

Proposed Lift Station Upgrade  
At Elks Country Estates  
October 28, 2008

We propose an upgrade of the Elks Country Estates Sanitary Sewer Lift Station Facility to accommodate future development planned within the lift station's service area or sewershed. A delineation of the sewershed is enclosed. The lift station upgrade is necessary to provide an increased pump rate and wet well operating volume. Generally speaking, the more homes and businesses that contribute sewer flows to a lift station, the larger will be the peak inflow rate expected at the wet well. It follows that the larger the peak inflow rate expected at the wet well, the bigger the pumps and wet well operating volume need be.

The existing sanitary sewer lift station at Elks Country Estates has a pump rate of 120 to 140 gpm with a single pump operating. Such a pump rate will generally accommodate 170 to 190 equivalent dwelling units (EDU). The existing wet well has an available operating volume of approximately 750 gallons. This volume would generally accommodate peak flows from approximately 360 EDU's and a pump rate of 250 gpm. Consequently, the existing wet well, when considered alone, does not have the capacity to accommodate a significant upgrade.

The extent of the pump upgrade is limited by the existing 6-inch forcemain. We propose maximizing the number of EDU's accommodated with this upgrade by providing a pump rate that will provide a velocity of 6 fps in the forcemain. It is usually accepted/ recommended that velocities in the forcemain be in the range of 2 fps to 8 fps; the maximum recommended velocity may be slightly different depending on the reference/ regulatory source.

With the upgrade, we propose installing 529 gpm pumps to accommodate 807 EDU's. We also propose installing a new single cell 9' x 9' concrete box wet well, a new 8' x 8' concrete box valve pit, and a manhole w/ air release system. We propose using the existing wet well to provide additional emergency storage volume at the facility. Preliminary calculations and selected pump data is enclosed.

The proposed upgrade has been designed to limit service interruptions at the facility. If things proceed as planned, we expect the longest service interruptions to not exceed 4 continuous hours. These interruptions will be scheduled for the night/ early morning hours.

## Lift Station Calculations

Project: Jolly Lane Lift Station - Renovation  
Date: 07OCT2008

- 807 = Number of EDU's  
213855 = ADF (gpd, assume 265 gpd per edu)  
3.56 = Peak Factor (based on population)  
529 = PH Flow (gpm)
- 6 = Forcemain Diameter (inches)  
5650 = Forcemain Equivalent Length (ft)  
130 = "C", Hazen-Williams coefficient  
529 = Flow Rate Q (pump capacity, gpm, normally set to PH Flow) @ 164.66 ft of Head  
6.00 = Velocity in Forcemain (minimum 2 fps)  
2 = minimum pump run time (minutes)  
1058 = Volume at minimum pump run time (gallons, should be less than Operating Volume)  
5 = maximum number of pump starts per hour  
12 = minimum Cycle Time t (minutes) for maximum pump starts per hour  
1587 = Operating Volume,  $V = tQ/4$  (gallons)  
4455 = ADF for 30 minutes (gallons, must be greater than Operating Volume) Dia = 9 9  
10.03 = Wet Well Inside Diameter (ft) (if rectangular, equivalent round dimension)  
2.69 = Depth (or Range) of Operating Volume (ft)  
3087.5 = Top Elevation of Lift Station (ft)  
69.40 = Inflow Pipe Invert Elevation (ft)  
68.90 = High Water Alarm Elevation (ft) (6-inches below inflow pipe invert)  
68.40 = Lag Pump On Switch Elevation (ft) (6-inches below high water alarm)  
67.90 = Lead Pump On Switch Elevation (ft) (6-inches below lag pump on switch)  
65.21 = All Pumps Off Switch Elevation (ft, Lead Pump On minus Range of Operating Volume)  
62.71 = Pump Base/ Floor Elevation (ft, 2.5 ft. below all pumps off elevation)  
62.55 = Bottom Slab Top Elevation (ft, floor elevation minus 2 inches for grout thickness)  
99.00 = Elevation of Downstream (Discharge or Receiving) Connection  
31.10 = Static Head at high end (lead pump on) of Operating Volume Range (ft)  
32.44 = Static Head at mid-point of Operating Volume Range (ft)  
33.79 = Static Head at low end (all pumps off) of Operating Volume Range (ft)  
0.00 = Back Pressure at Downstream/Receiving Forcemain (psi)  
0.0 = Back Pressure Head ( $H_{BP}$ ) at Downstream/Receiving Forcemain (ft)

$$H_{pump} = H_{static} + H_{BP} + H_{velocity} + H_{friction}$$

where

$$H_{static} = z_2 - z_1 \text{ (elevation difference)}$$

and

$$H_{velocity} = \frac{v^2}{2g} \text{ (velocity head loss)}$$

and

$$H_{friction} = 10.44 L_{eq} \frac{(gpm)^{1.85}}{C^{1.85} d_{inches}^{4.8655}}$$

Hazen-Williams equation

Hydraulic Horsepower, hyd hp =

$$\frac{gpm \times H_{pump} \text{ (in feet)}}{3960}$$

Brake Horsepower, BHP =

$$\frac{hyd \text{ hp}}{\text{efficiency}}$$

EXTREME Operating CONDITIONS
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gpm	h <sub>f</sub> (ft)	v (fps)	Total System Head (ft)				TSH w/o H <sub>BP</sub> (ft)		
			High	Mid	Low	High	Mid	Low	
0	0.00	0.00	31.10	32.44	33.79	---	31.10	32.44	33.79
10	0.08	0.11	31.18	32.53	33.87	---	31.18	32.53	33.87
20	0.30	0.23	31.40	32.75	34.09	---	31.40	32.75	34.09
25	0.46	0.28	31.56	32.90	34.24	---	31.56	32.90	34.24
30	0.64	0.34	31.74	33.09	34.43	---	31.74	33.09	34.43
40	1.09	0.45	32.19	33.54	34.88	---	32.19	33.54	34.88
50	1.65	0.57	32.75	34.10	35.44	---	32.75	34.10	35.44
60	2.31	0.68	33.42	34.76	36.10	---	33.42	34.76	36.10
70	3.07	0.79	34.18	35.52	36.87	---	34.18	35.52	36.87
75	3.49	0.85	34.60	35.94	37.29	---	34.60	35.94	37.29
80	3.93	0.91	35.04	36.39	37.73	---	35.04	36.39	37.73
90	4.89	1.02	36.01	37.35	38.69	---	36.01	37.35	38.69
100	5.94	1.13	37.06	38.40	39.75	---	37.06	38.40	39.75
110	7.09	1.25	38.21	39.55	40.90	---	38.21	39.55	40.90
120	8.32	1.36	39.45	40.80	42.14	---	39.45	40.80	42.14
125	8.98	1.42	40.11	41.45	42.79	---	40.11	41.45	42.79
130	9.65	1.47	40.79	42.13	43.47	---	40.79	42.13	43.47
140	11.07	1.59	42.21	43.55	44.90	---	42.21	43.55	44.90
150	12.58	1.70	43.72	45.07	46.41	---	43.72	45.07	46.41
175	16.73	1.99	47.89	49.23	50.58	---	47.89	49.23	50.58
180	17.62	2.04	48.79	50.13	51.48	---	48.79	50.13	51.48
200	21.42	2.27	52.60	53.94	55.28	---	52.60	53.94	55.28
210	23.44	2.38	54.63	55.97	57.31	---	54.63	55.97	57.31
225	26.63	2.55	57.83	59.18	60.52	---	57.83	59.18	60.52
240	30.01	2.72	61.22	62.57	63.91	---	61.22	62.57	63.91
250	32.36	2.84	63.59	64.93	66.27	---	63.59	64.93	66.27
275	38.60	3.12	69.85	71.20	72.54	---	69.85	71.20	72.54
300	45.35	3.40	76.63	77.97	79.31	---	76.63	77.97	79.31
325	52.58	3.69	83.89	85.24	86.58	---	83.89	85.24	86.58
350	60.31	3.97	91.65	93.00	94.34	---	91.65	93.00	94.34
375	68.52	4.25	99.90	101.24	102.59	---	99.90	101.24	102.59
400	77.21	4.54	108.63	109.97	111.32	---	108.63	109.97	111.32
425	86.37	4.82	117.83	119.18	120.52	---	117.83	119.18	120.52
450	96.01	5.10	127.51	128.85	130.20	---	127.51	128.85	130.20
475	106.11	5.39	137.66	139.00	140.34	---	137.66	139.00	140.34
500	116.67	5.67	148.27	149.61	150.95	164.66	148.27	149.61	150.95
600	163.47	6.81	195.29	196.63	197.98	---	195.29	196.63	197.98
650	189.56	7.37	221.50	222.85	224.19	---	221.50	222.85	224.19
700	217.42	7.94	249.49	250.84	252.18	---	249.49	250.84	252.18
750	247.01	8.51	279.24	280.58	281.92	---	279.24	280.58	281.92
800	278.34	9.07	310.72	312.06	313.40	---	310.72	312.06	313.40
850	311.38	9.64	343.92	345.26	346.60	---	343.92	345.26	346.60
900	346.10	10.21	378.82	380.17	381.51	---	378.82	380.17	381.51
950	382.51	10.78	415.42	416.76	418.10	---	415.42	416.76	418.10
1000	420.59	11.34	453.69	455.03	456.37	---	453.69	455.03	456.37
1050	460.32	11.91	493.62	494.96	496.31	---	493.62	494.96	496.31
1100	501.69	12.48	535.21	536.55	537.89	---	535.21	536.55	537.89
1150	544.69	13.04	578.43	579.78	581.12	---	578.43	579.78	581.12
1200	589.31	13.61	623.29	624.63	625.97	---	623.29	624.63	625.97
1250	635.54	14.18	669.76	671.10	672.45	---	669.76	671.10	672.45
1300	683.37	14.75	717.84	719.19	720.53	---	717.84	719.19	720.53

Company: DDI  
 Name gtb  
 Date: 10/10/08

based on "C" of 130 and v = 6 fps



**Pump:**  
 Size 4"5435MV  
 Type: 5430-NONCLOG  
 Synch speed: 1800 rpm  
 Curve: 35M404E  
 Specific Speeds:  
 Dimensions:

Speed: 1780 rpm  
 Dia: 12.9375 in  
 Impeller:  
 Ns: 1111  
 Nss: 7106  
 Suction: 4 in  
 Discharge 4 in

**Search Criteria:**  
 Flow: 529 US gpm  
 Head: 165 ft

**Fluid:**  
 Water  
 SG: 1  
 Viscosity: 1.105 cP  
 NPSHa --- ft  
 Temperature: 60 °F  
 Vapor pressure: 0.2563 psi a  
 Atm pressure: 14.7 psi a

**Motor:**  
 Consult vendor to select a motor for this pump.

**Pump Limits:**  
 Temperature: 104 °F  
 Pressure: 125 psi g  
 Sphere size: 3 in  
 Power: --- hp  
 Eye area: --- in<sup>2</sup>

**Data Point**

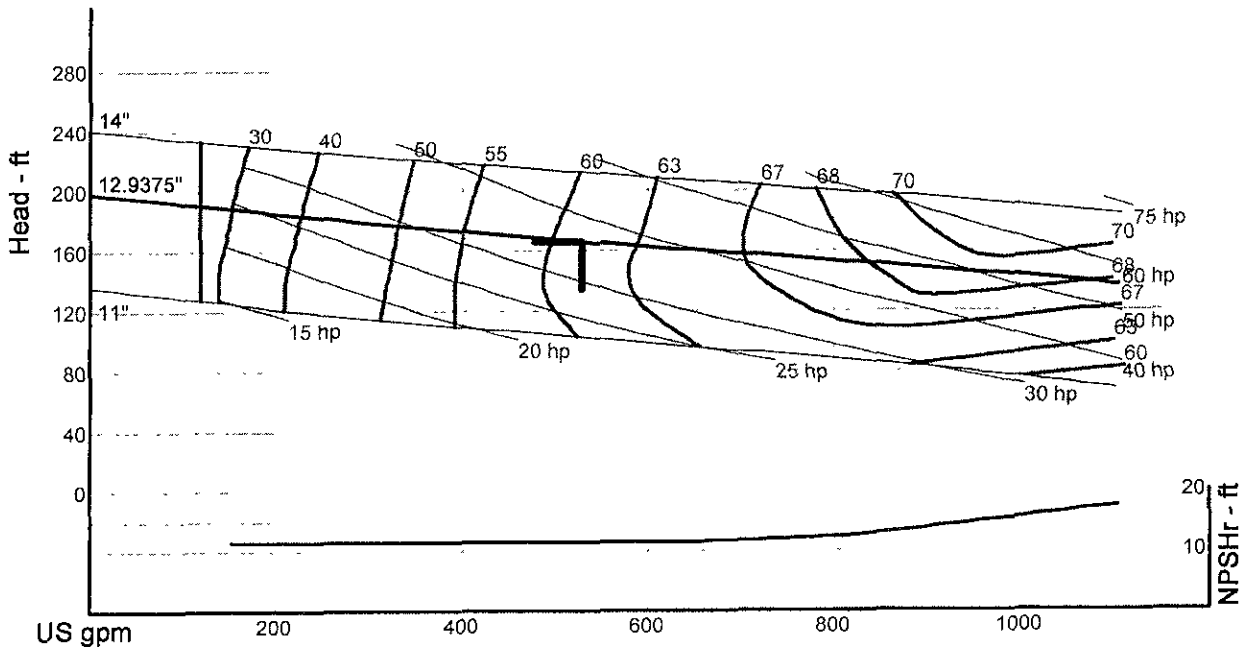
Flow: 529 US gpm  
 Head: 165 ft  
 Eff: 61%  
 Power: 35.9 hp  
 NPSHr: 11.5 ft

**Design Curve**

Shutoff Head: 197 ft  
 Shutoff dP: 85.3 psi  
 Min Flow: 120 US gpm  
 BEP: 69% eff  
 @ 933 US gpm  
 NOL Pwr: 55.8 hp  
 @ 1104 US gpm

**Max Curve**

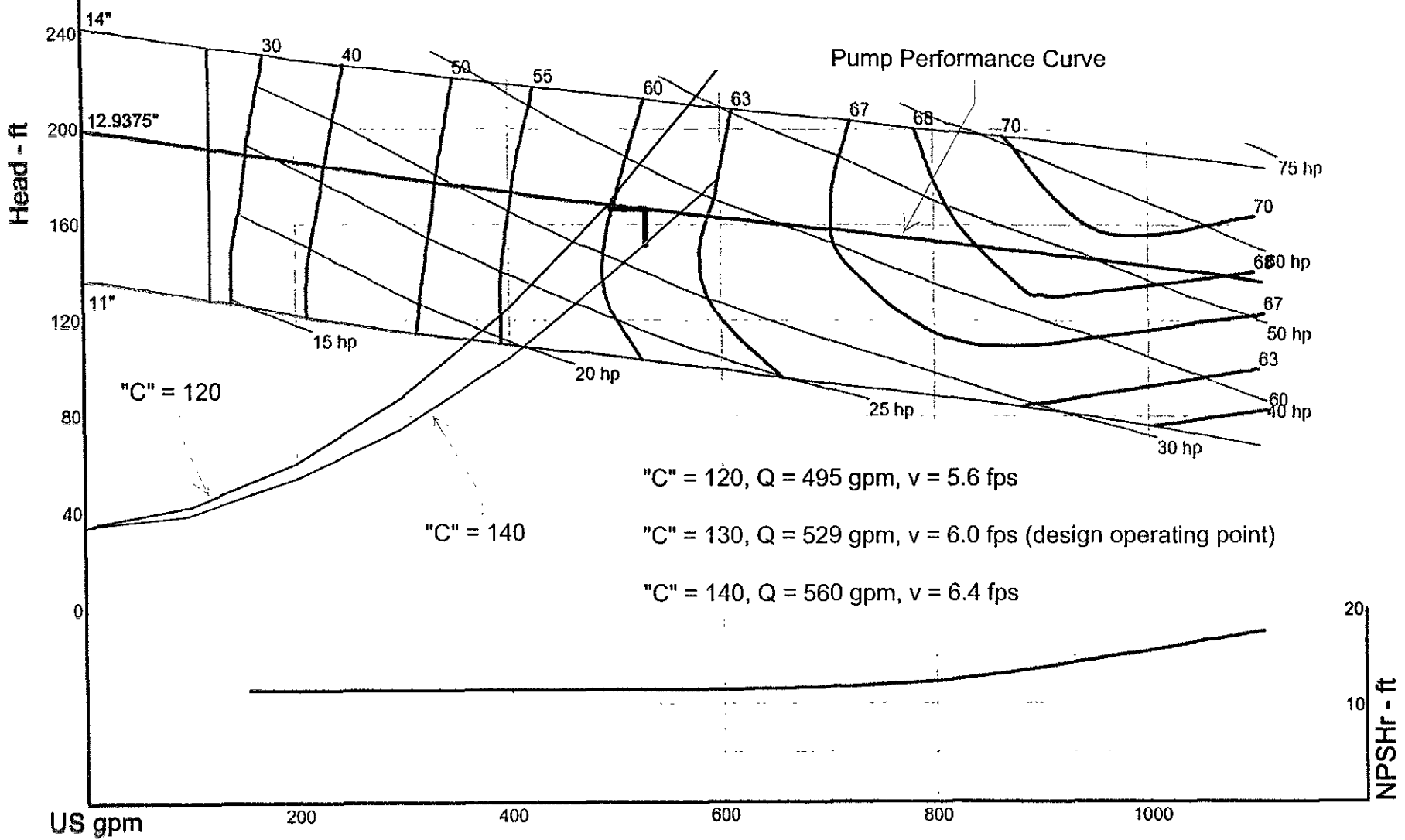
Max Pwr: 72.4 hp  
 @ 1108 US gpm



**Performance Evaluation:**

Flow US gpm	Speed rpm	Head ft	Pump %eff	Power hp	NPSHr ft
635	1780	160	65	39.5	11.6
529	1780	165	61	35.9	11.5
423	1780	171	56	32.3	11.5
317	1780	177	49	28.9	11.5
212	1780	184	38	25.8	11.5

## Comparison of System Head Curves and Operating Points based on varying the "C" value in the Hazen-Williams equation



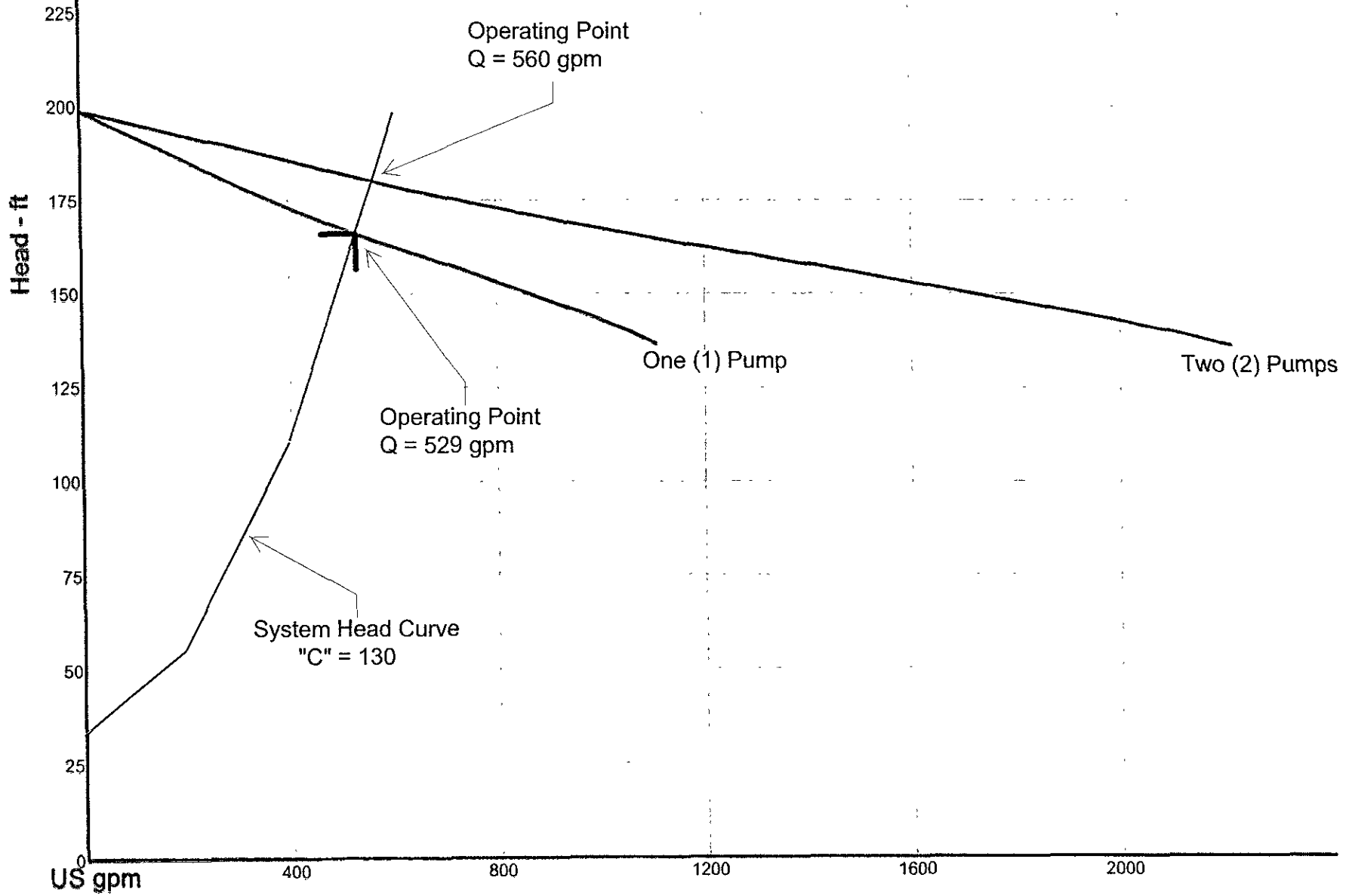
Company: DDI  
 Name: glb  
 10/10/08

Fairbanks Morse Pump, 60 Hz  
 Catalog: Fairbanks Morse Submersible.60, vers 2.0  
 5430-NONCLOG - 1800  
 Design Point: 529 US gpm, 165 ft

Size: 4"5435MV  
 Speed: 1780 rpm  
 Dia: 12.9375 in  
 Curve: 35M404E



2 Pumps in Parallel

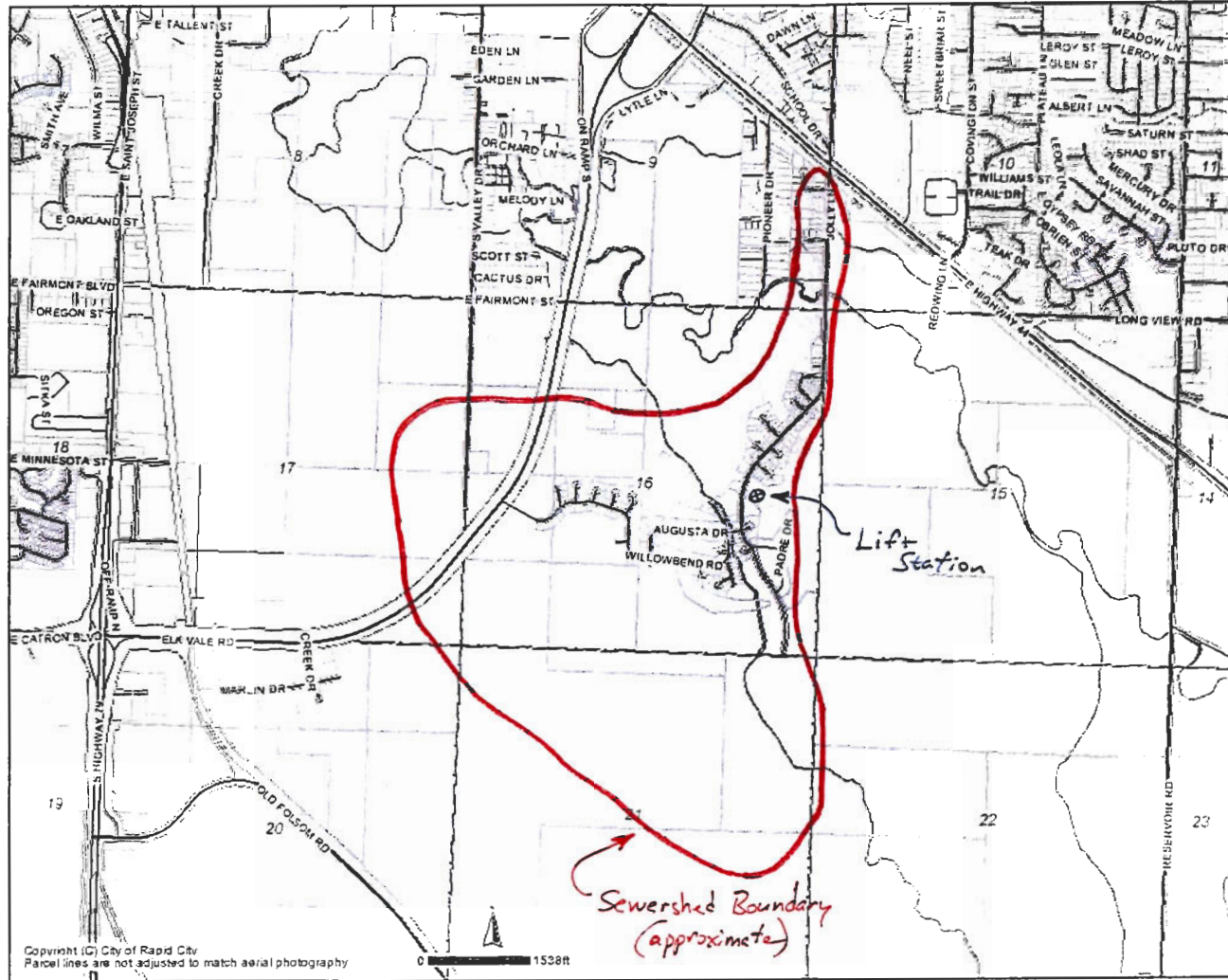


Company: DDI  
 Name: gtb  
 10/10/08

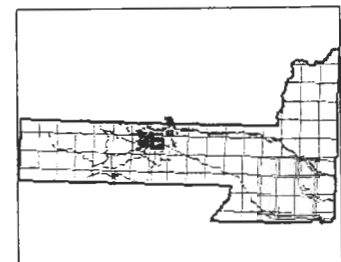
Fairbanks Morse Pump, 60 Hz  
 Catalog: Fairbanks Morse Submersible.60, vers 2.0  
 5430-NONCLOG - 1800

Size: 4"5435MV  
 Speed: 1780 rpm  
 Dia: 12.9375 in  
 Curve: 35M404E





- Roads**
- Not classified
  - Interstate
  - US Highway
  - SD Highway
  - County Highway
  - Main Road
  - Minor Arterial
  - Collector
  - Ramp
  - Paved Road
  - Unpaved Road
  - Unimproved Road
  - Trail
  - other
  - Not yet coded
- Township/Section lines**
- SECTION
  - TOWNSHIP
- Parcel Boundary**
- Lot Lines
  - COUNTY
  - LOT LINE
  - PARCEL LINE



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*Sewershed Boundary (approximate)*