United States Department of Agriculture

Natural Resources Conservation Service

CONSERVATION PLAN

TOWN OF ORLEANS

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3/23/2022

Putnam Farm-Town of Orleans

2022 Natural Resource Inventory
and Conservation Alternatives

Natural Resources Inventory:

A natural resources inventory is a description of the current soil, water, air, plant, and animal resources on the property. Integrated into the inventory are the natural resource concerns evaluated on your property and some conservation practices that can be used to improve them. In addition, proposed future use conditions are considered in this inventory, as one of the goals of the landowner is to consider land use change on the property to support more local food production.

Soil: Soils on this parcel are primarily mapped as Udipsamments, which indicates the land was previously impacted by a gravel removal operation. Natural topsoil has been stripped from the site, leaving the sandy and gravelly sub-soil as the top-most layer. The site has been leveled. The suitability of this soil for agricultural use is limited by excessive drainage in dry periods, poor water and nutrient holding potential, areas of high water table, and the lack of natural top-soil.

Soil Erosion: Soil erosion is not a concern on the property due to the flat topography and sandy soil texture.

Soil Quality: Soil quality is a combination of structural, biological, and chemical properties of the soils. Due to the prior removal of topsoil, much of the natural soil characteristics for the site are lacking. In order to restore the site with soils that can support agricultural use, conservation practices that build soil quality are critical. These conservation practices include:

- Cover Crop (340)
- Mulching (484)
- Soil Carbon Amendment (808)
- Conservation Crop Rotation (328)
- Residue and Tillage Management, Reduced Till (345).

Water: This property is located on Cape Cod and adjacent to the Rock Harbor Creek Marshes salt marsh area which drains to Cape Cod Bay through the Boat Meadow River, a Clean Water Act impaired waterway. Cape Cod is considered a sole source aquifer area and drinking water wells are also in proximity to the property. Soils on the site, as is common in the area, have a high risk of leaching losses of agrichemicals and nutrients. Runoff is less of a concern, although buffers should be maintained between crop production areas and surface water resources.

Water Quality: Surface and ground water resources are in proximity to this property. The planned management of this area for cropland should be done with careful consideration for the water resources in the area. In order to protect surface and ground water quality from potential adverse impacts of crop

production, the conservation practices outlined above for Soil Quality improvement and the following conservation practices are recommended:

- Nutrient Management (590)
- Irrigation Water Management (449)
- Riparian Forest Buffer (391)

In addition, it is important to be thoughtful in the implementation of the soil improvement practices. Applications of compost, manure, or other organic amendments should be done in accordance with a Nutrient Management plan. If on-site composting is considered and would involve animal manures or other high nutrient materials, a formal composting facility should be considered to minimize ground water quality impacts.

Source Water Depletion: Due to the droughty nature of the soil on this site, irrigation will be needed for crop production. As irrigation will be needed, it is best to establish an irrigation system that is efficient and able to be managed to provide adequate water but guard against over application and leaching. To maximize the efficiency of the irrigation system the following conservation practices should be utilized:

- Irrigation System, Microirrigation (441)
- Water Well (642)
- Irrigation Pipeline (430)
- Irrigation Water Management (449)

Air: No resource concerns were identified regarding air pollution on this site. If composing operations are done on the site, use of an appropriate compost recipe and management strategy to minimize odors should be considered, due to public access and proximity to residential areas.

Plants and Animals:

Terrestrial Habitat: In recent years, much of this site was not actively managed for farming. As farm use is reestablished, consideration should be given to improving the remaining less highly managed areas for wildlife improvements. Given the small size of this property, the following conservation practices for wildlife improvement are recommended:

- Structures for Wildlife (649)
- Upland Wildlife Habitat Management (645)
- Wildlife Habitat Planting (420)

Degraded Plant Condition: This natural resource concern is important for the property due to the intended use for crop production. Without effort to improve the soil health, plant productivity concerns are likely on the site. The conservation practices outlined in the Soil Quality section above are also needed to improve crop productivity and to maintain a group of producers on the property who are committed to continued improvement of the soils. In addition, there is currently a lack of season extension infrastructure on the site, which can also be a

limitation to this plant resource concern. NRCS assistance is available for season extension improvements, such as high tunnel facilities, if this is of interest.

Humans: This property is owned by the Town of Orleans. The oversite of the property is primarily undertaken by the town Conservation Commission, along with input from other stakeholders include the Agricultural Commission, tenant farmers, and other interested parties. The land is also accessible by the public. The planned use for agricultural production, as outlined in this conservation plan, has been proposed as a desired use from these stakeholders. The conservation plan outlined here provides information on how to best protect and improve natural resources on the property with the objective of use of the property for production of vegetable and fruit crops.

Recommended Practices:

Selected for Implementation (scheduled in this Conservation Plan):

- Cover Crop (340)
- Mulching (484)
- Soil Carbon Amendment (808)
- Irrigation System, Microirrigation (441)
- Water Well (642)
- Irrigation Pipeline (430)
- Irrigation Water Management (449)
- Structures for Wildlife (649)
- Upland Wildlife Habitat Management (645)
- Nutrient Management (590)
- Riparian Forest Buffer (391)

Potential Practices (not ready for implementation at this time or further planning needed):

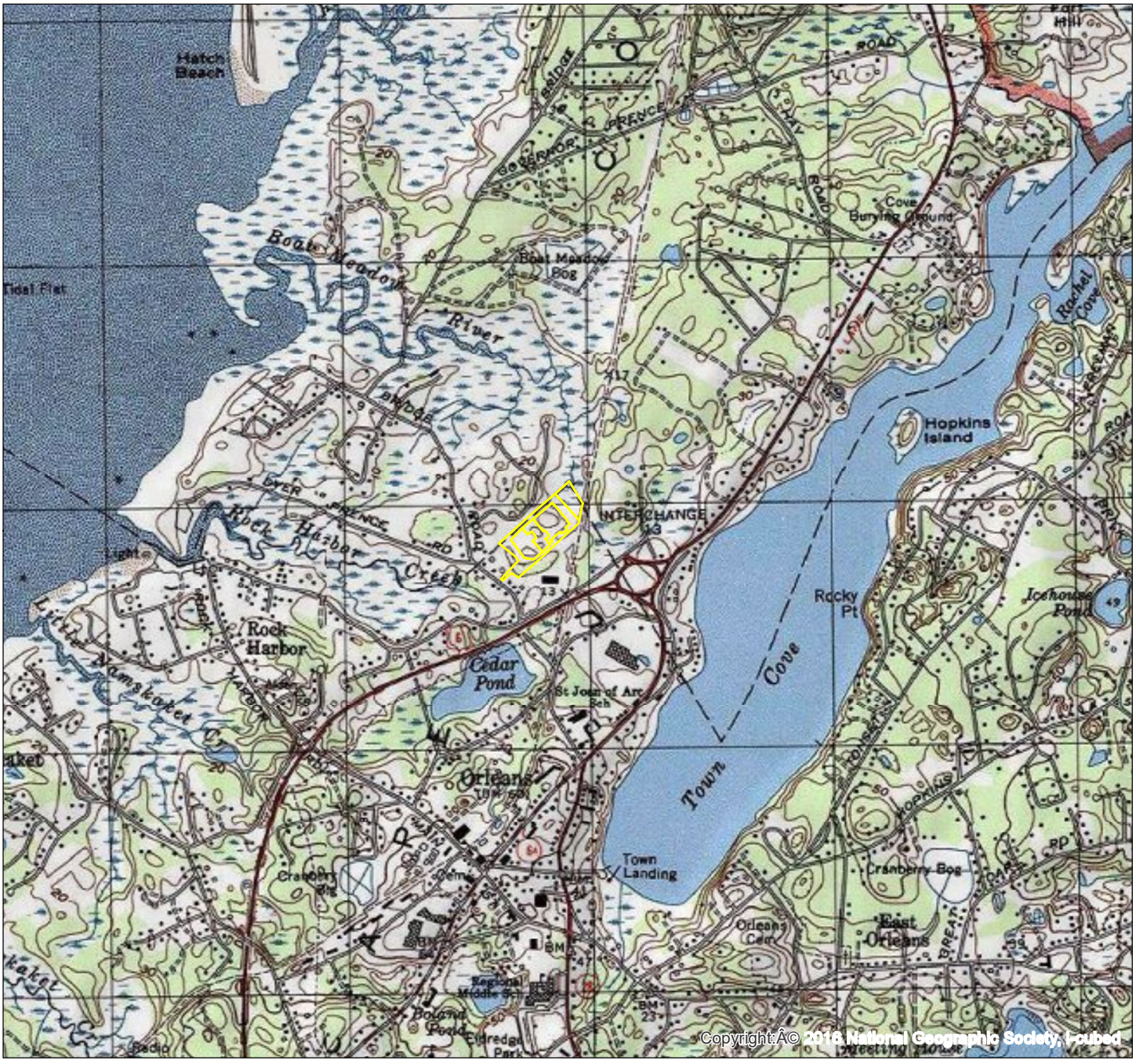
- Conservation Crop Rotation (328)
- Residue Management and Tillage Management, Reduced Till (345)
- Wildlife Habitat Planting (420)
- Composting Facility (317)- only if on site composting of manures or other high nutrient materials is under consideration
- High Tunnel System (325)- if desired for further season extension of crop production

Date: 3/23/2022

Topographic Map

Client(s): TOWN OF ORLEANS
Location: Farm: TDB Tract: TBD
Barnstable County, Massachusetts
Approximate Acres: 14.57

Assisted By: LISA PETRUSKI
USDA - NRCS
WEST YARMOUTH NRCS SERVICE CENTER
CAPE COD CONSERVATION DISTRICT



Prepared with assistance from USDA-Natural Resources Conservation Service

0 2000
Feet

Practice Schedule PLUs

N

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Date: 3/22/2022

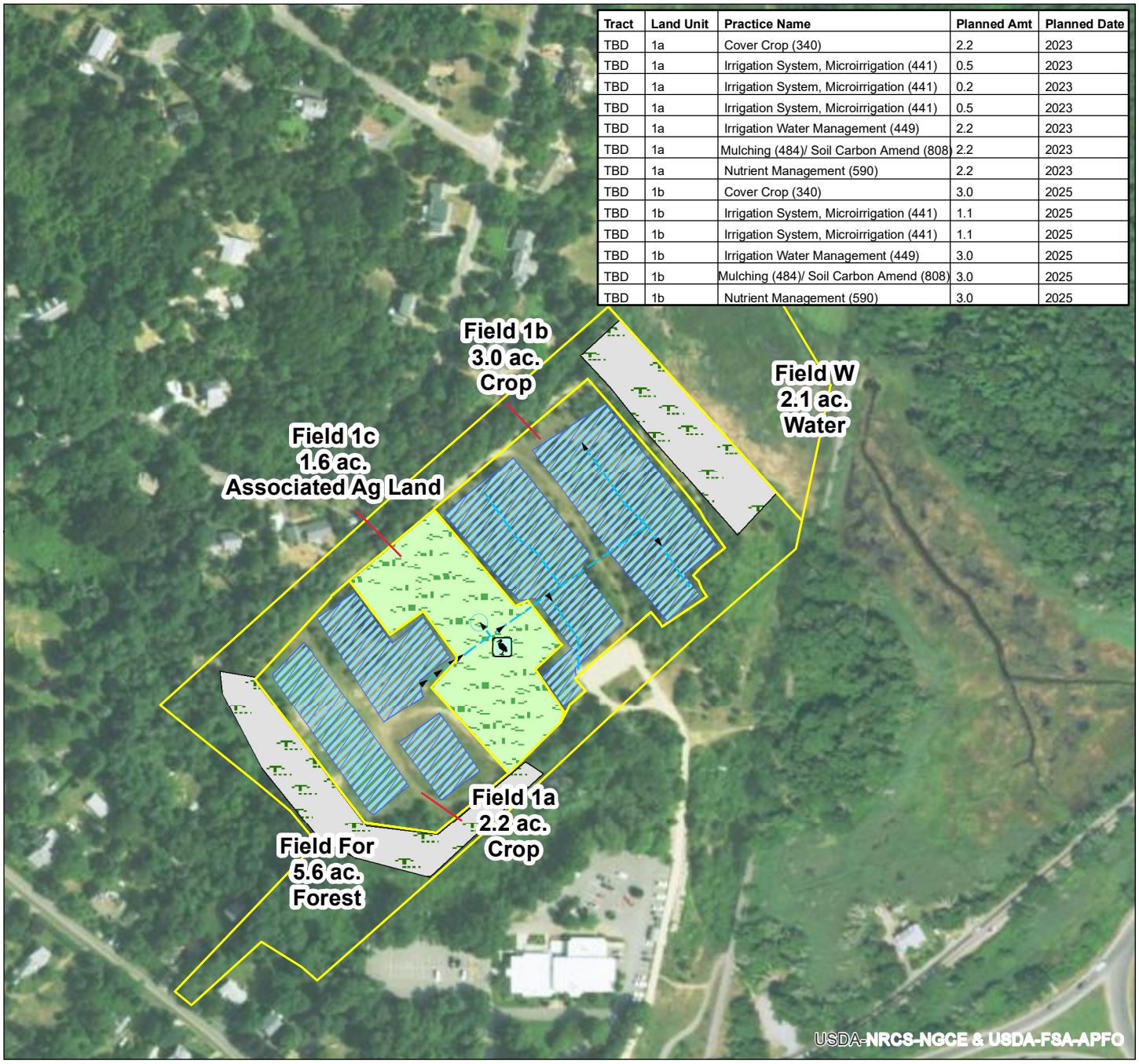
Conservation Plan Map

Client(s): TOWN OF ORLEANS- Putnam Farm
Location: Orleans, MA
Barnstable County, Massachusetts
Approximate Acres: 14.57

Assisted By: LISA PETRUSKI
USDA - NRCS
WEST YARMOUTH NRCS SERVICE CENTER
CAPE COD CONSERVATION DISTRICT

Land Units: Tract TBD, Fields 1a,1b,1c,For,W

Tract	Land Unit	Practice Name	Planned Amt	Planned Date
TBD	1a	Cover Crop (340)	2.2	2023
TBD	1a	Irrigation System, Microirrigation (441)	0.5	2023
TBD	1a	Irrigation System, Microirrigation (441)	0.2	2023
TBD	1a	Irrigation System, Microirrigation (441)	0.5	2023
TBD	1a	Irrigation Water Management (449)	2.2	2023
TBD	1a	Mulching (484)/ Soil Carbon Amend (808)	2.2	2023
TBD	1a	Nutrient Management (590)	2.2	2023
TBD	1b	Cover Crop (340)	3.0	2025
TBD	1b	Irrigation System, Microirrigation (441)	1.1	2025
TBD	1b	Irrigation System, Microirrigation (441)	1.1	2025
TBD	1b	Irrigation Water Management (449)	3.0	2025
TBD	1b	Mulching (484)/ Soil Carbon Amend (808)	3.0	2025
TBD	1b	Nutrient Management (590)	3.0	2025



Prepared with assistance from USDA-Natural Resources Conservation Service

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Feet

Practice Schedule PLUs

Conservation Practice Points
- Water Well (642)
- Structures for Wildlife (649)

Conservation Practice Lines
- Irrigation Pipeline (430)

Conservation Practice Polygons
- Riparian Forest Buffer (391)
- Irrigation System, Microirrigation (441)
- Upland Wildlife Habitat Management (645)

N

USDA

WEST YARMOUTH NRCS
SERVICE CENTER
303 ROUTE 28
WEST YARMOUTH, MA
02673-4661
(508) 771-6476

Conservation Plan

TOWN OF ORLEANS
19 SCHOOL RD
ORLEANS, MA 02653

Install the conservation practices, enhancements, and activities according to the implementation requirements, designs, construction plans, or other documents that facilitate meeting the applicable NRCS technical criteria. If you do not have such information, contact your local office before starting to install your conservation practices, enhancements, and activities.

Cover Crop (340)

Cover crop - Plant grasses, legumes and forbs for seasonal vegetative cover where seasonal cover will protect or improve natural resources.

Tract	Field	Planned Amount	Month	Year	Applied Amount	Date
TBD	1a	2.2 Ac	09	2023	--	--
TBD	1b	3.0 Ac	09	2025	--	--

Irrigation Pipeline (430)

Irrigation pipeline - Install a pipeline and appurtenances to convey water for storage or application, reduce energy use, or develop renewable energy systems as part of an irrigation water system.

Tract	Field	Planned Amount	Month	Year	Applied Amount	Date
TBD	1a	74.00 Ft	05	2025	--	--
TBD	1b	895.00 Ft	05	2025	--	--
TBD	1c	183.00 Ft	05	2025	--	--

Irrigation System, Microirrigation (441)

Microirrigation system - Install an irrigation system for frequent, efficient, and uniform application of small quantities of water on or below the soil surface: as drops, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line.

Tract	Field	Planned Amount	Month	Year	Applied Amount	Date
TBD	1a	0.5 Ac	06	2023	--	--
TBD	1a	0.2 Ac	06	2023	--	--
TBD	1a	0.5 Ac	06	2023	--	--
TBD	1b	1.1 Ac	06	2025	--	--
TBD	1b	1.1 Ac	06	2025	--	--

Irrigation Water Management (449)

Irrigation Water Management - Manage irrigation water by determining and controlling the volume, frequency, and application rate of irrigation water to improve irrigation water use efficiency, minimize irrigation induced soil erosion, decrease degradation of surface and groundwater resources, manage salts in the crop root zone, manage air, soil, or plant micro-climate, or reduce energy use.

Tract	Field	Planned Amount	Month	Year	Applied Amount	Date
TBD	1a	2.2 Ac	09	2023	--	--
TBD	1b	3.0 Ac	09	2025	--	--

Mulching (484)

Basic Mulching - Apply plant residues or other suitable materials evenly over the land surface to achieve a minimum of 70% ground cover.

Tract	Field	Planned Amount	Month	Year	Applied Amount	Date
TBD	1a	2.2 Ac	09	2023	--	--
TBD	1b	3.0 Ac	09	2025	--	--

Nutrient Management (590)

NM Level 1 - Implement a Nutrient Management Plan with 4Rs (right source, rate, time, place) to benefit plant productivity based on soil testing and LGU recommendations “within book values".

Tract	Field	Planned Amount	Month	Year	Applied Amount	Date
TBD	1a	2.2 Ac	09	2023	--	--
TBD	1b	3.0 Ac	09	2025	--	--

Riparian Forest Buffer (391)

Riparian Forest Buffer - Establish, restore or enhance woody plant communities located adjacent to watercourses or water bodies.

Tract	Field	Planned Amount	Month	Year	Applied Amount	Date
TBD	For	0.9 Ac	09	2022	--	--
TBD	For	1.0 Ac	09	2022	--	--

Soil Carbon Amendment (808)

Soil Biology - Apply compost, biochar or other organic carbon amendment at low rates improve soil organism habitat and plant productivity and health.

Tract	Field	Planned Amount	Month	Year	Applied Amount	Date
TBD	1a	2.2 Ac	09	2023	--	--
TBD	1b	3.0 Ac	09	2025	--	--

Structures for Wildlife (649)

Structures for Wildlife - Install a structure to replace or modify a missing or deficient wildlife habitat component. This includes installing structures to provide loafing, escape, nesting, rearing, roosting, perching and / or basking habitat and modification of existing structures to minimize the risks of injury or mortality to wildlife.

Tract	Field	Planned Amount	Month	Year	Applied Amount	Date
TBD	1c	1.00 No	03	2023	--	--

Upland Wildlife Habitat Management (645)

Upland Wildlife Habitat Management; Low - Enable movement and / or provide food and cover to sustain wildlife that inhabit uplands. Application of this practice will meet wildlife habitat planning criteria.

Tract	Field	Planned Amount	Month	Year	Applied Amount	Date
TBD	1c	1.6 Ac	11	2023	--	--

Water Well (642)

Well - Install a water well into an aquifer for water supply.

Tract	Field	Planned Amount	Month	Year	Applied Amount	Date
TBD	1c	1.00 No	09	2024	--	--

CERTIFICATION OF PARTICIPANTS

TOWN OF ORLEANS DATE

CERTIFICATION OF:

CERTIFIED PLANNER DATE

CONSERVATION DISTRICT

CAPE COD CONSERVATION DISTRICT DATE

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Washington, DC 20250-9410
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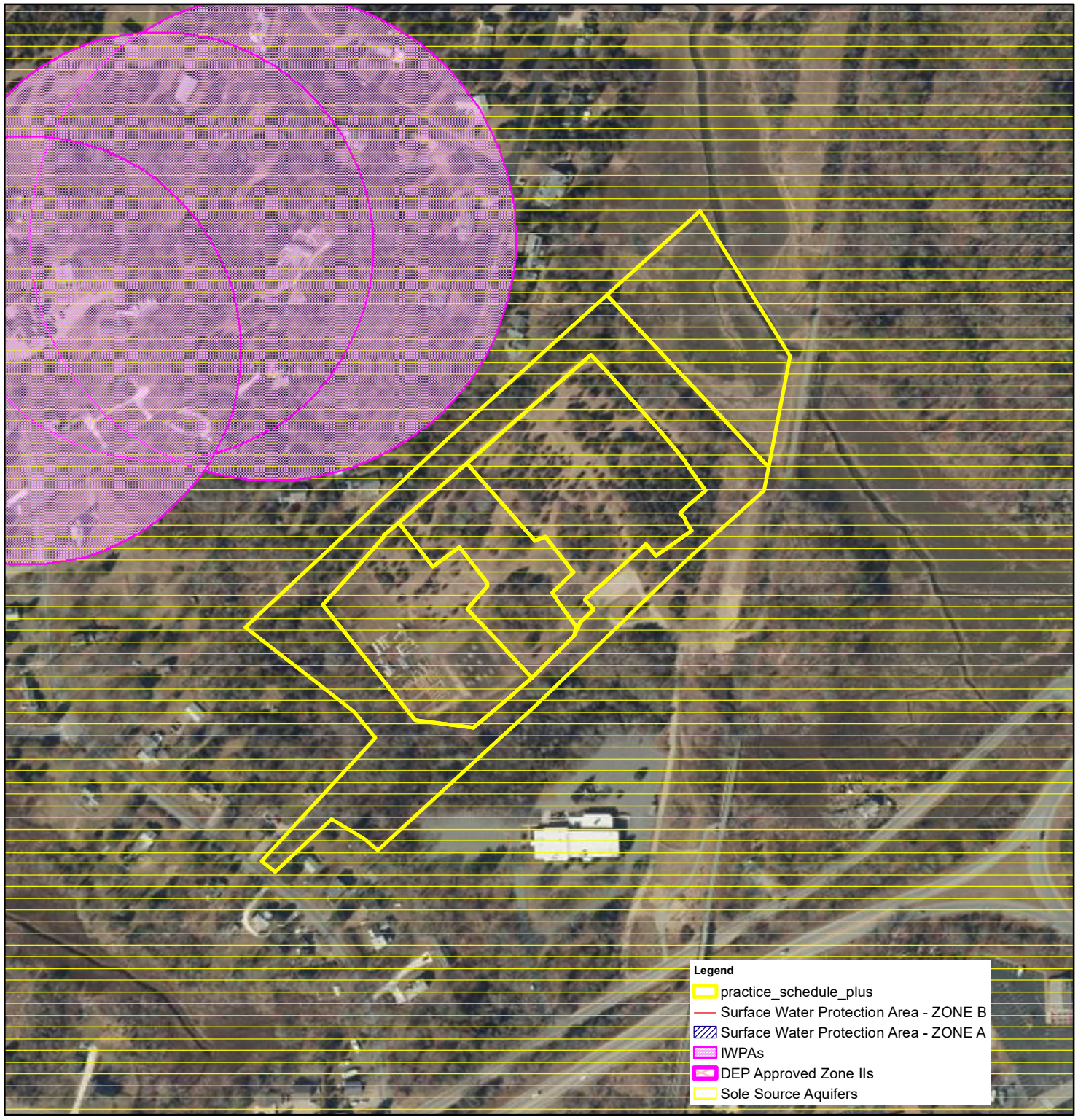
Ground Water Resources Map

Customer(s): Town of Orleans- Putnam Farm
Field Office: WEST YARMOUTH NRCS SERVICE CENTER
District: CAPE COD CONSERVATION DISTRICT
State and County: MA, Barnstable County

Agency: USDA-NRCS
Assisted By: LISA PETRUSKI
Date: 3/25/2022



Prepared with assistance from USDA-Natural Resources Conservation Service

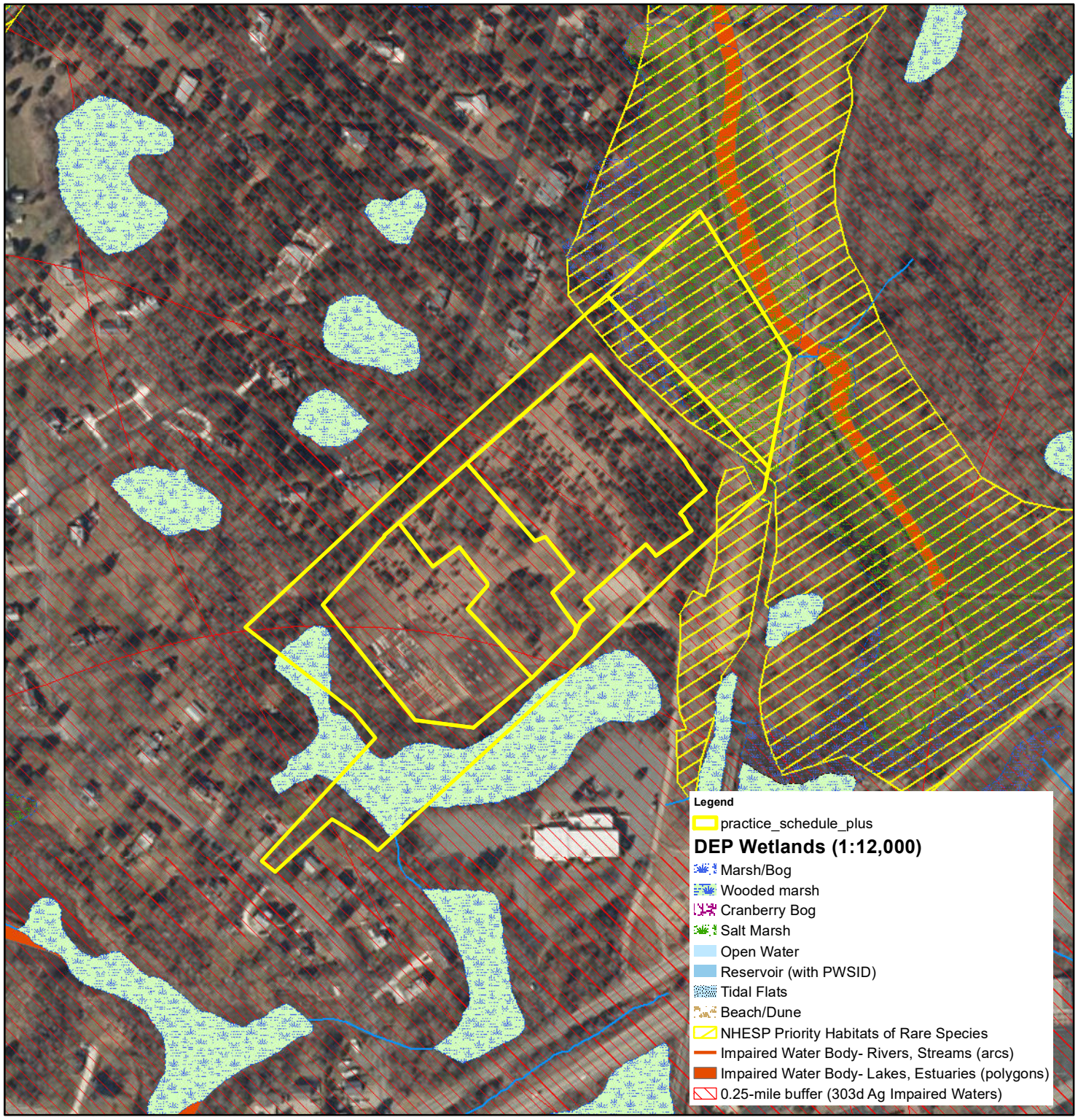
0 400 800 1,200 Feet

N

Surface Water/ NHESP Resources Map

Customer(s): Town of Orleans- Putnam Farm
Field Office: WEST YARMOUTH NRCS SERVICE CENTER
District: CAPE COD CONSERVATION DISTRICT
State and County: MA, Barnstable County

Agency: USDA-NRCS
Assisted By: LISA PETRUSKI
Date: 3/25/2022



Prepared with assistance from USDA-Natural Resources Conservation Service

0 400 800 1,200 Feet

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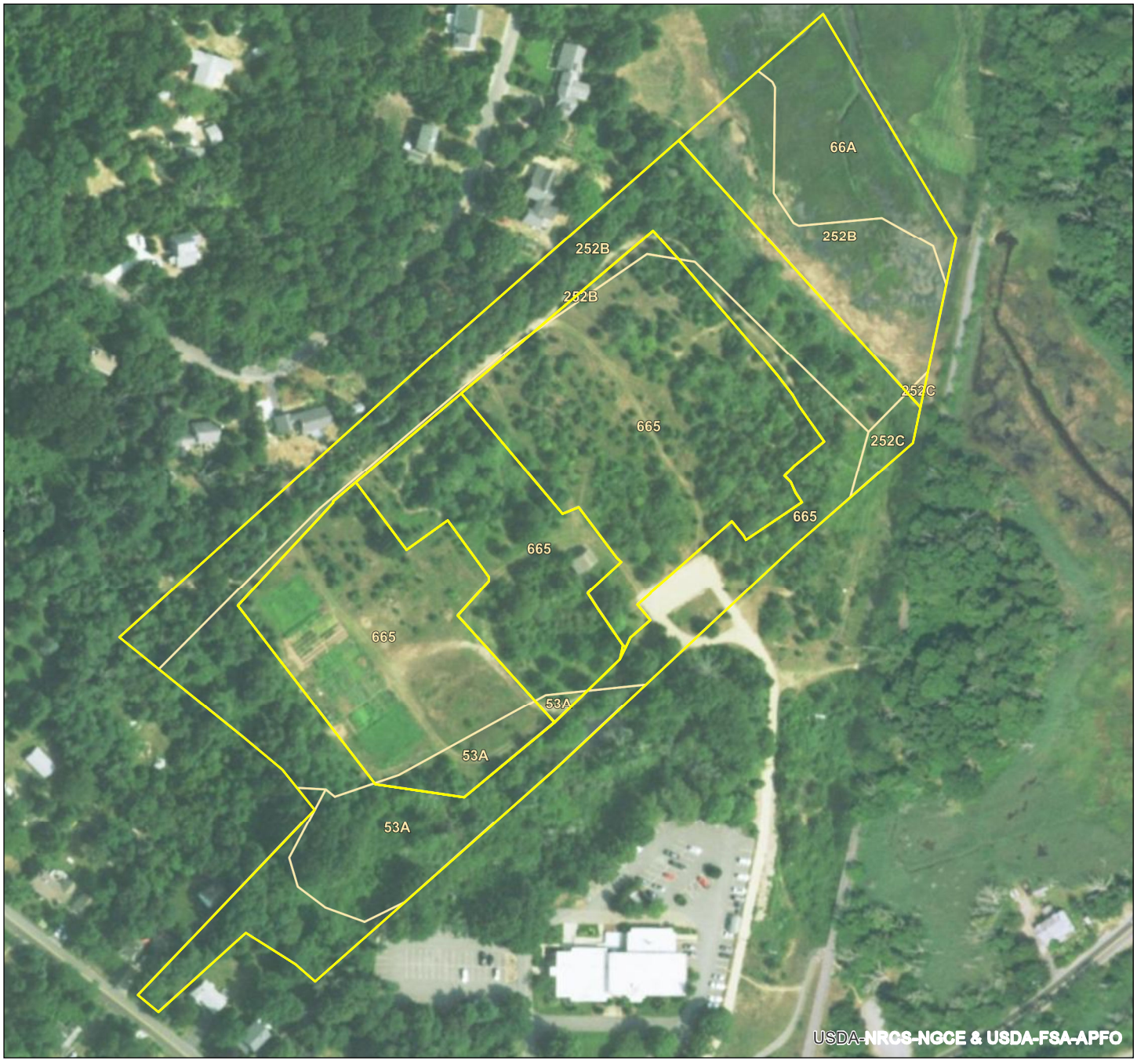
Date: 3/22/2022

Soils Map

Client(s): TOWN OF ORLEANS
Barnstable County, Massachusetts
Approximate Acres: 14.57

Assisted By: LISA PETRUSKI
USDA - NRCS
WEST YARMOUTH NRCS SERVICE CENTER
CAPE COD CONSERVATION DISTRICT

Land Units: Tract TBD, Fields 1a,1b,1c,For,W



Prepared with assistance from USDA-Natural Resources Conservation Service

0 200
Feet

Practice Schedule PLUs

Soils

Soil Mapunit

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Map Unit Description (Brief, Generated)

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, provide information on the composition of map units and properties of their components.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

The Map Unit Description (Brief, Generated) report displays a generated description of the major soils that occur in a map unit. Descriptions of non-soil (miscellaneous areas) and minor map unit components are not included. This description is generated from the underlying soil attribute data.

Additional information about the map units described in this report is available in other Soil Data Mart reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the Soil Data Mart reports define some of the properties included in the map unit descriptions.

Report—Map Unit Description (Brief, Generated)

Barnstable County, Massachusetts

Map Unit: 53A--Freetown muck, ponded, coastal lowland, 0 to 1 percent slopes

Component: Freetown, ponded (85%)

The Freetown, ponded component makes up 85 percent of the map unit. Slopes are 0 to 1 percent. This component is on depressions on uplands. The parent material consists of highly decomposed organic material. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is very poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is very high. Shrink-swell potential is low. This soil is rarely flooded. It is frequently ponded. A seasonal zone of water saturation is at 0 inches during January, February, March, April, May, June, July, August, September, October, November, December. Organic matter content in the surface horizon is about 82 percent. This component is in the F144AY043MA Acidic Organic Wetlands ecological site. Nonirrigated land capability classification is 5w. This soil meets hydric criteria.

Component: Scarboro (5%)

Generated brief soil descriptions are created for major soil components. The Scarboro soil is a minor component.

Component: Whitman, ponded (5%)

Generated brief soil descriptions are created for major soil components. The Whitman, ponded soil is a minor component.

Component: Swansea, ponded (5%)

Generated brief soil descriptions are created for major soil components. The Swansea, ponded soil is a minor

component.

Map Unit: 66A--Ipswich - Pawcatuck - Matunuck complex, 0 to 2 percent slopes, very frequently flooded

Component: Ipswich (50%)

The Ipswich component makes up 50 percent of the map unit. Slopes are 0 to 2 percent. This component is on tidal marshes on coastal plains. The parent material consists of partially- decomposed herbaceous organic material. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is very poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is very high. Shrink-swell potential is low. This soil is very frequently flooded. It is not ponded. A seasonal zone of water saturation is at 0 inches during January, February, March, April, May, June, July, August, September, October, November, December. Organic matter content in the surface horizon is about 64 percent. This component is in the R144AY002CT Tidal Salt High Marsh mesic very frequently flooded, Tidal Salt Low Marsh mesic very frequently flooded ecological site. Nonirrigated land capability classification is 8w. This soil meets hydric criteria. The soil has a moderately saline horizon within 30 inches of the soil surface. The soil has a maximum sodium adsorption ratio of 1 within 30 inches of the soil surface.

Component: Pawcatuck (25%)

The Pawcatuck component makes up 25 percent of the map unit. Slopes are 0 to 2 percent. This component is on tidal marshes on coastal plains. The parent material consists of partially- decomposed herbaceous organic material over sandy mineral material. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is very poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is very high. Shrink-swell potential is low. This soil is very frequently flooded. It is not ponded. A seasonal zone of water saturation is at 0 inches during January, February, March, April, May, June, July, August, September, October, November, December. Organic matter content in the surface horizon is about 64 percent. This component is in the R144AY002CT Tidal Salt High Marsh mesic very frequently flooded, Tidal Salt Low Marsh mesic very frequently flooded ecological site. Nonirrigated land capability classification is 8w. This soil meets hydric criteria. The soil has a moderately saline horizon within 30 inches of the soil surface. The soil has a maximum sodium adsorption ratio of 1 within 30 inches of the soil surface.

Component: Matunuck (15%)

The Matunuck component makes up 15 percent of the map unit. Slopes are 0 to 2 percent. This component is on tidal marshes on coastal plains. The parent material consists of partially- decomposed herbaceous organic material over glaciofluvial deposits and/or sandy marine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is very poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is very frequently flooded. It is not ponded. A seasonal zone of water saturation is at 0 inches during January, February, March, April, May, June, July, August, September, October, November, December. Organic matter content in the surface horizon is about 64 percent. This component is in the R144AY002CT Tidal Salt High Marsh mesic very frequently flooded, Tidal Salt Low Marsh mesic very frequently flooded ecological site. Nonirrigated land capability classification is 8w. This soil meets hydric criteria. The soil has a moderately saline horizon within 30 inches of the soil surface. The soil has a maximum sodium adsorption ratio of 2 within 30 inches of the soil surface.

Component: Hooksan (5%)

Generated brief soil descriptions are created for major soil components. The Hooksan soil is a minor component.

Component: Succotash (5%)

Generated brief soil descriptions are created for major soil components. The Succotash soil is a minor component.

Map Unit: 252B--Carver coarse sand, 3 to 8 percent slopes

Component: Carver, coarse sand (80%)

The Carver, coarse sand component makes up 80 percent of the map unit. Slopes are 3 to 8 percent. This component is on disected outwash plains on uplands, moraines on uplands. The parent material consists of sandy glaciofluvial

deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is excessively drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 80 percent. Below this thin organic horizon the organic matter content is about 2 percent. This component is in the F149BY005MA Dry Outwash ecological site. Nonirrigated land capability classification is 3s. This soil does not meet hydric criteria.

Component: Deerfield (10%)

Generated brief soil descriptions are created for major soil components. The Deerfield soil is a minor component.

Component: Hinckley (5%)

Generated brief soil descriptions are created for major soil components. The Hinckley soil is a minor component.

Component: Merrimac (3%)

Generated brief soil descriptions are created for major soil components. The Merrimac soil is a minor component.

Component: Mashpee (2%)

Generated brief soil descriptions are created for major soil components. The Mashpee soil is a minor component.

Map Unit: 252C--Carver coarse sand, 8 to 15 percent slopes

Component: Carver, coarse sand (80%)

The Carver, coarse sand component makes up 80 percent of the map unit. Slopes are 8 to 15 percent. This component is on disected outwash plains on uplands, moraines on uplands. The parent material consists of sandy glaciofluvial deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is excessively drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 80 percent. Below this thin organic horizon the organic matter content is about 2 percent. This component is in the F149BY005MA Dry Outwash ecological site. Nonirrigated land capability classification is 4e. This soil does not meet hydric criteria.

Component: Deerfield (10%)

Generated brief soil descriptions are created for major soil components. The Deerfield soil is a minor component.

Component: Hinckley (5%)

Generated brief soil descriptions are created for major soil components. The Hinckley soil is a minor component.

Component: Merrimac (5%)

Generated brief soil descriptions are created for major soil components. The Merrimac soil is a minor component.

Map Unit: 665--Udipsamments, smoothed

Component: Udipsamments (100%)

The Udipsamments component makes up 100 percent of the map unit. Slopes are 0 to 3 percent. This component is on leveled land. The parent material consists of sandy excavated or filled land. Depth to a root restrictive layer is greater than 60 inches. Available water to a depth of 60 inches (or restricted depth) is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches.

Data Source Information

Soil Survey Area: Barnstable County, Massachusetts
Survey Area Data: Version 18, Sep 01, 2021

For Additional Information on Nutrient Management refer to:

https://ag.umass.edu/vegetable/fact-sheets/soil-nutrient-management

- Utilize soil testing
- Develop a nutrient budget for your crops
- Know the nutrient analysis of materials you are applying for fertility improvements
- Nutrients are managed based on the 4Rs of nutrient stewardship—
    - apply the right nutrient source
    - at the right rate
    - at the right time
    - in the right place
- Maintain set back buffers from application areas and surface water resources

NRCS Natural Resources Conservation Service

Upland Wildlife Habitat Management - 645

Massachusetts Conservation Practice Implementation Requirements

DEFINITION
Provide and manage upland habitats and connectivity on a landscape scale to benefit upland wildlife.

PURPOSE
To treat upland wildlife habitat concerns identified during the conservation planning process that enable movement or provide shelter, cover and food in proper amounts, locations and times to sustain wild animals that inhabit uplands during a portion of their life cycle.

WHERE USED
This practice targets land where the decision maker has identified an objective for conserving wild animals and/or for enhancing habitat or ecosystems for the benefit of wildlife or land within the range of targeted wildlife species and capable of supporting the desired habitat.

Other facilitating NRCS conservation practice standards such as *Early Successional Habitat Development and Management*, code 647, *Tree and Shrub Establishment*, code 612, *Riparian Forest Buffer*, code 391, *Pest Management*, code 595. etc., can be used in conjunction with this standard to develop and enhance upland habitat for wildlife.

SPECIFICATIONS
This practice can involve many components that include, but are not limited to: **plantings** of trees, shrubs, grass, herbs and forbs, and wildflowers; **structures** for nesting, denning, colony establishment; protective cover; and **management** to restore or enhance habitat.

Written specifications, schedules and maps shall be prepared for each planning area and each habitat type. Specifications shall:

- Identify the amounts and kinds of habitat elements, locations and management actions necessary to achieve the management objectives.
- Describe the appropriate method, timing and intensity of management needed to produce the desired habitat conditions and sustain them over time.

Site-specific requirements are listed on the specifications sheet. Additional provisions may be entered on the job sketch sheet. Specifications are prepared in accordance with the MA NRCS Field Office Technical Guide. See practice standard *Upland Wildlife Habitat Management*, code 645.

OPERATION AND MAINTENANCE
The following actions shall be carried out to ensure that this practice functions as intended throughout its expected life:

- Evaluate habitat conditions on a regular basis in order to adapt the conservation plan and schedule of implementation.
- Annually inspect and repair structural or vegetative components of this practice.
- Any use of fertilizers, pesticides and other chemicals shall not compromise the intended purpose.

WORK WITH NRCS TO DEFINE TYPES OF IMPROVEMENTS BELOW

Upland Wildlife Habitat Management Implementation Requirements

Client:	**Farm #**:
	Tract #:
Planned By:	**Date**:
Management Goals/Objectives:	

VEGETATION MANAGEMENT

Field(s)	Type of Management	Management Frequency

Notes (e.g., type of treatment and additional details as needed, refer to any attached NRCS technical notes, etc.)**:**
Vegetation management will occur outside the primary reproductive season (i.e., April 15 - August 1st), unless specified by NRCS for the restoration and maintenance of healthy native plant communities.

PLANTINGS [1]

Site Preparation:

Field(s)	Species or Mix	Planting Stock	Rate (no. or lbs) \Units\ac.	Planting Details (e.g., broadcast, drill to depth, spacing, etc.)
			\	
			\	
			\	

Notes (e.g., additional details as needed, refer to any attached NRCS technical notes, etc.)**:**

[1] – *See conservation plan for recommended treatment year and month for plantings. Specifications for tree and shrub plantings beneficial to wildlife are provided under the appropriate NRCS conservation practice standard (e.g., tree and shrub establishment - code 612, hedgerow planting – code 422, etc.)*

STRUCTURAL HABITAT SUPPLEMENTS

Field(s)	Type of Structure (e.g., type of nest box, brush piles, snag\cavity tree, etc.)	Number

Notes (e.g., refer to attached as-built drawings, placement recommendations, NRCS technical notes, etc.)**:**

ADDITIONAL SPECIFICATIONS

1) Any use of pesticides and other chemicals shall follow label instructions and will not compromise the intended purpose.
2)
3)
4)

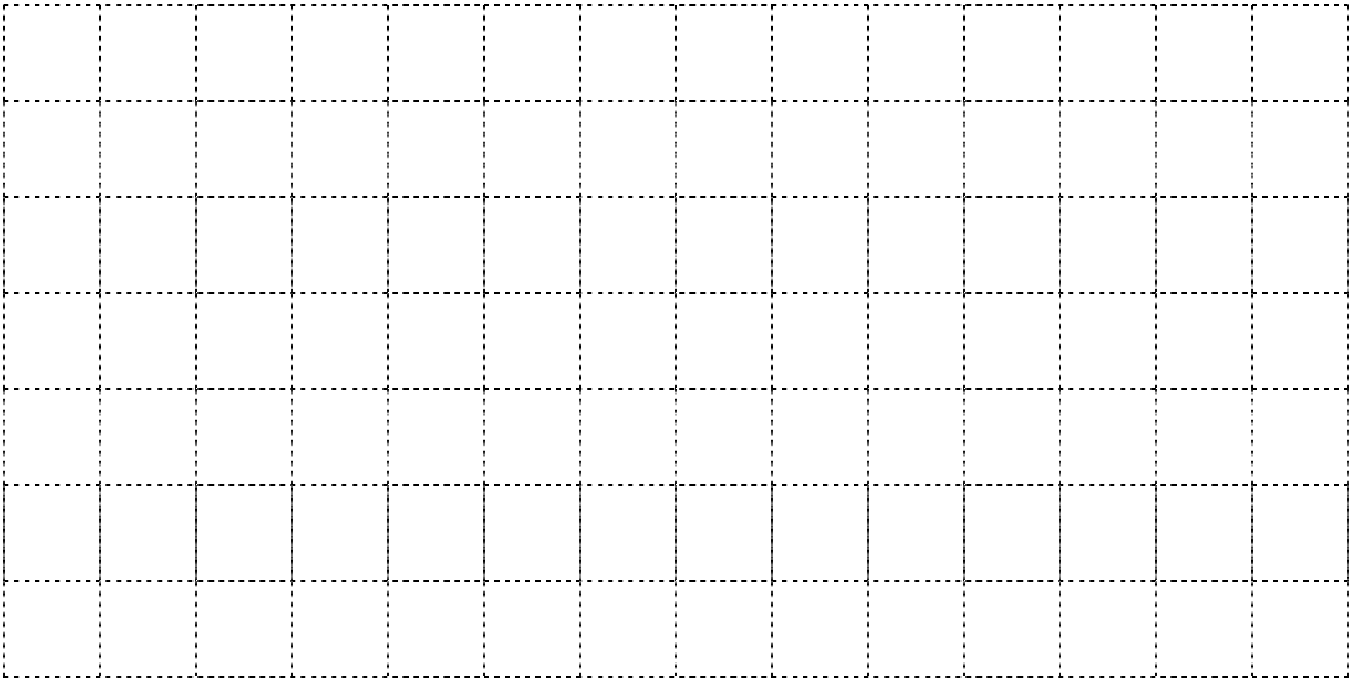
OPERATION AND MAINTENANCE

1) Annually inspect and repair structural or vegetative components of this practice.
2) Clean out nest boxes if present; add appropriate nesting material, if needed.
3)
4)

Upland Wildlife Habitat Management Implementation Requirements

Provide a map (may be attached) showing the location of the proposed practice and practice components.

Scale 1"=_____ ft. (NA indicates sketch not to scale: grid size=1/2" by 1/2")



RECORD OF COMPLETION AND CHECK OUT CERTIFICATION:

Treated Acres:	Date Completed by Client:	Date Inspected:	Inspector:
Notes:			

United States Department of Agriculture

Wildlife Habitat Planting - PCS 420

Massachusetts 420 Guidance Document - Pollinator Planting

DEFINITION

Establish and maintain permanent vegetative cover, with a focus on native species, to create flower-rich forage habitat (primarily offering nectar and pollen) for native bees, honey bees, and other pollinators.

Photo: Eric Mader, The Xerces Society

WHERE USED

This activity applies on lands requiring permanent protective cover that are adjacent to or within 1,500 feet of a farm field, are being converted from agricultural production or suited for permanent pollinator and beneficial insect habitat. Examples of appropriate locations include farm field borders, cranberry bog margins, roadsides, and unproductive farm plots, such as upland habitats, forest edges, sand pits, steep slopes, or wetland margins.

ESTABLISHMENT SPECIFICATIONS

Site Selection

Although larger areas of habitat (1/2 acre or more) will provide resources to support more pollinators, flower-rich habitat can be created in small patches or strips (greater than 325 ft^2) and still provide benefits for pollinators. When identifying planting sites, habitat patches that are bigger, closer together (less than 100 ft apart), or interconnected will support more abundant populations of pollinators than small, isolated, or fragmented patches. The risk of pesticide (especially insecticide) drift needs to be assessed for all locations proposed for pollinator conservation cover. Habitat plantings should be protected or prevented from being exposed to insecticides, including some insecticides approved for use on certified organic farms, including Pyrethrin and Spinosad. If insecticide spraying is to occur, then it is critical that the pollinator planting area is outside of the crop area and protected from drift by a buffer of at least 30 feet. If crop areas are treated with nitroguanidine neonicotinoid insecticides, such as clothianidin, dinotefuran, imidacloprid, or thiamethoxam, then a buffer of 120 feet is recommended. If planting sites were treated or polluted with nitroguanidine neonicotinoids within the past three years, then conservation cover plantings for pollinators are not recommended.

Site Preparation

Controlling weeds prior to planting wildflowers is critical for ensuring project success. Once cool-season grasses or broadleaf perennial weeds overtake a wildflower planting there are few control options other than hand weeding or spot spraying, or starting over. Competition control is a site-preparation process that may require a year or more of effort prior to planting. Control should focus on the eliminations of perennial weeds and will be done according to the Establishment Plan.

Seed Mixture

The species and seeding rates will be according to the Establishment Plan. For spring-seeding or if soil erosion is a concern, an annual rye or oat nurse crop should be used during the first growing season. Oats should be seeded at 40lbs/acre; annual rye should be seeded at 4lbs/acre. Seed tags and other information may be requested by the NRCS representative to verify contract compliance.

Soil Amendments

Most native forbs and grasses tolerate low pH and nutrient conditions; therefore, with the exception of lime, soil amendments are not typically planned for pollinator plantings. If a recent soil test indicates lime is needed, adhere to the following: If the pH is below 5.0, lime can be applied to achieve a pH of 5.5 to 6.5. If lime is to be incorporated, then applications should occur during the beginning of the weed abatement process. If lime will not be incorporated, apply at least 1 year prior to seeding. Surface applications shall not exceed 1.5 tons/acre and no more than 2 applications should be applied in any year.

Seedbed Preparation and Seeding

A clean, firm, and smooth seedbed is important when seeding wildflowers because it helps conserve moisture and ensures good seed-to-soil contact. As a general rule, a seedbed is firm when an adult's footprint is no more than ½ inch deep. To avoid bringing additional weed seeds to the surface, do not disturb soils more than 1 inch deep when preparing the seedbed.

Wildflower seed should be hand or mechanically broadcast or sown with a native seed drill operated by an experienced technician. Standard row crop planters (e.g., corn seed drills) may place wildflower seed too deep and are not recommended. An inert-carrier or bulking-agent is recommended when sowing seed mixes to ensure even rates of seed flow and provide visual estimates of seed coverage. Broadcast seed should be mixed at 1:4 seed to carrier and divided into two or more batches, which are perpendicularly sown. Appropriate carriers include any inert material such as clean sand, sawdust, cornmeal, or vermiculite. Seedbeds should be rolled with a culti-packer or turf-roller after sowing.

Planting Dates

There are three periods in which wildflowers can be seeded: spring, late summer, and a dormant seeding. Spring seedings usually have more annual weeds (e.g. cool season grasses) and will require a strict mowing regime during establishment. Late summer seedings are performed when days are shortening and heavy dew is typical. The exact date for late summer seedings is weather and soil-moisture dependent, but typically would occur in mid-August and no later than mid-September. Moisture conditions are considered ideal if the soil can be rolled into a ball by hand and the ball breaks easily when dropped. Late summer seedings should not be done on soils subject to frost heaving. Late summer seedings should be accompanied by a nurse crop to prevent seed predation, while reducing soil erosion and surface runoff. Dormant seedings (i.e., late fall before snow fall and after first hard frost of 27 °F or -3 °C) are *most recommended* for establishing native forbs, but may pose challenges due to erratic weather conditions in Massachusetts during that time of year. Refer to the Establishment Plan for the recommended planting period.

Weed Control during Establishment

In the first few years after seed germination, it is critical that the seedlings do not get shaded out by weeds, that annual weeds are not allowed to set seed, and that perennial weeds are controlled. Follow the recommended weed control in the Establishment Plan.

OPERATION AND MAINTENANCE

Site disturbance

Minimizing disturbance within pollinator plantings creates conditions that are favorable for the development of nesting opportunities for bumble bees and other ground nesting bees. However, to maintain the open, sunny nature of the habitat, mowing or burning will be necessary on an infrequent basis.

Habitats dominated by wildflowers and grasses must be managed over time to maintain early successional characteristics. Typical management tools/techniques include mowing or burning. Site management should be rotationally performed on a fraction (1/3 or less) of the site each year to reduce habitat disturbance. If mowing is used, then all equipment must be clean and free of weed seed prior to use. The habitat should be routinely monitored for weeds and managed accordingly.

SAMPLE SEED MIXES

Sample seed mixes are shown below. All sample species are known to provide floral rewards for pollinators. Other seed mixes may be acceptable with approval by NRCS prior to planting. If species are unavailable, then substitutions may be acceptable, but must be approved by NRCS. To calculate seeding rates, use the Massachusetts Pollinator Seed Rate Calculator, available online.

Table 1: Sample Dry Site Pollinator Mix. *Non-native to Massachusetts

Species	% in Mix	Bloom Color & Period		
		Early	Mid	Late
Aquilegia canadensis (eastern columbine)	2			
Baptisia australis (blue false indigo)*	0.5			
Baptisia tinctoria (horseflyweed)	0.4			
Lupinus perennis (sundial lupine)	0.1			
Penstemon digitalis (tall white beard tongue)	12			
Tradescantia ohioensis (Ohio spiderwort)	2			
Zizia aurea (golden Alexanders)	2			
Asclepias syriaca (common milkweed)	1			
Asclepias tuberosa (butterfly milkweed)	1			
Chamaecrista fasciculata (partridge pea)	4			
Echinacea purpurea (purple coneflower)*	4			
Coreopsis lanceolata (lance-leaf coreopsis)*	2			
Coreopsis tinctoria (plains coreopsis)*	2			
Gaillardia aristata (blanketflower)*	1			
Liatris spicata (Rough blazing star)*	2			
Monarda fistulosa (wild bergamot)	7			
Monarda punctata (dotted mint)	7			
Pycnanthemum virginianum (Virginia mountain-mint)	6			
Rudbeckia hirta (black-eyed Susan)	7			
Solidago juncea (early goldenrod)	5			
Euthamia caroliniana (slender goldentop)	5			
Helianthus maximiliani (Maxmillian sunflower)*	2			
Symphyotrichum laeve (smooth aster)	4			
Symphyotrichum pilosum (frost aster)	5			
Solidago nemoralis (gray goldenrod)	6			
Schizachyrium scoparium (little bluestem)	10			

Table 2: Sample Dry, Sandy Site Pollinator Mix. *Non-native to Massachusetts

Species	% in Mix	Bloom Color & Period		
		Early	Mid	Late
Aquilegia canadensis (eastern columbine)	2			
Baptisia australis (blue false indigo)*	0.5			
Baptisia tinctoria (horseflyweed)	0.3			
Lupinus perennis (sundial lupine)	0.2			
Penstemon digitalis (tall white beard tongue)	12			
Asclepias syriaca (common milkweed)	1			
Asclepias tuberosa (butterfly milkweed)	1			
Chamaecrista fasciculata (partridge pea)	4			
Coreopsis lanceolata (lance-leaf coreopsis)*	3			
Coreopsis tinctoria (plains coreopsis)*	2			
Gaillardia aristata (blanketflower)*	2			
Liatris spicata (Rough blazing star)*	2			
Lotus corniculatus (bird's-foot trefoil)*	3			
Monarda fistulosa (wild bergamot)	7			
Monarda punctata (dotted mint)	7			
Pycnanthemum virginianum (Virginia mountain-mint)	6			
Rudbeckia hirta (black-eyed Susan)	6			
Solidago juncea (early goldenrod)	6			
Desmodium canadense (showy tick trefoil)	2			
Euthamia caroliniana (slender goldentop)	5			
Helianthus maximiliani (Maxmillian sunflower)*	2			
Symphyotrichum laeve (smooth aster)	6			
Symphyotrichum pilosum (frost aster)	6			
Solidago nemoralis (gray goldenrod)	6			
Eragrostis spectabilis (purple lovegrass)	10			

Table 3: Wet Site Pollinator Mix. *Non-native to Massachusetts

Species	% in Mix	Bloom Color & period		
		Early	Mid	Late
Baptisia australis (blue false indigo)*	0.5			
Penstemon digitalis (tall white beard tongue)	12			
Polygonum pensylvanicum (Pennsylvania smartweed)	5			
Tradescantia ohioensis (Ohio spiderwort)	2			
Zizia aurea (golden Alexanders)	2			
Asclepias incarnata (swamp milkweed)	2			
Bidens cernua (nodding beggartick)	3			
Chelone glabra (turtlehead)	2			
Eupatorium perfoliatum (boneset)	1			
Eutrochium fistulosum (hollow Joe-Pye weed)	1			
Eutrochium maculatum (spotted Joe-Pye weed)	1			
Eutrochium purpureum (purple Joe-Pye weed)	2			
Lobelia cardinalis (cardinal flower)	3			
Monarda fistulosa (wild bergamot)	7			
Pycnanthemum tenuifolium (narrow mountain-mint)	6			
Verbena hastata (blue vervain)	7			
Helenium autumnale (common sneezeweed)	6			
Solidago patula (rough leaved goldenrod)	7.5			
Symphyotrichum novae-angliae (New England aster)	5			
Symphyotrichum novi-belgii (Yew York aster)	5			
Symphyotrichum puniceum (purple-stem aster)	5			
Vernonia noveboracensis (New York ironweed)	5			
Andropogon gerardii (big bluestem)	10			

Native Shrubs for Pollinator Conservation in Massachusetts

Below is a table with information about native shrubs and to consider for assessing and enhancing pollinator habitat on agricultural and wildlands. This table includes brief information on bloom timing, the basic cultural needs, and ranked pollen or nectar resources (*–*****, None, or N/A if unranked1) of the plants. The information provided is a starting point for determining plants to use for a particular project. To find species that are available and/or hardy for a specific location, consult your state NRCS Major Land Resource Area (MLRA) plant list or other plant zone criteria. Additional information such as the geographic distribution, cultural requirements and contraindications, and wildlife benefits for various plants is available from species fact sheets like those found at the USDA PLANTS database (http://plants.usda.gov/java/factSheet). These are some plant species that one might consider, paying attention to overlapping bloom periods and the appropriate plant for the site conditions. This table is not exhaustive: many other shrubs and trees provide nectar and pollen for bees. This list is limited to plants known to require insect pollination and to be regionally or locally widespread or commonly found in the public marketplace as seed or nursery stock2. Shrub plantings may be designed for a number of concurrent purposes, such as wildlife enhancement, stream bank stabilization, windbreak, and/or conservation biological pest control.

Common Name	Scientific Name	Bloom Period	Flower Color	Growth Form	Mature Ht. (ft.)	Soil Adaptation	Drought Tolerance	Shade Tolerance	Salt Tolerance	Hedge Tolerance	Pollen Nectar
Common serviceberry[3]	*Amelanchier arborea* (Michx. f.) Fernald	mid Spring	White	Single Stem	36.0	Coarse, Medium	Low	Tolerant	Low	Low	* *
Canadian serviceberry[3]	*Amelanchier canadensis* (L.) Medik.	Mid Spring	White	Multiple Stem	23.0	Coarse, Fine, Medium	Low	Intermediate	Medium	High	* *
Allegheny serviceberry[3]	*Amelanchier laevis* Wiegand	Early Spring	White	Multiple Stem	35.0	Coarse, Medium	Medium	Tolerant	Low	N/A	* *
Kinnikinnick[3]	*Arctostaphylos uva-ursi* (L.) Spreng.	Late Spring	Pink	Multiple Stem	0.5	Coarse, Medium	High	Intermediate	Medium	None	* *
Red chokeberry[3]	*Aronia arbutifolia* (L.) Pers.	Mid Spring	White	Thicket Forming	5.0	Fine, Medium	Low	Intolerant	Low	N/A	** ***
Black chokeberry[3]	*Aronia melanocarpa* (Michx.) Ell.	Mid Spring	White	Colonizing	6.0	Coarse, Medium	Medium	Tolerant	N/A	N/A	** ***
New Jersey tea	*Ceanothus americanus* L.	Late Spring	White	Multiple Stem	3.0	Coarse. Medium	High	Tolerant	None	Low	* ***
Common buttonbush	*Cephalanthus occidentalis* L.	Mid Summer	White	Multiple Stem	15.0	Coarse, Fine, Medium	Medium	Tolerant	Low	None	** ***
Eastern redbud	*Cercis canadensis* L.	Early Spring	Purple	Multiple Stem	30.0	Fine, Medium	High	Tolerant	None	None	** **
Coastal sweetpepperbush	*Clethra alnifolia* L.	Mid Summer	White	Multiple Stem	16.0	Coarse, Medium	Low	Intermediate	None	Low	** ***
Alternateleaf dogwood[3]	*Cornus alternifolia* L. f.	Early Summer	White	Multiple Stem	25.0	Medium	Low	Tolerant	None	N/A	* *
Silky dogwood[3]	*Cornus amomum* Mill.	Early Summer	White	Stoloniferous	10.0	Coarse, Fine, Medium	Low	Intermediate	None	Medium	* *
Gray dogwood[3]	*Cornus racemosa* Lam.	Early Summer	White	Rhizomatous	10.0	Fine, Medium	Medium	Tolerant	None	Medium	* *

Common Name	Scientific Name	Bloom Period	Flower Color	Growth Form	Mature Ht. (ft.)	Soil Adaptation	Drought Tolerance	Shade Tolerance	Salt Tolerance	Hedge Tolerance	Pollen Nectar
American hazelnut	*Corylus americana* Walter	Early Spring	White	Multiple Stem	10.0	Fine, Medium	Medium	Intermediate	None	Low	**** None
Cockspur hawthorn[3]	*Crataegus crus-galli* L.	Late Spring	White	Single Stem	30.0	Coarse, Fine, Medium	High	Intolerant	Medium	Medium	*** ***
Eastern teaberry[3]	*Gaultheria procumbens* L.	Early Summer	White	Stoloniferous	0.5	Coarse, Medium	High	Tolerant	None	N/A	* *
Black huckleberry[3]	*Gaylussacia baccata* (Wangenh) Koch	Late Spring	White	Multiple Stem	4.0	Coarse, Fine, Medium	Medium	Tolerant	None	N/A	** **
American witchhazel	*Hamamelis virginiana* L.	Fall	Yellow	Multiple Stem	20.0	Fine, Medium	Low	Intermediate	None	N/A	* *
Inkberry[4]	*Ilex glabra* (L.) A. Gray	Early Summer	White	Multiple Stem	8.0	Coarse, Fine, Medium	Low	Intolerant	Medium	Medium	** ****
American holly[4]	*Ilex opaca* Aiton	Early Summer	White	Single Stem	40.0	Coarse, Medium	Medium	Tolerant	Medium	Medium	*** ***
Common winterberry[4]	*Ilex verticillata* (L.) A. Gray	Early Summer	White	Multiple Stem	10.0	Fine, Medium	Low	Intermediate	None	Low	**** ****
Mountain laurel	*Kalmia latifolia* L.	Late Spring	Pink	Multiple Stem	6.0	Coarse, Medium	High	Tolerant	None	N/A	** **
Northern spicebush	*Lindera benzoin* (L.) Blume	Mid Spring	White	Multiple Stem	12.0	Fine, Medium	Low	Intermediate	None	Low	* *
Maleberry	*Lyonia ligustrina* (L.) DC.	Late Spring	White	Multiple Stem	9.0	Fine, Medium	High	Tolerant	N/A	N/A	** **
Beach plum[3]	*Prunus maritima* Marshall	Late Spring	White	Multiple Stem	12.0	Coarse, Medium	High	Intolerant	Low	Low	** **
Sandcherry[3]	*Prunus pumila* L.	Late Spring	White	Multiple Stem	6.0	Coarse, Medium	Medium	Tolerant	None	N/A	** **
Chokecherry[3]	*Prunus virginiana* L.	Mid Spring	White	Multiple Stem	25.0	Coarse, Fine, Medium	Medium	Intolerant	Medium	Low	** **
Great laurel	*Rhododendron maximum* L.	Mid Spring	Purple	Multiple Stem	25.0	Coarse, Medium	High	Tolerant	None	N/A	** **
Swamp azalea	*Rhododendron viscosum* (L.) Torr.	Early Summer	White	Multiple Stem	16.0	Coarse, Fine, Medium	Medium	Tolerant	None	N/A	** **
Winged sumac[4]	*Rhus copallinum* L.	Mid summer	Yellow	Rhizomatous	8.0	Coarse, Fine Medium	Medium	Intolerant	None	Low	** ****
Smooth sumac[4]	*Rhus glabra* L.	Mid Summer	Yellow	Rhizomatous	12.0	Coarse, Medium	Medium	Intolerant	Medium	Low	** ****
Staghorn sumac[4]	*Rhus typhina* L.	Mid Summer	Yellow	Multiple Stem	35.0	Coarse, Medium Fine	High	Intolerant	Medium	Low	** ****
Red currant	*Ribes triste* Pall.	Early Spring	White	Stoloniferous	2.0	Coarse, Medium	Low	Tolerant	None	N/A	** **
Carolina rose[3]	*Rosa carolina* L.	Early Summer	White	Multiple Stem	5.0	Coarse, Medium	High	Intermediate	Medium	N/A	*** **

Common Name	Scientific Name	Bloom Period	Flower Color	Growth Form	Mature Ht. (ft.)	Soil Adaptation	Drought Tolerance	Shade Tolerance	Salt Tolerance	Hedge Tolerance	Pollen Nectar
Swamp rose[3]	*Rosa palustris* Marshall	Early Summer	Red	Rhizomatous	8.0	Fine, Medium	Low	Tolerant	None	Low	*** **
Virginia rose[3]	*Rosa virginiana* Mill.	Early Summer	Purple	Rhizomatous	6.0	Coarse, Medium	Low	Intermediate	None	None	*** **
Allegheny blackberry[3]	*Rubus allegheniensis* Porter	Late Spring	White	Thicket Forming	6.0	Fine, Medium	High	Tolerant	None	Low	*** ***
Black raspberry[3]	*Rubus occidentalis* L.	Late Spring	White	Thicket Forming	6.0	Fine, Medium	Medium	Intermediate	None	Low	*** ***
Bebb willow[4]	*Salix bebbiana* Sarg.	Early Spring	Yellow	Multiple Stem	12.0	Coarse, Fine, Medium	None	Intolerant	None	Medium	*** **
Pussy willow[4]	*Salix discolor* Muhl.	Early Spring	Yellow	Single Stem	40.0	Coarse, Fine, Medium	Low	Tolerant	None	None	*** **
Prairie willow[4]	*Salix humilis* Marshall	Early Spring	Yellow	Multiple Stem	10.0	Coarse, Medium	Low	Intermediate	None	Low	*** **
American black elderberry[3]	*Sambucus canadensis* L.	Mid Summer	White	Multiple Stem	7.0	Medium	Medium	Intolerant	None	Low	** *
White meadowsweet[3]	*Spiraea alba* Du Roi	Late Spring	White	Multiple Stem	3.0	Coarse, Fine, Medium	Low	Intermediate	None	N/A	* *
Steeplebush[3]	*Spiraea tomentosa* L.	Summer	Pink	Rhizomatous	4.0	Coarse, Fine, Medium	Medium	Intolerant	None	N/A	* *
Common snowberry	*Symphoricarpos albus* (L.) Blake	Early Summer	White	Rhizomatous	3.0	Coarse, Fine, Medium	High	Intolerant	Medium	Low	** ****
Lowbush blueberry[3]	*Vaccinium angustifolium* Aiton	Mid Spring	White	Multiple Stem	2.0	Coarse, Fine, Medium	Medium	Intolerant	None	N/A	*** ***
Highbush blueberry[3]	*Vaccinium corymbosum* L.	Mid Spring	White	Multiple Stem	12.0	Coarse, Fine, Medium	Low	Tolerant	High	Low	*** ***
Mapleleaf viburnum[3]	*Viburnum acerifolium* L.	Late Spring	White	Multiple Stem	6.0	Coarse, Medium	High	Tolerant	None	Low	* *
Nannyberry[3]	*Viburnum lentago* L.	Late Spring	White	Multiple Stem	28.0	Fine, Medium	Low	Tolerant	None	None	* *

Native Shrubs for Pollinator Conservation in Massachusetts

Sample Shrub Mixes

Below are sample shrub mixes for Massachusetts farms or natural areas. Fruit farms include apple, cranberry, blueberry, or bramble farms.

Fruit Farm

- New Jersey tea, *Ceanothus americanus*
- Eastern redbud, *Cercis canadensis*
- Coastal sweetpepperbush, *Clethra alnifolia*
- Inkberry, *Ilex glabra*
- Great laurel, *Rhododendron maximum*
- Swamp azalea, *Rhododendron viscosum*
- Smooth sumac, *Rhus glabra*
- Prairie willow, *Salix humilis*

Vegetable Farm

- Red or Black chokeberry, *Aronia* spp.
- Cockspur hawthorn, *Crataegus crus-galli*
- Common winterberry, *Ilex verticillata*
- Rose, *Rosa* spp.
- Bramble, *Rubus* spp
- Smooth sumac, *Rhus glabra*
- Willow, *Salix* spp.
- Blueberry, *Vaccinium* spp.

Natural Area

- Red or Black chokeberry, *Aronia* spp.
- Dogwood, *Cornus* spp.
- Cockspur hawthorn, *Crataegus crus-galli*
- Rose, *Rosa* spp.
- Bramble, *Rubus* spp.
- Willow, *Salix* spp.
- Blueberry, *Vaccinium* spp.
- Viburnum, *Viburnum* spp.

Acknowledgements

This pollinator habitat technical note was written in 2016 by Jarrod Fowler and Mace Vaughan of the Xerces Society for Invertebrate Conservation. Please contact Jarrod Fowler at jarrod@xerces.org to improve this publication. Financial support to the Xerces Society for the development of this technical note was provided by NRCS Massachusetts, the NRCS National Technology Support Center, and Xerces Society Members.

1Lindtner, P. (2014). Garden plants for honey bees. Kalamazoo, MI: Wicwas Press. 2Always source seed or nursery stock that is free from systemic insecticides.3Alternate host of apple, blueberry, cranberry, or bramble pathogens and pests. 4Dioecious: pollen-producing (male) and nectar-producing (female) flowers found on separate plants: Only female plants produce fruit.

healthy, productive soils checklist for growers

unlock the SECRETS IN THE SOIL

Managing for soil health is one of the easiest and most effective ways for farmers to increase crop productivity and profitability while improving the environment.

Results are often realized immediately, and last well into the future. Using these four basic principles is the key to improving the health of your soil.

1. Keep the soil covered as much as possible
2. Disturb the soil as little as possible
3. Keep plants growing throughout the year to feed the soil
4. Diversify as much as possible using crop rotation and cover crops

Use the checklist on the back of this page to determine if you're using some or all of the core Soil Health Management System farming practices.

It is important to note that not all practices are applicable to all crops. Some operations will benefit from just one soil health practice while others may require additional practices for maximum benefit. But these core practices form the basis of a Soil Health Management System that can help you optimize your inputs, protect against drought, and increase production.

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Helping People Help the Land

Soil Health Management Systems Include:

What is it?		What does it do?	How does it help?
Conservation Crop Rotation Growing a diverse number of crops in a planned sequence in order to increase soil organic matter and biodiversity in the soil.		• Increases nutrient cycling • Manages plant pest (weeds, insects, and diseases) • Reduces sheet, rill, and wind erosion • Holds soil moisture • Adds diversity so soil microbes can thrive	• Improves nutrient use efficiency • Decreases use of pesticides • Improves water quality • Conserves water • Improves plant production
Cover Crop An un-harvested crop grown as part of planned rotation to provide conservation benefits to the soil.		• Increases soil organic matter • Prevents soil erosion • Conserves soil moisture • Increases nutrient cycling • Provides nitrogen for plant use • Suppresses weeds • Reduces compaction	• Improves crop production • Improves water quality • Conserves water • Improves nutrient use efficiency • Decreases use of pesticides • Improves water efficiency to crops
No Till A way of growing crops without disturbing the soil through tillage.		• Improves water holding capacity of soils • Increases organic matter • Reduces soil erosion • Reduces energy use • Decreases compaction	• Improves water efficiency • Conserves water • Improves crop production • Improves water quality • Saves renewable resources • Improves air quality • Increases productivity
Mulch Tillage Using tillage methods where the soil surface is disturbed but maintains a high level of crop residue on the surface.		• Reduces soil erosion from wind and rain • Increases soil moisture for plants • Reduces energy use • Increases soil organic matter	• Improves water quality • Conserves water • Saves renewable resources • Improves air quality • Improves crop production
Mulching Applying plant residues or other suitable materials to the soil surface to compensate for loss of residue due to excessive tillage.		• Reduces erosion from wind and rain • Moderates soil temperatures • Increases soil organic matter • Controls weeds • Conserves soil moisture • Reduces dust	• Improves water quality • Improves plant productivity • Increases crop production • Reduces pesticide usage • Conserves water • Improves air quality
Nutrient Management Managing soil nutrients to meet crop needs while minimizing the impact on the environment and the soil.		• Increases plant nutrient uptake • Improves the physical, chemical, and biological properties of the soil • Budgets, supplies, and conserves nutrients for plant production • Reduces odors and nitrogen emissions	• Improves water quality • Improves plant production • Improves air quality
Pest Management Managing pests by following an ecological approach that promotes the growth of healthy plants with strong defenses, while increasing stress on pests and enhancing the habitat for beneficial organisms.		• Reduces pesticide risks to water quality • Reduces threat of chemicals entering the air • Decreases pesticide risk to pollinators and other beneficial organisms • Increases soil organic matter	• Improves water quality • Improves air quality • Increases plant pollination • Increases plant productivity

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MULCHING CODE 484
MA Technical Reference

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*All materials must be installed according to manufacturer recommendations.

The Following specifications on mulching were taken directly from: Salon, P.R. and C.F. Miller. 2012. A Guide to: Conservation Plantings on Critical Areas for the Northeast. USDA, NRCS, Big Flats Plant Materials Center, Corning, NY.

Mulching

The term "mulch" covers a broad array of materials used to provide an instant cover over the ground to protect the soil from erosion and to improve conditions for seed germination and plant growth.

Mulching should be standard practice on critical area plantings, especially on difficult sites such as steep slopes, subsoils, and excessively dry soils. The steeper the slope and the poorer the soil, the more valuable it becomes. Apply mulch immediately following seeding or planting. On larger sites the mulching operation should follow the planting operation as it moves across the area so that delays are not occurring between the two procedures. Mulch is a tool for revegetation, since ultimately the plants, not the mulch, are expected to stabilize the site. Plant growth is the first goal. Mulch prevents erosion in the same manner as vegetation, by protecting the surface from raindrop impact and by reducing the velocity of overland flow. Mulch needs to be applied with a density that protects the soil from erosion while allowing water and light to penetrate and seedlings to emerge. Mulches are not a substitute for water control practices; water run-on from adjacent land or from seepage should be controlled with engineered water control structures or grading during site preparation.

Mulch is used for one or more of the following purposes:

- Provide temporary erosion control in lieu of temporary seeding when seeding must be delayed until the proper planting dates, or until seedings or plantings become well established
- Conserve soil moisture to aid seed germination and plant survival
- Reduce surface compaction or crusting, and improve water infiltration
- Protect soil from water and wind erosion
- Reduce weed pressure on the planted vegetation
- Moderate the fluctuation of temperature at the soil surface
- Reduce frost heaving
- Add organic matter
- Protect surface applied seed from birds and other consumers

Soils that are mulched stay cool and moist for longer periods in the spring. This is a positive benefit to cool season grasses, legumes, and woody plants as they establish root systems and begin growth. The seeds of warm season grass and some of the native wildflowers have evolved to germinate under the warmer conditions of early summer. Thus mulches tend to delay and prolong the germination process for those plants, elevating the risk of failure. If mulch needs to be used, reduce rates to 1,000 pounds per acre to allow for sunlight penetration to the soil surface.

Use mulch consisting of natural and/or artificial non-toxic materials. These include coconut fibers, wood shavings, straw, hay, bark chips, plastic, or fabric. Use straw in place of mulch hay for most applications where introduction of weed seeds from the hay is a concern. Mulch must be of sufficient thickness and durability to achieve the desired effect for the required time period. Use tackifiers, emulsions, netting, pinning, or other methods of anchoring mulch in place until it is no longer needed. There are many products available today for performing specific tasks that may be considered as mulches. Specifications for existing products are available from the manufacturers. Refer to Appendix 4e for a summary table of mulch materials, rates, and uses.

Types of Mulch

Straw: Apply clean, dry straw for mulching where the benefit to plant growth is the primary consideration. Clean straw contains no noxious weeds, minimal weed seed, minimal dust or mold and minimal grain seed. Straw can be from the cereal grains: oats, wheat, barley, rye or triticale. Apply straw mulch at the rate of 2 tons per acre (90 pounds per 1,000 square feet). Spread mulch uniformly by hand or by mechanical methods immediately following seeding, covering approximately 85 percent of the soil surface (Figure 4g). This provides erosion protection and allows adequate light penetration for seedling germination and emergence. For most applications the straw should be immediately anchored after placement (Figures 4h and 4i) to avoid mulch being moved by wind or water. Refer to the section below on mulch netting, crimping, and tacking. Straw can be tacked with wood/cellulose fiber spread by hydroseeder at 500 to 750 pounds per acre. For additional protection add tackifying agents following manufacturer's recommendations.

Hay: Hay is an acceptable alternative to straw only if weed seed content does not affect the site objectives as weed and forage crop seed can overwhelm the desired vegetation. If the introduction of weeds is an issue, for example, native warm season grass establishment or in ecologically sensitive areas, use straw in place of hay. Hay tends to break down faster than straw so heavier rates may be required and it also requires anchoring on sites subject to wind. Furthermore, it is more likely to contain mold that can be an allergy problem for workers on site.

Manure: Manures are usually used as a soil amendment to add organic matter. Composted manure is available in some locations although it is highly variable in its starting material, the methods used for mixing and the composting temperature reached. If compost reaches a high enough temperature, there is a reduction in viable weed seeds.

Bark and Wood Chip Mulch

Apply shredded hardwood bark mulch, bark chips or woodchips to a depth of 2 to 4 inches around plantings of trees, shrubs, groundcovers, and vines. The bark and wood should be pulled away from the trunk of the trees or shrubs. Shredded hardwood bark mulch, rather than bark chips, is used on steeper slopes because it is less subject to movement by water. Avoid incorporating bark and wood mulch into the soil. Incorporated mulch can cause nitrogen to be tied up by microorganisms breaking down the mulch.

Figure 4g. Mulch should be applied at a density of 85 percent cover to hold moisture but allow for seedlings to emerge.

Figure 4h. Straw mulch needs to be held in place to prevent movement from wind especially if chopped. Photo by John Price, Price and Company.

Figure 4i. Fiber mulch with tackifier can tack down straw and maintain good mulch density. Photo by John Price, Price and Company.

Hydraulic Mulch Types

Hydraulic mulch consists of cellulose (paper), shredded wood fiber, blended (wood and cellulose) or bonded fiber matrix. They are used with tackifiers to adhere the mulch to the soil surface and a dye to provide visual aid during application. They are used at rates from 2,000 to 4,000 pounds per acre depending on the material, additives, soil/site conditions and time of planting. Hydraulic mulches are short lived. Based on application rate and material used they usually last from 3 to 12 months and are therefore used to temporarily protect exposed soil from erosion by wind, raindrop impact and sheet flow while seeding becomes established. Additives can be used to extend their longevity. Hydraulic mulches are mixed in standard hydraulic mulching equipment (hydroseeder) to form a homogenous slurry and are continuously agitated. All wood fiber based mulches need mechanical paddle agitated equipment. This slurry should be sprayed under pressure, uniformly over the soil surface at the material application rate based on slope grades as recommended by the manufacturer.

Cellulose fiber mulch is manufactured from recycled newspaper, magazines, or other paper. Cellulose fiber is the least expensive fiber mulch and is primarily used to tack straw at 500 to 750 pounds per acre with a tackifier. It usually comes in bales but it also comes in pelletized forms for easier pouring into hydroseeders but is more expensive. It can also be used as a mulch on flat surfaces for turf applications at 1,500 pounds per acre to aid with germination during optimum seeding windows. Do not over apply cellulose mulch since it can create a consistency of papier maché reducing infiltration and air exchange, inhibiting seed germination and establishment. Therefore it is better to use a mixture of wood and cellulose fiber mulch when erosion control is a concern. Expected longevity for cellulose fiber mulch is no more than 3 months.

Wood fiber mulch manufactured from recycled wood or virgin wood fibers is typically applied with tackifiers. Wood fiber mulches retain water with interlocking fibers and are used to control erosion for slopes up to 3:1. Expected longevity is 3 to12 months.

Blended wood/paper mulches are 50 percent to 70 percent wood fiber, 30 percent to 50 percent paper fiber.

Blending allows a contractor to have a product that is easy to mix and will provide some erosion control for slopes from 6:1 to 4:1 depending on additives, soil/site conditions, and time of planting. For highly erodible sites use either wood fiber or bonded fiber matrix type mulches with tackifiers. Expected longevity is 3 to12 months.

Bonded fiber matrix (BFM) is a continuous layer/matrix of elongated wood fiber strands held together by water-resistant bonding agents such as soil flocculants, cross-linked hydro-colloidal polymers, or cross-linked tackifiers. It forms a lofty, interlocking matrix which creates air space and water absorbing cavities that improves seed germination, reduces the impact of raindrop energy, and minimizes soil loss. BFM may be used on slopes up to and including 2:1. Do not apply immediately before, during or immediately after a rainfall, or if the soil is saturated as it typically requires 24 hours to dry before rainfall occurs in order to be effective against erosion. Expected longevity is 3-12 months.

Mechanically bonded fiber matrix (MBFM) is produced from strands of elongated wood fibers and crimped synthetic fibers to create an interlocking mechanism between the fibers. This material is combined with additional binding agents. MBFM may be used on slopes up to and including 2:1 and provides immediate protection against erosion since no cure time is required to develop surface protection. Expected longevity is 12 months or greater.

There are many products on the market that blend the different materials described above. These products will have variable curing times, application rates, degree of protection, and cost. It is imperative that the user follow all manufacturer's recommendations for a specific site condition when applying materials.

Soil Stabilization Matting

Erosion control matting, rolled erosion control blankets, and turf re-enforcement mats are types of erosion control products which are rolled out on site for immediate erosion protection. Some mats are specifically designed to handle higher velocities in concentrated water flow areas (Figure 4j). These typically have straw or coconut fiber mulch between layers of jute (biodegradable), UV degradable or non-degradable netting. They are designed for many applications for a variety of slopes, velocity, and years of service. They are installed up and down the slope never on the contour. Some products are made of a non-degradable fiber layer with 95 percent pore space allowing for hydraulic seeding over the top for more structure. They need to be applied to obtain a firm continuous contact between the material and the soil and adequately stapled according to the manufacturer's recommendations. These materials vary in cost based on longevity and are typically more expensive than most of the hydraulic mulching options.

Figure 4j. Erosion control matting can withstand higher velocities of water than most hydraulic mulches.

Mulch Anchoring

Once mulch is applied it needs to be anchored in place for the time needed to establish a seeding and protect the soil. The following section details the different types of mulch anchoring systems. Refer to Appendix 4f for a summary of mulch anchoring techniques for different mulches.

Mulch Netting

Mulch netting is used as a cover for mulch; it is made from UV degradable plastic, jute, or cotton netting. Coconut fiber has been used as a longer-lasting natural material, bridging the gap between man-made fiber longevity and plant-derived fibers for biodegradability. Individual rolls of netting should be applied up and down the slope never along the contour. Bury the upper end of the netting at the top of the disturbed area in a trench at least 6 to 8 inches deep. Lay out rolls so edges overlap each other by at least 4 inches. When more than one roll is required going down slope, the ends going down the slope should overlap by at least 3 feet. Steel staples are used to fasten these materials to the surface. Installation is difficult on rocky sites. Staple the netting in place using wire staples according to manufacturer's recommendations.

Crimper

A tractor-drawn mulch anchoring coulter (crimper) is used to push mulch into the soil surface to anchor part of the mulch and leave part standing upright. When crimping mulch follow the general contours of the site and do not cut the straw. Farm disks are a poor substitute as they tend to cut the mulch and turn over the soil due to the concave form of the disk. Crimping operations are limited to areas accessible by tractor unless the implement is pulled by a small bulldozer. As a last resort, crimping can also be done by bulldozers traveling up and down the slope so that cleats are crimping along the contour.

Mulch Tackifiers and Binders

Tackifiers are sticking agents sometimes used independent of mulch to temporarily bind soil particles together and protect the surface from wind and water erosion. When applied with hydraulic mulch, tackifiers increase the effectiveness of the mulch as a soil cover by binding the mulch fibers and the surface soil particles together. For tacking straw at least 500 pounds per acre of fiber mulch is added. Two types of tackifiers are currently available, organic and polyacrylamide polymers. Organic tackifiers are usually made from guar gum, plantago, or corn and potato starches and are best used for flat to moderate slopes. Their holding ability and effective longevity is determined by the quantity added to the slurry, but are usually viewed as short-lived. Polyacrylamide (PAM) tackifiers last longer, are UV degradable and although applied at lower rates will produce the same or more holding ability as organic tackifiers. PAM tackifiers help bind soil particles together. It is important to use water-soluble anionic PAM labeled for this application. Organic and polyacrylamide tackifiers may be applied in the hydroseeding mix with excellent results. Tackifiers not only aid in bonding the application, they also "slick up" the slurry, reducing or eliminating clogs in hoses.

Inspection and Maintenance of Seeding

Inspect the seeding at least 3 weeks following the seeding, evaluate for weeds, and plan and implement all necessary weed control treatments. The success of any seeding will depend on the weed control during the establishment period. Additional inspections are needed following major rain events and periodically during the establishment year especially for seedings on steep slopes or areas with expected high velocity and volumes of concentrated water. Repair areas by reseeding and mulching where erosion is evident. Where there has been some movement in erosion control matting reinstall and staple as needed. Care should be taken to minimize the damage to protected areas recently established while making repairs. In critical area seedings the soil conditions are not as uniform as in an agricultural seeding leading to variability in establishment. Evaluate the growth of the seeding and check if there are areas under stress due to lack of fertility. If this is the case, spot applications of fertilizer may be necessary. This lack of uniformity may show up as moisture stress and additional mulching or irrigation may be necessary. In some high-priority areas irrigation should be initially used over the entire area to achieve the intended results. In some areas due to soil variability or poor grading excess soil moisture may be the concern.

Appendix 4e. Guide to Mulch Materials, Rates, and Uses

Application Rates

Mulch Materials	Quality Standards	Per 1000 sq. ft.	Per Acre	Depth of Application	Remarks
Straw or Hay	Air-dried, free of undesirable seeds and coarse materials	90 - 100 lbs 2 - 3 bales	2 tons, 100 - 120 bales	Cover about 90% of surface	Use straw where mulch is maintained for more than three months. Subject to wind blowing unless anchored. This is the most commonly used mulching material. Best micro environment for germinating seeds. Do not use mulch hay in areas where weed seeds are a concern, use straw.
Wood chips or shavings	Green or air dried, free from objectionable coarse materials	6 - 21 yd^3		2 – 7 in.	It is best to use composted wood chips, typically used as a mulch around ornamentals, small fruits and other nursery stock. Do not incorporate into the soil to avoid nitrogen deficiency during the breakdown of the organic matter and/or use 10 - 12 lb nitrogen/ton to offset the nitrogen deficiency. Resistant to wind blowing and decomposes slowly. Higher amounts in range are used when not planting. 1 ft3 weighs approximately 18 lbs. Use on slopes less than 15%.
Sawdust green, or composted	Free from objectionable coarse material	3 - 18 yd^3		1 - 5 in.	Has about the same use and nitrogen deficiency concerns as wood chips. May require 30 - 35 lbs nitrogen/ton to offset potential nitrogen deficiency. 1 ft3 weighs approximately 36 - 52 lbs.
Hydraulic mulches: wood fiber, cellulose, bonded fiber matrix and mechanically bonded fiber matrix	Dyed green, air-dried 30%, fibers 3.7 mm or longer	30 lbs	1500 - 4000 lbs		Many products exist which includes cellulose, wood fiber, combination of the two and those which combine natural and synthetic materials. Apply at rates according to Manufacturer's specifications based on slope and other site characteristics. Tackifiers are usually needed to hold mulch on site.
Leaves	No plastic bags, or household debris	375 - 700 lbs	8 - 15 tons	3 - 6 in.	Leaves should be shreaded and kept dry prior to use so they do not compost.
Cornstalks, shredded or chopped	Air-dried, shredded into 8 in. to 12 in. lengths	150 - 300 lbs	4 - 6 tons		Effective for erosion control, relatively slow to decompose. Resistant to wind blowing.

Appendix 4e. Guide to Mulch Materials, Rates, and Uses

Application Rates

Mulch Materials	Quality Standards	Per 1000 sq. ft.	Per Acre	Depth of Application	Remarks
Grass clippings	Unbagged, free of debris, minimal odor	700 - 1400 lbs	15 - 30 tons	1 - 2 in.	Obtain necessary permits. Must be spread within 24 hours of delivery. Observe buffer requirements. Incorporate with next tillage season for crop establishment.
Peat Moss	Dried, compressed free of coarse materials	200 ft^3	1/2 - 1 ton	2 - 4 in.	Most effective as a mulch around ornamentals. Subject to wind blowing unless kept wet. Bales weigh 6 - 8 lb/ft^3. Excellent moisture holding capacity.
Gravel, Crushed Stone or Slag	Washed; Size 2B or 3A, 1.5 in.	9 yds^3	-----	3 in.	Excellent mulch for short slopes and around woody plants and ornamentals. Use 2B when subject to foot traffic. Frequently used over black plastic for better weed control.
Jute Twisted Yarn	Undyed, unbleached plain, warp 78 per 4 ft width, Weft 42/yd length, 1.25 to 1.8 lb/yd	48 in. x 75 yds			Use without additional mulch. Tie down as in manufacturing specification. Can be used on slopes greater than 2:1 if used with fiber mulch.
Excelsior Wood Fiber Mats	Interlocking web of excelsior fibers with photodegradable plastic netting on one or both sides	Variable length based on product, 4 - 16 ft wide.			Use without additional mulch. Excellent for seed establishment. Tie down as per manufacturer specifications. Approximately 78 lbs/roll for excelsior with plastic on both sides. Use two sided plastic for centerline of waterways. Many new erosion control blanket products are available.
Plastic	4 - 6 mils	Variable			Use black for weed control. Effective moisture conservation and weed control for small fruits ornamentals.
Filter Fabrics	Woven or Spun	Variable			
Straw or coconut fiber or combination	Photodegradable plastic net on one or two sides.	Variable			Designed to tolerate higher velocity water flow in centerlines of waterways.

Appendix 4f. Mulch Anchoring Guide Specification Sheet

Anchoring Method or Material	Kind of Mulch to be Anchored	How to Apply
A. Manual		
1. Peg and twine	Hay or straw	After mulching, divide areas into blocks approx. 1 yd2. Drive 4 to 6 pegs per block to within 2 to 3 inches of soil surface. Secure mulch to surface by stretching twine between pegs in criss-cross pattern on each block. Secure twine around each peg with 2 or more turns. Drive pegs flush with soil where mowing and maintenance is planned.
2. Mulch netting	Hay or straw	Staple the light-weight paper, jute, wood fiber, or plastic nettings to soil surface according to manufacturer's recommendations. Should be biodegradable. Most products are not suitable for foot traffic.
3. Soil & Stones	Plastic	Plow a single furrow along edge of area to be covered with plastic, fold about 6 inches of plastic into the furrow and plow furrow slice back over plastic. Use stones to hold plastic down in other places as needed.
4. Cut-in	Hay or straw	Cut mulch into soil surface with square edged spade. Make cuts in contour rows spaced 18 inches apart. Most successful on contour in sandy soils.
B. Mechanical		
1. Wood cellulose fiber	Hay or straw	Apply with hydroseeder immediately after mulching. Use 500 to 750 pounds of wood fiber mulch per acre. Some products contain an adhesive material.
2. Pick chain	Hay or straw manure compost	Use on slopes steeper than 3:1. Pull across slopes with suitable power equipment.
3. Mulch anchoring tool, Mulch crimper	Hay or straw, manure/mostly straw	Set in straight position and pull across slope with suitable power equipment. Mulch material should be "tucked" into soil surface about 3 inches. Do not cut the straw.
4. Chemical	Hay or straw	There are many companies and products to choose from. Typically an anionic polyacrylamide tackifier with at least 200 lb/ac of fiber mulch is used. There are also organic materials such as guar gum, plantago and starches. Consult with manufacturer's specifications and representatives for the particular application.

Carbon to Nitrogen Ratios in Cropping Systems

Introduction

Carbon to Nitrogen ratio (C:N) is a ratio of the mass of carbon to the mass of nitrogen in a substance. For example, a C:N of 10:1 means there is ten units of carbon for each unit of nitrogen in the substance. Since the C:N ratio of everything in and on the soil can have a significant effect on crop residue decomposition, particularly residue cover on the soil and crop nutrient cycling (predominantly nitrogen), it is important to understand these ratios when planning crop rotations and the use of cover crops in agricultural systems.

Microbial C:N Ratio Feeding Soil Microorganisms

Soil microorganisms have a C:N ratio near 8:1. They must acquire enough carbon and nitrogen from the environment in which they live to maintain that ratio of carbon and nitrogen in their bodies. Because soil microorganisms burn carbon as a source of energy, not all of the carbon a soil microorganism eats remains in its body; a certain amount is lost as carbon dioxide during respiration. To acquire the carbon and nitrogen a soil microorganism needs to stay alive (body maintenance + energy) it needs a diet with a C:N ratio near 24:1, with 16 parts of carbon used for energy and eight parts for maintenance. It is this C:N ratio (24:1) that rules the soil!

If foodstuff such as mature alfalfa hay (C:N ratio of 25:1) is added to the soil (see Table 1), the soil microorganisms will consume it relatively quickly with essentially no excess carbon or nitrogen left over. The hay has an almost perfect balance of carbon to nitrogen that soil microorganisms (24:1) need.

What would happen if we added a foodstuff with a higher C:N ratio to the soil (see Table 1), such as wheat straw with a C:N of 80:1? Since wheat straw contains a greater proportion of carbon to nitrogen than the 24:1 perfectly balanced diet soil microorganisms require, the microbes will have to find additional nitrogen to go with the excess carbon to consume the wheat straw. This additional nitrogen will have to come from any excess nitrogen available in the soil. As soil microorganisms tie up excess nitrogen (immobilization), this situation could create a deficit of nitrogen in the soil until some of them die, decompose, and release nitrogen (mineralization) contained in their bodies, or some other source of nitrogen becomes available in the soil.

Conversely, what would happen if we added a foodstuff with a lower C:N ratio, such as a hairy vetch cover crop with a C:N of 11:1? Since the vetch contains a lesser proportion of carbon to nitrogen than the 24:1 perfectly balanced diet soil microorganisms need, the microbes will consume the vetch and leave the excess nitrogen in the soil. This surplus nitrogen in the soil will be available for growing plants, or for soil microorganisms to use to decompose other residues that might have a C:N ratio greater than 24:1.

Everything else being equal, materials added to the soil with a C:N ratio greater than 24:1 will result in a temporary nitrogen deficit (immobilization), and those with a C:N ratio less than 24:1 will result in a temporary nitrogen surplus (mineralization). This is why composting operations strive to achieve a blend of materials with a C:N ratio of about 30:1… so the resident microbes can readily decompose the compost pile leaving a little food and structure left over to feed and shelter the microbes after the compost is applied to the soil.

Next, let's examine C:N ratios from a practical perspective for crop production and soil health.

C:N Effects on Soil Cover

The faster crop residues are consumed by soil microorganisms the less time those residues will be covering the soil surface. Crop residues on the soil surface are important for protecting soil aggregates from the destructive force of raindrops hitting the soil, conserving soil moisture, and providing habitat for arthropods that shred crop residue and eat weed seeds. While it is important to maintain soil cover, it is also essential that those same residues decompose to release plant nutrients and build soil organic matter. Therefore, it is important to pay attention to crop residue C:N ratios to maintain soil cover when desired, yet allow the cover to ultimately break down and be recycled.

A cropping system of continuous no-till wheat certainly provides good soil cover, as wheat produces a fair amount of residue with a relatively high C:N ratio (80:1) that decomposes relatively slowly. However, such a cropping system does not allow the crop nutrients in the wheat straw to become readily available to soil microorganisms or plants. By adding a relatively low C:N ratio crop such as hairy vetch (11:1) to the rotation, nitrogen will be available to the soil microorganisms, thus allowing them to break down the wheat straw more quickly. Likewise, a cropping system of continuous no-till peas would result in very little soil cover as soil microbes would consume the pea residue (C:N of 29:1) relatively quickly, as not much additional nitrogen would be necessary for decomposition of the residue to take place.

C:N Effects on Nutrient Cycling

It should now be apparent from the discussion of C:N ratios and soil cover that management choices must strike a balance between crop residues covering the soil and nutrient cycling. An awareness of crop C:N ratios is necessary to select crop types and keep a cropping sequence on the right path toward sustainability, that of the ultimate C:N ratio of 24:1 that supports soil microorganisms.

Managing residues so they cover the soil when a growing crop is not providing soil protection requires some planning and experimentation to achieve a proper balance. If crops with high C:N ratios are grown too frequently in the rotation, residues will accumulate on the soil surface, and nitrogen for crop growth may be scarce unless supplemented with other sources of nitrogen. This may result in poor crop performance during times when soil microorganisms tie up nitrogen while working to decompose high C:N ratio crop residues.

Influence of Cover Crops

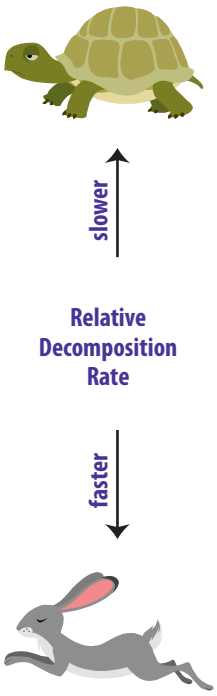
Cover crops added to a cash crop rotation can help manage nitrogen and crop residue cover in a cropping sequence. A low C:N ratio cover crop containing legumes (pea, lentil, cowpea, soybean, sunn hemp, or clovers) and/or brassicas (turnip, radish, canola, rape, or mustard) can follow a high C:N ratio crop such as corn or wheat, to help those residues decompose, allowing nutrients to become available to the next crop. Similarly, a high C:N ratio cover crop that might include corn, sorghum, sunflower, or millet can provide soil cover after a low residue, low C:N ratio crop such as pea or soybean, yet decompose during the next growing season to make nutrients available to the following crop.

Conclusion

Understanding carbon to nitrogen ratios of crop residues and other material applied to the soil is important to mange soil cover and crop nutrient cycling. Providing quality habitat for soil microorganisms should be the goal of producers interested in improving soil health. Soil is a biological system that functions only as well as the organisms that inhabit it.

Table 1. Carbon to nitrogen ratios of crop residues and other organic materials

Material	C:N Ratio
rye straw	82:1
wheat straw	80:1
oat straw	70:1
corn stover	57:1
rye cover crop (anthesis)	37:1
pea straw	29:1
rye cover crop (vegetative)	26:1
mature alfalfa hay	25:1
Ideal Microbial Diet	**24:1**
rotted barnyard manure	20:1
legume hay	17:1
beef manure	17:1
young alfalfa hay	13:1
hairy vetch cover crop	11:1
soil microbes (average)	8:1



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Prepared by the USDA NRCS East National Technology Support Center, Greensboro, NC, in cooperation with North Dakota NRCS

Table 1: Carbon to Nitrogen Ratios of Common Mulching Materials

Material	C:N Ratio
Rye Straw	82:1
Wheat Straw	80:1
Oat Straw	70:1
Sorghum-Sudan Grass	63:1
Rye Cover Crop (Anthesis)	37:1
Pea Straw	29:1
Rye Cover Crop (Vegetative)	26:1
Mature Alfalfa Hay	25:1
Ideal Microbial Diet	24:1
Rotted Barnyard Manure	20:1
Legume Hay	17:1
Beef Manure	17:1
Young Alfalfa Hay	13:1
Hairy Vetch Cover Crop	11:1
Annual Ryegrass	20.5
Crimson Clover	21.2
Alfalfa	11.3
Oilseed Radish	19.5

Source: Carbon to Nitrogen Ratios in Cropping Systems, NRCS Guide Sheet

Practice Specification
Conservation Crop Rotation (Code 328)

General Specifications

Specific conservation crop rotation requirements are prepared utilizing RUSLE2 (Revised Universal Soil Loss Equation, Ver.2) software in accordance with the NRCS Field Office Technical Guide. Refer to Massachusetts NRCS “Conservation Crop Rotation” (328) conservation practice standard and technical information regarding RUSLE2 (see references).

All crop rotations must have a positive Soil Conditioning Index (SCI); the SCI is embedded in the RUSLE2 software. There are three subcomponents of the SCI: 1) soil organic matter additions; 2) intensity of field tillage operations that mineralize soil organic matter; and 3) the amount of soil erosion.

The conservation crop rotation practice is considered applied when the most soil conserving crop has been planted at least once in each specified field, or when it is clear the specified crop ratio is currently in place for all affected fields or treatment units. The most soil-conserving crop is the crop with the lowest overall erosion potential.

After the most soil-conserving crop is established, it must be rotated with the other crops according to the planned rotation.

Weather conditions, unexpected herbicide carryover, and marketing considerations may affect year to year cropping decisions. These conditions may require a change in the scheduled rotation. A simple adjustment to rotations can often be made by following these guidelines:

- Crop substitution is permitted only if an equal or more soil-conserving crop is planted. In addition, any requirements for crop residue cover must also be met when planting the substitute crop and in following years.
- For vegetable farm crop rotations, a summer cover crop must be grown in one of the years.
- To reduce insect and disease pressures in vegetable rotations, members of the same family (See Table 17 below) may not be planned in consecutive years, members of the *Solanaceous (nightshade)* family (tomatoes, potatoes, peppers, eggplants) may only be planned once every three years,
- Small grains and hay can always be used to replace any row crop or low- residue crop.
- Corn harvested for grain with residues left in the field can always be used to replace any other low-residue producing crop.
- For crop rotations that include hay, the rotation can be lengthened by maintaining the existing hay stand for additional years to reduce erosion and/or increase soil organic matter.
- Crop sequences cannot be lengthened with additional years of annual crops without working with

NRCS prior to planting the crop.

Examples of crop rotations used by vegetable farmers in the Northeastern region of the US can be found on pages 49-54 of "**Crop rotation on Organic Farms : A Planning Manual."** See references below.

The following tables are located in the "2011 Midwest Vegetable Production Guide for Commercial Growers."

Table 17. Botanically Related Vegtables

Alliums	Corn	Cucurbits	Crucifers	Goosefoot Family	Legumes	Nightshade Family
Garlic	Dent corn	Cucumber	Cabbage	Beet	Dry bean	Eggplant
Onion	Sweet corn	Muskmelon	Cauliflower	Chard	Lima bean	Pepper
		Pumpkin	Broccoli	Spinach	Pea	Potato
		Summer squash	Brussels sprout		Snap bean	Tomato
		Watermelon	Horseradish		Soybean	
		Winter squash	Kale			
			Radish			
			Rutabaga			

Table 18. Classification of Vegtable Crops According to Their Adaptive Field Temperatures

Cool-season		Warm-season	
Hardy[1]	Semi-Hardy	Tender	Very Tender
Asparagus	Carrot	Snap bean	Cucumber
Broccoli	Cauliflower	Sweet corn	Eggplant
Cabbage	Chinese cabbage	Tomato	Lima bean
Horseradish	Lettuce		Muskmelon
Onion	Potato		Okra
Pea			Pepper
Spinach			Pumpkin
			Squash
			Watermelon

[1] Hardy crops are most tolerant of cool temperatures and frost. Very tender crops are most susceptible to frost and cool temperatures.

Considerations

When used in combination with Residue Management practices, use of high residue crops and cover crops and adjustment of plant population and row spacing can enhance production of the kind, amount, and distribution of residue required.

Reduced tillage practices, utilizing animal wastes, or applying mulches will also help to maintain or improve soil organic matter levels.

Selecting deep rooted crops or cover crops (e.g., alfalfa or radish) in the rotation can help recover or remove excess nutrients or contaminants from the soil profile. Deep- rooted crops can also help utilize all available water in the soil profile and penetrate compacted soil layers.

Soil moisture can be conserved for crop use by maintaining crop residues on the surface or by trapping snow with standing residue, windbreaks, or other barriers.

Unharvested crop rows and crop residues can provide over-wintering wildlife with valuable food and cover. Careful consideration should be given to pesticide use if applied to crops raised for wildlife.

Herbicide applications, where used, should be carefully planned to avoid negative impacts on the following crop.

Care should be taken, especially during site preparation and maintenance, to avoid adverse effects to significant cultural resources. Follow NRCS state policy for considering cultural resources during planning and maintenance.

Operation and Maintenance

Rotations shall provide for acceptable substitute crops in case of crop failure or shift in planting intentions for weather related or economic reasons. Acceptable substitutes are crops having similar properties that meet the criteria for all the resource concerns identified for the field or treatment unit.

References

ATTRA: Organic Crop Production Overview. 2004. George Kuepper and Lance Gegner, editors. https://attra.ncat.org/attra-pub/summaries/summary.php?pub=66

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Managing Cover Crops Profitably. 3rd ed. 2007. USDA Sustainable Agriculture Research and Education Program. http://www.sare.org/publications/covercrops/covercrops.pdf

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The Penn State Agronomy Guide. 2005- 2006. Pennsylvania State University, State College, PA. http://agguide.agronomy.psu.edu/

USDA
United States Department of Agriculture

MA Cover Crop - Code 340 – Implementation Requirements

Producer	Putnam Farm	**Program**	CTA
Farm, Tract #	TBD	**County**	Barnstable
Crop Hardiness Zone 7A	**Date:** 03/23/2022	**Planner:** L Petruski	

Purpose: (check all that apply) – Based on Identified Resource Concerns

- ☐ Reduce erosion
- ☑ Increase soil organic matter
- ☑ Capture and recycle excess nutrients
- ☑ Suppress weeds
- ☑ Improve biodiversity
- ☐ Minimize and reduce soil compaction
- ☐ Manage soil moisture

Additional Considerations: (check all that apply)

- ☑ Biological Nitrogen Fixation
- ☐ Host arbuscular mycorrhizal fungi
- ☐ Grazing or harvesting for hay or silage
- ☐ Seedbed Preparation for Grass Seeding
- ☐ Attract beneficial organisms, including pollinators

SPECIFICATIONS

Practice requirements are listed in the MA 340 Cover Crop Planting Specification Guide and are prepared in accordance with the MA 340 Cover Crop Practice Standard found in the MA NRCS Field Office Technical Guide. Information contained in this document is considered part of the conservation plan.

General Criteria Required by the Standard in all Cases

- Plant species, seedbed preparation, seeding rates, seeding dates, seeding depths, fertility requirements, and planting methods will be consistent with applicable local criteria and soil/site conditions.
- Select species that are compatible with other components of the cropping system.
- Ensure herbicides used with crops are compatible with cover crop selections and purpose(s).
- Cover crops may be established between successive production crops, or companion-planted or relay-planted into production crops. Select species and planting dates that will not compete with the production crop yield or harvest.
- Do not burn cover crop residue.
- Determine the method and timing of termination to meet the grower's objective and the current NRCS Cover Crop Termination Guidelines.
- When a cover crop will be grazed or hayed ensure that crop selection(s) comply with pesticide label rotational crop restrictions and that the planned management will not compromise the selected conservation purpose(s).
- Do not harvest cover crops for seed.
- If the specific rhizobium bacteria for the selected legume are not present in the soil, treat the seed with the appropriate inoculum at the time of planting.

Cover Crop Seeding Location and Plan **See attached Plan Map**

Tract, Field	Acres	Previous Crop	Species and Rate per acre	Seeding method, depth	Seeding date range	Termination date or stage	Termination method	
TBD-	TBD	Mixed Vegetable	Winter Wheat (50 lb/ac) Oats (35 lb/ac) Crimson Clover (12 lb/ac) Daikon Radish (2 lb/ac)	Broadcast and rake/pack	August 15-September 5	Grain at boot/ before head	Incorporate/ Turn under	Good general mix, harder to spring kill
TBD	TBD	Mixed Vegetable	Winter Oats (35 lb/ac) Forage Peas (60 lb/ac) Daikon Radish (2 lb/ac)	Broadcast and rake/pack	August 15-September 15	~April 15	Clip or Incorporate	Less biomass but easier Spring kill
TBD	TBD	Mixed Vegetable	Winter Rye or Triticale (120lb/ac)	Broadcast and rake/pack	September 15- October 30	Grain at boot/ before head	Incorporate/ Turn under	Late option- spring termination may be difficult

Prior Crop: Planned herbicides and last date of application on planned fields:

Mixed vegetable with no herbicide use

Soil Amendments, if needed:

N/A

Additional Specifications / Criteria Required by the Standard Depending on Client's Purpose(s)

Will need to be developed with specific growers

☐ **RUSLE2/WEPP Print-out is attached, if required by the Practice Purpose (i.e. soil loss or SCI).**

☐ **Termination Guidelines are attached.**

Explain the timing and role of the cover crop in the cropping system and will the following crop be planting using reduced tillage methods?

Will need to be developed with specific growers

OPERATION AND MAINTENANCE

1) Control growth of the cover crop to reduce competition from volunteer plants and shading.
2) Control weeds in cover crops by mowing or by using other pest management techniques.
3) Control soil moisture depletion by selecting water efficient plant species and terminating the cover crop before excessive transpiration.
4) Evaluate the cover crop to determine if the cover crop is meeting the planned purpose(s). If the cover crop is not meeting the purpose(s) adjust the management, change the species of cover crop, or choose a different technology.

CERTIFICATION (FOR AGENCY USE ONLY)	
Supporting Documentation (for file) ☐ Map showing practice locations	
Planning Certification This practice was planned according to NRCS standards and specifications. Job Class: Signature by individual with appropriate JAA	Date
Inspection/Certification Notes	
Implementation Certification This practice was applied according to NRCS standards and specifications. Signature by individual with appropriate JAA	Certified Amount: Date
Reporting Checklist ☐ CPA-06 Notes ☐ File copy of completed job sheet ☐ Photos	☐ Implementation Map ☐ Reported in Toolkit

USDA United States Department of Agriculture

SPECIFICATION GUIDE SHEET - 340 – COVER CROP – September 2018

Appendix – Species Descriptions

Cool-Season Annual Grains

Winter Rye (*Secale cereale*) is the most reliable cool season cover crop. Rye establishes easily, produces a lot of biomass, and suppresses weeds. It can be planted the latest in fall and is the most hardy. The 'Aroostook' variety was developed for the Northeast for seeding after late harvested crops. MA NRCS recommends the use of Aroostook over Common Rye (VNS), especially for late plantings. Rye may tie up N if not grown with a legume or if incorporated when too mature, though it may mow kill if mowed after it heads out. It is generally incorporated when it is 12-18" tall, about 2 weeks before planting. May be allelopathic if vegetables seeds are planted immediately after rye termination. Commonly mixed with hairy vetch or red clover.

Wheat, Triticale, and Spelt (*Triticum spp.*) are hardy cover crops that can suppress weeds and produce a moderate to high amount of biomass. Triticale is a cross between wheat and rye, and spelt is an ancient subspecies of wheat. Wheat, Triticale, and Spelt will not produce as much biomass as rye, and may not tie up as much N in the spring. Hessian fly can be a problem with wheat and spelt harvested for grain but is generally not a problem if used solely as a cover crop. Wheat is a good nutrient catch crop and prefers well-drained, fertile soils. Spelt may perform better on poor soils. Winter wheat can be sown in spring and will produce some growth, then die on its own. Spring wheat can be planted in the early spring and will produce a lot of biomass later into the summer. Commonly mixed with peas, vetch, and clover.

Barley (*Hordeum vulgare*) is an easy to grow, deep-rooted crop that is good at controlling erosion, suppressing weeds, and producing biomass. It does poorly in wet, heavy soils, and is more drought tolerant than other small grains. It is less winter hardy than rye or wheat and may winterkill in NH. Check for newer winter barley varieties for improved hardiness. Barley can be killed by mowing or rolling at milk stage. Commonly mixed with peas, oats, and crimson or red clover.

Oats (*Avena sativa*) are commonly used in MA as a spring and fall cover. Oats establish rapidly and are easily killed. They provide good erosion control and tend to leave a clean seedbed. Oats will winterkill in MA and are often used by vegetable growers prior to early spring crops. Commonly used as a nurse crop and mixed with alfalfa, hairy vetch and field peas. Fall oats must be planted earlier than other small grains, and when planted with hairy vetch the cover can provide sufficient soil N for sweet corn growth.

Warm-Season Annual Grains

Buckwheat (*Fagopyrum esculentum*) is one of the quickest growing summer annuals, and is commonly used as a smother crop, nurse crop and insectary. Buckwheat tolerates poor soils and can extract nutrients from the soil. Plants mature in 6-8 weeks, and residue degrades rapidly. If mown prior to flowering, the crop should regrow. Buckwheat should be mown or incorporated into the soil before seed set so that it does not become a weed problem.

Sudangrass and **Sorghum-Sudangrass** (*Sorghum bicolor x S. bicolor var Sudanese*) is a vigorous warm season grass that produces large amounts of biomass, increases organic matter,

reduces compaction and nematodes, and can provide excellent forage and insect habitat. Sudangrass is easier to manage due to its narrower stems than the hybrid, sorghum-sudangrass. These grasses can be mowed 2-3 times when they reach a height of 3-5 feet (leave at least 6" or 2 nodes for regrowth). This will increase root growth. Very responsive to nitrogen fertility and will frost kill. Mix with a buckwheat nurse crop or with forage soybeans and cowpeas. Use care if grazing because these hybrids and other sorghums can produce prussic acid poisoning in livestock. Grazing poses the most risk to livestock when plants are young (up to 24 inches tall), drought stressed, or killed by frost. Toxicity danger varies among cultivars.

Japanese Millet (*Echinochloa esculenta*)**, Pearl Millet** (*Pennisetum glaucum*) and **Foxtail Millet** (*Setaria italica*) are drought and heat tolerant summer annuals that produce a lot of biomass quickly. Plant Japanese and Foxtail millet early in the June because later plantings may be weak because of daylength response. Pearl millet is very tall and produces the most biomass. Pearl and Foxtail millet should mow kill, but Japanese millet will regrow. Commonly mixed with forage soybeans and cowpeas.

Teff (*Eragrostis tef*) is a fine-leaved African grain that shows a lot of potential as a living mulch. It is very drought tolerant, can be surface broadcast, does not need much mowing, and will not go to seed. Ensure a firm seedbed prior to planting. Teff is also a quality forage that can be grazed/hayed during dry summers.

Legumes

Red Clover (*Trifolium pratense*) is a short-lived cool season perennial that is often used as an annual. Red clover is deep-rooted, produces a lot of N, and provides beneficial insect/pollinator habitat. It tolerates poorly drained and acidic soils. It can be interseeded with many crops, such as small grains after planting, silage corn at last cultivation, or into vegetables before harvest. Red clover does very well when frost-seeded and mixed with small grains or annual ryegrass.

White Clover (*Trifolium repens*) is a low growing perennial that produces moderate levels of N, and tolerates traffic and close mowing. Common white clover is the lowest growing type that tolerates the most traffic and compaction. Dutch and New Zealand are intermediate, widely available types that are commonly used as living mulches. Ladino clover is the tallest white clover and produces the most nitrogen. White clover does well interseeded or frost seeded, and is often mixed with annual ryegrass, small grains, or red clover.

Alsike Clover (*Trifolium hybridum*) is an upright hybrid of red and white clover that produces more N than intermediate types and does the best in poorly drained soil. Alsike can be toxic to horses.

Yellow Sweetclover (*Melilotus officinalis*) is a highly productive biennial legume and **White Sweetclover** (*Melilotus alba*) is an annual. Sweetclover produces a lot of N and biomass, has a deep root that breaks up hardpan, and provides beneficial insect habitat. Better suited for well drained and droughty sites. Yellow sweetclover will mow kill after flowering in the second year. Use yellow sweetclover only if it will be grown through the second year, otherwise use annual or 'Hubam'. Prefers spring seeding. Hard seed may remain viable in soil for years.

Crimson Clover (*Trifolium incarnatum*) is an annual legume that may winter kill in the colder regions of MA. It has a greater chance of surviving the winter when planted with a short-statured small grain. It establishes easily, produces a moderate to high amount of N and biomass, suppresses weeds, and has beautiful flowers that attract a lot of beneficial insects and pollinators.

Select regionally-adapted varieties for improved cold hardiness. Crimson clover is easily crimped with a lasting residue. It has potential to be frost seeded, crimped, and used as mulch for late planted no- till pumpkin transplants. Often mixed with annual ryegrass, small grains, and brassicas. Caution: may support nematodes that impact tomatoes. Flowers at least 2 weeks earlier than hairy vetch, hence reaches its maximum nitrogen content sooner.

Balansa Clover (*Trifolium balansae*) is the most cold-tolerant annual clover, withstanding temperatures down to -14 degrees Fahrenheit. It can tolerate a variety of soil types. Early above-ground growth in the fall is slow, due to energy going towards the very deep taproot. Grows rapidly in the spring and flowers about 2 weeks later than crimson clover.

Subterranean Clover (*Trifolium subterraneum*) is a low growing, self-seeding annual hardy to 0-15º F. It produces a moderate amount of N, provides beneficial insect habitat and is best used as a living mulch. It is a shade tolerant crop that tolerates wet soils, acidic soils, mowing and grazing. Subterranean clover and teff may make a great living mulch between vegetable rows. Subterranean clover will reseed and should be mowed or killed prior to seeding if growing leafy greens or other crops where it could be a problem.

Berseem Clover (*Trifolium alexandrinum*) is a summer annual with traits similar to subterranean clover. It is a quick growing, heavy N producer that tends to be used as a living mulch. It establishes well with an oat nurse crop and tolerates most soils except sands. Mix with teff, ryegrass or small grains.

Hairy Vetch (*Vicia villosa*) is the most commonly used cool season legume. It is very winter hardy, an excellent N producer, increases nutrient availability, and provides beneficial insect habitat. It is slow to establish and often needs to be grown late into the spring/early summer to produce maximum N. It can provide sufficient N for many vegetable and late planted crops and partially replace N for corn. Smothers spring weeds. Commonly planted with winter cereals. Can be mow killed if in full flower.

Chickling Vetch (*Lathyrus sativus*) is an annual legume used that is a heavy N producer and is commonly used as a living mulch. It nodulates earlier than most legumes and produces a lot of nitrogen early on. It does well under low soil moisture and most soil conditions yet does not establish well if broadcast. Mow before flowering if regrowth is desired.

Field Pea (*Pisum sativum*) includes Spring Pea and the more winter-hardy Austrian Winter Pea. It is a large seeded, cool-season annual that produces a large amount of nitrogen. Peas generally require support from another cover crop and should be grown with another small grain like oats. Peas make for a good companion crop as long as the seed is planted deep enough. Spring peas will winterkill while the Austrian Winter Pea should survive the winter in Zone 6a and warmer.

Soybean (*Glycine max*) **and Cowpea** (*Vigna unguiculata)* are summer legumes that produce a lot of N and are best grown with sorghum- sudangrass or millets. Soybean is more cold tolerant than cowpea and tends to produce more biomass and N, though it is more susceptible to pests and drought. Use regionally adapted forage varieties for maximum benefit. Cowpea requires warmer conditions than soybean, but is more tolerant of poor soils, drought, heat, and pests. Cowpea grows quickly, suppresses weeds, and provides beneficial insect habitat.

Alfalfa (*Medicago sativa*) is a perennial cool- season legume that is a superior N fixer, reduces soil compaction, and provides habitat for beneficial insects. It prefers well-drained, fertile soils near pH 7, and is best grown with a small grain nurse crop or perennial grass. Choose varieties with a fall

dormancy class of 1-4. More hardy varieties (closer to class 1) tend to yield higher in the spring, but mature later.

Brassicas

Brassicas can be especially useful for planting after early vegetable crops. Brassica cover crops are well-suited for scavenging residual nitrogen in the fall because they grow rapidly during periods of cool weather. Some Brassicas are used to reduce the level of soil pathogens through biofumigation; however, Brassica cover crops should not be used before or after other Brassica vegetables. Mix with annual ryegrass and clovers.

Forage Radish (*Raphanus sativus*) and **Forage Turnip** (*Brassica rapa*) are deep-rooted cover crops that can reduce surface and subsoil compaction, scavenge N, and suppress weeds. Plant early enough to ensure that roots mature and grow deep. Will winterkill and leave a clean seedbed for early vegetable crops. *Do not let it go to seed.*

Mustard and Canola (*Brassica* spp.) grows rapidly in the spring and fall and can produce abundant biomass. These species are effective at scavenging nutrients, preventing erosion, and decreasing soil-borne pathogens. *Do not let them go to seed.*

Arugula (*Eruca sativa*) is an effective biofumigant that will overwinter. Mow and incorporate in the spring before seed set and seal soil with plastic, irrigation, or by rolling for at least 10 days.

Grasses

Annual and **Perennial Ryegrass** (*Lolium* spp.) are cool season grasses with a high utility value because they establish easily when surface broadcast and can be interseeded, frost-seeded, and dormant seeded. Ryegrass produces a tremendous amount of biomass, reduces surface compaction, scavenges nutrients, and is a strong erosion fighter. Annual varieties tend to be cheaper than perennial, are used as cool and warm-season cover, and are used as living mulches. Southern varieties will winterkill, whereas regionally adapted annual varieties may overwinter in warmer areas of MA. Perennial rye may be short-lived. Annual ryegrass has a reputation for being difficult to terminate with herbicide. Refer to the Purdue University website (https://www.extension.purdue.edu/extmedia/WS/WS-52-W.pdf) or others for detailed recommendations for effective control.

Orchardgrass (*Dactylis glomerata*) and **Timothy** (*Phleum pratense*) are perennial grasses that are commonly used forages in MA. They are highly productive and should be planted with clovers. Like alfalfa and sweetclover, these grasses are best used as a cover crop if grown for a full season and terminated in the second year.

NRCS Cover Crop Termination Guidelines

December 2013

Cover crops on a field in Black Hawk County, Iowa.
Photo: Lynn Betts, NRCS

Background:

To ensure that USDA policies are coordinated and up to date with evolving cover crop practices, the administrators of the Natural Resources Conservation Service (NRCS), Risk Management Agency (RMA) and Farm Service Agency (FSA) organized an interagency workgroup to develop consistent, simple and flexible policy across the three agencies. National and local experts, along with multiple stakeholders, were involved in the process. Research literature, plant growth and soil hydrology models, and input from national/local experts in cover crop management provided the basis for developing cover crop termination guidelines to achieve their conservation benefits while minimizing risk of reducing yield to the following crop due to soil water use.

The guidelines apply to non-irrigated cropland, including systems that contain a fallow period. Termination of cover crops utilized in an irrigated cropping system is not restricted to a given cover crop termination zone. Cover Crops in irrigated cropping systems should be terminated based on the crop system and conservation purpose, but before the planted crop emerges.
**See map on page 2.*

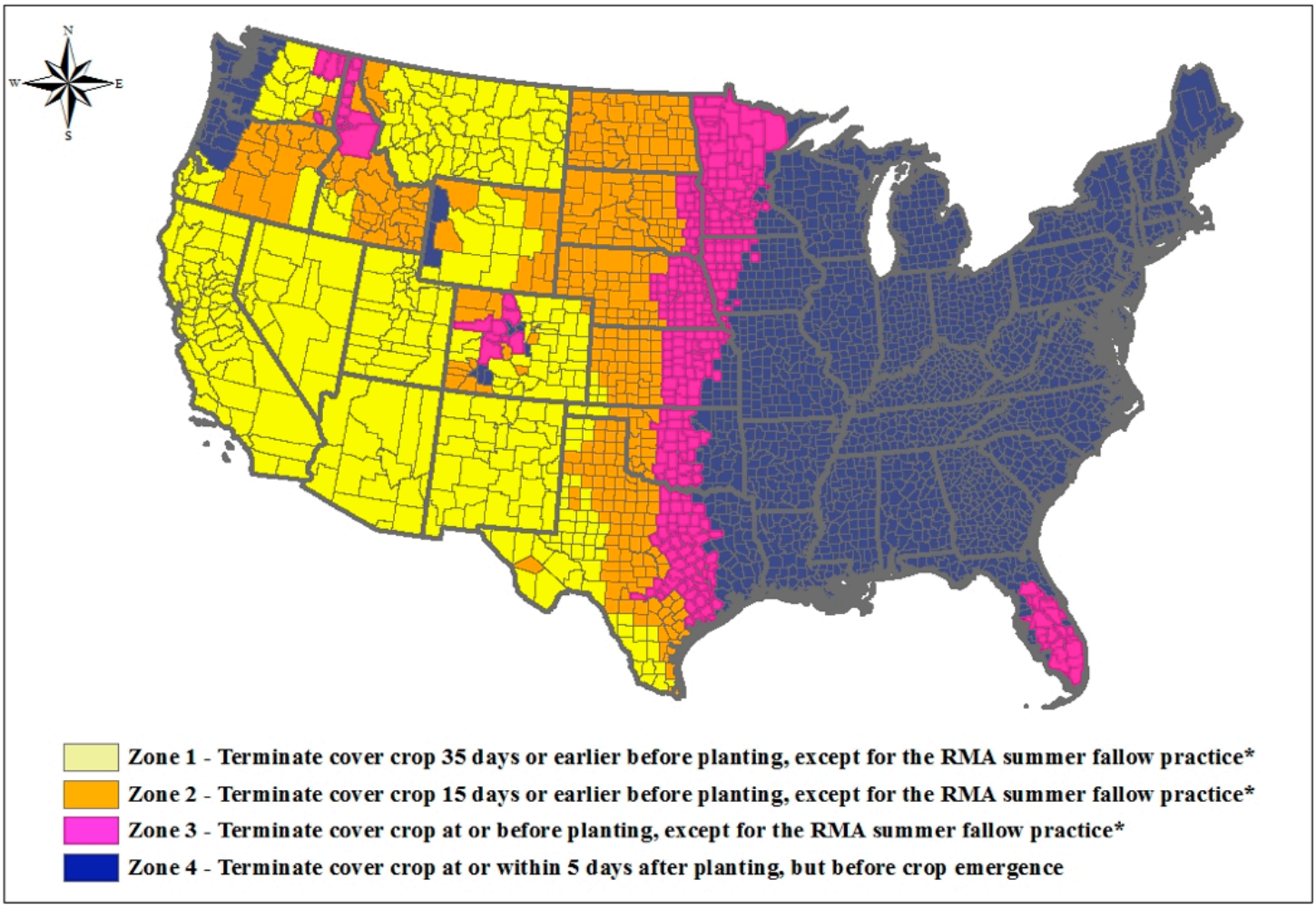
NRCS Cover Crop Termination Guidelines for Management Zones

Zone 1 - See Map	Zone 2 - See Map	Zone 3 - See Map	Zone 4 - See Map
NRCS Cover Crop Termination Period Guidance - Non-Irrigated Cropland:			
For Late Spring to Fall Seeded Crops - Terminate cover crops 35 days or earlier prior to planting the crop. **For Early Spring Seeded Crops** - Terminate cover crops as soon as practical prior to planting the crop. (Additional Cover Crop Termination Considerations 4 and 8)	**For Late Spring to Fall Seeded Crops** - Terminate cover crops 15 days or earlier prior to planting the crop. **For Early Spring Seeded Crops** Terminate cover crops as soon as practical prior to planting the crop. (Additional Cover Crop Termination Considerations 4 and 8)	Terminate cover crop at or before planting the crop.	Terminate cover crop at or within 5 days after planting, but before crop emergence.
RMA Designated Summer Fallow Practice * For summer seeded or fall seeded crops terminate the cover crop at least 90 days prior to planting. * For early spring seeded crops terminate the cover crop either in late fall or as early as possible in the spring prior to planting.	**RMA Designated Summer Fallow Practice** * For summer seeded or fall seeded crops terminate the cover crop at least 90 days prior to planting. * For early spring seeded crops terminate the cover crop either in late fall or as early as possible in the spring prior to planting.	**RMA Designated Summer Fallow Practice** * For summer seeded or fall seeded crops terminate the cover crop at least 90 days prior to planting. * For early spring seeded crops terminate the cover crop either in late fall or as early as possible in the spring prior to planting.	

Note: These guidelines can be used as a stand alone document, if needed.

* Cover Crop Termination Zones

Produced by: NRCS | ESD
December 2013



*See guidelines for details on the RMA summer fallow practice.

Additional Cover Crop Termination Considerations:

1. If the season is drier than normal nearing cover crop termination time, consider an earlier termination to conserve soil moisture.

2. If the spring season is wetter than normal at cover crop termination time, consider a later termination to use excess soil moisture and improve seedbed condition.

3. If the cover crop is part of a no-till system, termination can be delayed up to 7 days from the above termination period guideline, but terminated prior to crop emergence for all zones and systems.

4. In zones 1 and 2, fall seeded cover crops will have limited growth in the spring prior to “early” spring seeded crops (e.g., spring wheat, sugar beets, corn), and therefore the cover crop may be terminated at or just prior to planting.

Photo: Justin Fritsher, NRCS

Cover crops in an orchard reduce soil erosion.
Photo: Gary Kramer

Additional Cover Crop Termination Considerations (Continued):

5. Cover crop termination zones 1 and 2, in the largely mountainous regions in the Western U.S. (from Montana south to New Mexico and west to California), were refined by NRCS and other local university experts to identify proper cover crop management due to wide variability in climate and cropping systems in those areas.

6. Early vs. Later Spring Seeded Crops - Crops planted as early as possible after the spring thaw are considered early spring crops (e.g., spring wheat, spring barley, sugar beets, corn). Later spring crops include such crops as dry beans and soybeans.

7. New Technology - Where new technology has at least three years of satisfactory performance (achieves historical yield) based on farm records and the written approval of two "agricultural experts" as defined by RMA, the cover crop may be terminated closer to planting, if recommended by the experts.

8. Cover Crop Grazing or Forage Harvest – In all areas, except for the RMA summer fallow practice in Zones 1, 2 and 3, cover crops may be grazed or harvested as hay or silage as long as the planned amount of biomass is available at the time of termination to meet the conservation purpose. For the RMA designated summer fallow practice, cover crops should not be hayed or grazed. A cover crop harvested for grain or seed will not be considered to have been planted for conservation purposes, and will be considered a "crop".

9. Herbaceous Wind Barriers - There are specific cropping situations when seasonal cover is needed to protect young seedlings from wind erosion abrasion. The typical seasonal covers may include such crops as wheat, rye, or oats that are planted in rows, e.g., 20 feet apart (single or double row of small grain). These seasonal covers fall under the NRCS Conservation Practice Code 603 – Herbaceous Wind Barriers. These barriers are not considered cover crops.

10. Short Season Cover Crops – There are specific cropping situations where the producer will plant the intended crop, plus a short term seasonal cover crop (NRCS Conservation Practice Code 340 – Cover Crop) prior to or at the same time as planting the main or insured crop. In this case the seasonal cover emerges first and provides short term wind erosion protection until the main crop becomes established crops are terminated by cultivation, frost /winterkill, or herbicides once the main crop is established. The seasonal covers used for the purpose of early crop establishment must be appropriate species for the area and the planned purpose.

11. Early Crop Planting – When earlier than normal planting occurs due to favorable weather or soil conditions, cover crop termination will naturally occur closer to planting. For example, in zone 2, if planting occurs 2 weeks earlier than normal, the cover crop termination period may be 2 weeks closer to planting.

Stripcropping with Cover Crops, Lancaster County, PA.

Photo: Bob Nichols

Additional Cover Crop Termination Considerations (Continued):

12. Multiple Climates Within a County – Some counties may have multiple climate areas. In these situations, producers may request a different cover crop termination zone management or timeframe due to unique geographical and topographical features that reflect a different climate. Producers should contact either Extension or the local NRCS for management guidance. If the guidance includes practices other than indicated by the zones in this document, the producer must inform FSA and their crop insurance agent, as appropriate, and provide copies of the recommended management practice(s).

Definitions:

1. Over-Seeding/Interseeding – Both terms can be defined as planting one or more cover crop species into an existing or established crop. Common uses that involve over-seeding or interseeding include: (1) over-seeding a grass and/or legume cover crop into an existing stand of small grain at an appropriate time for the cover and germination, or (2) seeding a cover crop into an existing crop of corn or soybeans about the time of physiological maturity (leaves beginning to yellow) to get the cover crop started a few weeks earlier. Neither of these examples of over- seeding/interseeding would interfere with harvest of the main crop.
2. Interplanted – This involves multiple crop species grown together, with no distinct row pattern and does not permit separate agronomic maintenance or management. For RMA purposes, this means if a cover crop and cash crop are planted in a way that does not permit separate agronomic maintenance or management, then RMA will not insure the cash crop. This would also apply to cover crops if interplanted into the main crop and the cover crop interfered with the agronomic management and harvest of the main crop.
3. Relay Cropping – The practice of interseeding a second crop into the first crop well before it is harvested. The relay cropping strategy is used to enable production of a second crop in areas where time seeding the second crop following harvest of the first is considered inadequate for double cropping. This is not considered a cover cropping practice, but a method of double cropping and may fall under the RMA 1st / 2nd crop rules.
4. Double-Cropping – RMA and NRCS term: Harvesting at least 2 crops from the same land in the same year. This does not include cover crops.
5. Cover Crop - Crops including grasses, legumes and forbs for seasonal cover and other conservation purposes. A cover crop managed and terminated according to these guidelines is not considered a “crop”.
6. Good Farming Practice – RMA term - The production methods utilized to produce the insured crop and allow it to make normal progress toward maturity and produce at least the yield used to determine the for late planted acreage, which are: (1) for conventional or sustainable farming practices, those generally recognized by agricultural experts for the area; or (2) for organic farming practices, those generally recognized by organic agricultural experts for the area or contained in the organic plan.
7. Late Planting Period – RMA term - The period of time following the date considered as the final planting date for an insured crop. The late planting period may vary from a week up to a few weeks.
8. Prevented Planting – RMA term - Failure to plant the insured crop by the final planting date designated in the Special Provisions for the insured crop in the county, or within any applicable late planting period, due to an insured cause of loss that is general to the surrounding area and that prevents other producers from planting acreage with similar characteristics.
9. Continuous Cropping – RMA Term – A practice of growing crops annually in a rainfall limited area (where summer fallow is also a practice).