Biosolids Calculations

Rachel Barnes-McAden

Solids	30.94	309400
Nitrogen (TKN)	4.45	44500
Phosphorus	1.72	17200
Potassium	0.20	2000
Sulfur	0.60	6000
Calcium	9.86	98600
Magnesium	0.29	2900
Sodium	0.10	1000
Iron		49600
Manganese		178
Copper		269
Zinc		421
Ammonia Nitrogen	0.27	2700
NO_3-NO_2 Nitrogen		21
Cadmium		2.0
Chromium		49
Nickel		19
Lead		40
Arsenic		2.15
Mercury		0.96
Selenium		2.23
pH (Standard Units)	12.10	
Calcium Carbonate Eq	14.63	146300
Volatile Solids	64.88	648800
Organic Nitrogen	4.18	41800
Molybdenum		13

All Values, except for Solids, are on a Dry Weight Basis.

The biosolids analysis reports nutrient levels in terms of the percent by weight.

We’re going to figure out how much of each nutrient there is in terms of pounds per dry ton.

For % to decimal : divide by 100

(or use % button on calculator)

Calculating Nitrogen

0.045 (TKN) X 2,000 lbs/ T = 89.0 lbs TKN/ DT

(4.45%)

0.0027 (NH_3) X 2,000 lbs./ T = 5.4 lbs NH_3/ DT

(0.27%)

89.0 TKN/ DT - 5.4 lbs NH_3/ DT = **83.6 lbs organic N/ DT**

Nitrogen Calculations for Ammonium, Organic and Residual Nitrogen Based on Analysis of Material

Material: Biosolids DT

Analysis: TKN | NH_4-N | P_2O_5 | K_2O \ ton or 1,000 gals.

Days before Incorporation: (circle one)

Injected, Broadcast-Immediate Incorp., >2, >4, >7 or No Incorp., Irrigate-No Incorp.

Previous Application: 0-1 yr. of the last 5, 2-3 yrs. of the last 5, 4-5 yrs. of the last 5

First Year - **P**lant **A**vailable **N**itrogen (**PAN**)

89 DT TKN/unit			
- 5.4 DT NH_4-N/unit			
83.6 DT Organic N/unit			
	____ x availability coefficient	=	____ #/unit
	____ x availability coefficient	=	____ #/unit
		TOTAL PAN	____ #/unit

Availability Coefficients from Standards and Criteria

Manure	Biosolids
Table 8-2	Table 9-2
Table 8-2	Table 9-1

_____ #/unit x _____ units/ac. = _____ # PAN/ac.

Unit = Ton or 1,000 Gallons

Table 9-1
Estimated Nitrogen Mineralization Rates for Biosolids[1]
(S&C pg 117)

	Application Year			
Biosolids Type	**Application Year**	**1 Year After Application**	**2 Years After Application**	**3 Years After Application**
Lime Stabilized	0.30	0.10	0.10	0.05
Aerobic Digestion	0.30	0.10	0.10	0.05
Anaerobic Digestion	0.30	0.10	0.10	0.05
Composted[2]	0.10	0.05	0.03	0.00

Table 9-2
Biosolids Ammonium Nitrogen Availability Coefficients[1]
(S&C pg 117)

Method of Application	Biosolids pH < 10	Biosolids pH > 10
Injection	1.00	1.00
Incorporated within 24 hours	0.85	0.75
Incorporated within 1-7 days	0.70	0.50
Incorporated after 7 days or no incorporation	0.50	0.25

First Year - **P**lant **A**vailable **N**itrogen (**PAN**)

89 DT TKN/unit			
- 5.4 DT NH_4-N/unit	0.75 = x availability coefficient	____ #/unit	
83.6 DT Organic N/unit	0.30 = x availability coefficient	____ #/unit	
		TOTAL PAN ____ #/unit	

Availability Coefficients from Standards and Criteria

Manure	**Biosolids**
Table 8-2	Table 9-2
Table 8-2	Table 9-1

_____ #/unit x _____ units/ac. = _____ # PAN/ac.

Unit = Ton or 1,000 Gallons

First Year - **P**lant **A**vailable **N**itrogen (**PAN**)

89 DT TKN/unit			
- 5.4 DT NH_4-N/unit	0.75 x availability coefficient	=	4.05 #/unit
83.6 DT Organic N/unit	0.30 x availability coefficient	=	25.08 #/unit
		TOTAL PAN	29.13 #/unit

Availability Coefficients from Standards and Criteria

Manure	**Biosolids**
Table 8-2	Table 9-2
Table 8-2	Table 9-1

NUTRIENT MANAGEMENT Balance Sheet

Name: WilDaLyn Farms **Date:** February 2010
Tract: T-1989

Field Name	Ac.	Crop Rotation	Expctd Yield (bu or tons)	Nutrient Needs (from soil test & expctd yield) N-P_2O_5-K_2O	Nitrogen Residual (Leg./ Manure)	Days before Incorp	Organic Material Applied (1000 gal. or tons/ac)	Org. Nut. Applied N-P_2O_5-K_2O	N-P_2O_5-K_2O Need or (Surplus)	N-P_2O_5-K_2O (commercial)	Notes
HF-1	8	Orchard-grass Pasture	3.6 ac/au	50-40-70	0/14	----	-----	----	36-40-70	36-40- 70 br	
HF-2A	16	Corn (grain)	120 bu/ac.	120-80-100	0/14	>7					
HF-2B	12	Corn (grain)	90 bu/ac	90-0-0	0/0	>2					
HF-2C	9	Orchard-grass Hay (maint.)	3.3 t/ac	140-40-95	0/0	>7					1
HF-3A	11	Corn (grain)	150 bu/ac	150-120-100	0/14	>1					
HF-3B	11.3	Corn (silage)	15.6 t/ac	90-100-200	0/7	>2	6 k/ac Dairy	63-69-119	20-31-81	0-0-81 br 20-31-0 ba	

Notes: Application Methods: Ba= Banded, Br = Broadcast, Sd = Sidedress, k = 1000 gal.

1. Nitrogen needs are shown for 2 cuttings of hay.

Biosolids Application Rate

From case study, **Field 3A** is a **corn** (grain) field.

Crop nutrient need is **150-120-100**.

First, credit residual nitrogen carryover to crop nutrient needs:

150 lbs N – 14 lbs N = **136 lbs N** need

(dairy manure residual)

Balance of crop nutrient need is **136-120-100**

How Many Tons of Biosolids to Apply ?

Field Name	Acres	Crop Rotation	Expected Yield Bu/ Ton	Nutrient Needs (soil test) $N\text{-}P_2O_5\text{-}K_2O$	Nitrogen Residual (Leg./ Manure)	Days before Incorp	Material Applied (1,000 gal. or Tons/ac)	Org. Nut. Applied $N\text{-}P_2O_5\text{-}K_2O$	N N (S
HF-2C	9	Orchard grass Hay	3.3 t/ac	140-40-95	0/0	>7			
HF-3A	11	Corn (grain)	150 bu/ac	150-120-100	0/14	>1			
HF-3B	11.3	Corn (silage)	15.6 t/ac	90-100-200	0/7	>2	6k Dairy	63-69-119	

150 lbs N for corn - 14 lbs N residual = 136 lbs N from Biosolids

Nitrogen needs are to be met through biosolids application

From worksheet, we get 29.13 **lbs PAN/ DT**

Crop needs, less residual, are **136 lbs N**

(14 lbs. dairy manure)

$$\frac{136 \text{ lbs N/ Acre}}{29.13 \text{ lbs N/ DT}} = \mathbf{4.67\ DT/\ A}$$

Fill in Worksheet

$$\frac{136}{\#N/ac.\ needed} \div \frac{29.13}{PAN\#/DT} \text{ 1,000 gallons or tons} = \frac{4.67}{\text{1,000 gallons or tons/ acre}}$$

Unit = Ton or 1,000 Gallons

Remember that the biosolids will arrive as **wet tons**, but we just calculated dry tons. So- we'll need to convert:

$$\frac{\text{DT}}{\%\ \text{solids}} = \text{WT}$$

$$\frac{4.67\ \text{DT/ A}}{0.3094\ (30.94\%\ \text{solids})} = \mathbf{15.09\ WT/ A}$$

to achieve **N = 136 lbs/ A**

NUTRIENT MANAGEMENT Balance Sheet

me: WilDaLyn Farms Date: February 2010
ct: T-1989

ield ame	Ac.	Crop Rotation	Expctd Yield (bu or tons)	Nutrient Needs (from soil test & expctd yield) N-P_2O_5-K_2O	Nitrogen Residual (Leg./ Manure)	Days befor e Incor p	Organic Material Applied (1000 gal. or tons/ac)	Org. Nut. Applied N-P_2O_5-K_2O	N-P_2O_5-K_2O Need or (Surplus)	N-P_2O_5-K_2O (commercial)	Notes
-1	8	Orchard-grass Pasture	3.6 ac/au	50-40-70	0/14	----	-----	----	36-40-70	36-40- 70 br	
-2A	16	Corn (grain)	120 bu/ac.	120-80-100	0/14	>7					
-2B	12	Corn (grain)	90 bu/ac	90-0-0	0/0	>2					
-2C	9	Orchard-grass Hay (maint.)	3.3 t/ac	140-40-95	0/0	>7					1
-3A	11	Corn (grain)	150 bu/ac	150-120-100	0/14	>1	4.67 DT **15.09 WT/ac**	136-?-?			
-3B	11.3	Corn (silage)	15.6 t/ac	90-100-200	0/7	>2	6 k/ac Dairy	63-69-119	20-31-81	0-0-81 br 20-31-0 ba	

tes: Application Methods: Ba= Banded, Br = Broadcast, Sd = Sidedress, k = 1000 gal.

1. Nitrogen needs are shown for 2 cuttings of hay.

Calculating Phosphorus

1.72 % elemental P

0.0172 P X 2,000 lbs/ T = 34.4 lbs P/ DT

For field nutrients, P is dealt with as P_2O_5 (phosphate)

P X 2.29 = P_2O_5

(conversion factor)

34.4 lbs P/ DT X 2.29 = **78.8 lbs P_2O_5/ DT**

Calculating Potassium

0.20 % elemental K

0.0020 K X 2,000 lbs/ T = 4.0 lbs K/ DT

For field nutrients, K is dealt with as K_2O (Potash)

K X 1.2 = K_2O

(conversion factor)

4.0 lbs K/ DT X 1.2 = **4.8 lbs K_2O/ DT**

We'll need to know how much

Phosphate and **Potash** will be applied when biosolids are used to meet the **Nitrogen** needs of the corn.

78.8 lbs P_2O_5/ DT X 4.67 DT/ A = **368 lbs P_2O_5/ A**

4.8 lbs K_2O/ DT X 4.67 DT/ A = **22 lbs K_2O/ A**

Original Crop Needs: 150-120-100

Nutrient	Amount/ Source	Net
Nitrogen: 150	14 lbs/ A from Residual	136
	136 lbs/ A from Biosolids	0
Phosphate: 120	368 lbs/A from Biosolids	+248*
Potash: 100	22 lbs/ A from Biosolids	- 78
	78 lbs/ A from fertilizer	0

* Can be “banked” for crops in remainder of rotation (3 yrs X 120 #$P_2 0_5$/yr)

NUTRIENT MANAGEMENT Balance Sheet

me: WilDaLyn Farms Date: February 2010
ct: T-1989

ield ame	Ac.	Crop Rotation	Expctd Yield (bu or tons)	Nutrient Needs (from soil test & expctd yield) N-P_2O_5-K_2O	Nitrogen Residual (Leg./ Manure)	Days befor e Incor p	Organic Material Applied (1000 gal. or tons/ac)	Org. Nut. Applied N-P_2O_5-K_2O	N-P_2O_5-K_2O Need or (Surplus)	N-P_2O_5-K_2O (commercial)	Notes
-1	8	Orchard-grass Pasture	3.6 ac/au	50-40-70	0/14	----	-----	----	36-40-70	36-40- 70 br	
-2A	16	Corn (grain)	120 bu/ac.	120-80-100	0/14	>7					
-2B	12	Corn (grain)	90 bu/ac	90-0-0	0/0	>2					
-2C	9	Orchard-grass Hay (maint.)	3.3 t/ac	140-40-95	0/0	>7					1
-3A	11	Corn (grain)	150 bu/ac	150-120-100	0/14	>1	4.67 DT **15.09 WT/ac**	136-368-22	0-(248*)-78	0-0-78	*P
-3B	11.3	Corn (silage)	15.6 t/ac	90-100-200	0/7	>2	6 k/ac Dairy	63-69-119	20-31-81	0-0-81 br 20-31-0 ba	

tes: Application Methods: Ba= Banded, Br = Broadcast, Sd = Sidedress, k = 1000 gal.

1. Nitrogen needs are shown for 2 cuttings of hay.

*P-*Ensure this amount can be used during this this crop rotation.*

Lime Applied

- Calculating Lime Application

14.63 % Calcium Carbonate Equiv.

(from biosolids analysis)

4.67 DT/A X .1463 = **.68 T/A** of Lime

Biosolids Residual

Nitrogen Calculations for Ammonium, Organic and Residual Nitrogen Based on Analysis of Material

Material: Biosolids DT

Analysis: TKN | NH_4-N | P_2O_5 | K_2O \ ton or 1,000 gals.

Days before Incorporation: (circle one)
Injected, Broadcast-Immediate Incorp., >2, >4, >7 or No Incorp., Irrigate-No Incorp.

Previous Application: 0-1 yr. of the last 5, 2-3 yrs. of the last 5, 4-5 yrs. of the last 5

First Year - Plant Available Nitrogen (PAN)

89 DT TKN/unit			
- 5.4 DT NH_4-N/unit			
83.6 DT Organic N/unit			
	____ x availability coefficient =	____ #/unit	
	____ x availability coefficient =	____ #/unit	
	TOTAL PAN	____ #/unit	

Availability Coefficients from Standards and Criteria

Manure	Biosolids
Table 8-2	Table 9-2
Table 8-2	Table 9-1

_____ #/unit x _____ units/ac. = _____ # PAN/ac.

Unit = Ton or 1,000 Gallons

Use Table 9.1

Ammonium = 5.4 lbs.N/ Dry Ton TKN = 89 lbs. N/ DT

Organic N = 83.6 lbs. N/ DT

Section IX. Biosolids Management

Table 9-1
Estimated Nitrogen Mineralization Rates for Biosolids[1]

Biosolids Type	Application Year			
	Application Year	1 Year After Application	2 Years After Application	3 Years After Application
Lime Stabilized	0.30	0.10	0.10	0.05
Aerobic Digestion	0.30	0.10	0.10	0.05
Anaerobic Digestion	0.30	0.10	0.10	0.05
Composted[2]	0.10	0.05	0.03	0.00

1. To determine nitrogen available from previous Biosolids applications, multiply the percent organic nitrogen by the appropriate mineralization factor.
2. Total organic nitrogen content of 2% or less and no significant ammonia nitrogen.

Table 9-2
Biosolids Ammonium Nitrogen Availability Coefficients[1]

Method of Application	Biosolids pH < 1(	Biosolids pH > 10
Injection	1.00	1.00
Incorporated within 24 hours	0.85	0.75
Incorporated within 1-7 days	0.70	0.50
Incorporated after 7 days or no incorporation	0.50	0.25

1. To determine the plant-available Biosolids ammonium nitrogen in the soil, multiply the Biosolids ammonium nitrogen concentration or total weight applied by the appropriate availability coefficient.

Standards & Criteria, p. 117

To Calculate Biosolids Residual

One Year after Application

Residual - Plant Available Nitrogen (for following year)

83.6 DT	X	0.10	=	8.36 DT
Organic N/unit	x	availability coefficient		#/unit

Manure	Biosolids
Table 8-3	Table 9-1

_____ #/unit x _____ units/ac. = _____ # Residual Nitrogen/ac.

Completed Worksheet

Residual - Plant Available Nitrogen (for following year)

83.6	X	0.10	=	8.36
Organic N/unit DT	x	availability coefficient		#/unit DT

Manure	Biosolids
Table 9-3	Table 9-1

8.36 #/DT unit x 4.67 DT units/ac. = 39.03 # Residual Nitrogen/ac.


Questions ?