

# Estimating Carrying Capacity of Cool-Season Pastures in Kentucky using Web Soil Survey

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The stocking rate of livestock on a pasture is known to have a significant impact on both forage productivity and financial profitability of an operation. Too many animals in a field results in overgrazing and the need to provide costly supplemental feed; too few animals results in underutilized forages and therefore lost income. While many factors influence how many animals a farm can carry, soil type has a major influence and should be considered when purchasing, leasing, planning, or managing livestock on pastures.

*Carrying capacity* is defined as the number of animals that the environment can sustain indefinitely given the food, habitat, water, and other necessities available in the environment. For livestock, carrying capacity refers to how many animals a farm or pasture can carry throughout the year without negative environmental impacts. Carrying capacity is based on

the soil type and slope of the land, characteristics that take thousands of years or more to change. The productive capacity of the land will dictate what that land is most useful for.

## National Cooperative Soil Survey

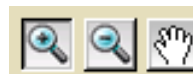
The National Cooperative Soil Survey (NCSS) program began in 1896 as an attempt to survey and map soils in the United States. The program started small, surveying 2.8 million acres in Maryland, Connecticut, Utah, and New Mexico. Today, soil survey data is available on the internet for the entire country as the Web Soil Survey (WSS) and is maintained by the United States Department of Agriculture Natural Resource Conservation Service (USDA-NRCS).

## Using Web Soil Survey

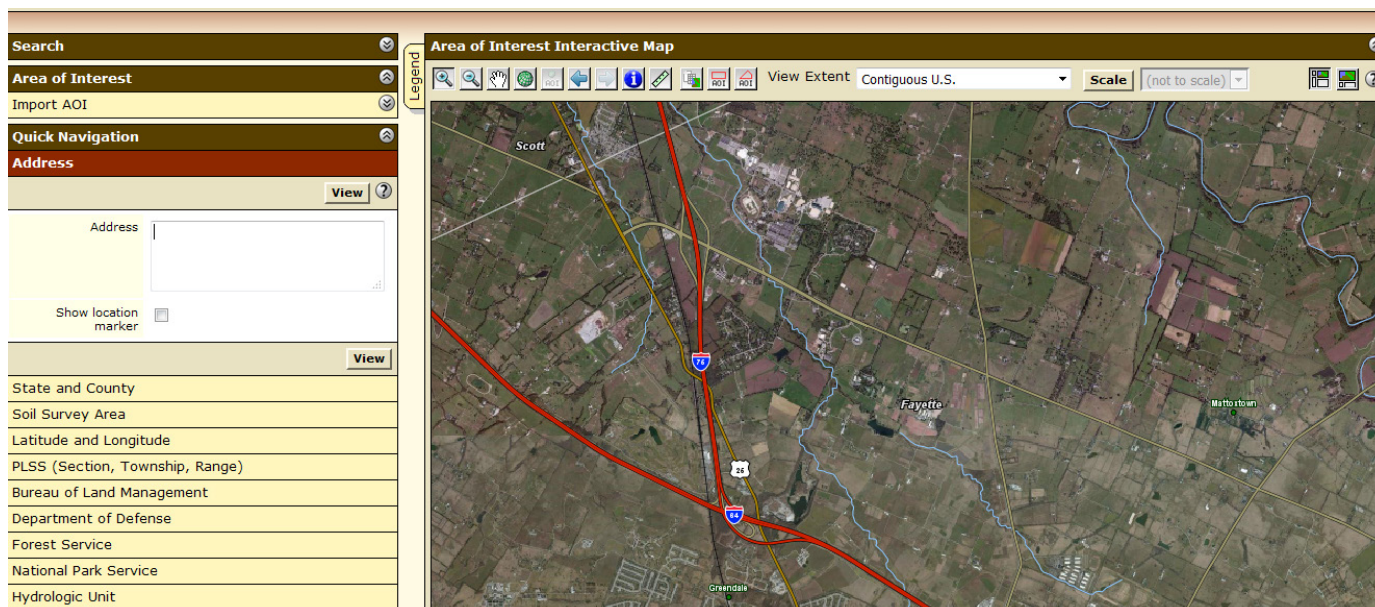
Web Soil Survey has a tremendous wealth of information both in and out of agriculture. This publication will focus

on using Web Soil Survey to calculate the livestock carrying capacity on cool season pastures.

1. Navigate to the Web Soil Survey homepage at <http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>. Click the green START WSS button.
2. Enter the address of the property in question and click VIEW to display the land area. (capture 1). The area of interest can also be located by other means such as latitude and longitude.
3. Find the property by using the tools at the top of the satellite photo. Use the + magnifying glass to zoom in, the - magnifying glass to zoom out, and the hand tool to move the map left, right, up or down.



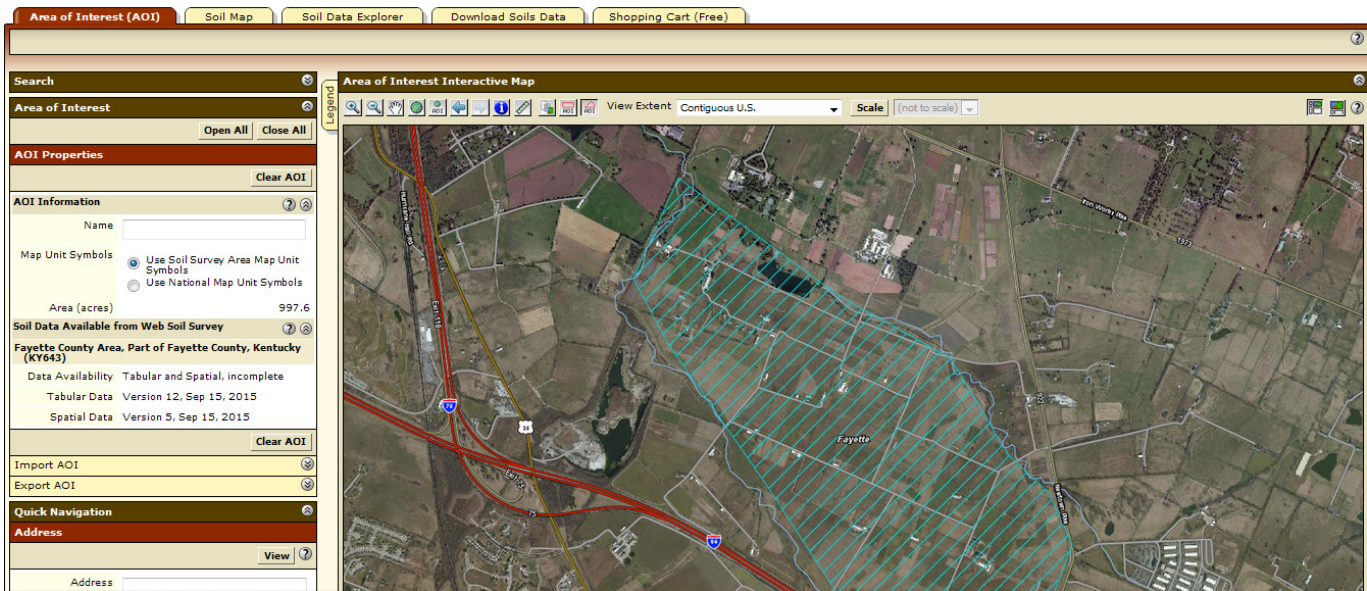
**Capture 1.** Find the property in question by entering the address, latitude and longitude or other criteria.



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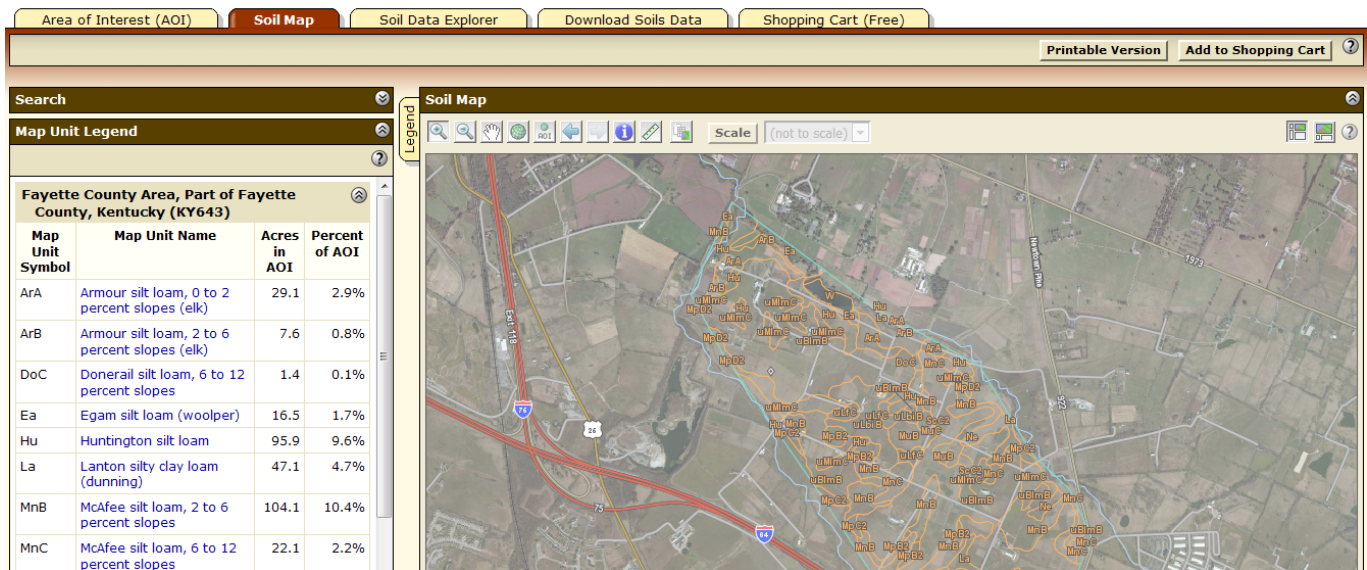
- Outline the area of interest (AOI) using the AOI rectangle or polygon buttons on the right. Double click on the last point to complete the area. When finished, the total acres selected will appear on the left (capture 2).
- To view the soil map for the selected area, click the Soil Map tab at the very top (above the map). Click Printable Version on the right (above the map). Click Printable Version on the right to view these documents in a PDF form. (Your browser pop-up blockers must be disabled) (capture 3).
- To retrieve the pasture ratings, click Soil Data Explorer, then the dropdown arrows for Vegetative productivity. Click Yields of Non-Irrigated Crops (Map Unit) and select Pasture from the dropdown menu under Basic Options (capture 4). Finally, click View Rating. Click Printable Version in the right corner to view as a PDF (capture 5).

Capture 2. Select the Area Of Interest (AOI)



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Capture 3. View the soil map for the Area Of Interest



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**Capture 4.** In the Soil Data Explorer tab, select “pasture” to view the pasture ratings for the Area Of Interest

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## Interpreting Soil Ratings

Soil ratings will range from 1 to 9.5 animal unit months (AUM). AUM is how many months one acre of land can carry one 1,000 lb animal (1,000 lbs = 1 animal unit). Acres per animal (A/A) is an easier unit to work with and easy to calculate. To convert the AUM to animals per acre you must first calculate an animal adjustment factor by dividing the average weight of your animals by one thousand, which provides the number of animal units per animal. Next, divide the AUM rating provided by Web Soil Survey by the animal adjustment factor. Finally, divide 12 (for months in a year) by the adjusted AUM rating to convert to acres per animal. The following example shows the steps to calculate acres per animal for sheep weighing an average of 300 lb on a field with an AUM rating of 9.5.

### Step 1. Animal Adjustment Factor

$$= \text{Average Animal Weight} \div 1,000$$

$$= 300 \div 1,000$$

$$= 0.3 \text{ animal units per animal}$$

### Step 2. Adjusted AUM

$$= \text{AUM Rating} \div \text{Animal Adjustment Factor}$$

$$= 9.5 \div 0.3$$

$$= 31.7 \text{ animal-months per acre}$$

### Step 3. Acres per animal

$$= 12 \div \text{Adjusted AUM}$$

$$= 12 \div 31.7 = 0.4 \text{ acres per animal - year}$$

**Capture 5.** The Soil Map will now be color coded to illustrate pasture ratings

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In the previous example we calculated that 0.4 acres would be required per 300 lb sheep to graze for one year on a field with an AUM rating of 9.5. The table below provides example calculations for two different fields, one with an AUM rating of 9.5 and one with a rating of 6.0, for three different sized animals.

Calculations from Table 1 indicate that 0.4 acres would be needed for sheep on well-rated soils (9.5) and slightly more for poorer soils. Two acres would be needed for a 1,000 lb cow on low rated soil and almost 2.5 acres for a 1,200 lb horse on similar land.

**Table 1. Example Acres per Animal needed for livestock on high and low AUM rated pastures.**

Animal	Size (lbs/animal)	AUM Rating	Acres per Animal
Sheep	300	9.5	0.4
Sheep	300	6.0	0.6
Cow	1000	9.5	1.3
Cow	1000	6.0	2.0
Horse	1200	9.5	1.5
Horse	1200	6.0	2.4

### Comparing Productive Capacities

For the purposes of this publication, two tracts of land were selected for comparison. Farm A contains just over 1,000 acres located in Fayette County and is currently used for horse pasture. Farm B is approximately 950 acres in Owen County and is currently used for beef production.

Farm A is dominated by Bluegrass-Maury silt loam with a 2 to 6 percent slope (uBlmB) and has a rating of 9.5. This is one of the highest ratings in Kentucky for pasture and could sustain a 1,000 lb cow on 1.3 acres or a 1,200 lb horse on 1.5 acres. Another soil type, Maury-Bluegrass silt loam with a 6 to 12 percent slope is similar but has a slightly lower rating of 9, mainly due to the increased slope. Water will run off sloped land more

quickly, increasing erosion and decreasing water available for pasture plants.

Farm B is dominated by Eden flaggy silty clay with 20 to 30 percent slope and is severely eroded (Efe3) with a rating of 4.8. Farm B will need to allocate 2.5 acres for a 1,000 lb cow or 3 acres for a 1,200 lb horse. Although this soil may not have the highest rating, it can still be productive and profitable when managed correctly and not over-grazed.

### Uses and Limitations

When rating soil types, Web Soil Survey makes a few key assumptions. The rating assumes good pasture management. Good pasture management includes maintaining good grass cover, managing weeds, rotational grazing, and maintaining soil fertility. Web Soil Survey also assumes average weather conditions. Events such as a late spring, hard winter, or dry summer will all impact the carrying capacity. Keep in mind that these are yearlong averages; in most years there will be excessive pasture growth in the spring that may not all be utilized, and hay feeding will be needed in the winter. Year-round grazing is possible in some areas but requires intensive management. Finally, most farms will also have roads, barns, and common areas that are not included in pasture; remember to account for these non-productive areas when determining the total carrying capacity of a farm.

Understanding the soil types available on a piece of property is valuable in many ways, especially when considering the production potential of a piece of land before renting or purchasing. Carrying capacity can be used to estimate the profitability of the land, and ultimately its value, based on the number of animals it might carry. In addition, understanding soil properties can help develop a strategy to locate buildings, roads, and fencing on marginal soils and utilize the best soils for pasture. Fundamentally, a clear understanding of your soils and how they are located will help you to better manage your land base.

To maximize the production potential of your soils you should maintain optimum soil fertility by collecting soil samples routinely and following laboratory fertilizer recommendations. Since permanent pastures benefit from recycled nutrients in manure and urine, you only need to soil sample pastures every three years. Cutting hay from pastures removes much more nutrients, therefore hay fields should be soil sampled every year. Multiple soil cores (10 to 20) should be taken with a soil probe and mixed together to form one sample for analysis at the lab. Soil samples should represent the top 3 to 4 inches of soil in untilled fields such as pastures. Generally, each sample submitted should represent no more than 20 acres. Separate samples should be submitted for areas within a pasture that have major differences in soil properties or historic management (for example if there was previously a tobacco patch within a pasture). Finally, fertilizer and lime should be applied according to laboratory recommendations. More information on fertilizer and lime recommendations can be found in the University of Kentucky Cooperative Extension Service publication *Lime and Nutrient Recommendations* (AGR-1) at <http://www2.ca.uky.edu/agc/pubs/agr/agr1/agr1.pdf>.

### Summary

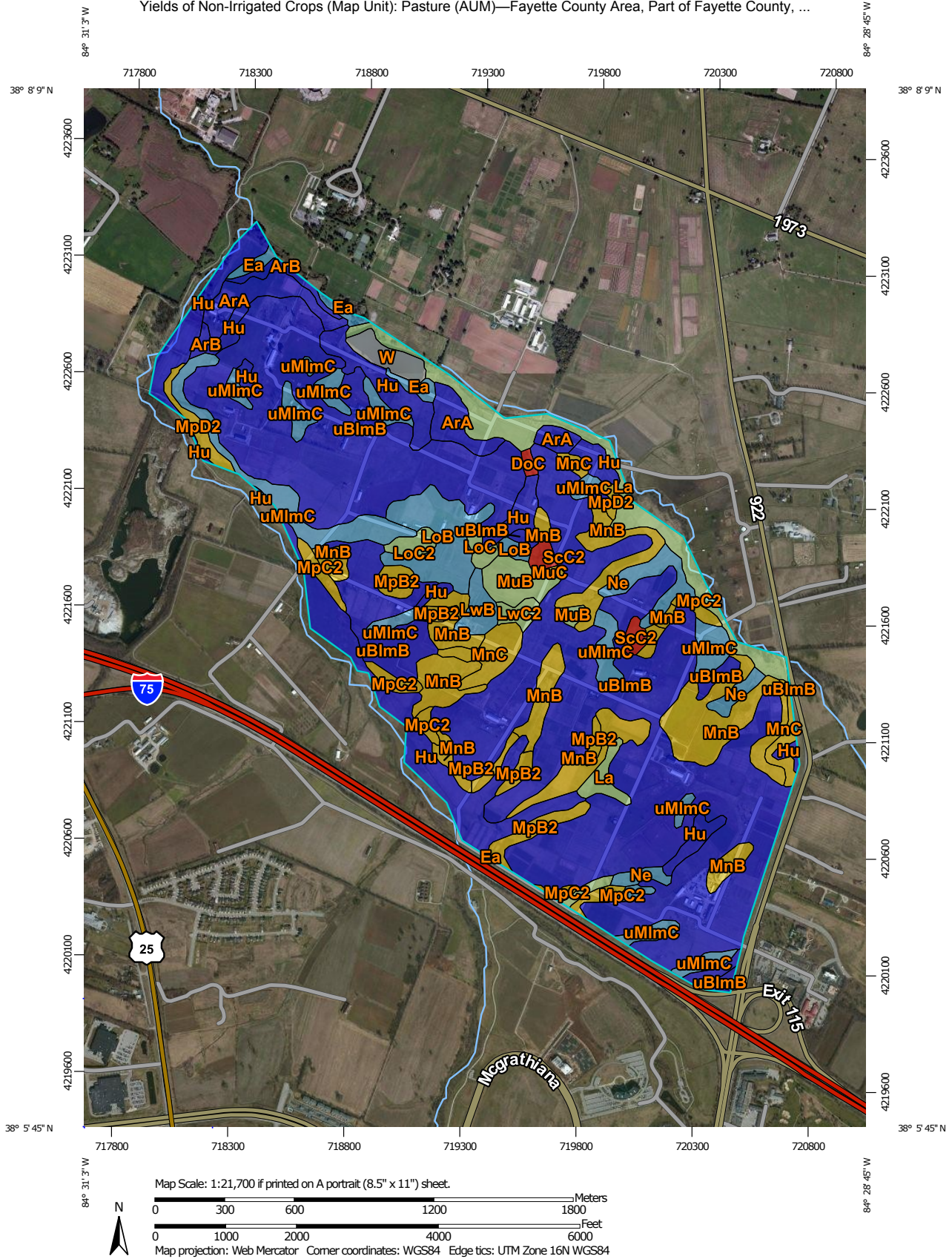
Soil type has a significant impact on the productivity and limitations of a pasture. Web Soil Survey provides farm managers and owners with valuable information that can be used to calculate the carrying capacity of the farm they manage. Proper pasture management is essential to reach maximum utilization without overgrazing and damaging pastures.

More information and soil sampling resources can be found by contacting your local county cooperative extension agent; visit [www.ca.uky.edu/county](http://www.ca.uky.edu/county) to locate your extension office.

# Appendix A





















**Appendix A - Farm A:** Approximately 1,000 acres located in Fayette County, currently used for horse pasture







Yields of Non-Irrigated Crops (Map Unit): Pasture (AUM)—Fayette County Area, Part of Fayette County, ...



Yields of Non-Irrigated Crops (Map Unit): Pasture (AUM)—Fayette County Area, Part of Fayette County, Kentucky

**MAP LEGEND**

- Area of Interest (AOI)**
-  Area of Interest (AOI)
- Soils**
- Soil Rating Polygons**
-  <= 7.10
-  > 7.10 and <= 8.10
-  > 8.10 and <= 8.60
-  > 8.60 and <= 9.00
-  > 9.00 and <= 9.50
-  Not rated or not available
- Soil Rating Lines**
-  <= 7.10
-  > 7.10 and <= 8.10
-  > 8.10 and <= 8.60
-  > 8.60 and <= 9.00
-  > 9.00 and <= 9.50
-  Not rated or not available
- Soil Rating Points**
-  <= 7.10
-  > 7.10 and <= 8.10
-  > 8.10 and <= 8.60
-  > 8.60 and <= 9.00
-  > 9.00 and <= 9.50
-  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 1:15,800. Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service  
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>  
 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: Fayette County Area, Part of Fayette County, Kentucky  
 Survey Area Data: Version 11, Sep 18, 2014

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

Date(s) aerial images were photographed: Oct 4, 2011—Feb 20, 2012

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.

## Appendix A

Yields of Non-Irrigated Crops (Map Unit): Pasture (AUM)—Fayette County Area, Part of Fayette County, Kentucky

### Yields of Non-Irrigated Crops (Map Unit): Pasture (AUM)

Yields of Non-Irrigated Crops (Map Unit): Pasture (AUM)— Summary by Map Unit — Fayette County Area, Part of Fayette County, Kentucky (KY643)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
ArA	Armour silt loam, 0 to 2 percent slopes (elk)	9.50	29.5	2.9%
ArB	Armour silt loam, 2 to 6 percent slopes (elk)	9.50	6.2	0.6%
DoC	Donerail silt loam, 6 to 12 percent slopes	7.10	1.4	0.1%
Ea	Egam silt loam (woolper)	9.00	7.5	0.7%
Hu	Huntington silt loam	9.50	109.2	10.6%
La	Lanton silty clay loam (dunning)	8.60	46.5	4.5%
LoB	Loradale silt loam, 2 to 6 percent slopes	9.00	29.2	2.8%
LoC	Loradale silt loam, 6 to 12 percent slopes	8.60	3.7	0.4%
LoC2	Loradale silt loam, 6 to 12 percent slopes, eroded	8.60	4.4	0.4%
LwB	Lowell silt loam, 2 to 6 percent slopes	9.00	7.5	0.7%
LwC2	Lowell silt loam, 6 to 12 percent slopes, eroded	8.60	4.1	0.4%
MnB	McAfee silt loam, 2 to 6 percent slopes	8.10	103.8	10.0%
MnC	McAfee silt loam, 6 to 12 percent slopes	8.10	20.6	2.0%
MpB2	McAfee silty clay loam, 2 to 6 percent slopes, eroded	8.10	21.8	2.1%
MpC2	McAfee silty clay loam, 6 to 12 percent slopes, eroded	8.10	16.4	1.6%
MpD2	McAfee silty clay loam, 12 to 20 percent slopes, eroded	7.60	7.8	0.8%
MuB	Mercer silt loam, 2 to 6 percent slopes (nicholson)	8.60	13.5	1.3%
MuC	Mercer silt loam, 6 to 12 percent slopes (nicholson)	7.60	1.1	0.1%



Yields of Non-Irrigated Crops (Map Unit): Pasture (AUM)—Fayette County Area, Part of Fayette County, Kentucky

<b>Yields of Non-Irrigated Crops (Map Unit): Pasture (AUM)— Summary by Map Unit — Fayette County Area, Part of Fayette County, Kentucky (KY643)</b>				
<b>Map unit symbol</b>	<b>Map unit name</b>	<b>Rating</b>	<b>Acres in AOI</b>	<b>Percent of AOI</b>
Ne	Newark silt loam, 0 to 2 percent slopes, occasionally flooded	9.00	18.7	1.8%
ScC2	Salvisa silty clay loam, 6 to 12 percent slopes, eroded	6.70	5.8	0.6%
uBlmB	Bluegrass-Maury silt loams, 2 to 6 percent slopes	9.50	500.1	48.4%
uMlmC	Maury-Bluegrass silt loams, 6 to 12 percent slopes	9.00	67.2	6.5%
W	Water		8.4	0.8%
<b>Totals for Area of Interest</b>			<b>1,034.3</b>	<b>100.0%</b>

## Appendix A

Yields of Non-Irrigated Crops (Map Unit): Pasture (AUM)—Fayette County Area, Part of Fayette County, Kentucky

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### Description

These are the estimated average yields per acre that can be expected of selected nonirrigated crops under a high level of management. In any given year, yields may be higher or lower than those indicated because of variations in rainfall and other climatic factors.

In the database, some states maintain crop yield data by individual map unit component and others maintain the data at the map unit level. Attributes are included in this application for both, although only one or the other is likely to contain data for any given geographic area. This attribute uses data maintained at the map unit level.

The yields are actually recorded as three separate values in the database. A low value and a high value indicate the range for the soil component. A "representative" value indicates the expected value for the component. For these yields, only the representative value is used.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby areas and results of field trials and demonstrations also are considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for the selected crop. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

### Rating Options

*Crop:* Pasture

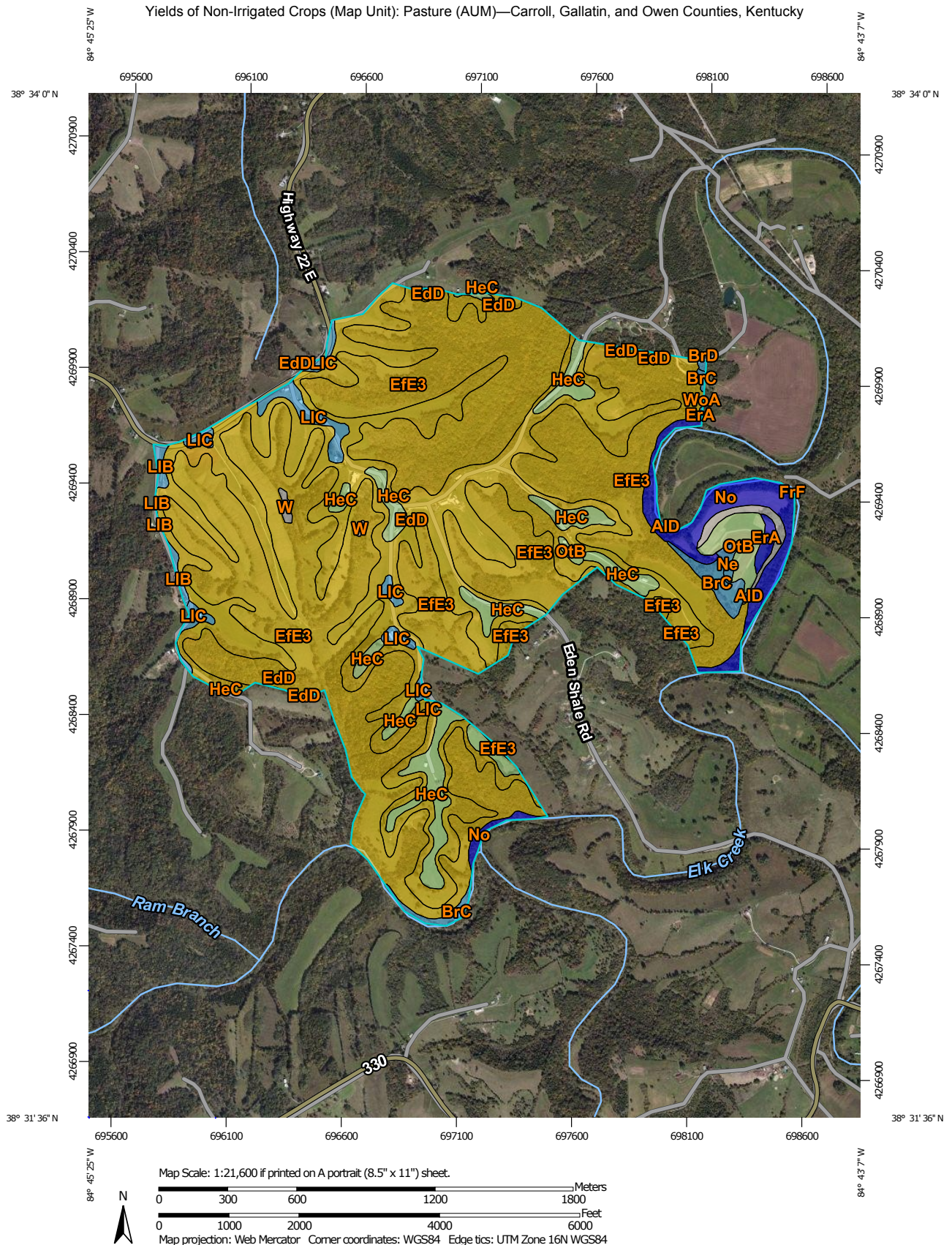
*Yield Units:* AUM

*Aggregation Method:* No Aggregation Necessary



























*Tie-break Rule:* Higher

# Appendix B

# Appendix B - Farm B: Approximately 950 acres in Owen County, currently used for beef production



**MAP LEGEND**

- Area of Interest (AOI)**
  -  Area of Interest (AOI)
- Soils**
  - Soil Rating Polygons**
    -  <= 1.90
    -  > 1.90 and <= 5.70
    -  > 5.70 and <= 8.10
    -  > 8.10 and <= 9.00
    -  > 9.00 and <= 9.50
    -  Not rated or not available
  - Soil Rating Lines**
    -  <= 1.90
    -  > 1.90 and <= 5.70
    -  > 5.70 and <= 8.10
    -  > 8.10 and <= 9.00
    -  > 9.00 and <= 9.50
    -  Not rated or not available
  - Soil Rating Points**
    -  <= 1.90
    -  > 1.90 and <= 5.70
    -  > 5.70 and <= 8.10
    -  > 8.10 and <= 9.00
    -  > 9.00 and <= 9.50
    -  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 1:15,800.

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

Source of Map: Natural Resources Conservation Service  
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>  
 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: Carroll, Gallatin, and Owen Counties, Kentucky  
 Survey Area Data: Version 11, Sep 17, 2014

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

Date(s) aerial images were photographed: Oct 4, 2011—Feb 20, 2012

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.

## Appendix B

Yields of Non-Irrigated Crops (Map Unit): Pasture (AUM)—Carroll, Gallatin, and Owen Counties, Kentucky

### Yields of Non-Irrigated Crops (Map Unit): Pasture (AUM)

Yields of Non-Irrigated Crops (Map Unit): Pasture (AUM)— Summary by Map Unit — Carroll, Gallatin, and Owen Counties, Kentucky (KY612)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AID	Alluvial land, steep (wheeling)		6.1	0.6%
BrC	Brashear silty clay loam, 6 to 12 percent slopes	8.60	11.0	1.2%
BrD	Brashear silty clay loam, 12 to 20 percent slopes	8.60	0.4	0.0%
EdD	Eden silty clay loam, 12 to 20 percent slopes	5.70	264.0	27.7%
EfE3	Eden flaggy silty clay, 20 to 30 percent slopes, severely eroded	4.80	539.9	56.7%
ErA	Elk silt loam, 0 to 2 percent slopes, rarely flooded	9.50	3.0	0.3%
FrF	Fairmount-Rock outcrop complex, 30 to 60 percent slopes	1.90	0.0	0.0%
HeC	Heitt silt loam, 6 to 12 percent slopes	7.60	54.3	5.7%
LIB	Lowell silt loam, 2 to 6 percent slopes	9.00	3.3	0.3%
LIC	Lowell silt loam, 6 to 12 percent slopes	8.60	18.1	1.9%
Ne	Newark silt loam, 0 to 2 percent slopes, frequently flooded	9.00	2.0	0.2%
No	Nolin silt loam	9.50	35.1	3.7%
OtB	Otwell silt loam, 2 to 6 percent slopes	8.10	13.7	1.4%
W	Water		1.6	0.2%
WoA	Woolper silty clay loam, 0 to 2 percent slopes	9.00	0.1	0.0%
<b>Totals for Area of Interest</b>			<b>952.5</b>	<b>100.0%</b>

## Description

These are the estimated average yields per acre that can be expected of selected nonirrigated crops under a high level of management. In any given year, yields may be higher or lower than those indicated because of variations in rainfall and other climatic factors.

In the database, some states maintain crop yield data by individual map unit component and others maintain the data at the map unit level. Attributes are included in this application for both, although only one or the other is likely to contain data for any given geographic area. This attribute uses data maintained at the map unit level.

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## Rating Options

*Crop:* Pasture

*Yield Units:* AUM

*Aggregation Method:* No Aggregation Necessary

*Tie-break Rule:* Higher

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