

BIOSOLIDS APPLICATION RATE CALCULATION

INSTRUCTIONS

- 1) As you work through the calculations, each data entry spot and calculation parameter is keyed to a number in parentheses in small font [ex. (22)] that appears either within a table cell or below the equation. As you work through the model, following the numbers assists in determining what data is used where.
- 2) Collect the information established in 'STEP 1 – DATA COLLECTION', and enter it on the worksheets. Enter the value '0' (zero) in 'Table 2' for all parameters in any season in which biosolids were not applied to the site. Similarly, enter the value '0' (zero) in 'Tables 5 & 6' for all parameters in any season in which dairy manure was not applied to the site. If dairy manure has not been co-managed on the site anytime within the last three years, you can skip 'STEP 1 -Section F' in its entirety.
- 3) After completing 'STEP 1', using the information collected, perform the calculations in 'STEP 2 – CALCULATE THE AMOUNT OF NITROGEN AVAILABLE IN THE BIOSOLIDS TO BE APPLIED'. Be sure to use the correct set of equations (fall or spring) for the application event you are planning and for the stabilization process employed.
- 4) After completing 'STEP 2', again using the information collected in 'STEP 1', perform the calculations in 'STEP 3 – CALCULATE THE AMOUNT OF RESIDUAL NITROGEN AVAILABLE FROM PREVIOUS APPLICATIONS OF BIOSOLIDS'. Be sure to use the correct set of equations (fall or spring) for the application event you are planning and for the stabilization process employed.

NOTE: After completing 'STEP 3', you may skip directly to 'STEP 5' if dairy manure has not been co-managed on the site anytime within the past three years.

- 5) If dairy manure has been co-managed on the site anytime during the past three years, complete 'STEP 4 - CALCULATE THE AMOUNT OF NITROGEN AVAILABLE FROM DAIRY MANURE APPLICATION EVENTS'. Be sure to use the correct set of equations (fall or spring) for the application event you are planning.
- 6) After completing the calculations in 'STEP 4' (or after having skipped directly from STEP 3), complete the calculations in 'STEP 5 – CALCULATE THE NITROGEN BASED APPLICATION RATE'.
- 7) Because the ceiling concentrations for the regulated metals enforced by VT-DEC are less than or equal to the federal exceptional quality standards (40 CFR 503.13 – Table 3), the annual pollutant loading rate (APLR) limits established under the federal standard do not apply and the nitrogen based application rate does not need to be adjusted to meet the APLR limits. However, because Vermont's current ceiling concentration for copper (1000 mg/kg, dry wt.) is lower than the corresponding federal Table 3 standard (1500 mg/kg, dry wt.), in this one case, Vermont will allow biosolids having a copper concentration of 1000 – 1500 mg/kg, dry wt., to

be managed via land application provided that the total amount of copper applied does not exceed that which would be applied at a copper concentration = 1000 mg/kg, dry wt.

If the copper concentration in the biosolids to be applied is in the range >1000 – 1500 mg/kg, dry wt., adjust the nitrogen based application rate by completing the calculation in 'STEP 6'.

- 8) Complete the appropriate calculation in 'STEP 7 – CONVERT APPLICATION RATE TO DESIRED UNITS', using the maximum allowable dry tons/acre application rate, if you wish to convert the dry tons/acre application rate into units of gallons/acre, wet tons/acre, or cubic yards/acre.

NOTES

- 1) The nitrogen mineralization rates (for both biosolids and manure) employed in these calculations are valid only for Vermont or locations with similar climate conditions.
- 2) The nitrogen content and availability factors employed in these calculations for manure are valid for dairy manure only and only for Vermont or locations with similar climate conditions.
- 3) The calculations for nitrogen derived from manure are not valid for composted manure.
- 4) It is important to remember that the nitrogen mineralization factors used in these calculations are only estimates, and that the actual rate of mineralization will vary from site-to-site, season-to-season, and year-to-year due to variations in climate, soil conditions, biosolids processing, etc.. Because of these natural variations, it is recommended that for corn crops, a "Pre-Sidedress Nitrate Test" (PSNT) should be performed on the site's soils when the corn crop is 8" – 12" tall in order to obtain an accurate characterization of PAN and any additional nitrogen needs. If the PSNT determines that additional nitrogen is required, contact the Residuals Management Section for approval before applying additional nitrogen to the site. Please note that the PSNT was developed specifically for corn crops and that its applicability to hay and other forage crops has not been demonstrated, although it likely is applicable to those crops as well.
- 5) The three sources that form the basis of these calculations can be obtained at the following two internet sites and in the Journal of Environmental Quality (not available on-line):

for biosolids:

"Estimating Plant Available Nitrogen in Biosolids"; Gilmour, et. al.; Water Environment Research Foundation – Project 97-REM-3; 2000; which is available on-line at:

http://www.epa.state.oh.us/dsw/sludge/WERF_sludge_PAN_calcs.pdf

and

"Nitrogen Availability from Sewage Sludge"; Magdoff and Amadon; J. Environ. Quality; 1980, 11 (4). (not available on-line)

for manure:

“Nutrient Recommendations for Field Crops in Vermont”; Jokela, et. al.; University of Vermont Extension; Publication BR-1390; which is available on-line at:

<http://www.uvm.edu/extension/publications/nutrientrec/manure.htm>

6) For questions or comments concerning the design or use of this calculation model, contact:

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IMPORTANT NOTE:

Please be aware that the application rate calculated by this model will provide sufficient PAN for the crop to be grown on the site during the growing season that follows the application of the biosolids for which this calculation is being performed. This means that if biosolids are applied at the full calculated application rate in the fall of the year, sufficient PAN is supplied for the entire growth cycle of the crop that will be planted in the following spring, and that no biosolids or other sources of nitrogen may be applied to the site in the following spring.

PLEASE PLAN YOUR APPLICATION EVENTS ACCORDINGLY

STEP 1 – DATA COLLECTION

Collect, enter, and calculate the information requested in Step 1. This information is needed in order to calculate the biosolids application rate.

A) For the biosolids to be applied, enter the appropriate data in Table 1:

If the lab reported the concentration as “less than” a detection limit (ex. <5.0), enter the detection limit (ex. 5.0).

Table 1

DATA FOR BIOSOLIDS TO BE APPLIED		
PARAMETER	CONCENTRATION	UNITS
TKN	(1)	% by weight
NO ₃ nitrogen	(2)	% by weight
NH ₄ nitrogen	(3)	% by weight
% solids	(4)	% by weight
Arsenic (As)	(5)	mg/kg, dry wt.
Cadmium (Cd)	(6)	mg/kg, dry wt.
Copper (Cu)	(7)	mg/kg, dry wt.
Lead (Pb)	(8)	mg/kg, dry wt.
Mercury (Hg)	(9)	mg/kg, dry wt.
Nickel (Ni)	(10)	mg/kg, dry wt.
Selenium (Se)	(11)	mg/kg, dry wt.
Zinc (Zn)	(12)	mg/kg, dry wt.

Calculate the organic and inorganic nitrogen content:

Organic nitrogen = TKN – NH₄ = (1) – (3) = % (13)

Inorganic nitrogen = NO₃ + NH₄ = (2) + (3) = % (14)

Select the appropriate stabilization process: anaerobic digestion
 aerobic digestion
 lagoon/lime stabilized

Select the appropriate incorporation strategy: injected or incorporated within 8 hours
 not incorporated within 8 hours

B) For previous biosolids applications:

Enter data in the dry tons/acre, TKN, and NH₄ columns of Table 2, then calculate the organic nitrogen content for each event and enter the value in its column, where:

organic nitrogen = TKN – NH₄

Table 2

DATA FOR PREVIOUS BIOSOLIDS APPLICATIONS				
APPLICATION EVENT	DRY TONS/ACRE APPLIED	TKN (% by wt.)	NH₄ nitrogen (% by wt.)	ORGANIC NITROGEN (% by wt.)
current year – fall	(15)	(16)	(17)	(18)
current year – spring	(19)	(20)	(21)	(22)
previous year – fall	(23)	(24)	(25)	(26)
previous year – spring	(27)	(28)	(20)	(30)
2 years ago – fall	(31)	(32)	(33)	(34)
2 years ago – spring	(35)	(36)	(37)	(38)
3 years ago – fall	(39)	(40)	(41)	(42)
3 years ago - spring	(43)	(44)	(45)	(46)

Calculate weighted averages for the applications for the last three years and enter the value in the appropriate column in the Table 3, where:

$$\text{weighted average [(48), (49), or (50)]} = \frac{[(23 \times (26))] + [(27) \times (30)]}{(23) + (27)} \quad \text{(for the previous year, and repeating for 2 and 3 years ago)}$$

$$\text{weighted average} = \frac{((\text{dt/ac : fall}) \times (\text{organic N : fall})) + ((\text{dt/ac : spring}) \times (\text{organic N : spring}))}{(\text{dt/ac : fall}) + (\text{dt/ac : spring})}$$

Table 3

WEIGHTED AVERAGES		
APPLICATION YEAR	TOTAL DRY TONS/ACRE APPLIED	WEIGHTED AVERAGE ORGANIC NITROGEN
previous year	(47)	(48)
2 years ago	(49)	(50)
3 years ago	(51)	(52)

Enter the cadmium concentrations for two of the three application events listed in Table 4. Note that data is only needed as follows:

- current year spring: needed only for fall application events*
- previous year fall: needed for both spring and fall application events*
- previous spring: needed only for spring application events*

If the lab reported the concentration as “less than” a detection limit (ex. <5.0), enter the detection limit (ex. 5.0).

Table 4

METALS CONCENTRATIONS FOR PREVIOUS APPLICATION EVENTS				
APPLICATION EVENT PARAMETER	CURRENT YEAR SPRING	PREVIOUS YEAR FALL	PREVIOUS YEAR SPRING	UNITS
Cadmium (Cd)	(53)	(54)	(55)	mg/kg, dry wt.

C) Select the appropriate site soil drainage characteristics: poorly to moderately drained
 moderately to well drained

D) Enter the amount of nitrogen derived from chemical fertilizer that will be applied in the current season:

lbs N/acre (56)

E) Enter the crop's nitrogen requirement:

lbs N/acre (57)

IF DAIRY MANURE HAS NOT BEEN APPLIED TO THE SITE ANYTIME IN THE LAST THREE YEARS, SKIP 'SECTION F' AND GO TO 'STEP 2'.

F) For dairy manure that is co-managed on the site with biosolids:

Enter the data for manure applications in Table 5. The volumes (and units) must be in either wet tons/acre or gallons/acre.

Table 5

APPLIED MANURE INFORMATION				
APPLICATION EVENT	VOLUME PER ACRE APPLIED	UNITS*	APPROXIMATE % SOLIDS	TIME TO TILLAGE
current year – fall	(58)	(59)	(60)	(61)
current year – spring	(62)	(63)	(64)	(65)
previous year – fall	(66)	(67)	(68)	(69)
previous year – spring	(70)	(71)	(72)	(73)
2 years ago – fall	(74)	(75)	(76)	(77)
2 years ago - spring	(78)	(79)	(80)	(81)

- units must be 'wet tons/acre' or 'gallons/acre'
 -
- Using the data entered in Table 5, select the appropriate values from Charts 1 – 4 and enter the corresponding values in Table 6.*

Table 6

MANURE NITROGEN CONTENT AND AVAILABILITY				
APPLICATION EVENT	ORGANIC N CONTENT	ORGANIC N AVAILABILITY	NH₄ CONTENT	NH₄ AVAILABILITY
current year – fall	(82)	(83)	(84)	(85)
current year – spring	(86)	(87)	(88)	(89)
previous year – fall	(90)	(91)	(92)	(93)
previous year – spring	(94)	(95)	N/A	0
2 years ago – fall	(96)	(97)	N/A	0
2 years ago - spring	(98)	(99)	N/A	0

Chart 1 – Nitrogen content

MANURE TYPE	ORGANIC N CONTENT	NH₄ CONTENT
liquid (<7.5 % solids)	12 lbs N/1000 gal.	11 lbs N/1000 gal.
semi-solid (7.5% - 20% solids)	5.5 lbs N/wet ton	3.5 lbs N/wet ton
solid (>20% solids)	8 lbs N/wet ton	2 lbs N/wet ton

Chart 2 – Organic nitrogen availability (%)

MANURE TYPE	SOIL DRAINAGE	CURRENT YEAR		PREVIOUS YEAR	2 YEARS AGO
		tilled	not tilled	N/A	N/A
liquid to semi-solid (<=20% solids)	poorly to moderately drained	24	16	10	4
	moderately to well drained	36	24	12	5
solid (>20% solids)	poorly to moderately drained	20	14	10	4
	moderately to well drained	30	24	12	5

Chart 3 – NH₄ availability (%) for manure applied:
 in the fall of the current year for fall application event calculations, or
 in the fall of the previous year for spring application event calculations

FOR FALL APPLICATION EVENTS				
	MANURE TYPE			
TIME TO TILLAGE	thin (<5% solids)	medium (5% -10% solids)	semi-solid (10% - 20% solids)	solid (>20% solids)
immediate	40	35	35	40
< 8 hours	30	25	25	30
1 day	30	25	15	25
2 days	25	20	10	20
3 – 4 days	25	20	10	15
5 – 7 days	25	15	10	10
>7 days or none	25	15	10	0

Chart 4 – NH₄ availability (%) for manure applied:
 in the spring or summer of the current year for spring application events

FOR SPRING APPLICATION EVENTS				
	MANURE TYPE			
TIME TO TILLAGE	thin (<5% solids)	medium (5% -10% solids)	semi-solid (10% - 20% solids)	solid (>20% solids)
immediate	95	95	90	95
< 8 hours	80	70	60	80
1 day	70	55	40	60
2 days	65	50	30	45
3 – 4 days	65	45	25	35
5 – 7 days	60	40	25	25
>7 days or none	60	40	20	10

The NH₄ availability for all other manure applications = 0

END OF STEP 1

STEP 2 – CALCULATE THE AMOUNT OF NITROGEN AVAILABLE IN THE BIOSOLIDS TO BE APPLIED

Based upon the data entered and the stabilization and incorporation choices selected in ‘Step 1 – Section A’, select the appropriate equation in ‘Step 2’ and calculate the amount of nitrogen that will be available from the biosolids to be applied. Select from the set of equations for a fall application event or a spring application event, as appropriate:

A) FALL APPLICATION EVENTS

anaerobic digestion – injected or incorporated within 8 hours

$$\left(\frac{\text{organic nitrogen}}{(13)} \times 3 \right) + \left(\frac{\text{NH}_4 \text{ nitrogen}}{(3)} \times 5 \right) = \text{_____ lbs N/dry ton} \quad (100)$$

anaerobic digestion – surface applied and not incorporated within 8 hours

$$\left(\frac{\text{organic nitrogen}}{(13)} \times 3 \right) + \left(\frac{\text{NH}_4 \text{ nitrogen}}{(3)} \right) = \text{_____ lbs N/dry ton} \quad (100)$$

aerobic digestion – injected or incorporated within 8 hours

$$\left(\frac{\text{organic nitrogen}}{(13)} \times 7 \right) + \left(\frac{\text{NH}_4 \text{ nitrogen}}{(3)} \times 5 \right) = \text{_____ lbs N/dry ton} \quad (100)$$

aerobic digestion – surface applied and not incorporated within 8 hours

$$\left(\frac{\text{organic nitrogen}}{(13)} \times 7 \right) + \left(\frac{\text{NH}_4 \text{ nitrogen}}{(3)} \right) = \text{_____ lbs N/dry ton} \quad (100)$$

lime stabilized or lagoon biosolids – any management technique

$$\left(\frac{\text{organic nitrogen}}{(13)} \times 7 \right) = \text{_____ lbs N/dry ton} \quad (100)$$

B) SPRING APPLICATION EVENTS

anaerobic digestion – injected or incorporated within 8 hours

$$\left(\frac{\text{organic nitrogen}}{(13)} \times 4 \right) + \left(\frac{\text{inorganic nitrogen}}{(14)} \times 20 \right) = \text{_____ lbs N/dry ton} \quad (100)$$

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anaerobic digestion – surface applied and not incorporated within 8 hours

$$\left(\frac{\text{_____}}{\text{organic nitrogen}} \times 4 \right) + \left(\frac{\text{_____}}{\text{NH}_4 \text{ nitrogen}} \times 6 \right) + \left(\frac{\text{_____}}{\text{NO}_3 \text{ nitrogen}} \times 20 \right) = \text{_____ lbs N/dry ton}$$

(13) (3) (2) (100)

aerobic digestion – injected or incorporated within 8 hours

$$\left(\frac{\text{_____}}{\text{organic nitrogen}} \times 8 \right) + \left(\frac{\text{_____}}{\text{inorganic nitrogen}} \times 20 \right) = \text{_____ lbs N/dry ton}$$

(13) (14) (100)

aerobic digestion – surface applied and not incorporated within 8 hours

$$\left(\frac{\text{_____}}{\text{organic nitrogen}} \times 8 \right) + \left(\frac{\text{_____}}{\text{NH}_4 \text{ nitrogen}} \times 6 \right) + \left(\frac{\text{_____}}{\text{NO}_3 \text{ nitrogen}} \times 20 \right) = \text{_____ lbs N/dry ton}$$

(13) (3) (2) (100)

lime stabilized or lagoon biosolids – any management technique

$$\left(\frac{\text{_____}}{\text{organic nitrogen}} \times 8 \right) + \left(\frac{\text{_____}}{\text{NO}_3 \text{ nitrogen}} \times 20 \right) = \text{_____ lbs N/dry ton}$$

(13) (2) (100)

END OF STEP 2

STEP 3 – CALCULATE THE AMOUNT OF RESIDUAL NITROGEN AVAILABLE FROM PREVIOUS APPLICATIONS OF BIOSOLIDS

Based upon the data entered and the stabilization and incorporation choices selected in ‘Step 1 – Section B’, select the appropriate equation in ‘Step 3’ and calculate the amount of nitrogen that will be available from previous applications of biosolids. Select from the set of equations for a fall application event or a spring application event, as appropriate:

A) FALL APPLICATION EVENTS

anaerobic digestion – injected or incorporated within 8 hours
 or
 anaerobic digestion – surface applied and not incorporated within 8 hours

$$\left(\frac{\text{dt/ac}}{\text{previous spring}} \times \frac{\text{org. N}}{\text{org. N}} \times 4 \right) + \left(\frac{\text{total dt/ac}}{\text{previous year}} \times \frac{\text{org. N}^*}{\text{org. N}^*} \times 2 \right) + \left(\frac{\text{total dt/ac}}{\text{2 years ago}} \times \frac{\text{org. N}^*}{\text{org. N}^*} \times 2 \right) + \left(\frac{\text{total dt/ac}}{\text{3 years ago}} \times \frac{\text{org. N}^*}{\text{org. N}^*} \right) = \text{lbs N/acre}$$

(19) (22) (47) (48) (49) (50) (51) (52) (101)

* = weighted average * = weighted average * = weighted average

aerobic digestion – injected or incorporated within 8 hours
 or
 aerobic digestion – surface applied and not incorporated within 8 hours
 or
 lime stabilized or lagoon biosolids – any management technique

$$\left(\frac{\text{dt/ac}}{\text{previous spring}} \times \frac{\text{org. N}}{\text{org. N}} \times 5 \right) + \left(\frac{\text{total dt/ac}}{\text{previous year}} \times \frac{\text{org. N}^*}{\text{org. N}^*} \times 2 \right) + \left(\frac{\text{total dt/ac}}{\text{2 years ago}} \times \frac{\text{org. N}^*}{\text{org. N}^*} \times 2 \right) + \left(\frac{\text{total dt/ac}}{\text{3 years ago}} \times \frac{\text{org. N}^*}{\text{org. N}^*} \right) = \text{lbs N/acre}$$

(19) (22) (47) (48) (49) (50) (51) (52) (101)

* = weighted average * = weighted average * = weighted average

B) SPRING APPLICATION EVENTS

anaerobic digestion – injected or incorporated within 8 hours

$$\left(\frac{\text{dt/ac}}{\text{previous fall}} \times \left(\frac{\text{org. N}}{\text{org. N}} \times 3 + \frac{\text{NH}_4 \text{ N}}{\text{NH}_4 \text{ N}} \times 5 \right) \right) + \left(\frac{\text{total dt/ac}}{\text{previous spring}} \times \frac{\text{org. N}}{\text{org. N}} \times 2 \right) + \left(\frac{\text{total dt/ac}}{\text{2 years ago}} \times \frac{\text{org. N}^*}{\text{org. N}^*} \times 2 \right) + \left(\frac{\text{total dt/ac}}{\text{3 years ago}} \times \frac{\text{org. N}^*}{\text{org. N}^*} \right) = \text{lbs N/acre}$$

(23) (26) (25) (27) (30) (49) (50) (51) (52) (101)

* = weighted average * = weighted average

anaerobic digestion – surface applied and not incorporated within 8 hours

$$\left(\frac{\text{dt/ac}}{\text{previous fall}} \times \left(\frac{\text{org. N}}{\text{org. N}} \times 3 + \frac{\text{NH}_4 \text{ N}}{\text{NH}_4 \text{ N}} \right) \right) + \left(\frac{\text{dt/ac}}{\text{previous spring}} \times \frac{\text{org. N}}{\text{org. N}} \times 2 \right) + \left(\frac{\text{total dt/ac}}{\text{2 years ago}} \times \frac{\text{org. N}^*}{\text{org. N}^*} \times 2 \right) + \left(\frac{\text{total dt/ac}}{\text{3 years ago}} \times \frac{\text{org. N}^*}{\text{org. N}^*} \right) = \text{lbs N/acre}$$

(23) (26) (25) (27) (30) (49) (50) (51) (52) (101)

* = weighted average * = weighted average

STEP 4 - CALCULATE THE AMOUNT OF NITROGEN AVAILABLE FROM DAIRY MANURE

Using the data entered in ‘Step 1 – Sections C and F’, select the appropriate set of equations in ‘Step 4’ for a fall application event or a spring application event, as appropriate, and calculate the amount of nitrogen that will be available from applications of dairy manure.

A) FALL APPLICATION EVENTS

current year – fall

$$\left(\frac{\text{_____}}{\text{volume/acre}} \times \left(\frac{\text{_____}}{\text{organic N}} \times \frac{\text{_____}}{\text{organic N availability}} \right) + \left(\frac{\text{_____}}{\text{NH}_4 \text{ N}} \times \frac{\text{_____}}{\text{NH}_4 \text{ N availability}} \right) \right) \div 100 = \text{_____ N units}$$

(58) (82) (83) (84) (85) (102)

adjust the N units:

if (volume/acre) is in units of ‘gallons/acre’: $\left(\frac{\text{_____}}{\text{(102)}} \text{ N units} \right) \div 1000 = \frac{\text{_____}}{\text{(103)}} \text{ adjusted N units}$

if (volume/acre) is in units of ‘wet tons/acre’: $\text{N units} = \frac{\text{_____}}{\text{(103)}} \text{ adjusted N units}$

current year – spring

$$\left(\frac{\text{_____}}{\text{volume/acre}} \times \left(\frac{\text{_____}}{\text{organic N}} \times \frac{\text{_____}}{\text{organic N availability}} \right) \right) \div 100 = \text{_____ N units}$$

(62) (86) (87) (104)

adjust the N units:

if (volume/acre) is in units of ‘gallons/acre’: $\left(\frac{\text{_____}}{\text{(104)}} \text{ N units} \right) \div 1000 = \frac{\text{_____}}{\text{(105)}} \text{ adjusted N units}$

if (volume/acre) is in units of ‘wet tons/acre’: $\text{N units} = \frac{\text{_____}}{\text{(105)}} \text{ adjusted N units}$

1 year ago - fall

$$\left(\frac{\text{_____}}{\text{volume/acre}} \times \left(\frac{\text{_____}}{\text{organic N}} \times \frac{\text{_____}}{\text{organic N availability}} \right) \right) \div 100 = \text{_____ N units}$$

(66) (90) (91) (106)

adjust the N units:

if (volume/acre) is in units of ‘gallons/acre’: $\left(\frac{\text{_____}}{\text{(106)}} \text{ N units} \right) \div 1000 = \frac{\text{_____}}{\text{(107)}} \text{ adjusted N units}$

if (volume/acre) is in units of ‘wet tons/acre’: $\text{N units} = \frac{\text{_____}}{\text{(107)}} \text{ adjusted N units}$

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1 year ago - spring

$$\left(\frac{\text{_____}}{\text{volume/acre}} \times \left(\frac{\text{_____}}{\text{organic N}} \times \frac{\text{_____}}{\text{organic N availability}} \right) \right) \div 100 = \text{_____ N units}$$

(70) (94) (95) (108)

adjust the N units:

if (volume/acre) is in units of 'gallons/acre': $\left(\frac{\text{_____}}{\text{(108)}} \text{ N units} \right) \div 1000 = \frac{\text{_____}}{\text{(109)}} \text{ adjusted N units}$

if (volume/acre) is in units of 'wet tons/acre': $\text{N units} = \frac{\text{_____}}{\text{(109)}} \text{ adjusted N units}$

2 years ago - fall

$$\left(\frac{\text{_____}}{\text{volume/acre}} \times \left(\frac{\text{_____}}{\text{organic N}} \times \frac{\text{_____}}{\text{organic N availability}} \right) \right) \div 100 = \text{_____ N units}$$

(74) (96) (97) (110)

adjust the N units:

if (volume/acre) is in units of 'gallons/acre': $\left(\frac{\text{_____}}{\text{(110)}} \text{ N units} \right) \div 1000 = \frac{\text{_____}}{\text{(111)}} \text{ adjusted N units}$

if (volume/acre) is in units of 'wet tons/acre': $\text{N units} = \frac{\text{_____}}{\text{(111)}} \text{ adjusted N units}$

2 years ago - spring

$$\left(\frac{\text{_____}}{\text{volume/acre}} \times \left(\frac{\text{_____}}{\text{organic N}} \times \frac{\text{_____}}{\text{organic N availability}} \right) \right) \div 100 = \text{_____ N units}$$

(78) (98) (99) (112)

adjust the N units:

if (volume/acre) is in units of 'gallons/acre': $\left(\frac{\text{_____}}{\text{(112)}} \text{ N units} \right) \div 1000 = \frac{\text{_____}}{\text{(113)}} \text{ adjusted N units}$

if (volume/acre) is in units of 'wet tons/acre': $\text{N units} = \frac{\text{_____}}{\text{(113)}} \text{ adjusted N units}$

Sum the calculated adjusted N units above to calculate the total N available from manure:

$$\left(\frac{\text{_____}}{\text{current year fall (103)}} \right) + \left(\frac{\text{_____}}{\text{current year spring (105)}} \right) + \left(\frac{\text{_____}}{\text{1 year ago fall (107)}} \right) + \left(\frac{\text{_____}}{\text{1 year ago spring (109)}} \right) + \left(\frac{\text{_____}}{\text{2 years ago fall (111)}} \right) + \left(\frac{\text{_____}}{\text{2 years ago spring (113)}} \right) = \text{_____ lbs N/acre (114)}$$

B) SPRING APPLICATION EVENTS

current year – spring

$$\left(\frac{\text{_____}}{\text{volume/acre}} \times \left(\frac{\text{_____}}{\text{organic N}} \times \frac{\text{_____}}{\text{organic N availability}} \right) + \left(\frac{\text{_____}}{\text{NH}_4 \text{ N}} \times \frac{\text{_____}}{\text{NH}_4 \text{ N availability}} \right) \right) \div 100 = \text{_____ N units}$$

(62) (86) (87) (88) (89) (102)

adjust the N units:

if (volume/acre) is in units of 'gallons/acre': $\left(\frac{\text{_____}}{\text{(102)}} \text{ N units} \right) \div 1000 = \frac{\text{_____}}{\text{(103)}} \text{ adjusted N units}$

if (volume/acre) is in units of 'wet tons/acre': $\text{N units} = \frac{\text{_____}}{\text{(103)}} \text{ adjusted N units}$

previous year – fall

$$\left(\frac{\text{_____}}{\text{volume/acre}} \times \left(\frac{\text{_____}}{\text{organic N}} \times \frac{\text{_____}}{\text{organic N availability}} \right) + \left(\frac{\text{_____}}{\text{NH}_4 \text{ N}} \times \frac{\text{_____}}{\text{NH}_4 \text{ N availability}} \right) \right) \div 100 = \text{_____ N units}$$

(66) (90) (91) (92) (93) (104)

adjust the N units:

if (volume/acre) is in units of 'gallons/acre': $\left(\frac{\text{_____}}{\text{(104)}} \text{ N units} \right) \div 1000 = \frac{\text{_____}}{\text{(105)}} \text{ adjusted N units}$

if (volume/acre) is in units of 'wet tons/acre': $\text{N units} = \frac{\text{_____}}{\text{(105)}} \text{ adjusted N units}$

previous year – spring

$$\left(\frac{\text{_____}}{\text{volume/acre}} \times \frac{\text{_____}}{\text{organic N}} \times \frac{\text{_____}}{\text{organic N availability}} \right) \div 100 = \text{_____ N units}$$

(70) (94) (95) (106)

adjust the N units:

if (volume/acre) is in units of 'gallons/acre': $\left(\frac{\text{_____}}{\text{(106)}} \text{ N units} \right) \div 1000 = \frac{\text{_____}}{\text{(107)}} \text{ adjusted N units}$

if (volume/acre) is in units of 'wet tons/acre': $\text{N units} = \frac{\text{_____}}{\text{(107)}} \text{ adjusted N units}$

2 years ago - fall

$$\left(\frac{\text{_____}}{\text{volume/acre}} \times \frac{\text{_____}}{\text{organic N}} \times \frac{\text{_____}}{\text{organic N availability}} \right) \div 100 = \text{_____ N units}$$

(74) (96) (97) (108)

BIOSOLIDS APPLICATION RATE CALCULATION – PAGE 13

adjust the N units:

if (volume/acre) is in units of 'gallons/acre': $\left(\frac{\text{_____}}{(108)} \text{ N units} \right) \div 1000 = \frac{\text{_____}}{(109)} \text{ adjusted N units}$

if (volume/acre) is in units of 'wet tons/acre': $\text{N units} = \frac{\text{_____}}{(109)} \text{ adjusted N units}$

2 years ago - spring

$$\left(\frac{\text{_____}}{\text{volume/acre}} \times \frac{\text{_____}}{\text{organic N}} \times \frac{\text{_____}}{\text{organic N availability}} \right) \div 100 = \text{_____ N units}$$

(78) (98) (99) (110)

adjust the N units:

if (volume/acre) is in units of 'gallons/acre': $\left(\frac{\text{_____}}{(110)} \text{ N units} \right) \div 1000 = \frac{\text{_____}}{(111)} \text{ adjusted N units}$

if (volume/acre) is in units of 'wet tons/acre': $\text{N units} = \frac{\text{_____}}{(111)} \text{ adjusted N units}$

Sum the calculated adjusted N units above to calculate the total N available from manure:

$$\left(\frac{\text{_____}}{\text{current year spring (103)}} \right) + \left(\frac{\text{_____}}{\text{previous year fall (105)}} \right) + \left(\frac{\text{_____}}{\text{previous year spring (107)}} \right) + \left(\frac{\text{_____}}{\text{2 years ago fall (109)}} \right) + \left(\frac{\text{_____}}{\text{2 years ago spring (111)}} \right) = \text{_____ lbs N/acre}$$

(103) (105) (107) (109) (111) (114)

END OF STEP 4

STEP 6 – ADJUST THE NITROGEN BASED APPLICATION RATE FOR COPPER:

- A) ***Complete this calculation only if the copper concentration in the biosolids to be applied is between 1000 mg/kg, dry wt. and 1500 mg/kg, dry wt. If the copper concentration is less than or equal to 1000 mg/kg, dry wt., skip directly to 'STEP 7'.***

Copper adjusted application rate = nitrogen based application rate ÷ (copper concentration ÷ 1000)

$$\left(\frac{\text{N based application rate (117)}}{\text{copper concentration (7)} \div 1000} \right) = \text{adjusted application rate (118) dry tons/acre}$$

END OF STEP 6

STEP 7 – CONVERT APPLICATION RATE TO DESIRED UNITS

Maximum allowable application rate = lesser of (117) or (118) = $\frac{\text{_____}}{(119)}$ dry tons/acre

NOTE: for each of the following conversions, % solids must be in decimal form – i.e. 0.05, not 5%.

*If you want the application rate in units of **gallons/acre**:*

$$\text{gallons/acre} = (\text{dry tons/acre} \times 23,981) \div (\% \text{ solids})$$

$$\left(\frac{\text{_____}}{(119)} \text{ dry tons/acre} \times 23,981 \right) \div \left(\frac{\text{_____}}{(4)} \% \text{ solids} \right) = \frac{\text{_____}}{(120)} \text{ gal/acre}$$

*If you want the application rate in units of **wet tons/acre**:*

$$\text{wet tons/acre} = (\text{dry tons/acre}) \div (\% \text{ solids})$$

$$\left(\frac{\text{_____}}{(119)} \text{ dry tons/acre} \right) \div \left(\frac{\text{_____}}{(4)} \% \text{ solids} \right) = \frac{\text{_____}}{(120)} \text{ wet tons/acre}$$

*If you want the application rate in units of **cubic yards/acre**:*

$$\text{cubic yards/acre} = (\text{dry tons/acre} \times 1.18) \div (\% \text{ solids})$$

$$\left(\frac{\text{_____}}{(119)} \text{ dry tons/acre} \times 1.18 \right) \div \left(\frac{\text{_____}}{(4)} \% \text{ solids} \right) = \frac{\text{_____}}{(120)} \text{ cubic yards/acre}$$

END OF CALCULATIONS