

Water Quantity Enhancement Activity – WQT03 – Irrigation pumping plant evaluation



Enhancement Description

This enhancement consists of the evaluation of the pumping plant performance and efficiency using the Nebraska Irrigation Pumping Plant Performance Criteria.

Land Use Applicability

Cropland, Pastureland

Benefits

A pumping plant performance test can determine the energy efficiency of an irrigation pumping plant and

provide information on adjustments or modifications needed to improve the energy efficiency. Efficiency improvements come in the form of reduced energy consumption, reduced water use and better management techniques. A pumping plant test may be performed regardless of the age of the system.

Conditions Where Enhancement Applies

This enhancement applies to all irrigation pumping plants in the crop or pasture land use.

Criteria

An irrigation pumping plant performance test must be performed by a qualified service provider with appropriate testing equipment. A full and complete report must be completed by the service provider. This should include:

1. Age and condition of the components of the irrigation system and pumping plant
2. Water levels during pumping, a pressure / discharge curve
3. Pump and engine speed (rpm)
4. Actual Pump Plant Performance versus the Nebraska Performance Criteria
5. Actual pump efficiency versus the Manufacturers Published efficiency
6. Recommendations for improvements to the overall system efficiency
7. Estimate of energy savings if improvements are implemented

Note: Below is the “Nebraska Performance Standards for Irrigation Pumping Plants” table.

Adoption Requirements

This enhancement is considered adopted when a full and complete report with the seven criteria above has been developed by a trained service provider.

Documentation Requirements

A completed pumping plant evaluation report including the items identified in the above criteria.



Nebraska Performance Standards for Irrigation Pumping Plants ⁽⁸⁾

Energy Source	Energy Unit	Hp-hr⁽¹⁾ Per Unit of Energy	Water Hp-hr⁽²⁾ Per Unit of Energy⁽³⁾
Diesel	Gallon	16.7	12.5
Gasoline	Gallon	11.5 ⁽⁴⁾	8.66
Propane	Gallon	9.2 ⁽⁴⁾	6.89
Natural Gas	1,000 cu ft	88.9 ⁽⁵⁾	66.7
Electricity	kWh	1.18 ⁽⁶⁾	0.885 ⁽⁷⁾

- (1) Horsepower-hours are the work being accomplished by the power unit with losses considered.
- (2) Water horsepower-hours are the work being accomplished by the pumping plant, engine or motor and pump, at the Nebraska Performance Criteria.
- (3) Based on 75 percent pump efficiency.
- (4) Taken from Test D of Nebraska Tractor Test Reports. Drive losses are accounted for in the data. (Assumes no cooling fan)
- (5) Manufacturers' data corrected for 5 percent gear-head drive loss and no cooling fan. Assumes natural gas energy content of 1,000 Btu per cubic foot
- (6) Assumes 88 percent electric motor efficiency.
- (7) Direction connection, assumes no drive loss.

Wisconsin Supplement 2/3/2012

Written documentation shall include the manufacturer and model number of irrigation pumping equipment currently being used.

See additional Wisconsin Supplement information on the following pages.

This is an 'Actual' type enhancement.



United States Department of Agriculture
 Natural Resources Conservation Service

WISCONSIN SUPPLEMENT

2012 Ranking Period 1

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State Criteria (same as NATIONAL CRITERIA)

Irrigation Pumping Plant Evaluation shall be conducted in accordance with the [Technical Irrigation Pumping Plant Test Procedure Manual](#) (1982, University of Nebraska Institute of Agriculture and Natural Resources).

Documentation Requirements (SEE NATIONAL ENHANCEMENT ACTIVITY JOBSHEET)

Complete the Table below:

To be completed by NRCS and Producer during planning			To be completed by Producer during certification process	
1	2	3	4	5
Tract	Field(s)	Acres Planned	No. of pumping plants evaluated	Date of irrigation pumping plant evaluation
Ex. T100	2b	7.3		

Ex. = example. NRCS completes column 1, 2 & 3 (Tract, Field and Acres Planned). Operator completes remaining columns.

IRRIGATION PUMPING PLANT EVALUATION

Name _____ County _____ Tract No. _____

Static Water Level (ft) _____ Pumping Water Level (ft) _____
 Pump Brand _____ Stages _____ Serial No. _____
 Pump Setting _____ Pump Shaft Dia. _____ Threads/in _____
 Pump RPM _____ Motor RPM _____

Pumping Head

Pumping Head											
Pressure at Pump Outlet (psi)		Pressure Conversion		Elevation Difference Between Pump Outlet and Pumping Water Surface (ft)			Estimated Friction Loss in Column or Suction Pipe (ft)		Miscellaneous Friction Loss (ft)		(A) Pumping Head (ft)
x		2.31	+		+		+		=		

Flow Test

Flow Meter Test										
Meter Type	Minutes	Seconds	Time of Test (min)	Gallons at End of Test	Gallons at Beginning of Test	Total Gallons	Time of Test (min)	(B) Flow (gpm)		
Propeller			=		-		=		÷	=
Ultra Sonic or Magnetic										

Collins Flow Gauge:

10 Pt. Setting	Setting Position	Right		Left	
.158D					
.275D					
.354D					
.420D					
.475D					

Pipe I.D. _____ Average Velocity _____ x 2.45 x D² = _____ gpm (B)

General Power Unit Inventory

- Internal combustion engine, diesel, gasoline, or propane (complete page 3, Tables 1 and 2)
- Internal combustion engine, natural gas (complete page 3, Tables 3 and 4)
- Electric Motor (complete page 4, Tables 5-7)

Diesel, Gasoline, or Propane Energy Use Test

Table 1. Diesel, Gasoline, or Propane Energy Use Test															
Fuel Type	Weight at Start of Test (lbs)		-	Weight at Stop of Test (lbs)		=	Net Weight Used (lbs)		÷	Unit Weight of Fuel (lbs/gal)	÷	Total Time of Test (hrs)		=	(C) Energy Use (gal/hr)
Diesel			-			=			÷	7.10	÷			=	
Gasoline			-			=			÷	6.00	÷			=	
Propane			-			=			÷	4.25	÷			=	

Table 2. Diesel, Gasoline, or Propane Performance Rating																	
Fuel Type	(A) Pumping Head (ft)	×	(B) Flow (gpm)	÷	Horsepower Conversion	=	Water horsepower (whp)	÷	(C) Energy Use (gal/hr)	=	Actual Plant Performance (whp hr/gal)	÷	NPPPC (whp hr/gal)	×	100	=	(D) Performance Rating (%)
Diesel		×		÷	3960	=		÷		=		÷	12.5	×	100	=	
Gasoline		×		÷	3960	=		÷		=		÷	8.66	×	100	=	
Propane		×		÷	3960	=		÷		=		÷	6.89	×	100	=	

Natural Gas Energy Use Test

Table 3. Natural Gas Energy Use Test													
	Dial Capacity	×	(B) Flow (gpm)	×	Dial Revolutions	÷	Time of Test (sec)	=	(C) Energy Use (mcf/hr)	×	Gas Pressure (psi)	÷	Elevation
3.6		×		×		÷		=		×		÷	

Table 4. Natural Gas Performance Rating																	
Fuel Type	(A) Pumping Head (ft)	×	(B) Flow (gpm)	÷	Horsepower Conversion	=	Water horsepower (whp)	÷	(C) Energy Use (mcf/hr)	=	Actual Plant Performance (whp hr/mcf)	÷	NPPPC (whp hr/mcf)	×	100	=	(D) Performance Rating (%)
Natural Gas		×		÷	3960	=		÷		=		÷	66.7	×	100	=	

Electric Energy Use Test

Table 5. Electric Energy Use Test									
Meter Type			Disc Revolutions		Kh		Time of Test (sec)		(C) Energy Use (kW)
Dial	3.6	×		×		÷		=	
Digital									

Table 6. Electrical Characteristics				
	Leg 1	Leg 2	Leg 3	Average
Volts				
Amps				

Table 7. Electric Performance Rating											
Energy Source	(A) Pumping Head (ft)	(B) Flow (gpm)	Horsepower Conversion	Water horsepower (whp)	(C) Energy Use (kW)	Actual Plant Performance (whp hr/(kWh))	NPPPC (whp hr/kWh)		(D) Performance Rating (%)		
Electric	×	÷	3960 =	÷	=	÷	0.885 ×	100 =			

Potential Savings

If the performance rating calculated for the pumping plant is less than 100 %, potential annual savings can be estimated using Tables 8 and 9. A performance rating at, or above 100% indicates that the pumping plant is operating at, or above the expected performance level as defined by the Nebraska Pumping Plant Performance Criteria (NPPPC). A performance rating below 100% indicates the pumping plant is using more energy than the criteria calls for.

Table 8. Potential Energy Savings Estimated from Annual Hours											
(D) Performance Rating (%)				(C) Energy Use (unit/hr)	(E) Excess Energy Consumed (unit/hr)	Annual Hours of Operation (hr/season)	Excess Energy (unit/season)	Unit Cost of Energy (\$/unit)	Potential Annual Savings (\$/season)		
100 -	=	÷	100 =	×	=	×	=	×	=		

Table 9. Potential Energy Savings Estimated from Annual Inches Applied											
(B) Flow (gpm)	(F) Water Application Capacity (ac-in/hr)	(E) Excess Energy Consumed (unit/hr)	Unit Cost of Energy (\$/unit)	Excess Energy Cost (\$/hr)	(F) Water Application Capacity (ac-in/hr)	Cost per Acre-Inch (\$/Ac-in)	Irrigated Acres	Annual Inches Applied (in/season)	Potential Annual Savings (\$/season)		
÷	452 =	×	=	÷	=	×	×	=			

Field Pump Test Data

While performing the energy use test it is required to document field pump test data. Document current pump configuration and if adjustments were made below.

Observation No.	Flow (GPM)	Well Pressure (psi)	Drawdown Pumping Level (ft)	Constant RPM	
				<input type="checkbox"/> Motor RPM	<input type="checkbox"/> Pump RPM
1					
2					
3					
4					

Note: Field pump test data must show data for all columns above. Flow points should be documented at a constant RPM.

Pump Adjustments*

_____ Pumping Head x _____ Downthrust = _____ Total Downthrust
 _____ Shaft Stretch x _____ Shaft Length/100 = _____ Total Stretch x _____ Threads/in
 = _____ Turns of Nut

Age and Condition of Pumping Plant and Components _____

	<u>Current Configuration</u>	<u>After Adjustments*</u>
Pumping Water Level	_____ Feet	_____ Feet
Operating Pressure	_____ psi	_____ psi
Operating Flow Rate	_____ gpm	_____ gpm
Power Requirements	_____ Whp	_____ Whp
Pump RPM	_____ RPM	_____ RPM
Engine RPM	_____ RPM	_____ RPM
Performance Rating	_____ %	_____ %

Adjustments, remarks and recommendations

Date of Test: _____
 Test completed by: _____
 Contact Number of Tester: _____

* It is recommended that the pump adjustment be made only by trained professionals. Adjustments are not required to meet the requirements of the Conservation Security Program Enhancement Water Quality Enhancement Activity WQT03, Irrigation Pumping Plant Evaluation.

Copies of this Field Data form should be completed for each test performed and submitted to NRCS.
 Form modified from Cooperative Extension Service Agricultural Engineering Department, University of Nebraska – Lincoln