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 part of a resource management system to achieve one or more of the following purposes:

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

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, reservoirs; transfer wastewater, remove surface runoff or groundwater, or provide a water supply for irrigation, livestock, and wildlife.

CRITERIA

General Criteria Applicable to All Purposes

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

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. Design flow rate, range of operating heads, and pump type shall meet the requirements of the application.

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

Pump design shall ~~should~~ use state-of-the-art technology with installed field efficiencies of at least 75% ~~70%~~. ~~Solar or wind-powered variable speed pumps~~ *Small volume pumps used for livestock water* and those used to pump wastewater are exempt from this efficiency requirement; *however, such pumps must operate within the manufacture's published recommended range of operating conditions (pen and ink change approved by J. Chris Stoner, State Conservation Engineer, 5/14/14).* Capabilities, range of operating head, general class and efficiency of equipment shall be determined by appropriate technical means.

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,

wastewater pumps, 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.

Wastewater or manure transfer pumps shall be sized to move material at the required system head and flow rate determined by the waste management plan. The pump shall be sized based on the characteristics of the material being pumped and the manufacturer's recommendations.

Solar- or wind-powered pumps 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 follow a "no-clog" design.

Power units. Pump power units shall be selected based on the availability, 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.

Electric wiring shall meet the requirements of the National Electrical Code.

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

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

Electric Motors. 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 both oil- and water-resistant. Electric motors shall meet NEMA (National Electric Manufacturers Association) requirements and installation practices and wiring shall meet NEC (National Electrical Code) and local code requirements. Electric motors shall be protected from overloading, overheating, and lightning.

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

The Variable Frequency Drive shall be protected against overheating and the control panel shall display real-time flow rate or pressure.

Photovoltaic 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 needed to operate the pump at the design flow rate with the appropriate service factor for 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 power is required. Panels and panel mounts shall be secured to resist movement by environmental factors like high winds.

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

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.

Internal Combustion Engines. Internal combustion engine shall deliver both the design horsepower and speed (RPM) required by the pump. The engine shall operate between the manufacturer's minimum and maximum RPM limits to deliver the required discharge rate and pressure. Engines shall be rated for continuous duty and have safety controls for shutdown in case of engine: 1) overspeed, 2) overheating, 3) low water for water-cooled engines, and 4) low oil pressure. All exposed drivelines, shafts, sheaves, gears, pulleys, and belts shall be properly shielded for safety.

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 degradation of 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 gauges, 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 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.

Pump systems using 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 minimal.

Pump manufacturer's recommendations shall be followed for 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.

Buildings and accessories. When buildings are needed to protect the pumping plant, provisions shall be included for adequate ventilation and accessibility for equipment maintenance, repairs, and removal. Plant appearance shall be compatible with the surrounding environment.

Structures and equipment shall have adequate safety features to protect operators, workers, and the public from potential injury. Drive shaft covers shall be required on all exposed rotating shafts.

Pumps may be mounted on pilings or concrete foundations in a well or pit or by other appropriate means. Where buildings are needed to protect the pumping plant, provision shall be made for accessing equipment for maintenance and repairs, and for protecting equipment from the weather, vandalism, and fire. Foundations shall be designed to safely support the loads imposed. Sheet piling or other measures shall be used, to prevent piping beneath the foundation.

Suction bays (or sumps) shall be designed to meet the pump manufacturer's hydraulic constraints and also prevent the introduction of air at the intake.

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 factored into the design. Trash racks shall be used to prevent debris and trash from entering the pump.

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

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 use a non-combustion power source, or cleaner-burning technology or fuel.

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.

Additional Criteria Applicable to the Installation of a Pumping Plant in an Existing Well

Water from an existing well must be of such quality and quantity to meet the intended purpose. Where water quality is not known, testing shall be performed in accordance with Oklahoma Conservation Practice Standard 355-Well Water Testing and performed by an Oklahoma Department of Environmental Quality certified or other approved laboratory. Types of tests will be based on the intended use of the water.

Prior to installation of a Pumping Plant into an existing well, the lifespan of the materials used in the well must be evaluated and determined adequate for continued operation. Oklahoma Conservation Practice Standard 642-Water Well details the requirements for a new well.

The well shall be certified by an Oklahoma Licensed Well Driller. Certification may have been when the well was originally developed and logged with the Oklahoma Water Resources Board (OWRB) or in its current condition, if no records are available from OWRB. A Completion Report for the well can serve as documentation of certification.

Wellhead protection measures shall conform to OWRB Rules and Regulations for any existing well installation. If observations around the well indicate a potential water quality concern, the well shall not be used and the owner notified.

CONSIDERATIONS

When planning this practice, the following should be considered:

- The long-term impact of removing surface water by a pumping plant on downstream flow and aquifer recharge.
- The potential impact on existing wetland hydrology when using a pumping plant to remove surface water or groundwater flowing into a wetland.
- The adverse impact of spilled maintenance and operation fuels and lubricants on surface and groundwater quality and protective measures needed to minimize this threat. 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.
- When installing new or replacing existing combustion equipment, non-combustion and renewable energy sources, such as solar, wind, and water, should be considered.

The efficiency of pumping 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 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.

Detailed drawings of the pumping plant and appurtenances, such as piping, inlet and outlet connections, mounting, foundations, and other structural components.

A performance curve for the installed pump

OPERATION AND MAINTENANCE

An Operation and Maintenance plan specific to the pumping plant being installed shall be prepared for the owner and responsible operator. The plan shall provide specific instructions for operating and maintaining facilities to ensure the pumping plant functions as designed. The plan shall include the following:

Electrical service must be disconnected and the absence of stray electrical current verified prior to repairing or retrofitting any electrically-powered equipment.

Inspection or testing of all pumping plant components and appurtenances.

Proper start-up and shut-down procedures for pumping plant operation

Routine maintenance of all mechanical components (power unit, pump, drivetrain, etc.) in accordance with the manufacturer's recommendations.

Procedures to protect the system from freezing temperatures.

Schedule procedures for checking the power unit, fuel storage facilities, and fuel lines for leaks and performing repairs.

Periodic checks and scheduled debris removal from trash racks and structures, to ensure adequate flow reaches the pump intake.

Periodic removal of suction bay sediment to maintain discharge capacity and efficiency.

Inspection and maintenance of anti-siphon devices.

Routine testing and inspection of all automated pumping plant components

Inspection and maintenance of secondary containment facilities.

Periodic inspection of all safety features.

REFERENCES

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

Title 785. Oklahoma Water Resources Board, Chapter 35. Well Driller and Pump Installer Licensing