USDA United States Department of Agriculture

CONSERVATION ENHANCEMENT ACTIVITY

E533B

CONSERVATION STEWARDSHIP PROGRAM

Complete pumping plant evaluation for energy savings

CONSERVATION PRACTICE: 533 - Pumping Plant

APPLICABLE LAND USE: Crop (Annual & Mixed); Crop (Perennial); Pasture; Associated Ag Land; Farmstead

RESOURCE CONCERN: Energy

ENHANCEMENT LIFE SPAN: 1 year

Enhancement Description

Evaluation of all pumping plants to determine the potential to rehabilitate/replace/reconfigure pump performance to reduce energy use. Evaluate to determine if a Variable Frequency Drive motor controller(s) will reduce energy use and is feasible.

Criteria

- Pump test evaluation will include all irrigation pumps on the on fields where the activity is implemented. There could be multiple pumps that are used on single or multiple fields.

- Minimum data necessary to complete the pumping evaluation:
  - Flow rate, instantaneous and for the season.
  - Pressure at different flow rates based on partial or complete irrigations.
  - Power usage to compute efficiency of the drive unit.
  - Area and fields irrigated.
  - Estimate of friction loss in pipelines based on pressure drop in lines during test.

Documentation and Implementation Requirements

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Participant will:

Prior to implementation:

- ☐ Provide NRCS with a map showing the location of all fields and pumps connected to the irrigation system.
- ☐ Arrange for pump test evaluations of all irrigation pumps on fields where activity is implemented.

During implementation

- ☐ Have a pump test evaluation performed on all irrigation pumps that service the fields where activity is implemented.

After implementation

- ☐ Make the following items available for review by NRCS to verify implementation of the enhancement:
  - Pump test evaluation report(s).
  - Provide a list of any adjustments to improve system efficiency made as a result of the evaluation. Calculate the reduction of energy use based on before and after conditions. Energy savings can be reported as the average annual or seasonal energy reduction compared to previous operating conditions.

NRCS will:

Prior to implementation

- ☐ Provide and explain Pumping Plant (Code 533) to participant as it relates to implementing this enhancement.
- ☐ As needed, provide additional technical assistance to the participant as requested.

After implementation

- ☐ Verify pump test evaluation, by reviewing evaluation report.
- ☐ Verify energy savings based on system efficiency before and after implementation of the enhancement.

United States Department of Agriculture

OREGON SUPPLEMENT TO CONSERVATION ENHANCEMENT ACTIVITY E533B

CONSERVATION STEWARDSHIP PROGRAM

Additional Information and Requirements for Oregon

The intent is to evaluate irrigation pumping plants to determine the potential to rehabilitate/replace/reconfigure the pump to reduce energy use, and to determine if a Variable Frequency Drive (VFD) will reduce energy use and is feasible. Pumping plants that were evaluated under CSP in previous years are not eligible.

The Enhancement indicates that an evaluation is to be conducted for all irrigation pumps on fields where the activity is implemented, however, do not confuse "fields" with the CLU. Under this Enhancement, a field is defined by the irrigation system that serves it and the pumping plant evaluation is to be conducted on the pump(s) that support that irrigation system. Also, as the Enhancement points out, there could be multiple pumps that are used on single or multiple fields, which means this Enhancement and accompanying financial assistance is to be applied per irrigation system, not on the number of individual pumps that support that irrigation system.

It is noteworthy that not all local vendors have the capability of satisfying the requirements of this evaluation. Accordingly, advise the program participant to provide the requirements of the evaluation to a proposed vendor prior or contracting for it to ensure the vendor has the capability to complete it.

The program participant is to arrange for a pump test evaluation(s) by a local vendor capable of performing such an evaluation. To conduct this evaluation the vendor shall complete the "Pumping Plant Detailed Evaluation Worksheet" taken from the NRCS National Engineering Handbook (NEH). A fillable .pdf version of this worksheet can be found in Section IV of the FOTG under Code 533 "Pumping Plant".

OREGON SUPPLEMENT TO CONSERVATION ENHANCEMENT ACTIVITY E533B (CONT)

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Additional Information and Requirements for Oregon

To determine if a VFD will reduce energy use and is feasible, the vendor must also address the following information via commentary and /or detailed calculations within the "Recommendations" section of the Pumping Plant Detailed Evaluation Worksheet:

- Does installation of a VFD meet the local power provider's standards regarding potential harmonics (e.g., the Institute of Electrical and Electronics Engineers (IEEE) Standard 519) and other interference issues?
- How the VFD would be protected against overheating?
- Would the VFD's control panel have a readout display of flow rate or pressure?
- Separation between VFD frequency (Hz) at low flow and high flow points must be greater than one hertz (>1 Hz).
- VFD frequency (Hz) at the high flow point must not exceed the base frequency (60Hz) by more than 10% (≤10%), i.e. VFD frequency must not exceed 66Hz.
- Reduction of energy use is to be a minimum of 10% (≥10%) as estimated in terms of the annual difference in energy use on an after-practice minus before-practice basis considering the same operating conditions.
- Pump is to be designed with a goal of maintaining pump efficiency at or above 80% (≥80%), but must not be less than 70% (≥70%) at any of the defined flow points for more than 20% (≤20%) of the total operating hours.
- Estimated payback period with the goal of being no more than 15 years (≤15 yrs).

Upon receiving the completed Pumping Plant Detailed Evaluation Worksheet, attached it to the Enhancement's completed Documentation and Implementation Requirements. Once the documentation requirements under this Enhancement are satisfied, regardless of what the evaluation recommends, no follow-on action by the program participant is required.

Pumping Plant Detailed Evaluation Worksheet

Land user _____ Field office _____

Observer _____ Date _____ Checked by _____ Date _____

Field name or number _____ Acres irrigated _____

Hardware Inventory:

Power plant:

Electric motor(s):	Main pump	Booster (if used)
Make	_____	_____
Model	_____	_____
Rated rpm	_____	_____
Rated hp	_____	_____

Internal combustion engine:

Make _____

Model _____

Continuous rated hp at output shaft _____ hp at _____ rpm

Comments about condition of power plant _____

_____

Gear or belt drive mechanism:

Type: (check one) direct drive _____ gear drive _____ belt drive _____

_____ rpm at driver _____ rpm at pump

Pumps

Type: (centrifugal, turbine, submers.)		
Make	_____	_____
Model	_____	_____
Impeller diameter	_____	_____
Number of impellers	_____	_____
Rated flow rate (gpm)	_____	_____
at head of (ft)	_____	_____
at rpm	_____	_____

Pump curves: Attached _____ (yes or no)

Comments about conditon of equipment

Pumping Plant Detailed Evaluation Worksheet

Land user _____ Field office _____

Existing suction or turbine column set-up (sketch showing dimensions)

Existing discharge set-up (sketch showing dimensions)

Data and computations:

Total Dynamic Head (TDH):

Elevation difference - water surface to pump outlet _____ feet

Pressure reading at pump outlet _____ psi

Pressure at pump inlet (where supply is pressurized) _____ psi

Estimated friction loss in suction pipe or pump column _____ feet

Miscellaneous friction loss _____ feet

TDH = (elevation difference between water source and pump discharge) + (discharge pressure - pressure at inlet) times 2.31 + (estimated suction pipe friction loss) + miscellaneous =

_____ = _____ feet

Flow rate:

Flow meter:

Flow rate = _____ gpm

Velocity meter:

Pipe ID _____ inches

Velocity _____ feet/second

Flow rate, Q, in gpm = (Velocity, in feet/second) x (2.45) x (pipe ID^2) =

= _____ = _____ gpm

Pumping Plant Detailed Evaluation Worksheet

Land user _____ Field office _____

Water horsepower:

$$whp = \frac{(\text{flow rate, in gpm}) \times (\text{TDH, in feet})}{3960} = \_\_\_\_\_ = \_\_\_\_\_ \text{ hp}$$

Energy input

Electric:

Disk revolutions _____

Time: min _____ sec _____ = _____ sec

Meter constant (Kh) _____

PTR (power transformer ratio - usually 1.0)[1/] _____

CTR (current transformer ratio - usually 1.0)[1/] _____

$$KW = \frac{(3.6) \times (\text{disk rev}) \times (Kh) \times (PTR) \times (CTR)}{(\text{time, in seconds})} = \_\_\_\_\_ = \_\_\_\_\_ (kwh/h)$$

Diesel or gasoline:

Evaluation time: hours _____ minutes_____ = _____ hours

Fuel use _____ gallons (a small quantity of fuel may also be weighed, at 7.05 lb/gal for diesel and 6.0 lb/gallon for gasoline)

$$\frac{(\text{fuel use, in gallons})}{(\text{time, in hours})} = \_\_\_\_\_ = \_\_\_\_\_ \text{ gallons/hour}$$

Propane:

Evaluation time: hours _____ minutes _____ = _____ hours

Fuel use _____ lb (weigh fuel used from small portable tank)

$$\frac{(\text{fuel use, in lb})}{(4.25 \text{ lb/gal}) \times (\text{time, in hr})} = \_\_\_\_\_ = \_\_\_\_\_ \text{ gallon/hours}$$

Natural gas:

Evaluation time: hours _____ minutes _____ = _____ hours

Meter reading: End _____ minus Start _____ = _____ mcf

$$\frac{(\text{fuel used, in mcf})}{(\text{time, in hr})} = \_\_\_\_\_ = \_\_\_\_\_ \text{ mcf/hr}$$

1/ Some power companies use a type of meter that requires a PTR or CTR correction factor. Check with local power company.

Pumping Plant Detailed Evaluation Worksheet

Land user _____ Field office _____

In the next step, the efficiency of the power plant and pump, as a unit, is compared to the Nebraska Standards for irrigation pumping plants. The Nebraska standard for a good condition, properly operated plant. If the comparison comes out less than 100%, there is room for improvement.

Nebraska performance rating:

Nebraska pumping plant performance criteria _____

Pump and Power Plant

Energy source	Whp-h/unit of energy	Energy unit
Diesel	12.5	gallon
Propane	6.89	gallon
Natural gas	61.7	mcf
Electricity	0.885	kW=kwh/hr
Gasoline	8.66	gallon

The Nebraska standards assume 75% pump and 88% electric motor efficiency.

Percent of Nebraska performance rating

$$= \frac{\text{(whp) x (100)}}{\text{(energy input) x (Nebraska criteria, in whp-h/unit)}} =$$

= _____ = _____ %

Horsepower input:

Electric:

$$\frac{\text{(input kW)}}{\text{(0.746 kW/bhp)}} = \text{_____} = \text{_____ bhp}$$

Diesel:

(16.66) x (energy input, in gal/hr) = _____ = _____ bhp

Propane:

(9.20) x (energy input, in gal/hr) = _____ = _____ bhp

Natural gas:

(82.20) x (energy input, in mcf/hr) = _____ = _____ bhp

Pumping Plant Detailed Evaluation Worksheet

Land user _____ Field office _____

Pumping plant efficiency:

$$Epp = \frac{\text{(water horsepower output, whp) x (100)}}{\text{(brake horsepower input, bhp)}} = \_\_\_\_\_ = \_\_\_\_\_ \%$$

Energy cost per acre-foot:

Fuel cost per unit _____ $/kW-hr, or $/gal, or $/mcf

$$\text{Cost, in \$/ac-ft} = \frac{\text{(5431) x (fuel cost, in \$/unit) x (energy input, in kW, gal/hr, or mcf/hr)}}{\text{(flow rate, in gpm)}}$$

= _____ = $ _____/acre-foot

Recommendations:

Design Approvals & Acknowledgements:

Design Approval	Date	Job Approval Authority
Designed by:		
Approved by:		

Client's Acknowledgement Statement:

The client acknowledges:

- I have received a copy of the specification and understand the contents and requirements.
- It is my responsibility to obtain all necessary permits and/or rights and to comply with all ordinances and laws pertaining to the application of this practice.
- I will not begin installation of this practice until I have received appropriate approval to do so. I understand NRCS also has Federal and state laws to comply with that may take some time to address (e.g. cultural resources).

Client's Signature	Date

Certification Documentation:

☐	Field Evaluation: Post-treatment inventory, measurements, notes, as-built, and supporting documentation (document completion in conservation plan), as required.
☐	Map(s): Including field numbers, fields treated, and units treated (may document on conservation plan map), as required.
☐	Photos or other supporting documentation (e.g., seed tags, soil tests, receipts, invoices, spray records, fertilizer records, etc.)
Brief Description of Work Accomplished (types of equipment used, date of application, extents and quantities installed, etc.)	

Certification Statement:

The employee certifies the implementation of this conservation practice:

- Meets the purpose, general criteria, and any required additional criteria as documented in the conservation practice standard and/or enhancement sheet.
- Meets the specifications contained herein and is complete.
- Conforms to my existing Job Approval Authority controlling factors and levels.

Name	Date	Job Approval Authority

Field Level Certification – For multiple applications of this design.				
Land Unit/ Contract Item Number	Date	Unit(s)	Amount Installed	Certifier