Project Final Report

Grant No: C9994861-04

Project Name:
Pesticide/Nutrient BMP Buffer: From the Classroom to the Field

Workplan Title:
Mud, Horses, and Clean Water- A BMP Demonstration Project for Suburban Horse Owners

Workplan Number: 04-08
Memorandum of Agreement Number: M-04555972
Project Period Start Date: 08/01/04
Project Period End Date: 06/15/08
Waterbody/Watershed Identification: Kentucky/Licking
NPS Category: BMP Technology Transfer

Submitted by:
Stephen R. Workman and Robert J. Coleman

The Natural Resources and Environmental Protection Cabinet (NREPC) and the University of Kentucky Research Foundation do not discriminate on the basis of race, color, national origin, sex, age, religion, or disability. The NPREC and the University of Kentucky Research Foundation will provide, on request, reasonable accommodations including auxiliary aids and services necessary to afford an individual with a disability an equal opportunity to participate in all services, programs and activities. To request materials in an alternative format, contact the Kentucky Division of Water, 14 Reilly Road, Frankfort, KY 40601 or call (502)564-3410 or contact the University of Kentucky Research Foundation.

Funding for this project, Mud, Horses, and Clean Water-A BMP Demonstration Project for Suburban Horse Owners, was provided in part from a grant from the U.S. Environmental Protection Agency (USEPA) through the Kentucky Division of Water, Nonpoint Source Section to the University of Kentucky as authorized by the Clean Water Act Amendments 1987, 319(h) Nonpoint Source Implementation Grant #C9994861-04. The contents of this document do not necessarily reflect the views and policies of the USEPA, KDOW, or the University of Kentucky Research Foundation nor does the mention of trade names or commercial products constitute endorsement.
Acknowledgements

Contributors:

Steve Higgins, PhD
Research Specialist
Biosystems and Agricultural Engineering

Ben Kostra, PE
Engineer Associate
Biosystems and Agricultural Engineering

Jessica Dagger
Student
Animal and Food Sciences

Nicole Gallagher
Student
Biosystems and Agricultural Engineering

Tiffany Graham
Student
Biosystems and Agricultural Engineering

Josh Long
Extension Agent
Fayette County

Ben Meredith
Extension Agent
Woodford County

Rob Amburgey
Extension Agent
Jessamine County

Mark Reese
Extension Agent
Scott County

Tommy Yankey
Extension Agent
Anderson County

Kentucky Quarter Horse Association
Frankfort

Kentucky Horse Council
Lexington

Cooperators:

Les Moore
Fayette County

Gene and Jennifer Manley
Manley Farm
Fayette County

Evie and Scott Russell
Jessamine County

Lucinda Masterson
Eventide Farm
Fayette County

Bennie Sargent
High Point Equestrian Center
Scott County

Brent and Cindy Peterson
Peterson Place
Anderson County

Mary Agneesens
Woodford County

University of Kentucky

Maine Chance Farm
Fayette County
Table of Contents

Executive Summary ....................................................................................................... 3
Introduction and Background ......................................................................................... 4
Materials and Methods ................................................................................................... 5
Results and Discussion .................................................................................................. 7
Conclusions .................................................................................................................. 11
Literature Cited ............................................................................................................. 11
Appendices .................................................................................................................. 12
  Appendix A – Financial & Administrative Closeout .......................................... 12
  Appendix B – BMP Implementation Plan ......................................................... 15
  Appendix C – Survey Results ........................................................................ 19
  Appendix D – Fact Sheets ............................................................................. 34

Executive Summary

This BMP demonstration project is related to environmental and water quality protection targeted to suburban and pleasure horse owners in Kentucky. With nearly 200,000 horses in Kentucky, an interdisciplinary team was assembled to provide the horse owner with the training and information needed to implement sound management decisions that enhances horse well being and protects the environment. Prior to the project, little information was available to the horse owner demonstrating the proper use of, or more importantly, the effectiveness of BMPs for suburban horse farms.

The goal of this project was to transfer and promote the knowledge that will be essential to realistically protect water quality in suburban horse farms while enhancing horse well being. A total of 22 high traffic area pads were constructed on eight suburban horse farms in central Kentucky. One composting bin was implemented and one composting shed was constructed. Four fact sheet publications were printed, additional fact sheet publications are in the printing/review process, and educational presentations were conducted. An instructional and educational video was developed and is in production. A web site was developed consisting of a summary of the project, a map showing the project locations, and links to educational materials.
Introduction and Background

Horses are a common site along Kentucky’s roads. It is estimated that there are about 100,000 pleasure horses in Kentucky. The total horse population is about 185,000 with Thoroughbreds accounting for the remaining 45%. It is well known that Kentucky’s Thoroughbred industry dominates the nation in terms of value of sales, but the number of farms not related to Thoroughbred breeding, including recreational farms, account for over 50% of the total number of horse farms in the Commonwealth. There is a significant concentration of horse farms around the Lexington area, including Fayette, Jessamine, Bourbon, Scott, and Woodford counties, and also around or near other major metropolitan areas, such as Louisville and Cincinnati (in Ohio). Lexington, for example has experienced an increase of 18% in its population in the last ten years (2000 Census). As a result, recreational horse owners increasingly find themselves in the middle or along the fringes of urban or rapidly growing suburban areas, where they often receive more scrutiny from their local government and neighbors than do their counterparts in rural areas. To maintain good relationships and minimize the need for regulation, it is critical they know and practice proper manure and pasture management.

There are other concerns for the suburban horse owner as well – overcrowded paddocks where horses are exposed to mud in heavy traffic areas typically around waterers, feed troughs, and gates. Additionally, these horse owners must deal with neighbors who might complain about odors, flies, and mud on paved roadways. Pasture quality and increasing areas of bare ground are always a problem when hay is fed on the ground, not to mention the likelihood of horses to be infested or re-infested by parasites, especially when manure is stockpiled in one of the paddocks’ corners. Runoff from soggy manure piles and muddy paddocks can cause serious surface and groundwater contamination problems.

Prior to the project, a survey on 346 Kentucky horse farms indicated that the major pasture problem was maintaining grass cover in high traffic areas. Other problems included having overgrazed paddocks and adequate grass in the spring, but not later in the year. Horse owners and horse farm managers often do not appreciate the correlation between overgrazed paddocks and the potential negative impact to surface and ground water.

The following BMPs were identified for demonstration purposes on suburban horse farms: a) Geotextile and crushed stone pads around waterers, near feeding areas, and at congregation points to demonstrate mud minimization techniques; b) Manure composting units to demonstrate manure management techniques; c) Managed stream crossings using geotextile, geoweb, and stone to demonstrate the advantage of limiting animal access to water; d) Temporary water system as an alternative to stream and pond water using plastic tanks and UV protected plastic pipes; and e) Paddock management. In most cases, several strategies will be demonstrated at each location.

Prior to BMP Implementation, baseline water quality issues of suburban horse farmers will be obtained by the use of a survey asking horse owners about farm characteristics, water quality and other environmental issues. The survey will be sent to 4,000 Kentucky owners of Quarter Horses. The information gathered from this survey will be used as baseline information that will guide us on the development of specific educational materials for suburban horse owners.
Since mud and/or wind blown dust are the primary reasons for water and air pollution on suburban horse farms, heavy use area protection will be implemented at most demonstration sites. Most horse owners and stable operators are unaware of the proper installation of heavy use protection areas. The typical practice is to place small diameter crushed stone in heavy use areas, which quickly reverts back to mud and dust because of the improper installation. This is problematic because of accumulated costs and the observed ineffectiveness. A key component of the project will be fact sheets and a video that describes the proper installation of a high traffic area pad.

**Materials and Methods**

This project was initiated with the development of a questionnaire for horse owners in Kentucky. The questionnaire consisted of the following topics: farm location, number of horses, type of farm (pleasure horse, boarding, breeding, etc.), land area, access to streams, barn types, number and size of paddocks, pasture management, type of bedding, type of feed, type of pasture, pasture fertilization and herbicide application practices, horse muck handling, eventually composting, and disposal, how muddy heavy traffic areas can get, how they minimize or control mud, and how they deal with runoff from heavy traffic areas and pastures. This survey was mailed to Kentucky members of the American Quarter Horse Association and was also available online through the project web site. Although we have a reasonable idea of the most challenging issues suburban horse owners currently face based on previous informal surveys, it was important to formally document the different types of issues. It is possible that researchers and educators are missing some information that is important to horse owners in Kentucky. This survey was used as guidance for the development of topical educational materials including an instructional video.

The BMP demonstration portion of the project consisted of the installation and construction of composting units and high traffic area pads. Construction was completed by a contractor supervised by project personnel. Composting units and sheds were built using existing guidelines available from several informational sources (Anon., 2000 and Rynk, 1992). Management strategies were used for manure including adding ammonium nitrate to stall manure in order to improve the material’s nitrogen content assuming bedding material was composed of wood products. Ammonium nitrate is effective in reducing the initial C/N ratio and is retained in the system according to James (1994). The high traffic area pads were constructed generally following NRCS and MWPS guidelines. Results from a previous research project on the optimization of geotextile and rock pads for heavy livestock traffic areas (Bicudo et al., 2003) were also used in order to implement the best combination of geotextile and crushed stone. Paddock management strategies were discussed with horse farmers in order to implement the strategy that best fit their particular operation. Horse farmers were instructed as to how they should manage their pastures in order to minimize overgrazing, bare spots, and mud. Minimization of mud in heavily stocked paddocks or pastures may involve clean water diversion. Sacrifice areas were discussed for several farms. Where land is limited, there is a need to create a sacrifice area to keep horses in the winter. A sacrifice area is a small enclosure, such as a run or pen. During wet periods, or when grass sod is likely to be destroyed or damaged, horses are placed in the sacrifice area, until paddock conditions improve. The sacrifice paddock is typically protected from generating direct runoff by location of the grass paddocks (Collins, 1996). This strategy has been successfully applied to dairy loafing lots in Virginia.
The BMP implementation was conducted on eight suburban horse farms in the Inner Bluegrass region of Kentucky (Figure 1). The following is a description of each of the project areas:

Les Moore Farm is located in rural western Fayette County. This farm is in an area that was once comprised of one large Thoroughbred farm, but has now been subdivided into many smaller farms/homes (approximately 5 to 20 acres). The Moore Farm typically has 4 to 6 horses and has a large tobacco barn that was converted into a stall barn which is surrounded by small pastures. This farm is surrounded by relatively new homes and is a short drive to the urban core of Lexington.

Manley Farm is a commercial boarding operation located in southwestern Fayette County. The farm has multiple stall barns, a jumping area, and large pastures. The farm typically has 20 to 30 horses and is surrounded by a mixture of homes, small farms, and large Thoroughbred operations. This farm is located in an area Fayette County near the border of Jessamine County that has experienced significant urban growth in the past 15 years.

Maine Chance Farm is part of the University of Kentucky’s Agricultural Experiment Station and is located northeast of Lexington at the urban-rural interface. Previously, part of a large Thoroughbred operation, this farm has multiple barns and typically has up to 100 horses used for research and education. The farm is located along a major roadway leading from the city to the Kentucky Horse Park.

Russell Farm is located in northern Jessamine County in an urbanized area near the border of Fayette County. The farm has a small stall barn and is surrounded by several small pastures and typically keeps 3 to 4 horses. Multiple new homes have been constructed around this farm and the area will likely see continued development resulting from the division of larger farms.

Eventide Farm is a small farm located among several of Fayette County’s major Thoroughbred operations in the western part of the county. This farm has a stall barn and typically has 10 to 15 horses. Numerous residences and small farms surround this farm.

Peterson Place is located in rural Anderson County, a short drive from Lawrenceburg. This farm is immediately adjacent to multiple tracts of land that are planned for
residential development. The farm has a relatively new stall barn, a riding area, and large pastures. Typically, 8 to 10 horses are kept at this farm.

High Point Equestrian Center is a commercial boarding operation located in western Scott County along a major roadway linking Georgetown to Frankfort. The farm has a large stall barn, an indoor riding arena, and outdoor riding areas surrounded by large pastures. Approximately 40 horses are trained or boarded at the farm plus up to 30 mares in residence at any one time during the breeding season. The entrance for a new residential development in Scott County is located adjacent to this facility.

Agneesens Farm is located in rural southern Woodford County. The farm has a new, small stall barn, a small riding area, and is surrounded by small pastures. This small farm is surrounded by residences and is adjacent to the intersection of two rural roadways. Typically, 3 to 4 horses are kept at this farm.

Multiple educational programs were conducted by the project investigators as part of specialized and concurrent extension activities. Fact Sheet publications were also developed as educational materials describing our experience with BMP implementation for small horse farms. The production of a video has been initiated with the assistance of the Agricultural Communications group of the College of Agriculture. This video will target horse owners in the construction and management of high traffic area pads. A project web site was developed and published for public access. This website provides a summary of the project, a map showing the project locations, and links to educational materials.

Results and Discussion

The horse owner survey was distributed to approximately 4,000 horse owners across Kentucky. 935 responses were received from owners across Kentucky. Analyses were completed to check the quality of responses. Figure 2 highlights areas on the farm that horse owners perceive to be problem areas relating to the ground being bare. Consistent with these results, this project concentrated on minimizing mud around gates, waterers, feeders, and congregated areas. It should be noted that more than 70% of the respondents stated they do not have a mud problem. A focus of our educational efforts was to link the bare ground to mud problems and eventually to water quality issues.

As previously indicated, Kentucky has a large percentage of small horse farms. The survey confirmed that more than 50% of the respondents have less than 6 horses on their farm.

Appendix D contains the full results of the survey with comments. Additional data includes farm size, numbers of barns and pastures, water quality concerns, methods of

![Figure 2 - Survey Results Relating to Areas of Bare Ground on Horse Farms](image-url)
bedding animals, other animals on the farm, and waste handling methods.

A BMP Implementation Plan (Appendix B) was developed for the project. This Plan was submitted to the agency staff and was approved with slight modifications. The Plan essentially describes the overall project and methodology to be used.

A total of 24 BMPs were implemented at 8 locations across 5 counties in central Kentucky. Table 1 is a summary of the BMPs implemented at each of the project locations. Table 2 shows photographs and descriptions that document the BMPs.

### Table 1 - BMP Implementation Summary

<table>
<thead>
<tr>
<th>Location</th>
<th>County</th>
<th>Date(s)</th>
<th>BMPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Les Moore Farm</td>
<td>Fayette</td>
<td>Nov 2004, May 2005</td>
<td>1 High traffic area pad, 3 High traffic area pads</td>
</tr>
<tr>
<td>Manley Farm</td>
<td>Fayette</td>
<td>Jun 2005</td>
<td>3 High traffic area pads</td>
</tr>
<tr>
<td>Maine Chance Farm</td>
<td>Fayette</td>
<td>Sep 2005</td>
<td>1 High traffic area pad</td>
</tr>
<tr>
<td>Russell Farm</td>
<td>Jessamine</td>
<td>Nov 2005, Nov 2005</td>
<td>2 High traffic area pads, 1 Compost bin</td>
</tr>
<tr>
<td>Eventide Farm</td>
<td>Fayette</td>
<td>Nov 2005</td>
<td>2 High traffic area pads</td>
</tr>
<tr>
<td>Peterson Place</td>
<td>Anderson</td>
<td>Nov/Dec 2006, Jun 2007</td>
<td>1 Compost shed, 3 High traffic area pads</td>
</tr>
<tr>
<td>High Point Equestrian Center</td>
<td>Scott</td>
<td>Sep 2007</td>
<td>4 High traffic area pads</td>
</tr>
<tr>
<td>Agneesens Farm</td>
<td>Woodford</td>
<td>Sep 2007</td>
<td>3 High traffic area pads</td>
</tr>
</tbody>
</table>

### Table 2 – Project Photographs and Descriptions

**Les Moore Farm**

- High traffic area prior to pad installation
- High traffic area with completed pad

**Manley Farm**

- High traffic area prior to pad installation
- High traffic area approximately 6 months after pad installation
Maine Chance Farm
High traffic area during construction

Russell Farm
High traffic area during construction showing geotextile in excavated area

Eventide Farm
Completed high traffic area pad

Peterson Place
Compost shed under construction
Four fact sheets were developed for this project and are included in Appendix C.

- Pervious Concrete as a Flooring Material for Horse Handling Areas
- High Traffic Area Pads for Horses
- Temporary Fencing for Horse Pastures
- Composting Horse Muck

Dr. Coleman is a co-author on an Extension publication with the Equine Extension Specialists at North Carolina State University on Dry-lots for Horse Pastures that incorporated the information gained from this project on high traffic pads. The publication is in press. Additional fact sheets are being developed for water quality, soil-cement applications, and dry-lots in Kentucky.

Drs. Coleman and Higgins conducted several presentations relating to BMP implementation including the Kentucky Horse Council (October 2006), the
A web site was developed to highlight activities of the project and is located at www.bae.uky.edu/HorseWQ/. The site includes a project summary, a map of the project locations, and photos of the BMP construction. Links to additional information are provided that may be of interest to horse owners implementing BMPs as well as the various fact sheets produced by the project.

A video will be produced for the project and made available via the Internet. The video describes mud development, heavy use area pad construction, composting, and pasture management. The video will be approximately 12 to 15 minutes in length. A script for the video has been drafted and approved. Preliminary video footage has been recorded. However, the quality of the initial video footage was not of acceptable quality and additional video sequences will be recorded for the final video.

Conclusion

This project was successful in demonstrating the proper use and effectiveness of BMPs for suburban horse farms. Through training and information resources developed through this project, these BMPs can be practically implemented as sound management decisions that enhance the well being of horses while protecting the environment.

Based on responses at extension programs, horse owners are now considering the construction of high traffic area pads on their farms. Rotational grazing and the use of temporary electric fencing are also being implemented. The value of these practices as BMPs has been demonstrated by this project. On-farm composting has also received a positive response from horse owners, but the management changes that are required will result in slower implementation.

In addition, numerous fact sheets have been developed. These fact sheets will be available at all extension offices in the state as well as online from the College of Agriculture Extension page. The educational benefits of the project will be long-lasting.

Literature Cited

Anon. 2000. How to compost and use horse manure. Horses for Clean Water, King County Department of Natural Resources, King County Solid Waste Division, Seattle, WA.


James, R.E. 1994 Horse manure management-preventing a soil nitrogen deficiency. Ohio State University, Publication AGF-212-95.
Appendix A: Financial and Administrative Closeout

Workplan Outputs:

<table>
<thead>
<tr>
<th>Output</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Meet with Extension Agents to organize BMP implementation at partner farms and at any additional farm that wants to participate.</td>
<td>Oct 04</td>
</tr>
<tr>
<td>2. Meet with horse farmers individually to decide on the BMP to be implemented.</td>
<td>Oct 04</td>
</tr>
<tr>
<td>3. Develop and submit a BMP Implementation Plan for NPS Program staff approval.</td>
<td>Nov 04</td>
</tr>
<tr>
<td>4. Submit preliminary video script for NPS Program staff approval.</td>
<td>May 05</td>
</tr>
<tr>
<td>5. Construction of BMPs at various horse farms.</td>
<td>Apr 05</td>
</tr>
<tr>
<td>6. Develop fact sheets about BMP’s.</td>
<td>Mar 05</td>
</tr>
<tr>
<td>7. Develop survey questionnaire.</td>
<td>Oct 04</td>
</tr>
<tr>
<td>8. Submit survey questionnaire for NPS Program staff approval.</td>
<td>Jan 05</td>
</tr>
<tr>
<td>9. Send survey.</td>
<td>May 05</td>
</tr>
<tr>
<td>10. BMP implementation/maintenance/monitoring at various horse farms.</td>
<td>Jun 05</td>
</tr>
<tr>
<td>11. Development of project web site.</td>
<td>Mar 05</td>
</tr>
<tr>
<td>12. Submit Annual Progress Report.</td>
<td>Aug 05</td>
</tr>
<tr>
<td>13. Submit video script for NPS Program staff approval.</td>
<td>Jul 05</td>
</tr>
<tr>
<td>14. Video shooting.</td>
<td>Jul 05</td>
</tr>
<tr>
<td>15. Survey results statistical analyses and report.</td>
<td>Jul 06</td>
</tr>
<tr>
<td>16. Submit Annual Progress Report</td>
<td>Aug 06</td>
</tr>
<tr>
<td>18. Finalize video.</td>
<td>Aug 06</td>
</tr>
<tr>
<td>19. Conduct field days.</td>
<td>Jan 07</td>
</tr>
<tr>
<td>20. Submit manual for NPS Program staff approval.</td>
<td>Jul 07</td>
</tr>
<tr>
<td>22. Develop materials for winter workshop at State Extension Conference</td>
<td>Dec 07</td>
</tr>
<tr>
<td>23. Submit advanced notice and materials to NPS Program for workshop.</td>
<td>Jan 08</td>
</tr>
<tr>
<td>24. Conduct winter workshop at State Extension Conference.</td>
<td>Jan 08</td>
</tr>
<tr>
<td>26. Submit three copies of Final Report and three copies of all products produced by this project to NPS Program staff.</td>
<td>Dec 07</td>
</tr>
<tr>
<td>27. Participate in the KY NPS Conference.</td>
<td>Feb 08</td>
</tr>
</tbody>
</table>

Key Outputs:
1. Demonstration sites
2. Survey Results
3. Fact Sheets
4. Video
**Detailed Budget:**

<table>
<thead>
<tr>
<th>EPA 319 Budget Item</th>
<th>Personnel</th>
<th>Supplies</th>
<th>Equipment</th>
<th>Travel</th>
<th>Contractual</th>
<th>Operating Costs</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personnel</strong></td>
<td>88,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Supplies</strong></td>
<td>35,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
<td>3,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Travel</strong></td>
<td>2,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Contractual</strong></td>
<td>48,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operating Costs</strong></td>
<td>6,600</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>3,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>185,600</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>University of Kentucky Budget Item</th>
<th>Pre-2006 Budget</th>
<th>Post-2006 Budget</th>
<th>Final Expenditures</th>
<th>Match</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Salary and Benefits</td>
<td>88,000</td>
<td>40,649</td>
<td>95,614.77</td>
<td>53,533.12</td>
<td>149,147.89</td>
</tr>
<tr>
<td>Student Salary and Benefits</td>
<td>0</td>
<td>15,000</td>
<td>38,329.19</td>
<td>0</td>
<td>38,329.19</td>
</tr>
<tr>
<td>Travel-domestic</td>
<td>2,000</td>
<td>0</td>
<td>522.63</td>
<td>0</td>
<td>522.63</td>
</tr>
<tr>
<td>Sub-contract &lt;$25,000</td>
<td>29,050</td>
<td>21,838</td>
<td>21,838.00</td>
<td>0</td>
<td>21,838.00</td>
</tr>
<tr>
<td>Sub-contract &gt;$25,000</td>
<td>15,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Direct Current Expenses</td>
<td>38,000</td>
<td>20,904</td>
<td>14,801.36</td>
<td>0</td>
<td>14,801.36</td>
</tr>
<tr>
<td>Postage</td>
<td>1,000</td>
<td>999.48</td>
<td>0</td>
<td>0</td>
<td>999.48</td>
</tr>
<tr>
<td>Rent</td>
<td>0</td>
<td>113</td>
<td>639.86</td>
<td>0</td>
<td>639.86</td>
</tr>
<tr>
<td>Commercial/Other Services</td>
<td>3,950</td>
<td>0</td>
<td>3,800.00</td>
<td>0</td>
<td>3,800.00</td>
</tr>
<tr>
<td>Computing Hardware</td>
<td>2,000</td>
<td>894</td>
<td>1,893.69</td>
<td>0</td>
<td>1,893.69</td>
</tr>
<tr>
<td>F&amp;A Costs</td>
<td>6,600</td>
<td>4,038</td>
<td>7197.03</td>
<td>70,146.88</td>
<td>77,343.91</td>
</tr>
<tr>
<td>Total Direct</td>
<td>179,000</td>
<td>99,398</td>
<td>178,438.98</td>
<td>53,533.12</td>
<td>231,972.10</td>
</tr>
<tr>
<td>Total Indirect</td>
<td>6,600</td>
<td>4,038</td>
<td>7197.03</td>
<td>70,146.88</td>
<td>77,343.91</td>
</tr>
<tr>
<td>Total</td>
<td><strong>185,600</strong></td>
<td><strong>103,436</strong></td>
<td><strong>185,636.01</strong></td>
<td>123,680</td>
<td><strong>309316.01</strong></td>
</tr>
</tbody>
</table>

**Budget Summary:**

Jose Bicudo and Robert Coleman were awarded the project in 2004. Prior to the money being available to the University of Kentucky, Dr. Bicudo accepted a position in consulting and left the university. Dr. Steve Workman took over the project on the departure of Dr. Bicudo. The project started on 8/01/04 with an expected federal budget of $185,600 as shown on the EPA319 application above. These funds were allocated in the University of Kentucky system as the “Pre-2006 Budget” in the table. As can be seen from the table, the UK system has to allocate funds more precisely into categories to meet Cost Accounting Standards. In June of 2006, the original project crossed the state’s biennial budget cycle and a new project number was received with a start date of 7/1/06 and an end date of 5/15/08. At that time, $82,164 had been expended on the project and the remaining $103,436 was allocated as shown in the “Post-2006 Budget”.
University of Kentucky Research Foundation was reimbursed $185,600. All dollars were spent; there were no excess project funds to reallocate. This project did generate overmatch provided by the University of Kentucky Research Foundation. This overmatch was not posted to the grant.

Equipment Summary: No equipment was purchased for the grant.

Special Grant Conditions: No special grant conditions were placed on the project by EPA.
1. List of Eligible BMPs:
A list of eligible BMP’s and items eligible for funding follows:

<table>
<thead>
<tr>
<th>Practice Name (NRCS)</th>
<th>Practice Code (NRCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composting Facility</td>
<td>317</td>
</tr>
<tr>
<td>Critical Area Planting</td>
<td>342</td>
</tr>
<tr>
<td>Heavy Use Area Protection</td>
<td>561</td>
</tr>
<tr>
<td>Stream Crossing</td>
<td>576</td>
</tr>
</tbody>
</table>

Other items available:
- Watering troughs
- Hay and feed troughs
- Composting pads

2. Description of BMP selection process:
Horses are a common site along Kentucky’s roads. It is estimated that there are about 100,000 pleasure horses in Kentucky. The total horse population is about 185,000 and thoroughbreds account for the remaining 45%. It is well known that Kentucky’s thoroughbred industry dominates the nation in terms of value of sales, but the number of farms not related to thoroughbred breeding, including recreational farms, account for about 50% of the total number of horse farms in the Commonwealth. There is significant concentration of horse farms around the Lexington area, including Fayette, Jessamine, Bourbon, Scott, and Woodford counties, and also around or near other major towns, such as Louisville and Cincinnati (in Ohio). Lexington, for example has experienced an increase of 18% in its population in the last ten years (2000 Census). As a result, recreational horse owners increasingly find themselves in the middle of urban or rapidly growing suburban areas, where they often receive more scrutiny from their local government and neighbors than do their counterparts in rural areas. To maintain good relationships and minimize the need for regulation, it is critical they know and practice proper manure and pasture management.

There are other concerns for the suburban horse owner as well – overcrowded paddocks where horses fight mud in heavy traffic areas (around waterers and feed troughs), and neighbors who complain about odor and flies. Pasture quality and increasing bare ground area is always a problem when hay is fed on the ground, not to mention the likelihood of horses to be infested or re-infested by parasites, especially when manure is stockpiled in one of the paddocks’ corners. Runoff from soggy manure piles and muddy paddocks can cause serious surface and groundwater contamination problems.

A recently conducted survey on 346 Kentucky horse farms indicated that the major pasture problem was maintaining grass cover in high traffic areas. Other problems included having overgrazed paddocks and adequate grass in the spring, but not later in
the year. Farmers do not seem to understand the correlation between overgrazed paddocks and potential water pollution.

The following BMPs have been identified for demonstration purposes on suburban horse farms: a) Geotextile and fly ash pads around waterers, near feeding areas, and at congregation points to demonstrate mud minimization techniques; b) Manure composting units to demonstrate manure management techniques; c) Managed stream crossings using geotextile, geoweb, and rocks to demonstrate the advantage of limiting animal access to water; d) Temporary water system as an alternative to stream and pond water using plastic tanks and UV protected plastic pipes; and e) Paddock management. In most cases, several strategies will be demonstrated at each location.

Prior to BMP Implementation, baseline water quality issues of suburban horse farmers will be obtained by the use of a survey asking horse owners about farm characteristics, water quality and other environmental issues. The survey will be sent to 4,000 Kentucky owners of Quarter Horses. The information gathered from this survey will be used as baseline information that will guide us on the development of specific educational materials for suburban horse owners.

Since mud and/or wind blown dust are the primary reasons for water and air pollution on suburban horse farms, heavy use area protection will be implemented at most demonstration sites. Most horse owners and stable operators are unaware of the proper installation of heavy use protection areas. The typical practice is the purchase and placement of gravel in heavy use areas, which quickly reverts back to mud and dust because of the improper installation. This is problematic because money is being wasted and operators are less likely to adopt a practice that fails. A key component of the project will be fact sheets and a video that describes the proper installation of a heavy use area.

**Estimated Cost**

The approximate cost for a heavy use area protection is one dollar per square ft. We estimate the average size of a protected area to be about 1000-1500 ft\(^2\) making the cost to be $1000-1500 per protected area. The construction of a composting facility is a little more involved because it includes a structure. We estimate the cost of the compost facility to be 3-6 dollars per square foot. Size of the facility will depend on the number of horses on the farm. Each horse produces approximately 700 ft\(^3\) of manure and bedding each year. If the horse was housed indoors all year and the average height of a compost pile is 5 ft, then a floor area of 175 ft\(^2\) would be needed.

**Relative Treatment Efficiency of BMP’s:**

Our long-term goal is to promote and facilitate management strategies and manure handling methods, which reduce water pollution from suburban horse farms. Conservation practices that protect water quality at horse farms add to a property’s value, promote horse health, and build good community relationships. Because of the significant destruction of vegetation near high traffic areas, the focal point of the project is the proper installation of heavy use protection areas to reduce sediment and dust transport from suburban horse farms.

**Operation and Maintenance**

The Project team will develop operation and maintenance plans for each BMP. These plans will be part of the fact sheets developed for landowners and operators. The plan
will specify the key components of the BMP, operational goals of the BMP, possible repair and maintenance needs, and inspection schedule. The plan will detail the level of repairs needed to maintain the effectiveness of the BMP.

3. Description of BMP Targeting Process:
A quick tour of suburban horse farms reveals the problem of maintaining grass cover near high traffic areas where horses congregate. Horse owners and farm operators are unaware of methods to alleviate the muddy conditions. The primary BMP to be demonstrated at each farm will be a heavy use area protection. At selected sites, manure management practices that include composting will be demonstrated. Field days will be conducted in order to demonstrate the benefits of a particular BMP (composting, geotextile pads, stream crossings, alternative water system, pasture management, etc.) as well as how to implement and maintain it on the farm. Field days will take place in different farms during construction of BMPs and after their implementation. Fact sheets will be specifically developed for the field days.

We will document pre and post BMP implementation photographically in order to show differences to horse owners and other interested parties in a web site, publications, and during field days. Workshops and in-service training sessions will provide horse owners, extension agents, and other interested groups with the best information available on BMP selection, implementation, and maintenance, and how they can affect water quality. The workshop materials will include handouts (concise extension fact sheet) and Power Point presentations. Workshops may be combined with field days/tours activity. Our industry collaborators will be asked to participate actively in this information dissemination process. We will also develop a manual on BMP selection and implementation for suburban horse owners. A project web site will be developed to facilitate the transfer of information to the general public. We will also develop a video on the benefits and implementation of specific BMPs to suburban horse farms.

4. NPS Section Notification Process
The NPS Program Staff through the DOC will be notified of BMP Implementation on project sites at least one week prior to implementation. The written notification will include a listing of BMP’s to be implemented, location of the site, and estimated costs. In addition to notification about BMP Implementation, all published materials will be submitted to NPS program for review and approval prior to final product development.

5. Financial Plan of Action
The Mud-Horse BMP Demonstration project is intended to illustrate proper installation techniques for key BMP’s on suburban horse farms. In order to illustrate these techniques, the project will construct BMP’s on a wide range of suburban horse farms in Fayette and surrounding counties. To achieve access to these farms, the Mud-Horse project will install the BMP’s at no cost to the farm operator.

6. Maintenance Agreements
An Operation and Maintenance (O&M) Plan will be developed for each BMP. The O&M Plan will be reviewed with the landowner or operator. At a minimum, the plan shall specify that the treated areas and associated practices are to be inspected annually and after significant storm events to identify repair and maintenance needs. The O&M plan will describe the level of repairs needed to maintain the effectiveness and useful life of the practice.
7. Assurance Statement
The Kentucky Agriculture Water Quality Act (KRS 224.71-100 through 224.71-140) was
enacted by the 1994 General Assembly to guide the state’s agriculture industry in its
efforts to address environmental issues. The KY Agricultural Water Quality Plan (KY
AWQP) was developed as a result of this Act. The KY AWQP is an effort to produce a
practical, flexible, coordinated natural resources management system that protects the
waters of the Commonwealth and complies with applicable government rules and
regulations. It is based on pollution prevention through the use of **Best Management
Practices** (BMPs). KRS 224.71 defines BMPs as the most effective, practical, and
economical means of reducing and preventing water pollution. BMPs establish minimum
acceptable quality levels for planning, siting, designing, installing, operating, and
maintaining agriculture and silviculture facilities and operations. BMP’s used as a part of
the Mud-Horse Demonstration Project will conform to guidelines identified in the KY
AWQP.
Mud, Horses, and Clean Water –
A BMP Demonstration Project for Suburban Horse Owners

Horse Owner Survey Results

In an attempt to quantify the problems associated with horse management and mud control on suburban horse farms, the project investigators conducted a survey of horse owners in Kentucky. In the spring and summer of 2005, approximately 4,000 surveys were distributed to Kentucky members of the American Quarter Horse Association. Additionally, the survey was available electronically through the project web site. 935 responses were received. The following paragraphs and graphs summarize the results of this survey.

As seen in Graph 1, 25% of Kentucky farmers feel that they have a mud problem. These problems could be caused by many factors. It is likely that there is not enough area allowed per horse. Management practices obviously also affect the actual and perceived mud problems. Interestingly, 70% of respondents do not feel they have a mud problem.

Do Farmers Think They Have a Mud Problem

Graph 1

To determine the stocking density, horse owners were questioned about the number of horses they owned and existed on the farm. Graph 2 shows the number of horses owned with over 70% having four or more horses. Graph 3 indicates that 76% of farm owners have four or more horses on their property. The good correlation between Graphs 2 and 3 indicate that the respondents generally owned all of the horses on their farm.
**Number of Horses Owned**

Graph 2

**Total Number of Horses on Farm**

Graph 3
Large groups of horses located in the same pastures can cause high traffic areas to become excessively muddy. Therefore, the amount of acreage and horses in pastures were questioned. Sixty percent of horse owners had more than 20 acres of land, but only 39% had more than 20 acres for pastures. An even greater concern is that 40% of horse owners have pastures with less than 10 acres and have between 1 and 3 pastures. Graph 7 shows that 46% of farmers have 4 or more horses in those pastures.

On some farms, horses are not the only type of livestock. While 48% of farms have only horses, the additional livestock will influence the stocking density and affect the amount of area needed in pastures. Beef cattle are the most prevalent livestock other than horses (Graph 8).
An interest in the survey was the practices and facilities for animal housing and feed storage. Fifty two percent of farms have 1 barn. Also, only 49% of the barns had between 1 and 4 stalls. Since 75% of horse owners have 4 or more horses on the farm, it can be assumed that on some farms the horses remain on pasture at all times.

For hay storage, 41% of farm owners indicated that they did not have a hay shed. Only 21% indicated they had no sheds. A question about run-in sheds shows that 46% of farm owners do not have run-in sheds. Since such a significant number of farm owners did not have hay or run in sheds, other methods of feeding and hay storage were investigated.
Farm owners were questioned on how hay was stored and the response was that 40% of hay is stored in lofts (Graph 14). However, 60% of owners feed hay on the ground. In addition, grain is fed in a variety of methods when the horses are on pasture (Graph 16).
Fifty percent of farm owners do not have an outdoor arena and 67% do not have an indoor area. Graph 19 shows that recreation and breeding are the most common activities for horses throughout Kentucky.
There are few walkers/exercisers found on farms (Graph 20). 60% of farmers had round pens while less than 1% had race tracks (Graphs 21 and 22). This further proves the observation that a majority of horses in Kentucky are raised for breeding and recreational purposes and farm owners may not have the resources to install more expensive equipment.

Of particular importance to this project was the type of land and how farm owners were managing their land relating to composting. Over 43% of farm owners had both rolling hills and flat lands. Manure was composted on 68% of farms. Manure was piled on 24% of farms (Graph 24).
Graph 25 shows that almost all composting areas are located on bare ground and compost is most often spread on pastures (Graph 26).

With the relatively high percentage of surface application of compost and manure, it is interesting to note that soil testing is not performed by 70% of horse owners (Graph 27). Soil testing can help reveal what nutrients are not available or are high in content in pastures and can provide guidance for future management practices relating to nutrients. Erosion is visible on 43% of horse farm pastures (Graph 28). Areas of bare ground, where mud problems often occur, were found most commonly in the high traffic areas, as expected (Graph 29). The most common areas were found to be in gates and around waterers.
Do Farmers Soil Test Pastures

Graph 27

Are There Visible Signs of Erosion on Pastures?

Graph 28
Areas of Bare Ground

Graph 29

Frequency of Cleaning Stalls

Graph 30
Graph 30 indicates that 48% of farm owners clean their stalls daily. This can be a direct correlation to the amount of manure or compost generated. Of the farmers that did compost materials, only 30% applied it to 10 or less acres (Graph 31). The timing of compost applications varied among farmers between weekly to yearly applications (Graph 32).

A variety of bedding types are used (Graph 33) with the most common being shavings, saw dust, and straw. These are likely the primary components of compost.

Horses are commonly watered in troughs or tanks (Graph 33) and only 27% of horses had full access to streams or ponds (Graph 34). Over 60% of farm owners were found to rotate their watering and feeding areas.
During times of intense precipitation, the types of waterways used for runoff can affect mud problems. Thirty eight percent of farms indicated no specific waterways for runoff conveyance (Graph 36). Just under 20% of horse owners noted a gully on the farm.
As shown in Graph 37, 56% of horse owners are between the ages of 36 and 55. Graph 38 shows that over 65% of farm owners have owned horses for over 15 years.

Graph 39 illustrates that the income range of horse owners is very diverse. The two largest areas cover 50% of horse farmers ranging within the $25,000 to $75,000.
In summary, this survey was instrumental in identifying factors relating to and perceptions about mud problems and manure management among horse owners and farm owners in Kentucky. With these data, project investigators believe that the fact sheets and demonstration areas developed through this funding will be useful resources for the horse owner.
Management Practices Survey for Kentucky Horse Owners

The purpose of this survey is to gather horse care information from Kentucky horse owners. The information gained from this survey will be used to develop Best Management Practices (BMP) related to pasture and manure management. Your time to complete this survey and information provided is greatly appreciated.

1. What is your age?  
   - < 18  
   - 18 - 25  
   - 26 - 35  
   - 36 - 45  
   - 46 - 55  
   - 56 - 65  
   - over 65

2. How long have you owned horses?  
   - < 2 yrs  
   - 3 - 5 yrs  
   - 6 - 10 yrs  
   - 11 - 15 yrs  
   - > 15 yrs

3. Household income:  
   - < $24,999  
   - $25,000 - 49,999  
   - $50,000 - 74,999  
   - $75,000 - 99,999  
   - > $100,000

4. What is your zip code?  

5. Equine activities you participate in:  
   (check all that apply)  
   - breeding  
   - training  
   - boarding  
   - recreation

6. How many horses do you own?  
   - 0  
   - 1 - 3  
   - 4 - 6  
   - 7 - 9  
   - 10 - 14  
   - 15 - 20  
   - > 20

7. How many do you care for on your farm?  
   - 0  
   - 1 - 3  
   - 4 - 6  
   - 7 - 9  
   - 10 - 14  
   - 15 - 20  
   - > 20

8. How many horses that you own are kept at a boarding or training facility?  
   - 0  
   - 1 - 3  
   - 4 - 6  
   - 7 - 9  
   - 10 - 14  
   - 15 - 20  
   - > 20

9. Total number of horses on the farm:  
   (including personal and client horses)  
   - 0  
   - 1 - 3  
   - 4 - 6  
   - 7 - 9  
   - 10 - 14  
   - 15 - 20  
   - > 20

10. Number of acres on farm:  
    - 1 - 4  
    - 5 - 7  
    - 8 - 10  
    - 11 - 13  
    - 14 - 16  
    - 17 - 20  
    - > 20

11. Number of acres for pasture:  
    - 1 - 4  
    - 5 - 7  
    - 8 - 10  
    - 11 - 13  
    - 14 - 16  
    - 17 - 20  
    - > 20

12. Number of pastures on farm:  
    (including pastures that have been divided to allow rotational grazing)  
    - 1 - 3  
    - 4 - 7  
    - 8 - 10  
    - 11 - 13  
    - 14 - 16  
    - 17 - 20  
    - > 20

13. Number of horses per pasture:  
    - < 3  
    - 4 - 6  
    - 7 - 9  
    - 10 - 14  
    - 15 - 20  
    - > 20

14. Other livestock on farm:  
   (check all that apply)  
   - dairy cattle  
   - beef cattle  
   - sheep  
   - swine  
   - goats  
   - poultry  
   - horses only  
   - other (llamas, etc.)

15. Indicate facilities on your farm:  
   a. Number of barns:  
      ____________________________
   
   b. Number of stalls used:  
      ____________________________
   
   c. Number of sheds:  
      (machinery/storage)  
      ____________________________
   
   d. Number of hay sheds:  
      ____________________________
   
   e. Number of run in sheds on pasture:  
      ____________________________
   
   f. Number of arenas:  
      indoor:  
      ____________________________
      outdoor:  
      ____________________________
   
   g. Number of round pens:  
      ____________________________
   
   h. Number of racetracks:  
      ____________________________
16. What is the contour of your pasture/farmland?
- flat
- rolling hills
- both

17. Do you actively compost your manure/muck?
- yes
- no
- pile manure
  If yes, the compost area is:
  (check all that apply)
  - a paved surface
  - a graveled surface
  - a covered building
  - piled on bare ground

18. How often do you clean stalls?
- daily
- 2 - 3 times per week
- weekly
- infrequently, horses are out most often

19. What do you do with the manure/compost?
(check all that apply)
- give it away
- sell it
- use on your garden
- use it on your pasture
- use it on your fields
- leave it in pile
- have it hauled away
- use it to fill low areas on farm
- apply fresh manure to pasture/crop land

22. How often is the manure/compost applied to the land?
- weekly
- monthly
- once every 6 - 12 months
- once per year

23. Type of bedding used:
(check all that apply)
- straw
- shavings
- saw dust
- grass hay
- paper
- woodchips
- peat moss
- sand
- pelleted wood products
- no bedding

24. How do you store your hay?
- stored in same facility where horses are housed
- stored separately from horse barn
- hay loft in barn

25. When feeding hay on pasture, do you:
(check all that apply)
- use a hay feeder
- feed on ground
- do not feed hay on pasture

26. When feeding grain on pasture, do you use:
(check all that apply)
- portable pans on ground
- buckets on fence
- stationary feed bunk
- feed bag
- no container on ground
- do not feed grain on pasture

27. Source of water in pasture:
(check all that apply)
- trough/tank
- automatic waterer
- stream/creek
- pond
- fence line buckets

28. After extended periods of precipitation, are there areas within your pasture(s) that tend to act as a:
- grassed waterway?
- intermittent stream?
- gulley (evidence of erosion)?
- no concentrated water flow exists.

29. If you have streams or ponds present within your pasture, do you:
- Supply an alternative source of water away from streams and ponds?
- Allow only limited access for drinking from streams and ponds?
- Allow full access to streams and ponds?
- No streams or ponds are present.

30. Do you soil test pastures on a regular basis?
- yes
- no

31. Are there any visible erosion and/or worn areas within your pastures?
- yes
- no
  If yes, what percentage of your pasture is eroded?

32. Areas of bare ground:
(check all that apply)
- around gates
- around waters
- around feeders
- around shaded areas
- around commonly congregated areas

33. To prevent build up of manure and mud conditions, do you rotate feeding, watering, and other heavy use areas on your pastures and paddocks?
- yes
- no

34. Do you think you have a mud problem?
- yes
- no
  If yes, name one practice you have done to try and minimize the problem?

We appreciate the time you have taken to fill out this survey.

Funding for this project, Mud, Horses, and Clean Water-A BMP Demonstration Project for Suburban Horse Owners, was provided in part from a grant from the U.S. Environmental Protection Agency (USEPA) through the Kentucky Division of Water, nonpoint Source Section to the University of Kentucky as authorized by the Clean Water Act Amendments 1987, 319(h) nonpoint Source Implementation Grant #C9994861-04. The contents of this document do not necessarily reflect the views and policies of the USEPA, KDOW, or the University of Kentucky Research Foundation nor does the mention of trade names or commercial products constitute endorsement. This document was printed on recycled paper.

Educational programs of Kentucky Cooperative Extension serve all people regardless of race, color, age, sex, religion, disability, or national origin.
Managing horses can be a rewarding experience, but it can also be challenging. Improper pasture management of horses during the winter and early spring months can adversely affect pasture quality and the environment. Horse owners can elect to use a dry lot. Dry lots are designed as permanent heavy traffic/use areas and are often used on cattle farms. They keep animals in a confined area to prevent them from damaging the entire pasture. A typical dry lot would contain water, feed buckets, salt or mineral blocks, and hay feeders. The area can be used for wintering animals, handling animals for medical treatments, reducing calorie intake for obese horses, etc.

**Justification for a Dry Lot**

Congregating horses around feeding and watering areas can create mud, increase soil compaction, and eliminate desired dormant vegetation that would otherwise emerge in early spring, and lead to increased weed infestation. Simply put, wintering horses on pastures can be problematic in Kentucky, because of the weather. One reason is the relationship between precipitation and evapotranspiration (ET), the process of losing water from wet surfaces and vegetation due to evaporation and transpiration. In the early summer months, plants survive by using their roots to remove water and nutrients from the soil. An intense rainfall event can produce runoff when the infiltration rate is exceeded, but this can be filtered by the existing vegetation. In late fall, precipitation begins to exceed ET, and the soil water becomes recharged (Figure 1). By winter time, ET has diminished, but precipitation is still occurring. The surface of the soil remains wet for longer periods and less water can be stored in the soil, increasing the potential for runoff. These wet conditions reduce soil strength and allow mud to develop if the vegetation is severely grazed, trampled, or removed. Grazing too many horses on a limited area over long periods of time during these wet periods creates muddy conditions for horse owners/operators (Figure 2). More important, increased traffic during wet periods increases the bulk density and reduces aeration of the soil, making it more difficult for root growth and water infiltration.

**Figure 1.** Rainfall and evapotranspiration by month.

Precipitation data provided by the UK Agricultural Weather Center, averaged on a per-month basis from 1895 to 2007. http://wwwagwx.ca.uky.edu/.
While the wintertime water movement is occurring and mud is accumulating, the horses in the pastures should be supplemented with additional feed to make up for the decrease in actively growing vegetation. However, the horses don’t stop feeding on the remaining forage. There is limited vegetation to reduce surface runoff, allowing sediment, manure, pathogens, and nutrients to flow off the soil surface and travel off-site. At this point, increased soil compaction is probably preventing absorption of water and nutrients into the soil. Meanwhile the streams are reaching the top of their banks and removing the water and contaminants from the watershed. Erosion of the soil, if allowed to go unchecked, can lead to environmental impacts such as the removal of soil and nutrients.

The nutrient that is most commonly taken with the soil particles is phosphorus, lack of which can cause eutrophication, a process that promotes aquatic plant growth, leads to a depletion of oxygen from the water, and possibly fish kills. Nitrogen, on the other hand, has more soluble chemical forms than phosphorus and is more prone to move off-site into water sources by leaching and cause eutrophication. In addition, drinking water contaminated with nitrate-nitrogen can be toxic to humans and animals if the concentration is above 10 mg per liter.

To prevent overgrazing, refer to College of Agriculture’s publication Using a Grazing Stick for Pasture Management (AGR-191). This publication can provide useful information regarding the stocking density for pastures and when to remove animals when forage becomes limited.

By spring, the once-green pasture is mostly bare with compacted soils. Weeds, which are more efficient at converting nutrients and sunlight into vegetative mass, are now able to propagate in the bare areas. In the areas that were used for feeding hay, a thick mat of uneaten material may have smothered the soil and vegetation. The area now holds moisture and has kept the soil temperatures cooler, preventing the reestablishment of a desired vegetative cover. The end results are fields that have soil and nutrient losses that will require more management and money to eliminate weeds and reestablish grass.

Benefits of Dry Lots

The use of dry lots can:
- Maintain forage and reduce mud on a larger pasture scale, thereby controlling the amount that an animal consumes. (Controlling the amount of forage consumed is especially important for older animals that require weight control.)
- Prevent erosion around the fence line, gates, waterer, and other high traffic areas.
- Reduce the need for vegetation maintenance. (Unlike pasture, any vegetation that does emerge is a weed and can be sprayed with a broad spectrum herbicide according to manufacturer’s recommendations.)
- Function as central locations for watering and supplemental feeding for several pastures.
- Provide shade.
- Reduce the need to renovate pastures in spring.
- Act as an outdoor facility that can be used to manage animals.
- Allow other pastures to be rested and fertilized to provide additional yield for the following year. (Stockpiling for Fall and Winter Pasture [AGR-162] is designed for cattle producers, but the concepts can be applied to horse production.)

How to Construct a Dry Lot

A dry lot is removed from a larger pasture area by a fenced boundary (Figure 3). A dry lot can also be set up as a hub for a series of paddocks. In either situation, horses are allowed access to the dry lot through one or two gates that lead from the existing pasture or pastures. The area is used year-round to provide access to water and supplements, but it can also be used during the winter and early spring months as a confined feeding area.

Figure 3 shows an ideal location for a dry lot that is in close proximity to the barn to reduce labor. This particular dry lot is intended to provide water, feed buckets, salt/mineral block, shade structure, and possibly a hay ring feeder. The size and layout of the dry lot allows gates, feed, and water to be adequately spaced to limit overcrowding that may expose the horses and handlers to risk. Farm gates are used to allow freedom to move from the dry lot to the pasture or as a means of limiting access to the much larger pasture area.
Location

Depending on the layout of a paddock, the location of the dry lot can be easily determined. Topography and environmentally sensitive areas should be considered when planning the location. The location of the dry lot should be a well-drained area that is relatively flat and does not have a drainage swale or ditch running through or across it. The logical location of the dry lot would be around an area where the water source is located. An ideal location is on a summit or flat area on top of a hill, as long as there is some protection from the wind (structure, trees, etc). A summit location usually provides a long distance for any runoff to travel before it reaches a stream or waterway. Farm managers should not place a dry lot near a stream or where the drainage to a stream or sinkhole is less than 150 feet away. If a stream is located nearby, producers should consider installing a riparian area (dense vegetation along a body of water) to protect water quality.

Figure 4 shows the location of a dry lot placed away from environmentally sensitive areas but close to the horse operation. This area already suffers from high traffic and could have a heavy traffic area installed to reduce mud. Ideally, the dry lot would be placed on a summit and should not be adjacent to a barn, because roof runoff can have an adverse effect if allowed to flow through any part of the dry lot. However, the dry lot should be close to the farm operations to save time. Drainage water should move off the area as sheet flow and drain into a buffer strip. Clean water should be diverted from the dry lot.

Size

Size should be considered in the design to provide adequate space for the planned number of animals to move around freely to eat, drink, and socialize. An area of at least 900 to 1,500 sq ft per horse is recommended. The size is dependent upon the age, type, size, and temperament of the horses as well as the area available for enclosure. Keep in mind that most horse operations that have constructed pads...
Construction

Individuals skeptical of the benefits of having horses on gravel instead of mud can opt to create an area that is only partially graveled. Construction can begin once the dry lot has been justified, located, and sized.

Excavation of the topsoil is required to construct the heavy use traffic pad. The topsoil is removed down to a soil horizon with a higher clay content and more stable surface. Livestock producers have used track and skidsteer loaders to excavate the soil down to a clay layer. Some producers have used plows to till the soil and to make it easier for the soil to be removed by skidsteer loaders. Producers installing these areas should strongly consider where the spoils will be placed. Producers may even want to consider selling the topsoil removed from these areas.

After excavation, geotextile fabric should be laid down over the exposed soil to prevent rock from sinking into the ground and soil from moving up through the matrix. The National Resources Conservation Service (NRCS) recommends a non-woven, non–heat bonded, and needle-punched geotextile fabric under all treatment areas unless the foundation is rock or concrete is used as the surface treatment. The fabric should have the minimum material requirements as specified in Table 1. A weight for the geotextile fabric is usually not specified, because the specific material features are different from one manufacturer to another. The fabric should have at least a 6 oz/sq yd weight fabric to meet the requirements in the above table. Your local agriculture extension agent, NRCS district conservationist, agricultural supply store, concrete supply store, etc., are potential sources of information on where geotextile fabric can be purchased.

A base layer of large rock (i.e. # 2 or 4s) should be laid on top of the fabric, to a depth of at least 6 inches (Figure 5). Caution should be taken when spreading the base layer not to disturb the geotextile fabric. After the base layer, a top layer of 2 to 3 inches of dense grade aggregate (DGA) should be spread over the area (Figure 5). This will provide a solid, stable surface for feeding over the winter. It may also be desirable to extend the geotextile fabric and rock out past the gates into the pasture, as these areas will see heavy traffic, especially if only one entrance to the pad exists. Further criteria and considerations for the construction of the dry lot surface can be found in NRCS Conservation Practice Standard Code 561, Heavy Use Protection Area, and the College of Agriculture publication High Traffic Area Pads for Horses (ID-164).

Fences and Gates

A wide range of fencing options exists, depending on the desires of the horse owner/operator. However, dry lots are permanent structures and should not be constructed using temporary or only electric tape materials. In a situation where the animals are crowded it is very important to think of horse and handler safety. Corners and metal T-posts should be avoided. Normally, the dry lot will have a gated access from a farm road or farmstead. Gates and fences should be designed to accommodate truck and tractor access to facilitate feeding and cleaning. It should also have at least one gated access from the dry lot to the remaining pasture. Further information for the construction of fences can be found in NRCS Conservation Practice Standard Code 382.

Costs

The cost of installing a high traffic area pad for a dry lot will be approximately $0.80/sq ft (Table 2); a concrete pad would cost about $4.00/sq ft. Costs of the project can be reduced by excavating the site yourself and possibly selling the topsoil. Costs of the project can be justified by the money that would typically be spent renovating lost pasture and the forage that would be saved. Forage losses can be reduced by 50% when feeding on a dry lot surface or from hay feeders placed on a dry lot surface rather than

| Table 1. Minimum Requirements for Non-Woven Geotextile. |
|---------------------------------|-----------------|------------------|
| Property                        | Test Method     | Value            |
| Tensile Strength (pounds)¹      | ASTM D 4632 Grab Test | 150 min          |
| Bursting Strength (psi)¹        | ASTM D 3786 Diaphragm Tester | 320 min          |
| Elongation @ Failure (percent)² | ASTM D 4632 Grab Test | > 50             |
| Puncture (pounds)²             | ASTM D 4833     | 80 min           |
| Ultraviolet Light (% residual tensile strength) | ASTM D 4755 150 hours exp. | 70 min |
| Apparent Opening Size - AOS    | ASTM D 4751     | # 40 max²        |
| Permittivity (1/sec)           | ASTM D 4491     | 0.70 min         |

1. Minimum average roll value (weakest principal direction)
2. U.S. standard sieve size
Source: NRCS Conservation Practice Standard, Heavy Use Area Protection Code 561.

| Table 2. High traffic area pad costs. |
|--------------------------------------|-------------------|-----------------|
| Item                                | Cost ( /sq ft)    |
| Geotextile Filter Fabric            | $0.06             |
| Rock Base (No. 4 Crushed Limestone) | $0.25             |
| Densely Graded Aggregate            | $0.14             |
| Total Materials                     | $0.45             |
| Labor/Grading Work                 | $0.35             |
| TOTAL COST                          | $0.80             |
from muddy surfaces. Horses placed on dry lots may also lose fewer shoes in the mud, which is another savings.

Riparian Area

When the loss of nutrients and sediment cannot be avoided, property owners should consider installing a riparian area, or vegetative buffer strip, as needed, to prevent sediment, nutrients, and other contaminants from reaching nearby streams, sinkholes, or other environmentally sensitive areas. Buffer strips are dense vegetation areas that slow surface water flows. The USDA-NRCS definition from Practice Code 391 reads, "An area of trees, woody shrubs, grasses, and other vegetation established in zones located adjacent and up-gradient from water courses, wetlands, sinkholes, and impounded water bodies."

The nutrients and pathogens in the water flows are filtered by the dense vegetation and thatch in these areas. Much of the filtered nutrients are taken up by the vegetation and thatch in these areas. Much of the nutrients and pathogens are destroyed or broken down by beneficial bacteria. Vegetative buffers are a simple and cost effective method for protecting water bodies from the pollution effects of animal and farming operations. The width of a proper buffer strip depends on many factors, such as the size of the stream, floodplain, slope, soils, etc.

The conservation plan for this farm also provides a riparian area to increase infiltration of water, filter nutrients, pathogens, and pesticides (Figure 4). Riparian buffers are considered a Best Management Practice (BMP) for improving water quality.

The illustration shows the actual and previous location of the perennial stream (blue line). There is no ideal width for riparian areas, because of numerous variables that include slope, soil type, water table, size of the stream and floodplain, etc. The local USDA-NRCS district conservationists are good sources to determine the location and width of a riparian and/or buffer strip area. District conservationists have contact information for forest service representatives who can prescribe tree and vegetation planting schemes to complement the area.

USDA-NRCS conservationists may also be able to provide cost share funds to offset the expense of installing buffer strips. Information on cost share opportunities and technical assistance for the installation of BMPs such as riparian buffers is also available through the Kentucky Division of Conservation. Individuals interested in more information regarding BMPs, producer eligibility, and signup opportunities should contact their local USDA-NRCS Division of Conservation office.

Dry Lot Management Strategies

A dry lot is typically designed to keep horses off a pasture to prevent them from harming the vegetation during the winter months. When managed in this manner the animals are fed supplemental feed (hay) on the dry lot until the seasons change and become drier. However, more management is required to prevent the animals from eating too much grass after being fed hay, because it could lead to colic, founder, and possibly death of the horse. Horses are not required to spend all of their time in the dry lot during the winter months. A good time to allow the horses to have access to pasture is when the field is frozen, because it is possible that they could still graze without harming the surface of the paddock. Getting the horses off of a gravel surface is also a good management practice when the gravel surface is frozen. During these times, the gravel can act as an abrasive surface that could wear and damage hooves. The chances of this occurring depend on the amount of manure and forage residue cushioning the gravel surface as well as whether the horses' hooves are protected by shoes.

Dry lots have been used as locations to provide lighting for open mares. Usually the horses are brought up from a pasture and placed under the lights before evening. This method has been used as an alternative to housing the mares in stalls through the night.

Dry lots can also be managed to prevent or restrict horses that are overweight or susceptible to founder from eating grass pastures during certain times. On average, in Kentucky, these animals would be held off pasture from the time grass begins to grow vigorously (April) until the time it begins to slow (June) and then again when the forage begins growing again in the fall. During the remaining times the horses can usually be placed on pasture without a significant chance that they will overeat.

Another approach to managing a dry lot is to allow the horses to freely move from the dry lot area to a pasture through an open gate year round. Ideally, the dry lot would be set up as a hub for several pastures to provide a rotational grazing system. In this case the dry lot is used more as a heavy traffic area pad for feeding and watering the horses. Although not considered a normal dry lot, it is a useful area for managing the horses and controlling mud.

Maintenance of the Dry Lot

Maintenance of the dry lot should include scraping up manure and unused hay on an "as needed" basis. The pad should be periodically cleaned to prevent the buildup of manure and the possible mixing of the manure with the rock surface. How often the pad needs to be cleaned depends on several factors, including the number of horses, the size of the pad, how long the horses are on the pad, the amount of feeding and wasted hay, etc. When removing the manure and wasted forage, try to remove as little rock from the surface as possible. The
areas with the highest concentration of manure and wasted forage should be cleaned on a regular basis. Typically, this will not involve cleaning the entire pad.

If possible, the manure should be stored in a covered structure until it can be properly disposed. One of the best methods is land application to cropland or pasture based on crop removal rates and soil test fertility levels. Manure applications should be preceded by soil test results. For more information see 2008-2009 Lime and Nutrient Recommendations (AGR-1) and Soil Testing: What It Is and What It Does (AGR-57) for how to collect soil samples. All manure applications should follow the NRCS Code 590 Nutrient Management recommendations. The manure could also be composted prior to land application. (See Composting Horse Muck [ID-168] for more information.)

Through proper operation and maintenance, the dry lot could provide a stable and secure area for winter feeding and year round watering for many years without the need for significant repairs or additions. Maintenance may include periodically top dressing with DGA, applying moisture, and compacting the area.

Further Reading