AGRICULTURAL MANAGEMENT PRACTICES CATALOGUE

FOR

NONPOINT SOURCE POLLUTION PREVENTION

AND

WATER QUALITY PROTECTION

IN

NEW YORK STATE

PREPARED BY:

Agricultural Management Practices Sub-Committee
of the
New York State Nonpoint Source Management Practices
Task Force

Summary Sheets Developed by:

NYS Department of Environmental Conservation
Division of Water
Bureau of Water Quality Management

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(Fourth Revision and update, inclusive of New Summary Sheets and Revisions)

PREFACE

The Agricultural Management Practices Catalogue was prepared by the New York State Department of Environmental Conservation, in cooperation with agencies of the New York Nonpoint Source Coordinating Committee. Funds for this activity were provided by the U.S. Environmental Protection Agency-Region II under a Section 319 Grant of the Clean Water Act.

The revisions and additions to this catalogue that were made in June 1994, October 1995, April 1996 and April 2007 are included in this printing of the catalogue.

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I. INTRODUCTION

A. Background

The Water Quality Act of 1987 placed increased attention on the development and implementation of nonpoint source control programs. Section 319 of the Act required states to prepare an Assessment Report identifying waterbodies affected by nonpoint source pollution, determining categories of nonpoint sources that are significant problems in the state and listing state programs available for the control of nonpoint source pollution. States were also required to prepare a Management Program which explained how they planned to deal with the source categories causing the major problems.

The New York State Department of Environmental Conservation (DEC) by virtue of its statutory authority for the management of water resources and control of water pollution in the state, has assumed the lead responsibility for control of nonpoint source pollution. One action taken by DEC to carry out its NPS responsibility was the development of a Nonpoint Source Management Plan in January 1990. The Management Plan outlines how DEC will identify, describe and evaluate management practices to be used to reduce nonpoint sources of pollution and make recommendations for additional control options needed to address nonpoint source pollution.

B. Candidate Management Practices

In New York, a list of candidate management practices was developed in 1989 by the Nonpoint Source Working Group, a task force under DEC leadership, composed of federal and state agencies and groups representing a broad range of issues. The Working Group recognized that there are numerous practices available with potential to control nonpoint source pollution, however, the management practices were not systematically inventoried or evaluated for effectiveness in preventing or remediating nonpoint water quality problems in a statewide context. In addition, they were not catalogued in a form that facilitated their widespread use throughout the state.

A Nonpoint Source Management Practice Task Force was created in early 1990 according to the guidelines contained in Chapter IV of the Nonpoint Source Assessment Report. Agencies listed in that chapter were invited to participate in a meeting of the Task Force on February 1, 1990. At that meeting, there was a discussion of the process to be followed for establishing the list of management practices, and each agency was given an opportunity to identify source category subcommittees on which they wanted to participate.

C. The Agricultural Management Practices Subcommittee

In June 1990, an Agricultural Management Practices Subcommittee was formed under DEC leadership to review the effectiveness of the candidate management practices and to consider additional management practices. Members on the Subcommittee represented agriculture at the university, research, federal, and state and private sector levels. All members served as reviewers of the management practice summary sheets, which were prepared by a DEC staff member. A few Subcommittee Members, with recognized, statewide technical leadership for a management practice, were asked to author some of the management practice summary sheets.

The individual management practice evaluations, known as Agricultural Management Practice Summary Sheets, collectively form the basis of the Agricultural Management Practices Catalogue. The Catalogue will contain the list of agricultural management practices eligible for financial assistance under Section 319 program implementation funds.

D. Agriculture as a Source of Nonpoint Source Pollution

In New York, Agriculture ranks as the second most common primary source of nonpoint pollution out of 14 primary sources. Information from the 1993 PWP Report indicates that as a primary source, Agriculture affects 191 waterbody segments covering over 90,375 acres of surface waterbodies and 1,394 miles of rivers. This information would suggest that as a primary source of nonpoint pollution, Agriculture is responsible for about 13% of the total water quality impacts to segments.

Using the information from the NPS Assessment, eleven land use/land management subcategories were identified as contributing to the agricultural NPS problem; row crops, truck crops, overgrazing, barnyard runoff, manure spreading, fertilizer application, pesticide application, riparian vegetation removal, livestock in stream, improper manure storage and "other" agricultural activities. The NPS Assessment documents that eight primary pollutants are responsible for water quality degradation in agricultural subcategories: sediment, nutrients, thermal modification, organic enrichment, pesticides, pathogens, aesthetics, and unknown toxic.

E. What are Agricultural Management Practices?

Agricultural management practices prevent or reduce the availability, release, or transport of substances which adversely affect surface and ground waters. They act generally to diminish the generation of pollutants from specific sources, in this case, agriculture. While a management practice can have standards associated with its installation, operation or maintenance, it does not impose effluent limits for specific substances. Rather, it provides an effective means of reducing or preventing the impact of nonpoint pollutants from a specific source category.

Agriculture management practices are means of achieving desired results, whether they are implemented by a private, commercial or governmental entity, and whether through voluntary action, financial incentives, or regulatory requirements. They can have a broad, generic application or can be highly specific to certain geographic, climatologic, hydrologic and chemical factors.

The list of Agricultural Management Practices for New York is outlined in Table I.

Using the Agricultural Catalogue as a starting point, "best" management practices (BMP) can be selected from this list by those professionals involved in watershed planning and related efforts. A management practice or series of practices is considered "best" only in the context of solving a particular nonpoint source problem in a specific watershed, or in response to a generic statewide situation. For example, contour farming might be the best management practice in one watershed while terraces are the correct treatment in another.

Agricultural management practices can be categorized as operational, vegetative, or structural, depending upon their purpose, function and design.

Operational practices: are practices that involve changes in farm management, usually resulting in a change in day-to-day decision-making. For example, Fertilizer Management and Land applications of Manure are examples of operational management practices.

Vegetative practices: increase the amount of herbaceous and/or woody vegetation on a field or critically eroding area. Permanent Vegetative Cover and Filter Strips are examples of vegetative management practices.

Structural practices: are usually practices that require engineering design, and often control surface runoff which is the primary transporter of most agricultural pollutants. Terraces and Barnyard Runoff Management Systems are examples of structural management practices.

With few exceptions, the practices listed in the Catalogue are currently in use by most segments of New York's agricultural community.

Depending on soil and groundwater conditions, the most appropriate agricultural management practice in one watershed may involve using practices that minimize the risk of leaching nutrients and pesticides to groundwater, while in another watershed the loss of nutrients and pesticides to surface waters may require practices that control surface runoff and erosion.

Table II lists the Agricultural Management Practices, by category and lifespan.

Management practices' lifespan vary by practice and are identified in Table II. An agricultural management practice's lifespan is based on the length of time the practice can be expected to control the pollutants for which it was designed. The lifespan listed is considered a minimum, if proper operation and maintenance of the practice is performed.

Agricultural Management Practice Summary Sheet

The following defines the terms used on the Management Practice Summary Sheets:

i.	Title:	is the management practice name found in the block at the top of the summary sheet.
ii.	Definition:	is a brief statement that defines the management practice to be summarized.
iii.	Water Quality Purpose:	states why the practice is used for NPS pollution control.
iv.	Source Category:	in all cases Agriculture/Surface Runoff is the source category for this Catalogue.
v.	Pollutants Controlled:	identifies the NPS pollutants controlled by the management practice.
vi.	Where Used:	identifies the land uses or situations where the management practice can be applied.
vii.	Practice Description:	describes the management practice in terms of its vegetative, structural and/or operational components.
viii.	Practice Effectiveness:	summarizes the documented practice effectiveness for controlling the NPS pollutants identified. This information is based on written national water quality research findings, university and agency research, water quality monitoring and water quality modeling. Practice effectiveness can be quite variable, due to watershed location, specific site conditions (soils, drainage, slope, crop, rainfall, runoff, etc.), farm management techniques, and the contribution of additional management practices used in a best management system. This section presents practice effectiveness as a range of quantitative values, or where that information is not available, in qualitative terms. The information provided should be used as guidance when estimating the potential effectiveness of the management practice within a specific watershed planning situation.
ix.	Impact on Surface Water:	defines what impacts, if any, the practice will have on surface water quality. Impacts are defined as None (neutral), Beneficial (positive), Slight (negative), Moderate (negative), and Severe (negative).
x.	Impact on Ground Water:	defines what impacts, if any, the practice will have on ground water quality. Impacts are defined as None (neutral), Beneficial (positive), Slight (negative), Moderate (negative), and Severe (negative).

xi. Advantages:	are favorable conditions associated with the installation of the management practice. Advantages include items such as cost effectiveness, ease of management or operation of the practice once installed and direct/indirect benefits associated with the practice.
xii. Disadvantages:	are unfavorable conditions associated with the installation of the management practice. Disadvantages include items such as unfavorable economics of the practice, extensive or expensive operations and maintenance requirements, and expected problems associated with the management practice.
xiii. Practice Lifespan:	described in quantitative or qualitative terms. Refer to Table II for a summary of practice lifespans.
xiv. Cost:	described in unit costs, system costs, or in qualitative terms. These are estimated average statewide costs.
xv. Operation and Maintenance	the successful control of agricultural NPS pollutants depends upon conducting the required O&M practices. In each case, where a management practice requires a specific course of O&M, it is detailed, or referenced in the management practice summary sheet.
xvi. Miscellaneous Comments:	this section deals with a variety of topics, including, if the management practice is currently recognized as a cost sharable practice under the New York State Agricultural Non-Point Source Abatement and Control Grant Program. Regulatory requirements (of NYS-DEC, U.S. Army Corps of Engineers; and other agencies) affecting installation of the management practice; additional management practices that are needed; availability of technical assistance, or equipment, from agencies that specialize in the installation of the management practice; and other pertinent miscellaneous information.
xvii. References:	those references used in the evaluation of the management practice are cited in this section. Many publications are nationally recognized sources of management practice evaluations, and information. Every effort was made to utilize information from New York State based university research and agency sources. When New York State based information was not available, and other states had appropriate information, those sources were cited. Management Practice Design Standards and Specifications are indicated as such in bold. In some cases, several agency or organizational standards and specifications are cited. USDA Natural Resource Conservation Service Management Practice Design Standard and Specification updates may be found at: http://www.nrcs.usda.gov/technical/efotg/. eFOTG website is the official reference for current Conservation Practice Standards and Guidelines.

F. How to Use this Catalogue

The catalogue should be used during the watershed planning process as a guide to selection of appropriate agricultural management practices for the control of pollutants from agricultural nonpoint sources. The catalogue is not a design manual, and should not be used to replace practice standards and specifications. The Catalogue is one of the technical tools professional watershed planners should use to evaluate agricultural management practices needed in a specific watershed planning effort. Using professional judgment, and the Catalogue, watershed planners can select the best management practice (BMP), or best management system (BMS), for the specific watershed situation at hand.

The following is a suggested procedure for using the Catalogue:

1. As a starting point, refer to Table IV for a quick reference of the Agricultural Environmental Management Tier II Worksheets that are available to assess the resource management area of concern. Agricultural Management Practices typically associated with the resource are also identified in Table IV.

2. Next, refer to Table III for the individual management practice summary sheets for the practices that control the pollutants you have identified.

   a. Determine if the practice is appropriate for the location by checking the "Where Used" section of each summary sheet.

   b. Refer to the "Practice Description" section to determine if this treatment is appropriate to the field problem.

   c. Read the "Practice Effectiveness" section to determine if this management practice will provide satisfactory expectations of pollutant prevention, or reduction of pollutant availability, release or transport.

For additional information on agricultural management practices, consult "Controlling Agricultural Nonpoint Source Water Pollution in New York State: A Guide to the Selection of Best Management Practices to Improve and Protect Water Quality", April 1991, by Patricia Longabucco, NYSDEC.

G. Updating the Agricultural Management Practices Catalogue
New York Nonpoint Source Coordinating Committee (NYNPSCC)

The New York Nonpoint Source Coordinating Committee (NYNPSCC) is responsible for updating the Agriculture Management Practices Catalogue. NYNPSCC meets quarterly and at one meeting each year considers updates to Management Practices Catalogues. NYNPSCC, which is composed of member organizations and agencies, including DEC as the lead agency, will be responsible for:

- Reviewing proposed additions, deletions, and revisions to the Management Practices Catalogue.
- Identifying additional categories of nonpoint source pollution, which have not been adequately addressed in the list of management practices.
- Suggesting research or demonstration projects on unproven or new management practices that appear to have potential for protecting water quality.

- Periodically reviewing the state list of management practices to verify the status of each practice. This review should be based on recently published literature and new or previously unknown research or demonstration projects.

Conditions For Updating The Catalogue

Any agency, organization, or group may propose an addition, deletion, or revision to the Catalogue, provided that it meets the following conditions described below.

The NYNPSCC will recognize four conditions for updating the Catalogue:

- Creation of a new agricultural management practice by an agency, university, or recognized group.
- Modification of an existing management practice, either in its design requirements or operation and maintenance requiring a modification of the practice definition, water quality purpose, practice description, practice effectiveness, impacts on surface or groundwater, advantages/disadvantages, practice lifespan, or cost.
- Emerging research data which indicates a change in management practice effectiveness and/or pollutants controlled, requiring modifications of water quality purpose, practice description, practice effectiveness, practice impacts on surface or groundwater, advantages/disadvantages, practice lifespan, or cost.
- Revisions in state or national water quality policy that necessitate a higher level of waterbody protection, resulting in higher management practice performance standards. Policy revisions would result in additions or deletions of management practices, modifications of practice description, design requirements, operation and maintenance requirement, practice effectiveness, impacts on surface and groundwater, costs and miscellaneous comments.

How To Propose An Update Of The Catalogue

1. By December 31 of each year, proposed updates should be stated in writing, and submitted to the attention of the New York Nonpoint Source Coordinating Committee, NYSDEC, Bureau of Water Quality Management, 625 Broadway, Albany, New York 12233-3508.
2. The Coordinating Committee will review the proposed updates at their next regularly scheduled meeting. A sub-committee of the Coordinating Committee may be formed to study the update and request input from groups not represented on the Coordinating Committee.
3. The sub-committee of the Coordinating Committee will review the proposed updates and determine if they meet the conditions for updating the Catalogue. In consultation with other interested groups, it will make a recommendation to the members of the New York Nonpoint Source Coordinating Committee by May 1 of the following year.
4. When the proposed update is approved, staff of the NYNPSCC will make the appropriate changes and distribute copies of the addition to all Coordinating Committee members and holders of the Management Practice Catalogue Binder.

Table I - MANAGEMENT PRACTICES FOR AGRICULTURE

Access Road Improvement	Jul 1991
Alternative Water Supply	Jul 1995
Barnyard Runoff Management System	Jul 1991
Conservation Tillage	Jul 1991
Constructed Wetlands	Jul 1991
Contour Farming	Jul 1991
Cover and Green Manure Crop	Jul 1991
Critical Area Protection	
Vegetative Crop	Jul 1991
Streambank and Shoreline Protection	Jul 1991
Crop Rotation	Jul 1991
Diversions	Jul 1991
Fencing	Jul 1991
Filter Strip	Jul 1991
Integrated Pest Management (IPM):Overview	Jul 1995
Biological Controls	May 1994
Cultural Practices	May 1994
Resistant Crop Varieties	May 1994
Scouting	Jul 1995
Trap Crops	Jul 1995
Irrigation Water Management	Feb 2007
Milking Center Wastewater Treatment	Feb 2007
Mulching – Vineyards/Cropland	Feb 2007
Nutrient Management: Planning	Feb 2007
Anaerobic Digestion	Jul 1995
Composting	Apr 1998
Feed Ration Evaluation and Balancing	Apr 1998
Manure Storage System	Apr 1996
Sequence Batch Reactor	Apr 1998
Nutrient/Sediment Control System	Jul 1991
Pathogen Management	Apr 1996
Pasture Management: Prescribed Grazing System	Jul 1995
Pesticide Management: Overview	Feb 2007
Agrichemical Mixing Facility	Feb 1991
Calibration and Application	Feb 2007
Evaluation of Site-Specific Leaching and Surface Loss Potential	Sep 1991
Pesticide Applicator Education and Training	May 1994
Read and Follow the Label Directions	Sep 1991
Petroleum Product Storage Spill Prevention and Containment	Apr 1996
Riparian Buffer	Jul 1991
Silage Leachate Control	Jul 1995
Stripcropping	Jul 1991
Terraces	Jul 1991
Waterway	Jul 1991

***this list of Management Practices and the accompanying Management Practice Summary Sheets were reviewed/revised/updated in 2007. The date associated with the practice represents when it was originally written or when major revision/rewrite was done on the practice summary sheet.**

Table II. Agricultural Management Practices by Category and Lifespan

- **The following lifespan is for BMP practices implemented under the New York State Agricultural NPS Abatement and Control Grant Program.**
- **Management Practice Lifespan indicates the minimum term that operation and maintenance must be preformed on the management system and/or practice. Implementation of an Operation and Maintenance (O & M) plan is required to assure efficient operation of the practice and may extend the practice lifespan beyond the minimum term.**
- **Management Practice Design Criteria is variable depending on the component practices that are used.**

Management Practices	Management Practice Categories			Management Practice Lifespan
	Operational	Vegetative	Structural	
Access Road Improvement		●	●	10 years
Alternative Water Supply	●		●	10 years
Barnyard Runoff Management System	●	●	●	10 years
Conservation Tillage	●	●		1 year
Constructed Wetlands		●	●	15 years
Contour Farming	●			1 year
Cover and Green Manure Crop	●	●		1 year
Critical Area Protection:				
- Vegetative Cover		●		10 years
- Streambank and Shoreline Protection	●	●	●	20 years
Crop Rotation	●	●		Length of crop rotation
Diversions		●	●	10 years
Fencing			●	10 years
Filter Strip		●		10 years
Integrated Pest Management (IPM):				
- Biological Controls	●			1 year
- Cultural Practices	●	●		1 year
- Resistant Crop Varieties		●		1 year
- Scouting	●			1 year
- Trap Crops	●	●		1 year
Irrigation Water Management	●		●	1 year
Milking Center Wastewater Treatment	●		●	10 years

Table II. Agricultural Management Practices by Category and Lifespan (Continued)

Management Practices	Management Practice Categories			Management Practice Lifespan
	Operational	Vegetative	Structural	
Mulching – Vineyards/Cropland		●		1 year
Nutrient Management: Overview - Anaerobic Digestion - Composting - Feed Ration Evaluation and Balancing - Manure Storage System - Sequencing Batch Reactor	● ● ● ● ● ●		 ● ● ● ●	1 year 20 years 15 years 1 year 15 years 20 years
Nutrient/Sediment Control System		●	●	10 years
Pasture Management: Prescribed Grazing System	●	●	●	10 years
Pathogen Management	●	●	●	10 years
Pesticide Management: Overview - Agrichemical Mixing Facility - Calibration and Application - Evaluation of Site-Specific Leaching and Surface Loss Potential	● ● ● ●		 ●	Temporary 20 years Temporary Temporary
Petroleum Product Storage, Spill Prevention and Containment	●		●	25 years
Riparian Buffer		●		Minimum 15 years
Silage Leachate Control	●	●	●	10 years
Stripcropping	●	●		5 years
Terraces	●	●	●	10 years
Waterway		●	●	10 years

Table III. Agricultural Management Practices and NPS Pollutants Controlled

Agricultural Management Practices	Sediment	Nutrients	Pesticides	Organic Matter	Pathogens	Ammonia	Metals	Thermal Modifications	Trace Organic Compounds
Access Road Improvement	X	X			X				
Alternative Water Supply	X	X			X				
Barnyard Runoff Management System	X	X		X	X				
Conservation Tillage	X	X	X						
Constructed Wetlands	X	X			X	X	X		X
Contour Farming	X	X	X						
Cover and Green Manure Crop	X	X							
Critical Area Protection:									
- Vegetative Cover	X	X						X	
- Streambank & Shoreline Protection	X	X						X	
Crop Rotation	X	X	X						
Diversions	X	X	X	X	X				
Fencing	X	X		X					
Filter Strips	X	X		X	X		X		
Integrated Pest Management:									
- Biological Controls		X							
- Cultural Practices		X							
- Resistant Crop Varieties		X							
- Scouting		X							
- Trap Crops		X							
Irrigation Water Management	X	X	X						
Milking Center Wastewater Treatment		X		X	X	X			
Mulching – Vineyards/Cropland	X	X	X						

Agricultural Management Practices	Sediment	Nutrients	Pesticides	Organic Matter	Pathogens	Ammonia	Metals	Thermal Modifications	Trace Organic Compounds
Nutrient Management:									
- Overview		X		X	X	X			
- Anaerobic Digestion		X		X		X			
- Composting Facility		X		X	X	X			
- Feed Ration Evaluation and Balancing		X							
- Manure Storage System		X							
- Sequencing Batch Reactor		X							
Nutrient/Sediment Control System				X	X	X			
Pasture Management: Prescribed Grazing System	X	X	X	X	X	X			
Pathogen Management		X				X			
Pesticide Management:									
- Overview			X						
- Agrichemical Mixing Facility			X						
- Calibration and Application			X						
- Evaluation of Site-Specific Leaching & Surface Loss Potential			X						
Petroleum Product Storage, Spill Prevention and Containment[1]									X
Riparian Buffer	X	X							
Silage Leachate Control				X					
Stripcropping	X	X							X
Terraces	X	X							
Waterway	X	X							

1. Petroleum Products contain solvents such as benzene, toluene, and xylene and additives such as ethylene dibrobide (EDB) and organic lead compounds.

Table IV: Agricultural Environmental Management Tier II Worksheets and Agricultural Management Practices

- **Agricultural Environmental Management (AEM) Tier II Worksheets are used to evaluate the potential environmental concern of this source.**
- **Agricultural Management Practices may be used to address the environmental concern.**

	AGRICULTURAL MANAGEMENT PRACTICES													
Tier II Worksheets	**Access Road Improvement**	**Alternative Water Supply**	**Barnyard Runoff Management System**	**Conservation Tillage**	**Constructed Wetlands**	**Contour Farming**	**Cover and Green Manure Crops**	**Critical Area Protection**	**Crop Rotation**	**Diversions**	**Fencing**	**Filter Strips**	**Integrated Pest Management (IPM):**	**Irrigation Water Management**
Barnyards	X		X					X		X	X	X		
Farmstead Water Supply														
Fertilizer Management														
Forest Management	X													
Greenhouse/Nursery	X									X		X	X	X
Horse	X	X	X				X			X	X	X		
Livestock Odor Management			X											
Management of Feed Nutrients														
Manure Management – Nutrient Management, Field Application & Storage							X					X		
Process Wash Water					X							X		
Orchards							X						X	
Pasture Management	X	X									X			
Pesticide Use													X	
Pesticide Storage, Mixing and Loading														
Petroleum Product Storage														
Silage Storage												X		
Small Fruits							X						X	
Soil Management				X		X	X	X	X	X		X		
Stream & Flood Plain Management								X			X	X		
Vegetables							X		X				X	X
Vineyards	X						X			X		X	X	X
Waste Disposal														
Water-Borne Pathogens											X	X		

Table IV: Agricultural Environmental Management Tier II Worksheets and Agricultural Management Practices (continued)

	AGRICULTURAL MANAGEMENT PRACTICES												
Tier II Worksheets	**Milking Center Wastewater Treatment**	**Mulching – Vineyards/Cropland**	**Nutrient Management**	**Nutrient/Sediment Control System**	**Pasture Management: Prescribed Grazing System**	**Pathogen Management**	**Pesticide Management**	**Petroleum Product Storage, Spill Prevention and Containment**	**Riparian Buffer**	**Silage Leachate Contol**	**Stripcropping**	**Terraces**	**Waterways**
Barnyards						X							X
Farmstead Water Supply							X	X					
Fertilizer Management													
Forest Management													
Greenhouse/Nursery			X				X						X
Horse						X							X
Livestock Odor Management	X		X										
Management of Feed Nutrients			X										
Manure Management – Nutrient Management, Field Application & Storage			X	X		X			X				
Process Wash Water	X					X							
Orchards		X					X						
Pasture Management						X	X		X				
Pesticide Use							X						
Pesticide Storage, Mixing and Loading							X						
Petroleum Product Storage								X					
Silage Storage										X			
Small Fruits		X					X						
Soil Management		X							X		X	X	X
Stream & Flood Plain Management				X					X				
Vegetables		X	X				X						
Vineyards		X	X									X	
Waste Disposal			X										
Water-Borne Pathogens						X			X				

Table V: New York State Management Practices for Agriculture

NRCS Component Practices

NYS Agricultural Nonpoint Source Abatement & Control Grant Program

Management Practice		Potential Component Practices
(from NYSDEC 319 Agricultural Management Practices Catalogue)	NRCS Code	NRCS Practices
Access Road Improvement	560	Access road
	342	Critical area planting
	362	Diversion
	655	Forest trails and landings
	350	Sediment basin
	587	Structure for water control
	620	Underground outlet
Alternative Water Supply	575	Animal trails and walkways
	342	Critical area planting
	382	Fencing
	561	Heavy use area protection
	516	Pipeline
	378	Pond
	574	Spring development
	472	Use exclusion
	731	Water testing
	642	Water well
	614	Watering facility
	351	Well decommissioning
Barnyard Runoff Management System	560	Access road
	575	Animal trails & walkways
	342	Critical area planting
	362	Diversion
	382	Fencing
	412	Grassed waterway
	561	Heavy use area protection
	468	Lined waterway
	516	Pipeline
	558	Roof runoff structure
	350	Sediment basin
	587	Structure for water control
	606	Subsurface drain
	608	Surface drainage – main or lateral
	620	Underground outlet
	472	Use exclusion
	635	Wastewater treatment strip
	614	Watering facility -trough or tank
Conservation Tillage	329A	Residue management , no till & strip till
	345	Residue management, mulch till
	346	Residue management, ridge till
	344	Residue management, seasonal

Management Practice (from NYSDEC 319 Agricultural Management Practices Catalogue)	NRCS Code	Potential Component Practices NRCS Practices
Constructed Wetland	656	Constructed wetland
	356	Dike
	774	Potholes
	587	Structure for water control
	657	Wetland restoration
Contour Farming	332	Contour buffer strips
	330	Contour farming
	331	Contour orchard or other fruit
	557	Row arrangement
Cover and Green Manure Crop	340	Cover crop
Critical Area Protection	322	Channel bank vegetation
	584	Channel stabilization
	326	Clearing & snagging
	327	Conservation cover
	342	Critical area planting
	410	Grade stabilization structure
	484	Mulching
	350	Sediment basin
	578	Stream crossing
	395	Stream habitat improvement & management
	580	Streambank & shoreline protection
	612	Tree/shrub establishment
	601	Vegetative barrier
	638	Water and sediment control basin
Crop Rotation	328	Conservation crop rotation
Diversion	362	Diversion
	620	Underground outlet
Fencing	382	Fencing
Filter Strip	386	Field border
	393	Filter strip
	601	Vegetative barrier
Integrated Pest Management	386	Field border
	595	Pest management
Irrigation Water Management	430	Irrigation water conveyance
	441	Irrigation system, microirrigation
	442	Irrigation system, sprinkler
	443	Irrigation system, surface & subsurface
	449	Irrigation water management
Milking Center Wastewater Treatment	719	Milkhouse wastewater infiltration area
	516	Pipeline
	587	Structure for water control
	359	Waste treatment lagoon
	635	Wastewater treatment strip
Mulching –Vineyards/Cropland	484	Mulching

Management Practice		Potential Component Practices
(from NYSDEC 319 Agricultural Management Practices Catalogue)	NRCS Code	NRCS Practices
Nutrient Management	591	Amendment for treatment of agricultural waste
	365	Anaerobic digester ambient temperature
	366	Anaerobic digester controlled temperature
	360	Closure of waste impoundments
	317	Composting facility
	592	Feed management
	511	Forage harvest management
	422	Hedgerow planting
	749	Manure pile area
	634	Manure transfer
	353	Monitoring well
	590	Nutrient management
	521A	Pond sealing and lining
	748	Record keeping
	367	Waste facility cover
	312	Waste management system
	313	Waste storage facility
	633	Waste utilization
Nutrient/Sediment Control System (Note- For this management practice you must install complete system including all component practices to be eligible for funding)	656	Constructed wetland
	393	Filter strip
	378	Pond
	350	Sediment basin
	587	Structure for water control
Pasture Management	575	Animal trails & walkways
	314	Brush management
	382	Fencing
	511	Forage harvest management
	548	Grazing land mechanical treatment
	512	Pasture & hayland planting
	528	Prescribed grazing
	587	Structure for water control
	472	Use exclusion
Pathogen Management	316	Animal mortality facility
	317	Composting facility
	783	Pathogen management
Pesticide Management	702	Agrichemical mixing facility
	595	Pest management
Petroleum Storage Spill Prevention		N/A
Riparian Buffer	575	Animal trails & walkways
	382	Fencing
	393	Filter strip
	490	Forest site preparation
	391	Riparian forest buffer
	390	Riparian herbaceous cover
	578	Stream crossing
	612	Tree/shrub establishment
	472	Use exclusion

Management Practice (from NYSDEC 319 Agricultural Management Practices Catalogue)	NRCS Code	Potential Component Practices NRCS Practices
Silage Leachate Control	**561**	**Heavy use area protection**
	516	**Pipeline**
	587	**Structure for water control**
	635	**Wastewater treatment strip**
Stripcropping	**500**	**Obstruction removal**
	585	**Stripcropping**
	606	**Subsurface drain**
Terrace	**600**	**Terrace**
	620	**Underground outlet**
	638	**Water & sediment control basin**
Waterway	**412**	**Grassed waterway**
	468	**Lined waterway or outlet**
	606	**Subsurface drain**

NOTES:

This list is not intended to be a complete list of NRCS practices eligible for funding. Additional component practices may be needed depending on the type of agricultural nonpoint source project being implemented.

USDA Natural Resource Conservation Service Management Practice Design Standard and Specification updates may be found at: http://www.nrcs.usda.gov/technical/efotg/. The eFOTG website is the official reference for current Conservation Practice Standards and Guidelines. The website should be used to confirm that the most recent standard is being used for the practice to be installed.

To meet SPDES requirements all Agricultural BMPs during construction must include erosion and sediment control and stormwater management provisions.

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II. MANAGEMENT PRACTICE SUMMARY SHEETS

ACCESS ROAD IMPROVEMENT

DEFINITION
Structural and vegetative improvements made to farm roadways.

WATER QUALITY PURPOSE
To prevent erosion, control runoff and maintain or improve water quality.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment, Nutrients and Pathogens.

WHERE USED
Agricultural access roads needing structural or vegetative improvements.

PRACTICE DESCRIPTION
Access road improvement may include one or more components. Water management (culverts, bridges or grade dips) is provided at all natural drainage ways to handle peak design flows. Surface water control (water bars, turnouts, swales) is provided at specified intervals, to handle road runoff. Cut and fill slopes are designed to be stable, and are protected with vegetation (grasses, legumes, trees, shrubs) or structural measures (erosion blankets, jute mats, riprap, gabion baskets) which reduce soil detachment and transport of sediment.

PRACTICE EFFECTIVENESS
Effectiveness of pollutant control is dependent on the practices installed. In general, vegetation is effective in reducing soil detachment and sediment transport. Structural practices handle peak design flows, assist in stabilizing slopes, and to a limited extent trap sediment.

IMPACT ON SURFACE WATER
Beneficial. Needs to be designed, installed and maintained properly.

IMPACT ON GROUNDWATER
Slight. Some water management and some surface water control practices may increase infiltration, resulting in a slight to moderate impact on groundwater.

ADVANTAGES
- Vegetative practices are relatively inexpensive to implement.
- Structural practices will increase the access road's year-round use.

DISADVANTAGES

- Structural practices are expensive and may be difficult to install on existing roads.

PRACTICE LIFESPAN

Ten (10) years.

COST

Dependent upon improvement needed and extent of access road.

OPERATION AND MAINTENANCE

Refer to O&M requirements of component practices installed. In general, keep all drainage ditches and culverts free of debris and ice.

MISCELLANEOUS COMMENTS

Some component practices may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES

Chesapeake Bay Foundation, Best Management Practices for Stormwater Control. Harrisburg, PA. November 1988.

New York State Standards and Specifications for Erosion and Sediment Control. August 2005. (Design Standards and Specifications)

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ALTERNATIVE WATER SUPPLY

DEFINITION
The provision of a temporary or permanent stable, protected, and reliable livestock water supply in a manner which eliminates or reduces the need for cattle to have water channel or impoundment access for drinking water.

WATER QUALITY PURPOSE
To prevent the direct discharge of animal waste into lakes, ponds and streams and to reduce streambank erosion caused by devegetation from animal traffic.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANT CONTROLLED
Sediment, Nutrients and Pathogens.

WHERE USED
In pastures, intensively grazed paddocks, loafing areas or other areas used for holding cattle and are adjacent to sensitive riparian areas.

PRACTICE DESCRIPTION
Alternative water supply is used to provide a stable, protected, reliable and easy to use means of dispensing a sufficient quantity of livestock water in confined or grazed areas. The practice can be accomplished by piping water from existing water supplies or spring development to portable or permanent water tanks. This practice will eliminate the need for direct stream access by livestock for drinking water. Depending on the area serviced and topography, multiple systems may be required.

PRACTICE EFFECTIVENESS
Alternative water supply is an effective way to maintain riparian areas which are effective sediment traps and filters along water channels and impoundments. The practice will also eliminate direct nutrient and pathogen contributions from livestock by restricting waterbody access.

IMPACT ON SURFACE WATER
Beneficial. Eliminates need for livestock to have access to waterbodies thereby reducing the direct discharge of animal waste into water channels and impoundments.

IMPACT ON GROUND WATER
Slight. Beneficial in areas where the groundwater is recharged from surface waterbodies.

ADVANTAGES
- Farmers are assured that livestock will always have an adequate and reliable water supply.

DISADVANTAGES

- Some water supply alternatives may be expensive.
- Temporary supplies used in conjunction with grazing systems will be more management intensive.

PRACTICE LIFESPAN

Ten (10) years.

COST

Variable, depending on the system which is installed.

OPERATION AND MAINTENANCE

Periodic inspection and repair of water supply feed lines, overflow drainage lines, overflow and check valves, water holding structure and periodic water testing to assure a clean potable water supply. Refer to O&M requirements of component practices installed.

MISCELLANEOUS COMMENTS

Certain components of this practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds

REFERENCES

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BARNYARD RUNOFF MANAGEMENT SYSTEM

DEFINITION
An installed system for the interception, collection and safe disposal of runoff water from a barnyard or concentrated livestock area.

WATER QUALITY PURPOSE
To exclude clean water from the barnyard and to reduce the transport of pollutants from barnyards and concentrated livestock areas into surface or groundwaters.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Nutrients, Sediments, Pathogens, and Oxygen-demanding organic matter.

WHERE USED
Barns, barnyards, loafing areas, paddocks, feedlots, or any area where livestock concentrate.

PRACTICE DESCRIPTION
The system is composed of one or more component practices. Structural practices may be employed to exclude clean water from areas of livestock concentrations (for example, diversions that intercept and transport upslope surface water away from barnyards and roof runoff systems that collect rain water from barn roofs) and to safely dispose of water originating inside the livestock area (ie: grassed waterway, filter strip, and sediment basin).

A variety of structural, vegetative and operational practices are used to treat polluted runoff and seepage from barnyards, loafing areas and other areas with concentrated waste. Examples are grassed waterways, settling tanks, filter strips and wastewater treatment strips.

PRACTICE EFFECTIVENESS
Because barnyard water management systems are site-specific and are composed of one or more management practices, system effectiveness varies. Generally these systems reduce nutrient loads in direct proportion to reductions in flow contributing area.

Substantial reductions (up to 50-60%) in total and dissolved phosphorus (P) loads have been achieved after the installation of the surface water control practices. Roof runoff practices have reduced P loads by up to 15-25%. Bacterial losses may be reduced by up to 90%. Barnyard practices that employ channelized flow systems (grassed waterway) are less effective in treating runoff compared to practices that employ overland flow (vegetative filter areas).

IMPACT ON SURFACE WATER
Beneficial.

IMPACT ON GROUNDWATER
Beneficial.

ADVANTAGES
- Dries up barnyard and loafing area.
- Improves herd health (less risk of mastitis and hoof rot in cattle).
- Improves ease of daily operating procedures.
- Reduces clean-up time during milking.
- Decreases the chance of milk production reduction during wet periods.
- Increases milk value due to lower somatic cell counts.

DISADVANTAGES
- Requires a higher level of producer management skill to achieve positive pollution control.
- May be expensive.

COST
Varies. Range: $3,000 to $20,000 or more, depending upon system design, complexity and total area to be treated.

PRACTICE LIFESPAN
Ten (10) years.

OPERATION AND MAINTENANCE
Varies with the system installed. Daily to weekly scraping of concrete pads. Maintain fences. Re-grade barnyards as needed to control water. Maintain vegetation. Check roof gutters after heavy storm events and remove debris and ice. Harvest and remove filter area vegetation. Check O&M requirements for individual component practices.

MISCELLANEOUS COMMENTS
Component practices may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds. Livestock operations that have been designated as a CAFO are required to comply with CAFO regulations.

REFERENCES
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USDA. Natural Resource Conservation Service. 2001. National Handbook of Conservation Practices. Underground Outlet, 620, March 2001. Syracuse, NY. (Management Practice Design Standard and Specification).

USDA. Natural Resource Conservation Service. 2001. National Handbook of Conservation Practices. Wastewater Treatment Strip, 635, April 2007. Syracuse, NY. (Management Practice Design Standard and Specification).

CONSERVATION TILLAGE

DEFINITION
Strip-till, mulch-till, ridge-till, reduced-till and zone till are minimum tillage and planting systems that leave a minimum of 30% of the soil surface covered with plant residue. No-tillage is the placing of a crop seed or seedling transplant into the soil by a device that opens a trench or slot through the sod or previous crop residue only sufficiently wide or deep to receive the seed or transplant roots and to provide satisfactory seed or root coverage.

WATER QUALITY PURPOSE
To reduce the detachment, transport and loss of sediment and solid-phase nutrients as well as a reduction in runoff volumes.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment, pesticides and solid-phase nutrients.

WHERE USED
Highly erodible cropland. On crops where adequate cover can be obtained. On soils that are rated as highly adapted, well adapted, or moderately-well adapted according to Cornell Cooperative Extension Tillage Rating System.

PRACTICE DESCRIPTION
Minimum-till equipment (chisel plows, field cultivators, discs, rototillers, etc.) tills and roughens the soil surface without incorporating the entire plant residue. A minimum of 30% of the plant residue remains on the soil surface.

No-tillage provides only a narrow band of tillage in the seed zone. Crop residues remain on the soil surface, virtually undisturbed by the planting operation. No-tillage affects pollutant transport in surface runoff by decreasing soil erosion and surface runoff volumes, increasing infiltration and reducing incorporation of agricultural chemicals.

PRACTICE EFFECTIVENESS
The degree of effectiveness is directly related to the percent of plant residue on the surface at the time the runoff-producing storm event occurs. Conservation tillage can reduce soil loss from 50-99%, runoff volumes from 40-50%, and soluble phosphorus losses by up to 45% compared to conventional tillage. Surface losses of nutrients and pesticides vary by tillage method depending on incorporation. Minimum tillage disrupts the continuity of soil macropores which can form under long-term no-till systems, thereby reducing the risk of pollutants reaching groundwater.

IMPACT ON SURFACE WATER
Generally beneficial. Concentrations of dissolved and sediment-bound chemicals in surface runoff may temporarily increase. The total amount of chemicals transported in surface runoff is lower than conventional tillage.

IMPACT ON GROUND WATER
Slight to moderate. Since minimum tillage disrupts soil macropore structure, the risk of leaching of immobile pesticides and dissolved chemicals to groundwater is less than under no-till systems. Considerable uncertainty remains as the effects of no-till on groundwater.

ADVANTAGES
- Provides cost-effective erosion control on highly- to moderately-well adapted soils, compared to conventional tillage.
- Reduces compaction
- Provides savings in time, fuel and labor due to fewer trips across the field.
- Increases soil organic matter which improves soil structure and moisture-holding capacity.
- Provides soil cover during critical times in the cropping cycle. Crop residues reduce the detachment and transportation of soil particles by rainfall and wind.
- Increases surface roughness.
- Increases infiltration and reduces surface runoff volumes, compared to conventional tillage. Minimum tillage provides incorporation of surface-applied fertilizers and pesticides, reducing the risk of loss in surface runoff.
- Reduces total soluble phosphorus loss (loading) for all minimum tillage systems because of significantly lower surface runoff volumes. Conserves water during the summer months.
- Produces yields, on average, equal to conventional tillage.
- Lowers soil loss due to wind.

DISADVANTAGES
- May easily bury residues with inexperienced tillage operator, fast operating speeds, secondary tillage operations, or deep tillage depths.
- Could increase the likelihood of phosphorus reaching surface waters if incorporation of manure is incomplete.
- May limit the incorporation of lime and fertilizers required by soil test.
- Reduced incorporation of chemicals may result in higher concentrations of chemicals in the soil mixing zone and increased potential for loss and higher concentrations in runoff.
- May not be suitable on all soils.
- Requires a high level of soil and grower management.
- Requires special equipment which is expensive and/or may not be available for rent.
- May delay soil surface warming, harbor insects and disease.
- Increases potential surface loss of fertilizer unless fertilizer is knifed-in.
- May increase concentrations of dissolved and sediment-bound chemicals in surface runoff.
- May increase nitrogen transport to groundwater since reduced runoff increases water infiltration.

PRACTICE LIFESPAN
One (1) year.

COST
Custom rates for minimum-tillage average $20.00 to $25.00 per acre.

OPERATION AND MAINTENANCE
Maintain minimum 30% plant residue cover. Annual soil test for soil pH and fertility needs. Appropriate weed control program should be followed.

MISCELLANEOUS COMMENTS
Practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds. Some county soil and water conservation districts have minimum-till equipment for rent.

REFERENCES
Chesapeake Bay Nonpoint Source Program Evaluation Panel. Overview of the Effectiveness of Best Management Practices. Annapolis, MD. June 1990.

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-Reid, W. Shaw, et al., Suitability of Tillage Systems for Various Soils. 1983.
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CONSTRUCTED WETLANDS

DEFINITION
A constructed, shallow water area, usually a marsh, dominated by cattail, bulrush, rushes or reeds, designed to simulate the water quality improvement function of natural wetlands. Constructed wetlands are usually a component practice in a total system approach to agricultural wastewater and surface agricultural runoff treatment.

WATER QUALITY PURPOSE
For the physical, chemical and biological treatment of wastewater and surface runoff.

SOURCE CATEGORY
Agricultural / Surface Runoff.

POLLUTANTS CONTROLLED
Nutrients, ammonia, trace organic compounds, pathogens, metals, and sediment.

WHERE USED
Below barnyards, manure treatment systems, feedlots, and concentrated livestock areas. Below agricultural effluent fields, including food processing and milkhouse waste filter areas. Below agricultural fields.

PRACTICE DESCRIPTION
Constructed wetlands can be either "free water surface systems" or "subsurface flow systems". Free water surface systems consist of basins or channels with a natural or constructed subsurface barrier to prevent seepage. Soil or another suitable medium supports emergent vegetation. Water depth is shallow and flows over the soil surface of the wetland.

Subsurface flow systems consist of trenches or beds underlain with a natural or constructed impermeable subsurface barrier. Soil or gravel is used in the trench or bed to support emergent vegetation. The wetland is constructed on a slight inclination between inlet and outlet. Wastewater or runoff to be treated is introduced into the wetland via drainage pipe and a stone-filled trench. Treated effluent leaves the wetland via drainage pipe in a stone-filled trench, hence the name "subsurface flow system". Treated effluent may be directed to a free water system for further treatment.

PRACTICE EFFECTIVENESS
The performance of any constructed wetland system is dependent upon the system’s hydrology as well as other factors. Precipitation, infiltration, evapotranspiration, hydraulic loading rate, water depth and pH can all affect the removal of organics, nutrients, and trace elements not only by altering detention time, but also by either concentrating or diluting the wastewater. Constructed wetlands are very effective when used as part of a total nutrient/sediment control system.

Nitrogen removal, due to nitrification/de-nitrification, ranges from 25-85%. Phosphorus removal in wetlands is not very effective because of the limited contact opportunities between the wastewater and the soil. Phosphorus removal of 30 to 55% has been reported for water hyacinths in constructed wetland research studies. When the hydraulic residence time of the constructed wetland ranges from 5 to 7 days, fecal coliform removal efficiency rates range from 65 to 99%. Similar removal efficiency rates were achieved for viruses. Removal efficiency rates of more than 95% have been reported for the heavy metals copper, zinc and cadmium.

IMPACT ON SURFACE WATER
Beneficial.

IMPACT ON GROUND WATER
Beneficial. In areas of highly permeable soils, constructed wetlands will require a watertight membrane lining.

ADVANTAGES
- Aesthetically pleasing.
- Benefits wildlife.
- Uses sustainable technology.
- Is highly efficient for nutrient removal.

DISADVANTAGES
- Requires large land area.
- Has the potential to become a breeding ground for disease producing organisms and insects.
- May generate odors if not properly managed.
- Introduced aquatic plant species may become a nuisance.

PRACTICE LIFESPAN
Fifteen (15) years.

COST
Varies, depending upon size needed.

OPERATION AND MAINTENANCE
Operation and maintenance typically consists of inspecting dike integrity, maintaining vegetation, and mowing dikes surrounding the constructed area. For free water surface systems, dry grasses are burned off annually to help maintain the hydraulic profile of the wetland and avoid build-up of grassy hillocks which encourage channelization. Harvesting of wetland vegetation is not necessary for subsurface flow systems.

MISCELLANEOUS COMMENTS
Constructed wetlands constructed specifically for agricultural use are exempt from state wetland regulations. Prior to construction, contact the Regional Office of the NYS Department of Environmental Conservation. Similar arrangements may be made with the Army Corps of Engineers.

Practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

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CONTOUR FARMING

DEFINITION
The alignment and operation of all farm tillage, planting and harvesting practices as close to the true contour as possible.

WATER QUALITY PURPOSE
To reduce erosion, and surface runoff and to reduce the transport of nutrients and pesticides from the field.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment, solid-phase nutrients and pesticides.

WHERE USED
On row crop fields where slopes are 8% or less.

PRACTICE DESCRIPTION
Contour farming reduces sediment transport by slowing surface water runoff volume and increasing infiltration. The crop is planted as close to the true contour as possible. Aligned with terraces, diversions, waterways or stripcropping, the contoured rows increase water retention during rainstorms and increase infiltration, thereby reducing runoff.

PRACTICE EFFECTIVENESS
Contour farming is effective in reducing the rate/volume of runoff and the transport of sediment and surface-applied pesticides to receiving watercourses when compared to farming against the contour. Contouring can reduce soil loss by up to 50% on moderate slopes of 8% or less.

Nutrient reductions are not as great as sediment reductions. Effectiveness decreases as the steepness of the slope and slope length increases and as rainfall intensity increases. Contouring is more effective when used in combination with stripcropping and diversions or terraces.

IMPACT ON SURFACE WATER
Beneficial.

IMPACT ON GROUND WATER
Slight to moderate. Contour farming increases infiltration, which may increase the risk of leaching nitrates and pesticides to groundwater.

ADVANTAGES
- Conserves soil moisture.
- Increases crop yields.
- Is easy to install.

DISADVANTAGES

- May not be effective during heavy rainstorms if accumulated rainfall exceeds the contoured row's capacity.
- May not be suitable due to irregular topography.
- Is not suitable for heavy-textured soils.

PRACTICE LIFESPAN

One (1) year.

COST

Consistent with typical costs associated with planting a crop.

OPERATION AND MAINTENANCE

Maintain row alignment.

MISCELLANEOUS COMMENTS

Practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES

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COVER AND GREEN MANURE CROP

DEFINITION

A crop of close-growing grasses, legumes or small grains grown primarily for temporary, seasonal soil protection and soil improvement. Cover crops are usually grown for 1 year or less and are left undisturbed until harvested or preparation for the next crop cycle begins. Green manure crops are cover crops, sod crops or intercrops that are plowed under and incorporated into the soil.

WATER QUALITY PURPOSE

To control erosion, add organic matter and nutrients, suppress weeds, remove surplus nitrogen remaining in the soil after the harvest of a primary crop, improve soil tilth and may reduce the need for nitrogen fertilizers.

SOURCE CATEGORY

Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED

Sediment, solid-phase and dissolved nutrients.

WHERE USED

Cropland, vineyards and orchards where temporary cover is needed between regular crop production.

PRACTICE DESCRIPTION

A cover crop is a grass, legume or small grain that provides temporary soil cover during critical times in the cropping cycle. Cover crops can be drilled, broadcast or aerially applied in the spring, during mid-summer or after the harvest of the primary crop. Cover crops reduce the detachment and transport of soil particles by rainfall and wind erosion.

Green manure crops are cover crops, sod crops or intercrops that are plowed under for their organic matter and nitrogen benefits. They improve soil tilth and structure, and return moisture to the soil. When legume cover crops are plowed under after 1 year, they return approximately 30-50 lbs. per acre of nitrogen back to the soil for use by the primary crop. Alfalfa and alfalfa-grass sods release 150 to 200 lbs. per acre of nitrogen during the first year after plowing.

PRACTICE EFFECTIVENES

Winter cover crops can be an effective erosion control practice, but only if significant growth takes place prior to the onset of cold weather. Leaving crop residues on the soil surface (as in no-till and minimum-till) instead of planting a winter crop may be a more effective erosion control practice in some instances. Cover crops can capture and remove excess nitrogen remaining in the soil after harvest of the primary crop, reducing leaching losses to groundwater. Effectiveness may be diminished by short, cold fall weather.

IMPACT ON SURFACE WATER
Variable. Impact is dependent upon type of cover crop selected, date of cover crop seeding, and amount and extent of cover crop growth.

IMPACT ON GROUND WATER
Beneficial. Some cover crops "scavenge" residual N from the soil, reducing the risk of leaching losses during fall, winter and early spring. Grass and small grain cover crops have been found to decrease nitrate leaching to groundwater as a result of plant nutrient uptake. Legume cover crops reduce the need for nitrogen fertilizers since they "fix" their own nitrogen.

ADVANTAGES
Cover crops:
- Increase erosion control.
- Reduce loss of sediment-bound nutrients.
- Conserve soil moisture.
- Reduce leaching, "scavenge" excess N.
- Make their own N fertilizers (legumes) for use by other crops.
- Provide residue for conservation tillage.

Green Manure Crops:
- Add organic matter.
- Return moisture to soil.
- Improve soil tilth and structure.
- Return nitrogen to the soil for use by successive crops.

DISADVANTAGES
- May be adversely affected by time of seeding, soil moisture conditions, previous herbicide use and type of cover selected. (Residual effects of using more than 1 to 2 lbs. of atrazine on the preceding corn crop will preclude the use of a cover crop).
- Increases chemical use, to burn down cover crop for reduced tillage systems.

PRACTICE LIFESPAN
One (1) year.

COST
Approximately $20 to $25 per acre for cover crops.

OPERATION AND MAINTENANCE
Maintain cover.

MISCELLANEOUS COMMENTS
Practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES

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CRITICAL AREA PROTECTION: Vegetative Cover

DEFINITION
To establish and/or maintain vegetation on highly erodible areas or land vulnerable to nonpoint source pollution.

WATER QUALITY PURPOSE
To stabilize highly erodible areas, discourage conversion of environmentally sensitive areas, and prevent sediment and nutrients from entering waterbodies.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment and solid phase nutrients.

WHERE USED
On highly erodible land, steep slopes, aquifer recharge areas, wetlands, mined land, or any environmentally sensitive area requiring vegetative protection.

PRACTICE DESCRIPTION
Vegetative cover is a practice that can be used in many different situations. It primarily involves a change in land use, usually from row crops to herbaceous or woody vegetation. The practice also includes stabilizing eroding areas using biotechnology, hydroseeding and mulching, sodding and the use of container-grown plants. This practice includes seeding cool season grasses and legumes, warm season grasses, placing sod, planting trees and shrubs, and utilizing existing perennial vegetation.

Vegetative cover controls surface runoff, sediment and solid phase nutrients by providing long-term perennial cover for critical areas.

PRACTICE EFFECTIVENESS
Vegetative cover can reduce soil loss by up to 95% and nitrogen loss in surface runoff by up to 90%. Reductions in surface runoff vary according to vegetation types and densities. However, 50% to 90% reductions are not uncommon. Vegetative cover can reduce pollution generation within a field. However, practice lifespan can be reduced significantly if sediment is allowed to accumulate on the vegetation.

IMPACT ON SURFACE WATER
Beneficial, while vegetative cover is maintained.

IMPACT ON GROUND WATER
Slight to moderate. Vegetative cover increases infiltration and may cause some nutrients and pesticides to be transported to groundwater.

ADVANTAGES
- Is a relatively inexpensive management practice.
- Is the most cost-effective practice for nutrient and sediment control.
- Improves wildlife habitat.
- May function like a buffer strip in surrounding environment.
- Can use some areas for disposal of excess livestock wastes.
- Can harvest some areas in grasses and legumes for forage.

DISADVANTAGES
- May take some agricultural land out of production when trees are planted as vegetative cover.
- Is easily converted by plowing.

PRACTICE LIFESPAN
Ten (10) years.

COST
Varies. Ranges from "no-cost", when existing vegetation is used, to up to $1,000 (or more) per acre for hydroseeding critically eroding areas.

OPERATION AND MAINTENANCE
Varies, depending upon vegetation. Ranges from low O&M effort for tree plantings to high O&M effort (mowing, topdressing) for grasses and legumes.

MISCELLANEOUS COMMENTS
Some component practices may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES
New York State Standards and Specifications for Erosion and Sediment Control. August 2005. (Design Standards and Specifications)

Cornell Cooperative Extension. Cornell Guidelines (Current Year). Ithaca, NY. (Management Practice Design Standard and Specification)

NYS Department of Environmental Conservation. Longabucco, P., Controlling Agricultural Nonpoint Source Water Pollution in New York State: A Guide to the Selection of Best Management Practices to Improve and Protect Water Quality, Albany, NY. 1991.

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CRITICAL AREA PROTECTION: Streambank and Shoreline Protection

DEFINITION
The use of vegetation, structures, biotechnology, or management techniques to stabilize and protect streambanks and shorelines.

WATER QUALITY PURPOSE
To reduce sediment and nutrients entering waterbodies from eroding streambanks and shorelines.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment and solid-phase nutrients.

WHERE USED
Streambanks, lake shores, estuaries and coastal shorelines.

PRACTICE DESCRIPTION
Streambank and shoreline protection may involve one or more of the following components:
- Vegetation (rushes, sedges, grasses, legumes, shrubs or trees)
- Structural improvements (slope stabilization, filter fabric, riprap, deflectors, fencing, bulkheads, or groin systems),
- Management techniques (removing debris, fallen trees, or gravel bars in the flood plain on the inside curves of the stream)
- Biotechnical alternatives (such as, willow wattles and direct seeding)
- Fluvial geomorphology techniques.

PRACTICE EFFECTIVENESS
The effectiveness of streambank and shoreline protection should be evaluated based on the component practices installed. In general, the practice will decrease the flow and bed load of the stream, reduce soil erosion, and decrease sediment and nutrient delivery to waterbodies.

IMPACT ON SURFACE WATER
Beneficial to slight, depending upon design or component selected.

IMPACT ON GROUNDWATER
Unknown to moderate. Vegetative cover and some structural practices increase infiltration and may cause some mobile nutrients or chemicals to be transported to groundwater.

ADVANTAGES

- Streambanks and shorelines stabilized with vegetation can provide wildlife cover.
- Some sites can provide fishing access to anglers.
- Vegetative treatments may have secondary benefits for their pollutant filtering ability.
- Mature woody vegetation lowers stream temperatures by shading stream segments, improving fishery habitat.
- Stabilized areas reduce sediments entering waterbodies, thereby reducing downstream flooding hazards.

DISADVANTAGES

- Installation of practice components may result in a temporary increase of sediment and nutrients delivered to the stream during construction.
- A temporary loss of wildlife habitat may occur during implementation of the practice.

PRACTICE LIFESPAN

Twenty (20) years.

COST

Ranges from a low cost ($5/lin.ft.) for biotechnical components, to very expensive ($200+/lin.ft.) for structural designs.

OPERATION AND MAINTENANCE

Varies with design or component selected. Debris should be removed from the stabilized streambank or shoreline. Structural practices should be inspected after storm events. Vegetation destroyed by bank failure must be replaced to maintain cover integrity.

MISCELLANEOUS COMMENTS

Some component practices may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds. All parties are alerted to the legal requirements affecting protected streams. Individuals wishing to undertake streambank and shoreline protection work that could disturb a protected stream are required to obtain a Protection of Waters Permit (Article 15) from their Regional Office of the Department of Environmental Conservation. The Regional Office can tell you if the stream segment to be affected is on the protected list. The Regional Office can also advise you whether or not other permits may be required, for example, Article 24-Freshwater Wetlands Permits, Article 25-Tidal Wetlands Permits, Article 36-Floodplain Permits (whether administered by local government or DEC), as well as possible requirements for work proposed along a stream or river protected under the Wild, Scenic and Recreational Rivers Act. The Regional DEC Office will advise you of Section 404 and Section 10 federal permits which might be required. By becoming a "party-in-interest", the public has the opportunity to review and comment and thus to influence the issuance of permits under the above programs.

REFERENCES

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USDA. Natural Resources Conservation Service. Guide to Conservation Plantings on Critical Areas. Syracuse, NY.

CROP ROTATION

DEFINITION
A planned sequence of annual and/or perennial crops.

WATER QUALITY PURPOSE
To reduce erosion and improve water quality. To improve or maintain good physical, chemical, and biological conditions of the soil. To break reproduction cycles of plant pests.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment, solid-phase and dissolved nutrients, and pesticides.

WHERE USED
Cropland.

PRACTICE DESCRIPTION
Annual row crops (usually corn silage) are rotated with several years of sod-forming grasses/legumes (crop rotation). Grasses and legumes in rotation can reduce erosion by increasing organic matter and improving soil tilth, resulting in a reduction in the delivery of sediment and associated pollutants to surface waters. Crop rotations may also disrupt disease, insect and weed reproduction cycles, reducing the need for pesticides. This removes or reduces the availability of some pollutants in the watershed.

PRACTICE EFFECTIVENESS
A well planned and executed cropping sequence can significantly reduce surface runoff and soil erosion losses. Model simulations done by Cornell University suggest that a rotation of 4 years of corn followed by 4 years of alfalfa could produce the following reductions of mean annual nutrient losses in runoff: dissolved N: 50-80%, dissolved P: 30-35%, solid-phase N: 60-70%, and solid-phase P: 60-70%. Reductions of 20-50% were estimated for dissolved N in percolation. The rotation of cash grain crops (corn and wheat) has fewer erosion control benefits than a sod-based rotation, but can substantially aid in the control of insect pests, diseases, and weeds that are specific to the monoculture systems.

IMPACT ON SURFACE WATER
Beneficial.

IMPACT ON GROUNDWATER
Slight. Because sod-based rotations improve soil structure and increase infiltration, there may be a slight risk of pollutants leaching to groundwater.

ADVANTAGES

- Improves soil structure.
- Increases organic matter.
- Increases infiltration.
- Breaks insect, weed and disease pest cycles, thereby reducing pesticide use.
- Reduces the amount of nitrogen fertilizer needed for crop production when legumes are used in a crop rotation.

DISADVANTAGES

- Reduces acreage of commodity grown.
- Limits the years a commodity is grown.
- May not be compatible in cash-cropping or vegetable cropping enterprises.

PRACTICE LIFESPAN

Length of crop rotation.

COST

No practice installation cost. Cost to farmer for seeding grasses and/or legumes.

OPERATION AND MAINTENANCE

Minimal. Maintain soil fertility, pH, approved weed control program and crop sequence.

MISCELLANEOUS COMMENTS

Costs related to seeding the sod portion of the rotation may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES

Cornell Cooperative Extension. Forage Production: A PRO-DAIRY Management Focus Workshop for Farm Managers. December 1989.

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USDA. Natural Resources Conservation Service. Effects of Conservation Practices on Water Quantity and Quality. Washington, DC, October 1988.

DIVERSIONS

DEFINITION
An earthen drainage way of parabolic or trapezoidal cross-section, with a supporting berm on the lower side. Diversions are constructed across the slope and are stabilized using grasses and legumes.

WATER QUALITY PURPOSE
To reduce erosion and intercept and re-route runoff away from areas of high pollution potential.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment and sediment-bound pollutants, such as pesticides, pathogens, organics, solid and dissolved nutrients.

WHERE USED
On cropland, pastureland, barnyards, feedlots and farmsteads, above stabilized or protected areas, and on slopes less than 15%.

PRACTICE DESCRIPTION
The earthen channel is designed to carry peak discharge from a 10-year frequency, 24-hour duration storm, as a minimum. It is constructed across the slope, usually on the contour. Grasses and legumes are seeded to stabilize the slopes and banks of the diversion. Diversions outlet into established grassed waterways, flat vegetated areas or other stabilized outlets.

PRACTICE EFFECTIVENESS
Diversions control erosion by shortening slope lengths. One study using computer modeling indicated that diversions could reduce soil erosion by about 40%, total nitrogen loss by about 20%, and total phosphorus loss by about 45%. Another study showed that phosphorus loads from barnyards were reduced by up to 45% when all upland drainage was diverted away from the barnyard.

IMPACT ON SURFACE WATER
Beneficial. Diversions reduce erosion by controlling surface runoff. Diversions exclude runoff from areas of high pollution potential.

IMPACT ON GROUND WATER
Beneficial. Diversions decrease the amount of surface runoff infiltrating into the soil, reducing the risk of transporting nutrients and pesticides to groundwater.

ADVANTAGES

- Are relatively easy to design and install.
- May allow timelier planting and potential yield increases by removing surface runoff.

DISADVANTAGES

- Impacts runoff volumes very little.
- Are not suitable below high sediment-producing areas unless other conservation practices are installed upslope, such as conservation tillage, and contour and strip cropping.
- Increases area of land taken out of crop production as the field slope increases.
- Use may be precluded or have an increased cost if a stable outlet is lacking.

PRACTICE LIFESPAN

Ten (10) years.

COST

Approximately $4.00 per foot.

OPERATION AND MAINTENANCE

Performed annually and after large storm events. Inspect channel cross-section for stable side slopes, points of scour, rodent holes, and breaches. Check channel bottom for erosion or excessive scour, deposition of sediment or other obstructions. Outlets should be checked to ensure that they remain adequate, show no sign of erosion or loss of structural integrity.

MISCELLANEOUS COMMENTS

Practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES

Chesapeake Bay Nonpoint Source Program Evaluation Panel. Overview of the Effectiveness of Best Management Practices, Annapolis, MD. June 1990.

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USEPA. Chesapeake Bay Nonpoint Source Programs. Annapolis, MD. January 1988.

FENCING

DEFINITION
To enclose or divide an area of land with a suitable permanent or temporary barrier to restrict livestock movement.

WATER QUALITY PURPOSE
To prevent soil erosion of fields, slopes and streambanks by livestock. To limit livestock access to waterbodies or grazed land requiring rest for rejuvenation.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment, nutrients, pathogens, oxygen-demanding organic matter, and thermal modification.

WHERE USED
Barnyards, feedlots, pastures, grazed hayfields, highly erodible fields, in riparian areas, wetland or any area adjacent to a waterbody.

PRACTICE DESCRIPTION
Fencing excludes livestock from highly erodible areas, resting sections of grazing systems, and limits access to drainageways and waterbodies, thereby limiting the detachment, transport and delivery of sediments, sediment-bound pollutants and the delivery of animal waste to surface waters.

PRACTICE EFFECTIVENESS
Fencing is effective in protecting riparian areas and enhancing grazed forage vegetation which act as sediment traps and filters along water channels and impoundments.

IMPACT ON SURFACE WATER
Beneficial. When used in pastures, on grazed land, and when livestock access to waterbodies is restricted.

IMPACT ON GROUND WATER
Beneficial. When it is used to exclude livestock from aquifer recharge areas or riparian areas, in general, fencing has no direct impact on groundwater.

ADVANTAGES
- Is inexpensive.
- Is an effective practice for keeping livestock out of waterbodies, water courses, and resting sections of grazing systems.

DISADVANTAGES
- Is labor-intensive to install. Where temporary fencing is used, it is labor-intensive to move.

PRACTICE LIFESPAN
Ten (10) years.

COST
Unit cost ranges from $1.50/linear foot installed up to $6.00/linear foot for high tensile, electric fence.

OPERATION AND MAINTENANCE
Check spacing, tension springs, bracing, posts, energizers, ground insulators and gates on a periodic basis. Temporary fencing may need to be checked and moved daily.

MISCELLANEOUS COMMENTS
This practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES
USDA. Natural Resources Conservation Service. Effects of Conservation Practices on Water Quantity and Quality. Washington, DC. October 1988.

USDA. National Resources Conservation Service. 2001. National Handbook of Conservation Practices. Fencing, 382, March 2003. Syracuse, NY. (Management Practice Design Standard and Specification).

FILTER STRIP

DEFINITION
An area of perennial grasses, legumes, or shrubs and trees planted across the slope, established adjacent to areas of high pollutant delivery potential, and managed for pollutant removal by overland flow.

WATER QUALITY PURPOSE
To reduce velocity and increase infiltration of runoff water so that sediment, nutrients and organic matter can be retained and utilized by the vegetation.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment, solid phase nutrients, organics, some heavy metals and pathogens.

WHERE USED
Riparian zones, compost pads, agricultural fields, road corridors, sand and gravel pits, etc.

PRACTICE DESCRIPTION
Filter strips are seeded to grasses, legumes, or a mixture of both. New plantings of trees and shrubs as filter strips require temporary cover to be effective. Occasionally, existing stands of trees or shrubs can be used for their filtering ability. Designed filter strip widths vary with land slope, type of vegetative cover, watershed area, soil suitability and type of pollutant to be filtered. Filter strips reduce the delivery of pollutants from runoff water by filtration, deposition, infiltration, absorption, adsorption, decomposition and volatilization.

PRACTICE EFFECTIVENESS
Filter strips are most effective when used in conjunction with erosion reducing management practices. Filter strips are very effective for sediment and sediment-bound pollutant removal (i.e., lead), with trapping efficiencies exceeding 50%. Filter strips in riparian zones have trapped 85-90% of the sediment and up to 50% of the phosphorus leaving cultivated fields. Filter strips do not remove soluble phosphorus or nitrates effectively. When the wastes are applied by overland flow, much of the pollutant load can be trapped on the surface of the filter strip vegetation and biodegradation can take place.

IMPACT ON SURFACE WATER
Beneficial.

IMPACT ON GROUND WATER
Slight. Practice may increase transport of pollutants to groundwater by increased infiltration.

ADVANTAGES

- May be inexpensive.
- Is easy to install and maintain.
- Are unobtrusive.
- May have benefits for wildlife.
- Controls surface runoff.

DISADVANTAGES

- Does not reduce pollutant generation within a field.
- Are ineffective in hilly areas, areas receiving concentrated flows, during larger runoff-producing storms, and when the ground is frozen and vegetation is snow-covered.
- May not effectively remove all pollutants from effluent.
- Lose effectiveness when sediment accumulates in the filter.
- May be expensive to install depending on the topography.
- May require a large land area

PRACTICE LIFESPAN

Ten (10) years.

COST

Relatively inexpensive for herbaceous filter areas where natural topography is suitable. Slightly higher costs when trees and shrubs are used. Areas that require regrading are the most expensive.

OPERATION AND MAINTENANCE

Removal of trapped sediment every year or after larger runoff-producing storms. Herbaceous vegetation should be harvested and removed each year.

MISCELLANEOUS COMMENTS

In some cases, the practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

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INTEGRATED PEST MANAGEMENT: Overview

DEFINITION
An ecologically-based integrated pest control strategy designed to keep pest populations below economically injurious levels using a variety of control tactics.

WATER QUALITY PURPOSE
To reduce pesticide use, availability and losses in crop and livestock production.

SOURCE CATEGORY
Agriculture / Surface Runoff

POLLUTANTS CONTROLLED
Pesticides

WHERE USED
Cropland, vegetables, hayland, orchards, vineyards, livestock, turf, and ornamentals, including greenhouse crops.

PRACTICE DESCRIPTION
IPM uses monitoring, pest forecasting, scouting and "economic thresholds" to determine the appropriate use of pesticides, and alternative pest control tactics. IPM uses "pest thresholds" to identify situations requiring economically justifiable control measures. A pest population must reach a particular level before expected losses in crop yield or quality will equal costs of pest control. An "action threshold" is the pest density at which management options are employed to minimize or prevent economic loss. Management options include use of biological control agents, cultural practices such as crop rotation, the use of trap crops, destruction of pest breeding and refuge sites, ecosystem diversification, scouting, resistant crop varieties, mechanical weed control, timing of planting and harvesting, the selection and use of pesticides, pesticide formulations and alternatives, timing of application, and the use of specialized equipment such as re-circulating or electrostatic sprayers. Factors affecting the choice of IPM options are crop and pest growth stage, days to harvest, crop yield and values.

IPM philosophy calls for pesticide use when all other management methods have been exhausted. IPM may reduce the amount of pesticides used in crop production, the frequency of pesticide applications, and it may encourage the use of a pesticide with reduced risks to human health and the environment.

PRACTICE EFFECTIVENESS
Overall, IPM is effective, highly profitable and relatively safe. Few if any studies have established a solid link between IPM usage and reduction of pesticide levels in receiving waters. However, IPM has been credited with reduction in chemical usage. IPM is an effective management practice for consideration in vegetables, fruit or field crops especially where large amounts of pesticides are applied, waterbodies are adjacent to crop fields, and soils are highly permeable. In 1989, apple producers scouted their orchards and used 27% less insecticide and miticide compared to their conventionally sprayed trees. Growers of cabbage, broccoli and

cauliflower used 43% fewer pesticide applications in their IPM fields than in conventional fields. Pesticide use for the control of house flies in dairy barns can be reduced 50% to 80% if manure is removed on a timely basis and fly biological control agent populations are enhanced.

IMPACT ON SURFACE WATER
Beneficial. In most management options, IPM reduces the availability of pesticides as a nonpoint source pollutant.

IMPACT ON GROUND WATER
Beneficial. In most management options, IPM reduces the availability of pesticides as a nonpoint source pollutant. Often, a pesticide's impact on groundwater is determined by other management practices used in conjunction with IPM.

ADVANTAGES

- Is an economically and environmentally defensible practice.
- Has higher average per acre crop yields.
- Realizes a higher net return per acre due to improved commodity quality.
- Use of pesticides usually declines under IPM.
- Usually requires fewer pesticides on a per acre basis.

DISADVANTAGES

- May result in more pesticide applications per growing season because scouts often find pest populations missed by non-IPM growers.
- May have pest control costs slightly higher, or equal to, conventional control techniques.
- May render IPM practices invalid, or result in an increase in pesticide use when variations in pest populations, weather, soils, plant resistance, and many other events occur.
- Requires additional time and training to adjust to new management strategies when IPM practices are adopted.

PRACTICE LIFESPAN
One (1) year.

COST
Variable. Dependent upon control tactic used.

OPERATION AND MAINTENANCE
Scouting and monitoring is an ongoing activity. O&M is specific for each control tactic used. Record keeping is an essential component of these practices. Scouting dates, stages of growth on those dates, numbers and types of pests found, chemical recommendations made, date and amount of chemicals applied need to be recorded promptly and accurately.

MISCELLANEOUS COMMENTS
Some component practices may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES

Cornell Cooperative Extension. Cornell Guidelines for Field Crops, Livestock/Poultry, Stored Grains, Floriculture/Cultural, Forest Crops/Pest Control, Turfgrass, Vertebrates, Tree-Fruit, Grapes, Small Fruit, Vegetable/Potato. Ithaca, NY (Current Year). (Management Practice Design Standard and Specification)

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University of Wisconsin – Extension. Nutrient and Pesticide Best Management Practices for Wisconsin Farms. Madison, WI. 1989.

IPM: Biological Controls

DEFINITION
The control of plant pests using natural enemies such as parasites, predators and pathogens

WATER QUALITY PURPOSE
To reduce pesticide use, availability and losses in livestock and crop production

SOURCE CATEGORY
Agriculture / Surface Runoff

POLLUTANTS CONTROLLED
Pesticides

WHERE USED
Cropland, hayland, vegetables, orchards, vineyards, livestock, turf and ornamentals, including greenhouse crops.

PRACTICE DESCRIPTION
Biological control consists of the human manipulation of natural pest enemies to decrease pest populations below economically acceptable levels (action thresholds). Biological control techniques include importation and release of exotic natural enemies, augmentation of indigenous natural enemies, introduction of insecticide-resistant natural enemies, introduction of insect diseases (primarily viruses and bacteria), rearing and releasing of sterilized insect pests, use of insect pheromones, selection of pesticides that are least toxic to the natural enemies, and reduction or elimination of pesticide applications when natural enemies are susceptible.

Overall, biological controls may have the effect of reducing or eliminating pesticide use.

PRACTICE EFFECTIVENESS
Biological control of pests by natural enemies is partially or entirely effective on most potential pests. Biological control can be long-lasting if it is not disrupted by pesticide use, certain crop rotations, or unusual climatic conditions.

Examples of effective biological control techniques include the use of Bacillus thuringiensis (Bt) to control lepidopterans, such as the cabbage looper, and Bacillus thuringiensis isrealensis, a sub-species, for the control of immature mosquitoes living in aquatic environments. Pheromones applied to crop fields can disrupt insect mating behavior and reduce the size of subsequent generations of pests. Two turf diseases, dollar spot and brown patch, have been controlled using topdressings of compost rich in bacteria and fungi that suppressed the diseases. Insect pathogens and parasites have been successful in controlling flies on dairy farms. Biological control is least effective when pest populations are above action thresholds.

IMPACT ON SURFACE WATER
Beneficial.

IMPACT ON GROUND WATER
Beneficial.

ADVANTAGES
- Uses natural control techniques.
- May reduce the need for pesticides.
- Satisfies consumer market demand for produce grown with fewer pesticides.
- May be cost-effective and long-lasting, provided that farming practices such as insecticide use, certain crop rotations or unusual climatic conditions do not disrupt the benefits of biological control.

DISADVANTAGES
- May not be practical or effective when pest populations exceed action thresholds.
- Does not guarantee 100% control, or blemish-free produce.

PRACTICE LIFESPAN
One (1) year.

COST
Varies. Depends on target pest(s) and control method.

OPERATION AND MAINTENANCE
Biological control requires an ongoing monitoring program, including scouting, traps and forecasting, to maintain pest populations below economically acceptable levels (action thresholds), with observations made and actions taken logged accurately and promptly.

MISCELLANEOUS COMMENTS
Biological control must be practiced within the context of a total Integrated Pest Management (IPM) system approach. Weather, crop phenology, unusual pest outbreaks and many other events may render this practice invalid.

REFERENCES
Cornell Cooperative Extension. Cornell Guidelines for: Field Crops, Livestock/Poultry, Stored Grains, Floriculture/Cultural, Forest Crops/Pest Control, Turfgrass, Trees/Shrubs, Vertebrates, Tree Fruit, Grapes, Small Fruit, Vegetable/Potato. Cornell University, Ithaca, NY. (Current Year). (Management Practice Design Standard and Specification)

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University of Wisconsin – Extension. Nutrient and Pesticide Best Management Practices for Wisconsin Farms. Madison, WI. 1989.

IPM: Cultural Practices

DEFINITION
A variety of pest control techniques that seek to modify or eliminate the pest's habitat.

WATER QUALITY PURPOSE
To reduce pesticide use, availability and losses in crop and livestock production.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Pesticides.

WHERE USED
Cropland, vegetables, hayland, orchards, vineyards, livestock, turf and ornamentals, including greenhouse crops.

PRACTICE DESCRIPTION
IPM cultural practices include destruction or modification of pest breeding sites through the use of crop rotations, increasing ecosystem diversity, adjusting the time of planting and harvest, precise management of water and fertilizer, modified cultivation and tillage practices, improved sanitation, and inter-planting species repellent to pests.

Cultural practices may reduce the amount of pesticide used in crop production, the frequency of the pesticide application, or may encourage the use of a pesticide with reduced risks to human health and the environment.

PRACTICE EFFECTIVENESS
Each control tactic must be evaluated separately to determine practice effectiveness. Cultural practices are currently the most effective alternative to herbicides. Cultural controls are usually used in combination with each other, and other management practices to minimize pest development and carryover.

Black rot control in cabbage can be achieved when the grower uses cultural controls such as direct seeding instead of transplants, elimination of alternate hosts, crop rotations, use of a clean seedbed, cleaning equipment and incorporation of crop residues as soon as possible. Strawberry growers who scouted their crop, used no fungicides, maintained narrow rows, proper nitrogen levels, and good weed control had the same disease level and same yield as growers who made one to five fungicide applications. Long Island potato growers have found when marigolds are grown in the soil before potatoes are planted, root lesion nematodes are reduced by 80%. Potato yields from plantings following a marigold crop can be as much as 39% more than yields following a fallow treatment. In addition, good sanitation practices and weekly removal of manure and bedding have proven effective in reducing fly populations on dairy farms.

IMPACT ON SURFACE WATER
Generally beneficial. However, some cultural practices may increase soil erosion because they promote the incorporation of crop residues by tillage.

IMPACT ON GROUND WATER
Generally beneficial. Cultural practices reduce the availability of pesticides as a nonpoint source pollutant. However, the impact on groundwater is primarily determined by other management practices that influence infiltration.

ADVANTAGES
- Some cultural practices are inexpensive and easy to perform.
- Control techniques are widely available.

DISADVANTAGES
- Higher level of grower management is required which may result in increased labor and equipment costs.
- Some practices may promote soil erosion.
- A complete systems approach must be followed for success.

PRACTICE LIFESPAN
One (1) year.

COST
Variable. Some practices involve a change in management rather than an expense to the grower. Other practices may result in increased labor and equipment costs.

OPERATION AND MAINTENANCE
Cultural practices require adherence to a scouting and monitoring program, including management of the pest according to action thresholds, with observations made and the actions taken logged accurately and promptly.

MISCELLANEOUS COMMENTS
None.

REFERENCES
Cornell Cooperative Extension. Cornell Guidelines for: Field Crops, Livestock/Poultry, Stored Grains, Floriculture/Cultural, Forest Crops/Pest Control, Turfgrass, Trees/Shrubs, Vertebrates, Tree Fruit, Grapes, Small Fruit, Vegetable/Potato. Cornell University, Ithaca, NY. (Current Year). (Management Practice Design Standard and Specification)

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IPM: Resistant Crop Varieties

DEFINITION
The use of plants that have been genetically manipulated or selectively bred for their ability to avoid, tolerate, or recover from pest infestations.

WATER QUALITY PURPOSE
To reduce pesticide use, availability and losses in crop production.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Pesticides.

WHERE USED
Cropland, vegetables, hayland, orchards, vineyards, turf, and ornamentals, including greenhouse crops.

PRACTICE DESCRIPTION
Crop resistance to disease may be due to plant physiological factors (e.g., toxic compounds produced by the plant), morphological factors (e.g., a cuticle which is too thick for penetration by the pest) or increased tolerance in which case pests continue to feed on the host but damage remains below economic injury level.

The level of disease resistance required by a crop depends on the nature of the disease, the type of site where the crop is grown, and the relative importance of various diseases in the local area.

PRACTICE EFFECTIVENESS
The effectiveness of resistant crop varieties can be measured by the percent of growers adopting the crop strain. In the fall of 1989, more than 50% of New York State's wheat acreage was planted to cultivars resistant to wheat spindle streak mosaic virus. Most varieties of alfalfa used in New York State have a moderate level of resistance to Verticillum wilt and a high level of resistance to bacterial wilt.

IMPACT ON SURFACE WATER
Beneficial. When resistant crop varieties are grown, pesticide use is reduced, therefore pesticide usage as a nonpoint source pollutant is reduced. Resistant crop varieties have an indirect beneficial impact on surface water.

IMPACT ON GROUND WATER
Beneficial. When resistant crop varieties are grown, pesticide use is reduced, therefore pesticide usage as a nonpoint source pollutant is reduced. Impact on groundwater is primarily a function of infiltration. In general, resistant crop varieties may have a beneficial effect on groundwater where infiltration is not a problem.

ADVANTAGES

- The use of resistant crops is one of the most common and easily adopted IPM control practice.
- Varietal resistance is often the single most important means of controlling vascular wilts in forages.

DISADVANTAGES

- Resistance in itself will not control pest populations.
- Resistance is not available for all commercially grown crops.
- Resistance takes many years to develop through expensive plant breeding programs.
- Pests can overcome resistance.

PRACTICE LIFESPAN

One (1) year.

COST

Purchase price of the seed. (Seed costs may be slightly higher for resistant varieties than for non-resistant varieties)

OPERATION AND MAINTENANCE

Continue scouting and following the IPM control techniques recommended by the scout.

MISCELLANEOUS COMMENTS

Cornell Recommends (Current Year) should be consulted for a list of resistant crop varieties.

REFERENCES

Cornell Cooperative Extension. Cornell Guidelines for Field Crops, Livestock/Poultry, Stored Grains, Floriculture/Cultural, Forest Crops/Pest Control, Turfgrass, Vertebrates, Tree-Fruit, Grapes, Small Fruit, Vegetable/Potato. Ithaca, NY (Current Year). (Management Practice Design Standard and Specification)

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IPM: Scouting

DEFINITION
The visual inspection, sampling, collection and documentation of pest and crop information either by a trained Integrated Pest Management (IPM) scout, or growers themselves.

WATER QUALITY PURPOSE
To reduce pesticide use, availability and losses in crop and livestock production.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Pesticides.

WHERE USED
Cropland, vegetables, hayland, orchards, vineyards, livestock, turf, and ornamentals, including greenhouse crops.

PRACTICE DESCRIPTION
Crops are monitored for signs of insects, disease, weeds, nutritional deficiencies, and other factors known to adversely affect crop health, yield or value. A trained scout identifies the pest or condition involved, determines if "action thresholds" have been reached, and recommends appropriate control measures.

When scouting activities are implemented, they may reduce the amount of pesticide applied to crops, and subsequently reduce the amount of chemical reaching a waterbody. In some scouting situations, scouting may eliminate the need for a pesticide application. In other cases, scouting may dictate the use of a pesticide because "action thresholds" have been exceeded.

PRACTICE EFFECTIVENESS
Scouting effectiveness is measured in the reduction of pesticide use. Long Island growers who used scouting on their IPM cabbage and cauliflower fields used 43% less pesticides than conventionally sprayed crops. Growers paid $8 to $10 per acre for IPM services, but saved between $24 and $79 per acre in insecticide costs. Apple growers, who participated in the Simplified Integrated Pest Management Program (SIMP,) used 27% less insecticide and miticide on SIMP (apple) blocks than on non-SIMP blocks. Because growers scouted on their own time, there was no expense for scouting services.

IMPACT ON SURFACE WATER
Beneficial. When scouting principles are implemented, they may reduce the availability of pesticides as a nonpoint source pollutant. Indirectly, scouting may have a beneficial effect on surface water.

IMPACT ON GROUND WATER
Beneficial. When scouting principals are implemented, they may reduce the availability of pesticides as a nonpoint source pollutant. However, impact on groundwater is primarily determined by practices that influence infiltration. In general, scouting may have a beneficial effect on groundwater when it is conducted on crops grown in soils which have infiltration and permeability.

ADVANTAGES
- Is very cost-effective.
- Needed for any IPM control technique.
- May be learned by grower who has working knowledge of crop and/or livestock pests.

DISADVANTAGES
- May not have trained scouts commercially available.
- May require a high level of expertise that may take considerable time to learn.
- May be an expensive "up-front cost" to the grower.

PRACTICE LIFESPAN
One (1) year.

COST
On average, $5 to $30 per acre for custom scouting services. Scouting services may pay for themselves in reduced pesticide costs and improved crop quality.

OPERATION AND MAINTENANCE
Scouting is an ongoing activity. Implementation of the scout's recommendations and continued monitoring is part of normal O&M.

MISCELLANEOUS COMMENTS
May be eligible for cost-sharing, check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES
Cornell Cooperative Extension. 1994 Onion IPM Scouting Procedures. IPM Bulletin 106. Cornell University and the NYS Department of Agriculture and Markets. Geneva, NY.

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IPM: Trap Crops

DEFINITION
A form of pest scouting that employs an early season crop, or an alternate crop, as pest bait.

WATER QUALITY PURPOSE
To reduce pesticide use, availability, and losses in crop production.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Pesticides.

WHERE USED
Cropland, vegetables, hayland, orchards, vineyards, turf and ornamentals, including greenhouse crops.

PRACTICE DESCRIPTION
The trap crop is used as an indicator of the onset and magnitude of pest outbreaks (normally insects). Pests attracted to the crop can be controlled if they reach action thresholds. Trap crops can reduce pesticide use by controlling pests at the time of outbreak and applying precise amounts of pesticides, rather than preventative spraying on a calendar schedule.

PRACTICE EFFECTIVENESS
The use of early planted potatoes as a trap crop has been an effective technique for attracting the Colorado potato beetle and determining the time and magnitude of spring emergence in the field.

IMPACT ON SURFACE WATER
Generally beneficial. Trap crops allow for more precise timing and selective application of pesticides, resulting in a lower total volume of pesticides used.

IMPACT ON GROUND WATER
Generally beneficial. However, the impact on groundwater is primarily determined by other management practices that influence infiltration.

ADVANTAGES
- Are relatively inexpensive, yet highly effective methods of implementing pest control strategies.

DISADVANTAGES
- Requires high levels of grower management.
- Usually effective only at the beginning or the end of the growing season.

PRACTICE LIFESPAN
One (1) year.

COST
Equates to 5% to 10% of the cost of the crop, including planting expenses.

OPERATION AND MAINTENANCE
Trap crops require adherence to a scouting and monitoring program, including management of the pest according to action thresholds.

MISCELLANEOUS COMMENTS
Refer to Cornell Recommends (Current Year) and the appropriate Grower's Guide for crops suitable for this control technique.

REFERENCES
Cornell Cooperative Extension. Cornell Guidelines for: Field Crops, Livestock/Poultry, Stored Grains, Floriculture/Cultural, Forest Crops/Pest Control, Turfgrass, Trees/Shrubs, Vertebrates, Tree Fruit, Grapes, Small Fruit, Vegetable/Potato. Cornell University, Ithaca, NY. (Current Year). (Management Practice Design Standard and Specification)

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IRRIGATION WATER MANAGEMENT

DEFINITION
A planned system that determines and controls the rate, amount, placement and timing of irrigation water.

WATER QUALITY PURPOSE
To reduce surface water runoff and/or leaching of nutrients and pesticides by applying irrigation water based upon the capacity of the soil to hold water and the needs of the crop.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment, nutrients and pesticides.

WHERE USED
On agricultural fields requiring irrigation where the potential for surface water runoff and/or groundwater contamination exists.

PRACTICE DESCRIPTION
Irrigation water management is utilized on cropland to supplement rainfall, and to apply fertilizer and pesticides to target crops. Several irrigation methods exist. Selection of the irrigation system to be used is based on the needs of the crop to be grown, soil type, topography, climate, distance to streams or other water bodies, and the source of water to be used for irrigation. To decrease non-point source pollution of surface and groundwater resources, water application must be at rates that minimize the transport of sediments, nutrients and chemicals to surface waters and that minimize the transport of nutrients and chemicals to groundwater.

The development of an “Irrigation Water Management Plan” that addresses the irrigation scheduling, in both timing and amount, control of runoff, minimizing deep percolation and the uniform application of water is an essential component of this practice.

PRACTICE EFFECTIVENESS
This practice can help prevent over irrigation, and the resulting loss of sediment, nutrients and pesticides by surface runoff and leaching.

IMPACT ON SURFACE WATER
Beneficial.

IMPACT ON GROUND WATER
Beneficial to slight. Leaching losses of nutrients and pesticides are minimized when scheduling is a part of an irrigation water management system. However, other management practice that promote infiltration may have adverse impacts on groundwater.

ADVANTAGES

- Minimizes leaching losses of nutrients and pesticides.
- Conserves irrigation water use, especially important during droughts.
- Prevents surface runoff which causes soil erosion and the resultant loss of pollutants attached to sediment and dissolved in runoff.
- Avoids crop stresses due to under-irrigation.
- May increase crop yields.
- Reduces water loss – applies what the crop needs.
- Reduces operating and labor costs.
- Increases control over fertilizer placement and timing, improving fertilization efficiency and the potential to reduce or prevent nutrient leaching.

DISADVANTAGES

- May require additional training, or an increase in irrigation operation management skills.
- Requires additional time and equipment to collect data.
- Changes in irrigation methods may require changes in equipment which can be costly.

PRACTICE LIFESPAN

One (1) year.

COST

Additional labor and equipment expenses to collect data may be encountered. No cost for technical assistance. Software scheduling programs may need to be purchased.

OPERATION AND MAINTENANCE

Accurate and timely records of rate, amount, timing and upkeep of equipment is a necessary component of this practice. A record keeping system and an O&M plan must be prepared for each system used.

MISCELLANEOUS COMMENTS

This practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

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MILKING CENTER WASTEWATER TREATMENT

DEFINITION
A system designed for the collection, storage, treatment and disposal of effluents from milkhouses. This practice is not applicable to treat dumped milk or sewage from rest rooms.

WATER QUALITY PURPOSE
To reduce the organic and nutrient component of the liquid waste of milkhouse wastewater, from dairy farms, prior to reaching receiving waters.

SOURCE CATEGORY
Agriculture/Surface Runoff.

POLLUTANTS CONTROLLED
Primarily, biodegradable organics and soluble phosphorous. Secondarily, ammonia, nitrates and pathogens.

WHERE USED
Livestock operations where wastewater is generated from washing of tanks, pipelines, parlor floors, milking machines and associated equipment.

PRACTICE DESCRIPTION
Wastewater from the milkhouse is collected and treated through a process of separation and treatment. Milk solids and organic matter are removed from the wastewater through a series of settling tanks and grease traps. Solids are removed from these tanks as necessary for land disposal. The effluent from the tanks is further treated by routing the wastewater through a designed wastewater treatment area. Remaining pollutants are treated through the processes of filtration, infiltration, absorption, adsorption, evaporation, biological reduction and volatilization.

PRACTICE EFFECTIVENESS
Treatment of milkhouse wastewater can remove up to 98% of the phosphorus, 90% of the suspended solids and lower the Biological Oxygen Demand (BOD5) by 80%.

IMPACT ON SURFACE WATER
Beneficial. Reduces phosphorous, fecal coliform and organics loading.

IMPACT ON GROUNDWATER
Beneficial. Slight in porous soils.

ADVANTAGES
- May apply treated washwater to the land surface for final treatment.
- Does not add additional water to the manure handling system.

DISADVANTAGE

- Must be located in close proximity to the barn gutter for gravity discharge.
- Can be expensive if modifications need to be made to the milkhouse.

PRACTICE LIFESPAN

Ten (10) years.

COSTS

$3800- $6300 depending on the modifications to the milkhouse.

OPERATION AND MAINTENANCE

Periodic monitoring and cleanout of solids tanks and grease traps. Pumps, valves and pipelines need to be periodically checked. Care should be taken to keep highly concentrated milk waste or contaminated milk from being discharged into the system.

MISCELLANEOUS COMMENTS

This practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES

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MULCHING – Vineyards/Cropland

DEFINITION
Applying plant residues, by products or other suitable materials produced off site, to vineyard alleyways and/or specialty crops.

WATER QUALITY PURPOSE
To prevent erosion, control runoff and maintain or improve water quality.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment, nutrients and pesticides.

WHERE USED
On vineyard and specialty crop lands, needing temporary stabilization. This practice may be used alone or in combination with other practices.

PRACTICE DESCRIPTION
Mulching consists of the application of a suitable material to unprotected soils, during the growing season, to protect potentially unstable cropland. The mulching materials selected will depend primarily on site conditions, the material's availability and the crop to be grown. Mulching materials shall consist of natural and/or artificial materials such as plant residue or other equivalent materials of sufficient depth or thickness to achieve the intended purpose for the required time period (usually 1 year).

Typically, vineyard mulching consists of rolling out large, round, weed free hay bales down the center alleys. This method will provide 100% cover, 3-4" thick, over the treated soil surface and could last 1 year or more. Other methods of application are also acceptable; however, the thickness of the loose mulch material may need to be increased to give the protection required for the same time period. Loose mulch material may need to be anchored to the soil using tackifiers, emulsions, pinning, netting, crimping or other suitable methods necessary to hold the mulch in place.

PRACTICE EFFECTIVENESS
Field trials conducted during the late 1980s by NRCS State Agronomist and CCE Grape Specialist found vineyard mulching to be very effective at controlling erosion. Runoff rates were reduced by 93% over clean tillage. Mulching was also found to be beneficial for weed control and moisture conservation.

IMPACT OF SURFACE WATER
Beneficial. Reduces soil loss, runoff and pesticide use to control weeds.

IMPACT OF GROUNDWATER

Beneficial. Increases infiltration, reduces soil moisture loss and pesticide use to control weeds.

ADVANTAGES

- Is relatively inexpensive erosion control to implement over a large land area.
- May increase crop yields.
- Reduces fuel usage.
- Reduces herbicide applications.
- Preserves moisture.

DISADVANTAGES

- May require special equipment to handle large round bales.

PRACTICE LIFESPAN

One (1) year.

COST

Cost can vary depending on source of mulch. $150-$250 per acre when every other row is mulched and $350 - $450 per acre when every row is mulched plus any special equipment needs.

OPERATION AND MAINTENANCE

Mulched areas will need periodic inspection and mulch reinstalled or repaired to accomplish the intended purpose for the planned time period.

MISCELLANEOUS COMMENTS

Some component practices may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES

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NUTRIENT MANAGEMENT

DEFINITION
An integrated approach to maximizing the efficient use of plant nutrients.

WATER QUALITY PURPOSE
To reduce or prevent surface and subsurface nutrient losses.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Nutrients, primarily nitrogen and phosphorus.

WHERE USED
Cropland, hayland, pasture, vegetables, orchards, vineyards, turfland, ornamentals, including greenhouses.

PRACTICE DESCRIPTION
Nutrients are managed for the economic production of feed, animal products, and protection of water quality. Nutrient management consists of determining the nutrient requirements of crops, subtracting nutrients supplied by the soil, crop residues, and manure, and supplementing additional needs with commercial fertilizer. A well integrated nutrient management program controls nutrient loss by reducing excessive applications.

Component practices include an annually updated nutrient management plan that incorporates soil testing, manure nutrient analysis, with rate, timing and placement of fertilizer, manure and other nutrient applications. Soil management practices to control runoff and erosion are a part of a nutrient management plan.

Soil analysis and accompanying recommendations should be used to maximize the efficient nutrient uses of manure, fertilizer and lime. Fertilizer and manure management techniques, such as, rate, timing and placement promotes the maximum uptake of nutrients by plants. Manure nutrient analysis may be an integral part of a nutrient management plan and where applicable should be managed as a major source of plant nutrients. Laboratory analyses of soil, organic and inorganic sources determine the percentages of total nitrogen, ammonium nitrogen, phosphorus, potassium and dry matter that is available. Nutrient management recommendations should be based on the best available research information for the soils and climate in New York State. Nutrient applications and their management should be consistent with “Cornell Recommends for Field Crops, etc.

PRACTICE EFFECTIVENESS
Optimum nutrient management prevents excessive applications and reduces the potential for nutrient loss. A well managed soil testing program will maximize economic returns and reduce the potential for nutrient losses. When manure nutrient analysis is utilized and the results are

adopted, livestock and poultry producers can capture much of the nutrient value of land-applied manure, as well as realizing a financial benefit from reduced purchase fertilizer costs. Proper rate, timing, and placement of the manure and fertilizer effectively increase nutrient utilization by crops and reduces nutrient losses. Nitrogen is most efficiently used by a crop if applied just prior to the period of maximum uptake. Phosphorus is more efficiently used when establishing a crop if placed in a band close to the seed at planting as compared to a broadcast application. Long-term experimentation demonstrates that recommendations based on field research, conducted in New York, provide the best estimate of economic response and improved nutrient cycling. Research at Cornell showed a reduction in nitrogen and phosphorus losses in surface runoff with improved nutrient management practices.

IMPACT ON SURFACE WATER
Beneficial, when the recommendations from a research-supported testing program are implemented.

IMPACT ON GROUNDWATER
Beneficial, when the recommendations from a research-supported testing program are implemented.

ADVANTAGES
- May provide direct fertilizer cost savings when recommended rates are applied.
- Reduces nutrient loss potential.
- Allows manure to be managed as a resource rather than a waste.
- Avoids over fertilizing.
- Relatively inexpensive and cost-effective.
- Provides accurate records of soil test results and fields tested.

DISADVANTAGES
- Requires high level of management.
- Cannot guarantee zero nutrient loss.

PRACTICE LIFESPAN
One (1) year.

COST
Variable depending on the size and type of farming operation. Consultation fees for developing and maintaining a nutrient management plan should be considered in addition to the costs for soil testing and manure nutrient analyses.

TOOLS
There are many computer-based tools available to assist in the development of nutrient management plans.

OPERATION AND MAINTENANCE

Annual update of the nutrient management plan is required. Soil testing and manure analyses should be performed as required. Records showing manure tests, time applied, amount applied and location are a necessary component of this practice.

MISCELLANEOUS COMMENTS

Nutrient management plans are limited to the management of nutrients. Comprehensive Nutrient Management Plans address other resource concerns on the farm and should be given priority consideration were:

- Excess nutrients are produced or imported.
- Highly erodible lands occur.
- Other farm related environmental concerns exist (ie: silage leachate runoff, barnyard runoff, milkhouse wastewater, petroleum product storage, pesticide storage, mixing and loading, pesticide use and waste disposal).
- The farm has been determined to be a Concentrated Animal Feeding Operation (CAFO) by NYS Department of Environmental Conservation..

Note: Nutrient Management Plan (NRCS Standard 590) does not meet the NYS requirements for CAFOs. A Comprehensive Nutrient Management Plan (NRCS Standard 312) must be developed for these farms.

Nutrient management plans, Comprehensive Nutrient Management Plans and certain components may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

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NUTRIENT MANAGEMENT: Anaerobic Digestion

DEFINITION
The microbiological reduction of manure, anaerobically, in a closed system to produce a stabilized odorless soil amendment.

WATER QUALITY PURPOSE
Nutrient management of manure.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Nutrients, organics, and odors.

WHERE USED
On livestock and poultry farms where manure is produced but odors prevent it from being spread according to a nutrient management plan.

PRACTICE DESCRIPTION
Anaerobic digestion is accomplished in a designed, enclosed system where the anaerobic bacteria convert carbon and hydrogen in the manure to methane and carbon dioxide. The methane may then be used as a fuel for electric generation and/or as a heat source. The stabilized effluent is much more likely to be spread for maximum nutrient uptake by crops, since it is odorless, and more liquid. Summer applications on growing crops become much more feasible physically, due to the liquefaction of the manure, as well as socially, due to the reduced odors.

PRACTICE EFFECTIVENESS
Anaerobic digestion is effective for odor control when complete stabilization of the manure occurs. Under the proper temperature and pH environment, complete stabilization is possible in 20 to 30 days hydraulic retention time. It may also be economical in the right conditions. Over time the energy produced may pay for the capital costs of the system. Operating an anaerobic digester takes a time and management commitment from the producer. Odorless, liquid manure can be applied to crops when they need it while limiting losses to the environment.

IMPACT ON SURFACE WATER
Beneficial. Manure spread during the growing season is much more likely to be utilized by the crop before runoff occurs.

IMPACT ON GROUNDWATER
Beneficial. Manure spread during the growing season is much less likely to use preferential flow paths to escape to the groundwater. The anaerobic digester is completely enclosed, so leakage during processing should not occur.

ADVANTAGES

- Odor reduction will allow the application of manure at times of the year and places on fields that were previously limited.

DISADVANTAGES

- Anaerobic digestion takes a large initial capital investment.
- Management of the unfamiliar processes of digestion and subsequent energy utilization may be a problem.

PRACTICE LIFESPAN

Twenty (20) years.

COSTS

Economics of scale make this practice less expensive the bigger the facility. Capital costs starting at $250,000, including equipment for energy utilization, should be expected. There should be a net operating gain to the farm enterprise to offset operating costs.

OPERATION AND MAINTENANCE

A written O&M plan needs to be developed for each facility. Technological maintenance and operating advice needs to be available from agencies, consultants or suppliers. Prior to construction, the farmer should understand and agree to all required O&M tasks.

MISCELANEOUS COMMENTS

This practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

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NUTRIENT MANGEMENT: Composting

DEFINITION
The microbiological conversion of raw organic waste into stable, soil-enriching humus.

WATER QUALITY PURPOSE
Nutrient management of manure, plant and animal wastes.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Nutrients, organics, ammonia and pathogens.

WHERE USED
On livestock or poultry farms, food processing facilities or other agricultural operations where manure, dead animal carcasses, food processing wastes or plant wastes are produced.

PRACTICE DESCRIPTION
Composting on the farm is accomplished by mixing an energy source (carbonaceous material: wood chips, sawdust, straw, corn cobs, or well-bedded horse manure) with a nutrient source (nitrogenous material: animal carcasses, livestock manure or food processing waste) in a prescribed manner under aerobic conditions. Microorganisms (primarily bacteria and fungi) break down the raw organic waste under controlled conditions. Air, water, nutrients, surface area, temperature and pH are all important factors in the composting process.

Three types of composting operations are common for on-farm use:
1. Aerated Windrows - organic materials are formed into long narrow piles, called windrows, and turned periodically with power equipment to aerate the piles and promote the composting process. This method is the most suitable and least expensive option for on-farm use.
2. Static Piles - organic material is mixed to a homogeneous condition and not turned during the composting process. Correct moisture content and bulk density facilitate air movement throughout the pile.
3. In-vessel Composting - blended organic material is placed in a totally enclosed structure where air flow is strictly controlled. This method is the most expensive, but most controlled option for on-farm use.

PRACTICE EFFECTIVENESS
Composting is an effective method of reducing the availability of inorganic nitrogen in plant and animal wastes. The by-products of aerobic decomposition are carbon dioxide, water and heat. When compost is kept well aerated, nitrogen loss by denitrification is minimized. A compost pH of 6.5 - 7.0 will avoid nitrogen loss by ammonification. High amounts of available carbon will aid nitrogen immobilization. When compost operating temperatures are achieved for the required time periods, pathogens are killed.

IMPACT ON SURFACE WATER
Beneficial. As long as the composting facility is properly sited and surface runoff from the compost facility is diverted away from waterbodies.

IMPACT ON GROUND WATER
Slight impact. When the composting facility is sited on soils having slow to moderate permeability. To minimize seepage of dissolved substances into the soil profile and movement toward groundwater, site paving may be needed in some areas to prevent adverse impacts.

ADVANTAGES
- Stabilization of putrescible organic matter is possible.
- Compost can be used as a soil amendment increasing soil tilth and water-holding capacity.
- Pathogens, insects, diseases, and weed seeds are destroyed by high temperatures.
- Compost is odor-free.

DISADVANTAGES
- If improperly managed, compost leachate can run off site, enter surface waters, depleting oxygen supply for fish.
- Equipment and operation increase expenses.
- When carbon/nitrogen ratios fall below 20:1, loss of nitrogen (ammonia) can occur.
- Winter temperatures may work against the windrow composting method.

PRACTICE LIFESPAN
Fifteen (15) years.

COST
Varies according to compost method and equipment available.

OPERATION AND MAINTENANCE
A written O&M plan should be developed for each composting facility. Maintain correct operating temperatures, proper aeration, carbon to nitrogen (C:N) ratio, and perform periodic testing of compost.

MISCELLANEOUS COMMENTS
Testing of compost for nutrients or heavy metals can be arranged through the local Cornell Cooperative Extension or through the Pomology Nutrient Analysis Laboratory at Cornell University. This practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

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NUTRIENT MANAGEMENT: Feed Ration Evaluation and Balancing

DEFINITION
An integrated system approach to reduce the amounts of nutrients in the manure produced on the farm by balancing the feed rations with livestock needs.

WATER QUALITY PURPOSE
To reduce surface and subsurface losses of nutrients.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Nutrients (nitrogen, phosphorus and potassium).

WHERE USED
Livestock and poultry operations.

PRACTICE DESCRIPTION
The management of nutrients in the feed ration, for the economical production of animal products and protection of water quality. Feed Ration Evaluation consists of determining the nutrient requirement of the animal based on production needs and reducing or eliminating excess nutrients within the purchased feeds beyond this level. A well integrated feed management program controls nutrient losses by reducing excessive nutrients not utilized by the animal and results in decreased levels of nutrients in the manure.

Component practices include:
1. Complete feed analysis
2. Production goals
3. Herd demographics (i.e. group size, production level, weather, body condition score, etc.)
4. Ration evaluation.

Nutrient management recommendations should be based on the best available research information. Feed rations and their management should be consistent with Cornell recommendations, where available, otherwise National Research Council recommendations should be utilized.

PRACTICE EFFECTIVENESS
Feed ration balancing optimizes production while reducing potential nutrient losses from manure applied on the land. Profitability is improved by reducing feed costs and/or increasing production. $50-$200 per cow per year improved profitability has been demonstrated on dairy farms. Research at Cornell University demonstrated a reduction in nitrogen and phosphorus levels in the manure produced on the farm with improved feed ration management.

IMPACT ON SURFACE WATER
Beneficial.

IMPACT ON GROUNDWATER
Beneficial.

ADVANTAGES
- Improved water quality and potential profitability will result especially when combined with other nutrient management practices.

DISADVANTAGES
- Requires a continuous high level of management.

PRACTICE LIFESPAN
One (1) year.

COST
Feed ration analysis can cost between $20-$100 per forage analysis. Consultation fees of $300-$500 for the initial plan development and annual costs of $3,500 per year.

OPERATION AND MAINTENANCE
Periodic update of the Feed Ration Evaluation and Balance Plan.

MISCELLANEOUS COMMENTS
This practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES
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NUTRIENT MANAGEMENT: Manure Storage System

DEFINITION
A system designed for the collection, transportation and storage of livestock manure.

WATER QUALITY PURPOSE
To reduce surface and subsurface loss of nutrients.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Nutrients, pathogens and organics.

WHERE USED
All livestock and poultry operations.

PRACTICE DESCRIPTION
The system is composed of multiple component practices that collect animal manure from livestock housing, and transport it to a structural storage facility. System design is dependent upon livestock operation, site location and management considerations. A manure storage system controls the loss of nutrients and pathogens by safely storing manure during critical runoff and leaching periods.

Undesigned manure storages must be evaluated based on the procedure outlined in "An AEM Tool for the Evaluation of Undesigned Manure Storage Facility". The outcome of the evaluation will result in either:

Certification of the storage as substantially meeting NRCS Conservation Practice Standard NY-313 Waste Storage Facility. There could also be additional requirements associated with the certification. These would include:

- Monitoring requirements.
- Additional operation & maintenance requirements.
- Certification of the storage as substantially meeting NY-313 Waste Storage Facility after reconstruction requirements have been completed and accepted.
- The storage facility must be closed utilizing NRCS Conservation Practice Standard 360 Closure of Waste Impoundments.

(NOTE: Prior to adoption of a manure storage system, a Comprehensive Nutrient Management Plan needs to be developed.)

PRACTICE EFFECTIVENESS
Manure storage is effective in reducing losses of nitrogen and phosphorus when surface runoff and erosion potential is high. Bacteria die off rapidly when wastes are stored in lagoons or applied to soil and incorporated. Extreme nutrient loss and water quality degradation may result if the storage is emptied when surface runoff, leaching or erosion potential is high or manure is applied at non-agronomical recommended rates. A Comprehensive Nutrient Management Plan is an important component of this practice.

IMPACT ON SURFACE WATER
Beneficial.

IMPACT ON GROUND WATER
Beneficial. However, care must be taken in site selection and construction of storage facilities.

ADVANTAGES
- Allows livestock manure to be treated as a resource rather than a waste.
- Reduces cost for purchased, commercial fertilizer.
- Improves herd health and facility operations.
- Improves aesthetics and relations with neighbors.
- Helps to reduce nutrient loss when runoff and erosion potential is high.

DISADVANTAGES
- Are usually very expensive.
- Requires frequent maintenance.
- Requires a high level of management.
- May result in extreme nutrient loss if emptied when surface runoff and erosion potential is high.
- May cause serious damage to streams and fish if storage structure leaks or break.

PRACTICE LIFESPAN
Fifteen (15) years.

COST
Expensive. Amount depends on size, design and construction materials.

OPERATION AND MAINTENANCE
Specific to system design. A written plan should be prepared for each system designed. Accurate records of timing of manure application and location need to be kept.

MISCELLANEOUS COMMENTS
Practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.
NOTE: A Comprehensive Nutrient Management Plan is required to receive cost-sharing.

REFERENCES

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NUTRIENT MANAGEMENT: Sequencing Batch Reactor

DEFINITION
Treatment of manure in a designed system to fill, react, settle and draw that concentrates the phosphorus in the solid end product and reduces the nitrogen, phosphorus, COD (Chemical Oxygen Demand), and odor in the liquid effluent, through bacteriological treatment.

WATER QUALITY PURPOSE
Nutrient management of manure

SOURCE CATEGORY
Agriculture / Surface runoff and ground water.

POLLUTANTS CONTROLLED
Nitrogen, phosphorus, organics, and odors.

WHERE USED
On livestock and poultry farms where manure is produced and excess nutrients and odors prevent it from being spread according to a nutrient management plan.

PRACTICE DESCRIPTION
Sequencing Batch Reactors (SBRs) are a tank or system of tanks providing a biological treatment that are operated in a sequence of filling, reacting (with or without aeration), settling, and then withdrawing treated effluent and sludge. This is a modification of the traditional activated sludge process used for treatment of municipal wastewater. The remaining biomass in the tank(s) accelerates the treatment time of the next batch loaded into the tank. By managing the aeration times the nitrification and denitrification rates can be controlled to release excess nitrogen to the atmosphere. This process also concentrates the phosphorus into the biomass so that it can be separated from the liquid effluent as sludge. The substantially treated liquid effluent can be spread with minimal odor onto crop land as irrigation water with a relatively low nutrient content, and the dewatered sludge can be exported off the farm to reduce the phosphorus loading. Exporting could include trucking to another farm as fertilizer, to a landfill or sold for further processing as a soil amendment.

PRACTICE EFFECTIVENESS
SBRs are effective for odor control, nitrogen removal and phosphorus concentration. COD reduction exceeding 90% is possible as part of the biological treatment of the manure. Nitrogen release as ammonia and nitrogen gas as well as export of the organic nitrogen in the sludge can reduce the nitrogen by at least 90%. Phosphorus concentration in the sludge can remove a majority of the phosphorus from the liquid effluent.

IMPACT ON SURFACE WATER
Beneficial. Liquid effluent would contain only minor amounts of nutrients and un-stabilized organic material. Solids export would allow controlled distribution of the phosphorus.

IMPACT ON GROUNDWATER

Beneficial. Liquid effluent containing low amounts of nitrogen would reduce the chance of nitrogen leaching. The SBR is completely enclosed, so leakage during processing should not occur. Sludge handling facilities would need to be properly sited.

ADVANTAGES

- Odor reduction and nutrient control would solve many large farm manure management problems.
- Depending on the local market, solids could be sold, or composted and then sold.

DISADVANTAGES

- SBRs initial capital investment and operating costs may impact some farms profitability.

PRACTICE LIFESPAN

Twenty (20) years.

COSTS

Capital costs for a 500 cow farm may range from $100,000 to $200,000. An equivalent annualized cost in the range of $90 to $150 per cow should be expected. Economies of scale make this practice less expensive the bigger the facility.

OPERATION AND MAINTENANCE

A written O&M plan needs to be developed for each facility. Technological maintenance and operating advice needs to be available from agencies, consultants or suppliers. Prior to construction the farmer should understand and agree to all required O&M tasks.

MISCELLANEOUS COMMENTS

No standard or specification has been developed for this practice. Each system must be individually designed. Practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

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NUTRIENT/SEDIMENT CONTROL SYSTEM

DEFINITION
A sequential system of structural and vegetated component practices installed down-gradient from concentrated operations.

WATER QUALITY PURPOSE
To reduce pollutants found in agricultural runoff water or intercepted groundwater.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Nutrients, ammonia, sediment, pesticides, bacteria and organic matter.

WHERE USED
Down gradient from all agricultural operations, at a point of concentrated flow where the land or water use contributes to a potential or existing water quality problem, and traditional management practices are not practicable or feasible to install.

PRACTICE DESCRIPTION
A nutrient/sediment control system consists of the following components:

1. Sediment basin - to trap and detain larger sediment particles and organic matter from runoff. It also regulates flow which minimizes excessive flushing of the treatment system.
2. Level-lip spreader - to transport discharges from the sediment basin to the grass filter area via sheet flow.
3. Grassed filter area - designed to receive sheet flow from the level-lip spreader. The filter is planted to cool season grasses and is constructed with a subsurface drainage system that increases infiltration and percolation, maintains the root zone in an aerobic condition, and prevents the filter from being saturated for extended periods.
4. Constructed freshwater wetland - planted to cattail and bulrush, to receive sheet flow from the grassed filter strip and constructed to maintain shallow water and saturated soil conditions necessary for the removal of nitrate and ammonia.
5. Deep water pond - designed to provide a limnetic biological filter for nutrient and fine sediment removal. It is stocked with selected species of fish and freshwater mussels and it is expected that intensive fish harvesting by humans and predators will also harvest nutrients.
6. Polishing filter - a stable vegetated area, either natural or constructed, between the pond outlet and the receiving waterbody that will remove algae and may remove some additional nutrients during spring runoff.

A nutrient/sediment control system uses physical, biological and chemical processes to remove sediment, nutrients, bacteria, pesticides and organic matter from agricultural runoff.

PRACTICE EFFECTIVENESS

Although the effectiveness of individual components to a nutrient/sediment control system will vary, the system as a whole improves water quality during all seasons.

Based on monitoring conducted in Maine, the nutrient/sediment control system removed over 90% of the total phosphorus during all monitored runoff periods. Total suspended solids and volatile suspended solids were reduced by an average of 95%. The sediment basin trapped 75% of the total suspended solids, but only 4% of the total phosphorus. Research concluded that most of the attached phosphorus was transported to the system on the fine soil particles delivered during major runoff events, but removed by the grass filter, wetland and pond ecosystem. Similar systems in other locations have resulted in similarly substantial reductions in biochemical oxygen demand (BOD), nitrogen, including ammonia, and fecal coliform bacteria.

IMPACT ON SURFACE WATER

Beneficial.

IMPACT ON GROUND WATER

Beneficial. No groundwater contamination from nutrients or pesticides has been found in similar control systems.

ADVANTAGES

- Is highly effective for nutrient and sediment removal.
- Reduces downstream flows by storing some of the runoff.
- The deep pond may serve to buffer elevated runoff water temperature changes, if groundwater cools the water in the pond.
- Water leaving the system is well oxygenated due to aeration through the outlet, aquatic plant photosynthesis, and removal of sediment and organic matter by the sediment basin, grassed filter and wetland.

DISADVANTAGES

- The lack of available land to construct the system down gradient from agricultural operation may be the biggest limiting factor.

PRACTICE LIFESPAN

Fifteen (15) years.

COST

Costs range in price and are dependent upon watershed size and design requirements. Construction and maintenance costs average $20/acre/year of watershed area to be treated.

OPERATION AND MAINTENANCE

Remove accumulated sediment from sediment basin. Rake stone trench of level-lip spreader. Mow and remove grass and maintain dense sod on grass filter strip. Harvest aquatic plants in constructed wetland where practical and needed.

MISCELLANEOUS COMMENTS

The nutrient/sediment control system is designed to supplement the effectiveness of land treatment measures, which may not be able to eliminate or reduce pollutants to acceptable levels. May be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES

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PASTURE MANAGEMENT: Prescribed Grazing Systems

DEFINITION
A prescribed grazing management system using 5 or more paddocks for a grazing season, alternating paddocks to allow for forage vigor and re-growth. Livestock graze for no more than a week before they are rotated to another paddock.

WATER QUALITY PURPOSE
To prevent soil erosion, reduce surface runoff, and improve forage cover while properly utilizing animal manures.

SOURCE CONTROLLED
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment, nutrients, pathogens, pesticides, organic matter and ammonia.

WHERE USED
On continuously grazed pastures, highly erodible fields, or cropland which is not highly erodible and can be converted to grassland.

PRACTICE DESCRIPTION
Short-duration grazing involves subdividing pastures and hayfields into grazing units called paddocks. The size and number of paddocks depend on the level of pasture productivity, stocking rate of livestock, and the residency period. Individual paddocks are grazed for a period long enough to harvest the available forage, then rotated to allow re-growth of the forage. Livestock are moved to new paddocks as often as twice per day but at least once per week. The frequent rotation of livestock allows forage to recover from grazing, permitting plant vegetative re-growth and increased plant productivity.

PRACTICE EFFECTIVENESS
Most of the pollution associated with livestock on pasture is overgrazing and allowing livestock direct access to surface water sources. Overgrazing reduces ground cover total forage yields. When comparing continuous to short-duration grazing systems, forage is improved and ground cover is increased with short-duration grazing. Short-duration grazing systems reduce the time livestock spend grazing on any single paddock, and improve the uniformity of manure and urine deposition over the pasture. Controlled grazing pressure increases the quality and quantity of pasture vegetation, thereby reducing the fiber content in manure and increasing the speed of manure decomposition. Livestock manure from a short-duration grazing system is less likely to cause surface water pollution, compared to continuous grazing pasture management. Because short-duration grazing improves overall pasture yields, farmers can fence out riparian areas, wetlands and other areas adjacent to waterbodies and still meet or exceed their pasture requirements.

IMPACT ON SURFACE WATER
Beneficial.

IMPACT ON GROUNDWATER
Beneficial.

ADVANTAGES
- Is a sustainable form of agriculture.
- Can recover the economic investment in one to three years.
- Increases forage yield.
- Enhances forage quality.
- Promotes increased harvest efficiency, and thereby maximizes animal production per acre.
- Reduces dependence on purchased feed.
- May improve herd health.
- Savings in lower annual feed costs.

DISADVANTAGES
- Requires a high degree of management skills.
- May be necessary to install a suitable stream crossing to provide livestock access to all grazed forage resources while protecting riparian reaches.
- Requires a fencing system to subdivide existing pastures.

PRACTICE LIFESPAN
Ten (10) years.

COST
Variable. Typically, $7,000 to $10,000 per system, depending upon number of livestock, system design, livestock watering facilities, and pasture seeding and fertility requirements, existing fencing and stream crossings.

OPERATION AND MAINTENANCE
Annual soil test recommendations for pH and fertility needs. Periodic forage analyses from actual pasture samples should be done about 3 times throughout the growing season. Excess forage growth (spring flush) must be captured either by mechanically harvesting or allowing another livestock group to graze it. Rotate paddocks according to forage growth stage.

MISCELLANEOUS COMMENTS
Practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES

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PATHOGEN MANAGEMENT

DEFINITION
Management and structural improvements made to young stock raising and manure handling facilities and construction of alternative young stock housing systems that provide a healthier environment for calves.

WATER QUALITY PURPOSE
To prevent pathogen infection and transmission in livestock or from livestock to humans and to reduce the potential risk of pathogens (e.g., Giardia and Cryptosporidium) in animal feces, from reaching water courses where it could potentially result in waterborne disease outbreaks.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Pathogens, nutrients.

WHERE USED
Primarily on farms located in watersheds of public and private drinking water supplies where runoff from young stock housing and/or exercise lots or land receiving manure application containing feces from infected animals may enter nearby water course. Feces from infected animals 6 months and younger are the most likely sources of pathogens on farms. Preliminary results of research in the NYC Watershed indicate that the highest prevalence of infection in dairy calves and heifers is 2-5 months of age for Giardia and less than one month of age for Cryptosporidium parvum.

PRACTICE DESCRIPTION
The first barrier for reducing pathogen risk from farming activities is proper calf and heifer management. Keep young stock separated from one another and the rest of the herd. Maintaining healthy calves may minimize the occurrence of pathogens on farms. Additional resources to reduce the offsite pathogen risk may include runoff prevention from animal housing and exercise lots, handling of manure from animals six months and younger separate from the rest of the herd, treatment of the manure by heating the manure above $65^{o}C$ for 30 minutes or more for Cryptosporidium and for 24 hours or more for Giardia, raising manure pH to 12 or more, storing manure for at least 6 months and careful selection of land application sites for disposing of younger animal manure (e.g., avoiding application on hydrologically-sensitive areas).

PRACTICE EFFECTIVENESS
Pollution prevention effectiveness increases if a multi-barrier approach is implemented that controls pathogens at the source (e.g., improved calf management) while also controlling pathogen transport on the farm (e.g., composting of infected manure) and controlling pollutants at the water course (e.g., vegetative filter strip).

IMPACT ON SURFACE WATER
Potential for significant reduction in the risk of waterborne disease outbreaks from agricultural activities.

IMPACT ON GROUND WATER
Actual risk of pathogens from agricultural activities polluting groundwater sources still needs to be determined. Avoiding spreading of infected manure on karst topography and within recharge areas of wells would reduce risk of well contamination.

ADVANTAGES
- Practices to improve health and survivability of young stock can increase overall farm profitability.

DISADVANTAGES
- There is limited research on whether the risk posed by livestock operations to drinking water supplies is significant enough to justify the high cost of providing separate housing facilities for raising calves on farms.
- Current knowledge may not be adequate to reduce risk of infecting water supplies to desirable level.

PRACTICE LIFESPAN
Ten (10) years.

COST
Varies. Ranges from no cost to $500-$750 per calf if separate housing is needed.

OPERATION AND MAINTENANCE
High level of management is required. Monitoring of animal health is needed to determine practice effectiveness.

MISCELLANEOUS COMMENTS
This practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

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PESTICIDE MANAGEMENT: Overview

DEFINITION
A combination of integrated pesticide systems used in agricultural crop production. Systems may include operator education for selection and use of general and restricted pesticides, handling and application training, and equipment operation and pesticide facilities management.

WATER QUALITY PURPOSE
To reduce or prevent pesticide contamination of surface and groundwater resources.

SOURCE CATEGORY
Agriculture / Surface Runoff.

WHERE USED
On all agricultural land, including farm ponds, greenhouses, barnyards and farmsteads.

POLLUTANTS CONTROLLED
Pesticides.

PRACTICE DESCRIPTION
There are several management activities that combine knowledge and education, decision-making, risk assessment, and needs assessment to target pests, plan source controls, prevent pollution, improve application efficiency and improve pesticide handling, mixing and disposal techniques. The Cornell University Pesticide Management Education Program provides up-to-date pesticide information on safe application, storage, disposal, decontamination, transportation, effects on human health and the environment and federal and state restrictions to producers, pesticide applicators, agribusinesses, and others. A well designed pesticide management program controls potential losses of pesticides by reducing risks associated with the selection, use, handling and disposal of pesticides.

PRACTICE EFFECTIVENESS
Practices that incorporate education and training, source controls, and management activities such as, equipment calibration and reading label directions are very effective in reducing potential pesticide losses. Pesticide management practices must be combined with erosion control, surface water management and irrigation water management practices to achieve maximum benefits.

IMPACTS ON SURFACE WATER
Beneficial. Pesticide management practices may eliminate or reduce the availability of pesticides as a potential pollutant. However, they must be combined with management practices that control erosion and reduce surface runoff volumes to achieve the maximum control.

IMPACT ON GROUND WATER
Beneficial. Pesticide management practices eliminate or reduce the availability of pesticides for leaching. However, they must be combined with soil management practices that reduce infiltration to achieve the maximum control.

ADVANTAGES
- Trained individuals have increased awareness and understanding of pesticide non point source pollution issues.
- Provides the applicator with current information.
- Following label directions may prevent illegal resides on any crop or animal.
- May reduce pesticide losses when needs assessment has been done and label directions are followed.
- May reduce the amount of pesticide used in crop production, thereby reducing pesticide costs.
- Improved application efficiency will reduce drift and volatilization losses.
- Reduces pesticide losses when pesticide application is timed to avoid adverse temperatures, winds and significant runoff events.

DISADVANTAGES
- Some pesticide management practices are expensive.
- Weather may render some pesticide management practices invalid.
- Labels may not include specific New York State restrictions for pesticide use.
- Private applicators using "general use" pesticides are not required to participate in formal training programs.

PRACTICE LIFESPAN
Varies. However, most management practices are temporary.

COST
Varies with management practice selected.

OPERATION AND MAINTENANCE
Specific to management practice selected. Accurate records of pesticide management, fields involved and results obtained need to be kept.

MISCELLANEOUS COMMENTS
None.

REFERENCES
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PESTICIDE MANAGEMENT: Agrichemical Mixing Facility

DEFINITION
A permanent structure with an impervious surface to provide an environmentally safe area for the handling of on-farm pesticides.

WATER QUALITY PURPOSE
To reduce the potential for soil, groundwater and surface water contamination during pesticide mixing, loading, unloading and rinsing operations.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Pesticides.

WHERE USED
Where current methods of mixing pesticides and rinsing equipment are polluting or have the potential to pollute water resources.

PRACTICE DESCRIPTION
An agrichemical mixing facility consists of a watertight containment structure comprised of a concrete pad and all necessary equipment for pumping, transferring, and storing water used in the pesticide mixing, loading, unloading, and rinsing operations. Size of the pad and storage capacity is related to the volume and size of the largest spray tank on the pad. Containment storage vessels incorporated into the facility design allow for the recovery of pesticides, rinsate storage, plus handling/mixing/recovery/disposal. Surface runoff from a 25-year, 24-hour duration storm event is diverted away from the facility using a grassed waterway or diversion.

A roof and sidewalls may be used to shelter the facility from rain, snow and ice, preventing precipitation from accumulating on the pad and contaminating runoff.

PRACTICE EFFECTIVENESS
Little or no information exists on the documented effectiveness of pesticide handling facilities on water quality improvement. Much is known about water quality impacts sustained when these facilities are not available for pesticide handling and rinsing operations. A recent study of commercial pesticide mixing and loading sites in Wisconsin, without pesticide handling facilities, found that two-thirds of the sites had significant groundwater contamination. Pesticides were detected in groundwater at more than half of these sites, with concentrations exceeding groundwater standards at one-third of the sites surveyed. Officials and the pesticide industry in Wisconsin recognized that use of agrichemical mixing facilities minimize the potential for surface and groundwater contamination.

IMPACT ON SURFACE WATER
Beneficial. When the agrichemical mixing facility is properly sited, designed and maintained, this practice will have a beneficial impact on surface water.

IMPACT ON GROUND WATER
Beneficial. When the agrichemical mixing facility is properly sited, designed and maintained, this practice will have a beneficial impact on groundwater.

ADVANTAGES
- Improves environmental safety by preventing contamination of ground and surface water from routine use and accidental pesticide spills.
- Improves water safety.
- Allows compliance with federal and state regulations.
- Enhances owner/operator management.
- Promotes recycling of rinse water as tank make-up water.
- Reduces liability risk.

DISADVANTAGES
- May be very expensive.
- May require a high level of management skill, which may require time to acquire.
- Must perform O & M frequently and diligently to ensure proper facility operation and water source protection.

PRACTICE LIFESPAN
Twenty (20) years.

COST
Varies depending on facility size. Construction costs start at $4,000.

OPERATION AND MAINTENANCE
A written O&M plan should be developed for each facility designed. An emergency response plan should be a part of the written O&M plan, in case of an accidental pesticide spill, exposure, fire or other incident that could adversely affect environmental health. The plan should include a record-keeping component to log accurately spills, exposure, fire or other incidents.

Safe pesticide handling procedures and frequent maintenance are critical to the performance of any agrichemical mixing facility. The proper disposal/utilization of rinsate, exterior washwater, accumulated sediment and spilled wastewater must be accomplished in accordance with the pesticide labeling requirements and federal, state and local laws and codes. Operator must perform periodic checks of the backflow prevention devices, inspect the pad and sump for cracks and leaks, clean the sump and pad between different chemical mixing operations and remove sediment accumulation from the sump. Personal protective equipment must be used during O&M procedures. Accurate records indicating maintenance, cleaning and inspection of equipment are necessary.

MISCELLANEOUS COMMENTS
NYSDEC recommends that all pesticide rinsates, including wash waters from cleaning of spray equipment, should be collected and stored above ground. Stored rinsates should be recycled for future mixing with the same concentrates.

A pesticide storage facility may be included. These should have good air ventilation and an impervious floor and sides to contain spills and leaks. The building should be locked at all times and be located adjacent to the pad. Practice may be eligible for cost-sharing. . Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES
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PESTICIDE MANAGEMENT: Calibration and Application

DEFINITION
Equipment is calibrated and monitored to precisely control pesticide application rates. Manual and computer controlled systems may be used for pesticide application.

WATER QUALITY PURPOSE
To reduce or prevent contamination of surface or groundwater resources.

SOURCE CATEGORY
Agriculture / Surface Runoff.

WHERE USED
Agricultural land.

POLLUTANTS CONTROLLED
Pesticides.

PRACTICE DESCRIPTION
Calibration involves determining the correct pesticide rate, checking and adjusting boom height, nozzle spacing, nozzle discharge angle, nozzle flow rate, nozzle spray pattern, operating speed and pressure.

Calibration ensures that equipment is applying the correct amount of liquid or granular pesticides over a given area. Pesticide delivery can change with equipment wear, gauge error, nozzle error, wheel slippage, speedometer error, and friction loss. Calibration is a critical factor in the operation and maintenance of pesticide application equipment and should be performed regularly.

With computer controlled pesticide application, separate injection pumps precisely meter a programmed amount of pesticide directly into the intake side of the sprayer pump. Pesticides enter the boom lines thoroughly mixed at uniform concentration. The application rate of each injection pump is individually programmed and is controlled in tenths of an ounce per acre. An individual pump can be turned on and off for spot spraying. Individual chemical application rates can be instantly changed when the applicator encounters different field or pest conditions. Computerized precision pesticide application eliminates tank mixing and rinsing, and pesticide handling is greatly reduced compared to conventional pesticide applications.

Properly maintained equipment results in correct pesticide application and reduces the availability of pesticides as a nonpoint source pollutant.

PRACTICE EFFECTIVENESS

The effectiveness of any pesticide depends upon the proper application and placement of the chemical. It is estimated that 60% of sprayers have a calibration error rate greater than plus or minus 10%, 43% of sprayers have greater than plus or minus 10% variation in discharge from individual nozzles, 32% have inaccurate travel speed, 27% have improper boom height for the nozzle spacing and nozzle discharge angle, 13% have inaccurate pressure gauges, and 8% have inadequate hose size to supply nozzles. Frequent calibration checks or computerized precision application greatly reduces this problem.

IMPACT ON SURFACE WATERS

Beneficial. Proper equipment calibration will greatly reduce or eliminate the availability of pesticides as a nonpoint source pollutant.

IMPACT ON GROUND WATER

Beneficial. Proper equipment calibration will greatly reduce or eliminate the availability of pesticides as a nonpoint source pollutant.

ADVANTAGES

- Computerized equipment eliminates the need to pre-mix chemicals and eliminates spray tank rinsing.
- Computerized application ensures that the exact amount of chemical required is applied.
- Pesticide and water are separate until the moment before the mixture leaves the spray booms, eliminating tank mix waste and disposal problems.
- Time savings realized due to elimination of pre-mixing and rinsing.
- Back-siphoning of tank spray into water system is eliminated.
- Increases pesticide application effectiveness.
- Saves pesticide materials and reduces application costs.
- Identifies faulty equipment components, which assists in O&M of equipment.

DISADVANTAGES

- Cost of computer equipment may not be economical for small pesticide applicators.
- Application is limited to post-emergence herbicides.

PRACTICE LIFESPAN

Temporary. Calibration should be performed prior to each pesticide application.

COST

None for calibration. Does require "time" from pesticide applicator. Computerized equipment costs are under $10,000.

OPERATION AND MAINTENANCE

Follow equipment manufacturer's directions. Initial calibration and recalibration should be done according to manufacturer’s directions. Records of calibration, maintenance and pesticide application should be kept.

MISCELLANEOUS COMMENTS

Pesticide Application Training Manual, Second Edition, discusses calibration procedures for different types of sprayers.

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PESTICIDE MANAGEMENT:
Evaluation of Site-Specific Leaching and Surface Loss Potentials

DEFINITION
Computer analysis of pesticides, soils and climatic factors to identify relative potentials for surface loss and leaching of pesticides.

WATER QUALITY PURPOSE
To identify relative potential surface loss and leaching of pesticides from soils and prevent contamination of surface and groundwater resources.

SOURCE CATEGORY
Agriculture / Surface Runoff.

WHERE USED
On agricultural land prior to final selection of a pesticide.

POLLUTANTS CONTROLLED
Pesticides.

PRACTICE DESCRIPTION
Evaluation of site-specific leaching and surface loss potentials is a preventative management practice that is an integral part of a pesticide management system. An evaluation of site-specific leaching and surface loss potentials is conducted using Windows Pesticide Screening Tool (WIN-PST) software, developed by USDA-NRCS National Water and Climate Center.
Note: (WIN-PST can be downloaded at: www.ncc.nrcs.usda.gov)

PRACTICE EFFECTIVENESS
When applicators evaluate site-specific leaching and surface loss potentials of pesticides, prior to their use, applicators gain improved knowledge which can lead to a change in pesticide use and management. As a decision-making tool, this management practice is very effective, allowing applicators an opportunity to rapidly conduct a risk assessment of their specific pesticide/soil combination.

IMPACT ON SURFACE WATER
Beneficial. When the results of this computer analysis are implemented, and all required management practices are applied, a beneficial impact on surface water can be expected.

IMPACT ON GROUND WATER
Beneficial. When the results of this computer analysis are implemented, and all required management practices are applied, a beneficial impact on groundwater can be expected.

ADVANTAGES

- Preventative management practice evaluations can be performed rapidly, saving staff time and money.
- Evaluations can be customized for on-site soil and pesticide conditions.

DISADVANTAGES

- This evaluation methodology is limited to stating risks in terms of high, medium and low probabilities.

PRACTICE LIFESPAN

Temporary.

COST

None.

OPERATION AND MAINTENANCE

Records on the pesticides used and the amounts along with the results need to be kept.

MISCELLANEOUS COMMENTS

WIN-PST is a pesticide environmental risk screening tool that is available to evaluate the potential for pesticides to move with water and eroded soil/organic matter and affect non-target organisms.

WIN-PST users can specify pesticides by product name or active ingredient.

Long-term human and fish toxicity data and ratings are also included in WIN-PST. These toxicity ratings can be combined with the off-site movement potential ratings to provide an overall rating of potential risks from pesticide movement below the root zone and past the edge of the field. Evaluations of site-specific leaching and surface loss potentials can be conducted using WIN-PST by correcting the soil properties in the model based on field-specific soil analyses. Used in conjunction with pesticide recommendations found in "Cornell Recommends for Integrated Field Crop Management," WIN-PST can provide recommendations for alternative pesticides to further reduce surface loss and leaching potentials

REFERENCES

Cornell Cooperative Extension. Cornell Field Crops and Soils Handbook, Second Edition. Ithaca, NY. 1987.

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Note: (WIN-PST can be downloaded at: www.ncc.nrcs.usda.gov)

PETROLEUM PRODUCT STORAGE SPILL PREVENTION AND CONTAINMENT

DEFINITION
A petroleum product storage tank is a stationary facility which may include one or more above-ground tanks, underground tanks, or a combination of both, for the storage of liquid petroleum products such as diesel fuel, gasoline, fuel oil, lubricating oils, waste oils and kerosene. (Note: Facilities with storae capacity grater than 1,100 gallos fall under the DEC's Petroleum Bulk Storage Regulations 6 NYCRR pats 612-614 and must be registered every 5 years with DEC.)

WATER QUALITY PURPOSE
To prevent ground and surface waterbodies from contamination from petroleum storage facility leaks and spills.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Petroleum products contain a number of potentially toxic compounds including common solvents, such as benzene, toluene, and xylene and additives such as ethylene dibrobide (EDB) and organic lead compounds.

WHERE USED
On agricultural operations where liquid petroleum products are stored

PRACTICE DESCRIPTION
This practice consists of a combination of one or more of the following depending on the water quality risk posed by the storage facility:

1. Proper storage tank siting – includes consideration of soil characteristics (corrosivity, permeability, bearing capacity, etc.), depth to groundwater, distance from a surface waterbody (min. 500 ft. recommended) or drinking water well (minimum of 100' required preferably downslope), location of floodplains, vehicular traffic patterns around the tank site, and distance from existing and planned farm buildings (minimum of 25 feet recommended).
2. Proper tank design and installation – includes the use of corrosive resistant tanks and pipes (e.g., tank contains label that it conforms with 6 NYCRR Part 614), double wall tanks with wall thickness of at least 7/16th" to protect against ballistics, steel posts to protect against vehicular traffic, anchoring or diking to avoid floatation in areas subject to flooding, a roof over tank to exclude rain water, etc., and utilizing an experienced tank installer who is familiar with state petroleum tank installation requirements.
3. Spill and overfill prevention equipment – includes color coding of fill ports, operating and shutoff valves, gauges and high level alarms, automated shutoff devices, tank labels (showing design and working capacity), spill catchment basin for fill ports of underground storage tanks.
4. Leak monitoring and tank inspection – includes checking of aboveground tank for corrosion and leaks, installing underground piping access ports for leak testing, installing a concrete pad under above-ground tanks to detect levels and installation of a monitoring well (e.g., 4"

slotted plastic pipe) between underground storage tank and secondary containment barrier. (Note: Any spills of 5 gal. or more need to be reported to DEC Spill Hotline, 800.457.7362 within 24 hours.)

5. Secondary containment barrier – includes aboveground engineered dikes, curbs, liners, or diversion system designed to contain spills from above-ground tank rupture, overfills, vandals and equipment failure. Also included are drainage provisions for stormwater that accumulates within the dike, curb or liner and installing double-wall tanks.
   (Note: Any contaminated stormwater must be treated to reduce oil and grease concentration to 15 ppm before discharging.), also includes
6. Spill emergency response plan –includes a written emergency plan at the storage facility location that shows action to be taken in case of a spill, leak, fire or explosion. Cleanup equipment should also be available at the site. Tank replacement - involves replacing underground bare steel tank with corrosive resistant tank especially if tank is 15 years or older.
7. Closing down an out-of-service facility – includes removing all liquid petroleum material, disconnecting all fill lines and filling with inert material such as sand or concrete slurry, and site assessment. (Note: DEC must be notified 30 days prior to filling or removal and permanently closed above ground tanks need to be stenciled with date of closure.)

PRACTICE EFFECTIVENESS

When designed, installed and maintained properly this practice can significantly reduce the risk of a cataclysmic event occurring from a petroleum spill or leak.

IMPACT ON SURFACE WATER

Beneficial.

IMPACT ON GROUNDWATER

Beneficial.

ADVANTAGES

- Provides direct protection to farmstead drinking water.
- Benefits potential offsite water quality particularly if a site evaluation is conducted to identify those facilities that pose a significant pollution risk.

DISADVANTAGES

- Requires continuous monitoring for potential leakage.

PRACTICE LIFESPAN

Twenty-five (25) years.

COST

Varies depending on whether a new storage facility is needed to replace an existing leaking facility or whether an existing facility needs to be upgraded to include leak detection and spill prevention equipment.

OPERATION AND MAINTENANCE

User should visually inspect tanks monthly and conduct structural inspection of the tank and lines every ten years. In un-metered tanks the fuel level should be checked twice per month. The tank should not be used for 12 hours. The level of fuel in the tank at start should be measured, recorded and compared with the level of fuel measured at the end of the 12-hour period. Leak detection system if installed (e.g. monitoring well for underground tank and pad under tank if aboveground) should be checked daily. A spill contingency plan should be developed for the farm and appropriate containment and control materials stored in a clearly marked, easily accessible cabinet or locker on the farm. Records should be kept of dates and types of inspections performed, as well as any leaks detected.

Note: State law requires landowners to report any leak or spill of petroleum using the 24 hour spill hotline 1-800-457-7362.

MISCELLANEOUS COMMENTS

Leaks from underground petroleum storage are difficult to detect especially since most of the tanks installed on farms lack a leak monitoring system. Also, most landowners are unaware of the significant groundwater contamination risk to their own water supply posed by these underground storage tanks. This practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES

University of Wisconsin-Extension, Cooperative Extension; Minnesota Extension Service; and the USEPA: Farmstead Assessment System Worksheet #4 Assessing the Risk of Groundwater Contamination from Petroleum Product Storage and Fact Sheet #4 Reducing the Risk of Groundwater Contamination by Improving Petroleum Product Storage, Madison, Wisconsin, July 1991.

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RIPARIAN BUFFER

DEFINITION
An area of trees, shrubs and grasses located adjacent to and up-gradient from water bodies.

WATER QUALITY PURPOSE
To intercept surface runoff, wastewater, subsurface flow and groundwater flow from agricultural upland sources, and to provide habitat benefits for both terrestrial and aquatic species.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Nutrients, sediment, organic matter and some pesticides.

WHERE USED
At the margins of lakes, ponds, and streams which occur at the lower edge of upslope cropland or pasture; at the margin of any intermittent or permanently flooded, environmentally sensitive, open water wetlands which occur at the lower edge of upslope cropland or pasture; on karst (limestone) formations at the margin of sinkholes and other small groundwater recharge areas.

PRACTICE DESCRIPTION
Riparian buffers will consist of three distinct zones and be designed to filter surface runoff as sheet flow and downslope subsurface flow which occurs as shallow ground water. Stream-side buffers will be designed to encourage sheet flow and infiltration and impede concentrated flow.

Zone 1 will begin at the top of the streambank and occupy a strip of land with a fixed width of fifteen feet measured horizontally on a line perpendicular to the streambank. Dominant vegetation will be composed of a variety of native riparian tree and shrub species and such plantings as necessary for streambank stabilization during the establishment period. A mix of species will provide the prolonged stable leaf fall and variety of leaves necessary to meet the energy and pupation needs of aquatic insects.

Zone 2 will begin at the edge of Zone 1 and occupy an additional strip of land with a minimum of 60 feet measured horizontally in the direction of flow. Predominant vegetation will be composed of riparian trees and shrubs suitable to the site, with emphasis on native species and such plantings as necessary to soil stabilization during the establishment period. Nitrogen fixing species should be discouraged where nitrogen removal or buffering is desired.

Zone 3 will begin at the outer edge of Zone 2 and have a minimum width of 20 feet. Additional width may be necessary to accommodate land shaping and mowing machinery. Upgrazed grassland meeting the purpose and requirements stated below may serve as Zone 3. Vegetation will be composed of dense grasses and forbs for structure stabilization, sediment control and nutrient uptake. Mowing and removal of clippings is necessary to recycle sequestered nutrients, promote vigorous sod and control weed growth. Zone 3 may be used for controlled intensive grazing when conditions are such that earthen water control structures will not be damaged.

PRACTICE EFFECTIVENESS

The riparian buffer will be most effective when used as a component of a sound land management system including nutrient management and runoff, sediment and erosion control practices. Filter strips are most effective when used in conjunction with erosion-reducing management practices. Filter strips are very effective for sediment and sediment-bound pollutant removal (i.e., lead), with trapping efficiencies exceeding 50%. Filter strips in riparian zones have trapped 85-90% of the sediment and up to 50% of the phosphorus leaving cultivated fields. Filter strips do not remove soluble phosphorus or nitrates effectively.

IMPACT ON SURFACE WATER

Beneficial.

IMPACT ON GROUND WATER

Slight. Practice may increase transport of pollutants to groundwater by increased infiltration.

ADVANTAGES

- Provides low cost, cost-effective approach to surface water control of agricultural runoff.

DISADVANTAGES

- Requires a large land area.
- May require land to be removed from production.

PRACTICE LIFESPAN

30 to 50 years, or more.

COST

Relatively low cost for seeding, and tree planting.

OPERATION AND MAINTENANCE

Inspect annually and immediately following severe storms for evidence of sediment deposit, erosion or concentrated flow channels. Avoid use of fertilizers, pesticides, other chemicals, vehicular traffic or disturbance of vegetation and litter inconsistent with erosion control and buffering objectives. Except for periodic cutting of mature trees, Zones 1 and 2 should remain undisturbed. Zone 3 should be mowed periodically and the clippings removed to promote dense vegetative growth and removal of nutrients.

MISCELLANEOUS COMMENTS

This practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

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SILAGE LEACHATE CONTROL

DEFINITION
The management of silage crops to reduce the generation of silage leachate and the collection, storage, transport, and disposal of the effluent and runoff from upright and bunk silos.

WATER QUALITY PURPOSE
To reduce and/or manage silo/silage leachate to reduce surface and ground water biochemical oxygen demand (BOD) loading.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANT CONTROLLED
Organic loading and Biochemical Oxygen Demand (BOD).

WHERE USED
In situations where the storage of silage and haylage can yield effluent and runoff which can enter either a surface water body or ground water. This practice can be used in barnyards, farmsteads, fields, or other areas where upright silos, bunk silos and silage bagging systems are used.

PRACTICE DESCRIPTION
Silage effluent and runoff control is a combination of structural and non-structural management practices to either control the source of the material or manage the collection and disposal of it. Source reduction is accomplished by growing the proper variety of corn for the area. Use of covered storage and exclusion of surface water runoff from the storage area will also reduce the source of silage leachate. An alternative to source reduction is the collection, storage, treatment and disposal of the silo effluent and runoff. If manure storage is available, the silage leachate can be directed there; otherwise separate collection and holding structures are necessary. Relocation of storage area is another option. Often silage leachate is a seasonal problem resulting from the harvest of immature corn and will require short term management. Silage leachate resulting from the passage of rainfall and surface water runoff through the storage may be address through the installation of a low flow collection system and a bypass system, in conjunction with a filter area, for high flows.

PRACTICE EFFECTIVENESS
Silage leachate exerts a high organic loading on the receiving water and produces a high Biochemical Oxygen Demand (BOD) which will deplete available dissolved oxygen resulting in fish kills, tastes and odors, and a general unaesthetic appearance. The proper management of leachate from silos and other types of storage facilities will eliminate these problems close to 100% of the time with the exceptions being during unusual weather patterns or extreme weather events.

IMPACT ON SURFACE WATER
Beneficial. Reduces organic loading and resultant depletion of dissolved oxygen.

IMPACT ON GROUND WATER
Beneficial. The oxygen depletion in ground water resulting from organic loading can cause bad odors and tastes which may be sustained for extended periods of time due to very low re-aeration rates.

ADVANTAGES
- May be corrected by growing a different variety of corn.
- Prevents surface runoff of nutrients.
- Prevents kill zones from concentrated effluent.

DISADVANTAGES
- Can be expensive if collection and storage are required.
- Due to amino acid content of silage leachate, collection facilities should be made of corrosion resistant material and land application should be carefully managed to prevent kill-off.

PRACTICE LIFESPAN
- Non-structural measures – as long as the farmer utilizes the practices.
- Structural measures - up to 25 years.

COST
Variable depending on the system which is installed.

OPERATION AND MAINTENANCE
- Keep location records to reduce potential over application of silage leachate.
- Periodically inspect and repair storage facility to prevent no leakage through floors and walls.
- Periodically inspection and repair pipes and other connections to eliminate leakage.

MISCELLANEOUS COMMENTS
This practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES
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STRIPCROPPING

DEFINITIONS
Growing annual and perennial crops in a systematic arrangement of strips or bands that are aligned with the contour of the land.

WATER QUALITY PURPOSE
To reduce erosion and control surface water runoff on sloping fields.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment and solid phase nutrients.

WHERE USED
Highly erodible cropland with field slopes less than 12% and on fields requiring crop rotation.

PRACTICE DESCRIPTION
Stripcropping consists of alternating strips of annual row crops, and/or small grains, with perennial grass and/or legume strips, planted on the contour and rotated for a specified number of years. The width of the alternating strips is a function of the field slope, type of crops grown, and the size of the farmer's equipment.

Stripcropping controls runoff by intercepting rainfall, reducing the amount of surface water runoff, and increasing infiltration, thereby reducing sediment and nutrient delivery to waterbodies.

PRACTICE EFFECTIVENESS
Stripcropping can reduce surface runoff by as much as 85%. Contour strips can be significantly more effective than contouring alone, especially on long slopes and in intense rainfall areas. High quality sod strips reportedly have filtered 75% or more of the suspended sediment in runoff from the tilled strip. Contour strips on slopes of 2-7% can reduce erosion by as much as 75% compared to planting up and down the hill. Fall-seeded grain strips are only half as effective as sod strips while corn and spring-seeded grains are least effective.

IMPACT ON SURFACE WATER
Beneficial.

IMPACT ON GROUNDWATER
Slight-Moderate. Practice increases infiltration and may increase the potential of groundwater contamination.

ADVANTAGES
- Is inexpensive and easy to install by farmer.
- Breaks insect and weed cycles when combined with a crop rotation.
- Increases organic matter content.
- Improves soil structure.
- May reduce the amount of pesticides used since commodity crop acreage is limited.

DISADVANTAGES
- Limits the years and acreage of a commodity.
- May prevent installation of contour stripcropping on irregular field topography.

PRACTICE LIFESPAN
Indefinite.

COST
$30.00 per acre.

OPERATION AND MAINTENANCE
Minimal. Strip boundaries must be maintained. Rotate sod strips according to planned conservation cropping sequence.

MISCELLANEOUS COMMENTS
This practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

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TERRACES

DEFINITION
An earth embankment, a channel, or a combination ridge and channel constructed across the slope.

WATER QUALITY PURPOSE
To reduce slope length and surface runoff, thereby reducing erosion and sediment delivery to waterbodies.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment and sediment-bound nutrients.

WHERE USED
On highly erodible land where soil erosion and runoff must be controlled. Terraces can also be used on droughty soils that require moisture conservation.

PRACTICE DESCRIPTION
Terraces control erosion by shortening slope length and regulating surface runoff. Terraces intercept and conduct surface runoff at a non-erosive velocity to stable outlets, reducing ephemeral and gully erosion.

Terraces are designed to control runoff from a 10-year frequency, 24-hour storm. Runoff can be stored in terraces for up to 48 hours. Terraces trap sediment and reduce sediment-bound pollutants in surface runoff.

PRACTICE EFFECTIVENESS
Terraces reduce soil erosion by 75% to 98%. Nutrient losses are reduced by 55% to 90% and runoff is reduced by 70% to 90%.

IMPACT OF SURFACE WATER
Beneficial.

IMPACT ON GROUND WATER
Slight to moderate. In the absence of a nutrient management program, terraces may increase nutrient leaching to groundwater. Impacts on groundwater may be reduced by increasing terrace release rates, thereby decreasing runoff storage time and potential soil saturation.

ADVANTAGES
- Controls gully and ephemeral erosion.
- Provides flood protection for crop fields.
- Stores runoff up to 48 hours, allowing sediment and sediment-bound pollutants to settle out.

DISADVANTAGES
- Increases soil saturation and potential leaching of pesticides to groundwater with extended runoff storage.
- Are very expensive and usually are not considered cost-effective management practices.

PRACTICE LIFESPAN
Ten to twenty-five years.

COST
Terrace installation costs average $200/acre.

OPERATION AND MAINTENANCE
Maintain terrace capacity, storage, ridge height and outlets. Clean out inlets for underground outlets. Remove sediment build-up and redistribute. Check structure after storm events.

MISCELLANEOUS COMMENTS
This practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds.

REFERENCES
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WATERWAY

DEFINITION
A natural or constructed below ground level channel of parabolic or trapezoidal cross-section that is stabilized with vegetation for the stable conveyance of runoff.

WATER QUALITY PURPOSE
To control erosion and convey runoff from concentrated agricultural areas or structures to a suitable outlet.

SOURCE CATEGORY
Agriculture / Surface Runoff.

POLLUTANTS CONTROLLED
Sediment and nutrients.

WHERE USED
In agricultural fields and below livestock areas where concentrated runoff could cause erosion.

PRACTICE DESCRIPTION
Grassed waterways control surface runoff by safely conveying surface runoff volumes to protected outlets to prevent gully erosion. Grassed waterways are designed to confine and carry the peak rate of runoff from a 10-year frequency, 24-hour duration storm, as a minimum. On slopes of less than 1% where out-of-bank flow will not cause erosion or property damage, the requirement for confinement of flow is not a design requirement.

PRACTICE EFFECTIVENESS
Grassed waterways are effective in containing and conveying runoff and may be somewhat effective at treating sediment and nutrient-laden runoff. Computer modeling indicates that grassed waterways reduce erosion by about 65%, total N by nearly 30%, and total P by 50%. Filter areas should be considered were high sediment, total N and total P loads are anticipated.

IMPACT ON SURFACE WATER
Variable. Impacts may be mitigated by incorporating an overland-flow treatment system, such as a filter area or retention basin before discharging to a waterbody. By reducing gully erosion and trapping sediment and sediment-bound pollutants on-site, losses to streams are reduced.

IMPACT ON GROUND WATER
Slight. Computer modeling indicates slight leaching of nitrates to groundwater.

ADVANTAGES
- Controls surface runoff and gully erosion.
- Are relatively easy to design and install.
- Functions like a filter strip with the same benefits when channel runoff flow is shallow.

DISADVANTAGES

- Unsuitable for areas where a base flow exists (sustained wetness prevents adequate vegetative cover) unless a stone-center lining and a subsurface drain are installed.
- Will trap excessive amounts of sediment and become useless when installed below high sediment-producing areas.
- Takes land out of crop production.

PRACTICE LIFESPAN

Ten (10) years.

COST

Approximately $4.00-$8.00 per ft.

OPERATION AND MAINTENANCE

Performed annually and after large storm events. Inspect channel cross-section for stable side slopes, points of scour, rodent holes, and breaches. Check channel bottom for erosion or excessive scour, deposition of sediment or other obstructions. Outlets should be checked to ensure that they remain adequate, show no sign of erosion or loss of structural integrity.

MISCELLANEOUS COMMENTS

Practice may be eligible for cost-sharing. Check with the local NRCS and/or SWCD office to determine practice eligibility and the availability of funds

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