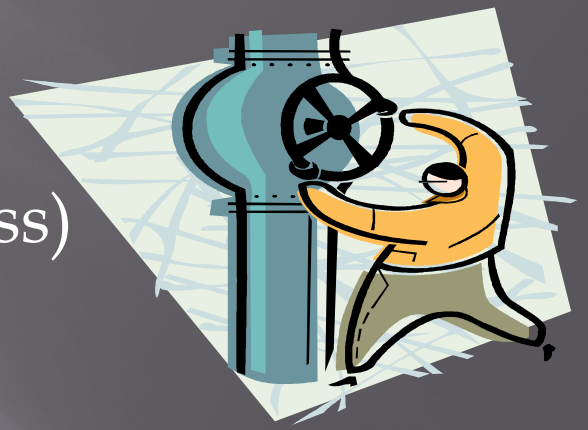
kW Demand

- 10 HP motor runs 15 *minutes* = 7.5 kW demand
- 10 HP motor runs 15 *hours* = 7.5 kW demand
- Two 10 HP motors *alternating* (running one at a time for 15 minutes each) = 7.5 kW Demand
- Two 10 HP motors running *together* for 15 minutes = **15** kW demand

Concurrent Operations

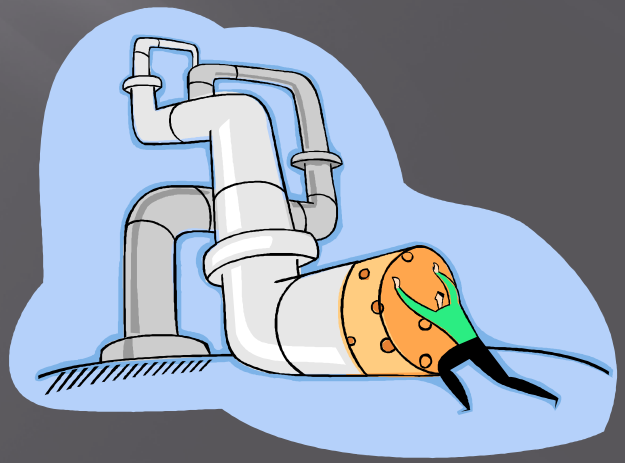
Blower motors, pumps, presses

- Larger horsepower
- Heavy load
- Cumulative processes (belt press)

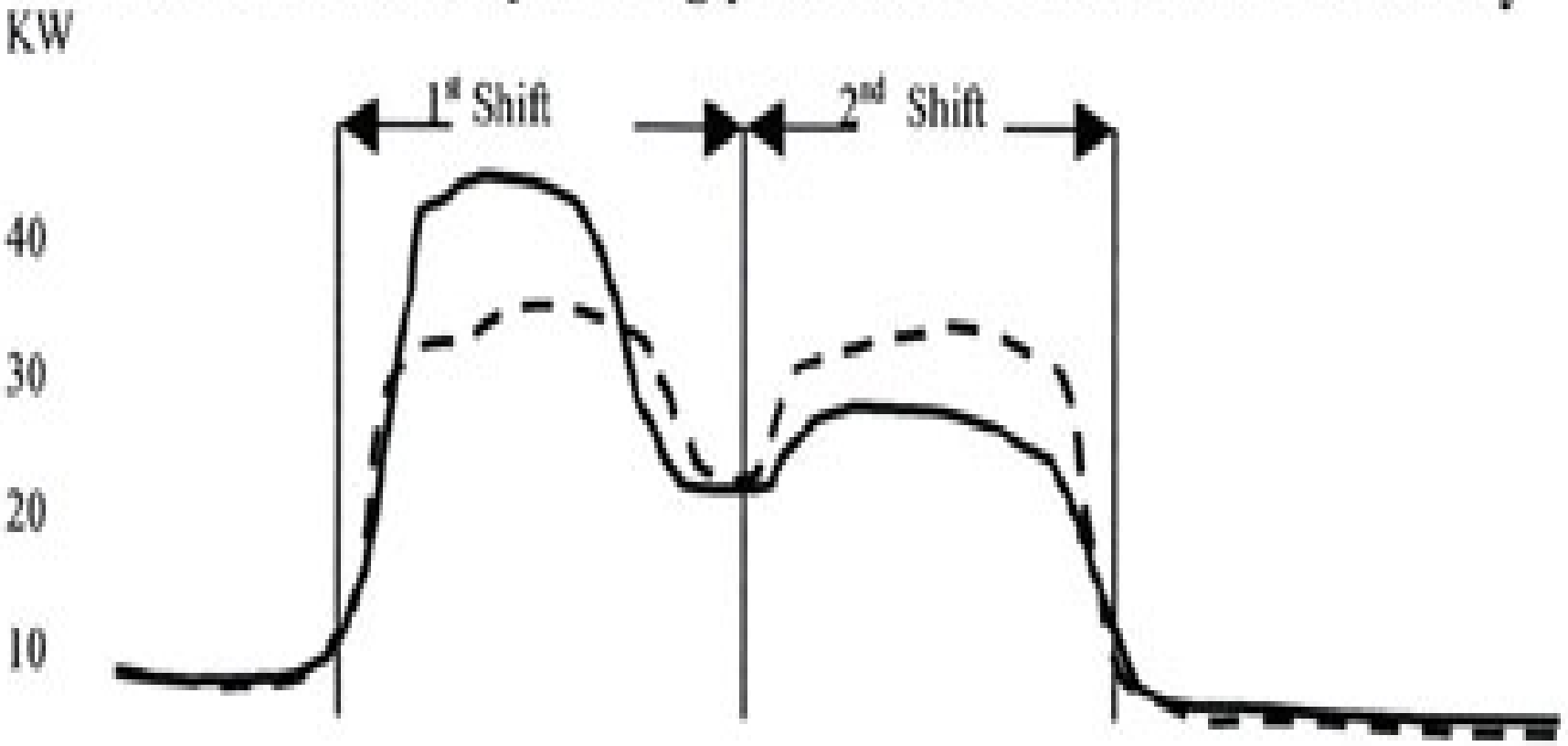


Identify best candidates

- Intermittent operation
- Manually operated



Reduce demand by shifting production to a different time of day



Solid line represents normal demand profile. Dotted line represents lower demand profile that can be obtained by shifting a portion of the electric load from the first shift to the second shift.

Concurrent operations

- Does it need to run 24/7 or at all?
- Does it need to run during the highest rate period of the day?
- Can it run unattended?

KWh Consumption

- 10 HP motor runs 1 hour = 7.5 KWh
- Two 5 HP motors run 1 hour = 7.5 KWh

To be more accurate- 1 HP = 0.746 kW

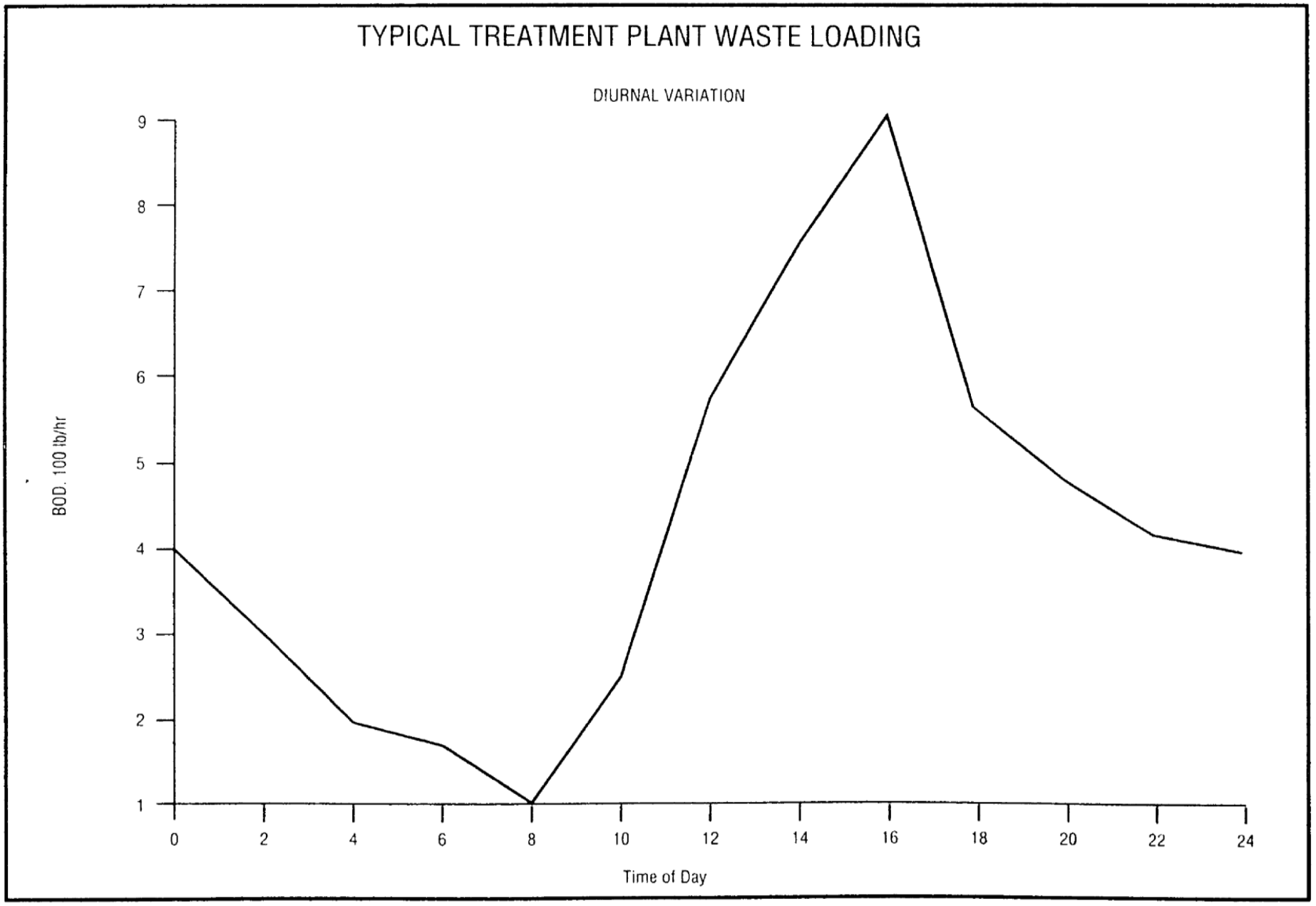


Figure 2. Variation in influent wastewater strength over 24 hours for a typical treatment plant.

ON-OFF AERATION

Do we need 24/7 aeration?

- On-off aeration is common practice
  - Extended air, SBR, Schreiber
  - Wet weather operations
- Usually more air than we need
  - Compare actual vs. design BOD loading
  - Look at process D.O.
  - Look at your effluent numbers

Benefits of on-off aeration

- **Can save $$$**
  - Lower run-hours on big motor
  - Run another motor when air is off
- **Can improve operations**
  - Better settleability & cleaner effluent
  - May reduce sludge production

On/Off Case studies

2.25 MGD Oxidation Ditch

- $1.70/lb BOD down to $1.10

6.0 MGD Conventional w/ coarse bubble

- Reduced chemical costs
- 45% lower costs

De-Nitrification

- Saves Energy
- Reduces Chemical Costs
- Improves Process Control
  - good sludge settling, reduces filamentous organisms
- Reduces Sludge Production
- Better Quality Effluent

De-Nitrification

- Returns 60% of the oxygen required for nitrification
- Returns 50% of the alkalinity consumed

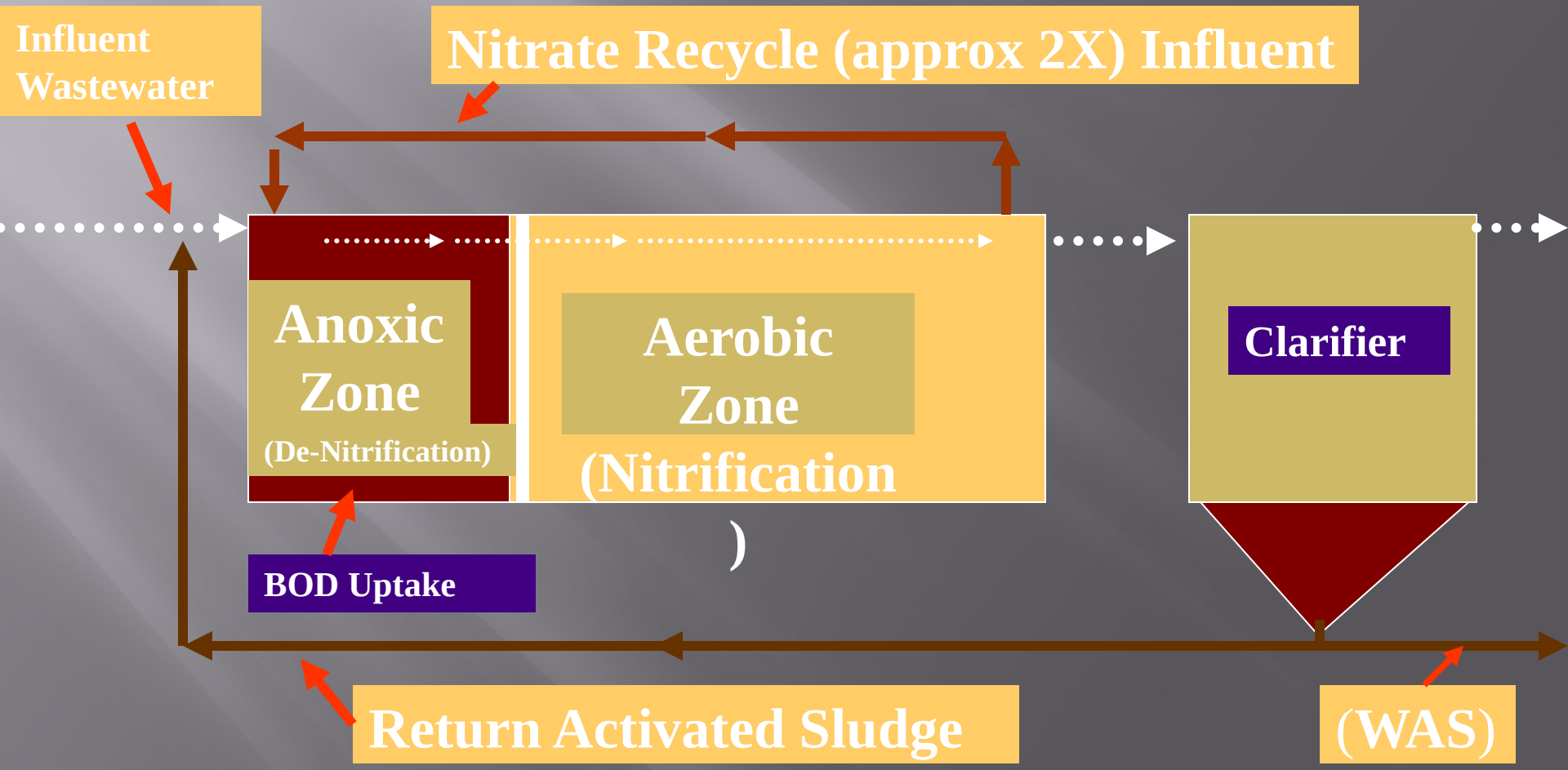
De-Nitrification

- Starves troublesome filamentous organisms
- Better sludge settling characteristics = less solids wash out due to bulking
- Reduces the need to chlorinate RAS

De-Nitrification

- Sludge production drops 5% or more in a system that denitrifies

Typical Layout (MLE)

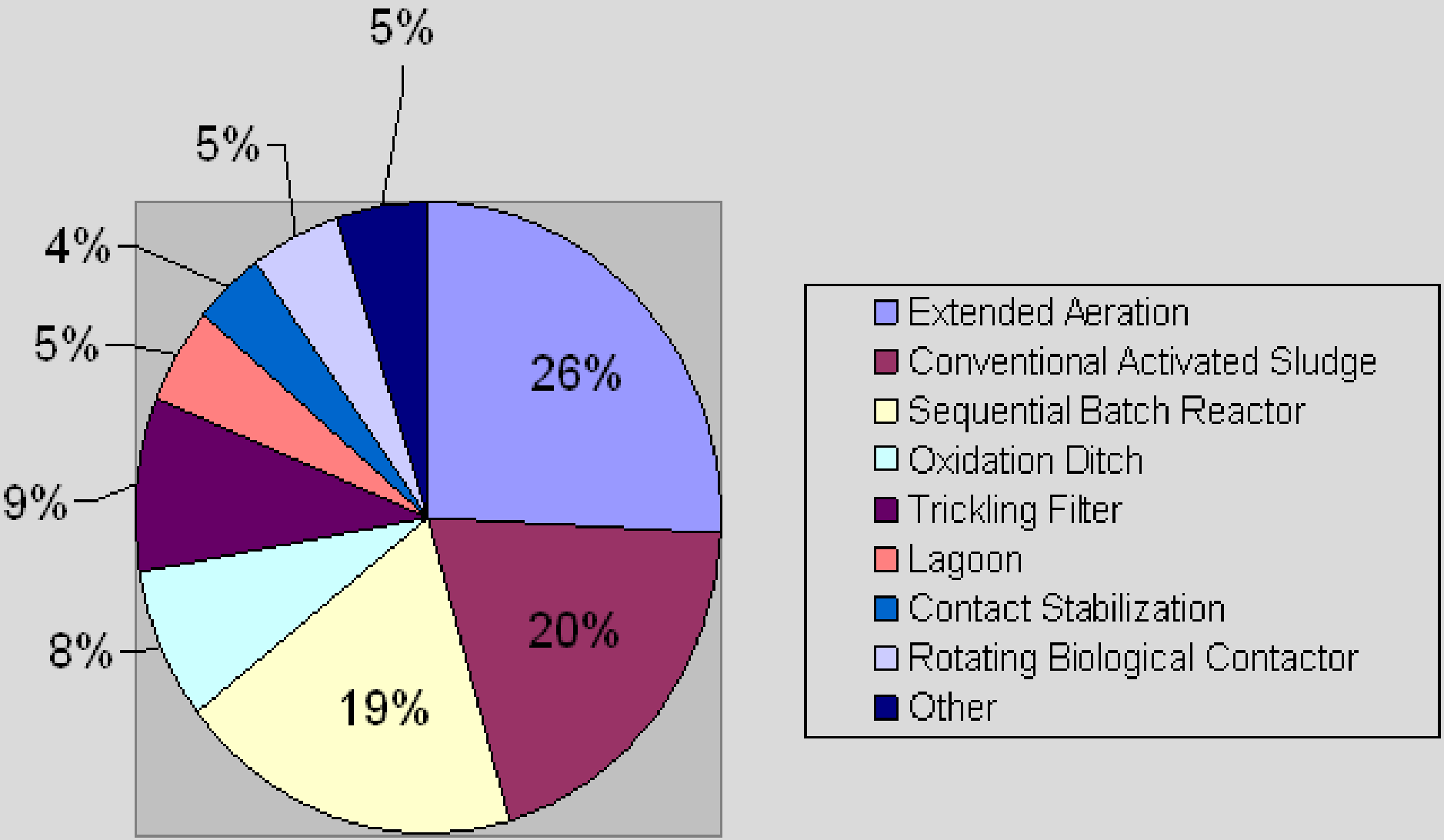


PA Plants

- 1123 Municipal STPs
- Total design flow = 2.3×10^9 GPD
- 7% of plants have 70% of total design flow
- 4 plants have 30% of total design flow

BASELINING

- *Electric Use at PA Sewage Treatment Plants*
  - Report released by DEP in March 2011
  - WWTP Efficiency Baseline calculator
  - Comparisons and categories to fit your plant


5%
5%
4%
5%
9%
8%
26%
20%
19%
Extended Aeration
Conventional Activated Sludge
Sequential Batch Reactor
Oxidation Ditch
Trickling Filter
Lagoon
Contact Stabilization
Rotating Biological Contactor
Other

Energy Use Survey Goals

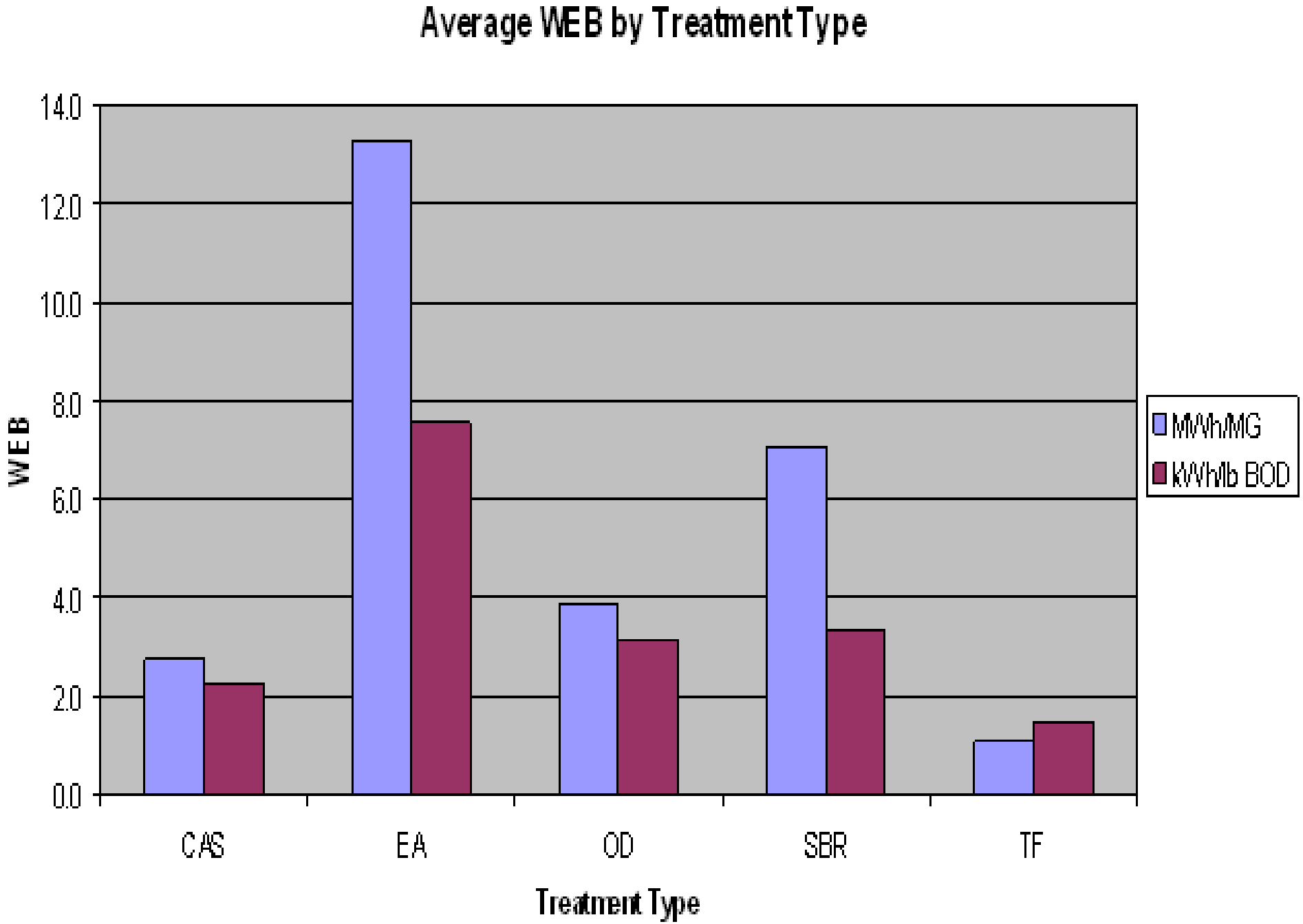
- Collect data from STPs
- Select best parameters for comparisons
- STP uses data to assess efficiency

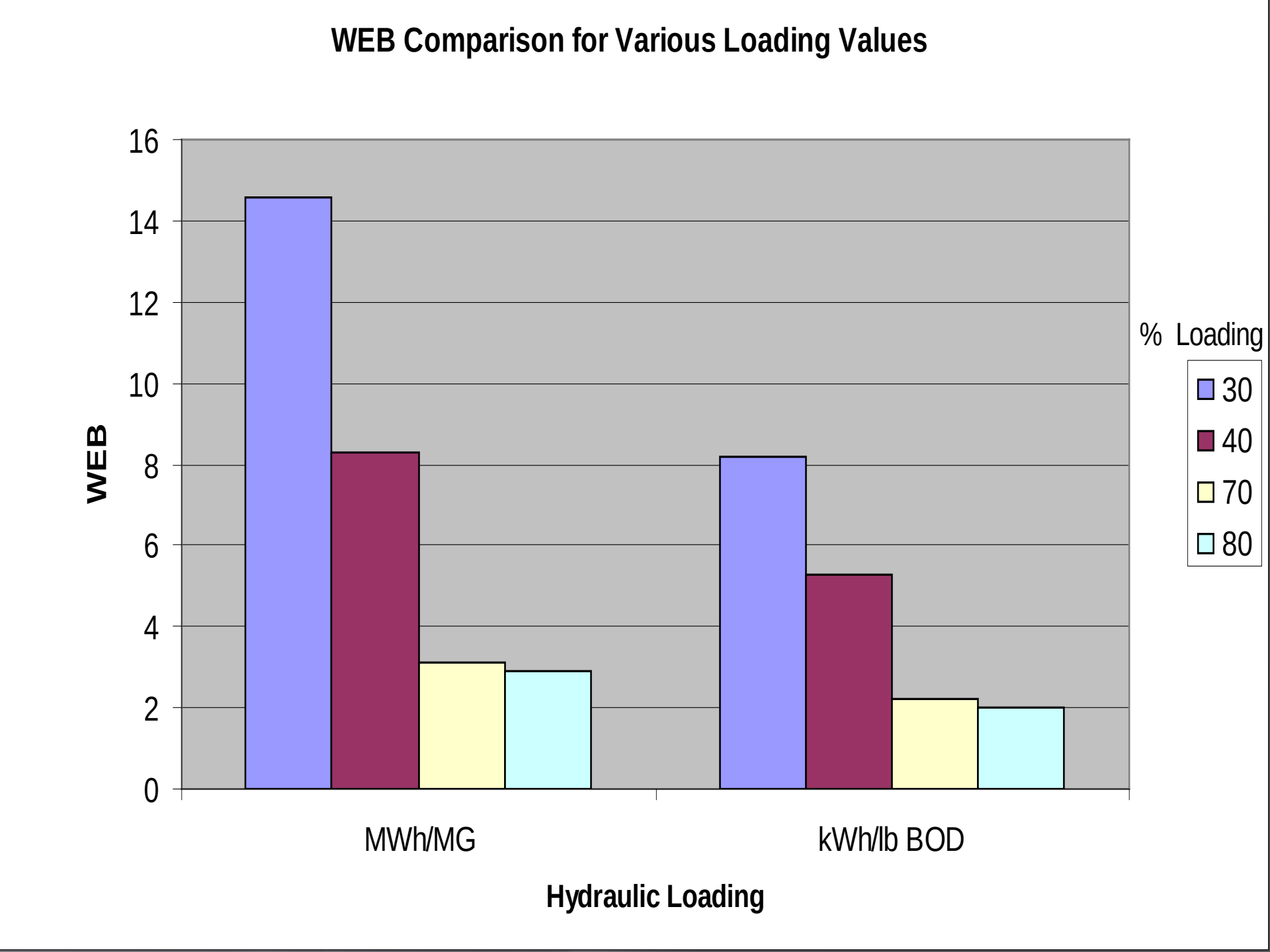
Parameters to Compare

- MWh/MG- energy used per million gallons flow
- KWh/lb BOD- energy used per lb influent BOD
- Treatment type- least vs. most efficient
- % Design load effect on efficiency

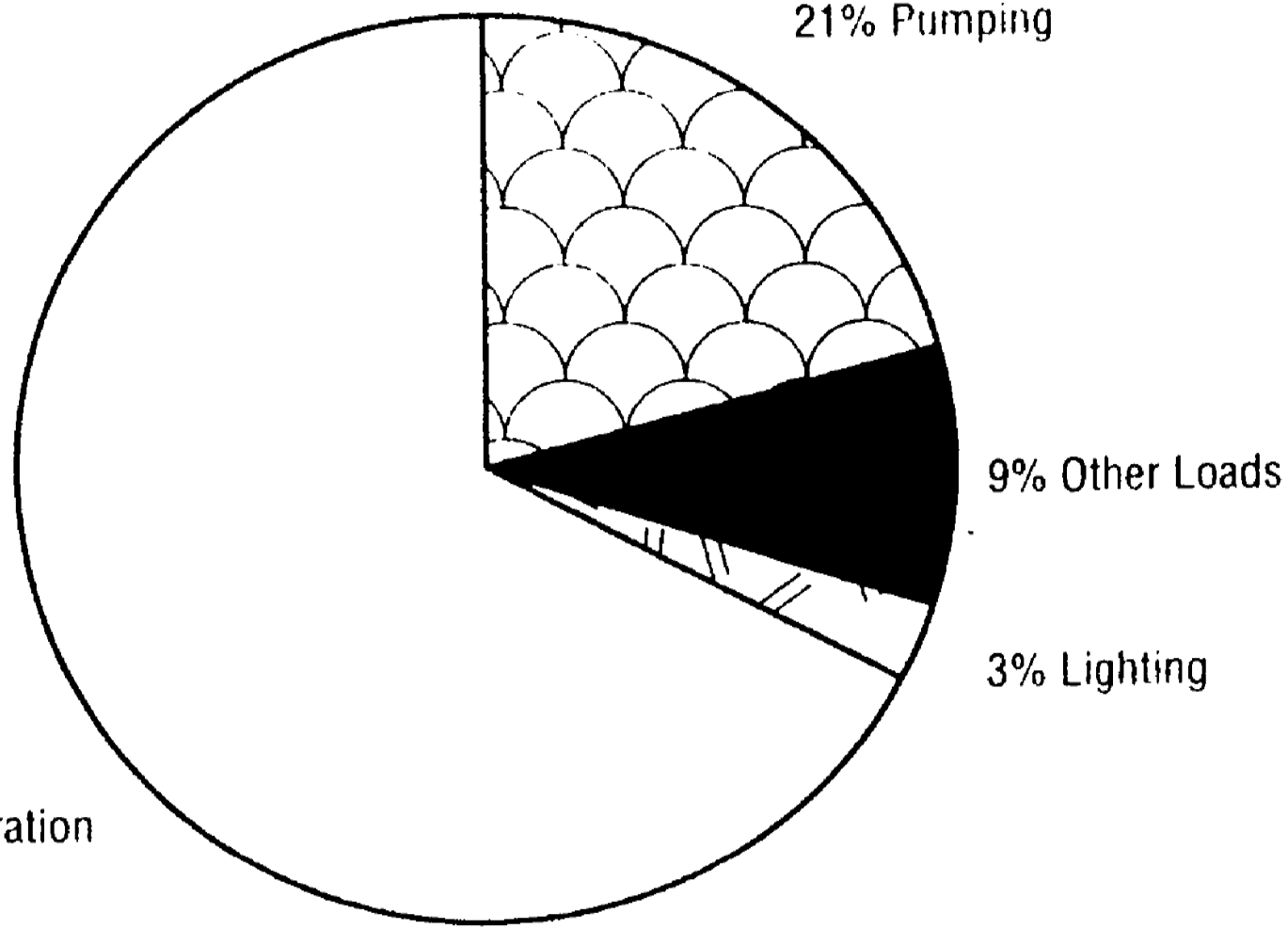
WWTP Efficiency Baseline

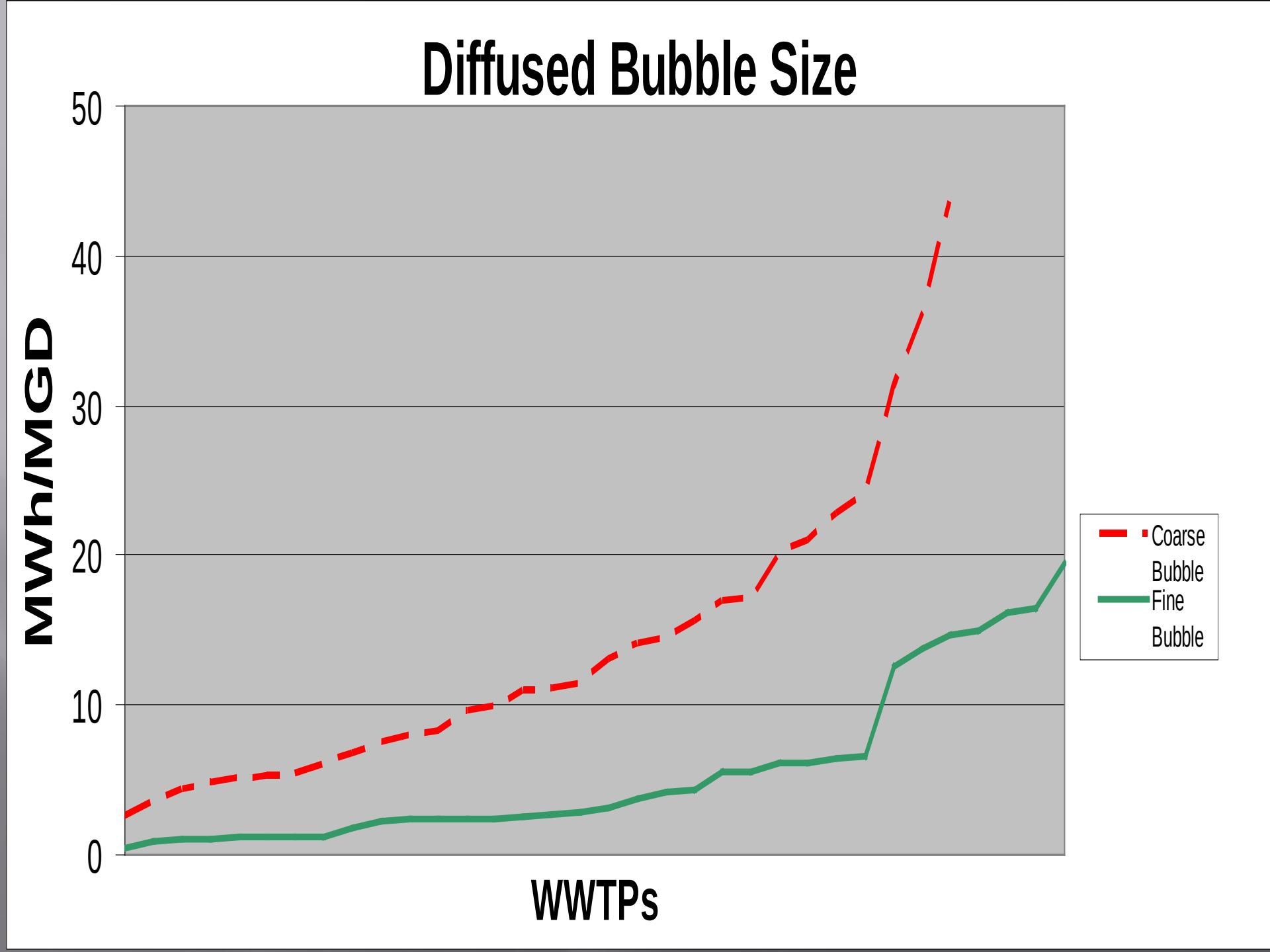
= WEB


Average WEB by Treatment Type
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
WEB
CAS
EA
OD
SBR
TF
Treatment Type
MWh/MG
kWh/lb BOD

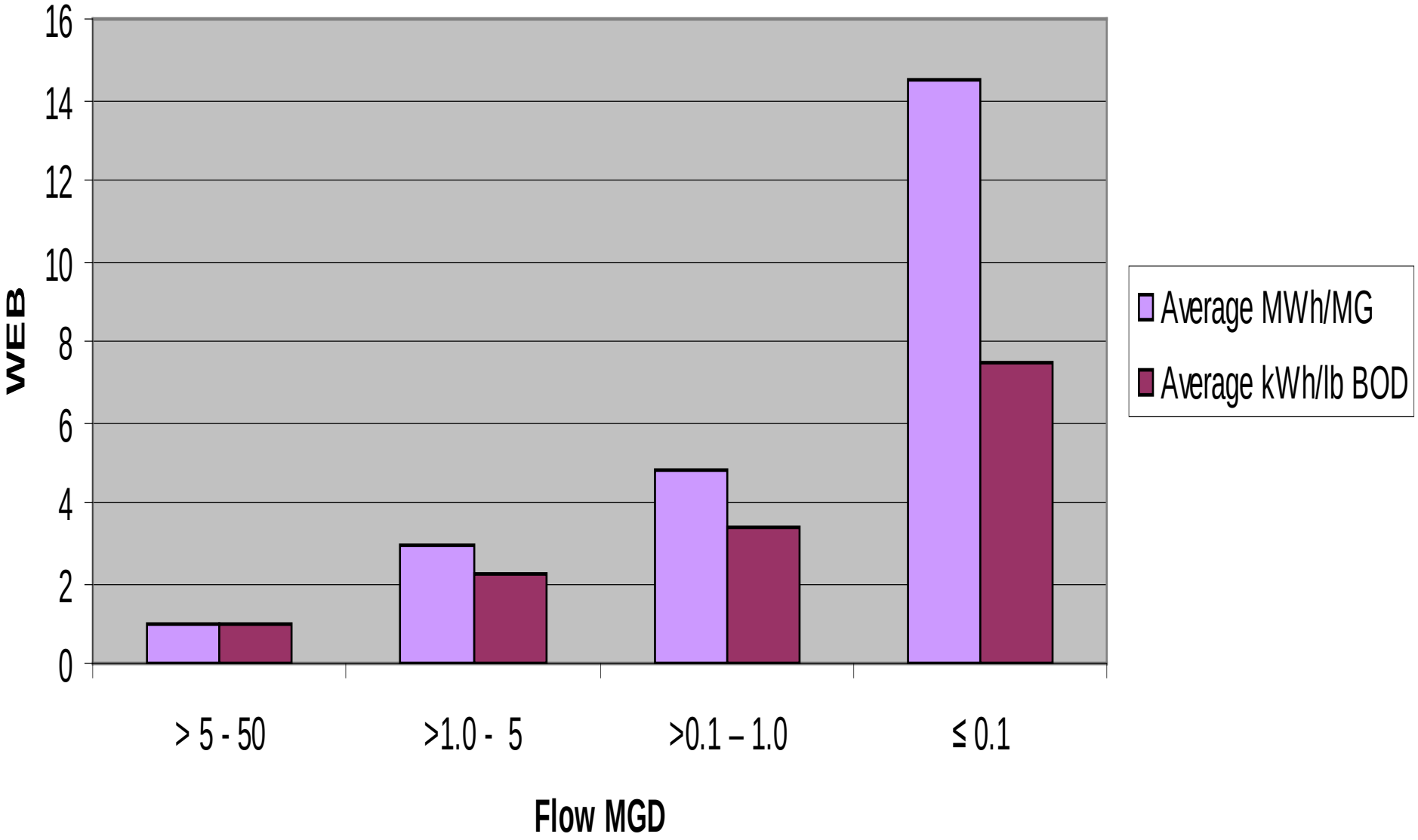

WEB Comparison for Various Loading Values
16
14
12
10
8
6
4
2
0
WEB
MWh/MG
kWh/lb BOD
Hydraulic Loading
% Loading
30
40
70
80

ELECTRICITY USE IN SEWAGE TREATMENT




Diffused Bubble Size
50
40
30
20
10
0
MWh/MGD
WWTPs
Coarse Bubble
Fine Bubble

Flow vs. WEB


16
14
12
10
8
6
4
2
0
WEB
> 5 - 50
>1.0 - 5
>0.1 – 1.0
≤ 0.1
Flow MGD
Average MWh/MG
Average kWh/lb BOD

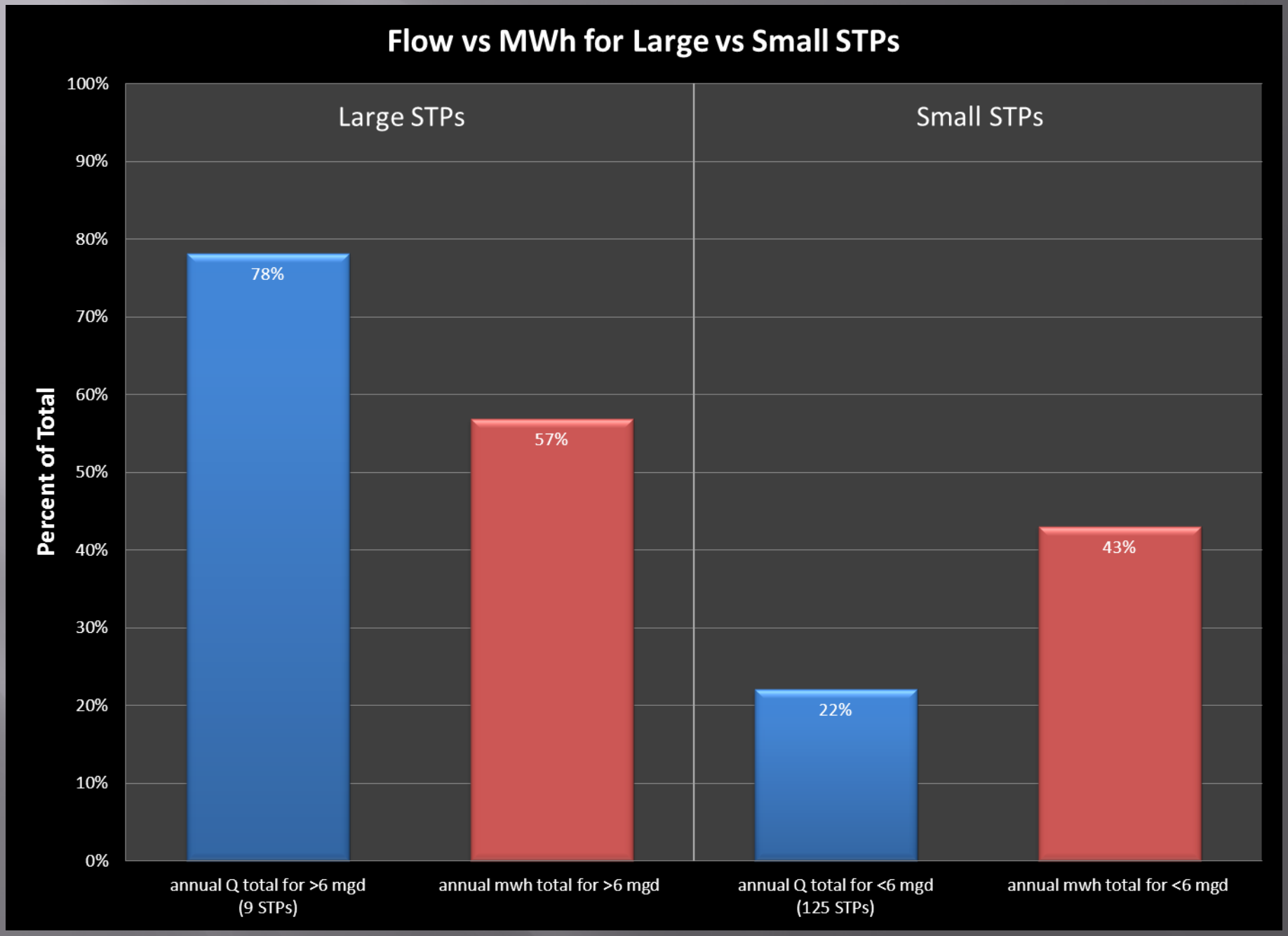

Flow vs MWh for Large vs Small STPs
Large STPs
Small STPs
Percent of Total
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
78%
57%
22%
43%
annual Q total for >6 mgd
(9 STPs)
annual mwh total for >6 mgd
annual Q total for <6 mgd
(125 STPs)
annual mwh total for <6 mgd

Table 1 WWTP Efficiency Baseline Calculator

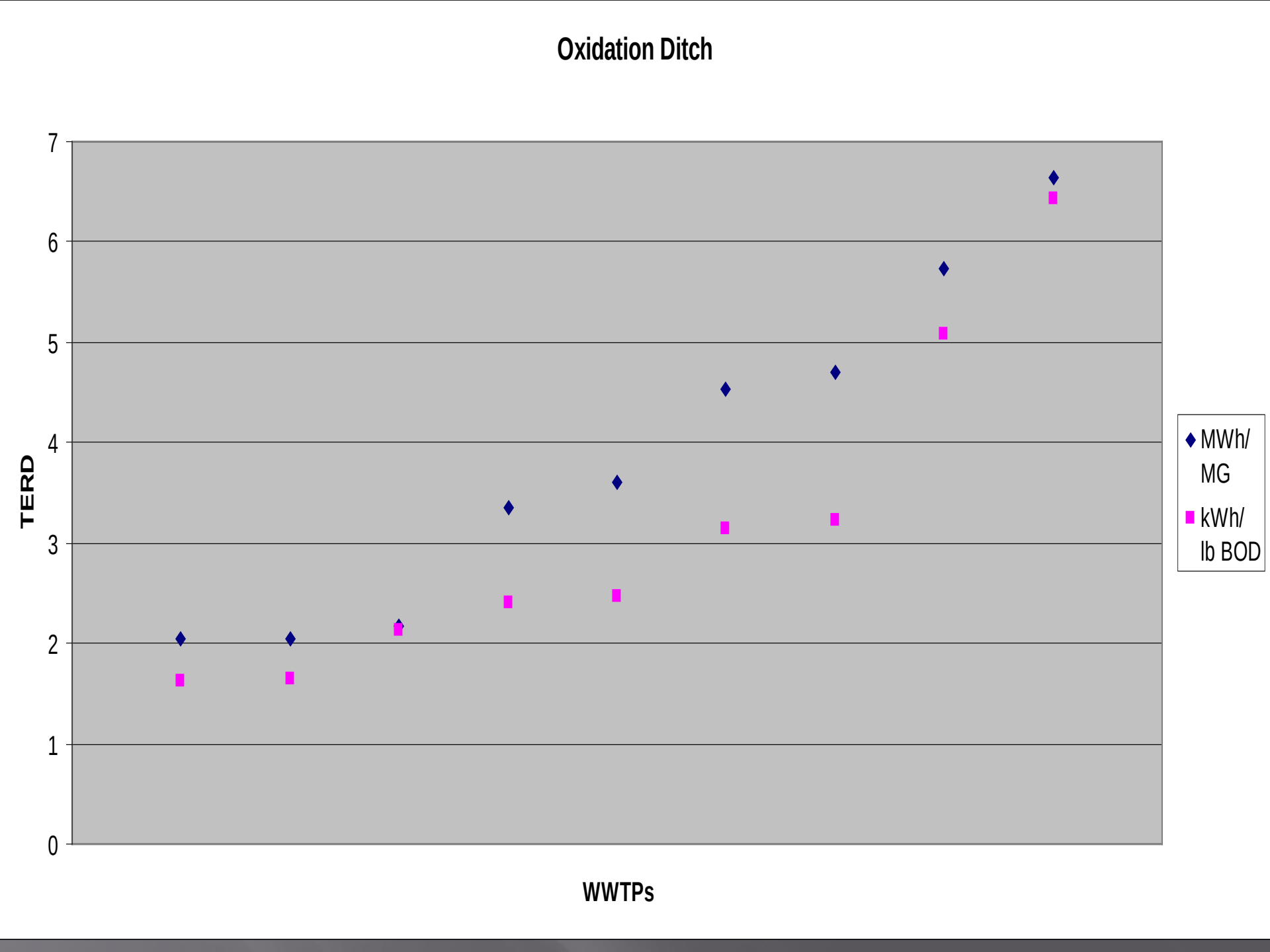
1	2	3	4
Electric use (kWh)	**Average daily flow (MGD)**	**Average daily influent BOD (lb/day)**	**Average daily effluent BOD or CBOD (lb/day)**
260000	2.5000	3300	58
240000	2.6000	3600	54
210000	4.0000	3500	112
220000	2.7000	3400	88
200000	2.9000	2900	44
300000	2.6000	2800	55
320000	2.4000	2400	66
310000	2.5000	2600	77
270000	2.9000	2300	74
290000	2.7000	2400	71
280000	2.2000	3200	64
254894	2.5698	3154	99

WWTP Efficiency Baseline			
3.2	MWh/MG	3.0	kWh/lb BOD

Figure 5 **WWTP Efficiency Benchmarks**

Treatment Type	MWh/MG	kWh/lb BOD
Extended Air	< 3.8	< 2.9
Conventional Activated Sludge	< 1	< 0.7
Sequential Batch Reactor	< 1.8	< 1.6
Oxidation Ditch	< 2	< 1.6
Trickling Filter	< 0.5	< 0.4
Lagoon* (3 wwtp)	0.7 - 16.2*	2.1 - 12.1*
Contact Stabilization* (4 wwtp)	3.0 - 3.6*	2.3 - 6.5*
Rotating Biological Contactor* (2 wwtp)	0.6 - 8.4*	0.6 - 5.0*

***** Entire range of values included due to small number of plants in category. More efficient plants have lower WEBs.


Oxidation Ditch
TERD
0
1
2
3
4
5
6
7
WWTPs
MWh/ MG
kWh/ lb BOD

Appendix D (references from *Electricity Use at PA STPs*)

Consortium for Energy Efficiency
www.cee1.org/ind/mot-sys/ww/cr.php3

Department of Energy, Pump Systems Matter, Hydraulic Institute
www.pumpsystemsmatter.org/

Department of Energy, Pumping System Assessment Tool
www1.eere.energy.gov/industry/bestpractices/software_psat.html

Department of Energy, MotorMaster
www1.eere.energy.gov/industry/bestpractices/software_motormaster.html

Electric Utility Rebate Programs
www.pennfuture.org/content.aspx?MenuID=1&SubSubSectionID=296&SubSectionID=293&SectionID=6

EPA ENERGY STAR for Wastewater Plants and Drinking Water Systems
www.energystar.gov/index.cfm?c=water.wastewater_drinking_water

EPA Ensuring a Sustainable Future: An Energy Management Guidebook for Wastewater and Water Utilities
www.epa.gov/waterinfrastructure/pdfs/guidebook_si_energymanagement.pdf

EPA Evaluation of Energy Conservation Measures for Wastewater Treatment Facilities
water.epa.gov/scitech/wastetech/upload/ecm_report.pdf