METHOD FOR ESTIMATING ATTENUATION OF NUTRIENTS FROM SEPTIC SYSTEMS (MEANSS)

MEANSS wastewater treatment system nitrate loading matrix for groundwater mixing zones

PERCENT NITRATE LOAD REDUCTION [(1)]	Hydrologic soil group (HSG) at absorption system	Groundwater mixing zone length (ft)
	(independent criterion 1)	(independent criterion 2)
0	A	<100
10	B	100 - 500
20	**C**	>500
30	D	

Notes:
The total nitrate reduction is the sum of the individual reductions for both criteria in the table.

MEANSS wastewater treatment system nitrate loading matrix for surface water analysis

PERCENT NITRATE LOAD REDUCTION [(1)]	Hydrologic soil group (HSG) at absorption system	Hydrologic soil group (HSG) adjacent to receiving surface water	Distance to receiving surface water (ft)
	(independent criterion 1)	(independent criterion 2)	(independent criterion 3)
0	A	A	<100
10	B		100 - 500
20	C	B	>500
30	D	C	
50		D	

Notes:
The total nitrate reduction is the sum of the individual reductions for each of the three criteria in the table.

MEANSS EXAMPLE 1:

1. Nitrate Sensitivity Analysis

Hydrological soil group at absorption system = C

Groundwater Mixing Zone length(ft) = 100

MEANSS wastewater treatment system nitrate loading matrix for groundwater mixing zones

PERCENT NITRATE LOAD REDUCTION (1)	Hydrologic soil group (HSG) at absorption system	Groundwater mixing zone length (ft)
	(independent criterion 1)	(independent criterion 2)
0	A	<100
10	B	100 - 500
20	C	>500
30	D	

Percent Nitrate Load Reduction = Reduction from HSG at absorption system + Reduction from Ground water mixing zone length (ft)

= 20% + 10%

= 30%

2. Adjacent to Surface Water/Trigger Value Calculation

- Hydrological soil group at absorption system = C
- Hydrological soil group adjacent to receiving surface water = B/D, use B (The top number describes the soils below 2.0 feet natural grade)
- Distance to receiving surface water (ft) = 330’

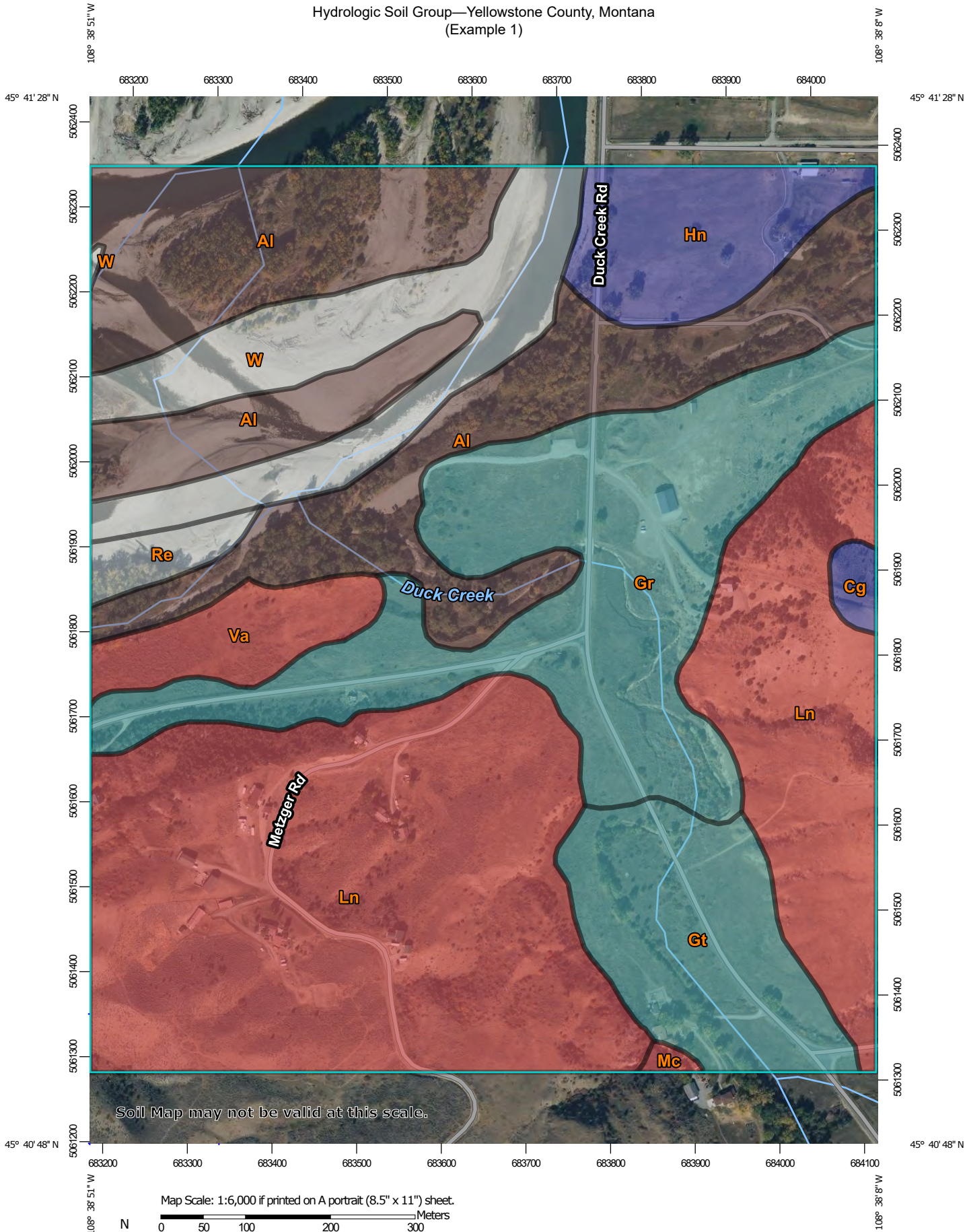
MEANSS wastewater treatment system nitrate loading matrix for surface water analysis

PERCENT NITRATE LOAD REDUCTION (1)	Hydrologic soil group (HSG) at absorption system	Hydrologic soil group (HSG) adjacent to receiving surface water	Distance to receiving surface water (ft)
	(independent criterion 1)	(independent criterion 2)	(independent criterion 3)
0	A	A	<100
10	B		100 - 500
20	C	B	>500
30	D	C	
50		D	

Percent Nitrate Load Reduction = Reduction from HSG at absorption system +Reduction from HSG adjacent to receiving surface water +Reduction from Distance to receiving surface water (ft)

= 20% + 20% + 10%

Hydrologic Soil Group—Yellowstone County, Montana
(Example 1)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Lines

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Points

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Yellowstone County, Montana
Survey Area Data: Version 21, Aug 25, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 22, 2021—Oct 4, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Al	Alluvial land, mixed	B/D	53.8	21.9%
Cg	Clapper gravelly loam, 7 to 15 percent slopes	B	1.2	0.5%
Gr	Grail clay loam, 2 to 4 percent slopes	C	42.6	17.3%
Gt	Grail soils, 2 to 15 percent slopes	C	17.8	7.3%
Hn	Haverson loam, gravelly variant, 0 to 1 percent slopes	B	12.0	4.9%
Ln	Lismas clay, 15 to 35 percent slopes	D	87.1	35.5%
Mc	Maginnis channery clay loam, 15 to 35 percent slopes	D	0.4	0.2%
Re	Riverwash		2.7	1.1%
Va	Vananda silty clay, 0 to 1 percent slopes	D	7.0	2.9%
W	Water		20.7	8.4%
Totals for Area of Interest			**245.5**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

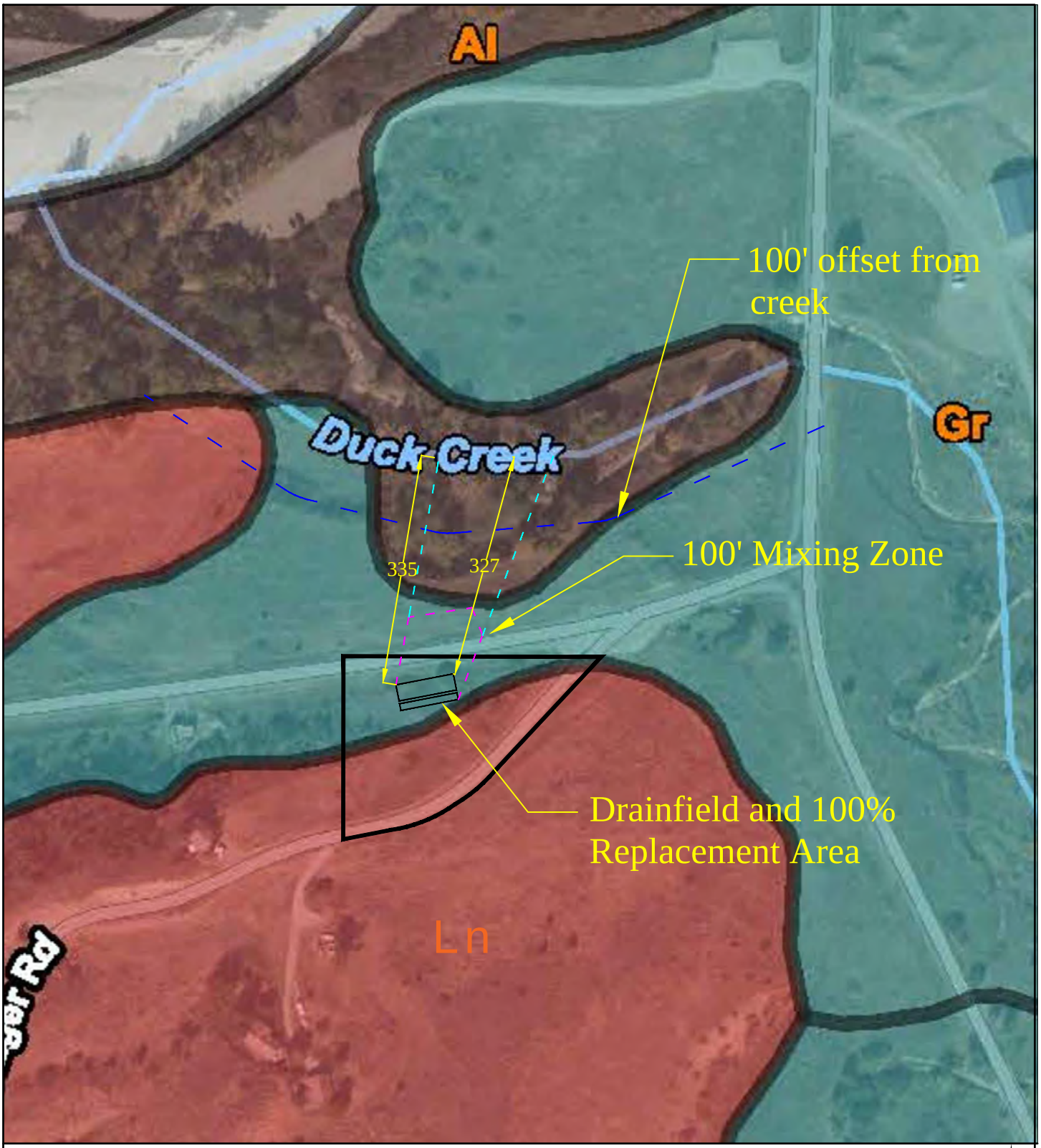
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



MAP UNIT SYMBOL	MAP UNIT NAME	RATING
Al	Alluvial land, mixed	B/D
Gr	Grail clay loam, 2 to 4 percent slopes	C
Ln	Lismas clay, 15 to 35 percent slopes	D

NORTH

Scale 1"=200'

Example 1: MEANSS Model
Hydrologic Soil Groups

DEQ
Montana Department of Environmental Quality

Appendix E

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY

NITRATE SENSITIVITY ANALYSIS

SITE NAME: Example #1
COUNTY:
LOT #:
NOTES:

24mg/L x (1-0.3) =16.8 mg/L

VARIABLES	DESCRIPTION	VALUE	UNITS
K	Hydraulic Conductivity	28.52	ft/day
I	Hydraulic Gradient	0.0397	ft/ft
D	Mixing Zone Thickness (usually constant)	15.0	ft
L	Mixing Zone Length (see ARM 17.30.517(1)(d)(viii)	100	ft
Y	Width of Drainfield Perpendicular to Ground Water Flow	85	ft
Ng	Background Nitrate (as Nitrogen) Concentration	5.93	mg/L
Nr	Nitrate (as Nitrogen) Concentration in Precipitation (usually constant)	1.0	mg/L
Ne	Nitrate (as Nitrogen) Concentration in Effluent	16.80	mg/L
#l	Number of Single Family Homes on the Drainfield	1.0	
Ql	Quantity of Effluent per Single Family Home	26.70	ft3/day
P	Precipitation	15.0	in/year
V	Percent of Precipitation Recharging Ground Water (usually constant)	0.20	
EQUATIONS			
W	Width of Mixing Zone Perpendicular to Ground Water Flow = (0.175)(L)+(Y)	102.50	ft
Am	Cross Sectional Area of Aquifer Mixing Zone = (D)(W)	1537.50	ft2
As	Surface Area of Mixing Zone = (L)(W)	10250.00	ft2
Qg	Ground Water Flow Rate = (K)(I)(Am)	1740.83	ft3/day
Qr	Recharge Flow Rate = (As)(P/12/365)(V)	7.02	ft3/day
Qe	Effluent Flow Rate = (#l)(Ql)	26.70	ft3/day
SOLUTION			
Nt	**Nitrate (as Nitrogen) Concentration at End of Mixing Zon =((Ng)(Qg)+(Nr)(Qr)+(Ne)(Qe)) / ((Qg)+(Qr)+(Qe))**	**6.07**	**mg/L**

BY:
DATE: July 18, 2024

REV. 03/2005

MEANSS EXAMPLE 1

Appendix Q

MEANSS REDUCTION 24mg/L x (1-.5) =12.0 mg/L

TRIGGER VALUE CALCULATION FOR ADJACENT TO SURFACE WATER DILUTION ANALYSIS

"An analysis of the effect of the proposed drainfield system on the quality of any adjacent surface water is required by ARM 17.36.312 and 17.30.715(1c). The increase in the nutrient concentration in the surface water cannot exceed the trigger value (T.V. of 0.01 mg/L nitrate and 0.001 mg/L phosphorous as set forth in Circular DEQ 7."

DILUTION EQUATION: $\frac{(QD)(CD) + (QL)(CL)}{QD + QL} < T.V. = non\text{-}significant$

Note: Effluent flow rate (QD) must be multiplied by the number of drainfields in the subdivision.

NITRATE CALCULATION:

	1.00		Number of drainfields in subdivision
QD =	26.70	ft^3/d	Effluent flow rate from drainfield in cubic feet per day (commonly 200 gpd or 26.7 ft^3/d for a 2 - 5 bedroom home)
CD =	12.00	mg/L	Nitrate concentration in mg/L (50 mg/L nitrate-N for standard drainfield, 24 mg/L for Level 2 wastewater treatment system)
QL =	0.65	ft^3/s	Flow rate in ft^3/s into (or out of) surface water determined by stream gauge (usually the 14-day, 5-year low flow or 14Q5)
CL =	0.00	mg/L	Nitrate concentration (in mg/L) in surface water; can typically assume zero since increase, not total, is important

0.0057200 mg/L = final result, must be < 0.01 mg/L to be considered nonsignificant nitrate increase

PHOSPHOROUS CALCULATION:

	1.00		Number of drainfields in subdivision
QD =	26.7	ft^3/d	Effluent flow rate from drainfield in cubic feet per day, (commonly 200 gpd or 26.7 ft^3/d for a 2 - 5 bedroom home)
CD =	10.6	mg/L	Phosphorous concentration in mg/L (commonly 10.6 mg/L) in effluent
QL =	0.65	ft^3/s	Flow rate in ft^3/s into (or out of) surface water determined by stream gauge (usually the 14-day, 5-year low flow or 14Q5)
CL =	0	mg/L	Phosphorous concentration (in mg/L) in surface water; can typically assume zero since increase, not total, is important

0.0050527 mg/L = final result, must be < 0.001 mg/L to be considered nonsignificant for phosphorous increase

= 50%

MEANSS EXAMPLE 2:

1. Nitrate Sensitivity Analysis

Hydrological soil group at PRIMARY absorption system (Replacement Area for this example is all within HSG 209 which has a 10% Reduction) Therefore, the Primary System is the most conservative.

TABLE 1: HYDROLOGIC SOIL GROUP AT PRIMARY ABSORPTION SYSTEM			
MAP UNIT	**RATING**	**PERCENT WWTS WITHIN MAP UNIT**	**WEIGHTED PERCENT REDUCTION**
61	B	$1700ft^2/4000ft^2$ = 42.5%	(10*0.425) = 4.25%
159	A	$1234ft^2/4000ft^2$ = 30.9%	(0*0.30.9) = 0%
209	B	$1066ft^2/4000ft^2$= 26.6%	(10*0.26.6) = 2.66%
		TOTAL	**6.91%**

Groundwater Mixing Zone length(ft) = 100

Percent Nitrate Load Reduction = Reduction from HSG at absorption system + Reduction from Ground water mixing zone length (ft)

= 6.91% + 10%

= 16.91%

2. Adjacent to Surface Water/Trigger Value Calculation

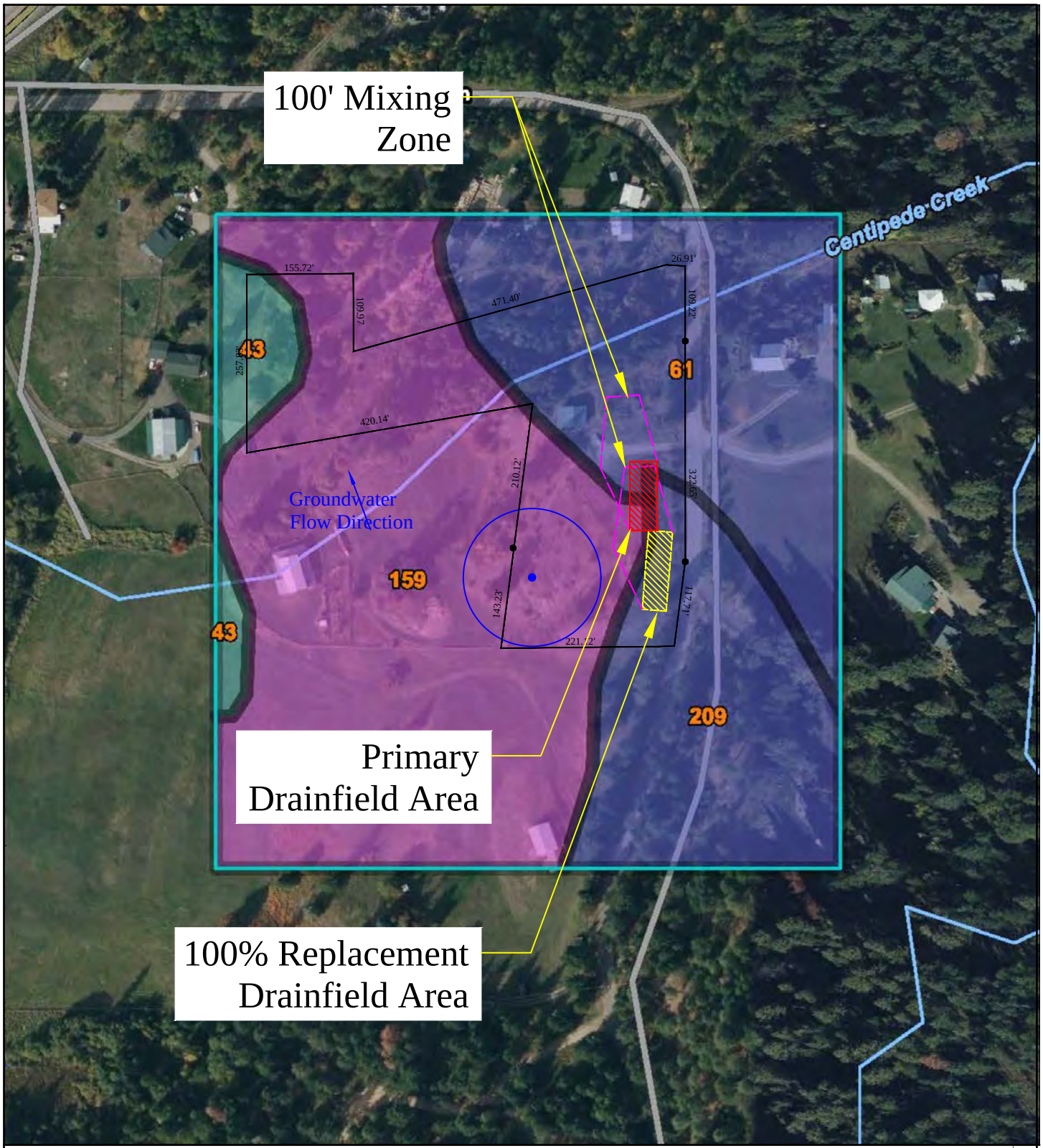
- Hydrological soil group at absorption system = See Table 1.
- Hydrological soil group adjacent to receiving surface water = B
- Distance to receiving surface water (ft) = 172’

Percent Nitrate Load Reduction = Reduction from HSG at absorption system +Reduction from HSG adjacent to receiving surface water +Reduction from Distance to receiving surface water (ft)

6.9% + 10%

= ~~16.9% + 20%~~ + 10%

= ~~46.9%~~ **26.9%**



MAP UNIT	MAP UNIT NAME	RATING
43	Dubay silt loam, 2 to 6 percent slopes	C
61	Flott very gravelly loam, dry, 30 to 60 percent slopes	B
159	Selon sandy loam, 8 to 15 percent slopes	A
209	Wildgen gravelly loam, 8 to 30 percent slopes, lake effect	B

NORTH

Scale 1"=200'

Example 2: MEANSS Model
Hydrologic Soil Groups

DEQ
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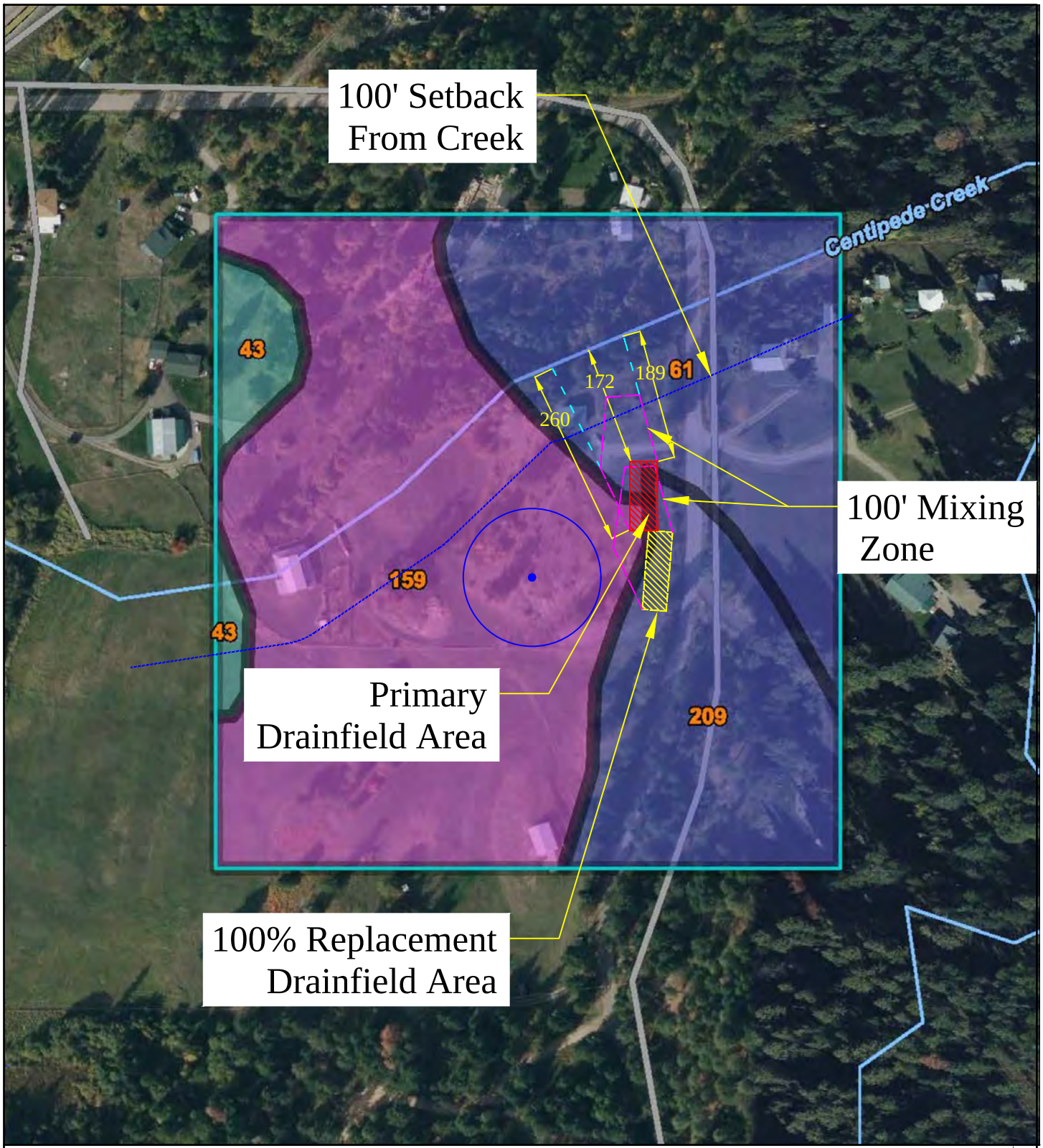


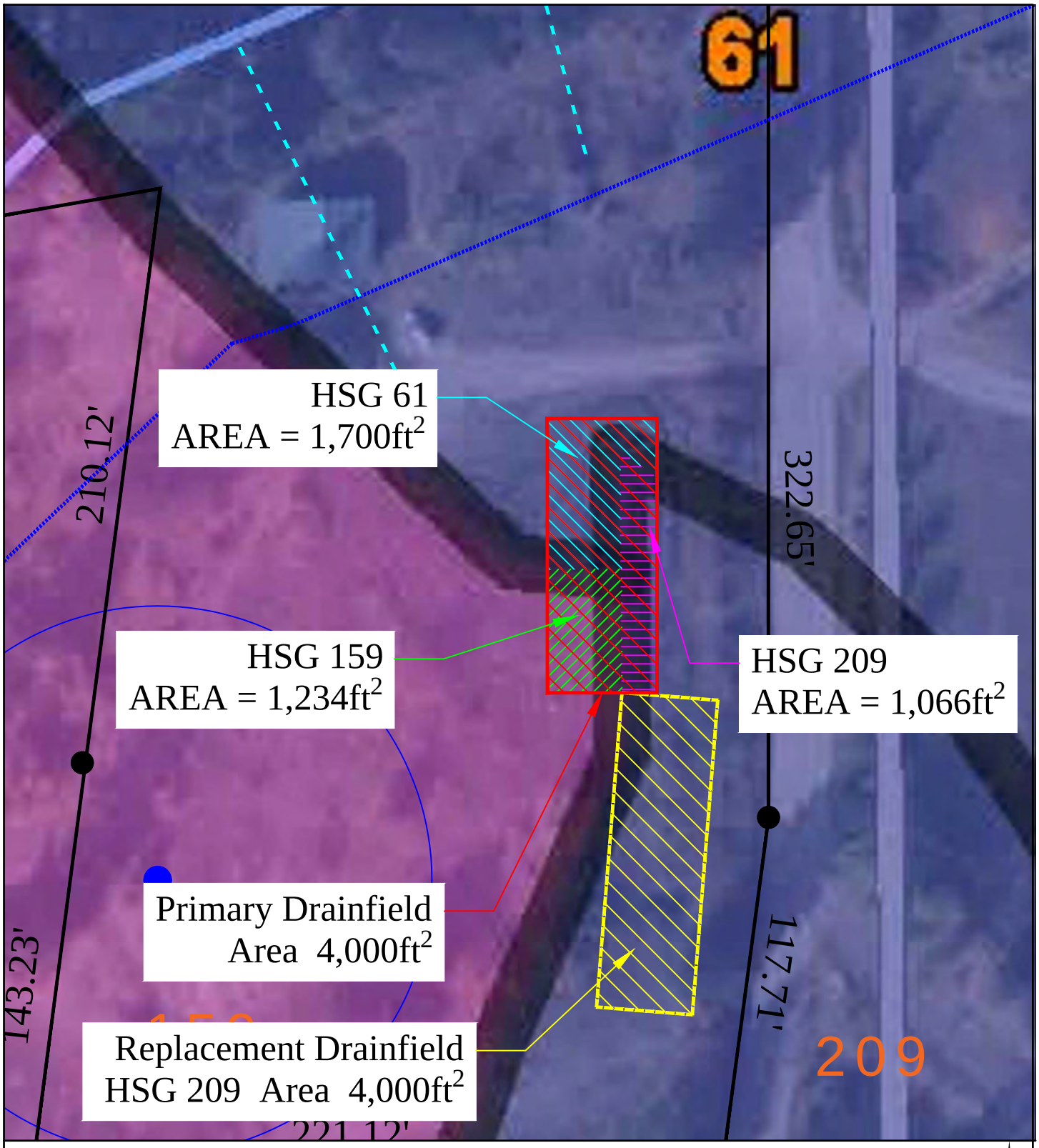
MAP UNIT	MAP UNIT NAME	RATING
43	Dubay silt loam, 2 to 6 percent slopes	C
61	Flott very gravelly loam, dry, 30 to 60 percent slopes	B
159	Selon sandy loam, 8 to 15 percent slopes	A
209	Wildgen gravelly loam, 8 to 30 percent slopes, lake effect	B

NORTH

Scale 1"=200'

Example 2: MEANSS Model
Hydrologic Soil Groups

DEQ
Montana Department of Environmental Quality



MAP UNIT	MAP UNIT NAME	RATING
43	Dubay silt loam, 2 to 6 percent slopes	C
61	Flott very gravelly loam, dry, 30 to 60 percent slopes	B
159	Selon sandy loam, 8 to 15 percent slopes	A
209	Wildgen gravelly loam, 8 to 30 percent slopes, lake effect	B

NORTH

Scale 1"=50'

Example 2: MEANSS Model
Areas of WWTS in Hydrologic Soil Groups

DEQ
Montana Department of Environmental Quality

Appendix E

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY

NITRATE SENSITIVITY ANALYSIS

SITE NAME: Example #2
COUNTY:
LOT #:
NOTES:

50mg/L x (1-0.1691) =41.5mg/L

VARIABLES	DESCRIPTION	VALUE	UNITS
K	Hydraulic Conductivity	118.30	ft/day
I	Hydraulic Gradient	0.0180	ft/ft
D	Mixing Zone Thickness (usually constant)	15.0	ft
L	Mixing Zone Length (see ARM 17.30.517(1)(d)(viii)	100	ft
Y	Width of Drainfield Perpendicular to Ground Water Flow	78	ft
Ng	Background Nitrate (as Nitrogen) Concentration	0.18	mg/L
Nr	Nitrate (as Nitrogen) Concentration in Precipitation (usually constant)	1.0	mg/L
Ne	Nitrate (as Nitrogen) Concentration in Effluent	41.5	mg/L
#l	Number of Single Family Homes on the Drainfield	1.0	
Ql	Quantity of Effluent per Single Family Home	26.70	ft3/day
P	Precipitation	15.0	in/year
V	Percent of Precipitation Recharging Ground Water (usually constant)	0.20	
EQUATIONS			
W	Width of Mixing Zone Perpendicular to Ground Water Flow = (0.175)(L)+(Y)	95.50	ft
Am	Cross Sectional Area of Aquifer Mixing Zone = (D)(W)	1432.50	ft2
As	Surface Area of Mixing Zone = (L)(W)	9550.00	ft2
Qg	Ground Water Flow Rate = (K)(I)(Am)	3050.37	ft3/day
Qr	Recharge Flow Rate = (As)(P/12/365)(V)	6.54	ft3/day
Qe	Effluent Flow Rate = (#l)(Ql)	26.70	ft3/day
SOLUTION			
Nt	**Nitrate (as Nitrogen) Concentration at End of Mixing Zon =((Ng)(Qg)+(Nr)(Qr)+(Ne)(Qe)) / ((Qg)+(Qr)+(Qe))**	**0.54**	**mg/L**

BY:
DATE: July 18, 2024

REV. 03/2005

MEANSS EXAMPLE 2

Appendix Q

MEANSS REDUCTION

~~50mg/L x (1-.469) =26.55 mg/L~~ 50mg/L x (1-0.269)= 36.55 mg/L

~~24mg/L x (1-.469) =12.744 mg/L~~ 24mg/L x (1-0.269)= 17.54 mg/L

TRIGGER VALUE CALCULATION FOR ADJACENT TO SURFACE WATER DILUTION ANALYSIS

"An analysis of the effect of the proposed drainfield system on the quality of any adjacent surface water is required by ARM 17.36.312 and 17.30.715(1c). The increase in the nutrient concentration in the surface water cannot exceed the trigger value (T.V. of 0.01 mg/L nitrate and 0.001 mg/L phosphorous as set forth in Circular DEQ 7."

DILUTION EQUATION: $\frac{(QD)(CD) + (QL)(CL)}{QD + QL} < T.V. = \text{non-significant}$

Note: Effluent flow rate (QD) must be multiplied by the number of drainfields in the subdivision.

NITRATE CALCULATION:

		1.00		Number of drainfields in subdivision
QD =		26.70	ft^3/d	Effluent flow rate from drainfield in cubic feet per day (commonly 200 gpd or 26.7 ft^3/d for a 2 - 5 bedroom home)
CD =	17.54	~~12.74~~	mg/L	Nitrate concentration in mg/L (50 mg/L nitrate-N for standard drainfield, 24 mg/L for Level 2 wastewater treatment system)
QL =		0.61	ft^3/s	Flow rate in ft^3/s into (or out of) surface water determined by stream gauge (usually the 14-day, 5-year low flow or 14Q5)
CL =		0.00	mg/L	Nitrate concentration (in mg/L) in surface water; can typically assume zero since increase, not total, is important

~~0.0064529~~ **mg/L = final result, must be < 0.01 mg/L to be considered nonsignificant nitrate increase**

0.008813

PHOSPHOROUS CALCULATION:

	1.00		Number of drainfields in subdivision
QD =	26.7	ft^3/d	Effluent flow rate from drainfield in cubic feet per day, (commonly 200 gpd or 26.7 ft^3/d for a 2 - 5 bedroom home)
CD =	10.6	mg/L	Phosphorous concentration in mg/L (commonly 10.6 mg/L) in effluent
QL =	0.61	ft^3/s	Flow rate in ft^3/s into (or out of) surface water determined by stream gauge (usually the 14-day, 5-year low flow or 14Q5)
CL =	0	mg/L	Phosphorous concentration (in mg/L) in surface water; can typically assume zero since increase, not total, is important

0.0053673 mg/L = final result, must be < 0.001 mg/L to be considered nonsignificant for phosphorous increase