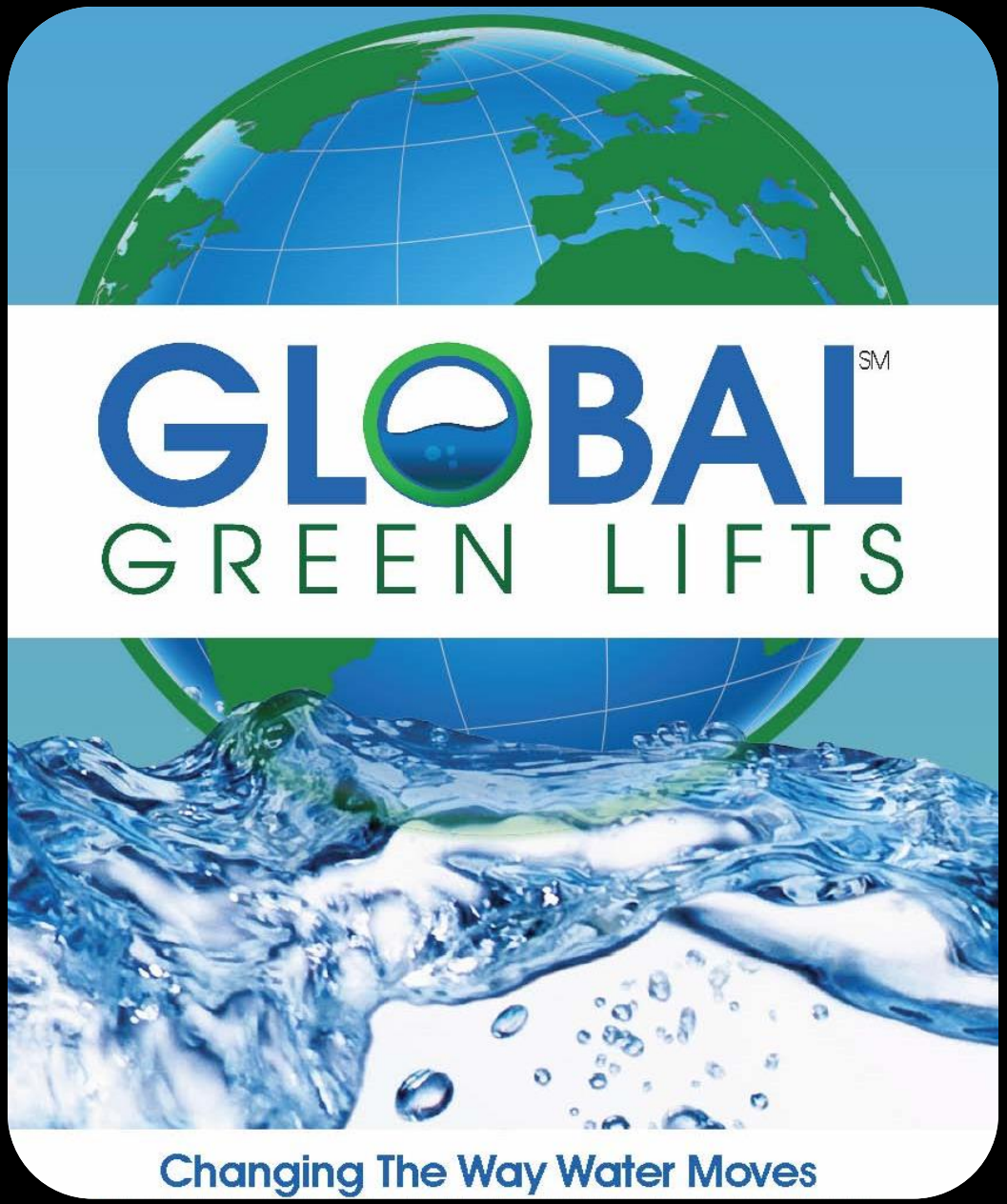
GLOBAL SM
GREEN LIFTS
Changing The Way Water Moves

Energy Saving Green Lift Station

The First Real Breakthrough In Wastewater Lift Station Operating Design Since The 1940's

Inventor: Fred Mehr, PhD

Patent Awarded January 23, 2013 – Control Panel

Patent Awarded July 15, 2014 – Green Lift-Station Design

Patent Awarded June 17, 2014 – Green Recycled Wet Well

US008777584B2

(12) **United States Patent**
Mehr

(10) **Patent No.: US 8,777,584 B2**
(45) **Date of Patent: Jul. 15, 2014**

(54) **ENERGY SAVING GREEN WASTEWATER PUMP STATION DESIGN**

(76) Inventor: **Nasser Fred Mehr**, Fort Lauderdale, FL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 257 days.

(21) Appl. No.: **13/335,908**

(22) Filed: **Dec. 22, 2011**

(65) **Prior Publication Data**

US 2013/0164149 A1 Jun. 27, 2013

(51) **Int. Cl.**
F04B 49/04 (2006.01)
F04B 41/06 (2006.01)

(52) **U.S. Cl.**
USPC **417/8**; 417/41; 417/12; 417/53

(58) **Field of Classification Search**
USPC 417/36, 40, 41, 53, 5, 7, 8, 12
See application file for complete search history.

(56) **References Cited**

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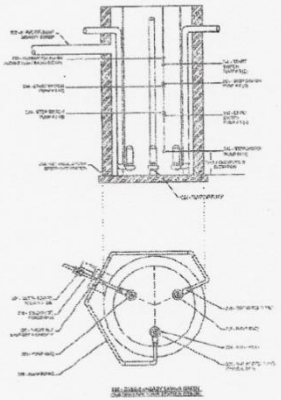
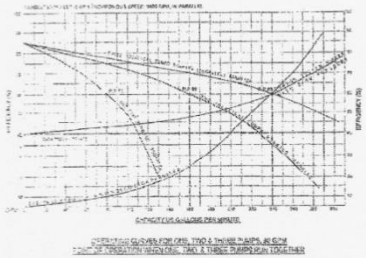
Primary Examiner — Charles Freay

(57) **ABSTRACT**

An energy saving three pump waste water pump station design that eliminates the high energy usage of traditional waste water pump stations, reduces maintenance costs to the pumps and increases the useful lives of the pumps by having a primary pump running continuously, a second pump mining during high demand periods and a third pump functioning primarily as a back up pump. Unlike conventional pump-station designs, the Energy Saving Green Pump Station Design utilizes a single float switch panel. Whereas independent float switches trigger start-stops in conventional pump station designs, the Green design incorporates a remote controllable panel for rotating the primary, secondary and third pumps on a schedule. This design also provides a process for determining in-flow rates for a pump station and efficiency operating points of pumps so that the most efficient pumps with the lowest horsepower can be selected.

1 Claim, 18 Drawing Sheets





US008371821B1

(12) **United States Patent**
Mehr

(10) **Patent No.: US 8,371,821 B1**
(45) **Date of Patent: Feb. 12, 2013**

(54) **GREEN WASTE WATER PUMP STATION CONTROL SYSTEM**

(76) Inventor: **Nasser Fred Mehr**, Fort Lauderdale, FL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/588,840**

(22) Filed: **Aug. 17, 2012**

(51) **Int. Cl.**
F04B 41/06 (2006.01)
F04B 49/04 (2006.01)

(52) **U.S. Cl.** **417/8**; 417/7; 417/12; 417/40

(58) **Field of Classification Search** 417/5, 7, 417/8, 12, 40
See application file for complete search history.

(56) **References Cited**

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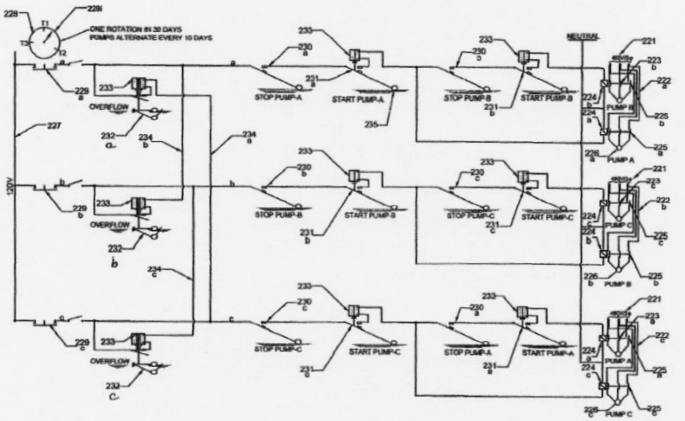
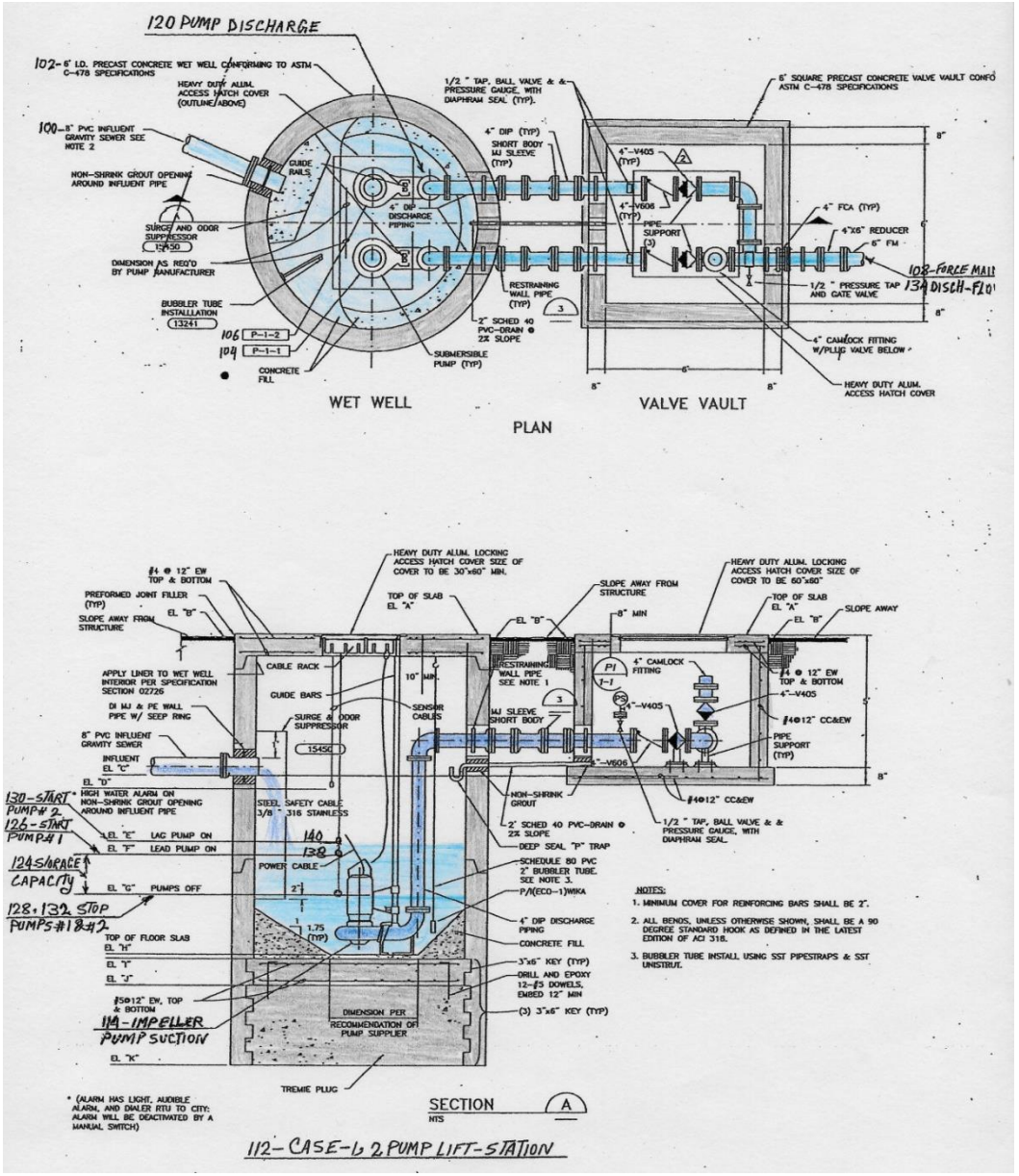
Primary Examiner — Charles Freay

(57) **ABSTRACT**

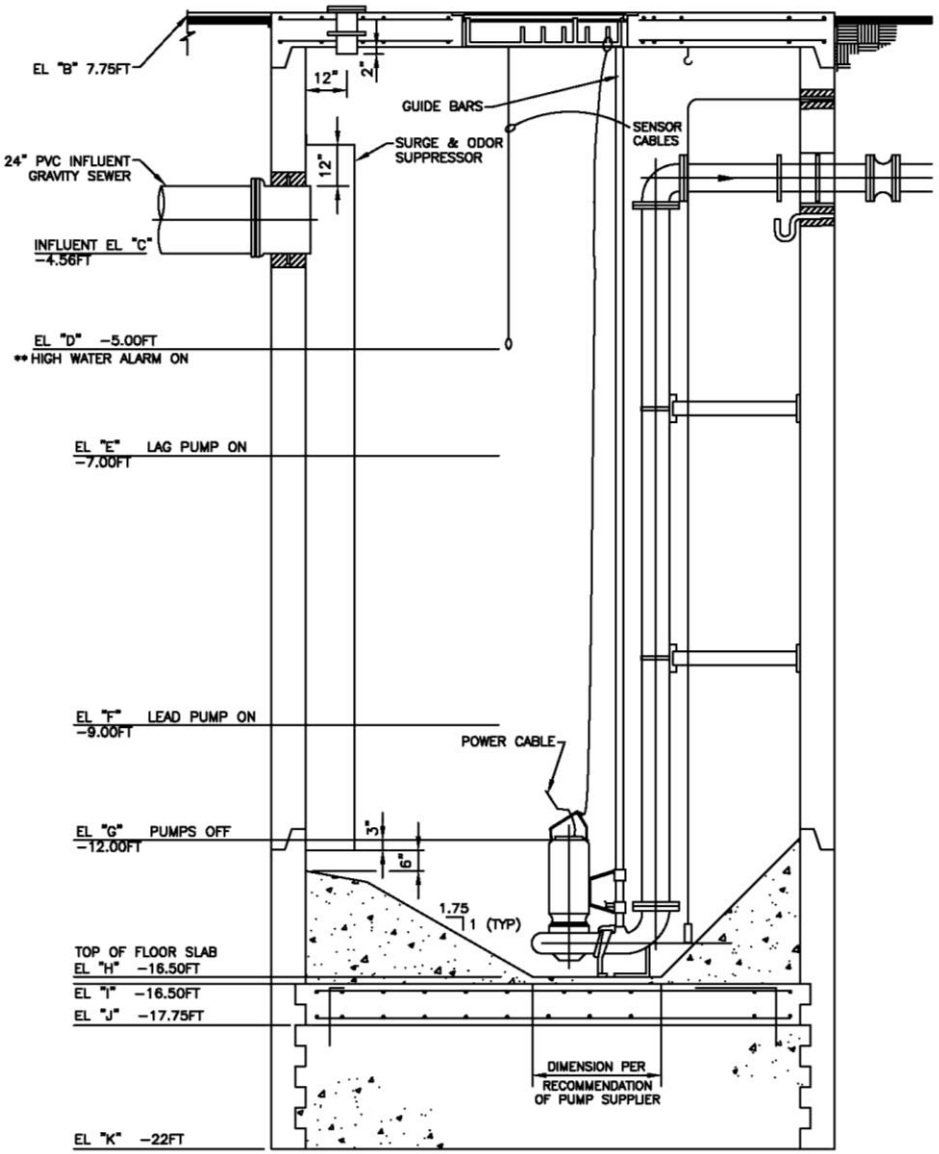
An electrical control system for energy efficient pump stations providing for continuous operation of a single primary pump with a second pump functioning as the support pump and a third pump acting as the standby/emergency pump. All pumps are of equal horsepower and horsepower selection is determined by the system curve to select the lowest, most efficient horsepower necessary to discharge water at the highest inflow rate while not allowing the water level to drop below the submerged pump level during continuous running of the primary pump. A timer having an indicator arm rotates one full revolution every thirty days changing the pump sequence to reduce wear and tear on individual pumps. Each pump functions as the primary, secondary and backup/emergency pump for the same number of hours during the monthly cycle. Adding control circuits enables one or more pumps to be added when necessary.

2 Claims, 3 Drawing Sheets

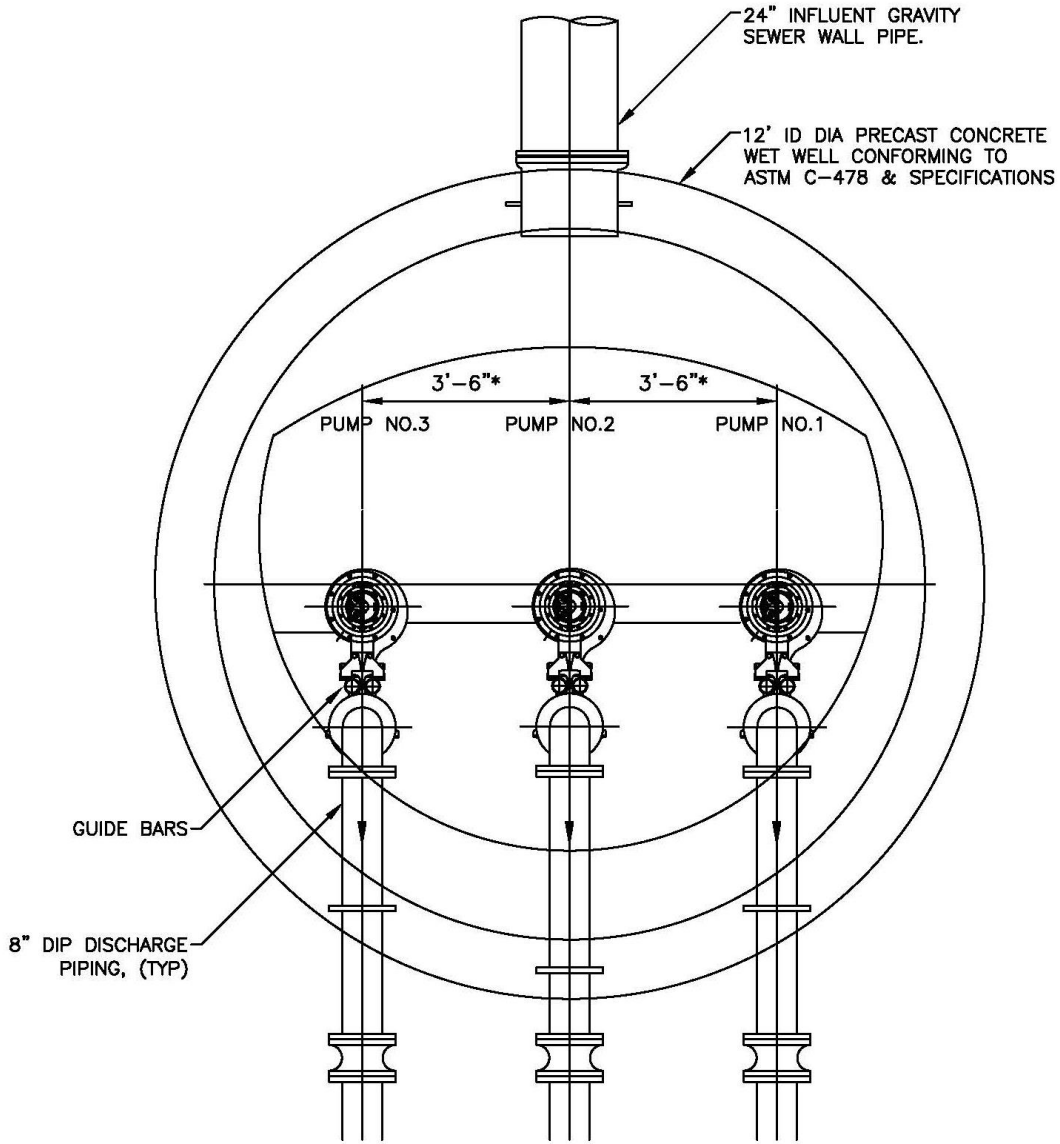




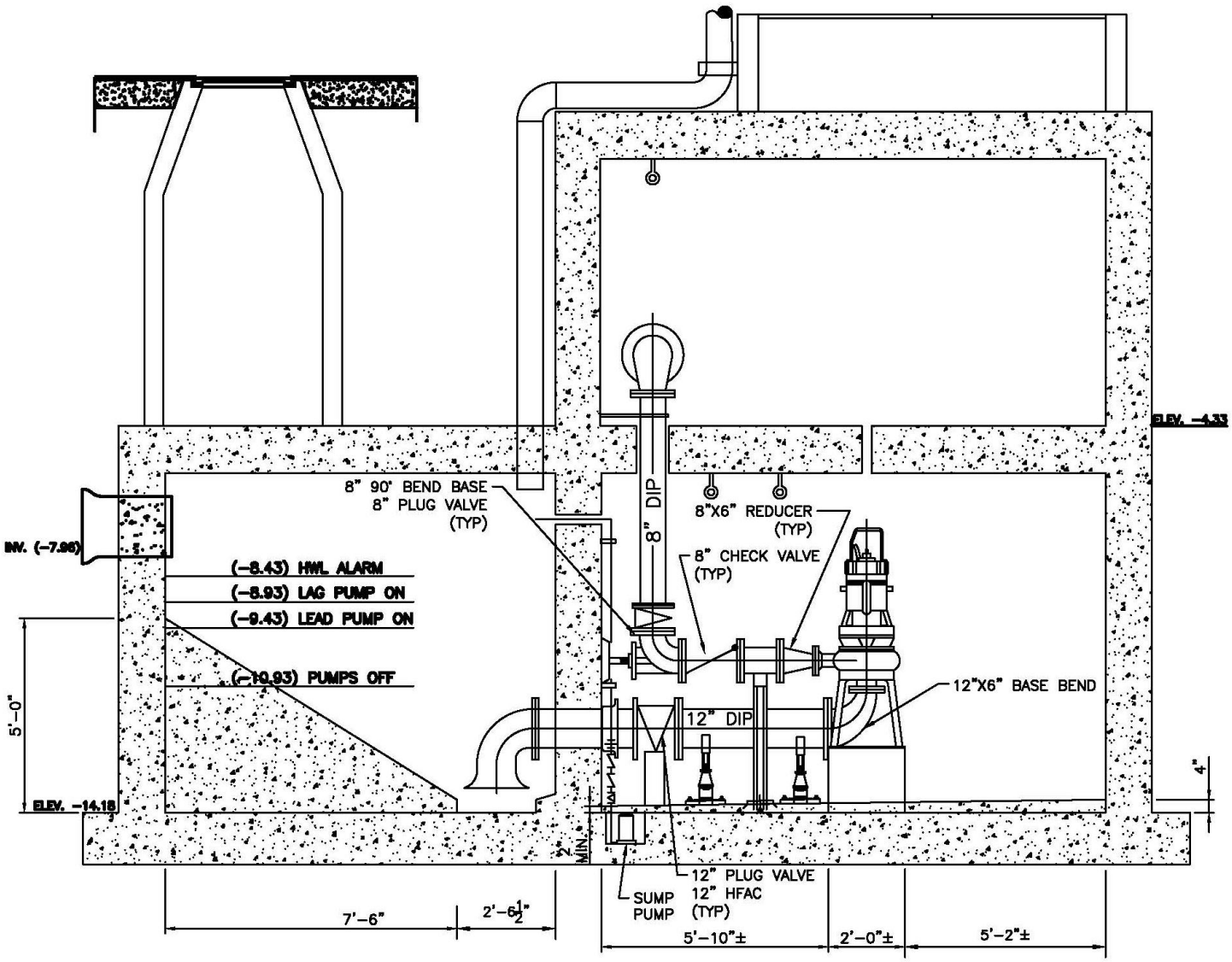
Traditional 2 pump lift - Stations



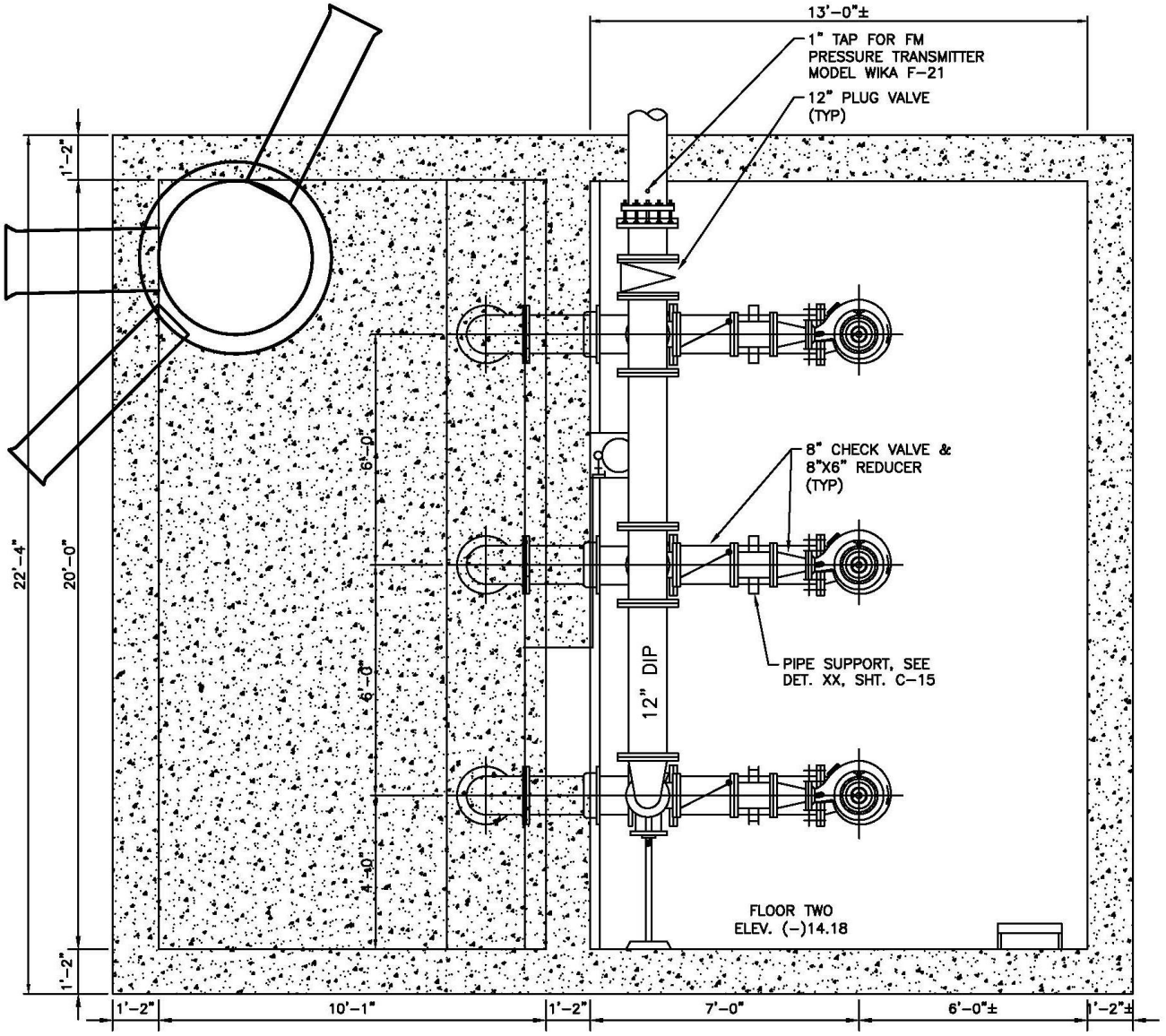
Submerged 3 Pumps With VFD



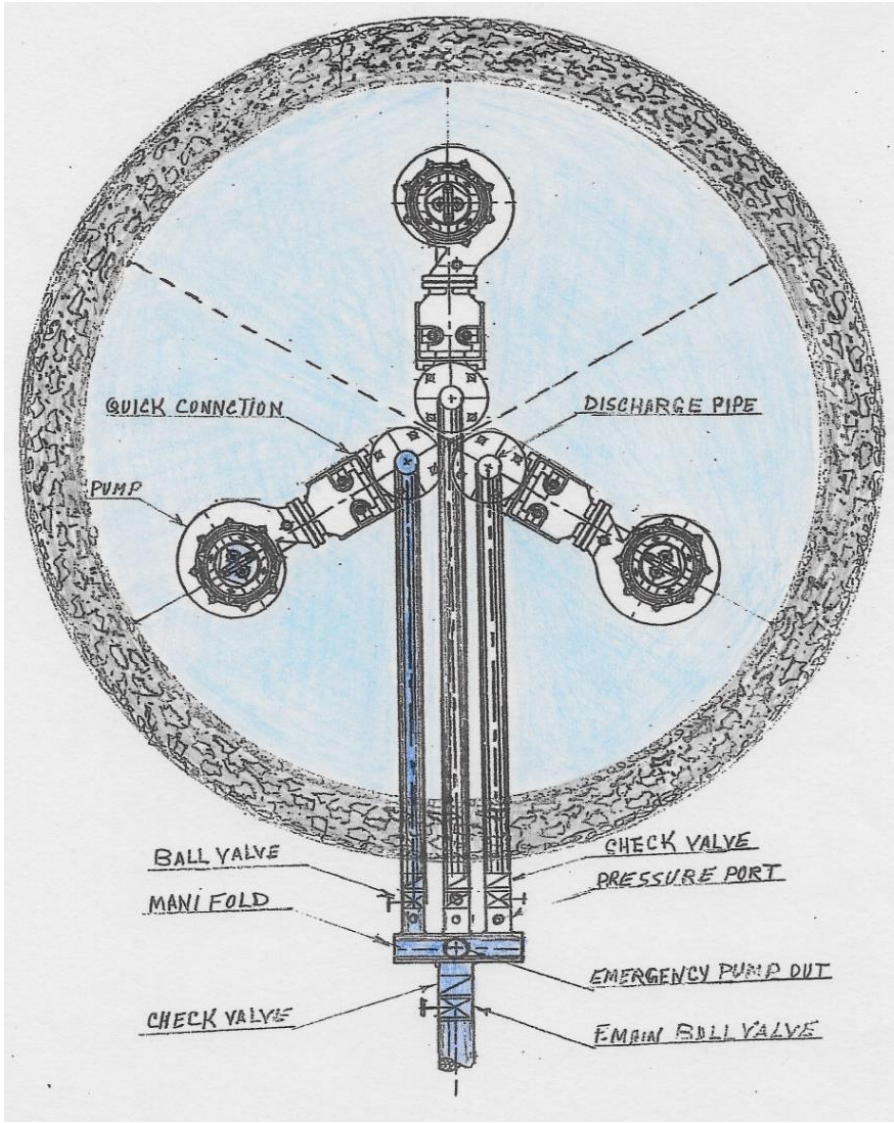
Submerged 3 Pumps With VFD



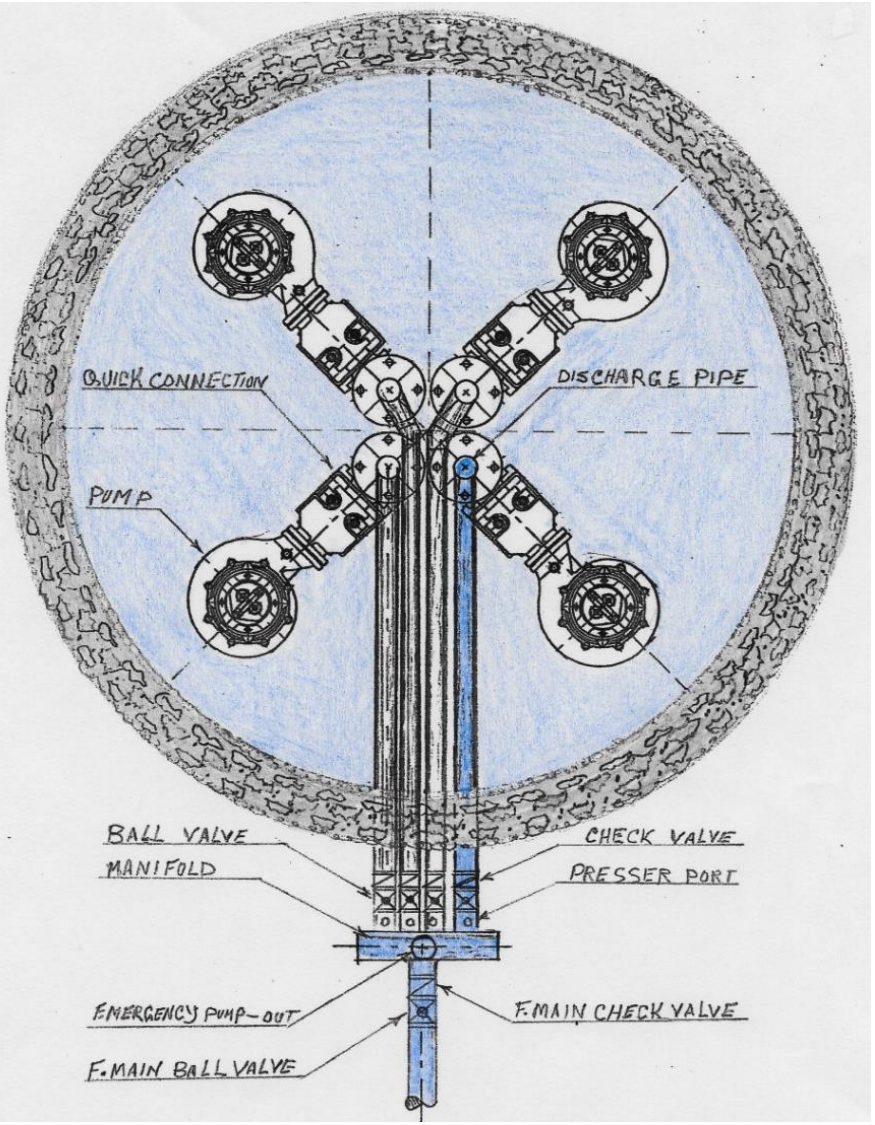
Dry Well With 3 Pumps



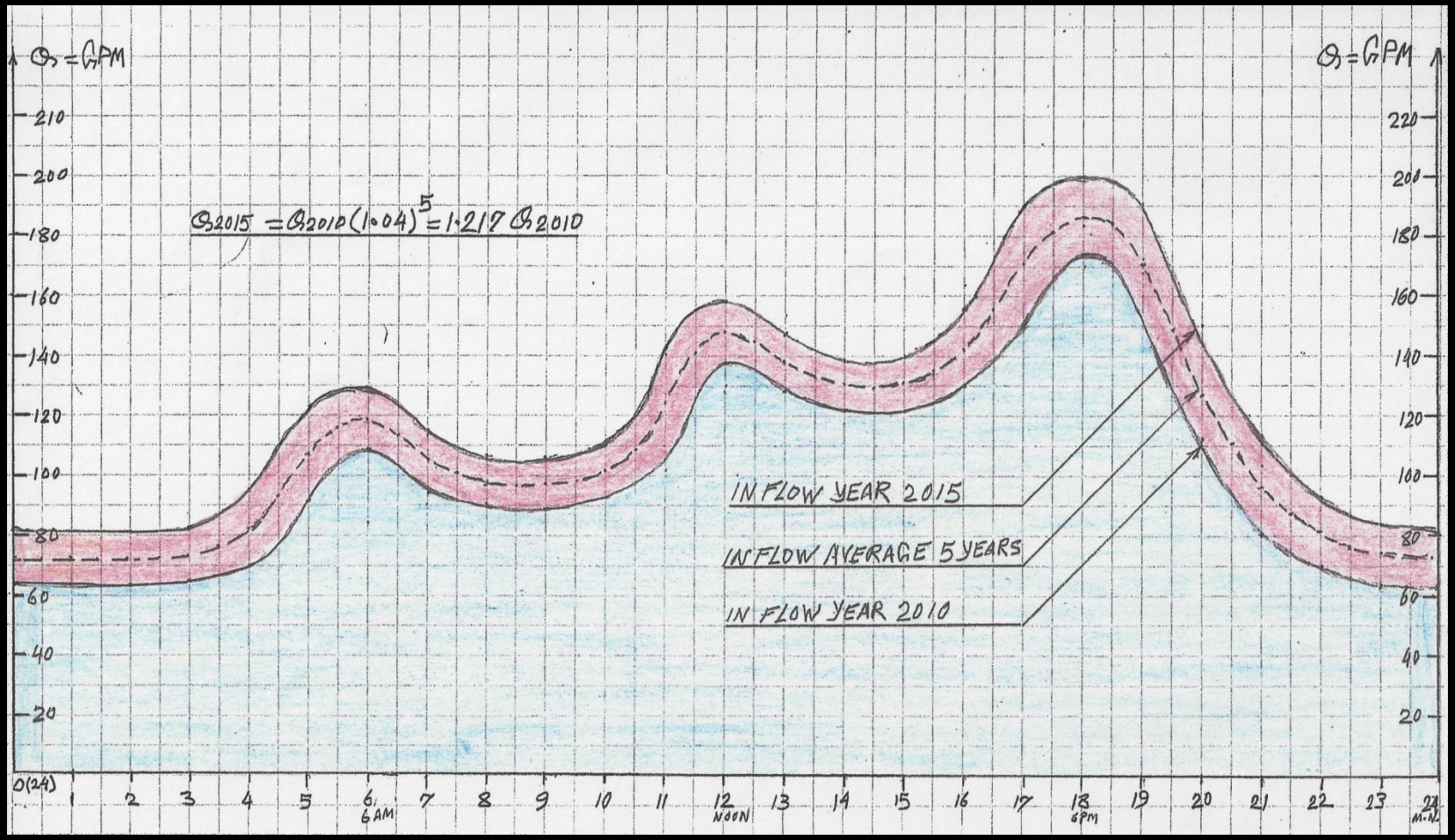
Dry Well With 3 Pumps



3 Pump Green Lift Stations

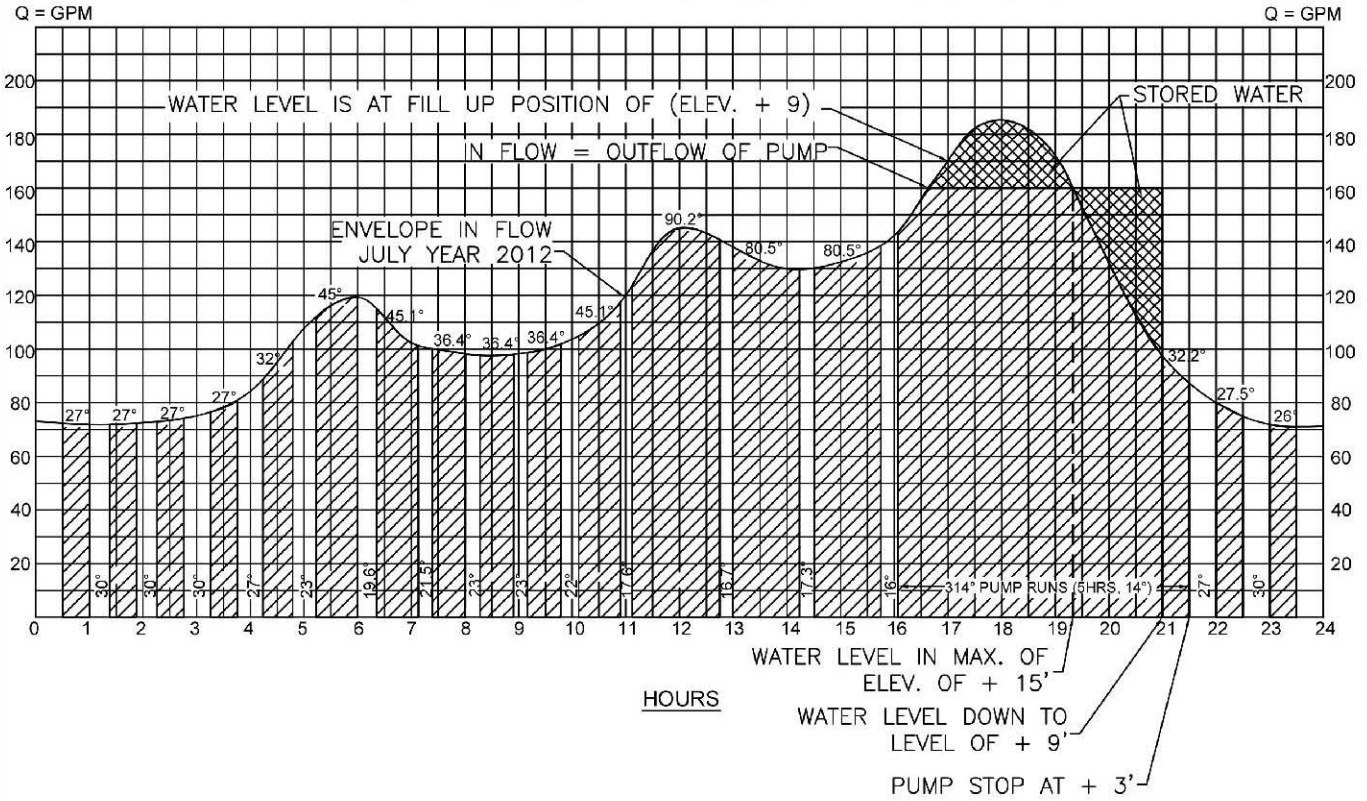


4 Pump Green Lift Stations



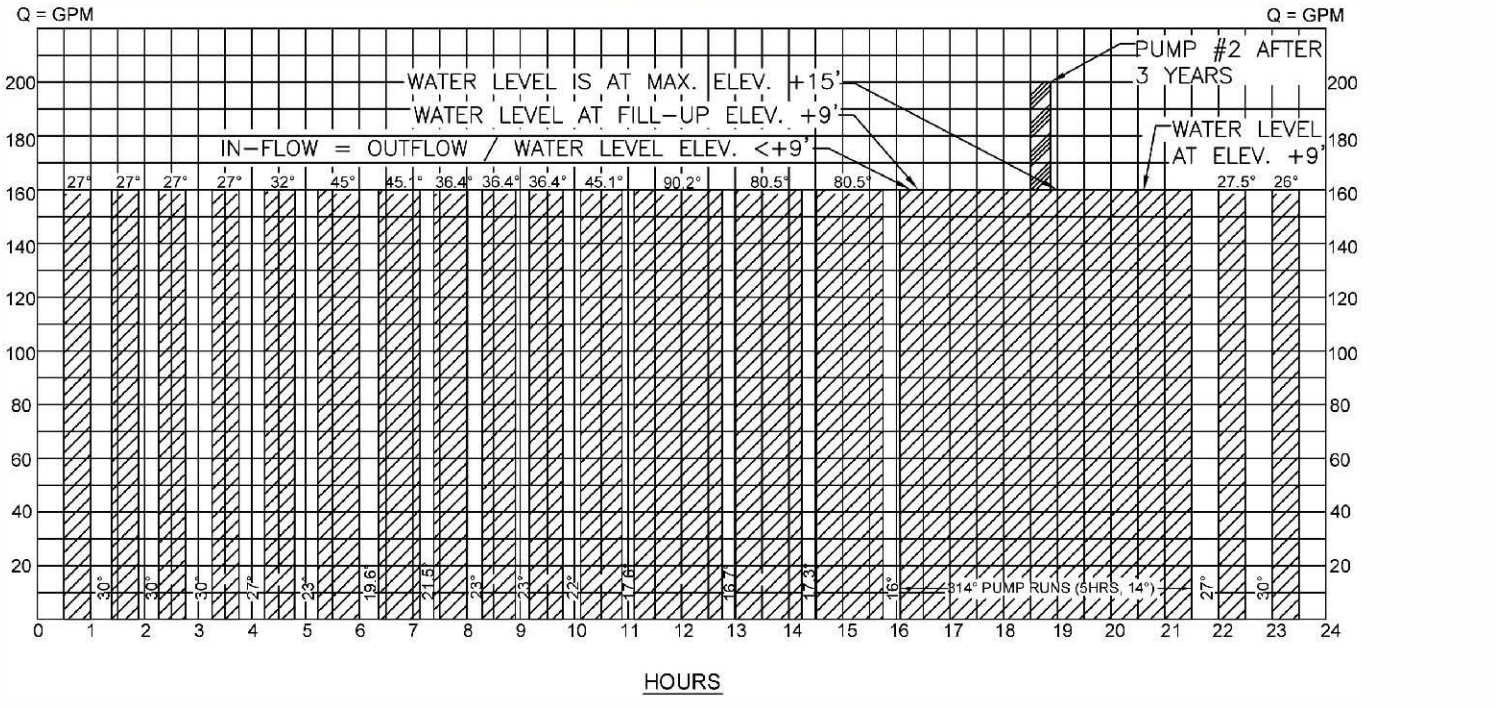
24 Hour Inflow Into Lift - Station

Traditional lift station with 2 pumps, 160 GPM/each, pump #1A cycles on and off as determined by flow and pump #2B is the backup



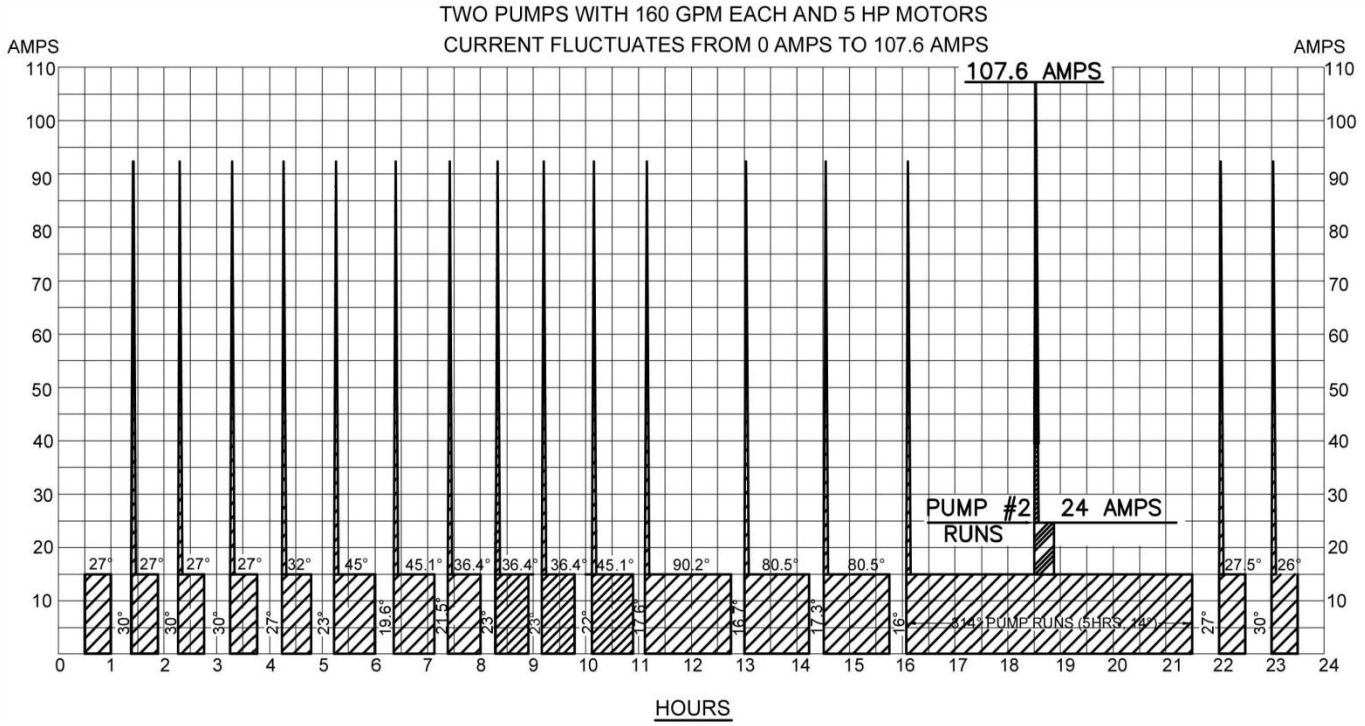
Periodic Fill-Up and Pumping

Operating time of 160 GPM pump in the traditional 2 pump lift station; pump #1A cycles 17 times/24 hrs, pump #2B cycles 1 time/24 hrs

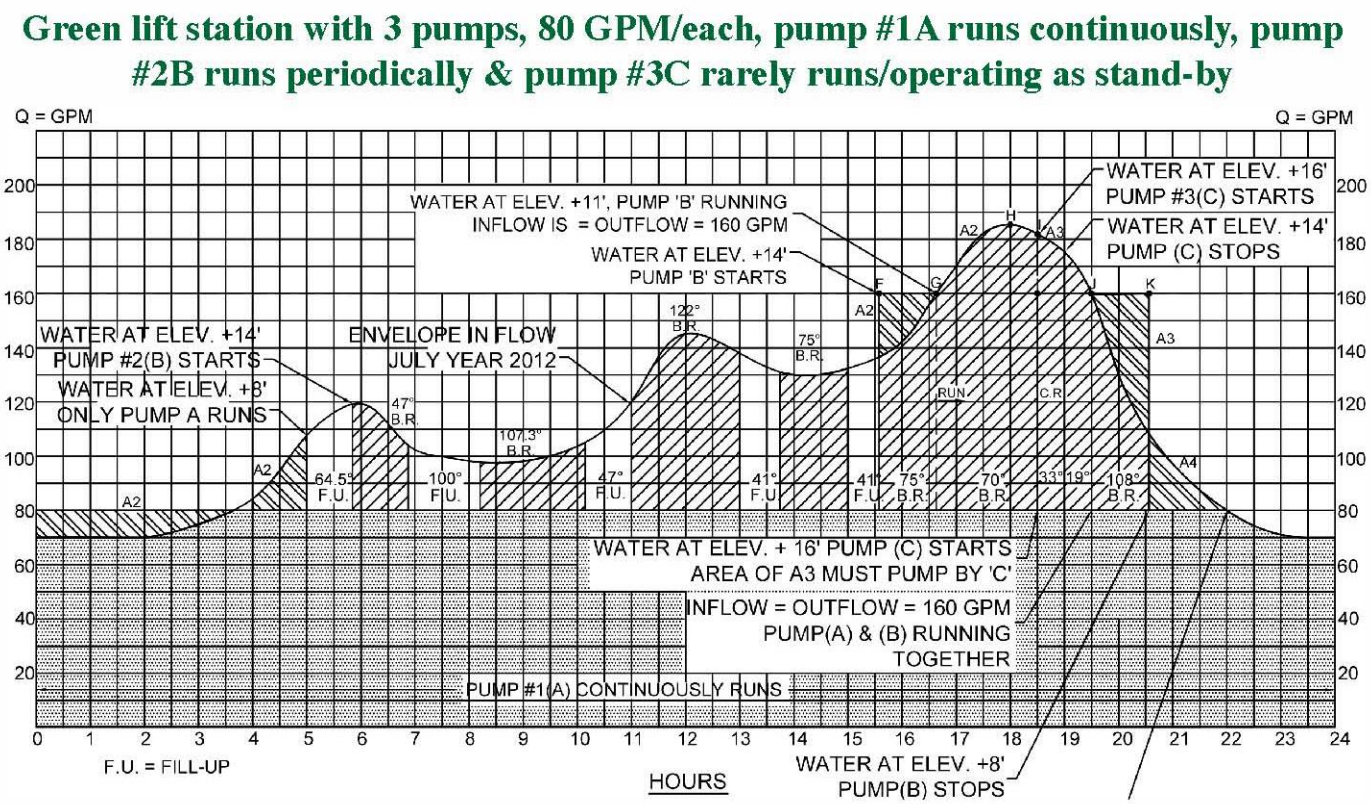


Periodic Discharge to Force Main

Power demand on a utility company – traditional 2 pump lift station

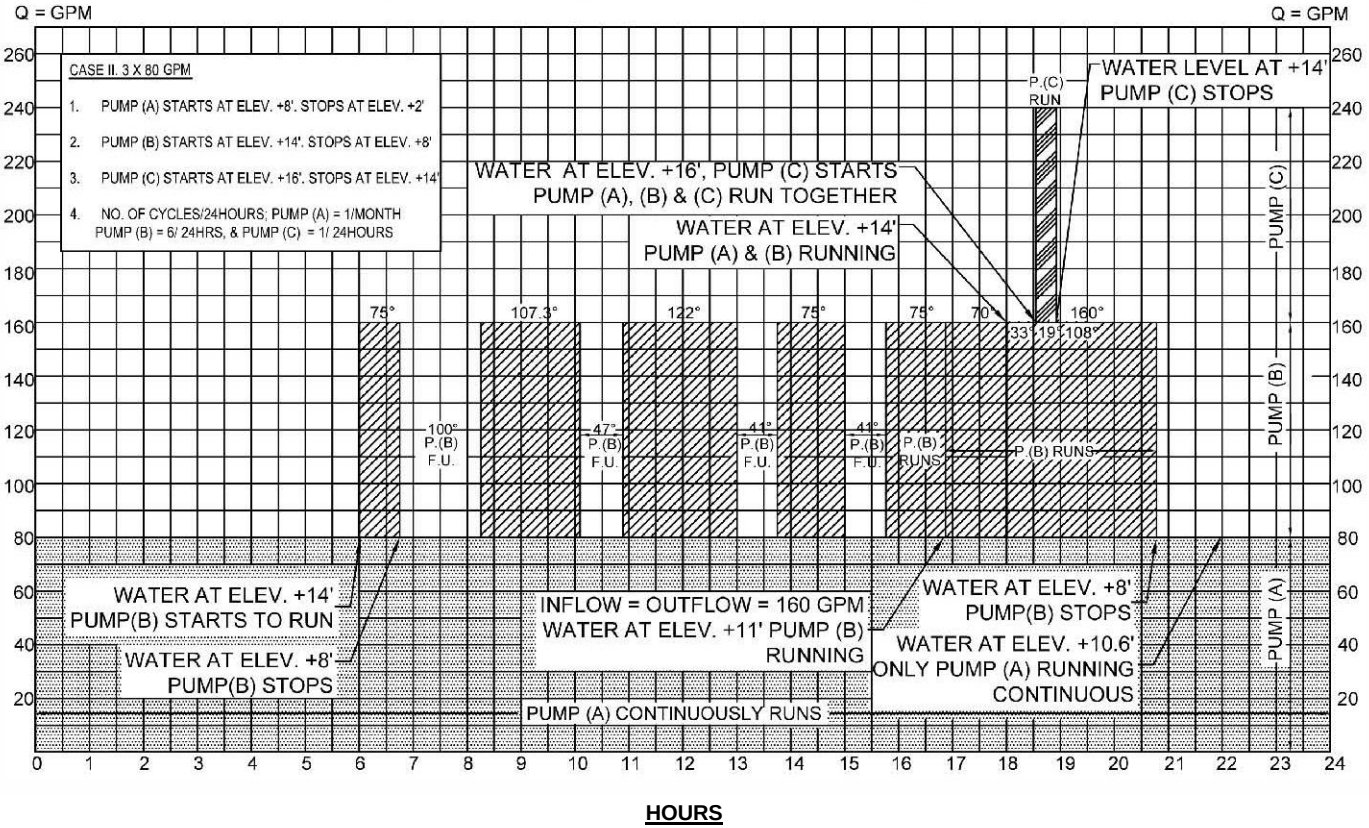


Periodic Power From Utility Network



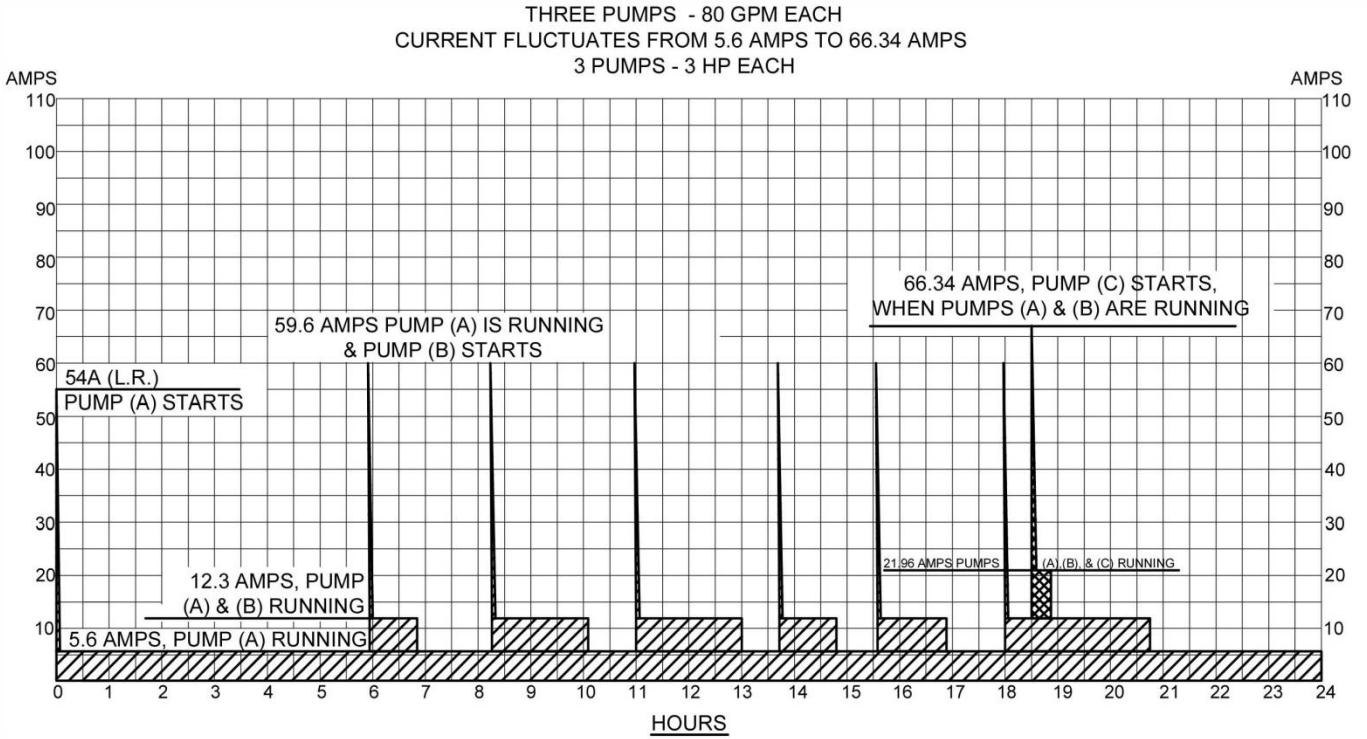
G.L. Station Continuous Fill-Up and Pumping

Operating times of 80 GPM pumps in the green design 3 pump lift station; pump #1A cycles 1 time per month, pump #2B cycles 6/24 hrs and pump #3C cycles 1 time/24 hrs



G.L. Station Continuous Discharge to Force Main

Power demand on a utility company – green design 3 pump lift station



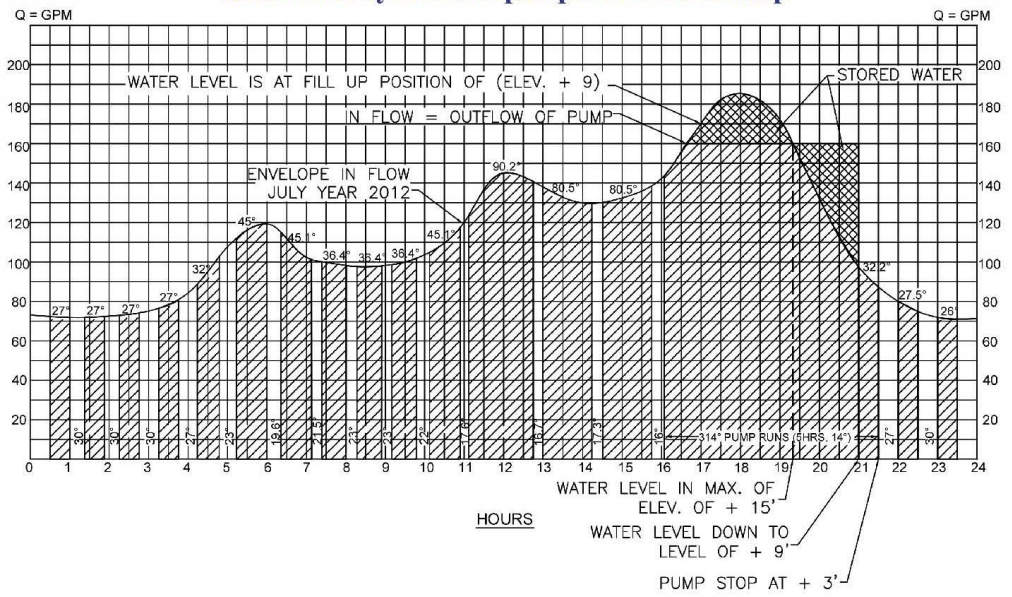
Traditional max = 107.6 amps vs **Green** max of 66.34 amps resulting in **38% reduction on power** demand from the utility company by green designed station.

G.L. Station Continuous Power From Utility Network

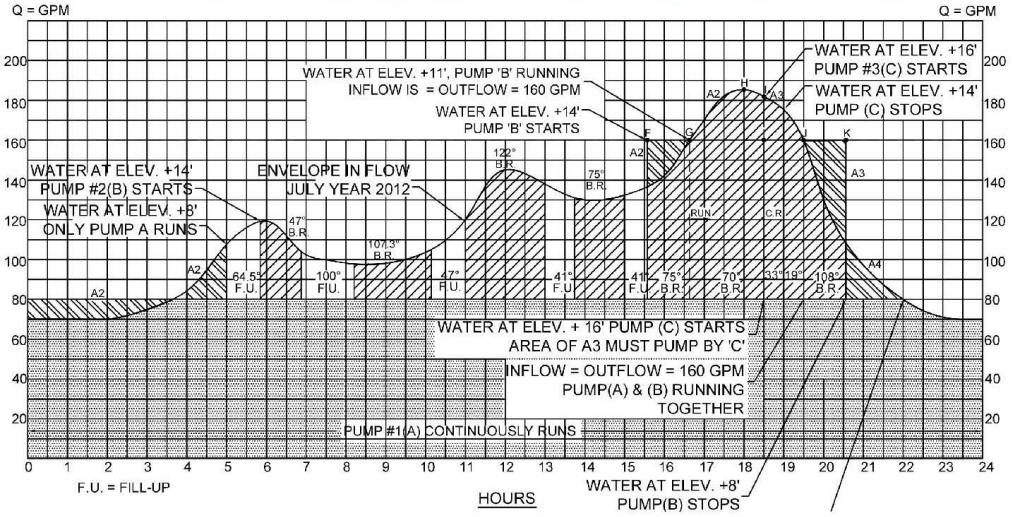
Green Lift Stations
vs.
Traditional Stations

“Fill-Up and pumping”

Traditional lift station with 2 pumps, 160 GPM/each, pump #1A cycles on and off as determined by flow and pump #2B is the backup



Green lift station with 3 pumps, 80 GPM/each, pump #1A runs continuously, pump #2B runs periodically & pump #3C rarely runs/operating as stand-by



Green Lift Stations
vs.
Traditional Stations

“Discharge to Force Main”

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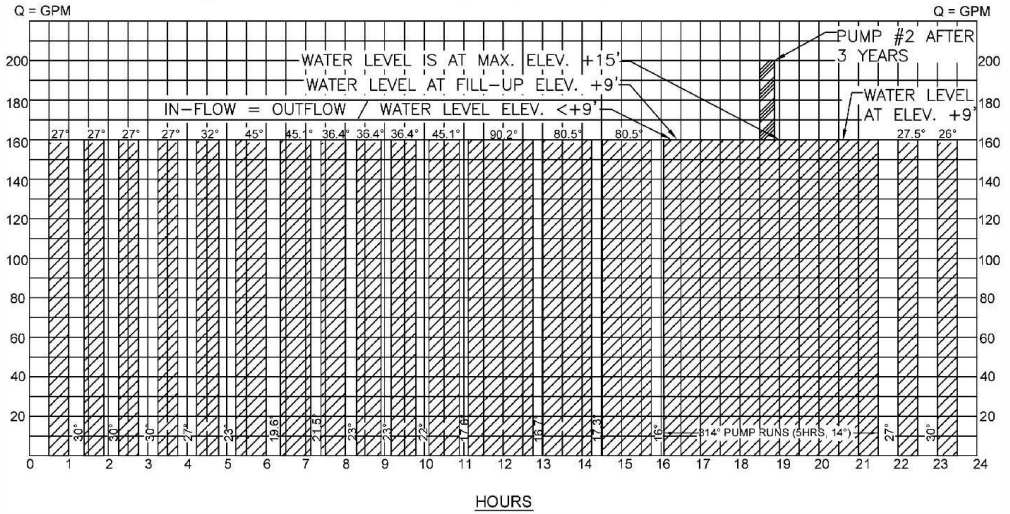
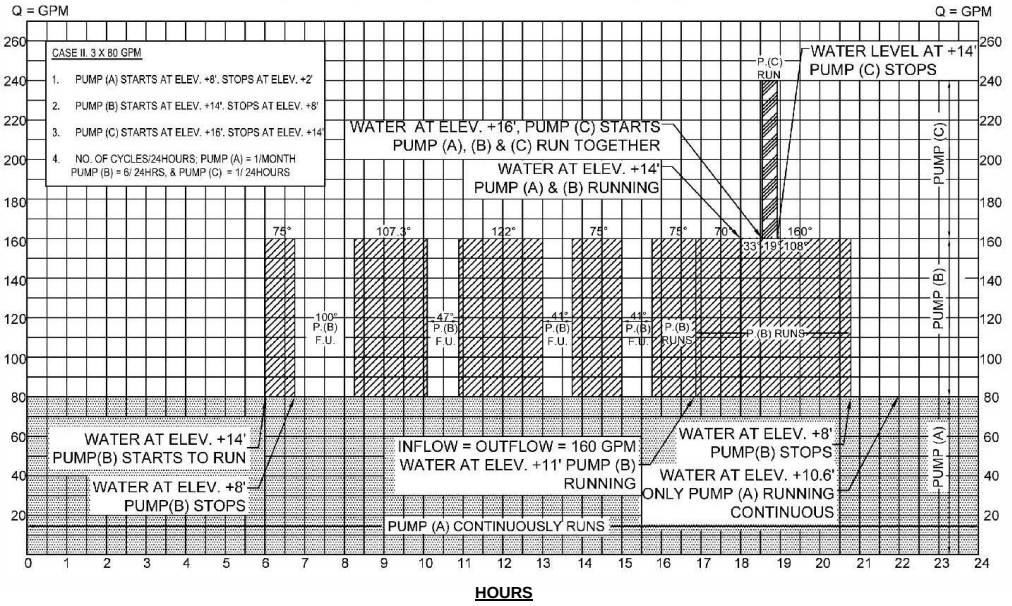


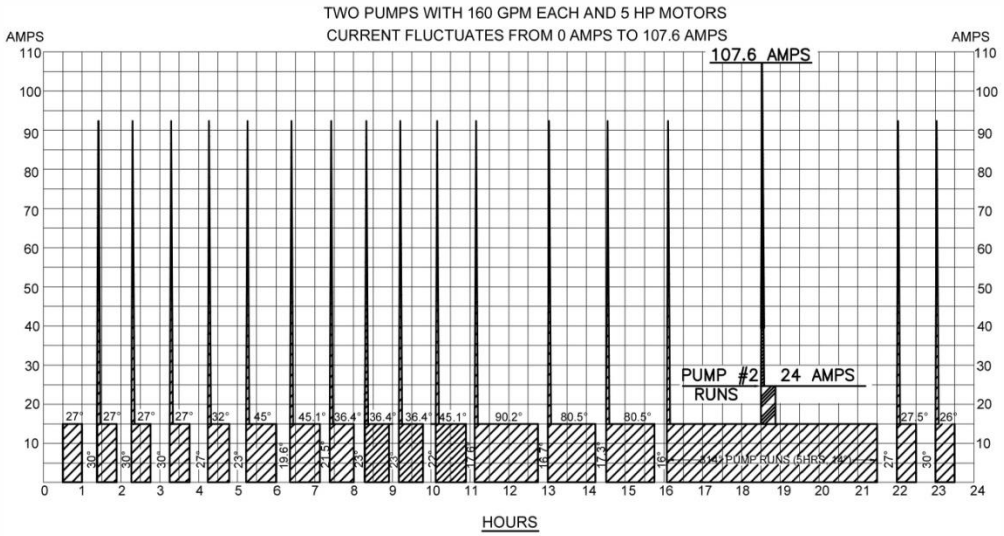
Operating times of 80 GPM pumps in the green design 3 pump lift station; pump #1A cycles 1 time per month, pump #2B cycles 6/24 hrs and pump #3C cycles 1 time/24 hrs



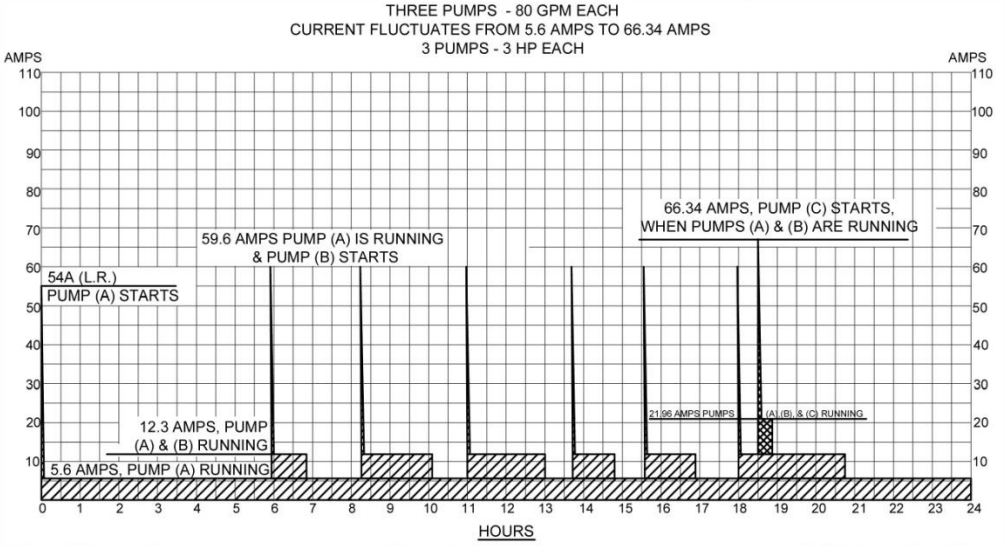
Green Lift Stations
vs.
Traditional Stations

"Power From Utility Network"

Power demand on a utility company – traditional 2 pump lift station



Power demand on a utility company – green design 3 pump lift station



Traditional max = 107.6 amps vs **Green** max of 66.34 amps resulting in **38% reduction on power** demand from the utility company by green designed station.

TRADITIONAL LIFT-STATION , A-12

MAX INFLOW : 1312 GMP

TOTAL HEAD : 90 Ft

PUMPS : 3x 60 HP

POWER INPUT : 50 HP /Each

PUMP MAX DESIGN FLOW :0.75x MAX = 980 GP

PUMP MADE: FLYGT, NT 3202 HT-3-480

Refer to Figure and the following TABLE

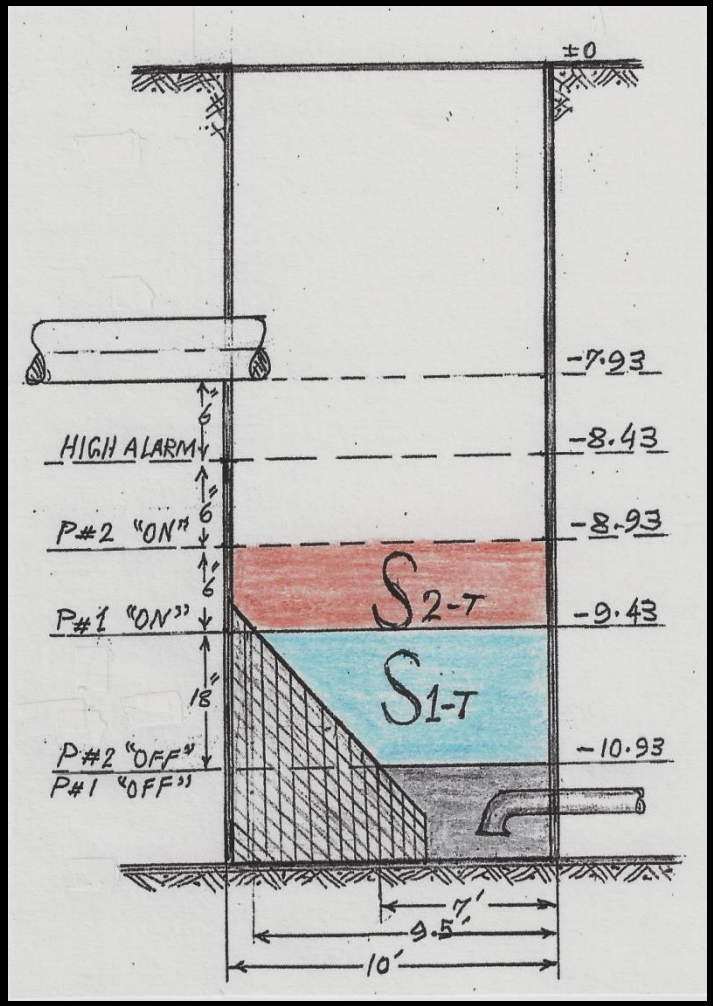
IN PERIODS A, B, and C, ONLY PUMP # 1 WILL OPERATES, AND ONLY WITH STORAGE " S1-T"

IN PERIODS OF D & E, BOTH PUMPS (P#1& P#2) OPERATE WITH STORAGE CAPACITY OF " S1-T + S2-T".

S1-T = 7.5xLxHx (W1 +W2)/2

S1-T = 7.5x20x1.5x(9.5+7)/2 = 1856 Gallons

S2-T = 7.5x20x10x0.5 =750 Gallons



TRADITIONAL LIFT-STATION

TRADITIONAL OPERARING ENERGY CONSUMPTION,

FOR PERIODS OF A, B, and C THE PUMP " RUN" TIME and " OFF " TIME WILL BE CALCULATED BY THE FOLLOWING EQUETIONS

WHERE:

"S1" , IS SAME AS "S1-T"

"S2" , IS SAME AS "S2-T"

P #1,("OFF") TIME = S1 / INFLOW GPM

P #1, ("RUN") TIME =S1 / (P#1GPM - INFLOW GPM)

FOR PERIOD OF D & E, THE " OFF " TIME and THE " ON " TIME FOR BOTH PUMPS ARE GIVEN BY;

P #2 ("OFF") TIME = S2(" FILL UP ") = S2 / (INFLOW GPM -P#1GPM)

(P#1+ P#2) ("RUN") TIME =(S1 +S2)/ (P#1 GPM + P#2 GPM -INFLOW GPM)

SUMMARY OF CACULATION IS GIVEN IN THE FOLLOWING TABLE

TRADITIONAL THREE PUMP LIFT-STATION, DRY WELL (3x 60 HP)

Identify Period	Inflow As %	Inflow As GPM	Period Duration (Hours)	Pump # 1 As Lead Pump					Pump # 2 As Lack Pump				
				Off Time (Mins)	Run Time (Mins)	Cycle Time (Mins)	Number of Cycles	Total Run (Hours)	Off Time (Mins)	Run Time (Mins)	Cycle Time (Mins)	Number of Cycles	Total Run (Hours)
A	50%	656	9	2.83	5.658	8.49	64	6.04	540	0	0	0	0
B	68%	892	4	2.08	20.17	22.25	10.8	3.36	240	0	0	0	0
C	75%	980	4	1.894	238.1	240	1	4	240	0	0	0	0
D	85%	1,115	5	1.665	8.78	10.445	28.72	4.2	7.39	3.055	10.445	28.72	1.462
E	100%	1,312	2	1.414	6.264	7.676	15.63	1.632	3.704	3.972	7.676	15.63	1.035
TOTAL			24				120.15	19.5				44.352	2.497

3x 60 HP PUMPS, FLYGT, MODEL# NF3202 HT-3-480V, Rushing Current 470 Amps, Rated Current 69 Amps

Efficiency a v e . (pump) = (E. A x A time +E. B x B time +E. C x C time +E.D x D time +E.E x E time)/ 24

Effi. a v e . (FLYGT 60HP PUMP) = (9 x 58 % +4 x 44 % +4 x 45 % +5 x 50 % +2 x 58 %)/24 = 51.8 %

KWH (L.S.) = KWH (P#1+P#2) =KWH r +KWH m + KWH f + KWH k

TRADITIONAL LIFT-STATION POWER CONSUMPTION/ 24 HOURS

KWH r = Running KWH = 50HP x 0.746(19.5 Hrs.+ 2.5 Hrs.) = 820.6 KWH

KWH m = Start up KWH =1.73x 480V x 470Amps X 5 sec/ 3,600,000 = 0.542 kwh

KWH f = Flow Establishment KWH =1.73X 480Vx 69 Amps x 0.8X 1min/ 60,000 = 0.764 KWH

KWH k = Kinetic Energy of Moving WATER in FORCE MAIN = ½(M x V x V)

a - For (P#1) Running =0.072 KWH

b - For (P#1+ P#2) Running = 0.285 KWH

KWH /Start P #1= 0.542+0.764+0.072 =1.379 KWH

KWH / Start (P#1+P#2) = 2(0.542+0.764+0.285) =2.898 KWH

KWH for(ON & OFF) of LIFT-STATION in 24 HR s = (P#1) (cycles x Kwh)+(P#1+P#2) (cycles x Kwh)

KWH (ON &OFF) =(75.8 x1.379 KWH) + (44.35x2.898 KWH) =233.05 KWH

TOTAL Kwh of LIFT-STATION/ 24 HRs =233.05 KWH +820.6KWH =1,053.65 KWH

GREEN LIFT–STATION DESIGN, A–12

MAX INFLOW : 1312 GPM

MIN INFLOW : 656 GPM

TOTAL HEAD : 90 Feet

PUMPS: MADE BY EBARA, MODEL #150x100 DDLF 622

SYNCHRONOUS, 1,800 RPM / 480V/3 PHASE

PUMPS : 3x 30 HP

PUMP'S BHP : 26 HP

POWER IN PUT : 27.4 HP

PUMP'S MAX DESIGNED FLLOW : 656 GPM

PUMP'S IMPELLER TRIMED DOWN from 304mm to 295mm

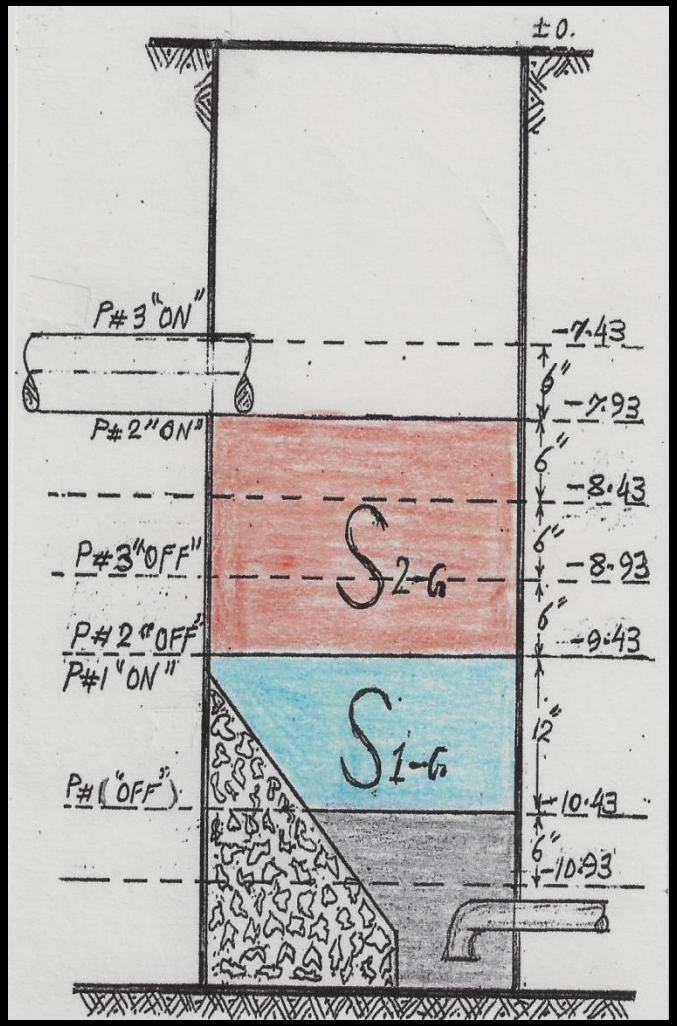
FINAL POWER IN PUT : 25 HP

STORAGE :

S = 7.5x Lx w x H GALLONS

S_{1-G} = 7.5 x 20'x 10'x 1' = 1500 GALLONS

S_{2-G} = 7.5 x 20' x 10' x 1.5' = 2250 GALLONS



GREEN LIFT–STATION

GREEN LIFT-STATION DESIGNED ENERGY CONSUMPTION,

REFER TO THE FOLLOWING SUMMARY TABLE,

- IN **A** Period, ONLY "**PUMP#1**" RUNS CONTINUOUSLY with HIGH EFFICIENCY,

  MIN. L.S.INFLOW GPM IS EQUAL TO "P#1 GPM", and STORAGE "S1-G" REMAINS FULL IN

  ALL THE PERIODS OF A, B, C, D, and E .
- IN **B, C, D,** and **E** period, ONLY STORAGE "**S2-G**" WILL BE PUMPED OUT PERIODICALLY

  BY "P #2", WITH HIGH EFFICIENCY.
- PUMP#2 (" **OFF** ") TIME= **S**2g/(INFLOW GPM - P #1GPM)
- PUMP#2 (" **RUN** ") TIME = S2g/(**P#1** GPM + **P#2** GPM - INFLOW GPM)
- P#2 (" CYCEL ") TIME = P#2(" OFF ") TIME + P#2(" RUN ")
- CYCELS/ PERIOD = PERIOD TIME/ CYCEL TIME

GREEN LIFT–STATION WITH THREE PUMPS, (3x 30 HP PUMPS)

Identify Period	Inflow As %	Inflow As GPM	Period Duration (Hours)	Pump # 1 , CONTINUOUS RUN	Pump # 2 , RUNS as NEEDED				
				RUN Duration (Hours)	Off Time (Mins)	Run Time (Mins)	Cycle Time (Mins)	Number of Cycles	Total Run (Hours)
A	50%	656	9	9	0	0	0	0	0
B	68%	892	4	4	9.53	5.357	14.89	16.1	1.437
C	75%	980	4	4	6.94	6.78	13.72	17.5	1.977
D	85%	1,115	5	5	4.9	11.42	16.32	18.38	3.5
E	100%	1,312	2	2	0	120	120	1	2
TOTAL			24	24				53	8.914

3x 30 HP PUMPS , MADE by EBARA ,MODEL # 150 x 100 DDLF 622, 480V/ 3 PHASE,1800 RPM, SYNCHRONE

IMPELLER TRIMMED OFF from 304 mm TO 295 mm, THAT REDUCED THE INPUT POWER by FACTOR of 0.914

PUMP'S INPUT HP = 27.4 HP x 0.914 =25 HP

DESIGNED PUMP'S MAX INFLOW = L.S.'S MIN INFLOW = 656 GPM

PUMP'S EFFICIENCY for PERIOD A, B, C, D, and E IS THE SAME AND IS AT THE DESINGED EFFICIENCY OF 63 %

KWH(L.S.) =KWH(P#1+P#2) = KWH r + KWH m + KWH f + KWH k

GREEN LIFT–STATION POWER CONSUMPTION/ 24 HOURS

KWH r = Running KWH = 25HP x 0.746(24 Hrs.+ 8.9 Hrs.) = 613.83 KWH

KWH m = Start up KWH =1.73x 480V x 191Amps X 5 sec/ 3,600,000 = 0.220 KWH

KWH f = Flow Establishment KWH =25 HP x 0.746 x 1min/ 60,000 = 0. 311 KWH

KWH k = Kinetic Energy of Moving WATER in FORCE MAIN = ½(M x V x V)

a – For (P#1) Running =0.032 KWH

b – For (P#1+ P#2) Running = 0. 127 KWH

KWH (ON & OFF) P#1 =0.0 P#1 Runs Continuously

KWH (ON & OFF) P #2 = 0.220 KWH + 0.311KWH + 0.032 KWH = 0.563 KWH

KWH for (ON & OFF) of LIFT–STATION in 24 HR s = (P#2) (cycles x KWH)

KWH (ON &OFF) for L.S. = 52 cycles x 0.563 KWH =29.86 KWH

TOTAL Kwh of GREEN–LIFT–STATION/ 24 HRs =613.83 KWH +29.86 KWH = 643.71 KWH

GREEN LIFT-STATION with THREE CONSTANT SPEED PUMPS, A-12

VERSUS

TRADITIONAL L. STATION with THREE CONSTANT SPEED PUMPS

GREEN -LIFT " **HP** " CAPACITY installed/ TRADITIONAL " **HP** " installed = 3x 30/3x 60 = **50 %**

GREEN-LIFT **ENERGY** SHAFT BHP/TRADITIONAL **ENERGY** SHAFT BHP = 643.7/1,053.7 = **61.1 %**

GREEN-LIFT **ERERGY** INPUT/ TRADITIONAL **ENERGY** INPUT = (51.83 % /63 %) x 61.1 % = **57.6 %**

MAINTENANCE IS RELATED TO NUMBER OF PUMP'S " ON & OFF " or the NUMBER OF CYCLES

TRAD. PUMP " **LIFE** "/GREEN PUMP " **LIFE** " = TRAD.CYCLES/ GREEN CYCLES = 53/ 164.5 =**32.7 %**

MAINT. G.L.STATION / **MAINT.** TRADITIONAL = 53/(120.15+44.35) = 53/164.5 = **32.7 %**

GREEN-LIFT " **CO2** " RELEASE /TRADITIONAL " **CO2** " RELEASE = 643.7/1,053.7 = **61.1 %**

ONLY GREEN LIFT-STATION CAN RECEIVES FEDERAL **GRANT**

CASE STUDY

We have performed a case study of an existing, traditional design, re-pump station. The study compared criteria and specifications (Table 1 below) of the traditional station with those of an energy efficient green designed station. Comparative costs of the construction of the traditional and green designed stations are presented in Table 2. Finally, the maintenance and energy cost savings of each designed station are provided in Table 3.

TABLE 1

Item Description	Traditional Design	Green Design
Wet Well		
Inner Diameter X Wall Thickness	12'x1'	12'x1'
Depth	30'	24'
Pumps		
Average Operating Efficiency	**12%**	**63%**
Maximum Inflow to Well	1750 GPM	1750 GPM
Pump Rated Power	85 HP	30 HP
Voltage	480 V	480 V
Nominal Rated Amps	109 A	36 A
Rush in Current (LRA)	685 A	231 A
Rated Speed	1185 RPM	1755 RPM
Impeller Diameter	15.875"	5.9375"
Pump Height	56.5"	39.25"
Pump Wieght (With/Without Jacket)	2066/1900	665/600

CRITERIA AND SPECIFICATIONS
TRADITIONAL RE-PUMP STATION VS. GREEN DESIGN

TABLE 2

Item Description	Compiling Cost Items	TRADITIONAL		GREEN DESIGN		GREEN DESIGNED STATION SAVINGS	
		Materials	Labor	Materials	Labor	Materials	Labor
Cost Of Construction							
Wet-Well	13/C.I.	$29,767	$14,034	$23,054	$11,417	22.55%	18.65%
Pumps & L	2/C.I.	$144,426	$15,865	$73,316	$6,831	49.24%	56.94%
Piping & Valves	12/C.I.	$43,996	$22,000	$24,474	$12,237	44.37%	44.38%
Electrical	16/C.I.	$158,028	$62,070	$96,720	$38,795	38.80%	37.50%
Emergency Generator	3/C.I.	$70,820	$18,665	$52,480	$13,500	25.90%	27.67%
Coffer Dam	9/C.I.	$40,022	$16,000	$34,653	$16,000	13.42%	0.00%
Excavation	11/C.I.	$8,307	$8,667	$6,069	$6,429	26.94%	25.82%
Dewatering	6/C.I.	$6,400	$7,680	$4,800	$5,760	25.00%	25.00%
Wet-Well Installation	20/C.I.	$24,454	$23,077	$17,512	$17,727	28.39%	23.18%
Totals		$526,220	$188,058	$333,078	$128,696	36.70%	31.57&
Total Cost Materials & Labor		**$714,278**		**$461,774**		**35.35%**	

CONSTRUCTION COST COMPARISON

TABLE 3

COST OF OPERATION (25 YRS)	TRADITIONAL	GREEN DESIGN	GREEN DESIGNED STATION SAVINGS
Maintenance	$1,435,516	$300,482	**79.07%**
Operating Energy Cost	$6,072,525	$1,602,660	**73.61%**

GREEN LIFT-STATION with (4x 30) HP CONSTANT SPEED PUMPS,

VERSUS

TRADITIONAL L. STATION with (3x85) HP VARIABLE SPEED PUMPS

GREEN -LIFT " **HP** " CAPACITY installed/ TRADITIONAL " **HP** " installed = 4x 30/3x 85 = **47 %**

GREEN-LIFT **ENERGY** CONSUMPTION/ TRADITIONAL **ENERGY** USE = 64,106/242,901 = **26.4 %**

TRADITIONAL MAINTENANCE IS VERY COSTLY, DUO TO VFD 'S HEAT SENSITIVITY AND VFD'S SHORT LIFE. ALSO LOWERING SPEED COULD CAUSE RESONANCE OF NATURAL FREQUENCY

MAINT. G.L.STATION / **MAINT.** TRADITIONAL = $12,019 monthly/$57,421 monthly = **32.7 %**

GREEN-LIFT " **CO2** " RELEASED/TRADITIONAL " **CO2** " RELEASED = 64,106/242,901 = **26.4 %**

GREEN L.-STATION'S PUMP **EFFICIENCY** IS **63 %** , TRADITIONAL L.-STATION AVERAGED **12 %**

ONLY GREEN LIFT-STATION CAN RECEIVES FEDERAL **GRANT**

Why Not Variable Speed Pumps?

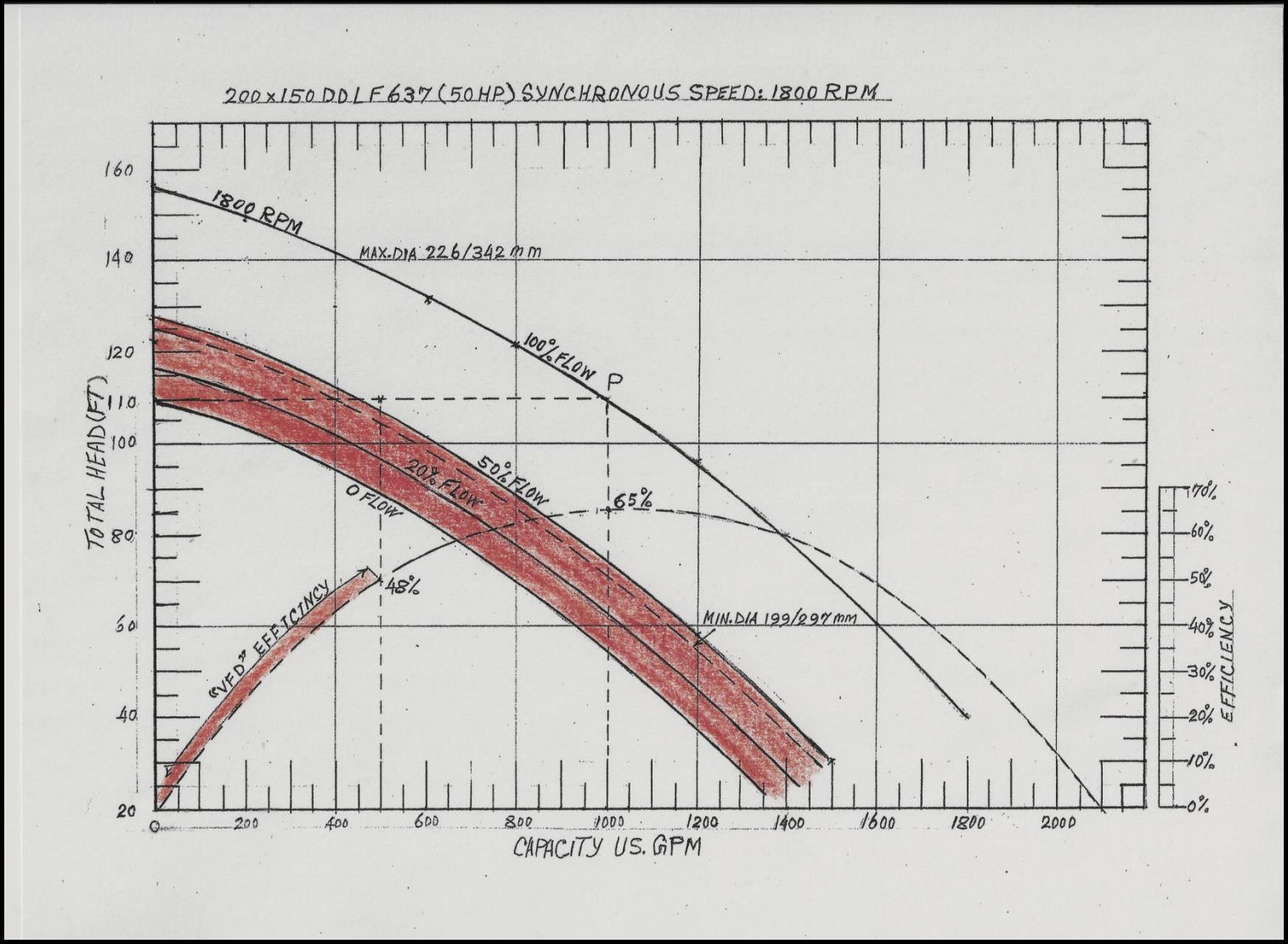
- Variable speed pumps have been used in lift stations SUPPOSEDLY to save energy
- On the contrary, they are less efficient than single speed pumps and do not accomplish energy or cost savings
- Dr. Thomas Walski is one of the most published and recognized water-resources modeling experts and educators in the world
- His research concludes **In sewage pump station wet well** variable speed pumps approach their maximum efficiency only when their variable frequency drive (VFD) is totally bypassed and the pumps run at constant speed.

TWO PUMP

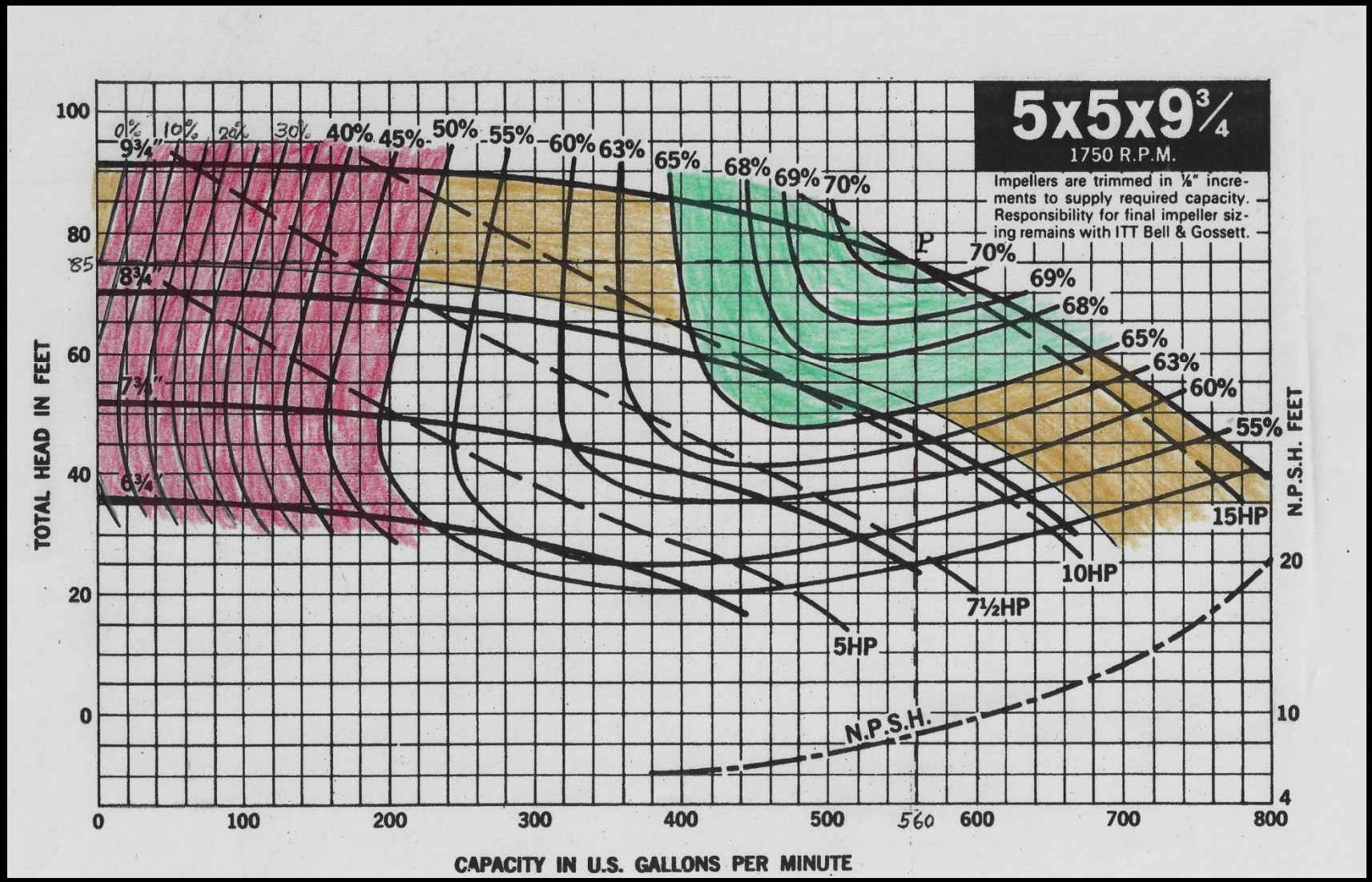
LIFT- STATION

EFFICIENY

0% to 48%



VARIABLE SPEED PUMP 'S CURVE (LIFT-STATION WITH TWO PUMPS)



EFFICIENCY – VARIABLE SPEED, 0% to 50% – SINGLE SPEED, 65% to 70%

CITY's SEWER SYSTEM ENERGY USE from Sept 2014 to Sept 2015

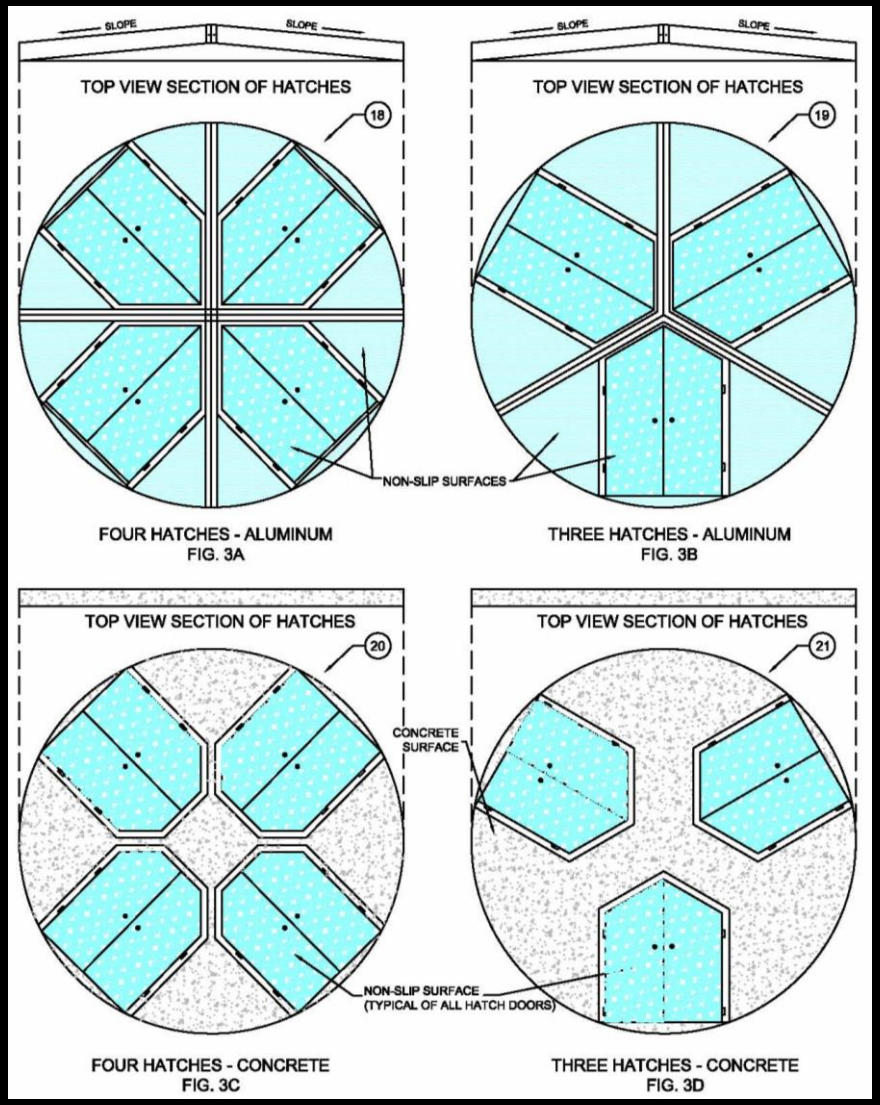
- TOTAL ENERGY USED 37,575,515 KWH
- PUMP – STATIONS ENERGY USED 10,382,792 KWH
- DEEP – WELL INJECTION PUMPS 20,313,670 KWH
- TOTAL PUMPING POWER USED 30,696,462 KWH
- PUMPING ENERGY % OF TOTAL 81.69 %

CONFIGURATIONS

OF

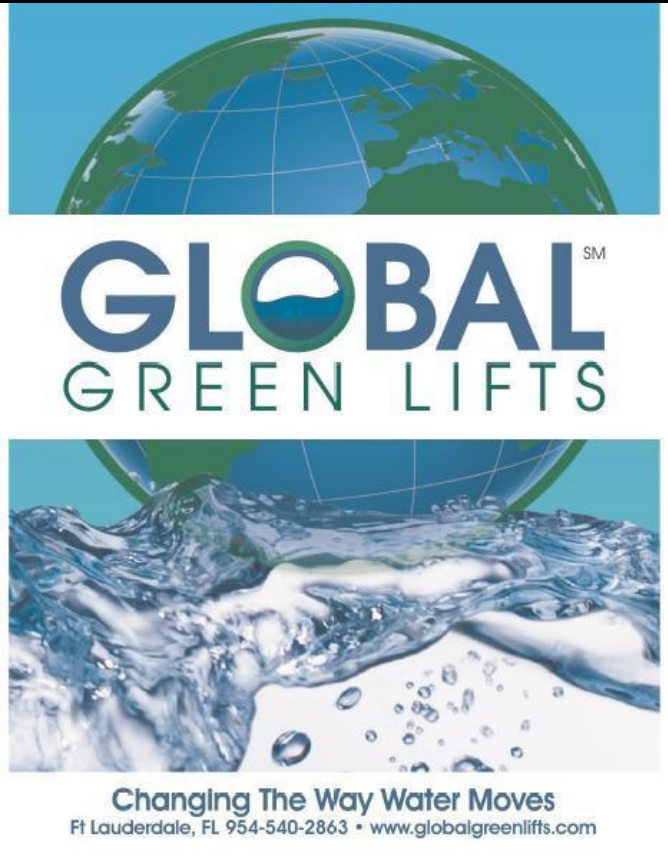
HATCHES

FIG.,3A, 3B, 3C, & 3D



GREEN LIFT-STATIONS' ALUMINUM or CONCRETE TOP COVERS

Why Not Start



Today?