

NorCal ASPE
Sept 9th 2008

Sewage & Sump Pumps

System Design
and
Equipment Selection

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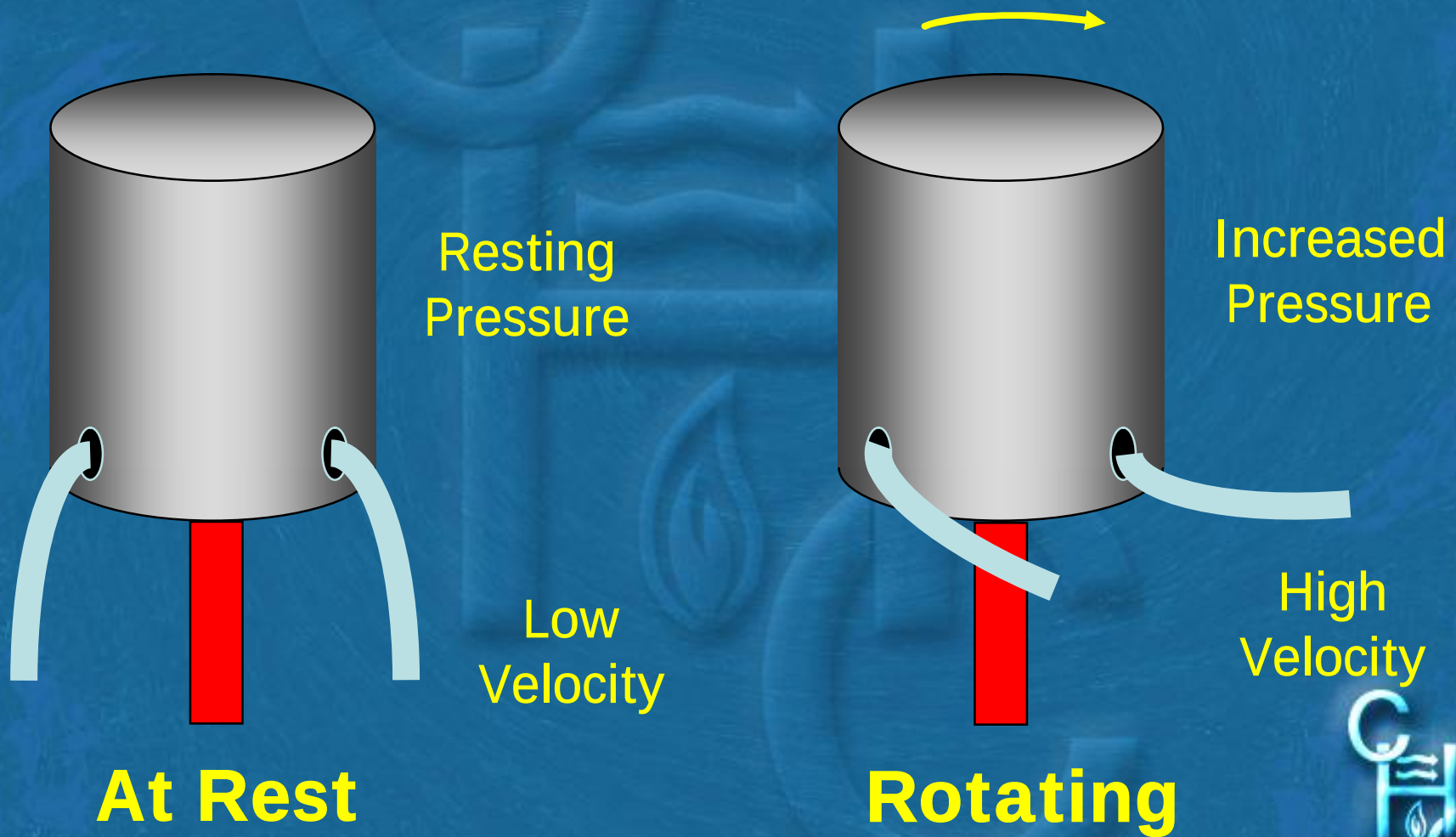


Seminar Overview

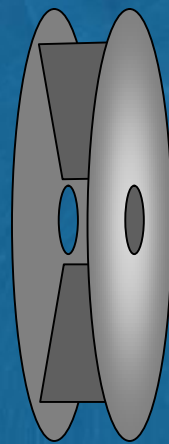
- Section 1: Centrifugal Pumps
- Section 2: System Sizing & Selection
- Section 3: Pump Stations



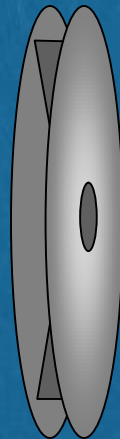
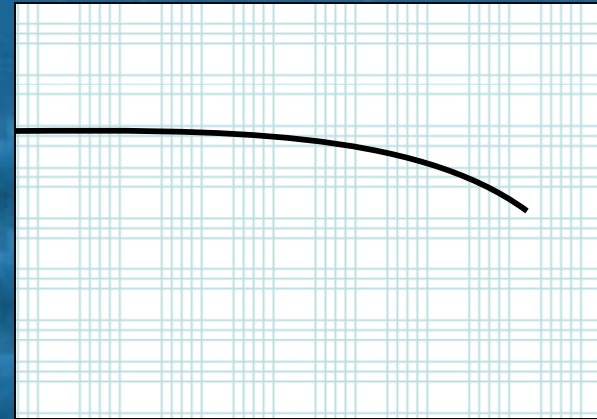
Operation of Centrifugal Pumps



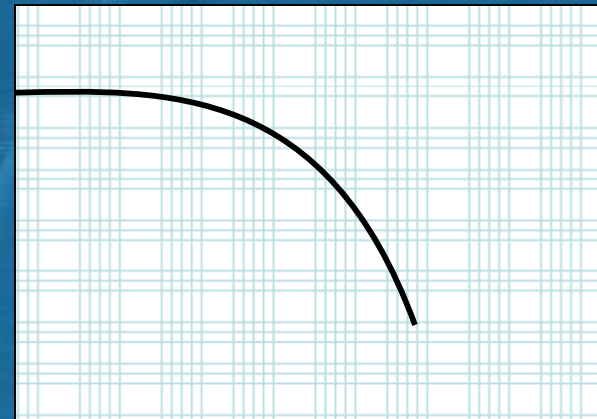
Pump Impellers



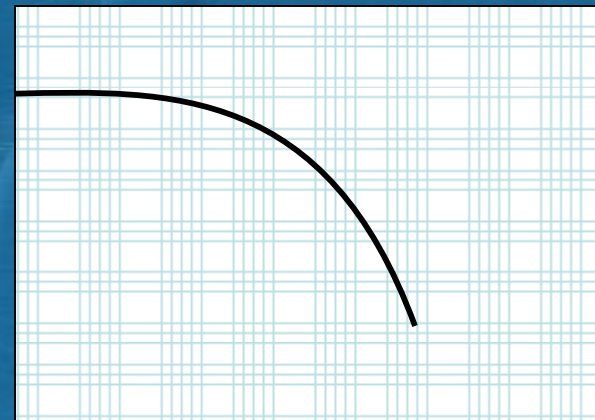
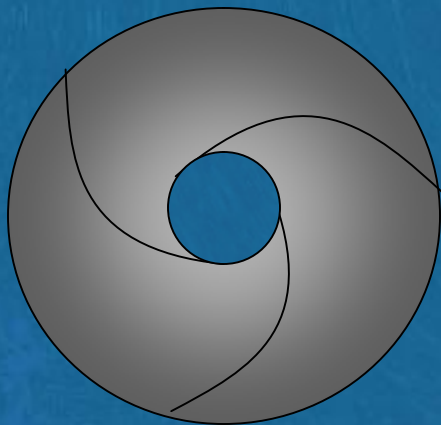
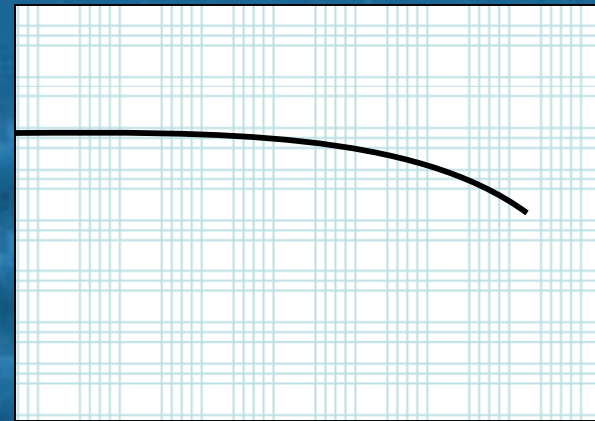
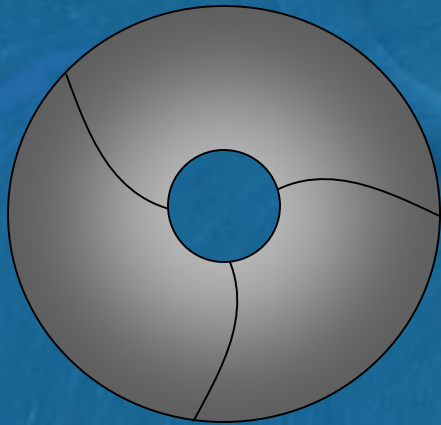
Wide



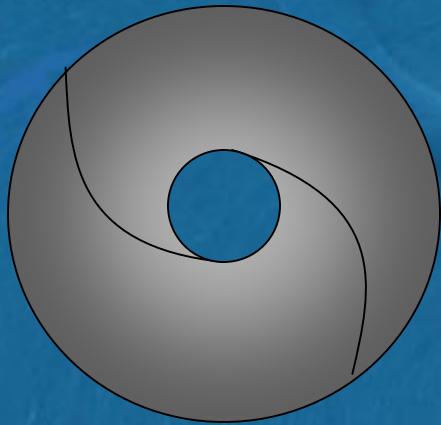
Narrow



Impeller Vanes



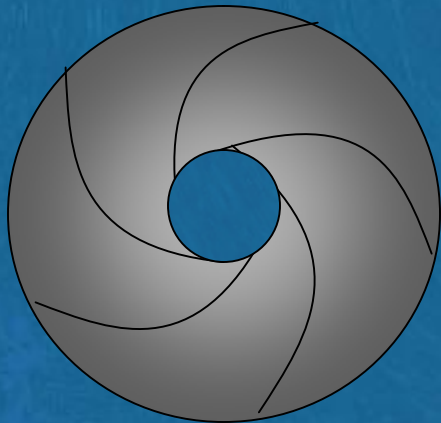
Sanitary vs. Storm Pumps



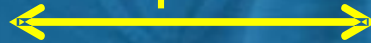
2-Vane
Impeller



**Sewage
Application**



5-Vane
Impeller



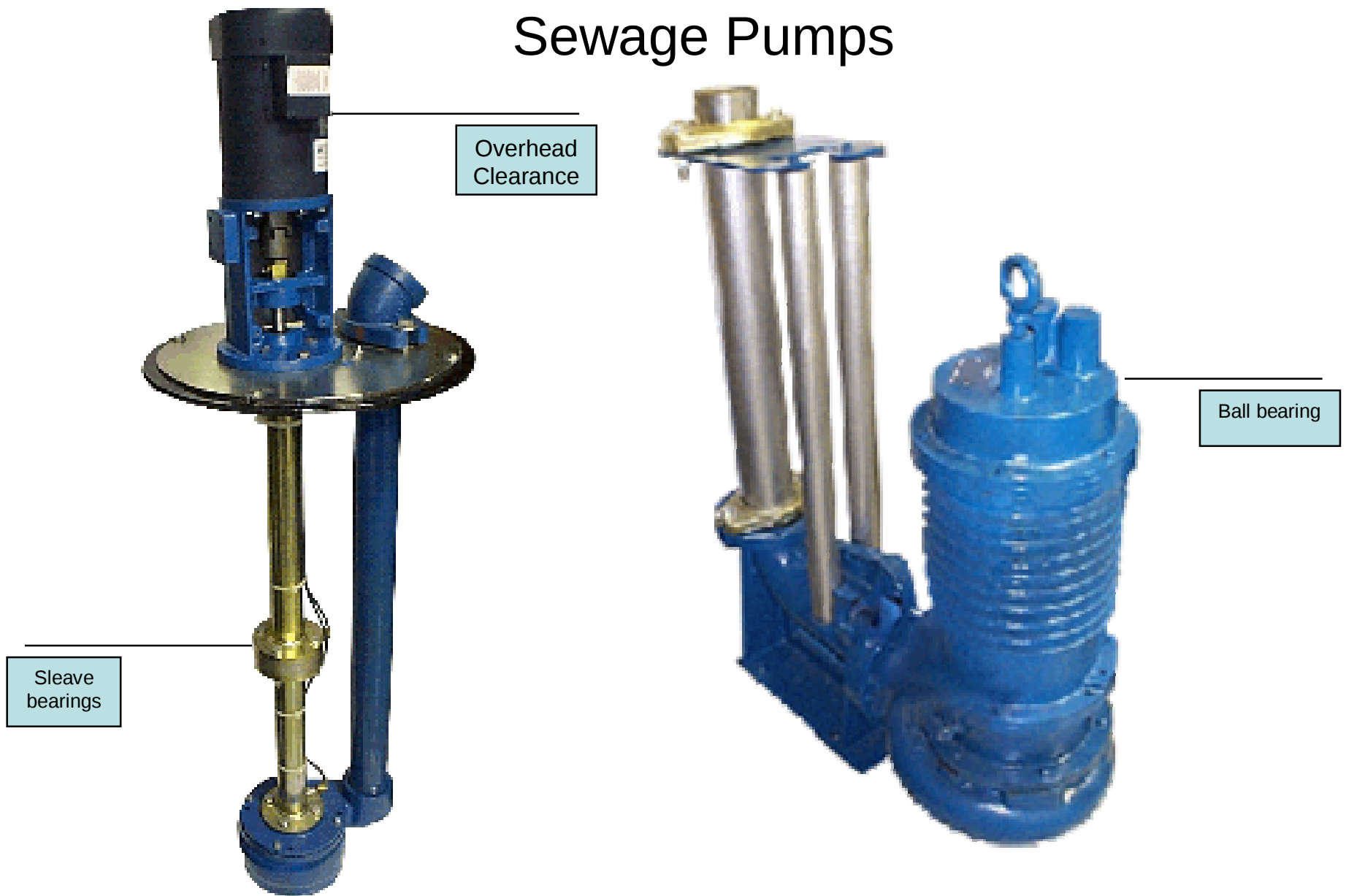
**Clean Water
Application**



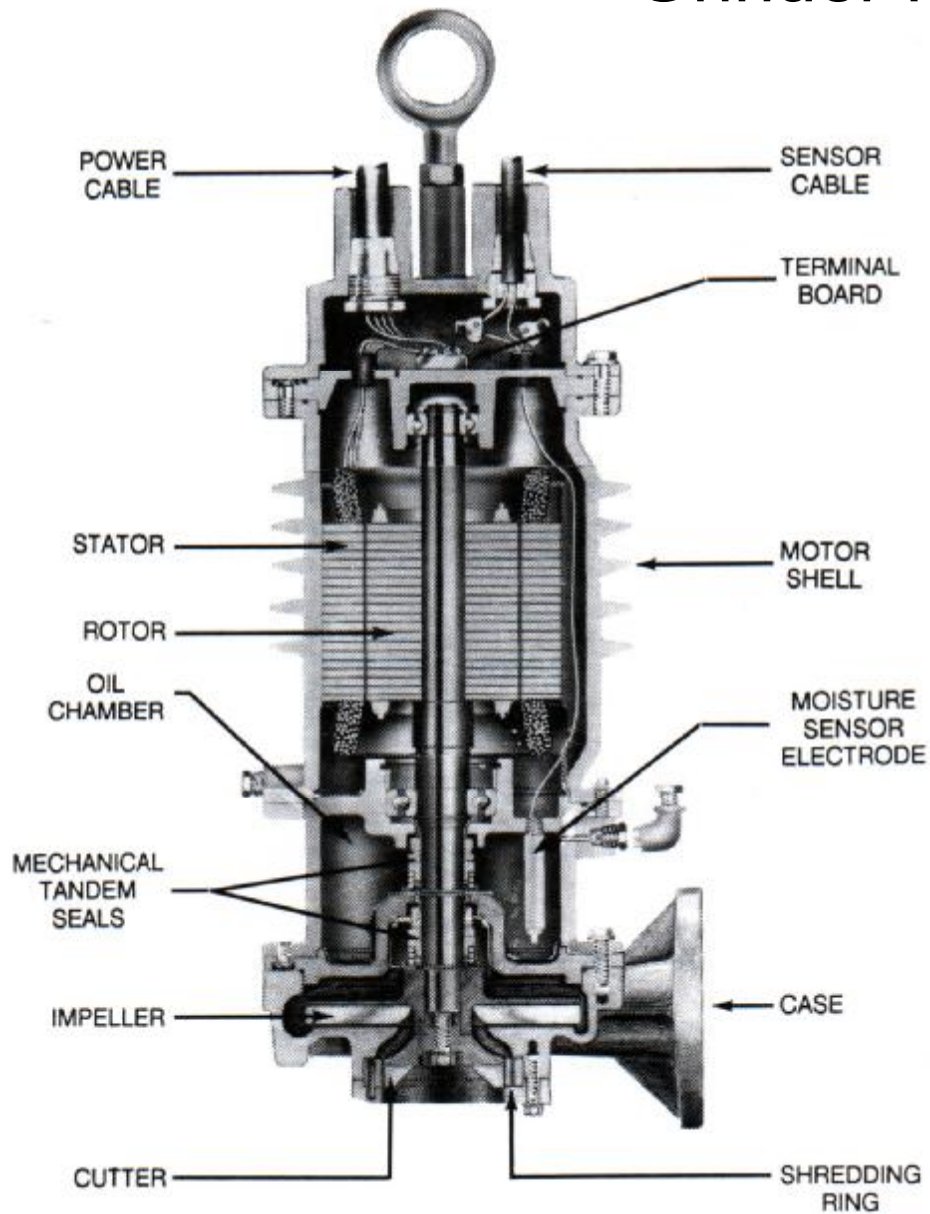
Effluent/Storm Pumps



Sewage Pumps



Grinder Pump



CUTTER



SHREDDING RING

Solids reduced to 3/8" dia

Outline: Section 2

- System Sizing & Selections:
 - Sewage System
 - Storm System



Sanitary System

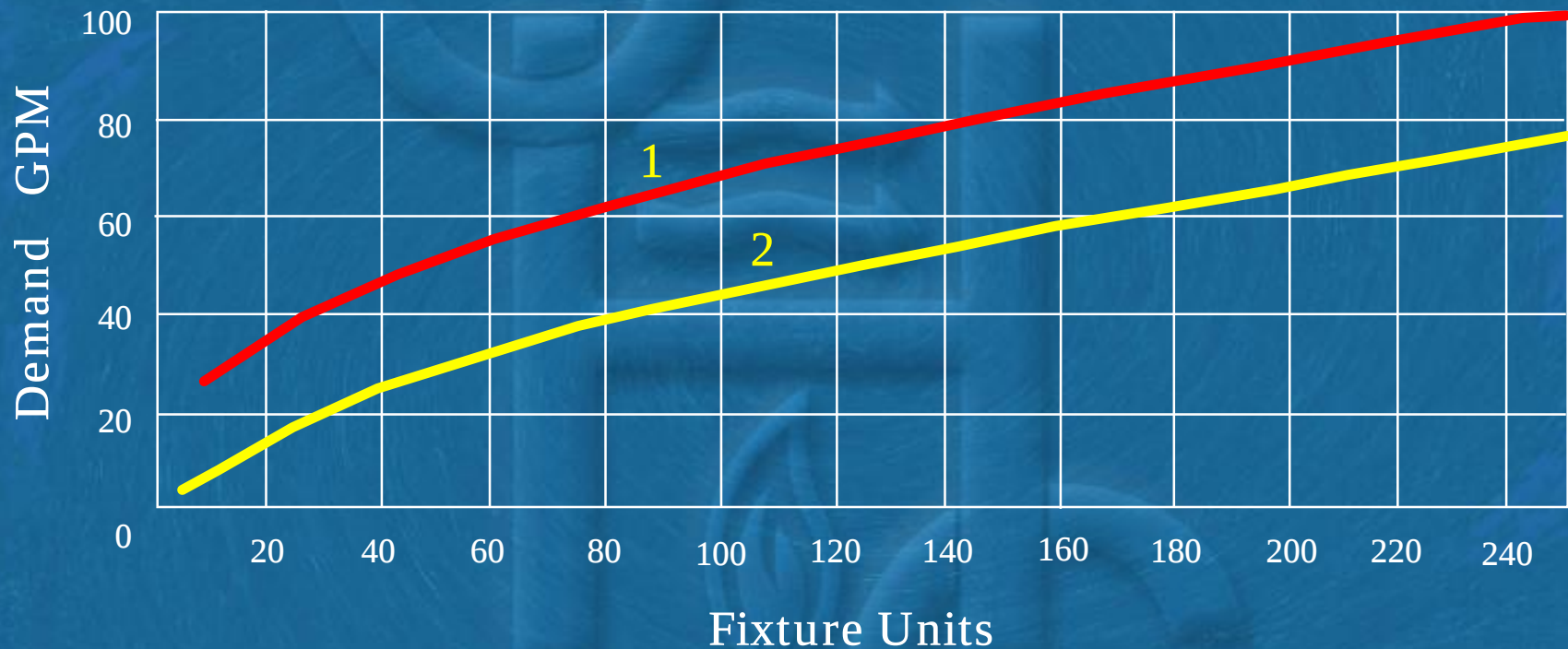
- California Plumbing Code (CPC) Chapter 7
 - Wastewater Fixture Units
 - Table 7-3: Drainage Fixture Unit Values
 - Hunter Curves
 - Total Flow, Appendix A (A-2 & A-3)
 - Pipe Sizing
 - Scouring Velocity
 - 2 ft/sec minimum (to prevent sedimentation)
 - 8 ft/sec maximum
 - Slope
 - 1/4" Standard
 - Invert
 - Pump Sizing
 - Duplex Requirements



UPC Table 7-3: Sample

Individual Fixtures	Min. Size Trap and Trap Arm	Private		Public	
		Individual Dwelling	3 or more Dwellings	General Use	Heavy-Use Assembly
Bar Sink	1-1/2"	1.0	1.0	2.0	
Bathtub or Combination Bath/Shower	1-1/2"	3.0	3.0		
Bidet	1-1/4"	1.0	1.0		
Clinical Sink	3"			6.0	
Clothes Washer, domestic	2"	3.0	3.0	3.0	
Dental Unit, cuspidor	1-1/4"			1.0	
Dishwasher, domestic	1-1/2"	2.0	2.0	2.0	
Drinking Fountain or Watercooler	1-1/4"			0.5	
Food-waste-grinder, commercial	2"			3.0	
Food Drain, emergency				0.0	
Kitchen Sink, domestic, with grinder	1-1/2"	2.0	2.0	2.0	
Laundry Sink, 1 or 2 compartments	1-1/2"	2.0	2.0	2.0	
Lavatory, single	1-1/4"	1.0	1.0	1.0	1.0
Urinal, 1.0 GPF				4.0	5.0
Water Closet, 1.6 GPF Gravity Tank	3"	3.0	3.0	4.0	6.0

“Hunter” Curves for Total Load

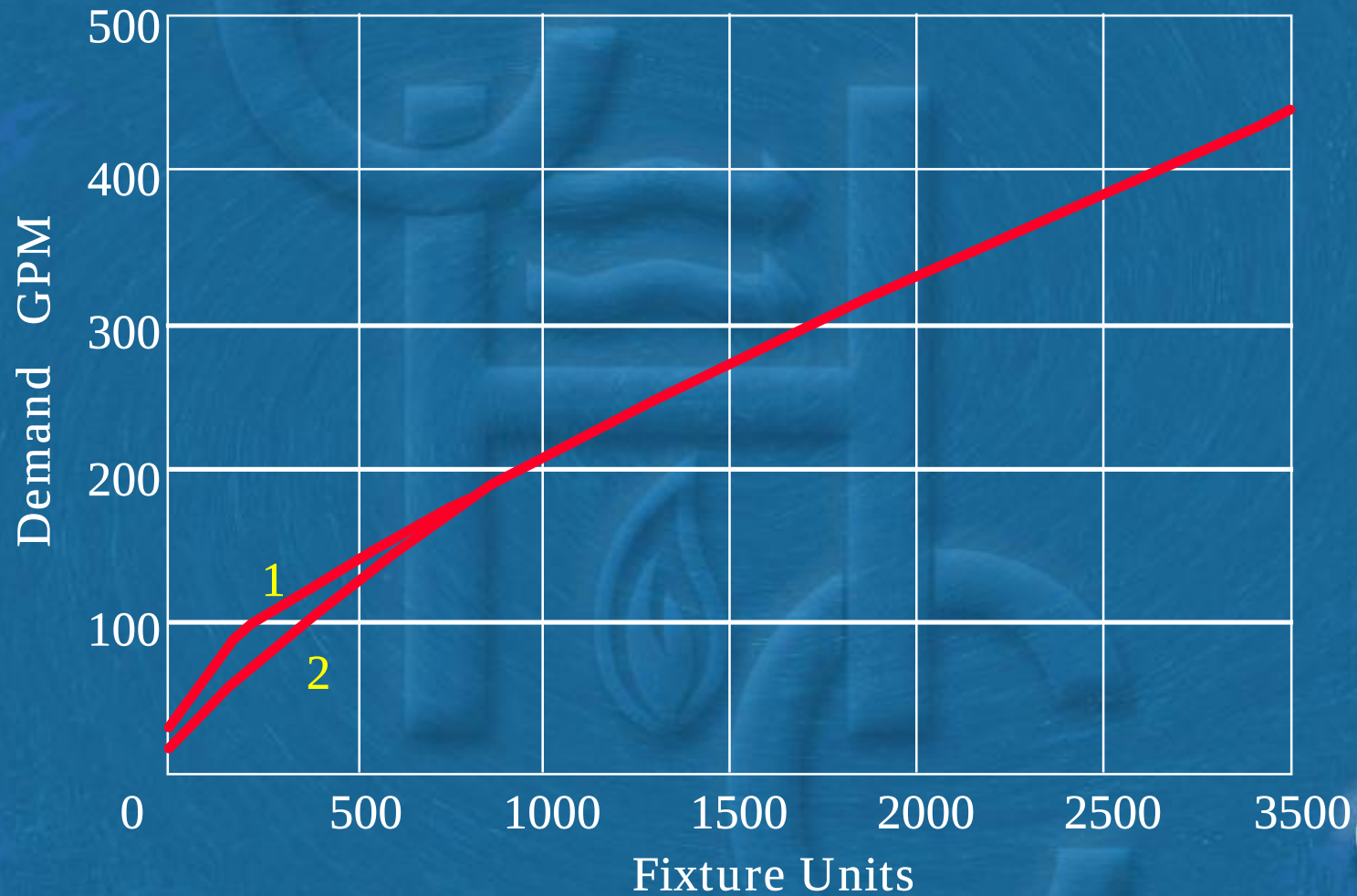


1 - Flush Valve Curve

2 - Flush Tank Curve



“Hunter” Curves for Total Load



Pipe Sizing

- Fluid Velocity Limitations
 - 2 ft/sec minimum (Scouring Velocity)
 - EPA Title 35, Subtitle C, Section 370.470.1
 - 8 ft/sec maximum (Erosion Prevention)
 - Optimum velocity range = 3.5 to 5 ft/sec
 - Reduces maintenance costs and prevents sedimentation
 - “Criteria for Sewage Works Design” C2-3.2
 - Minimum pipe size of 3” (Raw Sewage)



Pipe Sizing

- Pipe Slope

- Plumbing Code Requirements

- CPC 708.0: Grade of Horizontal Draining Piping

- Smaller than 4" pipe: Not less than $\frac{1}{4}$ " per foot, or 2%

- 4" pipe or larger: $\frac{1}{8}$ " per foot, or 1% when first approved by the authority having jurisdiction.

- $\frac{1}{4}$ " per foot standard



Pipe Sizing

- Invert Location
 - Result of Slope Requirements
 - Affects Depth of Wet Pit (Basin)
 - Limits Maximum Water Level



Pump Sizing

Pump Selection Considerations:

1. Flow Rate (Q)
2. Size of Pipe and Pump Discharge
 - Solid Size
3. Total Dynamic Head (TDH)
4. Type of Pump
 - Submersible, Vertical, Grinder



Pump Sizing

- Section 710.3 CPC*: Sewage Ejectors
 - Sewage Ejectors (710.3.1): Minimum pump capacity = 20 GPM
 - Sewage Ejectors (710.3.3) : Must pass 2" diameter solid ball & pump discharge requires backwater and gate valves with minimum size of 3" in diameter
 - Grinder pumps (710.12) may be used

* CPC= 2007 California Plumbing Code



Pump Sizing

- Select Pipe and Pump Discharge Size

For Range of Q =	Use Pipe Size
18 - 85 gpm	2 inch
45 - 180 gpm	3 inch
80 - 320 gpm	4 inch
180 - 700 gpm	6 inch

*Note: Maintains velocity
of 2 - 8 feet per second*



Pump Sizing

- Total Dynamic Head (TDH)
 1. Static Head
 2. Friction Loss through piping + valves
 3. Back Pressure



Pump Sizing

- Type of Pump
 - Ease of maintenance
 - Explosion proof requirements
 - Size and depth of basin
 - Size of solids vs. size of pipe



Duplex Requirements

- Section 710.9 (CPC) Duplex Equipment:
 - Any “public use” occupancy shall be provided with dual pumps.
 - Pumps to be arranged to function alternately in normal use and independently in case of overload or mechanical failure.



Storm System

- Storm Drainage (CPC) Chapter 11
 - Total Flow
 - Appendix D
 - No less than 15 GPM (CPC1101.5.3)
 - Pipe Sizing
 - 1 ½" minimum discharge (CPC1101.5.3)
 - Pump Sizing
 - Recommend Duplex System
 - Combining Systems



Total Flow

California Plumbing Code (CPC)

D1: Roof Drainage

Table D-1: Maximum Rates of Rainfall for Various Cities

<u>City, State</u>	<u>Inches / Hr.</u>	<u>GPM / SqFt.</u>
Anchorage, AK	0.6	0.006
San Francisco, CA	1.5	0.016
Boise, ID	1.0	0.010
Billings, MT	1.8	0.019
Reno, NV	1.2	0.012
Portland, OR	1.3	0.014
Seattle, WA	1.0	0.010



Total Flow

- Section 1101.5.3 CPC: Subsoil Drains
 - Sized for all calculated area
 - Minimum pump capacity of 15 GPM



Pump Sizing

Pump Selection Considerations:

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2. Size of Pipe and Pump Discharge
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Combining Systems

- Section 1104.3 CPC: Combining Storm with Sanitary Drainage
 - Sanitary and storm must be separated



Outline: Section 3

- Pump Stations
 - Basin Selection and Sizing
 - Level Detection
 - Control Panel
 - Slide Rails
 - Basin Cover
 - Discharge Piping



Basin Construction

- Epoxy Lined Steel
- Cement-pre-cast, water pipe
- Fiberglass
- Cast Iron

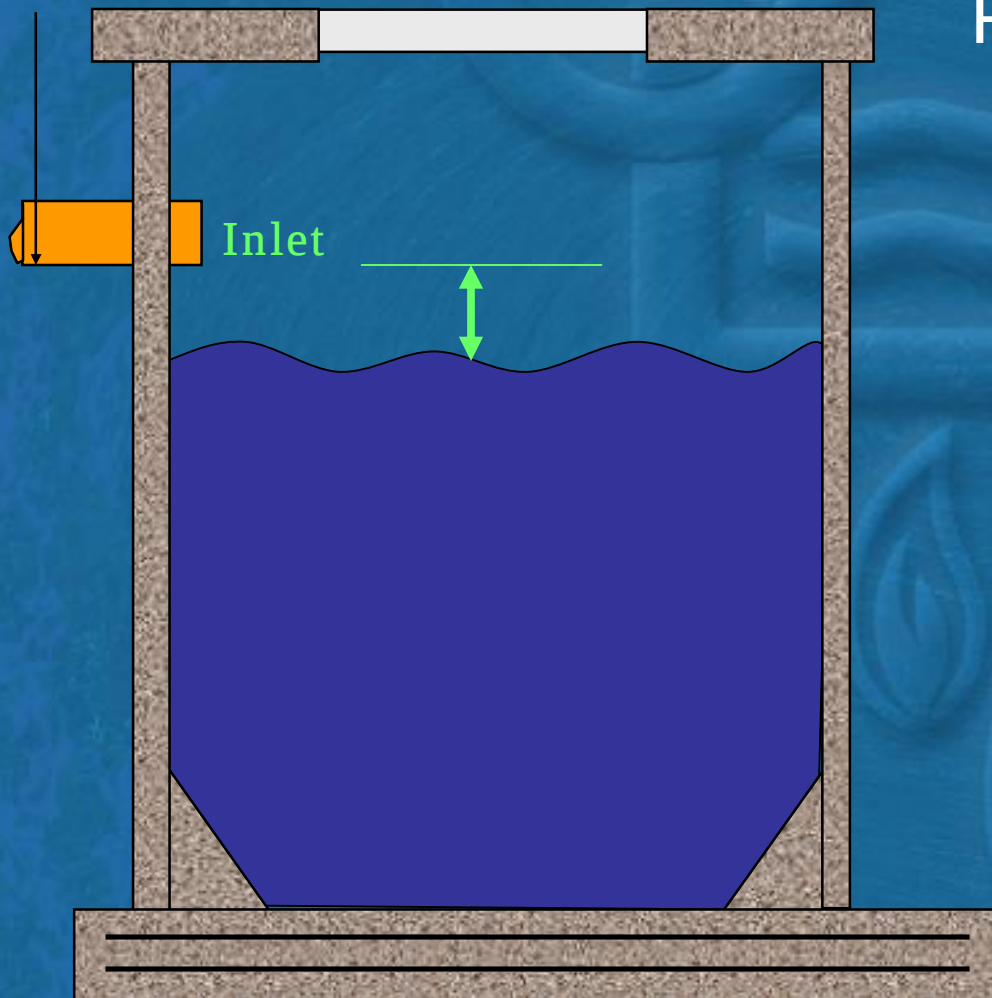


Sump Construction

- Section 710.8 CPC: Drainage of Fixtures
 - Sumps shall be watertight and shall be constructed of concrete, metal, or other approved materials.
 - Metal tanks shall be treated internally and externally to resist corrosion.



Basin Sizing



FIRST – What is the invert of the inlet pipe?

CPC 710.9:

“The lowest inlet shall have a minimum clearance of **2”** from the high water, or starting level, of the sump.”



Basin Sizing

- Sizing Considerations
 - Diameter to accommodate the pumps
 - 3 to 6" between high water alarm and inlet
 - Influential factors for depth and diameter
 - Building site constraints



Basin Sizing

- Sizing Considerations
 - Prevent Pump Short Cycling
 - Pump run time = 1.5 minutes (duplex)
 - Longer run time = Larger basin
 - Recommend 10 Starts per Hour Maximum
 - Increased pump life
 - 1 start every 6 minutes
 - (Pump run time of 3 minutes for a simplex pump)



Basin Sizing

- Pump Down Volume (V)

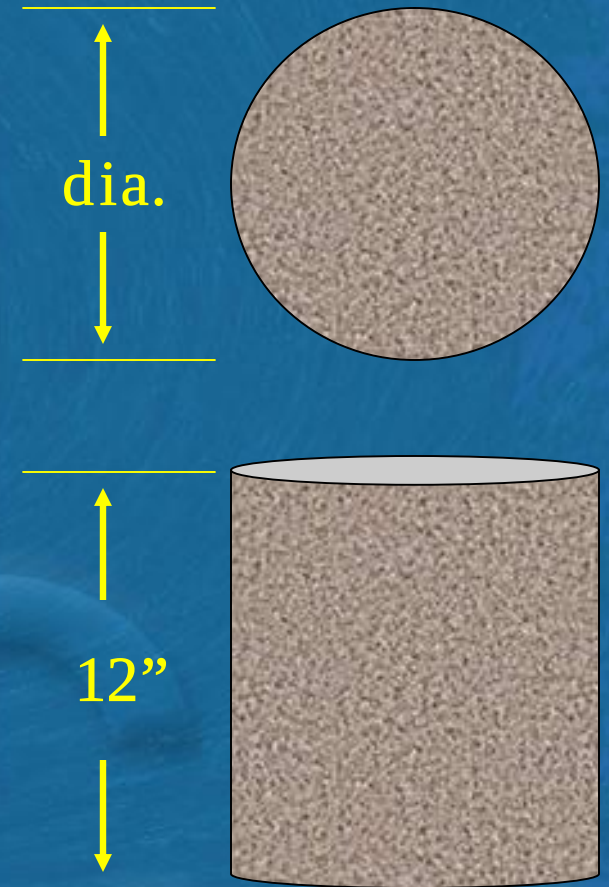
$$V = T \times Q$$

Where (T) is the desired minimum run time
and (Q) is the flow rate in GPM.



Cylindrical Basin Capacities

Diameter, in.	Capacity per Ft depth, gal
18	14
24	24
30	38
36	53
42	77
48	95
60	150
72	212
84	290
96	375



Finalize Basin Depth

1. Top of Basin to Invert of the Inlet Pipe = _____ inches

Codes may specify minimum

2. Inlet to “Alarm” Float = _____ inches

3 to 6 inches, Codes may specify

3. “Alarm” to “Lag” Float = _____ inches

3 to 6 inches

4. “Lag” to “On” Float = _____ inches

3 to 6 inches

5. Pump Down = _____ inches

6. Floor of Basin to Top of Pump Case = _____ inches

2” Removal Pumps - 10 inches

3” Removal Pumps - 12 inches

4” Removal Pumps - 15 inches

6” Removal Pumps - 19 inches

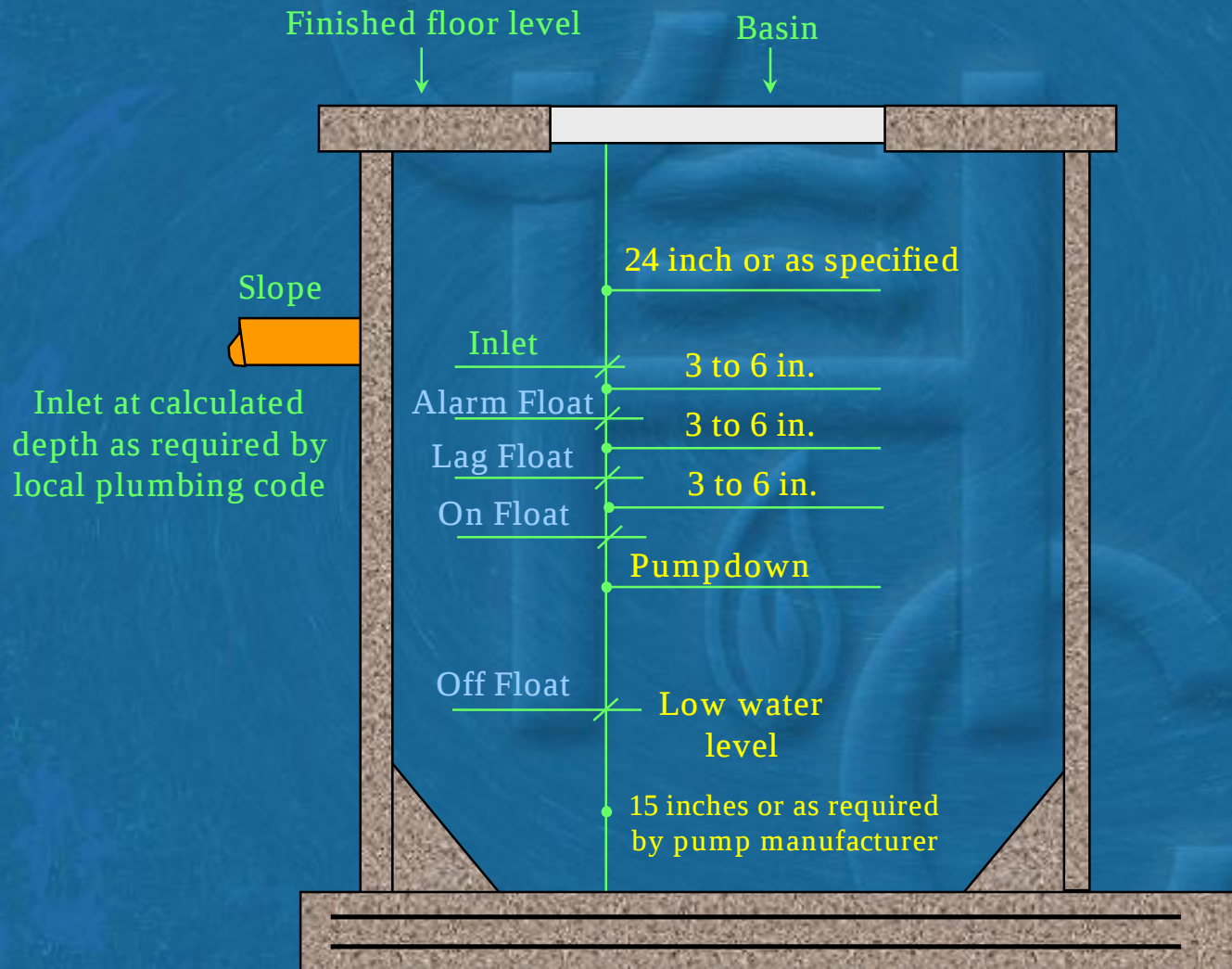
Small to Medium Sized Floor Mounted Pumps - 10 inches

Large Floor Mounted Pumps - 16 inches

(**Note:** depths vary - consult pump manufacturer)

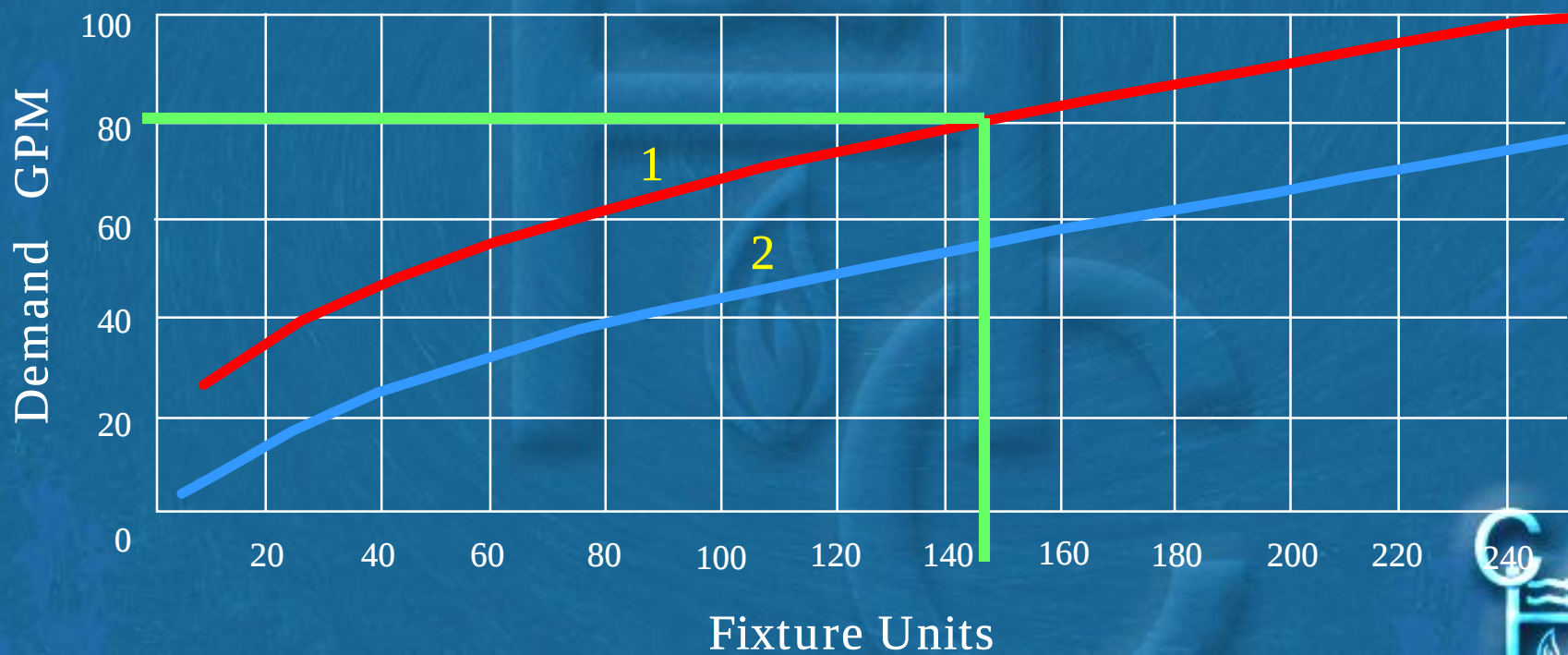
Total Basin Depth = _____ inches

Basin Elevations



Basin Sizing Example

- 145 Fixture Units (FU) with Flush Valves
Demand Flow (Q) = 80 GPM



Basin Sizing

- Pump Down Volume (V)

$$V = T \times Q$$

Where (T) is the desired minimum run time
and (Q) is the flow rate in GPM.

$$V = 1.5 \times 80 = 120 \text{ gallons}$$

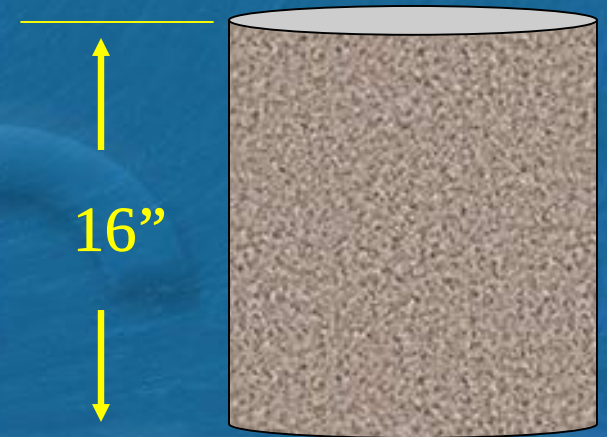
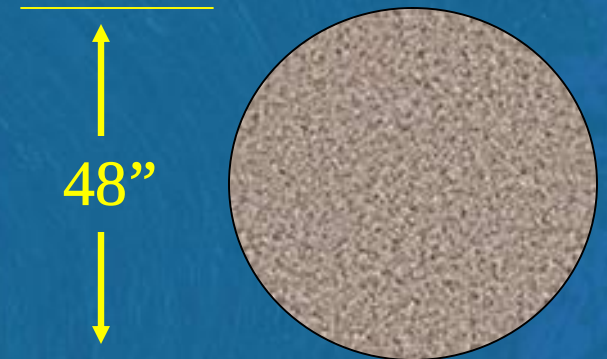


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42	77
48	95
60	150
72	212
84	290
96	375



120 gals
95 gals/ft
= 16"



Finalize Basin Depth

1. Top of Basin to Invert of the Inlet Pipe = 12 inches

Codes may specify minimum

2. Inlet to “Alarm” Float = 3 inches

3 to 6 inches, Codes may specify

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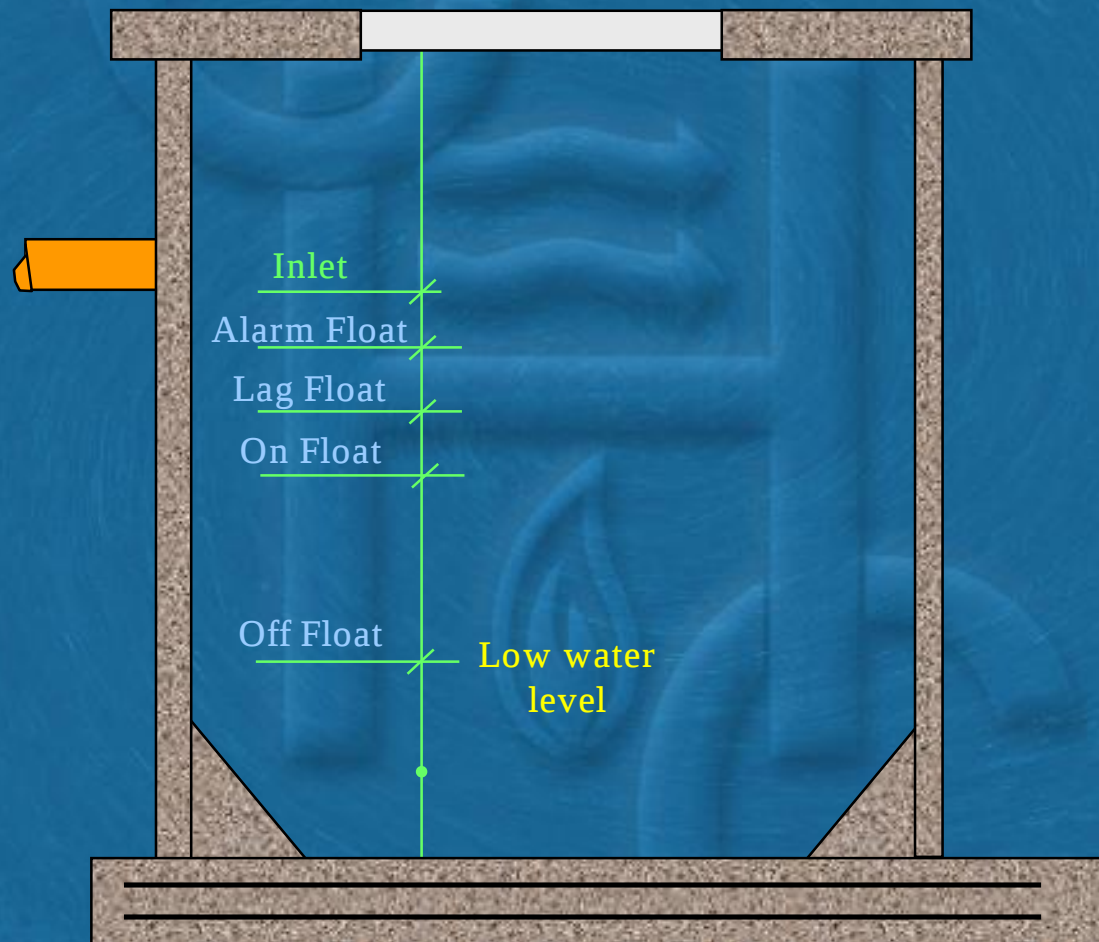
Small to Medium Sized Floor Mounted Pumps - 10 inches

Large Floor Mounted Pumps - 16 inches

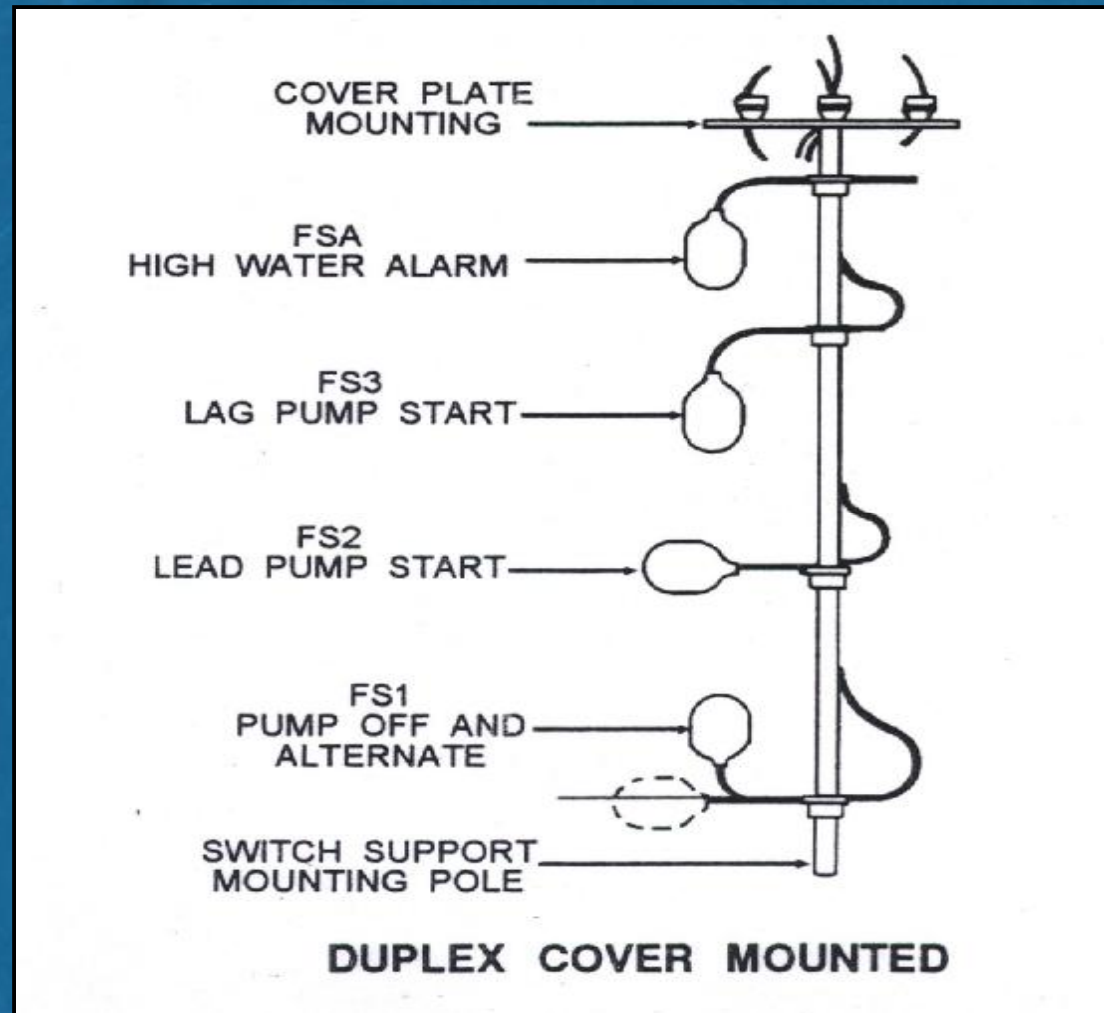
(Note: consult mfgr)

Total Basin Depth 52 inches

Level Detection



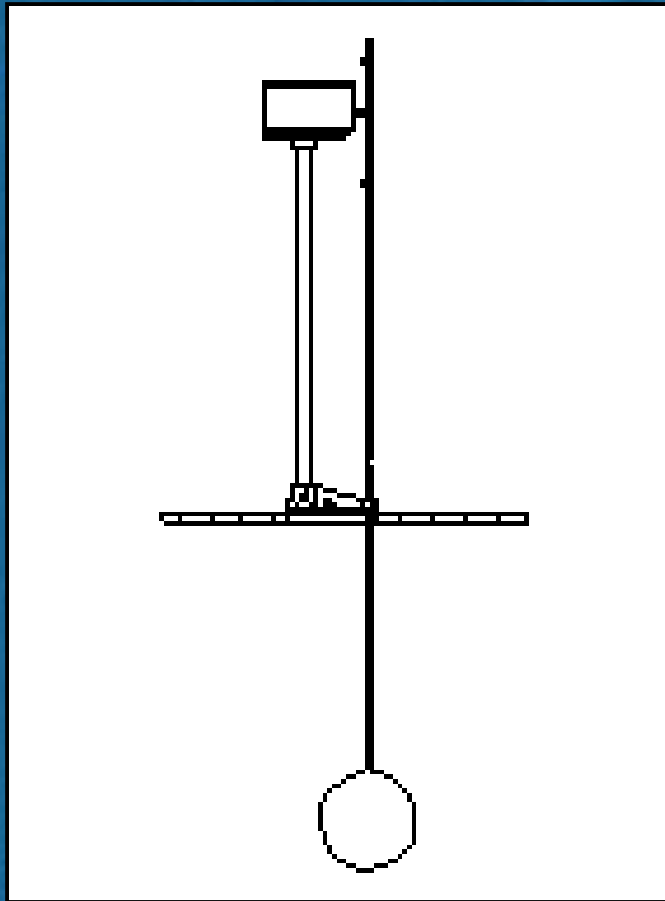
Level Detection



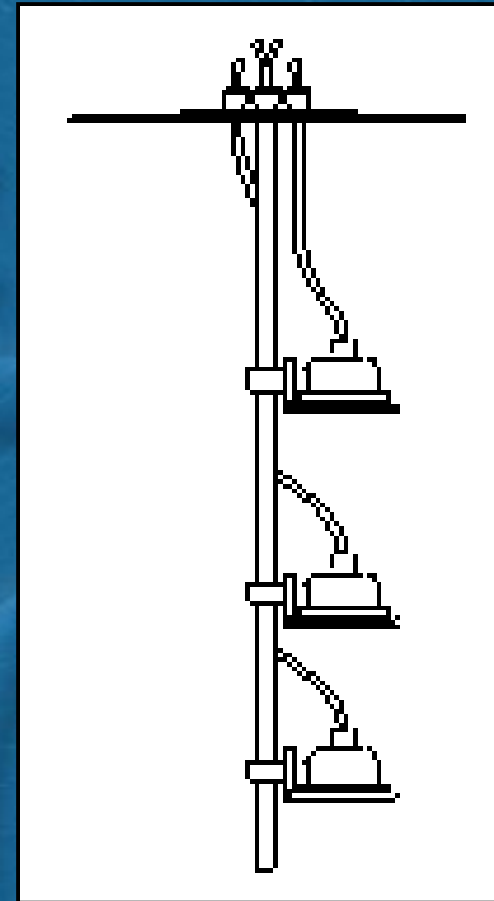
Tethered Floats



Level Detection

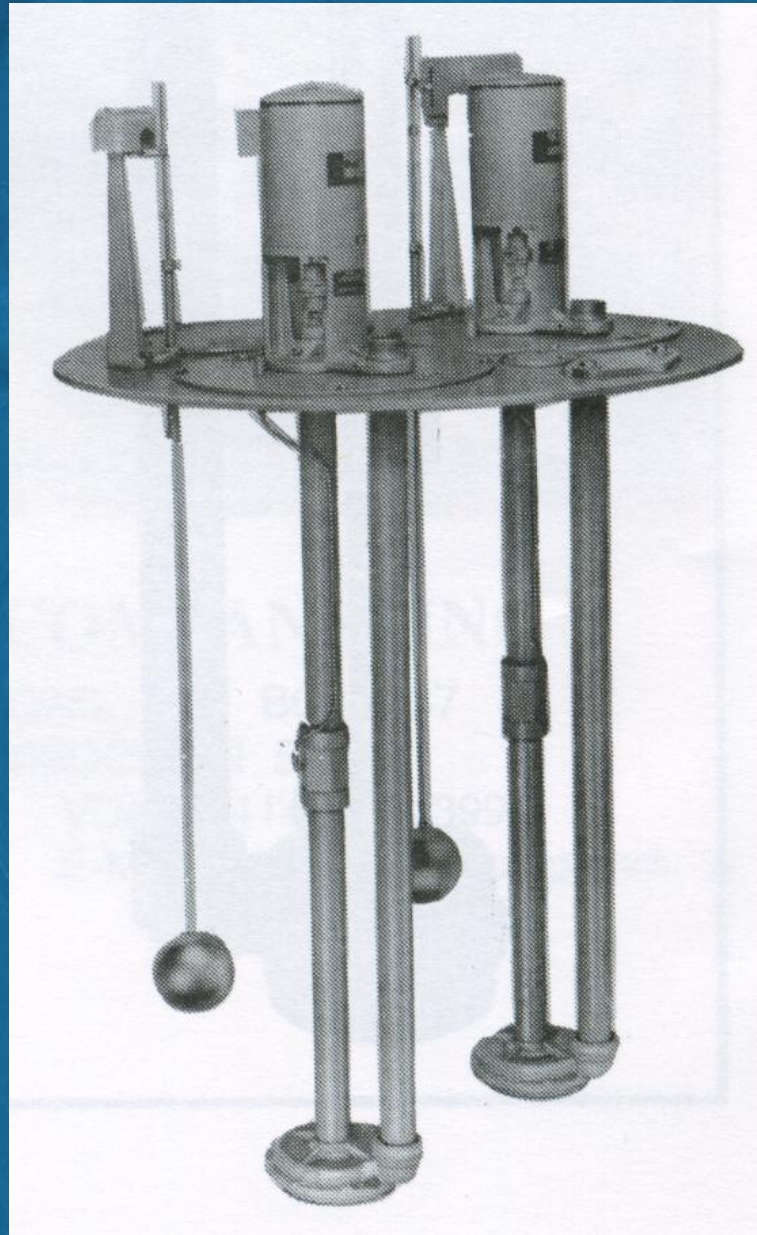


Pedestal Mounted



Pressure Diaphragm



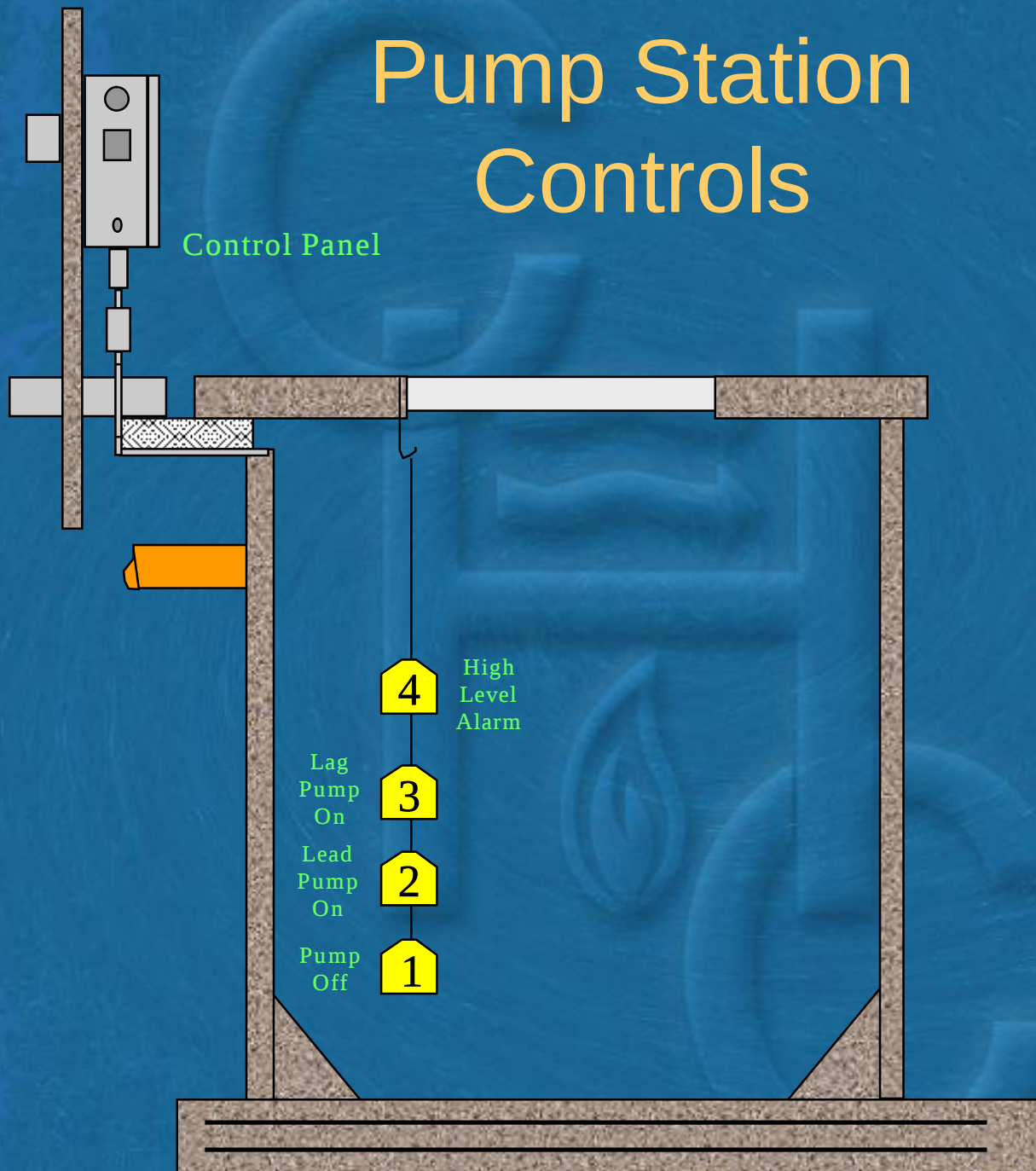


Control Panel

- Pump Control Panel
 - Disconnects
 - Starters with Overload Protection
 - H.O.A. Switches
 - Alarm Systems
 - Elapsed Time Meters
 - Lead/Lag Alternation for Duplex Systems

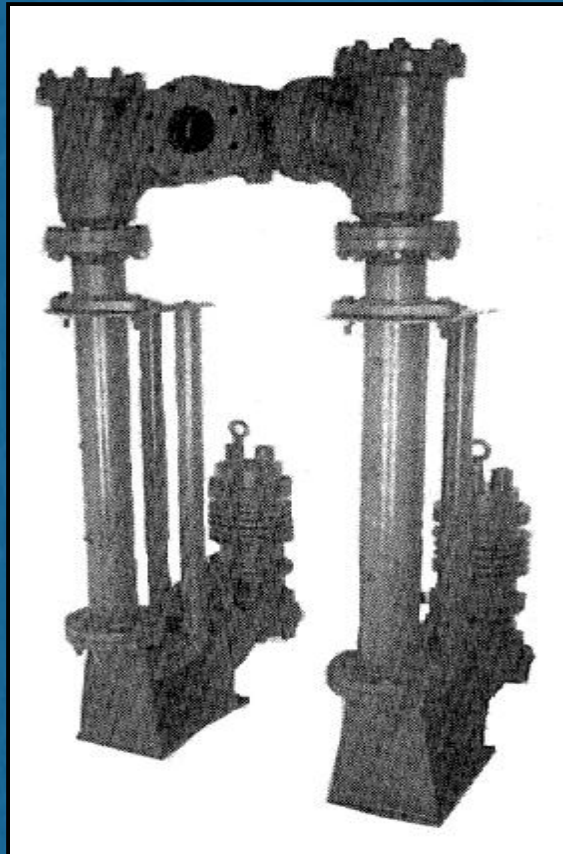


Pump Station Controls

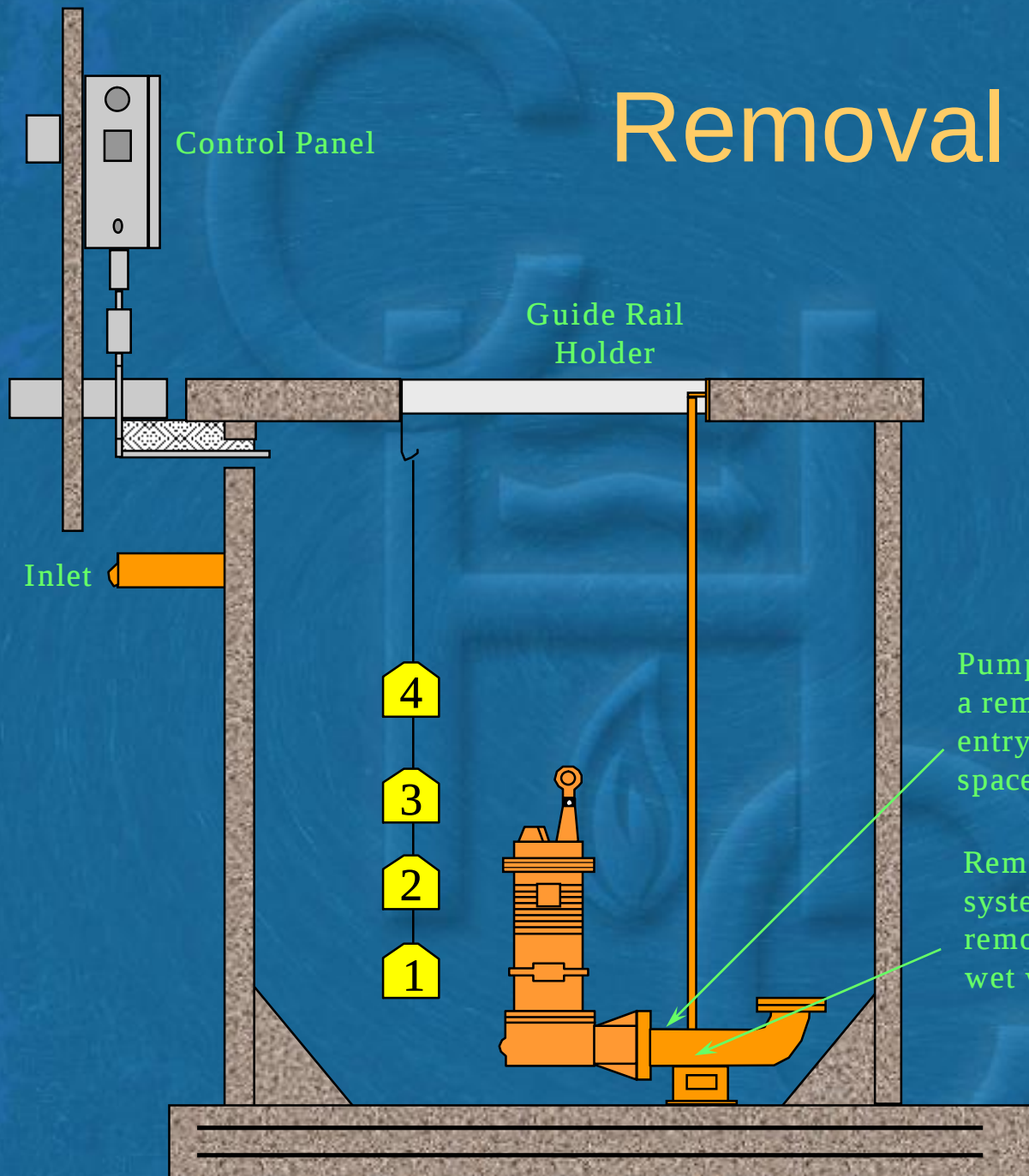


Slide Rails

- Pump Removal System



Removal System



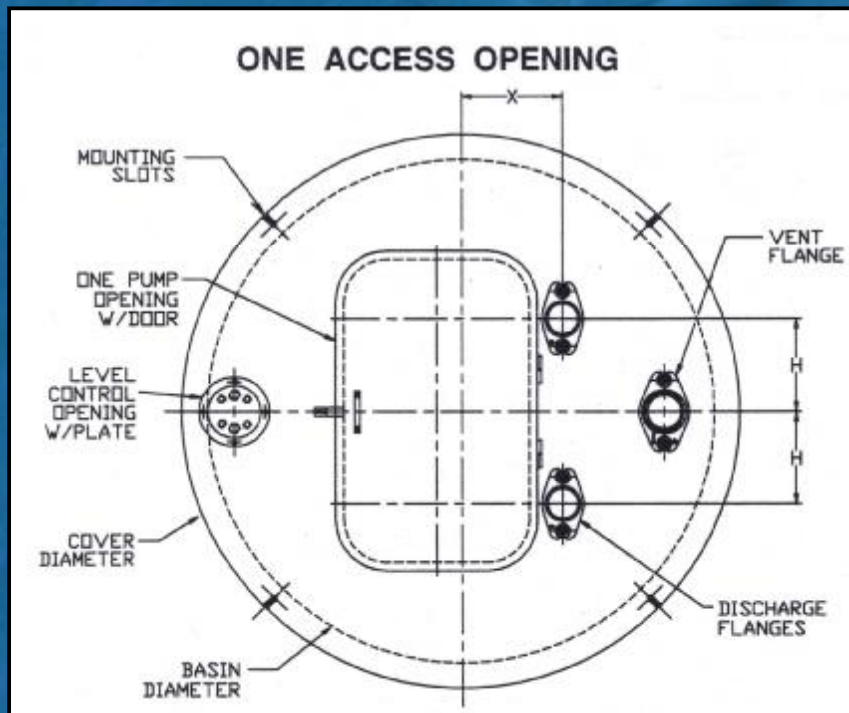
Pumps must be mounted onto a removal system to prevent entry into wet well “confined” space, as defined by OSHA.

Removal System slide rail system – allows pump removal without entry into wet well.



Basin Covers

- Covers, Frames and Hatches



- Pump Access
- Control Openings
- Discharge Openings
- Vent Openings



Traffic Rated Cover

- Load Category = “H20”
 - Parking Garage
 - Parking Lots
 - Access Roads



H2O Rated Cover

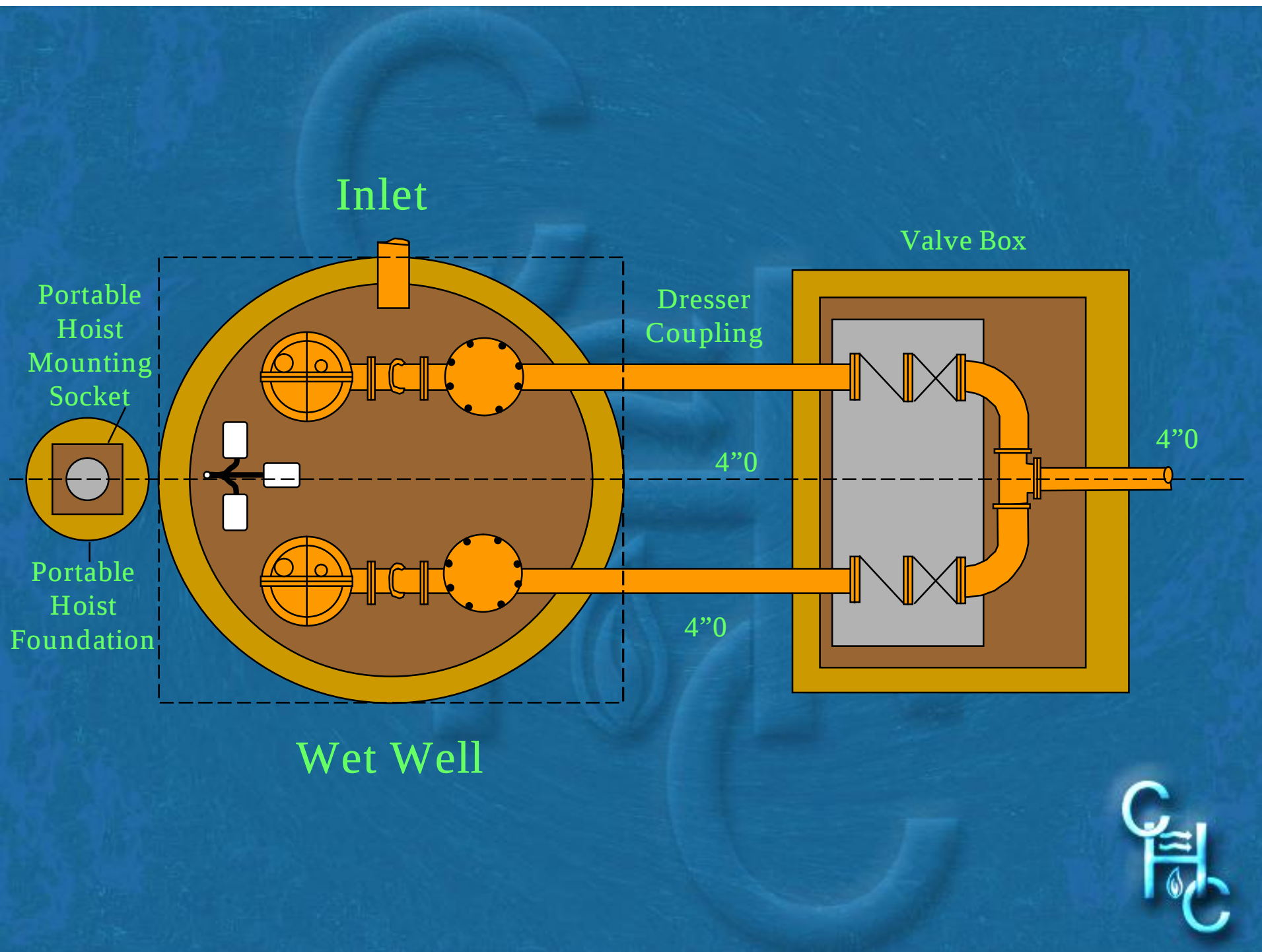
- Traffic Rated Cover
 - Parking Garage
 - Parking Lots
 - Access Roads



Discharge Piping

- Section 710.6 CPC:
 - Backwater valves, gate valves...unions...shall be located where they will be accessible for inspection and repair at all times....





- Motor/Panel Options:
 - Explosion Proof Motors
 - Intrinsically Safe Control Circuits



Intrinsically Safe

- Control Panel
 - Intrinsically safe control circuits
 - 9VDC Circuit inside floats

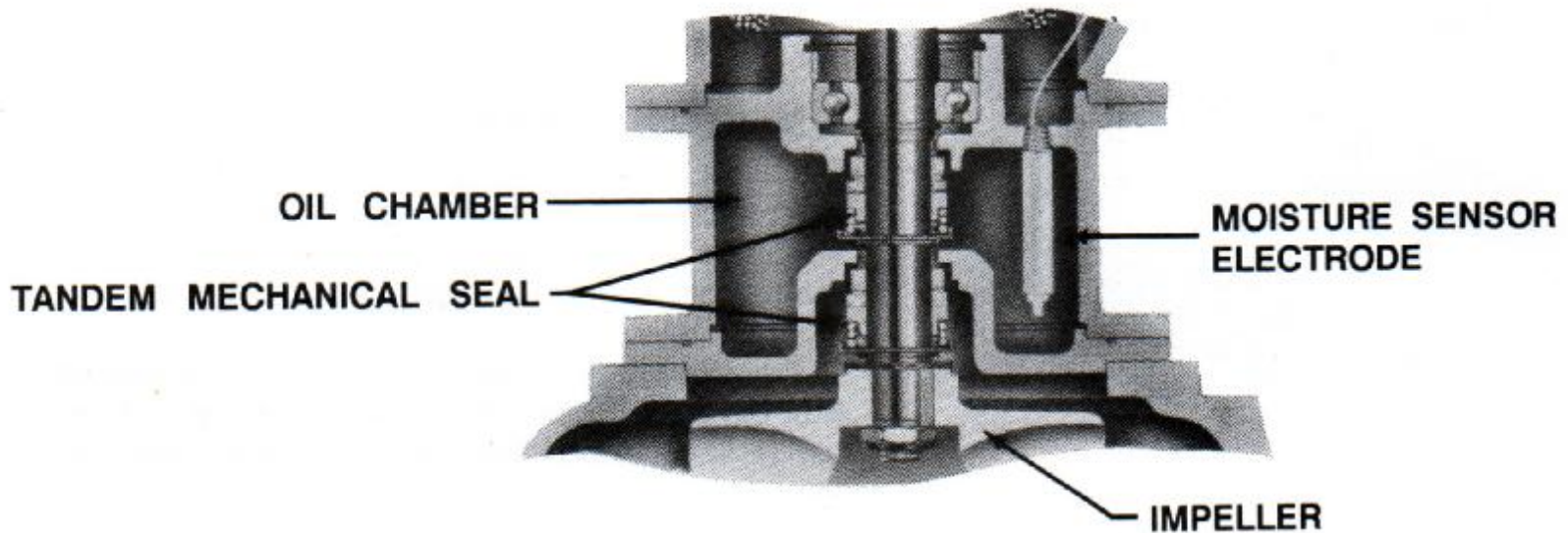


Motor Options

- Moisture Sensor
 - Used to sense failure of mechanical seal
- Temperature Sensor
 - Protect motor from overheating
- Explosion Proof
 - Required for Division 1 applications



Submersible Pump Options



**TANDEM SEAL
MOISTURE SENSOR DETAIL**



NorCal ASPE

Sewage & Sump Pumps

Thank You!

