WWSEC 2013

Opportunities for Energy Efficiency Gains at WPCF

Bob Sprick City of Eugene (541) 682-8617

Energy Management

Energy Management Group

Defining Energy Costs

Energy Conservation Measures (ECM)

Ways to Manage Energy Costs

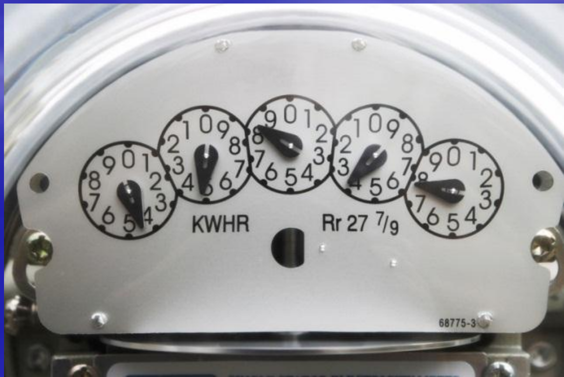
Basic Question: If it uses energy what is the control measure? Best Practice?

Energy Management Group

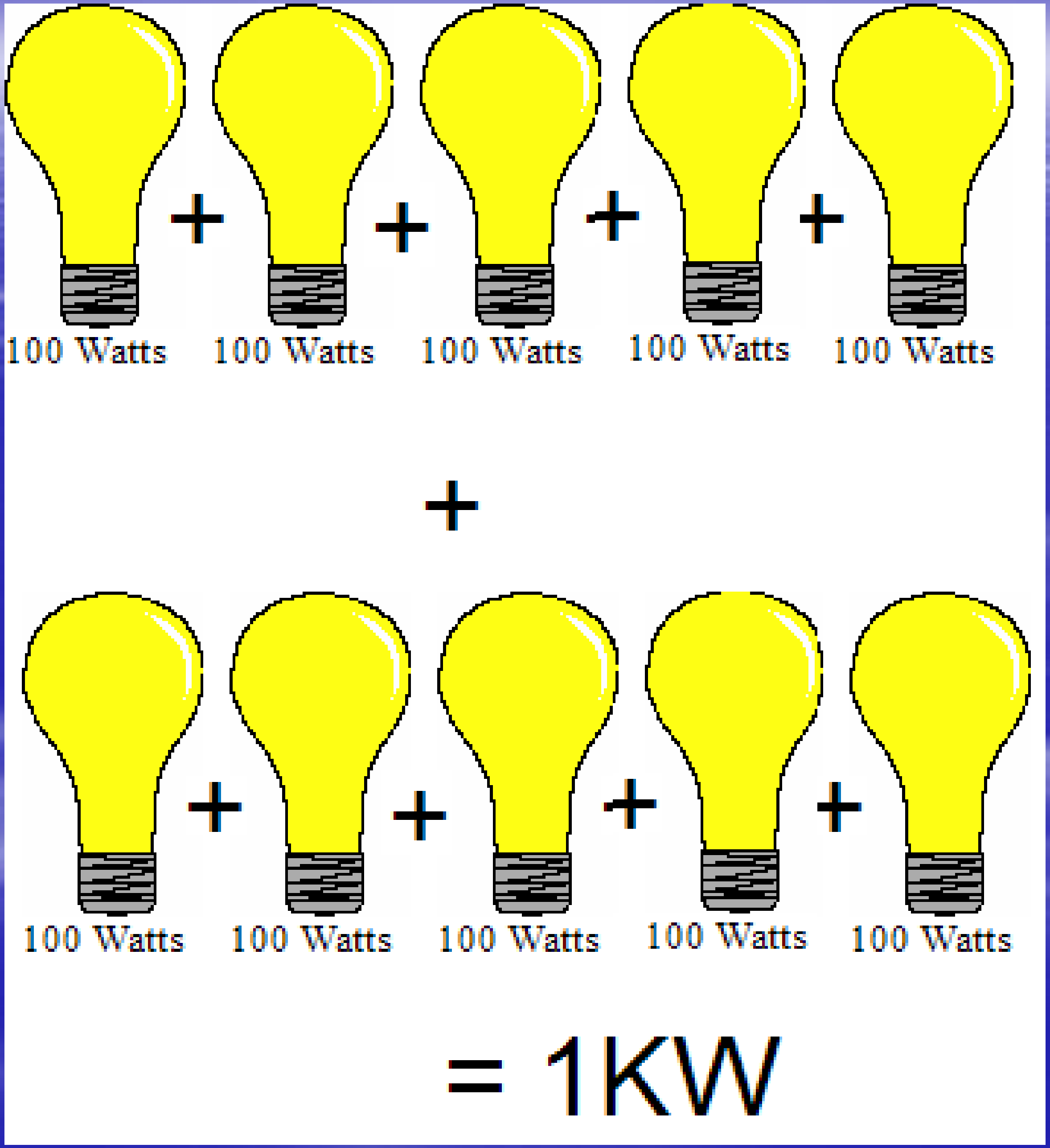
- Upper Management Support
- Biggest Users – Operations Off/On
- Process Control
- Maintenance – PM
- Purchasing- Spec for premium efficiency & Energy Life Cost component
- Design review team & Equip. Replacement
- Service Provider
- Everybody is a player

Defining Energy Costs

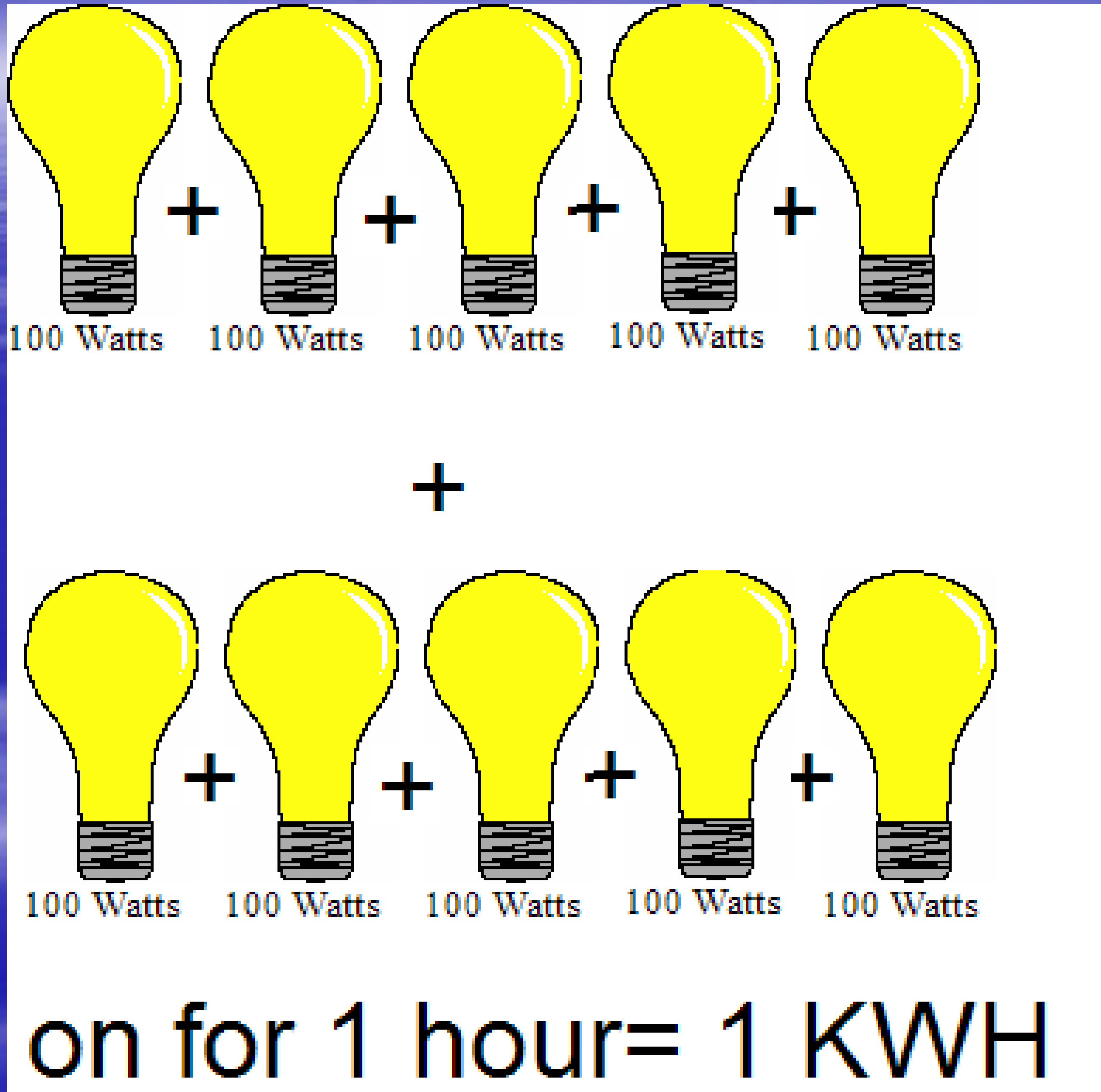
- Kilowatts (KW) = Watts/1000
- Kilowatt Hours (KWH) = KW X hours of operation
- Demand = highest KW for 15 minute period during billing period
- Power Factor= PF or KVAR



Kilowatts


100 Watts
100 Watts
100 Watts
100 Watts
100 Watts
+
100 Watts
100 Watts
100 Watts
100 Watts
100 Watts
= 1KW

Kilowatt Hour



Demand KW

- Usually the highest KW usage over 15 minutes during the billing period
- Read your power rate schedule /contract
- Demand is not easily stored. Generated as needed.
- Cost is highest rate ~$ 6.65 / KW
- KWH cost accumulates $0.0427 - $0.08 per KWH

Power Factor

Check your bill

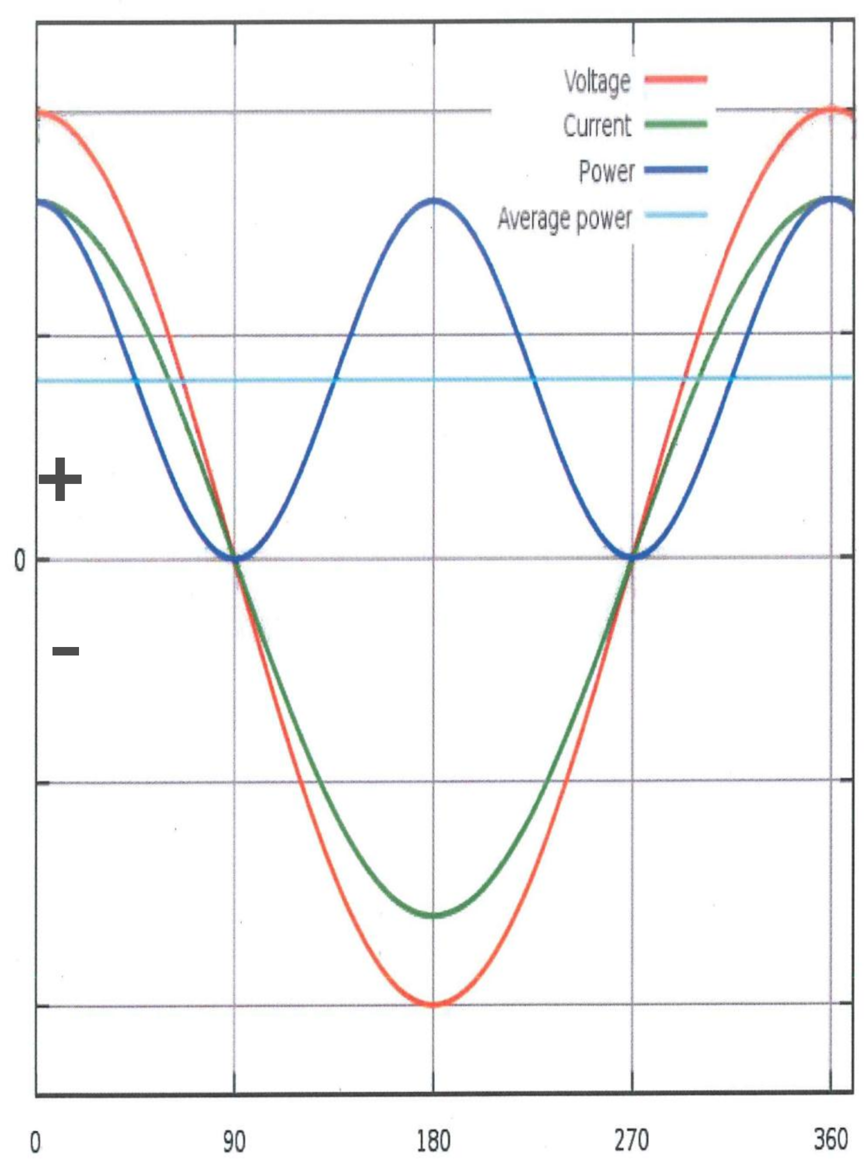
If you see PF or KVAR charges, contact your service provider for help.

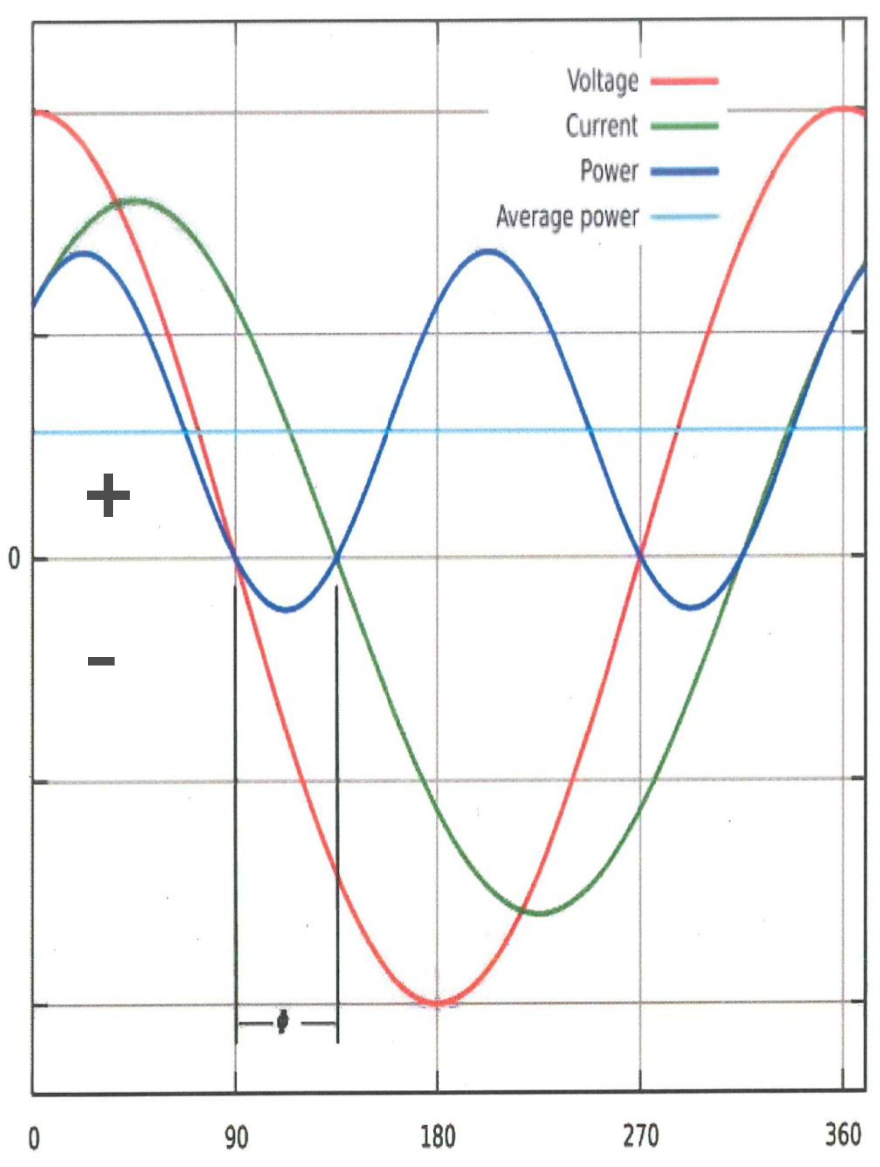
Power factor charge is money spent for no usable energy.

Pure Resistive Power

Inductive Power

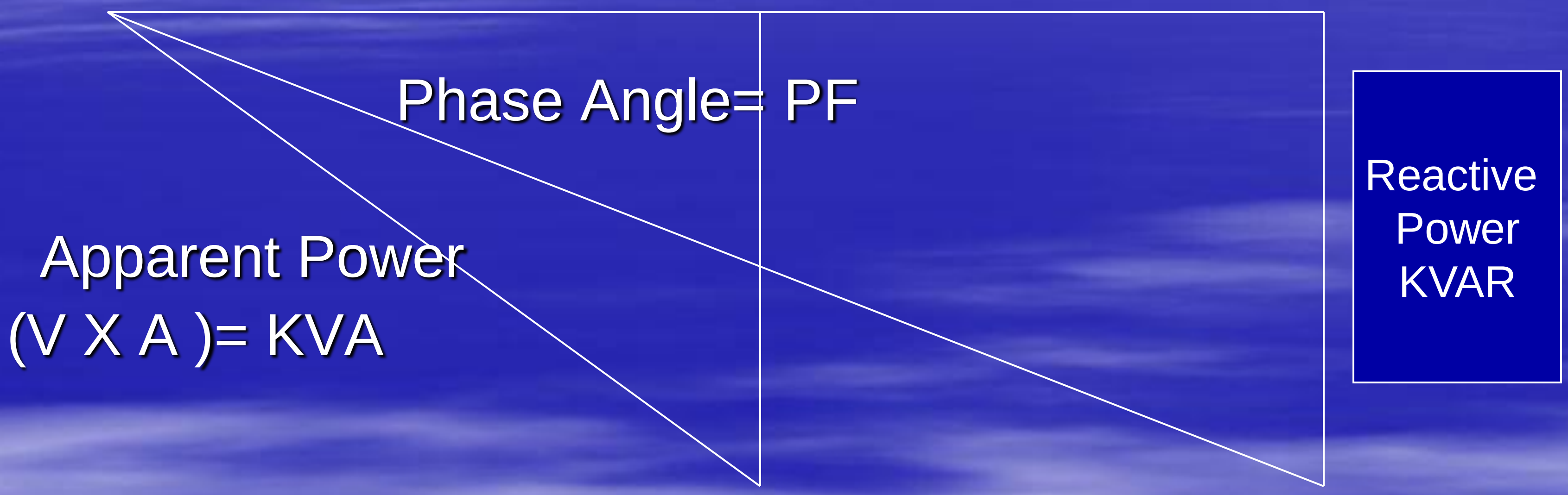
P=I*E





Power Factor

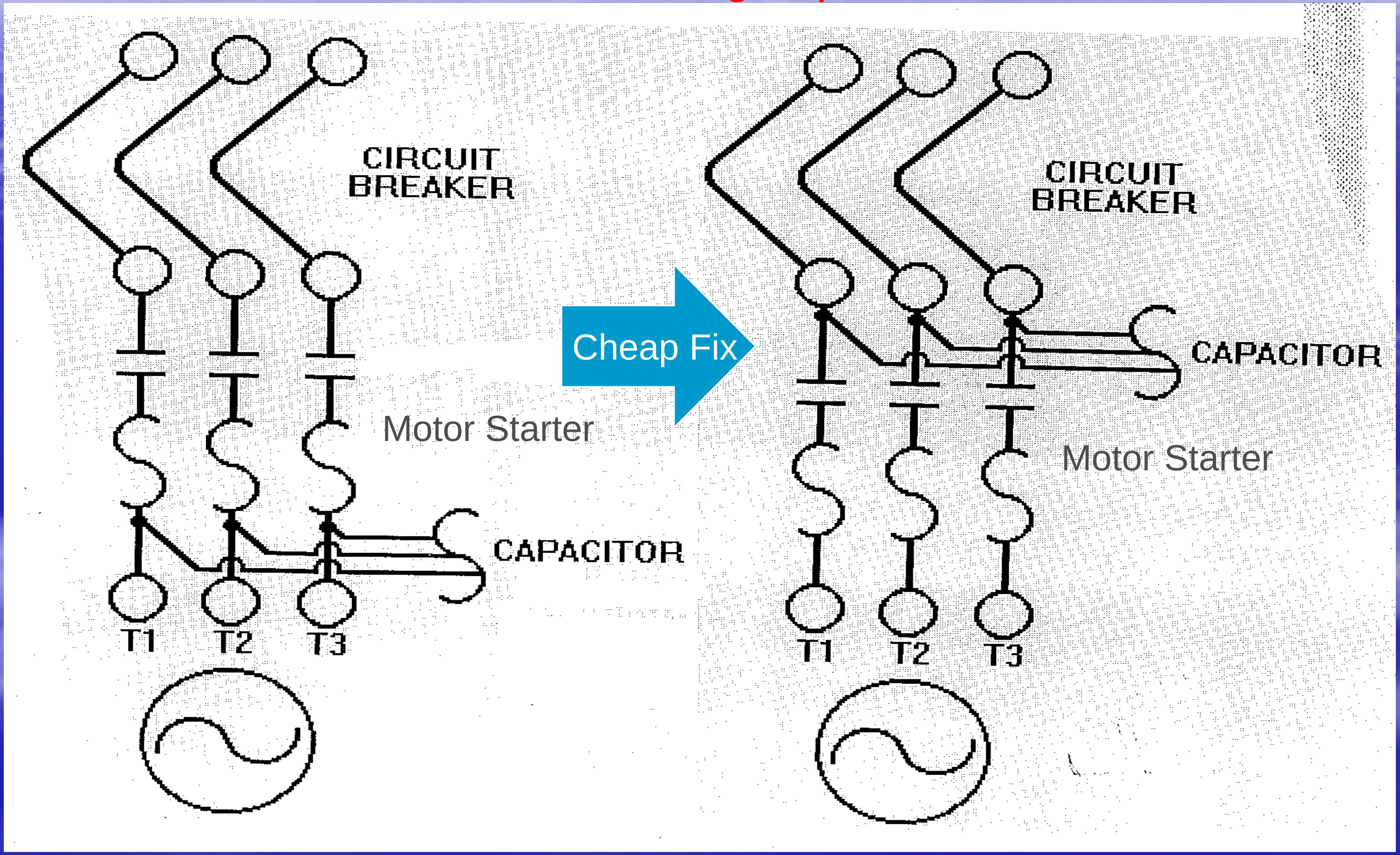
Active Power (V X A X PF) = KW



Reducing load to 50% increases PF problem

Fixing Power Factor

First check existing capacitors



Load Factor (LF)

- $LF = \dfrac{\text{KWH (billing period)}}{\text{KW X 24 X days in billing period}} \text{ X } 100$

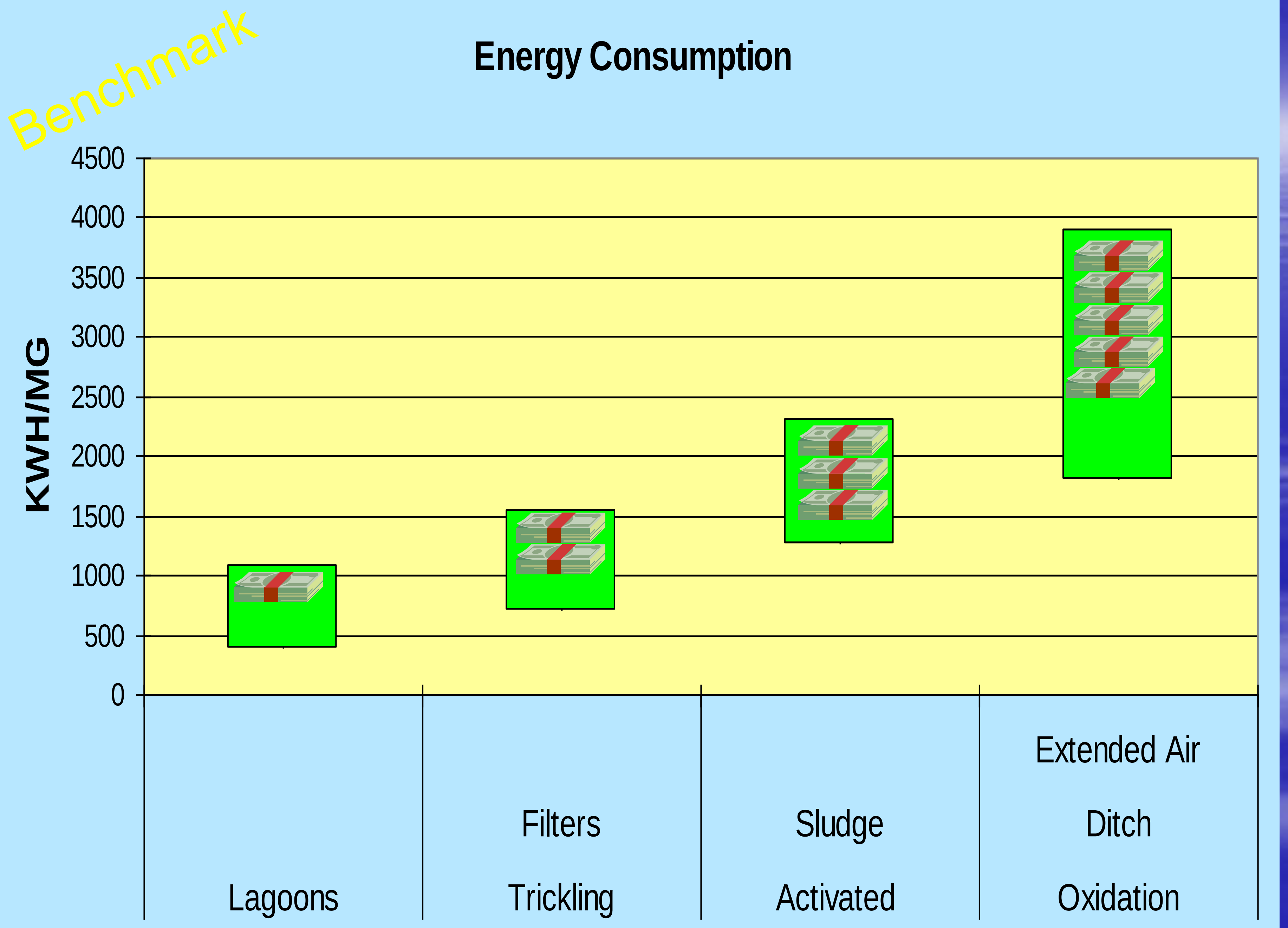
✓ Below 55% = oversized equipment

Evaluate cause - Storm event other?

➢ 70% and above is pretty good for WWTP

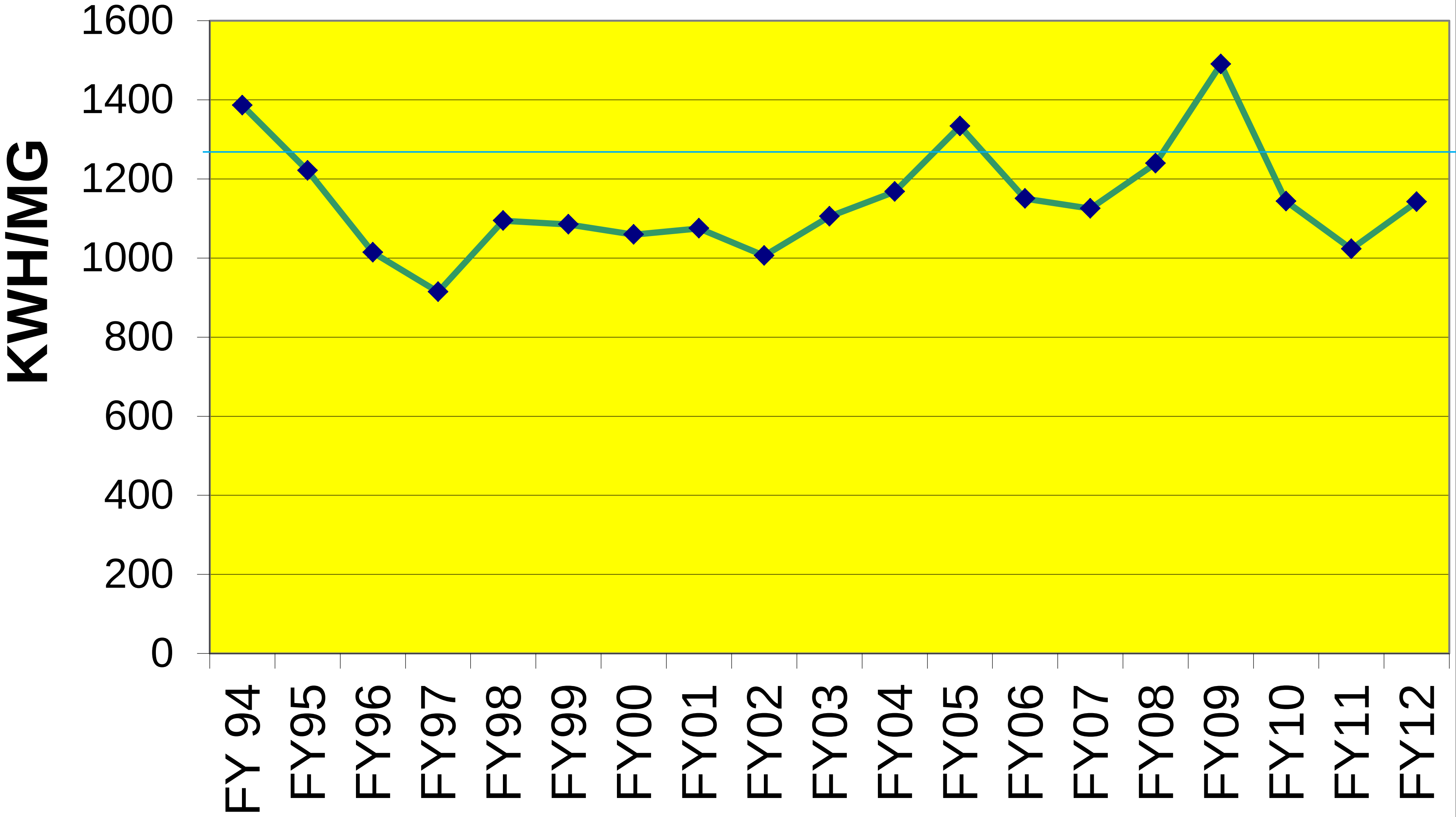
➢ Pump-stations KWH/Run Time

➢ Flow then track KWH/MG



Benchmark
Energy Consumption
KWH/MG
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Lagoons
Trickling Filters
Activated Sludge
Oxidation Ditch Extended Air

Power Usage E/S Metro



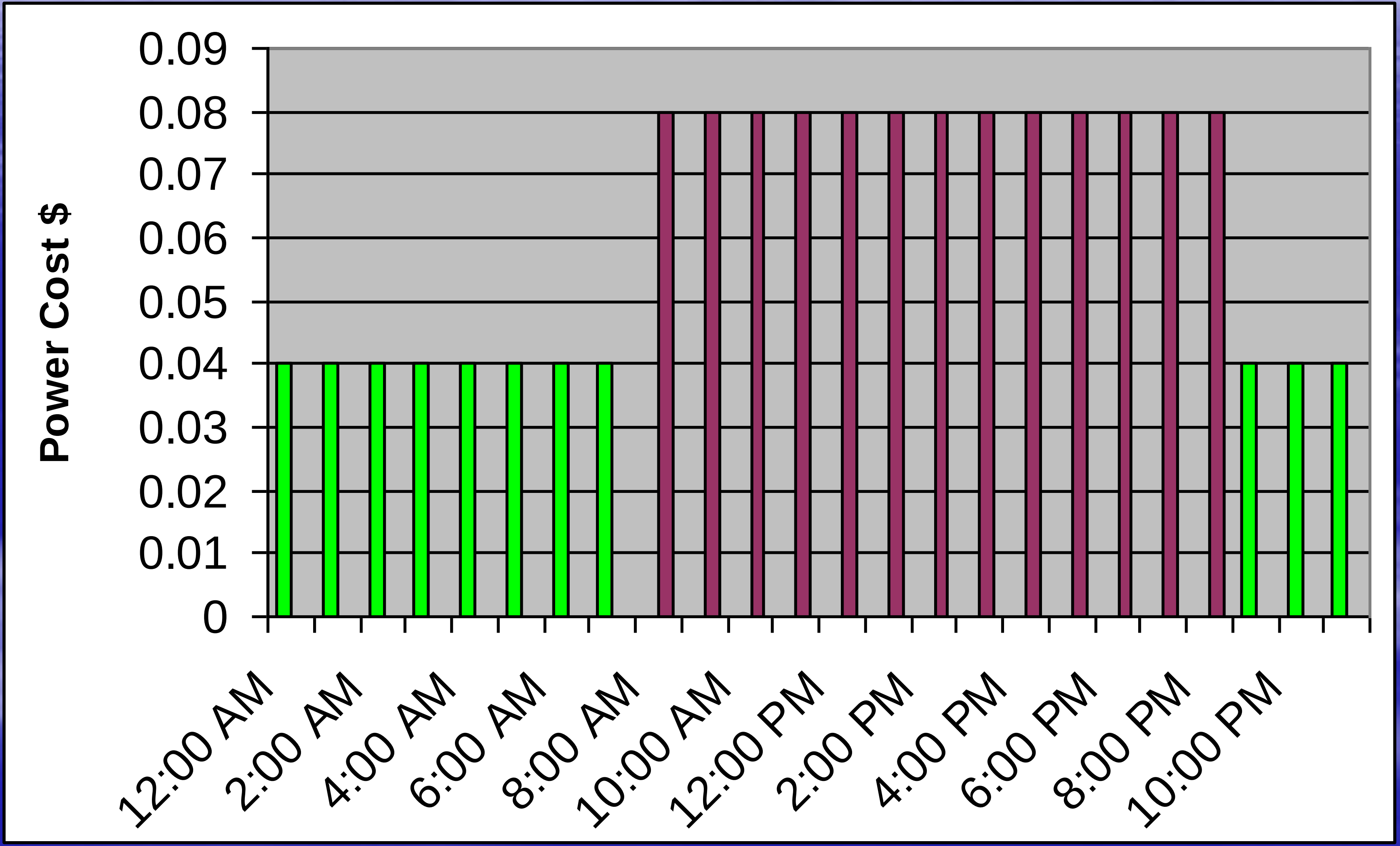
Energy Usage Costs 24hr Operation

Energy Usage Costs 24hr Operation

Oct-11 KVAR $.28 Base Charge $2,219 with first 300 KW =$0

HP	KW	$/KW $6.25	Hours/ Day	KWH/ Day	$KWH/Day $0.0422	$KWH/ Month	Total $ /Month	Total $ / Year
1	0.746	$4.66	24	18	$0.76	$23	$27	$328
2	1.492	$9.33	24	36	$1.51	$45	$55	$656
3	2.238	$13.99	24	54	$2.27	$68	$82	$984
4	2.984	$18.65	24	72	$3.02	$91	$109	$1,312
5	3.73	$23.31	24	90	$3.78	$113	$137	$1,640
10	7.46	$46.63	24	179	$7.56	$227	$273	$3,279
15	11.19	$69.94	24	269	$11.33	$340	$410	$4,919
20	14.92	$93.25	24	358	$15.11	$453	$547	$6,559
25	18.65	$116.56	24	448	$18.89	$567	$683	$8,199
30	22.38	$139.88	24	537	$22.67	$680	$820	$9,838
40	29.84	$186.50	24	716	$30.22	$907	$1,093	$13,118
50	37.3	$233.13	24	895	$37.78	$1,133	$1,366	$16,397
75	55.95	$349.69	24	1343	$56.67	$1,700	$2,050	$24,596
100	74.6	$466.25	24	1790	$75.55	$2,267	$2,733	$32,795
125	93.25	$582.81	24	2238	$94.44	$2,833	$3,416	$40,993
150	111.9	$699.38	24	2686	$113.33	$3,400	$4,099	$49,192
200	149.2	$932.50	24	3581	$151.11	$4,533	$5,466	$65,590
300	223.8	$1,398.75	24	5371	$226.66	$6,800	$8,199	$98,384
400	298.4	$1,865.00	24	7162	$302.22	$9,067	$10,932	$131,179
500	373	$2,331.25	24	8952	$377.77	$11,333	$13,664	$163,974
1000	746	$4,662.50	24	17904	$755.55	$22,666	$27,329	$327,948

Time of Use Billing Chart



If you have an on-peak / off-peak rate structure track power use percentage

Plan for Off- Peak Hours

- Look at your diurnal load and see what activities can be shifted
- Waste Thickening
- Thickened sludge pumping
- Tank draining
- Clean-up – flushing
- recycle water- irrigation
- Surge basin, back up influent
- Generation – gas storage- maintenance work

Energy Management

- Information on billing costs, check your bill
- Talk to power provider, identify best rate schedule, incentive funding, problem solving, audit programs
- Identify where energy is going-collect data- suitcase
- Ask what if questions about each piece of equipment
- Bring help from outside for expertise
- Make burgers out of sacred cows (change the way of doing)
- Find an Energy Champion(s)
- Invest in a management system
- Think private
- Just DO It, implement

Finding Energy Conservation Measures

- (ECM that effects WW treatment quality may not be well received “Risk Mgt.”)
- Is the power necessary? (Turn lights out, heat down, Hot water set points)
- Can the on time be changed and task will still be accomplished? (Is there a load shift to off peak demand opportunity here?)
- Is the size appropriate? Over sizing is the name of the game. Measure actual power required - Bio fans
- Is the load variable? (Timer, Frequency drive)
- Does a change require human interface? Increase labor cost, training, behavior management

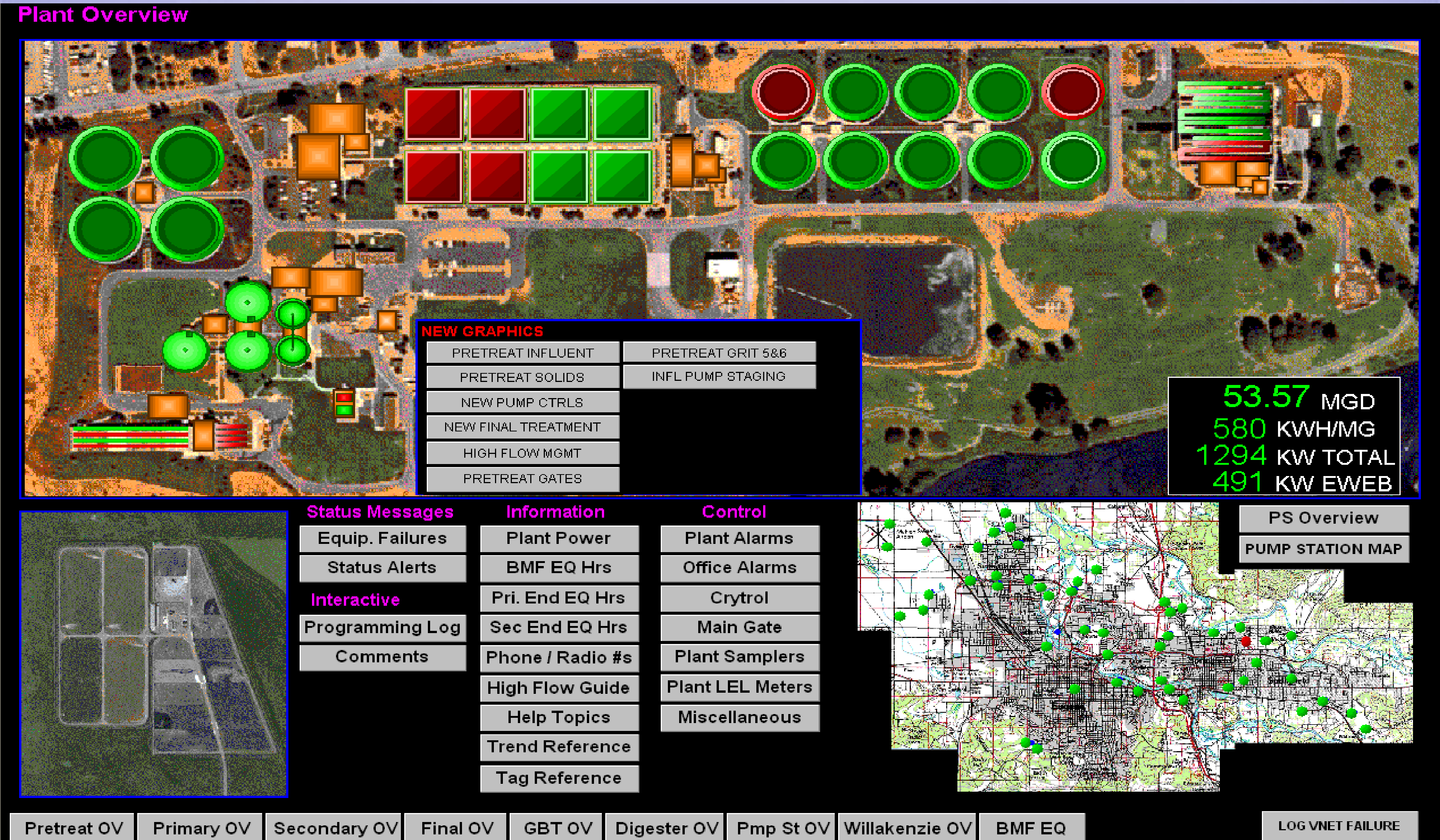
ECM that require a human interface to achieve requires training until you get it right.

Don't just act- communicate

Keep looking for a better best practice:

Plan
Do
Check
Act (Adjust)

Energy Conservation Measures (ECM)



Green = on / run

Red = off / stop

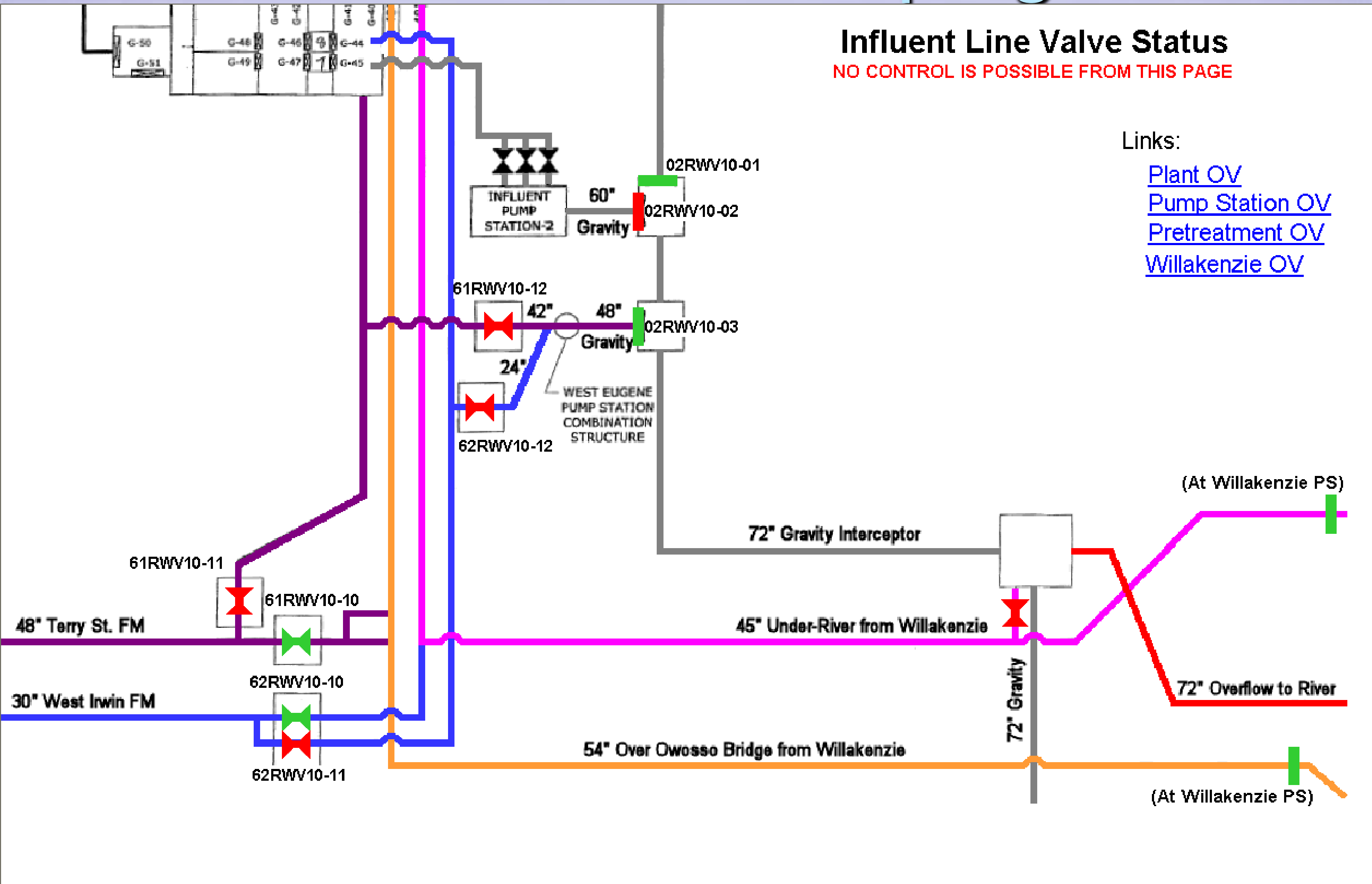
Design Review
/ Equipment Replacement

- Clear expectations/ specifications
- Outside review

Think out of the box

- Many ECM require a design change- be proactive
- Get design engineer to explain over design criteria used?
- Is equipment choice correct? i.e. Do pumps down stream of fine screens or grinders need to be open face impellers?
- Apply payback policy guidelines

Redundant Pumping



6/7/2010 12:31
COPY
OPC DataBase Equalize Complete
GR0006 Power analysis
Plant Power Usage
Current Power Usage
1000 KW
500 KW
Pre 188
Pri 30
Sec 749
Fin 131
GBT 52
Dig 106
Short-term Power Trend
11:30 11:45 12:00 12:15 12:
Long-term Power Trend
20:01 00:01 04:01 08:01 12:0
Pretreat
188 KW
Primary
30 KW
Secondary
749 KW
Final
131 KW
GBT
52 KW
Digester
106 KW
EWEB
669 KW
Power Fact.
0.800 KW
Pretreat OV
Primary OV
Secondary OV
Final OV
GBT OV
Digester OV
PMPST OV
Willakenzie
Plant Alarms
Crytrol
Plant LEL Meters
Main Gate
Plant Samplers
Equip. Failures
BMF / CWF
Ready

Power Distribution

Process Area	% Power	KWH/LB cBOD removed
Pretreatment	20%	NA
Primary	4%	0.17 KWH
Secondary	51%	1.19 KWH
Final	15%	
GBT	4%	
Digestion	6%	

Before 23 MGD 10% removal TSS
After 45 MGD > 50% removal TSS
Annual 25.5% improved capture
Annual 746,250 KWH

Energy Conservation Measures

- Audit reclaim water usage.
- lower volume & pressure
- Timers on sprays
- easy adjustment >>>>>>>>>>>>>>>>>
- booster pumps to increase psi where needed
- use nozzles, not open hose
- ask why it is on- adjust for need
- excessive cooling water
- increase pressure to do the work and turn back down when finished

Seal Water 10PSI
over discharge pressure
Electric solenoid

Changing final chemicals:
Reduced reclaim water usage for injectors saves 85,000 KWH and $5,270 annually. $13K incentive

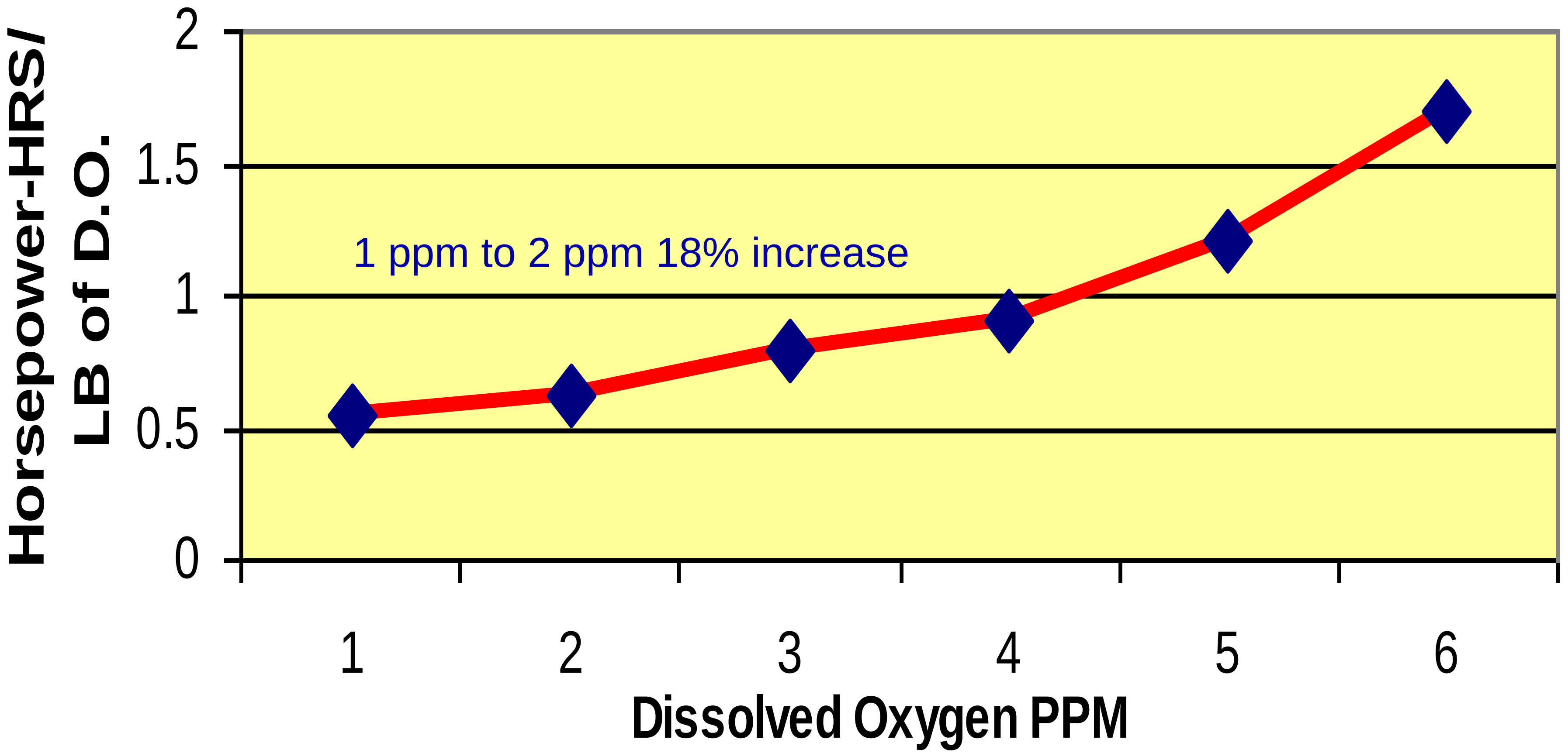
Grit cyclone overflow water used to operate screening sluice.

Reduces W2 use 20-25 HP or $7,000/year

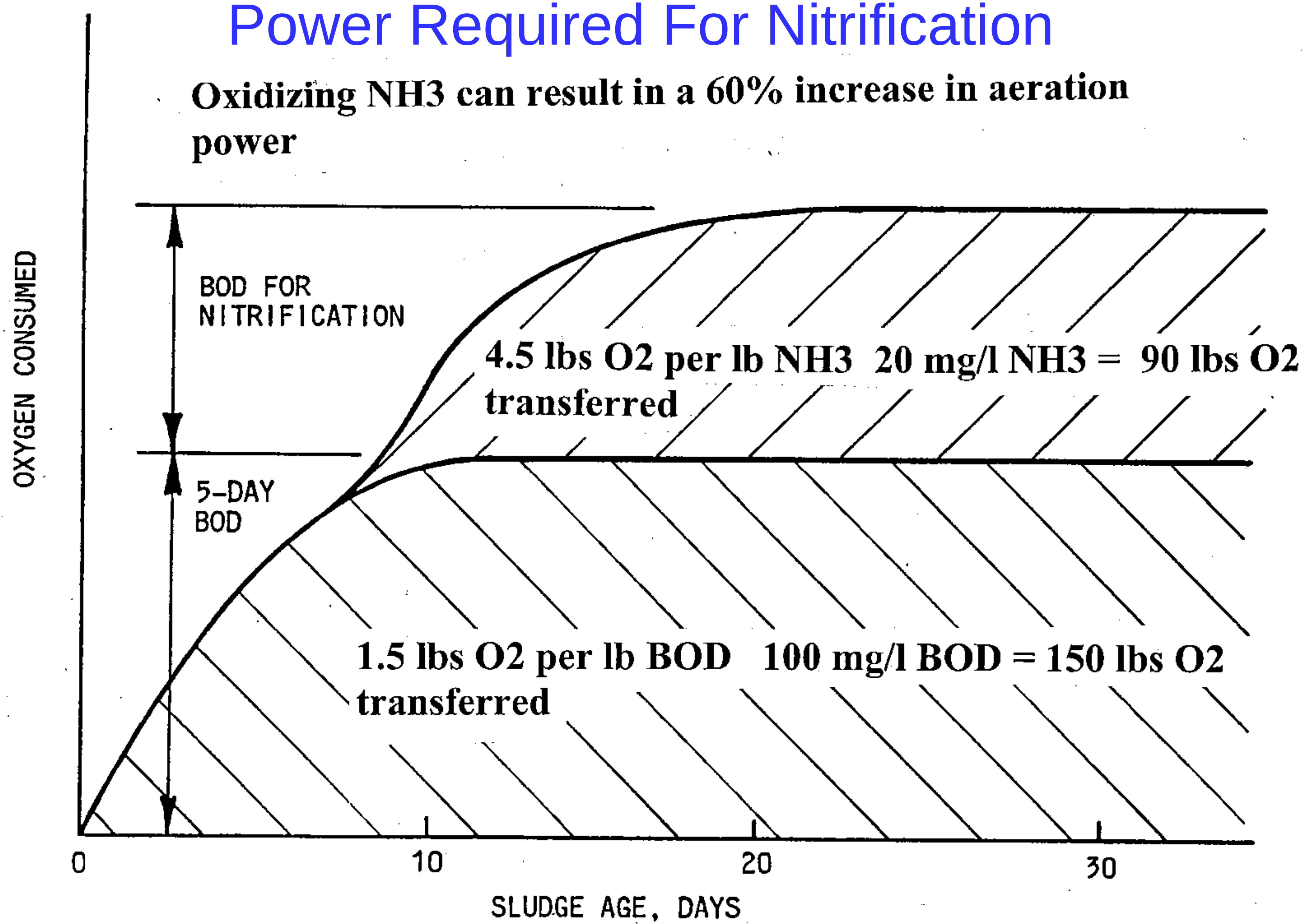
Aeration

- Automate D.O. control (25-40% savings)
- Lower header discharge pressure. We save 50KW per psi. ($20,000 per year)
- Clip blower maximum output
- Clean intake filters
- For centrifugal blowers, use inlet valve to throttle.
- Positive displacement, VFD, sheaves, timers
- Switch to smaller blower during low demand- Timers
- Mechanical – depth, timer, speed
- Motors < 25 HP turn down 66% load, > 25 HP 50%
- Fine bubble diffusers (save 50% or more)

Power Requirements as function of MLSS Dissolved Oxygen



Power Required For Nitrification

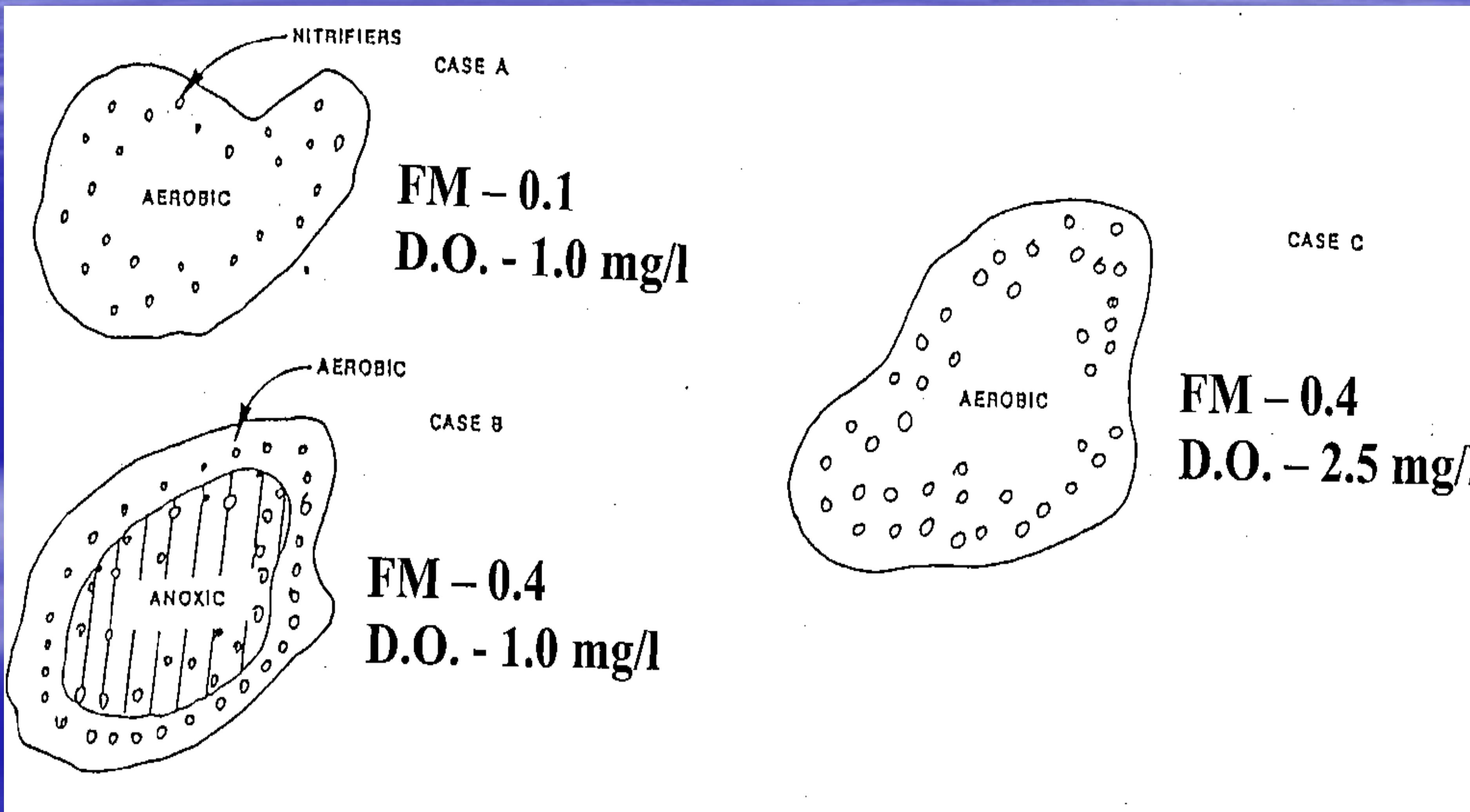


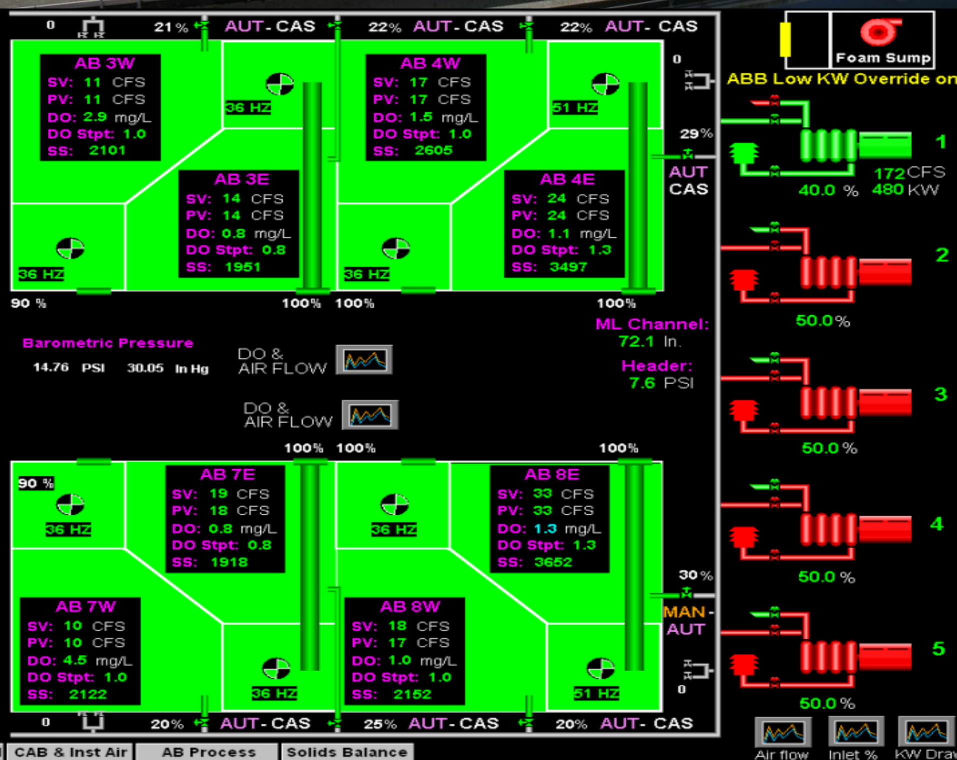
No ammonia limit- shut blower off a couple of hours each day- 8% savings

Nritrifiers are strict aerobes

Chlorine demand 5:1

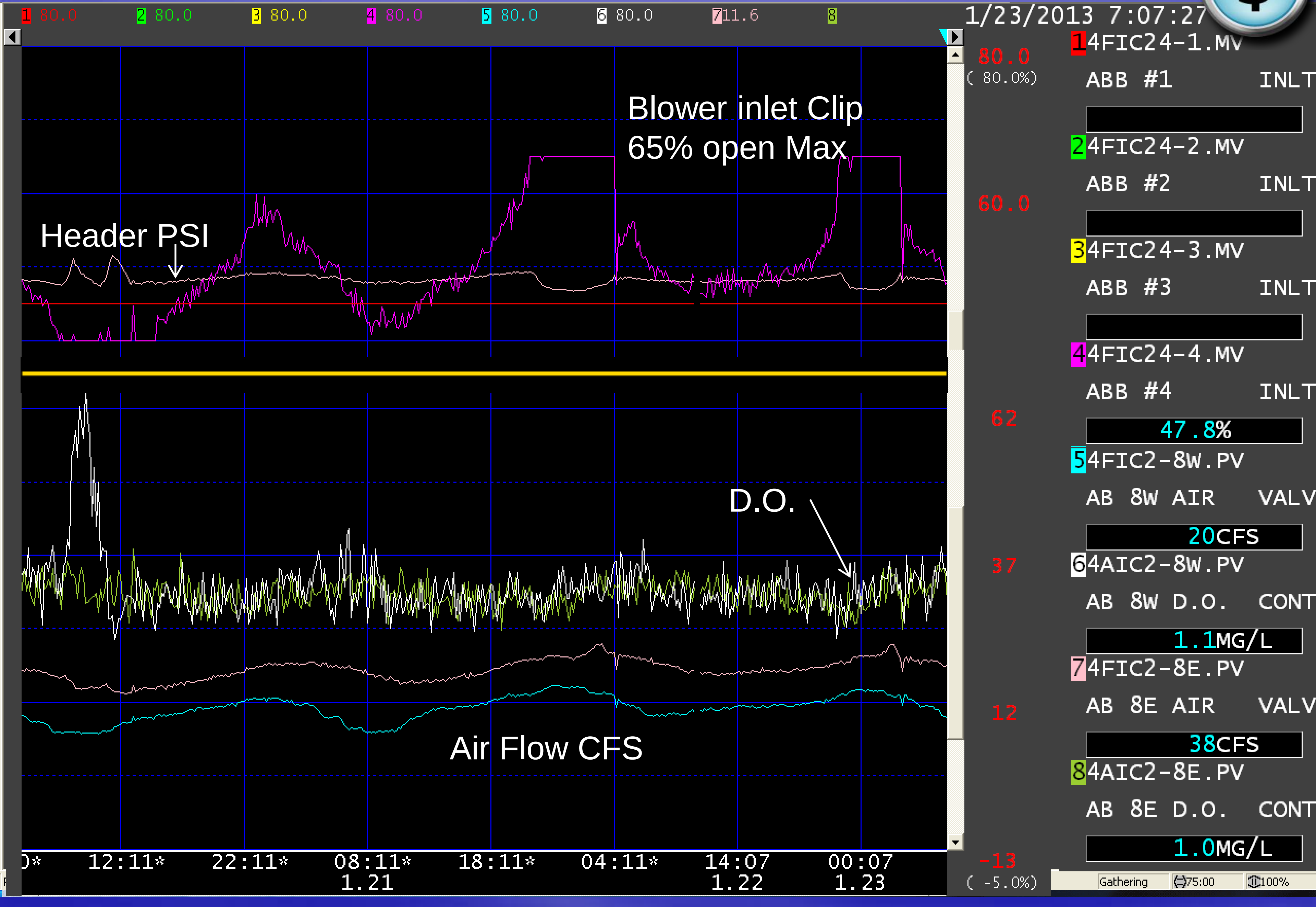
DO Concentration in relation to SRT




21 % AUT- CAS
22% AUT- CAS
22% AUT- CAS
AB 3W
SV: 11 CFS
PV: 11 CFS
DO: 2.9 mg/L
DO Stpt: 1.0
SS: 2101
AB 4W
SV: 17 CFS
PV: 17 CFS
DO: 1.5 mg/L
DO Stpt: 1.0
SS: 2605
36 HZ
51 HZ
AB 3E
SV: 14 CFS
PV: 14 CFS
DO: 0.8 mg/L
DO Stpt: 0.8
SS: 1951
AB 4E
SV: 24 CFS
PV: 24 CFS
DO: 1.1 mg/L
DO Stpt: 1.3
SS: 3497
29 %
AUT
CAS
90 %
100% 100%
100%
Barometric Pressure
14.76 PSI 30.05 In Hg
DO &
AIR FLOW
ML Channel:
72.1 In.
Header:
7.6 PSI
DO &
AIR FLOW
100% 100%
100%
AB 7E
SV: 19 CFS
PV: 18 CFS
DO: 0.8 mg/L
DO Stpt: 0.8
SS: 1918
AB 8E
SV: 33 CFS
PV: 33 CFS
DO: 1.3 mg/L
DO Stpt: 1.3
SS: 3652
AB 7W
SV: 10 CFS
PV: 10 CFS
DO: 4.5 mg/L
DO Stpt: 1.0
SS: 2122
AB 8W
SV: 18 CFS
PV: 17 CFS
DO: 1.0 mg/L
DO Stpt: 1.0
SS: 2152
30 %
MAN -
AUT
20% AUT- CAS
25% AUT- CAS
20% AUT- CAS
CAB & Inst Air
AB Process
Solids Balance
Foam Sump
ABB Low KW Override on
1
172 CFS
40.0 %
480 KW
2
50.0 %
3
50.0 %
4
50.0 %
5
50.0 %
Air flow
Inlet %
KW Draw


4SEL21
BLWR MASTER
MODE SELECT
MAN
NR
MAX VLV
AVG VLV
N. TOP 2
S. TOP 2
AV TOP 4
4PC21
BLOWER
MASTER
AUT
MLO
PV % 43
SV % 55
MV PSI 7.2
4PIC21
AER BSN
HDR PRES
CAS
NR
PV PSI 7.2
SV PSI 7.2
MV SCFS 230.0
4FIC24-1
ABB #1
INLT FLW
CAS
NR
PV SCFS 229
SV SCFS 230
MV % 59.4
4FCV25-1
ABB #1
VNT VLV
MAN NR
NR
PV 0
MV 0
OPEN
CLOSE
4FCV26-1
ABB #1
DIS VLV
MAN NR
NR
PV 2
MV 2
OPEN
CLOSE
4MS20-1
ABB #1
START
MAN NR
NR
PV 2
MV 2
RUN
STOP
8KWOVRD
GEN LOW KW
OVERRIDE
PV
ON
OFF

Clip blower output settings to save energy



Diffuser Cleaning Improves transfer efficiency 10-40%
Aeration zones with higher F/M foul faster

Aeration Paper

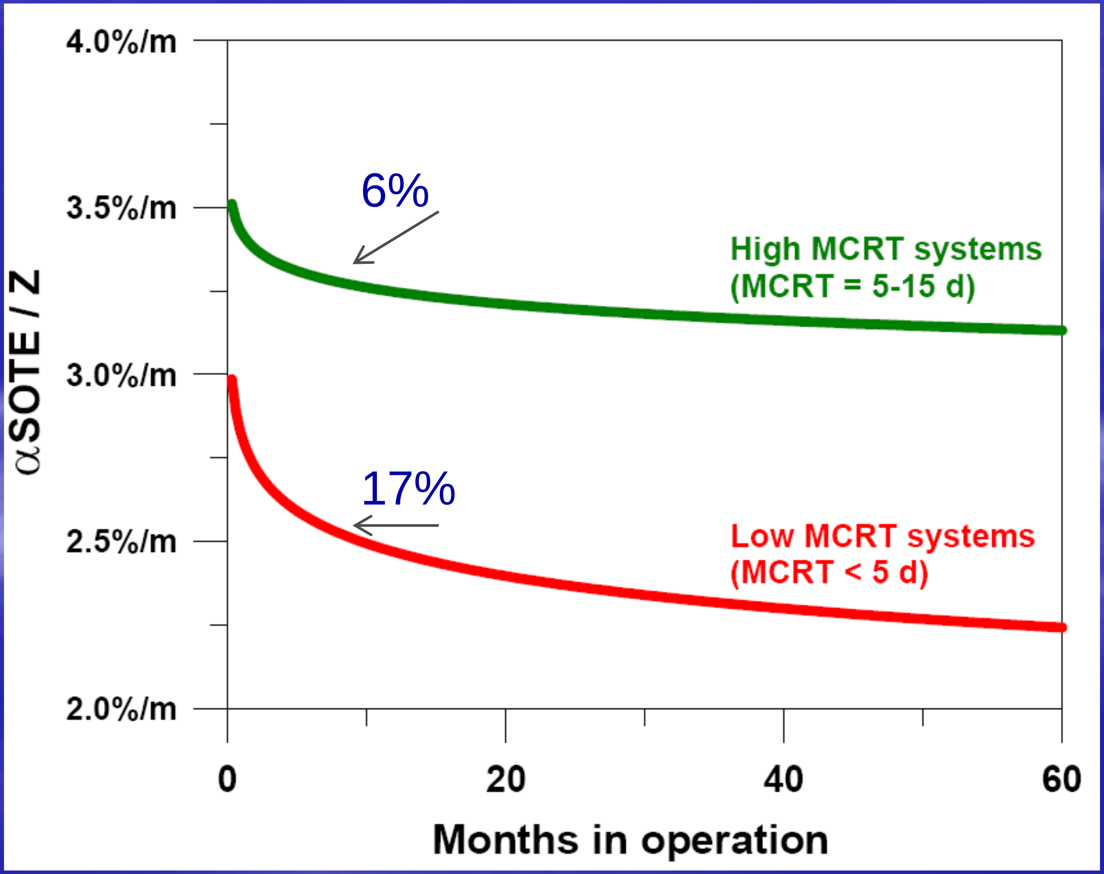
Michael Stenstrom and Diego Rosso

University of California – Los Angeles

University of California – Irvine

Feb 8, 2010

http://www.seas.ucla.edu/stenstro/Aeration.pdf



9%

25%

Turbo Blower

Twin 350 HP Neuros Blower Package

Project cost estimate $1.5 M

Actual $844,118

Incentives $514,612

Net Cost $329,505

Annual Power Savings 2,000,000 KWH

Annual Cost Savings @ $0.062/kwh $124,000

Pay back 2.7 years

Co-Gen 800 KW Induction Generator
~ Supplies 53% of onsite power usage.
Hot water for digester heating, Admin, Maintenance

32% methane production flared

Provider compensation set at KWH $ +$.005 /KWH
2010 production 6,325,065 KWH, $285,893
2011 production 5,613,758 KWH, $264,969
2112 production 5,402,352 KWH, $ 257,692

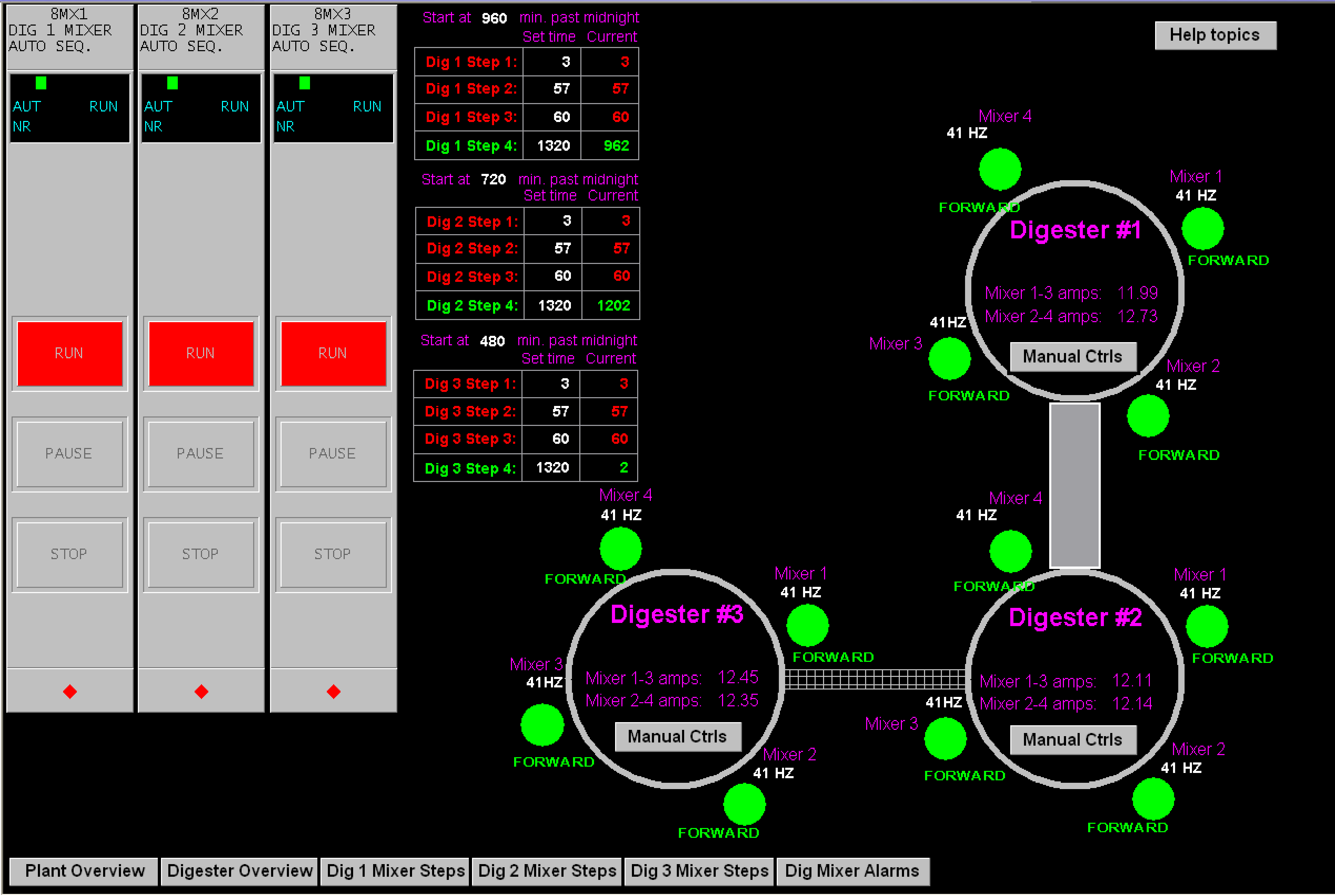
Load Shedding

- Genset fail – drop equal equipment- blower
- Lower return rates
- Reduce/ stop pumping
- Lower D.O. set points
- Reduce channel aeration
- Reduce reclaim water flow / pressure
- Shut blower off for a few hours

$38,000 incentive from provider
One drive runs two mixers.

Saves 250,000 KWH / $15.5K annually
Added project cost $68K

Mixer Energy Conservation SCADA Control



Maximum Motor Starts per Hour

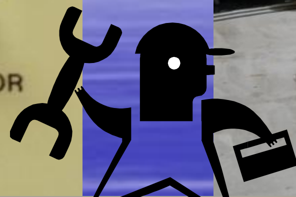
Motor Size HP	Max Starts per Hour	Minimum Off Time- Seconds
5	16	42
10	12.5	46
25	8.8	58
50	6.8	72
100	5.2	110

Motor Stop/Start Added Cost verses continuous run. Motor start is 8X normal run KW. 100 HP motor will add 13 cents per start ($0.05 / kwh). This equals 2.1 minutes of normal run time.

Equipment Rotation

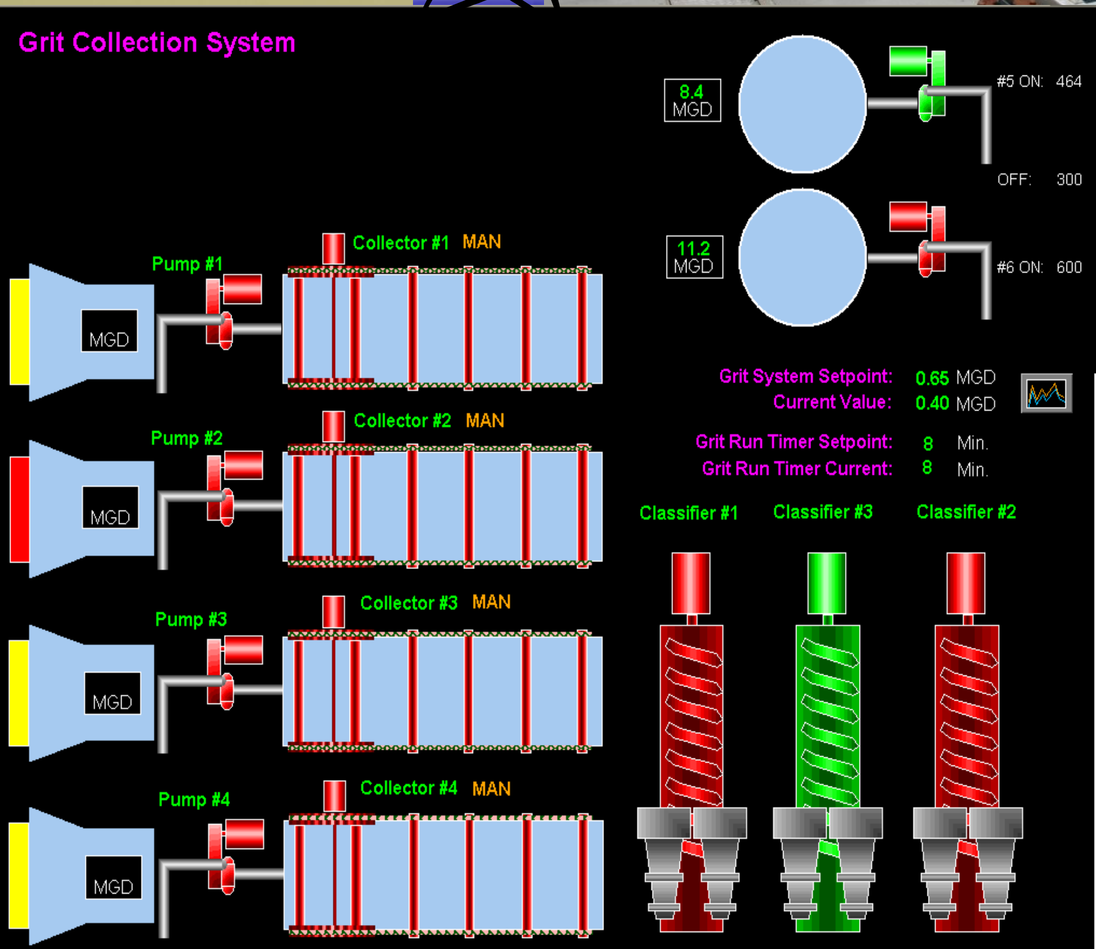
- Stop before you start- save demand charge

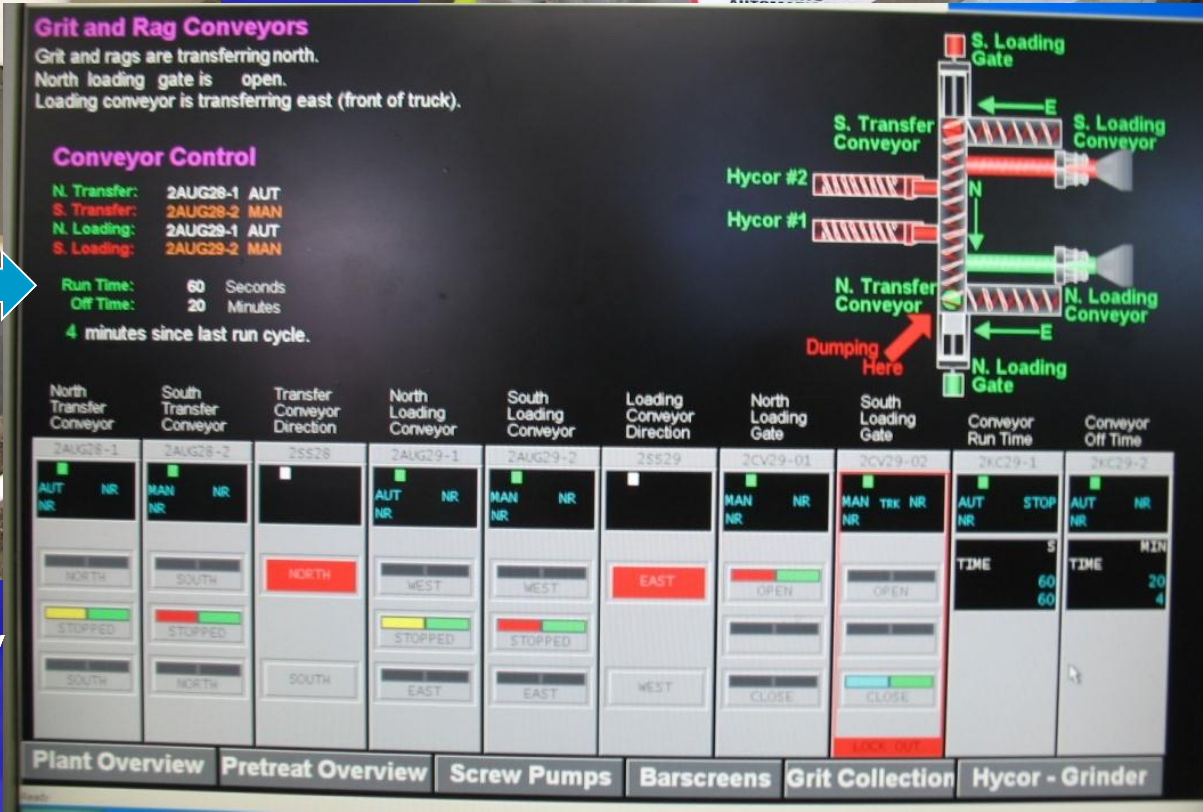
HP	Demand @ $6.25/KW
10	$47
25	$117
50	$233
100	$466
500	$2,331



Demand Charges
100 hp = $466 mo
25 hp = $117/ mo

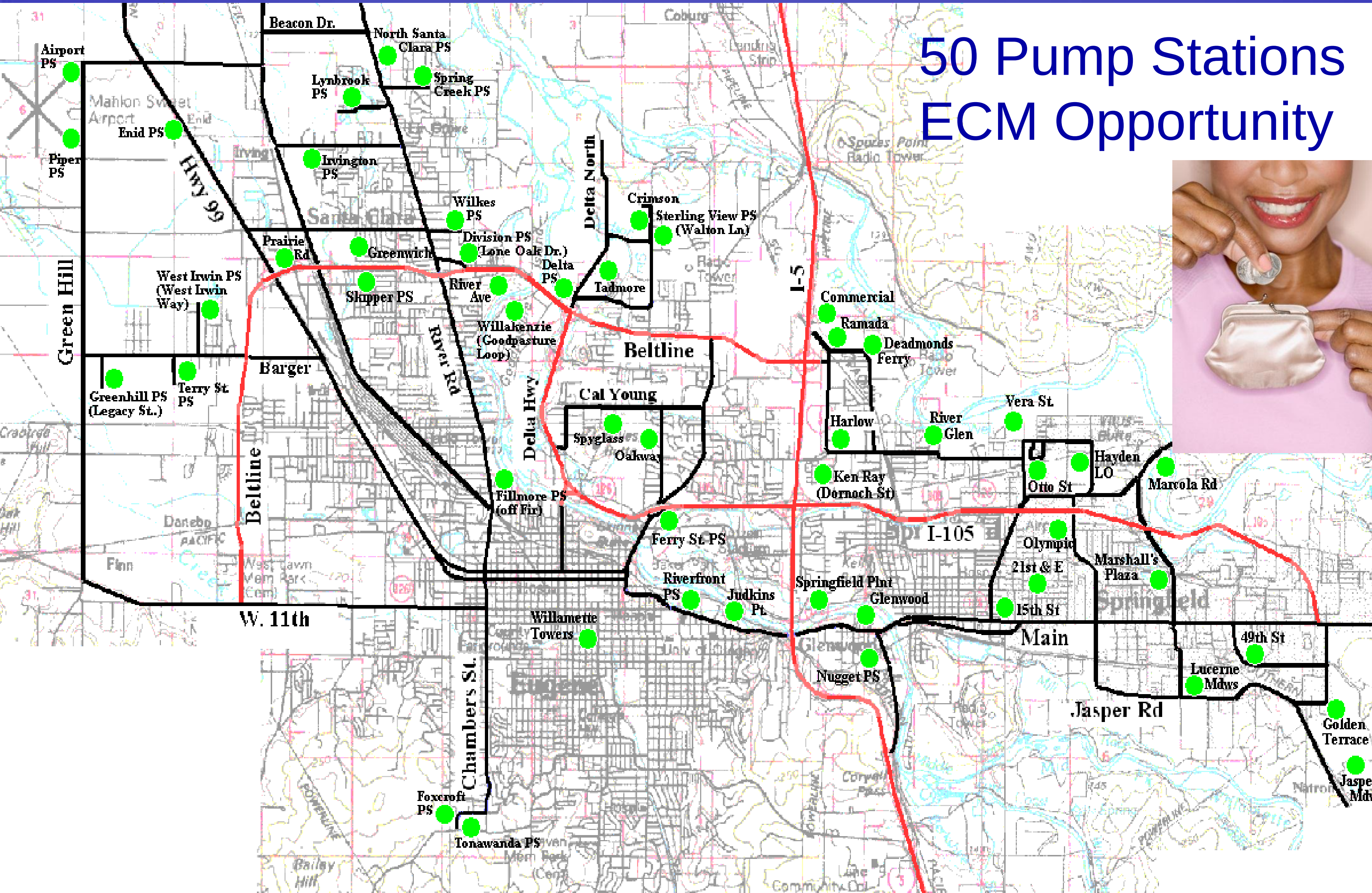
Maintenance savings = big bonus





Timers to adjust run time not only saves power but can be an even bigger savings for maintenance.

50 Pump Stations ECM Opportunity

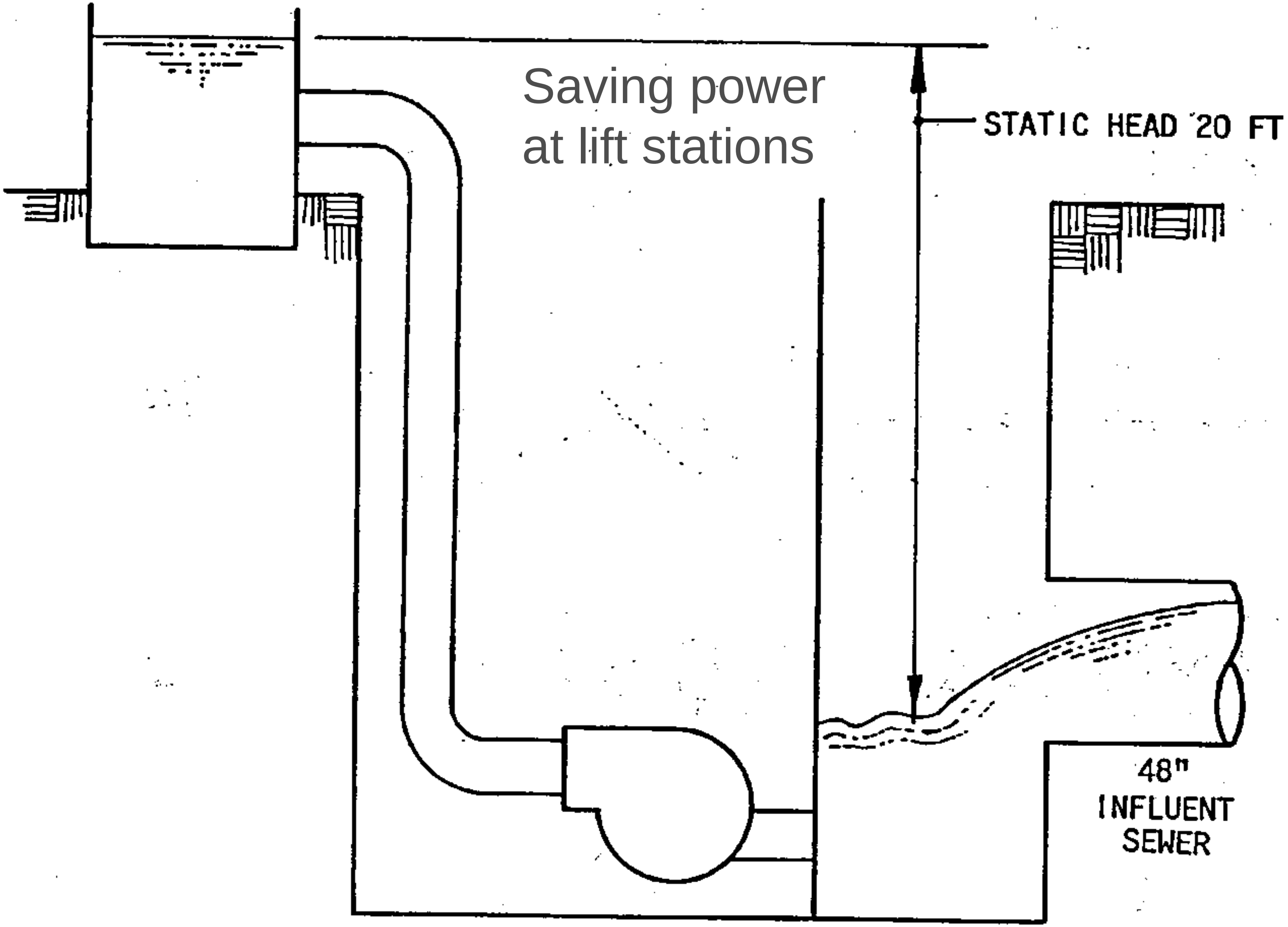


Plant Overview | Pretreat OV | Primary OV | Secondary OV | Final OV | GBT OV | Digester OV | Pmp St OV | Willakenzie OV | PUMPS STATION STATUS

Pumping

- PM pumps/ motors- excessive dirt, alignment, bearing play, motor temp, vibration, seal water, voltage 3.5% diff between legs = 25% temp increase
- Flush Lines (we see 53% savings) (320 gpm to 490 gpm)
- Pump control- Variable speed, timers, start stop points, stager for demand savings (grit pump/collector)
- Determine which pump on a header is most efficient- use it as lead
- Pump Station: KWH/Run Time (station as a whole and individual pumps)

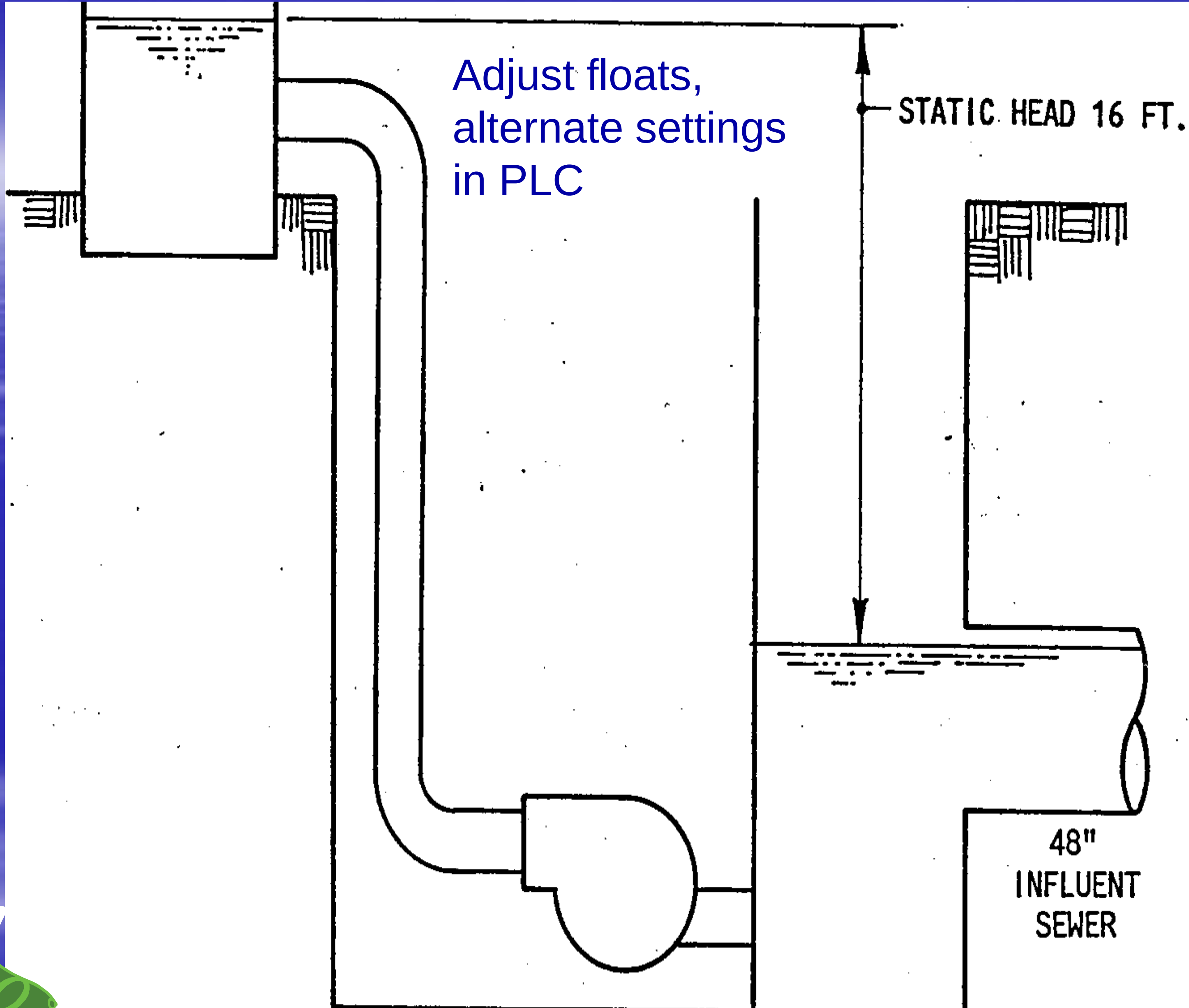
Saving power at lift stations



Horsepower = (Ft of head X GPM) ÷ (3960 X Efficiency)

HP for 1 mgd anoxic recycle pump = (5’X694) ÷ (3960X.90)= .97 HP

Adjust floats, alternate settings in PLC



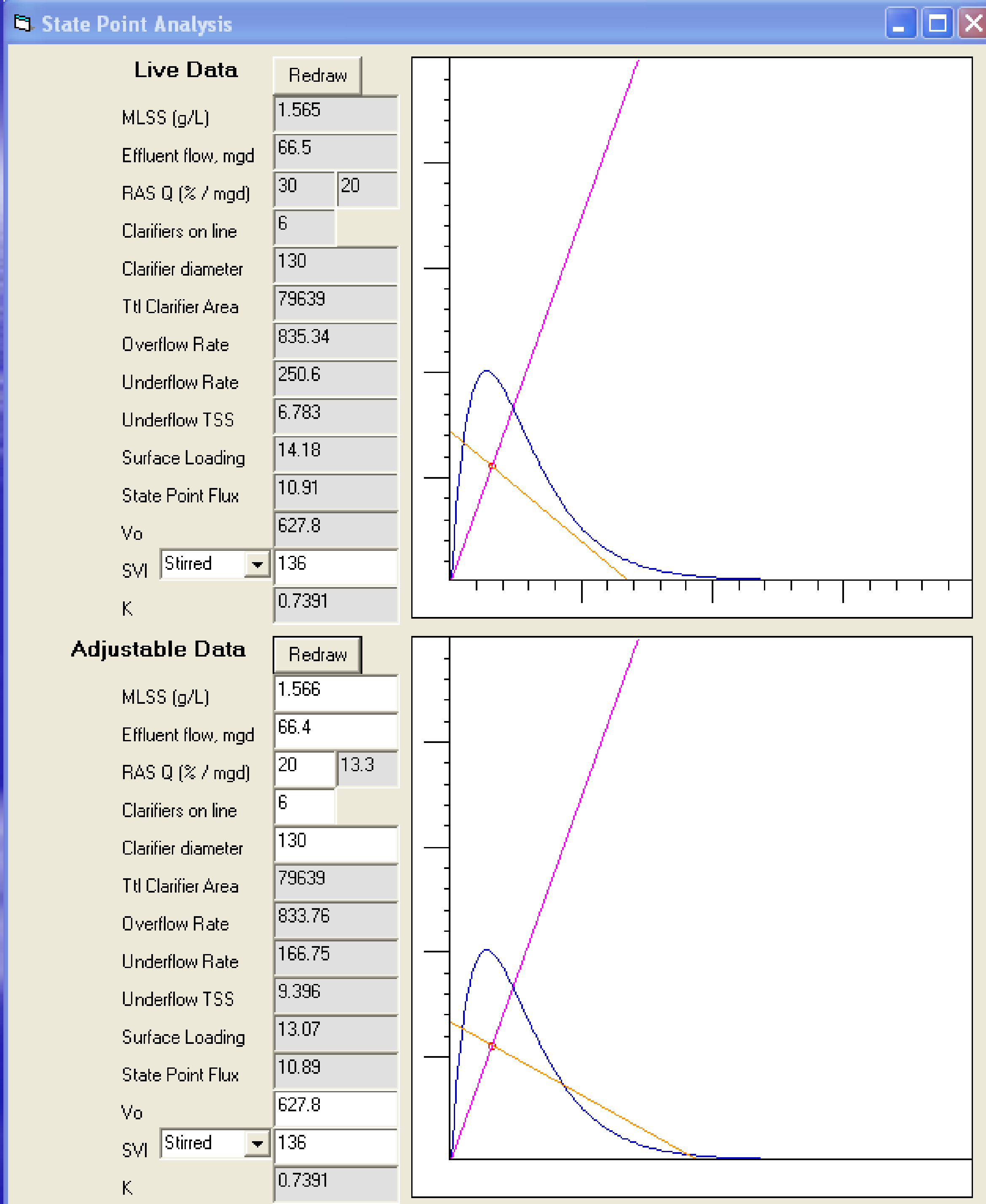
HORSEPOWER SAVINGS AT PEAK FLOW
15 TO 20%

% Return Sludge Rate

MLSS X 100 / ((1,000,000 /SVI) – MLSS)

FY 12 Month	% RSF	KWH Saved	$$ Saved
Jul	33.4	1,547	$91
Aug	31.6	2,936	$173
Sep	35.3	-278	-$16
Oct	30.5	4,114	$243
Nov	31.6	3,857	$228
Dec	31.1	4,692	$277
Jan	28.6	13,757	$812
Feb	29.2	10,103	$596
Mar	25.8	27,941	$1,648
Apr	27.5	16,635	$981
May	27.9	9,091	$555
Jun	29.2	6,617	$404
	Total	101,011	$5,960

Adjusted WW operation from 28' lift to 21' lift = 24% reduction in energy.

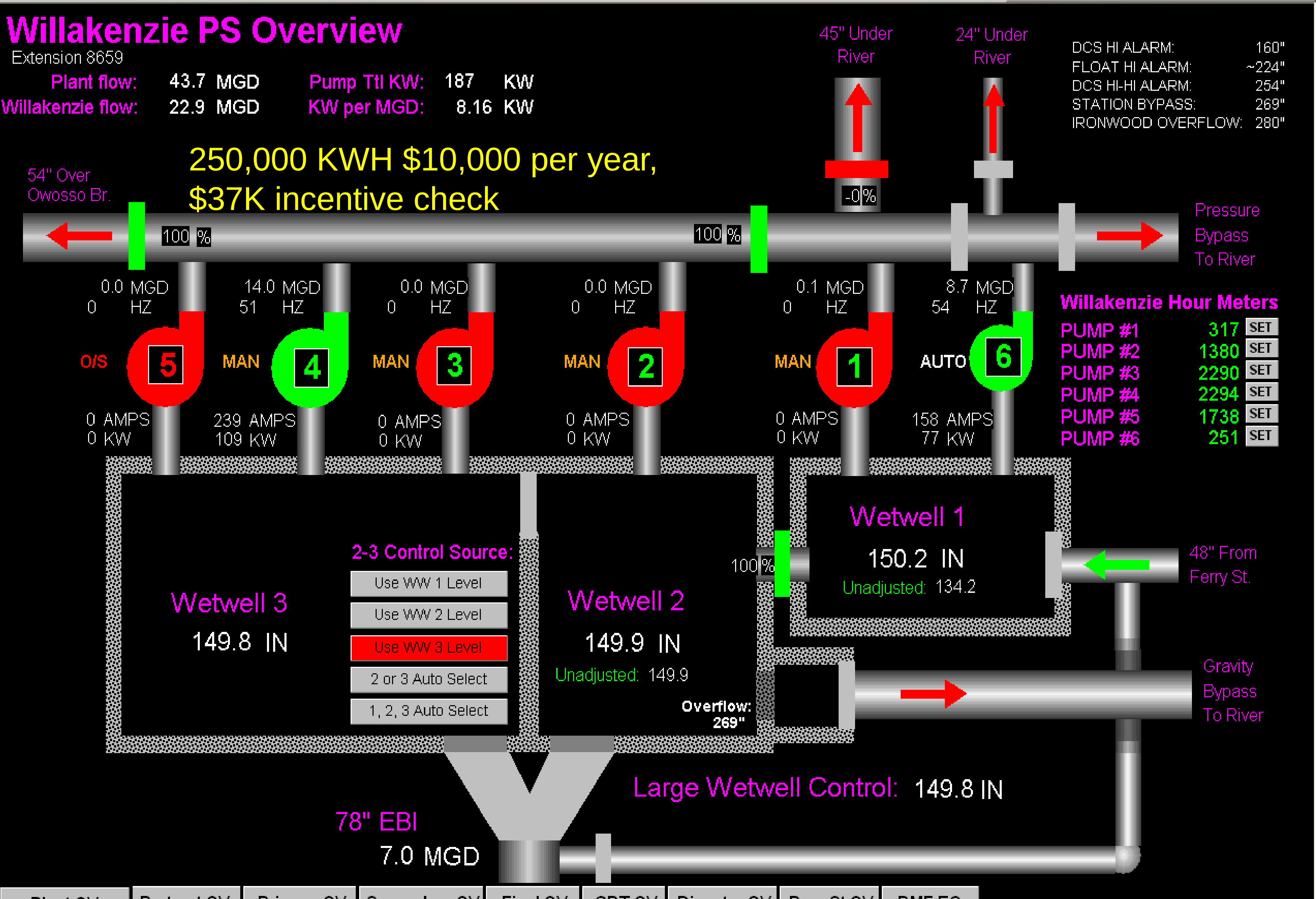


State Pont Analysis

Effected by:
Flow
MLSS concentration
RSF%
Clarifiers online
SVI
Settling velocity

Settleometer Tests to determine safe MLSS concentration that floculates

Design Opportunity + Equipment Replacement



Odorous Air ECM

VFD Control of 100 HP and 50HP Fans
Incentive Savings $80K.
536,000 KWH saved annually.
Air flow 41,000-25,000 cfm

+147K / $8,600

Month	KWH	$$$$$$$
Month	KWH	Cost
Jan-11	77,748	$4,587
Feb-11	70,224	$4,143
Mar-11	76,632	$4,521
Apr-11	43,992	$2,596
May-11	36,582	$2,158
Jun-11	30,643	$1,808
Jul-11	26,085	$1,539
Aug-11	21,866	$1,290
Sep-11	19,087	$1,126
Oct-11	18,459	$1,089
Nov-11	18,310	$1,080
Dec-11	14,910	$880
Jan-12	14,831	$875
Feb- 12	13,857	$818
Mar -12	14,651	$864

- OJ “Turn off lights when not needed”

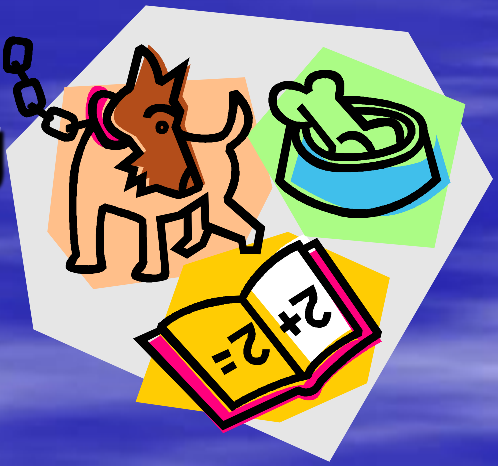
Process area HVAC control

Use Audit program to check settings


CAUTION
THIS EQUIPMENT IS
SUPPLIED BY MORE THAN
ONE POWER SOURCE

LED Street Lighting

- 16 Lights installed @ cost $11,664
- KWH savings 15,067 /yr = $829/yr
- >150,000 hour lamp life
- $320 year maintenance saving
- Incentive $6,757
- Simple pay back 4.3 yrs



Item	Year	Description	Annual kWh Savings	Utility Incentive	Project Cost	Annual Savings*	Savings to Date
		Energy Conservation Projects					
A	1996	Replace coarse diffusers with fine bubble	1,100,000	$ 126,128	$ 310,467	$ 68,200	$ 935,000
B	1997	Lighting retrofit from T12 to T8, motion sensors.	173,600	$ 16,580	$ 24,110	$ 10,763	$ 140,963
C	1997	Cogen engine upgrade	2,102,400	$ -	$ 652,000	$ 130,349	$ 1,707,149
D	1997	W2 pump VFD	221,146	$ 33,418	$ 100,000	$ 13,711	$ 179,571
E	1998	RAS pump VFD	225,590	$ 33,839	$ 416,763	$ 13,987	$ 174,268
F	2001	Reduce size and improve efficiency of biofilter fan motors.	15,768	$ 3,154	$ 3,932	$ 978	$ 10,170
G	2003	Instrument air inter-tie	17,000	$ 2,550	$ 8,009	$ 1,054	$ 9,393
H	2005	Reduce size and improve efficiency of recycle pump.	52,453	$ 3,784	$ 25,000	$ 3,252	$ 23,814
I	2005	Rebuild screw pump drives (motor, gearbox, coupler) and trough.	100,000	$ 15,000	$ 100,000	$ 6,200	$ 45,400
J	2006	Mechanical mixers on digesters replace gas mixing.	250,000	$ 38,000	$ 68,000	$ 15,500	$ 100,625
K	2006	Add VFD and improve efficiency of biosolids irrigation pumps.	122,000	$ 18,300	$ 60,000	$ 7,564	$ 49,105
L	2007	Add VFDs and improve efficiency of aeration mixers.	48,000	$ 7,200	$ 103,000	$ 2,976	$ 16,776
M	2008	Primary solids removal 25.5% improvement	746,250	$ -	$ 224,000	$ 46,268	$ 220,144
N	2009	LED street lighting	15,067	$ 6,757	$ 11,664	$ 934	$ 3,601
O	2009	Cyclone overflow for sluice water.	53,044	$ 16,000	$ 10,000	$ 3,289	$ 12,678
P	2009	Willakenzie pump station and force main rehab.	250,000	$ 37,500	$ 150,000	$ 15,500	$ 59,750
Q	2009	Dissinfect with neat solution, not W2 carrier water.	85,000	$ 12,750	$ 50,000	$ 5,270	$ 20,315
R	2009	Add VFDs, dampers, and pressure sensors on odorous air fans.	950,000	$ 80,417	$ 107,000	$ 58,900	$ 227,050
S	2010	Non-aerated grit removal	199,494	$ -	$ -	$ 12,369	$ 36,208
T	2012	DO control of pretreatment channel blowers.	70,000	$ 7,000	$ 10,000	$ 4,340	$ 4,340
U	2012	Acid clean force main (5.5 miles) to lagoon	31,000		$ 10,000	$ 1,922	$ 1,922
V	2013	Replace multi-stage blower with turbo blower.	2,000,000	$ 500,000	$ 850,000	$ 124,000	$ -
		TOTAL	**8,827,812**	**$ 958,377**	**$ 3,293,945**	**$ 547,324**	**$ 3,978,241**
		Non-Cost Process Control Improvements					
W	1986	RAS pump wet well setting	144,176	$ -	$ -	$ 8,939	$ 165,442
X	1988	Process DO setpoint	780,000	$ -	$ -	$ 48,360	$ 858,000
Y	1995	Blower Header Pressure control (11%/psi)	390,000	$ -	$ -	$ 24,180	$ 345,735
Z	1997	Grit Pump Timer/Flow Control	216,000	$ -	$ -	$ 13,392	$ 175,392
AA	1998	Lower W2 pressure setpoint	113,872	$ -	$ -	$ 7,060	$ 87,966
BB	2010	Return Sludge Flow %	101,000	$ -	$ -	$ 6,262	$ 18,332
		TOTAL	**1,745,048**	**$ -**	**$ -**	**$ 108,193**	**$ 1,650,867**
		GRAND TOTAL	**10,572,860**	**$ 958,377**	**$ 3,293,945**	**$ 655,517**	**$ 5,629,107**

Summary

- Good operations is energy conscious everyday
- Energy use is a human behavior problem

  (Success is an exercise in human relations)
- As supply deceases, the cost will rise
- "What About Bob"- Richard Dreyfuss & Bill Murray

  Baby Steps, Baby Steps

- Every Watt, every therm, counts
- Best ECMs 1. Engineered 2. Automated 3. Human interface
- Just Do It ! , Implement, implement, implement

What do we do with all the energy saved?

Store power in an electrolyte cell under the base of our signal tower

On July 4th we discharge the savings back to mother earth