Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

PUMPING PLANT

CODE 533

(no)

DEFINITION

A facility that delivers water or wastewater at a designed pressure and flow rate.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Deliver water for improved plant condition, livestock, or wetlands
- Remove excessive subsurface or surface water
- Provide efficient use of water on irrigated land
- Transfer of livestock waste or liquid byproducts as part of a wastewater transfer system
- Reduce energy use

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where conservation objectives require the addition of energy to—

- Pressurize and transfer water from a surface or underground source to irrigated land, wetlands, livestock watering facilities, or reservoirs.
- Transfer water for fire protection, or transfer of wastewater or liquid byproducts.
- Remove surface runoff or excess subsurface water.

The pumping plant includes one or more pumps and associated power units, plumbing, and appurtenances, and may include pressure tanks, onsite fuel or energy source, and protective structures.

For a combustion system replacement, repowering, or retrofit associated with a pumping plant (e.g., pumping plant power unit) for an air quality or energy purpose, use NRCS Conservation Practice Standard (CPS) Combustion System Improvement (Code 372).

CRITERIA

General Criteria Applicable to All Purposes

Plan, design, and construct all pumping plants to comply with all Federal, State, Tribal, and local laws and regulations.

Pump requirements

Select pumps to meet design flow rate, range of operating pressures, and pump-type requirements of the application. Document how the proposed pump meets the requirements using manufacturer-supplied pump curves and other technical data.

Select pump materials based on the physical and chemical qualities of the material being pumped, the operating environment, and manufacturer's recommendations.

Power (drive) units
Select pump drive units based on the availability and cost of power, operating conditions, need for automation, and other site-specific objectives. Match drive units to the pump requirements so the pumping plant can operate efficiently and effectively within the planned range of conditions. Size the pump drive unit to meet the horsepower requirements of the pump, including efficiency, service factor, and environmental conditions.

Internal combustion engines must meet local air emission requirements.

Electric drive units may include line power, photovoltaic panels, and wind- or water-powered turbines. Install electrical system to meet the requirements of the National Electrical Code. Other drive units may include power take-off (PTO), diesel, gasoline or distillate, or propane running engines. Ensure that diesel power units meet U.S. Environmental Protection Agency Tier 3 or higher engine technology.

Meet applicable design criteria in NRCS or industry standards for renewable energy power units and install units in accordance with manufacturer's recommendations.

Photovoltaic panels
Size the photovoltaic array based on average data for the location and the time of year pumping occurs, according to manufacturer's recommendations. Ensure that the photovoltaic array provides 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. Typically, panels are expected to degrade not more than about 1 percent each year. Orient fixed arrays to meet maximum efficiency. Base panel tilt angle on the location latitude and time of year for power requirements. Mount panels securely to resist movement by environmental factors.

Windmills
Size pumping units according to pumping lifts and capacities, as specified by the manufacturer. A minimum annual average wind speed of 6.5 m/s is required. This is determined by using the U.S. Department of Energy's Average Annual Wind Speed at 80-m height for California (https://windexchange.energy.gov/maps-data/319) or anemometer data. Size towers to the mill diameter, and to provide proper wind exposure, with adequate height for efficient and safe operation. Locate towers away from obstructions that will block wind movement.

Wind Generators
Wind generators are required to have automatic overspeed- governing systems to keep the rotor from spinning out of control in very high winds.

Towers (structures to which the generator are mounted) shall be proportioned to the blade span, with adequate height for efficient and safe operation. All towers need to be of sufficient height that the sweep of the blades is a minimum of 30 feet above and 100 feet away from any obstacle.

The structural components of tower wind generator shall be designed by a registered Civil Engineer, Structural Engineer or Architect, licensed to practice in California, to meet all state, county and local building codes. The tower shall be suitable for the site and designed to meet all site-specific requirements. NRCS shall provide the designer with a detailed site map (showing all planned practices), a detailed topographical map and NRCS Soil Survey information.

The engineer or architect shall provide signed and sealed construction plans, specifications and operation and maintenance guidance for the towers.

Wind generators shall not be installed within 200 feet of woody vegetation that may provide suitable habitat for birds that are nesting, resting, or using such vegetation for protection from the cold weather.

Exceptions to this distance may be given by NRCS biologists after the site has been accessed for any potential impacts.

Water-powered pumps (hydraulic rams)
Size pumping units according to flow rate, lift, fall, and efficiency. Return bypass water to the stream or storage facility, without erosion or impairment to water quality.

PTO-driven pumps
Size pump according to delivery rate required at outlet. Match pump size to the available operating equipment in addition to the pump demand.

Variable frequency drives
Prior to installation, it is the landowner's responsibility to inform the electric power provider of the proposed variable frequency drive (VFD) installation. Ensure that the power provider's standards are met regarding potential harmonics (e.g., the Institute of Electrical and Electronics Engineers (IEEE) Standard 519) and other interference issues.

Protect VFDs against overheating. Provide a VFD control panel that has a readout display of flow rate or pressure.

Suction and discharge pipes
Design suction and discharge pipes to prevent cavitation. Account for suction lift, net positive suction head, pipe diameter and length, minor losses, temperature, and altitude. Base the size of suction and discharge pipes on hydraulic analysis, operating costs, and compatibility with other system components.

Include appurtenances such as gate valves, check valves, relief valves, pressure-reducing valves, pressure gauges, pressure tanks, pipe connections, and other protective devices to meet the requirements of the application.

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

If chemicals or fertilizers are included in a delivery system using a water source, include backflow prevention devices according to Federal, State, and local laws to prevent contamination of water sources connected to the pumping plant.

Buildings and accessories
Mount floating pumps on floating structures as designed by the manufacturer. Support submersible pumps by a column pipe sufficient to support the pump and static and dynamic loads or provide additional support by stainless steel cable. For all other pumps securely mount on a solid foundation such as pilings or concrete. Design the foundation to safely support the loads imposed by the pumping plant and appurtenances. Use sheet piling or other measures as required, to prevent piping beneath the structure foundation.

Where enclosures, shelters, covers, or other structures are necessary to protect the pumping plant, include provisions for adequate ventilation and accessibility for equipment maintenance, repairs, or removal.

Design suction bays or sumps to prevent the introduction of air into the intake pipe and to eliminate rotating currents.

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

Backflow Prevention to Protect Freshwater Sources
All pump discharge pipes not discharging to the atmosphere shall be equipped with a check valve or similar device to prevent backflow or backsiphonage into the source when the pump shuts down. Check valves shall be spring loaded and must have a low pressure drain (which opens and drains any remaining liquid onto the ground when the pressure drops) on the bottom of the upstream section. A large volume air vent/vacuum relief valve must be installed upstream of each check valve.

Safety
Design structures and equipment to provide adequate safety features to protect operators, workers, and the public from potential injury. Require drive shaft covers on all exposed rotating shafts.

Construct barriers if needed to protect humans and livestock from the pump or drive unit.

If the project includes excavation, the landowner or contractor is responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

Additional Criteria for Providing the Efficient Use of Water on Irrigated Land

Include provisions for the connection of flow and pressure measurement devices in the pumping plant system design.

Additional Criteria for the Reduction of Energy Use

Meet or exceed the Nebraska Pumping Plant Performance Criteria for fossil fuel or electrical grid power sources and pumping plant installations, if applicable. Refer to NRCS National Engineering Handbook (NEH) (Title 210), Part 652, Chapter 12, “Energy Use and Conservation,” Table 12–2.

Alternatively, estimate reduced energy use that results directly from the application of this practice. Calculate the estimated annual difference in energy use on an after-practice minus before-practice basis under the same operating conditions. Use a documented assessment methodology as approved by NRCS.

Additional Criteria for Pumping Waste and Waste Byproducts

Size pumps utilized for the transfer of wastewater or manure based on the required system pressure and flow rate determined by the waste management plan. Select the pump type based on the consistency of the material being pumped and the manufacturer’s recommendations. See NRCS CPS Waste Transfer (Code 634) for additional criteria.

CONSIDERATIONS

When planning this practice, the following considerations are recommended:

- The removal of surface water by a pumping plant can affect downstream flows or aquifer recharge volumes. Consider potential long-term impacts downstream of the pumping plant.
- If using a pumping plant to remove surface 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.
- Consider having the visual appearance of pumping plant enclosures or housing compatible with the surrounding environment.
- Consider including protective sensors to detect low or stopped flow, or pressures that are too high

or too low.

- Powered pumps can create noise that reaches nuisance levels to the surrounding environment. Consider selecting energy sources compatible with sensitive areas.
- Consider mobile photovoltaic panels for livestock watering facilities to facilitate use in rotational grazing systems.
- Consider photovoltaic panels that track the sun.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for constructing a pumping plant that describe the requirements for properly installing the practice to achieve its intended purpose. As a minimum, the plans and specifications must include—

- A plan view showing the location of the pumping plant in relationship to other structures, water source, pressure tank, pipeline, end use, or natural features.
- Detailed drawings of the pumping plant and appurtenances, such as piping, inlet and outlet connections, mounting, foundations, and other structural components.
- Proposed pump manufacturer-supplied pump curves and data.
- Written specifications that describe the site-specific details of installation.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan specific to the pumping plant being installed for use by the owner and responsible operator with specific instructions for operating and maintaining facilities to ensure the pumping plant functions properly as designed. As a minimum, address in the plan—

- Inspection of the pumping plant annually and after significant storm events to identify repair and maintenance needs.
- Inspection or testing of all pumping plant components and appurtenances.
- Proper startup and shutdown 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, including lubrication of parts.
- Procedures to protect the system from damage due to freezing temperatures.
- Ensuring that tractors driving PTO pumps are secured or blocked as necessary to prevent movement prior to running them.
- When applicable, procedures to frequently check the power unit, fuel storage facilities, hydraulic lines, 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 and blowback devices, if applicable.
- For photovoltaic panels, changing the tilt angle seasonally if used year-round.
- Routine testing 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.
- Disconnecting electrical service and verifying the absence of stray electrical current prior to retrofitting any electrically powered equipment.
- Maintaining records, including manufacturer installation and operation and maintenance guide along with records of when equipment is serviced, work performed, and by whom.
- When applicable, periodically cleaning the solar array of snow, ice, dust, and film to maintain

efficiency.

REFERENCES

MidWest Plan Service. 1993. Livestock Waste Facilities Handbook (MWPS-18), Chapter 8, Pumps. Ames, IA.

USDA NRCS. 2010. Oregon Technical Note No. 28, Design of Small Photovoltaic (PV) Solar-Powered Water Pump Systems. Portland, OR.

Irrigation Association. 2015. Pumps and Pumping Systems. Fairfax, VA.

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USDA NRCS. 2016. National Engineering Handbook (Title 210), Part 623, Chapter 8, Irrigation Pumping Plants. Washington, D.C. https://directives.sc.egov.usda.gov/