USDA-Natural Resources Conservation Service
May 17, 2022

DESIGN PACKAGE

Raymond Barchik

Trail and Walkway (575)

Stream Crossing (578)

Livestock Pipeline (516)

Watering Facility (614)

Water Well (642)

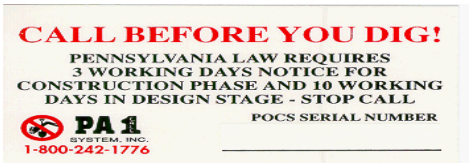
Pumping Plant (533)

Critical Area Planting (342)

Fence (382)

Luzerne County,

Pennsylvania



Prepared by MICHAEL SCHLAUCH (Affiliate) Digitally signed by MICHAEL SCHLAUCH (Affiliate) Date: 2022.06.08 12:59:46 -04'00' Date _____

Approved by *Andrew Wodehouse* Date *6/22*

NRCS Area Engineer: **Robert Deecki**
District Conservationist: **Janette Lesher**

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NARRATIVE

Currently Raymond's beef cows have free access to an existing wetland where his livestock loaf and get their daily water needs. The area has become highly degraded as well as an increase concern in water quality from nutrients, pathogens, and sediment entering a nearby tributary thus reducing soil and surface water quality. Additionally, the livestock must walk through deep mud to go from barn to nearby pastured areas. To mitigate these resource concerns a new HUA/Waste Storage Facility (other associated BMP's) are being planned in an adjacent field which is a more suitable location. With the construction of the new proposed HUA a Trail and Walkway, Stream Crossing, Livestock Pipeline, and additional Watering Facilities are being planned to exclude livestock from these sensitive areas. Installing the above-mentioned practices will reduce contaminants reaching the wetland and nearby tributary that drains into West Ashes Branch. In addition to installing watering facilities at the planned HUA there will be 5 frost free hydrants with portable troughs and approximately 2500' of buried 1" PE pipeline throughout the pastured areas. The system will be fed from the proposed well which location still needs to be determined. The pressure tank and pressure switch, valves, etc. will be located where the planned HUA is being constructed. The system will include a submersible well pump that will provide adequate water supply for all the livestock on the farm. This water system is for the 20 cow/calf pairs, 12 feeders and 1 bull. The design calls for 15 gallons/day/animal.

Installation:

The contractor or landowner shall notify an NRCS representative working on this project at least 24 hours prior to the start of construction. Failure to do so may result in NRCS being unable to check construction and certify that the installation meets NRCS standards, which is necessary to receive cost-share payment.

The scope of this project includes the necessary materials and complete installation of the watering system. All work shall be done as shown in the drawings and according to the following Pennsylvania Technical Guide Specifications (PATG) included in this design.

Tech Guide Standards and Specs Utilized in this design:

342 Critical Area Planting

578 Stream Crossing

516 Livestock Pipeline

614 Watering Facility

575 Trail and Walkway

642 Water Well

533 Pumping Plant

382 Fence

QUALITY ASSURANCE PLAN

Landowner: Raymond Barchik

Address: 85 Barchik Road, Benton PA 17814

Location: Farm 3010 Tract 973

Job Description: Raymond Barchik Grazing BMP's

Phase: 1

Assigned Planner: Michael Schlauch

Expected Performance Time: Fall 2022

CRITICAL ITEMS OF WORK AND TIME OF INSPECTIONS

ITEM	EXPECTED WORKDAYS	INSPECTION REQUIRED
Trail and Walkway	4	yes
Stream Crossing	2	yes
Livestock Pipeline	4	yes
Watering Facility	3	yes
Critical Area Planting	1	yes
Water Well	1	yes
Pumping Plant	1	yes
Fence	2	yes

GENERAL ITEMS

- **PA 1 Call** compliance is necessary, operator is responsible for making sure the contractor has called **8-1-1 or 1-800-242-1776** at least **three days prior** to planned start date. **Serial # pending**

- **OSHA** standards must be followed. If safety violations are observed, notify the contractor and contact the NRCS supervisor or engineer assigned to the job.

- The site will be checked randomly during the construction period when the contractor is working, expected to work, or could work. These visits should be unannounced and at a random time.

On the plan view sheet, the following items should be listed
Name the contractor(s).
Actual type and installed size (include length, width, depth, and volume) with verification of standard drawing and part number or model number matching approved list. This applies to all components (pump,, pipes, pressure tank, hydrants, water troughs).

Need certification of conformance for : Well / Pump (Refer to conformance form below)

CERTIFICATION OF CONFORMANCE

The undersigned primary manufacturer/supplier has furnished to:

Farmer's Name: Raymond Barchik

Address 85 Barchik Road

City/State/Zip Benton, PA 17814

Type of Structure: well/pump .

and hereby states that the quality of work and materials meets the requirements as set forth on NRCS contract drawings and Specifications No. 533 and 642 all as approved by the Natural Resources Conservation Service.
Name of Manufacturer/Supplier:_____

Signature/Title/Date:_____

Description of items completed:

In addition, the landowner and/or the following subcontractors were also involved in the installation and they hereby certify their work meets the requirements of the drawings and/or specifications as stated previously.

Landowner Signature/Date:_____

Description of items completed:
Subcontractor Signature/Date:_____

Description of items completed:
Received By: _____
Signature Title Date

Note: It is the primary manufacturer/supplier's responsibility to obtain and furnish all required signatures.

- Photos, measurements, surveys, and other notes should be taken throughout the construction process as required by each design check (see attached).

- All visits should be documented on the SCS-CPA-6 sheets OR a job diary.

EROSION & SEDIMENTATION PLAN

- No work is to be performed during rainfall or when the ground is saturated
- Equipment should be driven on existing access roads when possible
- If additional access is required, it must be stabilized with AASHTO No. 1 rock
- All other disturbed areas shall be graded to avoid ponding of water or concentrated flow, and heavily seeded with a standard seed mixture and mulched with hay/straw at approximately 3 tons to the acre (a loose layer ¾ to 1 inch thick) Compost may be applied at a rate of 270-540 cubic yards per acre (2-4-inch uniform layer).
- Any sediment, trees, brush or similar materials excavated shall be deposited in a suitable site away from all areas affected by flooding or wetlands and stabilized with permanent vegetative cover.

OPERATION & MAINTENANCE

CRITICAL AREA PLANTING

- Control access to the area to ensure the site remains stable with vegetation.
- Protect plantings from pests (e.g., weeds, insects, diseases, livestock, or wildlife) as necessary to ensure long term survival.
- Inspect regularly to ensure grass is not grazed below 3 inches.
- Reseeding or seasonal supplemental seeding of annual covers may be needed to ensure that this practice functions as intended throughout its expected life.
- Observe establishment progress and success at regular intervals until the practice has met the criteria for successful establishment an implementation.
- Successful establishment should have a stand density that provides a minimum of 85% ground cover within one year.

Watering Facility

- Check for leaks, site erosion, and damage to fences, heavy use areas, and appurtenances associated with the watering facility. Repair or replace damaged components, as needed.
- Check the performance of the automatic water level device, if present.
- Ensure that the outlet pipe is freely operating and is not causing erosion.
- Regularly clean the facility. Algae and iron sludge accumulation should be addressed in areas with water quality that is known to cause problems. Chemicals such as copper sulfate and chlorine can be recommended as needed, as long as local rules and regulations are followed. Examples of commonly used materials include copper tubing, barley straw, or goldfish.

- Maintain the facility to ensure that there is adequate inflow and outflow.
- Prepare the facility for winter as dictated by the climate. This may include draining supply pipes, emptying tanks, or ensuring that float valves will not be damaged by ice. -CPS-5 NRCS, PA 614 April 2015
- For a portable facility, include the plan for moving the facility and for monitoring/repair of the areas around the facility.

Livestock Pipeline

- Opening/closing valves to prevent excessive water hammer
- Filling at the specified rate requirements
- Inspecting and testing valves, pressure regulators, pumps, switches, and other appurtenances
- Maintaining erosion protection at outlets
- Checking for debris, minerals, algae, and other materials which may restrict system flow; and
- Draining and/or providing for cold weather operation of the system.
- Monitoring of any cathodic protection systems.

TRAILS AND WALKWAYS

- Inspect at least annually and after significant runoff events.
- Repair eroded areas or damaged surface materials.
- Install water bars or other runoff control structures if erosion persists.
- Remove sediment from water control features.
- Maintain standard grade and shape of walkway.
- Apply dust control measures as needed.
- Repair safety or control measures as needed.
- Periodic removal and management of manure accumulations as needed.
- Mending of fenced and replacements of gates as needed.
- Exclude livestock from trail when not traveling, do not allow livestock to linger in walkway for extended periods of time.

STREAM CROSSING

- Inspect the stream crossing, appurtenances, and associated fence at least annually and after each major storm event. Make repairs, if needed.
- Replace surfacing stone used for livestock crossing as needed.
- Remove any accumulation of organic material, woody material, or excess sediment.

Pumping Plant

- Inspection or testing of all pumping plant components and appurtenances.
- Proper start-up and shut-down procedures for the operation of the pumping plant.
- Routine maintenance of all mechanical components (power unit, pump, drive train, etc.) in accordance with the manufacturer’s recommendations.
- Procedures to protect the system from damage due to freezing temperatures.

- When applicable, procedures to frequently check the power unit, fuel storage facilities, and fuel lines, for leaks and repair as needed.
- Periodic checks and removal of debris as necessary from trash racks and structures, to assure adequate flow capacity reaching the pumping plant intake.
- Periodic removal of sediment in suction bays, to maintain design capacity and efficiency.
- Inspection and maintenance of anti-siphon devices, if applicable.
- Routine test and inspection of all automated components of the pumping plant, to assure the proper functioning as designed.
- Inspection and maintenance of secondary containment facilities, if applicable.
- Periodic inspection of all safety features, to ensure proper placement and function.
- Prior to retrofitting any electrically powered equipment, electrical service must be disconnected and the absence of stray electrical current verified.

Water Well

- Ensure no agricultural chemicals, such as fertilizers and pesticides, are stored or mixed or containers rinsed within a 100 ft. radius of the wellhead. The inspection must include conditions that affect well performance as designed for the water use. As a minimum, these conditions include:
    - Declines in discharge, static level, maximum pumping level, and pressure (for artesian wells) that are outside acceptable limits for the well design.
    - Appearance of sediment that may damage the well, pump, or appurtenances.
    - Changes in water quality including odor, color, taste, and chemistry.
    - Presence of algae or iron bacteria. For screen wells that have blank casing installed at the bottom, periodically bail or flush the well to remove excessive, accumulated sediment.

In the maintenance record, include statements describing identified problems, corrective action taken and date, and specific capacity of well before and after corrective action. The owner must remedy unacceptable conditions in a timely manner.

Fence

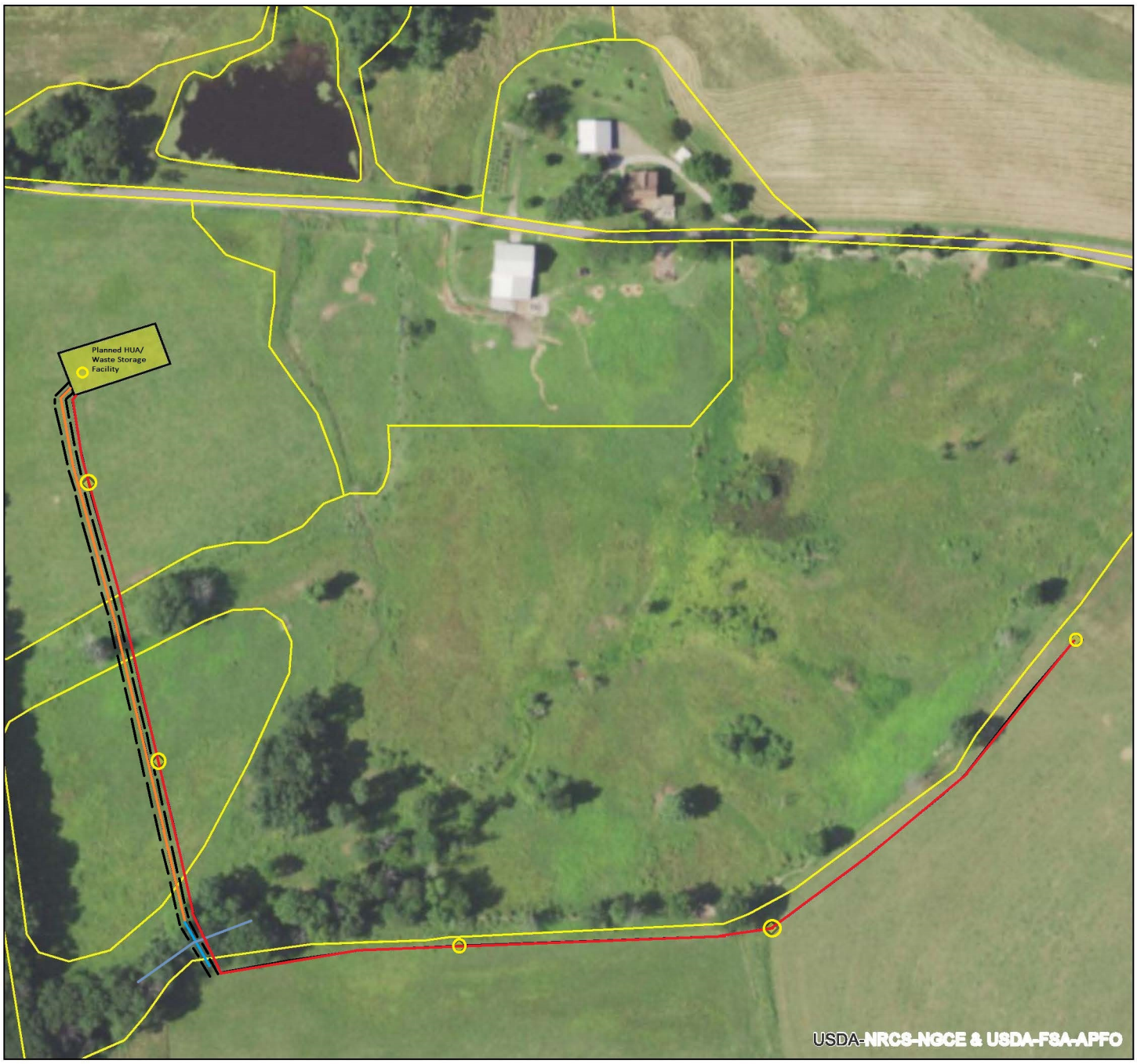
• Repair or replacement of loose or broken material, gates and other forms of ingress/egress
• Removal of trees/limbs
• Replacement of water gaps as necessary
• Repair of eroded areas as necessary
• Repair or replacement of markers or other safety and control features as required.
• Annual clearing of weeds and brush under and near the fence systems will prolong life expectancy.

Date: 5/23/2022

Conservation Plan Map

Client(s): RAYMOND H BARCHIK
Luzerne County, Pennsylvania
Approximate Acres: 112.10

Assisted By: MICHAEL SCHLAUCH
Natural Resources Conservation Service
PLYMOUTH SERVICE CENTER



Prepared with assistance from USDA-Natural Resources Conservation Service

0 200
Feet

Practice Schedule
PLUs

Livestock Pipeline
Trail and Walkway
Stream Crossing
Stream
Fencing

Watering Facilities

N

USDA

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Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

TRAILS AND WALKWAYS

CODE 575

(ft)

DEFINITION

A trail is a constructed path with a vegetated or earthen surface. A walkway is a constructed path with an artificial surface. A trail/walkway is used to facilitate the movement of animals, people, or off-road vehicles.

PURPOSE

A trail/walkway is used to accomplish one or more of the following purposes:

- Provide or improve animal access to forage, water, working/handling facilities, or shelter.
- Facilitate improved grazing efficiency and distribution
- Protect ecologically sensitive, erosive, or potentially erosive sites.
- Provide pedestrian or off-road vehicle access to agricultural, construction, or maintenance operations
- Provide trails/walkways for recreational activities or access to recreation sites

CONDITIONS WHERE PRACTICE APPLIES

This practice applies on all lands where management of animal or human movement is needed.

The practice applies to a trail/walkway constructed for use by off-road vehicles, such as All-Terrain Vehicles or snowmobiles, which are not designed for use on public roads. This practice does not apply to travel ways routinely or primarily used for vehicular traffic. Access Road (PA 560) is applicable to those areas.

CRITERIA

General Criteria Applicable to All Purposes

Design the trail/walkway to accommodate the planned use and site constraints. Minimize erosion and adverse on-site and off-site impacts to areas such as riparian zones, stream channels, streambanks, or wildlife habitat (e.g. fragmentation or restriction of wildlife movement). Trails and walkways shall be designed and constructed with consideration of site soil characteristics.

All planned work shall comply with all federal, state, and local laws and permit conditions and requirements. The landowner shall obtain all necessary permits prior to construction or any land clearing activities.

Clearing

Design clearing widths and heights to accommodate the safe use of the trail/walkway. Use NRCS Trails and Walkways Design Aid, 210-VI-LAN-04, for guidance, as needed.

Grades
Design trail/walkway grades to safely accommodate the planned use and to reduce the potential for erosion from runoff.

Design the cross-slope (the surface perpendicular to the direction of travel) or crown of the trail/walkway to allow water to drain off without creating erosion.

A trail/walkway for agricultural access generally should not exceed a 10% grade, although short sections of 50 feet or less may be up to 20%. Break long, steep grades by the use of switch backs. The grades of general use pedestrian and equestrian trail/walkway should generally not exceed 10%. Grades for other uses may be steeper, such as cross-country skiing, which may be as steep as 50% for difficult trails. Hiking trails may be as steep as 20%.

Trails or walkways shall be constructed with a crown or cross slope to drain water. The cross slope or crown shall meet the Table 1 slope requirements, measured perpendicular to the direction of travel.

Table1

Minimum Crowns and Cross Slopes	
Trail Width	Slope
≤ 6.0 Ft	1.0 In/Ft
6.1 – 11.9 Ft	0.75 In/Ft
≥ 12 Ft	0.5 In/Ft

Side slopes
Construction of embankments should be kept to a minimum. The walkway surface (Table 2) shall be installed above original grade on poorly and somewhat poorly drained soils so that drainage can occur. All earthfill and cut slopes need to be revegetated in accordance with Practice Standard Critical Area Planting, (PA342). Where upslope runoff is intercepted, it shall be conveyed in a stabilized swale outside the trail or walkway.

Design all cuts and fills to have stable slopes that are a minimum of 2 horizontal to 1 vertical. For short lengths, rock areas, or very steep hillsides, steeper slopes may be permitted if soil conditions warrant and special stabilization measures are installed.

Where possible, avoid areas with geological conditions and soils that are subject to slides. When the area cannot be avoided, treat the area to prevent slides.

Turns
Design turning radii based on the intended use of the trail/walkway.

Water Control
Divert concentrated water flows away from the trail or walkway by installing surface or subsurface drainage measures such as *Subsurface Drain (PA606)* or *Diversion (PA362)*, as needed. Surface cross drains, such as broad-based or rolling dips, may be used to control and direct water flow off the trail/walkway surface. Use the chart (Figure 1) in *Access Road (PA560)* for maximum spacing requirements. Protect the outlets of drainage measures to limit erosion.

Avoid traversing wet soil areas whenever possible. If unavoidable, provide an all-weather surface or elevate the walkway above ponded water or wet soil areas.

Avoid locating the trail/walkway where runoff will flow directly from the trail/walkway into a stream or body of water. To the extent possible, place the trail/walkway along the contour and avoid placement perpendicular to the contour.

Where a trail/walkway crosses a stream, use *Stream Crossing (PA578)*. If a drainage feature is typically dry, use *Structure for Water Control (PA587)*. At a minimum, design drainage culverts to carry the flow

from the 2-year, 24- hour storm event. Use a larger storm event to design the drainage culvert where watershed conditions or anticipated usage warrant a larger structure.

Bridges and Elevated Walkways
Design bridges in accordance with *Stream Crossing (PA578)*.

Design walkways in a manner that is consistent with sound engineering principles and adequate for the use and type of walkway. For elevated walkways, use the maximum loading anticipated during normal use plus a safety factor of at least 1.5. For elevated walkways that will only be used for pedestrian traffic, use the AASHTO *Guide Specification for Design of Pedestrian Bridges* for design or State guidelines, whichever is more restrictive.

Design bridges and elevated walkways that will be used for horses or other large livestock for a uniformly applied load of not less than 200 pounds per square foot (psf).

Surface
A trail can have a vegetated or unvegetated surface if the soil surface will support the intended use.

The lane or walkway shall have a minimum surfacing based on soil drainage classes as contained in Table 2.

Sensitivity of the animal's feet, with respect to the intended purpose of the trail or walkway, will be included as a design parameter in selecting the surface material for trails or walkways.

If a trail is planted to vegetative cover, protect the vegetation from traffic until it is fully established and capable of withstanding the expected traffic. Establish a vegetative surface in accordance with the criteria in *Heavy Use Area Protection (PA561)*.

Trail or Walkway Cross Section		
Cross Section Option	Soil Drainage Classification*	
	Well to Moderately Well Drained	Somewhat Poorly to Poorly Drained
Compacted earth**	X	
Minimum 2" surface material	X	
Minimum 2" surface material over 2" binder course over 4" base course	X	
Minimum 2" surface material over 6" base course***	X	
Minimum 2" of surface material over 6" base course over class IV geotextile (non-woven)		X
Minimum 2" of surface material over 2" binder course over 4" base course over class IV geotextile (non-woven)		X

* Based on site specific investigations due to soil complexes in local soil surveys.

** Compacted earth, including weathered shale, shall be used only on slopes less than 5% where the walkway runoff is directed across a pasture or a vegetated *Filter Strip (PA 393).*

*** Select surface materials that are of the appropriate size and mixture when placed over the desired base course.

Trail or Walkway Cross Section
Definitions **Surface Material**: PennDOT gradations Select Granular Material (2RC) or Driving Surface Rock Aggregate (Dirt & Gravel Roads DSA Mix); AASHTO/PennDOT No. 10 (stone dust); or cementitious coal combustion by-products. **Binder Course**: AASHTO/PennDot No. 57, No. 67, or 2A. **Base Course**: AASHTO/PennDOT No.1, No. 3 or No. 57.

Where an all-weather surface is needed, refer to the criteria in *Heavy Use Area Protection (PA561)*. Select a surface material for the walkway that is appropriate for the intended use and frequency.

When selecting the surface material for a walkway used by animals, consider the sensitivity of the animals' feet.

Erosion Control
Include provisions to control water and wind erosion during construction.

Where possible, establish vegetation on disturbed areas as soon as practicable. Use the criteria in *Critical Area Planting (PA342)* or the NRCS State-approved seeding specification. Use vegetation adapted to the site. Give preference to native plant species where compatible with land use and existing plant species.

If soil, shade, or climatic conditions prevent establishment of vegetation, use the criteria in *Mulching (PA484)* for erosion control.

Safety and Use Control
Incorporate use control and the safety of the users into the design of the trail/walkway. Where needed, install directional and warning signs, handrails, gates, fencing, and other safety devices. Provide protection from slides and falling rocks, as needed.

Additional Criteria Applicable to Provide or Improve Animal Access to Forage, Water,Working/Handling Facilities, or Shelter
Construct the trail/walkway wide enough to accommodate the movement of the animals and access by the operator for management and maintenance. For this purpose, minimum width shall be six (6) feet wide.

When needed to facilitate movement of animals through a series of paddocks or pastures, design gate openings and trails/walkways for efficient flow of animals.

Where fencing is needed to keep animals confined to the trail or walkway, use *Fence (PA382)*.

Additional Criteria to Facilitate Improved Grazing Efficiency and Distribution
When one of the purposes of a grazing plan is to improve animal distribution or to allow better pasture utilization, a trail/walkway may be needed to facilitate animal movement. Use *Prescribed Grazing (PA528)* to plan the grazing system.

Additional Criteria Applicable to Pedestrian or Off-Road Vehicle Access for Agricultural,Construction, Maintenance Operations, orRecreation
Base the design requirements on the type and class of trail or walkway described in NRCS Trails and Walkways Design Aid, 210-VI-LAN- 04. When a trail/walkway will have multiple uses, design for the most restrictive criteria. When needed, use *Access Control (PA472)* to provide temporary or permanent exclusion from an area.

Width
Design the trail/walkway width to safely accommodate the intended use. The minimum width is determined by the type and class of trail. See the tables in Appendix A in 210-VI-LAN-04 for design parameters.

Accessibility for Recreation
The Americans with Disabilities Act of 1990 (ADA) requires outdoor recreation access routes and some hiker/pedestrian trails to be accessible to people with disabilities. Address accessibility requirements for new construction and when existing facilities are being altered. Compliance with the ADA outdoor recreation guidelines is not required where:

- compliance would cause harm to cultural, historic, religious, or significant natural features;
- compliance would substantially alter the nature of the setting;
- compliance would require construction methods or materials that are prohibited by Federal, State or local regulations; or
- compliance would not be feasible due to terrain or the prevailing construction practices.

Make an accessibility evaluation to determine the required level of accessibility for a trail/walkway design. Refer to NRCS Trails and Design Aid, 210-VI-LAN-04 for accessible trail design procedures. For agricultural operations, the width is determined by equipment width plus up to two (2) additional feet to allow for safe passage.

CONSIDERATIONS

General
Cultural resources, threatened or endangered species, wetlands, streambanks, floodways or other ecologically sensitive areas, and areas of special scenic value will be protected through the proper design and placement of trail(s) or walkway(s).

Contribute to food safety by channeling animals away from sensitive sites where pathogen transfer might occur.

In areas that are vulnerable to wind erosion, or have frequent dry, loose surfaces that can easily create mechanically-generated particulate matter (i.e., dust), use a surfacing material with a coarse texture for a walkway requiring non- vegetated surface treatment. Coarser materials will have larger particle sizes that are less easily entrained in the air and will minimize the potential for dust formation.

An unvegetated trail can be a prime source of dust emissions resulting in a particulate matter resource concern. Utilize additional conservation practices, such as *Dust Control on Unpaved Roads and Surfaces (PA373),* to reduce the potential for generation and transport of particulate matter emissions, if warranted.

Other conservation practices, such as Use Exclusion (PA472) can be used in conjunction with trails or walkways to minimize the impact on sensitive areas.

Animal Access
To facilitate maintenance of a walkway, consider putting the fence outside of the surface material.

For areas of high livestock concentration, such as around ponds, tanks, troughs, or other feeding areas, use Heavy Use Area Protection (PA561).

Where a trail or walkway meets a pasture, as part of a continuous grazing system and not part of a rotational system, the walkway should be widened in a V shape up to 5 times its normal width, over a length 5 times the normal width.

Pedestrian and Off-Road Vehicle Access
For a recreational trail that starts from a roadway, adequate parking for users may need to be provided as part of the design.

A trail/walkway for agricultural purposes may need to incorporate staging areas where equipment, supplies or harvested crops can be stockpiled.

Consider saving and maintaining key trees and other vegetation that have scenic value, provide shade, reduce erosion and runoff, provide habitat for fish and wildlife, or add to the visual quality of the area. Some selective cutting or trimming of trees or other vegetation may be necessary to provide and maintain scenic vistas at overlooks. At overlooks, keep tree removal or trimming to the minimum needed to provide an unobstructed view of the most salient features present.

PLANS AND SPECIFICATIONS

Provide plans and specifications that describe the requirements for applying the practice to achieve its intended purpose. As a minimum, include:

- A plan view showing the location of the trail/walkway.
- Typical cross-sections for each reach of the trail/walkway showing the width, typical side slopes and any surfacing needed.
- Profile for each reach.
- Details of water control structures and other appurtenances.
- Erosion protection measures.
- Material quantities.
- Construction specifications.
- Fencing, as needed.
- Safety features, as needed.
- Expected application types, amounts, and frequency of dust suppressants, if needed.

OPERATION AND MAINTENANCE

Prepare a written Operation and Maintenance (O&M) plan for each site. As a minimum, the plan must include the following:

- A schedule for inspections at least annually and after significant runoff events. The inspections must include drainage structures, trail/walkway surfaces, vegetation, fencing, bridges and elevated walkways, and safety features, as appropriate.
    - For bridges and elevated walkways that are open or accessible to the public, conduct inspections in accordance with AASHTO Guide Manual for Bridge Element Inspection.
- Maintenance activities:
    - Removal of sediment from water control features.
    - Repair of eroded areas or damaged surface materials.
    - Grading and shaping of the trail/walkway to maintain design grades and dimensions.
    - Application of dust control measures, as needed.
    - Repair of safety or control features, as required.
    - Re-seeding of areas where vegetation has been damaged or destroyed.
    - Periodic removal and management of manure accumulations, as needed.
    - Mending of fences and replacement of gates.

For multiple adjacent vegetated animal trails, include a rotation plan to allow for recovery of vegetation and for improvement of traffic- supporting conditions.

REFERENCES

These references were current at the time the CPS was developed. Use more recent editions, if available.

Using All-Weather Geotextile Lanes and Pads, Agricultural Engineering Digest AED-45, Midwest Plan Service, Ames, Iowa, 1999.

Constructing Mud Free Cow Lanes, Pequea-Mill Creek Information Series, College of Agricultural Sciences, Penn State University, University Park, Pennsylvania

United States Department of Agriculture, Forest Service. 2007. Trail Construction and Maintenance Notebook. Washington, DC.

USDA-NRCS. 2003. National Range and Pasture Handbook, Revision 1. Washington, DC.

Wood, Gene. 2007. Recreational horse trails in rural and wildland areas: design, construction and maintenance. Clemson University.

American Association of State Highway and Transportation Officials. 2010. AASHTO Load and Resistance Factor Rating Bridge Design Specifications, 5th Edition. Washington, DC.

American Association of State Highway and Transportation Officials. 2011. Guide Manual for Bridge Element Inspection. 1st edition. Washington, DC.

American Association of State Highway and Transportation Officials. 2002. Standard Specifications for Highway Bridges, 17th Edition. Washington, DC.

American Association of State Highway and Transportation Officials. 2009. Guide Specification for Design of Pedestrian Bridges, 2nd Edition. Washington, DC.

USDA - NRCS. 2009. LAN Architecture Note 4. Trails and Walkways Design Aid. Washington, DC.

USDA - FS. 1991. Trails Management Handbook. Washington, DC.

USDI-NPS. 1996. Handbook for Trail Design, Construction and Maintenance. Washington, DC.

Practice Specification
Trails and Walkways (Code 575)

1. SCOPE

The work shall consist of furnishing materials and installing all components of the trails and walkways as outlined in this specification and the drawings.

2. MATERIALS

All materials used shall conform to the quality and grade noted on the plans, set forth in Section 8, or as otherwise listed below:

WEARING SURFACE, BINDER COURSE, and BASE COURSE aggregate shall meet the requirements and gradation specified in Section 8 or on the drawings.

GEOTEXTILE shall meet the requirements as outlined in the following table or as otherwise set forth in Section 8 or on the drawings:

Requirements for Nonwoven Geotextiles		
Property	**Test Method**	**Value**
Tensile Strength	ASTM D4632 Grab Test	115 lbs
Elongation at Failure	ASTM D 4632	> 50%
Puncture	ASTM D 4833	40 lbs
Apparent opening size	ASTM D 4751	#40 max.
Permittivity	ASTM D 4491	0.10 $secs^{-1}$
Ultravoilet light (%residual tensile strength)	ASTM D 4355 150 Hr Exposure	70%

PIPE shall meet the requirements specified in Section 8 or on the drawings.

WOOD PRODUCTS shall be Douglas Fir, Southern Yellow Pine, or as otherwise specified on the drawings or in Section 8.

They shall be treated with preservatives in accordance with the American

Wood Preservers Association (AWPA) Standard C16, “Wood Used on Farms, Pressure Treatment.” Each piece shall bear the AWPA stamp of quality. In the absence of such a stamp, the Contractor or material supplier shall provide written certification that the pressure treated wood products meet the designated quality criteria.

FASTENERS for wood structures shall be stainless steel, galvanized, or otherwise protected from corrosion due to contact with moisture and soil.

3. FOUNDATION PREPARATION

All trees, brush, fences, manure, and rubbish shall be cleared within the trail or walkway area, including any associated drainage control features and borrow areas. All stumps and roots larger than two inch diameter shall be removed down to the subgrade elevation. All material removed by clearing operations shall be disposed of as directed by the Owner or his/her Representative.

Topsoil shall be stripped and stockpiled in a convenient location for use on disturbed areas to facilitate seeding.

Mineral soil shall be excavated and placed as fill as shown on the drawings to establish a uniform, stable subgrade. Wet soil, mud, and topsoil shall not be used as fill. The fill material shall be compacted as specified in Section 8 or on the drawings.

Borrow material shall be taken from the designated borrow area as needed after excavation of the trail or walkway is complete. The borrow area shall be final graded to drain freely and blend into the surrounding undisturbed area.

Excess excavated material shall be disposed of in the designated spoil area, which shall be graded to blend into the surrounding undisturbed area.Geotextile or base course material shall beset on undisturbed soil or non-yielding compacted material. Over-excavation must be corrected as noted on the drawings, or as directed by the Engineer or his/her designated Representative.

4. DRAINAGE STRUCTURES

Culverts, subsurface drains, and swales shall be installed as shown on the drawings. Surface and subsurface drainage structures shall be adequately removing water from the foundation to allow for proper placement of base and surface materials.

5. GEOTEXTILE

Where specified in Section 8 or on the drawings, geotextile shall be installed on the prepared subgrade. The geotextile shall be placed, overlapped and anchored as recommended by the manufacturer, unless otherwise specified in Section 8 or on the drawings.

Vehicles and heavy equipment shall not be operated directly on top of the geotextile. Base course or surface material shall be placed on the geotextile ahead of the construction equipment.

6. E&S CONTROL

E&S control measures shall be as set forth in the E&S Plan, and as otherwise detailed in the drawings.

Vegetation shall be established as set forth in Construction Specification PA 342, and/or as set forth in Section 8 and the drawings.

7. SURFACING

Where specified in Section 8 or on the drawings, the base and binder course shall be placed on the trail or walkway to the specified grades and thickness. The material shall be wetted and compacted by rollers or other construction equipment approved by the Engineer.

Surface material shall be placed to the grades and thicknesses set forth in Section 8 or on the drawings. The material shall be compacted by rollers or other construction equipment approved by the Engineer. The finished surface shall be smooth and free of projecting stones.

Vegetation shall be established in accordance with Construction Specification PA342.

The surface material in or adjacent to surface water control devices and other structures shall be compacted using manually directed tamping equipment.

8. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

Specific Site Requirements

Date: 5/23/2022

Conservation Plan Map

Client(s): RAYMOND H BARCHIK
Luzerne County, Pennsylvania
Approximate Acres: 112.10

Assisted By: MICHAEL SCHLAUCH
Natural Resources Conservation Service
PLYMOUTH SERVICE CENTER

Prepared with assistance from USDA-Natural Resources Conservation Service

0 150
Feet

Practice Schedule PLUs

Stream Crossing
Trail and Walkway
Watering Facility
Waterbar
Livestock Pipeline

N

USDA

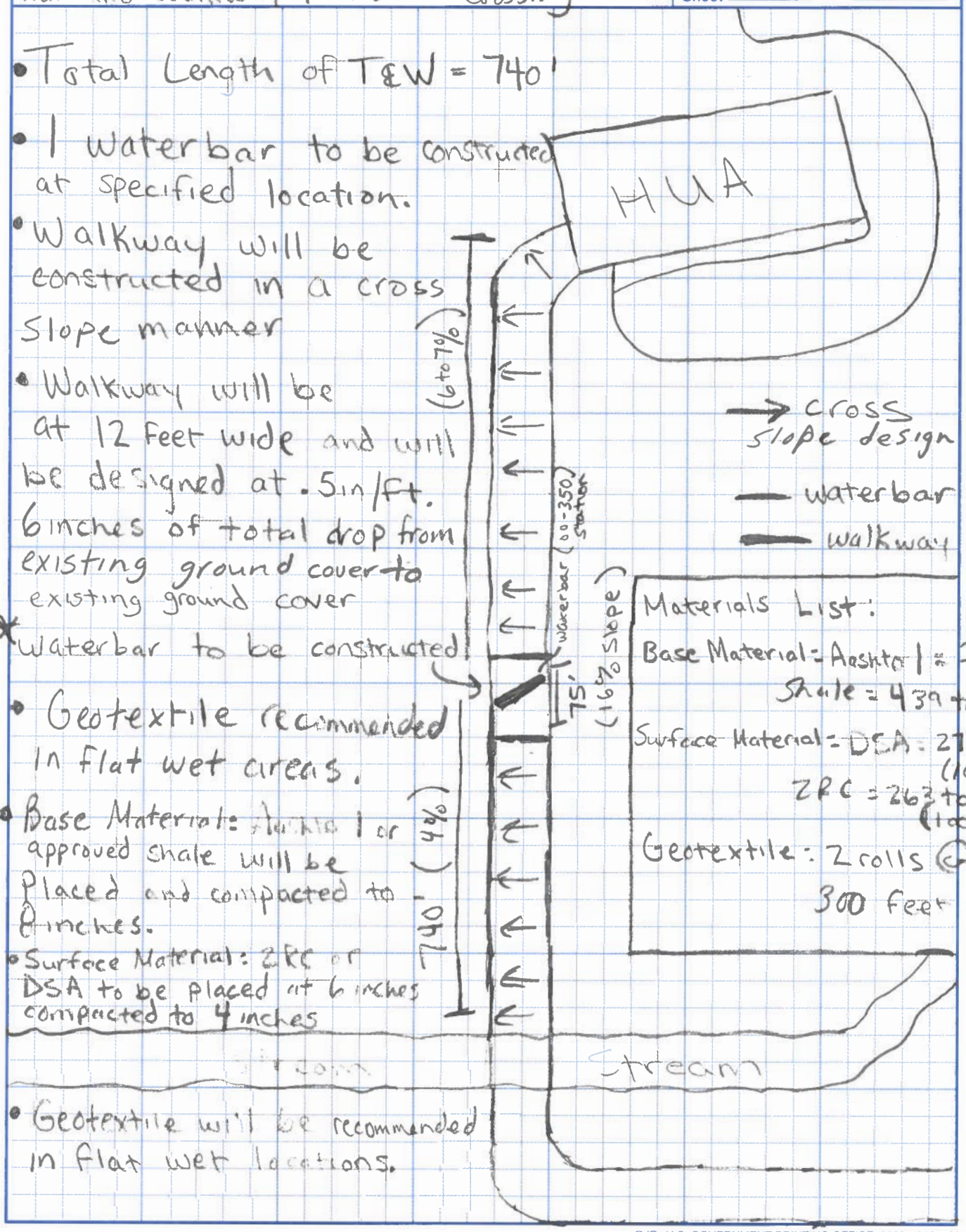
Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State		Project		
PA		Raymond Barchik Livestock		
By	Date	Checked by	Date	Job No.
MS	5/17/2022	AW	6/22	
Subject				Sheet ____ of ____
Trail and Walkway / Stream Crossing				

- Total Length of T&W = 740'
- 1 waterbar to be constructed at specified location.
- Walkway will be constructed in a cross slope manner
- Walkway will be at 12 feet wide and will be designed at .5in/ft. 6 inches of total drop from existing ground cover to existing ground cover
- *Waterbar to be constructed
- Geotextile recommended in flat wet areas.
- Base Material: Aashto 1 or approved shale will be Placed and compacted to 6 inches.
- Surface Material: ZRC or DSA to be placed at 6 inches compacted to 4 inches
- Geotextile will be recommended in flat wet locations.



Date: 5/23/2022

Conservation Plan Map

Client(s): RAYMOND H BARCHIK
Luzerne County, Pennsylvania
Approximate Acres: 112.10

Assisted By: MICHAEL SCHLAUCH
Natural Resources Conservation Service
PLYMOUTH SERVICE CENTER

Prepared with assistance from USDA-Natural Resources Conservation Service

0 125
Feet

Practice Schedule
PLUs

Waterbar Location (00-350)

N

USDA

-0.023278788 100

Profile

Station	Rod Reading	Elev.
0+00		94.41
0+50		93.4
0+100		91.45
0+150		88.57
0+200		85.95
0+250		81.19
1+300		76.9
1+350		72.62
1+400		64.35
1+450		62
1+500		60.75
1+550		59.25
1+600		58.2
1+650		56

Channel Slope Slope -38.41

Cross-Sections

0+00

	Left	Center	Right			
Rod Reading	5.6	5.59	5.9		Depth	
Elev.	94.4	94.41	94.1		-0.01	-500.00

1+50

	Left	Center	Right			
Rod Reading	6.57	6.6	6.7		Depth	
Elev.	93.43	93.4	93.3		0.03	166.67

1+100

	Left	Center	Right			
Rod Reading	8.56	8.55	8.7		Depth	
Elev.	91.44	91.45	91.3		-0.01	-500.00

1+150

	Left	Center	Right			
Rod Reading	11.44	11.43	11.59		Depth	
Elev.	88.56	88.57	88.41		-0.01	-500.00

1+200

	Left	Center	Right			
Rod Reading	13.9	14.05	14.25		Depth	
Elev.	86.1	85.95	85.75		0.15	33.33

1+250

	Left	Center	Right			
Rod Reading	18.71	18.81	19		Depth	
Elev.	81.29	81.19	81		0.1	50.00

1+300

	Left	Center	Right			
Rod Reading	23.09	23.1	23.2		Depth	
Elev.	76.91	76.9	76.8		0.01	500.00

1+350

	Left	Center	Right			
Rod Reading	27.6	27.38	27.55		Depth	
Elev.	72.4	72.62	72.45		-0.22	-22.73

1+400

	Left	Center	Right			
Rod Reading	35.7	35.65	35.6		Depth	
Elev.	64.3	64.35	64.4		-0.05	-100.00

1+450

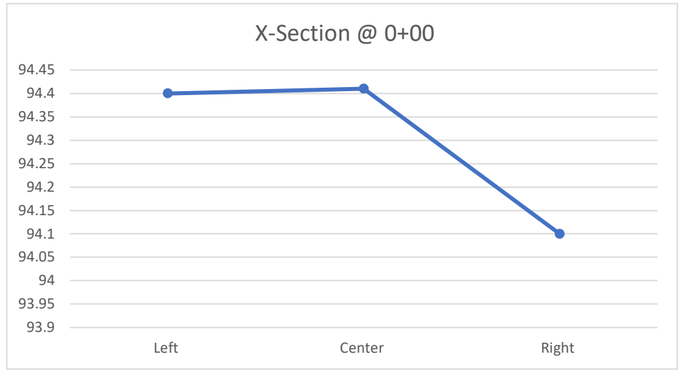
	Left	Center	Right			
Rod Reading	38.1	38	38.03		Depth	
Elev.	61.9	62	61.97		-0.1	-50.00

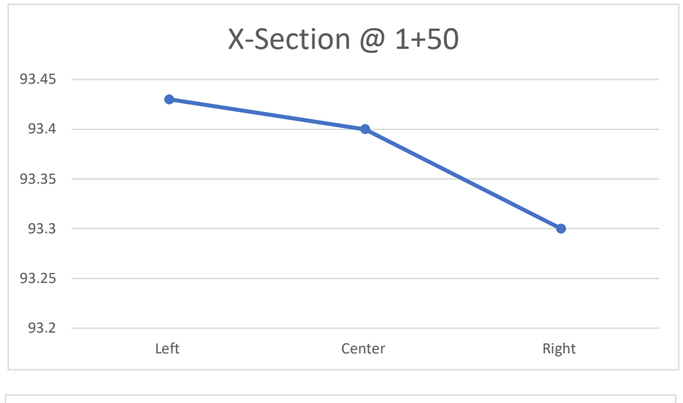
1+500

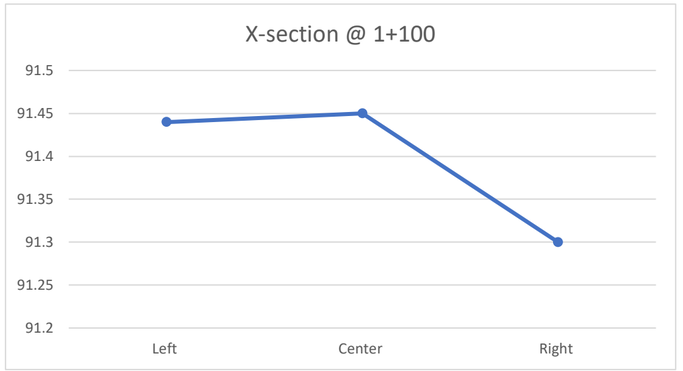
	Left	Center	Right			
Rod Reading	39.4	39.25	39.03		Depth	
Elev.	60.6	60.75	60.97		-0.15	-33.33

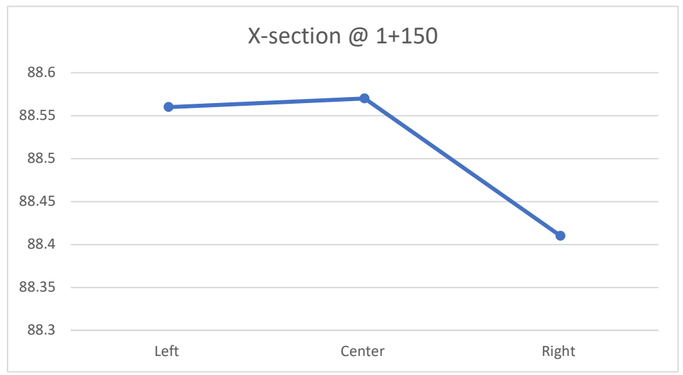
1+550

	Left	Center	Right		
Rod Reading	40.77	40.75	40.72		Depth









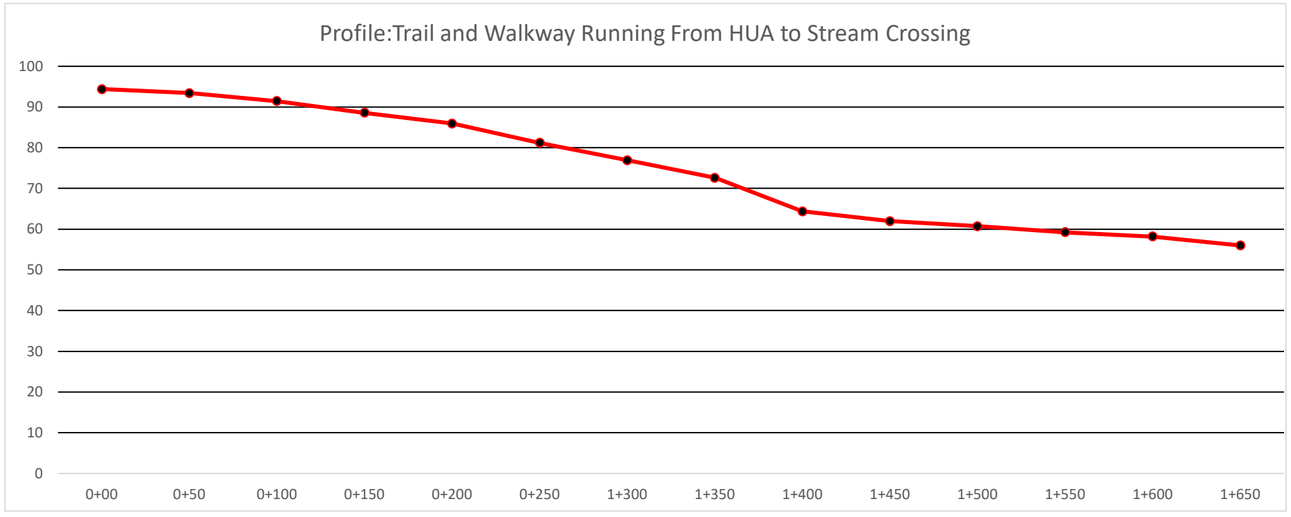
Elev.	59.23	59.25	59.28		-0.02	-250.00

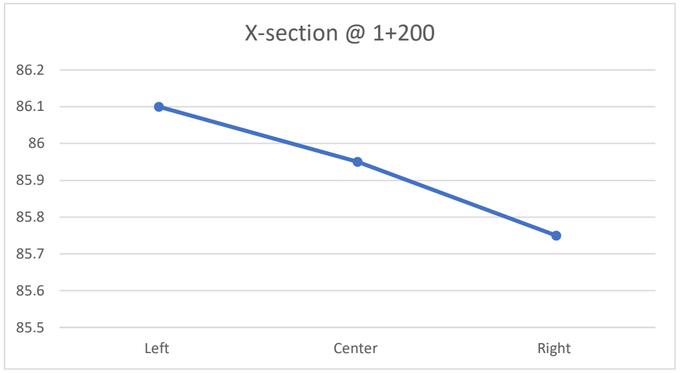
1+600

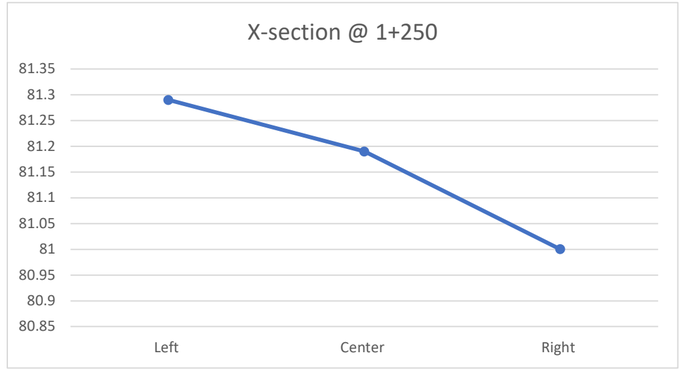
	Left	**Center**	**Right**			
Rod Reading	41.7	41.8	41.94		Depth	
Elev.	58.3	58.2	58.06		0.1	50.00

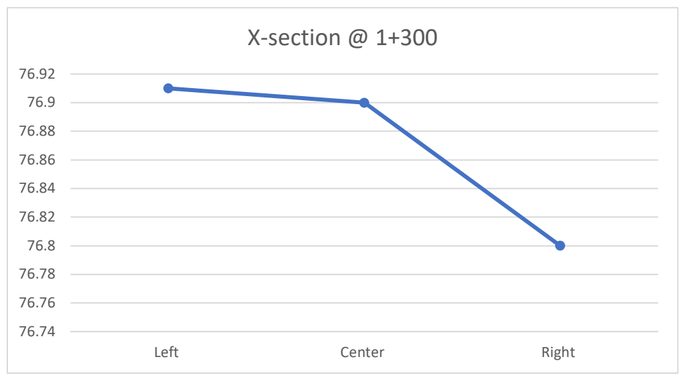
1+650

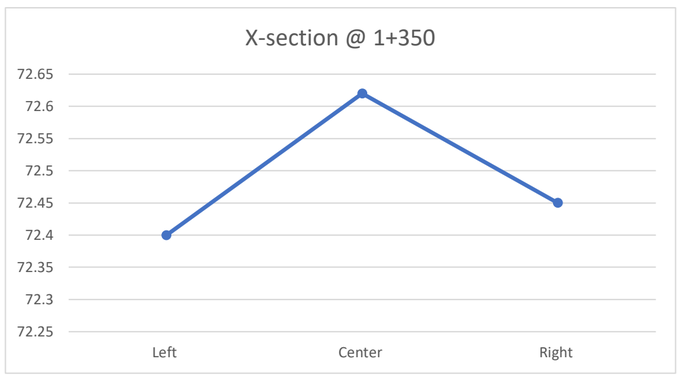
	Left	**Center**	**Right**			
Rod Reading	44.3	44	44.1		Depth	
Elev.	55.7	56	55.9		-0.3	-16.67

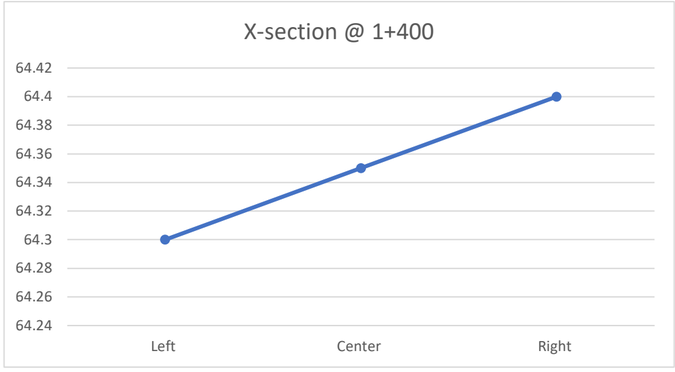


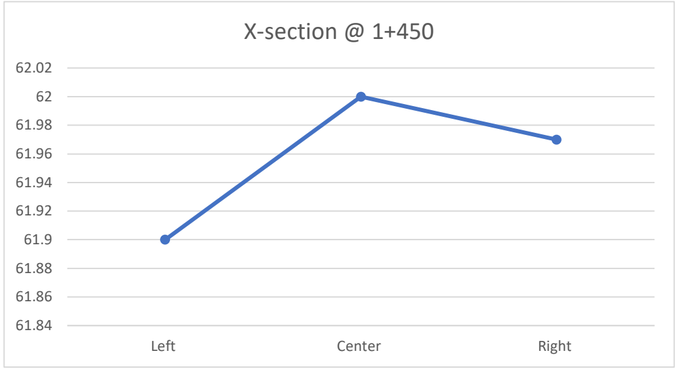


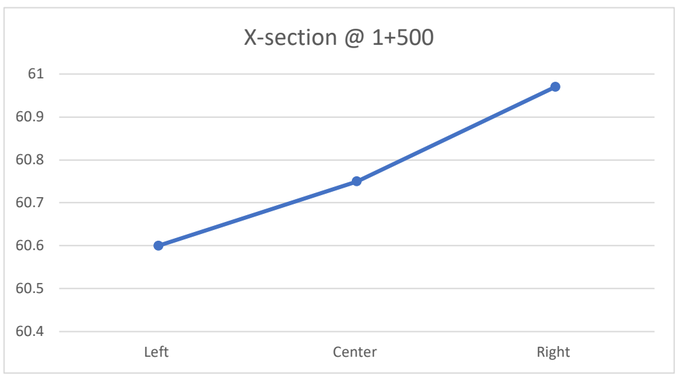


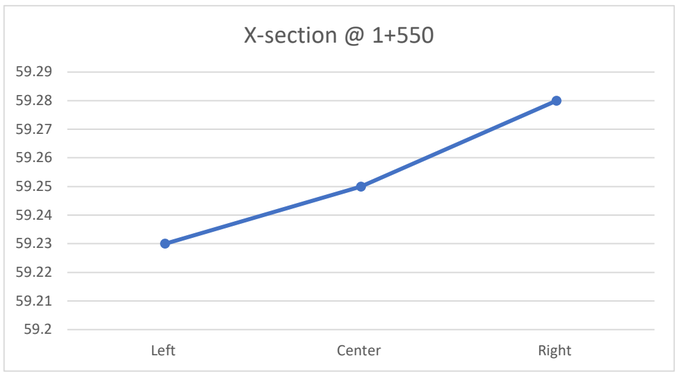


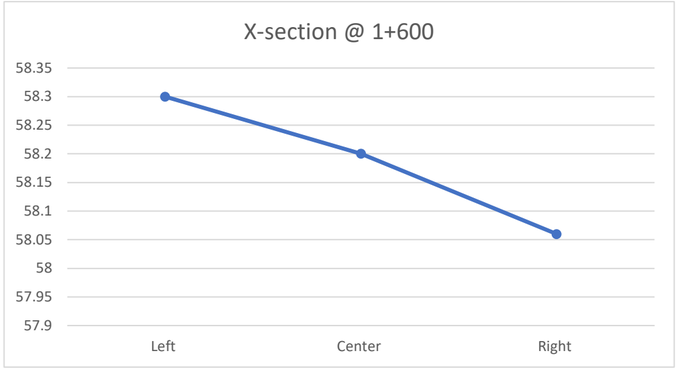


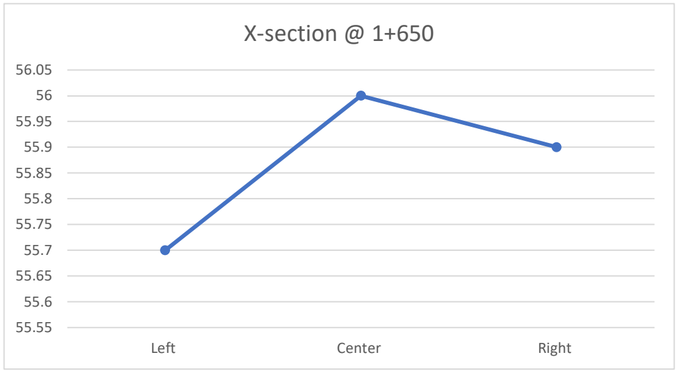

X-section @ 1+400
64.42
64.4
64.38
64.36
64.34
64.32
64.3
64.28
64.26
64.24
Left
Center
Right


X-section @ 1+450
62.02
62
61.98
61.96
61.94
61.92
61.9
61.88
61.86
61.84
Left
Center
Right


X-section @ 1+500
61
60.9
60.8
60.7
60.6
60.5
60.4
Left
Center
Right


X-section @ 1+550
59.29
59.28
59.27
59.26
59.25
59.24
59.23
59.22
59.21
59.2
Left
Center
Right


X-section @ 1+600
58.35
58.3
58.25
58.2
58.15
58.1
58.05
58
57.95
57.9
Left
Center
Right


X-section @ 1+650
56.05
56
55.95
55.9
55.85
55.8
55.75
55.7
55.65
55.6
55.55
Left
Center
Right

-0.023278788 100

Profile

Station	Rod Reading	Elev.
0+00		94.41
0+50		93.4
0+100		91.45
0+150		88.57
0+200		85.95
0+250		81.19
1+300		76.9
1+350		72.62
1+400		64.35
1+450		62
1+500		60.75
1+550		59.25
1+600		58.2
1+650		56

Channel Slope Slope -38.41

Cross-Sections

0+00 Planned

	Left	Center	Right			
Rod Reading	5.6	5.9	6.2		Depth	
Elev.	94.4	94.1	93.8		0.3	16.67

1+50 Planned

	Left	Center	Right			
Rod Reading	6.57	6.87	7.17		Depth	
Elev.	93.43	93.13	92.83		0.3	16.67

1+100 Planned

	Left	Center	Right			
Rod Reading	8.56	8.86	9.16		Depth	
Elev.	91.44	91.14	90.84		0.3	16.67

1+150 Planned

	Left	Center	Right			
Rod Reading	11.44	11.74	12.04		Depth	
Elev.	88.56	88.26	87.96		0.3	16.67

1+200 Planned

	Left	Center	Right			
Rod Reading	13.9	14.2	14.5		Depth	
Elev.	86.1	85.8	85.5		0.3	16.67

1+250 Planned

	Left	Center	Right			
Rod Reading	18.71	19.01	19.31		Depth	
Elev.	81.29	80.99	80.69		0.3	16.67

1+300 Planned

	Left	Center	Right			
Rod Reading	23.09	23.39	23.69		Depth	
Elev.	76.91	76.61	76.31		0.3	16.67

1+350 Planned

	Left	Center	Right			
Rod Reading	27.6	27.9	28.2		Depth	
Elev.	72.4	72.1	71.8		0.3	16.67

1+400 Planned

	Left	Center	Right			
Rod Reading	35.7	36	36.3		Depth	
Elev.	64.3	64	63.7		0.3	16.67

1+450 Planned

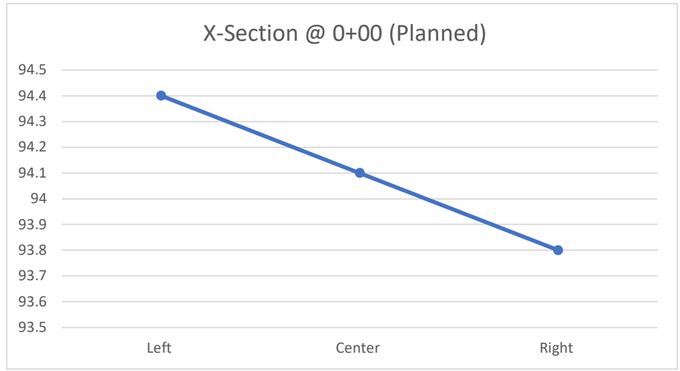
	Left	Center	Right			
Rod Reading	38.1	38.4	38.7		Depth	
Elev.	61.9	61.6	61.3		0.3	16.67

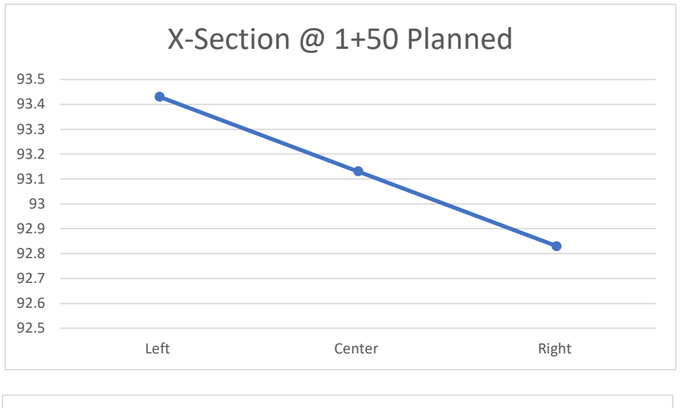
1+500 Planned

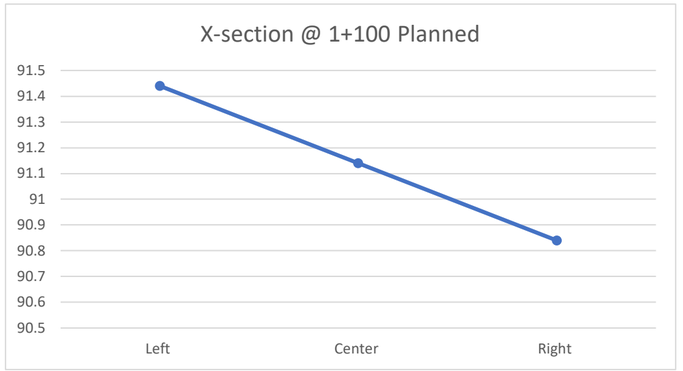
	Left	Center	Right			
Rod Reading	39.4	39.7	40		Depth	
Elev.	60.6	60.3	60		0.3	16.67

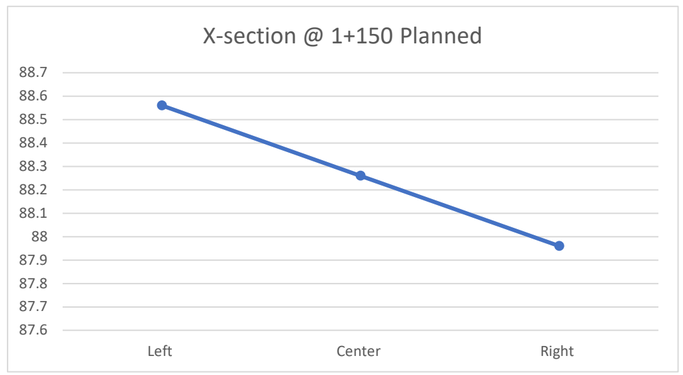
1+550 Planned

	Left	Center	Right		
Rod Reading	40.77	41.07	41.37		Depth









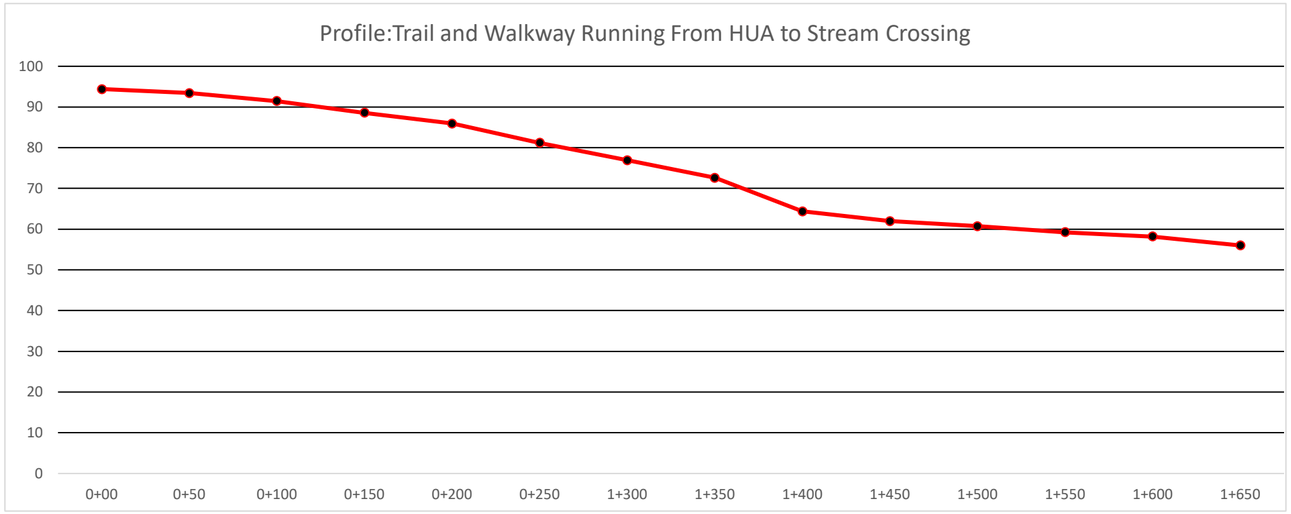
Elev.	59.23	58.93	58.63		0.3	16.67

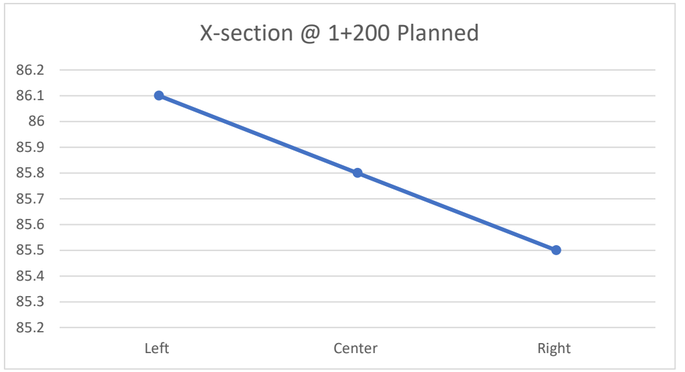
1+600 Planned

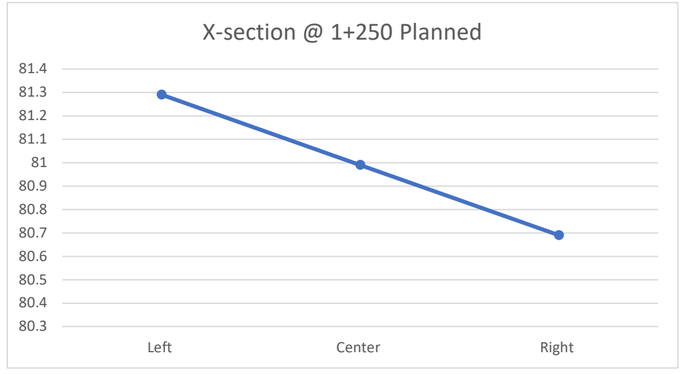
	Left	**Center**	**Right**			
Rod Reading	41.7	42	42.3		Depth	
Elev.	58.3	58	57.7		0.3	16.67

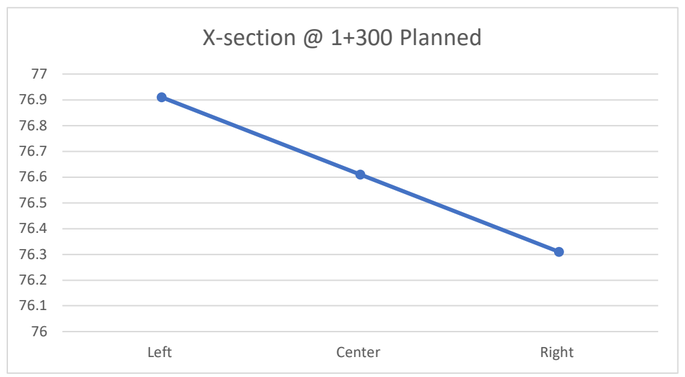
1+650 Planned

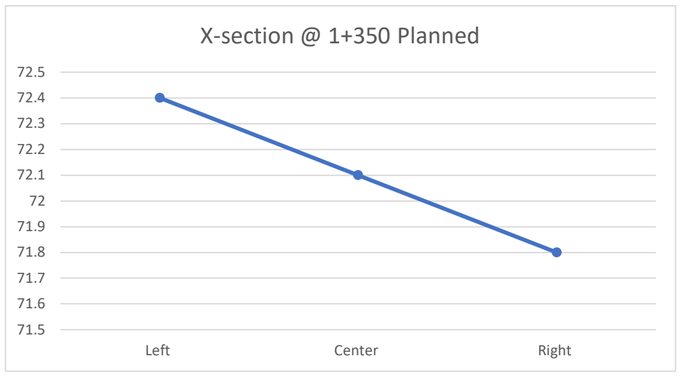
	Left	**Center**	**Right**			
Rod Reading	44.3	44.6	44.9		Depth	
Elev.	55.7	55.4	55.1		0.3	16.67

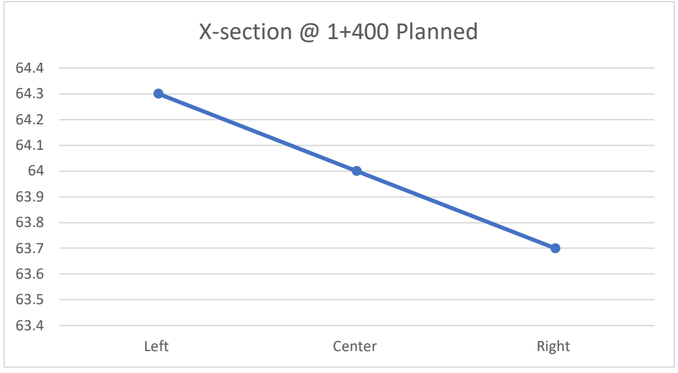


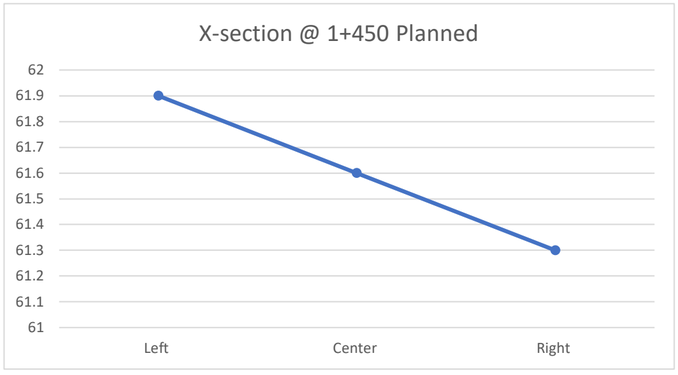


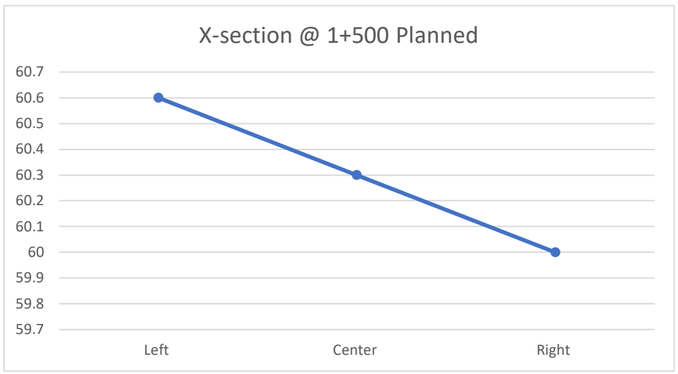


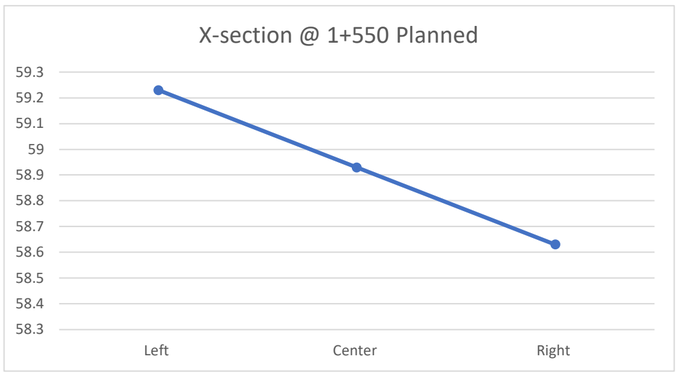


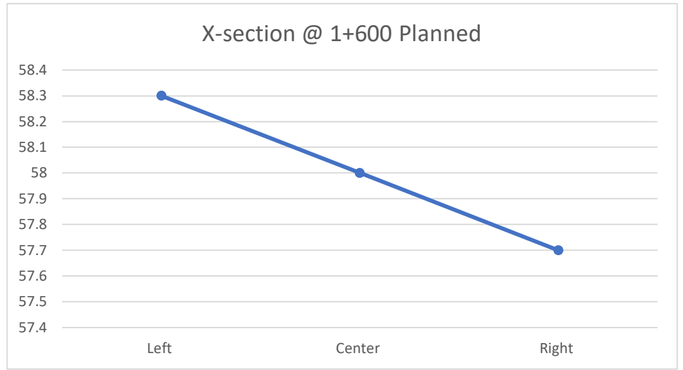


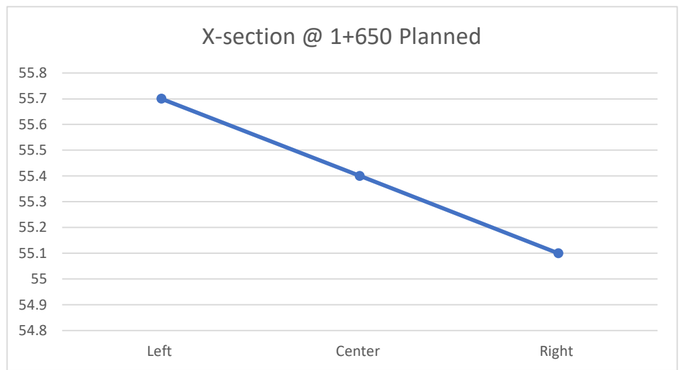

X-section @ 1+400 Planned
64.4
64.3
64.2
64.1
64
63.9
63.8
63.7
63.6
63.5
63.4
Left
Center
Right


X-section @ 1+450 Planned
62
61.9
61.8
61.7
61.6
61.5
61.4
61.3
61.2
61.1
61
Left
Center
Right

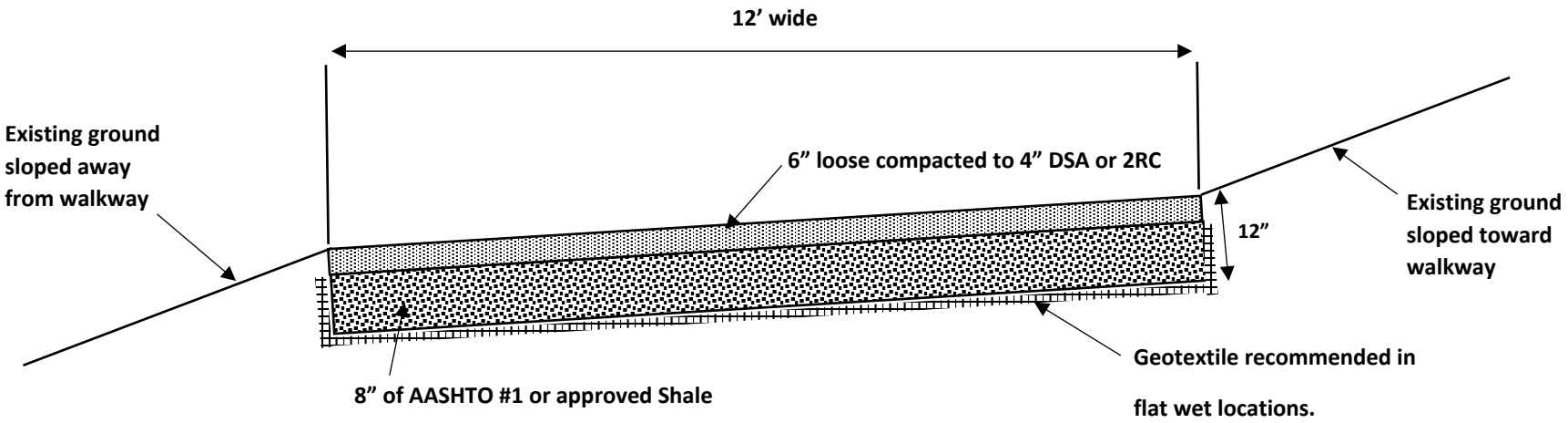

X-section @ 1+500 Planned
60.7
60.6
60.5
60.4
60.3
60.2
60.1
60
59.9
59.8
59.7
Left
Center
Right


X-section @ 1+550 Planned
59.3
59.2
59.1
59
58.9
58.8
58.7
58.6
58.5
58.4
58.3
Left
Center
Right


X-section @ 1+600 Planned
58.4
58.3
58.2
58.1
58
57.9
57.8
57.7
57.6
57.5
57.4
Left
Center
Right


X-section @ 1+650 Planned
55.8
55.7
55.6
55.5
55.4
55.3
55.2
55.1
55
54.9
54.8
Left
Center
Right

Trail and Walkway Detail



Note:

1. Trail and Walkway will be designed at .5 in/ft. There will be 6" of drop from existing ground sloped towards the walkway to existing ground sloped away from walkway.
2. Base and Surface Material needs to be compacted with a roller.
3. Geotextile shall be woven and have the following minimum properties;
   a. Refer to information and tables below.
4. At seams of geotextile a 1 ft. overlap shall be required.
5. All layers shall be compacted
   (a minimum of 3 passes) with a vibratory roller.
6. Moisture content in the top 6 inches of walkway shall be sufficient to provide near

Designation	Size and Grading Requirements Total Percentage Passing										
	4"	3 ½"	2 ½"	2"	1 ½"	3/4"	3/8"	#4	#16	#100	#200
AASHTO #1	100	90–100	25–60		0–15	0–5					
AASHTO #10							100	85–100		10–30	
#2A				100		52–100	36–70	24–50	10–30		0–10

USDA NRCS
Natural Resources Conservation Service

GEOTEXTILE
ACCESS ROAD USE:

1. Geotextile for roads with normal farm machinery use shall be WOVEN or NON-WOVEN with a minimum tensile strength of 200 pounds.
2. Geotextile for roads with heavy equipment shall be WOVEN or NON-WOVEN with a minimum tensile strength of 315 pounds.
ANIMAL WALKWAY USE:
3. Geotextile shall be WOVEN or NON-WOVEN with a minimum tensile strength of 160 pounds.
PLACED BELOW CONCRETE & ON TOP OF BEDDING STONE USE:
4. Geotextile shall be WOVEN with an Apparent Opening Size (AOS) between 20 and 100, inclusive.
ALL USES:
5. Geotextile installed on slopes greater than 8% shall be NON-WOVEN.
6. Geotextile installed where a wet subgrade is an issue shall be WOVEN or NON-WOVEN.
The inspector shall have a discussion with the contractor to see which geotextile type the contractor recommends for the wet subgrade issues. The inspector shall then discuss with the design engineer.
Allow 1' overlap between adjacent panels of geotextile where applicable.

WOVEN GEOTEXTILES

February-03

Manufacturer	Product Name	Tensile Strength (lbs)	Tensile Elongation (%)	Puncture (lbs)	Burst Strength (psi)	Trapezoidal Tear Strength (lbs)	Apparent Opening Size (AOS)	Meets CLASS 2 Type A "Equipment"	Meets CLASS 2 Type B "Animals"	Meets CLASS 4 "Heavy Duty"
Material Specifications	**CLASS 2**									
PennDot 408	**Type A - Equipment**	**200**	**15**	**80**	**320**	**50**	**30(1)**			
	Type B - Animals	**90**	**15**	**40**	**140**	**30**	**30(1)**			
	CLASS 4									
	Heavy Duty	**270**	**50**	**100**	**430**	**100**	**30(1)**			
Advanced Drainage Systems	ADS 9530	200	15	100	450	75	40	X	X	
	ADS 9750	315	15	125	650	120	70	X	X	
	ADS 9670	250	24	120	480	70	70	X	X	
Amoco Fabrics	ProPex 1198	200	15	120	450	65	40	X	X	
	ProPex 1199	250	15	135	480	60	70	X	X	
	ProPex 2000	140	15	65	325	45	30		X	
	ProPex 2002	200	15	90	400	75	40	X	X	
	ProPex 2004	250	15	100	500	90	40	X	X	
	ProPex 2006	315	15	120	600	120	40	X	X	
	ProPex 2016	315	15	120	800	120	40	X	X	
	ProPex 2019	250	15	140	510	95	70	X	X	
	ProPex 2044	500	15	170	1350	250	30	X	X	
Carthage Mills	Carthage 6%	250	15	135	480	60	70	X	X	
	Carthage 10%	255	15	125	500	75	40	X	X	
	Carthage 15%	200	10	105	480	75	40			
	Carthage 20%	275	15	135	590	105	50	X	X	
	Carthage 30%	200	15	115	400	50	40	X	X	
	Carthage 10%-HD	360	23	170	700	140	40	X	X	
Maccaferri Inc - MacTex	MX M10	250	24	120	480	70	70	X	X	
	MX M30	255	15	135	420	40	20			

WOVEN GEOTEXTILES

February-03

Manufacturer	Product Name	Tensile Strength (lbs)	Tensile Elongation (%)	Puncture (lbs)	Burst Strength (psi)	Trapezoidal Tear Strength (lbs)	Apparent Opening Size (AOS)	Meets CLASS 2 Type A "Equipment"	Meets CLASS 2 Type B "Animals"	Meets CLASS 4 "Heavy Duty"
Material Specifications	**CLASS 2**									
PennDot 408	**Type A - Equipment**	**200**	**15**	**80**	**320**	**50**	**30(1)**			
	Type B - Animals	**90**	**15**	**40**	**140**	**30**	**30(1)**			
	CLASS 4									
	Heavy Duty	**270**	**50**	**100**	**430**	**100**	**30(1)**			
Maccaferri Inc Cont'd	MX W9	200	15	100	450	75	40	X	X	
	MX W13	315	15	125	650	120	70	X	X	
WebTec Inc.	TerraTex SC	124	15	65	300	65	30		X	
	TerraTex GS-150	140	15	65	325	45	30		X	
	TerraTex GS	200	15	90	400	75	40	X	X	
	TerraTex GS-250	250	15	100	500	90	40	X	X	
	TerraTex HD	315	15	120	600	120	40	X	X	
	TerraTex EP	250	15	135	480	60	70	X	X	
	TerraTex EP-10	200	15	120	450	65	40	X	X	
	TerraTex EP-12	200	10	100	450	75	40			
	TerraTex EP-20	255	15	125	500	70	40	X	X	
	TerraTex EP-40	275	15	135	550	105	50	X	X	

(1) Soil with 50% or less by weight passing the No. 200 sieve, AOS $\geq$ No. 30 sieve
Soil with more than 50% by weight passing the No. 200 sieve, AOS > No. 50 sieve

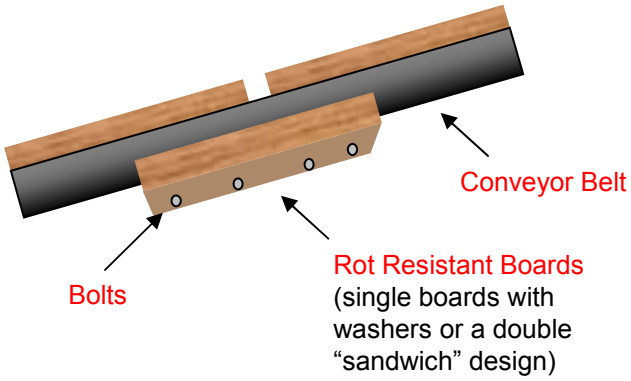
Technical Bulletin

Conveyor Belt Diversions

Version 1.0 6/19/07

CONVEYOR BELT DIVERSION – A conveyor belt embedded diagonally in the road on a downhill slope for the entire width of the road. The belt directs concentrated surface drainage to the lower side where it is dispersed at a stable outlet.

Completed Conveyor Belt Diversion



Top View Pre-Installation

PURPOSE – Conveyor Belt Diversions reduce erosion caused by flowing water that is trapped in wheel tracks and ruts by diverting concentrated drainage from the surface of the road while still allowing vehicles to pass. The belt diversion gives under tire pressure, then springs back to its original position.

BENEFITS OF A CONVEYOR BELT DIVERSION:

- Remains stable even during wet road conditions.
- Functions when road crown is lost (provided belt diversions are properly spaced).
- Conserves road material by lessening the erosive force of concentrated water on the road.
- Will not deform or crush under heavy hauling as can be the case with earthen and aggregate structures.

WHERE TO USE A CONVEYOR BELT DIVERSION:

- Low-volume traffic roads and access roads (consider for driveways, farm lanes and camp lanes).
- On sloping sections of road with evidence of water velocity damage to the surface.
- At intervals frequent enough to prevent a concentration of water that will cause erosion of the road surface or of the discharge area.
- On roads that do not receive sufficient surface maintenance to maintain proper crown or cross-slope.

CONSIDERATIONS:

- Large rocks should be placed at the end of the diversion to slow water and disperse flow. This will reduce erosion at the road edge (space rocks to minimize choking with road material). Additionally, the diversion should outlet to a stable area.
- On longer sections of road, multiple Conveyor Belt Diversions may be used to prevent the buildup of erosive volume and velocity. Spacing between the diversions is determined by the grade of the road, the stability of the surface material, available outlets and the amount of water entering the road drainage system (including off right-of-way sources). The goal is to install enough diversions to prevent the concentration of erosive surface flow.
- Once installed, each Conveyor Belt Diversion should be marked similar to a pipe, to prevent damage to the structure by crews doing future maintenance work.

The publishers of this publication gratefully acknowledge the financial support of the PA State Conservation Commission. For additional information or assistance, contact: Center for Dirt & Gravel Roads Studies, Penn State University, 207 Research Unit D, University Park, PA 16802 (Toll-Free Phone: 1-866-668-6683, Fax: 814-863-6787, Email: dirtandgravel@psu.edu). Additional copies available on our website at: www.dirtandgravelroads.org.

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

STREAM CROSSING

CODE 578

(no)

DEFINITION

A stabilized area or structure constructed across a stream to provide controlled access for people, livestock, equipment, or vehicles.

PURPOSE

This practice is applied to—

- Improve water quality by reducing sediment, nutrient, or organic loading to a stream
- Reduce streambank and streambed erosion

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all land uses where—

- An intermittent or perennial watercourse (stream) exists.
- Controlled access from one side of the stream to the other side is necessary to reduce or eliminate environmental degradation.
- Soils, geology, fluvial geomorphology, and topography are suitable for construction of a stream crossing.

CRITERIA

General Criteria Applicable to All Stream Crossing

Apply this standard in accordance with all Federal, State, Tribal, and local regulations, including floodplain regulations, and flowage easements.

At minimum, all stream crossings shall be stable during the 10-year, 24-hour peak discharge.

Identify significant cultural resources or threatened or endangered species that could be affected by the implementation of the practice.

The landowner/contractor is responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

Do not create a passage barrier where aquatic species are present and using the stream.

Location

Locate the stream crossing in an area where the streambed is stable or where the streambed can be stabilized (see NRCS Conservation Practice Standard (CPS) Channel Bed Stabilization (PA584); and Title 210, National Engineering Handbook (NEH) Part 650, Chapter 16, “Streambank and Shoreline Protection”). Do not place a crossing where the channel grade or alignment changes abruptly, excessive

seepage or instability is evident, overfalls exist (evidence of incision and bed instability), where large tributaries enter the stream, or within 300 feet of known spawning areas of listed species.

Install the stream crossing perpendicular to the direction of stream flow where possible. Consider potential future lateral migration of the stream in developing the design.

Locate crossings, where possible, out of shady riparian areas to discourage cattle loafing time in the stream.

Avoid the use of or minimize the number of stream crossings through evaluation of alternative trail or travel-way locations, and land user operations. Where feasible, use existing roads. Discourage livestock loafing in the stream by locating crossings, where possible, out of shady riparian areas or by including gates in the design.

Access road crossing
Where the stream crossing is installed as part of an access road, design the crossing in accordance with CPS Access Road (PA560) and Title 210, National Engineering Manual (NEM), Part 536 “Structural Engineering.”

Width
Provide an adequate travel-way width for the intended use. Make a “livestock-only” crossing no less than 6 feet wide and no more than 30 feet wide, as measured from the upstream end to the downstream end of the stream crossing, not including the side slopes. A multi-use stream crossing shall have a travel-way no less than 10 feet wide.

Side Slopes
Make all side slope cuts and fills stable for the channel materials involved. Make the side slopes of cuts or fills in soil materials no steeper than 2 horizontal to 1 vertical (2:1). Make rock cuts or fills no steeper than 1.5 horizontal to 1 vertical (1.5:1).

Stream approaches
Where possible, blend approaches to the stream crossing with existing site topography. Use streambank soil bioengineering practices and other streambank stabilization measures such as CPS Streambank and Shoreline Protection (PA580) as appropriate and feasible. Design stable approaches, with gradual ascent and descent grades that are no steeper than 4 horizontal to 1 vertical (4:1). Construct approaches with suitable material to withstand repeated and long-term use. Design the minimum width of the approaches equal to the width of the crossing surface.

Divert surface runoff around the approaches to prevent erosion. Use CPSs Diversion (PA362), Structure for Water Control (PA587), Lined Waterway or Outlet (PA468), or Grade Stabilization Structure (PA410) as needed.

Rock
Use only rock that is sound, durable, and able to withstand exposure to air, water, and freezing and thawing. Use rock of sufficient size and density to resist mobilization by design flood flows. Use appropriate rock sizes that will accommodate the intended traffic without causing injury to livestock or people, or damage to vehicles using the crossing. For a rock livestock crossing, use a hoof contact zone or alternative surfacing method over the rock.

Fencing
Exclude livestock access to the crossing using fence and gates, as needed. Install cross- stream fencing at fords, with breakaway wire, swinging floodgates, hanging electrified chain, or other devices to allow the passage of floodwater and large woody material during high flows. Design and construct all fencing in accordance with CPS Fence (PA382).

Vegetation
As soon as practical after construction, vegetate highly disturbed areas in accordance with CPS Critical Area Planting (PA342). In areas where the vegetation may not survive, use CPS Heavy Use Area Protection (PA561).

Criteria Applicable to Bridge Crossings
Design the bridge in a manner that is consistent with sound engineering principles and adequate for its intended use. Refer to 210-NEM, Part 536.

Design the bridge to fully span the stream, passing at least the bank-full flow where the design flow is not dictated by regulations. At design flow capacity, the structure must convey stream flow, sediment, and other materials without appreciably altering stream flow characteristics and pass the design flow without causing erosion or overtopping of the structure.

For all bridge crossings, perform a geologic subsurface investigation that is in sufficient detail and analysis to support the design. Describe the soil material observed, subgrade conditions, bearing capacity, and depth to bedrock; and any geologic conditions or hazards that needs to be addressed in the design, construction, or operation of the bridge Refer to 210- NEM, Part 531, “Geology.”

Adequately protect the bridge so that flows exceeding the bridge’s flow capacity can safely bypass without damaging the bridge or eroding the streambanks.

Follow requirements in 210-NEM, Part 536 on acceptable bridge materials and necessary safety measures.

Criteria Applicable to Culvert Crossings
Design the culvert in a manner that is consistent with sound engineering principles and adequate for its intended use.

If the culvert is not associated with a road crossing, design the culvert to have sufficient capacity to pass at least the bank-full flow or the 2-year, 24-hour storm flow, whichever is greater, without appreciably altering stream flow characteristics. Adequately protect the culvert crossing so that flows in excess of culvert capacity can safely bypass the structure without damaging it, or eroding the streambanks or crossing fill material. Do not use culverts in locations where large flows of sediment or large woody material are expected, or where the channel gradient exceeds 6 percent (100 horizontal to 6 vertical).

At least one culvert pipe must be placed with its entire length set 6 inches below the existing stream bottom. Additional culverts may be used at various elevations to maintain terrace or floodplain hydraulics and water surface elevations. The length of the culvert system must be adequate to extend the full width of the crossing, including side slopes, and inlet or outlet extensions.

Acceptable culvert materials include concrete, corrugated metal, corrugated plastic, new or used high quality steel, and any other materials that meet requirements of CPS Pond (PA378). Evaluate the need for safety measures such as guardrails at the culvert crossing.

Criteria Applicable to Ford Crossings
Ford crossings have the least detrimental impact on water quality when their use is infrequent. Ford crossings are adapted for crossing wide, shallow watercourses with firm streambeds. Do not place ford crossings immediately downstream from a pipe or culvert because of potential damage from localized high-velocity flows. Use a culvert crossing or curbed bridge if the stream crossing is to have frequent or daily use, such as in a dairy operation.

Ensure that the cross-sectional area of the crossing is equal to or greater than the natural channel cross-sectional area. To the extent possible, design the top surface of the ford crossing to follow contours of the streambed. Slope the crossing toward the center of stream to provide a thalweg (low-flow) channel. Where possible, recess the subgrade of the stream crossing so that the constructed surface of the

crossing is at or below the original surface of the streambed. Never construct the top surface of the ford crossing to be higher than 0.5 feet above the original streambed at the upstream edge.

Where possible, design the downstream edge of the ford crossing to be at exactly the same elevation as the original streambed. Never install the downstream edge with a low-flow hydraulic drop greater than 0.5 feet above the original stream bottom. Provide cutoff walls at the upstream and downstream edges of the ford when needed to protect against undercutting.

Evaluate the need for water depth signage.

Concrete fords
Use a concrete ford crossing only where the foundation of the stream crossing has adequate bearing strength. Perform a subsurface investigation that is in sufficient detail and analysis to support the design. Describe the soil material observed, subgrade conditions, bearing capacity, and depth to bedrock. Refer to 210- NEM, Part 531, Subpart B, “Engineering Geology.”

Use a minimum thickness of 5 inches of placed concrete. Construct the concrete slab on a minimum 4-inch-thick gravel base, unless the foundation is otherwise acceptable. Refer to 210- NEM, Part 536 for design criteria.

Precast concrete panels may be used in lieu of cast-in-place concrete slabs. Precast concrete units shall comply with ACI 525 or 533, or as otherwise acceptable for local conditions. To the extent possible, the panels must follow the contours of the streambed in order to avoid potential problems with sediment accumulation. As with the poured-in-place concrete, install a gravel base and toe walls.

When heavy equipment loads are anticipated, the concrete slab shall be designed using an appropriate procedure as described in American Concrete Institute, ACI 360, Design of Slabs on Grade.

Dewatering of the site and toe walls is required during placement of the concrete to lessen the potential for segregation and to maintain the proper water/cement ratio. Flowing water will erode concrete that is not sufficiently hardened. The stream must be diverted or retained from flowing over the concrete until the concrete makes its final set, and a minimum of 12 hours after placement of the concrete.

Construct toe walls at the upstream and downstream ends of the crossing. Make the toe walls a minimum of 6 inches thick and 18 inches deep. Extend the toe walls in the stream approaches to the bank-full flow elevation.

Rock fords and the use of geosynthetic materials
In steep areas subject to flash flooding and where normal flow is shallow or intermittent, use coarse aggregate or crushed rock at ford crossings. When the site has a soft or unstable subgrade, use geotextiles to improve the foundation bearing capacity in the design of rock ford crossings. Select geotextile material for separation and stabilization according to American Association of State Highway and Transportation Officials (AASHTO) M-288 and/or the requirements of PennDOT Specification Section 735, Class 4.

Dewater and excavate the bed of the channel to the necessary depth and width and cover with geotextile material. Install the geotextile material to extend across the bottom of the stream and, at least, up the side slopes to at least the bank-full flow elevation.

Use durable geosynthetic materials and install them according to the manufacturer’s recommendations, including the use of staples, clips, and anchor pins. Cover the geotextile material with at least 6 inches of crushed rock. If geocells are to be installed, use minimum 6-inch-deep geocells.

Design the rock ford stream crossing to remain stable for the bank-full design flow. Compute channel velocities and choose rock size using procedures and guidelines set forth in the appropriate section in 210-NEH, Part 630, “Hydrology;” 210-NEH, Part 654, Technical Supplement (TS) 14N “Fish Passage and

Screening Design;" and 210-NEH 650, Chapter 16, Appendix 16A, "Size Determination for Rock Riprap," or other procedures approved by the State conservation engineer.

Where rock is used for-ford type stream crossings for livestock, use a hoof contact zone or alternative surfacing method over the surfacing rock.

CONSIDERATIONS

For culvert crossings, consider incorporating natural streambed substrates throughout the culvert length for passage of aquatic organisms. See Bunte and Abt, (2001) for sampling procedures. Natural streambeds provide passage and habitat benefits to many life stage requirements for aquatic organisms and may reduce maintenance costs.

Consider including a well-graded rock riprap apron on the downstream edge of concrete crossings to dissipate flow energy.

Consider all life stages of aquatic organisms in the stream crossing design to accommodate their passage, in accordance with the species' requirements. NRCS aquatic organism passage standards can be found in CPS Aquatic Organism Passage (PA396). Design criteria are available in 210-NEH, Part 654, TS 14N; Clarkin, Keller, et.al, (2006); and Forest Service stream simulation guidance (USFS, 2008). Also, see Harrelson, et al. (1994), for stream reference site descriptions. Consider the habitat requirements of other aquatic or terrestrial species that may be affected by construction of a stream crossing. For example, a crossing may be designed with features that also promote safe crossing by terrestrial vertebrates.

Locate stream crossings to avoid adverse environmental impacts and consider—

- Using the "riffle" section of the stream for the proposed crossing, for it is frequently one of the most stable sections of a stream. When riffles are not present, consider using a stable straight reach.
- Effects on upstream and downstream flow conditions that could result in increases in erosion, deposition, or flooding. Consider habitat upstream and downstream of the crossing to avoid fragmentation of aquatic and riparian habitats.
- Short-term and construction-related effects on water quality.
- Overall effect on erosion and sedimentation that will be caused by the installation of the crossing and any necessary stream diversion.
- Effects of large woody material on the operation and overall design of the crossing.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for stream crossings in accordance with this standard. Clearly describe the requirements for applying the practice to achieve its intended purpose in the plans and specifications must as a minimum, include the following in plans and specifications:

- Location of stream crossing.
- Stream crossing width and length with profile and typical cross sections.
- Thickness, gradation, quantities, and type of rock or stone.
- Type, dimensions, and anchoring requirements of geotextile.
- Thickness, compressive strength, reinforcement, and other special requirements for concrete, if used.
- Applicable structural details of all components, including reinforcing steel, type of materials, thickness, anchorage requirements, lift thickness, covering.
- Load limits for bridges and culverts.
- Vegetative requirements that include seed and plant materials to be used, establishment rates, and season of planting.

- Location, type, and extent of fencing required.
- Method of surface water diversion and dewatering during construction or a statement making the contractor responsible for selecting such.
- Location of utilities and notification requirements (PA OneCall).
- Additional site-specific considerations.

OPERATION AND MAINTENANCE

Develop an operation and maintenance plan and implement it for the life of the practice. Include the following items in the operation and maintenance plan, as a minimum:

- Inspect the stream crossing, appurtenances, and associated fence at least annually and after each major storm event. Make repairs, if needed.
- Replace surfacing stone used for livestock crossing as needed.
- Remove any accumulation of organic material, woody material, or excess sediment.

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Practice Specification
Stream Crossing (Code 578)

1. SCOPE

The work shall consist of furnishing materials and installing all components of the stream crossing, as outlined in this specification and the drawings.

2. MATERIALS

Unless otherwise set forth in Section 7, the following materials are to be used:

a. ROCK shall be durable and obtained from sources listed in PennDOT Bulletin 14 or as otherwise approved by the designer. Size and gradation, where required, shall be as specified in Section 7 or as shown on the drawings. The nominal size of a rock is that dimension (middle) which passes through a square opening with the same size dimension; i.e. it is not the greatest dimension. The rock shall be free from soil and trash. Rocks shall be angular or subangular in shape. However, the least dimension of any individual rock shall be not less than one-third the greatest dimension.

b. GEOSYNTHETICS shall meet the requirements set forth in Section 7 and/or on the drawings. In addition, geotextiles shall meet the requirements of PennDOT Specifications, Section 735, for the appropriate class defined in Section 212. Certification from the manufacturer shall be provided by the Contractor that the geosynthetics meets these requirements.

c. BIOTEXTILES, BIOMATS and other manufactured, natural materials shall conform to the requirements in Section 7, and be installed according to the manufacturer's recommendations for flowing water applications.

d. AGGREGATE for bedding, drainfill, and concrete shall be durable and obtained from sources listed in PennDOT Bulletin 14. The gradation shall be as set forth in Section 7 or on the drawings.

e. PORTLAND CEMENT shall be Type I, with air-entrainment agent, or Type IA, unless otherwise required in Section 7. All cement shall conform to ASTM-C150.

f. MASONRY shall meet the requirements of ASTM-C90 & C270.

g. PRECAST concrete units shall meet the requirements of ACI-525 & 533, unless otherwise specified in Section 7.

h. LUMBER shall be the dimensions and species specified in Section 7 or shown on the drawings. Pressure treated products shall conform to the requirements of the AWPA Standard C16, except that only non-CCA preservatives, suitable for use in aquatic habitats, can be used.

i. PLANT MATERIALS, including seed, shall be true to the type, name and size required on the drawings or in Section 7. Plants and seeds shall be viable and free from disease, injurious insects, mechanical injury, decay, or other defect that will decrease survivability. All bare rootstock shall have a root:stem ratio of at least 1:1 by volume. Bulbs and tubers shall be firm and rhizomes resilient. Balled and burlapped, multi-stem stock shall be pruned to one-half height prior to planting. Transport and storage of all stock shall be done in a manner that prevents windburn and drying. All local, state, and Federal regulations regarding plant shipments shall be complied with.

3. SITE ACCESS AND CLEARING

Only those areas, shown on the drawings, to be protected or actually required for access shall be cleared. Tree and brush removal shall be done in such a manner to prevent damage to other trees and property, and to minimize erosion. Unless otherwise specified in Section 7, all cleared materials, including trash, shall be burned or removed from the site. Burning shall comply with all state and local applicable regulations.

4. GRADING

Soil surfaces shall be graded to the lines or sections shown on the drawings and/or staked in the field. Surfaces which have been over-excavated shall be brought to the planned grade by replacement with

soils similar to, and at a density equal to, that of the adjacent soils. Unless otherwise set forth in Section 7, fill that is required to be imported to the site shall be similar to, and placed at a density equal to, that of the adjacent soils, except that areas to be vegetated shall receive topsoil approved by the Engineer. Excess soil material shall be disposed of as set forth in Section 7 or shown on the drawings.

Provide for water diversion and erosion control as set forth in plans and permits.

5. STRUCTURAL INSTALLATION

Structures shall be installed as set forth in Section 7, as shown on the drawings, and in such a manner as to minimize erosion and sedimentation.

Rock shall be placed by equipment on the surface and to the depths specified, and in such a manner as to avoid displacement or damage to the underlying materials or adjacent structures. Graded rock shall be delivered and placed in such a manner that will ensure that the in-place material is homogeneous with no one size dominating an area. Some hand placing may be necessary to provide a neat and uniform surface on grade.

Commercially manufactured structures, including but not limited to culverts, gabions, precast slabs, etc., shall be installed as required by the manufacturer for flowing water applications.

6. VEGEATATION

Vegetation shall be established at the locations shown on the drawings and/or staked in the field, and as set forth herein, in Section 7, and/or as shown on the drawings. Unless otherwise set forth in Section 7, all woody vegetation shall be planted between October 1 and April 15.

Unless otherwise approved by the Engineer, the application of seed, soil supplements, and mulch shall be done by mechanical methods that ensure uniform coverage.

7. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

Specific Site Requirements

Date: 5/24/2022

Conservation Plan Map Stream Crossing Cross Section

Client(s): RAYMOND H BARCHIK
Luzerne County, Pennsylvania
Approximate Acres: 112.10

Assisted By: MICHAEL SCHLAUCH
Natural Resources Conservation Service
PLYMOUTH SERVICE CENTER

Prepared with assistance from USDA-Natural Resources Conservation Service

0 50
Feet

N

USDA

USDA is an equal opportunity provider, employer, and lender

Date: 5/24/2022

Conservation Plan Map Stream Crossing Cross Section

Client(s): RAYMOND H BARCHIK
Luzerne County, Pennsylvania
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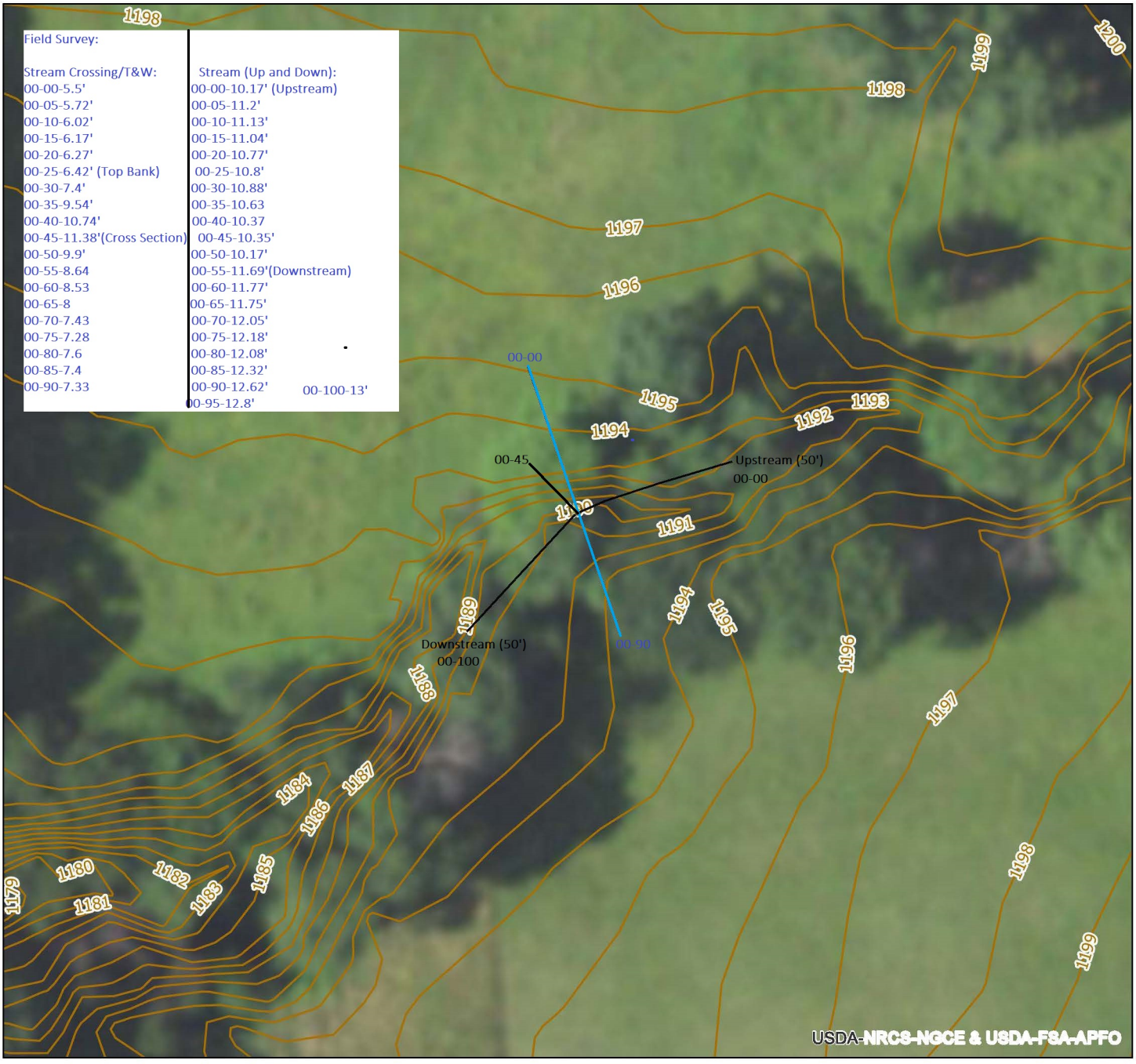
PLYMOUTH SERVICE CENTER



Prepared with assistance from USDA-Natural Resources Conservation Service

0 50
Feet

Stream Crossing

N

USDA is an equal opportunity provider, employer, and lender

Natural Resources Conservation Service

U. S. DEPARTMENT OF AGRICULTURE

IN COOPERATION WITH

Luzerne COUNTY CONSERVATION DISTRICT
PENNSYLVANIA

DETAIL PLANS FOR

(PRACTICE) *Animal Stream Crossing*

(COOPERATOR) *Raymond Barchik*

(LOCATION) *Benton, PA*

NOTICE TO THE COOPERATOR AND CONTRACTOR

PA ACT 199: IT IS THE DUTY OF COOPERATORS AND CONTRACTORS TO COMPLY WITH THE PROVISIONS OF PENNSYLVANIA ACT 199 (2004) BEFORE PERFORMING ANY EXCAVATION WORK.
Serial No.:_____
DATE:_____

INDEX OF DRAWINGS

TITLE	SHEET NO.
COVER SHEET	*1*
	2
	3
	4
	5

CONSTRUCTION DATA

LAYOUT BY:

_____ DATE: _____

CONTRACTOR NAME AND ADDRESS:

CONSTRUCTION COMPLETED (DAT_____

PRACTICE (DOES) (DOES NOT) MEET STANDARDS AND SPECIFICATIONS.

_____ DATE: _____

TI

AS-BUILT DRAWINGS

SUBMITTED _____

TITLE:

REVIEWED AND APPROVED BY:

_____ DATE: _____

TI

PREPARED BY:

Michael Schlauch DATE: *5/24/2022*

TITLE: *Conservation Specialist*

REVIEWED AND APPROVED BY:

ANDREW WODEHOUSE 6/22 DATE: _____

TITLE:

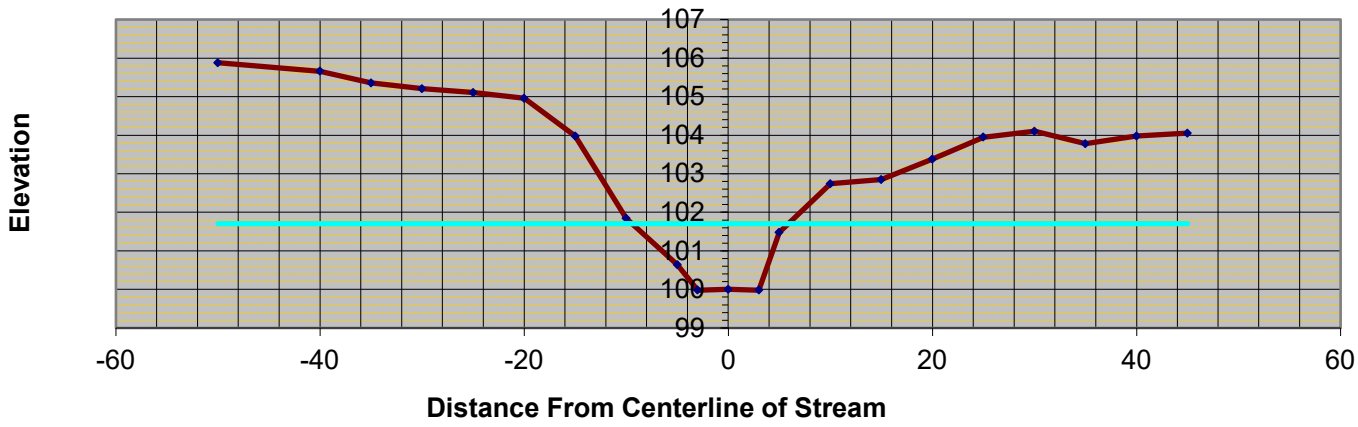
REVIEWED AND CONCURRED BY:

_____ DATE: _____

TITLE:

SHEET 1 OF _____

Channel Cross Section



Section Survey notes

Height of Instrument (ft): 111.38

Pnt no.	Distance (ft)	FS (ft)	Elevation (ft)
1	-50	5.5	105.88
2	-40	5.72	105.66
3	-35	6.02	105.36
4	-30	6.17	105.21
5	-25	6.27	105.11
6	-20	6.42	104.96
7	-15	7.4	103.98
8	-10	9.54	101.84
9	-5	10.74	100.64
10	-3	11.4	99.98
11	0	11.38	100
12	3	11.4	99.98
13	5	9.9	101.48
14	10	8.64	102.74
15	15	8.53	102.85
16	20	8	103.38
17	25	7.43	103.95
18	30	7.28	104.1
19	35	7.6	103.78
20	40	7.4	103.98
21	45	7.33	104.05

channel slope (%)	Manning's "n"
2.68	**0.04**

Est. Bankfull

Depth **1.73** ft.

Elev 101.7 ft.

Peak Discharge 113 cfs

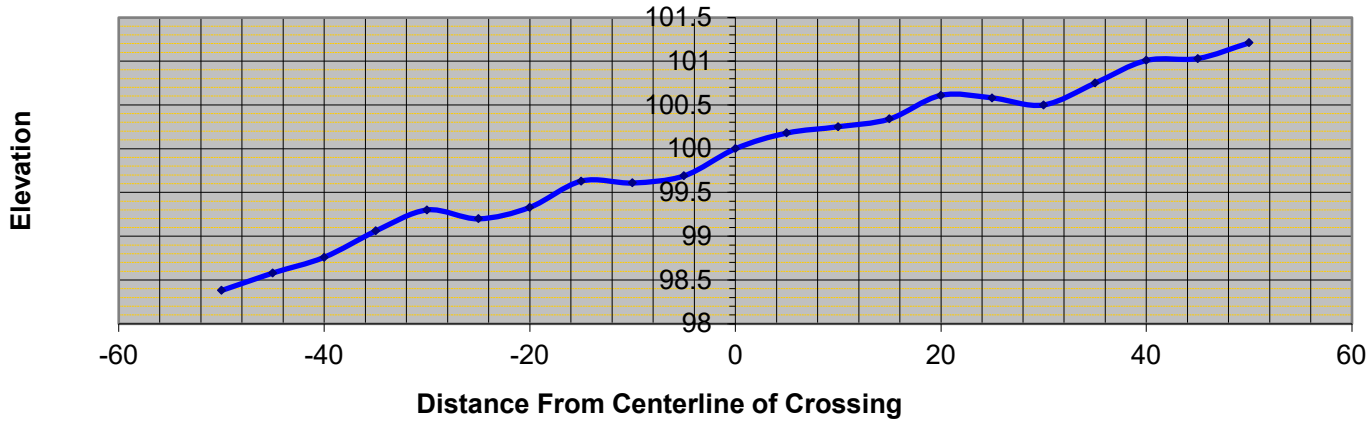
Calculated Discharge 113.1 cfs **OK**

Exterior Frame Stone size R-4

Dimensions			
17.6	x-section area (ft^2)	1.1	d mean
15.4	width (ft)	16.1	wet P
1.7	d max (in)	1.09	hyd radi

Hydraulics	
6.4	velocity (ft/sec)
113.1	discharge rate, Q (cfs)
1.82	shear stress (lbs/ft^2)
0.97	shear velocity (ft/sec)
1.13	Froude number

Channel Profile



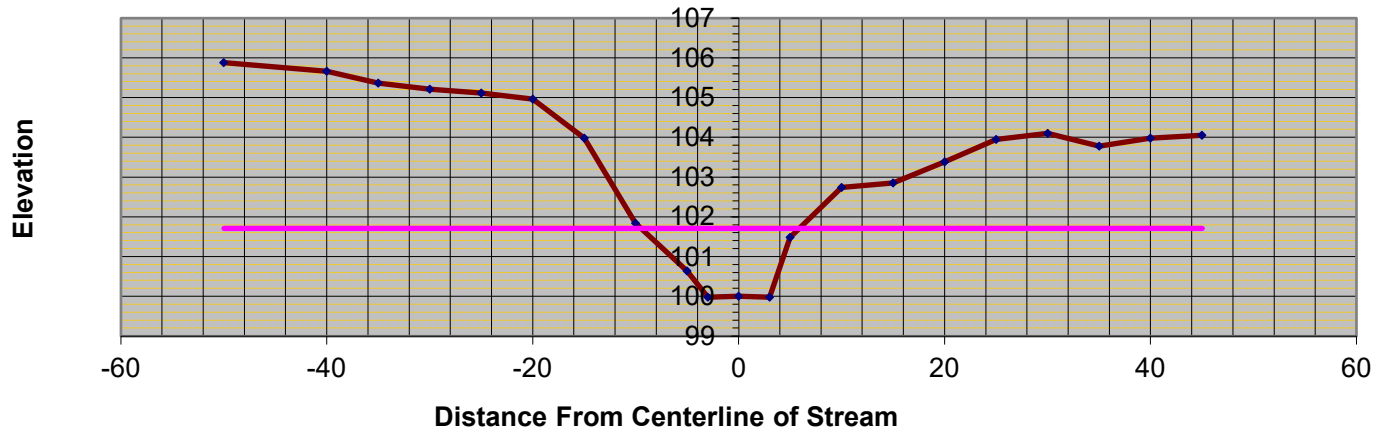
Profile Survey notes

channel slope (%)
2.68

Height of Instrument (ft): 111.38

Pnt no.	Distance (ft)	FS (ft)	Elevation (ft)
1	50	10.17	101.21
2	45	10.35	101.03
3	40	10.37	101.01
4	35	10.63	100.75
5	30	10.88	100.5
6	25	10.8	100.58
7	20	10.77	100.61
8	15	11.04	100.34
9	10	11.13	100.25
10	5	11.2	100.18
11	0	11.38	100
12	-5	11.69	99.69
13	-10	11.77	99.61
14	-15	11.75	99.63
15	-20	12.05	99.33
16	-25	12.18	99.2
17	-30	12.08	99.3
18	-35	12.32	99.06
19	-40	12.62	98.76
20	-45	12.8	98.58
21	-50	13	98.38

Cross Cut Slope



Type Of Crossing:

Moderate Gradient

R-4

Sizing Frame Stone

Not Required

Or Use…

Volume of stone				
Interior Stone	in.	Yd^3	Tons	
MODIFIED 2A	4	3.13	5	Top
AASHTO #1	6	4.70	7	Base
Frame Stone	R-4	5.67	9	

Exterior Frame

Stone Length	Width	Depth
26	1.5	1.5

Stream Bottom: 6

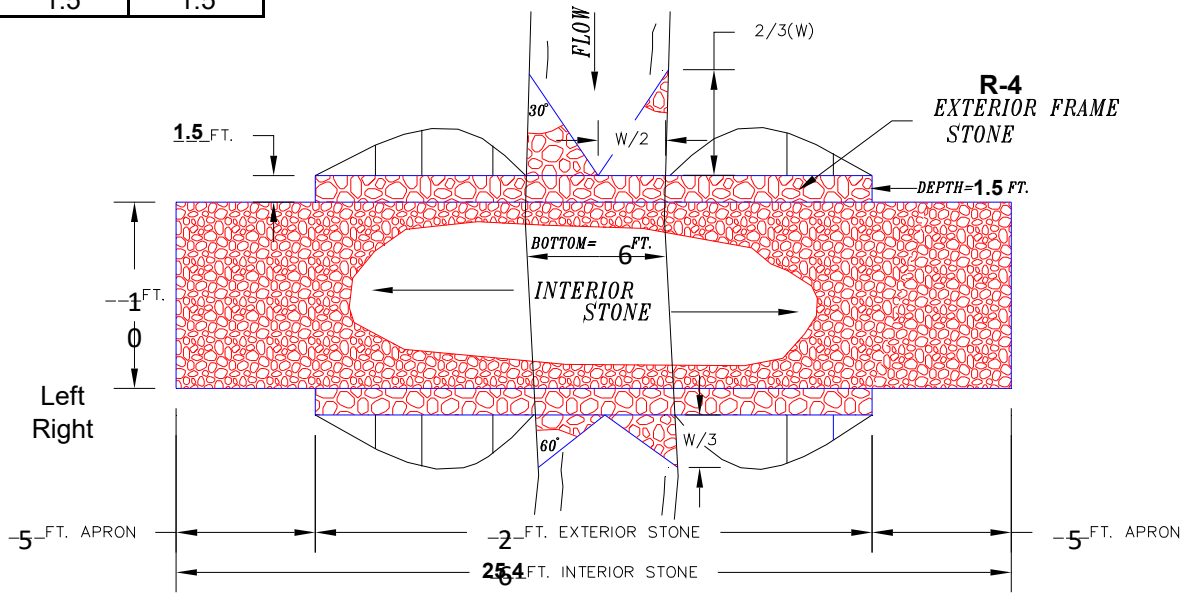
Crossing width: 10

Crossing length: 15.4

Additional Apron Length

Left: 5

Right: 5



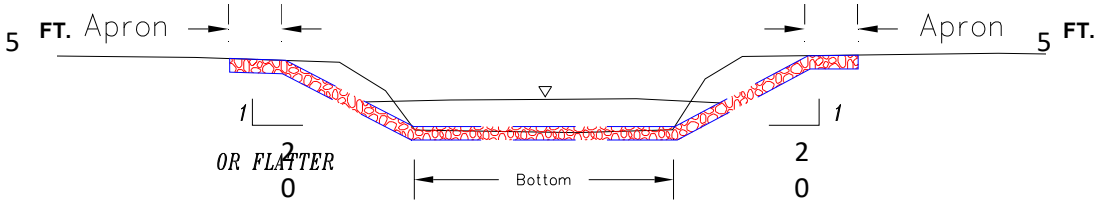
Stream Approaches

20 Left Bank

20 Right Bank

(L Bank)

(R Bank)



Raymond Barchik Design Sheet

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

FENCE

CODE 382

(ft)

DEFINITION

A constructed barrier to animals or people.

PURPOSE

This practice facilitates the accomplishment of conservation objectives by providing a means:

- To control movement of animals and people, including vehicles

CONDITIONS WHERE PRACTICE APPLIES

This practice may be applied on any area where management of animal or human movement is needed.

CRITERIA

General Criteria Applicable to All Purposes

Fencing materials, type and design of fence installed shall be of a high quality and durability. The type and design of fence installed will meet the management objectives and site challenges. Based on objectives; fences may be permanent, or temporary.

Fences shall be positioned to facilitate management requirements. Ingress/egress features such as gates and cattle guards shall be planned. The fence design and installation should have the life expectancy appropriate for management objectives and shall follow all federal, state and local laws, regulations, easements, right-of-ways, and access agreements. The landowner shall obtain all necessary permits prior to construction and installation.

Height, size, spacing and type of materials used will provide the desired control, life expectancy, and management of animals and/or people of concern.

Fences shall be designed, located, and installed to meet appropriate local wildlife and land management needs and requirements. Selection and design of fences shall adhere to manufacturer's recommendations to ensure suitability to use and site conditions.

Additional criteria to implement fencing associated with prescribed grazing management

Improve resource management by locating fences to separate areas with differences in forage seasons of growth and palatability, use, topography, or production potential.

Pasture/paddock divisions shall be consistent with grazing needs as projected by a grazing plan developed under Pennsylvania Conservation Practice Standard *Prescribed Grazing (Code 528)*.

Any permanent fencing for grazing livestock should allow flexibility to facilitate implementation of the prescribed grazing plan and permit land management activities such as nutrient application, pest control, forage harvest, and other appropriate practices.

Additional criteria to implement fencing associated with Waste Storage Facilities (WSF), Waste Transfer (WT), and Heavy Use Areas (HUA)

All WSF, some WT systems, and HUA with exterior drops greater than 3.5 feet shall be fenced to exclude children and small animals. Typically openings are limited to 4" for horizontal members unless distance is limited to 6" and then spacing can be up to 6". Fencing on WSF with vertical walls exceeding 4' is optional. HUA for animal inclusion only allows for greater vertical spacing of horizontal members. WT system openings with grate spacing exceeding 4" will require fencing for exclusion.

CONSIDERATIONS

General

The fence design and location should consider: topography, soil properties, livestock management and safety, livestock trailing, wildlife class and movement, location and adequacy of water and feeding facilities, development of potential grazing systems, human access and safety, landscape aesthetics, erosion problems, moisture conditions, flooding potential, stream crossings, and durability of materials. When appropriate, natural barriers should be utilized instead of fencing.

Where applicable, cleared rights-of-way may be established that facilitate fence construction and maintenance. Avoid clearing of vegetation during the nesting season for migratory birds. Consider movement needs of livestock when locating fences. Fence wire heights and spacing may require adjustments to repel predators or to avoid entanglement.

The type and class of livestock as well as degree of control needed will have a specific influence on type of fence selected to perform intended function. The number and spacing of wires, spacing of vertical stays (for woven wire fence), and height of fence as well as need for an electric component to the system should be considered during the planning process.

When using electric fences to control livestock, a training area should be planned to condition livestock to fences.

Fences across gullies or streams may require special bracing, designs or approaches.

Fence design and location should consider ease of access for construction, repair and maintenance.

Fence construction requiring the removal of existing unusable fence should provide for proper disposal of scrap materials to prevent harm to animals, people and equipment.

Safety is also a concern with Waste Storage Facilities, Waste Transfers Systems and certain situations with Heavy Use Areas. Exclusion of small children and animals requires smaller spacing.

SAFETY

Safety is a concern when constructing electric fences. The following are safety guidelines to adhere to:

1. Do not erect wires or ground wires near overhead power lines, telephone wires, or radio antennas. It is illegal to cause interference.
2. Install energizers inside a building when possible. Energizers need not be attached to a power pole. All power supply lines should comply with local electrical codes.
3. All energizers must be connected to a separate grounding system. Never attach an energizer to other farm related grounding devices (e.g. electric panels, ground rods, lightning rods on buildings, houses, barns, etc).
4. Fence charger ground rods need to be at least 50 feet away from grounding rods that are not part of the fencing system.

5. Only one energizer should be installed onto a fence line.
6. Where there is public access to the fence, both interior and exterior fence, warning signs should be placed at a minimum of 300 feet apart.
7. Warn all children that electric fencing is being used and let neighbors know where and how to shut off the current.
8. Install lightening arrestors and chokes to protect fence.

PLANS AND SPECIFICATIONS

Plans and specifications are to be prepared for all fence types, installations and specific sites. Requirements for applying the practice to achieve all of its intended purposes shall be described.

OPERATION AND MAINTENANCE

Regular inspection of fences should be part of an ongoing maintenance program to ensure continuing proper function of the fence.

Operation and Maintenance (O&M) includes the following: A schedule for regular inspections and maintenance as well as after storms and other disturbance events. Maintenance and repairs shall be performed in a timely manner to maintain the desired control.

Maintenance activities:

- Repair or replacement of loose or broken material, gates and other forms of ingress/egress
- Removal of trees/limbs
- Replacement of water gaps as necessary
- Repair of eroded areas as necessary
- Repair or replacement of markers or other safety and control features as required.
- Annual clearing of weeds and brush under and near the fence systems will prolong life expectancy.

REFERENCES

ASTM STANDARD 116. www.astm.org/Standards/A116.htm

American Association for Vocational Materials 1980. *Planning Fences.* Second Edition. Winterville, Georgia.

Fence Brace Assemblies, Circular 792, Institute of Food and Agricultural Sciences, Rev. 1992

Gallagher, W.M. 2005. *Gallagher Power Fence Systems Manual. 12th Edition.* New Zealand.

Karsky, Richard. 1988. *Fences.* USDA Forestry Service Technology & Development Program. Missoula Tech & Development Center.

Kencove Farm Fence Inc. *Kencove Farm Fence Supplies 2008. www.kencove.com*

Knapp, J.W. 1980. *How to Build Fences with Max-Ten 200 High-Tensile Fence Wire*. USSC Pittsburgh, PA.

National Engineering Handbook, 2009, Part 3 Std. Material *Spec 585 Wood Preservatives and Treatment*

Planning and Building Fences on the Farm, Univ. of Tennessee, AES, PB1541

Practice Specification
Fence (Code 382)

SCOPE

Fences are constructed as barriers to control the movement of animals and people, including vehicles. Fences may be designed or installed as permanent or temporary use.

Permanent fencing is intended to be in place for long periods of time with minimum maintenance requirements; therefore, it should be built with durable materials and constructed to endure a longer life span. Permanent fences are most often used for exterior grazing or property boundaries and/or where animals or humans are prohibited. This can include fencing associated with Waste Storage Facilities (WSF), Waste Transfer (WT), and Heavy Use Areas (HUA).

Temporary or moveable fences are designed to be in place for short periods of time. Temporary fences are best used as subdivision fences for frequent movement or control of animals and where the exact location of the fence may not be the same from time to time. This fencing offers maximum flexibility in rotational stocking systems for subdividing pastures to enhance grazing efficiency, livestock movement, and afford temporary stream and riparian protection.

FENCE TYPE OR STYLE (SEE Table 1)

Barbed wire fence is commonly used as multi- strand permanent fencing material for perimeter fences, land use boundaries, exclusion, livestock containment and isolation areas as well as interior cross fencing to facilitate grazing management. Barbed wire fence is generally not recommended for horses, sheep, goats and hogs.

Woven, net and mesh wire fences are used as permanent fences for both perimeter and subdivision fences. Wire spacing and height varies depending on the type of livestock or animals being controlled.

Woven wire fences consist of a series of horizontal (line) wires and vertical (stay) wires, and are offered in two main types including “hinge joint” and “continuous stay fixed knot.”

In a hinge-joint woven wire fence, the vertical stays actually wrap around the line wires. In a continuous stay fixed knot fence, the vertical stay wires are fixed with a separate wire to the line wire. Both of these main types come in various designs (line and stay spacing), tensile strength grades and metallic coating types and grades. High-tensile continuous stay fixed knot woven wire at 12.5 gauge may be used for all animals as specified by manufacturer.

High tensile smooth wire fence is commonly used as a multi-strand permanent fence for both perimeter and subdivision purposes. It can be used to control almost all animals when properly spaced. Smooth wire may be steel, aluminum or vinyl coated and electrified or non- electrified.

Electric fences may be permanent or temporary. The electrical power source can be from 110 or 220 electrical current or battery. Batteries may be re-charged by solar or electrical power. Livestock must be trained to respect electric fence.

Board fences are usually wood or some composite material used for permanent and subdivision purposes. Board fence is used primarily where aesthetics or animal safety is a concern and most often used around horses or for working facilities.

Other fence types may include chain link, pipe, vinyl, galvanized panel, guard rail, and cable fences. These are commonly used around homesteads, waste storage facilities and in corrals. They may be used to restrict access to unsafe or prohibited areas.

Heavy use area containment fencing is used to control access into and out of feed areas to minimize damage to soil and pasture around these permanent feed sites. This fencing is usually constructed of board, pipe, guard rail, cable or high tensile smooth wire built to sustain heavy use by high numbers of livestock around a confined feed area.

Non-conventional fencing includes variations of alternative fence systems that may be acceptable when installed according to manufacturer’s recommendations and pre- approved by the *PA NRCS State*

Grassland Conservationist. Alternative fence systems are often applicable for horses and other animals having special needs.

MATERIAL SPECIFICATIONS

Acceptable fencing criteria for various fencing needs may be selected from Tables 1 and 2; except when fencing requirements are shown in a set of Engineering Drawings and Specifications associated with WSF, WT, and HUA. Install as per details included; variations must be approved by the *Engineer of Record*.

The materials used in the construction of a chosen fence type must be new and of high quality and meet the size, strength, durability and lifespan requirements found in this specification including Tables 3 - 9.

Variations of what is presented in this document may be approved if alternatives will meet or exceed current specifications. Sufficient documentation must be presented to *PA NRCS State Grassland Conservationist.*

INSTALLATION

Fence-Line Clearing

Prior to construction, the fence line shall be cleared of any obstruction that would hinder fence placement and operation. Clearing along stream banks will be held to a minimum except as required for stream crossings. The soil surface along the fence line shall be relatively smooth such that placement of the bottom wire does not exceed specified maximum wire spacing from soil surface.

Setting posts

All post shall be set and maintained in a vertical position or leaning slightly (1-2” off vertical) away from direction of wire tension.

Posts in curves should be set approximately 4” off vertical. Posts set with a driver have about 9 times the holding strength of hand- set posts. If hand set, holes should be at least 6” larger than the diameter of the posts and all backfilled material shall be thoroughly tamped in layers no thicker than 4 inches. The post hole shall be filled to the ground surface. Concrete backfill is not necessary when posts are driven or hand set with proper tamping; however, if used it shall be rodded into place in layers not thicker than 12 inches and shall completely fill the post hole to the ground surface. No stress shall be applied to posts set in concrete for 24 hours.

Line Posts

Specifications of line posts are found in Table 4. The maximum spacing of line posts for permanent fences is found in Table 1 and will be the same for all types of posts. **Spacing will vary depending on terrain and pressure from livestock.** Installation shall ensure that adequate fence height is maintained based on its purpose.

Note: Landscaping timbers should not be used for any post or brace component of a fence system.

Installing Curves

Installing curves in high tensile, woven wire, and barbed wire fences is permissible as long as the change in direction from one post to the next does not exceed 20 degrees. Posts on curves shall be 5 inch minimum top diameter for changes up to 14 degrees and 6 inch minimum top diameter for changes up to 20 degrees.

Posts on curves should be driven 48 inches deep with 4 inches of lean to the outside of the curve and spaced no closer than 4 foot apart. (In an 8-foot long section, 14 degrees is approximately 24 inches off straight line and 20 degrees is approx. 35 inches off the straight line).

Line Posts – Stream Crossing

Anchor posts are required on both sides of a stream crossing. For crossings less than 16 feet wide, standard line posts set on both sides will be adequate. For crossings wider than 16 feet, or when non-electrified heavy flood gate is used, a single H-brace assembly or other suitable brace shall be used.

- Where needed, flood gates will be attached below bottom wire and will be designed to allow water and debris to pass while still controlling livestock. Some type of hinged or breakaway floodgate works best.

Posts that are set in low areas or gullies may need to be weighted or anchored to prevent lifting out.

Stays or battens between line posts

Stays or wire spacers or battens may be used to maintain desired wire spacing between line posts; note that specifications for post spacing differs with and without stays (Table 1). Stays shall be secured sufficiently to remain in position along wire line.

Offset Brackets

Offset brackets made of galvanized high tensile spring wire with an insulator of high density polyethylene with ultraviolet stabilizer or porcelain can be attached to standard barbed wire fence or woven wire fence to provide transmission line and /or to protect a standard fence. Other corrosion resistant offset brackets with insulators that attach directly to the fence posts can also be used.

Place offset brackets up to 40 feet apart and attach to wires of standard fence next to post. If control of animals is desired, place offset brackets at 2/3 the height of the animals to be controlled. Make sure no wires of the old fence come in contact of the electric fence wire, as a short will occur. Use offset brackets that hold the electric wire at least 4 inches from the non- electrified fence material.

Post Bracing

Bracing of anchor (pull) posts is required at all corners, gates, fence ends and at definite slope and alignment changes in the fence line. The type of fence, number of fence wires, and length of span will determine type, size and spacing of bracing required to support a fence. See table 8 for additional information.

Bracing shall withstand the forces of the fence load and transfer to the surrounding soil. They come in a number of configurations depending on the purpose and number of posts utilized. The length of braces should be at least 2 times the height of the fence fabric they are supporting. See Tables 5 and 6 for selection criteria and design specifications of single and double brace assemblies.

Corner braces are required at all points where the fence alignment has a change of 20 degrees or more from one post to the next. (In an 8-foot long section, 20 degrees is approx. 35 inches off the straight line).

End braces are required where fence ends and on both sides of gate openings and has pull from only one direction.

In–line pull post assemblies are located in straight sections of the fence line and where there are sudden changes in elevations, such as at the bottom and top of slopes. Tie off all wires at in-line pull assemblies and start new wires for the next fence section. Posts that are set in low areas or gullies may need to be weighted or anchored to prevent lifting out.

Single post braces may be used with 2- strand or less high tensile electrical wire (Table 7) if corner/end post are set 4’ deep. If this cannot be accomplished, then a single H corner/end brace assembly should be used.

Brace Rails

Refer to Table 6 for Criteria and Specifications.

- Placement of the horizontal brace rail will be between the top two wires of the fence or fence fabric. This should be a minimum 3 feet above ground.

- The length of the horizontal brace shall be at least 2 times the height of the fence fabric it is supporting.
- The longer the brace rail the stronger the brace.
- The brace and anchor posts should be fastened to the compression brace using galvanized brace pins (3/8” X 9” and 3/8” X 4”), drilled through vertical post and into end of horizontal brace, 2” deep. An H-brace bracket (dacromet-coated heavy gauge steel) may be used in place of brace pins. Install with minimum 1.75” screws.
- Do not notch vertical posts (wood) for stabilizing horizontal brace support as this will increase chance of wood rot.

Note: Landscaping timbers should not be used for any post or brace component of a fence system.

Adjoining Fences

A fence adjoining an existing fence must terminate in a brace assembly as required per fence brace specifications in Table 5, 6, and 7.

Tension of Brace (Guy) Wires

For guy wires use two complete loops of 12½ gage HT wire or one loop of 9 gauge soft wire, or a single 3/16” galvanized cable with cable lock.

For horizontal braces, brace wire will be double wrapped and stapled to brace post at a height of just above the brace member and to the anchor (pull) post at a point approximately 2-3 inches above the ground level.

Brace (Guy) wire will be tightened using a wire tightener or strainer. Another suitable method is to tension the brace wire with a chain grab and splice using a double crimp or compression sleeve.

INSTALLATION OF WIRE

Barbed and woven wire will be stretched to sufficient tension prior to being fastened to posts. Temperature variations must be considered (wire will tighten in cold weather and expand in hot weather). See wire specification requirements in Table 3.

Tensioning the wire

Woven Wire - In warm weather, wire shall be stretched until 1/3 of the height of the “tension curve” is removed. In cold weather, remove ½ of the tension curve. *Fixed-Knot High Tensile Woven Wire* - The tension crimp should be ½ the size of an un-tensioned crimp.

Barbed Wire - In warm weather, a 100 ft. stretch of wire should sag no more than 4 inches in the middle (prior to attaching to posts) and no more than 2 inches in cold weather.

High Tensile Wire - Tension should be 250 lbs. for cattle, horses, goats and sheep. For electrified high tensile wire the tension should be sufficient to maintain the proper average height and spacing of the fence wires.

Tension springs

In-line wire spring-tensioners are designed to indicate lbs. of tension on the line, assuming placement within the line is appropriate.

On most fences the use of one tensioner per pull will provide sufficient indication of the tension on adjacent wires.

Springs offer only 3-6 inches of elasticity therefore are of little benefit when something like a tree falls on the wire.

Staples and fasteners

Staples should be installed into post to allow free slippage of wire.

Staples shall be driven diagonally across the grain of the wood and at a slight downward angle (except in dips of landscape) and shall not be driven so tightly as to bind the wire against the post.

Electrically charged smooth wires must be attached to conductive posts with an appropriate ceramic, UV resistant HDPE (High Density Polyethylene) or HDPP (High Density Polypropylene) or tube type plastic reinforced insulators.

For steel line posts, the fencing shall be fastened with either 2 turns of 14 gauge galvanized steel wire or the post manufacturer's special wire clips. For all other types of posts, attach as specified by manufacturer.

Tie off of wire or insulators: High tensile wire is tied off using the "thread through method" (a half hitch and 3 wraps) or with compression sleeves. A length of high tensile wire is fastened around the groove of the insulator then looped around the post and stapled on opposite side of post. An alternative is the tubular plastic reinforced insulator to prevent cracking of the plastic and grounding of the wire. All insulators must be rated for use with high tensile fence.

Wire attachment to posts

Attaching Fence Wire to Anchor (Pull) Post: For **Barbed wire** fences, wires will be attached to anchor (pull) post by one complete wrap around the post, double stapled (wood posts) or wired (steel posts) and ends tightly wrapped around stretched wire five times. Compression sleeves may be used to connect ends of brace wire.

For **Woven or Mesh wire**, determine amount of wire needed to fully wrap around post once then remove enough vertical stays to provide that length. The wire ends are then attached as described in previous paragraph. All lines are stapled to the post.

For **High Tensile** wire, the line wires are attached to each anchor post by wrapping the post and securing with a half hitch with 3 wraps, or using appropriate double crimp sleeves.

Fixed-knot woven wire fence shall be stapled to wood post or fastened to steel post at every horizontal wire using manufacturer recommended wire c lips.

High Tensile electric wire that pulls through corners or bends may be suspended from the inside of posts in corners and bends using ceramic or appropriate UV resistant HDPE or HDPP donut type plastic high strain insulators. The tubular plastic reinforced high strain insulators can wrap around the outside of bends and corner posts.

Attaching Fence Wire to Line Post: **Barbed wire** shall be attached at each post with 1.5 inch staples driven to allow slippage. The top wire shall be at least 2 inches below the top of posts on wood posts and at least 1 inch below the top on steel posts. Wire shall be spaced no more than 10 inches apart and often closer depending on livestock controlled.

Woven wire and fixed-knot woven wire fencing shall be attached to posts at the top 3 and bottom 3 strands on every posts and then alternate every other line making sure you attached to the missed lines on the next alternating line post.

HT electric wire shall be attached using ceramic or appropriate UV resistant HDPE or HDPP plastic insulators. The tubular plastic reinforced high strain insulator can be used on the outside of corners, curves or bends.

Post side wire placement: the wire shall be placed on the livestock side of line posts and on the outside of curves and bends.

Wire Splicing

There are two basic ways to splice wire:

1. Hand knot
2. Crimping or compression sleeves (per manufacturer recommendation)

Barbed wire and woven wire shall be spliced by means of a western union splice or by suitable compression sleeves applied with a tool designed for the purpose.

Gates

Gates weighing less than 100 lbs may be hung from single end post properly installed. Heavy metal or wood gates more than 6 ft. wide shall best be attached to the pull post of an H-brace or diagonal floating brace.

All gates must be substantial enough to withstand expected pressures from livestock and wildlife.

A 12 ½ gauge overhead or insulated underground transmission line will be used to carry electricity across all gate openings (including electrified gates) to charge the remainder of the fence.

Gates Over Streams and Ditches

Hanging gates should terminate approximately 6 inches above average normal water level.

Non-electric flood gates should be hinged such that gate will swing with rising water during storm events.

An electrified flood gate may be used to minimize debris problems on stream crossings. The electrified flood gate is constructed by stretching an electrified wire across the drainage above high water flow level. Attach, with compression sleeves, hanging galvanized chains or wire to the electrified wire at a spacing of 6 inches for goats, hogs and sheep or 12 inches for cattle and horses. It is advisable to connect the gate to electric fence with double insulated cable through a cut-off switch and flood gate controller.

Stream Bank Protection

Permanent fencing will be placed at least 10 feet from the top of the stream bank and should allow for more area in meanders and in areas with bank erosion to minimize corner bracing. Permanent fencing setback distance from drainage ditches should be enough to allow sufficient room for vegetation management and fence maintenance.

SAFETY

- Electrical fences shall be clearly labeled or identified with the appropriate warning signs spaced every 300 feet where the public has access. Barbed wire shall not be electrified because of safety hazard.
- Fencing operations can result in painful and serious injury. Wear heavy gauntlet leather gloves to protect hands and wrists, and boots or high-top shoes to protect legs and ankles.
- Tough, close fitting clothing will reduce risks of catching on wire. Wear safety glasses to protect eyes from injury. When stretching woven, fixed- knot, or barbed wire, stand on the opposite side of the post from the wire and stretcher unit.
- It is dangerous to use a tractor to stretch wire fencing because of potential breaking of the wire resulting in serious injury from the recoil of the clamp bar, chain, or wire. Keep chains and wire stretching clamps in good condition.
- Carry staples, nails, or other fasteners in a metal container or in an apron and not in your trouser pockets. Do not hold fasteners in your mouth which is a common but extremely dangerous habit.
- If you handle preservative treated posts, do not rub your hands or gloves on your skin, nose, eyes, or month. Wash your hands after handling treated posts. Minimize the inhaling of sawdust. Do not burn treated posts or apply the ash to a garden. Properly dispose of treated wood in a landfill.

Additional conditions which apply to this practice:

1. A professional fencing contractor is recommended during the planning phase of any fence system.
2. Woven wire for sheep and goats should have vertical wire wide enough (9” to 12”) or narrow enough (<4”) to minimize potential injury. Otherwise use an electric offset wire to keep animals away from woven wire that might “entangle” them.
3. Never use household electrical wire for any part of an electrified fence. Splicing wires of different metals often results in oxidation and corrosion which causes short circuits and poor conductivity.

4. A digital voltmeter is essential to monitoring and maintaining electrical power fences.
5. Avoid placing electrical fences parallel with telephone or commercial power lines since static field can sometimes be created.
6. It is recommended that fences be located 20 feet or more from streams with a maintenance gate to allow for emergency access to water. This distance can also lessen fence maintenance by reducing flood damage. Temporary fencing may be used to protect streambanks while using forage adjacent to the stream.

PA NATURAL RESOURCES CONSERVATION SERVICE CONSERVATION PRACTICE STANDARD FENCE (382)

Table 1. Permanent Fence Selection Criteria

Fence design and construction must meet the minimum requirements for controlling specific animal types.

Animal Type to Control	Fence Type	Purpose of Fence				Suggested Spacing (in. above ground) ww fences start 2-4" above ground	Line Posts and Stay Spacing (Maximum spacing)		
		Perimeter	Travel Lanes	Interior Subdivision	Surface Water Exclusion		Posts w/o stay	Post with stay	Stay Spacing
		Minimum Criteria				Inches	Feet		
Cattle	Barbed 3-wire	NO	Meets	Meets	NO	18, 28, 38	16	20	10
Cattle	Barbed 4-wire	Meets	Exceeds	Exceeds	Meets	14 to 44 evenly spaced	12	20	10
Cattle	Barbed 5-wire	Exceeds	Exceeds	Exceeds	Exceeds	10 to 46 evenly spaced	12	20	10
Cattle	Non-Electric 6-wire high tensile smooth	Meets	Exceeds	Exceeds	Meets	9 to 46 evenly spaced	16	30	10
Cattle*	Non-Electric 8-wire high tensile smooth	Exceeds	Exceeds	Exceeds	Exceeds	6 to 46 evenly spaced	16	30	10
Cattle	Electric 1-wire high tensile smooth	NO	Meets	Meets	Meets	26-32	60	NA	NA
Cattle	Electric 2-wire high tensile smooth (both hot)	NO	Meets	Exceeds	Meets	20, 34	50	80	20
Cattle	Electric 3-wire high tensile smooth (min. 2 hot)	**NO	Exceeds	Exceeds	Exceeds	13, 24, 36	50	80	20
Cattle	Electric 4-wire high tensile smooth (min. 2 hot)	Meets	Exceeds	Exceeds	Exceeds	8, 20, 32, 44	50	80	20
Cattle	Electric 5-wire high tensile smooth (min. 2 hot)	Exceeds	Exceeds	Exceeds	Exceeds	8, 16, 24, 34, 44	50	80	20
Cattle	Woven wire (hinge joint) plus one or more HT or barbed top wires	Meets	Exceeds	Exceeds	Meets	47 min, 6" max between top wires	10	NA	NA
Cattle	HT woven wire (hinged joint) plus one or more HT or barbed top wires	Meets	Exceeds	Exceeds	Meets	47"min, 6" max between top wires	20	NA	NA
Cattle	HT Woven wire (fixed knot)	Meets	Exceeds	Exceeds	Meets	47 min	20	NA	NA
Cattle	Wood or Composition 4 board (6" wide)	Exceeds	Exceeds	Exceeds	Exceeds	6 , 6, 8, 10 between boards	8	NA	NA
Goats & Sheep***	Electric 3-wire high tensile smooth (min. 2 hot)	NO	Meets	Meets	NO	6, 18, 35	50	80	20
Goats & Sheep***	Electric 4-wire high tensile smooth (min. 2 hot)	NO	Exceeds	Exceeds	Meets	6, 16, 26, 36	50	80	20
Goats & Sheep***	Electric 5-wire high tensile smooth (min. 2 hot)	Meets	Exceeds	Exceeds	Exceeds	6, 12, 18, 28, 38	50	80	20
Goats & Sheep	Woven wire plus one HTE offset inside	Meets	Meets	Meets	Meets	42" min, one HTE offset 2/3 animal ht	10	NA	NA
Goats & Sheep	Woven wire plus one or more HT or Barbed top wires to 48"	Meets	Meets	Meets	Meets	36 min, 6" max between top wires	10	NA	NA
Goats & Sheep	HT fixed knot woven wire plus one or more HT or Barbed top wires to 48"	Meets	Exceeds	Meets	Meets	42 min, 6" max between top wires	20	NA	NA
Horses****	Electric 2-wire high tensile smooth (both hot)	No	Meets	Meets	Meets	28, 38	50	80	20
Horses****	Electric 3-wire high tensile smooth (min 2 hot)	No	Exceeds	Exceeds	Exceeds	28, 38, 48	50	80	20
Horses****	Electric 4-wire high tensile smooth (min 2 hot)	Meets	Exceeds	Exceeds	Exceeds	18 – 54 evenly spaced, minimum 2 hot	50	80	20
Horses	Woven wire (2"x 4" openings max.)w/1 wire HT on top	Meets	Exceeds	Exceeds	Meets	48 + HT at 54	10	NA	NA
Horses	HT vinyl-coated or polymer encased (2"x 4" openings)	Meets	Exceeds	Exceeds	Meets	48 + HT at 54	10	NA	NA
Horses	HT woven wire (fixed knot) (2"x 4" openings max.)	Meets	Exceeds	Exceeds	Meets	60	20	NA	NA
Horses	Mesh "No climb" (2"x4" spacing)	Exceeds	Exceeds	Exceeds	Exceeds	48 + HT at 54"	16	NA	NA
Horses	Wood or Composition boards (6" wide)	Exceeds	Exceeds	Exceeds	Exceeds	18 min. 12 max. between boards	8	NA	NA

PA NATURAL RESOURCES CONSERVATION SERVICE CONSERVATION PRACTICE STANDARD FENCE (382)

Table 1. Permanent Fence Selection Criteria Continued

Fence design and construction must meet the minimum requirements for controlling specific animal types.

Animal Type to Control	Fence Type	Purpose of Fence				Suggested Spacing (above ground) ww fences start 2-4" above ground	Line Posts and Stay Spacing (Maximum spacing)		
		Perimeter	Travel Lanes	Interior Subdivision	Surface Water Exclusion		Posts w/o stay	Post with stay	Stay Spacing
		Minimum Criteria				Inches	Feet		
Hogs	Electric 2-wire high tensile smooth (both hot)	NO	Meets	Meets	Meets	6-10, & 16-18	20	30	15
Hogs	Electric 6-wire high tensile smooth (min 2 hot)	Meets	Exceeds	Exceeds	Exceeds	6, 12(+), 18(+), 26, 34, 42	20	30	15
Hogs	Woven wire 32" w/ barbed wire	Meets	Exceeds	Exceeds	Meets	32 + 1 barb above, and one barbed 2" off ground and 2" below woven wire	10	NA	NA
Hogs	Woven wire 32" w/ 1 HT electric inside	Meets	Exceeds	Exceeds	Meets	32 + 1barbed or HTE 6" above and one HTE wire 8" off ground, 8" inside of fence.	10	NA	NA
Hogs	HT woven wire (fixed knot) 32" w/ 1 barb or HTE	Meets	Exceeds	Exceeds	Meets	35" + 1 HTE offset like above	20	NA	NA
Deer*****	HT woven wire (fixed knot) 96" tall with 12" verticals	Meets	Meets	Meets	Meets	96	20	NA	NA
Deer*****	Electric 7-wire High tensile smooth wire slanted	Meets	Meets	Meets	Meets	see diagram of slant measurements	30	100	25
Deer*****	Electric 9-wire High tensile smooth wire	Meets	Meets	Meets	Meets	8, to 72 evenly spaced	30	100	25
Deer*****	Electric 12-wire High tensile smooth wire	Exceeds	Exceeds	Exceeds	Exceeds	6, to 72 evenly spaced	30	100	25
Deer*****	Electric 15-wire High tensile smooth wire	Exceeds	Exceeds	Exceeds	Exceeds	2, to 96 evenly spaced	30	100	25
Buffalo	Electric 4-wire high tensile smooth	NO	Meets	Meets	Meets	16 to 42 evenly spaced	30	100	25
Buffalo	Electric 5-wire high tensile smooth	NO	Exceeds	Exceeds	Exceeds	16 to 48 evenly spaced	30	100	25
Buffalo	Electric 6-wire high tensile smooth	Meets	Exceeds	Exceeds	Exceeds	12 to 52 evenly spaced	30	100	25
Buffalo	HT woven wire (fixed knot)	NO	Meets	Meets	Meets	48	20	NA	NA
Buffalo	HT woven wire (fixed knot)	Meets	Exceeds	Exceeds	Exceeds	60	20	NA	NA
Chickens/turkey	Woven wire 2"x4" 1 wire HT or barb above	Exceeds	Exceeds	Exceeds	Exceeds	72	10	NA	NA
Emu and ostrich	Woven wire 2"x4" 1 wire HT or barb above	Exceeds	Exceeds	Exceeds	Exceeds	72	10	NA	NA
Chickens/turkey	HT Woven wire 2"x4" 1 wire HT or barb above	Exceeds	Exceeds	Exceeds	Exceeds	72	18	NA	NA
Emu and ostrich	HT Woven wire 2"x4" 1 wire HT or barb above	Exceeds	Exceeds	Exceeds	Exceeds	72	18	NA	NA
People WSF	Chain link	Meets Preferred option				60	10	NA	NA
People WSF	Electric 15-wire HT	Meets				4 to 60 evenly spaced	8	NA	NA
People WSF	Woven wire 48 inch plus 3 barbed wires or 2 HT electric	Meets				48 min. WW with HT or barb at 4"space to 60. HT may be electrified	10	NA	NA

Use the information in this table as a guide to determine the number of strands and spacing requirements. Adjustments may be made based on manufacturer's recommendations and landowners preference for confinement with NRCS approval.

*HUA containment fencing should be built of a suitable material (usually HT smooth wire, pipe, cable, guardrail, or board) and post spacing to endure heavy use around permanent feed areas. WSF, WT and HUA fencing requirements are found in associated engineering drawings.

**May be used as perimeter fence for dairy cattle only.

***If the goats or sheep are not trained to electric fencing. then high tensile electric fencing is probably not a good option for the livestock operation.

****Consideration for visibility should be taken when using high tensile fence for horses. Poly coated or vinyl encased wire or rail can be used following manufacturer recommendations for installation.

***** Exclusion fence only

PA Natural Resources Conservation Service Conservation Practice Standard Fence (382)						
Table 2. Temporary Fence Selection Criteria						
Fence design and construction must meet the minimum requirements for controlling specific animal types.						
Animal Type to Control	**Fence Type[1] (all wires hot)**	**Purpose of Fence**			**Suggested Spacing Above Ground**	**Line Posts (maximum spacing)**
		Travel Lanes	**Interior Subdivision**	**Surface Water Exclusion**		
		Minimum Criteria			**Inches**	**Feet**
Cattle	Electric 1-wire Polywire or Polytape or galvanized steel braided wire	Meets	Meets	Meets[2]	26-36	40
Cattle	Electric 2-wire Polywire or Polytape or galvanized steel braided wire	Exceeds	Exceeds	Exceeds	20, 32	40
Goats/Sheep	Electric 4-wire Polywire or Polytape	Meets	Meets	NO	8, 16, 24, 32,	40
Goats/Sheep	Electric Net Fencing[3]	Meets	Meets	Meets	0, (minimum 35 inches tall)	built in[4]
Horses	Electric 1-wire Polywire or Polytape	Meets	Meets	NO	34	25
Horses	Electric 2-wire Polywire or Polytape	Exceeds	Exceeds	Meets	28, 40	25
Hogs	Electric 2-wire Polywire or Polytape or galvanized steel braded wire	Meets	Meets	NO	8, 18	40
	Electric Net Fencing[3]	Meets	Meets	Meets	0, (35 inches tall)	built in[4]
Poultry	Electric Net Fencing[3]	Meets	Meets	Meets	0, (minimum 40 inches tall)	built in[4]
[1] Livestock must be trained to respect electric fencing prior to using temporary fence products for complete containment.						
[2]Two wires may be needed to prevent young calves from going beneath the fence.						
[3]Use electric netting specifically designed for the type of livestock being controlled; it is not suggested for small animals with horns (consider spacing of vertical stays and horizontal lines and fence height).						
[4]Line posts are typically built into the rolls of netting near 12.5 feet spacing.						
Based on the type of livestock, use the information in this table as a guide to determine the number of strands and spacing for different types of temporary fencing products. Adjustments may be made based on manufacturer's recommendations and landowners preference and ability to control the livestock. Temporary fencing products are not intended to be used as permanent or semi-permanent containment fencing.						

PA Natural Resources Conservation Service Conservation Practice Standard Fence (382)				
Table 3. Wire Specifications				
Wire Type	Minimum Wire Size	Minimum Wire Coating/Composition	Wire Strength and Other Considerations	
Barbed, Standard Double Strand (must meet ASTM A121)	12.5 gauge (ga.) with 4 point barbs spaced on 5" centers	Class 3 zinc coating per ASTM A641-	950 lbf	
	15.5 ga. with 4 point barbs spaced on 5" centers	Class 3 zinc coating per ASTM-A641		
Barbed, High-Tensile Double Strand (Gaucho Wire) (must meet ASTM A121)	15.5 ga. 4 point barbs	Class 3 zinc coating per ASTM-A641	170,000 psi or 950 lbs.	
High Tensile Smooth single strand (must meet ASTM A854)	12.5 ga.	Class 3 zinc coating per ASTM-A641	200,000 psi or 1540 lbs.	
High Tensile Vinyl Coated or Polymer Encased Wire	12.5 ga.	UV resistant polymer	1,300 lbs per wire or 4,000 lbs per rail	Can be used for permanent fences
Galvanized Steel	14 ga.	Class IV	160 lbs	Can be used for 1 or 2 wire temporary fences
Standard Woven Wire "hinged joint" or continuous stay "fixed knot" (must meet ASTM A116)	Top & Bottom wires: 12 gauge min. Intermediate wires: 12.5 ga.	Class 3 zinc coating per ASTM A641	Horizontal and vertical spacing should be appropriate for animal types. Design numbers of woven fence are related to the characteristics of the fence fabric. For example: 1047-12-12 ½ has 10 line wires is 47" high has 12" stay wire spacing and is 12.5 gauge.	
High Tensile Woven Wire (must meet ASTM A116)	12.5 gauge	Class 3 zinc coating per ASTM A641	175,000 psi on line wires	
Mesh Wire; such as Horse-No-Climb	Top & Bottom wires: 12.5 gauge Intermediate & Stay Wires: 12.5 gauge	Class 3 zinc coating per ASTM A641	At least 48" high, less than or equal to 2-inch x 4-inch mesh spacing.	
Polywire or "Twine " – Type	Minimum of 6 strands of aluminum, stainless steel or mixed metal wires	Wires interwoven with polyethylene or polypropylene fiber.	Polywire (twine-type), as compared to polytape is more durable under frequent movement. Polytape is best used where high visibility is needed. Do not use on fences more than 1 mile in length (low-conductivity). Life expectancy is 3-5 years if moved frequently.	
Polytape or Tape-Type	Minimum ½ inch wide and 5 strands of stainless steel or mixed metal wire filaments			
Aluminum	12.5 gauge	Aluminum	May be used as one of the wires in a multi-wire fence or as single wire subdivision fence. May be used as lead out cable from Power Energizer to fence.	
Steel wire and hardware used to construct a permanent fence will be new and galvanized material. Not all materials are for permanent or containment fencing, reference Table 1 to ensure the fence material selected is appropriate for the type of fence and the livestock to control.				

PA Natural Resources Conservation Service Conservation Practice Standard Fence (382)			
Table 4. Line Post Type, Size and Depth Specifications			
Fence Type	**Post Type**	**Minimum Diameter/ Weight**	**Minimum Depth***
Barbed Wire Woven Wire Smooth High Tensile wire non-electrified	Pressure treated wood (Material Spec 585), black locust, red cedar (>50% heartwood)	4"	30"
	Steel T posts[1] Steel U posts[1] Steel L posts[1] (When using steel posts, wooden posts shall be set every 4th post)	1-3/8" x 1-3/8" x 1/8" thick 2" x 1-1/4" x 3/32" thick 2" x 2" x ¼" thick All 1.25 lbs. per foot, exclusive of anchor plates	18"
	Steel pipe, galvanized	2" outside diameter	18"
Smooth High Tensile wire electrified	Pressure treated wood (Material Spec 585), black locust, red cedar (>50% heartwood) bb	4"	30"
	Steel T posts[1] Steel U posts[1] Steel L posts[1] (When using steel posts, wooden posts shall be set every 4th post)	1-3/8" x 1-3/8" x 1/8" thick 2" x 1-1/4" x 3/32" thick 2" x 2" x ¼" thick All 1.25 lbs. per foot, exclusive of anchor plates	18"
	Fiberglass[2,4]	5/8"	16"
	HDPE[3,4]	1.33" (per manufacturer recommendations)	12"
	Composite[3,4]	1 1/8" (per manufacturer recommendations)	16"
	PVC T or H posts[3,4]	1.5"	12"
Stays (Battens, Droppers, or Spacers)	Wire stays Composite Fiberglass Steel T post w insulators Wood PVC	12 ga. galvanized for barbed wire 1" ½" Listed above 1.5"X1.5" 1"	Stays are not always designed to touch the soil surface, but should be sufficient to maintain wire spacing
Temporary Electric Fences	Fiberglass, composite, plastic, PVC, steel rod	3/8"	4"

[1]All steel posts shall be new and painted or galvanized.
[2]Fiberglass posts should be coated to prevent splintering and cracking.
[3] All HDPE, PVC and composite material must be UV protected.
[4]Fiberglass, composite, PVC and HDPE posts are not to be used in bends, curves or at places in the fence with abrupt changes in elevation.
*Minimum depth unless specified by manufacturer. If top fence wire is greater than 60 inches minimum depth increases, consult NRCS technical specialist during design for approval prior to construction.

PA Natural Resources Conservation Service Conservation Practice Standard Fence (382)			
Table 5. H-Brace Pull Post (corner, gate and end) Specifications			
Brace Post Type	**Minimum Top Diameter**	**Depth Anchoring[1]**	**Other**
Pressure treated pine (Material Spec 585) or other wood of suitable strength: red cedar (>50% heartwood), black locust.	6" top diameter (corners, ends, pull posts and gates); 5" top diameter all other wooden brace posts	48" 48"	Minimum post lengths should allow for required buried depth and fence height plus at least 2 inches of post above top wire. Posts will have appropriate treatment to prevent rust and deterioration. The assembly strength of a corner post set 2.5' deep is approximately half compared to a post set at 3.5' deep. A single post brace assembly can be used as bracing for ≤2 HT smooth electric wires. See Table 7.
Steel round pipe – braced[2]	2-3/8" nominal; 7 lbs/ft. or equivalent	36" set in 12 in diameter hole with concrete	
	4" nominal; 10 lb./foot or equivalent	36" driven	
Steel, angle iron – braced[2]	2.5" x 2.5" x 0.25"	36" set in 12 in diameter hole with concrete	
[1]If top fence wire is greater than 60 inches depth anchoring increases, consult NRCS technical specialist during design for approval prior to construction. [2]All steel posts shall be new and galvanized.			

PA Natural Resources Conservation Service Conservation Practice Standard Fence (382)			
Table 6. Brace Rail Specifications for H-Brace			
Brace Member Type	**Minimum Diameter/ Weight**	**Typical Length**	**Other**
Pressure treated pine (Material Spec 585) or other wood of suitable strength; red cedar (>50% heartwood), black locust.	4 inches	8-10 feet	Posts will be straight and free of splintering. Posts will have appropriate treatment for rust and deterioration. The wider this brace the stronger the brace.
Galvanized steel pipe[1]	2" diameter, schedule 40	8-10 feet	
Steel, angle iron[1]	2.5" x 2.5" x 0.25"	8-10 feet	
[1]All steel posts shall be new and galvanized.			

PA Natural Resources Conservation Service Conservation Practice Standard Fence (382)			
Table 7. Single Post Brace[1] Specifications for 1-2 strands high tensile electric fence only			
Brace Post Type	**Minimum Top Diameter**	**Minimum Depth Anchoring**	**Other**
Steel round pipe or tubular steel[2] (galvanized)	2.5" outside diameter schedule 40	24" set in 12" diameter hole with concrete	For single wire fences, concrete not needed if posts are driven 3 feet deep
Steel angle iron[2]	2.5" x 2.5" x 0.25"		
Steel[2]	4" outside diameter	48"	Concrete not needed
Pressure treated pine (Material Spec 585) or other wood of suitable strength; red cedar (>50% heartwood), black locust.	6 inch (post must be driven)		*If single brace post cannot be installed to 48", use a corner or end brace.*
[1]Single posts as braces should lean approximately 4 inches away from the direction of pull.			
[2]All steel posts shall be new and galvanized.			

PA Natural Resources Conservation Service Conservation Practice Standard Fence (382)			
Table 8. Maximum Brace Assembly Spacing (on straight and level pulls)*			
Fence Type	**Distance Between Anchor (pull) Posts (ft.)**	**End / Corner Brace Types**	**Inline Brace Type**
Barbed Wire and Standard Woven (net) wire (Hinge Joint)	0 - 600	Single H Brace	NA
	601-1,320	Double H Brace	NA
	>1,320	Double H Brace	Double H Brace
High Tensile Fixed Knot Woven Wire (Continuous Stay)[2]	0 – 1,320	Single H Brace	NA
	>1,320	Double H Brace	Double H Brace
Smooth HT wire – non-electrified or electrified	3-6 strands [1]	Single H Brace	N/A
	6+ strands	Double H Brace	N/A
*The maximum distance between anchor posts of a brace assembly will often be shorter than what is listed in this table due to abrupt changes in topography or fence direction that will require closer brace assembly spacing.			
*All wires must be tied off at in-line pull assemblies and new wires started for the next fence section.			
*Use this information as a guide to determine bracing requirements for the type of fence being constructed. Minor adjustments may be made based on topography and the number or height of fence wires installed with NRCS approval.			

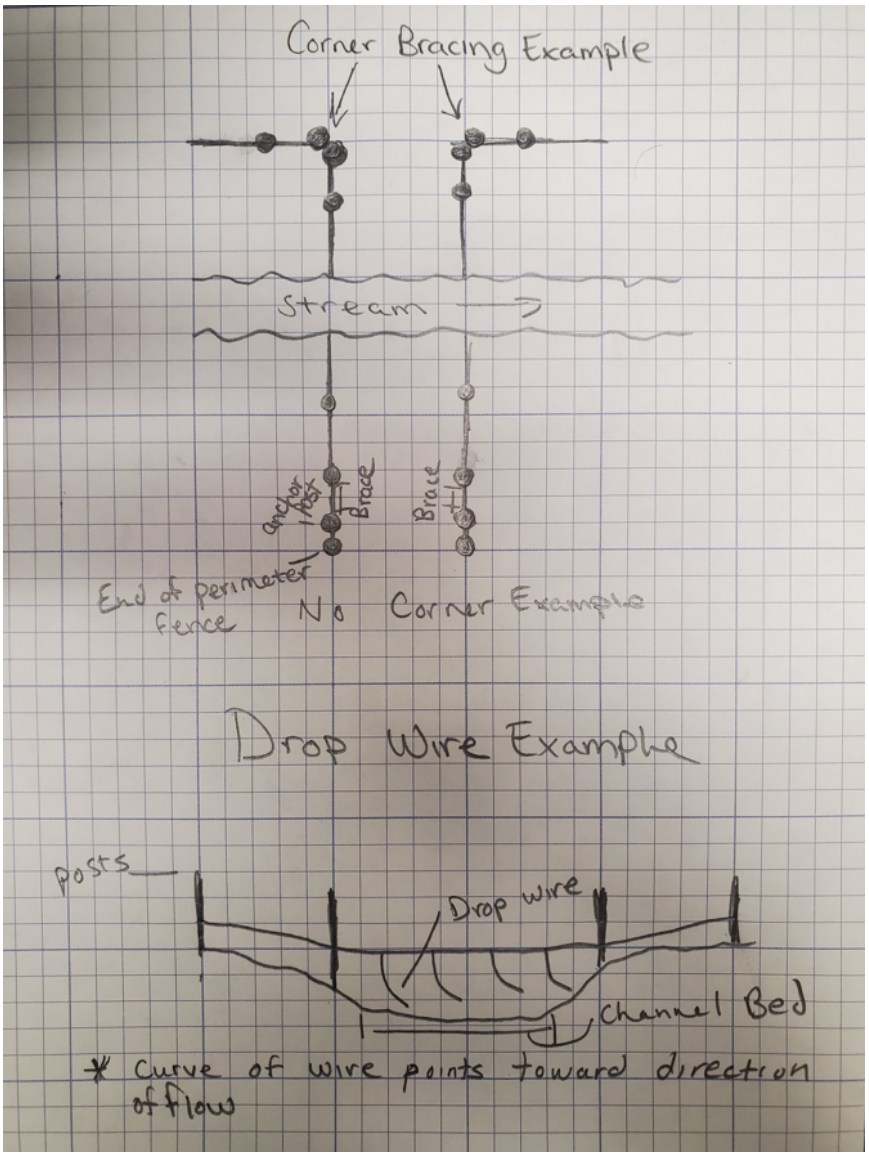
[1]Single post brace assembly of suitable diameter can be used for fences with 1-2 strands HT electric wires, see Table 7.
[2]Build HT fixed knot WW fence according to recommendations of the fencing manufacturer.

PA Natural Resources Conservation Service Conservation Practice Standard Fence (382)	
Table 9. Specifications of other Fence Components	
Component	**Description/Specification**
Electrical Energizers or "Chargers"	Energizers for permanent electric fencing must be manufactured for the purpose of agricultural fencing and be high power, low impedance that can produce at least 5,000 volt peak output and a short pulse less than 300 milliamps (mAmps) in intensity, finished within 0.0003 of a second, and at a rate of 35-65 pulses per minute. It is recommended that the energizer have a fence charge meter. Only one charger is allowed per fence. It is recommended the unit include a high impact self-insulating weather resist case, a snap-in circuit panel, a safety pace fuse, a lightening arrester, have full power input and reduced power output. May be solar, 110 or 220 volt, or 12 volt battery units. OUT PUT Joule rating should be based on the size of fence system, the type of fence being electrified and high enough to provide a minimum shock at the farthest point in the fence. To control most livestock it is recommended to maintain fence line voltage ≥ 3,000 volts. Use higher voltage for sheep, goats and predator control.
Lightening Arrestor	A properly grounded lightning arrester and a "lightning choke" shall be installed to protect the energizer from lightning strikes. A voltage spike protector is also recommended.
Electrical Insulators	Insulators shall be made of high quality glazed porcelain or UV resistant HDPE or HDPP plastic manufactured for durability under high tensile strain. UV resistant tubular plastic insulators that wrap around end and corner posts must have a reinforced strip to prevent cracking and grounding under high tensile strain. Galvanized 12.5 gauge wire may be used on fiberglass and other non conductive posts to secure wire to post.
Wire connecting energizer to fence or beneath gate or road	Underground cable (insulated wire) is often used where wires are buried under gates and as leads from the energizer to the fence. Underground cable should be 12.5 gauge galvanized or soft steel wire with bonded, high density, ultra-violet stabilized polyethylene or polypropylene or polypropylene insulation. Never use household or underground electrical copper wire with fence energizers. Where underground insulated wire is buried under gates or roads, it is strongly recommended to run the wire through a non-metal conduit (with water tight connections) to decrease the incidence of short circuiting over time.
Ground rod and installation	Ground rods should be 6 to 8 feet long x ½"- 5/8" galvanized steel rod set minimum 10 feet or 1 ½ times the length of the rod whichever is greater apart and driven to no more than 6" above the ground. The number of ground rods needed is based on a minimum of 3 feet of ground rod per joule of energizer output capacity. All energizers must be grounded sufficiently to test less than 300 Ohms on the last ground rod when the fence is "grounded" 300 feet from energizer. Galvanized ground rods for the fence must be driven into the ground a minimum of 6 feet. Install ground fields at least 75' away from other ground fields. If this is impossible, alternative methods of grounding include putting rods in trenches surrounded with Epson Salt or Bentonite. Placing ground rods in damp areas will improve effectiveness. Follow manufacturer's recommendations for grounding the system.
Staples or Fasteners	Staples used to fasten wire to wood post shall be 9 gauge Class 3 galvanized barbed with a minimum length of 1 ½ inches for treated posts and 1 ¼ inches for locust posts.For ACQ treated wood use only stainless steel or galvanized fasteners. For steel line posts, the fencing shall be fastened with 14 gauge galvanized steel wire or the post manufacturer's special wire clips. For all other types of posts, attach as specified by manufacturer.
Gates	Only new materials may be used for gates and they must be made of suitable material and coated to be durable enough to last 20 years with suitable maintenance. All non-electrified gates must be substantial enough to withstand expected pressures from livestock and wildlife. Gates between electrical subdivision fences may be of polywire, polyrope or coiled spring connected to spring loaded handles.

Specific Site Requirements

At Stream Crossing depending upon wire gap between lowest wire and stream may need to install drop wires. Galvanized wire will need to be crimped to the lower wire and will need to be electrified.

Stream Crossing fencing will be separate from Animal Trails/Perimeter fencing. Separate anchor posts will be needed at crossing.



Watering System Design:

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Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

LIVESTOCK PIPELINE

CODE 516

(ft)

DEFINITION

Pipeline having an inside diameter of 8 inches or less.

PURPOSE

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

- Convey water from a source of supply to points of use for livestock, wildlife, or recreation
- Reduce energy use
- Develop renewable energy systems (i.e., in-pipe hydropower)

CONDITIONS WHERE PRACTICE APPLIES

Where it is desirable or necessary to convey water in a closed conduit from one point to another.

CRITERIA

General Criteria Applicable to All Purposes

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.

Capacity

For livestock water, the installation shall have a capacity to provide seasonal high daily water requirements for the number and species of animals to be supplied. Animal water requirements can be obtained from the NRCS Field Office Technical Guide, Reference #86; *Watering Systems for Grazing Livestock*, or from Midwest Plan Service (MWPS-1); *Structures and Environmental Handbook*.

For recreation areas, the water capacity shall be adequate for all planned uses. Typical examples are drinking water, fire protection, showers, flush toilets, and irrigation of landscaped areas. Additional water capacity will be provided for wildlife when applicable.

Sanitary protection

If water from the pipeline is to be used for human consumption, applicable state and local regulations shall be met.

Friction and Other Losses

For design purposes, head loss for hydraulic grade line computations shall be computed using one of the following equations: Manning's, Hazen- Williams, or Darcy-Weisbach. 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 evaluated 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
All pipe must withstand the pressure it will be subjected to, including hydraulic transients, internal pressures and external pressures. As a safety factor against surge or water hammer, the working pressure should not exceed 72% of the pressure rating of the pipe and the design flow velocity at system capacity should not exceed 5 ft/sec. If either of these limits is exceeded, special consideration must be given to flow conditions and measures must be taken to adequately protect the pipeline against surge.

Flexible conduits such as plastic pipe, steel pipe, aluminum pipe, corrugated metal pipe, or ductile iron pipe, shall be designed using NRCS National Engineering Handbook (NEH) Part 636, Chapter 52, *Structural Design of Flexible Conduits.*

Steel pipe shall meet the requirements of AWWA Specification C-200.

Plastic pipe shall conform to the requirements of the following ASTM specifications, as applicable:

D 1527 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80

D 1785 Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

D 2104 Polyethylene (PE) Plastic Pipe, Schedule 40

D 2239 Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter

D 2241 Poly(Vinyl Chloride) (PVC), Pressure-Rated Pipe (SDR)

D 2282 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR)

D 2447 Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter

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

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

For smooth-wall aluminum pipe, the maximum allowable pressure of the pipe shall be determined using the hoop stress formula limiting the allowed tensile stress to 7,500 psi.

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 joint type and pipe material used.

For sloping steel 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.

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.

Plastic pressure pipe fittings shall conform to the following ASTM specifications, as applicable:

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 2468 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40

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 for solvent-welded plastic pipe joints shall conform to the following ASTM specifications, as applicable:

D 2235 Solvent Cement for Acrylonitrile- Butadiene-Styrene (ABS) Plastic Pipe and Fittings

D 2564 Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

D 2855 Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings

Rubber gaskets for pipe joints shall conform to the requirements of ASTM F477, Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

Protection

When steel pipe is used, interior protective coatings shall be provided in accordance with Conservation Practice Standard PA430, Irrigation Pipeline. If a coal- tar enamel protective coating is needed for corrosion protection, the coating shall meet the requirements of AWWA Specification C-203.

Steel pipe installed above ground shall be galvanized or shall be protected with a suitable protective paint coating, including a primer coat and two or more final coats.

All metal to metal fittings, such as risers, bends, tees, and reducers, should be of similar metals. If dissimilar metals are used, the fittings shall be protected against galvanic corrosion (e.g., separate dissimilar metals with rubber or plastic insulator).

When cathodic protection is required, joints and connecting bands shall be electrically bridged to ensure continuous flow of current. A dielectric connection shall be placed between the pump and the pipeline and between pipes with different coatings.

The total current required, kind and number of anodes needed, and life expectancy for the cathodic protection shall be designed in accordance with NRCS Design Note 12, *Control of Underground Corrosion.*

Bolts used to join galvanized steel shall be galvanized; plastic coated, stainless steel, or otherwise protected to prevent galvanic corrosion. Bolts used to join aluminum, other than aluminum alloy bolts, must be plastic coated or otherwise protected to prevent galvanic corrosion.

Plastic pipe installed above ground shall be resistant to ultraviolet light throughout the intended life of the pipe. For plastic pipe, thermal effects must be properly factored into system design. Pressure ratings for pipes are normally based on a pipe temperature of 73.4ºF. When operating temperature is higher the effective pressure rating of the pipe shall be reduced accordingly. Values and procedures for pressure rating reduction shall follow information described in the NEH Part 636, Chapter 52.

All pipes shall be protected from hazards presented by traffic, farm operations, freezing temperatures, fire, thermal expansion and contraction. Reasonable measures should be taken to protect the pipe from potential vandalism.

Support of Pipe
Pipelines, both below and 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.

Thrust Control
Abrupt changes in pipeline grade, horizontal alignment, reduction in pipe size, or if the factors of safety for surge or water hammer are exceeded an anchor or thrust block, pressure regulator, or valve, to absorb any axial thrust of the pipeline will be required.

Thrust blocks and anchors must be large enough to withstand the forces tending to move the pipe, including those of momentum and pressure as well as forces due to expansion and contraction.

The pipe manufacturer's recommendations for thrust control shall be followed. In absence of the pipe manufacturer's requirements, design in accordance with NRCS NEH Part 636, Chapter 52; Structural Design of Flexible Conduits.

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.

Pressure Reduction
Pressure reduction shall be incorporated in circumstances such as head gain exceeding pressure loss by a significant amount, excessive line pressured for the type of system, or excessive static pressures.

Inlets
Inlets shall be of adequate size for the type of entrance condition to ensure design flow capacity without excessive head losses.

Provision shall be made to prevent the inflow of trash or other materials into the pipeline if these materials would be detrimental to the pipe capacity or performance of the system.

For gravity flow inlets with square-edged or gated orifices, the nappe created by inflow at the orifice entrance shall be vented.

Water control structures, stands, Z-pipes and dog-legs are all acceptable inlet devices. Water control structures are commonly used for gravity flow pipelines, but do not account for removal of entrained air. Therefore, pipelines using these inlets must also meet the requirements listed under Vents.

Check Valves and Backflow Prevention
A check valve shall be installed between the pump discharge and the pipeline if detrimental backflow may occur. Check valves can cause extreme internal pressures, due to water hammer; if they close too fast as flow reversal occurs. “Non slam” type check valves or solenoid operated valves may be required.

Valves and Other Appurtenances
Pressure ratings of valves and other appurtenances shall equal or exceed the pipeline working pressure. When lever operated valves are used, an analysis shall be performed to evaluate potential surge/water hammer assuming an instantaneous valve closure.

Stands Open to the Atmosphere
Stands shall be used when water enters the pipeline to avoid entrapment of air; to prevent surge pressures and collapse because of vacuum failure; and to prevent pressure from exceeding the design working stress of the pipe. The stand shall be designed to:

- Allow a minimum of 1 foot of freeboard. The maximum height of the stand above the centerline of the mainline pipeline must not exceed the maximum working head of the pipe.
- Have the top of each stand at least 4 feet above the ground surface except for surface gravity inlets or where visibility is not a factor. Gravity inlets and stands shall be equipped with trash racks and covers.
- Have a downward water velocity in stands not in excess of 2 feet per second. The inside diameter of the stand shall not be less than the inside diameter of the pipeline.

The cross sectional area of stands may be reduced above a point 1 foot above the top of the upper inlet, but the reduced cross section shall not be such that it would produce an average velocity of more than 10 feet per second if the entire flow were discharging through it.

If the water velocity of an inlet pipe exceeds three times the velocity of the outlet, the centerline of the inlet shall have a minimum vertical offset from the centerline of the outlet at least equal to the sum of the diameters of the inlet and outlet pipes.

Stands shall be constructed of steel pipe or other approved material and be supported on a base adequate to support the stand and prevent movement or undue stress on the pipeline.

The size of float valve stands shall be adequate to provide accessibility for maintenance.

Stands must be constructed in a manner to insure vibration from the pump discharge pipe is not carried to the stand.

Pressure-relief valves can be used as an alternative to stands open to the atmosphere. A pressure-relief valve shall serve the pressure-relief function of the open stand or vent for which it is an alternative.

Stands Closed to the Atmosphere
If pressure-relief valves and air-and-vacuum valves are used instead of open stands, all requirements detailed in “Stands Open to the Atmosphere” shall apply except as modified below.

The inside diameter of the closed stand shall be equal to or greater than that of the pipeline for at least 1 foot above the top of the uppermost inlet of outlet pipe. To facilitate attaching the pressure-relief valve and the air- and-vacuum valve, the stand may be capped at this point, or if additional height is required, the

stand may be extended to the desired elevation by using the same inside diameter or a reduced cross section. If a reduced section is used, the cross-sectional area shall be such that it would produce an average velocity of no more than 10 feet per second if the entire flow were discharged though it. If no vertical offset is required between the pump discharge pipe and the outlet pipeline and the discharge pipe is “dog-legged” below ground, the stand shall extend at least 1 foot above the highest part of the pump discharge pipe.

An acceptable alternative design for stands requiring no vertical inlet offset (when inlet velocity is less than three times that of the outletting pipeline) shall be:

- Construct the dog-leg section of the pump discharge pipe with the same nominal pipe diameter as that of the pipeline.
- Install the pressure-relief valve and the air- and-vacuum valve on top of the upper horizontal section of the dog-leg.

Pressure-relief and air-and-vacuum valves shall be installed on stands with the nominal size pipe required to fit the valves’ threaded inlets.

Surge Tanks and Air Chambers
If surge tanks and/or air chambers are required for control of hydraulic transients or water column separation, they shall have adequate size to ensure the water volume needs of the pipeline are met without the tank/chamber being emptied, and that the required flow into the pipeline for the calculated pressure drop is met.

Pressure Relief Valves
A pressure relief (PR) 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 pressure-reducing valve malfunction or failure, PR valves shall be installed downstream of pressure reducing valves.

Manufacturers of PR valves marketed for use under this standard shall provide capacity tables that give the discharge capacities of the valves at the maximum permissible pressure and differential pressure settings. These tables shall be based on performance tests, and shall be the basis for acceptance of these valves and selection of the design pressure setting.

PR valves shall be set to open at a pressure as low as practical, but no greater than 5 psi above the pressure rating or maximum allowable pressure of the pipe. The valves shall have sufficient flow capacity to reduce the excessive pressures in the pipeline. In lieu, of a detailed surge/pressure analysis, the minimum size of PR valve shall be ¼ inch nominal valve size per inch of the nominal pipeline diameter.

The pressure at which the valves start to open shall be marked on each PR valve. Adjustable PR valves shall be sealed or otherwise altered to prevent changing the adjustment from that marked on the valve.

Vents
Venting must be designed into systems open to the atmosphere to provide for the removal and entry of air and protection from surge. The following criteria shall apply:

Vents shall have a minimum freeboard of 1 foot above the hydraulic gradeline at design capacity. The maximum height of the vent above the centerline of the pipeline must not exceed the maximum allowable working pressure of the pipe.

A vent chamber shall be constructed to intercept and/or capture air within the pipeline. The chamber shall intercept the circumference arc of 75 degrees at the top of the pipe (i.e., a vent chamber diameter of 2/3 the diameter of the pipeline). The chamber shall extend vertically at least one pipeline diameter up from the centerline of the pipeline. Above this elevation, the vent chamber may be reduced to minimum diameter of 2 inches.

When an AVR or COMB valve is used instead of a vent, the above requirements shall apply except that the reduced section shall be sized to meet the nominal pipe size required to fit the valve's threaded inlet. An acceptable alternative is to install the valve(s) in the side of a service outlet, provided that the service outlet riser is properly located and adequately sized. If both AVR and PR valves are required at the location, the 10 feet per second velocity criteria given under the "Stands Open to the Atmosphere" section of this standard, shall apply to the reduced section.

Vent chambers shall be installed on all open vents and closed vents with air valves, when the normal operating pressure of the pipe is 10 psi or less.

A vent shall be located at the downstream end of laterals, at summits in the line, and at points where the grade changes more than 10 degrees in a downward direction of flow.

Drainage
Valves or unions shall be installed at low points in the pipeline so that the line can be drained as needed. Check valves shall be installed as needed to protect groundwater quality or maintain a full pipeline.

Vegetation
Disturbed areas shall be established with vegetation or otherwise stabilized as soon as practical after construction. Seedbed preparation, seeding, fertilizing, and mulching shall conform to Conservation Practice Standard PA342, Critical Area Planting.

Visual resources
The visual design of pipelines and appurtenances in areas of high public visibility shall be carefully considered.

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

General

Enviroment
Base pipe material selection on exposure considerations (such as soil resistivity, pH, sunlight, and traffic). Soil texture, resistivity, pH, moisture content, redox potential and depth are important soil properties to be aware of for pipelines and in reducing soil limitations related to corrosivity, or packing of soil material. Refer to soil survey information of the area and on-site soil investigations should be considered during planning.

Pipelines installed below the ground surface should have a soil plan describing soil reconstruction of disturbed soil during and after pipeline installation so original soil productivity is restored after pipeline installation. Appropriate vegetation should be established to stabilize disturbed areas that will not be cropped.

Economic
Economics can be a major factor in pipeline design, as follows:

- Select pipe based on lifetime energy requirements, as well as initial costs of materials.
- Select pipe material based upon expected life of practice.
- Consider hydropower applications as alternatives to use of pressure reduction valves or reduced pipe diameter to induce friction loss.

PLANS AND SPECIFICATIONS

Plans and specifications for installing pipelines shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. If the pipeline is a component of a system that includes additional conservation practices, the information necessary to construct these additional practices will also be conveyed on the plans.

As a minimum the plans and specifications shall include:

- A plan view of the layout of the pipeline.
- Profile of the pipeline.
- Pipe material and sizes, including coatings, if any.
- Pipe joint requirements.
- All vents, valves, supports, etc.
- Site specific construction specifications that describe in writing the installation of the pipeline. Include the specification for pressure testing of the pipeline.
- Depth of cover and backfill requirements.
- Disposal requirements for excess soil material.
- Vegetative establishment requirements.

The NRCS Engineering Field Handbook, Chapter 5, Preparation of Engineering Plans, will guide the development of drawings and specifications.

OPERATION AND MAINTENANCE

An O&M plan specific to the type of installed pipeline shall be provided to the landowner.

The plan shall include, but not be limited to, the following provisions:

- Opening/closing valves to prevent excessive water hammer;
- Filling at the specified rate requirements;
- Inspecting and testing valves, pressure regulators, pumps, switches and other appurtenances;
- Maintaining erosion protection at outlets;
- Checking for debris, minerals, algae and other materials which may restrict system flow; and
- Draining and/or providing for cold weather operation of the system.
- Monitoring of any cathodic protection systems.

REFERENCES

McKinney, J.D., et al. Microhydropower Handbook, IDO-10107, Volumes 1 & 2. U.S. Department of Energy, Idaho Operations Office.

Midwest Plan Service (MWPS-1); Structures and Environmental Handbook

NRCS Field Technical Guide, Reference #86; Watering Systems for Grazing Livestock

USDA-NRCS, National Engineering Handbook, Part 636, Chapter 52; Structural Design of Flexible Conduits.

USDA-NRCS, National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 5, Preparation of Engineering Plans.

USDA-NRCS, Engineering Design Note 12, *Control of Underground Corrosion*.

Practice Specification
Livestock Pipeline (Code 516)

1. SCOPE

The work shall consist of furnishing materials and installing all components of a pipeline, as outlined in this specification and the drawings.

2. MATERIALS

All materials used shall conform to the quality and grade noted on the plans, set forth in Section 5, or as otherwise listed below:

PIPE

If the pipe is stored on site, it should be protected from sunlight.

Pipe and fittings shall meet the requirements of one of the following types and standards, or as otherwise set forth in Section 5 or on the drawings.

1. Steel Pipe. AWWA standard C200; ASTM standards A53, A134, A135 and A139, A858, and A865.
2. Ductile Iron. AWWA standard C600; and ASTM standard A746.
3. Aluminum (Tubing). ASTM standards B210, B241, and B313; ANSI standards H35.1 and H35.2.
4. Corrugated Metal. ASTM standards A760 and B745; AASHTO standards M36, M196, and M245. Pipe bands or couplers shall meet the requirements of the applicable pipe specification, except that channel bands (for use with flanged pipe), smooth or flat bands, nor dimple bands shall be allowed.
5. Polyvinyl chloride (PVC). ASTM standards D1784, D1785, D2241, D2466, F794, D2774; AASHTO standard M304; AWWA standards C900 or C905; and ASABE/ANSI standard S376.
6. Acrylonitrile-butadiene-styrene (ABS). ASTM standards D1527 and D3965.
7. Polyethylene (PE; commonly referred to as PE or HDPE, the primary difference being product density). ASTM standards D3350, F714, D2104, D2239, D2447, D2737, D3035, F405, F667, F771, F894, and D2774; AASHTO standard M294; AWWA standards C901 and C906; and ASABE/ANSI standard S376.

Pipe shall be marked as directed by the applicable reference standard(s) but shall have at a minimum: nominal pipe size, pipe material, dimensioning system (IPS, NPS, Sch, etc), thickness (pressure rating or substitute designation from which the pressure rating can be obtained), and manufacture's name or trademark.

Unless otherwise set forth in Section 5, pipe and fittings shall have a protective coating applied and shall conform to one of the following specifications, as applicable:

AWWA C104, AWWA C116,AWWA C203, AWWA C203, AWWA C209, AWWA C210, AWWA C213,

AWWA C214, AWWA C218, ASTM A53,ASTM A123/A 123M, or ASTM A153/A

All joints and connections shall be constructed to withstand the design working pressure for the pipeline without leakage and shall leave the inside of the pipeline free of any obstruction which could reduce the pipe capacity below design requirements.

All fittings, such as couplers, reducers, bends, tees and endives shall be made of material that is recommended for use with the type of pipe specified and shall be installed in accordance with the recommendations of the pipe manufacturer.

Joints and connections for steel pipe shall meet the following requirements:

- Field joints shall be installed according to the manufacturer's recommendations. On buried pipelines, high-resistance joints between pipe lengths shall be electrically bridged with a welded, brazed, or soldered copper wire. If coated pipe is field welded, care shall be taken to avoid burning the protective coating. After joints are welded, they shall be covered with a coating equal in quality to that specified for the pipe and hardware.

Plastic pressure pipe fittings shall conform to the following ASTM specifications, as applicable:

D 2464, D 2466, D 2467, D 2468, D2609, D, D 3139, or D 3261

Solvents for solvent-welded plastic pipe joints shall conform to the following ASTM specifications, as applicable:

D 2235, D 2564, or D 2855

Rubber gaskets for pipe joints shall conform to the requirements of ASTM F477.

VALVES AND OTHER APPURTENANCES

The pipeline valves and appurtenances shall be of the size, type, material and pressure rating as shown on the drawings. If not specified in the design, pressure ratings shall equal or exceed that of the pipe.

Pressure relief valves shall be stamped with the pressure at which the valve starts to open. Adjustable valves shall be sealed or otherwise altered to insure that the setting marked on the valve is not changed.

All other appurtenances, such as valve housings, shall be made of non-corrosive material and shall be according to manufacturer's recommendations, Section 5 and/or the drawings.

CONCRETE

Concrete used for thrust blocks shall have a minimum compressive strength, at 28 days, of 3000 psi. If the supplier cannot show evidence that a mix will meet strength requirements, a mix with a maximum net water content of seven gallons per bag (94 lbs) of cement, and a minimum cement content of five and a half (5.5) bags per cubic yard of concrete, may be used

3. PIPE INSTALLATION

Pipelines shall be placed so that they are protected against hazards imposed by traffic, livestock, farm operations, freezing temperatures, or soil cracking. Other means of protection must be provided if the depth required for protection is impracticable because of shallow soils over rock or for other reasons. Abrupt changes in grade must be avoided to prevent rupture of the pipe. All special pipe installation requirements of the pipe manufacturer shall be followed.

ABOVE GROUND INSTALLATIONS

For suspension installations the pipe supports (saddle, rack, stand, hanger, etc.) shall meet design specifications and manufacturer's or industry recommendations. Unless otherwise specified on the drawings, pipe shall (1) be supported a minimum of one foot above the ground, (2) have two layers of felt strips placed between the pipe and the support, and (3) have graphite lubricant placed between the pipe and the felt strip. Treated wood shall be used for timber supports.

Unless otherwise specified on the drawings, above ground pipelines with restrained joints (e.g., welded steel or banded CMP) shall have: (1) expansion couplers installed at a spacing not to exceed 400 feet, (2) a maximum distance between a coupler and a fixed or anchored location of 200 feet, and (3) couplers that provide for a minimum of 4 inches of travel distance.

For installations designed for laying the pipe across naturally occurring terrain, the pipe shall be firmly and uniformly bedded throughout its entire length. For corrugated metal pipe the bedding shall facilitate pipe installation so that at least the bottom 25% of the pipe circumference shall be in contact with the pipe. Unless otherwise specified on the design, bedding material shall be imported if the ground surface will result in point loads or unacceptable abrasion on the pipe (e.g., bedrock or rock outcrops). Blocking or mounding shall not be used to bring the pipe up to final grade. Unless otherwise specified on the drawings, supports/saddles specifications as described above shall be followed.

The pipe shall not be handled in a manner to cause damage to the pipe and its coating. The pipe shall not be rolled or dragged on the ground. The pipe shall be placed onto above ground supports by the use of canvas slings or padded cables. Individual joints of pipe shall be inspected and any damaged pipe shall be removed and replaced.

UNDERGROUND INSTALLATIONS

a. Trench Construction

Trench depth and depth of cover shall be as specified on the drawings.

Trench width at any point below the top of the pipe should be only wide enough to permit the pipe to be easily placed and joined and to allow the initial backfill to be safely and properly placed and compacted. The minimum trench width is dependent on backfill placing and compacting equipment, but for typical manual installation clearance on either side of the pipe shall be 9 inches unless the trench is precision excavated with a semicircular bottom that closely fits the pipe. In that case, the minimum clearance on either side of the pipe shall be 6 inches. The maximum trench width shall be no greater than the minimum required by backfill placing and compacting equipment, but for typical manual installation shall be 30 inches greater than the outside diameter of the pipe (i.e., maximum clearance between the pipe and trench wall shall be 15 inches).

Trenches more than 5 feet deep shall be shored, sloped, or benched to provide safe and stable trench walls. Unless otherwise specified on the drawings trenches shall be constructed according to Figures 1 through 5; or as provided in OSHA Construction Safety Regulations, Subpart P, Excavations, Appendix B – Sloping and Benching.

Where rock, hardpan, cobbles or other hard material which might prevent the pipe from being uniformly supported is encountered in the bottom of the trench, the trench shall be undercut a minimum of four inches below final grade. The trench shall then be brought back to grade with appropriate backfill material placed and compacted to provide proper bedding.

More than one pipe may be placed in a common trench. In such cases with typical manual installation the minimum and maximum clearances shall apply, and the minimum distance between pipes shall be 12 inches to facilitate safe and proper backfill installation.

b. Bedding

The pipe shall be firmly and uniformly bedded throughout its entire length. Bedding material, if necessary, shall be placed and spread in uniform layers and in such a manner as to fill the trench so there are no unfilled spaces (air pockets) below the pipe. For pipe with bell joints, holes shall be dug in the bedding at the bells to permit the body of the pipe to be in contact with the bedding along its entire length. Blocking or mounding shall not be used to bring the pipe up to final grade.

The pipe shall not be dropped into the trench or handled in a manner to cause damage. PVC pipe shall not be handled when the temperature is less than 20°F or greater than 100°F. PE pipe shall not be handled when the temperature is less than 10°F or greater than 110°F. The pipe shall be allowed to come within a few degrees of the temperature it will have after it is completely backfilled before placing fill other than that needed for shading or before connecting the pipe to other facilities. Individual joints of pipe shall be inspected and any damaged pipe shall be removed and replaced.

Thrust blocks shall be formed against a solid trench wall. They shall be of the minimum size and materials as specified on the drawings.

The thrust block cavity shall be in undisturbed soil or previously placed compacted backfill that yields an acceptable allowable bearing pressure. The cavity shall be formed with soil or wood to hold the freshly placed concrete without displacement until an initial set has occurred.

When excavation beyond the designated trench widths and depths, as shown on the drawings or specified in Section 5 of this specification, occurs at locations where installation of concrete thrust blocks is required, the contractor shall install an alternative thrust block provision.

The concrete thrust block shall have a thickness, length, and depth as shown on the drawings or specified in Section 5. Backfill shall be placed on all sides of the thrust block and to the sides of the excavation.

c. Backfill

Initial Backfill. Unless otherwise specified in the design solid wall pipe 18 inches nominal diameter or less the initial backfill material may be fine grained soil. This may be the on site trench excavated materials as long as any unsuitable materials are removed; it must be free of rocks, gravels, frozen materials larger than 1 inch or earth clods greater than 2 inch in diameter. Unless otherwise specified in the design, for solid wall pipe greater than 18 inches nominal diameter and corrugated, ribbed, or profile wall pipe, the initial backfill material shall be angular 1 to ¼ inch size crush stone with a maximum of 10 percent cohesive fines or sand and gravels (Soil types GW, GP, SW, and SP) with a maximum particle size of 1 inch containing a maximum of 12 percent of noncohesive fines. Sands shall have a maximum of 45 percent passing the # 40 sieve.

Unless otherwise specified in the design, initial backfill shall be placed in lifts no greater than 8 inches deep before being compacted. For typical manual installation, each lift shall be worked to eliminate any unfilled spaces and compacted with appropriate tamping equipment and significant effort. When backfilling is done by mechanical means the initial fill shall first be worked to eliminate any voids.

The initial backfill materials shall be placed in a manner so as not to displace, deform or damage the pipe.

When water packing is used, the pipe shall be filled with water. The initial backfill, before wetting, shall be of sufficient depth to ensure complete coverage of the pipe with backfill after consolidation has taken place. Water packing shall be accomplished by adding water to diked reaches of the trench in such quantity as to thoroughly saturate the initial backfill. After the backfill is saturated, the fill shall be consolidated by rodding or with a vibrator. The wetted fill shall be allowed to dry until firm before completing the final backfill. The pipeline shall remain full of water until after the final backfill is placed.

Final Backfill. The final backfill material shall be free of rocks, frozen clods or other debris larger than 1inch in diameter within 6 inches of the pipe and 6 inches in particle size for the remaining portion of the final backfill unless otherwise specified in the design. The material shall be placed and spread in approximately uniform layers so there are no unfilled spaces in the backfill. Rolling equipment shall not be used until a minimum of 18 inches of compacted backfill material has been placed over the top of the pipe

Final backfill shall result in a finished trench surface that is smooth, slightly rounded so that the trench surface is higher than the surrounding ground, free of rocks greater in size than the surrounding surface, and has a clean and finished appearance.

Plastic pipelines may be placed by plow-in equipment if soils are suitable and rocks and boulders will not damage the pipe.

All disturbed areas shall be revegetated according to the recommendations for permanent seeding as stated in Conservation Practice Standard PA342, Critical Area Planting and/or the Pennsylvania Agronomy Guide.

4. BASIS OF ACCEPTANCE

The acceptability of the pipeline shall be determined by inspections to check compliance with all the provisions of this standard and specifications including the design of the line, the pipe, and pipe marking, the appurtenances, and the minimum installation requirements.

The pipeline shall be pressure tested for leaks. Before pressure testing, the joints of the assembled pipeline shall be allowed to set as recommended by the manufacturer and all concrete thrust blocks shall be in place and allowed to cure for a minimum of 3 days.

Pipeline shall be pressure tested by one of the following methods:

1. Before backfilling, fill the pipe with water and test at the design working head or at a minimum head of 10 ft., whichever is greater. All leaks must be repaired, and the test must be repeated before backfilling.
2. Pressure test at the working pressure for 2 hours. The allowable leakage shall not be greater than one gallon per diameter inch per mile. If the test exceeds this rate, the defect must be repaired until retests show that the leakage is within the allowable limits, but all visible leaks must be repaired.

If water is not available to complete a test, the installer shall provide a guarantee stating they will return and fix leaks that are found when the pipe is initially filled with water.

All materials shall conform to these minimum requirements and to the tests prescribed in the applicable ASTM Specification. If requested by the engineer, a qualified testing laboratory must certify with supporting test results that the pipe meets the requirements specified in this specification. The seal of approval of a recognized laboratory on pipe bearing the ASTM or AWWA designations may be accepted for this certification.

The installing contractor shall certify that the materials and installation comply with the requirements of these specifications. He shall furnish a written guarantee against defective workmanship and materials to cover a period of not less than one year. The installing contractor shall furnish a copy of the certification and guarantee, which will be made a part of the supporting records of the pipeline.

5. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

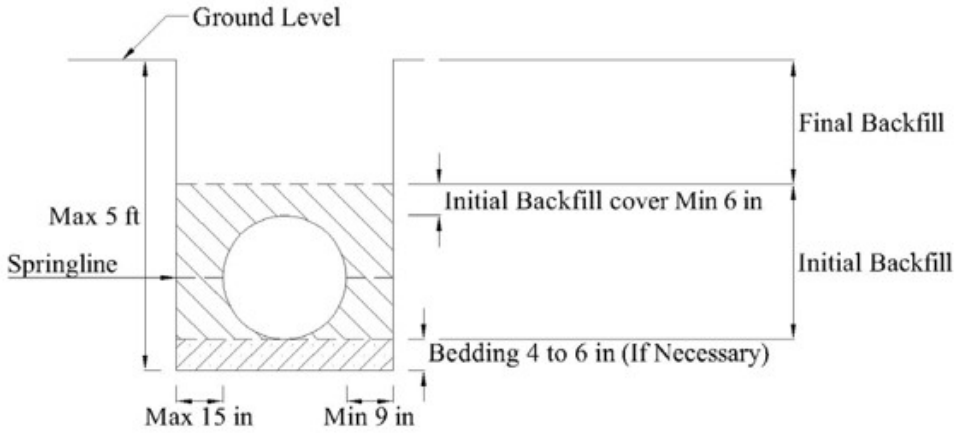


Figure 1. ***Typical Trench with flat bottom, Manual Installation of Backfill***

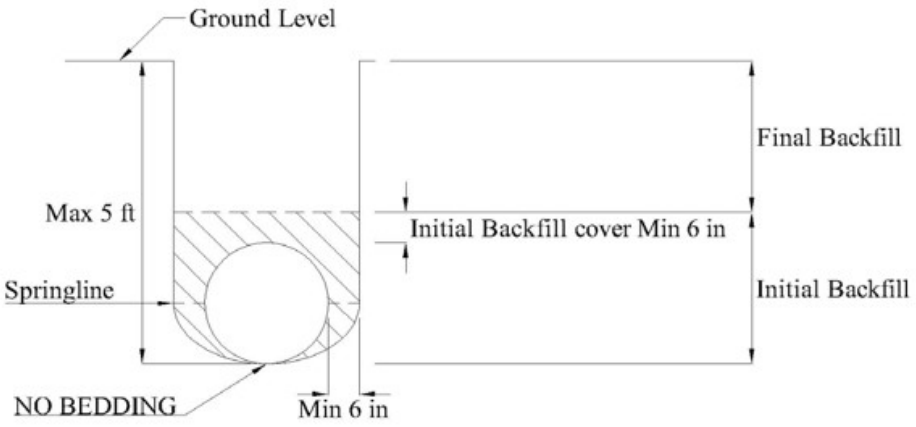


***Figure 2**. Typical Trench with semi-circular bottom, Manual Installation of Backfill*

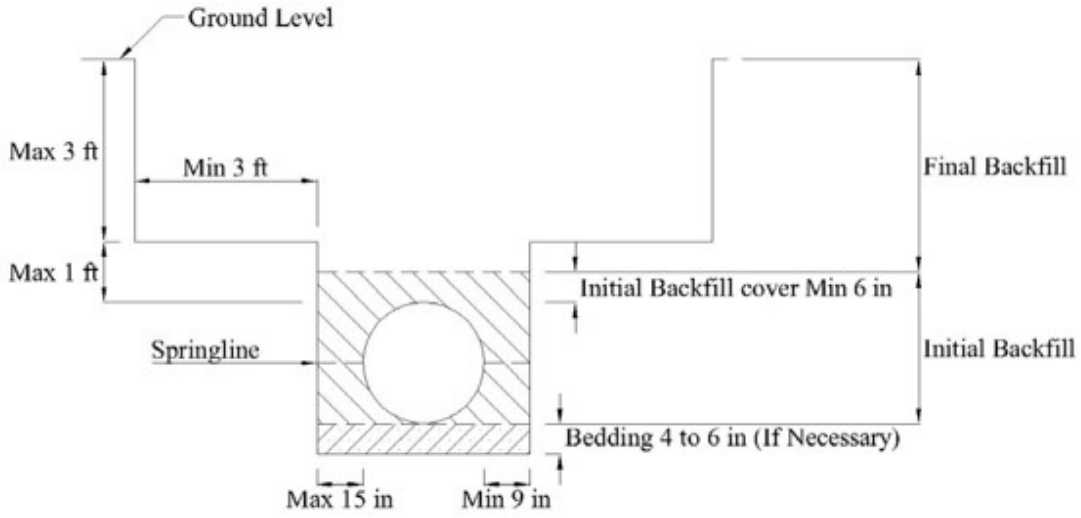


Figure 3. ***Trench Depth 5 to 10 feet: Benching System.***

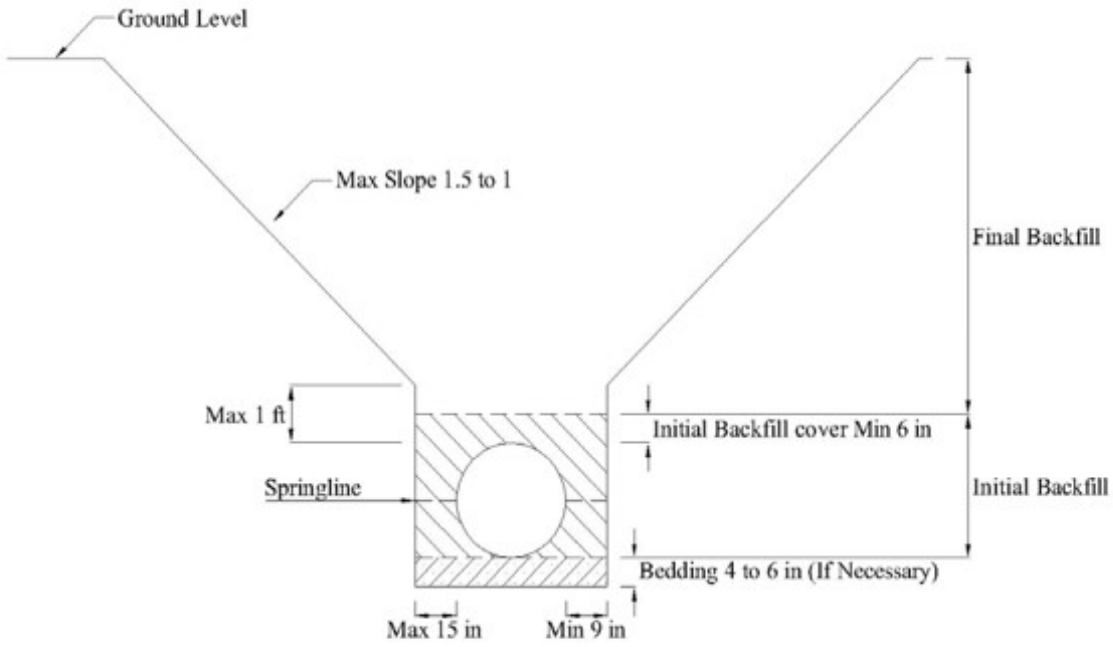


Figure 4. ***Trench Depth 5 to 10 feet: Vertically-sided lower portion with sloped upper portion***

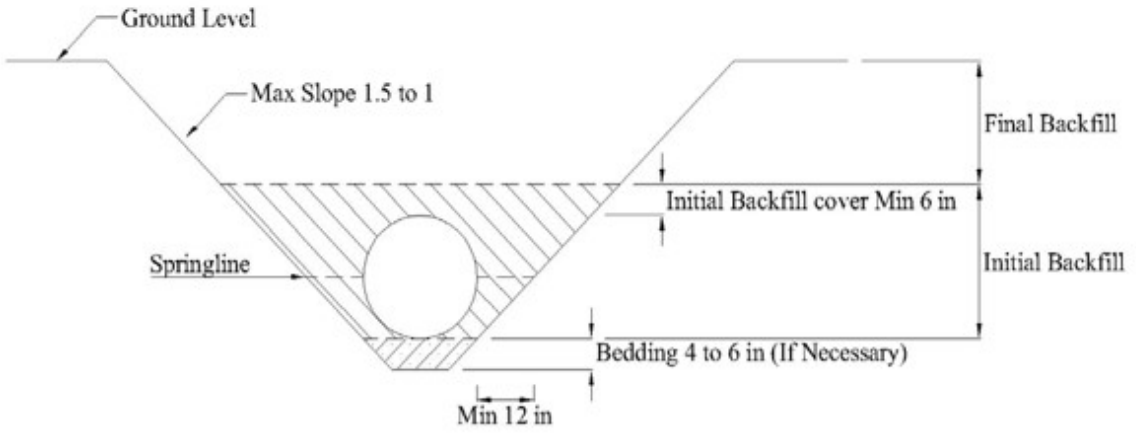


Figure 5. ***Trench Depth 5 to 12 feet: Sloped walls***

Specific Site Requirements

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

WATERING FACILITY

CODE 614

(no)

DEFINITION

A permanent or portable device to provide an adequate amount and quality of drinking water for livestock and/or wildlife.

PURPOSE

To store or provide designated access to drinking water for livestock or wildlife to:

- supply daily water requirements
- improve animal distribution
- provide a water source that is an alternative to a sensitive resource

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all land uses where there is a need for a watering facility for livestock or wildlife, where there is a source of water that is adequate in quantity and quality for the purpose, and where soils and topography are suitable for a facility.

CRITERIA

General

Capacity

Identify the type of livestock or wildlife that will be the primary user(s) of the facility. If the watering facility will supply water to different species of animals, provide sufficient water to meet the sum of the seasonal high daily water requirements of all the animals.

Refer to the National Range and Pasture Handbook (Chapter 6), State guidance, or university publications for information on livestock water quantity and quality requirements. For wildlife, base water quantity and quality requirements on targeted species needs.

User Needs

Design the watering facility so that access is adequate to accommodate the number of animals that will be drinking at the same time. Include design elements to meet the specific needs of the primary user(s). Examples of specific design needs would include accommodation for antler size, species, and ingress and egress requirements.

Materials and Appurtenances

Construct the watering facility from durable materials that meet or exceed the lifespan of the practice. Follow NRCS design procedures for the selected materials. Use industry standards where NRCS standards do not exist. Unless otherwise set forth in the above procedures and standards, use the material requirements as follows:

Concrete	3000 psi compressive strength
Galvanized Steel	20 gauge thickness
Plastic	Ultraviolet resistance
Fiberglass	Ultraviolet resistance

Stabilization of Disturbed Area
Vegetate or stabilize areas disturbed by construction in accordance with the planned use of the facility. Use the criteria in Conservation Practice Standard *Critical Area Planting (PA342)* to establish vegetation. If establishment of vegetation is precluded by site conditions, use the criteria in *Mulching (PA484),* as appropriate.

Troughs and Tanks
Capacity
Design the watering facility with the storage volume necessary to provide water between periods of replenishment. Base the additional storage volume on the availability of water, replenishment rate, location, and planned operation.

Location
Locate the watering facility to meet the needs of the managed livestock or wildlife species. Select a site that will promote even grazing distribution and reduce grazing pressure on sensitive areas. Where multiple watering facilities are planned, place the watering facilities at distances that are appropriate for the species that will be managed.

When possible, locate the watering facility away from streams, ponds, or riparian areas to minimize chance of contamination from fecal contamination or surface pollution.

When a watering facility is installed adjacent to a well, provide positive drainage away from the well head.

Foundation
Install the watering trough or water storage tank on a firm, level foundation that will not settle differentially. Examples of suitable foundation materials are bedrock, concrete, compacted gravel and stable, well-compacted soils. Where necessary, prepare the foundation by removal and disposal of materials that are not adequate to support the design loads.

Anchor or brace the watering facility to prevent overturning by wind and animals, if needed.

Tanks
Analyze the foundation conditions and provide a design that will ensure the stability of the storage tank. For a vertical storage tank with a tank height greater than the tank diameter, also analyze the potential for overturning and identify the anchoring requirements.

Use NRCS design procedures or manufacturer's guidelines to ensure that buried tanks will withstand all earth and vehicle loads anticipated for the site.

Stabilization
For a fixed trough, protect the area around the watering facility where animal concentrations or overflow from the watering facility will cause resource concerns. Use *Heavy Use Area Protection (PA561)* to design the protection.

For a portable facility, move the trough frequently to prevent damage from animal concentrations.

Appurtenances
Use the criteria in *Livestock Pipeline (PA516)* to select the components needed to attach the water supply to the trough. Include backflow prevention devices on facilities connected to wells or to domestic or municipal water systems.

Provide a stable outlet for the overflow pipe when an overflow pipe is included in the design. Protect the outlet from damage.

Direct overflow from the trough to another beneficial use or to the original watercourse, where possible.

Where water is supplied under pressure to the watering facility, use an automatic water level control or float valve to control the flow of water to the facility in order to reduce energy use and prevent overflows.

As needed, install a float valve on a gravity-fed trough to avoid draining the water source.

Protect valves and controls from damage by livestock, wildlife, freezing, and ice.

Escape Features
Install escape features where local knowledge and experience indicate that wildlife may be at risk of drowning.

An effective escape device must:

- Meet the inside wall of the tank or trough
- Reach to the bottom of the trough or tank
- Be firmly secured to the trough rim
- Be built of durable material with a rough surface animals can grip
- Have a slope no steeper than 45 degrees
- Be located to cause minimal interference with livestock

Provide one escape device for every 30 linear feet of rim.

Refer to *Water for Wildlife – A Handbook forRanchers and Range Managers*, Bat Conservation International, for additional information on escape features.

Watering Ramps
Where livestock or wildlife will drink directly from a pond or stream, use a watering ramp to provide a stabilized access to the water. Evaluate the existing and proposed fences, grazing patterns, shoreline slope, and water depth when choosing the optimum location for the ramp.

Width
Make the ramp wide enough to accommodate the expected usage.

Length
Extend the ramp into the stream or pond far enough to achieve the desired depth.

Surface drainage
Divert surface runoff from the approach to the ramp.

Slope
Make the slope of the watering ramp consistent with planned animal usage but not steeper than 3 horizontal to 1 vertical (3:1).

Side slopes
Make all side slope cuts and fills stable for the soil materials on the site. Make the side slopes of cuts or fills in soil materials no steeper than 2 horizontal to 1 vertical (2:1). Make rock cuts or fills no steeper than 1.5 horizontal to 1 vertical (1.5:1).

Foundation
Where necessary, prepare the foundation by removal and disposal of material that are not adequate to support the design loads.

Surface Material

Use the criteria in *Heavy Use Area Protection (PA561)* to design the ramp surface. The selected material must be of adequate quality to withstand underwater conditions.

Access

Use fencing or other barriers to delineate the boundaries of the ramp. Use *Fence (PA382)* for the design and construction of a fence. Barriers must be of sufficient size, strength, and quality to meet the intended use of the facility.

Ramps in Ponds

Use the criteria in *Stream Crossing (PA578)* for the design and construction of a ford crossing except as noted above.

Locate the watering ramp so that it does not impede the movement of aquatic organisms in the stream.

Ramps in Ponds

A minimum water depth of 3 feet, measured from the designed permanent water level, is recommended. Where the pond depth is greater than 3 feet at the ramp location, it may be necessary to excavate the ramp into the pond bank to provide a stable base at the lower end. Extend the ramp a minimum of 0.5 feet above the designed permanent water level.

CONSIDERATIONS

General

Not all species need or benefit from supplemental water. Consider impacts to both target and non-target wildlife species before installation of a watering facility. Observed or documented use of a facility by wildlife does not necessarily indicate net benefits. Introducing a new water source within an ecosystem can have effects such as the concentration of grazing, predation, entrapment, drowning, disease transmission, and expansion of the wildlife populations beyond the carrying capacity of the available habitat. Providing a water source for wildlife could enhance the habitat for species that compete with or prey on at-risk species.

Design fences associated with the watering facility to allow safe ingress and egress for area wildlife species. To protect species that access water by skimming across the surface, make fencing materials highly visible with appropriate openings. Add permanent streamers or coverings to wire fences that extend across a watering facility to make them more visible to skimmers.

Consider designing the facility to benefit wildlife. Such designs would include providing ground-level access to water for species that cannot use raised structures such as troughs. Ground-level access can be provided through creation of an overflow collection area or a secondary ground-level water source. Depending on the target species, planners may want to consider protecting these areas through the use of suitable fencing (marked as needed) that excludes livestock and larger wildlife species while allowing access of the site to small ground-dwelling species.

Consideration should also be given to prevention of disease transmission at watering facilities. Suitable controls/treatments for water-transmissible diseases and parasites should be considered if they are a problem locally.

When windmill, solar, or other potentially unreliable power source is used, supply additional daily water storage volume (3-5 days), provide a battery back-up system or provide an alternate water source. Use of a float valve on a system with one of these types of power supply may not be practical.

Consider the effects of water development on the balance or budget of water resources in the area of the new project. In some settings, this could be important and may result in effects to adjacent or associated habitats and species.

If there is the potential for small livestock, such as lambs or kids, to fall into the trough, provide a ledge or similar structure in the trough to provide an escape route or provide a second trough that has a shorter height.

Watering ramps
Where livestock exclusion from a stream is part of the planned installation, consider installing a watering ramp that can be used if emergency access to water is needed. Use a gate to restrict access to the ramp.

The slope of the ramp can influence animal behavior. Steeper slopes tend to discourage loitering in the ramp area.

Select a surface material for the ramp that will discourage loitering but still provide a stable footing. The larger stone will make the hoof contact slightly uncomfortable.

Avoid locating watering ramps in shady places where possible.

It is difficult to put a fence in the middle of a stream. Where possible, extend the fence completely across the stream. Swinging gates can be used to restrict animal movement.

PLANS AND SPECIFICATIONS

Provide plans and specifications that describe the requirements for applying this practice to achieve its intended purpose. As a minimum, include:

- A map or aerial photograph showing the location of the facility and any associated pipelines
- Type and number of animals expected to use the facility.
- Special conditions for access, as needed
- Foundation stability requirements.
- Site-specific detail drawings showing the facility and necessary appurtenances (foundations, pipes and valves, escape features, anchoring, etc.)
- Requirements for stabilization of any areas disturbed by the installation of the facility
- Fencing, as needed
- Materials and quantities
- Construction specification PA614 to describe the installation of the facility, along with other specifications, such as PA516 for pipelines, as needed.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan and review it with the operator. The plan, with a monitoring schedule, will describe the actions that must be taken to ensure that the facility functions properly for its design life. As a minimum, include the following items:

- Check for leaks, site erosion, and damage to fences, heavy use areas, and appurtenances associated with the watering facility. Repair or replace damaged components, as needed.
- Check the performance of the automatic water level device, if present.
- Ensure that the outlet pipe is freely operating and is not causing erosion.
- Regularly clean the facility. Algae and iron sludge accumulation should be addressed in areas with water quality that is known to cause problems. Chemicals such as copper sulfate and chlorine can be recommended as needed, as long as local rules and regulations are followed.
- Examples of commonly used materials include; copper tubing, barley straw, or gold fish.
- Maintain the facility to ensure that there is adequate inflow and outflow.
- Prepare the facility for winter as dictated by the climate. This may include draining supply pipes, emptying tanks, or ensuring that float valves will not be damaged by ice.

- For a portable facility, include the plan for moving the facility and for monitoring/repair of the areas around the facility.

REFERENCES

Brigham, William and Stevenson, Craig, 1997, Wildlife Water Catchment Construction in Nevada, Technical Note 397.

National Engineering Handbook, Part 650 Engineering Field Handbook, Chapters 5, 11 & 12, USDA Natural Resources Conservation Service.

National Range and Pasture Handbook, Chapter 6, Page 6-12, Table 6-7 & 6-8, USDA- Natural Resources Conservation Service.

National Research Council, 1996 Nutrient Requirements of Domestic Animals, National Academy Press.

Prescribed Grazing and Feeding Management for Lactating Dairy Cows", New York State Grazing lands and USDA NRCS, January 2000).

Taylor, Daniel A. R. and Merlin D. Tuttle. Water for Wildlife, A Handbook for Ranchers and Range Managers. Bat Conservation International. 2012.

Tsukamoto, George and Stiver, San Juan, 1990. Wildlife Water Development, Proceedings of the Wildlife Water Development Symposium, Las Vegas, NV, USDI Bureau of Land Management.

Yoakum, J. and W.P. Dasmann. 1971. Habitat manipulation practices. Ch. 14 in Wildlife Management Techniques, Third Edition. Ed. Robert H. Giles, Jr. Pub. The Wildlife Society. 633 pp.

Practice Specification
Watering Facility (Code 614)

1. SCOPE

The work shall consist of furnishing materials and installing all components of the watering facility, as outlined in this specification and the drawings.

2. MATERIALS

All materials used shall conform to the size, quality and grade noted on the plans, set forth in Section 6, or as otherwise noted below.

a. Concrete and masonry

Precast concrete and masonry structures are acceptable when their design and construction have been reviewed and approved.

Precast units shall comply with ACI-318, Chapter 16 and ACI-533.

Masonry components shall meet the requirements of ASTM-C90 & C270, and placed in accordance with ACI-530.

Concrete shall have a minimum compressive strength, at 28 days, of 3000 psi. If the supplier cannot show evidence that a mix will meet strength requirements, a mix with a maximum net water content of seven gallons per bag (94#) of cement and a minimum cement content of six bags per cubic yard of concrete, may be used. Course Aggregates shall be #57 or #67 for ready-mix and hand- mixed concrete. Hand-mixed concrete shall be mixed at a ratio of 1 part cement, 2 parts sand, and 3 parts coarse aggregate. Pre- bagged concrete mix will be mixed according to the manufacturer's recommendation.

Mixing water will be clean and free of substances that would affect the strength or durability of the concrete.

Concrete shall be mixed to a consistency that will allow proper consolidation; i.e. slump between 3" and 6"

b. Metal

Steel tanks shall have a minimum thickness of 20 gauge. The steel shall be galvanized for protection from deterioration.

c. Wood

Wood products used for anchoring or protection measures shall be graded and stamped by an agency accredited by the American Lumber Standards Committee as meeting the required species, grade, and moisture content. Pressure treated wood products shall be Douglas Fir, Southern Yellow Pine, or as otherwise specified in Section 6 or on the drawings. They shall be treated with preservatives in accordance with the American Wood Preservers Association (AWPA) Standard UI as it relates to farm applications. In the absence of a stamp of quality, the contractor or material supplier shall provide written certification that the wood meets the designated quality criteria.

d. Rubber

Rubber tires, used for troughs, shall be free of holes or deep abrasions. The tire sidewall shall be cut at an inward angle so to not expose any metal chords in the tire.

Tires that were filled with antifreeze or other toxic liquids cannot be used for watering facilities, unless they are thoroughly cleaned before use. As a minimum, this shall include scrubbing the inside of the tire with a detergent and rinsing with a high pressure washer. This process should be repeated at least four (4) times.

The tire shall be placed such that approximately 1/3 to 1/2 of the tire is below grade. As a minimum, 3" to 4" layer of compacted clay shall be placed as a foundation or seal before installing the tire. A 4" to 6" thick slab of concrete shall be placed to seal the hole in the bottom of the tire trough.

e. Plastic and fiberglass

Plastic and fiberglass structures shall be made of ultraviolet resistant materials or shall have a durable coating for protection from sunlight.

Cast-iron, plastic, or fiberglass bathtubs are not acceptable for use, as a trough or tank.

f. Aggregate and geotextile

Aggregates used for stabilization around the watering facilities shall meet the requirements of Penn DOT, Publication 408, Section 703, for coarse aggregate.

The size and gradation shall be as specified in Section 6 or on the drawings. The aggregate shall be hard, durable, and resistant to weathering.

Geotextile fabrics, used for in the construction of the stabilization around the watering facility, shall meet the requirements as outlined in PennDOT Publication 408, Section 735, Table A, Class 4 (non-woven).

g. Pipe

Unless otherwise shown on the plans or in Section 6, pipe, fittings, and components (e.g. valves), and their installation, shall comply with the requirements of construction specification PA516.

3. FOUNDATION PREPARATION

The foundation area, for the watering facility and related stabilization areas shall be cleared of organic matter and all other unsuitable material. When backfill is required to establish planned grade lines, within 2’ of a structure, the backfill shall be compacted by hand-operated compaction equipment.

The foundation area and the immediately surrounding area shall be smoothed and graded to permit free drainage of surface water.

All construction shall be performed in a workmanlike manner and the job site shall have a neat appearance when finished.

4. EROSION AND POLLUTION CONTROL

Construction operations will be carried out in such a manner so erosion and air and water pollution will be minimized. Where required, this shall be in accordance with the E&S Control Plan

5. SEEDING

All disturbed areas shall be protected from erosion as soon, after installation of the structure, as practical. Vegetation, if required, shall be established at the locations shown on the drawings and/or staked in the field, and as set forth herein, in Section 6, and/or as shown on the drawings.

6. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

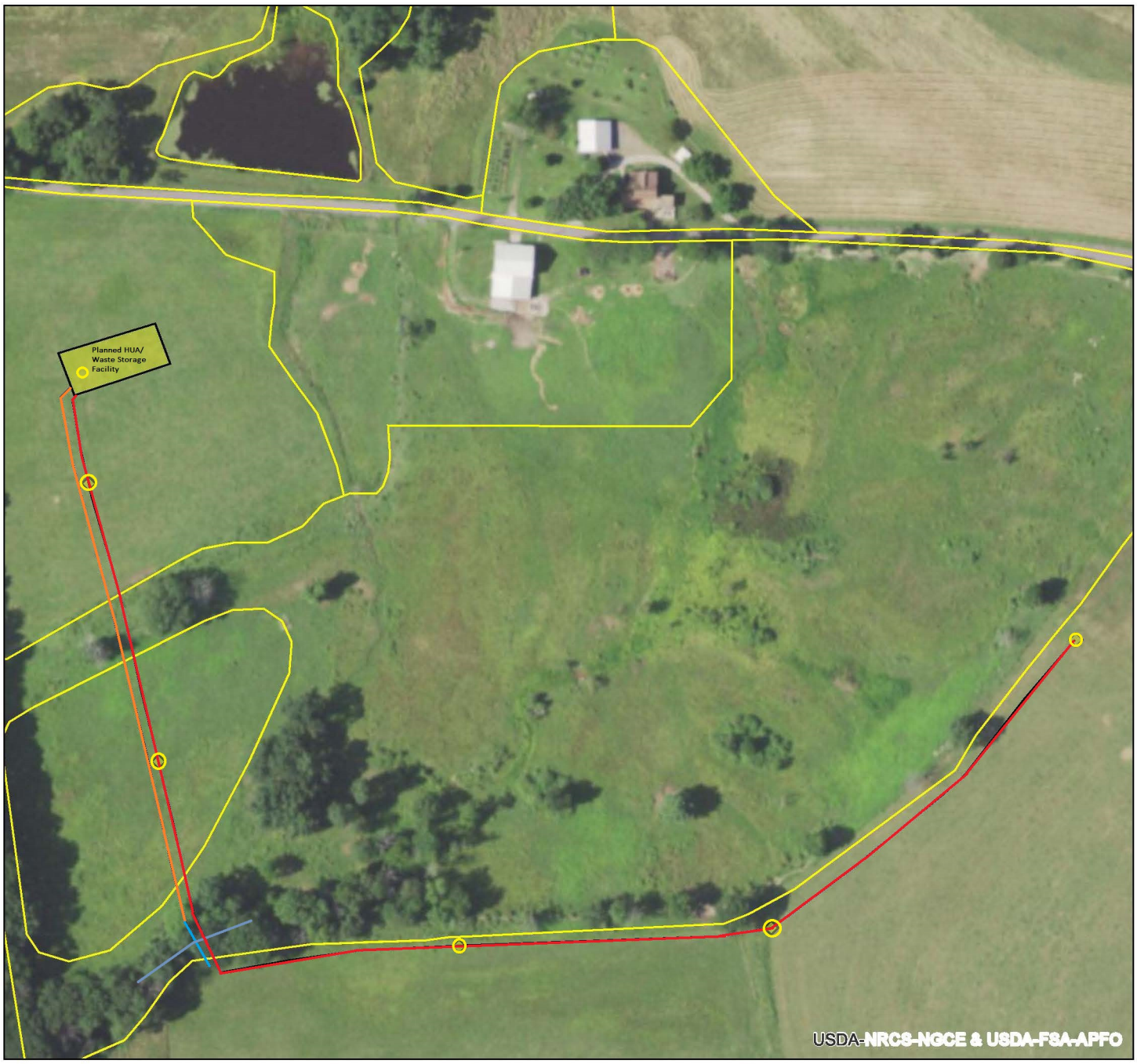
Specific Site Requirements

Date: 5/23/2022

Conservation Plan Map

Client(s): RAYMOND H BARCHIK
Luzerne County, Pennsylvania
Approximate Acres: 112.10

Assisted By: MICHAEL SCHLAUCH
Natural Resources Conservation Service
PLYMOUTH SERVICE CENTER



Prepared with assistance from USDA-Natural Resources Conservation Service

0 200
Feet

Practice Schedule
PLUs

Livestock Pipeline
Trail and Walkway
Stream Crossing
Stream

Watering Facilities

N

USDA

USDA is an equal opportunity provider, employer, and lender

Date: 5/31/2022

Conservation Plan Map

Client(s): RAYMOND H BARCHIK
Luzerne County, Pennsylvania
Approximate Acres: 112.10

Assisted By: MICHAEL SCHLAUCH
Natural Resources Conservation Service
PLYMOUTH SERVICE CENTER

Prepared with assistance from USDA-Natural Resources Conservation Service

0 300 Feet

HUA - proposed HUA location

--- - Livestock Pipeline (516) - 1 1/4" P.E. Pipe - Roughly 2200'

X - Watering Facility (614) - Frost free hydrants / Portable troughs.

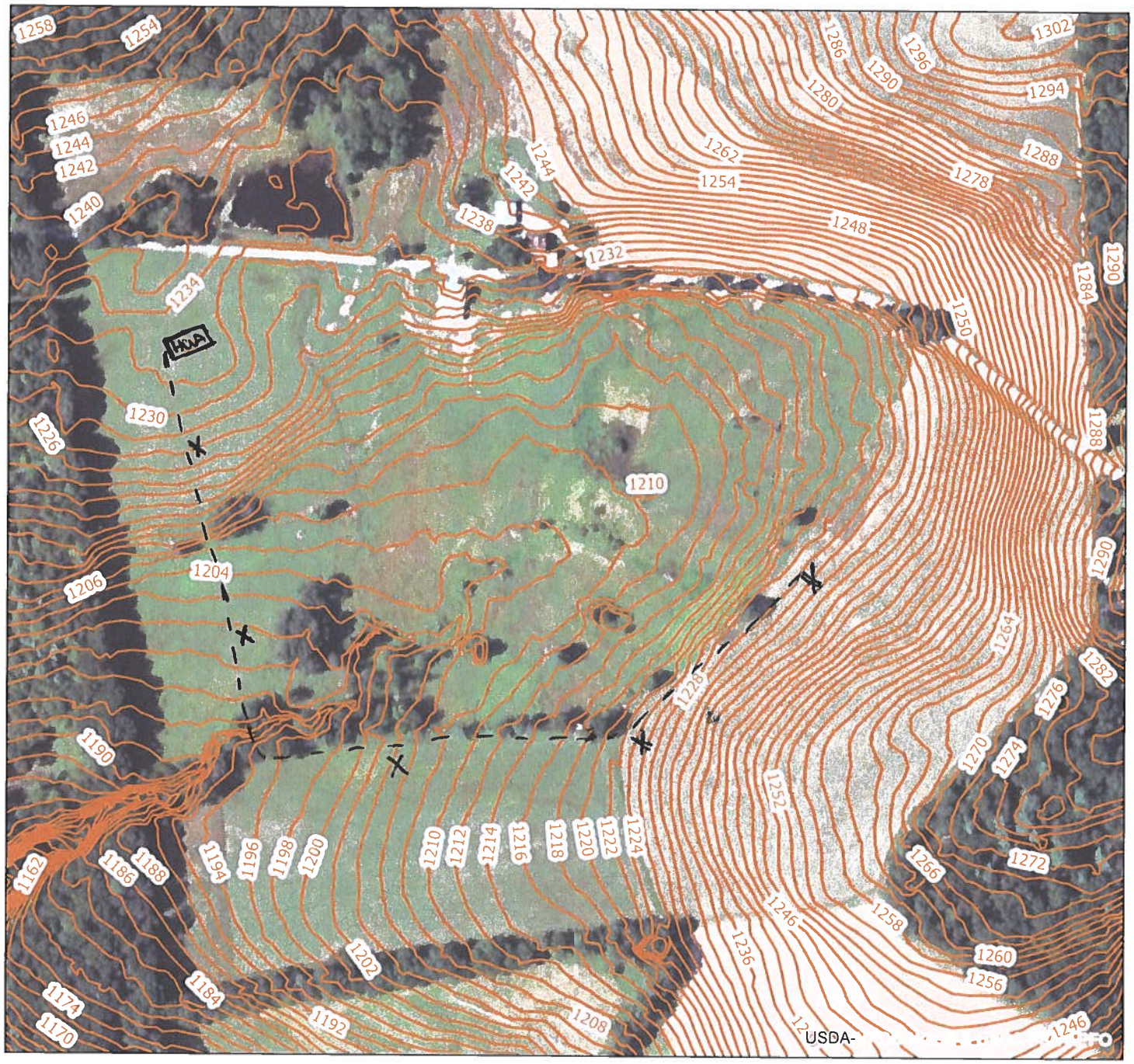
USDA

Date: 5/31/2022

Conservation Plan Map

Client(s): RAYMOND H BARCHIK
Luzerne County, Pennsylvania
Approximate Acres: 112.10

Assisted By: MICHAEL SCHLAUCH
Natural Resources Conservation Service
PLYMOUTH SERVICE CENTER



0 300 Feet

Prepared with assistance from USDA-Natural Resources Conservation Service

HUA - Proposed HUA location

--- - Livestock Pipeline (516)

X - Watering Facility (614)

USDA

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AW

Livestock Watering Systems-Pressure System Calculation Worksheet

Cooperator: Raymond Barchik | Service Center: Plymouth | Date: 5/31/2022

Conservation District: Luzerne CD | Assisted By: Mike S

Tract Number: 365 | Field Number(s): 2, 3 and 4

1. Determine the number of animals using the system:

# of animals to use system: 53 | Animal Type: Beef Cattle | Consumption per animal per day: 15 gallons

# of animals to use system: | Animal Type: | Consumption per animal per day: 15 gallons

2. Determine the water demand the animals will have per typical day:

# of animals to use system:	53	X	15 gallons/day/animal	=	795	gallons/day
# of animals to use system:	0	X	15 gallons/day/animal	=	0	gallons/day
			Total Demand	=	795	**gallons/day**

3. Determine Target Supply Rate (TSR): This is based on the number of planned drinking events per day, assuming each event is two hours long.

Enter the number of drinking events per day you are planning for (typically 2 or 3): 3

Total Demand of 795 gallons per day divided by 360 minutes = 2.21 gallons per minute **(TSR)**

4. Source flow rate in gallons per minute: 5 gpm. Value may be from a spring, well, or known pump flow rate for a planned or existing pump.

Select whether the Target Supply Rate or the supply rate from the source will be used in the following friction loss calculations: *See note at bottom of next page.

Rate from Source

5. Measure distance to farthest watering point: 2200 feet

6. Determine vertical elevation difference from the pressure tank to the highest watering point: 44 feet

Select type of pipe to be used: Plastic | **Select Diameter of pipe to be used:** 1-1/4"

7. Friction loss in the pipeline:

a: Measured length of pipeline from Step 5 = 2200 feet

b: Add additional pipe lengths due to fittings. Multiply number of fittings by their Equivalent Lengths (E.L.) and total:

				# :	X E.L.	Length added (ft):
# of fittings:	4	Fitting type:	Insert Coupling	4	3	12
# of fittings:	5	Fitting type:	Threaded adapter - Plastic or Copper to thread	5	3	15
# of fittings:	5	Fitting type:	Standard tee straight flow thru run	5	5	25
# of fittings:	4	Fitting type:	90 degree standard elbow	4	7	28
# of fittings:	1	Fitting type:	Gate or ball valve	1	10	10
# of fittings:	1	Fitting type:	Swing check valve	1	18	18
# of fittings:		Fitting type:				0
# of fittings:		Fitting type:				0
# of fittings:		Fitting type:				0
# of fittings:		Fitting type:				0

Total length added by fittings: 108

c: Add length due to fittings: 108 feet to measured length of 2200 feet (from Step 5) to determine total overall length in feet = 2308

d: Using selected pipe diameter, selected flow rate (steps 3 & 4), and friction loss equations we determine friction loss per 100 feet is: 0.5 feet

Total calculated length = 2308 so the calculated friction loss will be = 2308 /100 feet X 0.5 = 10.6 feet

The total friction loss for the scenario detailed above is: 10.6 feet. This is equivalent to a loss of: 4.6 psi

THE SELECTED FLOW RATE FLOWING THROUGH THE CHOSEN PIPE DIAMETER RESULTS IN MINIMAL FRICTION LOSS (<10psi)

Livestock Watering Systems-Pressure System Worksheet Continued

8. Expected or needed pressure at most remote watering point (may vary depending on type of float). *AW*

Use manufacturer's recommended minimum pressure or 10 psi, whichever is greater. Use Pressure at Outlet = 5 psi

9. Operating pressure at the pressure tank

Pressure losses due to elevation differences equals the elevation difference determined in Step 6: 44 divided by 2.31= 19.0 psi

Friction Loss determined in Step 7: 4.6 psi

Pressure needed at Outlet: 5.0 psi

Total = 28.6 psi

Round to the nearest multiple of 10= 30 psi. This is the lower setting of the pressure switch. A minimum setting of 20 psi will be used.

Add 20 to the lower setting = 50 psi. This is the higher setting.

A maximum of 80 psi will be used only when the pressure tank is rated for such a pressure.

Use a pressure switch setting of: 30 / 50 psi. Make sure a minimum setting of 20/40 psi has been calculated.

10. Convert needed data to dynamic head added to the pump by livestock watering system:

Multiply higher switch setting: 50 X 2.31= **115.5** feet. This is the dynamic head added to the pump by the watering system.

Dynamic Head added to pump by watering system: 115.5 feet. This is not Total Dynamic Head but rather the amount of head added to that total by the planned livestock watering system.

11. Compile the system requirements into a list that the pump supplier can use to size the pump.

Pump to provide a minimum of: 5.0 gallons per minute. (This value is dependent on whether you selected the Target Supply Rate or the source rate as the basis for the design calculations.)

The system is **adding** 115.5 feet to the pump's dynamic head. Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the water source to the pressure tank. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

The pressure switch setting is: 30 / 50 psi.

Pressure tank will have minimum effective drawdown of: 5.0 (supply rate) X 1 (minimum) = 5.0 gallons.

The effective drawdown is sized so that the pump will come on and operate for a minimum of one minute before shutting off. One minute operating time reduces wear on the pump caused by excessive starting and stopping. The pressure tank may be sized to have an effective drawdown of two, three, or more times greater than the pumping rate. But a minimum effective drawdown of one times the pumping rate should be provided.

* The user should choose a value based on whether you are designing a system to match the Target Supply Rate or whether you are using a known value for the pumping rate in gallons per minute. If you select TSR from the dropdown menu, then the design will be based on pumping that amount. Otherwise, if you want to pump 8 gallons a minute, for example, then you should enter 8 gpm in step 4 and select 'Rate from Source' from the dropdown menu. The remaining calculations will be based on this value.

The Target Supply Rate is a design number based on trying to deliver water to the livestock over a selected number of 2-hour drinking events. When designing a watering system with no existing components it can be used as the basis for the sizing of the pump. Where a source already exists (a well with a given yield, a spring to be collected in the reservoir, etc.) you should attempt to match the pump rate to the source yield. Where the pumping rate is planned to be higher than the source yield, the designer will need to ensure there is adequate storage (water column in a well, storage in a reservoir, etc.) so the pump does not draw the water level below the pump intake.

You can also overcome low source yield or pumping rates by providing storage in reservoirs that will supply the troughs by gravity or by providing additional storage at the watering location through the use of larger concrete troughs.

The pumping system for this project will need to supply 2.21 gpm @ 115.5 Total Dynamic Feet of head.

Planned Water System Components :		
Planned Pump	Goulds	Pending*
Planned Troughs or Equivalent	Portable Trough	Plastic or Fiberglass Ultraviolet Resistant
	Frost Free Hydrant	3' buried 3 foot above ground
Planned Float Valves in Non-frost-free troughs or equivalent (if any)	Jobe or equiv.	Mega-Flow, 5 to 150 psi rating
Planned Pipeline	1 1/4" P.E. 160 psi or >	ASTM # 2239

Installation:

The contractor or landowner shall notify an NRCS representative working on this project at least 24 hours prior to the start of construction. Failure to do so may result in NRCS being unable to check construction and certify that the installation meets NRCS standards, which is necessary to receive cost-share payment.

The scope of this project includes the necessary materials and complete installation of the watering system. All work shall be done as shown in the drawings and according to the following Pennsylvania Technical Guide Specifications (PATG) included in this design.

Tech Guide Standards and Specs Utilized in this design:

516 Pipeline
614 Water Facility
533 Pumping Plant for Water Control (***Pending until water well depth is determined. Once constructed will be able to determine pump characteristics. ***)

4. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT FOR 516 PIPELINE:

A. The scope of this project includes the complete installation of the pipelines identified on the plan view map. The purpose of the pipeline is to supply drinking water to troughs for cattle in the grazing system as part of the implementation of a prescribed grazing plan.

B. The landowner shall notify an NRCS representative working on this project at least 24 hours prior to the start of construction. Failure to do so may result in NRCS being unable to check construction and certify that the installation meets NRCS standards, which is necessary to receive cost-share payment.

C. All pipeline installed shall be Polyethylene that is a minimum of 160 psi and 1 1/4 inch in diameter. *(See attached 516 Practice Standard for acceptable ASTM numbers) Note ASTM numbers as well as the pressure rating will be located on the pipeline itself usually in white or blue lettering.*

D. All fittings and pipeline components shall be of equal or greater quality than the pipeline. Preferably brass fittings. ***(See attached 516 Practice Standard for acceptable ASTM numbers) Note ASTM numbers as well as the pressure rating will be located on the pipeline itself usually in white or blue lettering.***

E. If the pipeline is buried it should be buried to a depth of at least 1' for protection, if ***for a frost-free system at least 3' deep***. The pipeline can be blinded with soil material as long as someone is removing the large rocks during back fill so as not to damage the pipeline. Alternatives to this would be to use 4 to 6" of sand or 2-B stone or to use a conduit of some kind. Bedding

F. Producer must ensure that ***a back-flow prevention valve (Watts 9D)*** *is installed at the pressure tank in the house. This is required by many dairy cooperatives and dairy inspectors. Check with your local inspector for actual requirements*

G. ***Shutoff valves or connectors shall be installed so that the pipeline may be drained or shutoff in case of repair.*** Valves shall be installed to allow pipeline system to be drained for the winter when not in use as well as for repair needs in the future. (see layout map)

H. ***Frost*-free hydrants** shall be installed as shown on the map.

I. Any areas where soil was disturbed shall be limed, fertilized, reseeded, and mulched immediately following completion of the pipeline installation***. In the absence of a soil test loosen the soil surface and apply Agricultural lime (100% CCE basis) at a rate of 8000 lbs/acre (200 lbs /1000 sq. ft.), 100 lbs/acre each of P & K (2.5 lbs./ 1000 sq. ft.). When the grass is up and growing apply 40 lbs./acre of actual N. Use as seeding mix of 25 lbs./acre Perennial Ryegrass and 15 lbs./acre Kentucky Bluegrass. Mulch the seeding with hay or straw to lessen the impacts of erosion. Or if in a pasture, use a commercial pasture seeding mixture seeded at the recommended seeding rate/acre for that mix.***

4. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT FOR 614 WATER FACILITIES:

A. The scope of this project involves installing eight frost-free hydrants and portable type water troughs. The purpose is to supply drinking water to cattle in the grazing system. Troughs shall be installed as shown in the drawings/plan view and according to the 614 water facility standard and spec. as well as to the manufacture's recommendations.

B. The landowner shall notify an NRCS representative working on this project at least 24 hours prior to the start of construction. Failure to do so may result in NRCS being unable to check construction and certify that the installation meets NRCS standards, which is necessary to receive cost-share payment.

C. All eight frost-free hydrants will be buried at a depth of 3' and be 3' above ground. Place gravel at the base of the hydrant to allow water to drain out when shut off.

D. Trough Valve Specifications (min. pressure ratings) : #1 – 63 psi, #2 – 63 psi, #3 –52 psi, #4 – 56 psi.

E. All portable troughs will be used seasonally, ***100 gallon or greater Rubbermaid type troughs or equivalent would be acceptable***. Valves and connections shall have ***a minimum pressure rating of* 125 *psi***. (Jobe Megaflow float valve or equivalent). All seasonal troughs will be connected to a frost-free hydrant or quick connector along the main pipeline via a 5/8" industrial garden hose.

F. Portable troughs shall be moved if a muddy denuded area begins to form around the trough. This area should be re-seeded, and the trough placed in a different location next time cattle are in that paddock.

4. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT FOR 533 Pumping Plant for Water Control: (Existing System Evaluation)

A. The scope of this project includes the installation and maintenance of a submersible well pump and pressure tank system. The purpose is to supply drinking water to the cattle when they are grazing in the pastures to improve grazing efficiency and manure distribution. This system shall be installed and maintained as shown in the drawings and according to manufactures and installation contractor's recommendations.

B. The pump shall supply a minimum of ***supply 2.21 gpm @ 115.5 Total Dynamic Feet of head. *Planned pumping system will need to be evaluated and determined once depth of well is determined****

C. The pressure switch settings should be set at ***30 and 50 psi*** to meet the needs of this water system.

D. The pressure tanks should have a minimum effective drawdown of at least ***5 gallons at a pressure switch setting of 30/50 psi.***

E. The pump should be equipped with a low water level disconnect so that the pump does not continue to run if the well were to run dry.

F. In addition to the typical installation, it shall also include an anti-siphon valve, pressure relief valve. ***Watts 9D backflow prevention valve.***

QUALITY ASSURANCE PLAN:

A representative from the Bloomsburg NRCS Field Office will be performing all installation inspection for this livestock watering system. Any questions or concerns about the design or installation should address with this person when they are assigned.

Items of concern to be checked by the Field Office Representative:

A. Inspect pipeline for leaks before the trench is covered over.

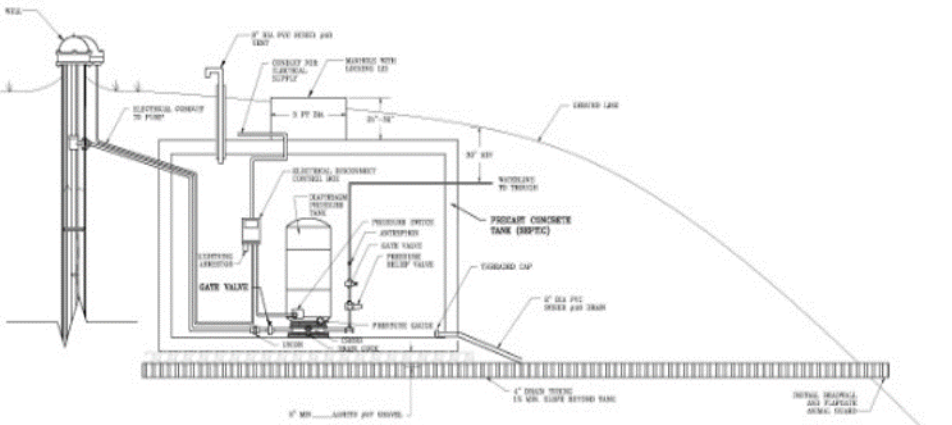
B. Inspect all materials used on the projects to make certain they meet the design criteria as well as the applicable standards and specifications.

C. Communicate with the designer/engineers about any design modifications or problems that may arise during the installation process.

D. Document necessary As-Built information on the project. (Take photos if applicable) ****See Attached Design and Check Data Requirements for Trough/Tank and Pipeline***

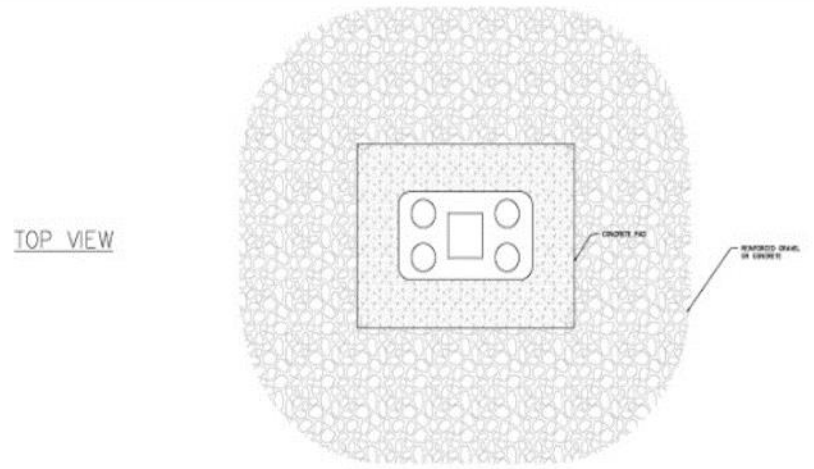
Inspector: _____ Date:_____

District Conservationist: _____ Date:_____



USDA NRCS

BURIED PRESSURE TANK AND PUMP CONTROLS



USDA NRCS

Trough Detail

Examples of Troughs and Valves:

Jobe Mega FlowFull-Flow Trough Valve

Richie Frost-Free Troughs

MiraFount Frost Free Trough

Jug Frost-Free Trough

Frost Free Hydrant
3' burial depth (3' above ground)

Watts 9D backflow valve

100 Gallon Rubbermaid Tank

*Note there are many brands and types of frost-free waterers on the market none of these are recommend, you can use any brand that you would like.

Cost Estimate:

Item:	Units:	Estimated Unit Cost:	Estimated Total Cost
516 Livestock Pipeline	2,200 (Linear Foot)	$2.09/ft	$4,598.00
614 Watering Facility	6 (Each)	$201.77/ea.	$1,210.62
642 Water Well	200’ (Linear Foot)	$17.11/lf	$3,422.00
533 Pumping Plant	1 (Each)	$5,185.93/ea.	$5,185.93
			$14,416.55 (Cost Share)

Item:	Units:	Estimated Unit Cost	Estimated Total Cost
Well and Pump	1	1 well (ea.) 1 pump (ea.)	$8,660.00
1 1/4” P.E Pipe (open trench)	2,200	$1.15.00 (linear foot)	$2,530.00
Excavated Trench (2’ - 4’)	2,200	$1.25.00 (linear foot)	$2,750.00
Frost Free Hydrants	6	$60.00 (each)	$360.00
Portable Rubbermaid Troughs	6	$100.00 (each)	$600.00
Stone	20	$20.00 (ton)	$400.00
Seeding	1	$250.00 (acre)	$250.00
			$15,550.00 (Total)

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

PUMPING PLANT

CODE 533

(no)

DEFINITION

A facility that delivers water at a designed pressure and flow rate. Includes the required pump(s), associated power unit(s), plumbing, appurtenances, and may include on-site fuel or energy source(s), and protective structures.

PURPOSE

This practice may be applied as a part of a resource management system to achieve one or more of the following:

- Delivery of water for irrigation, watering facilities, wetlands, or fire protection
- Removal of excessive subsurface or surface water
- Provide efficient use of water on irrigated land
- Transfer of animal waste as part of a manure transfer system
- Improvement of energy use efficiency
- Improvement of air quality

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where conservation objectives require the addition of energy to pressurize and transfer water to maintain critical water levels in soils, wetlands, or reservoirs; transfer wastewater; or remove surface runoff or groundwater.

CRITERIA

General Criteria Applicable to All Purposes

Design, installation, and operation of a pumping plant shall comply with all federal, state, and local laws, rules and regulations.

The efficiency of units, type of power, quality of building, automation features, and other accessories installed shall be in keeping with the economic and environmental value of the system to accomplish the conservation objectives.

Criteria for the design of components not addressed in this practice standard shall be consistent with sound engineering principles.

Pump requirements

Design flow rate, range of operating heads, and pump type shall meet the requirements of the application. Size and number of pumps and their performance shall be determined on the basis of system conservation requirements in order to meet the intended purpose. The pump capacity shall be adequate to efficiently supply or remove the required volume of water when pumping against the maximum required

total dynamic head. Total dynamic head shall be determined for critical operating conditions, taking into account all hydraulic losses. Automatic controls shall be included as required.

Pumps utilized for the transfer of wastewater or manure shall be sized to transfer material at the required system head and flow rate determined by the waste management plan.

Selection of pump materials shall be based on the physical and chemical qualities of the material being pumped and manufacturer's recommendations.

Power units
Power units shall be selected on the basis of availability and cost of fuel or power, operating conditions, conservation needs, and objectives, including the need for automation. The power unit shall be matched to the pump and be capable of operating the pump efficiently and effectively within the range of operating conditions.

Electric power units may include line power, photovoltaic panels, and wind or water powered turbines. Electrical wiring shall meet the requirements of the National Electrical Code.

Variable Frequency Drives
The owner shall inform the electric power provider that a Variable Frequency Drive will be installed prior to installation, and be responsible for following requirements of the electric power provider.

The Variable Frequency Drive shall be protected against overheating.

The Variable Frequency Drive control panel shall provide the read out display of flow rate or pressure.

Photovoltaic panels
The photovoltaic array shall be sized based on average data for the location and the time of year pumping occurs, according to manufacturer's recommendations. The photovoltaic array shall provide the power necessary to operate the pump at the design flow rate, with the appropriate service factor considering a minimum panel degradation of 10 years. Fixed arrays shall be oriented to receive maximum sunlight. Panel tilt angle shall be based on the location latitude and time of year for power requirements. Panels shall be mounted securely to resist movement by environmental factors.

Windmills
Pumping units shall be sized according to pumping lifts and capacities, as specified by the manufacturer. The diameter of the mill shall be based on the stroke length and the average wind speed. Towers shall be proportioned to the mill diameter, with adequate height for efficient and safe operation.

Water powered pumps (hydraulic rams)
Pumping units shall be sized according to flow rate, lift, fall, and efficiency. Bypass water shall be returned to the stream or storage facility, without erosion or impairment to water quality.

Suction and discharge pipes
The size of suction and discharge pipes shall be based on a hydraulic analysis, operating cost, compatibility with other system components, and the quantity of water required to be conveyed. To prevent cavitation, suction and discharge pipes shall be designed to account for suction lift, net positive suction head, pipe diameter and length, minor losses, temperature, and altitude.

Pipe shall be chosen so that the pressure of the designed system will not exceed seventy-two percent (72%) of the pipes pressure rating. Flow velocity shall not exceed five feet per second (5 fps).

The arrangement and length of discharge pipe shall be based on the need for recovery of head through siphoning action, and for delivery of water in keeping with conservation and environmental objectives. Gates, valves, pipe connections, discharge bays, and other protective devices shall be installed, as needed, and according to manufacturer's recommendations.

Appurtenances such as gate valves, check valves, pressure reducing valves, pressure gages, pipe connections, and other protective devices, shall be included to meet the requirements of the application.

Screens, filters, trash racks, or other devices shall be installed as needed to prevent the intake of sand, gravel, debris, or other objectionable material into the pump. Intake screens shall be designed according to applicable Federal and State guidelines, to avoid entrainment or trapping of aquatic organisms.

Federal, State, and local laws and regulations concerning back flow prevention shall be followed to prevent contamination of water sources connected to the pumping plant.

Building and accessories
Pumps shall be securely mounted on a solid foundation such as pilings or concrete, in a well or pit. Foundations shall be designed to safely support the loads imposed. Sheet piling or other measures shall be used, as required, to prevent piping beneath the foundation.

The design of the pumping plant and associated housing, if required, shall consider adequate ventilation, accessibility for equipment maintenance and repairs (including possible removal), and the need for protecting equipment from the elements, vandalism, and fire. The appearance of the plant shall be compatible with the surrounding environment, as applicable.

Suction bays (or sumps) shall be designed to conform to the hydraulic characteristics established by the pump manufacturer.

The discharge bay or connection with the distribution system shall meet hydraulic and structural requirements. Provisions for repair or removal of pumps and engines shall be provided. Trash racks shall be provided, as needed, to exclude debris and trash from the pump.

All structural features and equipment shall provide adequate safety features to protect workers and the public from injury. In particular, drive shafts covers are required on all exposed rotating shafts.

Additional Criteria Applicable to Providing the Efficient Use of Water on Irrigated Land

Provisions for the connection of flow and pressure measurement devices shall be included in power plant system design.

Additional Criteria Applicable to the Improvement of Energy Use Efficiency

For fossil fuel or electrical grid power sources, pumping plant installations shall meet or exceed the Nebraska Pumping Plant Performance Criteria. Refer to the NRCS National Engineering Handbook, Part 652, National Irrigation Guide, Table 12-2.

Additional Criteria Applicable to the Improvement of Air Quality

Replacement pumping plants shall have lower total emissions of oxides of nitrogen and fine particulate matter, compared to the unit being replaced.

New, replacement, or retrofitted pumping equipment shall utilize a non-combustion power source, or cleaner-burning technologies or fuels.

CONSIDERATIONS

When planning this practice, the following should be considered as applicable:

- The removal of surface water by a pumping plant can affect downstream flows or aquifer recharge volumes. Consider potential the long term impacts downstream of the pumping plant.
- If using a pumping plant to remove surface water or ground water flowing into a wetland, consider the potential impacts on existing wetland hydrology.
- The operation and maintenance of a pumping plant can involve the use of fuels and lubricants that when spilled may adversely affect surface or ground water quality. Consider measures to protect

the environment from potential spills. In some cases, secondary containment of spilled fuel may be required by Federal and State laws or regulations.

- Pumping plants are often constructed in flood-prone areas or can be subject to other unexpected natural events.
  Consider how the pumping plant may be protected from extreme natural events and the consequences of damage or failure.

- Include protective sensors to detect low or stopped flow, or pressures that are too high or too low.
- The visual appearance of buildings or structures associated with the pumping plant should be compatible with the surrounding environment.
- When installing new or replacing existing combustion equipment, non-combustion and renewable energy sources, such as solar, wind, and water, should be considered.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing pumping plants shall be in keeping with this standard and shall describe the requirements for properly installing the practice to achieve its intended purpose. As a minimum, the plans and specifications shall include the following:

- A plan view showing the location of the pumping plant in relationship to other structures or natural features.
- Detail drawings of the pumping plant and appurtenances, such as piping, inlet and outlet connections, mounting, foundations, and other structural components.
- Written specifications that describe the site specific details of installation.

OPERATION AND MAINTENANCE

An Operation and Maintenance plan specific to the pumping plant being installed shall be prepared for use by the owner and responsible operator. The plan shall provide specific instructions for operating and maintaining facilities to ensure the pumping plant functions properly as designed. As a minimum, the plan shall address the following:

- Inspection or testing of all pumping plant components and appurtenances.
- Proper start-up and shut-down procedures for the operation of the pumping plant.
- Routine maintenance of all mechanical components (power unit, pump, drive train, etc.) in accordance with the manufacturer’s recommendations.
- Procedures to protect the system from damage due to freezing temperatures.
- When applicable, procedures to frequently check the power unit, fuel storage facilities, and fuel lines, for leaks and repair as needed.
- Periodic checks and removal of debris as necessary from trash racks and structures, to assure adequate flow capacity reaching the pumping plant intake.
- Periodic removal of sediment in suction bays, to maintain design capacity and efficiency.
- Inspection and maintenance of anti-siphon devices, if applicable.
- Routine test and inspection of all automated components of the pumping plant, to assure the proper functioning as designed.
- Inspection and maintenance of secondary containment facilities, if applicable.
- Periodic inspection of all safety features, to ensure proper placement and function.
- Prior to retrofitting any electrically powered equipment, electrical service must be disconnected and the absence of stray electrical current verified.

REFERENCES

NRCS National Engineering Handbook, Part 652, National Irrigation Guide.

NRCS, PA
June 2011

Practice Specification
Pumping Plant (Code 533)

1. SCOPE

The work shall consist of furnishing materials and installing all components of the pumping facility, as outlined in this specification and the drawings.

2. MATERIALS

All materials used shall conform to the size, type, etc. noted on the plans, set forth in Section 6, or as otherwise listed below:

1. PUMP:

   The pump shall meet the required capacity, pressure, and head requirements, as specified in Section 6 or on the drawings. Pumps shall be compatible and resistant to the type of water or manure being conveyed.

   The contractor shall be responsible for assessing the consistency, nature, quality and quantity of the substance to be pumped, and provide the appropriate equipment.The contractor shall provide in writing, or by performance tables provided by the manufacturer, the pumps performance characteristics (discharge, head, and pressure) and the relationship to or requirements of the following;

   a. Operating power requirements
   b. Estimated service life
   c. Maintenance requirements
   d. Efficiency

2. PIPE:

   Suction and Discharge pipe shall be chosen so that the type and class of pipe exceeds the systems pressure requirement. The operating pressure shall be specified in Section 6 or on the drawings, or as determined by the pump manufacturer. If the pipe is an integral part of another related planned practice or distribution system, the pipe type and class shall meet or exceed the requirements of the pipe installed in that planned system.

   Fittings shall be rated equal to the pipe being specified.

   The pipe and fittings, where applicable, shall be marked by the manufacturer as described in the applicable ASTM specification.

   Used pipe or seconds shall not be used. Pipe shall be approved by the engineer prior to installation.

3. CONTROLS:

   All check valves and directional control valves, gauges, quick disconnects, and automatic controls shall be durable and constructed with a rust resistant, non-corrosive, material able to withstand the type of water, or manure being pumped.

4. SUCTION AND DISCHARGE BAYS:

   Suction and discharge bays shall be designed to conform to the hydraulic characteristics of the pump. They shall be to the dimension and capacity as specified in Section 6 or on the drawings.

   Precast concrete units shall be in conformance with PennDot specifications for such units and/or comply with ACI-525 and 533. All concrete units shall have a 28-day compressive strength of 4000 psi., or greater, and all reinforcement bars shall be of grade 60 steel or higher, unless otherwise specified in Section 6 or on the drawings.

   Portland cement shall be Type I, IA, II, or IIA and conform to ASTM-C150, unless otherwise set forth in Section 6. If Type I or II is used, an air-entrainment agent shall be used.

Concrete Aggregate shall meet the requirements and gradation specified in ASTM-C33. Coarse aggregate shall meet the gradation for size numbers 57 or 67.

Reinforcement bars shall conform to ASTM-A615, A616, or A617. Welded wire fabric reinforcement shall conform to ASTM-A185 or A497. Reinforcement shall be free from loose rust, oil, grease, curing compound, paint or other deleterious coatings.

All rock structures shall be of rock that is durable and resistant to weathering. The rock shall be of the type specified in Section 6 and shall be obtained from a source listed in the most current edition of PennDot Bulletin #14. The gradation of the rock shall comply with the requirements set forth by the National Crushed Stone Association.

5. HOUSING AND ACCESSORIES:

Trash racks, housings, and other devices shall be installed as shown on the drawings provided to and concurred in by NRCS. All materials furnished and installed shall conform to the quality and grade noted on the drawings. A site specific set of construction drawings shall be at the site during construction.

Wood shall be graded and stamped by an agency accredited by the American Lumber Standards Committee as meeting the required species, grade, and moisture content. All exposed or buried lumber shall be pressure treated. Pressure treated wood products shall be Douglas Fir, Southern Yellow Pine, or as otherwise specified in Section 6 or on the drawings. They shall be treated with preservatives in accordance with the American Wood Preservers Association (AWPA) Standard C16 for “wood used on Farms, Pressure Treatment”. Non-CCA preservative pressure treated lumber shall be used where aquatic life is a concern.

Roofing material shall be corrugated 29 gage galvanized steel. Equivalent or better material may be approved by the Engineer.

Sheet piling shall be of steel or vinyl type. The piling must be of the thickness and grade specified in Section 6, and as recommended by the manufacturer for the intended use. Suitable methods of installing and anchoring the piling shall be as listed in Section 6, and as recommended by the manufacturer.

3. SITE PREPARATION

All trees, brush, fences, and other debris shall be cleared so as not to interfere with construction or proper functioning of the Pumping Plant system. All material removed by the clearing and grubbing operation shall be disposed of as directed by the Owner or his/her Representative.

4. SAFETY

All positive responses from the Pennsylvania One Call System should be shown on the drawings and the Pennsylvania One Call serial number and date noted on the plans. It is the Contractor’s or Landowner’s responsibility to contact the affected utility for marking at the time of construction.

The Contractor must comply with OSHA requirements Part 1926, subpart P, for protection of workers entering trenches.

5. INSTALLATION

Pipelines shall be placed so that they are protected against hazards imposed by traffic, farm operation, freezing temperatures, or soil cracking. Other means of protection must be provided if the depth required for protection is impractical because of shallow soils over rock or for other reasons.

Trenches for pipeline shall be free of rocks and other sharp-edged materials. The pipe shall be carefully placed to prevent damage.

Before backfilling, the pipeline shall be pressure tested. To pressure test the pipe, fill the pipe with water and test at the design working head and pressure. All leaks must be repaired, and the test must be repeated before backfilling.

All backfilling shall be completed before the line is placed in service. The initial backfill shall be of selected material that is free of rocks or sharp-edged materials that can damage the pipe.

Deformation or displacement of the pipe must not occur during backfilling.

All seeding shall be in accordance with the Critical Area Planting Standard and Specifications (PA342).

6. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

Specific Site Requirements

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

WATER WELL

CODE 642

(no)

DEFINITION

A hole drilled, dug, driven, bored, jetted or otherwise constructed into an aquifer for water supply.

PURPOSE

This practice is used to accomplish of the following purpose:

- To provide access to a groundwater supply suitable for livestock watering, fire control, wildlife, and other agricultural uses

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all types of agricultural land where the quality and quantity of underground water is appropriate for the intended purpose.

This practice does not apply to wells constructed solely for domestic or public water supply. It does not apply to wells installed solely for monitoring or observation purposes (use Conservation Practice Standard (CPS) *Monitoring Well (PA353)*), injection wells, temporary test wells, or piezometers.

This practice does not apply to pumps, surface supply lines, storage facilities, and related appurtenances.

CRITERIA

General

Laws and Regulations

The investigation, design, and installation of an agricultural water supply well must comply with all applicable governmental regulations, laws, permits, licenses, and registrations. In particular, federal law requires:

- A proposed well that has a domestic usage component must comply with criteria in *ANSI/AWWA American National Standard, A100-06, 2007*;
- A proposed irrigation well must comply with criteria in *ANSI/ASAE American National Standard, EP400.3, 2007*;
- The well design and installation must follow applicable industry consensus standards.

The landowner is responsible for obtaining all permits and water rights.

Suitability of Site

Use reliable local experience and all available relevant geologic maps, reports, and well records maintained by State and Federal agencies. Review design, construction, and maintenance records of nearby wells to help determine whether groundwater is available in sufficient quantity and of the desired quality for the intended use. If local hydrogeologic data are limited or if conditions are complex and

uncertain, use additional expertise to conduct on-site evaluation and to provide professional recommendations regarding the suitability of the site.

Do not locate the well near overhead and underground utility lines and other safety hazards.

If site conditions allow, locate the well up- gradient from potential sources of surface contamination and away from areas subject to flooding. In determining gradient, consider both pumped and static conditions.

Clear the site of all trees, brush, and obstructions and provide a relatively flat, reasonably dry, working surface for the drill rig and related equipment to ensure a safe and effective working environment.

Wellhead Protection
Divert all surface runoff, precipitation, and drainage away from the wellhead. At the wellhead, compact, mound, and slope earth material away from the wellhead.

Protect the wellhead and associated appurtenances from contamination or damage by wildlife, livestock, farm machinery, vehicle parking, or other harmful human activity. Locate the well at least 100 feet from potential sources of surface and subsurface pollution.

The top of the casing shall be equipped with a cap or well seal to prevent rainfall or insects from entering the well. If the top of the well casing is subject to flooding from surface water, the cap shall be water tight and equipped with a vent that extends two feet above the 100 year flood level. As an alternative, the well casing may be extended two feet above the 100 year flood level.

If the well water is intended for human consumption, the casing shall be surrounded at the ground surface by a 4-inch thick concrete slab extending at least 2 feet in all directions from the outside of the casing to prevent contamination. The slab shall slope away from well.

Grouting and Sealing the Casing
Drilled, jetted, bored, and driven wells shall be sufficiently round, straight, and of adequate diameter, to permit satisfactory installation of inlet, well casing, filter pack, and annular seal, and passage of tremie pipe (including couplings), if used. Hard rock formations or physically stable geologic materials may not require casing except for the uppermost 10 feet. However, casing shall be installed to seal out undesirable surface or shallow groundwater, and to support the side of the hole through unstable earth materials

If drilling encounters erodible, friable, or otherwise unstable material, install watertight, grouted casing throughout, with the exception of the intake portions.

Provide a watertight seal in the annulus of all well casing. Acceptable sealants include mortar containing expansive hydraulic cement (ASTM C 845), bentonite-based grout, bentonite chips and pellets, sand-cement grout, neat cement, or concrete. The length of the grout seal shall be no less than 10 feet, and not less than the minimum specified in state or locally applicable construction codes.

If one or more zones are encountered that produce water of unacceptable quality, use grout or packers to prevent comingling of waters or cross-contamination of aquifers.

Provide a packer, or similar retaining device, or a small quantity of sealant between the casing and the less pervious material overlying the aquifer of artesian wells. Provide a similar positive seal to separate water bearing zones where co-mingling of waters is undesirable.

For artesian conditions, seal the confining geologic units directly above and below the aquifer in such a manner as to retain its confining pressure.

Casing shall extend from above the ground surface down through unstable earth materials to an elevation of at least 2 feet into stable material or to the top of the screen.

If casing extends to the bottom of the drill hole, install a watertight end cap or grout seal to prevent entry of geologic material into the well from the bottom.

When the design requires telescoped screen assemblies, install one or more sand-tight seals between the top of the telescoped screen assembly and the casing.

Upon completion, provide a suitably threaded, flanged, or welded cap or compression seal to prevent entry of contaminants into the well.

Casing Materials
Acceptable materials for casing include steel, iron, stainless steel, copper alloys, plastic, fiberglass, concrete or other material of equivalent strength and which has sufficient chemical resistance to the groundwater for the design life of the well. To prevent galvanic corrosion, do not join dissimilar metals.

Use only steel pipe casing in driven wells. Steel well casings shall meet or exceed requirements specified in ASTM A589. Steel pipe manufactured for other purposes may be used if the quality of the pipe meets or exceeds requirements specified in ASTM A589.

Select a casing diameter to permit satisfactory installation and efficient operation of a submersible pump, if used.

Select casing material that can withstand all anticipated static and dynamic pressures imposed on the casing during installation, well development, and use throughout the design life of the well. Refer to NEH 631.3200, Water Well Design, for guidance in determining proper differential head limitations for approved casing materials.

Unless otherwise required by law or new technology, use the following:

- Plastic casings made of acrylonitrile- butadiene-styrene (ABS), polyvinyl chloride (PVC), or styrene-rubber (SR) shall conform to material, dimensional and quality requirements specified in ASTM F 480.
- Filament-wound fiberglass casings (glass-fiber-reinforced-thermosetting- resin pipe, RTRP) may be used if material meets requirements specified in ASTM D 2996. Tests for long-term cyclic pressure strength, long-term static pressure strength, and short-term rupture strength as required in ASTM D 2996 are not needed because the pipe is to be used for well casing. Joints shall meet requirements specified in section 3.8, ASTM F 480.
- Fiberglass pressure pipe (also called reinforced plastic mortar pipe, RPMP, or fiberglass pipe with aggregate) shall meet or exceed requirements specified in ASTM D 3517.

Ensure well casing joints have adequate strength to carry the weight of casing throughout its length while maintaining a watertight seal. If needed, mechanically support the casing during installation to maintain joint integrity. Terminate mechanically supported casings on material that can adequately support the casing weight.

Screen and Filter Pack
Use a screen and filter pack (also called gravel pack) if any of the following conditions exist:

- Presence of a poorly graded, fine sand aquifer or heaving or caving sands;
- Presence of a highly variable aquifer, such as alternating sand and clay layers;
- Presence of a poorly cemented sandstone or other loosely compacted material;
- Requirement for maximum yield from a low- yielding aquifer;
- Holes drilled by reverse circulation.

If acceptable filter materials are unavailable, use a commercially manufactured, pre-packed well screen. A pre-packed well screen consists of inner and outer screens that contain the engineered filter material. The material must meet the following quality criteria:

- Less than five percent fines (the proportion that passes the number 200 sieve);
- Predominantly rounded, dense, siliceous materials;
- No angular particles, such as crushed rock, or flat particles, such as mica;
- No earthy or soft materials, such as clay, shale, silt, gypsum, or anhydrite;
- No organic matter, no other impurities or metallic substances;
- No material soluble in hydrochloric acid, such as limestone.

For heaving or caving sands, silty or fine-grained aquifers, and for horizontal or angled wells, a commercial pre-packed well screen may be substituted for a conventionally installed (by tremie) filter pack.

Position the well screen according to the depth of the water-bearing zone(s) below the ground surface and the thickness of the water-bearing zone penetrated by the drill hole. Install a conventional filter pack from the bottom up and place in a manner that avoids segregation and bridging of particles.

Do not design maximum drawdown to reach the top of the highest screen or pump intake.

Screen perforation by any method is allowable with the following provisions:

- For uniform size aquifer material, screen openings are smaller than the average diameter of aquifer material;
- For non-uniform aquifer material, screen openings are smaller than 60 percent of the aquifer material;
- Screen openings, for filter/gravel pack must exclude at least 85 percent of the filter pack material;
- Size the length and open area of the screen to keep entrance velocity or shear stress below the threshold for erosion of filter pack particles and transport into the well;
- Casing must not be functionally weakened or deformed.

For a screened well cased to the bottom of the well, install several extra feet of blank screen or casing at the bottom of the well to accommodate sediment that passes through the well screens and settles to the bottom of the well.

Access Port
Install an access port with a minimum diameter of 0.5 inch to allow for unobstructed measurement of depth of the water surface, or for the installation of a pressure gage for measuring shut-in pressure of a flowing well.

Seal or cap access ports, pressure gages, and all other openings in the well cover to prevent entry of unwanted materials and to discourage tampering. A removable cap is acceptable for an access port.

Well Development
After completion of well construction, ensure that the well is developed. Well development is required regardless of whether the well is finished in unconsolidated materials or hard rock aquifers. Use one or more development techniques to effectively loosen and remove silt, fine sand, drill cuttings, drilling muds, or additives deposited by the drilling operation on the uncased borehole face and in adjacent portions of the aquifer. For screened zones, the development technique must collapse sand bridges and remove fines outside the screen. Following the development process, remove accumulated sediment at the bottom of the well bore by bailing or pumping.

Pump the well at approximately 120 percent of the anticipated normal production rate until suspended sediment and associated turbidity clears. Do not use the permanent pump to conduct any well development work.

Refer to NEH 631.32 for guidance on various well development techniques.

Well Water Testing
Sampling and testing shall comply with all applicable Federal, State and Local requirements. If local water quality conditions are unknown or questionable, test the well water using parameters that pertain to well performance or the suitability of the water for its intended usage. Test well water according to CPS *Groundwater Testing (PA355)*.

Disinfection
The disinfection process shall comply with all Local and State requirements. Prior to final chemical disinfection, remove foreign substances, such as grease, soil, sediment, joint dope, and scum from the well and near the wellhead. Clean all pump parts before placing them into the well. Disinfect the well using a chlorine compound at a concentration of no less than 100 mg/L (100ppm) available chlorine in solution to treat the entire well.

Well Performance
After completion of well construction and the water level is stable, conduct a pump test to determine specific capacity and dynamic water level. Record the length of test and pumping rate.

CONSIDERATIONS

Consider evaluating the potential for adverse interference with existing nearby production wells when planning and designing the water well.

In planning, consider the potential for groundwater overdraft and the long-term safe yield of the aquifer.

Potential effects of installation and operation of the well on cultural, historical, archeological, or scientific resources at or near the site should be considered in planning.

Fencing of the well and associated equipment should be considered to prevent contamination and damage by wildlife, livestock, or human activity.

PLANS AND SPECIFICATIONS

Develop plans and specifications that clearly describe requirements for applying the practice to achieve its intended purpose(s). If not already specified in the documentation required by the State regulatory authority, record the following information in the installation record:

- Location of water well by Global Positioning System (GPS) coordinates or in a sufficiently detailed narrative description to readily locate the well
- Type of casing material or schedule, and whether new or used
- Date of completion of the water well
- Name, title, and address of person responsible for the water well
- Total depth of the water well
- Length of casing and screening
- Inside diameter of well bore or casing
- Height of casing extending above ground surface
- Static water level measured from top edge of casing or from ground surface
- Notification of whether aquifer is artesian or non-artesian. If well is flowing artesian, provide flow rate and pressure
- Well development method(s) used

- Results of pump test including length of test, stability of water level, pumping rate, and specific capacity after water level had stabilized, if needed.
- Driller's log
- If water quality was tested, record the parameters and test results, date of sampling, name of person who took sample, and name of laboratory that conducted tests.

OPERATION AND MAINTENANCE

Prepare a plan for operation and maintenance of the water well. The owner is responsible for keeping and maintaining well construction records with the maintenance plan. The owner must ensure periodic inspection of the well for proper functioning and water quality.

Ensure no agricultural chemicals, such as fertilizers and pesticides, are stored or mixed or containers rinsed within a 100 ft. radius of the wellhead.

The inspection must include conditions that affect well performance as designed for the water use. As a minimum, these conditions include:

- Declines in discharge, static level, maximum pumping level, and pressure (for artesian wells) that are outside acceptable limits for the well design;
- Appearance of sediment that may damage the well, pump, or appurtenances;
- Changes in water quality including odor, color, taste, and chemistry;
- Presence of algae or iron bacteria.

For screen wells that have blank casing installed at the bottom, periodically bail or flush the well to remove excessive, accumulated sediment.

In the maintenance record, include statements describing identified problems, corrective action taken and date, and specific capacity of well before and after corrective action. The owner must remedy unacceptable conditions in a timely manner.

Note that in the event the well becomes unserviceable, it may be decommissioned according to CPS *Well Decommissioning (PA351)*.

REFERENCES

USDA, NRCS, Conservation Engineering Division, National Engineering Handbook, Geology, 631.32, Water Well Design.

USDA, NRCS, Conservation Engineering Division, Agricultural Waste Management Field Handbook 651.01, Laws, Regulations, Policy, and Water Quality Criteria.

ANSI/ASAE American National Standard *EP400.3, 2007, Designing and Constructing Irrigation Wells*.

ANSI/AWWA American National Standard, *A100-06, 2007, Standard for Water Wells*.

Practice Specification
Water Well (Code 642)

1. SCOPE

The work shall consist of furnishing materials and installing all components of the water well as outlined in this specification and the drawings.

2. MATERIALS

Casings: Casings shall be of steel, iron, stainless steel, copper alloys, plastic, fiberglass, or concrete of sufficient strength and durability consistent with the intended use of the water and the maximum anticipated differential head between the inside and outside of the casing. Unless otherwise set forth in Section 5 of this specification:

- Plastic casings made of acrylonitrile- butadiene-styrene (ABS), polyvinyl chloride (PVC), or styrene-rubber (SR) shall conform to material, dimensional and quality requirements specified in ASTM F 480.
- Filament-wound fiberglass casings (glass-fiber-reinforced-thermosetting- resin pipe, RTRP) may be used if material meets requirements specified in ASTM D 2996. Tests for long-term cyclic pressure strength, long-term static pressure strength, and short-term rupture strength as required in ASTM D 2996 are not needed because the pipe is to be used for well casing. Joints shall meet requirements specified in section 3.8, ASTM F 480.
- Fiberglass pressure pipe (also called reinforced polymer mortar pipe, RPMP, or fiberglass pipe with aggregate) shall meet or exceed requirements specified in ASTM D 3517.

Other casing materials shall be certified by the manufacturer or a registered Professional Engineer as being of adequate strength.

Joints: Well casing joints shall have adequate strength to carry the load due to the casing length and still be watertight, or shall be mechanically supported during installation to maintain joint integrity. Such mechanically supported casings shall terminate on firm material that can adequately support the casing weight.

Screen: Well screens shall be constructed of commercially manufactured screen sections, well points, or field-perforated sections.

Perforation by any method is allowable provided the following provisions can be met:

- For uniform size aquifer material, screen openings are smaller than the average diameter of aquifer material;
- For non-uniform aquifer material, screen openings are smaller than 60 percent of the aquifer material;
- Screen openings, for filter/gravel pack must exclude at least 85 percent of the filter pack material;
- Size the length and open area of the screen to keep entrance velocity or shear stress below the threshold for erosion of filter pack particles and transport into the well;
- Casing must not be functionally weakened or deformed.

Gravel Pack: If gravel pack is used, it shall have the gradation and thickness specified in Section 5, or as shown on the drawings.

If acceptable *filter materials are unavailable*, use a commercially manufactured, pre-packed well screen. A pre-packed well screen consists of inner and outer screens that contain the engineered filter material. The material must meet the following quality criteria:

- Less than five percent fines (the proportion that passes the number 200 sieve);
- Predominantly rounded, dense, siliceous materials;
- No angular particles, such as crushed rock, or flat particles, such as mica;
- No earthy or soft materials, such as clay, shale, silt, gypsum, or anhydrite;

- No organic matter, no other impurities or metallic substances;
- No material soluble in hydrochloric acid, such as limestone.

3. EQUIPMENT

The installer shall provide and operate all equipment necessary to install the well in a safe manner. The operator shall have a Water Well Driller's License and a Drilling Rig Permit, issued by the PA Geological Survey, for the equipment used on the site.

4. INSTALLATION

Drilled, jetted, bored, and driven wells shall be sufficiently round, straight, and of adequate diameter, to permit satisfactory installation of inlet, well casing, filter pack, and annular seal, and passage of tremie pipe (including couplings), if used. Hard rock formations or physically stable geologic materials may not require casing except for the uppermost 10 feet. However, casing shall be installed to seal out undesirable surface or shallow groundwater, and to support the side of the hole through unstable earth materials

If drilling encounters erodible, friable, or otherwise unstable material, install watertight, grouted casing throughout, with the exception of the intake portions.

Provide a watertight seal in the annulus of all well casing. Acceptable sealants include mortar containing expansive hydraulic cement (ASTM C 845), bentonite-based grout, bentonite chips and pellets, sand-cement grout, neat cement, or concrete. The length of the grout seal shall be no less than 10 feet, and not less than the minimum specified in state or locally applicable construction codes.

If one or more zones are encountered that produce water of unacceptable quality, use grout or packers to prevent comingling of waters or cross-contamination of aquifers.

Provide a packer, or similar retaining device, or a sealant between the casing and the less pervious material overlying the aquifer of artesian wells. Provide a similar positive seal to separate water bearing zones where co- mingling of waters is undesirable.

For artesian conditions, seal the confining geologic units directly above and below the aquifer in such a manner as to retain its confining pressure.

Casing shall extend from above the ground surface down through unstable earth materials to an elevation of at least 2 feet into stable material or to the top of the screen.

If casing extends to the bottom of the drill hole, install a watertight end cap or grout seal to prevent entry of geologic material into the well from the bottom.

When the design requires telescoped screen assemblies, install one or more sand-tight seals between the top of the telescoped screen assembly and the casing.

Upon completion, provide a suitably threaded, flanged, or welded cap or compression seal to prevent entry of contaminants into the well.

Well Development: After completion of well construction, ensure that the well is developed. Well development is required regardless of whether the well is finished in unconsolidated materials or hard rock aquifers. Use one or more development techniques to effectively loosen and remove silt, fine sand, drill cuttings, drilling muds, or additives deposited by the drilling operation on the uncased borehole face and in adjacent portions of the aquifer. For screened zones, the development technique must collapse sand bridges and remove fines outside the screen. Following the development process, remove accumulated sediment at the bottom of the well bore by bailing or pumping.

Pump the well at approximately 120 percent of the anticipated normal production rate until suspended sediment and associated turbidity clears. Do not use the permanent pump to conduct any well development work.

Unless otherwise set forth in Section 5, wells to be completed without a filter pack in unconsolidated granular aquifers shall be developed following guidance provided in ASTM D 5521, *Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers.*

The method shall be selected based on geologic character of the aquifer, type of drilling rig, and type of screen.

Aquifer Development: For massive, unfractured rock formations unresponsive to well development procedures, the use of aquifer stimulation techniques may be used to improve well efficiency and capacity, if permitted in Section 5 of this specification.

Techniques may include dry ice, acidizing, explosives, or hydrofracturing, depending on the composition and structure of the formation, and as specified in Section 5.

Access Port: An access port with a minimum diameter of 0.5 inch shall be installed to allow for unobstructed measurement of depth of the water surface, or for a pressure gage for measuring shut-in pressure of a flowing well. Access ports and pressure gages or other openings in the cover shall be sealed or capped to prevent entrance of surface water or foreign material into the well. Removable caps are acceptable as access ports.

Wellhead Protection: Surface runoff and drainage that might reach the wellhead from areas used by livestock or other contaminant sources shall be diverted away from the well.

The ground surface around the well shall be graded away from the well for a distance of at least five feet in all directions. Low points where water can puddle on the surface shall be eliminated.

If the well water is intended for human consumption, the casing shall be surrounded at the ground surface by a 4-inch thick concrete slab extending at least 2 feet in all directions.

If the top of the well casing is subject to flooding from surface water, either of two methods shall be used to prevent floodwater from entering the well: (1) the well cap shall be water tight and equipped with a vent that extends two feet above the 100 year flood level, or (2) the well casing shall be extended to two feet above the 100 year flood level.

Disinfection: Wells shall be disinfected immediately following their construction or repair to neutralize any contamination from equipment, material, or surface drainage introduced during construction. The disinfection process shall comply with all local or state requirements.

Prior to final chemical disinfection, remove foreign substances, such as grease, soil, sediment, joint dope, and scum from the well and near the wellhead. Clean all pump parts before placing them into the well. Disinfect the well using a chlorine compound at a concentration of no less than 100 mg/L (100 ppm) available chlorine in solution to treat the entire well.

Water Quality Testing: Sampling and testing shall comply with all applicable federal, state, and local requirements. These requirements vary according to the water quality parameters associated with the intended use(s) of the water. Test well water according to the *Construction Specification for Groundwater Testing (PA355)*.

Well Performance Testing. After completion of well construction and the water level is stable, conduct a pump test to determine specific capacity and dynamic water level.

Record the length of test and pumping rate.

Documentation: The well driller shall provide to the landowner and the PA-DCNR Topographic and Geological Survey copies of the water well completion report.

5. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

Specific Site Requirements

United States Department of Agriculture

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

CRITICAL AREA PLANTING

CODE 342

(ac)

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 seeding/planting methods.

PURPOSE

This practice is used to accomplish one or more of the following purposes–

- Stabilize areas with existing or expected high rates of soil erosion by wind or water
- Stabilize stream and channel banks, pond and other shorelines, earthen features of structural conservation practices
- Stabilize areas such as sand dunes and riparian areas

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to highly disturbed areas such as—

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

CRITERIA

General Criteria Applicable to All Purposes

Earth Disturbance Activities

For earth disturbance activities other than agricultural plowing and tilling or animal heavy use areas, follow the erosion and sediment control requirements of Pennsylvania's Erosion and Sediment Control and Stormwater Management Chapter 102 regulations.

Site preparation

Conduct a site investigation to identify any physical, chemical, or biological conditions that could affect the successful establishment of vegetation.

Clear areas to be planted of unwanted materials and smooth or shape, if needed, to meet planting purpose(s).

Prepare a suitable seedbed for all seeded species. Rip compacted layers and re-firm the soil prior to seedbed preparation, as needed.

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

Species selection
Select species for seeding or planting that are suited to local site conditions and intended uses, and 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.

Establishment of vegetation
Plant seeds using the method or methods best suited to site and soil conditions.

Limit sod placement to areas that can naturally supply needed moisture or sites that can be irrigated during the establishment period. Place and anchor sod using techniques to ensure that it remains in place until established.

Specify species, rates of seeding or planting, legume inoculation, minimum quality of planting stock (e.g., pure live seed (PLS) or stem caliper), method of seedbed preparation, and method of establishment before application. Use only viable, high-quality seed or planting stock.

Seed or plant at a time and in a manner that best ensures establishment and growth of the selected species.

Plant during approved times for the species to be used.

Apply soil amendments (e.g., lime, fertilizer, compost, manure) according to the requirements in the local Field Office Technical Guide.

Mulch or otherwise stabilize (e.g., polyacrylamide (PAM)) plantings as necessary to ensure successful establishment.

Additional Criteria to Stabilize Stream and Channel Banks, Pond and Other Shorelines, Earthen Features of Structural Conservation Practices

Bank and channel slopes
Shape channel side slopes 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 3:1 to ensure adequate stability.

Species selection
Plant material used for this purpose must—

- 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.
- Be compatible with existing vegetation in the area.
- Protect the channel banks but not restrict channel capacity.

Establishment of vegetation
Specify species, planting rates, spacing, methods and dates of planting based on local planting guides or technical notes. Refer to guidance found in the PA Practice Guide for Critical Area Planting (342), PA Construction Specification for Critical Area Planting, and A Guide to: Conservation Plantings on Critical Areas for the Northeast.

Identify and protect desirable existing vegetation during practice installation.

Use a combination of vegetative and structural practices with living and inert material when flow velocities, soils, and bank stability preclude stabilization by vegetative establishment alone. Use Conservation Practice Standard (CPS) Streambank Stabilization (Code 580) for the structural measures.

Control existing vegetation on a site that will compete with species to be established vegetatively (e.g.. bare-root, containerized, ball-and-burlap, potted) to ensure successful establishment of the planted species.

Plant streambank stabilization vegetation in accordance with the NRCS Engineering Field Handbook Part 650, Chapter 16, “Streambank and Shoreline Protection,” and Chapter 18, “Soil Bioengineering for Upland Slope Protection & Erosion Reduction.”

Site protection and access control
Restrict access to planted areas until fully established.

Additional Criteria to Stabilize Areas Such As Sand Dunes and Riparian Areas

Plants for sand dunes and coastal sites must be able to survive being buried by blowing sand, sand blasting, salt spray, salt water flooding, drought, heat, and low nutrient supply.

Include sand trapping devices such as sand fences or brush matting in the revegetation/stabilization plans where applicable.

CONSIDERATIONS

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

Follow the requirements of Pennsylvania’s Dam Safety and Waterway Management Regulations, Chapter 105, as applicable.

To benefit pollinators and other wildlife, flowering shrubs and wildflowers with resilient root systems and good soil-holding capacity also should be considered for incorporation as a small percentage of a larger grass-dominated planting. Where appropriate consider a diverse mixture of forbs to support pollinator habitat.

Planning and installation of other CPSs such as Diversion (Code 362), Obstruction Removal (Code 500), Subsurface Drain (Code 606), Underground Outlet (Code 620), or Anionic Polyacrylamide Application (Code 450) may be necessary to prepare the area or ensure vegetative establishment.

Areas of vegetation established with this practice can create habitat for various type of wildlife. Maintenance activities, such as mowing or spraying, can have detrimental effects on certain species. Perform management activities at the times and in a manner that causes the least disruption to wildlife.

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. Record practice specifications using approved Implementation Requirements document.

Address the following elements in the plan, as applicable, to meet the intended purpose(s):

- Practice purpose(s).
- Site preparation.
- Topsoil requirements.
- Fertilizer/manure/compost application.
- Seedbed/planting area preparation.
- Timing and method of seeding/planting.
- Selection of species.
- Seed/plant source.
- Seed analysis/pure live seed (PLS).
- Seeding rate/plant spacing.
- Mulching, PAM, or other stabilizing materials.
- Supplemental water needed for establishment.
- Protection of plantings.
- Describe successful establishment (e.g., minimum percent ground/canopy cover, percent survival, stand density).

OPERATION AND MAINTENANCE

- Control access to the area to ensure the site remains stable.
- Protect plantings shall be protected from pests (e.g., 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.
- Observe establishment progress and success at regular intervals until the practice has met the criteria for successful establishment and implementation.
- Description of successful establishment (e.g., minimum percent ground/canopy cover, percent survival, stand density).

REFERENCES

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

USDA NRCS. 2007. National Engineering Handbook, Part 654. Stream restoration guide.

USDA NRCS. 2015. The PLANTS Database (http://plants.usda.gov, 8 December 2015). National Plant Data Team, Greensboro, NC.

USDA NRCS. 2012. A Guide to: Conservation Plantings on Critical Areas for the Northeast. Big Flats Plant Materials Center, Corning, NY.

Practice Guide for Critical Area Planting (342). 2012. PA Field Office Technical Guide, Section IV.

Construction Specification for Critical Area Planting. 2012. PA Field Office Technical Guide, Section IV.

Vegetative Stabilization. March 2012. Erosion and Sediment Pollution Control Program Manual. Pennsylvania Department of Environmental Protection.

Practice Specification
Critical Area Planting (Code 342)

1. SCOPE

The work shall consist of furnishing and planting the plant materials as set forth in the drawings and/or Section 7.

Critical area planting specifications are divided into four subsections based on the type of vegetation to be established:

Temporary cover

Permanent cover – seeding grasses and legumes

Permanent cover – sod establishment

Permanent cover – trees & shrubs

2. TEMPORARY COVER

A. MULCHING – Unless otherwise set forth in Section 7, use if the period of soil exposure without permanent vegetation will be less than two months, temporary vegetation is not feasible, or where seeding is delayed because of weather conditions. Follow the specification for Mulching (PA484).

B. ANNUAL GRASS or CERAEL GRAIN – Unless otherwise set forth in Section 7, use on all sediment producing areas where the period of soil exposure will be more than two months, but less than 12 months.

1. Site Preparation
   a. Install all required water control measures (temporary and permanent) prior to cover application.
   b. Perform all cultural operations at right angles to the slope on slopes 3:1 or flatter.
   c. Apply agricultural lime according to the soil test. If no test results are available when ready to seed, apply at the rate of 8000 pounds per acre (200 pounds per 1000 square feet) on a 100 percent calcium carbonate equivalent basis as a preliminary application. Apply the balance recommended by the test when the results are received. If lime is to be worked into a depth of five inches or deeper, use the amount full recommended in the soil test report. Apply no more than 8000 pounds per acre at one time if the limestone is to be worked into less than five inches. Apply the balance of the recommendation as the lime dissolves and infiltrates into the soil.

      Where pH levels are extremely low, it may not be feasible or practical to apply the lime all at once. In these cases, apply 6,000 pounds per acre (150 pounds per 1,000 square feet) on a 100 percent calcium carbonate equivalent basis for the temporary cover, and the balance of the test recommendation with the permanent cover.

   d. Apply fertilizer according to the soil test. If the test results are not available prior to seeding, apply 40 pounds each of actual N. P_2O_5, and K_2O per acre (1 pound each per 1000 square feet) as a preliminary application. Apply any balance recommended by the test when the results are received.
2. Materials
   a. Seed using the species or mixtures for the appropriate site type in **Table 1 Temporary Cover or Nurse Crop** unless otherwise set forth in Sections 7.
   b. All seed shall conform to the certifications of the PA Dept. of Agriculture and in addition, be labeled in accordance with the USDA Federal Seed Act in effect at the time of planting.
   c. No seed will be accepted with a test date more than 9 months before delivery to the site. Seed that is moldy or otherwise damaged will not be accepted.

3. Establishment

   a. Seeding rates shall be at the rates set forth in **Table 1 Temporary Cover or Nurse Crop**, unless otherwise set forth in Section 7.

   b. Cover grass seeds with ¼-inch, and small grains with 11/2-inches of soil by drilling, cultipacking, harrowing, or other suitable method when the site conditions permit; cultipack or track hydroseeded area where slopes will allow safe equipment operation.

   c. Mulch all seeded areas according to the construction specification for Mulching (PA484).

3. PERMANENT COVER – SEEDING GRASSES AND LEGUMES

A. SITE PREPARATION

1. Install all required water control measures (temporary and permanent) prior to cover application.
2. Perform all cultural operations at right angles to the slope on slopes 3:1 or flatter.
3. Where site conditions permit, prepare a seedbed by loosening the soil to a depth of 2 to 6 inches with suitable equipment. Where site conditions do not permit such normal seedbed preparation, loosen the soil surface by dragging a heavy chain or other suitable devices over the area to be seeded. Where possible on mined land, the surface should be left furrowed (as typically left by ripper teeth spaced 12 to 18 inches apart) when seeding herbaceous plants.
4. Apply agricultural lime according to the soil test. If no test results are available when ready to seed, apply at the rate of 8000 pounds per acre (200 pounds per 1000 square feet) on a 100 percent calcium carbonate equivalent basis as a preliminary application. Apply the balance recommended by the test when the results are received. If lime is to be worked into a depth of five inches or deeper, use the amount full recommended in the soil test report. Apply no more than 8000 pounds per acre at one time if the limestone is to be worked into less than five inches. Apply the balance of the recommendation as the lime dissolves and infiltrates into the soil.

   Where pH levels are extremely low, it may not be feasible or practical to apply the lime all at once. In these cases, apply the lime in increments of 6,000 pounds per acre (150 pounds per 1,000 square feet) on a 100 percent calcium carbonate equivalent basis and incorporate it before the next increment.

5. Apply nitrogen only when the plants will be actively growing during the period immediately following the application (March to May and August to October for cool- season grasses, June to August for warm- season grasses). On remote sites with poor access for standard fertilization (e.g., mine reclamation), apply all nitrogen as slow release compounds (e.g. ureaformaldehyde, sulfur-coated urea, other slow release formulation, animal manure, or sewage sludge), and at a rate of not greater than 80 pounds of actual nitrogen per acre (2 pounds per 1000 square feet) in any one application. On sites with good access (e.g. agricultural fields), apply 40% of the required nitrogen as slow release compounds, and no more than 40 pounds of actual nitrogen per acre (1 pound per 1000 square feet) in any one application.
6. Apply fertilizer according to a soil test. If test results are not available prior to seeding, apply as follows:

   a. Where a seedbed can be, prepared, apply 100 pounds each of actual P_20_5 and K_20 per acre (2.5 pounds each per 1OOO square feet) during seedbed preparation and at time of seeding. Apply 100 pounds of actual P_20_5 and 100 pounds actual K_20 per acre (2.5 pounds of actual P_20_5 and 2.5 pounds of actual K_20 per 1,000 square feet) as a preliminary application.
   Apply 40 pounds of actual N per acre (1 pound per 1,000) square feet) during the first period of active growth following the seeding. (Cattle manure or sewage sludge can be used to meet the nutrient requirements and will add needed organic matter when they can be incorporated into the soil. Heavy metal content of sewage sludge should not exceed that allowed on agricultural lands.) Test the soil before application and apply any balance recommended by the test when the results are received. Apply maintenance fertilizer the following growing season according to a soil test.

b. Where seedbed cannot be prepared, 80 pounds of actual $P_2 0_5$ and $K_2 0$ per acre (2 pounds of actual $P_2 0_5$ and 2 pounds of actual $K_2 0$ per 1,000 square feet) at time of seeding. Apply 40 pounds of actual N per acre (1 pound per 1,000 square feet) during the first period of active growth following the seeding.

c. If legumes are hydroseeded alone or in a mixture, use four times the normally recommended amount of inoculants to the slurry just before seeding, and apply lime and fertilizer by any method that will provide a uniform distribution.

B. MATERIALS

1. Apply seed species or mixtures as set forth in Section 7 and at the rates in **Table 2 Permanent Cover Grass and Legume Seeding Rates** for the permanent cover. Also apply a nurse crop seed mixture at the rates in **Table 1Temporary Cover or Nurse Crop** unless otherwise set forth in Section 7.
2. All seed shall conform to the certifications of the PA Dept. of Agriculture and in addition be labeled in accordance with the USDA Federal Seed Act in effect at the time of planting. No seed will be accepted with a test date more than 9 months before delivery to the site. Seed that is moldy or otherwise damaged will not be accepted.

C. ESTABLISHMENT

1. Where the seedbed is prepared:
   a. Smooth and firm the seedbed with a cultipacker or other similar equipment prior to seeding.
   b. Apply seeds uniformly by drilling, broadcasting, or hydroseeding. When broadcast or drilled, cover grass and legume seeds with ¼-inch of soil.Cultipack or track with a tracked- vehicle where slopes allow.
   c. Cultipack or track with a tracked- vehicle where slopes allow.
   d. Mulch all areas according to construction specification for Mulching (PA484).
2. Where seedbed is not prepared:
   a. Apply seed species or mixtures as set forth in Section 7 and at the rates in **Table 2 Permanent Cover Grass and Legume Seeding Rates** for the permanent cover. Also apply a nursery crop seed mixture at the rates in **Table 1 Temporary Cover and Nurse Crop**, unless otherwise set forth in Section 7.
   b. All seed shall conform to the certifications of the PA Dept. of Agriculture and in addition be labeled in accordance with the USDA Federal Seed Act in effect at the time of planting. No seed will be accepted with a test date more than 9 months before delivery to the site. Seed that is moldy or otherwise damaged will not be accepted.
   c. Apply seeds uniformly by drilling, broadcasting, or hydroseeding.
   d. Cultipack or track with a tracked- vehicle where slopes allow.
   e. Mulch all areas according to construction specification for Mulching (PA484).

4. PERMANENT COVER – ESTABLISHING SOD

A. SITE PREPARATION

1. Prepare the area, including lime and fertilizer, as set forth for Permanent Cover- Seeding in Section 3.A.
2. Till the soil surface to a depth of three inches and dampen immediately prior to laying sod.

B. MATERIALS

1. Sod shall be of the species set forth in Section 7.
2. Sod shall be grown from certified seed of adapted varieties, tested and approved by the PA Experiment Station, and under the cultural practices conducive to high quality sod that is free of any significant thatch, weeds, insects, and disease.
3. Sod shall be at least one-year old and no older than three years. Cultivated turfgrass shall be

considered ready for harvest when a cut portion of sod three feet in length and about 1-1/2 feet wide will support its own weight.

4. Cut sod of a width and length suited to the equipment and site, or as otherwise set forth in Section 7. Sod shall be cut, folded in the middle or rolled, and stacked on pallets. Folded sod shall be between 3 and 4 feet in length, unless otherwise allowed in Section 7. Sod shall be cut with a ½- to 1-inch layer of soil.
5. Have sod delivered to the site as soon as possible after harvesting. During hot weather, delivery shall be made within six hours. During cooler weather, when allowed in Section 7, delivery time may be extended up to 48 hours. Unless allowed in Section 7, sod shall not be planted during July and August, and when allowed shall be cut with at least 1-1/4 inch of soil and irrigated as necessary to ensure survival.

C. ESTABLISHMENT

1. Lay sod strips at right angles to the direction of water flow (slope), starting at the lowest elevation. Wedge the edges and ends of the sod strips together and tamp or roll. Stagger all end joints. Score the adjacent undisturbed ground so that the sod edges are flush and embedded (i.e. do not allow feathered edges).
2. On steep slopes or where required by Section 7, use wire or starch staples, fine mesh, or wooden pins and baler twine to secure the sod in place. When required in Section 7, remove wire and wooden stakes after the sod has rooted sufficiently to be secure.
3. Irrigate sod when dry conditions prevail to ensure survival. If required in Section 7, irrigate the sod to be lifted prior to harvesting.

5. PERMANENT COVER – TREES & SHRUBS ON HIGHLY DISTURBED AREAS

A. SITE PREPARATION

1. For seedings:
   a. Site preparation shall be the same as set forth in Sections 3.A. (1 through 3).
   b. Apply lime at the rate of 4000 pounds per acre on a 100-percent calcium carbonate basis over the area to be planted.
   c. Apply fertilizer at the rate of 40 pounds of actual P2O5 and 40 pounds of actual K2O per acre (1 pound per 1000 square feet) at the time of seeding. Apply 40 pounds of actual N per acre (1 pound per 1000 square feet) during the first period of active growth following the seeding. When strip-seeding, apply all of the fertilizer in the herbaceous strips.
2. For individual plantings:
   a. Prepare the area by clearing and mowing to allow access for planting and plant growth, or as otherwise set forth in Section 7.
   b. Planting pits in confined spaces or other harsh environments shall be excavated as recommended in *A guide to: Conservation Plantings in Critical Areas for the Northeast* (http://plant-materials.nrcs.usda.gov//nypmc/) unless otherwise set forth in Section 7.

B. MATERIALS

1. Plant species shall be as set forth in Section 7. Plant names required under this contract shall conform to those set forth in Standardized Plant Names, 1942 Edition, prepared by the American Joint Committee on Horticulture Nomenclature. Names not included therein shall conform to names generally accepted in the nursery trade.
2. All seed shall conform to the certifications of the PA Dept. of Agriculture and in addition be labeled in accordance with the USDA Federal Seed Act in effect at the time of planting. No seed will be accepted with a test date more than 9 months before delivery to the site. Seed that is moldy or otherwise damaged will not be accepted.
3. Plant materials shall be of the size and quality set forth in the rules adapted by the American Association of Nurserymen, Inc. and conform to the “American Standard for Nursery Stock”. All

plants shall be supplied from plant hardiness zones 5 or 6, as described in Plant Hardiness Zone Map, USDA-ARS, Miscellaneous Publication No. 814.

4. All plant materials shall be full, well- branched and proportioned, particularly with respect to width and height. Plants shall have well developed branches and vigorous fibrous roots (except unrooted cuttings).Plants shall be free of defects, decay, injury, disease, insect infestation, or objectionable disfiguration.
5. The source(s) of plant materials shall be made known and available for inspection at least one week prior to planting. Plant identification and information labels shall be securely attached to each plant. Plants rejected shall be replaced with acceptable materials.

C. ESTABLISHMENT

1. Plant vegetation at the locations set forth in Section 7.
2. For seeds, where both are required, seed the herbaceous species in strips, with woody species between each strip. Orient strips on the contours, unless otherwise set forth in Section 7. Apply seeds uniformly by drilling, broadcasting, or hydroseeding. Cultipack or track with a tracked-vehicle where slopes allow.
3. For trees and shrubs, follow recommendations in *A guide to: Conservation Plantings in Critical Areas for the Northeast* (http://plant-materials.nrcs.usda.gov//nypmc/).

   Unless otherwise set forth in Section 7, plant conifers at the rate of 680 per acre, deciduous trees at the rate of 435 per acre (spacing 10’ x 10’), shrubs at the rate of 2,700 per acre (spacing 4’ x 4”).
4. For bare root plants, protect the root systems from drying by treating roots with a moisture-retaining gel immediately upon arrival at the planting site.

6. TABLES

See Attached

7. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

TABLE 1: Temporary Cover or Nurse Crop

SPECIES OR MIXTURE	SEEDING RATE (LBS/ACRE)		RECOMMENDED SEEDING DATES PLANT HARDINESS ZONE		ADAPTATION		
	TEMPORARY COVER	NURSE	4 & 5	6 & 7	DROUGHTY	POORLY DRAINED	ACIDITY pH
Redtop	5	3	3/15 – 7/01 8/01 – 9/01	3/01 – 6/15 8/15 – 9/15	X	X	4.0 – 7.5
Annual Ryegrass	40	20	3/15 – 7/01 8/01 – 9/01	3/01 – 6/15 8/15 – 9/15	X	X	5.5 – 7.5
Spring Oats	96	48	3/15 – 7/01	3/01 – 6/15	X		5.5 – 7.0
Sudangrass	40	20	7/01 – 8/01	6/15 – 8/15	X		5.5 – 7.5
Japanese Millet (*Echinochloa frumentacea*)	30	15	7/01 – 8/01	6/15 – 8/15	X		4.5 – 7.0
Winter Rye Grain	168	56	8/01 – 11/01	8/15 – 11/15	X		5.5 – 7.5
Winter Wheat	180	90	8/01 – 11/01	8/15 – 11/15	X		5.0 – 7.0

TABLE 2 - Permanent Cover Grasses and Legumes Seeding Rates
(Use a nurse crop from Table 1 selected for the site conditions)

SPECIES OR MIXTURE[1]	SEEDING RATE (LBS/ACRE)		ADAPTATION		
	PREPARED DRILLED CULTIPACKED	UNPREPARED ADVERSE SITE HYDROSEEDED	DROUGHTY	POORLY DRAINED	ACIDITY pH
1. Tall Fescue	60	75	X	X	4.0 - 8.0
2. Tall Fescue and Red Fescue or Hard Fescue	40 10	60 15	X		5.0 - 7.5
3. Tall Fescue and Birdsfoot Trefoil[2/3]	20 6	30 10	X	X	5.0 - 7.5
4. Birdsfoot Trefoil[2/3] and Hard Fescue or Red Fescue	6 20	10 30	X		5.0 - 7.5
5. Crownvetch[2] and Tall Fescue or Red Fescue or Hard Fescue or Perennial Ryegrass[4]	10 20	15 30		X	6.0 - 7.5
6. Crownvetch[2] and Birdsfoot Trefoil[2/3] and Tall Fescue	10 6 20	15 10 30	X		6.0 -7.5

TABLE 2 - Permanent Cover Grasses and Legumes Seeding Rates cont.
(Use a nurse crop from Table 1 selected for the site conditions)

SPECIES OR MIXTURE[1]	SEEDING RATE (LBS/ACRE)		ADAPTATION		
	PREPARED DRILLED CULTIPACKED	UNPREPARED ADVERSE SITE HYDROSEEDED	DROUGHTY	POORLY DRAINED	ACIDITY pH
7. Flatpea[2/6] and	20	30	X		5.0- 7.5
Tall Fescue or	20	30			
Red Fescue or					
Hard Fescue or					
Perennial Ryegrass[4]					
8. Perennial Pea2/6 and	40	60			5.0-7.5
Tall Fescue or	20	30			
Red Fescue or					
Hard Fescue or					
Perennial Ryegrass[4]					
9. Alfalfa and[2/5]	10	15			6.5 - 7.5
Tall Fescue or	10	15			
Orchardgrass or	3	5			
Timothy[8]	4	6			

SPECIES OR MIXTURE[1]	SEEDING RATE (LBS/ACRE)		ADAPTATION		
	PREPARED DRILLED CULTIPACKED	UNPREPARED ADVERSE SITE HYDROSEEDED	DROUGHTY	POORLY DRAINED	ACIDITY pH
10. Birdsfoot Trefoil[2/3/5] and	6	10			
Tall Fescue or	6	10	X	X	5.0- 7.5
Orchardgrass or	3	5	X		
Timothy	2	3			
11. Perennial Ryegrass[4] and	25	30	X	X	5.0 - 8.0
Tall Fescue or	25	35			5.5 - 7.0
Kentucky Bluegrass	15	20			5.5 - 7.5
12. Switchgrass[5]	10	15	X	X	5.0- 7.5
13. Switchgrass and	10	15	X	X	5.0 -7.5
Birdsfoot Trefoil[2/3]	6	10			
14. Deertongue[5]	15	25	X		3.5 - 7.5
15. Deertongue[5] and	15	25	X		5.0 -7.5
Birdsfoot Trefoil[2/3]	6	10			

Footnotes for Table 2

[1]Consult the Agronomy Guide for cultivar recommendations of forage and turf species. Other species:

- Crownvetch ‘Penn gift’
- Flatpea ‘Lathco’
- Perennial Pea ‘Lancer’
- Switchgrass ‘Blackwell’ - Erosion control
  - ‘Cave-in-Rock’ - Forage
  - ‘Shelter’ - Wildlife
- Deertongue ‘Tioga’

[2]Inoculate legume seeds, use four times the normal rate of inoculate when hydroseeding.

[3]Birdsfoot Trefoil is not recommended in MLRA 148 and 149, where crown and root rots may injure the stand.

[4]Use only the “turf-type” fine-leaved perennial ryegrass varieties

[5]Use these mixtures on gentle, less erosive slopes; must be drilled or broadcast and cultipacked.

[6]Drill ½-inch deep or broadcast flatpea and perennial pea then cultipack.

Table 2a – Grass and Legume Seed Mixtures in Table 2 suitable for various areas or purposes.	
Area/Purpose	Suitable Mixtures (Select One)
Slopes and Banks – non-mowed	
Well drainage	3, 4, 5, 6, 7, 8
Variable drainage	3, 6
Slopes and Banks (mowed)	1, 2, 11
Gullies and eroded areas	3, 4, 5, 6, 7, 8
Conservation Structures	
Sod waterways, spillways, and other frequent waterflow areas	1, 2, 3
Drainage ditches	
Shallow, less than 3 feet	1, 2, 3
Deep, non-mowed	5, 6, 7, 8
Pond banks, dikes, levees, dams, diversion channels, and occasional waterflow areas	
Mowed areas	1, 2, 3, 4, 11
Non-mowed areas	5, 6, 7, 8
Hay or silage on diversion channels and occasional waterflow areas	use adapted hay mixtures or 9, 10
Sanitary landfill areas	3, 4, 5, 6, 12, 13, 14, 15
Strip-mined spoils, mine wastes, fly ash, slag, settling-basin residues, and other severely disturbed areas (lime to soil test)	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,15
Wildlife habitat	9, 10, 12, 13, 14, 15
Effluent Disposal Areas	10, 12, 13
Sand and Gravel Pits	12, 13, 14, 15

Table 2b – SEEDING DATES for species and mixes in Table 2 Permanent Cover Grasses and Legumes		
COOL SEASON PLANTS (MIXES 1 - 12)		
	Hardiness Zone 6 & 7	**Hardiness Zone 4 & 5**
Optimum	03/01- 04/15	03/15 - 05/01
Normal Range	11/15 - 06/15	11/01 - 07/01
	08/15 - 09/15	08/01 - 09/01
Project	11/15 - 09/15	01/01 - 09/01
WARM SEASON PLANTS (MIXES 12 - 15)		
	Hardiness Zone 6 & 7	**Hardiness Zone 4 & 5**
Optimal	03/01- 04/15	03/15 - 05/01
Normal Range	12/01 - 04/15	01/15 - 05/01

Table 3 – Trees suitable for highly disturbed areas

SPECIES	LOWER LIMIT pH TOLERANCE	TOLERANCE TO SHADE[1]	DRAINAGE ADAPTATION	ELEVATION[2]
CONIFERS				
Larch, Japanese	4.0	intermediate	Excessive – poor	
Pine, Austrian	4.0	intermediate	Well	
Pine, Pitch	4.0	intolerant	Excessive – well	Below 3000 feet
Pine, Red	4.0 – 4.5	intolerant	Excessive – well	Above 2000 feet
Pine, Scotch	4.0	intolerant	Well	
Pine, Virginia	4.0	intolerant	Excessive – well	Below 2500 feet
Pine, White	4.5	intermediate	Well – poor	
Spruce, Norway	4.5 – 5.0	tolerant	Well	
Spruce, White	4.5 – 5.0	tolerant	Well - poor	
HARDWOODS				
Alter, European Black	3.5	intolerant	Well-poor	Below 2500 feet
Aspen, Bigtooth	4.0	intolerant	Excessive-well	
Aspen, Quaking	4.0	intolerant	Excessive-well	
Birch, Gray	3.5	intolerant	Excessive-well	
Birch, Sweet	4.0	intermediate	Excessive-well	
Chestnut, Chinese	5.0	intermediate	Well	
Locust, Black[3] 'Steiner'	4.0	intolerant	Excessive-well	Below 3000 feet
Oak, Red	4.0	intermediate	Well	
Oak, Sawtooth 'Gobbler'	5.0	intolerant	Excessive-well	
Poplar, Hybrid	4.0 – 4.5	intolerant	Well	
Poplar, Yellow	4.5	intolerant	Well	Below 3000 feet
Sycamore	4.0 – 4.5	intolerant	Poor	Below 2500 feet

[1]Shade tolerance of species defined as follows: **Tolerant** – can withstand completely shaded conditions; **Intermediate** – partial shade is tolerated; plant requires some sunlight; **Intolerant** – plant requires full sunlight

[2]Blank spaces indicates no restriction: "Below" means that species are to be planted below this elevation

TREE PLANTING DATES: Plant as soon as frost is out of the ground but no later than April 15 in hardiness zones 6 & 7; May 1 in hardiness zones 4 & 5.

TABLE 4: Shrubs suitable for highly disturbed areas					
SPECIES[1]	LOWER LIMIT pH TOLERANCE	TOLERANCE TO SHADE[2]	DRAINAGE ADAPTATION	YEARS TO FRUIT MATURITY	MONTHS OF FRUIT MATURITY
Coral berry	5.0	tolerant	excessive-well	3	September – October
Crabapple	4.5 – 5.0	intolerant	well	3	September – October
Dogwood, Gray	5.0	intermediate	excessive-well	5	September – October
Dogwood, Silky	4.0	tolerant	well-poor	4 – 5	August – September
Honeysuckle, Amur	4.5 – 5.0	intermediate	excessive-well	3 – 4	September – October
Indigobush	4.0	intermediate	excessive-well	3	August
Locust, Bristly	3.5	intolerant	excessive-well	3 – 5	September
Privet, Amur	4.5 – 5.0	tolerant	well	4	September
Sumac, Aromatic	4.5	tolerant	excessive-well	5	July – August
Sumac, Shining	4.0	intermediate	excessive-well	4	September – October
Sumac, Smooth	4.5	intermediate	excessive-well	4	September – October
Viburnurn, Arrowwood	4.5	tolerant	well-poor	3 – 5	September – October
Viburnum, Cranberrybush	4.5	intermediate	well-poor	3 – 5	August – September

[1]Recommended varieties are:

- Crabapple - ‘Midwest’, ‘Roselow’
- Dogwood, Silky - ‘Indigo’
- Honeysuckle, Amur - ‘Rem Red’
- Locust, Bristly - ‘Arnot’
- Sumac, Aromatic - ‘Konza’

[2]Shade tolerance of species defined as follows;

- Intermediate - partial shade is tolerated; plant requires some sunlight
- Intolerant - plant requires full sunlight
- Tolerant - can withstand completely shaded conditions

PLANTING DATES: Plant as soon as frost is out of the ground but no later than:	
HARDINESS ZONE	**DATE**
6 & 7	04/15
4 & 5	05/01

Specific Site Requirements