SPARE ENGINEERING

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April 17, 2026

RE: 2026-ITI-43 / GMD5 / 22075 - 22075

Southwestern College, c/o Matt Foos
c/o FNC, P.O. Box 454,
Spearville, KS 67876

Mr Foos,

You have given me the opportunity to test and evaluate the irrigation system located on the **22075** field located at **NE 29-24-18W**. The field work was completed April 15 along with you and your tenant's assistance.

Three primary systems need to work together properly for an efficient system operation. First, the well needs to produce a sustained flowrate. Secondly the pump transports the water from the well into the irrigation system with reasonable friction (pressure) loss. Thirdly, the irrigation system's sprinkler package (sprinklers, nozzles, regulators, end sprinklers) uniformly distributes the pumped water onto the ground or crop. Each of the three systems works together and must be individually optimized in order for the full operation to provide economical results.

WELL PERFORMANCE is most often measured as Specific Capacity (gpm per net ft of drawdown (DD)). Having access to the water level during pumping allows one to assess Specific Capacity (SC).

This well was completed in 1976 to a total depth of 69 ft using 7 ga steel casing. The screen utilized was in the lower 18 ft of the well—8 ft of Doerrs steel and 10 ft of Johnson steel, all of 3/16" slots. At that time the static water level (SWL) was 29 ft. The well was pumped for one hour then at 500 gpm, and pumping water level was 44 ft; hence the SC came to 33 gpm/ft of DD.

We measured the SWL at 46 ft. After 30 minutes of pumping at 310 gpm the PWL was measured at 55 ft. The resulting calculation of SC was 34 gpm/ft of DD which indicates a fair water yield in this well, and still yielding water at the same SC as found in 1979.

PUMPING PLANT. For evaluations of irrigation pumping plants, we use the Nebraska Performance Standards for Irrigation Pumping Plants (NPPPC) as targets. The target Pumping Plant Efficiency for diesel powered pumping plants is 14.5, measured as Water Horsepower (WHP) per gal/hr of diesel consumption.

The Goulds 4-stage 10RJLO pump, rated for 500 gpm, was installed in 2006 along with 60 ft of column pipe.

The right angle gear drive has a 6:5 ratio.

As mentioned above, the pump produced 310 gpm, and at 22 psi (measured at the pump). This flowrate was determined over 30 minutes via the McCrometer flowmeter register; the flowmeter needle indicated 290 gpm. The pump was turning at 1626 rpm.

A buried pipe of approximate length, 1632 ft, transports water from the pump to the center pivot. Pressure at the pivot point at 2 ft above the pad was 23 psi. Ground surface elevation at the well is 2069 ft, and at the pivot point is 2063 ft. Thus it appears that there was a friction loss of 0.5 psi between the two points.

Total dynamic head (TDH) was calculated at 111 ft. Power being generated by the pump was 9 WHP.

Diesel fuel consumption was measured at 2.3 gal/hr.

The pumping plant performance was calculated to be 3.8 WHP/gal/hr which is 26% of the NPPPC standard and is very poor.

SPRINKLER PACKAGE. The center pivot irrigation machine and sprinkler package is the third sub-system that must be analyzed—the required flowrate and pressure from the well and pumping plant must be conveyed efficiently from end to end of the system and distributed uniformly via each of the sprinklers. The industry standard rule-of-thumb is that the pressure on the upstream side of pressure regulators needs to be at least 5 psi above the rated pressure, thus a 15 psi regulator needs 20 psi going into its upstream side.

The installed sprinklers are R3000 Green plate with no pressure regulators. No sprinkler chart was available. The Zimmatic center pivot has side outlets with galvanized ¾" elbows, and poly drop pipes. Drop pipe spacings are too wide from Span 3 to the end. We estimate that these sprinklers are about 28 years old. Based on the WIMAS-reported acre-feet of water used, we estimate that this sprinkler package has operated over 22,000 hrs.

As noted above we determined the existing flowrate to be 310 gpm (position was about 250 degrees from North). The high point of the field for the end tower (ET) was at about 120 deg,

Pressure at the top-of-pivot was 19 psi while the pressure at the ET was 8 psi, a difference of 11 psi.

Discussion and Recommendations

Your well appeared to be providing water with a good water yield as the SC is 34 gpm per ft of DD. SWL was 46 ft at our field test. But we also noted that the SWL was 44 ft in 2006.

The pumping plant efficiency was determined to be 3.8 WHP/(gal/hr) which is considered very POOR. It appears that much of this reduced efficiency has to do with the quite low flowrate which is related to the SWL starting at 46 ft for our field test in contrast with the SWL at 29 ft in 1979 when the well was completed. Furthermore, the screen was installed from 51 to 69 ft. Our PWL was approximately 54 ft; however it was somewhat unclear as to this level since the water level sensor's electrical signal was somewhat intermittent, probably due to cascading water into the well.

I expect that air was being introduced into the pumped water due to the cascading well water and this complicates the situation. Air can be released from the produced water as it is being pumped at high points of accumulation. You do have a steel can at the pumping plant interface with the buried pipeline. On the top of that can are a vacuum vent and a high pressure relief valve. The existing vacuum vent is not able to release air while it is under pressure. But that location would be ideal to also plumb in a continuous air valve.

Another possibility for the low flowrate may be some plugging of the well screen. You have provided an invoice from the well driller indicating that in 2006 the pump was pulled and serviced, and the well was acidized and sand-bucketed. So there may be some degradation of the well screen or casing in the ensuing 20 years. To ascertain the condition of the well one could use a video camera to verify. At the same time, one may also determine whether sand intrusion to the interior of the well is occurring during pumping.

If sand intrusion appears to be one of the identified problems, then it will be important to flush the pipeline at the base of the pivot, and then the end of the pivot system.

A buried pipeline carries the water to the pivot point. It is not clear whether the pipeline route is direct to the pivot or not. However, there is a rise of several feet between the pumping plant in the first 100 ft or so toward the pivot point.

If the pipeline was installed with a high point but without an air vent at that high point, then there could feasibly be an air pocket which prevents the expected flowrate from being achieved. The following graph shows the direct route from the pumping plant to the pivot point. If this is the route where the pipe was installed, and if the pipe was laid according to that elevation profile, then one may need to explore where the high points exist and place continuous air vents there.

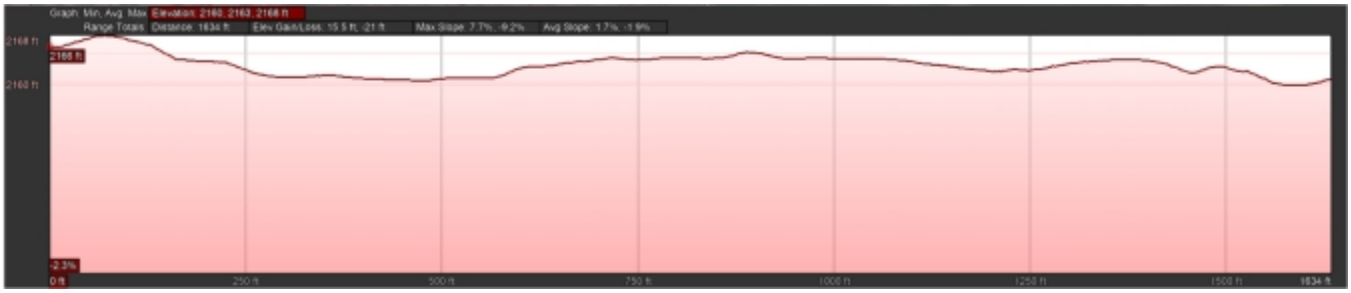

Figure 1. Elevation profile between well (left side) and pivot (right side).

The sprinkler package with this pivot appears to have operated for over 22,000 hrs; the manufacturers indicate that at around 12,000 to 15,000 hrs the regulators and sprinklers are usually in a condition needing replacement. With the low flowrate of 310 gpm the pressure loss between the pivot point and the ET of 11 psi is a strong indication that the pressure regulators are not functioning correctly but are allowing more water to pass than expected, thus we see less pressure at the ET than we expected.

If the well issue is resolved to the extent of being able to produce 500 gpm, then I would recommend that the sprinkler package be changed for one at this flowrate and 23 psi for top-of-pivot, using 10 psi regulators, and sprinklers suited to this pressure regulator rating. Pump pressure would need to be 27 psi.

Any new sprinkler package should also be configured to use sprinkler drop spacings from Span 3 and to the end according to standard spacings which are recommended by the sprinkler manufacturers. The wider spacings found on the current sprinkler package are not valid for sprinklers that use 10 psi regulators as the water application uniformity will be poor.

In the chart below, **FUTURE – With Improvements**, you can see some estimated savings resulting from installing this replacement sprinkler package and with the pump producing 500 gpm. The amount of annual energy cost savings that appears there is considerable at over $19,000. If you discover that the pump is not able to produce at this flowrate, then you may need to consider other options, including possibly irrigating fewer acres.

If you use cost share funds from GMD5 then you may be able to obtain much of the full cost of the new sprinkler package. I suggest that you be in contact with the GMD5 Manager, Orrin Feril, to explore your options.

If you have questions about the above information, or would like to discuss, feel free to contact me.

Sincerely yours,

Daniel P Spare

Daniel Spare, P.E. (Kansas 23540)
Agricultural Engineer

AS-IS

SW College, c/o FNC (Matt Foos)	Diesel-Powered	
ITI Energy and Water Use Audit	2026-ITI-43	
Date	4/17/2026	
Legal	NE 29-24-18W	
Field #	**22075**	
McCrometer Timed Test gpm	310	
McCrometer Needle reading gpm	290	
Ultrasonic Meter		
Pressure at pump, psi	22	engine heater coils in pipe
Pressure at pivot base	24	pivot point lower than pumpsite
Press on top of pivot	19	
Nozzling Package Design GPM		no chart found
PSI on top of pivot		
Pressure REG setting	15	
Installed Sprinklers	R3000 Green	
Measured Pressure at end Tower	11	test at 250deg; 14psi@4' ; elev 2159
Lowest ET Pressure (hi point)	7	ET 4 ft higher than pivot
Req'd ET Pressure Minimum(Hi Point)	20	based on R3000Grn needs 20psi
Static Water Level, ft	46	
Pumping Water Level, ft	55	
Well's Specific Capacity		
gpm/ft of DD	34	
Total Dynamic Head, ft (TDH)	111	
Water HP	8.7	
Adjusted WHP for GenSet/HydT&L	8.7	pivot not moviing
Diesel Fuel Consumption gal/hr	2.30	
Gearhead Ratio	6:5	
PUMP shaft RPM	1626	
Engine RPM	1951	
Engine Tach Reading	n/a	
GENSET	?	
Volts		
amps		
Pfactor		
Estimated Motor HP	n/a	
Estimated Water HP equivalent		
WHP/gal/hr Diesel	3.8	
NPPPC standard	14.5	
% of NPPPC standard	26%	
	VERY POOR	
Permit number	27774	
Allotted Acres	130	
Maximum Flow rate	745	
Alloted AF	195	
Actual acres irrigated	123	
WELL Depth WIZARD KGS	67	
SWL at Drilling	29(1979)	44(2006)
Operating Hours Calculations		
Max Inches applied per acre	19.02	
OP Hours in a drier year	3,419	
Elevation at Pivot	2163	
Elevation at Well	2169	
Elevation at Highest pt in field	2167	120deg fr North
spr pkg age, yrs	?28?	uncertain--?1998?
Estim. Operating Hrs	22071	
Age of pump, yrs	20	new in 2006

FUTURE - WITH IMPROVEMENTS

New Spr Pkg w 10 psi regs;
Explore well screen and casing

Field Number	**22075**
Flow Rate, gpm	500
per acre flowrate	4.1
Press at end tower	15.0
HF pivot friction loss psi	6.4
Psi loss to highest pt in field	1.7
Measured Hf to pivot base psi	-1.9
(adjusted to design flow rate	
Required Press at Pump	26.5
Required Press at Pivot on Top	23.1
Design Total Dynamic Head, TDH	127.6
PWL-Includes 5 future GW decline	66
Water HP	16.1
Press at Pivot Base using Pump psi	22.3
Mainline to Pivot Hydraulics Pipe ID	7.8
Length ft	1630
Hf friction loss psi	4.2
Cost per gallon of Diesel ($)	$3.50
Energy Use Comparison	
AS IS gallons Diesel	7,857
Energy Cost AS IS ($)	$27,499
OP Hours at Design Flow Rate	2,120
New Pump Water HP	16.12
Brake HP 82% pump efficiency	19.65
Motor Size, HP	
Pump KWDemand	16.66
Total New Diesel gal/hr	1.11
New gallons Diesel	2356
NEW annual cost of Diesel	$8,247
Savings in Energy Cost	$19,252
Combined BTU As Is	1,089,660,661
Combined BTU Future	326,780,414
Savings in BTU per year	762,880,247
% Energy Savings	70.01%
IMPROVEMENT COSTS	
Pump Pull and video well	$15,000
Replacement Sprinkler Package	$12,000
NET TOTAL COSTS	$27,000
Payback Years	1