available nitrogen, and then compute the biosolids agronomic application rate.

Biosolids Plant Available Nitrogen (PAN) & Agronomic Application Rate Calculation Worksheet

NOTE: Gray Cells Require User Input

1 Calculate Biosolids Organic Nitrogen (%TKN - (%NH₄-N + %NO₃-N))

Note: if in mg/Kg convert to % before entry (mg/Kg/10,000 =%)

%TKN	
- %NH ₄ -N	
- %NO ₃ -N	
= %Org-N	#VALUE!

2 Biosolids %NH₄-N Remaining after Volatilization [(%NH₄(fv/100))]

Estimated NH ₄ Retained (fv) %					
Days to Incorporate	Surface-applied				Injected
	Liquid Biosolids	Dewatered Biosolids	Alkaline Stabilized	Compost or Air Dried	
0 to 2	50 - 80	55 - 85	10	100	100
3 to 6	30 - 65	45 - 75	10	100	100
over 6+	10 - 35	20 - 45	10	100	100

%NH ₄ -N	
x (fv)	
= %avail NH ₄ -N	#VALUE!

3 Biosolids %Org-N Remaining after Mineralization [(%Org N(fm/100))]

1st Year Estimated Mineralization Rate (fm)		
Processing	Moisture Content	% Org-N
Anaerobic digestion	liquid	20-40
Aerobic digestion	liquid	30-45
Aerobic/anaerobic digestion	liquid	15-30
storage in lagoon > 6 months	liquid	15-30
Anaerobic digestion & dewatering	semi-solid	25-32
Drying bed	solid	15-30
Heat-dried	solid	20-40
Compost	solid	0-20
CSU Average		27

%Org-N	#VALUE!
x (fm)	
= %avail Org-N	#VALUE!

4 TOTAL % Available Biosolids N
= %NO₃-N + %avail NH₄-N + %avail Org-N

%NO ₃ -N	
+ %avail NH ₄ -N	#VALUE!
+ %avail Org-N	#VALUE!
= %avail N	#VALUE!

5 Plant Available Nitrogen (PAN) per Dry Ton of Biosolids
= [(% Available N)/(100)](2000 lbs per ton)
= (% Available N)(20)

%avail N	#VALUE!
x 20	20.00
= lbs PAN/dt	#VALUE!

6 Crop N requirement (lbs.N/ acre)

crop N requirement

7 Biosolids Agronomic Application Rate, dry tons/acre

dt/ac

8 Biosolids Agronomic Application Rate Biosolids % Total Solids
wet tons/ac = [(dt/ac)/(%TS)]100
gallons/ac = [(dt/ac)(2000)/(8.34)(%TS)]100

wet tons/ac	#VALUE!
gallons/ac	#VALUE!