Land Use Loading Rate Ratios

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Background

- February 2025
- Created two new Land Uses:
  - Managed Pasture
  - Managed Hay
- Designed to represent high application Land Uses
- Require a factor that describes how N loads off the land

Unless we get feedback, we will use the following:

Jurisdiction	Method to determine Managed acres	Method to allocate NM	Managed Hay Nitrogen Application rate (lbs/acre)	Managed Hay Phosphorus Application rate (lbs/acre)	Managed Pasture Nitrogen Application rate (lbs/acre)	Managed Pasture Phosphorus Application rate (lbs/acre)	Source
DE			120	40	60	30	TEST DATA (Provided by VA DCR)
MD			120	40	60	30	TEST DATA (Provided by VA DCR)
NY	Based on reported Core N NM acres	Based on reported Core N NM acres	75	0-50 Dependent on Morgan Soil Test P	50	0-50 Dependent on Morgan Soil Test P	Cornell Nitrogen Guidelines for Field Crops in NY for Native and improved grasses (Pasture) and Grasses in a 1-2 cut system (Hay) Cornell Phosphorus Guidelines for Field Crops in NY for Native and improved grasses (Pasture) and Grasses in a 1-2 cut system (Hay)
PA	No managed acres	No NM acres	120	40	60	30	TEST DATA (Provided by VA DCR)
VA	To be reported like construction acres (state provided in advance of progress runs)	Reported Core N NM on specific land use	120	40	60	30	Low end of VT LGU recommendation
WV	Based on reported Core N NM acres	Based on reported Core N NM acres	120	40	60	30	TEST DATA (Provided by VA DCR)

Some background: Loading Rate Ratios

Chesapeake Bay Average			
Land class	Land Use	Loading Rate Ratio	Loading Rate (pounds per acre per year)
Cropland	Double Cropped Land	0.79	30.9
	Full Season Soybeans	0.71	27.7
	Grain with Manure	1.4	54.7
	Grain without Manure: **Reference land use**	1	39.1
	Other Agronomic Crops	0.45	17.6
	Silage with Manure	1.62	63.3
	Silage without Manure	1.16	45.3
	Small Grains and Grains	0.84	32.8
	Specialty Crop High	1.34	52.4
	Specialty Crop Low	0.31	12.1
Pasture	Ag Open Space	0.43	5.1
	Legume Hay	0.74	8.7
	Other Hay	1.04	12.3
	Pasture: **Reference Land Use**	1	11.8

CAST Ag Land Use Loading

- Land Classes
  - Basic split of ag into Cropland and Pasture

Chesapeake Bay Average			
Land class			
Cropland			
Pasture			

CAST Ag Land Use Loading

- Divided into Land Uses
  - Groups of crops we believe behave similarly.
- Reference Land Uses are determined for each class
  - Foundation for behavior of all other land uses

Chesapeake Bay Average			
Land class	Land Use		
Cropland	Double Cropped Land		
	Full Season Soybeans		
	Grain with Manure		
	Grain without Manure: **Reference land use**		
	Other Agronomic Crops		
	Silage with Manure		
	Silage without Manure		
	Small Grains and Grains		
	Specialty Crop High		
	Specialty Crop Low		
Pasture	Ag Open Space		
	Legume Hay		
	Other Hay		
	Pasture: **Reference Land Use**		

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- Divided into Land Uses
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	Grain with Manure		
	Grain without Manure: **Reference land use**		
	Other Agronomic Crops		
	Silage with Manure		
	Silage without Manure		
	Small Grains and Grains		
	Specialty Crop High		
	Specialty Crop Low		
Pasture	Ag Open Space		
	Legume Hay		
	Other Hay		
	Pasture: **Reference Land Use**		

CAST Ag Land Use Loading

- Loading Rate Ratio
  - Relative loading behavior of Land Uses compared to the reference.

Chesapeake Bay Average			
Land class	Land Use	Loading Rate Ratio	
Cropland	Double Cropped Land	0.79	
	Full Season Soybeans	0.71	
	Grain with Manure	1.4	
	Grain without Manure: **Reference land use**	1	
	Other Agronomic Crops	0.45	
	Silage with Manure	1.62	
	Silage without Manure	1.16	
	Small Grains and Grains	0.84	
	Specialty Crop High	1.34	
	Specialty Crop Low	0.31	
Pasture	Ag Open Space	0.43	
	Legume Hay	0.74	
	Other Hay	1.04	
	Pasture: **Reference Land Use**	1	

CAST Ag Land Use Loading

- Loading Rate
  - Pounds/acre/year of nutrients delivered to the water from the land.
  - Modeling workgroups purview
    - Encompass physical transport

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	Pasture: **Reference Land Use**	1	11.8

Phase 7 CAST Ag Land Uses

- Two new Land Uses
  - Managed Hay
  - Managed Pasture
- Need to think about differences between new Land Uses and existing ones.

Chesapeake Bay Average			
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	Managed Hay	?	?
	Pasture: **Reference Land Use**	1	11.8
	Managed Pasture	?	?

Literature Review:

Concerns:

- What do we mean by “managed”?
- No codified definition of managed vs unmanaged hay/pasture in literature

Solution:

- Managed pasture/hay = high application
- Unmanaged pasture/hay = low application

Literature Review

- Long-Term Leachate Water Quality Trends from a Broiler-Litter-Amended Udult in a Karst Region R.L. McMullen, K.R. Brye,* A.L. Daigh, D.M. Miller, E.E. Gbur, A.L. Pirani, M.A. Evans-White, and R.E. Mason 2014

- "The impacts of nitrogen fertilisation and increased stocking rate on pasture yield, soil physical condition and nutrient losses in drainage from a cattle-grazed pasture, Monoghan et al 2005"

- Field-Scale Nitrogen and Phosphorus Losses from Hayfields Receiving Fresh and Composted Broiler Litter R. W. Vervoort,* D. E. Radcliffe, M. L. Cabrera, and M. Latimore, Jr. 1998

- Nutrient Losses from Fertilized Grassed Watersheds in Western North Carolina V. J. Kilmer,2 J. W. Gilliam,a J. F. Lutz,a R. T. Joyce,4 a4nd C. D. Eklund 1974"

Data Processing:

Variable	low application state (unmanaged)	high application state (managed)	Ratio (high/low)
no3 kg ha	0.41	0.74	1.80
No3 mg/L	0.11	0.14	1.27
No3 kg ha yr	29	49	1.69
Nh4 kg ha yr	1.6	2.1	1.31
No3 kg ha yr	31	54	1.74
Nh4 kg ha yr	0.8	2.7	3.38
No3 kg ha yr	42	65	1.55
Nh4 kg ha yr	2.1	1.4	0.67
No3-N kg ha yr	1.6	4.3	2.69
No3_N mg/L	0.2	2.3	11.50
Total N losses kg/ha/yr	3.28	12.08	3.68
No3 Losses kg/ha/yr	2.36	10.34	4.38
Nh4 losses kg/ha/yr	0.33	0.76	2.30
organic losses N kg/ha/yr	0.76	1.26	1.66
deep seepage N losses kg/ha/year	2.6	4.3	1.65
kg/ha/cm runoff No3	0.12	0.39	3.25
kg/ha/cm runoff Nh4	0.02	0.03	1.50
kg/ha/cm runoff TotN	0.16	0.46	2.88

Data Processing: Isolating NO3

Variable	low application state (unmanaged)	high application state (managed)	Ratio (high/low)
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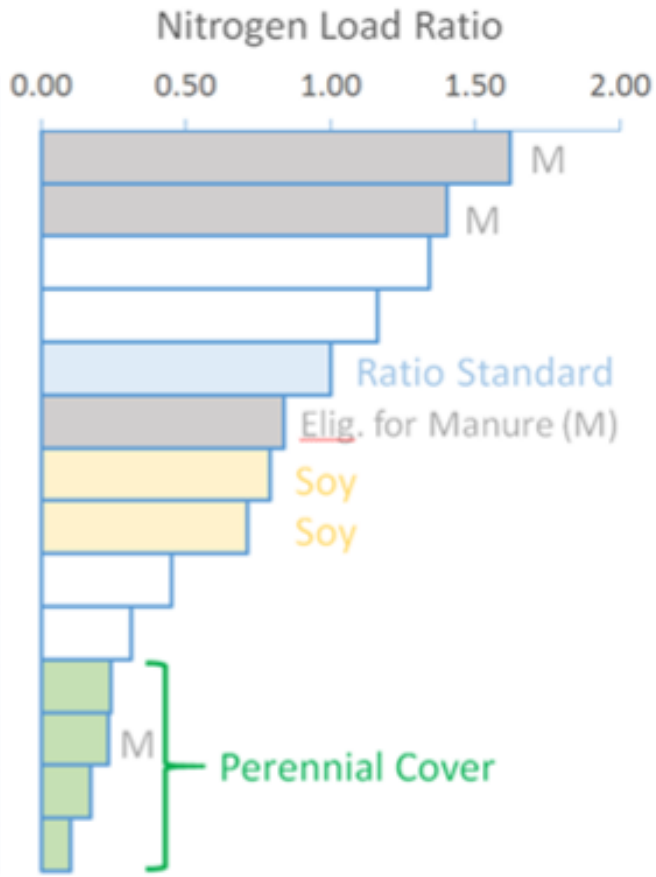
kg/ha/cm runoff Nh4	0.02	0.03	1.50
kg/ha/cm runoff TotN	0.16	0.46	2.88

Data Processing: Remove Outliers

Variable	low application state (unmanaged)	high application state (managed)	Ratio (high/low)	z score
no3 kg ha	0.41	0.74	1.80	-0.46
No3 kg ha yr	29	49	1.69	-0.57
No3 kg ha yr	31	54	1.74	-0.52
No3 kg ha yr	42	65	1.55	-0.70
No3-N kg ha yr	1.6	4.3	2.69	0.35
No3 Losses kg/ha/yr	2.36	10.34	4.38	1.90

A concern: Perennial Grass ratio

	Load Ratio	Std Err
Corn Silage Manure	1.62	
Corn Grain Manure	1.40	0.20
Specialty High	1.34	
Corn Silage *	1.16	
Corn Grain	1.00	
Sm Grain & Forage M.*	0.84	
Sm Grain & Soy	0.79	0.09
Full Season Soy	0.71	0.11
Other Ag Crops	0.45	
Specialty Low *	0.31	
Other Hay	0.24	0.06
Pasture Manure	0.23	0.06
Legume or Mix	0.17	0.02
Ag Open	0.10	0.01



* BPJ estimate by analogies to other crops

Figure 2. Nitrogen Load Ratio Relative to Corn (or Sorghum) Grain Without Manure

Additional rates from Chapter 2 table 2.7:

- **Ag**
- Full Season Soybean 27.7
- Other Agronomic 17.6
- Specialty Low 12.1
- Other Hay 12.3
- Pasture 11.8
- **Non - Ag**
- MS4 Construction 26.80
- MS4 Tree Canopy over Turfgrass 8.53
- Non-Regulated Turf Grass 11.19
- Harvested Forest 11.88
- Other Hay 12.3

A new proposal

- We should have Loading Ratios for managed hay/pasture that result in lower Loading Rates then traditional row crops
  - Other Agronomic Crops
  - Specialty Low Crops

What are these row crops?

LoadSource	CropName
Other Agronomic Crops	tobacco
Other Agronomic Crops	cropland idle or used for cover crops or soil improvement but not harvested and not pastured or grazed
Other Agronomic Crops	peanuts for nuts
Other Agronomic Crops	dry edible beans excluding limas
Other Agronomic Crops	cotton
Other Agronomic Crops	sod
Other Agronomic Crops	sweet corn
Other Agronomic Crops	cropland in cultivated summer fallow
Specialty Crop Low	peas - green southern (cowpeas)
Specialty Crop Low	aquatic plants
Specialty Crop Low	nursery stock
Specialty Crop Low	berries - all
Specialty Crop Low	short-rotation woody crops
Specialty Crop Low	snap beans
Specialty Crop Low	sunflower seed - oil varieties
Specialty Crop Low	green lima beans
Specialty Crop Low	sunflower seed - non-oil varieties
Specialty Crop Low	asparagus
Specialty Crop Low	land in orchards
Specialty Crop Low	peas - chinese (sugar and snow)
Specialty Crop Low	peas - green (excluding southern)
Specialty Crop Low	cut christmas trees production

How can we get there?

Applications will not always equal high end of Land Grant University (LGU) Recommendations (some studies cited used **above** LGU recommend rate)

Most states will probably apply to 80% of this rate

We can take 80% of the high application values from the study and calculate the ratio

VT Recommendations for Pasture and Hay

Other Hay – 120-200 lbs N

Pasture – 60-75 lbs N

- Other Hay: 120/200 = 60 %
- Pasture: 60/75 = 80%
  - Bound to Pasture as a reference

Fescue, Tall - Perennial (*Festuca arundinacea*)	
Description	Long-lived, tufted, deep-rooted; noted for early spring and late fall growth; leaves are dark green, shiny, and barbed along the edges, making them feel rough; leaves rolled in bud; very short ligule; sheath reddish pink belowground. Most existing tall fescue stands are infected with a fungal endophyte that induces fescue toxicosis in cattle.
Varieties	Endophyte-free varieties are somewhat less hardy than endophyte-infected tall fescue, requiring more careful management. Modern endophyte-free varieties are stronger than earlier varieties. Endophyte-enhanced varieties have potential for greater adoption.
Uses	Pasture, hay, and turf. Excellent when seeded at high rates for turf. Widely used for winter grazing.
Weight per bushel	24 lbs
Seeds per pound	220,000
Germinating time	14 days
Fertilizer	Establishment: 40 lbs N, 120-140 lbs P_2O_5, and 120-140 lbs K_2O at medium soil test levels. Pasture topdressing 30 lbs P_2O_5 and 30-60 lbs K_2O annually, or 40-125 lbs P_2O_5 and K_2O every 3-4 years. (For winter grazing, apply 60-75 lbs N in mid-August.) Hay topdressing: 120-200 lbs N, 40-90 lbs P_2O_5, and 85-185 lbs K_2O. For turf, see Turf section.
pH range	5.6-6.2
Soil adaptation	Adapted to practically all tillable soils. Tolerant to both dry and wet soils.
Time of planting	Early fall or spring at 15-25 lbs when seeded alone, and 6-12 lbs in mixtures for pasture; 4-6 lbs per 1,000 sq ft for turf.
Harvesting (hay)	First cut when heads begin to emerge. **Stems and seedheads of endophyte-infected fescue are highly toxic.** Approximate yields 2-6 tons hay/A.
Harvesting (seed)	When the field takes on a yellowish-brown cast and heads droop.
Harvesting (pasture)	Tolerant of continuous stocking. With rotational stocking, turn in at 8 inches; remove cattle at 2-3 inches. Keep vegetative to reduce potential problems with endophyte. **Remove pregnant mares from endophyte-infected fescue during last 3 months of gestation.**

Unless we get feedback, we will use the following:

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WV	Based on reported Core N NM acres	Based on reported Core N NM acres	120	40	60	30	TEST DATA (Provided by VA DCR)

Reprocessing: 80% of LGU application

Variable	low application state (unmanaged)	high application state (managed)	80% high	Ratio (high/low)	z score
no3 kg ha	0.41	0.74	0.592	1.44	-0.46
No3 kg ha yr	29	49	39.2	1.35	-0.57
No3 kg ha yr	31	54	43.2	1.39	-0.52
No3 kg ha yr	42	65	52	1.24	-0.70
No3-N kg ha yr	1.6	4.3	3.44	2.15	0.35
No3 Losses kg/ha/yr	2.36	10.34	8.272	3.51	1.90

Proposed Pasture Land Use Loading Rate Ratio = **1.52**

Current Progress

- We should adopt the following Loading Rate Ratios:
  - Managed Pasture = 1.52
  - Managed Hay = 1.56
    - 1.52+0.04
    - existing Hay rate is 0.04 higher than existing pasture

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Pasture	Ag Open Space	0.43	5.1
	Legume Hay	0.74	8.7
	Other Hay	1.04	12.3
	Managed Hay	1.56	-
	Pasture: **Reference Land Use**	1	11.8
	Managed Pasture	1.52	-

Example Calculations:

- Managed Hay example math:
- 11.8lbs/acre/yr * 1.56 = 18.4 lbs/acre/yr

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Land class	Land Use	Loading Rate Ratio	Loading Rate (pounds per acre per year)
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	Pasture: **Reference Land Use**	1	11.8
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Example Calculations:

- Managed Pasture example math:
- 11.8lbs/acre/yr * 1.52* = 17.9 lbs/acre/yr

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	Managed Hay	1.56	18.4
	Pasture: **Reference Land Use**	1	11.8
	Managed Pasture	1.52	17.9

Questions?

Decision Proposal

- We should adopt the following Land Use Loading Rate Ratios:
  - Managed Pasture (High Application) = 1.52
  - Managed Hay (High Application) =1.56