NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

PUMPING PLANT

(No.)

CODE 533

DEFINITION

A pumping facility including required pumps, their associated power units (e.g. motors, engines, batteries) and all plumbing and appurtenances required to enable the facility to convey water from one location to another. It may include an on-site fuel or energy sources and specified structures (e.g. protective buildings, pads etc.)

PURPOSE

- To provide removal of excessive subsurface water.
- To provide removal of excessive runoff, flooding, or ponding.
- To promote efficient water use on irrigated land
- To provide adequate water for fish and wildlife
- To provide adequate stock water
- To reduce excessive nutrients and organics in surface Water
- To provide water to maintain soil quality

CONDITIONS WHERE PRACTICE APPLIES

Wherever water must be pumped to accomplish a conservation objective, which may include, but is not limited to, one of the following:

- To provide a water supply for such purposes as irrigation, recreation, livestock, or wildlife.
- To maintain critical water levels in swamps, marshes, open water, or for newly constructed wetlands and ponds.
- To provide drainage by the removal of surface runoff water or groundwater.
- To transfer wastewater for utilization as part of a waste management system.

This standard encompasses all components of a pumping plant including the pump, power unit, suction and discharge lines, and accessories.

CRITERIA

Criteria below, unless otherwise specified, pertain to the pumping plant as a complete unit.

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

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

Pump requirements. Pump design should use state-of-the-art technology with installed field efficiencies of at least 70%. Solar powered or wind powered variable speed pumps and pumps used to pump wastewater are exempt from this efficiency requirement. Capabilities, range of operating heads, general class and efficiency of equipment shall be determined by appropriate technical means.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Centrifugal or turbine type pumps are most commonly used in conservation activities. This would include drainage pumps, submersible livestock water well pumps, tailwater recovery system return flow pumps, booster pumps, pumps to transfer wastewater, and deep well irrigation pumps.

Size and number of pumps and their performance shall be determined on the basis of system conservation requirements in order to meet the intended purpose. Total head shall be determined for critical operating conditions, taking into account all hydraulic losses including pumping lift, line friction, field elevation head, and miscellaneous losses. Automatic controls shall be included as required.

Pumps utilized for the transfer of wastewater or manure shall be sized to transfer material at the required system head and flow rate determined by the waste management plan. The pump shall be designed based on the consistency of material being pumped and manufacturer's recommendations.

Pumps with solar or wind power supplies shall be sized based on manufacturers recommendations for the efficient delivery of the required flow or volume of water to meet the planned purpose. Solar or wind powered pumps used in conjunction with livestock watering facilities shall be designed to deliver 1.5 times the daily livestock need (Ref. Standard 614 - Watering Facility).

Pumps planned for handling abrasives and mineral salts shall be constructed of materials designed for such use. Pumps handling trashy materials should be of no-clog design.

Power units. Power units shall be selected on the basis of availability of fuel, power costs, operating conditions, conservation needs, and objectives, including the need for automation. The power unit shall be matched to the pump and be capable of operating the pump efficiently and effectively within the range of operating conditions. The power unit shall be sized to meet the horsepower requirements of the pump including pump efficiency, service factor, and environmental conditions.

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

An existing power unit may be used as part of the pumping plant provided it meets or exceeds the system requirements and will be properly maintained or replaced to meet the life expectancy of the practice.

Electric motors shall be rated for continuous duty. Corrosion resistant construction or ball bearing type (greased for life) installations shall be specified, if necessary. Power cables for float-type pump installations shall be rated "severe duty" and be oil and water-resistant. Electric motors shall meet NEMA (National Electric Manufacturers Association) requirements and the installation and wiring shall meet NEC (National Electrical Code) and local code requirements. Electric motors shall provide necessary protection from overload, thermal, and lightning protection.

Photovoltaic (PV) panels. Manufacturer's recommendations and the average insolation for the location and time of year pumping occurs shall be used to size the PV array. The PV array shall provide the power necessary to operate the pump at the design flow rate with appropriate service factor considering a minimum panel degradation of 10 years. To receive maximum sunlight fixed arrays shall be oriented towards true south. Tilt angle shall be based on latitude and time of year of power requirements. Panels and panel mounts shall be securely mounted to resist movement by environmental factors and shall meet the requirements of the specifications. Manufacturer's recommendations shall be used to determine the required solar panel size and number for the installation to meet the intended purpose.

Wind powered electric pumps.
Variable frequency pumps powered by wind generators shall be sized and designed as per manufacturer's recommendations.

Windmills. Windmill pumping units shall be sized according to manufacturer's pumping lift and capacities. The stroke length of the mill (short or long) and the average wind speed shall be used in selecting the diameter of mill to be used. Towers shall be in proportion to mill size and of adequate height for efficient and safe operation.

Internal combustion engines shall be matched to the pump to deliver the required brake

horsepower to the pump at the operating speed (RPM) of the pump. The engine shall operate between the manufacturer's minimum and maximum RPM limits when driving the pump at the required RPM to deliver the required volume and head. Engines shall be rated for continuous duty. Engines shall have safety controls installed and in operation for shutdown in case of engine overspeed, high temperature, no water for water-cooled engines, and low oil pressure. All exposed drivelines, shafts, sheaves, gears, pulleys, and belts shall be properly shielded for safety.

Suction and discharge pipes. Suction lift, NPSH, pipe diameter and length, minor losses, temperature and altitude shall be used in a hydraulic analysis to prevent cavitation**.** The size of suction and discharge pipes shall be based on a hydraulic analysis, operating cost, and compatibility with other system components. The arrangement and length of discharge pipe shall be based on the need for recovery of head through siphoning action, and for delivery of water in keeping with conservation and environmental objectives.

Appurtenances such as gates, valves, regulators, gages, pipe connections, and other protective devices shall be installed to meet the design requirements.

Screens, filters or other devices shall be installed as needed to prevent intake of sand, gravel or other objectionable material

Pump systems utilizing casings and inlet pipes shall be sized to limit suction head loss to 2.0 feet and to have adequate perforations or openings to deliver the design flow to the pump. Dimensions and spacing of perforations shall be specified for each job. Perforations may be prefabricated or made by drilling, milling, sawing, or punching. Controlled torch-cut slots may be used on steel pipes for installations where debris is limited.

Pump manufacturer's recommendations shall be followed in regard to interior dimensions, clearances, elbows, valves, controls, and pump head characteristics.

Federal, State, and local laws and regulations concerning back flow prevention shall be followed when pumping from wells or when chemigating.

Necessary precautions shall be taken to prevent cavitation.

Building and accessories. Pumps may be mounted on piling or concrete foundations, in a well or pit, or by other appropriate means. Where buildings are specified to protect the pumping plant, provision shall be made for accessibility for equipment maintenance and repairs, and for protecting equipment from the elements, vandalism, and fire. The appearance of the plant shall be compatible with the surrounding environment, as applicable.

Foundations shall be designed to safely support the loads imposed. Sheet piling or other measures shall be used, as required, to prevent piping beneath the foundation.

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

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

All structural features and equipment shall provide adequate safety features to protect workers and the public from injury.

Criteria applicable to promote efficient water use on irrigated land.

Provision to measure flow rate shall be incorporated into the pumping plant design

CONSIDERATIONS

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

- Effects on downstream flows or aquifer recharge volumes.
- Effects on existing wetland hydrology.
- Effects on surface and ground water by leaked or spilled fuels and lubricants.
- Secondary containment of spilled fuel for water quality as may be required by federal and state laws or regulations.
- Protection of system components from "natural" events such as floods.

- The appearance of buildings should be compatible with the surrounding environment.

The efficiency of units, type of power, material qualities, workmanship, automation features, and other accessories installed should be in keeping with the economic and environmental value of the system to accomplish the conservation objectives. Plans and specifications

Plans and specifications for constructing pumping plants shall be in compliance with this standard and describe the requirements for properly installing the practice to achieve its intended purpose. A pump performance curve, specific to the pump installed, shall be maintained in the plan.

OPERATION AND MAINTENANCE

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

- Inspection or testing of all pumping plant components and appurtenances, as applicable.
- Proper start-up 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 freezing.
- When applicable, the power unit, fuel storage facilities and fuel lines should be frequently checked for fuel or lubricant leaks and repaired as needed.
- Periodic checks and removal of debris as necessary from trash racks and structures to assure adequate flow capacity reaches the pumping plant.
- Periodic removal of sediment in suction bays to maintain design capacity and efficiency.
- Inspect and maintain anti-siphon devices, if applicable.
- Routinely test and inspect all automation components of the pumping plant to assure they are functioning as designed.
- Inspect and maintain secondary containment facilities, if applicable.
- Periodic inspection of all safety features to ensure they are in place and functional.
- Prior to retrofitting any electrically powered equipment, electrical service must be disconnected and the absence of stray electrical current verified.

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE GENERAL SPECIFICATIONS

PUMPING PLANT

(No.)

CODE 533

CONSTRUCTION SPECIFICATIONS

Pumps shall be installed according to manufacture's instructions. Pump manufacturer's recommendations shall be followed in regard to interior dimensions, clearances, elbows, valves, controls, and pump head characteristics.

POWER UNITS. Power units shall be matched to the pumping requirements as close as practical. Where an existing power unit is planned for use, the pump manufacturer must first approve the device for use with the pump. Both solar and electric powered submersible pumps shall be of stainless steel construction and shall come with a five year warranty on the pump and motor assembly. Following installation, the pump shall be checked to determine functionality.

Electric. All electric motors, including submersible pump and motor combinations, shall be installed by a licensed electrician or licensed pump installer and be appropriately grounded.

Internal Combustion Engine. Engines may run on diesel, gasoline, natural gas, propane, or other approved fuel sources. Engines shall be securely anchored and equipped with appropriate safety shields.

Solar. Solar panels may be mounted on a fixed or tracking type structure. Fixed panels shall be installed within the specified range and tilt angle for maximum performance. Pole mounted solar panel structures shall meet the minimum pole requirements as established in Table 1-a. Length in ground shall be increased 6 inches for each additional foot of height added above ground, but total height shall not be increased more than 3 additional feet above what is listed in this table. Hole will be filled with concrete which will produce a minimum strength of 3000 psi in 28 days.

Table 1-a

Panel Area (sq-ft)	Pole Size Sch-40 Steel (in.)	Length in Ground (in.)	Height Above Ground (in.)	Hole Dia. (in.)	Estimated Concrete (ft^3)
15	2	36	60	12	2.3
20	2.5	38	60	12	2.4
28	3	40	60	14	3.4
35	3	42	66	14"	3.5
60	4	46	66	20	8.1
90	6	54	72	28	18.3
120	6	60	78	28	20.4

The solar module array mounting structure shall be installed and anchored in accordance with the manufacturer's instructions and these specifications.

Mounting frame shall be made of steel with a minimum wall thickness of 1/8th inch and shall be either a pre-engineered structure that meets the minimum requirements of this specification, or a structure listed on the Oklahoma NRCS Pre-Approved Structures, Components, and Appurtenances list.

The solar module array mounting structure shall be installed and anchored in accordance with the manufacturer's instructions and these specifications. Concrete shall be placed at least 24-hours before the array is attached. Solar panels shall be tested and listed by Underwriters Laboratories (UL) to meet UL 1703; or tested and certified to withstand the impact of 25-mm (1-inch) diameter hail at a minimum velocity of 23-m/s (51-mph) without major visual defects by another nationally recognized testing lab in accordance with IEC 61215, or IEC 61646. Modules must also be

certified to withstand winds of 130-km/h (81-mph) or greater.

Each module shall be labeled by the manufacturer with rated open-circuit voltage, operating voltage, maximum permissible system voltage, operating current, short-circuit current, and maximum power. Modules shall be assembled with seals capable of remaining watertight over a temperature range of -20°F to +120°F. The manufacturer shall warrant each module for a minimum period of ten years against power degradation in excess of 10% of the rated power. Module junction boxes shall be moisture resistant and shall have sufficient space for addition of bypass diodes. Boxes that accept conduit are preferred. Junction boxes shall be mounted to the solar module frame and not to the surface of the module. During installation, the panels shall be covered until all electrical work has been completed.

The controller and other necessary electrical components shall be located in a weatherproof enclosure and mounted at a level for convenient access. The entire solar powered pumping system shall be enclosed by fencing or other protective measures to assure protection from livestock. The enclosure must provide adequate access to all components for service and maintenance. All pertinent components shall be adequately grounded.

Windmills. Windmill towers shall be sized and constructed according to manufacture's recommendations and installed according to manufacture's instructions. Towers not approved by the manufacture must be approved by a licensed professional engineer.

Flow Testing. When the power source and water are available at the time of installation, the installer shall operate the pump at the design capacity for a minimum of 1-hour.

Certification. For all installations, the installer shall provide certification that the completed pumping plant meets all criteria of the Oklahoma Conservation Practice Standard and Specification.