Biosolids Calculations

Nick Moody

Biosolids NM Coordinator

Biosolids Analysis Report

Parameter	Result %	Result (Mg/Kg)
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 = (4.45%)

89.0 lbs TKN/DT

0.0027 (NH_3) X 2,000 lbs./ T = (0.27%)

5.4 lbs NH_3/DT

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]

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 < 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

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.

Primary Nutrient Availability for Biosolids

Biosolids Phosphorus

Available P_2O_5 = Biosolids Analysis P_2O_5

If soils are testing M+ or above in phosphorus and the Biosolids will supply enough phosphorus for the crop according to the formula Available P_2O_5 = Total P_2O_5, no fertilizer phosphorus should be used due to unlikely crop response and water quality concerns.

For soils testing Medium or below, starter applications of fertilizer phosphorus should be made even if the Biosolids contain sufficient phosphorus, since it is contained in slow release organic forms. For soils testing low, higher levels of phosphorus starter fertilizer are recommended.

Biosolids Potassium

Available K_2O = Biosolids analysis K_2O

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
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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		
83.6 DT	Organic N/unit		
0.75 =	x availability coefficient	____ #/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

83.6 DT
Organic N/unit

0.75 = 4.05 #/unit
x availability coefficient

0.30 = 25.08 #/unit
x availability coefficient

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 2014
Tract: T-1989

Field Name	Ac.	Crop Rotation	Expctd Yield (bu or tons)	Nutrient Needs (from soil test & expctd yield) $N\text{-}P_2O_5\text{-}K_2O$	Nitrogen Residual (leg./ organic)	Days before Incorp	Organic Material Applied (1000 gal. or tons/ac)	Org. Nut. Applied $N\text{-}P_2O_5\text{-}K_2O$	$N\text{-}P_2O_5\text{-}K_2O$ Need or (Surplus)
HF-1	8	Orchard-grass Pasture	2.94 ac/au	50-40-70	0/14	----	-----	----	36-40-70
HF-2A	16	Corn (grain)	121 bu/ac	120-80-100	0/14	>7	1.45 t/ac Litter	55-80-77	51-0-23
HF-2B (P-1.5x) P-Index	12	Corn (grain)	90 bu/ac	90-0-0	0/0	>2	4.4 k/ac Dairy	46-51-87	44-(51)-(87)
HF-2C (N-based) Thres.	9	Orchard-grass Hay (maint.)	3.3 t/ac	140-40-95	0/0	>7	3.68 t/ac Litter	140-202-196	0-(162)-(101)
HF-3A	**11**	**Corn (grain)**	**100 bu/ac**	**100-100-80**	**0/14**	**>1**			
HF-3B	11.3	Corn (silage)	22.5 t/ac	165-120-240	0/7	>2	6 k/ac Dairy	63-69-119	95-51-121

Biosolids Application Rate

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

Crop nutrient need is: **100-100-80**

First, credit residual nitrogen carryover to crop nutrient needs:

100 lbs N – 14 lbs N = **86 lbs N** need

(dairy manure residual)

Balance of crop nutrient need is: **86-100-80**

How Many Tons of Biosolids to Apply ?

Field Name	Ac.	Crop Rotation	Expctd Yield (bu or tons)	Nutrient Needs (from soil test & expctd yield) $N\text{-}P_2O_5\text{-}K_2O$	Nitrogen Residual (leg./ organic)	Days before Incorp	Organic Material Applied (1000 gal. or tons/ac)	Org. Nut. Applied $N\text{-}P_2O_5\text{-}K_2O$	$N\text{-}P_2O_5\text{-}K_2O$ Need or (Surplus)	$N\text{-}P_2O_5\text{-}K_2O$ (commercial)	Notes
HF-2C (N-based) Thres.	9	Orchard-grass Hay (maint.)	3.3 t/ac	140-40-95	0/0	>7	3.68 t/ac Litter	140-202-196	0-(162)-(101)	----	3
HF-3A	11	Corn (grain)	100 bu/ac	100-100-80	0/14	>1					4
HF-3B	11.3	Corn (silage)	22.5 t/ac	165-120-240	0/7	>2	6 k/ac Dairy	63-69-119	95-51-121	0-31-121 br 20-20-0 ba 75-0-0 sd	4

100 lbs N for corn - 14 lbs N residual = 86 lbs N from Biosolids

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

0.75 = 4.05 #/unit
x availability coefficient

0.30 = 25.08 #/unit
x availability coefficient

TOTAL PAN 29.13 #/unit

Availability Coefficients from Standards and Criteria

Manure	**Biosolids**
Table 8-2	Table 9-2
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Nitrogen needs are to be met through biosolids application

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

Crop needs, less residual, are **86 lbs N**

(14 lbs. dairy manure)

$$\frac{\text{86 lbs N/ Acre}}{\text{29.13 lbs N/ DT}} = \textbf{2.95 DT/ A}$$

Fill in Worksheet

$$\frac{86}{\#N/ac.\ needed} \div \frac{29.13}{PAN\#/DT} \text{ 1,000 gallons or } \underline{\text{tons}} = \frac{2.95}{} \text{ 1,000 } \underline{\text{tons}}/\text{acre}$$

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:

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

$$\frac{2.95\ \text{DT/ A}}{0.3094} = \textbf{9.53 WT/ A}$$

(30.94% solids)

to achieve **N = 86 lbs/ A**

NUTRIENT MANAGEMENT Balance Sheet

Name: WilDaLyn Farms **Date:** February 2014
Tract: T-1989

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HF-1	8	Orchard-grass Pasture	2.94 ac/au	50-40-70	0/14	----	-----	----	36-40-70
HF-2A	16	Corn (grain)	121 bu/ac	120-80-100	0/14	>7	1.45 t/ac Litter	55-80-77	51-0-23
HF-2B (P-1.5x) P-Index	12	Corn (grain)	90 bu/ac	90-0-0	0/0	>2	4.4 k/ac Dairy	46-51-87	44-(51)-(87)
HF-2C (N-based) Thres.	9	Orchard-grass Hay (maint.)	3.3 t/ac	140-40-95	0/0	>7	3.68 t/ac Litter	140-202-196	0-(162)-(101)
HF-3A	**11**	**Corn (grain)**	**100 bu/ac**	**100-100-80**	**0/14**	**>1**	**9.53 WT (2.95 DT)**	**86-?-?**	
HF-3B	11.3	Corn (silage)	22.5 t/ac	165-120-240	0/7	>2	6 k/ac Dairy	63-69-119	95-51-121

Biosolids Analysis Report

Parameter	Result %	Result (Mg/Kg)
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.

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**

Biosolids Analysis Report

Parameter	Result %	Result (Mg/Kg)
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.

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 2.95 DT/ A = **232.46 lbs P_2O_5/ A**

4.8 lbs K_2O/ DT X 2.95 DT/ A = **14.16 lbs K_2O/ A**

Original Crop Needs: 100-100-80

Nutrient	Amount/ Source	Net
Nitrogen: 100	14 lbs/ A from Residual	86
	86 lbs/ A from Biosolids	0
Phosphate: 100	232 lbs/A from Biosolids	+132*
Potash: 80	14 lbs/ A from Biosolids	- 66
	66 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

Name: WilDaLyn Farms **Date:** February 2014

Tract: T-1989

Field Name	Ac.	Crop Rotation	Expctd Yield (bu or tons)	Nutrient Needs (from soil test & expctd yield) $N\text{-}P_2O_5\text{-}K_2O$	Nitrogen Residual (leg./ organic)	Days before Incorp	Organic Material Applied (1000 gal. or tons/ac)	Org. Nut. Applied $N\text{-}P_2O_5\text{-}K_2O$	$N\text{-}P_2O_5\text{-}K_2O$ Need or (Surplus)	$N\text{-}P_2O_5\text{-}K_2O$ (commercial)	Notes
HF-1	8	Orchard-grass Pasture	2.94 ac/au	50-40-70	0/14	----	-----	----	36-40-70	36-40-70 br	
HF-2A	16	Corn (grain)	121 bu/ac	120-80-100	0/14	>7	1.45 t/ac Litter	55-80-77	51-0-23	0-0-23 br 20-0-0 ba 31-0-0 sd	1 2
HF-2B (P-1.5x) P-Index	12	Corn (grain)	90 bu/ac	90-0-0	0/0	>2	4.4 k/ac Dairy	46-51-87	44-(51)-(87)	20-0-0 ba 24-0-0 sd	2
HF-2C (N-based) Thres.	9	Orchard-grass Hay (maint.)	3.3 t/ac	140-40-95	0/0	>7	3.68 t/ac Litter	140-202-196	0-(162)-(101)	----	3
HF-3A	**11**	**Corn (grain)**	**100 bu/ac**	**100-100-80**	**0/14**	**>1**	**9.53 WT (2.95 DT)**	**86-232-14**	**0-(132)-66**	**0-0-66 br**	**4**
HF-3B	11.3	Corn (silage)	22.5 t/ac	165-120-240	0/7	>2	6 k/ac Dairy	63-69-119	95-51-121	0-31-121 br 20-20-0 ba 75-0-0 sd	4

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 < 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

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.

Primary Nutrient Availability for Biosolids

Biosolids Phosphorus

Available P_2O_5 = Biosolids Analysis P_2O_5

If soils are testing M+ or above in phosphorus and the Biosolids will supply enough phosphorus for the crop according to the formula Available P_2O_5 = Total P_2O_5, no fertilizer phosphorus should be used due to unlikely crop response and water quality concerns.

For soils testing Medium or below, starter applications of fertilizer phosphorus should be made even if the Biosolids contain sufficient phosphorus, since it is contained in slow release organic forms. For soils testing low, higher levels of phosphorus starter fertilizer are recommended.

Biosolids Potassium

Available K_2O = Biosolids analysis K_2O

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Molybdenum		13

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

Calcium Carbonate Equivalent

- Pure calcium carbonate is used as the standard for liming materials and is assigned a rating of 100%.
- This rating is known and the calcium carbonate equivalent (CCE).
- All other liming materials are rated in relationship to pure calcium carbonate.

Lime Applied

- Calculating Lime Application

14.63 % Calcium Carbonate Equiv.

(from biosolids analysis)

2.95 DT/A X .1463 = **.43 T/A of Lime**

Biosolids Nitrogen Residuals

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

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Primary Nutrient Availability for Biosolids

Biosolids Phosphorus

Available P_2O_5 = Biosolids Analysis P_2O_5

If soils are testing M+ or above in phosphorus and the Biosolids will supply enough phosphorus for the crop according to the formula Available P_2O_5 = Total P_2O_5, no fertilizer phosphorus should be used due to unlikely crop response and water quality concerns.

For soils testing Medium or below, starter applications of fertilizer phosphorus should be made even if the Biosolids contain sufficient phosphorus, since it is contained in slow release organic forms. For soils testing low, higher levels of phosphorus starter fertilizer are recommended.

Biosolids Potassium

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 To TKN = 89 lbs. N/ DT

Organic N = 8 .6 lbs. N/ DT

Section IX. Biosc Management

Ta
Estimated Nitrogen Mineral on 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.

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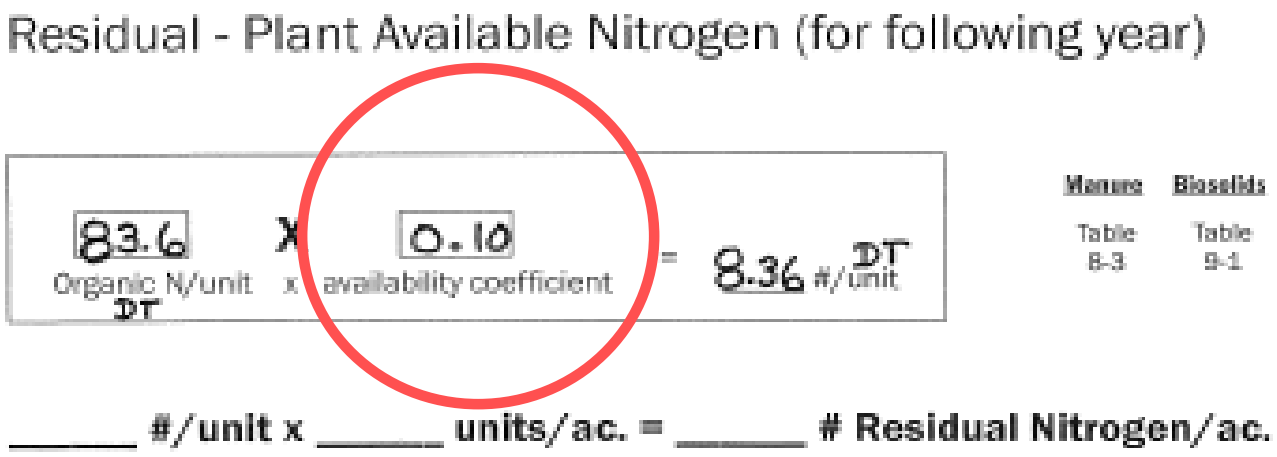
1. To determine the plant-available Biosolids ammonium nitrogen in the soil, multiply the Biosolids ammonium nitrogen concentration or total weight applied by the appropriate availability coefficient.

Standards & Criteria, p. 117

To Calculate Biosolids Residual

One Year after Application



Completed Worksheet

Residual - Plant Available Nitrogen (for following year)

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

Manure	Biosolids
Table 9-3	Table 9-1

8.36 #/unit DT x 2.95 units/ac. DT = 24.66 **Residual Nitrogen/ac.**

Questions ?