Flat Land, Low Level Farm Drainage

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Florida Crystals
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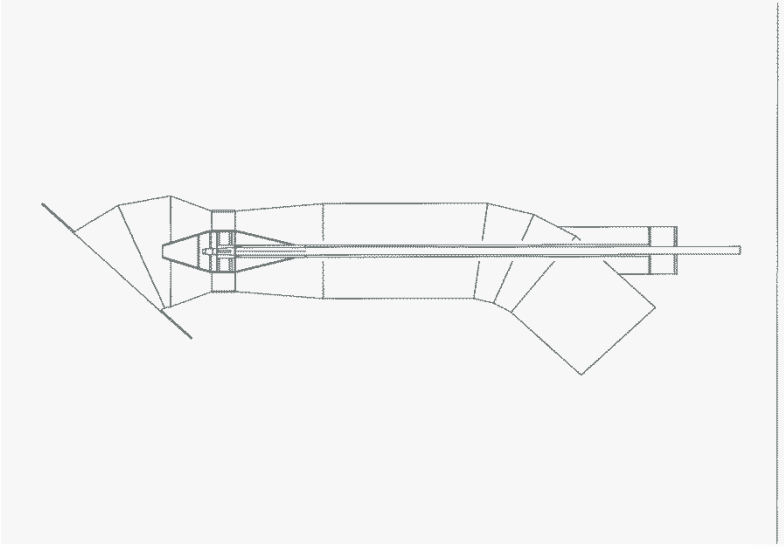
Pumping



- **Head**
- **Pump Size**
- **Power**
- **Discharge Arrangement**
- **Problems To Avoid**

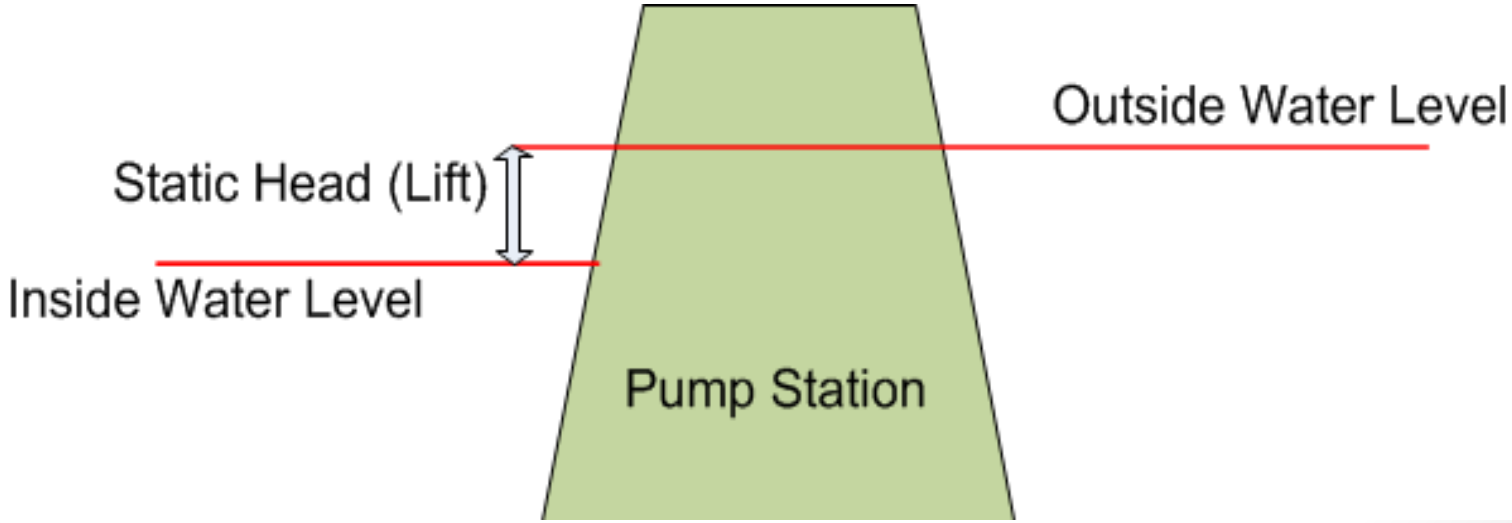
Pump Stations

Head From The Field To The Pump

- Start With The Desired Field Water Elevation, 8 Feet
- - .2 Feet For The Field Ditch And Field Culvert
- - .2 Feet For The Lateral
- -.2 Feet For The Lateral Culvert
- 1 Foot for the 2 Miles Long Main Canal
- -.4 Feet For 2 Crossings With Culverts
- **Yields A Pump Shut Off Or Hold For 6 Hours At Elevation 6 Feet**
- The Maximum Outside Water Level Elevation is 12.8 Feet
- A Maximum Static Head of 6.8 Feet For This Site
- The Pump Will Create This Lower Water Surface Elevation To Which Water Flows From The Farm

Static Head

- Static Head Is The Minimum Head Of The Pump Station
- All Other Head Elements Add To It
- **These Other Head Elements Should Be Controlled To The Maximum Extent Practicable**
- The Goal Is to Use Minimum Power



Average Condition Total Head

- From Pump Data I Had An Average Static Head of 4.2 to 4.6 Feet As Normal
- Add To That Velocity Head and Drag Created By Piping to Calculate the Total Head Sometimes Referred To as Total Dynamic Head
- That Is The Work Load (Head) For The Pump

- This Where The Pump Size And Configuration Is Selected To Minimize Power Input

Pump Size At Max Head

- ***30”***
- ***16,000 GPM***
- ***6.8’ Static Head***

- 9.11’ TDH
- 42.5 HP
- Fuel Advantage 27%

- ***24”***
- ***16,000 GPM***
- ***6.8’ Static Head***

- 11.99’ TDH
- 54.3 HP

The Same Pumps At Average Head

- ***30”***
- ***16,000 GPM***
- ***4.6’ Static Head***

- 6.91’ TDH
- 32.64 HP
- Fuel Advantage 37.6%

- ***24”***
- ***16,000 GPM***
- ***4.6’ Static Head***

- 9.79’ TDH
- 44.93 HP

Choosing lower velocity pump systems can save 25% or more of the fuel costs. Smaller pumps pushed to high velocities can be expensive when the fuel is considered.

Then, The Cost Of Power

- Currently Diesel Fuel Costs Compared to Electric Costs Will Give Electricity Approximately a 50% Advantage
- Using An Electric Motor If Electric Power is Available In A Multiple Pump Station Can Save Significant Money Because The Electric Pump Will Move 70% Of the Water In Any One Year At A 50% Cost Reduction Compared To Diesel Fuel

Diesel Power Curve

- A Diesel Engine Operated at Part Of The Rated RPM and Part Of The Rated HP Will Loose 12% to 25%+ Off Of Potential Best Efficiency

Electric Bottom Line

- An Electric Motor At Part HP will Loose About 7% of Potential Best Efficiency
- Add This to The Cost Of Power And You Will Realize The 50%+ Fuel Cost Advantage With an Electric Motor

- Caveat, Fuel And Electricity Prices Are Subject to Change.

Wire (Power) to Water Efficiency

1. A Comparison Of The Static Head To The Total Head
2. A Comparison Of Power Used For Different Pumping Configurations
3. What Configuration Uses Minimum Power?

What Is The Cost To Move Water Off Of The Farm? Assumes Efficient Pump Speed And Engine Speed And 75%+ Power Use
1,000 Acres, 17" Per Year, Avg. 6.9' TDH

Diesel @ Best Efficiency, $3.40/Gal, $2982/yr
Electricity Avg Cost $0.11/KWH, $1853/yr

KSU Irrigation Energy Cost
Kevin Dhuyveter

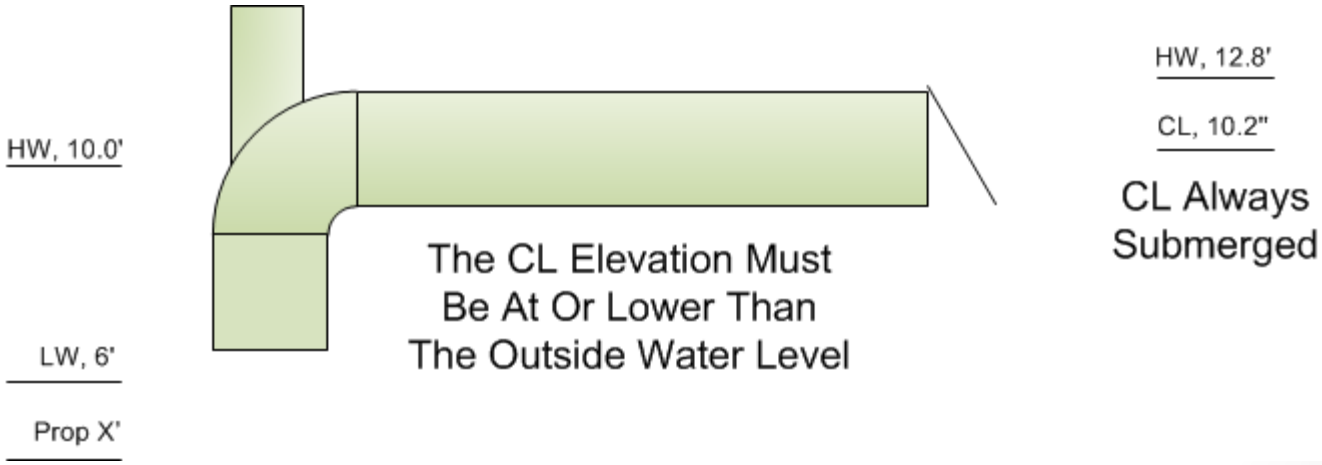
Other Fuels

- Propane as LPG (300 psi tank) is viable as it costs about a third less than diesel fuel and engines the use it are pre-certified by EPA and bypass the diesel engine tier system.
- Natural Gas is also useful for the same reasons.
- Many irrigation systems in the midwest have already converted to these types and away from diesel fuel and in some cases electricity.

Most did the change over for cost savings.

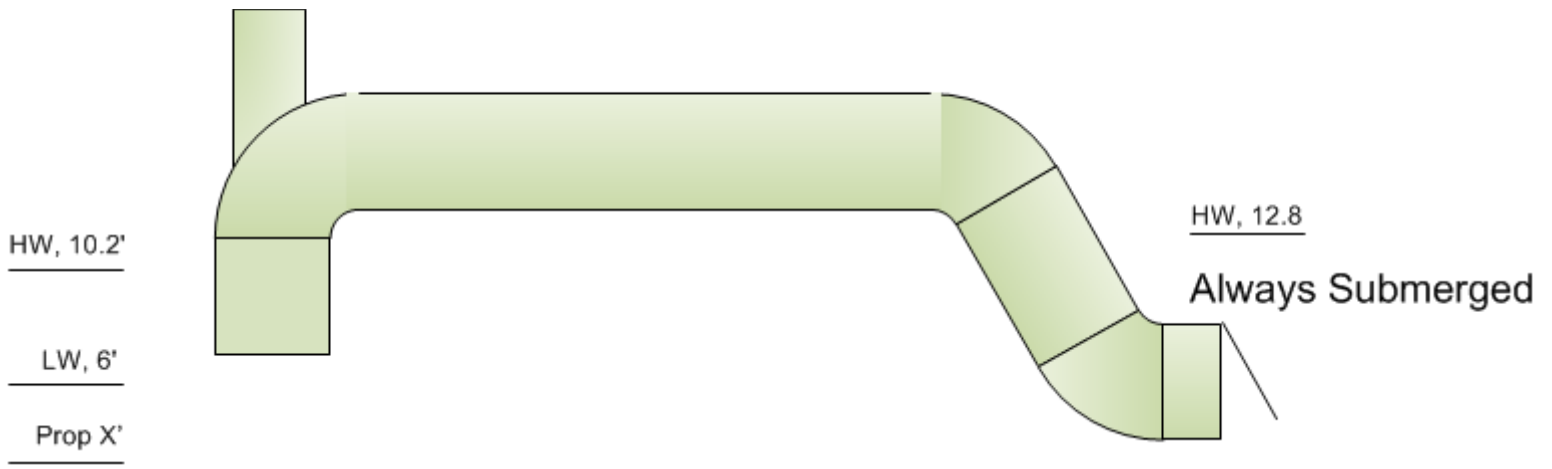
Discharge Method 1

- Submerged, Pipe Centerline



Discharge Method 2

- The End Of The regain Tube Is Submerged



Basics

- ***The Idea Is To "Lift" Push The Water No Higher Than Needed, "No Extra Head"***
- ***Method 1 Works Only If The Center Line Of The Discharge Pipe Is Submerged***
- ***Method 2 Works If The End Of The Regain Tube Is Submerged***

Regain Tubes, No Waste

Centerline Of Pipe, Low Risk Of Waste

Centerline Too High, 80% Power Waste Compared To Typical Systems

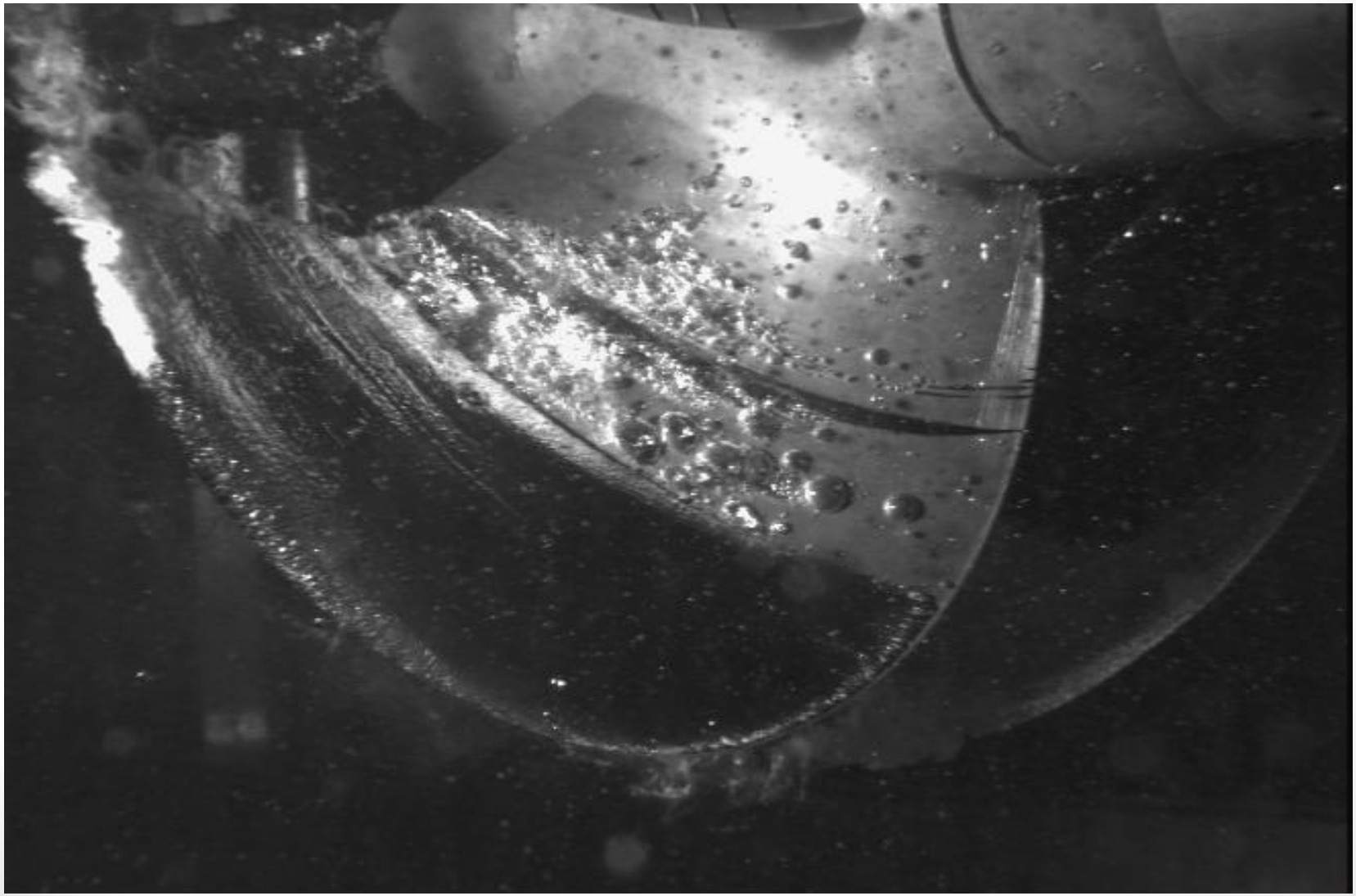
Air Impingement

- Photo, Tim Lang

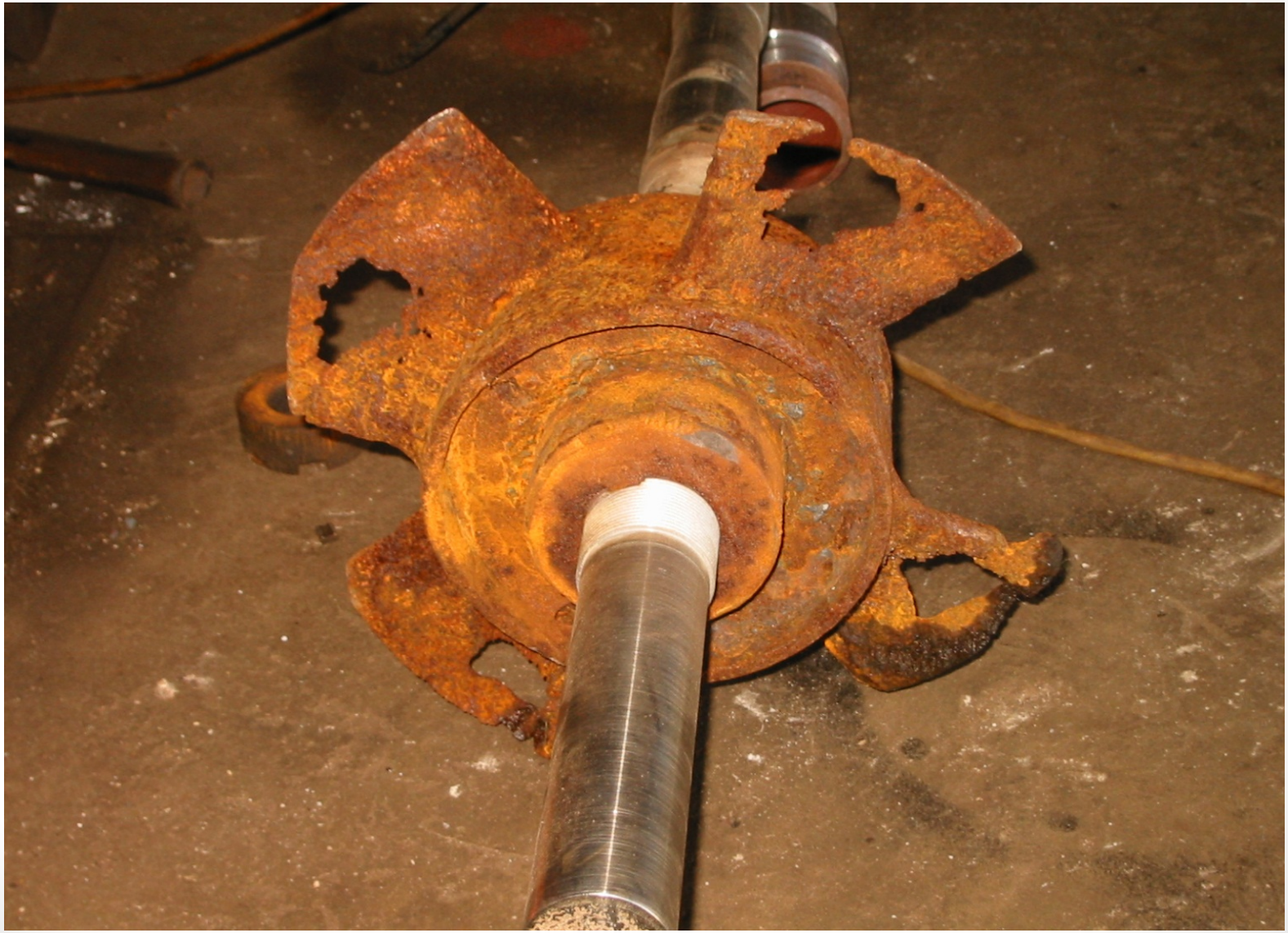
Air Impingement

- It Is Different Than Cavitation In That It Causes The Propeller A Loss Of Vane Vector. In Short, It Slips. The Causes a Constant Loading And Unloading Of The Driver/Propeller Resulting In Extreme Wear. All Components Go From Low Stress to High Stress Several Times Each Minute.

Cavitation



Cavitation Result



Cavitation Effect

- In Cavitation The Water Is Separated By -1 Atmosphere + Submergence – Vapor Pressure Causing What You See As Bubbles And May Hear As A Metallic Pinging. This Effect Causes A Loss Of Vector And A Loss Of Metal. This Loss Of Vector Can Happen At A High And Unstable Frequency.

Pump Mismount

- Expensive, The Entire Water Control System Is Likely In Need

Staff Gauge Leveling

Addendum

- This Is A Simple Method To Check And Adjust Staff gauges