Irrigation Pipeline

(NRCS Conservation Practice Code 430)

General:

An Irrigation Pipeline and all appurtenances will be designed by a Certified Irrigation Designer (CID) for the conveyance of water for storage or application for the new irrigation system cost-shared thru the local Soil and Water Conservation District (SWCD) as part of the Sustainable Irrigation Expansion Initiative through the PL-566 program in Alabama.

The following documents are to be used in the design of the Irrigation Pipeline:

- Irrigation Pipeline (Code 430) Conservation Practice Standard
- Irrigation Pipeline (430) Statement of Work
- Irrigation Pipeline (430) Construction Specifications

As a minimum, the Irrigation Pipeline design and construction details shall include and/or address:

- The minimum criteria in the Conservation Practice Standard.
- A design package showing all calculations.
- A clear profile and grade of the pipeline system that shows the location of all appurtenances (valves, flow meters, pressure gauges, angles, etc.).
- Type, length and size of mainlines and submains.
- Maximum working pressure of the pipe.
- Requirements for UV protection.
- Pipeline grade.
- Minimum depth of cover over pipe.
- Details of trenching and backfill requirements.
- Details and location of thrust blocks.
- Source of water supply.
- Location and details of filter requirements.
- Location and details of pressure and air relief valves, if required.
- List of materials.

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

IRRIGATION PIPELINE

(Ft.)

CODE 430

DEFINITION

A pipeline and appurtenances installed to convey water for storage or application, as part of an irrigation water system.

PURPOSE

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

- Conveyance of water from a source of supply to an irrigation system or storage reservoir.
- Reduce energy use.
- Develop renewable energy systems (i.e., in-pipe hydropower).

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to water conveyance and distribution pipelines installed above or below ground.

This standard does not apply to multiple outlet irrigation system components (e.g., surface gated pipes, sprinkler lines, or micro irrigation tubing).

CRITERIA

General Criteria Applicable to All Purposes

Federal, State, and Local Laws. All planned activities shall comply with all federal, state, and local laws and regulations.

Cultural Resources. Ground disturbing activities have the potential to affect significant cultural resources. Complete a cultural resources review prior to ground disturbing activities to assure that existing cultural resources will not be adversely impacted.

The water supply, quality, and rate of irrigation delivery for the area served by the pipeline shall be sufficient to make irrigation practical and feasible, for the crops to be grown and the irrigation water application methods to be used.

Pipelines shall be placed only in soils and environmental conditions suitable for the material type being selected.

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. Capacity shall be sufficient to convey the design delivery flow rate for the planned conservation practices.

Design capacity of the pipeline conveyance or distribution system for irrigation systems shall be sufficient to meet the requirements for efficient application based on one of the following:

- Adequate to meet the moisture demands of all crops to be irrigated in the design area.
- Sufficient to meet the requirements of selected irrigation events during critical crop growth periods when less than full irrigation is planned.
- For special-purpose irrigation systems, sufficient to apply a specified amount of water to the design area in a specified operating period.

In computing the above capacity requirements, allowance must be made for reasonable water losses during application or use.

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

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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.

Flexible Conduit Design. 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, and the following criteria:

Smooth Wall Plastic Pipe. When operating at design capacity, the full-pipe flow velocity should not exceed 5 feet per second in pipelines with valves or some other flow control appurtenances placed within the pipeline or at the downstream end. As a safety factor against surge, the working pressure at any point should not exceed 72 percent of the pressure rating of the pipe. If either of these limits is exceeded, special design consideration must be given to the flow conditions, and measures must be taken to adequately protect the pipeline against transient pressures.

Corrugated or Profile Wall Plastic Pipe. When operating at design capacity, the full-pipe flow velocity should not exceed 5 feet per second in pipelines with valves or some other flow control appurtenance placed within the pipeline or at the downstream end. As a safety factor against surge, the working pressure at any point should not exceed 72 percent of the pressure rating of the pipe. If the pipe is not pressure rated, the maximum allowable pressure shall be 25 feet of head, or the maximum pressure as specified by the manufacturer for the pipe and connecting joints used.

Smooth Wall Steel Pipe. The specified maximum allowable pressure shall be determined using the hoop stress formula, limiting the allowable tensile stress to 50 percent of the yield-point stress for the material selected. Design stresses for commonly used steel and steel pipe are shown in the NEH Part 636, Chapter 52.

Corrugated Metal Pipe. Maximum allowable pressure for the pipe shall be:

- 20 feet of head for annular and helical pipe with sealed seams and watertight coupling bands.
- 30 feet of head for helical pipe with welded seams, annular ends, and watertight couplings.

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.

Rigid Conduit Design. Rigid conduits such as concrete pipe or plastic mortar pipe shall be designed using the following criteria:

Non-reinforced Concrete Pipe with Mortar Joints. The maximum allowable pressure for pipe with mortar joints shall not exceed one-fourth of the certified hydrostatic test pressure as determined by the test procedure described in ASTM C118. Nor shall they exceed the following:

Diameter (inches)	Maximum Allowable Pressure (feet)
6 through 8	40
10 and greater	35

Non-reinforced Concrete Pipe with Rubber Gasket Joints. The maximum allowable pressure for non-reinforced concrete pipe with rubber gasket joints shall not exceed one-third the certified hydrostatic test pressure as determined by the test procedure described in ASTM C505. Nor shall they exceed the following:

Diameter (inches)	Maximum Allowable Pressure (feet)
6 through 12	50
15 through 18	40
21 and greater	30

Cast-in-Place Concrete Pipe. Maximum working pressure for cast-in-place concrete pipe shall be 15 feet above the centerline of pipe. Cast–in-place concrete pipe shall be used only in stable soils that are capable of being used as the outside form for approximately the bottom half of the conduit.

Reinforced Concrete Pipe with Gasket Joints. The maximum allowable pressure for reinforced concrete pipe with rubber gasket joints shall be not exceed the rated hydrostatic pressure for the

specified pipe according to appropriate ASTM or AWWA standards.

Reinforced Plastic Mortar Pipe. The pipeline shall be designed to meet all service requirements without a static or working pressure at any point greater than the maximum allowable working pressure of the pipe used. The static or working pressure of pipelines open to the atmosphere shall include free board. The minimum acceptable pipe pressure rating shall be 50 psi.

Support of Pipe. Irrigation 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.

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.

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 irrigation 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 irrigation application 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.

Approved backflow prevention devices (chemigation valves) shall be used on all pipelines in which fertilizer, liquid manure, waste water, pesticides, acids, or other chemicals are added to the water supply and where back flow may contaminate the source water supply or groundwater.

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.

Sand traps, when combined with a stand, shall have a minimum inside dimension of 30 inches and shall be constructed so the bottom is at least 24 inches below the invert of the outlet pipeline. The downward velocity of flow of the water in a sand trap shall not exceed 0.25 feet per second. Suitable provisions shall be made for cleaning sand traps.

The dimensions of gate stands shall be adequate to accommodate the gate or gates required, and shall be large enough to make the gates accessible for repair.

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.

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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.

Air Release Valves. Five types of air vents/valves commonly used on irrigation pipelines are continuous acting air release valves (CAV), vacuum-relief valves (VR), air release and vacuum relief valves (AVR), combination air valves (COMB), and open vents. Open vents are described in the "Vents" section of this standard.

If accumulation of air during operation may occur CAV shall be used to release air from the filled pipeline while under pressure. Normal orifice venting diameter is 1/16 to 3/8 inch.

VR valves shall be used for relief of vacuum pressures (i.e., negative pressures) due to sudden gate or valve closure, pump shutoff, or drainage of the pipeline.

AVR valves may be used for the same requirements described for VR valves. These valves shall also be used to release air from the pipeline on filling prior to the pipe being pressurized. They shall be used to alleviate flow restrictions, air locks, and water surging due to the presence of air within pipelines.

COMB valves have the combined function of all three valves (CAV, VR, and AVR) in one body. COMB valves may be used for any of the conditions in which a CAV, VR, or AVR is required.

If needed to provide positive means for air escape during filling and air entry while emptying, an AVR, VR, or COMB valve shall be installed at all summits, upstream and downstream of all in line valves as needed, at the entrance, and at the end(s) of the pipelines. Such valves are needed at these locations if the pipeline is closed to the atmosphere. However, they may not be needed if other features of the pipe system, such as permanently located sprinkler nozzles or other unclosed service outlets, adequately vent the particular location during filling and emptying operations. The use of these system features must be analyzed for air flow rate and the proper use of such features described in the Operation and Maintenance plan. High points in the pipeline require a CAV unless an outlet is located at that point.

In addition to the locations described above, an AVR or COMB valve shall be located at changes of grade in downward direction of flow in excess of 10 degrees, to ensure adequate air release during filling. On long pipelines, additional AVR or COMB valves may be required to adequately vent the pipe during filling.

For air release, the AVR or COMB valve shall be sized to exhaust air from the pipeline at the rate needed to prevent operational problems with the pipeline, while maintaining the proper operation of the valve. For design purposes, the exhaust pressure differential shall be limited to 2 psi.

For vacuum relief, the AVR, VR, or COMB valves shall be sized for air entry into the pipeline, ensuring the pipeline does not collapse due to vacuum created during drainage of the pipeline. For design purposes, the vacuum pressure differential shall be limited to 5 psi.

If the required vacuum relief orifice diameter is significantly larger than the required air release orifice diameter, separate valves may be required to help eliminate excessive water hammer caused when the air is released too fast from the pipeline.

CAV or COMB valves shall be used as needed to permit air to escape while the line is at working pressure. Small orifices of these valve types shall be sized according to the design working pressure and venting requirements recommended by the valve manufacturer.

The location of the CAV or COMB valves shall be sufficient distance downstream from the introduction of air into the system (under pressure conditions) to allow the air to be collected at the top of the pipe. Under some circumstances (e.g., pumped system with low pressure or velocity) consideration should be given to installing vent

chambers for CAV or COMB valves. The vent chamber should be constructed according to the requirements under the second criteria in the "Vents" section of this standard.

In lieu of a detailed design, for the corresponding pipe material below, the following size air valves shall be used:

For Plastic ≤ 50 psi - 0.22 x pipe diameter

For Plastic > 50 psi - 0.10 x pipe diameter

For Metal - 0.125 x pipe diameter

For Concrete - 0.125 x pipe diameter

Manufacturers of air valves marketed for use under this standard shall provide dimensional data or a capacity table based on performance tests, which shall be the basis for selection and acceptance of these valves.

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.

Outlets. Appurtenances to deliver water from the pipe system to the field, ditch, reservoir, or surface pipe system, are known as outlets. Outlets shall have adequate capacity to deliver the required flow to:

- The hydraulic gradeline of a pipe or ditch,
- A point at least 6 inches above the field surface,
- The design surface elevation in a reservoir, or
- An individual sprinkler, lateral line, hydrant, or other device at the required operating pressure.

Outlets shall be designed to minimize erosion, physical damage, or deterioration due to exposure.

Filling. The pipe system shall have a means of controlling the filling of the pipeline to prevent entrapped air and excessive transient pressures.

Filling velocities greater than 1 foot per second in a closed to the atmosphere pipe system (i.e., all outlets closed) requires special evaluation and provisions to remove entrapped air and prevent transient pressures.

If filling at a low flow rate is not possible, the system shall be open to the atmosphere (outlets open) prior to pressurizing. The valves to the irrigation system components (gated pipe, wheel line, pivot, etc.) should be opened to release entrapped air and minimize transient pressures in the system. The system shall be designed for air removal and excessive transient pressures that may develop at higher filling rate.

Flushing. If the sediment load in the water is significant, the pipeline shall have adequate velocity to ensure that sediment is moved through and flushed out of the pipeline.

If provisions are needed for flushing sediment or other foreign material, a suitable valve shall be installed at the distant end or low point of the pipeline.

Draining. Provisions shall be made for the complete removal of water from the pipeline by gravity or other means when:

- Freezing temperatures are a hazard.
- Draining is required by the pipe manufacturer.
- Draining of the pipeline is otherwise specified.

The water drained from pipelines shall not cause water quality, soil erosion, or safety problems upon release.

Safe Discharge of Water. Provisions shall be made for water being discharged from valves, especially air valves and pressure relief valves. Such valves shall be located such that flows are directed away from system operators, livestock, electrical equipment, and other control valves or hook-ups.

Thrust Control. Abrupt changes in pipeline grade, horizontal alignment, tees, or reduction in pipe size, normally require an anchor or thrust blocks to absorb pipeline axial thrust. Thrust control is typically needed at the end of the pipeline, and at in-line control valves.

The pipe manufacturer's recommendations for thrust control shall be followed. In absence of manufacturer's data, thrust blocks shall be designed using NEH Part 636, Chapter 52.

Longitudinal Bending. For plastic pipe, the allowable longitudinal bending for the pipeline shall be based on material type and the pressure rating, and shall be in accordance with industry standards, or as described in NEH Part 636 Chapter 52.

Thermal Effects. For plastic pipe, thermal effects must be properly factored into system design. Pressure ratings for pipes are normally based on a pipe temperature of 73.4°F. 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.

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

Plastic pipe installed above ground shall be resistant to ultraviolet light throughout the intended life of the pipe or measures taken to protect the pipe from damage due to ultraviolet light.

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

Corrosion Protection. 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).

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.

Interior protective coatings shall be provided when the pH of the water falls outside the ranges shown in the following table.

Material	Water pH
Aluminized Steel	Less than 5 or greater than 9
Galvanized Steel	Less than 6 or greater than 10
Aluminum Alloy	Less than 4 or greater than 10

Unlined steel pipelines can experience corrosion from very pure water (e.g., snow melt). If the Langelier Saturation Index (LSI) is a greater negative number than -1, corrosion protection shall be provided.

To calculate the LSI, it is necessary to know the alkalinity (mg/l as CaCO3), the calcium hardness (mg/l Ca+2 as CaCO3), the total dissolved solids (mg/l TDS), the actual pH, and the temperature of the water (°C). These values are used in the following equations:

$LSI = pH - pH_s$

$pH_s = (9.3 + A + B) - (C + D)$

Where:

$A = (\text{Log10 [TDS]} - 1) / 10$

$B = -13.12 \times \text{Log10 (°C} + 273) + 34.55$

$C = \text{Log10 [Ca}^{+2} \text{ as CaCO}_3\text{]} - 0.4$

$D = \text{Log10 [alkalinity as CaCO}_3\text{]}$

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Galvanized steel pipe may be used when the soil resistivity is greater than 4000 ohm-cm.

Hot-dipped asphalt or polymeric-coated, galvanized steel pipe shall be provided if the soil resistivity along any part of the pipeline is between 3000 and 4000 ohm-cm. In addition to the above coatings, cathodic protection shall be provided for galvanized steel pipe if the soil resistivity is less than 3000 ohm-cm.

Aluminized steel pipe may be used when the soil resistivity is greater than 1500 ohm-cm and the soil pH is between 5 and 9.

Aluminum alloy pipe may be used when the soil resistivity is greater than 500 ohm-cm and the soil pH is between 4 and 10.

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.

Resistivity Measurement Requirements for Metal Pipe. If risk of corrosion is "high" based on the Cooperative Soil Survey's Soil Features Report, soil-resistivity measurements shall be conducted to determine corrosion protection requirements. .For this purpose, field resistivity measurements shall be made or samples for laboratory analysis shall be taken at least every 400 feet along the proposed pipeline and at points where a visible change in soil characteristics occurs. If adjacent readings differ markedly, additional measurements shall be taken to locate the point of change. Resistivity determinations shall be made at two or more depths in the soil profile at each sampling station; with the lowest depth at the stratum in which the pipe will be laid. The lowest value of soil resistivity found at each sampling station shall be used as the design value for that station.

After the pipe trench is excavated, a detailed soil resistivity survey shall be made as a verification of the final required cathodic protection. At this time, resistivity measurements shall be made in each exposed soil horizon at intervals not exceeding 200 feet. The lowest value of soil resistivity found at each sampling station shall be used as the design value for that station. If design values for adjacent stations differ significantly, additional intermediate measurements shall be made.

Electric Fields. An electric field can develop where a metal pipeline is installed adjacent to an existing metal pipeline. This situation can adversely affect the new pipeline. The new pipeline shall be adequately protected from this condition.

Environmental Constraints for Aluminum Pipe. Water quality shall be considered for aluminum pipeline installations. A copper content in excess of 0.02 ppm produces nodular pitting and rapid deterioration of the pipe if water is allowed to become stagnant. When the copper content exceeds this limit, the pipeline shall be designed to allow draining after each use.

Protection from corrosion shall be provided for aluminum pipe installed in contact with concrete.

Environmental Constraints for Concrete Pipe. Concrete pipelines shall not be installed on sites where the sulfate-salt concentration in the soil or soil water exceeds 1.0 percent. On sites where the sulfate concentration is more than 0.1 percent but not more than 1.0 percent, concrete pipe may be used only if the pipe is made with Type V or Type II cement, with tricalcium aluminate content not exceeding 5.5 percent.

Additional Criteria Applicable to Reduce Energy Use

Provide analysis to demonstrate reduction of energy use from practice implementation.

Reduction of energy use is calculated as average annual or seasonal energy reduction compared to previous operating conditions.

Additional Criteria Applicable to Develop Renewable Energy Systems

Renewable energy systems shall meet applicable design criteria in NRCS and/or industry standards, and shall be in accordance with manufacturer's recommendations. Hydropower systems shall be designed, operated, and maintained in accordance with the Microhydropower Handbook, Sections 4 and 5, as appropriate.

CONSIDERATIONS

Safety. Pipelines may present a threat to the safety of people, during both installation and operation. Consider safety as follows:

- Address trench safety in design and during construction.
- Provide protection for people from inlets of pipelines and open stands.
- Provide protection for people from water blowing from pressure-relief, air-release, and other valves.
- Determine the existence or non-existence of underground utilities prior to construction.

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.

Water Quality and Quantity. The effects of an irrigation pipeline on water quality and quantity should be considered when designing an irrigation pipeline. Consider the effects:

- On the water budget, especially on infiltration and evaporation,
- On downstream flows or aquifers that would affect other water uses or users,
- On potential use for irrigation management,
- Of installing a pipeline in vegetation that may have been located next to the original conveyance,
- Of installing the pipeline (replacing other types of conveyance) on channel erosion or the movement of sediment and soluble and sediment-attached substances carried by water,
- On the movement of dissolved substances into the soil and on percolation below the root zone or to ground water recharge,
- Of controlled water delivery on the temperatures of water resources that could cause undesirable effects on aquatic and wildlife communities,
- On wetlands or water-related wildlife habitats, and
- On the visual quality of water resources.

Environment. 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.

The Langelier Saturation Index and related indices may be a factor in determining type of material to use for a pipeline.

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.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for irrigation pipelines that describe the requirements for applying the practice according to this standard. As a minimum the plans and specifications shall include:

- A plan view of the layout of the pipeline.
- Profile of the irrigation pipeline.
- Pipe material and sizes.
- Pipe joint requirements.
- Site specific construction specifications that describe in writing the installation of the irrigation pipeline. Include the specification for pressure testing of the irrigation pipeline.
- Depth of cover and backfill requirements.
- Disposal requirements for excess soil material.
- Vegetative establishment requirements.

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) Plan shall be developed for each pipeline system installed. The plan should document needed actions to ensure that practices perform adequately throughout their expected life.

O&M requirements shall be included as an identifiable part of the design. Depending on the

scope of the project, this may be accomplished by brief statements in the plans and specifications, the conservation plan narrative, or as a separate O&M Plan.

Other aspects of O&M, such as draining procedures, marking crossing locations, valve operation to prevent pipe or appurtenant damage, appurtenance or pipe maintenance, and recommended operating procedures, should be described as needed within the O&M Plan.

Monitoring of any cathodic protection systems shall be performed as specified in the O&M Plan.

A filling procedure shall be developed, which details allowable flow rates and appurtenance operation at the various phases of the filling process, required to assure safe filling of the pipeline. Flow measuring appurtenances such as flow meters or weirs, or other means (e.g., number of turns of a gate valve) should be used to determine the rate of flow into the pipeline system. This information shall be provided to the operator, and shall be incorporated into the Operation and Management Plan as appropriate.

REFERENCES

ASTM C118, Standard Specification for Irrigation Pipe for Irrigation or Drainage.

ASTM C505, Standard Specification for Nonreinforced Concrete Irrigation Pipe with Rubber Gasket Joints.

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

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

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

STATEMENT OF WORK
Irrigation Pipeline (430)
Alabama

These deliverables apply to this individual practice. For other planned practice deliverables refer to those specific Statements of Work.

DESIGN

Deliverables

1. Design documentation that will demonstrate that the criteria in Alabama NRCS practice standard have been met and are compatible with other planned and applied practices
    a. Practice purpose(s) as identified in the conservation plan
    b. List of required permits to be obtained by the client
    c. Compliance with NRCS national and state utility safety policy (NEM Part 503-Safety, Subpart A - Engineering Activities Affecting Utilities 503.00 through 503.06)
    d. Practice standard criteria related computations and analyses to develop plans and specifications including but not limited to:
        i. Alabama Supplement, National Engineering Field Handbook (NEFH), Part 650 Chapter 1
        ii. Capacity
        iii. Hydraulics and Appurtenance Design
        iv. Trench and Backfill Requirements
        v. Materials
        vi. Vegetation
2. Written plans and specifications including sketches and drawings shall be provided to the client that adequately describes the requirements to install the practice and obtain necessary permits.
3. Design Report and Inspection Plan as appropriate (NEM Part 511, Subpart B Documentation, 511.11 and Part 512, Subpart D Quality Assurance Activities, 512.30 through 512.32)
4. Operation and Maintenance Plan
5. Certification that the design meets practice standard criteria and comply with applicable laws and regulations (NEM Subpart A, 505.03 (a) (3))
6. Design modifications during installation as required

INSTALLATION

Deliverables

1. Pre-Installation conference with client and contractor.
2. Verification that client has obtained required permits.
3. Staking and layout according to plans and specifications including applicable layout notes.
4. Installation inspection (according to inspection plan as appropriate)
    a. Actual materials used (Part 512, Subpart D Quality Assurance Activities, 512.33)
    b. Inspection records
5. Facilitate and implement required design modifications with client and original designer.
6. Advise client/NRCS on compliance issues with all federal, state, tribal, and local laws,

regulations and NRCS policies during installation.

7. Certification that the installation process and materials meet design and permit requirements.
8.

CHECK OUT

Deliverables

1. Check out notes as specified in the Alabama Supplement, NEFH, Part 650 Chapter 1
2. As-Built documentation
    a. Extent of practice units applied
    b. Drawings
    c. Final quantities
2. Certification that the installation meets Alabama NRCS standards and specifications and is in compliance with permits (NEM Subpart A, 505.03 (c) (1))
3. Progress reporting

REFERENCES

- Alabama NRCS Field Office Technical Guide (eFOTG), Section IV, Conservation Practice Standard - Irrigation Pipeline, Code 430
- NEFH, Part 650 Chapter 1, Procedure for Documenting, Planning, Design, Construction, and Checkout of Engineering Conservation Practices.
- NRCS National Engineering Manual (NEM)
- NRCS National Environmental Compliance Handbook
- NRCS Cultural Resources Handbook

STATE CONTACT

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NATURAL RESOURCES CONSERVATION SERVICE
ALABAMA
CONSERVATION PRACTICE CONSTRUCTION SPECIFICATION
IRRIGATION PIPELINE, CODE 430

1. SCOPE

   This specification covers the installation of an irrigation pipeline. The work shall consist of furnishing all materials, labor, and equipment necessary for and installing pressurized plastic pipe, fittings, and appurtenances as specified.

2. LOCATION

   The pipeline shall be located as shown on furnished drawings or as staked in the field.

3. SAFETY

   Landowners or operators, sponsoring organizations, and/or contractors shall be liable for damage to utilities and damage resulting from disruption of service caused by construction activities.

   It is the responsibility of the installer to determine if there are buried or overhead utilities in the vicinity of the proposed work. The installer is required to call Alabama 811 for utilities to be located prior to commencing construction. They shall follow proper procedures to insure that the utilities are not jeopardized and that equipment operators and others will not be injured during construction operations. They will conduct all work and operations in accordance with the proper safety codes for the types of construction being performed with due regard to the safety of all persons and property.

   The Natural Resources Conservation Service (NRCS) makes no representation on the existence or non-existence of any utilities. Absence of utilities on the drawings is not assurance that no utilities are present at the site.

4. CONSTRUCTION OPERATIONS

   NRCS should be notified at least 72 hours before construction operations.

   Construction operations shall be carried out in such a manner and sequence that erosion and air and water contamination are minimized and held within legal limits.

   The owner, operator, contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

5. PERMITS

   The owner will be responsible to obtain all required permits. All required permits must be obtained prior to the start of construction.

   All permits required to install and operate this irrigation system shall be the responsibility of owner.

6. INSTALLATION

Installation and materials shall meet Alabama NRCS conservation practice standard, Irrigation Pipeline, Code 430.

The installer (if not the owner) shall furnish a written guarantee to the owner that protects the owner against defective workmanship and materials for no less than one year. Copies shall be provided to NRCS.

Minimum Depth of Cover. The depth of cover for the pipe shall be as shown on the drawings or as specified in the Construction Details.

Where the depth of cover is not specified, the pipe shall be installed at sufficient depth below the ground surface to provide protection from hazards imposed by traffic crossings, farming operations, freezing temperatures, or soil cracking. The minimum depth of cover for pipe subject to any of these hazards shall be 30 inches.

In areas where the pipe will not be susceptible to freezing and vehicular or cultivation hazards, and the soils do not crack appreciably when dry, the minimum depth of cover may be reduced to 24 inches.

At low places on the ground surface, extra fill shall be placed over the pipeline to provide the minimum depth of cover. The top width of the fill shall be no less than 10 feet and the side slopes no steeper than 6:1. Where needed, extra protection may be provided at vehicle crossings with encasement pipe or other approved methods. All crossings of public roads shall be made using encasement pipe and in accordance with applicable city, county, state or federal codes. All necessary permits will be obtained before construction is initiated.

Trench Construction. The trench at any point below the top of the pipe shall be only wide enough to permit the pipe to be easily placed and joined and to allow the initial backfill material to be uniformly placed under the haunches and along the sides of the pipe. The maximum trench width shall be 36 inches. If the trench is precision excavated and has a semi-circular bottom that closely fits the pipe, the width shall not exceed the outside diameter of the pipe by more than 10 percent.

The trench bottom shall be uniform so that the pipe lays on the bottom without bridging. Clods, rocks, and uneven spots that can damage the pipe or cause no uniform support shall be moved.

If rocks, boulders, or any other material that can damage the pipe are encountered, the trench bottom shall be undercut a minimum of 4 in. below final grade and filled with bedding material consisting of sand or compacted fine-grained soils.

Provisions shall be made to insure safe working conditions where unstable soil, trench depth, or other conditions can be hazardous to personnel working in the trench.

Placement. Pipe shall be installed to the lines, grades, and spacings as shown on the drawings.

service. Partial backfills needed to hold the pipe in place during testing shall be placed as specified in "Initial Backfill". Any leaks shall be repaired and the system retested.

The pipeline shall be tested to insure that it functions properly at design capacity. At or below design capacity there shall be no objectionable flow conditions. Objectionable flow conditions shall include water hammer, continuing unsteady delivery of water, and damage to the pipeline, or detrimental discharge from control valves.

If requested by the state conservation engineer, a qualified testing laboratory must certify with supporting test results that the pipe meets the requirements specified in this standard. The seal of approval of a recognized laboratory or pipe bearing one of the ASTM designations listed in this standard may be accepted for this certification.

Initial Backfill. Hand, mechanical, or water packing methods may be used.

The initial backfill material shall be soil or sand that is free from rocks or stones larger than 1 inch in diameter. At the time of placement, the moisture content of the material shall be such that the required degree of compaction can be obtained with the backfill method to be used. The initial backfill material shall be placed so that the pipe will not be displaced, excessively deformed, or damaged.

If backfilling is done by hand or mechanical means, the initial fill shall be compacted firmly around and above the pipe as required to provide adequate lateral support to the pipe.

If the water packing method is used, the pipeline first shall be filled with water. The initial backfill before wetting shall be of sufficient depth to insure complete coverage of the pipe after consolidation. Water packing is accomplished by adding enough water to diked reaches of the trench to thoroughly saturate the initial backfill without excessive pooling. After the backfill is saturated, the pipeline shall remain full until after the final backfill is made.

The wetted fill shall be allowed to dry until firm before beginning the final backfill.

Final Backfill. The final backfill material shall be free of large rocks, frozen clods, and other debris greater than 3 in. in diameter. The material shall be placed and spread in approximately uniform layers so that there will be no unfilled spaces in the backfill and the backfill will be level with the natural ground or at the design grade required to provide the minimum depth of cover after settlement. Rolling equipment shall not be used to consolidate the final backfill until the specified minimum depth of cover has been placed.

All special backfilling requirements of the pipe manufacturer shall be met.

7. MATERIALS

Quality of plastic pipe. All mains and submains, fittings, valves, vacuum breakers, and other system components shall be of the size and type of material as specified on the drawings. The installer shall certify that his/her installation complies with this specification and the standard listed above..

Markings. Markings on the pipe shall include the following, which shall be spaced at intervals of not more than 5 ft:

1. Nominal pipe size (for example, 2 in).
2. Type of plastic pipe material, by designation code(for example, PVC 1120).
3. Pressure rating, in lb/in^2, for water at 23°C (73.4°F)(for example, 160 lb/in^2).
4. Specification designation with which the pipe complies:
   a. For IPS-size pipe, the ASTM designation (for example, D-2241). Pipe meeting one of the ASTM designations listed for IPS-size pipe and intended for the transport of potable water shall also be marked with the seal of a recognized laboratory making the evaluation for this purpose.
   b. For plastic irrigation pipe, the designation PIP.
5. Manufacturer's name (or trademark) and code.

All materials shown on the drawings or in the Construction Details of the specifications shall conform to the minimum requirements under this construction specification.

Fittings and couplers. All fittings and couplers shall meet or exceed the same strength requirements as those of the pipe and shall be made of material that is recommended for use with the pipe.

Listed below are the ASTM standard specifications for fittings suitable for use with IPS-size pipe and inside diameter controlled PE pipe covered by this standard:

D-2466 Socket-type Polyvinyl chloride (PVC) Plastic Pipe, Schedule 40

D-2467 Socket-type Polyvinyl chloride (PVC) Plastic Pipe, Schedule 80

D-2468 Socket-type Acrylonitrile-Butadiene-Styrene (ABS) Plastic Fittings, Schedule 40

D-2609 Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe

D-2683 Socket-type Polyethylene Fittings for SDR 11.0 Polyethylene Pipe

D-3139 Standard Specification for Plastic Pressure Pipe using Flexible Elastomeric Seals

D-3261 Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

Plastic irrigation pipe (PIP) shall have belled ends or separate couplers and fittings that are suitable for joining the pipe and appurtenances by solvent cement, rubber gaskets, or other methods recommended by the pipe manufacturer. Such fittings and joints shall be capable of withstanding a working pressure equal to or greater than that for the pipe.

Solvent cement joints. Solvent for solvent cement joints shall conform to ASTM Specification D-2564 for PVC pipe and fittings and to D-2235 for ABS pipe and fittings. Solvent cement joints shall be used and constructed according to the recommendations of the pipe manufacturer.

Rubber gasket joints. Rubber gasket joints shall conform to ASTM Specification D-3139.

Fittings made of steel or other metals susceptible to corrosion shall be adequately protected by being wrapped with plastic tape or by being coated with a substance that has high corrosion-preventative qualities. If plastic tape is used, all surfaces shall be thoroughly cleaned and coated with a primer compatible with the tape before wrapping.

8. WORKMANSHIP

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

The installing contractor shall certify that his installation complies with the requirements of this standard. The certification identifies the manufacturer and markings of the pipe used.

9. BASIS OF ACCEPTANCE

The acceptability of this practice shall be determined by **inspections** to insure compliance with all the provisions of this specification and to the drawings. Installation shall be approved by an NRCS employee with appropriate engineering job approval authority or Technical Service Providers.

Sprinkler System

(NRCS Conservation Practice Code 442)

General:

A Sprinkler System and all appurtenances will be designed by a Certified Irrigation Designer (CID) for the distribution of water by nozzles for the new irrigation system cost-shared thru the local Soil and Water Conservation District (SWCD) as part of the Sustainable Irrigation Expansion Initiative through the PL-566 program in Alabama. The center pivot irrigation sprinkler system will be considered a low-pressure drop-nozzle system.

The following documents are to be used in the design of the Irrigation Pipeline:

- Sprinkler System, (Code 442) Conservation Practice Standard
- Sprinkler System (442) Statement of Work
- Sprinkler System (442) Construction Specifications

As a minimum, the Sprinkler System design and construction details shall include and/or address:

- The minimum criteria in the Conservation Practice Standard.
- A design package showing all calculations.
- A determination of the adequacy of the water supply during drought conditions.
- Design maximum application rate to be consistent with soil intake rate, slope, and conservation practices used on the land so that the sprinkler application rate does not exceed the soil infiltration rate.
- Determine Coefficient of Uniformity (CU) of at least 85 % using the Heermann-Hein weighted area method for a center pivot.
- List of materials.
- Manufacturer's operating instructions for the pivot.
- Warranty information.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

SPRINKLER SYSTEM

(Acre)

CODE 442

DEFINITION

A distribution system that applies water by means of nozzles operated under pressure.

PURPOSE

This practice is applied as part of a conservation management system to accomplish one or more of the following:

- Efficient and uniform application of water on irrigated lands
- Improve plant condition, productivity, health and vigor
- Prevent the entry of excessive nutrients, organics, and other chemicals in surface and groundwater
- Improve condition of soil contaminated with salts and other chemicals
- Reduce particulate matter emissions to improve air quality
- Reduce energy use

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to the planning and functional design of all sprinkler system components (e.g., laterals, risers, nozzles, heads, and pressure regulators).

Individual sprinkler design discharge rates covered by this standard typically have design nozzle discharge rates exceeding 1 gallon per minute and wet the entire field surface uniformly.

Areas must be suitable for sprinkler water application, and have a water supply of adequate quantity and quality for intended purpose(s).

This standard applies to planning and design of sprinkler application systems for:

- meeting crop water demands
- crop cooling, frost protection, or bloom delay
- leaching or reclamation of saline or sodic soils, or soils contaminated by other chemicals that can be controlled by leaching
- application of chemicals, nutrients, and/or waste water
- dust and particulate control from:
    - confined animal pen areas
    - unpaved road
    - staging areas
    - equipment storage yards

This standard applies to re-nozzling existing sprinkler systems to reduce pressure, reduce flow rate, or increase distribution uniformity.

This standard does not include criteria for mini- or micro-sprinkler systems, which are covered by Alabama NRCS Conservation Practice Standard (CPS) Code 441, Irrigation System, Microirrigation.

CRITERIA

General Criteria Applicable to All Purposes

The sprinkler system must be an integral part of a conservation plan that addresses intended purpose(s) and operator needs. Base system selection on site evaluation, operating conditions, soils, and topography. Design sprinkler positions, flow rates, and operating pressures within manufacturers' recommended ranges.

System Capacity. Sprinkler capacity must be adequate to accomplish the primary purpose(s) of the system. Determine capacity based on appropriate design application efficiency. Select design application efficiency based on system type and purpose.

In computing capacity requirements, provide an allowance for reasonable application water losses, system maintenance downtime, and auxiliary water requirements such as leaching.

Criteria Applicable to Efficient and Uniform Application of Water on Irrigated Lands.

Design Application Rate and Depth. Select application rates and depths that will minimize runoff, translocation of water or soil, and deep percolation (except for planned leaching).

Design maximum application rate to be consistent with soil intake rate, slope, and conservation practices used on the land. If sprinkler design application rate exceeds soil infiltration rates, use boom backs or additional storage features such as furrow dikes and enhanced residue management to minimize runoff. In lieu of approved runoff model simulation results (e.g., CP® Nozzle), use field observations to assess the need for runoff prevention measures.

Distribution Patterns, Nozzle Spacing, and Height. Select a combination of sprinkler spacing, nozzle sizes, and operating pressures that provide the design application rate and a uniform distribution.

Use coefficient of uniformity (CU) data or distribution uniformity (DU) as defined in NRCS (1983) when selecting sprinkler spacing, nozzle size, and operating pressure.

Center Pivot and Linear Move Systems

For center pivot and linear move systems, select sprinkler spacing, nozzle height, and operating pressure to provide required CU. For center pivots, compute CU using the Heermann-Hein weighted area method. For linear systems, compute CU using equivalent unit areas (Christensen method). The minimum CU value for a pivot or linear move system is 85 percent (76% DU). Use Center Pivot Evaluation and Design (CPED) software, or other NRCS approved modeling software to estimate CU values when manufacturer provided CU information is not available. Limit nozzle spacing and pressures to within manufacturer's recommended ranges.

For center pivot and linear move systems with nozzles that operate in canopy for 50 percent or more of the growing season, nozzle spacing shall not exceed every other crop row or 80 inches maximum. Avoid placing nozzles at heights of high leaf concentration (e.g., avoid sprinkler height in corn near ear height, approximately 4 feet). Use nozzle heights higher or lower than high leaf concentration areas. Do not use in-canopy operation on narrow-and ultra-narrow row plantings.

Low Energy Precision Application (LEPA)

Do not exceed a nozzle spacing of 80 inches. Discharge water through a sock or hose dragged on the ground, or through a nozzle with a bubble shield or pad set at a uniform height of 18 inches or less.

LEPA systems are only applicable on crops planted with furrows or beds. LEPA systems shall have row patterns that match the lateral line movement (e.g., circular for center pivots and straight row for linear move). Do not irrigate tower wheel tracks. Eliminate runoff and water translocation under LEPA systems by appropriate methods such as furrow dikes, dammer dikes, implanted reservoirs, or residue management.

Fixed-Solid-set, Big Gun, Periodic Move, and Traveling Sprinkler Systems

For fixed-solid-set, big gun, and periodic move sprinkler systems, CU (or DU) data shall be used when selecting sprinkler spacing, nozzle size, and operating pressure. CU shall not be less than 75 percent (60% DU) for deep-rooted (4 feet or more) field and forage crops where fertilizers and pesticides are not applied through the system, and 85 percent (76% DU) for high-value or shallow-rooted crops and for any crop where fertilizer or pesticides are applied through the system. Comply with tables 1a and 1b if CU/DU data is not provided.

Table 1a. Maximum Spacing for Fixed Solid-set, Big Gun and Periodic Move Sprinklers with Rectangular Pattern

Sprinkler Classification & (Operating Pressure)	Average Wind Velocity (mph)	Lateral Spacing (percent)*	Sprinkler Spacing (percent)*
Low (2 – 35 psi), Moderate (35 – 50 psi), Medium (50 – 75 psi)	0 to 1	65	50
	1 to 5	60	50
	5 to 10	50	50
	> 10	45	50
	Average Wind Velocity (mph)	Maximum diagonal distance between sprinkler locations on adjacent laterals (percent)*	
High (> 75 psi)	0 to 4	65	
	4 to 10	50	
	> 10	30	
* Percent of Wetted diameter when operating at design pressure based on manufacturer's performance tables			

Table 1b. Maximum Spacing for Fixed Solid-set, Big Gun and Periodic Move Sprinklers with Triangular Pattern

Sprinkler Classification & (Operating Pressure)	Average Wind Velocity (mph)	Lateral Spacing (percent)*	Sprinkler Spacing (percent)*
Low (2 – 35 psi), Moderate (35 – 50 psi), Medium (50 – 75 psi)	0 to 1	70	65
	1 to 5	65	65
	5 to 10	54	65
	> 10	48	65
* Percent of Wetted diameter when operating at design pressure based on manufacturer's performance tables			

For traveling sprinkler irrigation systems use Table 2 for towpath spacing.

Table 2 - Towpath Spacing for Traveling Sprinkler Systems (expressed as percent of wetted diameter*).

Average Wind Velocity (mph)	Ring Nozzle	Tapered Nozzle
0 to 1	80	80
1 to 6	70	75
6 to 10	60	65
> 10 **	50	55

** Because the distribution pattern of traveling systems is seriously affected by wind, operation in winds greater than 10 mph is not recommended.

Land Slope. Field slope for a LEPA system shall not exceed 1percent on more than 50 percent of the field with a maximum slope of 3 percent. Field slopes for other center pivot or linear move systems with sprinklers on drops shall not exceed 3 percent on more than 50 percent of the field for fine and moderately fine soils, as described in the National Engineering Handbook, Part 652, National Irrigation Guide, Table 2-5. On coarser soils, analyze how runoff will be controlled on center pivot or linear move systems installed on slopes greater than 5 percent. Base the analysis on field observations or approved runoff models (e.g. CP® Nozzle).

Regardless of soil texture, field slopes shall not exceed 3 percent on more than 50 percent of the field for center pivot or linear move systems that operate sprinklers within the crop canopy for 50 percent or more of the growing season,

Maximum field slopes for center pivot or linear move systems shall not exceed manufacturer's slope limitations based on pivot profile, span length, pipe diameter, and tire size.

Pressure Regulators. In absence of manufacturer's recommendations for pressure regulator operation, ensure line pressure upstream of all regulators is at least 5 psi above rated regulator pressure.

Linear Move/Periodic Move Lateral Lines. Unless pressure reducers or regulators are installed at each outlet, or other pressure compensating or flow control devices are used, lateral lines shall be designed so that pressure variation along the lateral line does not exceed 20 percent (or 10% of design flow) of average design operating pressure.

Risers. Except for under-tree operation, place the riser pipes used on lateral lines high enough to prevent interference with the distribution pattern when irrigating the tallest crop. Riser heights shall not be less than shown in table 3.

Table 3 - Riser heights

Sprinkler discharge (gallons/minute)	Riser height* (inches)
Less than 10	6
10-25	9
25-50	12
50-120	18
More than 120	36

* Risers over 3 feet in height shall be anchored and stabilized.

Additional Criteria Applicable to Improve Plant Condition, Productivity, Health and Vigor

Design Capacity. As a minimum, use peak daily evapotranspiration for design capacity on sprinkler systems used for soil cooling.

Sprinkler systems used for foliar cooling, shall have sufficient capacity to satisfy the crop's evaporative demand on a minute-by-minute basis throughout peak use hours during peak use days.

The design capacity for systems used for cooling or frost protection shall be adequate to allow water application to the entire area simultaneously.

Design Application Rate. For frost protection base application rate on minimum air temperature, maximum anticipated wind speed and relative humidity. Design sprinkler system

uniformity coefficient of not less than 85 percent. For undertree sprinkling, use design application rates in the range of 0.08 to 0.12 in/hr. For overtree sprinkling, use design application rates ≥ 0.15in/hr.

Additional Criteria Applicable to Prevent the Entry of Excessive Nutrients, Organics and Other Chemicals in Surface and Ground Water.

Comply with all Federal, State, and local laws, rules, and regulations regarding backflow and anti-siphon prevention measures on the installation and operation of a sprinkler system designed for the purpose of chemical, nutrient, or wastewater application. Protect surface waters from direct chemical, nutrient, or wastewater applications.

Locate injector (for chemical, fertilizer or pesticide) and other automatically operating equipment adjacent to the pump and power unit and installed in accordance with state regulations, or lacking the same, in compliance with manufacturer's recommendation. The chemical injection device shall be accurate to within 1 percent of maximum injection rates, and easily calibrated and adjustable for all chemicals and all injection rates.

Design sprinkler irrigation systems used to apply wastewater with inlet filtration or with sprinkler nozzles of sufficient size to prevent clogging.

Design Application Rate and Timing. Application rates shall follow label recommendations. Duration of chemical applications shall be the minimum length of time required to apply the chemicals and flush the pipelines.

Chemical application shall comply with runoff criteria set forth in Efficient and Uniform Application of Water on Irrigated Lands section.

Coefficient of Uniformity. Use distribution and uniformity requirements stated in criteria for Efficient and Uniform Application of Water on Irrigated Lands.

In sustained wind conditions exceeding 10 miles per hour, or in wind conditions exceeding product label directions, do not use sprinklers to apply chemicals, nutrients, or wastewater

Additional Criteria Applicable to Improve Condition of Soil Contaminated With Salts and Other Chemicals.

Design Application Depth. Base design application depth on crop rooting and salinity tolerance thresholds (NRCS 1993).

Design Application Rate. Use application rates less than soil intake rates to prevent ponding and runoff. Use distribution and uniformity requirements stated in criteria for Efficient and Uniform Application of Water on Irrigated Lands.

Additional Criteria Applicable to Reduce Particulate Matter Emissions to Improve Air Quality

The installation and operation of sprinkler systems for confined animal pen dust control shall cover the majority of each pen area occupied by livestock (except for concrete feed bunk aprons and similar areas). The quality of applied water shall be fit for animal consumption.

Capacity and Application Depth. The sprinkler system shall have capacity and flexibility to apply the design application depth in a cycle of 3 days or less. Determine application depth requirements with an allowance for reasonable application losses.

The minimum design application amount shall equal the maximum total daily wet-soil evaporation, with allowances for moisture input to pen areas from animal manure and urine.

When used to suppress dust in confined animal pen areas, avoid over-application and excessive sprinkler overlap to minimize runoff, reduce odor, fly problems, and chronically wet areas.

Verify water supplies are adequate to meet other operating needs during sprinkler system operation.

Water Amendments. Sprinklers may apply chemical injectants labeled for dust

suppression when the system has backflow prevention and anti-siphon devices.

When chemicals are applied through the sprinkler system, surface waters and livestock watering facilities shall be protected from direct application unless chemical labels indicate that direct application will not negatively impact human or animal health or water quality.

Distribution Patterns and Spacing. Spacing of sprinklers along laterals shall be between 50 and 75 percent of the wetted diameter listed in manufacturer's performance tables.

Spacing between laterals shall comply with the following criteria:

- For medium pressure sprinkler nozzles (50–75 psi), the spacing of laterals along the main line shall be between 70 and 90 percent of the wetted diameter.
- For high pressure sprinklers (>75 psi), the maximum distance between two sprinklers on adjacent lateral lines shall not exceed 100 percent of wetted diameter.

Risers. Construct risers in a manner that provides protection from corrosive soils, equipment damage, and livestock damage. Riser heights shall place the discharge sprinkler not less than 6 feet above ground surface. Anchor and stabilize risers.

System Valves and Controllers. Due to high application rates, variable operating conditions, and needed system flexibility and control, utilize an automated control system to ensure maximum operating efficiency of the sprinkler system. Equip systems with a rain sensor connected to the control system to prohibit system operation during rainfall events.

Because wind may affect water distribution patterns, equip the automated system controller with timer overrides that allow system to be operated manually during periods of calmer winds, such as evening, nighttime, and early morning. The operating system shall provide the flexibility to change sprinkling duration in 1-minute increments and have a minimum of 6 start times per day to provide for adjustment for climate conditions.

Utilize automatic valves for the automated control system to facilitate operation of individual sprinkler nozzles. The valves shall be of a size and quality consistent with standard engineering practice. Incorporate zone isolation valves on laterals to allow partial system operation during periods of maintenance and repair. Install pressure regulators, pressure compensating valves, or flow-control devices at each sprinkler outlet.

Minimize line drainage to the lowest sprinkler in areas of uneven or sloping terrain by incorporating a control valve or low-head drainage device at each sprinkler.

Additional Criteria Applicable to Reduce Energy Use

Provide an analysis that demonstrates reduction of energy use from practice implementation by documenting reduction in one or more of the following:

- pressure
- flow rate
- seasonal hours of operation
- application depth

Sprinkler operating pressure or flow rate reduction must translate to corresponding pumping plant discharge pressure or flow reduction.

The required analysis shall calculate energy reduction as the difference between average annual or seasonal energy uses compared to previous operating conditions.

CONSIDERATIONS

All Systems, General

For guidance on selecting design application efficiency, see NRCS (1983 and 1997).

Refer to NRCS (1993) for additional guidance on using sprinkler irrigation systems for temperature control, and chemigation.

Use of pressure regulators on a sprinkler system increases pumping cost because increased operating pressures are required upstream of each regulator/nozzle to

overcome losses through the regulator, typically assumed to be 5 psi.

Beneficial effects of conservation practices applied to limit translocation and runoff may diminish over the irrigation season.

Systems designed to operate with multi-day irrigation sets should consider varied time increments or set times to balance effects of day and night temperature and wind patterns.

Filter or screen irrigation water before it enters the system if it contains particulate matter, algae, or other material that could plug sprinkler nozzles.

Wastewater Application

To avoid sprinkler plugging and reduce system design operating pressure when applying wastewater, solids should be removed by use of solid separators, screens, filters, two-stage lagoons or waste-holding ponds, or similar methods.

The use of wastewater may reduce system life due to corrosion or abrasion. If fresh water is available the system should be flushed after use.

Pivot/Linear-Move

Computation of the effective irrigated area of the system should be based on a system radius from pad to the last sprinkler plus 75 to 80 percent of wetted radius of last sprinkler or end gun.

System effective irrigated area computations should be based on a system radius from pad to the last sprinkler plus 75 to 80 percent of wetted radius of last sprinkler or end gun.

Elevation changes in the field have more impact on systems with lower system design pressures.

Consider using pressure regulators even on relatively level ground if the system flow rate fluctuates significantly due to variable inlet water surface elevation or other reasons (e.g. corner systems or end guns).

Light frequent applications can reduce runoff problems but may increase soil-surface evaporation.

Use nozzle offsets or booms to reduce peak application rates and tower wheel track rutting.

Keller and Bliesner (2000) recommended end-gun wetted sector angle settings of 135 degrees (L90, R45) for guns operated only in corners, and 150 degrees (L105, R45) for smaller end guns continuously operated.

In order to conserve energy on pivot/lateral move systems consider using an end gun booster pump in lieu of providing increased pressure to the entire system.

Cyclic on/off operation of center pivot corner arm units and end guns impact system performance and application uniformity. A large end gun may reduce the average CU by 1 percent for each 1 percent of area covered past the main system hardware. Impact of transition speed and dual operating characteristics will impact pumping plant performance; and can impact water supply and delivery system performance.

Flexible drop tubes should be installed alternately on both sides of pivot/linear-move span pipe when used in-crop. Flexible drops should be weighted or secured in windy areas.

Center pivots and linear-move systems that are full of water will cause deflection in the span pipes and towers. Consider deflection amount when determining drop lengths and nozzle heights. Any wheel track rutting depth will also affect nozzle height. When the system is full of water, all nozzles installed on drops should be at same relative height along the lateral.

Nozzles discharges on center pivot or linear move systems, can be diverted away from wheel tracks to reduce rutting.

Traveler Systems

Reduce reel hose length to only what is needed for the longest field. Standard supplied hose lengths are often longer than

needed. The additional length reduces pressure for every application and wastes energy.

Solid Set and Periodic Hand Move

Consider limiting pressure loss in laterals to a maximum of 10 percent of the operating pressure to improve water distribution uniformity.

Particulate Matter Emissions Reduction

Scraping and removing manure between operations may reduce the amount of dust control needed. As a stand-alone practice, this may be sufficient to eliminate the need for sprinklers. For more information, see NRCS CPS Code 375, Dust Control from Animal Activity on Open Lot Surfaces.

Open-lot management practices can be applied that include scraping and removing manure in pens between occupations, and shaping of the holding areas to prevent ponding water and chronically wet areas.

Riser pipes used in lateral lines shall be high enough to minimize interference from surrounding structures.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing sprinkler systems describe the requirements for properly installing the practice to achieve its intended purpose. As a minimum, plans shall include:

- Plan map showing location of system, application area, elevations, north arrow, and scale
- System design pressure and flow rate
- Sprinkler location, type, nozzle size, operating pressure, and flow rate
- Appurtenance location, type, size and installation requirements

OPERATION AND MAINTENANCE

An operation and maintenance plan must provide specific instructions for operating and maintaining the system to ensure that it functions properly throughout its expected lifespan. It should also provide information regarding periodic inspections and prompt repair or replacement of damaged components. Disconnect electrical service and check for stray voltage before servicing or retrofitting any electrical equipment.

The plan, as a minimum, shall address the following:

- Periodic check and removal of debris and sediment as necessary from nozzles to assure proper operation
- Inspection or testing of pipeline and pumping plant components and appurtenances, as applicable
- Regular testing of pressures and flow rates to assure proper operation
- Periodic checks of nozzles and spray heads for proper operation and wear
- Routine maintenance of mechanical components in accordance with the manufacturer's recommendations

Additional information regarding operation of the system will be included in the Irrigation Water Management Plan, Waste Recycling Plan and/or Nutrient Management Plan, Pest Management Plan, or Salinity Management/Reclamation Plan, as applicable for the practice purpose.

REFERENCES:

Keller, J., and R. D. Bliesner. 2000. Sprinkle and Trickle Irrigation. p. 349-351. The Blackburn Press. Caldwell, NJ. ISBN: 1-930665-19-9.

Natural Resources Conservation Service (NRCS). 1997. National Engineering Handbook (NEH), Part 652, Irrigation Guide.

Natural Resources Conservation Service (NRCS). 1983. NEH, Section 15, Chapter 11, Sprinkle Irrigation.

Natural Resources Conservation Service (NRCS). 1993. NEH, Part 623, Chapter 2, Irrigation Water Requirements.

NRCS, AL
April 2016

NATURAL RESOURCES CONSERVATION SERVICE
ALABAMA
CONSERVATION PRACTICE CONSTRUCTION SPECIFICATION
SPRINKLER SYSTEM, CODE 442

1. SCOPE

This specification covers the construction and installation of a sprinkler system. The work shall consist of furnishing and installing the irrigation system and furnishing the materials required by drawings, design, plan, specifications, and manufacturer's recommendation for the complete installation of the work.

2. SAFETY

It is the responsibility of the installer to determine if there are buried or overhead utilities in the vicinity of the proposed work. The installer is required to call Alabama 811. They shall follow proper procedures to ensure that the utilities are not jeopardized and that equipment operators and others will not be injured during construction operations.

The Natural Resources Conservation Service (NRCS) makes no representation on the existence or non-existence of any utilities. Absence of utilities on the drawings is not assurance that no utilities are present at the site.

The owner, operator, contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

3. CONSTRUCTION OPERATIONS

NRCS should be notified at least 72 hours before the start of construction operations.

4. PERMITS

The owner will be responsible to obtain all required permits. All required permits must be obtained prior to the start of construction.

All permits required to install and operate this sprinkler system shall be the responsibility of owner.

5. DESIGN, PLANS AND DRAWINGS

The vendor or contractor furnishing the sprinkler irrigation system shall provide the complete plan and design, including necessary drawings, materials, specifications, and all other items necessary for proper functioning of the system. The plan shall specify type, grades, quality, size and construction materials of all equipment and appurtenances included in the system design. The plan and design shall contain sufficient detail to allow it to be installed by someone unfamiliar with the job and the installation to be checked for conformance to this standard and specification. Plans and designs shall be in accordance with the conservation

practice standard Sprinkler System, Code 442 in the Alabama NRCS Field Office Technical Guide.

The plan and design, for the sprinkler irrigation system and the specifications for installation of all components with all needed supporting data shall be provided to the landowner and must be approved by the responsible NRCS technician before installation begins.

6. INSTALLATION

Construction shall be installed to the neat lines and grades specified by the design, plans, and drawings or staked in the field. Equipment materials shall be of the type, size, and quantities specified in the plans, designs, drawings and specifications.

Construction operations shall be conducted in a skillful and workmanlike manner. The completed job shall present a workmanlike appearance. Air and water pollution will be minimized and held within legal limits.

Pumps, Power Units and Filters. Pumps, power units, and filters shall be set on a firm base and be placed in proper alignment. All pertinent safety codes and manufacturer's recommendations shall be met for the type of equipment installed. They shall meet the power, capacity, and pressure requirements specified.

Quality of Pipe. The pipe shall meet the standard and specification for Irrigation Pipeline (Code 430) for permanently installed underground pipelines.

The manufacturer shall provide performance data on all other pipe used in the system, including the maximum allowable operating pressure.

Sprinklers. Sprinklers shall be installed as recommended by the manufacturer. The manufacturer shall provide the performance capabilities of the sprinkler to determine that it meets the requirements specified in the plan and specifications.

Injectors (Chemical, Fertilizer or Pesticides) and Automatic Operating Equipment (Timer). The equipment shall be located adjacent to the pump and power unit and placed in accordance with manufacturer's recommendation, where automatic equipment or injectors (chemical, fertilizer, pesticide) has been planned for the system. Back-flow prevention devices shall be provided when chemicals are injected as required by state law.

Joints and Connections. All joints and connections shall be made in accordance with the manufacturer's recommendations and shall be constructed to withstand the maximum design working pressure for the pipelines without damage or leakage.

Valves. All valves shall be equal to the size of pipe in which they are installed and of the material and type specified. Valves shall adequately withstand the maximum design working pressure and meet the performance requirements of the system without damage or leakage.

7. TESTING THE SYSTEM

The system shall be thoroughly and completely tested at the design pressure for pressure strength, proper functioning, and leakage. Any leaks shall be repaired and the system retested.

The system shall be tested to insure that it functions properly at design capacity, that the distribution pattern and spacing requirements are met, and that the variation in pressure or discharge rate are within the allowable specified. At or below design capacity there shall be no objectionable flow conditions and all appurtenances shall perform properly.

8. WORKMANSHIP

All special requirements of the equipment manufacturer shall be met.

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

9. BASIS OF ACCEPTANCE

The acceptability of the system shall be determined by inspections to check compliance with the provisions of this standard with respect to the design of the system, the appurtenances, and the minimum installation requirements specified in the engineering plans and specifications.

Any modification or changes to the design, plans and and specifications shall be approved by responsible Natural Resources Conservation Service Technician before installation begins and any modification or changes needed during installation will be approved before installed.

The landowner shall notify the NRCS when construction is to start so that adequate construction quality assurance checks can be made, otherwise the NRCS may not be able to certify practice.

10. CERTIFICATION AND GUARANTEE

The installing contractor shall certify that the installation complies with the requirements of this specification. A written guarantee that protects the owner against defective workmanship and materials for not less than one (1) year shall be provided to the landowner.

Irrigation Water Management

(NRCS Conservation Practice Code 449)

General:

An Irrigation Water Management Plan (IWM Plan) will be developed by a Certified Irrigation Designer (CID) for the new irrigation system cost-shared thru the local Soil and Water Conservation District (SWCD) as part of the Sustainable Irrigation Expansion Initiative through the PL-566 program in Alabama.

The following documents are to be used in the development of the IWM Plan:

- Irrigation Water Management (Code 449) Conservation Practice Standard
- Irrigation Water Management (449) Statement of Work

As a minimum, the IWM Plan shall include and address:

- The Date of the IWM Plan development.
- The cooperator's name and location.
- A map that clearly shows the farm, field numbers, and new irrigation system will all the components.
- The crop(s) to be grown and the growing season(s).
- The rooting depths for the crop(s).
- The peak consumptive use rate for the crop(s).
- A thorough description of the new irrigation system.
- Water supply.
- Predominant soil series.
- A signature location for the CID, NRCS concurrence, and landowner.
- A statement of the clear Objective of the irrigation system.
- A complete list of any permit requirement or certificate of use.
- System operation recommendations based on the soils, crop stage, rooting depth, available water capacity, and management allowable depletion (MAD).
- A system for irrigation scheduling (As a minimum, the "feel and appearance" method.)
- A record keeping procedure.
- A checklist for general O&M for system maintenance (including flowrate and pressure monitoring).

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

IRRIGATION WATER MANAGEMENT

(Ac.)

CODE 449

DEFINITION

The process of determining and controlling the volume, frequency, and application rate of irrigation water.

PURPOSE

- Improve irrigation water use efficiency
- Minimize irrigation induced soil erosion
- Decrease degradation of surface and groundwater resources
- Manage salts in the crop root zone
- Manage air, soil, or plant micro-climate
- Reduce energy use

CONDITIONS WHERE PRACTICE APPLIES

This practice is applicable to all irrigated lands.

An irrigation system adapted for site conditions (soil, slope, crop grown, climate, water quantity and quality, air quality, etc.) must be in place and capable of efficiently applying water to meet the intended purpose(s).

CRITERIA

General Criteria Applicable to All Purposes

Develop an Irrigation Water Management (IWM) Plan that will guide the irrigator or decision-maker in the proper management and application of irrigation water.

When irrigation water is limited, develop an IWM Plan that will meet critical crop growth stages.

Include in the IWM plan the method for determining the flow rate or total volume of irrigation water required for each irrigation event.

Include in the IWM plan the method for determining the timing and amount of each irrigation event using at least one of the following methods:

- Evapo-transpiration of the crop, using appropriate crop coefficients and reference evapo-transpiration data,
- Soil moisture monitoring, and/or
- Scientific plant monitoring (e.g. leaf water potential or leaf/canopy temperature measurements).

When irrigation water is not available on demand, such as when provided by an irrigation district, use the planned availability to determine the timing of the irrigation event. In this case, adjust irrigations amounts appropriately.

In locations where rains expected during the growing season, and where a soil water balance is calculated, include measurements from a rain gauge (or other accurate method of determining local rainfall) that represent the managed field(s).

Base the volume of water needed for each irrigation event on:

- the available water-holding capacity of the soil for the crop rooting depth,
- the management allowed soil water depletion,
- the current soil moisture status,
- the current crop/forage growth stage,
- the distribution uniformity of the irrigation event, and
- the water table contribution.

For adjustable rate systems (e.g. variable rate irrigation center pivots), base the application rate of irrigation water on:

- the volume of water to be applied,
- the frequency of irrigation applications, soil infiltration and permeability characteristics, and
- the capacity of the irrigation system.

For surface irrigation, apply irrigation water at a rate that achieves an acceptable distribution uniformity (DU) and that minimizes irrigation-induced erosion.

Additional Criteria to Decrease Degradation of Surface and Groundwater Resources

Plan irrigation-water application rates and volumes that minimize transport of sediment, nutrients and chemicals to surface waters and groundwater.

Schedule the application of nutrients and chemicals to avoid excess leaching below the root zone to the groundwater and excess runoff to surface waters.

Do not conduct fertigation or chemigation operations if rainfall that may produce runoff or deep percolation is imminent. Limit application of chemicals or nutrients to the minimum length of time required to deliver them and flush the pipelines. Limit the irrigation application amount to the amount necessary to apply the chemicals or nutrients to the soil depth recommended by the manufacturer.

Base the timing and rate of application on the NRCS approved pest, herbicide, or nutrient management plan.

Ensure that the irrigation and delivery system is equipped with properly designed and operating valves and components to prevent backflows into the water source(s) and/or contamination of groundwater, surface water, or the soil.

Additional Criteria to Manage Salts in the Crop Root Zone

Ensure the irrigation application volume provides an appropriate salt balance in the soil profile.

Base the water requirement on the leaching procedure contained in NRCS National Engineering Handbook (NEH), Part 623, Chapter 2, Irrigation Water Requirements, and NEH, Part 652, National Irrigation Guide, Chapters 3 and 13.

Additional Criteria to Manage Air, Soil or Plant Micro-Climate

The irrigation system must have the capacity to apply the required rate of water for cold or heat protection as determined by the methodology contained in NEH, Part 623, Chapter 2, Irrigation Water Requirements.

Additional Criteria Applicable to Reduce Energy Use

Provide analysis to demonstrate reduction of energy use from practice implementation.

Calculate the reduction of energy use as the average annual or seasonal energy reduction compared to previous operating conditions.

CONSIDERATIONS

Consider the following when planning irrigation water management:

Crop residue and soil surface storage can increase effective precipitation and reduce soil surface evaporation.

There is a potential for spray drift and odors when applying agricultural and municipal wastewaters. Timing of irrigation based on prevailing winds to reduce odor. In areas of high visibility, irrigating at night is favorable.

Overspray from end guns should not reach public roads.

Modify equipment and/or soil amendments such as polyacrylamides and mulches to decrease erosion.

The water quality can affect the crop quality and plant development.

The water quality can affect the soil's physical and chemical properties, such as soil crusting, pH, permeability, salinity, and structure.

Avoid traffic on wet soils to minimize soil compaction.

Schedule salt leaching events to coincide with low levels of residual soil nutrients and pesticides.

Manage water so it does not drift or come in direct contact with surrounding electrical lines, supplies, devices, controls, or components that would cause shorts in the same or the creation of an electrical safety hazard to humans or animals.

The effect of the electrical load control/interruptible power schedules, repair and maintenance downtime, and harvest downtime may change the IWM Plan.

Improvements to the irrigation system may increase the distribution uniformity or application efficiency of irrigation water applications.

PLANS AND SPECIFICATIONS

Application of this standard may include job sheets or similar documents that specify the applicable requirements, system operations, and components necessary for applying and maintaining the practice to achieve its intended purpose(s).

The Irrigation Water Management (IWM) Plan will contain, at a minimum:

- An irrigation system layout map showing the main pipeline(s), irrigated area, soil moisture sensor locations and depths (if used), and soils.
- The methods used to measure or determine the flow rate or volume of the irrigation applications.
- Documentation of the scientific method used for scheduling the timing and amount of irrigation applications.
- The seasonal or annual planned water application volumes by crop.
- The management allowable depletion (MAD) and depth of the managed crop root zone for each crop.
- An estimate of the irrigation-system distribution uniformity, based on testing, evaluation, or observation.
- The specific soil moisture monitoring objectives, if soil moisture sensors are used. Indicate how data from the soil-moisture sensor locations and depths to make field-wide irrigation decisions.
- Information on how to recognize irrigation-induced erosion and how to mitigate it.
- Recordkeeping documents for the irrigator to use during operation and management.

OPERATION AND MAINTENANCE

Include a maintenance checklist to ensure the system performance is optimum.

The irrigator will document all irrigation-water management activities with adequate records. At a minimum:

- Record each irrigation event, including the amount or depth of water applied and the date of application, and
- Record the data from the method(s) used for determining the timing and amount of the irrigation event.

Other necessary O&M items addressed in the physical component standards considered

companions to this standard; Irrigation System, Microirrgiation, Code 441, Irrigation System, Sprinkler System, Code 442, and Irrigation System, Surface and Subsurface, Code 443.

REFERENCES

USDA-NRCS, National Engineering Handbook, Part 623, Chapter 2, Irrigation Water Requirements.

USDA-NRCS, National Engineering Handbook, Part 623, Chapter 9, Water Measurement Manual.

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

STATEMENT OF WORK
Irrigation Water Management (449)

These deliverables apply to this individual practice. For other planned practice deliverables refer to those specific Statements of Work.

DESIGN

Deliverables:

1. Design documents that demonstrate criteria in NRCS practice standard have been met and are compatible with planned and applied practices.
    a. Practice purpose(s) as identified in the conservation plan
    b. List of required permits to be obtained by the client
    c. List of facilitating practices
    d. Practice standard criteria-related computations and analyses to develop plans and specifications including but not limited to:
        i. Volume of water (per irrigation & per season)
        ii. Frequency of irrigation
        iii. Application rate
        iv. Environmental considerations
2. Written plans and specifications including sketches and drawings shall be provided to the client that adequately describes the requirements to install the practice and obtain necessary permits.
3. Operation and maintenance plan.
4. Certification that the design meets practice standard criteria and comply with applicable laws and regulations.
5. Design modifications during installation as required.

INSTALLATION

Deliverables

1. Pre-installation conference with client.
2. Verification that client has obtained required permits.
3. Staking and layout of measures according to plans and specifications including applicable layout notes.
4. Installation guidance as needed.
5. Facilitate and implement required design modifications with client and original designer.
6. Advise client/NRCS on compliance issues with all federal, state, tribal, and local laws, regulations and NRCS policies during installation.
7. Certification that the installation process and materials meet design and permit requirements.

CHECK OUT

Deliverables

1. Records of installation.
    a. Extent of practice units applied
    b. Actual amount of water applied during the growing season
2. Certification that the application meets NRCS standards and specifications and is in compliance with permits.
3. Progress reporting.

STATEMENT OF WORK
Irrigation Water Management (449)

REFERENCES

- NRCS Field Office Technical Guide, Irrigation Water Management, 449
- NRCS National Engineering Handbook, Part 652, National Irrigation Guide
- National Engineering Manual (NEM)
- NRCS National Environmental Compliance Handbook
- NRCS Cultural Resources Handbook
- NRCS Field Office Technical Guide, Irrigation Water Management-AL-ENG-10-Irrigation Design and Specification Data Sheet-Form

CONTACT INFORMATION

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Pumping Plant

(NRCS Conservation Practice Code 533)

General:

A Pumping Plant and all appurtenances will be designed by a Certified Irrigation Designer (CID) for the pumping of water for storage or application for the new irrigation system cost-shared thru the local Soil and Water Conservation District (SWCD) as part of the Sustainable Irrigation Expansion Initiative through the PL-566 program in Alabama.

The following documents are to be used in the design of the Pumping Plant:

- Pumping Plant (533) Conservation Practice Standard
- Pumping Plant (533) Statement of Work
- Pumping Plant (533) Construction Specifications

As a minimum, the Pumping Plant design and construction details shall include and/or address:

- The minimum criteria in the Conservation Practice Standard.
- An engineering design and specification package will include all required calculation details (pump size/horsepower, discharge capacity, total dynamic head, power requirements, etc.).
- The design package will also include:
    - Pump location.
    - Type of pump.
    - Pump mounting details (may be left up to the manufacturer).
    - Pump pad details including dimensions, type of material, foundation preparation, etc.
    - Details of appurtenances.
    - Utility locations.
    - Irrigation storage details if required
    - Pump maintenance requirements.

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

PUMPING PLANT

(No.)

CODE 533

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
- Reduce energy use
- 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

Federal, State, and Local Laws. All planned activities shall comply with all federal, state, and local laws and regulations.

Cultural Resources. Ground disturbing activities have the potential to affect significant cultural resources. Complete a cultural resources review prior to ground disturbing activities to assure that existing cultural resources will not be adversely impacted.

Pump requirements. Ensure design flow rate, range of operating heads, and pump type meets the requirements of the application.

Base selection of pump materials on the physical and chemical qualities of the material being pumped and manufacturer's recommendations.

Pressure Tank. Unless otherwise approved, construct all wells utilizing a pressure tank of sufficient size to extend the life of the pump. Pressure tanks are generally used on wells for livestock watering systems.

Power units. Select pump power units based on the availability and cost of power, operating conditions, need for automation, and other site specific objectives. Power units shall match the pump requirements and be capable of operating efficiently and effectively within the planned range of conditions. The power unit shall be sized to meet the horsepower requirements of the pump, including efficiency, service factor, and environmental conditions.

Electric power units may include line power, photovoltaic panels, and wind or water powered turbines.

Ensure electrical wiring meets the requirements of the National Electrical Code (NEC) and state and local codes for outdoor installation. Place all electrical wiring in conduit. A qualified state licensed electrician will certify in writing all electrical installations. Wherever installation could be classified as a hazardous location, specific conformance to NEC Article 500 will be met.

Renewable energy power units shall meet applicable design criteria in NRCS and/or industry standards, and shall be in accordance with manufacturer's recommendations.

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. 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. The size of suction and discharge pipes shall be based on hydraulic analysis, operating costs, and compatibility with other system components.

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.

Backflow prevention devices shall be included according to Federal, State, and Local laws, to prevent contamination of water sources connected to the pumping plant.

Buildings and accessories. Pumps shall be securely mounted on a solid foundation such as pilings or concrete. Foundations shall be designed to safely support the loads imposed by the pumping plant and appurtenances. Sheet piling or other measures shall be used, as required, to prevent piping beneath the foundation.

Where buildings are necessary to protect the pumping plant, provisions shall be included for adequate ventilation and accessibility for equipment maintenance, repairs, or removal. A well house enclosing small pumping plants may be fabricated on-site or may be a manufactured enclosure. Where the enclosure is accessible to livestock it shall have sufficient structural integrity to withstand abuse from the livestock or it shall be fenced to exclude livestock. Well houses shall have a minimum R-value of R-9 and be insulated on all walls, ceiling, and door. Cracks shall be sealed, and an electrical outlet provided for heating if needed.

Suction bays or sumps shall be designed to prevent the introduction of air at the intake.

The discharge bay or the connection to the distribution system shall meet all hydraulic and structural requirements.

Structures and equipment shall be designed to provide adequate safety features to protect operators, workers, and the public from potential injury. Drive shaft covers shall be 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 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.

Additional Criteria Applicable to Reduce Energy Use

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

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 accordance with this standard and 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

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

STATEMENT OF WORK
Pumping Plant (533)

These deliverables apply to this individual practice. For other planned practice deliverables refer to those specific Statements of Work.

DESIGN

Deliverables:

1. Design documentation that will demonstrate that the criteria in NRCS practice standard have been met and are compatible with other planned and applied practices.
    a. Practice purpose(s) as identified in the conservation plan.
    b. List of required permits to be obtained by the client.
    c. Impacts on adjacent properties and structures.
    d. Compliance with NRCS national and state utility safety policy (NEM Part 503, Safety, 503.00 through 503.06).
    e. Practice standard criteria related computations and analyses to develop plans and specifications including but not limited to:
        i. Mechanical
        ii. Structural
        iii. Appurtenances
2. Written plans and specifications including sketches and drawings shall be provided to the client that adequately describes the requirements to install the practice and obtain necessary permits.
3. Design Report and Inspection Plan as appropriate (NEM Part 511, Design, 511.11 and Part 512, Construction, 512.30 through 512.32).
4. Operation and Maintenance Plan
5. Certifications that the design meets practice standard criteria and comply with applicable laws and regulations [NEM Part 505, Non-NRCS Engineering, 505.03 (b) (2)].
6. Design modifications during installation as required.

INSTALLATION

Deliverables

1. Pre Installation conference with client and contractor which includes information on minimizing erosion and controlling sediment during construction.
2. Verification that client has obtained required permits.
3. Staking and layout according to plans and specifications including applicable layout notes.
4. Installation inspection (according to inspection plan as appropriate).
    a. Actual materials used.
    b. Inspection records
5. Facilitate and implement required design modifications with client and original designer.
6. Advise client/NRCS on compliance issues with all federal, state, tribal, and local laws, regulations and NRCS policies during installation.
7. Certification that the installation process and materials meets design and permit requirements.

CHECK OUT

Deliverables

1. As-Built documentation.
    a. Extent of practice units applied
    b. Drawings
    c. Final quantities
2. Certification that the installation meets NRCS standards and specifications and is in compliance with permits [NEM Part 505, Non-NRCS Engineering, 505.03 (c) (1)].
3. Progress reporting.

STATEMENT OF WORK
Pumping Plant (533)

REFERENCES

- NRCS Field Office Technical Guide (eFOTG), Section IV, Conservation Practice Standard - Pumping Plant, 533.
- National Engineering Manual (NEM).
- NRCS National Environmental Compliance Handbook
- NRCS Cultural Resources Handbook

CONTACT INFORMATION

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NATURAL RESOURCES CONSERVATION SERVICE
ALABAMA
CONSERVATION PRACTICE CONSTRUCTION SPECIFICATION
PUMPING PLANT, CODE 533

1. SCOPE

This specification covers the installation of a pumping plant. The work shall consist of furnishing all materials, labor, and equipment necessary for installing the pumping plant, including all appurtenances, in accordance with the construction drawings, design, these specifications, and manufacturer's recommendations.

2. SAFETY

It is the responsibility of the installer to determine if there are buried or overhead utilities in the vicinity of the proposed work. The installer is required to call Alabama 811 for utilities to be located prior to commencing construction. They shall follow proper procedures to ensure that the utilities are not jeopardized and that equipment operators and others will not be injured during construction operations. They will conduct all work and operations in accordance with the proper safety codes for the types of construction being performed with due regard to the safety of all persons and property.

The Natural Resources Conservation Service (NRCS) makes no representation on the existence or non-existence of any utilities. Absence of utilities on the drawings is not assurance that no utilities are present at the site.

3. CONSTRUCTION OPERATIONS

NRCS should be notified at least 72 hours before the start of construction operations.

Construction operations shall be carried out in such a manner and sequence that erosion and air and water contamination are minimized and held within legal limits.

The owner, operator, contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

4. PERMITS

The owner will be responsible to obtain all required permits. All required permits must be obtained prior to the start of construction.

All permits required to install and operate this irrigation system shall be the responsibility of owner.

5. MANUFACTURER'S DATA

The vendor or contractor furnishing pumps and motors shall provide the necessary manufacture's data including performance curves, ratings, shop drawings, and other operating data prior to installation. The date will be used to determine if the pump will meet the capacity, head, and other operating requirements as shown on the engineering plans and specifications.

When NRCS is required or expected to certify the practice to the landowner, pumping plant shall be approved by the responsible NRCS person before installation begins.

6. MATERIALS

Steel. Exposed steel surfaces shall be protected from corrosion by galvanizing, painting, or other approved coatings.

Concrete. The concrete mix design and testing of concrete shall be consistent with the size, and requirements of the job and as shown on the engineering plans. Mix requirements or necessary compressive strength, type of cement, air entrainment, slump, aggregate, or other properties will be as specified in Section 13 of this specification.

Curing compound shall conform to the requirements of Material Specification 534, Concrete Curing Compound.

Portland cement shall conform to the requirements of Material Specification 531, Portland Cement, for the specified type.

Aggregates shall meet NRCS material Specification 522 Aggregates for Portland Cement Concrete. Aggregates shall be reasonably well graded, clean, durable and shall not contain clay lumps and organic matter in excess of 3 percent of the total weight. Concrete water shall be free of acid, alkali, oils, and organic matter. All concrete is to consist of a workable mix that can be placed and finished in an acceptable manner.

Subgrades and forms shall be installed to line and grade, and the forms shall be watertight and unyielding as the concrete is placed.

Reinforcing steel shall be placed as indicated on the engineeringplans.

Timber. All lumber in contact with the ground or compost shall be pressure-treated in accordance with ASTM D 1760, latest edition.

Gates and Valves. Gates, valves, pipe connections, discharge bays, power units, pumps, automatic controls, suction pipe and bays and other accessories and appurtenances shall perform satisfactorily.

Pumps, Power Units and Filters. Set pumps, power units, and filters on a firm base, place in proper alignment, and meet the power, capacity, and pressure requirements specified. Meet all pertinent safety codes and manufacturer's recommendations for the type of equipment

installed. As a minimum, revolving engine components, outside faces of pulleys, sheaves, sprockets, and gears on drives that rotate with projections, revolving shafts, except smooth shaft ends protruding less than one half of the diameter of the shaft, and nip points on exposed gears, belts, chain drives and idlers shall be shielded or shall be guarded by location to minimize inadvertent contact.

7. TESTING

   As determined by procedures developed by the system designer, the system shall be thoroughly and completely tested at the design pressure and capacity for strength and leakage. The test should also ensure that all appurtenances, to also include the pressure relief valve, perform properly. All defects or malfunctions shall be repaired (and modified if necessary) and re-tested. There shall be no objectionable flow conditions at or below design capacity.

   The installer, vendor, or contractor shall demonstrate by testing that the pumping plant will function properly at design capacity. There shall be no objectionable flow conditions.

8. POLLUTION CONTROL

   There may be potential for soil erosion during construction. Construction operations shall be carried out so that erosion and air and water pollution are minimized and held within legal limits.

9. WORKMANSHIP

   Construction shall be performed to the neat lines and grades specified by the design and as shown on the engineering plans. All special requirements of the equipment manufacturer shall be met.

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

10. BASIS OF ACCEPTANCE

    The acceptability of this practice shall be determined by quality assurance inspections to insure compliance with all the provisions of this specification and construction drawings. Installation shall be approved by an NRCS employee with appropriate engineering job approval authority or Technical Service Providers.

    Any modifications to the plans and specifications or changes shall be approved by the responsible NRCS employee before installation begins and any modification or changes needed during installation will be approved before installed.

11. CERTIFICATION AND GUARANTEE

    The installing contractor shall certify that the installation complies with the requirements of this standard. A written guarantee that protects the owner against defective workmanship and materials for not less than one (1) year and that identifies the manufacturer and appropriate

ratings (horsepower, capacity, rpm, head, etc.) of equipment used shall be furnished. The one-year guarantee is not required when the landowner installs the pumping plant.

November 2019

STATEMENT OF WORK
Water Well (642)

These deliverables apply to this individual practice. For other planned practice deliverables refer to those specific Statements of Work.

DESIGN

Deliverables:

1. Design documentation that will demonstrate that the criteria in NRCS practice standard have been met and are compatible with other planned and applied practices.
    a. Practice purpose(s) as identified in the conservation plan.
    b. List of required permits to be obtained by the client.
    c. Impacts on adjacent properties and structures.
    d. Compliance with NRCS national and state utility safety policy (NEM Part 503, Safety, 503.00 through 503.06).
    e. Practice standard criteria related computations and analyses to develop plans and specifications including but not limited to:
        i. Hydrogeology
        ii. Wellhead Location and Protection
        iii. Materials
        iv. Environmental Considerations (e.g. water quality)
2. Written plans and specifications, including sketches and drawings, and applicable Guide Sheets shall be provided to the client that adequately describes the requirements to install the practice and obtain necessary permits.
3. Design Report and Inspection Plan as appropriate (NEM Part 511, Design, 511.11 and Part 512, Construction, 512.30 through 512.32).
4. Operation and Maintenance Plan
5. Certifications that the design meets practice standard criteria and comply with applicable laws and regulations [NEM Part 505, Non-NRCS Engineering, 505.03 (b) (2)].
6. Design modifications during installation as required.

INSTALLATION

Deliverables

1. Pre-Installation conference with client and contractor which includes information on minimizing erosion and controlling sediment during construction.
2. Verification that client has obtained required permits.
3. Staking and layout according to plans and specifications including applicable layout notes.
4. Installation inspection (according to inspection plan as appropriate).
    a. Actual materials used.
    b. Inspection records
5. Facilitate and implement required design modifications with client and original designer.
6. Advise client/NRCS on compliance issues with all federal, state, tribal, and local laws, regulations and NRCS policies during installation.
7. Certification that the installation process and materials meet design and permit requirements.

CHECK OUT

Deliverables

1. As-Built documentation.
    a. Extent of practice units applied
    b. Drawings
    c. Final quantities
    d. Well drillers log
2. Certification that the installation meets NRCS standards and specifications and is in compliance with permits [NEM Part 505, Non-NRCS Engineering, 505.03 (c) (1)].
3. Progress reporting.

November 2019

STATEMENT OF WORK
Water Well (642)

REFERENCES

- NRCS Field Office Technical Guide (eFOTG), Section IV, Conservation Practice Standard - Water Well, 642.
- NRCS Field Office Technical Guide (eFOTG), Section IV, Guide Sheet – Water Well Protection of the Farm, AL642
- National Engineering Manual (NEM).
- NRCS National Environmental Compliance Handbook
- NRCS Cultural Resources Handbook

CONTACT INFORMATION

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