

PUMP SIZING AND SELECTION RECOMMENDATIONS

SUCTION LIFT PUMP STATION

I. GENERAL INFORMATION

DATE PRINTED: 10/25/2024

PROJECT: New Castle County
Port Saint Georges North PS
New Castle, DE

DESIGN ENGINEER: Verdantas
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EQUIPMENT: Suction Lift Duplex Pump Station

PIPING SIZES: 6.09 inch Force Main Piping
4 inch Header Piping
6 inch Suction Piping

MANUFACTURER: The Gorman-Rupp Company

MANUFACTURER'S REPRESENTATIVE: Envirep, Inc.
3705 Trindle Road
Camp Hill, PA 17011
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Calculations by: Will Hesse

COMMENTS: FM - 6" PVC DR18
0

DISCLAIMERS:

Recommendations contained herein are based upon information provided by the Design Engineer. They are for review and evaluation by the Design Engineer and for incorporation into the project design consistent with his/her best professional judgement.

Gravity sewers, upstream of pumping stations, should be designed such that pump station failures will not cause backflow into residential homes or commercial establishments.

II. DESIGN INFORMATION

A. ELEVATIONS

Force Main Discharge Invert (High Point)	<u>42.00</u> FT
Pump Suction Centerline	<u>36.88</u> FT
Pump Slab Elevation (Ground Level)	<u>34.75</u> FT
Wet Well Influent Invert	<u>21.98</u> FT
Wet Well Bottom (for existing wet well only)	<u>16.75</u> FT

B. SUCTION PIPING

Pipe Diameter	<u>6</u> IN
Pipe Length	<u>20</u> FT
Inlet Opening Diameter	<u>10</u> IN
Distance between Wet Well Bottom and Inlet High Point	<u>0.83</u> FT
Hazen & Williams C-Factors for Friction Loss Calculation:	
High Roughness	C= <u>100</u>
Design Roughness	C= <u>120</u>
Low Roughness	C= <u>140</u>

Standard Fittings

Description	Quantity
90° Standard Bend	1
90° Long Radius Bend	0
45° Bend	0
22.5° Bend	0
Plug Valve	0
Swing Check valve	0
Std Tee, Thru Flow	0
Std Tee, Side Flow	1
Gate Valve, Fully Open	0
Increaser 6 x 8	1
Increaser 8 x 10	1
Decreaser 6 x 4	1
Decreaser 4 x 3	0

Nonstandard Fittings

Description	Quantity	Equivalent Length
Fitting #1	0	0 FT
Fitting #2	0	0 FT
Total Length		0 FT

C. HEADER PIPING

Pipe Diameter	<u>4</u> IN
Pipe Length	<u>5</u> FT
Hazen & Williams C-Factors for Friction Loss Calculations:	
High Roughness	C= <u>100</u>
Design Roughness	C= <u>120</u>
Low Roughness	C= <u>140</u>

Standard Fittings

<i>Description</i>	<i>Quantity</i>
90° Standard Bend	1
90° Long Radius Bend	0
45° Bend	0
22.5° Bend	0
Plug Valve	1
Swing Check valve	0
Std Tee, Thru Flow	0
Std Tee, Side Flow	1
Gate Valve, Fully Open	1
Increaser 4 x 6	1
Increaser 6 x 8	0
Decreaser 4 x 3	0
Decreaser	0

Nonstandard Fittings

<i>Description</i>	<i>Quantity</i>	<i>Equivalent Length</i>
6" Ductile Iron Pipe Between Header & PVC FM	1	45 FT
Fitting #2	0	0 FT
Total Length		45 FT

D. FORCE MAIN #1

Pipe Diameter _____ 6.09 IN

Pipe Length _____ 1229 FT

Hazen & Williams C-Factors for Friction Loss Calculations:

High Roughness C= _____ 100

Design Roughness C= _____ 120

Low Roughness C= _____ 140

Standard Fittings

<i>Description</i>	<i>Quantity</i>
90° Standard Bend	0
90° Long Radius Bend	0
45° Bend	3
22.5° Bend	2
Plug Valve	0
Swing Check valve	0
Std Tee, Thru Flow	0
Std Tee, Side Flow	5
Gate Valve, Fully Open	1
Increaser 6.09 x 10	0
Increaser 10 x 12	0
Decreaser 6.09 x 6	0
Decreaser 6 x 4	0

Nonstandard Fittings

<i>Description</i>	<i>Quantity</i>	<i>Equivalent Length</i>
Fitting #1	0	0 FT
Fitting #2	0	0 FT
Total Length		0 FT

E. PUMPING RATE

Initial Design

230 GPM

Future Design

230 GPM

F. SUCTION INLET OPENING CONFIGURATION

Inlet Opening Inside Diameter

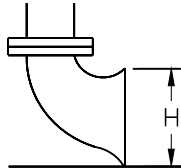
10 IN

Distance from Wet Well Bottom to Inlet Elevation (H)

0.83 FT

Configuration:

Vertical



G. WET WELL SIZING

Circular

Diameter 6.00 FT

Distance Between Influent Sewer Invert and Alarm On

(Recommend 0.0 FT Without Basket Strainer)

(Recommend 1.0 FT With Basket Strainer)

0.06 FT

H. PUMP CYCLE TIME

Cycle Time - Minimum Allowable Cycle Time

(Use 10 Minutes for 15 HP Motors and Less)

(Use 15 Minutes for 20 HP to 100 HP)

12 MINUTES

I. NET POSITIVE SUCTION HEAD

Correction for Elevation Above Sea Level

(Use -1.0 FT For 0 FT To 800 FT Above Sea Level)

(Use -2.0 FT For 800 FT To 1500 FT Above Sea Level)

-1 FT

Vapor Pressure

(Use -1.0 FT For Municipal Wastewater)

-1 FT

Safety Factor

(Recommended -5.0 FT Minimum)

-5 FT

NPSH Req, Initial Pumping Rate (From Pump Curve)

5 FT

NPSH Req, Future Design Pumping Rate (From Pump Curve)

5 FT

J. PUMP INFORMATION

Pump Model No.

T4A3S-B

Pump Size

4 IN

Number of Pumps:

2

Flow Rates for System Head Curves:

Minimum 0 GPM

Maximum 700 GPM

III. WET WELL SIZING

A. MINIMUM DEPTH

Determines the minimum distance between the wet well bottom and the pump off elevation to prevent vortexing. Design calculations are based on the future design pumping rate.

Determine velocity at inlet opening using $V=Q/A$

Q = **Future** Design Pumping Rate

230.00 GPM

A = Area At Inlet Opening

Inlet Opening Diameter (D)

0.83 FT

Inlet Opening Area

0.545 SQ FT

V = Inlet Velocity at Diameter D

0.94 FPS

(Refer to Metcalf & Eddy, Wastewater Engineering, Table 9-3, page 360)

Minimum submergence (S)

1.25 FT

Bottom of wet well to inlet high point distance

0.83 FT

Minimum Depth (MD)

2.08 FT

RECOMMENDED MINIMUM DEPTH (MD)	2.25 FT
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B. DRAWDOWN DEPTH

Determine minimum drawdown depth from the operating volume required to prevent short cycling of pumps

(Refer to Metcalf & Eddy, Wastewater Engineering, Equation 9-1, page 354)

$$V = (T * Q_d / 4) * f = (12 * 230 / 4) * 0.5$$

T = Minimum Allowable Time for One Pump Cycle

12.00 MIN

Q_d = Future Design Pumping Rate, GAL/MIN

230.00 GPM

f = Factor for Identical Pumps with Alternation

0.50

V = Minimum Drawdown Volume = 345.00 GAL / 7.481 =>

46.12 CU FT

Circular Diameter

6.00 FT

Vol/FT. of Elev.

28.27 CU FT/FT

Calculated Drawdown Depth

1.63 FT

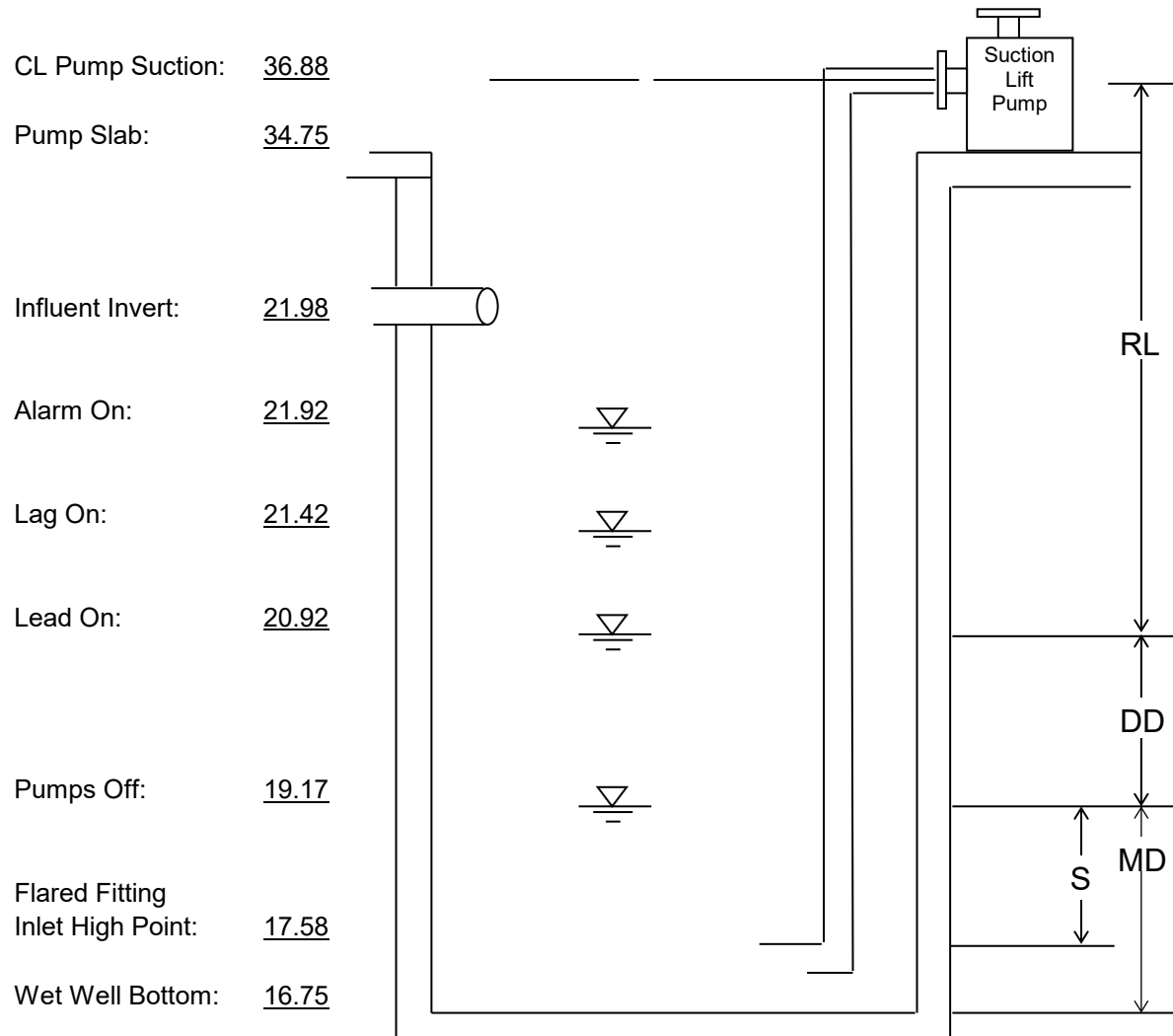
RECOMMENDED DRAWDOWN DEPTH (DD)	1.75 FT
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Effective Drawdown Volume

49.48 CU FT

370.16 GAL

C. WET WELL ELEVATION DIAGRAM



Legend:

Minimum depth based on submergence (MD)	2.42 FT
Submergence (S)	1.59 FT
Drawdown depth (DD)	1.75 FT
Reprime lift (RL)	15.96 FT

IV. PIPING SYSTEM

A. SYSTEM HEAD CURVE

1. STATIC SUCTION LIFT:

Pump Off Elevation	19.17 FT
Pump Suction Center Line Elevation	<u>-36.88 FT</u>
Static Suction Lift	-17.71 FT

2. SUCTION PIPING, EQUIVALENT LENGTH OF PIPE:

Pipe Diameter 6 IN

	Number Needed	Eq Len/ Fitting FT	Safety Factor 1.25	Total Eq Len FT
Length of Pipe				20.00
Standard				
90° Standard Bend	1	16	x 1.25	20.00
90° Long Radius Bend	0	10	x 1.25	0.00
45° Bend	0	7	x 1.25	0.00
22.5° Bend	0	4	x 1.25	0.00
Plug Valve	0	50	x 1.25	0.00
Swing Check valve	0	40	x 1.25	0.00
Std Tee, Thru Flow	0	11	x 1.25	0.00
Std Tee, Side Flow	1	33	x 1.25	41.25
Gate Valve, Fully Open	0	4	x 1.25	0.00
Increaser 6 x 8	1	4	x 1.25	5.00
Increaser 8 x 10	1	4	x 1.25	5.00
Reducer 6 x 4	1	4	x 1.25	5.00
Reducer 4 x 3	0	4	x 1.25	0.00
Non-standard				
Fitting #1	0	0 FT	x 1.25	0.00
Fitting #2	0	0 FT	x 1.25	0.00
TOTAL EQUIVALENT LENGTH				96

3. STATIC DISCHARGE HEAD:

Force Main Discharge Invert. Elev. (High Pt.)	42.00 FT
Pump Suction Centerline Elevation	<u>-36.88 FT</u>
Static Discharge Head	5.12 FT

4. DISCHARGE HEADER PIPING, EQUIVALENT LENGTH OF PIPE:

Pipe Diameter 4 IN

	Number Needed	Eq Len/ Fitting FT	Safety Factor 1.25	Total Eq Len FT
Length of Pipe				5.00
Standard				
90° Standard Bend	1	11	x 1.25	13.75
90° Long Radius Bend	0	7	x 1.25	0.00

45° Bend	0	5	x 1.25	0.00
22.5° Bend	0	3	x 1.25	0.00
Plug Valve	1	32	x 1.25	40.00
Swing Check valve	0	25	x 1.25	0.00
Std Tee, Thru Flow	0	7	x 1.25	0.00
Std Tee, Side Flow	1	22	x 1.25	27.50
Gate Valve, Fully Open	1	3	x 1.25	3.75
Increaser 4 x 6	1	3	x 1.25	3.75
Increaser 6 x 8	0	3	x 1.25	0.00
Reducer 4 x 3	0	3	x 1.25	0.00
Reducer	0	3	x 1.25	0.00
Non-standard				
6" Ductile Iron Pipe Betw	1	45 FT	x 1.25	56.25
Fitting #2	0	0 FT	x 1.25	0.00
TOTAL EQUIVALENT LENGTH				150

5. FORCE MAIN PIPING, EQUIVALENT LENGTH OF PIPE:Pipe Diameter 6 IN

	Number Needed	Eq Len/ Fitting FT	Safety Factor 1.25	Total Eq Len FT
Length of Pipe				1229.00
Standard				
90° Standard Bend	0	20	x 1.25	0.00
90° Long Radius Bend	0	15	x 1.25	0.00
45° Bend	3	10	x 1.25	37.50
22.5° Bend	2	5	x 1.25	12.50
Plug Valve	0	60	x 1.25	0.00
Swing Check valve	0	55	x 1.25	0.00
Std Tee, Thru Flow	0	14	x 1.25	0.00
Std Tee, Side Flow	5	42	x 1.25	262.50
Gate Valve, Fully Open	1	5	x 1.25	6.25
Increaser 6.09 x 10	0	5	x 1.25	0.00
Increaser 10 x 12	0	5	x 1.25	0.00
Reducer 6.09 x 6	0	5	x 1.25	0.00
Reducer 6 x 4	0	5	x 1.25	0.00
Non-standard				
Fitting #1	0	0 FT	x 1.25	0.00
Fitting #2	0	0 FT	x 1.25	0.00
TOTAL EQUIVALENT LENGTH				1548

B. PIPE VELOCITIES

	Initial	Design
Suction Piping	2.61	2.61 FPS
Header Piping	5.87	5.87 FPS
Force Main Piping	2.53	2.53 FPS
Interconnection Piping	N/A	N/A FPS

V. SYSTEM HEAD CALCULATION TABLE

Note: Uses Cameron Hydraulic Data Hazen and Williams Equation (page 27) to calculate friction losses in pipes carrying water

$$f = .2083 \left(\frac{100}{C} \right)^{1.85} \left(\frac{q^{1.85}}{d^{4.8655}} \right) \left(\frac{L}{100} \right)$$

f = Friction head in feet of water
 C = Constant accounting for surface roughness
 d = Inside diameter of pipe in inches
 q = Flow in gallons per minute
 L = Equivalent length of pipe in feet

		d = 6 INCH SUCTION PIPING L = 96 FT		d = 4 INCH HEADER PIPING L = 150 FT		d = 6.09 INCH FORCE MAIN PIPING L = 1548 FT			
FLOW RATE	STATIC SUCTION LIFT	SUCTION PIPING FRICTION LOSSES	TOTAL DYNAMIC SUCTION LIFT	STATIC DISCHARGE HEAD	HEADER PIPING FRICTION LOSSES	FORCE MAIN PIPING FRICTION LOSSES	TOTAL DYNAMIC DISCHARGE HEAD	TOTAL DYNAMIC HEAD	
q = GPM	FT	f = FT	FT	FT	f = FT	f = FT	FT	FT	
High Roughness									
		C= 100			C= 100	C= 100			
0	-17.71	0.00	-17.71	5.12	0.00	0.00	5.12	22.8	
50	-17.71	-0.05	-17.76	5.12	0.51	0.68	6.31	24.1	
150	-17.71	-0.35	-18.06	5.12	3.90	5.21	14.23	32.3	
200	-17.71	-0.59	-18.30	5.12	6.64	8.87	20.63	38.9	
230	-17.71	-0.77	-18.48	5.12	8.60	11.48	25.21	43.7	
250	-17.71	-0.89	-18.60	5.12	10.04	13.40	28.56	47.2	
300	-17.71	-1.25	-18.96	5.12	14.06	18.77	37.96	56.9	
400	-17.71	-2.13	-19.84	5.12	23.95	31.97	61.04	80.9	
450	-17.71	-2.65	-20.36	5.12	29.78	39.75	74.65	95.0	
500	-17.71	-3.22	-20.93	5.12	36.19	48.31	89.61	110.5	
550	-17.71	-3.84	-21.55	5.12	43.16	57.62	105.91	127.5	
700	-17.71	-6.00	-23.71	5.12	67.44	90.02	162.57	186.3	
Design Roughness									
		C= 120			C= 120	C= 120			
0	-17.71	0.00	-17.71	5.12	0.00	0.00	5.12	22.8	
50	-17.71	-0.03	-17.74	5.12	0.36	0.49	5.97	23.7	
150	-17.71	-0.25	-17.96	5.12	2.78	3.72	11.62	29.6	
200	-17.71	-0.42	-18.13	5.12	4.74	6.33	16.19	34.3	
230	-17.71	-0.55	-18.26	5.12	6.14	8.20	19.46	37.7	
250	-17.71	-0.64	-18.35	5.12	7.16	9.56	21.85	40.2	
300	-17.71	-0.89	-18.60	5.12	10.04	13.40	28.56	47.2	
400	-17.71	-1.52	-19.23	5.12	17.09	22.82	45.03	64.3	
450	-17.71	-1.89	-19.60	5.12	21.25	28.37	54.74	74.3	
500	-17.71	-2.30	-20.01	5.12	25.83	34.48	65.42	85.4	
550	-17.71	-2.74	-20.45	5.12	30.81	41.12	77.05	97.5	
700	-17.71	-4.28	-21.99	5.12	48.13	64.25	117.50	139.5	
Low Roughness									
		C= 140			C= 140	C= 140			
0	-17.71	0.00	-17.71	5.12	0.00	0.00	5.12	22.8	
50	-17.71	-0.02	-17.73	5.12	0.27	0.37	5.76	23.5	
150	-17.71	-0.19	-17.90	5.12	2.09	2.79	10.01	27.9	
200	-17.71	-0.32	-18.03	5.12	3.56	4.76	13.44	31.5	
230	-17.71	-0.41	-18.12	5.12	4.62	6.16	15.90	34.0	
250	-17.71	-0.48	-18.19	5.12	5.39	7.19	17.70	35.9	
300	-17.71	-0.67	-18.38	5.12	7.55	10.07	22.74	41.1	
400	-17.71	-1.14	-18.85	5.12	12.85	17.15	35.13	54.0	
450	-17.71	-1.42	-19.13	5.12	15.98	21.33	42.43	61.6	
500	-17.71	-1.73	-19.44	5.12	19.42	25.92	50.46	69.9	
550	-17.71	-2.06	-19.77	5.12	23.16	30.92	59.20	79.0	
700	-17.71	-3.22	-20.93	5.12	36.19	48.31	89.61	110.5	

VI. PUMP SELECTION

A. NET POSITIVE SUCTION HEAD

	Initial Design	Future Design	
Pumping Rate=	230	230	GPM
Atmospheric Pressure at Sea Level		33.90	FT
Correction For Elev. Above Sea Level		-1.00	FT
Static Suction Lift		-17.71	FT
Suction Piping Friction Losses (Design Roughness)		-0.55	FT
Vapor Pressure		-1.00	FT
Safety Factor		-5.00	FT
NPSH Available		8.64	FT
NPSH Required		5.00	FT
NPSH Excess Available		3.64	FT

B. REPRIME LIFT

Center Line of Pump Suction	36.88	FT
Lead Pump on Elevation	20.92	FT
Reprime Lift	<u>16.0</u>	FT

C. PUMPING CONDITIONS

	Initial Design	Future Design
Pump Capacity	230	230 GPM
Total Dynamic Head	37.7	37.7 FT

D. EQUIPMENT RECOMMENDATION

	Initial Design	Future Design
Pump Model	T4A3S-B	T4A3S-B
Pump Size	4	4 IN
Pump Speed	1160	1160 RPM
Reprime Lift Capability	24	24 FT
Motor Horsepower	10	10 HP
Motor Speed	1750	1750 RPM

TOTAL HEAD

REPRIMING LIFTS

RPM	650	750	850	950	1050	1150	1250	- 1950
FEET	5	8	16	19	22	24	25	
METERS	1.5	2.4	4.9	5.8	6.7	7.3	7.6	

Figure NPSH required prior to using above table. DO NOT use as available Suction Lifts.

3.00"/[76.2 MM] DIA. MAX. SPHERICAL SOLIDS

PERFORMANCE CURVE

VOLUTE 10525D
10525B

CURVE T4A-B-4

IMPELLER 10528

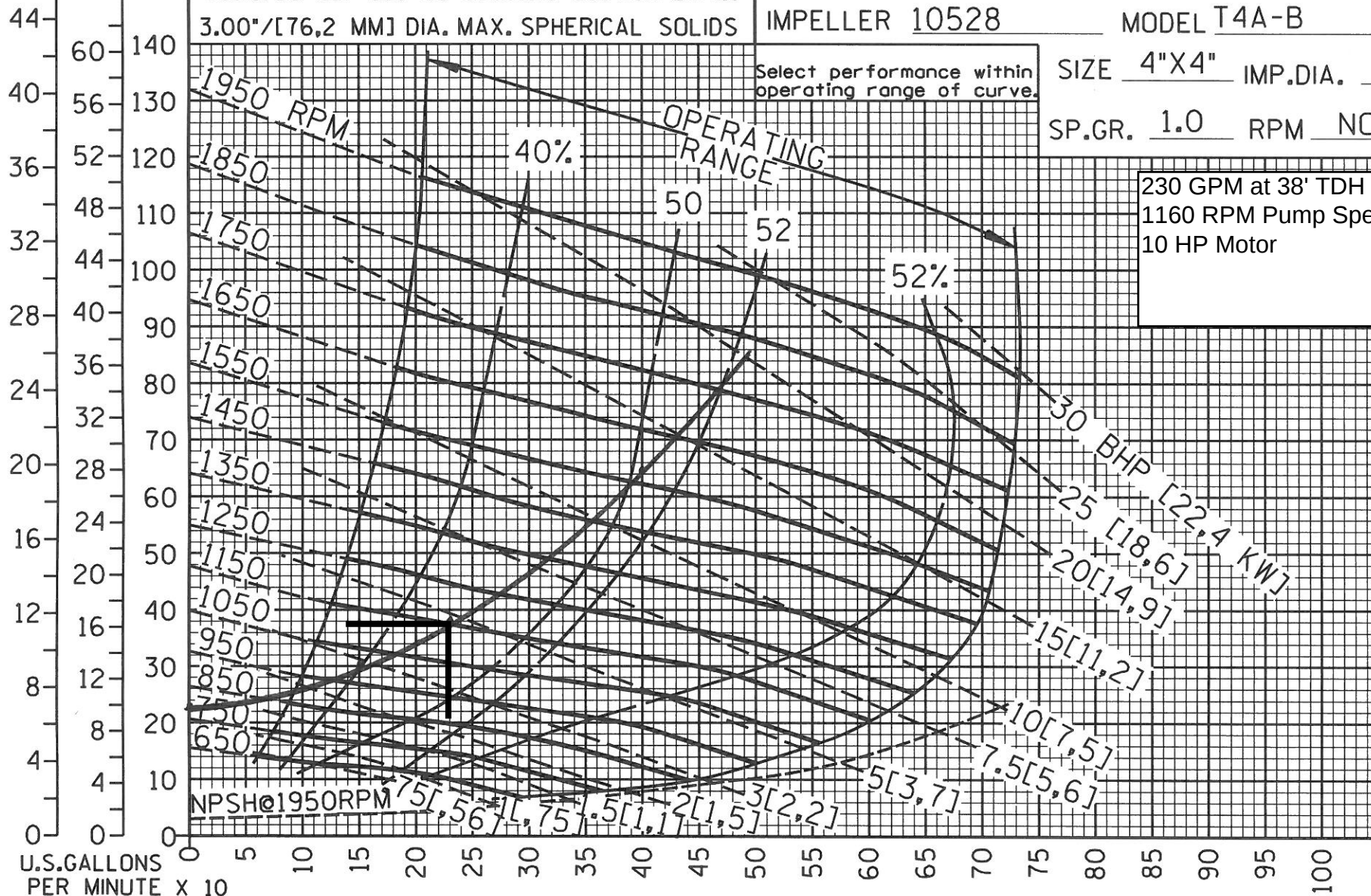
MODEL T4A-B

SIZE 4"X4" IMP.DIA. 9.75"

SP.GR. 1.0 RPM NOTED

Select performance within operating range of curve.

230 GPM at 38' TDH
1160 RPM Pump Speed
10 HP Motor



NPSH

FT M
30 10
20 8
10 6
0 4
0 2
0 0

GORMAN-RUPP
PUMPS
T-4-13-R