USDA
United States Department of Agriculture

August 31, 2016

WISCONSIN FIELD OFFICE TECHNICAL GUIDE
450-11-TECHNICAL GUIDE
FOTG NOTICE WI-82

SUBJECT: WISCONSIN FIELD OFFICE TECHNICAL GUIDE

Purpose. Revisions to Wisconsin Conservation Practice Standards and Specifications.

Explanation of Changes.

Section IV: Conservation Practice Standards and Specifications:

Controlled Traffic Farming (Code 334) - New practice standard.

Critical Area Planting (Code 342) - Deleted the purpose to rehabilitate and revegetate degraded sites that cannot be stabilized using normal establishment techniques as this purpose is implied in other purposes. Added the implementation requirement document to the specifications and plans.

Diversion (Code 362) - The definition was revised and the purpose modified for clarity. The "Criteria," "Considerations," and "Operations and Maintenance" sections were refined and the references were updated.

Field Operation Emissions Reduction (Code 376) - New practice standard.

Firebreak (Code 394) - Updated to align with national standard.

Forage Harvest Management (Code 511) - Updated to align with national standard.

Grade Stabilization Structure (Code 410) - Refined the definition, modified criteria, and updated terminology related to hazard classification.

Herbaceous Wind Barriers (Code 603) - New practice standard.

Livestock Pipeline (Code 516) - Removed withdrawn ASTM Standards. Added ASTM D 2855 Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.

Multi-Story Cropping (Code 379) - New practice standard.

Plastic Pipe Conduits (Code WCS 015) - Removed withdrawn ASTM Standards. Listed ASTM Standards by "Pressure Rated" and by "Non-Pressure Rated". Added ASTM Standards for joining methods.

Pond (Code 378) - Refined the definition, modified criteria, updated considerations, updated requirements for plans and specifications, and updated requirements for operation and maintenance.

Pond Sealing or Lining, Compacted Soil Treatment (Code 520) - New WI standard combines the existing compacted soil liner standards (521B, 521C, and 521D) into one standard. As a result, a change to the title was necessary, along with other changes needed for clarification, consistency, and 508 compliance requirements.

Sediment Basin (Code 350) - The purpose was refined, the criteria was modified, and the references were updated. Other changes improved the clarity of the language used in the standard.

Stormwater Runoff Control (Code 570) - Minor updates to bring the WI standard current.

Stream Habitat Improvement and Management (Code 395) - Updated to align with national standard.

Vegetative Barrier (Code 601) - New practice standard.

Waste Transfer Pipe (Code WCS 634) - Removed withdrawn ASTM Standards from Table 1. Added ASTM D 2855 Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets. Added ASTM F 2620 Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

Water and Sediment Control Basin (Code 638) - Minor updates to bring the WI standard current.

Remove the following outdated Standards and Specifications from any printed copies of the WI FOTG:

- Index
- Waste Transfer Pipe (Code WCS 634)
- Plastic Pipe Conduits (Code WCS 015)
- Critical Area Planting (Code 342)
- Diversion (Code 362)
- Firebreak (Code 394)
- Forage Harvest Management (Code 511)
- Grade Stabilization Structure (Code 410)
- Livestock Pipeline (Code 516)
- Pond (Code 378)
- Sediment Basin (Code 350)
- Stormwater Runoff Control (Code 570)
- Stream Habitat Improvement and Management (Code 395)
- Water and Sediment Control Basin (Code 638)

Add the following Standards and Specifications from any printed copies of the WI FOTG:

- Index
- Controlled Traffic Farming (Code 334)
- Critical Area Planting (Code 342)
- Diversion (Code 362)
- Field Operation Emissions Reduction (Code 376)
- Firebreak (Code 394)
- Forage Harvest Management (Code 511)
- Grade Stabilization Structure (Code 410)
- Herbaceous Wind Barriers (Code 603)
- Livestock Pipeline (Code 516)
- Multi-Story Cropping (Code 379)
- Plastic Pipe Conduits (Code WCS 015)
- Pond (Code 378)
- Pond Sealing or Lining, Compacted Soil Treatment (Code 520)

- Sediment Basin (Code 350)
- Stormwater Runoff Control (Code 570)
- Stream Habitat Improvement and Management (Code 395)
- Vegetative Barrier (Code 601)
- Waste Transfer Pipe (Code WCS 634)
- Water and Sediment Control Basin (Code 638)

A link to the Wisconsin FOTG is located on the Wisconsin NRCS website at:
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/fotg/

Jimmy Bramblett

JIMMY BRAMBLETT
State Conservationist

Natural Resources Conservation Service
8030 Excelsior Drive, Suite 200, Madison, WI 53717
www.wi.nrcs.usda.gov Phone: (608) 662-4422 Fax: (855) 819-6165

INDEX
Wisconsin Field Office Technical Guide, Section IV
Conservation Practice Standards

Practice Name	Code	Discipline	Date
Access Control	472	Resources	4/2016
Access Road	560	Engineering	10/2014
Agrichemical Handling Facility	309	Engineering	10/2014
Alley Cropping	311	Resources	1/2012
Amending Soil Properties with Gypsum Products	333	Resources	3/2016
Amendments for Treatment of Agricultural Waste	591	Engineering	3/2014
Anaerobic Digester	366	Engineering	8/2011
Animal Mortality Facility	316	Engineering	3/2016
Anionic Polyacrylamide (PAM) Application	450	Engineering	3/2014
Aquaculture Ponds	397	Engineering / Resources	8/2013
Aquatic Organism Passage	396	Resources / Engineering	7/2016
Brush Management	314	Resources	8/2015
Building Envelope Improvement	672	Engineering	1/2014
Channel Bed Stabilization	584	Engineering	3/2016
Clearing and Snagging	326	Engineering	6/2016
Composting Facility	317	Engineering / Resources	1/2012
Conservation Cover	327	Resources	1/2013
Conservation Crop Rotation	328	Resources	9/2015
Constructed Wetland	656	Engineering	9/2012
Contour Buffer Strips	332	Resources	7/2016
Contour Farming	330	Resources	3/2016
Contour Orchard and Other Perennial Crops	331	Resources	6/2016
Controlled Traffic Farming	334	Resources	8/2016
Cover Crop	340	Resources	8/2015
Critical Area Planting	342	Resources / Engineering	8/2016
Cross Wind Ridges	588	Resources	6/2016
Cross Wind Trap Strips	589C	Resources	6/2016
Denitrifying Bioreactor	605	Engineering	9/2015
Diversion	362	Engineering	8/2016
Drainage Water Management	554	Engineering	6/2011
Dust Control on Unpaved Roads and Surfaces	373	Engineering / Resources	10/2014
Early Successional Habitat Development/Mgt.	647	Resources	5/2014
Emergency Animal Mortality Management	368	Engineering	3/2016
Farmstead Energy Improvement	374	Engineering	12/2011
Feed Management	592	Resources	7/2016

Practice Name	Code	Discipline	Date
Fence	382	Resources	1/2014
Field Border	386	Resources	6/2016
Field Operation Emissions Reduction	376	Resources	8/2016
Filter Strip	393	Resources	8/2015
Firebreak	394	Resources	8/2016
Fish Raceway or Tank	398	Resources / Engineering	6/2016
Forage and Biomass Planting	512	Resources	1/2013
Forage Harvest Management	511	Resources	8/2016
Forest Stand Improvement	666	Resources	10/2015
Forest Trails and Landings	655	Resources / Engineering	9/2015
Fuel Break	383	Resources	4/2014
Grade Stabilization Structure	410	Engineering	8/2016
Grassed Waterway	412	Engineering / Resources	7/2016
Groundwater Testing	355	Engineering	10/2014
Heavy Use Area Protection	561	Engineering	8/2015
Herbaceous Weed Control	315	Resources	6/2016
Herbaceous Wind Barriers	603	Resources	8/2016
High Tunnel System	325	Resources	9/2015
Integrated Pest Management (IPM)	595	Resources	1/2013
Irrigation Pipeline	430	Engineering	7/2011
Irrigation Reservoir	436	Engineering	7/2016
Irrigation System, Microirrigation	441	Engineering	4/2016
Irrigation System, Tailwater Recovery	447	Engineering	10/2014
Irrigation Water Management	449	Engineering / Resources	10/2014
Karst Sinkhole Treatment	527	Engineering	3/2016
Lighting System Improvement	670	Engineering	4/2016
Lined Waterway or Outlet	468	Engineering	3/2013
Livestock Pipeline	516	Engineering	8/2016
Livestock Shelter Structure	576	Resources	3/2014
Mine Shaft and Adit Closing	457	Engineering	7/2016
Monitoring Well	353	Engineering	10/2014
Mulching	484	Resources	6/2016
Multi-Story Cropping	379	Resources	8/2016
Nutrient Management	590	Resources / Engineering	12/2015
Obstruction Removal	500	Engineering	7/2016
On-Farm Secondary Containment Facility	319	Engineering	10/2014
Open Channel	582	Engineering	3/2016
Pond	378	Engineering	8/2016

Practice Name	Code	Discipline	Date
Pond Sealing or Lining , Flexible Membrane	521A	Engineering	9/2012
Pond Sealing or Lining, Compacted Soil Treatment	520	Engineering	8/2016
Prescribed Burning	338	Resources	3/2016
Prescribed Grazing	528	Resources	12/2008
Pumping Plant	533	Engineering	7/2016
Residue and Tillage Management, No Till	329	Resources	4/2016
Residue and Tillage Management, Reduced Till	345	Resources	6/2016
Restoration and Management of Rare or Declining Habitats	643	Resources	5/2014
Riparian Forest Buffer	391	Resources / Engineering	1/2013
Road/Trail/Landing Closure and Treatment	654	Resources / Engineering	1/2014
Roof Runoff Structure	558	Engineering	9/2015
Roofs and Covers	367	Engineering	4/2016
Saturated Buffer	604	Engineering	6/2016
Sediment Basin	350	Engineering	8/2016
Shallow Water Management for Wildlife	646	Resources	4/2016
Spoil Spreading	572	Engineering	7/2016
Spring Development	574	Engineering	3/2014
Sprinkler System	442	Engineering	4/2016
Stormwater Runoff Control	570	Engineering	8/2016
Stream Crossing	578	Engineering	3/2015
Stream Habitat Improvement and Management	395	Resources	8/2016
Streambank and Shoreline Protection	580	Engineering	8/2013
Stripcropping	585	Resources	6/2016
Structure for Water Control	587	Engineering	1/2011
Structures for Wildlife	649	Resources	12/2014
Subsurface Drain	606	Engineering	3/2014
Surface Drain, Field Ditch	607	Engineering	4/2016
Surface Drain, Main or Lateral	608	Engineering	4/2016
Terrace	600	Engineering	3/2015
Trails and Walkways	575	Engineering / Resources	4/2016
Tree/Shrub Establishment	612	Resources / Engineering	7/2011
Tree/Shrub Pruning	660	Resources	3/2016
Tree/Shrub Site Preparation	490	Resources	1/2013
Underground Outlet	620	Engineering	3/2014
Upland Wildlife Habitat Management	645	Resources	1/2013
Vegetated Treatment Area	635	Engineering	10/2014
Vegetative Barrier	601	Resources	8/2016
Waste Facility Closure	360	Engineering / Resources	3/2013

Practice Name	Code	Discipline	Date
Waste Separation Facility	632	Engineering	4/2014
Waste Storage Facility	313	Engineering	1/2014
Waste Transfer	634	Engineering	1/2014
Waste Treatment	629	Engineering	1/2014
Water and Sediment Control Basin	638	Engineering	8/2016
Water Well	642	Engineering	10/2014
Watering Facility	614	Engineering / Resources	10/2014
Well Decommissioning	351	Engineering	10/2014
Wetland Creation	658	Resources / Engineering	5/2002
Wetland Enhancement	659	Resources / Engineering	9/2015
Wetland Restoration	657	Resources / Engineering	9/2000
Wetland Wildlife Habitat Management	644	Resources	1/2013
Windbreak/Shelterbelt Establishment	380	Resources	11/2011
Windbreak/Shelterbelt Renovation	650	Resources	1/2013
Woody Residue Treatment	384	Resources	1/2012

Wisconsin Construction Specifications

Number	Practice Name	Discipline	Date
1	Clearing	Engineering	5/12
2	Excavation	Engineering	5/12
3	Earthfill	Engineering	5/12
3a	Earthfill (Ditch Fills or Partial Filling)	Engineering	6/13
4	Concrete	Engineering	6/16
5	Construction Site Pollution Control	Engineering	5/12
6	Corrugated Metal Pipe Conduits	Engineering	1/12
7	Mobilization and Demoblization	Engineering	5/12
8	Drainfill	Engineering	5/12
9	Rock Riprap	Engineering	11/11
10	Fences	Engineering	3/15
11	Small Rock Aggregate (Non-Concrete)	Engineering	3/13
12	Cathodic Protection	Engineering	5/12
13	Geotextiles	Engineering	5/10
14	Timber Fabrication & Installation	Engineering	9/10
15	Plastic Pipe Conduits	Engineering	8/16
16	Stream Clearing and Snagging	Engineering	5/12
17	Wire Mesh Gabions or Mattresses	Engineering	5/12
18	Sack or Tubular Gabion	Engineering	4/09
19	Drilled Well Abandonment/Decommissioning	Engineering	5/12
20	Soil Bioengineering	Engineering	5/12
21	Structural Measures for Streambank and Shorelines	Engineering	5/12
22	Temporary Wave Barrier (Breakwaters)	Engineering	5/12
23	Aluminum or Steel Roof Gutters	Engineering	9/15
24	Construction Surveys	Engineering	5/12
25	GPS Machine Control Construction	Engineering	3/15
26	Topsoiling	Engineering	5/12
44	Corrugated Polyethylene Tubing	Engineering	5/12
50	Organic Fill for Ditch Fills or Filling	Engineering	6/13
51	Organic Fill for Embankments and Ditch Plugs	Engineering	6/13
100	Poultry Carcass Composter	Engineering	4/09
200	Grouted Rock Riprap	Engineering	5/12
201	Steel Sheet Piling	Engineering	5/12
202	Polyethylene Geomembrane Lining	Engineering	9/12
203	Geosynthetic Clay Liner	Engineering	4/11
204	Earthfill for Waste Storage Facilities	Engineering	10/12
205	Ethyl Propylene Diene Monomer (EPDM) Geomembrane Lining	Engineering	9/12
211	Vinyl Sheet Piling	Engineering	3/12
300	Clay Liner	Engineering	3/15
634	Waste Transfer Pipe	Engineering	8/16

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

CRITICAL AREA PLANTING

CODE 342
(ACRE)

DEFINITION

Establishing permanent vegetation on sites that have or are expected to have high erosion rates, and on sites that have physical, chemical, or biological conditions that prevent the establishment of vegetation with normal practices.

PURPOSE

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- Stabilize stream and channel banks, pond and other shorelines – Resource concern (SOIL EROSION – Excessive bank erosion from streams shorelines or water conveyance channels).
- Stabilize areas with existing or expected high rates of soil erosion by wind or water – Resource concern (SOIL EROSION – Concentrated flow erosion and/or SOIL EROSION - Sheet, rill, & wind erosion and/or SOIL QUALITY DEGRADATION – Concentration of salts or other chemicals).
- Stabilize areas, such as sand dunes and riparian areas – Resource concern (SOIL EROSION – Concentrated flow erosion and/or SOIL EROSION - Sheet, rill, & wind erosion).

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to highly disturbed areas such as:

- Active or abandoned surface mine sites,
- Urban conservation sites,
- Construction areas,
- Conservation practice construction sites,
- Areas needing stabilization before or after natural disasters such as floods, tornados, and wildfires,
- Eroded banks of natural channels, banks of newly constructed channels, and lake shorelines, and
- Other areas degraded by human activities or natural events.

CRITERIA

General Criteria Applicable to All Purposes

Site Preparation. A site investigation shall be conducted to identify any physical, chemical, or biological conditions that could affect the successful establishment of vegetation.

Areas to be planted will be cleared of unwanted materials and smoothed or shaped, if needed, to meet planting and landscaping purposes.

A suitable seedbed shall be prepared for all seeded species. Compacted layers will be ripped and the soil re-firmed prior to seedbed preparation.

As site conditions dictate, when grading slopes, stockpile topsoil to be redistributed over area to be planted.

For details on seedbed preparation, refer to Wisconsin Agronomy Technical Notes 5, Establishing and Maintaining Native Grasses, Legumes, and Forbs; and 6, Establishing and Maintaining Introduced Grasses and Legumes.

Specie Selection and Seed Quality. Species selected for seeding or planting shall be suited to local site conditions and intended uses, and be common to the site or location.

Selected species will have the capacity to achieve adequate density and vigor to stabilize the site within an appropriate period.

Seeding rates will be based on Pure Live Seed (PLS). Actual adjusted seeding rates will be based on the equivalent of 100 percent PLS, determined by multiplying the percent purity by total percent germination.

Untested introduced and native grass and forb seed are not approved for planting.

Only viable, high quality seed or planting stock will be used. Increase the seeding rate for legumes to accommodate percentage of hard seed.

Introduced and native legume seed shall be inoculated immediately prior to planting. Rhizobia inoculant shall be specific to the legume seeded. When more than one legume specie is used, each specie will be inoculated separately.

Sod placement shall be limited to areas that have adequate moisture or that can be irrigated during the establishment period.

Sod will be placed and anchored using industry techniques to ensure that it remains in place until established.

Seeding Periods. Seeding will follow planting zone dates. Refer to Figure 1 for planting zones and Tables 1 and 2 for seeding dates.

The specific date that provides the best chance for success will vary from south to north and from year to year with prevailing moisture and temperature conditions. Late summer seeding is generally riskier than spring seeding. Planting at either end of the allowable range is riskier than the middle of the range.

Seeding outside of the recommended dates must be approved by the Area Resource Conservationist or State Agronomist.

Frost seeding is not an authorized seeding method when using this standard.

Dormant seeding can be used when planting introduced species. When dormant seeding in concentrated flow areas, the site must be mulched according to the engineering design (if applicable) and Wisconsin NRCS Conservation Practice Standard (WI NRCS CPS), Mulching (Code 484).

Figure 1. Planting Zones

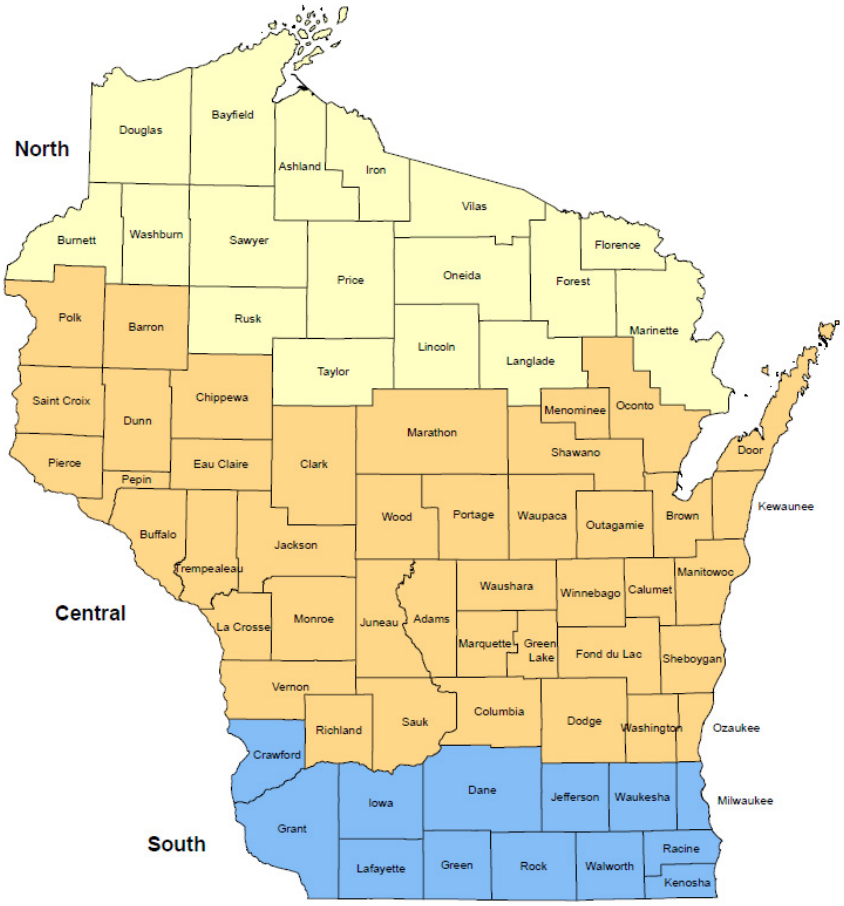


Table 1. Seeding Date/Ranges for Native Mixtures and Companion Crops

Zone	Spring Seeding
Northern	Thaw - 7/15
Central	Thaw - 6/30
Southern	Thaw - 6/30

Table 2. Seeding Date/Ranges for Introduced Grasses, Legumes, and Companion Crops

Planting Zone	Spring	Late Summer	Dormant
North	5/1 - 6/15	7/15 - 8/10	11/1 - Freeze Up
Central	4/15 - 6/1	8/1 - 8/21	11/1 - Freeze Up
South	4/1 - 5/15	8/7 - 8/29	11/1 - Freeze Up

Nutrient and Soil Amendment Requirements. When seeding introduced species, soil fertility and pH level will be amended to satisfy the needs of the plant species to be established. Fertilizer and lime recommendations will be determined by a soil test, and all nutrients will be applied following WI NRCS CPS, Nutrient Management (Code 590). If no soil test is available, apply a minimum of 150 pounds of 20-10-10 fertilizer and 2 tons of 80-89 lime or equivalent per acre. Soil amendments may be waived at the discretion of a certified conservation planner. The basis for waiving the use of soil amendments shall be documented in the client's case file.

For establishment of native species, use of soil amendments should not be used.

Seedbed Preparation. A minimum of 4 inches of friable soil material or topsoil shall be added and mixed to exposed rocky, sandy, gravelly, shale material, or extremely fine textured subsoil.

All gullies and deep rills will be filled and leveled during seedbed preparation.

Prior to planting into cropland fields, verify that herbicides previously applied to the site will not "carry over" and damage the new seeding.

Site preparation shall be adequate to assure weed suppression and to promote germination and growth of the species planted.

Planting equipment type, use, and timing shall be appropriate for the site conditions, soil characteristics, and type of seeds (size, etc.) selected to assure uniform placement and germination.

Refer to Wisconsin Agronomy Technical Notes 5 and 6 for detailed guidance for specific situations.

Mulching, Temporary Cover, and Companion Crop. Plantings shall be mulched as necessary to ensure establishment. Other disturbed areas shall be mulched as necessary to prevent erosion.

Mulching, temporary cover, and companion crops are vital practices utilized to support the establishment of a critical area planting. Temporary cover and companion crops suppress weed growth and limit soil erosion during the establishment period. Use depends on the site conditions, method of planting, and seed mixture.

For further details on mulching, temporary cover and companion crop recommendations, refer to Wisconsin Agronomy Technical Notes 5 and 6.

Criteria for Seed Mixture Development

Seeding rates are based on seeds per square foot of Pure Live Seeds. Refer to Wisconsin Agronomy Technical Notes 5 and 6 for the recommended species and seeding rates.

Approved species for critical area planting can be found in Wisconsin Agronomy Technical Notes 5 and 6. Species not listed in the technical notes must be approved in advance by the State Agronomist.

Introduced Grass and Legume Plantings on Critical Sites. Custom and standard mixtures will contain at least 50 percent grass seed of which 25 percent will be sod forming (not bunch) grass.

A minimum of 160 seeds per square foot is required for either a solid stand of grasses or a combination of grasses and legumes.

Increase seeding rate by 15 percent when dormant seeding occurs.

Refer to Table 8 of Agronomy Technical Note 6 for suggested seed mixes.

Native Herbaceous Plantings on Critical Sites. Native species are generally not recommended for critical area plantings due to their slow establishment and because they are clump grasses rather than sod forming. Only sod forming grasses are permitted in concentrated flow channels.

Additional Criteria to Stabilize Stream and Channel Banks, Pond and Shorelines

Bank and Channel Slopes. Channel side slopes shall be shaped so that they are stable and allow establishment and maintenance of desired vegetation.

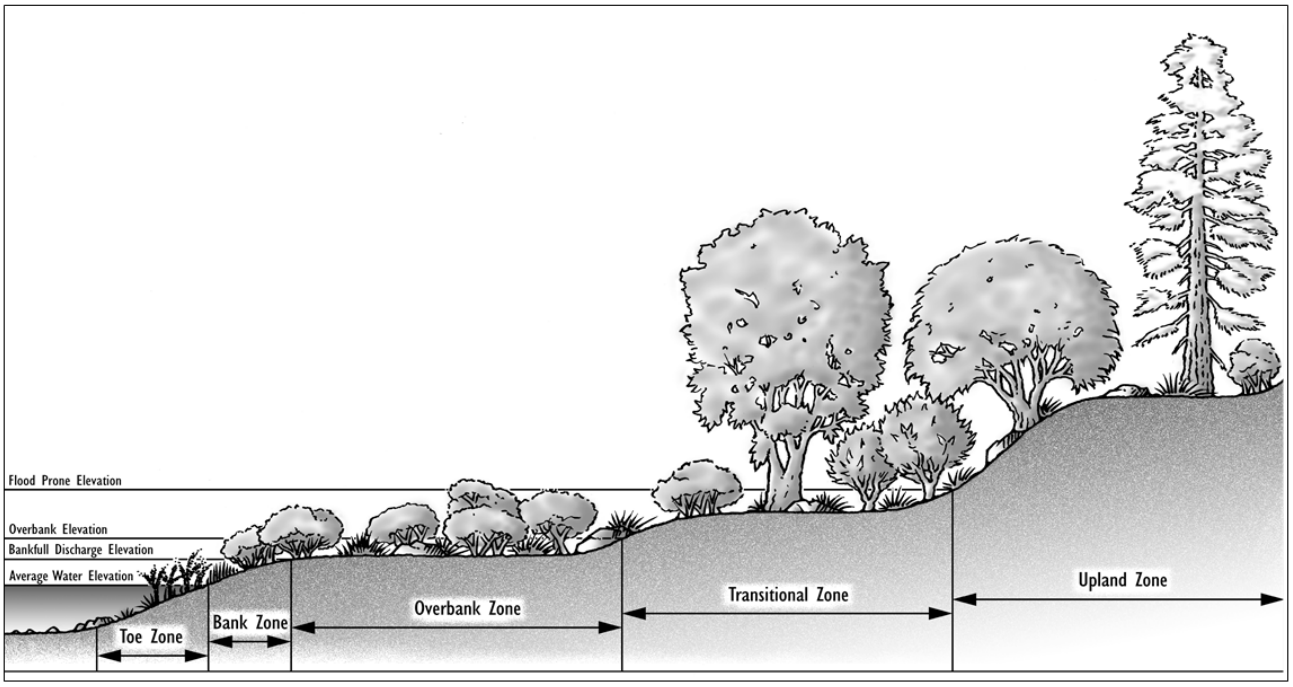
A combination of vegetative and structural measures may be necessary on slopes steeper than 2:1 to ensure adequate stability.

On sites that are too steep for regular seeding equipment to operate, the use of hydro-seeding and mechanically blown mulch is recommended. For more information regarding hydro-seeding, refer to Wisconsin Agronomy Technical Note 6.

Plant Materials used for this purpose shall:

- Be adapted to the hydrologic zone into which they will be planted,
- Be adapted and proven in the regions in which they will be used,
- When mature, produce plant communities that are compatible with those already existing in the area and,
- Protect the channel banks but not restrict channel capacity.

Figure 2.



Additional Criteria to Stabilize Areas with Existing or expected High Rates of Erosion by Wind and Water

The amount of plant biomass and cover needed to reduce wind and water erosion to the planned soil loss objective shall be determined using the current approved wind and/or water erosion prediction technology.

Do not use tillage where desirable vegetation is already present or where soil disturbance will increase the potential for erosion or cause sedimentation to environmentally sensitive areas.

Use a companion crop as added protection.

The toe of the slope, or the outlet of the concentrated flow channel, shall be stable before attempting seeding on the slope.

Concentrated flow may need to be diverted from the critical area during the establishment period.

CONSIDERATIONS

Minimize activities which disturb wildlife during the primary nesting season May 15 through August 1.

Heavy traffic and/or compacted soil areas may need special site preparation prior to seeding.

Consider planting native vegetation and/or local genotypes when restoring sites adjacent to remnant prairies.

Species or mixes that are adapted to the site and have multiple benefits should be considered. Native species may be used when appropriate for the site.

To benefit pollinators and other wildlife, consider using flowering shrubs and wildflowers and other forms that have resilient root systems and good soil holding capacity. These species should be used as a small percentage of the overall grass component.

Competition and poor establishment of some species. Seeds per square foot should not exceed 25 percent of the minimum requirement, with the exception of mixtures designed for wet mesic and wet sites.

Consider the use of soil bioengineering techniques to arrest and prevent slope failures and erosion. For approved design procedures, refer to Chapter 18 of the NRCS Engineering Field Handbook (EFH).

Consider alternatives to reduce or eliminate the delivery of sediment and associated pollutants into the riparian zone by implementing upland treatment practices.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for each field or management unit according to the Criteria and Operation and Maintenance sections of this standard. Specifications shall describe the requirements for applying this practice to meet the intended purpose using the appropriate specification and/or job sheets. The following elements shall be addressed in the plan, as applicable, to meet the intended purpose.

- Site preparation.
- Topsoil requirements
- Fertilizer application.
- Seedbed and planting area preparation
- Methods of seeding and planting
- Time of seeding and planting

- Selection of species.
- Seed/Plant source
- Seed Analysis
- Seeding rate/planting spacing
- Required Supplemental water
- Mulching (if applicable).
- Temporary cover or companion crop (if applicable).
- Describe successful establishment (percent ground cover, percent survival, stand density.

Specifications shall be recorded using Wisconsin Job Sheets 134, How to Establish and Maintain Introduced Grasses and Legumes; and 135, How to Establish and Maintain Native Grasses, Forbs, and Legumes

OPERATION AND MAINTENANCE

Use of the area shall be managed as long as necessary to ensure the site remains stable.

Plantings shall be protected from pests (weeds, insects, diseases, livestock or wildlife) as necessary to ensure long term survival.

Inspections, reseeding or replanting and fertilization may be needed to ensure that this practice functions as intended throughout its expected life. Observation of establishment progress and success should be performed at regular intervals unit he practice has met the criteria for successful establishment and implementation.

Sites may require on-going periodic maintenance consisting of mowing or herbicide treatment to control invasive pressure.

All areas to be grazed will follow a grazing plan that meets the criteria in the WI NRCS CPS, Prescribed Grazing (Code 528).

Grazing will be permanently excluded on high hazard sites, such as cut banks, areas of seepage, or other potential unstable areas.

FEDERAL, TRIBAL, STATE AND LOCAL LAWS

Users of this standard should be aware of potentially applicable federal, tribal, state and local laws, rules, regulations or permit requirements governing cover crops. This standard does not contain the text of federal, tribal, state or local laws.

REFERENCES

Curtis, J. T. 1959. The Vegetation of Wisconsin: an ordination of plant communities. University of Wisconsin Press, Madison, Wisconsin.

Federal Interagency Stream Restoration Working Group. 1998. Stream corridor restoration: principles, processes, and practices. National Engineering Handbook, Part 653.

USDA-NRCS. 2007. National Engineering Handbook, Part 654. Stream Restoration Guide.

USDA-NRCS. 2010. The PLANTS Database (http://plants.usda.gov, checked September 2010). National Plant Data Center.

Henderson, R. A. 1995. Plant Species Composition of Wisconsin Prairies: An Aid to Selecting Species for Plantings and Restorations Based Upon University of Wisconsin-Madison Plant Ecology Laboratory Data. Wisconsin Department of Natural Resources Technical Bulletin No. 188.

Ladd, D. and Oberle, F. 1995. Tallgrass Prairie Wildflowers, A Field Guide. The Nature Conservancy.

Nichols, S. and Entine, L. 1976. Prairie Primer. University of Wisconsin - Extension, publication G2736.

Packard, S. and Mutel, C. 1997. The Tallgrass Restoration Handbook for Prairies, Savannas and Woodlands. Society for Ecological Restoration.

Rock, H. W. 1971. Prairie Propagation Handbook. Boerner Botanical Gardens.

USDA, NRCS, National Engineering Handbook, Part 650, Engineering Field Handbook.

USDA, NRCS, Wisconsin Field Office Technical Guide (FOTG), Section IV, Practice Standards and Specifications.

USDA, NRCS, Wisconsin Agronomy Technical Note 5, Establishing and Maintaining Native Grasses, Forbs, and Legumes.

USDA, NRCS, Wisconsin Agronomy Technical Note 6, Establishing and Maintaining Introduced Grasses and Legumes.

USDA, NRCS, Wisconsin Job Sheet 134, How to Establish and Maintain Introduced Grasses and Legumes.

USDA, NRCS, Wisconsin Job Sheet 135, How to Establish and Maintain Native Grasses, Forbs, and Legumes.

DEFINITIONS

Actual Adjusted Seeding Rates. An increase in seeds per square foot or pounds per acre, when the PLS is less than 100 percent.

Aspect. The exposure of the site to direct sunlight, prevailing winds, and other factors that influence plant growing conditions. For example, a north slope tends to be cooler and moister while a south-facing slope tends to be drier and warmer.

Soil Bioengineering. Practice of combining mechanical, biological, and ecological concepts to arrest and prevent shallow slope failures and erosion.

Certified Seed. Seed that meets the standards established by the designated official seed certifying agency for the purpose of ensuring species/variety, species/varietal purity and mechanical quality. The Wisconsin Crop Improvement Association is the official seed certifying agency for Wisconsin.

Genotype. A group of individual plants which share a specified genetic makeup. For example, all big bluestem plants that are genetically adapted to grow and mature in the climatic conditions found in the driftless region could be considered a genotype.

Introduced Species. Plant species that historically were not native to North America and were brought here from other parts of the world, for example, smooth brome grass and alfalfa.

Native Species. Plants species that historically would have been found growing in North America such as big bluestem or green needle-grass.

Non-Certified Seed. Seed that is grown, processed, tested and labeled for species/variety and mechanical quality factors, but is not certified by an official seed certifying agency.

Pure Live Seed (PLS). PLS is a means of expressing seed quality, based on the percentage of seed in a seed lot that is both pure and viable. PLS is calculated by multiplying the percentage of total viable seed (germination + hard seed + dormant seed) by the percentage of pure seed divided by 100.

Tested Seed. A term used to describe seed quality attributes such as seed viability and vigor or assessment of percent germination of a given mass of seed evaluated. This term may be used to describe seed labeled as both certified and non-certified.

Untested Seed. Seed that has no assurances of testing for species/variety and mechanical quality, i.e., species/variety purity, inert matter, other crop or weed seeds and germination potential. Untested seed legally cannot be labeled.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

POND SEALING OR LINING – COMPACTED SOIL TREATMENT

CODE 520
(FT^2)

DEFINITION
A liner for an impoundment constructed using compacted soil with or without soil amendments.

PURPOSE
This practice is installed to reduce seepage losses from impoundments constructed for water conservation and environmental protection.

CONDITIONS WHERE PRACTICE APPLIES
This practice applies where:

- In-place natural soils have excessive seepage rates, and
- An adequate quantity and type of soil suitable for constructing a compacted soil liner without amendments is available, or
- An adequate quantity and type of soil suitable for treatment with a soil dispersant or bentonite amendment is available for an amended soil liner.

CRITERIA
General Criteria Applicable to All Purposes
Design and install measures according to a site-specific plan in accordance with all local, State, Tribal, and Federal laws and regulations. Apply measures that are compatible with improvements planned or being carried out by others.

General Criteria Applicable to All Soil Liners
Design Seepage Requirements. Compacted soil liners for waste storage impoundments shall be designed to meet the criteria contained in Wisconsin Conservation Practice Standard (WI NRCS CPS), Waste Storage Facility (Code 313).

Methods for computing unit seepage rates contained in the NRCS National Engineering Handbook (NEH), Part 651, Agricultural Waste Management Field Handbook (AWMFH), Chapter 10, Appendix 10D or other generally accepted methods for computing unit seepage rates may be used.

Lower specific discharge rates must be used if required by regulatory authorities, and may be used at the discretion of the designer even if no such lower limit exists.

Laboratory testing of compacted soil liner material for a waste storage impoundment is required to document the specific discharge to meet the design seepage threshold.

Design a compacted soil liner for a clean water pond to reduce seepage to a rate that will allow the pond to function as intended.

Liner filter compatibility. Design a compacted soil liner that is filter-compatible with the subgrade on to which it is placed to prevent loss of the liner soil into larger openings in the subgrade material. NEH, Part 633, Chapter 26, Gradation Design of Sand and Gravel Filters, provides criteria on filter compatibility.

Liner Thickness. The minimum thickness of the finished compacted liner must be the greater of:

- The liner thickness required to achieve a specific discharge (unit seepage) design value, or
- A liner thickness required by State regulations, or
- The minimum liner thickness specified in WI NRCS CPS, Waste Storage Facility (Code 313), or
- The minimum liner thickness as shown in Table 1.

Table 1. Minimum liner thickness by design storage depth for clean water ponds.

Design Storage Depth (ft.)	Liner Thickness (in.)
≤16	12
16.1–24	18
24.1–30	24

Liner Construction. Use methods described in the AWMFH, Appendix 10D, for liner construction. Properly seal all protrusions through the liner, such as pipes.

Liner Protection. Protect the soil liner against damage caused by the effects of water surface fluctuations, desiccation and cracking, wave action, rainfall during periods when the liner is exposed, water falling onto the liner from pipe outlets, agitation equipment, solids and sludge removal activity, animal activity, penetrations through the liner, and any other activity capable of causing physical damage to the liner.

A protective soil cover may be used to protect the soil liner from desiccation or erosion. The soil cover will be of a soil type, thickness, and density that is resistant to erosion and desiccation. Under severe conditions, a protective soil cover may not adequately protect the liner from desiccation. For example during long periods, of hot, low-humidity condition, a soil cover constructed with very high plasticity soils may experience damage. Under severe conditions, additional design measures such as installation of a geomembrane in conjunction with the soil cover may be required.

Side Slopes. The side slopes of the impoundment should be 3H (horizontal) to 1V (vertical) or flatter to facilitate compaction of soil on the slopes when the "bathtub" method of construction is used, as described in AWMFH, Appendix 10D. Slopes as steep as 2H to 1V can be considered if the "stair-step" method of construction as described in appendix 10D of the AWMFH is used. Steeper side slopes can be designed for isolated areas if the slope is protected.

Foundation. For waste storage impoundment, foundation conditions for compacted soil liners, including the location and proximity of groundwater and bedrock, will be designed in accordance to WI NRCS CPS, Waste Storage Facility (Code 313).

The liner design will include measures to protect against damage to the soil liner due to uplift water pressures if a seasonal high water table occurs at a level above that of the lowest potential level of liquid in the impoundment. Examples of protective design measures are the use of perimeter drains to lower the water table, maintaining minimum liquid depth in the impoundment, and using liners thick enough and heavy enough to resist uplift water pressures.

Evaluate the foundation for conditions such as karstic bedrock, joints, and other discontinuities of the underlying bedrock to determine the appropriateness for a compacted soil liner.

Additional Criteria for Soil Dispersant Treatment

Dispersant Materials. The dispersant must be tetrasodium pyrophosphate (TSPP), sodium tripolyphosphate (STPP), or soda ash unless laboratory tests using other dispersant types are used in the design.

Application Rate. For waste storage impoundments, conduct laboratory permeability tests using a dispersant of the same quality and fineness as that proposed for use. To meet the liner design threshold, use the application rate and the number and thickness of compacted soil lifts specified in the geotechnical laboratory report.

For clean water ponds, in the absence of laboratory tests or field performance data on soils similar to those to be treated, apply dispersant at a rate equal to or greater to the amount lined in Table 2. Install the liner with a maximum 6-inch-lift thickness.

Table 2. Minimum Dispersant Application Rates for Clean Water Ponds.

Dispersant Type	Minimum Application Rate per 6-inch lift thickness (lbs./100 ft^2)
Polyphosphate (TSPP, STPP)	7.5
Soda Ash	15

Safety. During dispersant handling, application and mixing, personnel on-site must wear masks and goggles for protection against dispersant dust.

Additional Criteria for Bentonite Treatment

Bentonite Material. The bentonite must be a sodium bentonite with a free swell of at least 22 milliliters as measured by ASTM Standard Test Method D5890, unless laboratory tests using other bentonite types are used for design.

Application Rate. For waste storage impoundments, conduct laboratory permeability tests using bentonite of the same quality and fineness as that proposed for use. To meet the liner design threshold, use the application rate and number and thickness of compacted soil lifts specified in the geotechnical laboratory report.

For clean water ponds, in the absence of laboratory tests or field performance data on soils similar to those to be treated, apply the bentonite at a rate equal to or greater to the amount listed in Table 3. Install the liner with a maximum of 6-inch-lift thickness.

Table 3. Minimum Bentonite Application Rates for Clean Water Ponds.

Pervious Soil Description	Minimum Application Rate (lbs./ft^2) per 1-inch Lift thickness
Silts (ML, CL-ML)	0.375
Silty Sands (SM, SC-SM, SP-SM)	0.5
Clean Sand (SP, SW)	0.625

Safety. During bentonite handling, application and mixing, personnel on site must wear masks and goggles for protection against bentonite dust.

CONSIDERATIONS

Consider maintenance access safety and slope stability when selecting inside side slopes for design.
Consider using a composite liner system, including a geomembrane and/or geosynthetic clay liner for sites that have liquid depths greater than 24 feet.
Consider installing a 12-inch protective soil cover over the compacted soil liner.
In areas where the liner can potentially be damaged or scoured by agitation, pumping, or other equipment access, consider installing a concrete pad over the liner.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for a compacted soil liner for a pond or a waste storage impoundment that describe the requirements for applying the practice to achieve its intended purpose. As a minimum, include:

- Soils investigation, including subgrade.
- Soil amendment requirements, as needed.
- Quantities of soil liner material and soil cover material, as needed.
- Quantity and gradation of filter material, as needed.
- Compaction requirements.
- Supplemental practices, such as geomembrane, as needed.
- Construction and material specifications.
- Safety requirements.

OPERATION AND MAINTENANCE

Maintenance activities required for this practice consist of those operations necessary to prevent and/or repair damage to the compacted soil liner. This includes, but is not limited to:

- Excluding animals and equipment from the treated area.
- Repairing damage to the liner; restoring the liner to its original thickness and condition.
- Removing roots from trees and large shrubs at first appearance.

REFERENCES

USDA Natural Resources Conservation Service. 2012. Agricultural Waste Management Field Handbook (AWMFH). USDA-NRCS, Washington, D.C.

NRCS National Engineering Handbook, Part 633, Chapter 26 – Gradation Design of Sand and Gravel Filters.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

VEGETATIVE BARRIER

CODE 601
(FT.)

DEFINITION
Permanent strips of stiff, dense vegetation established along the general contour of slopes or across concentrated flow areas.

PURPOSE
- Reduce sheet and rill erosion.
- Improve water quality by trapping sediment.

CONDITIONS WHERE PRACTICE APPLIES
This practice applies to all land uses where sheet and rill erosion are resource concerns.

CRITERIA
General Criteria Applicable to All Purposes

Physical Characteristics of Plants.

Stiffness Index. Establish vegetative barriers with vegetation having the minimum Vegetation Stiffness Index (VSI) designated in Table 1 measured at a point 6 inches above the ground.

Table 1. Stem Diameter and Minimum Stem Density Values for Vegetation Stiffness Index (VSI) Values of 0.05 and 0.10.

Stem Diameter (Inch)	Stem Density Per Square Foot @ VSI=0.05
0.10	500
0.15	100
0.20	30
0.25	15
0.50	10
=	1.0

Density. Gaps between plants will be no greater than 3 inches at the end of the first growing season.

Species Selection. Species must be adapted to local soil and climate conditions, be easily established, long-lived, and manageable.

Select species which exhibit characteristics that are required for adequate functions, such as, emergence though several inches of sediment or resuming growth from buried stem nodes, rhizomatous or stoloniferous growth habit, and stems that remain intact and erect year-round

Establishment. Barriers may be established vegetatively or from seed.

Seeding dates, depths, and rates will be appropriate for the species selected and the conditions of the site. Seeds will be placed to ensure good seed-to-soil contact.

Barriers established vegetatively will be planted at a density to ensure a functional barrier as quickly as possible (usually two growing season). For most herbaceous species, this will require a spacing in the row of no more than 6 inches for bare-root seedlings, cuttings, sod chunks, plugs, rhizomes, or divisions consisting of no less than 5 viable stems. Suckering shrubs or herbaceous species established from 6-inch (gallon) potted material will be established at a spacing in the row of no more than 12 inches.

Site preparation must be sufficient to ensure seed germination or proper rooting conditions for vegetated material establishment. Plants will be placed to ensure good root-to-soil contact and packed after planting.

Plan appropriate site stabilization measures when needed, during the barrier establishment period.

Barrier Width. The mature barrier widths will be the largest of 3 feet wide or 0.75 times the design vertical interval. Broadcast or drilled seed will be sown in a strip at least 3 feet wide. Seed sown with a row planter will be seeded in a minimum of 2 rows.

Do not use vegetative barriers as a field road or turn row.

Additional Criteria for Reducing Sheet and Rill Erosion

Gradient. Gradients along the barrier will be no less than 0.2 percent and no greater than 1.0 percent except where the vegetative barrier crosses concentrated flow areas. Gradients entering a concentrated flow area may be up to 1.5 percent for 100 feet in order to get better row alignment.

All tillage and equipment operations in the interval between barriers will be parallel to the vegetative barrier.

A berm must exist at the upslope edge of the barrier and/or a channel must exist immediately upslope of the barrier to divert water along the vegetative barrier. Minimum berm height/ channel depth will be 3 inches. Water flowing along a vegetative barrier berm/channel must be delivered to a stable outlet.

Spacing. Horizontal spacing between the vegetative barriers will be determined using the lesser of:

- The horizontal distance between barriers when the vertical interval is 6 feet, or
- The water erosion planning length of slope "L" that achieves the allowable soil loss for the field, considering the planned practices in the conservation management system.

Crop strip width will be planned in multiples of widths of planting, tillage, spraying, and harvest equipment. This spacing may be adjusted up to 10 percent between the barriers.

Vegetation. The vegetation will be of species to provide the designated minimum stem density with the designated stem diameter and have a minimum VSI of 0.05. See Table 1 for guidance.

Additional Criteria for Trapping Sediment

Location and Alignment. Barriers will be aligned as close to perpendicular as possible to flow coming off the fields or out of the ends of furrows.

Width. Vegetative barriers for this purpose will be a minimum of 3 feet wide.

CONSIDERATIONS

General Considerations

This practice is not well-suited to soils that are shallow to rock or other restrictive layers and where tillage is used on the cropped strips. The "benching" process that occurs on slopes where barriers are installed (tillage erosion moves soil from the upper part of the cropped strip, which then accumulates in the lower part of the cropped strip) can expose soil material unfavorable for crop growth.

Wisconsin Conservation Practice Standards (WI NRCS CPS), Conservation Crop Rotation (Code 328) and the residue and tillage management practices (Codes 329 and 345) should be considered in designing the conservation management system on cropland.

Practices such as water and sediment control basins, subsurface drainage, and underground outlets may be needed to adequately handle surface and subsurface water.

This practice may improve the efficiency of other practices such as stripcropping, filter strips, riparian forest buffers, grassed waterways, diversions and terraces.

On tilled fields, consider soil profiles that have sufficient depth to retain productivity where benches will develop as soil is moved down gradient by tillage. Soil upslope of barriers will gradually build up while soil will be removed down slope of the barrier. The effect of this movement should be considered with respect to soil depth, subsoil characteristics and response to amendments.

Established vegetative barriers systems can pond water above the barriers. Subsurface drains may need to be installed across the slope parallel to the barrier, or through the ponded areas above barriers that are installed across concentrated flow areas.

When compatible with the purposes and criteria for this practice, plant materials can be selected to attract undesirable insects away from crops or desirable insects that are beneficial to the adjacent crops.

When compatible with the purposes and criteria for application of this practice, plant materials can be selected that enhance food and cover for targeted wildlife.

When compatible with the purpose and the barrier vegetation avoid conducting activities within the barrier during the nesting season to minimize illegal take of birds, nests, and eggs.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared for each field site where a vegetative barrier will be installed. Record practice specifications on the Vegetative Barrier Implementation Requirement document. Plans and specifications will include:

- Field map with location of vegetative barriers
- Purpose of the barrier
- Width of crop strip
- Vegetative barrier and crop strip orientation
- Width of barrier
- Vegetative species and cultivar
- Establishment date, establishment method, seeding rate (when seeded) or spacing of vegetative planting stock
- Site stabilization, if needed to ensure establishment

OPERATION AND MAINTENANCE

The following actions will be carried out to ensure that this practice functions as intended. These actions include normal activities in the application and use of the practice and repair and maintenance of the practice.

- Establishment failures will be replanted or reseeded immediately; short gaps in seeded barriers may be reestablished more effectively and immediately with transplanted plant material.
- Mowing of herbaceous barriers may be used as a management practice to encourage the development of a dense stand and prevent shading of crops in adjacent fields. Mow at a 15-inch stem height, or the recommended height for the species, whichever is taller.
- Barriers may be burned (where permitted), if the species used will tolerate fire. Carry out burns just prior to the spring regrowth period, while the vegetation is dormant. All burns will be conducted in accordance with a smoke/burn management plan.
- Control any plant on the Federal or State noxious weed list. Control other weeds as necessary to ensure a dense stand within the barrier.
- Perform pest control with techniques and pesticides that will not irreversibly damage the vegetative barrier.
- Washouts or rills that develop will be filled and replanted immediately. Short gaps in established barriers will be reestablished with transplanted plant material.

FEDERAL, TRIBAL, STATE AND LOCAL LAWS

Users of this standard should be aware of potentially applicable federal, tribal, state and local laws, rules, regulations or permit requirements governing cover crops. This standard does not contain the text of federal, tribal, state or local laws.

REFERENCES

Dabney, S.M., Z. Liu, M. Lane, J. Douglas, J. Zhu and D. C. Flanagan. 1999. Landscape benching from tillage erosion between grass hedges. Soil Tillage Res. 51:219-231.

Dewald, C., J. Henry, S. Bruckerhoff, J. Ritchie, D. Shepard, J. Douglas, and D. Wolfe. 1996. Guidelines for the establishment of warm season grass hedge for erosion control. J. Soil Water Conserv. 51(1):16-20.

Douglas, J.L., and C.E. Mason. 1996. An alternative erosion control practice for cropland. Jamie L. Whitten Plant Materials Center Progress Report. 12(7).

Dunn, G.H., and S.M. Dabney. 1996. Modulus of elasticity and moment of inertia of grass hedge stems. Trans. ASAE 39(3):947-952.

WISCONSIN CONSTRUCTION SPECIFICATION

15. Plastic Pipe Conduits

1. SCOPE

The work shall consist of furnishing and installing polyvinyl chloride (PVC), acrylonitrile-butadienestyrene (ABS), and polyethylene (PE) plastic pipe and the necessary fittings as shown on the drawings. **This specification does not apply to corrugated polyethylene tubing used for subsurface drainage systems.**

2. MATERIALS

Polyvinyl chloride (PVC) pipe and fittings shall conform to the requirements of the following ASTM specifications unless otherwise stated on the drawings.

Pressure Rated:

a. D 1785 PVC Plastic Pipe, Schedules 40, 80, and 120.
b. D 2241 PVC Pressure-Rated Pipe (SDR Series).
c. D 2464 Threaded PVC Plastic Pipe Fittings, Schedule 80.
d. D 2466 PVC Plastic Pipe Fittings, Schedule 40.
e. D 2467 Socket-Type PVC Plastic Pipe Fittings, Schedule 80.
f. D 2855 Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
g. D 3139 Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

Non-Pressure Rated:

h. D 2729 PVC Sewer Pipe and Fittings.
i. D 2855 Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
j. D 3034 Type PSM PVC Sewer Pipe and Fittings.
k. D 3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals.
l. F 679 PVC Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
m. F 794 PVC Profile Gravity Sewer Pipe and Fittings, Based on Controlled Inside Diameter.
n. F 949 PVC Corrugated Sewer Pipe with a Smooth Interior and Fittings.
o. F 1760 Standard Specification for Coextruded Poly (Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe having Reprocessed-Recycled Content.

Acrylonitrile-butadiene-styrene (ABS) plastic pipe and fittings shall conform to the requirements of the following ASTM specifications unless otherwise stated on the drawings.

Non-Pressure Rated:

a. D 2661 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.

Polyethylene (PE) plastic pipe and fittings shall conform to the requirements of the following ASTM specifications unless otherwise stated on the drawings.

Pressure Rated:

a. D 2239 PE Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
b. D 2683 Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
c. D 3035 PE Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.
d. D 3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
e. D 3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
f. F 714 Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
g. F 2620 Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

Non-Pressure Rated:

h. F 667 Large Diameter Corrugated PE Tubing and Fittings.
i. F 2306 PE Plastic Pipe and Fittings - Annular Corrugated Profile Walled - Based on Inside Diameter

The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign matter, or other defects. The pipe shall be as uniform in color, opacity, density, and other physical properties as is commercially practicable.

3. JOINTS AND FITTINGS

Joints and fittings shall be of the same or similar materials as the pipe and equal to or exceeding that specified for the pipe to which it is attached.
Joints may be bell and spigot type with elastomeric gaskets, coupling type with elastomeric gaskets on each end or solvent cemented. The joints shall be installed according to the manufacturer's recommendations unless otherwise specified.

When a lubricant is required to facilitate joint assembly, it shall be a type having no detrimental effect on the gasket or pipe material.

4. HANDLING AND STORAGE

Pipe shall be delivered to the job site and handled by means which provide adequate support to the pipe and does not subject it to undue stresses or damage. When handling and placing plastic pipe, care shall be taken to prevent impact blows, abrasion damage, and gouging or cutting. All special handling requirements of the manufacturer shall be strictly observed. Special care shall be taken to avoid impact when the pipe must be handled at temperatures of 40°F or less.

Pipe shall be stored on a relatively flat surface so that the barrels are evenly supported. Unless the pipe is specifically coated to withstand exposure to ultraviolet radiation, it shall be covered with an opaque material when stored outdoors for a period of 15 days or longer.

5. LAYING AND BEDDING THE PIPE

The pipe shall be laid to the lines and grades as shown on the drawings and specified herein. The pipe shall be laid so that there is no reversal of grade between joints, unless otherwise shown on the drawings. The pipe shall not be dropped or dumped on the bedding or into the pipe trench. The ground surface near the pipe trench shall be free of loose rocks and stones greater than 1 inch in diameter. This ensures that rock will not be displaced and impact the pipe.

Just before placement, each pipe section shall be inspected to ensure that all foreign material is removed from inside the pipe. The pipe ends and the couplings shall be free of foreign material when assembled. At the completion of a work shift, all open ends of the pipeline shall be temporarily closed off using a suitable cover or plug.

Care shall be taken to prevent distortion and damage during unusually hot (over 90°F) or cold weather (under 40°F). After the pipe has been assembled in the trench, it shall be allowed to reach ground temperature before backfilling to prevent pull out of joints due to thermal contraction.

Bell and spigot pipe shall be laid with the bell pointed upstream. The pipe ends and couplings shall be free of foreign material when assembled.

Perforated pipe shall be laid with the perforations down and oriented symmetrically about the vertical centerline. Perforations shall be clear of any obstructions when the pipe is laid and before the pipe is approved for backfill.

The pipe shall be firmly and uniformly bedded throughout its entire length. The bedding depth and materials to be used will be as shown on the drawings. For pipe with bell joints, the bedding material shall be excavated at the locations of the bells to prevent the pipe from being supported by the bells.

6. PIPE EMBEDMENT

Earth bedding – The pipe shall be firmly and uniformly placed on compacted earthfill bedding or an in-place earth material bedding of ample bearing strength to support the pipe without noticeable settlement. The earth material on which the pipe is placed shall be of uniform density to prevent differential settlement.

Unless otherwise specified, a groove that closely conforms to the outside surface of the pipe shall be formed in the bedding. The depth of the groove shall be equal to or greater than 0.3 of the pipe diameter.

Earth bedding shall be compacted to a density not less than adjacent undisturbed in-place earth material or be compacted earth backfill. Earthfill material used for compacted earth bedding shall be free of rocks or stones greater than 1 inch in diameter and earth clods greater than 2 inches in diameter. The pipe shall be loaded sufficiently during the compaction of bedding under the haunches and around the sides of the pipe to prevent displacement from its final approved placement.

Sand, gravel, or crushed rock bedding – When sand, gravel, or crushed rock bedding is specified, the pipe shall be firmly and uniformly placed on the bedding material. Material for bedding shall not exceed 1 inch in diameter. Unless otherwise shown on the drawings, the coarse-grained bedding material shall be carefully placed and compacted to a depth equal to or greater than 0.3 of the

diameter of the pipe above the bottom of the pipe. The pipe shall be loaded sufficiently during backfilling and compaction around the sides to prevent displacement of the pipe from its final approved placement.

Pipe encased in drainfill – The pipe shall be firmly and uniformly placed on bedding of specified drainfill. Drainfill shall be placed and compacted as specified in Wisconsin Construction Specification 8, Drainfill or as shown on the drawings. The pipe shall be loaded sufficiently during backfilling around the sides and during compaction to prevent displacement of the pipe.

Pipe encased in concrete – Concrete encasement shall be carefully placed to form a continuous uniform support around the entire circumference of the pipe or as shown on the drawings. Pipes encased in concrete shall be securely anchored to prevent movement of the pipe during concrete placement. A clear distance of 1.5 inches shall be maintained between the pipe and any reinforcing steel.

7. BACKFILL

Initial backfill – Unless otherwise specified or shown on the drawings, initial backfill to 6 inches above the top of the conduit is required. Earth haunching and initial backfill material shall consist of soil material that is free of rocks, stones, or hard clods more than 1 inch in diameter. Coarse backfill material shall be the specified sand, gravel, crushed rock, or drainfill material.

Initial backfill shall be placed in two stages. In the first stage (haunching), backfill is placed to the pipe spring line (center of pipe). In the second stage, it is placed to 6 inches above the top of the pipe.

The first stage material shall be worked carefully under the haunches of the pipe to provide continuous support throughout the entire pipe length. The haunching backfill material shall be placed in layers that have a maximum thickness of about 6 inches and are compacted as shown on the drawings or as stated in the Wisconsin Construction Specification appropriate for the backfill material. During compaction operations, care shall be taken to ensure that the tamping or vibratory equipment does not come in contact with the pipe and the pipe is not deformed or displaced.

Final backfill – Final backfill shall consist of placing the remaining material required to complete the backfill from the top of the initial backfill to the ground surface, including mounding at the top of the trench. Final backfill material within 2 feet of the top of the pipe shall be free of debris or rocks larger than 3 inches nominal diameter. Coarse backfill material shall be the specified sand, gravel, crushed rock, or drainfill. Final backfill shall be placed in approximately uniform, compacted layers. Final backfill compaction and layer thickness requirements shall be as shown on the drawings or as stated in the Wisconsin Construction Specification appropriate for the backfill material.

WISCONSIN CONSTRUCTION SPECIFICATION

634. Waste Transfer Pipe

1. SCOPE

The work shall consist of furnishing and installing waste transfer pipes, necessary fittings, and appurtenances as shown on the drawings.

2. MATERIALS

The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign matter, or other defects. The pipe shall be as uniform in color, opacity, density, and other physical properties as is commercially practicable.

PVC pipe material shall be Type 1 (1120/1220) for pressure transfer systems. ABS pipe material shall be virgin plastic resin and meet ASTM D 3965. PE pipe material shall meet ASTM D 3350.

Pipes shall meet the criteria in Table 1. Pipes of equivalent strength, durability, and liquid tightness are acceptable. All pipe and fittings proposed for use shall be submitted for approval prior to installation.

Fittings and couplers shall meet or exceed the same strength requirements as those of the pipe. Standard manufactured pieces shall be used for angles required to make direction changes.

3. HANDLING AND STORAGE

Pipe shall be delivered to the job site and handled by means which provide adequate support to the pipe and does not subject it to undue stresses or damage. When handling and placing plastic pipe, care shall be taken to prevent impact blows, abrasion damage, and gouging or cutting. All special handling requirements of the manufacturer shall be strictly observed. Special care shall be taken to avoid impact when plastic pipe must be handled at temperatures of 40°F or less.

Pipe shall be stored on a relatively flat surface so that the barrels are evenly supported. Unless the pipe is specifically coated to withstand exposure to ultraviolet radiation, it shall be covered with an opaque material when stored outdoors for a period of 15 days or longer.

4. LAYING THE PIPE

The pipe shall be laid to the lines and grades as shown on the drawings. The pipe shall be laid so that there is no reversal of grade between joints, unless otherwise shown on the drawings. The pipe shall not be dropped or dumped on the bedding or into the pipe trench. The ground surface near the pipe trench shall be free of loose rocks and stones greater than 1 inch in diameter.

The pipe shall be laid starting from one end proceeding continuously upstream or downstream.

The pipe shall not be laid at both ends and proceeding towards the middle.

Standard manufactured pieces shall be used for angles required to make direction changes. Directional pipe deflection shall be allowed in PVC and solid wall PE pipe per the manufacturer's allowable bend radius.

Just before placement, each pipe section shall be inspected to ensure that all foreign material is removed from inside the pipe. The pipe ends and the couplings shall be free of foreign material when assembled. At the completion of a work shift, all open ends of the pipeline shall be temporarily closed off using a suitable cover or plug.

Care shall be taken to prevent distortion and damage to plastic pipe during unusually hot (over 90°F) or cold weather (under 40°F). After the pipe has been assembled in the trench, it shall be allowed to come within a few degrees of the ground temperature before backfilling to prevent pull out of joints due to thermal contraction.

Bell and spigot pipe should be laid with the bell pointed upstream. The pipe ends and couplings shall be free of foreign material when assembled.

The pipe shall be uniformly and continuously supported over its entire length on firm stable material. Blocking or mounding shall not be used to bring the pipe to final grade.

For pipe with bell joints, bell holes shall be excavated in the bedding material, as needed, to allow for unobstructed assembly of the joint and to permit the body of the pipe to be in contact with the bedding material throughout its length.

5. PIPE EMBEDMENT

Earth bedding – The pipe shall be firmly and uniformly placed on compacted earthfill bedding or an in-place earth material bedding of ample bearing strength to support the pipe without noticeable settlement. The earth material on which the pipe is placed shall be of uniform density to prevent differential settlement.

Unless otherwise specified, a groove that closely conforms to the outside surface of the pipe shall be formed in the bedding. The depth of the groove shall be equal to or greater than 0.3 of the pipe diameter.

Earth bedding shall be compacted to a density not less than adjacent undisturbed in-place earth material or be compacted earth backfill. Earthfill material used for compacted earth bedding shall be free of rocks or stones greater than 1 inch in diameter and earth clods greater than 2 inches in diameter. The pipe shall be loaded sufficiently during the compaction of bedding under the haunches and around the sides of the pipe to prevent displacement from its planned alignment. Pipe shall not be deformed to the extent that joint integrity is adversely impacted.

Sand, gravel, or crushed rock bedding – When sand, gravel, or crushed rock bedding is specified, the pipe shall be firmly and uniformly placed on the bedding material. Material for bedding shall not exceed 1 inch in diameter. Unless otherwise shown on the drawings, the coarse-grained bedding material shall be carefully placed and compacted to a depth equal to or greater than 0.3 of the diameter of the pipe above the bottom of the pipe. The pipe shall be loaded sufficiently during backfilling and compaction around the sides to prevent displacement of the pipe from its final approved placement.

Pipe encased in drainfill – The pipe shall be firmly and uniformly placed on bedding of specified drainfill. Drainfill shall be placed and compacted as specified in NRCS FOTG Section IV, Wisconsin Construction Specification 8, or as shown on the drawings. The pipe shall be loaded sufficiently during backfilling around the sides and during compaction to prevent displacement of the pipe.

Pipe encased in concrete – Concrete encasement shall be carefully placed to form a continuous uniform support around the entire circumference of the pipe or as shown on the drawings. Pipes encased in concrete shall be securely anchored to prevent movement of the pipe during concrete placement. A clear distance of 1.5 inches shall be maintained between the pipe and any reinforcing steel.

6. LIQUID TIGHT PIPE PENETRATIONS

- Hydrophilic sealants (swell in contact with water) shall be non-bentonite.
- Sealant, grout, flexible connections, fitting, etc. used to seal pipe penetration joints between wall and pipe shall be liquid tight.
- Pipes shall be continuous through walls. (i.e. no pressure from pumps shall be exerted on penetration joints between wall and pipe.)
- Pipes at penetration joints shall be properly supported to prevent undue stress on the seal.
- Grouted joints shall be pinned, keyed, or otherwise attached to structure to prevent joint separation.
- Flexible connection systems shall be installed according to manufacturer's recommendations for the specific application.

7. BACKFILL

Initial backfill – Unless otherwise specified or shown on the drawings, initial backfill to 6 inches above the top of the conduit is required. Earth haunching and initial backfill material shall consist of soil material that is free of rocks, stones, or hard clods more than 1 inch in diameter. Coarse backfill material shall be the specified sand, gravel, crushed rock, or drainfill material.

Initial backfill shall be placed in two stages. In the first stage (haunching), backfill is placed to the center of the pipe. In the second stage, it is placed to 6 inches above the top of the pipe.

The first stage material shall be worked carefully under the haunches of the pipe to provide continuous support throughout the entire pipe length. The haunching backfill material shall be placed in layers that have a maximum thickness of about 6 inches and are compacted as shown on the drawings or as stated in the NRCS Wisconsin Construction Specification appropriate for the backfill material. During compaction operations, care shall be taken to ensure that the tamping or vibratory equipment does not come in contact with the pipe and the pipe is not deformed or displaced.

Final backfill – Final backfill shall consist of placing the remaining material required to complete the backfill from the top of the initial backfill to the ground surface, including mounding at the top of the trench. Final backfill material within 2 feet of the top of the pipe shall be free of debris or rocks larger than 3 inches nominal diameter. Coarse backfill material shall be the specified sand, gravel, crushed rock, or drainfill. Final backfill shall be placed in approximately uniform, compacted layers. Final backfill compaction and layer thickness requirements shall be as shown on the drawings or as stated in the NRCS Wisconsin Construction Specification appropriate for the backfill material.

8. PRESSURE TESTING

This pressure test procedure consists of filling, an initial expansion phase, a test phase, and depressurizing. Severe service transfer pipe shall be pressure tested in the following manner prior to being placed into service.

Before Pressure Testing

a. Solvent welded or heat fused joints of the assembled severe service transfer pipe shall be allowed to cure. Solvent-welded joints should be allowed to cure for a minimum of 24 hours, or more time if recommended by the glue manufacturer.

b. Severe service transfer pipe shall be flushed and cleaned.

c. All thrust control structures shall be in place, and all cast-in-place thrust blocks shall be allowed to cure according to one of the following options:

   i. 3 days for early strength concrete (5,000 psi);
   ii. 7 days for normal strength concrete (3,500 psi); or
   iii. A strength of 500 psi is reached, with data that's field- or lab-verified to support.

d. Pipes shall be backfilled or otherwise restrained sufficiently along its length to anchor the pipe against movement during the pressure testing. The pipe shall also be braced and/or anchored at each end to prevent movement.

e. The ends of the pipe shall be plugged, and a pressure gauge shall be attached to the upstream and downstream ends. All high points along the severe service transfer pipe shall be vented to permit the complete removal of all air within the pipe.

Filling

Slowly fill the restrained test section completely with clear water. ***WARNING – Ensure that there is no air trapped in the test section. Failure to remove entrapped air can cause explosive release resulting in death or serious bodily injury. Use equipment vents at high points to remove air.***

Initial Expansion Phase

Gradually pressurize the test section with water to the working pressure (as specified in the construction plans) plus 10 psi and maintain that pressure for three hours. During the initial expansion phase, pipe may expand slightly, requiring additional water to maintain pressure.

Test Phase

Immediately following the initial expansion phase, reduce test pressure back to working pressure, stop adding water and isolate test section. If test pressure remains steady (within 5% of the target value) for one hour, no leakage is indicated and the test section passes.

Depressurizing

Following the test phase, and prior to putting the pipe into service, gradually reduce pressure on the test section, drain out and properly dispose of all test water.

Table 1
Pipe Specifications Note 1,2

Installation Type	Size	Material	Specification	Joint Performance Specs	Joint Fitting Spec. Note 3
GRAVITY PIPELINES (Including Abrasive Materials)	(4"-10")	HDPE Pipe	AASHTO M252, Type S	ASTM D 3212 (10.8 psi)	F2306/F477
	(12"-60")	HDPE Pipe	AASHTO M294, Type S or ASTM F2306	ASTM D 3212 (10.8 psi)	F2306/F477
	(18"-48")	PVC Pipe	ASTM F 679	ASTM D 3212, & D 3139 & D 2672	ASTM F 679
	(3"-15")	PVC Pipe	ASTM D 3034 (SDR 35)	ASTM D 3212, & D 3139 & D 2672	ASTM D 3034
	(1/8"-36")	PVC Pipe	ASTM D 2241 (SDR 32.5)	ASTM D 3212, & D 3139 & D 2672	ASTM D 2241
	Any pipe listed below is also acceptable.				
PRESSURE PIPELINES • < 70 psi max. working pressure • Non-Abrasive Materials	(1/8"-24")	PVC Pipe	ASTM D 1785 (Sch. 40)	ASTM D 3212, & D 3139 & D 2672	ASTM D 2464 & D 2466
	(1/8"-36")	PVC Pipe	ASTM D 2241 (SDR 26)	ASTM D 3212, & D 3139 & D 2672	ASTM D 2467
	(4"-12")	PVC Pipe	AWWA C900 (DR 25)	ASTM D 3212, & D 3139 & D 2672	Per manufacturer recommendation
	(14"-48")	PVC Pipe	AWWA C905 (DR 25)	ASTM D 3212, & D 3139 & D 2672	Per manufacturer recommendation
	(3.5"-54")	PE Pipe	ASTM F 714 (DR 21)	Per manufacturer recommendation / ASTM D 3261 / ASTM F 2620	ASTM D 2683
	(1/8"-42")	Steel	ASTM A 53 / ANSI/ASME B36.10 (Sch. 40)	Flanged: to ANSI B16.5 Threaded: to ANSI B 16.11 Butt-Weld	Flanged: to ANSI B16.1 Thread to ANSI B16.11 Butt-Weld
	Any pipe listed below is also acceptable.				
PRESSURE PIPELINES Note 4 • ≥ 70 psi max. working pressure • Abrasive Materials • Recirculation Systems	(1/8"-24")	PVC Pipe	ASTM D 1785 (Sch. 80)	ASTM D 3212, & D 3139 & D 2672	ASTM D 2467
	(1/8"-36")	PVC Pipe	ASTM D 2241 (SDR 21)	ASTM D 3212, & D 3139 & D 2672	ASTM D 2467
	(1/8"-36")	PVC Pipe	ASTM D 2241 (SDR 17)	ASTM D 3212, & D 3139 & D 2672	ASTM D 2467
	(4"-12")	PVC Pipe	AWWA C900 (DR 18)	ASTM D 3212, & D 3139 & D 2672	Per manufacturer recommendation.
	(14"-48")	PVC Pipe	AWWA C905 (DR 18)	ASTM D 3212, & D 3139 & D 2672	Per manufacturer recommendation
	(3.5"-54")	PE Pipe	ASTM F 714 (DR 17)	Per manufacturer recommendation / ASTM D 3261 / ASTM F 2620	ASTM D 2683
	(1/8"-42")	Steel	ASTM A 53 / ANSI/ASME B36.10 / 19 (Sch. 80)	Flanged: to ANSI B16.5 Threaded: to ANSI B 16.11 Butt-Weld	Flanged: to ANSI B16.1 Thread to ANSI B16.11 Butt-Weld
	(3"-64")	Ductile Iron	ASTM A746 / AWWA C150 / C151	AWWA C111 / C115	AWWA C110 or AWWA C153

Note 1 Pipe, joints, and fittings must meet the designed maximum operating pressure (for both daily use and during cleanout.)
Note 2 PVC pipe material shall be Type 1 (1120/1220) for pressure pipelines. All glued PVC pipe joints shall meet ASTM D 2855 Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets
Note 3 Other joints and metal/cast fittings may be used if pressure rating of fitting is equal to, or greater than, pressure rating of pipe used.
Note 4 Use thicker walled pipes when waste contains abrasive material (i.e. sand) that may cause the pipe to wear (erode), or when pump operates at higher velocities.

Pipes and Fittings that Meet Wisconsin Construction Specification 634-Waste Transfer Pipe

ASTM/AWWA/ AASHTO	Description
ASTM A 53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM C 76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 478	Standard Specification for Reinforced Concrete Manhole Sections
ASTM C 1227	Standard Specification for Precast Concrete Septic Tanks
ASTM D 1785	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2412	Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D 2464	Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2657	Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
ASTM D 2661	Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2672	Standard Specification for Joints for IPS PVC Using Solvent Cement
ASTM D 2683	Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D 2729	Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 2774	Standard Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
ASTM D 3034	Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3139	Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
ASTM D 3965	Specification for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Materials for Pipe and Fittings

ASTM F 412	Standard Terminology Relating to Plastic Piping Systems
ASTM F 477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 480	Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80
ASTM F 679	Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F 714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 1417	Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
ASTM F 1760	Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content
ASTM F 1668	Standard Guide for Construction Procedures for Buried Plastic Pipe
ASTM F 2306	Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications
ASTM F 2487	Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Corrugated High Density Polyethylene Pipelines
ASTM F 2620	Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.
ASTM F 2736	Standard Specification for 6 to 30 in. (152 To 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe
ASTM F 2764	Standard Specification for 30 to 60 in. [750 to 1500 mm] Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm Diameter
AASHTO M306	Standard Specification for Drainage, Sewer, Utility, and Related Castings
AWWA C110	AWWA Standard for Ductile-Iron and Gray-Iron Fittings
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	Standard for Flanged Ductile-Iron Pipe With Threaded Flanges
AWWA C150	American National Standard for Thickness Design of Ductile-Iron Pipe
AWWA C151	AWWA Standard for Ductile-Iron Pipe, Centrifugally Cast
AWWA C153	American National Standard for Ductile-Iron Compact Fittings for Water Service
AWWA C200	Steel Water pipe - 6 Inch and Larger
AWWA C605	Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
AWWA C900	AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution
AWWA C905	AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm), for Water Transmission and Distribution
AWWA C909	AWWA Standard for Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. Through 24 In. (100 mm Through 600 mm), for Water, Wastewater, and Reclaimed Water Service

Pipes and Fittings that DO NOT meet Wisconsin Construction Specification 634-Waste Transfer Pipe

Note-Some of the ASTMs listed below allow a dual marking of the pipe. The second marking may include an ASTM that is included on the list of pipes that will meet this specification. This will make the dual marked pipe acceptable.

ASTM/AWWA/ AASHTO	Description
ASTM C 425	Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 700	Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 877	Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
ASTM C 1244	Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
ASTM D 2665	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2680	Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer
ASTM F 628	Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core
ASTM F 667	Standard Specification for Large Diameter Corrugated Polyethylene Pipe and Fittings
ASTM F 891	Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core
ASTM F 949	Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings
ASTM F 1803	Standard Specification for Poly (Vinyl Chloride) (PVC) Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 1866	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Schedule 40 Drainage and DWV Fabricated Fittings
ASTM F 2648	Standard Specification for 2 to 60 inch [50 to 1500 mm] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

CONTROLLED TRAFFIC FARMING

CODE 334
(AC.)

DEFINITION
Controlled traffic farming (CTF) is confining all high load wheel/track traffic from farm equipment to specific lanes or tramlines (traffic pattern) in crop fields year after year.

PURPOSE
Improve soil health by limiting wheel traffic compaction to limited traffic lanes.

CONDITIONS WHERE PRACTICE APPLIES
This practice applies to cropland where wheel traffic can be limited to specific traffic lanes.

CRITERIA
Ensure that controlled traffic lanes are designed and used in a manner that avoids concentrated flow that may result in gully erosion.

Limit wheel/track traffic to no more than 33 percent of the soil surface. The same tracks must be used for all high load traffic continually. High wheel load traffic is defined here as any tire or track that bears a load higher than 6,000 pounds at 30 psi or 6 tons per axle.

If wide flotation tires are used they must be big enough that the inflation pressure will be below 18 psi to minimize compaction on trafficked rows.

Use a Geographic Positioning System (GPS) to guide field operations and wheeled/track traffic when the designated traffic lanes are obscured.

Once the tram lines or traffic pattern is established, do not till deeper than 4 inches.

CONSIDERATIONS
For narrow width or drilled crops, use a skip row system (where the wheel tracks are not planted) or use GPS guidance.

Recognize tire or rubber tracks should be less than 26 inches wide or less than the row crop spacing. Wide flotation tires do not work well in a CTF system. Split duals are a better alternative if single tires are inadequate.

Once tramlines are well established, operations which previously required the use of duals or extra-wide tires may no longer need them. Removing duals will significantly reduce the amount of trafficked area.

Extend the front axles of tractors to match the rear tires to reduce traffic lanes.

All traffic (high and low load) that crosses the field should utilize the designated traffic pattern. This includes custom applicators, pickup trucks, etc.

Consider no-till or direct-seed planting systems to further reduce compaction.

Utilize cover crops known to help reduce compaction, such as cereal rye, oil seed radish, or annual ryegrass.

Consolidated tramlines have lower rolling resistance and wheel slip than cultivated soil.

The compacted traffic lanes/tramlines are able to support higher axle loads, so tramlines also allow machinery access in higher soil moisture conditions.

Consolidated wheel tracks increase traction and reduce cultivation draft in the uncompact soil.

Consider subsoiling prior to establishing the controlled traffic lanes.

Repair all ruts prior to establishing the system.

All equipment should cover the same working width or multiples of that width. Adjust the traffic pattern of each piece of equipment to minimize the number of lanes or tramlines across the field.

As older equipment is replaced, consider the working width of the equipment and how it fits into the controlled traffic farming system. The goal of controlled traffic farming is to limit the wheel/track traffic to as low a percent of the field as possible. This can be improved by having all equipment with the same working width or multiples of that width.

Utilize hitch offsets in no-till systems to avoid salt buildup and/or pH imbalances where fertilizer is banded in the same zone year after year. Hitch offsets can also help with positioning row placement in relation to previous crop rows and residues without altering wheel track lanes.

Extend tractor tires or tracks to the width of the combine and grain cart to reduce traffic lanes. Be sure to check equipment warranty when extending axle widths.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared for each field site where the Controlled Traffic Farming system will be installed. Record practice specifications on the Controlled Traffic Farming Implementation Requirement document. Plans and specifications will include:

- Crops to be grown
- Row widths of all crops
- Width and spacing of tires/tracks of all equipment
- Percent of the field that receives controlled traffic

OPERATION AND MAINTENANCE

As older equipment is replaced, purchase equipment that will enhance the CTF system, reducing the number of tramlines in the system.

If ruts develop, use tillage or other specialized equipment to remove ruts and reestablish controlled traffic lanes.

REFERENCES:

Reeder, Randall, and John M. Smith. 2000. Controlled Traffic. In: Conservation Tillage Systems and Management, MWPS-45. Midwest Plan Service, Ames, IA. (Pages 77-82).

Reeder, Randall C. 2002. Controlled traffic. Encyclopedia of Soil Science. Marcell Dekker, Inc. pp.233-236.

M.A. Hamza, W.K. Anderson 2005 Soil compaction in cropping systems - A review of the nature, causes and possible solutions. Soil & Tillage Research 82 (2005) 121–145.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

FIELD OPERATIONS EMISSIONS REDUCTION

CODE 376
(AC.)

DEFINITION
Adjusting field operations and technologies to reduce particulate matter (PM) emissions from field operations.

PURPOSE
Improve air quality by reducing emissions of particulate matter.

CONDITIONS WHERE PRACTICE APPLIES
This practice applies to crop, range, pasture, and forestland.

CRITERIA
General Criteria
There shall be a demonstrated reduction in PM emissions from the benchmark (current system) to the planned system by using one or more of the techniques below:

- Combined Tillage Operations. Utilize equipment that allows multiple operations in a single pass to reduce the number of field passes per crop rotation.
- Precision Guidance Systems. To reduce total soil disturbance, use global positioning system (GPS) and steering technologies that minimize overlap of field passes.
- Alternative Equipment Technology. Use alternative equipment and/or equipment retrofits that reduce PM emissions. This can include dust-reducing technology (such as misters, deflectors, etc.) increasing equipment size to reduce net field passes, and changes to bed/row size or spacing.
- Timing of Field Operations. Modify the timing of field operations so that PM emissions are reduced. This can include conducting operations when relative humidity and/or soil moisture levels are higher, winds are lighter, or by limiting operations during high-wind events. This could also include a reduction in the amount of time between seedbed preparation and planting, and other such timing modifications that reduce PM emissions.
- Modify Crop Cultural and Harvest Methodologies. Modify operations to use other means of crop production such as performing soil disturbance and/or harvest operations at slower speeds. For example, harvesting a forage crop without allowing it to dry in the field, hand harvesting, applying water or other soil stabilizing material prior to soil disturbance or harvest, using transplants instead of direct seeding, and applying chemicals and fertilizers via irrigation to reduce field passes.

For applicable mechanical nut harvest operations manage pre-harvest irrigation water to create a more consolidated and firm soil surface to reduce harvest-related PM emissions.

CONSIDERATIONS

Managing higher levels of crop residue can reduce the potential for PM emissions from wind erosion and increase the potential for carbon sequestration.

Maintaining cover between rows or on alternate crop rows will reduce the potential for wind erosion.

Using alternatives to tillage for weed control (e.g. mowers, sprayers, flamers, etc.) can significantly reduce the PM emissions.

Increasing the time interval between uncombined tillage passes (e.g., disking) may help reduce PM emissions by reducing the effects of thermal profile changes that cause additional entrainment of the soil particles.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for each field or treatment unit according to the planning criteria and operation and maintenance requirements of this standard. Specifications shall describe the requirements to apply the practice to achieve the intended purpose for the practice site. Plans for the implementation of this practice shall, as a minimum, include the following specification components in an approved Field Operations Emissions Reduction, 376, Implementation Requirements document:

- field number and acres
- purpose of the emission reduction
- listing of the current benchmark field operations system
- listing of the planned field operations system
- listing of emission reduction activities and when and how the activities will be applied
- special considerations

Record specifications using the approved implementation requirements document.

OPERATION AND MAINTENANCE

Review the PM emission reduction activities seasonally or annually as appropriate to ensure the activities are working properly and modify if needed.

REFERENCES

Agricultural Air Quality Conservation Management Practices for San Joaquin Valley Farms. 2004. San Joaquin Valley Air Pollution Control District and USDA-NRCS. 14 pp.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

MULTI-STORY CROPPING

CODE 379
(ACRE)

DEFINITION

Existing or planted stands of trees or shrubs that are managed as an overstory with an understory of woody and/or non-woody plants that are grown for a variety of products.

PURPOSE

- Improve crop diversity by growing mixed but compatible crops having different heights on the same area.
- Improve soil quality by increasing utilization and cycling of nutrients and maintaining or increasing soil organic matter.
- Increase net carbon storage in plant biomass and soil.

CONDITIONS WHERE PRACTICE APPLIES

On all lands where trees, shrubs, woody or non-woody crops can be grown in combination. The practice does not apply on land that is grazed.

CRITERIA

General Criteria Applicable to All Purposes

Combinations of overstory and understory woody and/or non-woody plant species shall be compatible and complementary.

Plants shall be selected based on their adaptation to the climatic region and soil properties and capabilities. A precondition for any tree/shrub establishment is appropriately prepared sites. Refer to Wisconsin Conservation Practice Standard (WI NRCS CPS), Tree/Shrub Site Preparation (Code 490).

The planting and care of selected tree and shrub species will comply with WI NRCS CPS, Tree/Shrub Establishment (Code 612).

Canopy covers will be balanced/managed to optimize health and growth of plants in each story or level as determined by client objectives for each story of vegetation.

Plants selected for purposes of protection, growth and production will, at a minimum, maintain soil organic matter content.

Moisture conservation or supplemental watering shall be provided for plant establishment and growth where natural precipitation is too low for one or more of the selected species.

Select pest-resistant plant varieties.

Select species that enhance habitat for beneficial insects including pollinators.

Avoid selecting tree or shrub species, which provide habitat to pests of the accompanying crop or forage.

The overstory canopy density will be determined by the following tree or shrub management objectives:

- Light requirements and growth period of the managed crops dispersed in the understory.
- Erosion control needs.
- Machinery widths and turning areas.

For areas with frequent or periodic high to severe winds, leave denser canopies towards the windward side(s).

To reduce surface water runoff and erosion on erosion-prone sites, ground-level vegetation will be of sufficient coverage and oriented on or near the contour. Use mulch as needed to cover bare areas. Any bedding for any story of vegetation will be placed on the contour.

Heights and widths of trees or shrubs will be controlled so they will not interfere with structures and above or below ground utilities.

Additional Criteria to Improve Soil Quality by Increasing Utilization and Cycling of Nutrients and Maintaining or Increasing Soil Organic Matter

Plants selected for purposes of protection, growth and production will improve soil organic matter content.

Select deep-rooted species for the overstory.

Include nitrogen fixing species in the overstory and/or understory.

Retain thinning and pruning material on-site.

Additional Criteria to Increase Net Carbon Storage in Plant Biomass and Soil

For optimal carbon storage, select plant species that are adapted to the site to assure strong health and vigor and plant the full stocking rate for the site.

Manage the appropriate density for the site that will maximize above and below ground biomass production.

Minimize soil disturbance during establishment of the site.

Minimize soil disturbance during cultivation of the understory crop(s).

CONSIDERATIONS

Select crop, forage, tree and/or shrub varieties based on their tolerance to agriculture chemicals that will be used at the site.

Species diversity including use of native species should be considered to avoid loss of function due to species-specific pests or to enhance pollinator and wildlife needs.

High value trees or shrubs should be selected to maximize economic returns.

Consider selecting plants that are culturally important.

For areas with frequent or periodic high to severe winds, consider the use of WI NRCS CPS, Windbreak/Shelterbelt Establishment (Code 380) on the windward side(s) of multi-story cropped areas.

Anticipate possible off-site effects and modify the practice design accordingly.

Coppice ability of selected species of trees and shrubs should be considered when they are to be pruned periodically.

PLANS AND SPECIFICATIONS

Plans and Specifications for applying this practice shall be prepared for each site and recorded using approved technical notes, and narrative statements in the conservation plan. Wisconsin job sheets will address species planted and management of those species.

- Field map with location of multi-story cropping.
- Purpose of multi-story cropping.
- Define light requirement objectives of all crops and compatibility.
- Include job sheets to define planting and seeding requirements of all species (establishment dates, methods, seeding rates, spacings).

OPERATION AND MAINTENANCE

The trees, shrubs, crops, and/or forages will be inspected periodically and protected from adverse impacts including insects, diseases or competing vegetation. Newly planted trees or shrubs will also be protected from fire and damage from livestock or wildlife.

All other specified maintenance measures and techniques of tree/shrub establishment will continue until plant survival and establishment are assured. This includes replacement of dead and dying trees or shrubs, pruning of dead or damaged branches for safety reasons, periodic pruning of selected branches for control of product quality, and control of undesirable competing vegetation.

Any removals of tree or shrub products, use of agricultural chemicals, and maintenance operations shall be consistent with the intended purpose of the practice. Avoid damaging the site and soil and comply with applicable federal, state and local regulations pertaining to on-site and off-site effects.

FEDERAL, TRIBAL, STATE AND LOCAL LAWS

Users of this standard should be aware of potentially applicable federal, tribal, state and local laws, rules, regulations or permit requirements governing cover crops. This standard does not contain the text of federal, tribal, state or local laws.

REFERENCES

Bentrup, Gary. 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station.

Josiah, Scott. 1999. Farming the forest for specialty products. Proceedings of the North American Conference on Enterprise Development through Agroforestry. University of Minnesota, Minneapolis, MN.

Josiah, Scott. 2001. Productive Conservation: Growing Specialty Forest Products in Agroforestry Plantings. National Arbor Day Foundation. Nebraska City, NE. http://www.unl.edu/nac/morepublications/sfp2.pdf

Thomas, M.G. 1993. Income Opportunities in Special Forest Products: Self-help Suggestions for Rural Entrepreneurs. Ag. Info Bulletin 666. USDA Forest Service. Washington, D.C. http://www.fpl.fs.fed.us/documnts/usda/agib666/agib666.htm

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

STREAM HABITAT IMPROVEMENT AND MANAGEMENT

CODE 395
(ACRE)

DEFINITION

Maintain, improve or restore physical, chemical and biological functions of a stream, and its associated riparian zone, necessary for meeting the life history requirements of desired aquatic species.

PURPOSE

- Provide suitable habitat for desired fish and other aquatic species.
- Provide stream channel and associated riparian conditions that maintain stream corridor ecological processes and hydrological connections of diverse stream habitat types important to aquatic species.

CONDITIONS WHERE PRACTICE APPLIES

All streams and their adjoining backwaters, floodplains, associated wetlands, and riparian areas where geomorphic conditions or habitat deficiencies limit reproduction, growth, survival and diversity of aquatic species.

CRITERIA

General Criteria Applicable to All Purposes

Planned stream habitat improvements will;

- Address the aquatic species and life history stages for which the stream is being managed,
- Be based on a site-specific assessment of local hydrology, channel morphology, geomorphic setting, fish and other aquatic species present, riparian and floodplain conditions, and any habitat limitations including water quantity and quality, food supply, and restriction of upstream and downstream movement of aquatic species using the NRCS Stream Visual Assessment Protocol, Version 2 or comparable evaluation tool,
- When applied, result in a conservation system that meets or exceeds the minimum quality criteria for stream habitat established in Section III of the FOTG.

Manage adjoining riparian areas to support a diverse vegetation community suitable for the site conditions and desired ecological benefits. Such benefits include stream temperature moderation, recruitment of instream large wood and fine organic matter, input of riparian nutrients, habitat for terrestrial insects and other riparian dependent species, streambank integrity, and filtration of contaminants from surface runoff.

Design in-stream structures to be compatible with the dynamic nature of streams and rivers, facilitate natural geomorphic recovery when possible, and minimize disruption of recreational and other traditional uses of the stream corridor.

Structures installed for the purposes of this standard will not;

- Impede or prevent passage of fish and other aquatic organisms at any time, unless intended to isolate populations of native species of conservation concern,
- Cause excessive bank erosion,
- Cause unintentional lateral migration, aggradation or degradation of the channel,
- Hinder channel-floodplain interactions.

Where practical, restore or maintain stream habitat and channel forming processes such as natural flow regime, meander migration, sediment transport, recruitment and storage of large wood, and floodplain interactions with the stream.

All stream and riparian activities will occur within state and federal guidelines with regard to timing of spawning, incubation, and rearing of aquatic organisms, and breeding and nesting of terrestrial organisms.

Manage livestock to sustain a healthy stream corridor and associated habitats.

CONSIDERATIONS

Any stream habitat management project is most effective when applied within the context of overall watershed conditions and with clear objectives for stream management goals. Stream habitat management provisions should be planned in relation to other land uses that may affect stream corridors.

Before designing and implementing stream habitat improvements, consider the known or expected concerns within the watershed, such as: point and non-point source pollution; water diversions; and land management activities likely to influence stream habitat conditions. Additional measures that should be taken singularly or in combination to improve stream habitat include:

- Complete a general assessment of watershed conditions that are likely to affect the functions of the stream and its riparian area.
- Incorporate stream habitat improvements into a conservation plan that addresses soil quality, prescribed grazing, nutrient management, pest management, and other management practices for reducing non-point sources of pollution.
- Provide fish passage upstream and downstream and allow movement of other aquatic species and organic matter to the extent possible and when compatible with state and federal fish management objectives (see Wisconsin NRCS Conservation Practice Standard (WI NRCS CPS), Fish Passage (Code 396)).

- Reduce or manage excessive runoff due to watershed development, roads or land-use activities.
- Restore or protect riparian and floodplain vegetation and associated riverine wetlands.
- Maintain adequate in-stream flows to sustain diverse habitats for fish and other aquatic species, especially during critical life history stages of spawning, incubation and rearing.
- Provide heterogeneous and complex physical habitat components consistent with the physiographic setting and important to fish and other aquatic species in the watershed. These include suitable spawning substrates, structural elements such as boulders and/or large wood where appropriate, resting pools, overhead cover, and diverse riparian plant communities.
- Provide instream barriers to exclude aquatic nuisance species from upstream habitats where prescribed by state and federal fish management agencies to protect native fish populations.
- Provide screens on water pumps, diversion ditches, or any area where unintentional entrainment of aquatic species is likely to occur
- Improve floodplain-to-channel connectivity for development of seasonal or permanent backwater, wetland and off-channel habitats consistent with the local climate and hydrology of the stream.
- Maintain natural surface water, hyporheic, and ground water interactions to the extent possible.
- Control spread of exotic plant and animal species.
- Manage recreational and other land use activities to minimize impacts on stream banks, riparian vegetation and water quality.

PLANS AND SPECIFICATIONS

Plans and specifications shall be developed for each site where stream corridor management and improvement actions are to be implemented.

The plan will include:

- Detailed goals and objectives of the planned actions
- A site description
- The dates and sequence in which improvements or management actions will be completed
- A vegetation planting plan
- Maintenance requirements
- Monitoring guidelines for evaluating the effectiveness of the conservation actions

The plan shall specify;

- Location and extent of modification of the stream reach to accomplish the planned purpose.
- Riparian plant species and stocking rates if needed to accomplish the planned purpose.
- Planting dates, as well as the care and handling of seed or other planted materials to ensure an acceptable rate of survival.
- Site protection and preparation requirements for establishment or recruitment of riparian vegetation if needed.
- Drawings to illustrate installation or implementation requirements.

OPERATION AND MAINTENANCE

A detailed operation and maintenance plan shall be developed for all applications. The plan shall provide for periodic inspection and prompt repair or modification of any structures that are found to cause excessive streambank or streambed instability. All structural measures shall be evaluated on an annual basis. Post-project monitoring and evaluation of stream and riparian habitat conditions shall be conducted to determine if actions implemented are providing for management of the stream corridor habitats as planned. Any repair actions, if needed, shall comply with state and federal guidelines for protecting spawning, incubation and rearing times of aquatic species and breeding and nesting times of terrestrial species.

FEDERAL, TRIBAL, STATE AND LOCAL LAWS

Users of this standard should be aware of potentially applicable federal, tribal, state and local laws, rules, regulations or permit requirements governing cover crops. This standard does not contain the text of federal, tribal, state or local laws.

REFERENCES

Bureau of Land Management. 1998. Riparian Area Management: A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas. TR-1737-15.

Federal Interagency Stream Restoration Working Group (FISRWG). 1998. National Engineering Handbook 653 –Stream Corridor Restoration: Principles, Processes and Practices.

NRCS. 1998. The Practical Streambank Bioengineering Guide.

NRCS. 2002. Streambank Soil Bioengineering Field Guide for Low Precipitation Areas.

NRCS. 2005. National Biology Handbook Part 620. Aquatic and Terrestrial Habitat Resources.

NRCS. 2006. National Engineering Handbook Part 654. Stream Restoration Design Handbook.

NRCS. 2009. National Biology Handbook Part 614, Subpart B. Stream Visual Assessment Protocol. Version 2.

Roni, P. 2005. Monitoring stream and watershed restoration. American Fisheries Society, Bethesda, MD.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

HERBACEOUS WIND BARRIERS

CODE 603
(FT.)

DEFINITION
Herbaceous vegetation established in narrow strips within the field to reduce wind speed and wind erosion.

PURPOSE
- Reduce soil erosion (wind erosion: saltation, creep, and suspension)
- Reduce soil particulate emissions to improve air quality.
- Improve plant health by reducing crop damage by wind or wind-borne soil particles.

CONDITIONS WHERE PRACTICE APPLIES
Cropland where wind erosion is a resource concern.

CRITERIA
General Criteria Applicable to All Purposes
Practice is designed to reduce wind speed and wind erosion to the planned soil loss objectives using current wind erosion prediction technology.

Herbaceous plant materials that are used include the following characteristics:

- Perennial, annual or mix
- Adapted to local site conditions (i.e., soil and climate factors)
- Erect growth habit with stiff stems
- Resistant to lodging and strong leaf retention
- Tolerant to soil deposition
- Minimize competition to adjacent crop growth

The wind barrier orientation, spacing, composition, width and height needed to achieve the desired purpose shall be designed using the current NRCS approved wind erosion prediction technology.

Wind barriers are installed across the prevailing wind erosion direction as determined by site conditions and current wind erosion prediction technology soil loss objectives for the planned crop system.

Where both wind and water erosion is a concern, orient the wind barriers to address both wind and water erosion (avoid water accumulation and erosion adjacent to the barriers going up and down slope).

Wind barriers consist of one or more rows that provide the required porosity to achieve the planned soil loss objective. Row spacing within the wind barrier width is no greater than 36 inches.

Spacing between wind barriers is measured along the prevailing wind erosion direction during the critical wind erosion period(s) for the field. Barrier spacing does not exceed 10 times the planned wind barrier height, plus or minus 10 percent to accommodate equipment width and achieve the planned soil loss objective.

Additional Criteria to Reduce Soil Erosion and Particulate Generation

Wind barriers have a minimum expected height of 1.5 feet and porosity of 40 to 50 percent during the wind erosion periods for which the barriers are designed.

Additional Criteria to Protect Growing Crops from Damage from Wind or Wind-borne Soil Particles

During periods when sensitive crops are susceptible to damage by wind and wind-borne soil particles, wind erosion estimates do not exceed the crop tolerance as specified in the National Agronomy Manual (part 502) or other planned crop protection objectives.

Barriers designed for this purpose have a minimum expected height of 1.5 feet and porosity of 40 to 50 percent during the wind erosion period when growing crops need protection.

CONSIDERATIONS

Herbaceous wind barriers are most effective when combined with other conservation practices as a resource management system.

Adjust the spacing of barriers within the field within the limits of criteria above to accommodate width of field operations and minimize partial or incomplete passes.

Manage pest control in adjacent fields with techniques and pesticides that will not irreversibly damage the vegetation in the herbaceous wind barrier.

When compatible with the purposes and criteria for this practice, plant materials can be selected to attract undesirable insects away from crops or desirable insects that are beneficial to the adjacent crops.

When compatible with the purposes and criteria for application of this practice, plant materials can be selected that enhance food and cover for targeted wildlife.

Utilize supporting erosion control practices in the conservation system along with thoughtful positioning of this practice to reduce the risk of concentrated flow along the barrier.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared for each field site where Herbaceous Wind Barrier will be installed. Record practice specifications on the Herbaceous Wind Barrier Implementation Requirement document. Plans and specifications will include:

- Conservation purposes for the herbaceous wind barrier(s)
- Benchmark crop system wind erosion estimates
- Predominant wind erosion direction from benchmark simulation
- Planned crop system with herbaceous wind barriers wind erosion estimates
- Planned barrier number and positions within the field
- Planned barrier effective height, width, porosity and orientation to the wind erosion direction
- Planned crop strip width between barriers
- Plant materials used, seeding rate, method, and timing
- A field map showing the planned positioning of the wind barriers

OPERATION AND MAINTENANCE

Annual barriers shall be reestablished each year by planting at recommended dates, leaving rows standing and maintained throughout the critical periods for which the barrier was designed.

Gaps in wind barriers (e.g., 10-15 feet) shall be reestablished as soon as practical to maintain barrier effectiveness.

Nutrients are supplied as needed and weeds are managed to maintain the planned growth and effectiveness of the wind barriers.

When barriers become ineffective due to sediment accumulation or begin to accumulate runoff along the leading edge of the barriers, reposition and reestablish the wind barriers as needed after leveling the accumulated sediment.

Barriers shall be reestablished and/or relocated as needed to meet the purposes for this practice.

REFERENCES

Brandle, J.R., D.L. Hintz, and J.W. Sturrock; 1988. Wind Break Technology. ISBN 0-444-43019-9. Elsevier Science.

CORE4 Conservation Practices – The Common Sense Approach to Natural Resource Conservation; 1999. USDA, NRCS.

National Agronomy Manual. 190-V. 3rd ed., Part 502, Wind erosion; 2010. USDA, NRCS.

Skidmore, E.L. and N.P. Woodruff; 1968. Wind Erosion Forces in the United States and their use in predicting soil loss. Agriculture Handbook 346. USDA.

USDA-NRCS. PLANTS Database; 2010. http://plants.usda.gov. (Verified April 2010).

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

SEDIMENT BASIN

CODE 350
(NO.)

DEFINITION
A basin constructed with an engineered outlet, formed by constructing an embankment, excavating a dugout, or a combination of both.

PURPOSE
To capture and detain sediment-laden runoff, or other debris for a sufficient length of time to allow it to settle out in the basin.

CONDITIONS WHERE PRACTICE APPLIES
This practice applies to urban land, construction sites, agricultural land, and other disturbed lands where:

- Physical conditions or land ownership preclude treatment of a sediment source by the installation of erosion-control measures.
- Failure of the basin will not result in loss of life, damage to homes, commercial or industrial buildings, main highways or railroads; or in the use of public utilities.
- The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the auxiliary spillway.
- The effective height of the dam is 35 feet or less. The effective height of the dam is the difference in elevation between the auxiliary spillway crest and the lowest point in the cross section taken along the centerline of the dam.
- The dam is classified low hazard according to section 520.21(E) of the NRCS National Engineering Manual (NEM).

CRITERIA
Design and install measures according to a site-specific plan in accordance with all local, State, Tribal, and Federal laws and regulations. Apply measures that are compatible with improvements planned or being carried out by others.

Location

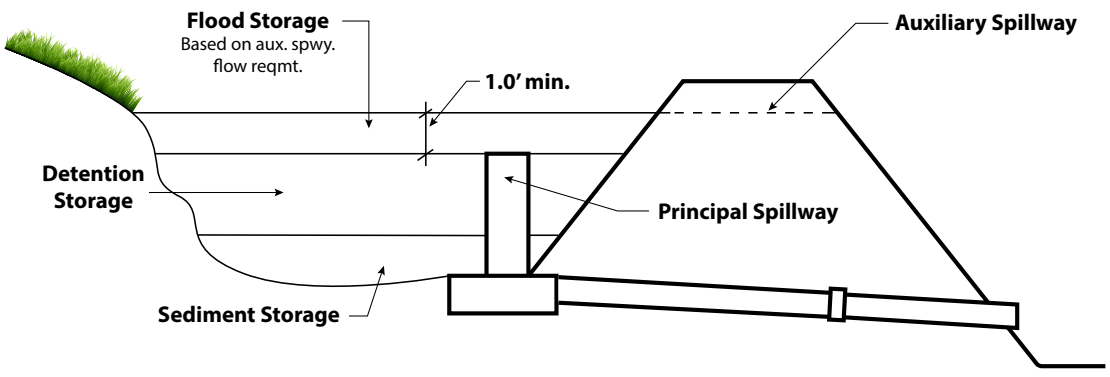
Sediment basins provide the last line of defense for capturing sediment when erosion has already occurred. When possible construct the basin prior to soil disturbance in the watershed. Choose the location of the sediment basin so that the basin intercepts as much of the runoff as possible from the disturbed area of the watershed. Choose a location that minimizes the number of entry points for runoff into the basin and interference with construction or farming activities. Do not locate sediment basins in perennial streams.

Storage Capacities

The sediment basin must have sediment storage, detention storage, and temporary flood storage capacities as follows:

- Design a minimum sediment storage capacity equal to the design life of the structure, or provide for periodic cleanout.
- For maximum sediment retention, design the basin so that the detention storage remains full of water between storm events. However, if site conditions, safety concerns, or local laws preclude a permanent pool of water, provide for dewatering of all or a portion of the detention and sediment storages between storm events.
- Design flood storage based on the required design storm for the auxiliary spillways. Provide a minimum of 1 foot in elevation between the principal and auxiliary spillways.
- Calculate the sediment storage volume from the bottom of the basin to the top of the sediment storage.
- Calculate the detention volume from the top of the sediment storage to the crest of the principal spillway.
- Calculate the flood storage between the crest of the principal spillway and the crest of the auxiliary spillway.

Figure 1. Sediment Basin Storage



Principal and Auxiliary Spillway Design

Design the principal and auxiliary spillways as follows:

- Design the principal spillway to carry long-duration, continuous, or frequent flows without discharge through the auxiliary spillway.
- Design the principal spillway to drawdown the temporary flood storage within 24 hours.
- Use a principal spillway pipe 6-inches diameter or greater.

- Provide a stable outlet of the principal spillway for anticipated design flow conditions.
- Provide means such as perforations or small openings in the principal spillway riser when dewatering all or a portion of the detention and sediment storages.
- Design the auxiliary spillway to pass large storms without damage to the basin.

Refer to criteria in Wisconsin NRCS Conservation Practice Standard (WI NRCS CPS), Pond (Code 378), for the required design criteria for the principal and auxiliary spillways.

Basin Shape and Surface Area

Design the sediment basin with a length-to-width ratio of 2 to 1 or greater. If needed, use baffles to divert the flow in the basin to lengthen the flow path of incoming water to achieve the required length-to-width ratio.

The minimum surface area of the sediment basin, measured at the principal spillway elevation, shall be sized based on the texture of the soil entering the basin and the peak outflow during the 1-year, 24-hour duration storm.

$$S_a = 1.2 * (q_{out} / v_s)$$

Where:

S_a = Minimum treatment surface area of the sediment basin (square feet)

q_{out} = Peak outflow (cubic feet/second) during the 1-year, 24-hour design storm for the principal outlet

v_s = Particle settling velocity (feet/second) See Table 1

1.2 = safety factor

Table 1

V_s (ft./sec.)	Soil Textural Class*
.0012	S, LS, SL
.000073	L, SiL, Si, SCL
.000012	CL, SiCL, SC, SiC, C

S = Sand Si = Silt C = Clay L = Loam

*Based on dominant textural class.

Embankment and Side Slopes

If the sediment basin includes an embankment, refer to criteria in WI NRCS CPS, Pond (Code 378), for design requirements.

Provide side slopes of the pool area 3 horizontal to 1 vertical, or flatter, above the permanent waterline, and 2 horizontal to 1 vertical, or flatter, below the permanent waterline.

Safety

Design measures necessary to prevent serious injury or loss of life in accordance with requirements of NRCS NEM, Part 503, Safety.

Vegetation and Soil Protection

Seed or sod the exposed surfaces of earthen embankments, earth spillways, borrow areas, and other areas disturbed during construction in accordance with the criteria in WI NRCS CPS, Critical Area Planting (Code 342). When necessary to provide surface protection where climatic conditions preclude the use of seed or sod, use the criteria in WI NRCS CPS, Mulching (Code 484), to install inorganic cover material such as gravel.

Cultural Resources

Evaluate the existence of cultural resources in the project area and any project impacts on such resources. Provide conservation and stabilization of archeological, historic, structural, and traditional cultural properties when appropriate.

CONSIDERATIONS

A large sediment basin may have an effect on the peak discharge rate from a watershed. Planners should consider this, and take steps to mitigate any potential negative effects this may have on riparian habitat downstream from the structure.

In many cases, the use of a sediment basin alone may not provide sufficient protection for offsite sedimentation problems. To work most effectively, the sediment basin should be the last practice in a series of erosion control and sediment capturing practices installed in the disturbed area. This incremental approach will reduce the load on the basin and improve effectiveness of the overall effort to prevent off-site sedimentation problems.

Many factors influence the efficiency of sediment removal in a basin. These include the detention time of runoff, the type of dewatering device, the presence of a permanent pool in the basin, a decrease in turbulence in the basin, and soil particle size. Use the following techniques as needed to remove clay and other fine-grained particles.

- Increase detention time by increasing the storage volume in the basin. Increased storage along with a properly designed dewatering device can significantly improve the efficiency of sediment capture.
- Dewater in a manner that removes the cleaner water above the sediment storage, without removing the sediment-laden water found deeper in the basin. The use of a skimming device that floats on the surface and adjusts to water level changes can improve the quality of the water leaving the basin. The "North Carolina Erosion and Sediment Control Planning and Design Manual" provides details for this type of dewatering device.
- Maintaining a permanent pool also improves sediment trapping by reducing the resuspension of sediment in the basin. Only dewatering the temporary flood storage or a portion of the detention storage can accomplished this goal. Removal of sediment from the basin before it reaches the sediment storage elevation will maintain the pool volume and improve trapping efficiency.
- Reduce turbulence in the basin by constructing porous baffles that extend across the entire basin. The baffles slow down flows and force water to spread across the entire width of the basin. The "North Carolina Erosion and Sediment Control Planning and Design Manual" contains a thorough discussion and design criteria for porous baffles.

- For very fine-grained sediments, add flocculants to the runoff before it enters the basin. One commonly used flocculant is anionic polyacrylamide (PAM). Do not use cationic polyacrylamide because it can be toxic to aquatic life.

Diverting runoff from undisturbed areas away from the basin will improve the function of the basin. The design storm for diversion measures should be equal to the design storm for the auxiliary spillway of the basin.

Use forebays, separate from the main basin and easily accessible for cleanout, to reduce turbulence and allow larger particles to settle out of the runoff before it enters the main basin.

Because the sediment storage capacity of a basin is finite, choose a location that allows access for sediment removal when the storage capacity is full.

Visual resource design. Carefully consider the visual design of sediment basins in areas of high public visibility and those associated with recreation. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

Shape the embankment to blend with the natural topography. Shape the edge of the pond so that it is generally curvilinear rather than rectangular. Shape excavated material so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, add islands to provide visual interest and to attract wildlife.

Changed Use. In some situations, after they have served the sediment capture function, sediment basins may remain in place to function as stormwater detention or wildlife ponds. This requires appropriate planning during the design phase to ensure that the basin can function for a different use. This may also require significant modifications to outlet structures as well as removal of accumulated sediment to convert it to a new use.

Use by Wildlife. If the basin will be used by wildlife, the use of native species is recommended to provide food and habitat diversity. Also, consider wildlife use of the basin when scheduling maintenance activities that may disrupt wildlife life cycles or negatively impact pollinators.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice according to this standard. As a minimum, include the following items:

- A plan view of the layout of the sediment basin.
- Typical profiles and cross sections of sediment basin.
- Details of the outlet system.
- Structural drawings adequate to describe the construction requirements.
- Requirements for vegetative establishment and/or mulching, as needed.
- Safety features.
- Site-specific construction and material requirements.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator.

As a minimum, include the following items in the operation and maintenance plan:

- Periodic inspections of all structures, earthen embankments, spillways, and other significant appurtenances.
- Prompt removal of trash from pipe inlets and trash racks.
- Prompt repair or replacement of damaged components.
- Prompt removal of sediment when it reaches predetermined storage elevations.
- Periodic removal of trees, brush, and undesirable species.
- Periodic inspection of safety components and immediate repair if necessary.
- Maintenance of vegetative protection and immediate seeding of bare areas as needed.

REFERENCES

American Society for Testing and Materials. Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM D2487. West Conshohocken, PA.

California Stormwater Quality Association. 2003. California Stormwater BMP Handbook, Construction. Menlo Park, CA.

Center for Watershed Protection. 2000. Improving the Trapping Efficiency of Sediment Basins, Article 58, The Practice of Watershed Protection: Techniques for Protecting and Restoring Urban Watersheds. Ellicott City, MD.

Department of Conservation and Recreation, Commonwealth of Virginia. 1992. Virginia Erosion and Sediment Control Handbook, 3rd Edition, Richmond, VA.

Jarrett, A. R. August 1998. Controlling the Dewatering of Sedimentation Basins, Agricultural and Biological Engineering, Pennsylvania State University, University Park, PA.

North Carolina Department of Environmental and Natural Resources, Division of Land Resources. 2006. North Carolina Erosion and Sediment Control Planning and Design Manual. Raleigh, NC.

Tennessee Erosion and Sediment Control Handbook. 2002. Tennessee Department of Environment and Conservation. Nashville, TN.

USDA NRCS. Engineering Technical Releases, TR-210-60, Earth Dams and Reservoirs. Washington, DC.

USDA NRCS. National Engineering Handbook (NEH), Part 628, Dams. Washington, DC.

USDA NRCS. NEH, Part 633, Soil Engineering. Washington, DC.

USDA NRCS. NEH, Part 636, Structural Engineering. Washington, DC.

USDA NRCS. NEH, Part 650, Engineering Field Handbook. Washington, DC.

USDA NRCS. NEH, Section 3, Sedimentation. Washington, DC.

USDA NRCS. National Engineering Manual. Washington, DC.

USDA NRCS & Illinois Environmental Protection Agency. 2002. Illinois Urban Manual. Champaign, IL.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

DIVERSION

CODE 362
(AC.)

DEFINITION
A channel generally constructed across the slope with a supporting ridge on the lower side.

PURPOSE
This practice may be applied to support one or more of the following purposes:

- Break up concentrations of water on long slopes, on undulating land surfaces and on land that is generally considered too flat or irregular for terracing.
- Divert water away from farmsteads, agricultural waste systems, and other improvements.
- Collect or direct water for storage, water-spreading, or water-harvesting systems.
- Protect terrace systems by diverting water from the top terrace where topography, land use, or land ownership prevents terracing the land above.
- Intercept surface and shallow subsurface flow.
- Reduce runoff damages from upland runoff.
- Reduce erosion and runoff on urban or developing areas and at construction or mining sites.
- Divert water away from active gullies or critically eroding areas.
- Supplement water management on conservation cropping or stripcropping systems.

CONDITIONS WHERE PRACTICE APPLIES
This practice applies to all land uses where surface runoff water control and management are needed, and where soils and topography are such that the diversion can be constructed and a suitable outlet is available or can be provided.

CRITERIA
Design and install measures according to a site-specific plan in accordance with all local, State, Tribal, and Federal laws and regulations. Apply measures that are compatible with improvements planned or being carried out by others.

Capacity

Diversions as temporary measures, with an expected life-span of less than 2 years, will be designed for a minimum capacity for the peak discharge from the 2-year frequency, 24-hour-duration storm.

Diversions that protect agricultural land must have a minimum capacity for the peak discharge from a 10-year frequency, 24-hour-duration storm.

Diversions designed to protect areas such as urban areas, buildings, roads, and animal waste management systems require a minimum capacity for the peak discharge from a storm frequency consistent with the hazard involved but not less than a 25-year frequency, 24-hour-duration storm. Freeboard minimum depth is 0.3 ft.

Peak discharges for all storms will be determined by the method outlined in NRCS National Engineering Handbook (NEH) Part 650, Engineering Field Handbook (EFH) Chapter 2 or Technical Release 55 (TR-55).

Design depth is the channel storm-flow depth plus freeboard.

Cross Section

The channel may be parabolic or trapezoidal. The diversion shall be designed to have stable side slopes, but no slope shall be steeper than two horizontal to one vertical (2:1).

The minimum top width of the supporting ridge is 4 feet **except** for diversions with less than 10 acres of drainage area above cropland, pastureland, or woodland, where the minimum top width of the supporting ridge may be 3 feet.

The top of the constructed ridge at any point must not be lower than the design depth plus the specified overfill for settlement. The minimum additional fill for settlement shall be 10 percent of the fill height.

The diversion design depth at a culvert crossing must equal the headwater depth for the culvert design storm plus freeboard.

Channel Stability and Capacity

Channel grades may be uniform or variable. Determine minimum depth and width requirements for channel stability by using the procedures in the National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 9, Diversions; or Agricultural Research Service (ARS) Agricultural Handbook 667, Stability Design of Grass-Lined Open Channels (Sept. 1987); or other equivalent methods (permissible velocity method). The ARS handbook can be found on the USDA National Agricultural Library Digital Collections Web site.

When a retardance class method is used to determine capacity (Q) of the diversion by the relationship

$$Q=AV \quad (A = \text{flow area}),$$

and, the velocity (V) is calculated by using Manning's Equation; use the highest expected value of Manning's "n", which represents the flow retardance due to the height, density and type of vegetation.

Channel velocity shall not exceed values as shown in Table 1.

Maximum velocities for diversions with linings shall be as specified in the Wisconsin NRCS Conservation Practice Standard (WI NRCS CPS), Lined Waterway (Code 468), or as specified by the manufacturer for commercially available lining products.

Maximum velocities for diversions with bare soil channels shall be as shown in Table 2. A Manning's "n" value of 0.03 or less shall be used for determining the velocity in bare soil channels.

Table 1. Vegetated Diversion Velocity

Diversion Slope Range (%)	Permissible Velocity[1]	
	Erosion Resistant Soils[2] (ft./sec.)	Easily Eroded Soils[3] (ft./sec.)
0-5	7	5
5.1-10	6	4
Over 10	5	3

[1]Use velocities exceeding 5 ft./sec. only where good cover and proper maintenance can be obtained.
[2]Cohesive (clayey) fine-grain soils and coarse-grain soils with cohesive fines with a plasticity index of 10 to 40 (CL, CH, SC, and GC).
[3]Soils that do not meet the requirements for erosion-resistant soils.

Table 2. Bare Soil Channel Diversion Velocity

Soil Texture[1]	Permissible Velocity (ft./sec.)
Sands, silts, and loams (SW, SP, ML, SM, SM-SC, CL-ML)	1.5
Silty clay loams, and sandy clay loams (SC, CL) PI<10	2.0
Silts, Clays (MH, CL, CH) PI≥10	2.5

[1]General description and Unified Soil Classification System designation. PI is plasticity index.

Protection Against Sedimentation

Diversions normally should not be used below high sediment-producing areas. When they are, a practice or combination of practices for the drainage area are needed to prevent damaging accumulations of sediment in the channel. This may include practices such as land treatment erosion control practices, cultural or tillage practices, vegetated filter strip, or structural measures. Install needed sediment control practices in conjunction with or before the diversion construction.

If movement of sediment into the channel is a problem, include extra capacity for sediment accumulation in the design and instructions for periodic removal in the operation and maintenance plan.

Outlets

Each diversion must have a safe and stable outlet with adequate capacity. The outlet may be a grassed waterway, a lined waterway, vegetated or paved area, a grade stabilization structure, an underground outlet, a stable watercourse, a sediment basin, or a combination of these practices. The outlet must convey runoff to a point where outflow will not cause damage. Install vegetative outlets before diversion construction to insure establishment of stable vegetative cover in the outlet channel.

When using an underground outlet, the diversion ridge must contain the design storm runoff combined with an underground outlet release rate to protect from overtopping. To prevent the diversion from overtopping, the designed outflow capacity of the outlet(s) must be achieved at, or below, the design depth of the diversion at their junction.

Vegetative Establishment

Vegetate diversions according to WI NRCS CPS, Critical Area Planting (Code 342). Select species suited to the site conditions and intended uses. Use plant species that exhibit the capacity to achieve adequate density, height, and vigor within an appropriate time frame to stabilize the diversion.

Establish vegetation as soon as conditions permit. Use mulch anchoring, nurse crop, rock, straw or hay bale dikes, fabric checks, filter fences, or runoff diversion to protect the vegetation until it is established. Planting of a close-growing crop, (e.g., small grains or millet), on the contributing watershed prior to construction of the diversion can significantly reduce the flow through the diversion during establishment.

Lining

If the soils or climatic conditions preclude the use of vegetation for erosion protection, nonvegetative linings such as concrete, gravel, rock riprap, cellular block, or other approved manufactured lining systems may be used.

Design diversion channel liners in accordance with WI NRCS CPS, Lined Waterway or Outlet (Code 468).

CONSIDERATIONS

A diversion in a cultivated field should be aligned and spaced from other structures or practices to permit use of modern farming equipment. The side slope lengths should be sized to fit equipment widths when cropped.

At noncropland sites, consider planting native vegetation in areas disturbed due to the diversion construction.

Diversion of upland water to prevent entry into a wetland may convert a wetland by changing the hydrology. In analyzing downslope impacts, minimize adverse effects to existing wetland functions and values. Similarly consider how to maximize wetland functions and values with the diversion design.

Provide construction inspection to ensure that the top of the constructed ridge at any point meets the design depth plus the specified overfill for settlement.

Any construction activities should minimize disturbance to wildlife habitat. Opportunities should be explored to restore and improve wildlife habitat, including habitat for threatened, endangered, and other species of concern.

For vegetated diversions, avoid areas where unsuitable subsurface, subsoil, substratum material that limits plant growth such as salts, acidity, root restrictions, etc., may be exposed during implementation of the practice. Where these areas cannot be avoided, seek recommendations from a soil scientist for improving the condition or, if not feasible, consider stock piling the topsoil, over excavating the diversion and replace the topsoil over the excavated area to facilitate vegetative establishment.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for diversions that describe the requirements for applying the practice according to this standard. As a minimum, the plans and specifications must include:

- A plan view of the layout of the diversion.
- Typical cross sections of the diversion(s).
- Profile(s) of the diversion(s) that include both the channel bottom and supporting ridge top.
- Disposal requirements for excess soil material.
- Vegetative establishment requirements.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for use by the client. Include specific instructions for maintaining diversion capacity, storage of runoff water, ridge height, and outlets in the plan.

The minimum requirements to be addressed in the operation and maintenance plan are:

- Provide periodic inspections, especially immediately following significant storms.
- Promptly repair or replace damaged components of the diversion as necessary.
- Maintain diversion capacity, ridge height, and outlet elevations especially if high sediment-yielding regions are in the drainage area above the diversion. Establish necessary clean-out requirements.
- Each inlet for underground outlets must be kept clean and sediment buildup redistributed so that the inlet is at the lowest point. Inlets damaged by farm machinery must be replaced or repaired immediately.
- Redistribute sediment as necessary to maintain the capacity of the diversion.
- Maintain vegetation and trees and control brush by hand, chemical, and mechanical means. Maintenance of vegetation will be scheduled outside of the primary nesting season for grassland birds.
- Control pests that will interfere with the timely establishment of vegetation.
- Keep machinery away from steep-sloped ridges. Keep equipment operators informed of all potential hazards.

REFERENCES

USDA, ARS. 1987. Stability design of grass-lined open channels. Agriculture Handbook 667.

USDA, NRCS. National Engineering Handbook, Part 650, Engineering Field Handbook, Chap. 9, Diversions.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

POND

CODE 378
(NO.)

DEFINITION

A pond is a water impoundment made by constructing an embankment, by excavating a dugout, or by a combination of both.

In this standard, NRCS defines ponds constructed by the first method as embankment ponds, and those constructed by the second method as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at the auxiliary spillway elevation is 3 feet or more above the lowest original ground along the centerline of the embankment.

PURPOSE

A pond stores water for livestock, fish and wildlife, recreation, fire control, erosion control, flow detention, and other uses such as improving water quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all excavated ponds. It also applies to embankment ponds that meet all of the criteria for low-hazard dams as listed below:

- The failure of the dam will not result in loss of life, damage to homes, commercial or industrial buildings, main highways, or railroads, or in interruption of the use or service of public utilities.
- The product of the storage times the effective height of the dam is less than 3,000 acre-feet[2].
- The effective height of the dam is 35 feet or less.

This standard does not apply to ponds with the primary purpose of controlling solids loading and attached pollutants. Such ponds shall meet the criteria set forth in Wisconsin Department of Natural Resources (DNR) Standard for Wet Detention Basin (1001)

CRITERIA

General Criteria Applicable to All Purposes

Plan, design, and construct this practice to comply with all Federal, State, and local regulations. The owner and/or operator is responsible for securing required permits. Permitting authorities should be contacted during the planning phase of the project. This standard does not contain the text of the federal, tribal, state or local laws.

A site assessment shall be conducted, documented, and incorporated into the design. The assessment shall be performed to determine physical site characteristics that will influence the placement, construction, maintenance, and environmental integrity of a proposed pond. The assessment shall include input from the owner/operator. The site assessment shall include:

a. Locations and elevations of buildings, roads, lanes, soil test pits, property lines, setbacks, easements, springs, wells, floodplains, surface drains, drain tile, utilities, overhead lines, cultural resources, wetlands, and potential contamination sources.
b. Geological investigations. Use pits, trenches, borings, reviews of existing data, or other suitable means of investigation to characterize materials within the embankment foundation, auxiliary spillway, and borrow areas. Classify soil materials using the Unified Soil Classification System (ASTM D2487). Test pits or test holes shall be recorded to include:
    (1) The number and distribution needed to characterize the subsurface.
    (2) The elevation of bedrock and bedrock type, if encountered, such as sandstone, limestone, dolomite, or granite.
    (3) Saturation indicators, if encountered, such as seepage from sand and gravel lenses, lens thickness, and elevation. Groundwater maps and well construction logs may be included when available and applicable.
    (4) Soil test results.
c. Locations and elevations of sinkholes and other karst features within 500 feet of the pond.
d. Locations and elevations, soil volumes, soil samples, and
e. Identification of potential impacts from failure of the embankments, liners, or structures. Document hazard potential classification.
f. An estimate or measurement of the base flow rate, when present.
g. Identification of potential navigability, water quality and wetland issues that may require permits.
h. Community wells, existing or proposed private wells, ponds, or springs

The pond owner must have ownership or legal control of the pond site and impoundment including the right to flood all land in the impoundment up to the 1% flood event. Legal control is usually obtained through permanent easements recorded on the deed of the affected property.

A pond may not be constructed with a horizontal separation distance less than 25 feet to an existing or proposed private well, pond, or spring OR 400 feet of an existing or proposed community well. This distance is measured from the edge of the pond formed during the 1% flood event, unless the well is properly decommissioned in accordance with Wisconsin Administrative Code Chapter NR 812 and Wisconsin NRCS Conservation Practice Standard (WI NRCS CPS), Well Decommissioning (Code 351).

Design a minimum sediment storage capacity equal to the design life of the structure, or provide for periodic cleanout. Protect the drainage area above the pond to prevent sedimentation from adversely affecting the design life.

Design measures necessary to prevent serious injury or loss of life in accordance with requirements of NRCS National Engineering Manual (NEM), Part 503, Safety. Appropriate safety measures such as warning signs, rescue facilities, visual barriers, safety shelf, and other applicable features shall be incorporated as appropriate for the site.

Construction operations shall be carried out in such a manner and sequence that erosion and water pollution will be minimized. Sources for acceptable construction site erosion/ sediment control practices can be found in NRCS FOTG Section IV, NRCS Wisconsin Standard Detail Drawings for Conservation Practices, DNR Construction Site Erosion Control Best Management Practices (BMPs), and Chapter 10 of the Department of Transportation (DOT) Facility Development Manual.

Seed or sod the exposed surfaces of earthen embankments, earth spillways, borrow areas, and other areas disturbed during construction in accordance with the criteria in WI NRCS CPS, Critical Area Planting (Code 342). When necessary to provide surface protection where climatic conditions preclude the use of seed or sod, use the criteria in WI NRCS CPS, Mulching (Code 484), to install inorganic cover material such as gravel.

Cultural resources. Evaluate the existence of cultural resources in the project area and any project impacts on such resources. Provide conservation and stabilization of archaeological, historic, structural, and traditional cultural properties when appropriate.

Site conditions. Select or modify the site to allow runoff from the design storm to safely pass through (1) a natural or constructed auxiliary spillway, (2) a combination of a principal spillway and an auxiliary spillway, or (3) a principal spillway.

Select a site that has an adequate supply of water for the intended purpose via surface runoff, groundwater, or a supplemental water source. Water quality must be suitable for its intended use.

Reservoir. Provide adequate storage volume to meet user demands for all intended purposes. Account for sedimentation, season of use, evaporation loss, and seepage loss when computing the storage volume.

When seepage losses from the pond area are expected to compromise the intended use, the pond area shall be sealed. Acceptable methods are included in WI NRCS CPS, Pond Sealing or Lining , Flexible Membrane (Code 521A), Pond Sealing or Lining, Bentonite Treatment (Code 521C), or Pond Sealing or Lining, Compacted Clay Treatment (Code 521D).

Criteria Applicable to Embankment Ponds.

The area under the footprint of the embankment shall be cleared of all sod, roots, vegetation, organic matter, and other undesirable materials.

Soils should be suitable for construction and water retention. Soils should not contain any hazardous or toxic substances.

Foundation cutoff. Design a cutoff of relatively impervious material under the dam and up the abutments as required for preventing seepage. Locate the cutoff at, or upstream from, the centerline of the dam. Extend the cutoff deep enough to intercept flow and connect with a relatively impervious layer. Combine seepage control with the cutoff as needed. Use a cutoff bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Design cutoff side slopes no steeper than one horizontal to one vertical.

Seepage control. Include seepage control if (1) foundation cutoff does not intercept pervious layers, (2) seepage could create undesired wet areas, (3) embankment stability requires seepage control, or (4) special problems require drainage for a stable dam. Control seepage by (1) foundation, abutment, or embankment filters and drains; (2) reservoir blanketing; or (3) a combination of these measures.

Top width. Table 1 provides the minimum top widths for dams of various total heights.

Design a minimum width of 16 feet for one-way traffic and 26 feet for two-way traffic for the top of dams used as public roads. Design guardrails or other safety measures where necessary and follow the requirements of the responsible road authority. For dams less than 20 feet in total height, maintenance considerations or construction equipment limitations may require increased top widths from the minimum shown in Table 1.

Table 1. Minimum top width for dams

Design fill height of dam (feet)	Top width (feet)
Less than 10	6
10-14.9	8
15-19.9	10
20-24.9	12
25-34.9	14
35 or more	15

Side slopes. Design each side slope with a ratio of two horizontal to one vertical or flatter. Design the sum of the upstream- and downstream-side slopes with a ratio of five horizontal to one vertical or flatter. As required, design benches or flatten side slopes to assure stability of all slopes for all loading conditions.

Slope protection. Design special measures such as berms, rock riprap, sand-gravel, soil cement, or special vegetation as needed to protect the slopes of the dam from erosion. Use NRCS Engineering Technical Release (TR) 210-56, A Guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments, and TR-210-59, Riprap for Slope Protection against Wave Action, as applicable.

A berm at least 6 feet wide shall be constructed across the embankment at normal pool elevation on the upstream side and extend to the abutments on all dams with a permanent pond area of more than 2 acres or when the pond has an exposure of more than 500 feet of fetch.

A semicircular berm at normal pool elevation extending not less than 5 feet from the edge of any pipe inlet shall be installed on all dams not covered by the preceding paragraph to protect the inlet from damage by ice or floating debris

Freeboard. This criteria applies to boxes a, c, and e of Table 3. Design a minimum of 1.0 feet of freeboard between design high-water-flow elevation in the auxiliary spillway and the top of the settled embankment. Design a minimum 2.0 feet of elevation difference between the crest of the auxiliary spillway and the top of the settled embankment when the dam has more than a 20-acre drainage area or more than 20 feet in effective height. Design a minimum of 1.0 feet of freeboard above the peak elevation of the routed design hydrograph to the top of the settled embankment, when the pond has no auxiliary spillway.

For ponds that meet the criteria in box b or d of Table 3, the freeboard shall be a minimum of 0.3 feet.

Settlement. Increase the height of the dam by the amount needed to ensure that the settled top elevation of the dam equals or exceeds the design top elevation. Design a minimum of 5 percent of the design fill height of the dam associated with each dam cross section, except where detailed soil testing and laboratory analyses or experience in the area shows that a lesser amount is adequate.

Principal spillway and pipe conduit through the embankment. Design a pipe conduit with needed appurtenances through the dam, except where rock, concrete, or other types of lined spillways are used, or where a vegetated or earth spillway can safely handle the rate and duration of base flow.

Design a minimum of 0.5-feet difference between the crest elevation of the auxiliary spillway and the crest elevation of the principal spillway when the dam has a drainage area of 20 acres or less. Design a minimum of 1.0-foot difference when the dam has a drainage area of over 20 acres.

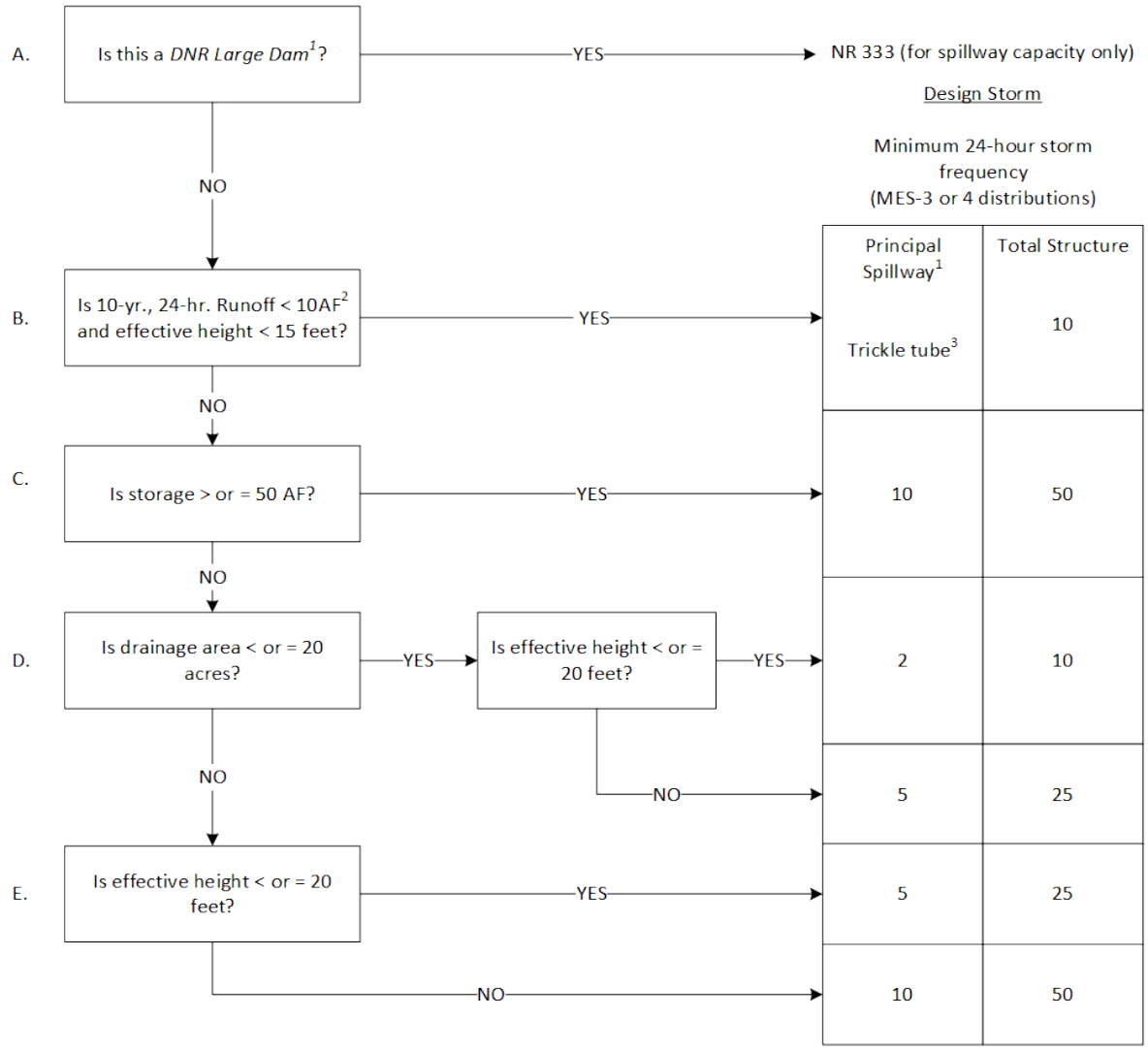
Polyethylene or plastic in-line water level control structures, typically used in drainage water management, may be used for wetland restoration principal spillways when their manufactured depth 6 feet or less.

Table 2. Trickle Tube Separation

Height Effective (ft.)	Separation Distance (ft.)
≥ 10	2
6-9.9	1.5
≤ 5.9	1

For designs without a principal spillway but with a trickle tube, see Table 2 for the separation distance between the trickle tube invert elevation and the auxiliary spillway elevation, or the top of dam if there is no auxiliary spillway. An armored auxiliary spillway capable of handling the expected rate and duration of flow may be used in lieu of a trickle tube for designs without a principal spillway.

Table 3. Minimum Spillway Capacity



[1]Consideration should be given to increasing principal spillway design storm frequency to reduce the frequency of the auxiliary spillway's use.
[2]AF = acre-feet
[3]Trickle tube or other type of principal spillway required. If another type of principal spillway is used, it shall meet the separation distances required for a trickle tube. If a trickle tube is used, it shall be a 4-inch diameter minimum conduit, or the size required to pass 2 times the base flow. Trickle tube material shall meet the requirements of WI NRCS CPS, Underground Outlet (Code 620)

The minimum capacity of the principal spillway shall be that required to pass the peak discharge from the design storms (Table 3) less any reduction creditable to detention storage between the crest of the principal spillway and the crest of the auxiliary spillway. Flood-routing methods are in NRCS NEH Part 650, EFH Chapter 11, NRCS NEH Part 630, Hydrology, and in NRCS Technical Releases 20 (TR-20) or 55 (TR-55).

When design discharge of the principal spillway is considered in calculating peak outflow through the auxiliary spillway, the crest elevation of the inlet shall be such that the full flow will be generated in the conduit before there is discharge through the auxiliary spillway. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

Design adequate pipe conduit capacity to discharge long-duration, continuous, or frequent flows without causing flow through the auxiliary spillway. Design a principal spillway pipe with a minimum inside diameter of 4 inches.

If the pipe conduit diameter is 10 inches or greater, its design discharge may be considered when calculating the peak outflow rate through the auxiliary spillway.

Design pipe conduits using ductile iron, welded steel, corrugated steel, corrugated aluminum, reinforced concrete (pre-cast or site-cast), or plastic. Do not use cast iron or unreinforced concrete pipe if the dam is 20 feet or greater in total height.

Design and install pipe conduits to withstand all external and internal loads without yielding, buckling, or cracking. Design rigid pipe for a positive projecting condition. Design flexible pipe conduits in accordance with the requirements of NRCS National Engineering Handbook (NEH), Part 636, Chapter 52, Structural Design of Flexible Conduits. Flexible pipe strength shall not be less than that necessary to support the design load with a maximum of 5 percent deflection. The modulus of elasticity for plastic pipe shall be assumed as one-third of the amount designated by the compound cell classification to account for long-term reduction in modulus of elasticity values for the pipe. The minimum thickness of flexible pipe shall be SDR 26, Schedule 40, Class 100, or 16 gage as appropriate for the particular pipe material.

Hood and canopy inlets shall have a minimum vertical distance between the invert of the inlet and the crest of the auxiliary spillway of 1.8 times the diameter of the pipe. The minimum size for box drop inlets in combination with hood inlets shall be two times the diameter of the pipe in both directions if square, or two times the diameter if circular. The minimum depth of the box will be 1.25 times the diameter of the pipe. An anti-vortex device shall be attached.

The minimum diameter of a riser pipe shall be at least 1.25 times the diameter of the conduit.

Design connections of flexible pipe to rigid pipe or other structures to accommodate differential movements and stress concentrations. Design and install all pipe conduits to be watertight using couplings, gaskets, caulking, water stops, or welding. Design joints to remain watertight under all internal and external loading including pipe elongation due to foundation settlement.

Provide an anti-vortex device for a pipe conduit designed for pressure flow. Design the inlet and outlet to function for the full range of flow and hydraulic head anticipated.

Design a concrete cradle or bedding for pipe conduits if needed to reduce or limit structural loading on pipe and improve support of the pipe.

Design outlet structures, such as cantilever pipe outlet sections and impact basins, to dissipate energy as needed.

Materials

For dams 20 feet or less in effective height, acceptable pipe materials are corrugated steel or aluminum, pre-cast simple or reinforced concrete, Polyvinyl Chloride (PVC), High Density Polyethylene (HDPE) ASTM D3350, and cast-in-place reinforced concrete.

For dams more than 20 feet in effective height, conduits shall be corrugated steel or aluminum, pre-cast reinforced concrete, PVC, or cast-in-place reinforced concrete.

Concrete pipe shall be laid in a concrete bedding or have a concrete cradle, if required. A detailed structural analysis is required if concrete pipe is used.

All annular corrugated metal pipe (CMP) shall be caulk seamed and close riveted.

The inlets and outlets shall be structurally sound and made of materials compatible with those of the pipe.

The maximum height of fill over any principal spillway corrugated steel or corrugated aluminum pipe must not exceed 25 feet.

Specifications in Tables 4 and 5 are to be followed for PVC, corrugated steel, and corrugated aluminum pipe. Specifications in Table 6 are to be followed for HDPE pipe.

Outlets

The outlet section of all CMP conduits flowing under pressure and over 10 inches in diameter shall have a minimum length of 20 feet. The minimum length of the outlet section of PVC pipe shall be 10 feet for pipe that has cemented couplings and 20 feet for gasket-type couplings. The slope of the outlet section of pipe conduits over 12 inches in diameter shall not exceed 5 percent.

Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe outlet, see NRCS Technical Release 54 (TR-54), Structural Design of Saint Anthony Falls Stilling Basins.

For non-plastic cantilever outlets, pipe supports shall be provided for all conduits 18 inches in diameter or larger. Pipe supports for smaller diameters will be provided if required for stability. The outlet end of pipe conduits shall extend a minimum distance of 5 feet downstream from the point where the flow line of the downstream channel and the back slope of the embankment intersect or from the pipe support if used. This distance shall be increased to 8 feet for outlet pipes larger than 18 inches in diameter.

For cantilever outlets of plastic conduits, the outlet end of plastic conduits shall extend a minimum of 5 feet downstream from the point where the flow line of the downstream channel and the back slope of the embankment intersect. A pipe support located a maximum of 3 feet from the end of the pipe shall be provided. The pipe support may be constructed by using an earthfill or gravel-fill pad, wood, wood-metal combinations, or CMP to encase the plastic conduit.

Corrosion protection. Provide protective coatings for all steel pipe and couplings in areas that have traditionally experienced pipe corrosion or in embankments with saturated soil resistivity less than 4,000 Ohm-cm or soil pH less than 5. Protective coatings may include asphalt, polymer over galvanizing, aluminized coating, or coal tar enamel.

Ultraviolet protection. Use ultraviolet-resistant materials for all plastic pipe or provide coating or shielding to protect plastic pipe exposed to direct sunlight.

Cathodic protection. Provide cathodic protection for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating and where the need and importance of the structure warrant additional protection and longevity. If the original design and installation did not include cathodic protection, consider establishing electrical continuity in the form of joint-bridging straps on pipes that have protective coatings. Add cathodic protection later if monitoring indicates the need.

Filter diaphragms. When the effective height of the dam is 15 feet or greater and the effective storage of the dam is 50 acre-ft. or more, provide filter diaphragms to control seepage on all pipes extending through the embankment. Design filter diaphragms or alternative measures (Anti-seep collars) as needed to control seepage on pipes extending through all other embankments.

Design the filter diaphragm in accordance with the requirements of NEH, Part 628, Chapter 45, Filter Diaphragms. Locate the filter diaphragm immediately downstream of the cutoff trench, but downstream of the centerline of the dam if the foundation cutoff is upstream of the centerline or if there is no cutoff trench.

To improve filter diaphragm performance, provide a drain outlet for the filter diaphragm at the downstream toe of the embankment. Protect the outlet from surface erosion and animal intrusion.

Ensure filter diaphragm functions both as a filter for adjacent base soils and as a drain for seepage that it intercepts. Materials for the filter diaphragm shall meet the requirements of NEH Part 628, Chapter 45, Filter Diaphragms, Section 628.4503(d), Filter and Drain Gradation.

When using anti-seep collars in lieu of a filter diaphragm, ensure a watertight connection to the pipe. Limit the maximum spacing of the anti-seep collars to 14 times the minimum projection of the collar measured perpendicular to the pipe, or 25 feet, whichever is less. Locate anti-seep collars no closer than 10 feet apart. Use a collar material that is compatible with the pipe material.

When using anti-seep collars, design the collars to increase the seepage path along the pipe within the fill by at least 15 percent.

Trash guard. Install a trash guard at the riser or inlet to prevent clogging of the conduit, unless the watershed does not contain trash or debris that could clog the conduit.

Pool Drain. Provide a pipe with a suitable valve to drain the pool area if needed for proper pond management or if required by State law. The designer may use the principal spillway conduit as a pond drain if it is located where it can perform this function.

Auxiliary spillways. A dam must have an open channel auxiliary spillway, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The minimum criteria for acceptable use of a closed conduit principal spillway without an auxiliary spillway consist of a conduit with a cross-sectional area of 3 feet^2 or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash. (This criteria applies to Table 3 boxes a, c, and e) (A conduit with a minimum diameter of 4 inches is required for Table 3 boxes b and d. without an auxiliary spillway)

Design the minimum capacity of a natural or constructed auxiliary spillway to pass the peak flow expected from a total design storm of the frequency and duration shown in Table 3, less any reduction creditable to the conduit discharge and detention storage.

Design the auxiliary spillway to safely pass the peak flow through the auxiliary spillway, or route the storm runoff through the reservoir. Start the routing either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days drawdown, whichever is higher. Compute the 10-day drawdown from the crest of the auxiliary spillway or from the elevation attained from impounding the entire design storm, whichever is lower. Design the auxiliary spillway to pass the design flow at a safe velocity to a point downstream where the flow will not endanger the dam.

A constructed auxiliary spillway consists of an inlet channel, a control section, and an exit channel. Design the auxiliary spillway with a trapezoidal cross section. Locate the auxiliary spillway in undisturbed or compacted earth or in-situ rock. Design for stable side slopes for the material in which the spillway is to be constructed. Design a minimum bottom width of 10 feet for dams having an effective height of 20 feet or more.

Design a level inlet channel upstream from the control section for the distance needed to protect and maintain the crest elevation of the spillway. The minimum length of the level section shall be 20 feet. If necessary, curve the inlet channel upstream of the level section to fit existing topography. Design the exit channel grade in accordance with NEH Part 628, Chapter 50, Earth Spillway Design, or with equivalent procedures. The exit channel shall be straight until at least as far as the downstream toe of the embankment.

Natural auxiliary spillways may be used wherever there is a good vegetative cover in the spillway area and the topography is suitable. Natural or earth spillways must be designed by using the procedure described in NRCS NEH Part 650, EFH Chapter 11.

If an access road crosses the auxiliary spillway, the downstream edge of the road shall be located upstream of the level section but need not be greater than 30 feet upstream of the control section.

Structural auxiliary spillways. When used for principal spillways or auxiliary spillways, design chute spillways or drop spillways according to the principles set forth in NEH, Part 650, Engineering Field Handbook; and NEH, Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. Design a structural spillway with the minimum capacity required to pass the peak flow expected from a total design storm of the frequency and duration shown in Table 3, less any reduction creditable to the conduit discharge and detention storage.

Criteria for Excavated Ponds

Runoff. Design a minimum of 1.0 feet of freeboard above the peak elevation of the routed design hydrograph. Design a pipe and auxiliary spillway that will meet the capacity requirements of Table 3. Consider runoff flow patterns when locating the excavated pond and placing the spoil.

Side slopes. Design stable side slopes in the excavated area. The maximum slope for various soil materials shall be as follows:

- Sand: 3 horizontal to 1 vertical
- Peat: 1 horizontal to 1 vertical
- Muck and other: 2 horizontal to 1 vertical

Wildlife ponds shall have at least 50 percent of the side slopes 5 horizontal to 1 vertical, or flatter and have at least 40 percent of the perimeter less than 5 feet deep.

Watering Ramp. When wildlife or livestock need access to stored water, use the criteria in WI NRCS CPS, Watering Facility (Code 614), to design a watering ramp.

Inlet protection. Protect the side slopes from erosion where surface water enters the pond in a natural or excavated channel.

Excavated material. Place the material excavated from the pond so that its weight does not endanger the stability of the pond side slopes and so that the soil will not wash back into the pond by rainfall. Dispose of excavated material in one of the following ways:

- Uniformly spread to a height that does not exceed 3 feet, with the top graded to a continuous slope away from the pond.
- Uniformly place or shape reasonably well, with side slopes assuming a natural angle of repose. Place excavated material at a distance equal to the depth of the pond, but not less than 12 feet from the edge of the pond.
- Shape to a designed form that blends visually with the landscape.
- Provide for low embankment construction and leveling of surrounding landscape.
- Haul material off-site.

Table 4. Acceptable PVC Pipe For Use in Earth Dams[1]

Normal Pipe Size (in.)	Schedule or Standard Dimension Ratio (SDR)	Maximum Depth of Fill Over Pipe (ft.)[2]
4 or smaller	SDR 26	15
4 or smaller	Sch 40, 80 or SDR 17, 21	20
6 or 8	Sch 40 or SDR 21, 26	14
6 or 8	Sch 80 or SDR 17	20
10, 12 or 16	Sch 40	12
10, 12 or 16	SDR 21, 26	15
10, 12 or 16	Sch 80 or SDR 17	20

[1]Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM D 1785 or ASTM D 2241.
[2]Unit weight of soil = 120 lb/ft^3 and wheel loading = 16,000 lbs (H20)

Table 5. Minimum Gages for Corrugated Metal Pipe

Fill Height (ft.)	Minimum Gage for Steel Pipe (2⅔ in. x ½ in. corrugations)[1] With Diameter (in.) of:					Minimum Gage for Steel Pipe (3 in. x 1 in. corrugations)[1] With Diameter (in.) of:							Minimum Thickness (in.) of Aluminum Pipe2 (2⅔ in. x ½ in. corrugations)[1] With Diameter (in.) of:			
	≤ 21	24	30	36	42	48	36	42	48	54	60	66	≤ 21	24	30	36
1-15	16	16	163	144	125	106	16	16	16	16	16	16	0.06	0.06	0.075	0.075
15-20	16	16	16	14	12	10	16	16	16	16	14	14	0.06	0.075	0.105	0.105
20-25	16	14	12	10	8	----7	16	16	14	12	10	8	0.06	0.105	0.135	----7

[1]Pipes with diameters of 6, 8, and 10 in. have 1 ½ in. x ¼ in. corrugations.
[2]Riveted or helical fabrication.
[3]16-gage pipe - thickness of 0.064 inch
[4]14-gage pipe - thickness of 0.079 inch
[5]12-gage pipe - thickness of 0.109 inch
[6]10-gage pipe - thickness of 0.138 inch
[7]Not permitted

Table 6. Acceptable HDPE Pipe for Use in Earth Dams[1]

Pipe Values	Maximum Height of Fill Over the Top of Pipe[2] (feet)
SDR 21-32.5 PS 34-50	10
SR 17 PS 100	11.5

[1]High density polyethylene pipe, ASTM-D3350 flexural modulus cell class 4 or greater, conforming to ASTM F714. These materials will typically have standard dimension ration (SDR) values ranging from 32.5 to 21 or pipe stiffness (PS) values ranging from 34 to 100 psi respectively.
[2]The maximum height of fill over top of the pipe. This is based on 0 degree bedding (line support at the invert only). Backfill is assumed to be at 85 to 95% of maximum standard proctor density.

Specific Use-based Criteria

1. Fish and Wildlife
   Management potential of cold and warm water fishponds vary widely according to available water quality and quantity and land resource area. Similarly, various design features including size, depth, side slopes, spacing, and site selection affect the management potential of wildlife ponds. Minimum surface area of the pond varies from 0.1 to 1.0 acre, depending on the design purpose. Additional planning and design criteria are contained in WI NRCS CPS, Fishpond Management (Code 399), Wildlife Wetland Habitat Management (Code 644), and Wetland Restoration (Code 657).

2. Crop and Orchard Spraying
   If the pond will be used as a water supply for field or orchard spraying the following minimum amounts of water will be needed per application:

   - 100 gal/acre for field spraying
   - 1000 gal/acre for orchard spraying

3. Recreation
   If the pond will be used for recreation, basic criteria can be found in Corps of Engineers Engineering Manual 1110-1-400 and DNR Design Standards Handbook, Chapter 20 (Swimming Beaches).

4. Fire Control
   If the pond will be used as a water supply for fire control, basic criteria can be found in the National Fire Protection Association (NFPA) Standard 1142. Some factors that can affect the suitability of a site can include: distance to structures to be protected; accessibility for fire control equipment to the water, such as ingress and egress to the pond, adequate surfacing of the loading site, location of the pump within 20 feet of the static elevation of the anticipated drought water level, and compatibility of dry hydrant requirements; drought conditions; and dependability of water supply. Contact the local Fire Chief to clarify local design requirements.

CONSIDERATIONS

Visual resource design. Carefully consider the visual design of ponds in areas of high public visibility and those associated with recreation. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

Shape the embankment to blend with the natural topography. Shape the edge of the pond so that it is generally curvilinear rather than rectangular. Shape excavated material so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds.

Fish and wildlife. Locate and construct ponds to minimize the impacts to existing fish and wildlife habitat.

When feasible, retain structures such as trees in the upper reaches of the pond and stumps in the pool area. Shape upper reaches of the pond to provide shallow areas and wetland habitat.

If operations include stocking fish, use WI NRCS CPS, Fishpond Management (Code 399).

Vegetation. Stockpile topsoil for placement on disturbed areas to facilitate revegetation.

Consider selecting and placing vegetation to improve fish habitat, wildlife habitat and species diversity.

Water quantity. Consider effects upon components of the water budget, especially:

- Effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.
- Variability of effects caused by seasonal or climatic changes.
- Effects on downstream flows and impacts to environment such as wetlands, aquifers, and social and economic impacts to downstream uses or users.

Water quality. Consider the effects of:

- Erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that runoff carries.
- Short-term and construction-related effects of this practice on the quality of downstream watercourses.
- Water-level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.
- Wetlands and water-related wildlife habitats.

- Water levels on soil nutrient processes such as plant nitrogen use or denitrification.
- Soil water level control on the salinity of soils, soil water, or downstream water.
- Potential for earth moving to uncover or redistribute toxic materials.
- Livestock grazing adjacent to the pond. Consider fencing to keep livestock activities out of direct contact with the pond and dam.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice according to this standard. This should include the following items:

- Location map
- Site plan view with existing contours, dam layout, dimensions, and appurtenant features
- Benchmark descriptions and elevations
- Typical profiles and cross sections along centerline of dam, principal spillway (or maximum cross section if no principal spillway), auxiliary spillway, and appurtenant features
- Soil boring symbol logs
- Elevations of inlet and outlet of conduit and other appurtenant features
- Structural drawings adequate to describe the construction requirements
- Site-specific construction and material requirements
- Construction site pollution control measures
- Reclamation plans of any borrow areas.
- Requirements for vegetative establishment and/or mulching, as needed
- Safety features

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator.

As a minimum, include the following items in the operation and maintenance plan:

- Periodic inspections of all structures, earthen embankments, spillways, and other significant appurtenances
- Prompt repair or replacement of damaged components
- Prompt removal of sediment when it reaches predetermined storage elevations
- Periodic removal of trees, brush, and undesirable species
- Periodic inspection of safety components and immediate repair if necessary
- Maintenance of vegetative protection and immediate seeding of bare areas as needed

REFERENCES

American Society for Testing and Materials, Standard Guide to Site Characterization for Engineering, Design, and Construction Purposes, ASTM Standard D 420.

American Society for Testing and Materials. Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM D2487. West Conshohocken, PA.

USDA NRCS. Engineering Technical Releases, TR-210-60, Earth Dams and Reservoirs. Washington, DC.

USDA NRCS. National Engineering Handbook (NEH), Part 628, Dams. Washington, DC.

USDA NRCS. NEH, Part 633, Soil Engineering. Washington, DC.

USDA NRCS. NEH, Part 636, Structural Engineering. Washington, DC.

USDA NRCS. NEH, Part 650, Engineering Field Handbook. Washington, DC.

National Fire Protection Association, Water Supplies for Suburban and Rural Fire Fighting, Standard 1142.378-15 NRCS, WI 7/11

United States Department of Agriculture – Natural Resources Conservation Service, Agriculture Handbook Number 590 (Ponds – Planning, Design, Construction).

Wisconsin NRCS Home Page www.wi.nrcs.usda.gov

United States Department of Agriculture – Natural Resources Conservation Service, Wisconsin Standard Detail Drawings For Conservation Practices.

Wisconsin Department of Natural Resources, A Guide to Planning and Installing Dry Fire Hydrants.

Wisconsin Department of Natural Resources, Wisconsin Construction Site Best Management Practice Handbook, Publication WR-222 92 Rev, 1992.

Wisconsin Department of Transportation, Facilities Development Manual, Chapter 10 (Erosion Control and Storm Water Quality), 1997.

DEFINITIONS

1% flood event. A flood determined to be representative of large floods, which in any given year has a 1% chance of occurring or being exceeded. The 1% flood is based on a statistical analysis of lake level or streamflow records available for the watershed or an analysis of rainfall and runoff characteristics in the watershed, or both. This is commonly referred to as the 100 year event or regional flood.

Allowance for settlement. The product of the design fill height and the settlement factor. See Figure 1.

Auxiliary spillway. The auxiliary spillway is the spillway designed to convey excess water through, over, or around a dam. This has been commonly referred to as an "emergency spillway".

Bedrock. The solid or consolidated rock formation typically underlying loose surficial material such as soil, alluvium or glacial drift. Bedrock includes but is not limited to limestone, dolomite, sandstone, shale and igneous and metamorphic rock.

Constructed Elevation. The sum of the design elevation and the allowance for settlement. See Figure 1.

Control section. The control section of an open channel spillway where accelerated flow passes through critical depth.

Design elevation. Design elevation is the required top elevation of the embankment along the centerline before allowance for settlement has been added. See Figure 1.

Design Fill Height (Table 1). The difference in elevation between the design elevation and foundation elevation after stripping along the centerline of embankment. See Figure 1.

DNR Large Dam (Table 3). Any dam with a structural height of more than 6 feet and impounds 50 acre-feet or more of water at the design elevation or has a structural height of 25 feet or more and impounds more than 15 acre-feet of water at the design elevation. See Figure 1. Structures meeting this definition must be designed in accordance with the standards of Wisconsin Administrative Code NR 333.

Earth spillway. An earth spillway is an open channel spillway in earth materials without vegetation.

Effective height. The effective height of the dam is the difference in elevation, in feet, between the lowest open channel auxiliary spillway crest and the lowest point in the original cross section taken on the centerline of the dam prior to stripping. If there is no open channel auxiliary spillway, the design elevation for the top of the dam is the upper limit. See Figure 1.

Exit channel. The exit channel of an open channel spillway is the portion downstream from the control section which conducts the flow to a point where it may be released without jeopardizing the dam.

Fetch. The longest distance that wind can blow across a body of water to the embankment.

Freeboard. Freeboard is the additional depth or elevation required above computed design requirements.

High hazard potential. Dams assigned the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life.

Inlet channel. The inlet channel of an open channel spillway is the portion upstream from the control section.

Karst. Refers to areas of land underlain by carbonate bedrock (limestone or dolomite). Typical land features in karst areas include sinkholes, disappearing streams, closed depressions, blind valleys, caves, and springs.

Low hazard potential. Dams assigned the low hazard potential classification are those where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are primarily limited to the owner's property.

Principal spillway (Table 3). The principal spillway is the lowest ungated spillway designed to convey water from the reservoir (pond) at predetermined release rates.

Significant hazard potential. Dams assigned the significant hazard potential classification are those dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

Sinkholes. Closed, usually circular, depressions that form in karst areas. Sinkholes are formed by the downward migration of unconsolidated deposits into solutionally enlarged openings in the top of bedrock.

Spillway (Auxiliary Spillway). A spillway is an open or closed channel, conduit, or drop structure used to convey water from a reservoir. It may contain gates, either manually or automatically controlled, to regulate the discharge of water.

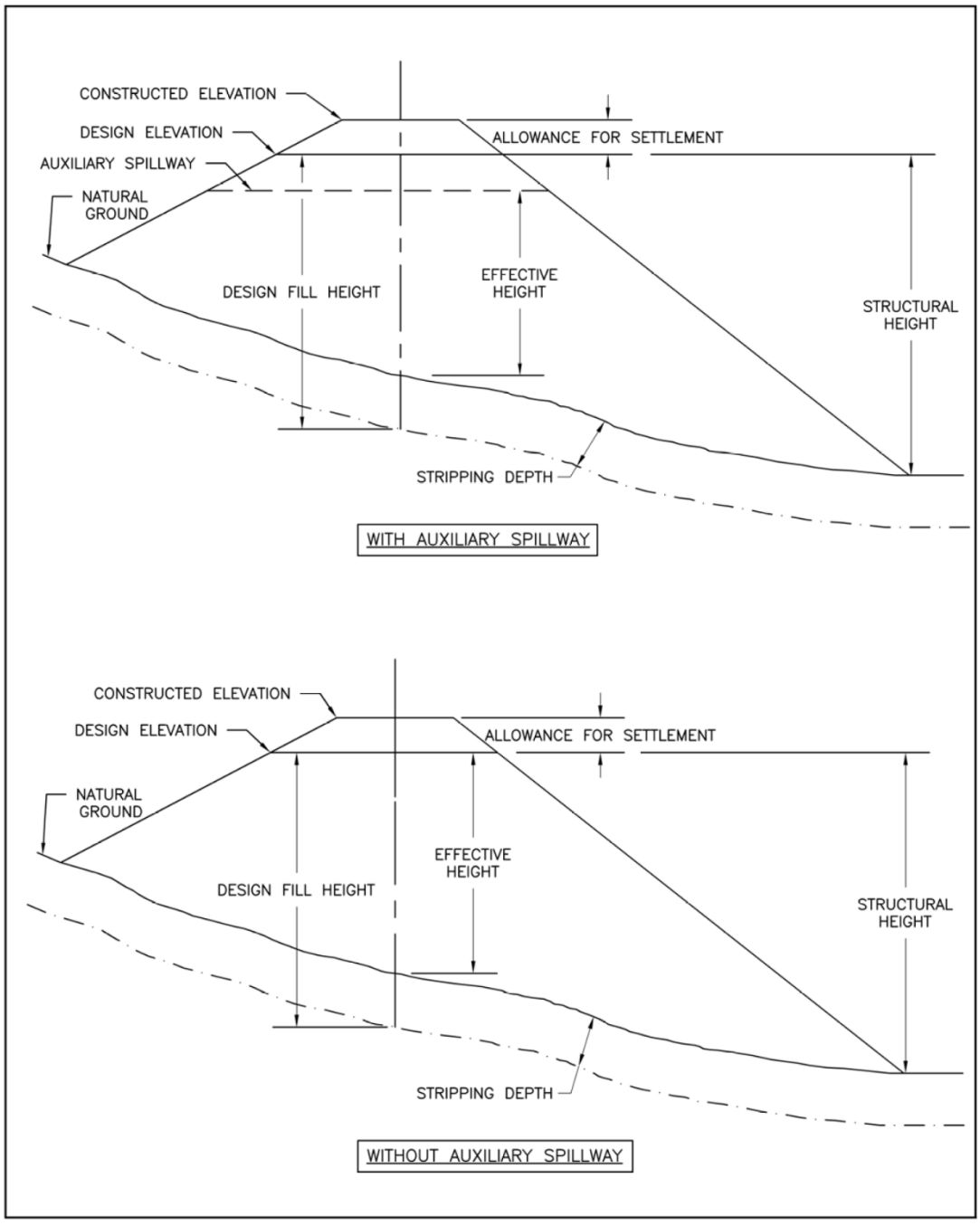
Storage. Storage is the capacity of the reservoir in acre-feet below the elevation of the crest of the lowest auxiliary spillway or the elevation of the top of the dam if there is no open channel auxiliary spillway.

Structural height (DNR Large Dam). The difference in the elevation between the design elevation and the lowest elevation of the natural stream or lake bed at the downstream toe of the embankment. See Figure 1.

Trickle tube (Table 3). A trickle tube is a minimum 4 inch diameter conduit intended to draw down the pool to a level below the auxiliary spillway. The Trickle tube discharge is not credited in the design, nor is it considered the principal spillway.

Vegetated spillway. A vegetated spillway is a vegetated open channel spillway in earth materials.

Figure 1



NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

FIREBREAK

CODE 394
(FT.)

DEFINITION
A permanent or temporary strip of bare or vegetated land planned to retard fire.

PURPOSE
- Reduce the spread of wildfire.
- Contain prescribed burns.

CONDITIONS WHERE PRACTICE APPLIES
This practice applies on all land uses where protection from wildfire is needed or prescribed burning is applied.

CRITERIA
General Criteria Applicable to All Purposes
Firebreaks may be temporary or permanent and shall consist of fire-resistant vegetation, non-flammable materials, bare ground, or a combination of these.

Firebreaks will be of sufficient width and length to contain the expected fire.

Firebreaks shall be located to minimize risk to the resources being protected.

Erosion control measures shall be installed to prevent sediment from leaving the site.

Plant species selected for vegetated firebreaks will be noninvasive and capable of retarding fire.

CONSIDERATIONS
Use barriers such as streams, lakes, ponds, rock cliffs, roads, field borders, skid trails, landings, drainage canals, railroads, utility right-of-ways, cultivated land, or other areas as existing firebreaks. Electric lines can be hazardous in heavy smoke as they may conduct electricity.

When using barriers consider the effects on wildlife and fisheries.

Attempt to locate firebreaks near ridge crests and valley bottoms.

If winds are predictable, firebreaks should be located perpendicular to the wind and on the windward side of the area to be protected.

Consider using diverse species combinations which best meet locally native wildlife and pollinator needs.

Locate on the contour where practicable to minimize risk of soil erosion.

Design and layout should include multiple uses.

Consider the beneficial and other effects of installation of the firebreak on cultural resources and threatened and endangered species, natural areas, riparian areas and wetlands.

Most firebreaks consist of short cool season grasses such as Kentucky Blue Grass or Creeping Red Fescue. Mow periodically to keep brush out and grass green and growing.

Firebreaks for Tree Plantations. The primary firebreak should be around the perimeter of the planted area. It should consist of a grassy strip at least 14 feet wide which can also serve as a road, and a bare soil strip adjacent to the trees at least 14 feet wide.

Within the plantation, secondary firebreaks should be located at intervals of 300 feet or less. These firebreaks should be at least 18 feet wide and will normally be used as access roads and should generally follow the contour to avoid erosion.

Firebreaks established between the plantation and buildings should be at least 100 feet wide.

Firebreaks for Grasslands and Other Areas. Prescribed burning may be a management technique in and around areas of wetlands managed for wildlife, natural areas of prairie vegetation, and the like. Control of the prescribed burn will typically require firebreaks.

- A perimeter firebreak is usually adequate to confine fire to the intended area. Firebreaks should be non-combustible and at least two times as wide as the height of the vegetation to be burned.
- In very large areas, secondary breaks within the area may be necessary to limit size and intensity of burn. Design will be governed by size of area, topography and flammability of fuels. See Wisconsin NRCS Conservation Practice Standard (WI NRCS CPS), Prescribed Burn (code 338), for details.
- A minimum firebreak of 50 feet should be used to protect buildings or other high value areas. This should include a 14 feet bare strip adjacent to the area to be burned.
- Burned firebreaks, using backing fire techniques during prescribed burns, should have an adequate width based on fuel types prior to ignition of headfire (i.e., 100 feet for tall grass; 200 feet for tall grass/woody vegetation).

Construction of Firebreaks. Stumps, logs, large stones, and other debris will be removed from soil surface prior to soil preparation.

Firebreaks to be maintained in a bare soil condition will be worked up to expose bare soil. Bare firebreaks will not be used if a significant erosion hazard exists if such firebreaks run up and down hill.

Legumes may be seeded with the grasses to improve wildlife habitat value. Proportion of legumes to grasses will be held to a minimum to prevent a buildup of fuel on the surface.

PLANS AND SPECIFICATIONS

Specifications for applying this practice shall be prepared for each site and recorded using approved job sheets, technical notes, and narrative statements in the conservation plan. An approved burn plan shall be utilized prior to prescribed burning.

Bare soil firebreaks should be used where erosion hazards are controlled.

OPERATION AND MAINTENANCE

Mow, disk, or graze vegetative firebreaks to avoid a build-up of excess litter and to control weeds. Treatment should be timed to reduce impacts to nesting when possible.

Inspect all firebreaks for woody materials such as dead limbs or blown down trees and remove them from the firebreak.

Inspect firebreaks at least annually and rework bare ground firebreaks as necessary to keep them clear of flammable vegetation.

Repair erosion control measures as necessary to ensure proper function.

Access by vehicles or people will be controlled to prevent damage.

Bare ground firebreaks, which are no longer needed, will be stabilize.

FEDERAL, TRIBAL, STATE AND LOCAL LAWS

Users of this standard should be aware of potentially applicable federal, tribal, state and local laws, rules, regulations or permit requirements governing cover crops. This standard does not contain the text of federal, tribal, state or local laws.

REFERENCES

USDA, NRCS Wisconsin Field Office Technical Guide (FOTG), Section IV, Practice Standards and Specifications.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

GRADE STABILIZATION STRUCTURE

(NO.)
CODE 410

DEFINITION

A grade stabilization structure is a structure used to control the grade in natural or constructed channels.

PURPOSE

The purpose of a grade stabilization structure is to stabilize grade, reduce erosion, or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

- This practice applies where channels require a structure to stabilize the grade or to control gully erosion.
- The product of the storage times the effective height of the structure is less than 3,000, the effective height of the structure is 35 feet or less, and the structure is low hazard potential.
- Failure of the structure will not result in loss of life; in damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.

CRITERIA

General Criteria. Plan, design, and construct this practice to comply with all federal, State, and local regulations. The owner and/or operator is responsible for securing required permits. Permitting authorities should be contacted during the planning phase of the project. This standard does not contain the text of the federal, tribal, state or local laws.

A site assessment shall be conducted, documented, and incorporated into the design. The assessment shall be performed to determine physical site characteristics that will influence the placement, construction, maintenance, and environmental integrity of the proposed structure. The assessment shall include input from the owner/operator. The site assessment shall include:

a. Locations and elevations of buildings, roads, lanes, soil test pits, property lines, setbacks, easements, springs, wells, floodplains, surface drains, drain tile, utilities, overhead lines, cultural resources, wetlands, and potential contamination sources.
b. Test pit logs, soil test results, and a soil survey photo, if available. Test pits or test holes shall include:

(1) The number and distribution needed to characterize the subsurface. Key areas to be investigated include the foundation, auxiliary spillway area, and borrow area.
(2) The elevation of bedrock and bedrock type, if encountered, such as sandstone, limestone, dolomite, or granite.
(3) Saturation indicators, if encountered, such as seepage from sand and gravel lenses, lens thickness, and elevation. Ground water maps and well construction logs may be included when available and applicable.

c. Locations and elevations of sinkholes and other karst features within 500 feet of any impoundment.
d. Locations and elevations, soil volumes, soil samples, and reclamation plans of any borrow areas.
e. Identification of potential impacts from failure of the embankments, liners, or structures. Document hazard potential classification.
f. An estimate or measurement of the base flow rate, when present.
g. Identification of navigability, water quality and wetland issues by permitting authorities.

The structure owner must have ownership or legal control of the structure site and impoundment including the right to flood all land in the impoundment up to the 1% flood event. Legal control is usually obtained through permanent easements recorded on the deed of the affected property.

The structure cannot be constructed within 400 feet of an existing or proposed community well. Additionally, it cannot be constructed within a horizontal separation distance of 25 feet of an existing or proposed private well, pond, or spring. This distance is measured from the edge of the pond formed during the 1% flood event, unless the well is properly decommissioned in accordance with Wisconsin Administrative Code Chapter NR 812 and Wisconsin NRCS Conservation Practice Standard (WI NRCS CPS), Well Decommissioning (Code 351).

Set the crest of the inlet at an elevation that will stabilize the channel and prevent upstream head cutting.

The foundation preparation, compaction, top width, and side slopes must ensure a stable earthen embankment for anticipated flow conditions.

Provide a minimum sediment storage capacity equal to the expected life of the structure, or provide for periodic cleanout.

Provide measures necessary to prevent serious injury or loss of life such as protective guardrails, warning signs, fences, or lifesaving equipment.

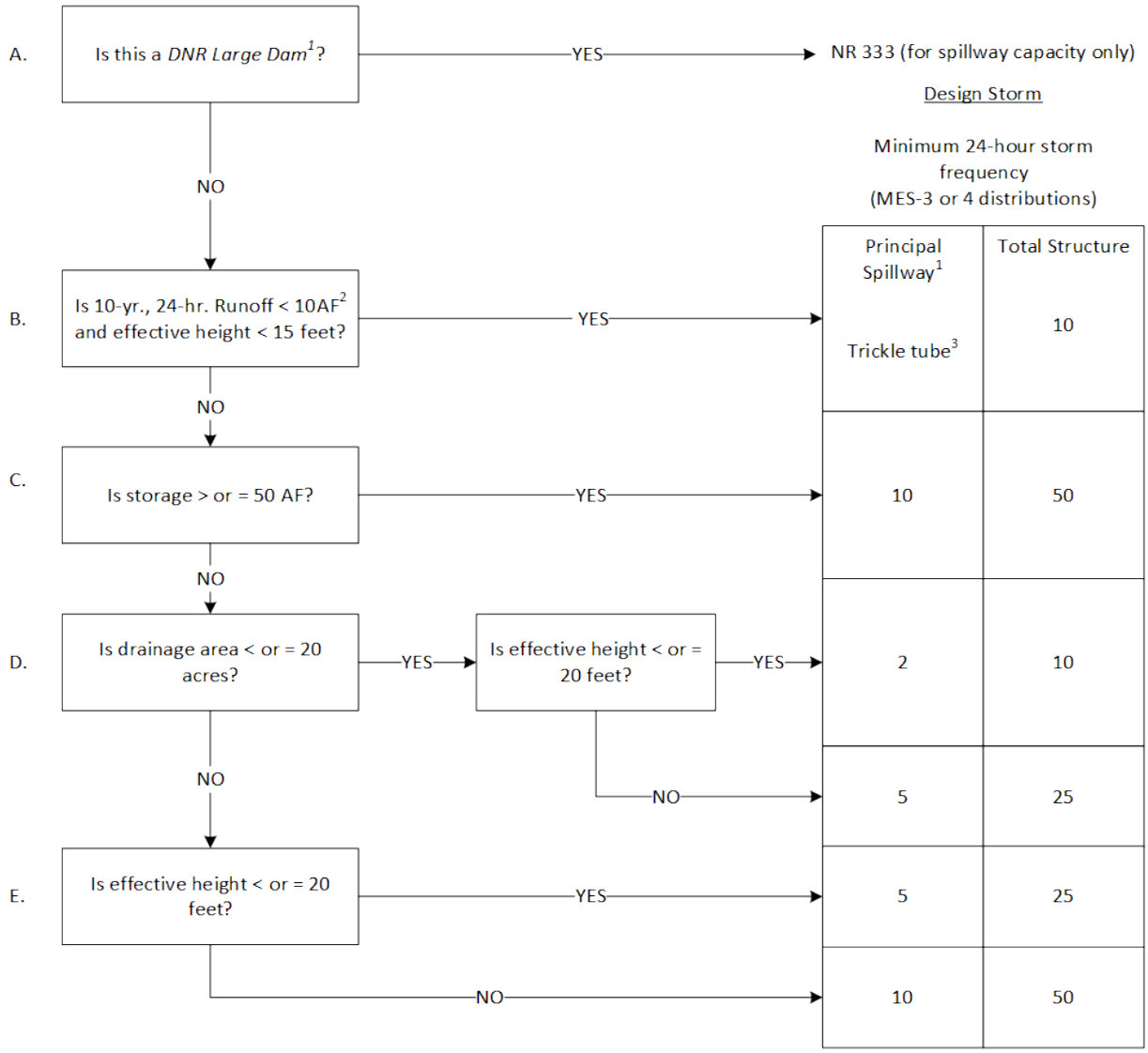
Seed or sod the exposed surfaces of earthen embankments, earth spillways, borrow areas, and other areas disturbed during construction in accordance with WI NRCS CPS, Critical Area Planting (Code 342). If climatic conditions preclude the use of seed or sod, use WI NRCS CPS, for Mulching (Code 484) to install inorganic cover material such as gravel.

Embankment dams. Low hazard dams that have a product of storage times the effective height of the dam of 3,000 ac-ft.^{2} or more, those more than 35 feet in effective height, and all significant and high hazard dams must meet or exceed the criteria specified in Engineering Technical Release TR-210-60, Earth Dams and Reservoirs.

Low hazard dams that have a product of storage times the effective height of the dam of less than 3,000 ac-ft.[2] and an effective height of 35 feet or less must meet or exceed the requirements specified in WI NRCS CPS, Pond (Code 378). (General Criteria and Criteria Applicable to Embankment Ponds.)

Pond sized dams. If mechanical spillways are required, the minimum capacity of the principal spillway must convey the peak flow expected from a 24-hour duration design storm of the frequency shown in Table 1, less any reduction from detention storage.

Table 1. Minimum Spillway Capacity



Design Storm

Minimum 24-hour storm frequency (MES-3 or 4 distributions)

	Principal Spillway[1]	Total Structure
B.	Trickle tube[3]	10
C.	10	50
D.	2	10
	5	25
E.	5	25
	10	50

[1]Consideration should be given to increasing principal spillway design storm frequency to reduce the frequency of the auxiliary spillway's use. DNR Large Dam.
[2]AF = acre-feet
[3]Trickle tube or other type of principal spillway required. If another type of principal spillway is used, it shall meet the separation distances required for a trickle tube. If a trickle tube is used, it shall be a 4-inch diameter minimum conduit, or the size required to pass 2 times the base flow. Trickle tube material shall meet the requirements of WI NRCS CPS, Underground Outlet (Code 620).

Small pond-sized dams. For dams with an effective height of less than 15 feet and 10-year frequency, 24-hour storm runoff volume less than 10 acre-feet, the designer may design the grade control structure to control the peak flow from the 10-year frequency, 24-hour duration storm without overtopping. If the combination of storage and mechanical spillway discharge will handle the design storm, an auxiliary spillway is not required. (Table 1, box b)

Full-flow open structures. Design drop, chute, and box inlet drop spillways to the requirements in the National Engineering Handbook, Part 650, Engineering Field Handbook and other applicable NRCS publications and reports. Provide a minimum capacity to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any reduction from detention storage. Structures must not create unstable conditions upstream or downstream. Install provisions for reentry of bypassed storm flows.

The ratio of the capacity of drop boxes to road culverts must meet the requirements of the responsible road authority or as specified in Table 2 or 4, as applicable, less any reduction from detention storage, whichever is greater. The drop box capacity (attached to a new or existing culvert) must equal or exceed the culvert capacity at design flow.

Table 2. Design Criteria for Establishing Minimum Capacity of Full-Flow Open Structures

Maximum Drainage Area (acre)	Overfall Height[1] (feet)	Minimum 24-hr design storm (MSE-3 or 4 distribution) frequency	
		Principal spillway capacity (yr.)	Total capacity (yr.)[2]
450	5 or less	5	10
900	10 or less	10	25
All others	25	100	

[1] For rock chutes, this is measured from the inlet apron to the design elevation of the outlet channel.
[2] If an island type structure, auxiliary spillway flow must be bypassed at a non-erosive velocity for reentry into the downstream channel.

Toewall Drop Structures

Toewall drop structures can only be used if the vertical overfall height is 4 feet or less, flows are intermittent, downstream grades are stable, and tailwater depth at design flow is equal to or greater than one-third of the overfall height. Toewall drop structures shall be designed according to the principles set forth in NRCS NEH Part 650, EFH, Chapter 6.

(1) Drainage systems
Drainage systems shall be provided for headwalls and sidewalls of structures having an overfall height of 4 feet or more. Drainage components may consist of collection pipes, "weep" holes, or drain fill material.

(2) Riprap for drop spillways and toewall drop structures
Riprap shall be placed at least 3 feet upstream and 5 feet downstream from structures with the following dimensions.

- Drop spillways or toewall drop structures with weir depths 2.5 feet or greater.
- Drop spillways with an overfall height of 4 feet or greater.
- Toewall drop structures with overfall heights of 3 feet or greater.

If tailwater depth is less than three-fourths of the overfall height, the length of riprap needs to be evaluated. For additional guidance, see NRCS NEH Section 11, Drop Spillways.

(3) Embankment for drop spillways and toewall drop structures.
The embankment shall extend at least 1 foot above the headwall extension and have a top width of 6 feet or more. The combined upstream and downstream side slopes shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper and 2 horizontal to 1 vertical.

(4) Headwall elevation for drop spillways and toewall drop structures.
The minimum headwall elevation shall be set by adding 0.25 feet to the design flow depth over the weir.

Gabion Structures

Structures made of rock-filled gabions can be used for vertical overfall heights of 8 feet or less. When available, manufacturer's instructions shall be used in the design for this type of structure. Otherwise, use guidelines for proportioning drop spillways, shown in NRCS NEH Section 11, Standard Drawing ES-67. The following items apply to gabion design:

(1) Aprons or stilling basins shall be installed downstream from the weir to prevent undercutting.
(2) Structures must be keyed into both banks to prevent flanking during high water.
(3) Foundations must provide sufficient strength to adequately support the structure.
(4) The structural components must be tied or stacked so they will act as a unit to prevent overturning or displacement by the action of ice and water.
(5) Suitable drain fill material or geotextile shall be placed adjacent to the baskets to prevent piping of foundation soil material into the rock-filled gabions.

Rock Chutes

The cross section of the completed chute shall be trapezoidal. Side slopes shall be 2 horizontal to 1 vertical or flatter.

Chutes shall be designed by using the D_{50} rock size for a roughness value, allowable velocity, rock gradation and thickness of the rock layer. A minimum factor of safety (FS) of 1.2 shall be used to size the rock. The rock gradation shall be as shown in Table 3.

NRCS NEH Part 650, EFH Chapter 6; American Society of Agricultural Engineers (ASAE) Paper No. 972062, "Design of Rock Chutes"; ASAE Paper No. 982136 "Rock Chutes on Slopes Between 2% and 40%"; or ASAE Paper No. 002008, "An EXCEL Program to Design Rock Chutes for Grade Stabilization" shall be used for the design.

The following criteria apply to all rock chutes:

(1) The rock-lined section must be straight.
(2) The maximum chute slope shall be 3 horizontal to 1 vertical.
(3) The minimum depth for the chute shall be the design flow depth needed to pass the design flow through a trapezoidal-shaped, broad-crested weir at the inlet or the depth of the hydraulic jump at the outlet, plus 0.5 feet.
(4) Inlet apron length shall be a minimum of 10 feet and be flat (0% grade).

(5) Outlet apron length shall be 15 x D^{50} (feet) x FS and recessed a minimum of 1 foot below the outlet channel bottom and be flat (0% grade).
(6) The minimum rock thickness shall be 2 times the D^{50*} rock size.
(7) A geotextile must be placed beneath the rock. If a sand-gravel bedding is used, the bedding thickness shall be a minimum of 2 inches and placed beneath the geotextile.
(8) Flow in the upstream channel shall be sub-critical. The upstream channel shall be at least as wide as the chute inlet apron for a minimum of 50 feet upstream of the chute inlet apron.
(9) The bottom width and side slopes of downstream channels in line with the chute shall be the same as the bottom width and side slopes at the downstream end of the outlet apron. A transition section in the downstream channel at least 50 feet long must be provided for other channel dimensions or configurations.
(10) The slope of the downstream channel shall be stable at the design flow for a minimum distance of 100 feet and provide sufficient tailwater on the rock chute. Outlets other than in-line channels shall be stable and provide sufficient tailwater at the design flow.

Table 3. Rock Gradation

Percent Passing	Size[1] (in.)
100	1.5 x D_{50}*[2] -- 2.0 x D_{50}*
85	1.3 x D_{50}* -- 1.8 x D_{50}*
50	1.0 x D_{50}* -- 1.5 x D_{50}*
10	0.8 x D_{50}* -- 1.3 x D_{50}*

[1]Round up to nearest inch.
[2]D_{50}* is the specified D_{50} which equals the designed D_{50} x factor of safety.

Sod Chutes

Sod chutes shall be designed according to the procedures shown in NRCS NEH Part 650, EFH Chapters 6 and 7. The maximum design velocity shall not exceed 6 feet/second. Sod strips shall extend a minimum of 2 feet on the side slope (measured on the sloping plane) or provide 0.3 feet freeboard above the flow depth, whichever is greater.

Sod chutes which outlet into permanent tailwater or other conditions which will not support continuous vegetation shall be protected from erosion by drop structures, rock riprap or other suitable methods.

Turf reinforcement can be used to increase the maximum design velocity. Maximum velocity shall be based on manufacturer's recommendations but not to exceed 10 feet/second for erosion-resistant soils and 8 feet/second for easily eroded soils as defined in NRCS NEH Part 650, EFH Chapter 7. Installation of the turf reinforcement shall be based on manufacturer's recommendations

Island-type structures. Design the minimum capacity equal to the capacity of the downstream channel. Design the minimum auxiliary spillway capacity equal to that required to pass the peak flow expected from a 24-hour duration storm of the frequency shown in Table 2 for total capacity without overtopping the headwall extensions of the mechanical spillway. Make provision for safe reentry of bypassed flow as necessary.

Side-inlet, open weir, or pipe-drop drainage structures. Table 4 provides the design criteria for minimum capacity of open-weir or pipe structures used to lower surface water from field elevations or lateral channels into deeper open channels. Design the minimum principal spillway capacity equal to the design drainage curve runoff for all conditions.

Table 4. Design criteria for establishing minimum capacity of side-inlet, open weir, or pipe-drop drainage structure.

Maximum Drainage Area (acre)	Overfall Height (feet)	Receiving Channel Depth (feet)	Minimum 24-hr design storm (MSE-3&4 distribution) frequency	
			Principal Spillway Capacity	Total Capacity (yr.)
450	0-5	0-10	(Cypress Creek equation):[1]	5
450	5-10	10-20	(Cypress Creek equation):[1]	10
900	0-10	0-20	(Cypress Creek equation):[1]	25
All others			(Cypress Creek equation):[1]	50

[1](Cypress Creek equation):
See NRCS NEH Part 650, Chapter 14

$Q = C * M^{(0.83)}$

Q = Flow in ft^3/s for which the drain is to be designed
C = The appropriate drainage curves. Use C=37
M = Area in mi^2 of watershed

CONSIDERATIONS

Provide sufficient discharge to minimize crop damaging water detention.

In highly visible public areas and those associated with recreation, give careful consideration to landscape resources. Landforms, structural materials, water elements, and plant materials should complement their surroundings visually and functionally. Shape excavated material and cut slopes to blend with the natural topography. Shape shorelines and create islands to add visual interest and wildlife habitat. Form and finish exposed concrete surfaces to add texture, reduce reflection, and to alter color contrast. Select sites to reduce adverse impacts or create desirable focal points.

Consider the effect of the grade control structure on aquatic habitat. For channels supporting fish, consider the effect of the structure on fish passage.

In natural channels, consider the effect of the grade control structure on fluvial geomorphic conditions.

Provide fences to protect structures, earth embankments, and vegetated spillways from livestock. Near urban areas, provide fencing as appropriate to control access and exclude traffic.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for installing grade stabilization structures that describe the requirements for applying the practice according to this standard. This should include the following items:

- Location map.
- Site plan view with existing contours, dam layout, dimensions, and appurtenant features.
- Benchmark description and elevations.
- Typical profiles and cross sections along centerline of dam, principal spillway (or maximum cross section if no principal spillway), auxiliary spillway, and appurtenant features.
- Profile of any constructed channels extending several hundred feet upstream and downstream from structure.
- Elevations of inlet and outlet of conduit, weirs, outlets and other appurtenant features
- Soil boring symbol logs.
- Structural drawings adequate to describe the construction requirements.
- Site-specific construction and material requirements.
- Construction site erosion control measures.
- Requirements for vegetative establishment and/or mulching, as needed.
- Safety features.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator. As a minimum, include the following items in the operation and maintenance plan:

- Require periodic inspections of all structures, earthen embankments, spillways, and other significant appurtenances.
- Require prompt repair or replacement of damaged components.
- Require prompt removal of sediment when it reaches pre-determined storage elevations.
- Require periodic removal of trees, brush, and invasive species.
- Require periodic inspection of safety components and immediate repair if necessary.
- Require maintenance of vegetative protection and immediate seeding of bare areas as needed.

REFERENCES

USDA Natural Resources Conservation Service. Engineering Technical Releases, TR-210-60, Earth Dams and Reservoirs. Washington, DC.

USDA Natural Resources Conservation Service. National Engineering Handbook, Part 628, Dams. Washington, DC.

USDA Natural Resources Conservation Service. National Engineering Handbook, Part 650, Engineering Field Handbook. Washington, DC.

American Society of Agricultural Engineers (ASAE), Paper no. 972062, "Design of Rock Chutes."

American Society of Agricultural Engineers (ASAE), Paper no. 982136, "Rock Chutes on Slopes Between 2% and 40%."

DEFINITIONS

1% flood event. A flood determined to be representative of large floods, which in any given year has a 1% chance of occurring or being exceeded. The 1% flood is based on a statistical analysis of lake level or streamflow records available for the watershed or an analysis of rainfall and runoff characteristics in the watershed, or both. This is commonly referred to as the 100 year event or regional flood.

Auxiliary spillway. The auxiliary spillway is the spillway designed to convey excess water through, over, or around a dam. This has been commonly referred to as an "emergency spillway".

Bedrock. The solid or consolidated rock formation typically underlying loose surficial material such as soil, alluvium or glacial drift. Bedrock includes but is not limited to limestone, dolomite, sandstone, shale and igneous and metamorphic rock.

Cypress Creek equation (Table 2 footnote). Curves for determining runoff for drainage design have been prepared in most of the humid areas of the United States. They are based on the climate, soils, topography and agriculture of the particular area. See NRCS EFH, Chapter 14.

D^{50}. The D^{50} rock size is the rock diameter of which 50% of the material by weight is smaller.

D^{50*}. D^{50*} is the specified D^{50} which equals the designed D^{50} x factor of safety.

DNR Large Dam (Table 1). Any dam with a structural height of more than 6 feet and impounds 50 acre-feet or more of water at the design elevation or has a structural height of 25 feet or more and impounds more than 15 acre-feet of water at the design elevation. Structures meeting this definition must be designed in accordance with the standards of Wisconsin Administrative Code NR 333.

Effective height. The effective height of the dam is the difference in elevation, in feet, between the lowest open channel auxiliary spillway crest and the lowest point in the original cross section taken on the centerline of the dam prior to stripping. If there is no open channel auxiliary spillway, the design elevation for the top of the dam is the upper limit. See Figure 1.

Freeboard. Freeboard is the additional depth or elevation required above computed design requirements.

Full-flow open structures. Full-flow open structures are those which must pass the design storm through the principal and auxiliary spillways without creating storage above the design flow's normal depth.

High hazard potential. Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

Island-type structure. The island-type structure uses a drop spillway in the channel with auxiliary earth spillways for carrying excess flows around the structure. To prevent washing around the structure, dikes extending each way from the structure must be provided.

Karst. Refers to areas of land underlain by carbonate bedrock (limestone or dolomite). Typical land features in karst areas include sinkholes, disappearing streams, closed depressions, blind valleys, caves, and springs.

Low hazard potential. Dams assigned the low hazard potential classification are those where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are primarily limited to the owner's property.

Overfall height. Vertical drop from the weir crest to the downstream outlet invert.

Principal spillway (Table 1). The principal spillway is the lowest ungated spillway designed to convey water from the reservoir (pond) at predetermined release rates.

Sediment storage. Sediment storage is the reservoir capacity allocated to total sediment accumulation (submerged and aerated) during the life of the dam.

Side-inlet drainage structures. A structure designed to convey surface water from fields or open areas into drainage ditches.

Significant hazard potential. Dams assigned the significant hazard potential classification are those dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

Sinkholes. Closed, usually circular, depressions that form in karst areas. Sinkholes are formed by the downward migration of unconsolidated deposits into solutionally enlarged openings in the top of bedrock.

Spillway. A spillway is an open or closed channel, conduit, or drop structure used to convey water from a reservoir. It may contain gates, either manually or automatically controlled, to regulate the discharge of water.

Storage. Storage is the capacity of the reservoir in acre-feet below the elevation of the crest of the lowest auxiliary spillway or the elevation of the top of the dam if there is no open channel auxiliary spillway. (From NHCP-378)

Structural height (DNR Large Dam). The difference in the elevation between the design elevation and the lowest elevation of the natural stream or lake bed at the downstream toe of the embankment.

Trickle tube (Table 1). A trickle tube is a minimum 4 inch diameter conduit intended to draw down the pool to a level below the auxiliary spillway. The trickle tube discharge is not credited in the design.

Vegetated spillway. A vegetated spillway is a vegetated open channel spillway in earth materials.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

FORAGE HARVEST MANAGEMENT

CODE 511
(ACRE)

DEFINITION
The timely cutting and removal of forages from the field as hay, green-chop or ensilage.

PURPOSE
- Optimize yield and quality of forage at the desired levels
- Promote vigorous plant re-growth
- Manage for the desired species composition
- Use forage plant biomass as a soil nutrient uptake tool
- Control insects, diseases and weeds
- Maintain and/or improve wildlife habitat

CONDITIONS WHERE PRACTICE APPLIES
This practice applies to all land uses where machine harvested forage crops are grown.

CRITERIA
General Criteria Applicable to All Purposes
Forage will be harvested at a frequency and height that optimizes the desired forage stand, plant community, and stand life. Follow UW Extension recommendations for forage harvest based on stage of maturity, moisture content, length of cut, stubble height and harvest interval. The following criteria must be met:

Stage of Maturity. Harvest forage at the stage of maturity that provides the desired quality and quantity without compromising plant vigor and stand longevity.

Moisture Content. Harvest silage/haylage crops within the optimum moisture range for the type of storage method(s) or structure(s) being utilized.

UW Extension recommendations must be followed for optimum moisture content and levels as well as methods and techniques to monitor and/or determine moisture content and levels.

Avoid fermentation and seepage losses of digestible dry matter from direct cut hay crop silage (moisture content >70 percent) by treatment with chemical preservatives or add dry feedstuffs.

For optimal dry hay quality, rake hay at 30 to 40 percent moisture and ted or invert swaths when moisture is above 40 percent.

To preserve forage quality and quantity, bale field cured hay at 15–20 percent moisture and bale force air-dried hay and 20–35 percent moisture.

Length of Cut. When harvested for ensilage forage will be chopped to a size appropriate for type of storage structure used and optimal effective fiber. The length of chop selected will allow adequate packing to produce the anaerobic conditions necessary to ensure the proper ensiling process.

A shorter chop length on very dry silage may help to ensure good packing and adequate silage density.

Stubble Height. Cut forage plants at a height that will promote the vigor and health of the desired species. Cutting heights will provide adequate residual leaf area; adequate numbers of terminal, basal or auxiliary tillers or buds; insulation from extreme heat or cold; and/or unsevered stem bases that store food reserves needed for full, vigorous recovery. Follow UW Extension recommendations for proper stubble heights and harvest dates to avoid winterkill of forage species in cold climates.

Contaminants. Forage shall not contain contaminants that can cause illness or death to the animal being fed or rejection of the offered forage. Check UW Extension contaminant notices, cautions, and recommendations for the specific harvest information.

Additional Criteria to Improve or Maintain Stand Life, Plant Vigor and Forage Species Mix

Stage of Maturity and Harvest Interval. Cut forage plants at a stage of maturity or harvest interval range that will provide adequate food reserves and/or basal or auxiliary tillers or buds for regrowth and/or reproduction to occur without loss of plant vigor.

Cut reseeding annuals at a stage of maturity and frequency that ensures the production of ample viable seed or carryover of hard seed to maintain desired stand density.

If plants show signs of short-term environmental stress, harvests will be adjusted in a manner that encourages the continued health and vigor of the stand. Follow UW Extension recommendations in these cases.

Manipulate timing and cutting heights of harvest to ensure germination and establishment of reseeding or seeded annuals.

Additional Criteria for Use as a Nutrient Uptake Tool

Employ a harvest regime that utilizes the maximum amount of available or targeted nutrients. Using this practice for this purpose may require more frequent harvests to increase uptake.

Additional Criteria to Control Disease, Insect, Weed and Invasive Plant Infestations

Follow UW Extension guidelines when available for control of disease, insect, weed and invasive plant infestations to forage crops.

Schedule harvest periods to control disease, insect, and weed infestations. When a pesticide is used to control disease, insects or weeds, adhere to the specified days to harvest period stated on the pesticide label. Evaluate pest management options by planning Wisconsin Conservation Practice Standard (WI NRCS CPS), Pest Management (Code 595) for all forage areas to be harvested. Also plan and schedule removal of invasive plants and noxious weeds.

Lessen incidence of disease, insect damage, and weed infestation by managing harvests to maintain a full, vigorous, dense forage stand.

Cut forages after dew, rain, or irrigation water on the leaves has evaporated.

Additional Criteria to Improve Wildlife Habitat Values

If client objectives include providing suitable habitat for desired wildlife species then appropriate harvest schedule(s), cover patterns, and minimum plant heights to provide suitable habitat for the desired species should be implemented and maintained.

Time harvests to benefit the desired wildlife species by following state guidelines.

Coordinate this practice with WI NRCS CPS, Upland Wildlife Habitat Management (Code 645) and accompanying job sheets.

CONSIDERATIONS

Where applicable coordinate this practice with WI NRCS CPS, Prescribed Grazing (Code 528).

When nutrients or other soil amendments are applied coordinate forage harvests with WI NRCS CPS, Nutrient Management (Code 590) and/or Waste Utilization (Code 633) as appropriate. An excess or improper balance of nutrients such as nitrogen can produce plant material that causes toxicity in some animals.

Produce stored forages of the quality needed for optimum performance of the animal being fed. Legume forages too low in fiber and lead to metabolic disorders in ruminants and an economic loss to the producer due to lowered animal performance. Consider analyzing harvested forages for feed quality. Coordinate this practice with WI NRCS CPS, Feed Management (Code 592).

Direct cut grass and legume silage can create silage leachate (seepage) in storage. Consider use of WI NRCS CPS, Runoff Management System (Code 570) and Waste Storage Facility (Code 313).

In conjunction with harvest options, consider storage and feeding options that will retain acceptable forage quality and minimize digestible dry matter loss.

Where weather conditions make it difficult to harvest the desired quality of forage consider use of mechanical or chemical conditioners, forced air barn curing and/or ensile.

Consider delaying harvest if prolonged or heavy precipitation is forecast that would reduce forage quality.

When rainfall and/or humidity levels cause unacceptable forage quality losses consider green chopping or ensiling the forage to reduce or eliminate field drying time. Other options are: the use of desiccants, preservatives, or macerating implements to reduce field-drying time.

To reduce safety hazards, avoid operating harvesting and hauling equipment on field slopes over 25 percent, particularly on cross slope traffic patterns.

Consider Harvesting Forages in the afternoon to optimize water soluble carbohydrates and nutritional quality.

Select cultivars that are suitable for the harvest regime, species mix, and forage quality desired. For specific nutrient uptake, select species that can maximize uptake. See WI NRCS CPS, Pasture and Hay Planting (Code 512).

When insect and disease outbreaks exceed economic thresholds and are uncontrollable by harvest management pesticide applications may be needed. Another option is to select a resistant cultivar when the stand is replaced. See WI NRCS CPS, Pest Management (Code 595).

To control forage plant diseases, insects, and weeds, clean harvesting equipment after harvest and before storing. Do not cut forages until dew, rain, or irrigation water on leaves has evaporated.

When weed infestation exceeds the economic threshold and is uncontrollable by forage harvest management alone, weed management should be planned and applied. See WI NRCS CPS, Pest Management (Code 595).

Take care not to produce stored forages whose quality is not that needed for optimum performance of the animal being fed. For instance, immature legume forages can be too low in fiber and lead to metabolic disorders in ruminants and an economic loss to the producer due to lowered animal performance.

PLANS AND SPECIFICATIONS

Place the detailed specifications in a site-specific job or design sheet or in the practice narrative in the conservation plan.

Plans and Specifications must include as minimum for the forage harvest operations:

- Goals, objectives, specific purpose (such as high forage quantity and quality or nutrient uptake, etc.)
- Forage species to be harvested

By each dominant forage species harvested show:

- Method of harvest
- Stage of maturity
- Optimal harvest moisture content
- Length of cut
- Stubble height to be left
- Harvest interval including late harvest if applicable
- Contaminant avoidance recommendations.

Document any additional factors to consider prior to harvest:

- Wildlife nesting dates
- Late season harvest dates
- Strategies to maximize nutrient uptake
- Strategies to address insect or weed problems

These plans and specifications shall be available through appropriate job sheets and other materials for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

Before forage harvest, clear fields of debris that could damage machinery or if ingested by livestock, lead to sickness (for example, hardware disease) or death.

Operate all forage harvesting equipment at the optimum settings and speeds to minimize loss of leaves.

To control forage plant diseases, insects, and movement of weeds, clean harvesting equipment after harvest and before storing.

Set shear-plate on forage chopper to the proper theoretical cut for the crop being harvested. Keep knives well sharpened. Do not use re-cutters or screens unless forage moisture levels fall below recommended levels for optimum chopping action.

Follow all agricultural equipment manufacturer's safety measures when operating forage harvesting equipment.

Regardless of silage/haylage storage method, ensure good compaction and an airtight seal to exclude oxygen and mold or bacterial formations.

Dispose of the plastic wrap or bags used to store forage in an environmentally sound manner.

Regardless of silage/haylage storage method, ensure good compaction and an air-tight seal to exclude oxygen and mold formation.

FEDERAL, TRIBAL, STATE AND LOCAL LAWS

Users of this standard should be aware of potentially applicable federal, tribal, state and local laws, rules, regulations or permit requirements governing cover crops. This standard does not contain the text of federal, tribal, state or local laws.

REFERENCES:

Ball, D. M., C. S. Hoveland, & G. D. Lacefield. Southern Forages. 1991. Potash & Phosphate Institute, Norcross, GA.

Barnes, R. F., D. A. Miller, & C. J. Nelson. Forages, The Science of Grassland Agriculture, Fifth Edition. 1995. Iowa State University Press, Ames, IA.

Hanson, A. A., D. K. Barnes, & R. R. Hill, Jr. Alfalfa and Alfalfa Improvement. 1988. American Society of Agronomy, Madison, WI.

Ishler, V. A. Et al. Harvesting and Utilizing Silage. 1991. Penn State University Circular 396. University Park, PA.

Matches, A. G. Anti-Quality Components of Forages. 1973. Crop Science Society of America Special Pub. No. 4, Madison, WI

Pitt, R. E. Silage and Hay Preservation. 1990. Northeast Regional Agricultural Engineering Service. Ithaca, NY.

Serotkin, N., Ed. The Penn State Agronomy Guide, 1995-1996. Pennsylvania State University. 1994. University Park, PA.

Smith, D. Forage Management in the North, Third Edition. 1975. Kendall/Hunt Publishing Company, Dubuque, IA.

Taylor, N. L. Clover Science and Technology. 1985. American Society of Agronomy, Madison, WI

Alfalfa Management Guide NCR547.

UWEX Publication A3529, Pastures for Profit.

UWEX Publication A3492, Red Clover Establishment, Management, and Utilization.

USDA, NRCS Wisconsin Field Office Technical Guide (FOTG), Section IV, Practice Standards and Specifications.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

LIVESTOCK PIPELINE

CODE 516
(FT.)

DEFINITION
A pipeline and appurtenances installed to convey water for livestock or wildlife.

PURPOSE
This practice may be applied as part of a resource management system to achieve one or more of the following purposes:

- Convey water to points of use for livestock or wildlife.
- Reduce energy use.
- Develop renewable energy systems.

CONDITIONS WHERE PRACTICE APPLIES
This standard applies to the conveyance of water through a closed conduit, from a source of supply to a watering facility, for use by livestock or wildlife.

This practice does not apply to the use of pipelines for irrigation, which are addressed by Wisconsin NRCS Conservation Practice Standard (WI NRCS CPS), Irrigation Pipeline (Code 430).

CRITERIA
General Criteria Applicable to All Purposes
The volume, quality, and rate of delivery by the pipeline shall be sufficient to make use for livestock or wildlife practical and feasible.

Pipelines shall be placed only in or on soils with environmental conditions suitable for the type of material selected.

Capacity. Capacity shall be sufficient to convey the design delivery flow rate for the planned conservation practices. In computing the capacity requirements, allowance must be made for reasonable water losses during conveyance and use.

The rate at which livestock drink and their watering habits must be assessed in order to provide adequate pipeline capacity. A combination of tank sizing and pipeline capacity can be used to satisfy the water demand.

For livestock or wildlife, provide the capacity necessary to meet the seasonal high daily water requirements for the number and species of animals to be supplied.

Livestock water requirements can be obtained from Table 1.

Table 1. Minimum Daily Livestock Water Requirements

Livestock	Drinking Water Quantity[1] (gals/head)	
	Continuous / Low Management Grazing System	Prescribed / Managed Grazing System
Beef Cow	20	15
Cow & Small Calf	20	15
Horses & Mules	20	15
Sheep & Goats	4	2
Dairy Cow	25	20
Hog	2	

[1]Daily water consumption for livestock classes not listed may be calculated at one gallon per day per 100 pounds of body weight.

Friction and Other Losses. For design purposes, head loss for hydraulic grade line computations shall be based using one of the following equations: Hazen-Williams, Darcy-Weisbach, or Manning's. Equation selection shall be based on the given flow conditions and the pipe materials used. Other head losses (also called minor losses) from change in velocity and direction of flow due to inlet type, valves, bends, enlargements or contractions can be significant and shall be included as appropriate. For closed, pressurized systems, the hydraulic grade line for all pipelines shall be maintained above the top of the pipeline at all locations for all flows, unless specifically designed for negative internal pressures.

Pipe Design. Pipelines shall be designed to meet all service requirements such that internal pressure, including hydraulic transients or static pressure at any point is less than the pressure rating of the pipe.

Flexible conduits such as plastic and metal pipe shall be designed using NRCS National Engineering Handbook (NEH), Part 636, Chapter 52, Structural Design of Flexible Conduits, and the following criteria:

Plastic Pipe. When operating at design capacity, the full-pipe flow velocity should not exceed 5 feet per second in pipelines with valves or some other flow control appurtenances placed within the pipeline or at the downstream end. As a safety factor against transient pressures, the working pressure at any point should not exceed 72 percent of the pressure rating of the pipe. If either of these limits is exceeded, special design consideration must be given to the flow conditions, and measures must be taken to adequately protect the pipeline against transient pressures.

Pressure ratings for pipes are normally based on a pipe temperature of 73.4°F. When operating temperatures are higher, the effective pressure rating of the pipe shall be reduced accordingly.

Plastic pipe, fittings, and solvents shall conform to the requirements of the ASTM specifications in Table 2.

For plastic pipe, thermal effects must be properly factored into system design. Values and procedures for pressure rating reduction shall follow information described in the NEH, Part 636, Chapter 52.

Metal Pipe. The specified maximum allowable pressure shall be determined using the hoop stress formula, limiting the allowable tensile stress to 50 percent of the yield-point stress for the material selected. Design stresses for commonly used metal pipes are shown in NEH, Part 636, Chapter 52.

Steel pipe shall meet the requirements of AWWA Specification C-200.

Support of Pipe. Pipelines installed above ground shall be supported, where needed, to provide stability against external and internal forces. Pipe support shall be designed using NEH, Part 636, Chapter 52.

Joints and Connections. All connections shall be designed and constructed to withstand the pipeline working pressure without leakage and leave the inside of the pipeline free of any obstruction that would reduce capacity.

Permissible joint deflection shall be obtained from the manufacturer for the type of joint and pipe material used.

For sloping metal pipe, expansion joints shall be placed adjacent to and downhill from anchors or thrust blocks.

For welded pipe joints, expansion joints shall be installed, as needed, to limit pipeline stresses to the allowable values.

The allowable longitudinal bending for the pipeline shall be based on type of material and the pressure rating, and shall be in accordance with industry standards, or as described in NEH, Part 636, Chapter 52.

For suspended pipelines, joints shall be designed for pipe loading, including the water in the pipe, wind, ice, and the effects of thermal expansion and contraction.

Joints and connections for metal pipes should be of similar materials whenever possible. If dissimilar materials are used, the joints or connections shall be protected against galvanic corrosion.

Depth of Cover. Buried pipe shall be installed at sufficient depth below the ground surface to provide protection from hazards imposed by traffic loads, farming operations, freezing temperatures, or soil cracking, as applicable.

Pipelines shall have sufficient strength to withstand all external loads on the pipe for the given installation conditions. Appropriate live loads shall be used for the anticipated traffic conditions.

Where it is not possible to achieve sufficient cover or sufficient strength, a carrier (encasement) pipe or other mechanical measures shall be used.

Valves and Other Appurtenances. Pressure ratings of valves and other appurtenances shall equal or exceed the design working pressure. When lever operated valves are used, an analysis shall be performed to evaluate potential transient pressures, assuming rapid valve closure.

Pressure Reduction. Pressure Reducing Valves or Breaker Tanks shall be incorporated in circumstances such as head gain exceeding pressure loss by a significant amount, excessive static pressures, or excessive flow rates.

Check Valves and Backflow Prevention. A Check Valve shall be installed between the pump discharge and the pipeline if detrimental backflow may occur.

Approved backflow prevention devices shall be used on all pipelines where back flow may contaminate the source water supply or groundwater.

Pressure Relief Valves. A Pressure Relief Valve shall be installed between the pump discharge and the pipeline if excessive pressure can build up when all valves are closed. If needed to protect the pipeline against malfunction or failure of Pressure Reducing Valves, Pressure Relief Valves shall be installed downstream of Pressure Reducing Valves.

Pressure Relief Valves shall be set to open at a pressure as low as practical, but no greater than 5 pounds per square inch above the design working pressure rating or maximum allowable pressure of the pipe. The valves shall have sufficient flow capacity to reduce the excessive pressures in the pipeline. The pressure at which the valves start to open shall be marked on each Pressure Relief Valve. Adjustable Pressure Relief Valves shall be sealed or otherwise altered to prevent changing the adjustment from that marked on the valve.

In lieu of a detailed transient pressure analysis, the minimum size of Pressure Relief Valve shall be ¼ inch nominal valve size per inch of the nominal pipeline diameter.

Air Vents. Provide for entry and removal of air along the pipeline, as needed to prevent air locking, hydraulic transients, or pipe collapse. Include provisions for air release and vacuum relief, as needed to protect the pipeline. Design the pipeline to remain below the hydraulic grade line during operation. If parts of the pipeline will be located above the hydraulic gradient, periodic use of an air pump may be required.

Surge Tanks and Air Chambers. Where surge tanks or air chambers are required for control of hydraulic transients or water column separation, they shall be of adequate size to ensure the water volume needs of the pipeline are met without the tank/chamber being emptied, and the required flow rate into the pipeline for the calculated pressure drop is met.

Outlets and Water Level Control. Appurtenances to deliver water from the pipe to the watering facility shall have adequate capacity to deliver the required flow. Where water is supplied continuously to the watering facility, use automatic water level controls (such as Float Valves) to control the flow of water and to prevent unnecessary overflows.

Design outlets and water level controls to withstand or be protected from damage by livestock, wildlife, freezing and ice damage. Outlets shall be designed to minimize erosion, physical damage, or deterioration due to exposure.

Thrust Control. Abrupt changes in pipeline grade, horizontal alignment, or size reductions, may require an anchor or thrust blocks to absorb pipeline axial thrust. Thrust control is typically needed at the end of the pipeline, and at in-line control valves. The pipe manufacturer's recommendations for thrust control shall be followed. In absence of manufacturer's data, thrust blocks shall be designed using NEH, Part 636, Chapter 52.

Physical Protection. All pipes shall be protected from hazards presented by traffic loads, farm operations, freezing temperatures, fire, thermal expansion and contraction. Reasonable measures shall be taken to protect the pipe from potential vandalism.

Steel pipe installed above ground shall be galvanized or shall be protected with a suitable protective paint coating.

Plastic pipe installed above ground shall be resistant to ultraviolet light throughout the intended life of the pipe, or measures must be taken to protect the pipe from damage due to ultraviolet light.

Polyethylene pipe used in above-ground systems will be made of materials with 2 percent carbon black and be designated with code letter "C" in the material cell classification as defined in ASTM D 3350 to provide ultraviolet resistance. It shall be resistant to ultraviolet light throughout the intended life of the pipe. Pipe of this type is suitable for seasonal use. Protect the pipe by placing it under perimeter and/or cross fences. Where pipelines cross heavy traffic areas or dissect a pasture, they shall be buried to a depth of 8-12 inches. Winterizing of these pipeline systems shall be done prior to freezing temperatures. This can be done by blowing out the system to remove any water within the pipeline or equivalent method.

Water shall not be allowed to freeze in pipelines or appurtenances. Protection from freezing may be achieved by draining or using compressed air to evacuate the pipe and fittings during freezing conditions, insulating, burying below frost depth, or heating.

Frost depth may be obtained from the NRCS National Engineering Handbook (NEH) Part 651, Agricultural Waste Management Field Handbook, Chapter 10 Wisconsin Supplement or local information.

Filling. The pipeline system shall have a means of controlling the filling of the pipeline to prevent entrapment of air or excessive transient pressures.

Filling velocities greater than 1 foot per second in a closed to the atmosphere pipe system (i.e., all outlets closed), requires special evaluation and provisions to remove entrapped air and prevent excessive transient pressures.

If filling at a low flow rate is not possible, the system shall be open to the atmosphere (outlets open) prior to pressurizing. The system shall be designed for air removal and excessive transient pressures that may develop at higher filling rates.

Flushing. If the sediment load in the water is significant, the pipeline shall have adequate velocity to ensure that sediment is moved through and flushed out of the pipeline.

If provisions are needed for flushing sediment or other foreign material, a suitable valve shall be installed at the distant end or low point of the pipeline.

Draining. Provisions shall be made for the complete removal of water from the pipeline by gravity or other means when:

Freezing temperatures are a hazard.

Draining is required by the pipe manufacturer.

Draining of the pipeline is otherwise specified.

The water drained from pipelines shall not cause water quality, soil erosion, or safety problems upon release.

Safe Discharge of Water. Provisions shall be made for water being discharged from valves, especially air valves and pressure relief valves. These valves shall be located such that flows are directed away from system operators, livestock, electrical equipment, or other control valves.

Vegetation. Reestablish vegetation or otherwise stabilize disturbed areas as soon as practical after construction. Seedbed preparation, seeding, fertilizing, and mulching shall meet applicable criteria in WI NRCS CPS, Critical Area Planting (Code 342).

Additional Criteria Applicable to Reduce Energy Use

Provide analysis to demonstrate reduction of energy use from practice implementation.

Reduction of energy use is calculated as average annual or seasonal energy reduction compared to previous operating conditions.

Additional Criteria Applicable to Develop Renewable Energy Systems

Renewable energy systems shall meet applicable design criteria in NRCS and/or industry standards, and shall be in accordance with manufacturer's recommendations. Hydropower systems shall be designed, operated, and maintained in accordance with the Microhydropower Handbook, Sections 4 and 5, as appropriate.

CONSIDERATIONS

Safety. Pipeline systems may present a hazard to the safety of people, during installation and operation. Consider safety as follows:

- Address trench safety in design and during construction.
- Provide protection for people from high pressure water blowing from Pressure Relief, Air Release, and other valves.
- Determine the existence or non-existence of underground utilities prior to construction.

Economics. Consider economics in pipeline design, as follows:

- Select pipe sizes based on lifetime energy requirements, versus initial costs of materials.
- Select pipe material based upon the expected service life of practice.
- Consider hydropower applications as alternatives to the use of Pressure Reducing valves or reduced pipe diameters to induce friction loss.

Other Resources. Consider potential impacts to other resources as follows:

- Address rare plant species and cultural resources during the installation of buried pipelines. When possible, avoid these resources, as well as wetlands and other habitats that are highly sensitive to disturbance, or include measures to minimize impacts.
- Consider the visual design of pipelines and appurtenances, especially in areas of high public visibility.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for Livestock Pipelines that describe the requirements for applying the practice according to this standard. As a minimum, the plans and specifications shall include:

- A plan view of the layout of the pipeline.
- Profile view of the pipeline.
- Pipe sizes and materials.
- Pipe joint requirements.
- Site specific construction specifications that describe in writing the installation of the pipeline. Include requirements for pressure testing of the pipeline.
- Depth of cover and backfill requirements.
- Vegetative establishment requirements.

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) Plan shall be developed for each Livestock Pipeline system installed. The plan should document needed actions to ensure that practices perform adequately throughout their expected life.

O&M requirements shall be included as an identifiable part of the design. Depending on the scope of the project, this may be accomplished by written statements in the plans and specifications, the conservation plan narrative, or as a separate O&M Plan.

Other aspects of O&M, such as draining procedures, marking crossing locations, valve operation to prevent pipe or appurtenant damage, appurtenance or pipe maintenance, and recommended operating procedures, should be described as needed within the O&M Plan.

Monitoring of any cathodic protection systems shall be performed as specified in the O&M Plan.

A filling procedure shall be developed, which details allowable flow rates and appurtenance operation at the various phases of the filling process, required to assure safe filling of the pipeline. Flow measuring devices, such as flow meters or other means (e.g., number of turns of a gate valve), should be used to determine the rate of flow into the pipeline system. This information shall be provided to the operator, and shall be incorporated into the O&M Plan as appropriate.

FEDERAL, TRIBAL, STATE AND LOCAL LAWS

Users of this standard should be aware of potentially applicable federal, tribal, state and local laws, rules, regulations or permit requirements governing cover crops. This standard does not contain the text of federal, tribal, state or local laws.

REFERENCES

USDA, NRCS, Wisconsin Field Office Technical Guide, Section IV, Conservation Practice Standards and Specifications.

USDA, NRCS, National Engineering Handbook, Part 650, Engineering Field Handbook.

USDA, NRCS, National Engineering Handbook, Part 651, Agricultural Waste Management Field Handbook.

USDA-NRCS, National Engineering Handbook, Part 636, Chapter 52, Structural Design of Flexible Conduits.

McKinney, J.D., et al. Microhydropower Handbook, IDO-10107, Volumes 1 and 2. U.S. Department of Energy, Idaho Operations Office.

Table 2. Plastic Pipe Materials, Fittings, and Solvents for Pipeline Installation

Pipe Materials (ASTM Specifications unless otherwise noted)	D 1785 Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
	*D 2239 Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
	D 2241 Poly (Vinyl Chloride) (PVC), Pressure-Rated Pipe (SDR)
	D 2513 Thermoplastic Gas Pressure Pipe, Tubing and Fittings
	*D 2737 Polyethylene (PE) Plastic Tubing
	D 2672 Joints for IPS PVC Using Solvent Cement
	*D 3035 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter
	F 876 (PE) Crosslinked Polyethylene (PEX) Tubing
	AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4 inches through 12 inches
	*AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, ½ inch through 3 inches
Pressure Fittings (ASTM Specifications)	D 2464 Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
	D 2466 Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
	D 2467 Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
	D 2609 Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe
	D 2683 Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
	D 3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
	D 3261 Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
Solvents (ASTM Specifications)	D 2235 Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
	D 2855 Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
Rubber Gaskets (ASTM Specifications)	F 477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe

*Must contain the code letter "C" in the material cell classification for above-ground use. (ASTM D 3350 states that code letter C pipe contains 2% carbon black.)

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

STORMWATER RUNOFF CONTROL

CODE 570
(NO. AND ACRE)

DEFINITION
Controlling the quantity and quality of stormwater runoff.

PURPOSE
To control stormwater runoff to achieve one or more of the following:

- Minimize erosion and sedimentation during and following construction activities.
- Reduce the quantity of stormwater leaving developing or developed sites.
- Improve the quality of stormwater leaving developing or developed sites.

CONDITIONS WHERE PRACTICE APPLIES
This practice applies to sites where stormwater runoff causes or may cause undesirable downstream flooding, sedimentation or channel degradation and/or degradation of surface or ground water quality if left untreated. This practice may apply both to sites undergoing development as well as remedial work on already developed sites.

This practice does not apply to sediment basins, see the criteria in Wisconsin NRCS Conservation Practice Standard (WI NRCS CPS), Sediment Basin (Code 350).

FEDERAL, TRIBAL, STATE, AND LOCAL LAWS
Users of this standard should be aware of potentially applicable federal, tribal, state and local laws, rules, and regulations or permit requirements governing stormwater runoff control. This standard does not contain the text of federal, tribal, state, or local laws.

CRITERIA
General Criteria Applicable to All Purposes
Develop a plan to reduce the impacts of stormwater runoff from the site based on an assessment of the downstream area. As applicable include in the plan practices or management activities that will:

- Reduce on-site erosion.
- Reduce off-site impacts from sedimentation.
- Reduce the quantity of stormwater leaving the site to levels that will not adversely affect downstream receiving channels.

- Improve the quality of runoff leaving the site.
- Leave the site in a stable condition after construction.

Vegetative Measures. Where appropriate, stabilize all areas disturbed by construction with vegetation as soon as possible after construction. Refer to WI NRCS CPS, Critical Area Planting (Code 342), for the establishment of vegetation. If vegetation is not appropriate for the site, use other measures to stabilize the area.

Safety. Detention ponds and other areas where water is detained or flows swiftly, can present hazards to the public. Where necessary, include appropriate safety features to warn of potential dangers or deter entry to hazardous areas such as fences, gates and warning signs.

Additional Criteria for the Reduction of Water Quantity

Design stormwater control systems to control flow from the area of concern to rates and volumes that will not cause degradation of downstream areas due to erosion or sedimentation. Acceptable peak rates are dependent upon the capacity and stability of the receiving channel. Local regulations may specify acceptable discharge rates for different storm frequencies.

Runoff is controlled by slowing the release of runoff from the site. This can be accomplished by on-site storage, increasing infiltration on-site, lengthening the flow path of runoff or a combination of these methods.

All runoff control methods must include provisions to safely bypass runoff in excess of the design storm.

Additional Criteria for the Improvement of Water Quality

Runoff from developing areas can be contaminated with a variety of substances including sediment, oils, chemicals and trash. Runoff control systems must include provisions to reduce contaminates in the runoff leaving the site. This can include vegetated filtration areas and other biofilters, trash guards and settling areas that are readily accessible for cleanout. For runoff that is known to be contaminated with substances that may be particularly harmful to the water supply or fish and wildlife, additional measures may be necessary.

Additional Criteria for Erosion and Sediment Control

Control erosion on the site by limiting the amount and length of time that bare soil is exposed to precipitation. This can be accomplished by staging construction and only removing vegetation from a portion of the site at a time, re-vegetating areas incrementally during construction or using temporary seeding and mulching to stabilize areas until permanent vegetation can be established. Structural erosion control practices can also be installed to reduce the flow length and velocity of runoff to limit erosion.

Temporary sediment barriers are used to trap sediment from construction or other disturbed areas where the barriers are needed for less than 2 years and the drainage areas are less than 1 acre. Temporary sediment barriers include synthetic fabric silt fences, straw bale barriers, coarse aggregate barriers, and other appropriate materials.

A temporary sediment barrier may be used where the minimum barrier height is less than 5 feet, and where failure of the barrier would not cause loss of life or damage to high-value property, or significant damage to lower-value property. The barrier shall be adequate to retain the sediment and handle the 10-year, 24-hour duration storm frequency discharge without failure or significant erosion for the anticipated life of the barrier.

1. **Straw Bale Sediment Barriers**
   Straw bale sediment barriers should only be used in situations where a life span of less than 3 months is required.

   Straw bale sediment barriers shall be installed on the contour, except that the ends shall be extended upslope to prevent water from bypassing the ends.

   The maximum length of uncontrolled slope upstream from a straw bale sediment barrier should be 100 feet.

   Bales shall be installed so that the bindings are oriented around the bale, not the top and bottom of the bales.

   The straw bales must be entrenched at least 4 inches into the ground and anchored with two stakes driven through the bale and at least 12 inches into the ground. The stakes shall be 2″ x 2″ (nominal) wooden stakes, standard steel fence posts, or ½-inch diameter steel reinforcing bars.

   Soil shall be compacted against the upstream base of the bales to prevent undermining by runoff. Gaps between bales must be filled by wedging them full of loose straw or equivalent material to prevent water flow between the bales.

   Straw bale sediment barriers shall not be used in channels or other areas of concentrated flow.

   Straw bale sediment barriers shall be removed once the disturbed area is permanently stabilized and no longer susceptible to erosion

2. **Silt Fences**
   Geotextile fabric silt fence used to trap sediment from disturbed areas shall be installed on the contour, except that the ends shall be extended upslope to prevent water from bypassing the structure.

   The maximum length of uncontrolled slope upstream from the silt fence should be 100 feet.

   The geotextile fabric silt fence shall not be used in channels or other areas of concentrated flow.

   Commercially available silt fence products may consist of either woven or non-woven polyester, polypropylene, stabilized nylon, polyethylene, or polyvinylidene chloride geotextile fabric. A heavy-duty nylon top support cord or equivalent is required.

   Where joints are necessary, each end of the fabric shall be securely fastened to a post. The posts shall then be wrapped around each other to produce a stable, secure joint.

The bottom edge of the silt fence fabric must be anchored by burying in a trench 6 inches deep by 4 inches wide on the upslope side of the posts. The fabric shall be folded to fit the trench and backfilled and compacted to the existing ground line.

The maximum spacing of support posts for non-woven silt fence shall be 3 feet and for woven fabric, 8 feet.

Wood support posts shall be a minimum length of 4 feet and the full height of the silt fence. The posts shall be a minimum dimension of 1⅛ inches by 1⅛ inches hardwood.

All posts shall be driven at least 2 feet into the ground.

Steel support posts shall be the full height of the silt fence. The posts shall be at least 5 feet long with a strength of 1.33 pounds per foot and have projections for the attachment of fasteners.

The silt fence fabric shall be attached to the posts in at least three places on the upslope side.

Silt fences shall be removed once the disturbed area is permanently stabilized and no longer susceptible to erosion.

3. Storm Drain Inlet Protection Barriers

Inlet protection barriers include, but are not limited to, filter fabric barriers, straw bales, sandbags, other material filled bags and socks, and stone weepers.

For temporary barriers that are installed around storm drain inlets, the perimeter length of the barrier must be at least 4 times the perimeter of the storm drain inlet. Where storm flows could over-top the barrier, the top of the barrier needs to be level throughout the perimeter length.

Barriers shall be located where a traffic hazard will not be created and where traffic and construction activities will not destroy or cause constant need for maintenance of the barriers. Barriers shall be located so that any resulting ponding of storm water will not cause excessive inconvenience or damage to adjacent areas or structures.

4. Fabric Barriers

Fabric barriers used as gully checks during vegetative establishment shall be spaced 50 to 100 feet apart. The fabric must be 36 inches wide with 18 inches buried and 18 inches lying on the ground. Barriers shall extend across the waterway bottom and up the side slopes to a minimum depth of (0.7) x (design depth) or 0.5 ft., whichever is greater.

CONSIDERATIONS

Considerations include additional design recommendations that are not required criteria, but may be used to enhance or avoid problems with the design and function of this practice.

Research has shown that the first runoff from a site is often the most contaminated. After this initial flush, less pollutants are available for removal and dilution lessens the impact. Consequently treatment of this "first flush" of runoff is often sufficient to address the water quality concern. The exact amount of runoff to treat varies depending upon the surface and level of contamination. Determine the amount of runoff to treat based on appropriate research or experience.

Stormwater control practices can affect downstream hydrology. While this is the point of most stormwater control systems the effect of changing the peak rate and volume of runoff should be considered on downstream areas. The effect of a single project should also be considered in context with other projects in the watershed to determine the cumulative effect. Generally peak rates of runoff should be kept at or below pre-development rates of runoff from the site for the 2-year, 24-hour storm. For already developed areas consider reducing the peak flow from the current developed condition.

Design stormwater control practices to fit into the visual landscape as well as to function for runoff control. Since stormwater control practices are generally installed in public spaces, consider how the space will be used and the visual impact the practices will have.

If properly designed, stormwater control practices can be beneficial to wildlife. When possible use native vegetation to provide food and habitat for wildlife and pollinators. Since most stormwater control practices are in aquatic environments, they can inhibit the movements of aquatic organisms. When designing these structures, include provisions for the safe passage of aquatic organisms that may inhabit the site.

To be most effective, stormwater control should include a system of practices working together. This might include detention along with infiltration areas and the maintenance of natural, undisturbed areas.

However, it could also include managing the development of the site to limit the disturbed area, ensuring that re-vegetation occurs in a timely manner and controlling where heavy equipment is allowed to travel on a site.

Large storms can quickly fill stormwater runoff practices with sediment that must be removed in order for the practices to function correctly. Consequently these practices should be designed for easy access and maintenance.

Since stormwater control practices are often installed in urban and public spaces, vandalism may be a problem. Consider using practices that cannot be easily vandalized such as grouting rock in place and installing barriers and locks where appropriate.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for stormwater runoff control systems that describe the requirements for applying the practice according to this standard. As a minimum the plans and specifications shall include:

- A plan view showing the extent of the practice.
- Cross-sections and/or profiles showing elevations and distances.
- Plans for structural details.
- Seeding requirements or other site stabilization measures.
- Construction specifications that describe in writing site specific installation requirements for the stormwater runoff control systems.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator. The minimum requirements to be addressed in the operation and maintenance plan are:

- Periodic inspections, especially immediately following significant rainfall events.
- Prompt repair or replacement of damaged components especially surfaces that are subjected to wear or erosion.
- Regular inspection of settling basins, trash guards and other practices to collect and remove accumulated sediment and debris.
- Where vegetation is specified, periodic mowing, fertilization and control of vegetation.

REFERENCES

USDA, NRCS Wisconsin Field Office Technical Guide (FOTG), Section IV, Practice Standards and Specifications.

Bannerman, Roger, and E. Considine, 2003. Rain Gardens: A How-to Manual for Homeowners. University of Wisconsin Extension Publication GWQ037 or Wisconsin Department of Natural Resources Publication PUB-WT-776 2003. Madison, WI.

US Environmental Protection Agency. 2007. Developing Your Stormwater Pollution Prevention Plan. Washington, DC.

US Environmental Protection Agency. 1999. Stormwater Technology Fact Sheet: Bioretention. Publ. EPA-832-F-99-012. Office of Water, Washington, DC.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

WATER AND SEDIMENT CONTROL BASIN

CODE 638
(NO.)

DEFINITION

An earth embankment or a combination ridge and channel constructed across the slope of minor watercourses to form a sediment trap and water detention basin with a stable outlet.

PURPOSE

This practice may be applied as part of a resource management system for one or more of the following purposes:

- To reduce watercourse and gully erosion,
- To trap sediment,
- To reduce and manage on-site and downstream runoff,
- To improve farmability of sloping land, and
- To improve downstream water quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to rural sites where:

- The topography is generally irregular,
- Watercourse and gully erosion is a problem,
- Sheet and rill erosion is controlled by other conservation practices,
- Runoff and sediment damage land and improvements,
- Soil and site conditions are suitable,
- Adequate outlets are available or can be provided, and
- 10-year, 24-hour runoff is less than 10 acre feet and the effective height of the embankment is 15 feet or less.

Do not use this standard in place of terraces. Where the ridge and/or channel extends beyond the detention basin or level embankment, use Wisconsin NRCS Conservation Practice Standards (WI NRCS CPS), Terrace (Code 600), or Diversion (Code 632), as appropriate.

FEDERAL, STATE, TRIBAL, AND LOCAL LAWS

Water and sediment control basin structures shall comply with all federal, state, tribal, and local laws, rules or regulations. The owner and/or operator is responsible for securing required permits. Permitting authorities should be contacted during the planning phase of the project. This standard does not contain the text of the federal, state, tribal, or local laws.

CRITERIA

Design Criteria

Locate water and sediment control basins to control erosion in drainage ways. Basins may be installed singly or in series as part of a system. Adjust the location to fit the topography, maximize storage and accommodate farm equipment and farming operations.

The resource management system must reduce soil loss in the interval above and below the basin to less than, or equal to, the allowable soil loss (T).

Where land ownership or physical conditions preclude treatment of the upper portion of a slope, a water and sediment control basin may be used to separate this area from, and permit treatment of, the lower slope.

The basin design must limit inundation, infiltration, and seepage to prevent crop damage. Water detention areas that will be cropped shall be designed to drain within 24 hours.

Spacing

Water and sediment control basins shall generally be spaced at terrace intervals. The grade of the watercourse between basins shall be considered, and the spacing shall be set to prevent watercourse or gully erosion.

Table 1. The maximum spacing between basins:

Slope Percent	Maximum Spacing (ft.)
0-4	700
4-6	6
6-12	5
More than 12	400

The system of basins and row arrangements shall be parallel when possible and spaced to accommodate farm machinery widths. Consideration shall be given to embankment slope lengths, top width, and inlet location when determining spacing.

Alignment

The embankment orientation and row direction shall be approximately perpendicular to the land slope to permit contouring as near as possible. The arrangement should permit farmability without excessive short point rows or sharp curves. Field boundaries and row length should also be considered when determining basin location and row direction.

Earth Embankment

The constructed elevation of the embankment shall be at least 5 percent greater than the design fill height to allow for settlement. The maximum design fill height shall be 15 feet.

The combined upstream and downstream side slopes of the settled embankments shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2 horizontal to 1 vertical.

Slopes to be cropped shall be 8 horizontal to 1 vertical or flatter.

The minimum top width shall be as shown in the following:

Fill Height (feet)	Top Width (feet)
0-5	3
5-10	6
10-15	8

Capacity

The minimum basin design capacity shall be large enough to control the runoff from a 10-year frequency, 24-hour duration storm without overtopping. The basin shall also have the capacity to store 10 years of sediment accumulation unless provisions are made for periodic sediment removal from the basin to maintain the design capacity. The following two table can be used to size basins, slotted risers, and underground outlets (UGOs).

Require water storage and Minimum Design Discharge with perforated/slotted risers, and UGO systems		
Duration of Flooding	**Water Storage**	**Design Outflow**
Hours	**Inches per inch of runoff per unit area (IN/IN/AC)**	**CFS per Acre-inch of runoff**
6	0.33	0.1
12	0.42	0.06
18	0.45	0.049
24	0.50	0.035
30	0.53	0.029
36	0.56	0.025
42	0.59	0.021
48	0.61	0.019

Require sediment storage (as expressed as water storage, inches)	
Soil Loss (Ton / Ac / Year)	**Estimated 10 year Sediment yield (Inches / AC)**
1	0.07
2	0.14
3	0.21
4	0.28
5	0.34
7	0.48
10	0.83

The basin shall have the ends closed to the design elevation. A maximum of 1 feet of freeboard may be added to the design fill height to provide for an auxiliary spillway around one or both ends of the basin. The auxiliary spillway must not contribute runoff to a lower basin that does not have an auxiliary spillway.

Foundation Preparation

The area under the embankment shall be cleared of all sod, roots, vegetation, organic matter, and other undesirable materials.

Portions of basin ridges designed to impound more than a 3-foot depth of water must include foundation cutoff (core trench) and anti-seep collars as required by the WI NRCS CPS, Pond (Code 378).

Outlets

Water and sediment control basins shall have spillways, underground outlets or soil infiltration outlets that meet the requirements of WI NRCS CPS, Pond (Code 378), or Underground Outlet (Code 620), as appropriate.

Vegetation

Where necessary to restore or maintain productivity, topsoil must be stockpiled and spread over disturbed areas.

Slopes and disturbed areas that are not to be cropped shall be established to appropriate vegetation or otherwise protected from erosion using organic or gravel mulch or other suitable measures.

Environmental quality and wildlife food and habitat shall be considered in selecting the species of vegetation. Seedbed preparation, fertilizing, seeding, and mulching shall be in accordance with WI NRCS CPS, Critical Area Planting (Code 342), and Mulching (Code 484).

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator. The minimum requirements to be addressed in the operation and maintenance plan include the following:

- Periodic inspections, especially immediately following significant runoff events.
- Prompt repair or replacement of damaged components.
- Maintenance of basin ridge height and outlet elevations.
- Removal of sediment that has accumulated in the basin to maintain capacity and grade.
- Regular cleaning of inlets for underground outlets. Repair or replacement of inlets damaged by farm equipment.
- Removal of sediment around inlets to ensure that the inlet remains the lowest spot in the basin.
- Where vegetation is specified, regular mowing and control of trees and brush. Vegetative disturbance should be scheduled to avoid the peak nesting season.
- Notification of hazards about steep slopes on the basin.

CONSIDERATIONS

Additional recommendations relating to design that may enhance the use of, or avoid problems with, this practice, but are not required to ensure its basic conservation functions are as follows:

- Water and sediment control basins should be part of a resource management plan including such practices as terraces, grassed waterways, contouring, a conservation cropping system, conservation tillage, and crop residue management.
- Where possible, the basin should be configured to enhance sediment deposition. This can be accomplished by using flow deflectors, inlet and outlet selection, and by adjusting the length to width ratio.
- For cropped fields, embankment orientation and crop row direction should be approximately perpendicular to the land slope to support contour farming. The design should support farmability by limiting short point rows or sharp curves. Field boundaries and row lengths should also be considered in planning basin location and row direction.
- Effects on streams and wetlands must be considered. Mitigation may be required where water is diverted or degraded for downstream uses.
- This practice can be used to develop/enhance seasonally ponded areas for migratory waterfowl.
- Where possible, the design should enhance habitat for native and endangered species.
- Effects on downstream water quality and temperature may be critical for some species.
- This practice may adversely affect cultural resources. Planning, installation, and maintenance must comply with General Manual 420, Part 401, Cultural Resources (Archeological and Historic Properties).
- Operation safety of vehicle and farming equipment should be considered when selecting cut and fill slopes, especially where cropping or haying is planned.

Design Documentation, Plans and Specifications

Plans and specifications for installing water and sediment control basins shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Design Documentation Requirements

Location and site map, soils, drainage area and volume computations including sediment volume required, design cross sections, spacing, and outlet requirements.

PLANS AND SPECIFICATIONS

Location map, profile along centerline of structure, cross section, outlet diameter, length, material, elevations, and seeding requirements.

As-Built Documentation

Completed cross section of structure at locations most likely to not meet design; profile along centerline of structure; outlet diameter, length, material, manufacturer, location, and elevations; vegetation adequacy.

REFERENCES

USDA, NRCS, National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 2 (Estimating Runoff).

USDA, NRCS, Technical Release 55, Urban Hydrology for Small Watersheds (TR-55).

USDA, NRCS Wisconsin Field Office Technical Guide (FOTG), Section IV, Practice Standards and Specifications.

USDA, NRCS, Wisconsin General Manual, Title 420, Part 401, Cultural Resources (Archeological and Historic Properties).

DEFINITIONS

Auxiliary spillway. The auxiliary spillway is the spillway designed to convey excess water through, over, or around a dam. This has been commonly referred to as an "emergency spillway".

Constructed elevation. The sum of the design elevation and the allowance for settlement.

Design elevation. Design elevation is the required top elevation of the embankment along the centerline before allowance for settlement has been added.

Design fill height. The difference in elevation between the design elevation and foundation elevation after stripping along the centerline of embankment.

Effective height. The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway crest and the lowest point in the cross section along the centerline of the dam prior to stripping. If there is no auxiliary spillway, the design elevation for the top of the dam is the upper limit.

Freeboard. Freeboard is the additional depth or elevation required above computed design requirements.