

TOP TEN HASSLES IN WASTEWATER PUMPING

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September 10, 2015*

*Iowa WEA Fall Short Course
Marshalltown, Iowa*

Ten common problems in no particular order

Your troubles will vary

Problem #1: Clogging

1

There's no such thing as "non-clog"

Shall we go looking for unicorns, too?

Is this real life? Or is this just fantasy?



Anyone who insists that a pump is "non-clog" clearly hasn't seen the kinds of things real people dump down the drain

ANY pump can clog. Period.



What matters

- Resistance to clogging
- How quickly the pump can be unclogged
- How quickly the pump can return to service



Trash baskets

- People don't use them because they clog
- ...but then the pumps clog

Low pump speeds can reduce inlet velocities



And slow inlet velocities can lead to clogging

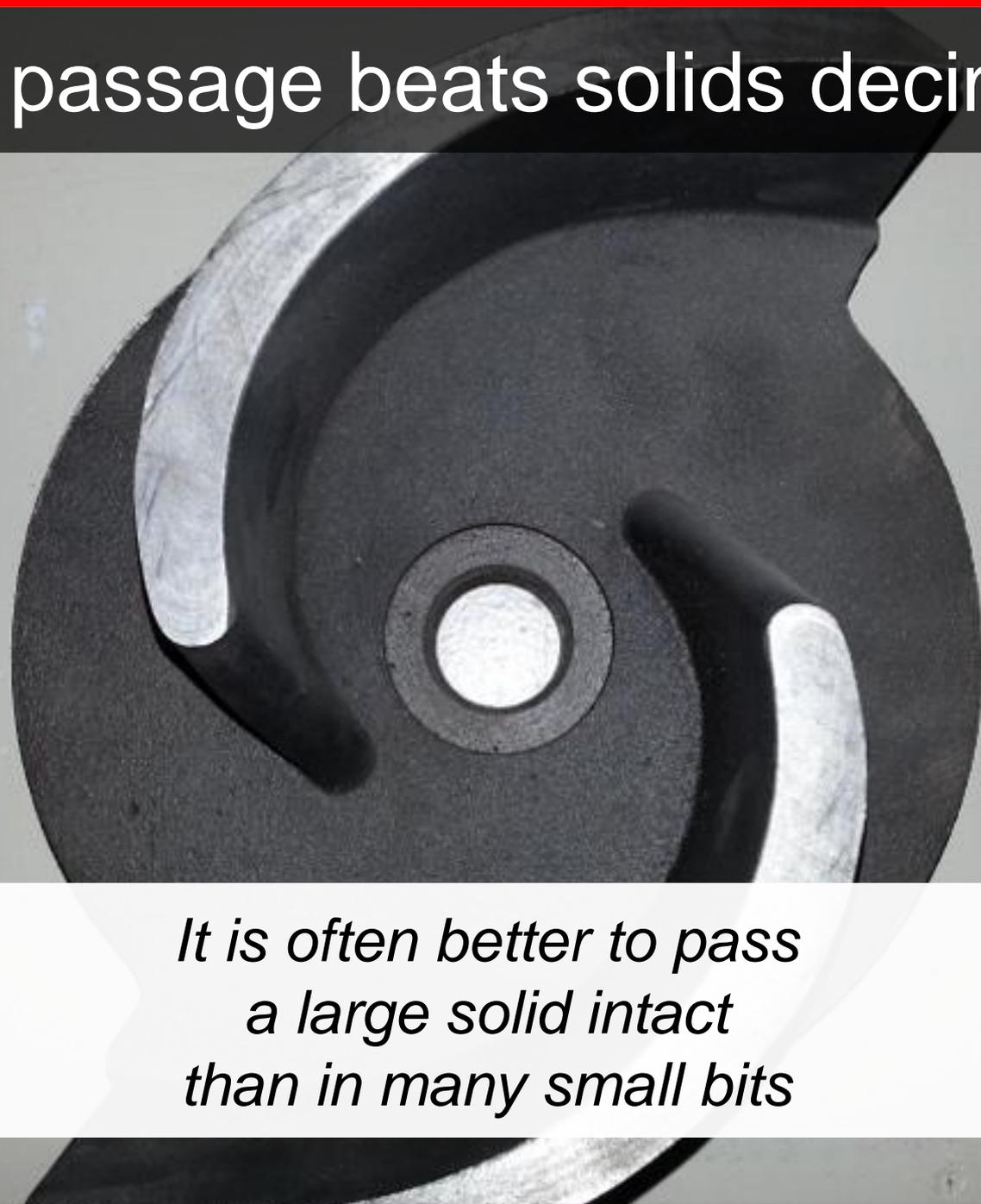
VFDs are not a magic pill

*They can be helpful in some cases,
but they risk running too slowly*

Use caution with shredders and grinders

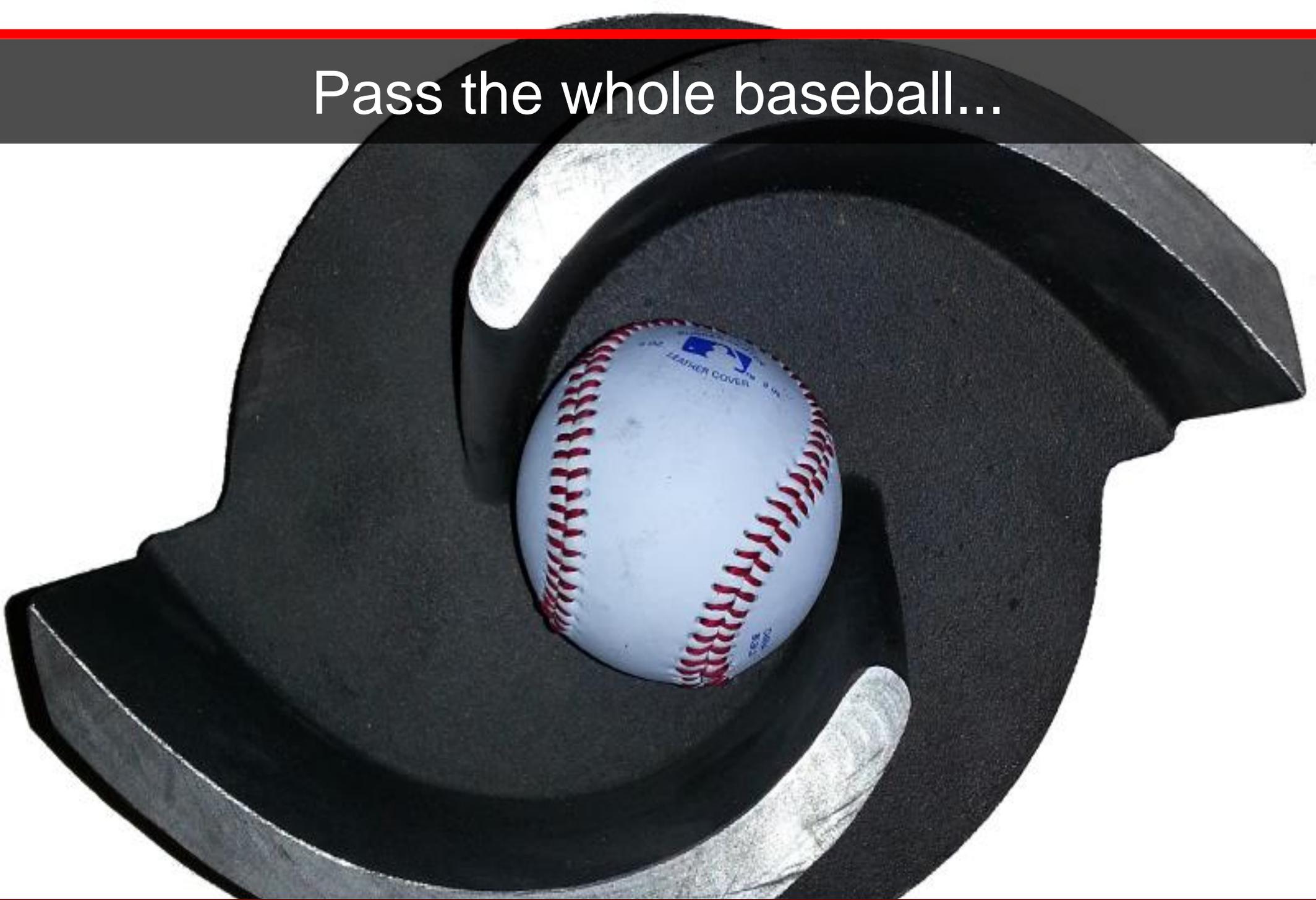


Solids passage beats solids decimation

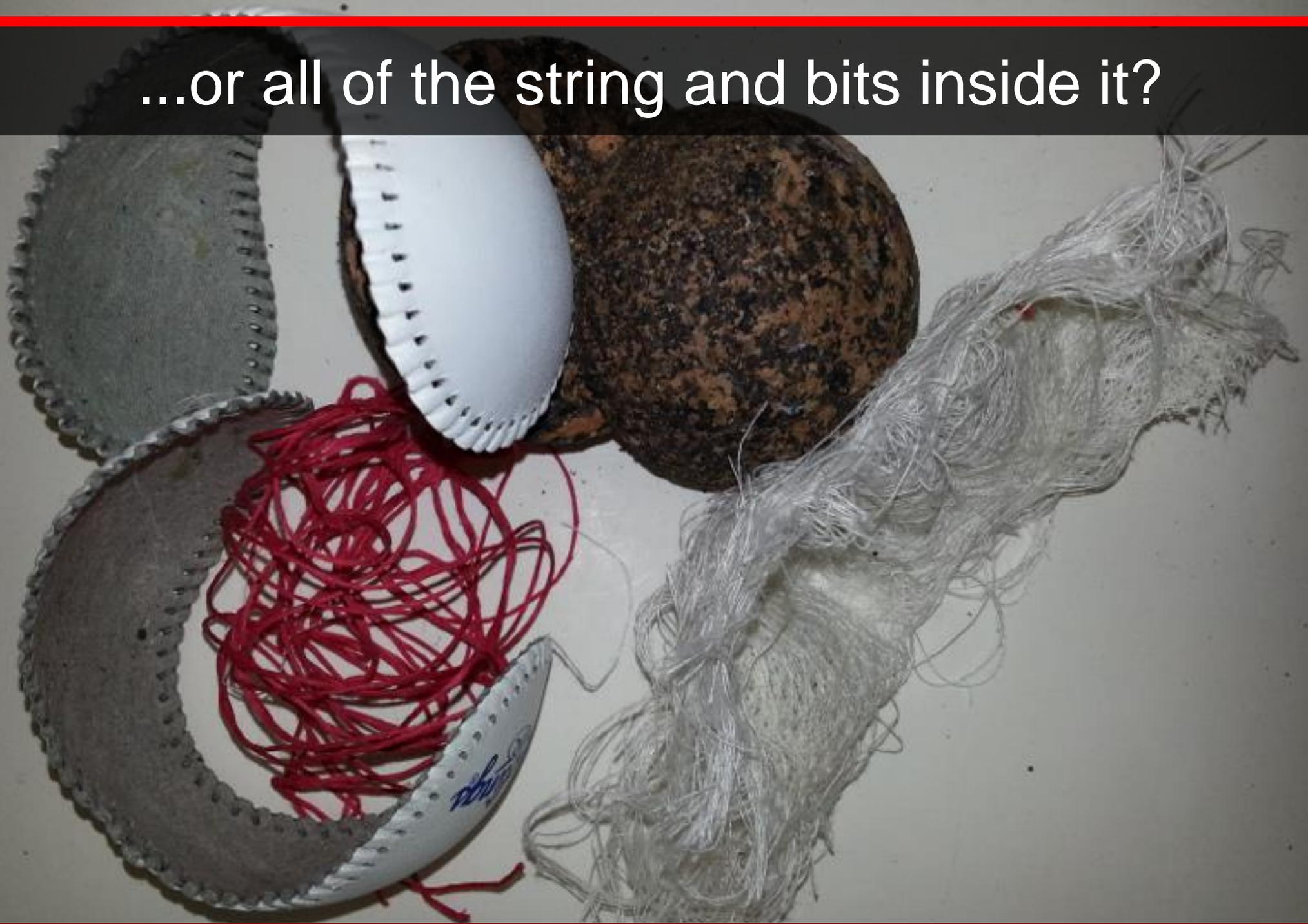


*It is often better to pass
a large solid intact
than in many small bits*

Pass the whole baseball...



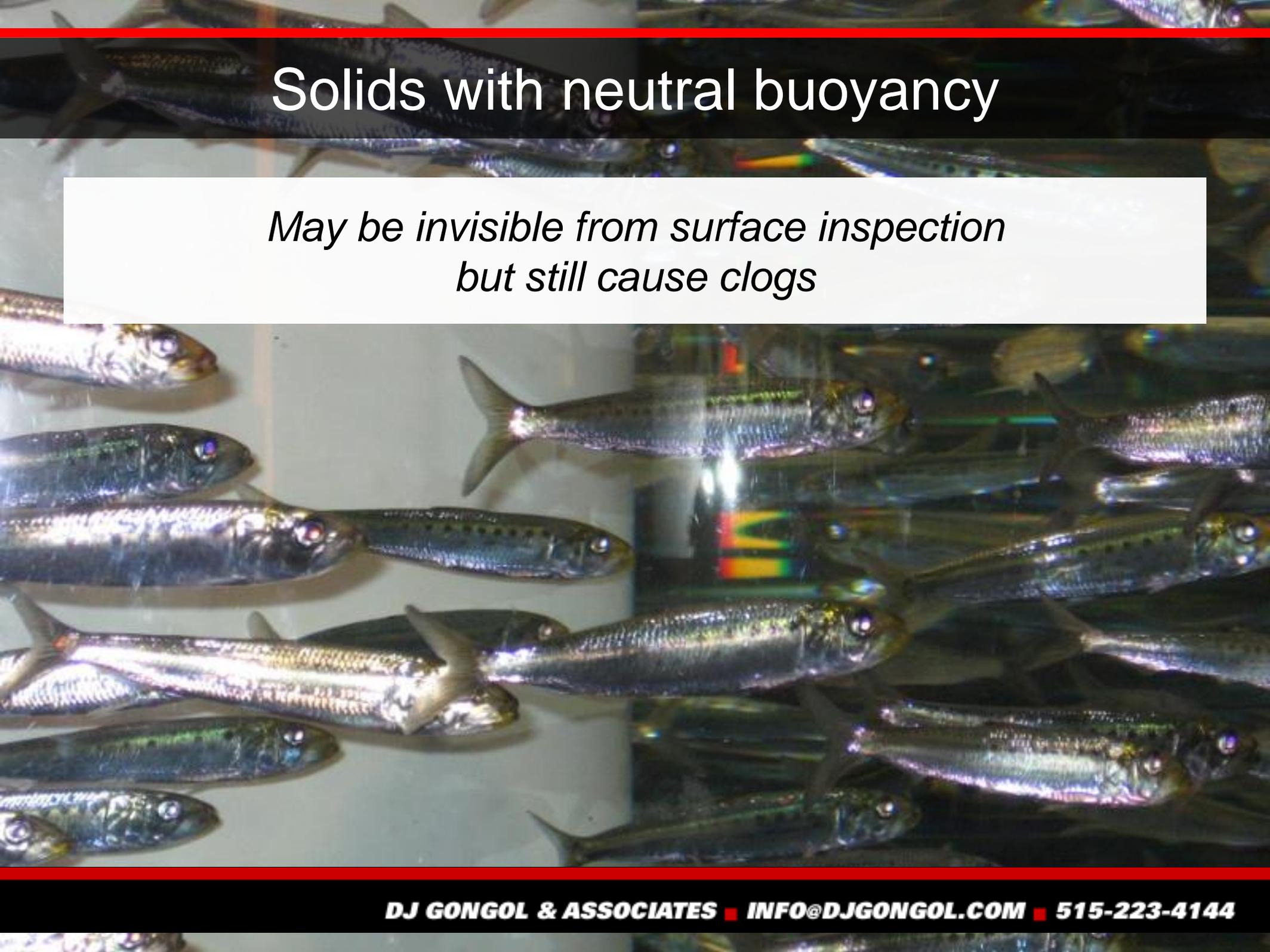
...or all of the string and bits inside it?



Small solids plus high FOG



A recipe for disgusting trouble



Solids with neutral buoyancy

*May be invisible from surface inspection
but still cause clogs*

A close-up photograph of a grey, frayed mop head wedged inside a yellow plastic bucket. The mop head is tangled and appears to be stuck, preventing it from being easily removed. The bucket's interior is visible, showing the yellow plastic walls and some mechanical parts of the bucket's design.

You can't prevent every clog

(Not as long as idiots can still flush mop heads)

Half-filled basketballs



Waterlogged wood



Drywall, insulation, and sheets of liner material

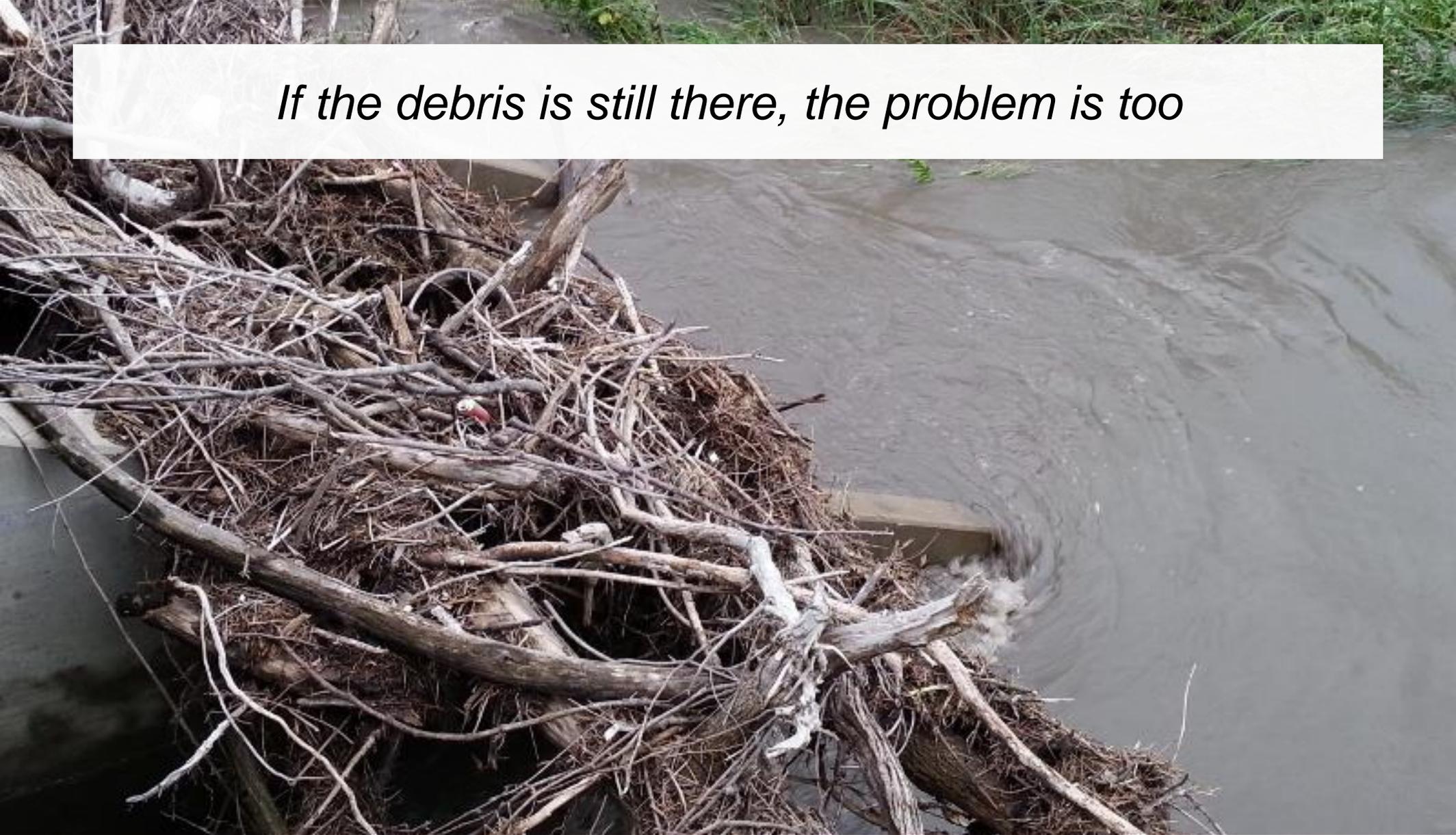


Storms will always bombard wetwells



Backflushing/jetting doesn't always solve it

If the debris is still there, the problem is too



Clogged suction piping may require cutters



Wetwells may require vacuum trucks



New pumps may clog when old ones didn't

- Better suction pulls settled material from the wetwell

Prevent clogs

- Make sure you have true 3" clearances
- Keep the wetwell clear
- Run pumps at appropriate speeds

But when clogs happen...

Ask: How quickly can you return to service?



How much does downtime really cost?



Total cost of a clog

- Cost of pump downtime
- Cost of extraction
- Cost of labor (service charges or your own time)
- Cost of transit
- Cost of unclogging
- Cost of parts
- Cost of bypass pumping if required
- Cost of sewer backup risk
- Cost of reinstallation

And one very important cost

- Opportunity cost of your time

Opportunity cost

- You might be a pump specialist
- You might be a jack of all trades
- Either way...

You have to place a value on your time



Opportunity cost

*The cost of doing one thing
when you could be doing something else*

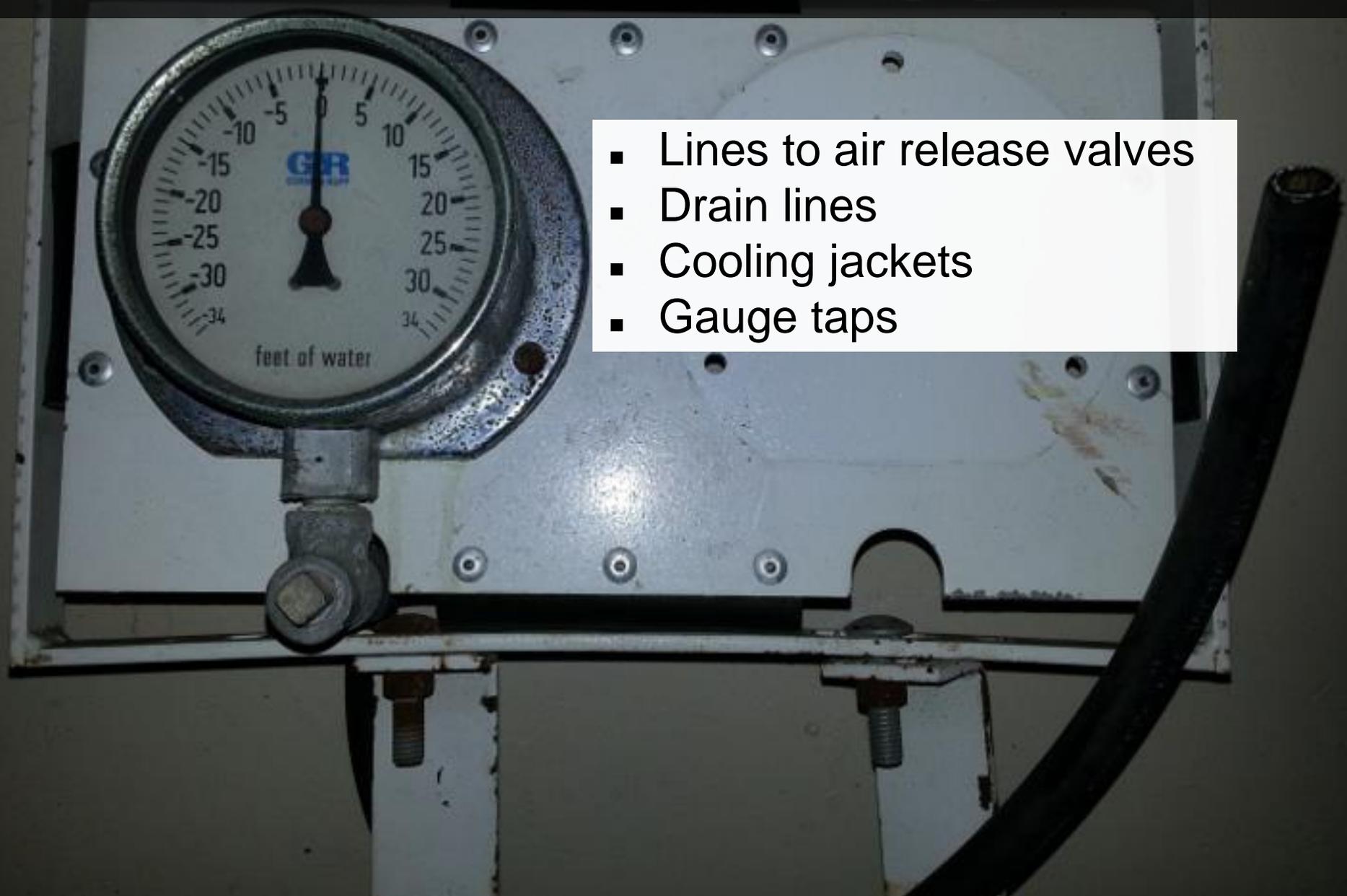


Real total costs

Real total cost =

+ out-of-pocket cost
+ labor cost
+ opportunity cost

Don't overlook other potential clogging sites



- Lines to air release valves
- Drain lines
- Cooling jackets
- Gauge taps

Little clogs, big headaches

- Rubber center of a golf ball
- Springs

Problem #2: Cavitation

2

Cavitation can occur on suction or discharge

Any centrifugal pump is at risk

- Submersible
- Flooded-suction
- Suction-lift

Cavitation cause #1

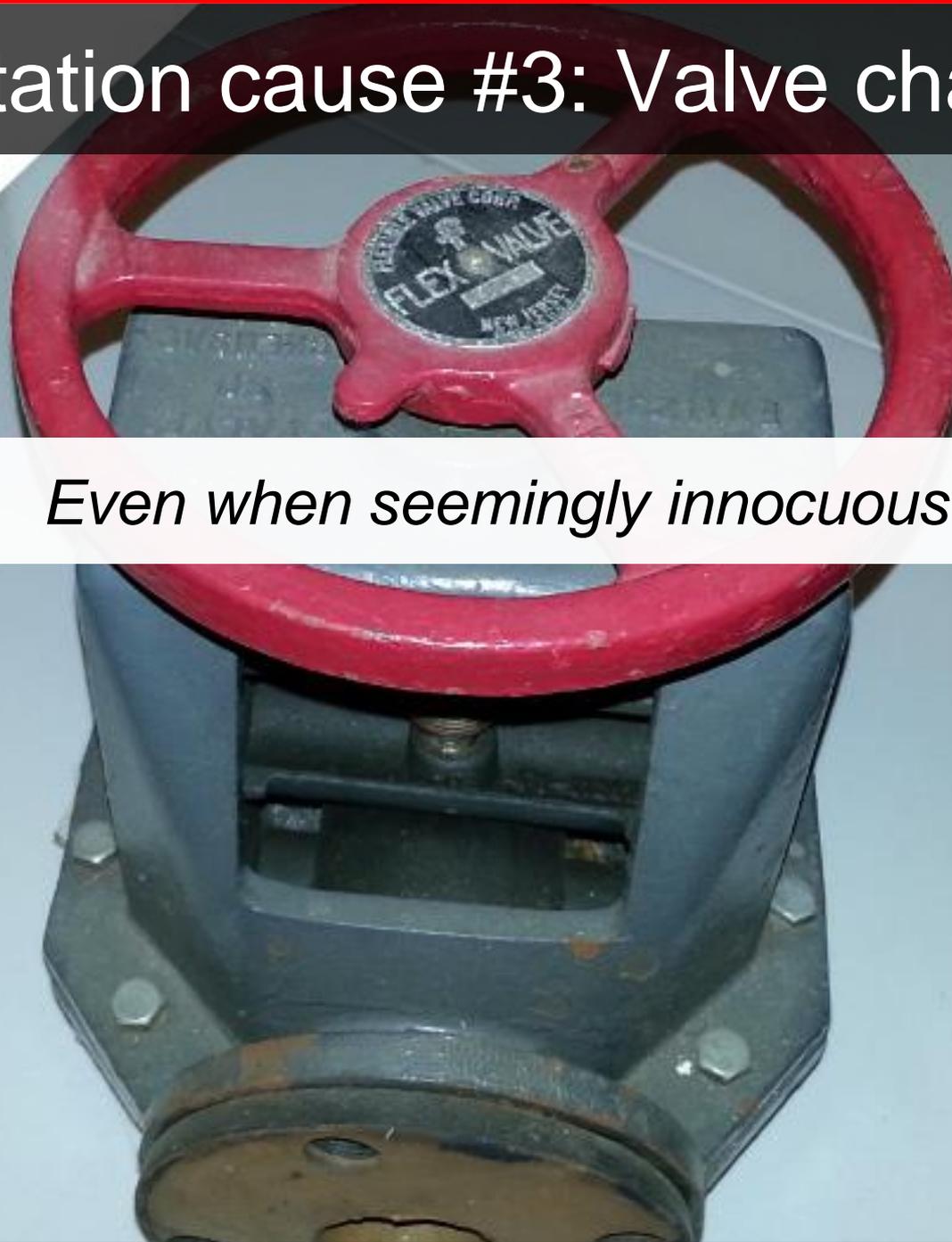
Errors in system design

Cavitation cause #2

- Pump clearances open up over time due to wear

Cavitation cause #3: Valve changes

Even when seemingly innocuous



Cavitation cause #4



Broken, damaged or closed ARVs on a forcemain

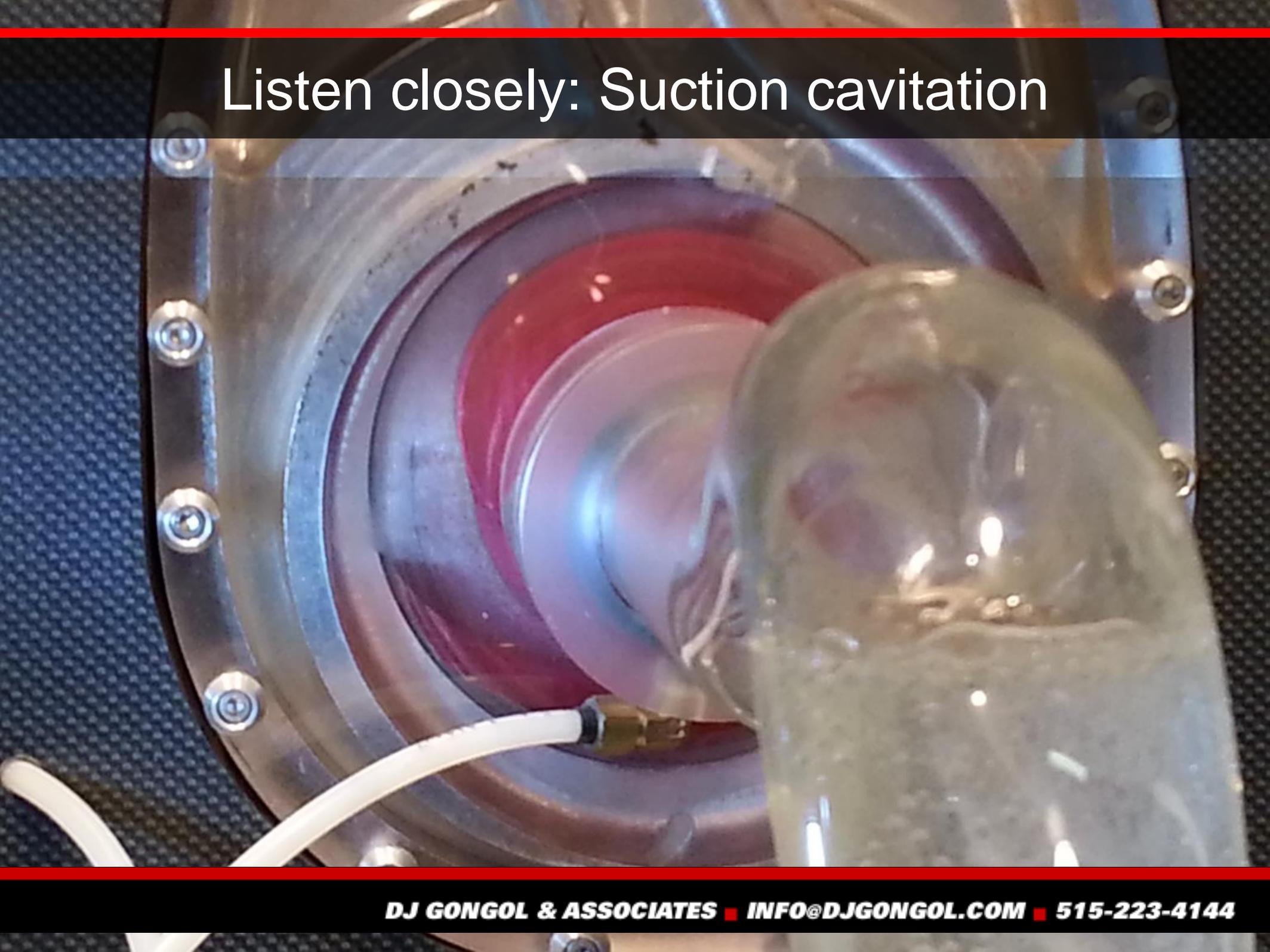
Cavitation cause #5

Force main constriction due to sedimentation or air pockets

Cavitation cause #6: Broken mains and valves



Listen closely: Suction cavitation



Listen closely: Discharge cavitation



Document performance with all of your senses

Or maybe all but one.



We use sight as a crutch

- Sounds, smells, and temperatures all matter

If you're at risk for cavitation

- Hardened parts can reduce wear
- Delays the pump from falling out of tolerance



Ask this

- How easily can the tolerances and clearances be maintained?

Identifying cavitation by autopsy



Discharge-side cavitation

Identifying cavitation by autopsy



Suction-side cavitation

Uniform abrasive wear isn't cavitation



Problem #3: Animals, vermin, and nature being a jerk



Warm, protected spaces are attractive



Seal your gaps with gaskets

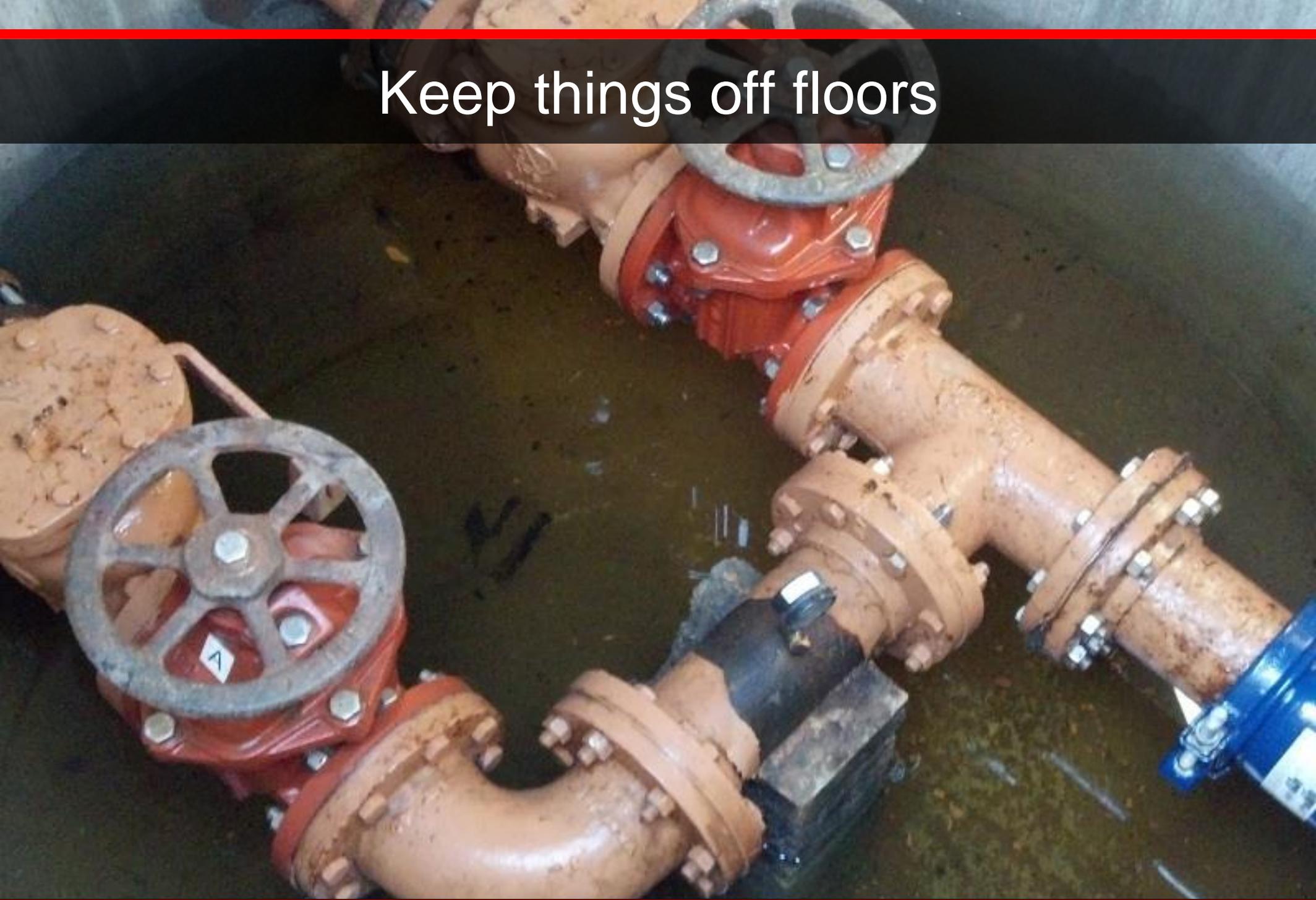
Keep doors closed

If we are
Closed - just slide
your money under
the door.

Patch holes



Keep things off floors



Containerize with plastic

Bubble Wrap (L)

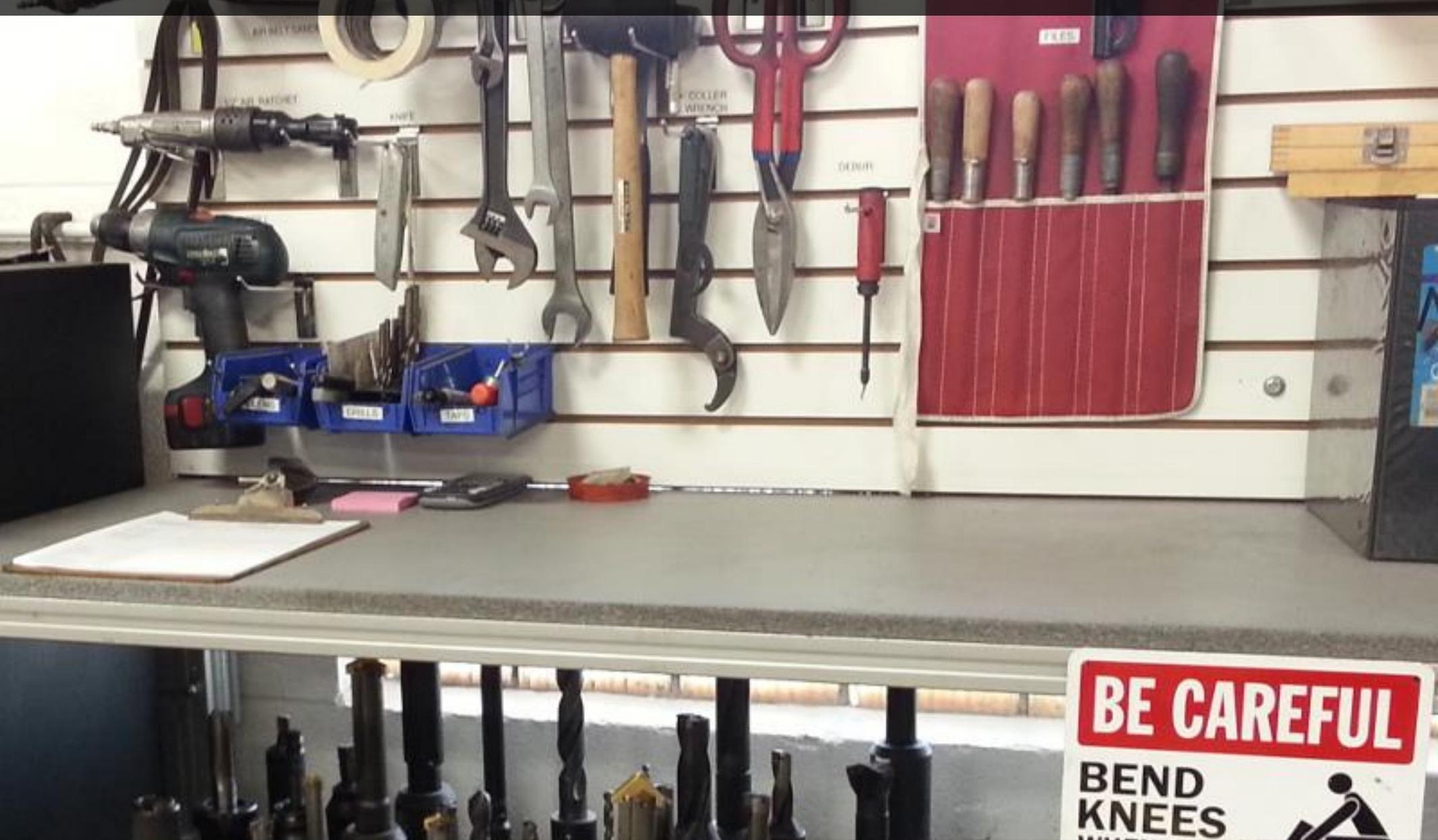
Packing Peanut

Containerize with plastic

Avoid wood, cardboard, and metal

Sweep and clean up

A place for everything; everything in its place

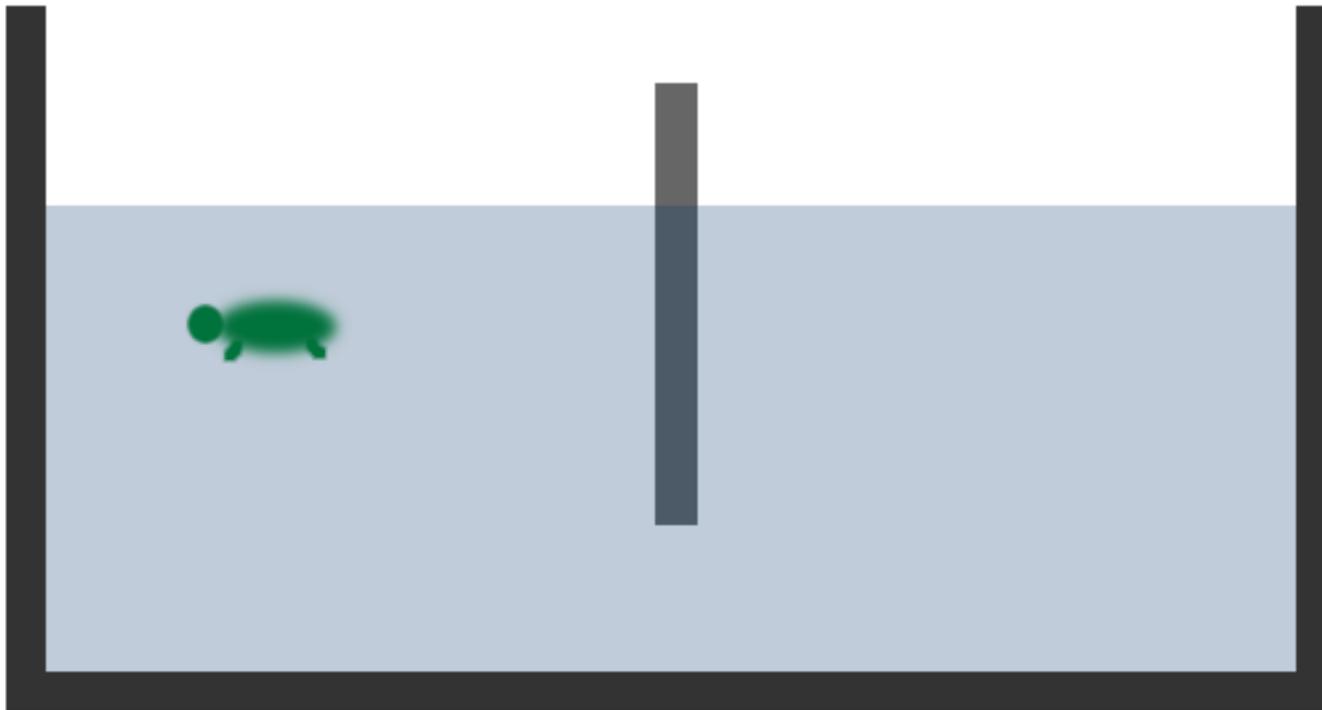


Natural enemy: Muskrats

- Swim into warm wetwells
- Get sucked up into pipes and pumps (they're squishy)

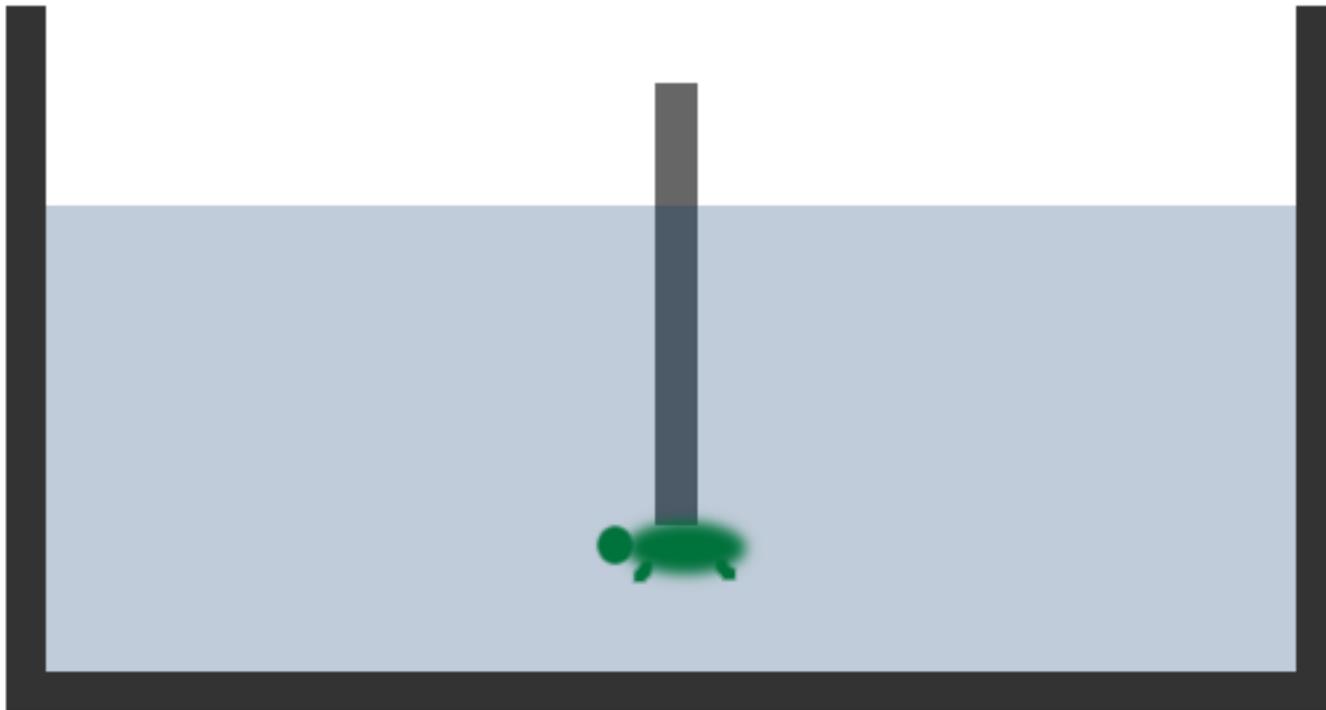
Natural enemy: Turtles

- Swim into warm wetwells



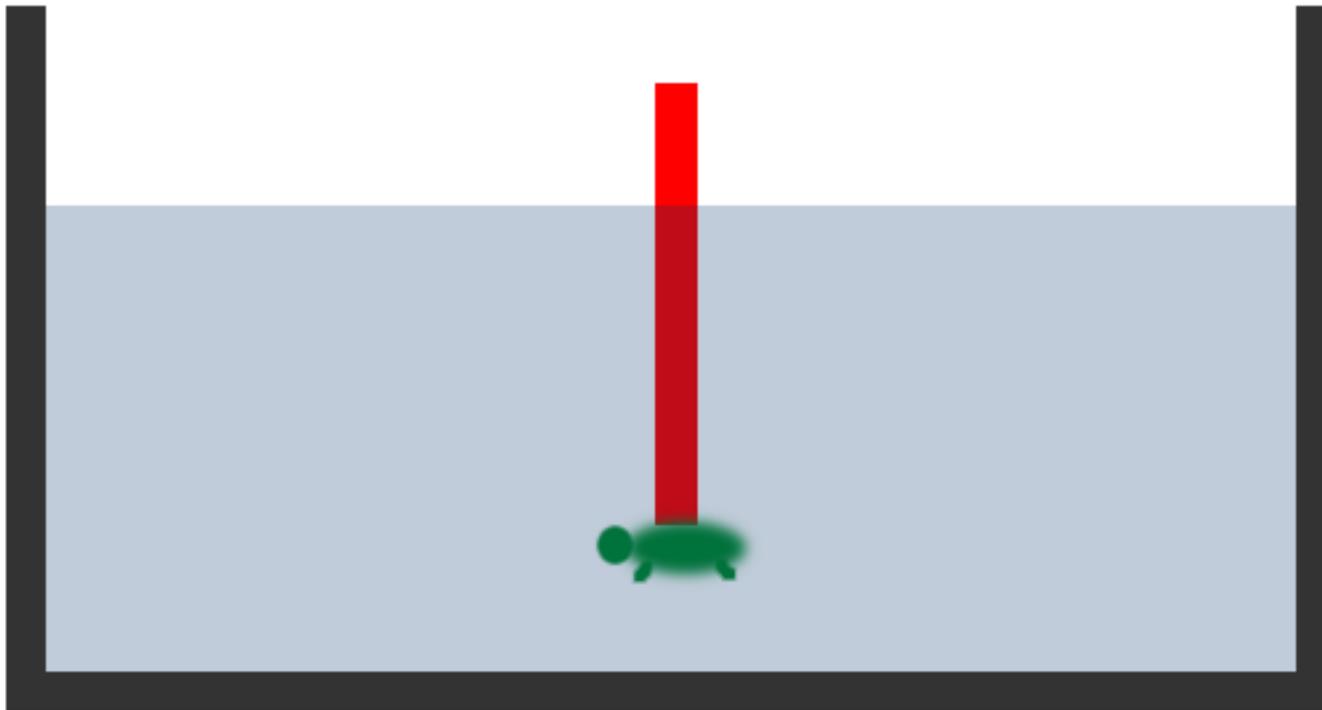
Natural enemy: Turtles

- Block off suction inlets



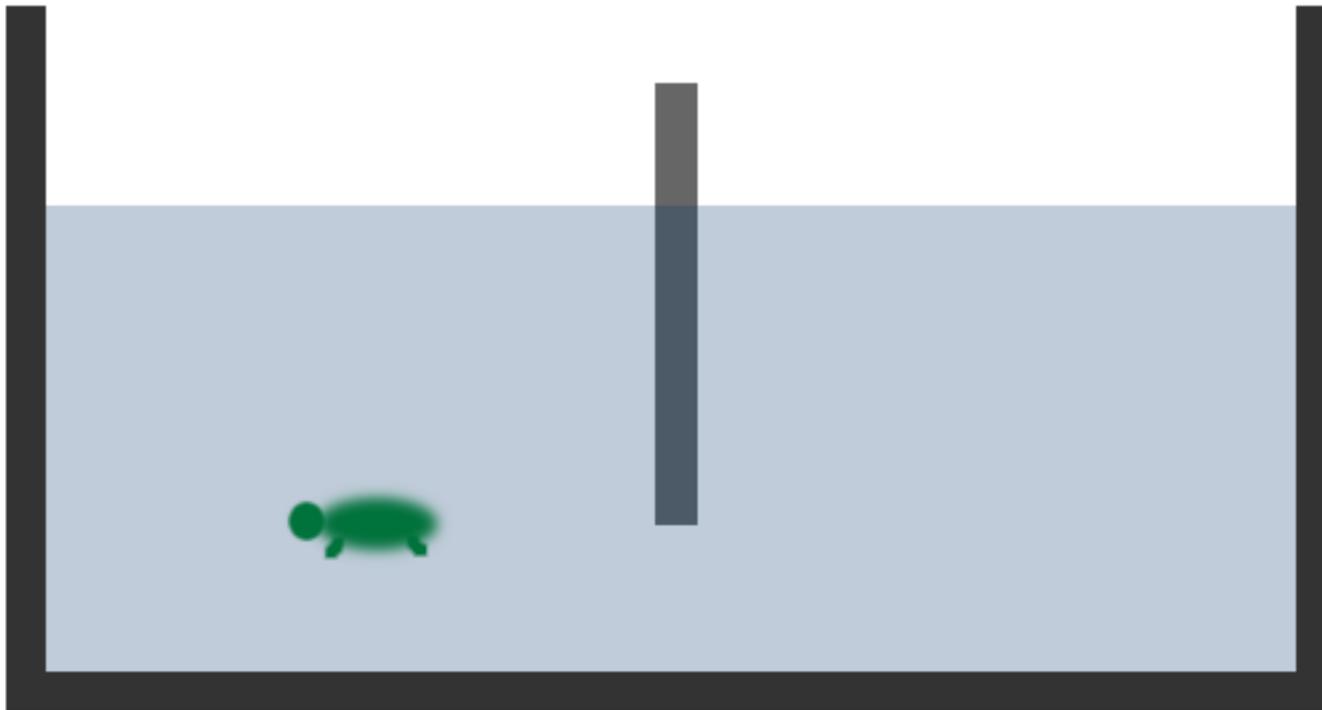
Natural enemy: Turtles

- Cause pumps to overheat and shut down



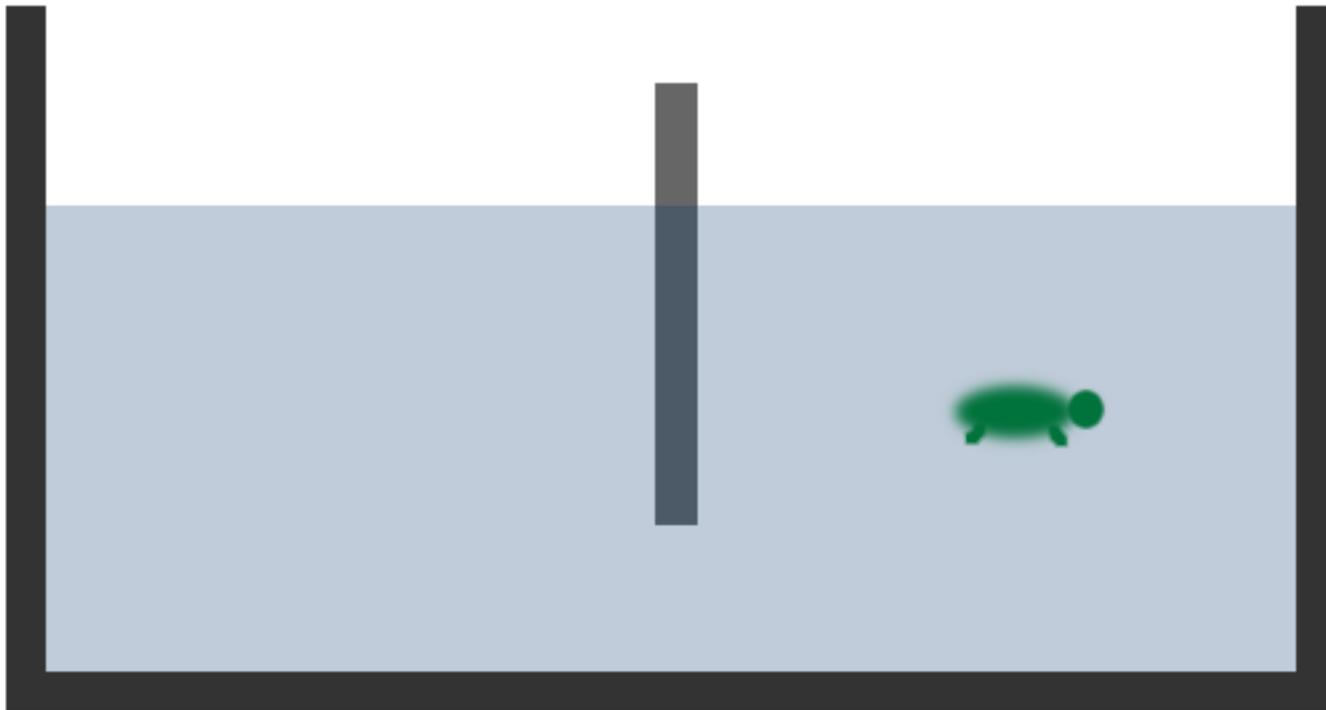
Natural enemy: Turtles

- Swim away once the lag pump lowers the wetwell to the off-elevation



Natural enemy: Turtles

- The operator gets the call, runs out to the station and can't find anything wrong



Natural enemy: Rattlesnakes

- Southern and Eastern Iowa

Natural enemy: Bees, wasps, and hornets



Natural enemy: Spiders



Ask: Can we really keep the pump station clean?

Problem #4: Lubrication

4

Seals

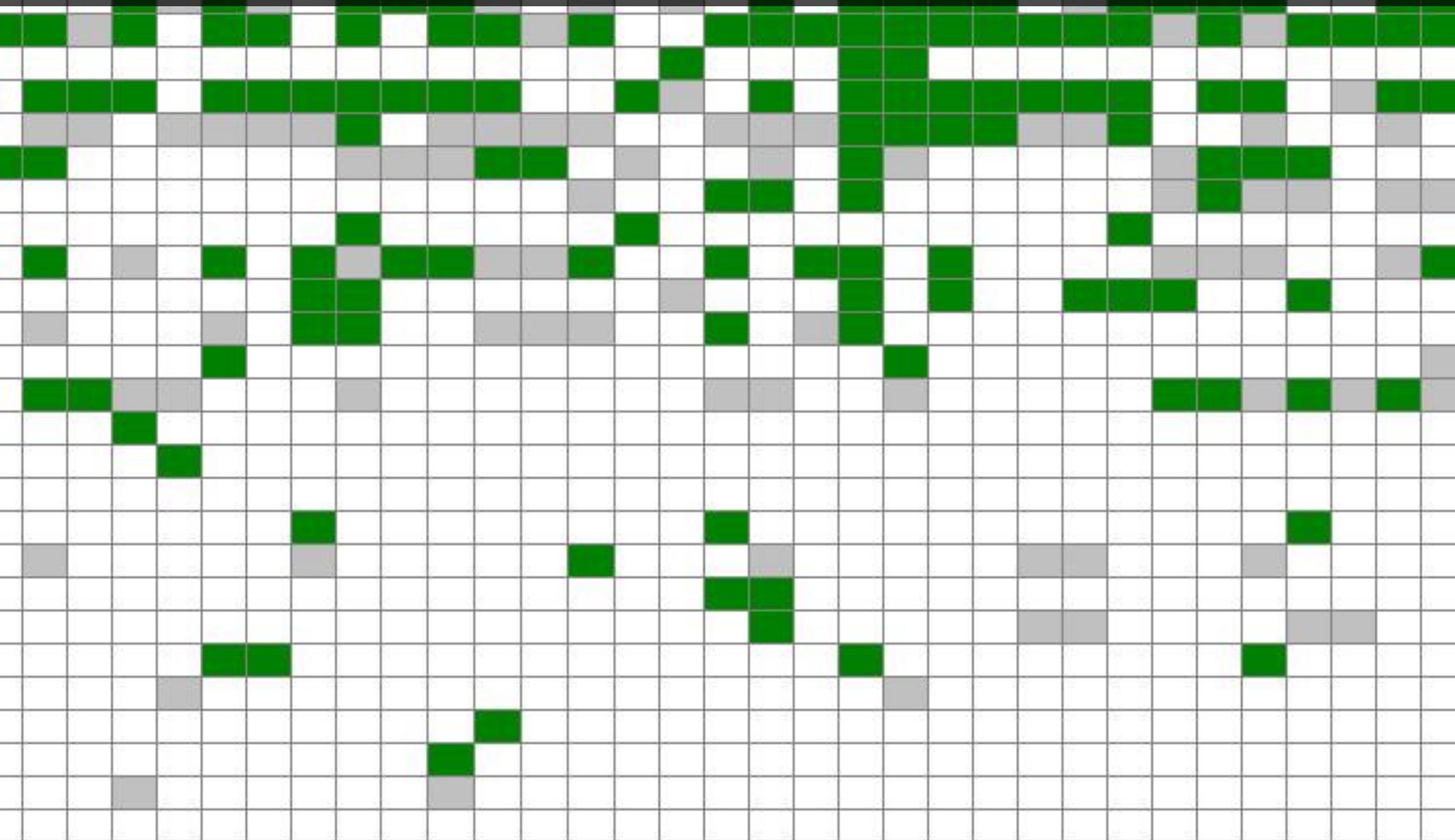
- Oil-lubricated
- Grease-lubricated
- Water-lubricated
- Lubrication by media

Bearings

- Oil or grease

Maintenance charts

Treat it like a bowling scorecard



Clean up spills



Use simple checklists

Oxygen Masks & Regulators..... ON, 100%
Crew Communications ESTABLISH
No Smoke & Seat Belt Signs ON

Continental Airlines B737-300/500 Quick Reference Handbook

TWO ENGINE FLAMEOUT CHECKLIST

IMMEDIATE ACTION:

Start Switches..... FLIGHT
Start Levers CUTOFF
Start Levers (After EGT Decreases)..... IDLE

UNCOMMANDED RUDDER YAW OR ROLL

Rule of 7



Problem #5: Seal failures

5

Cause: Debris like sand and grit



Cause: Alignment problems



Factory-aligned
on base

V-belts are
forgiving

Cause: Mechanical vibration



Cause: Hydraulic imbalance

Ask: Can I replace my own seals?



Keep pump stations clean

You can only see what's wrong
if you know what looks right



Problem #6: Motor failure



Power surges and lightning strikes



Excessive starts per hour

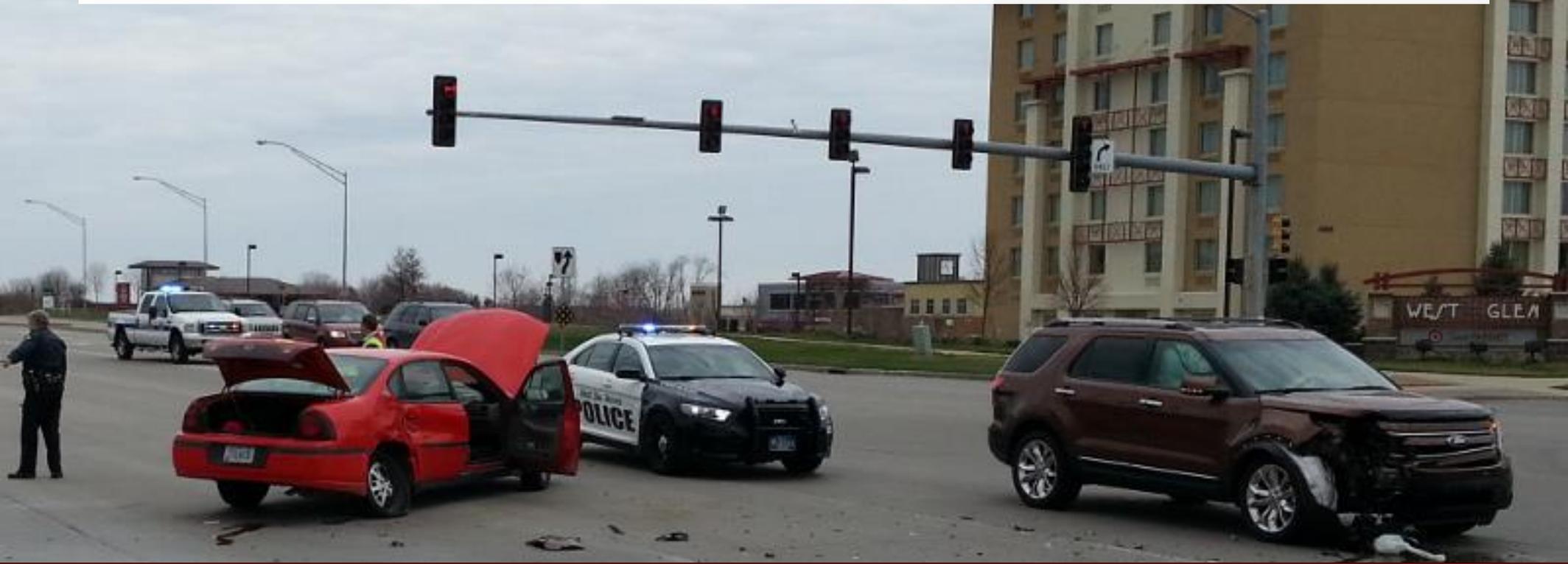
Mice building nests in motors

Car accidents can cause pump problems



Car accidents can cause pump problems

- Power line comes down
- Power company changes transformer
- Phases get reversed
- Motor runs backwards, leading to half or zero flow overnight



VFDs at a distance

- VFDs more than 100' from the motor can cause reflected waves

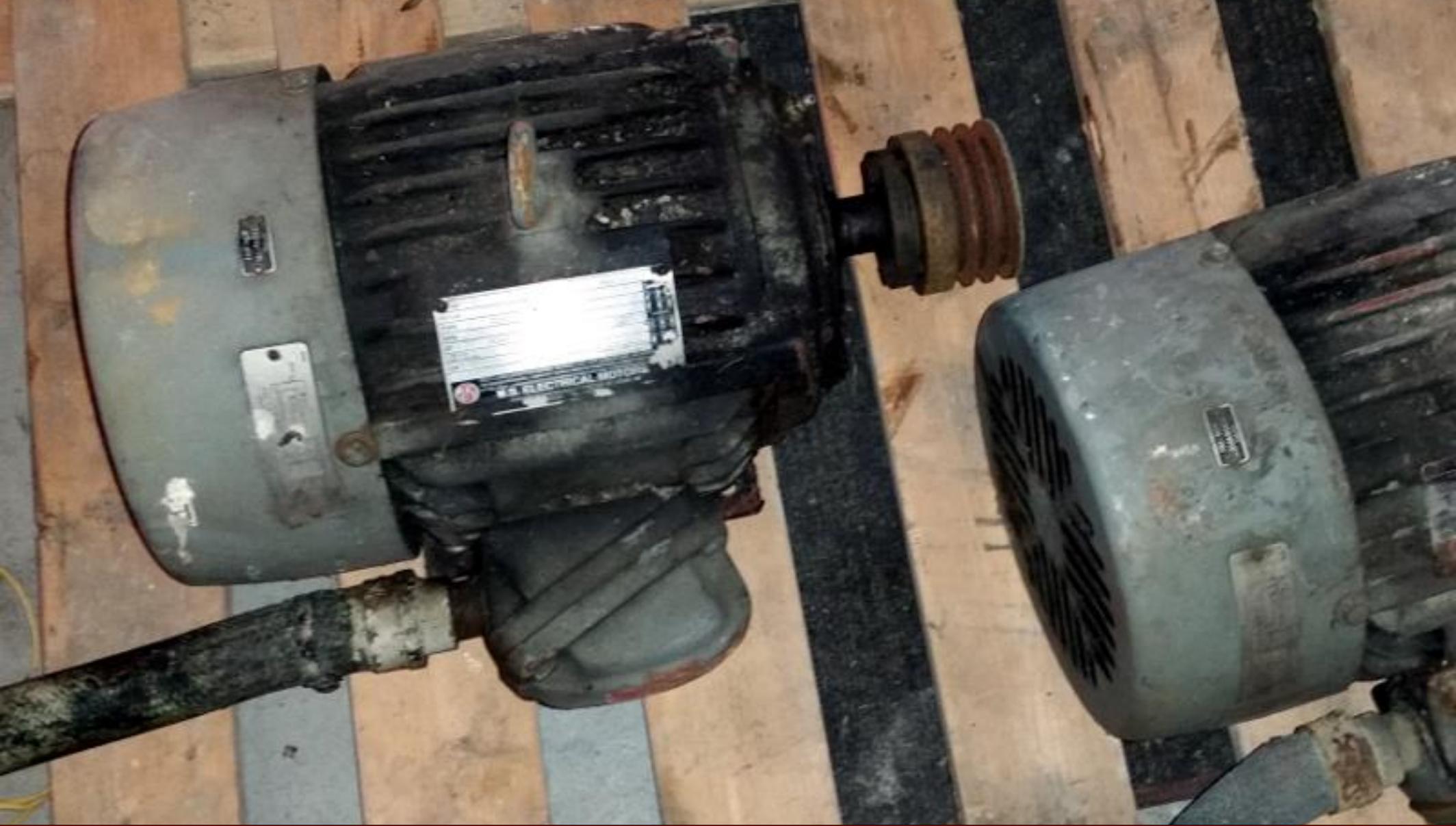
Use infrared temperature sensors to track

Know the motor's lubrication requirements

INTEGRITY
COUPLING.
BRUSH FROM SHAFT.
NG AND SHAFT.
G BRUSH TO MAKE

406255-339-A

Ask: Are replacement motors readily available?



Ask: Are the sensors useful?

- Do moisture sensors give you time to react?

Problem #7: Temperature problems



Overheating...and freezing

Proper ventilation for summer and winter



Heaters are cheap



Frozen water-line epidemic of 2014



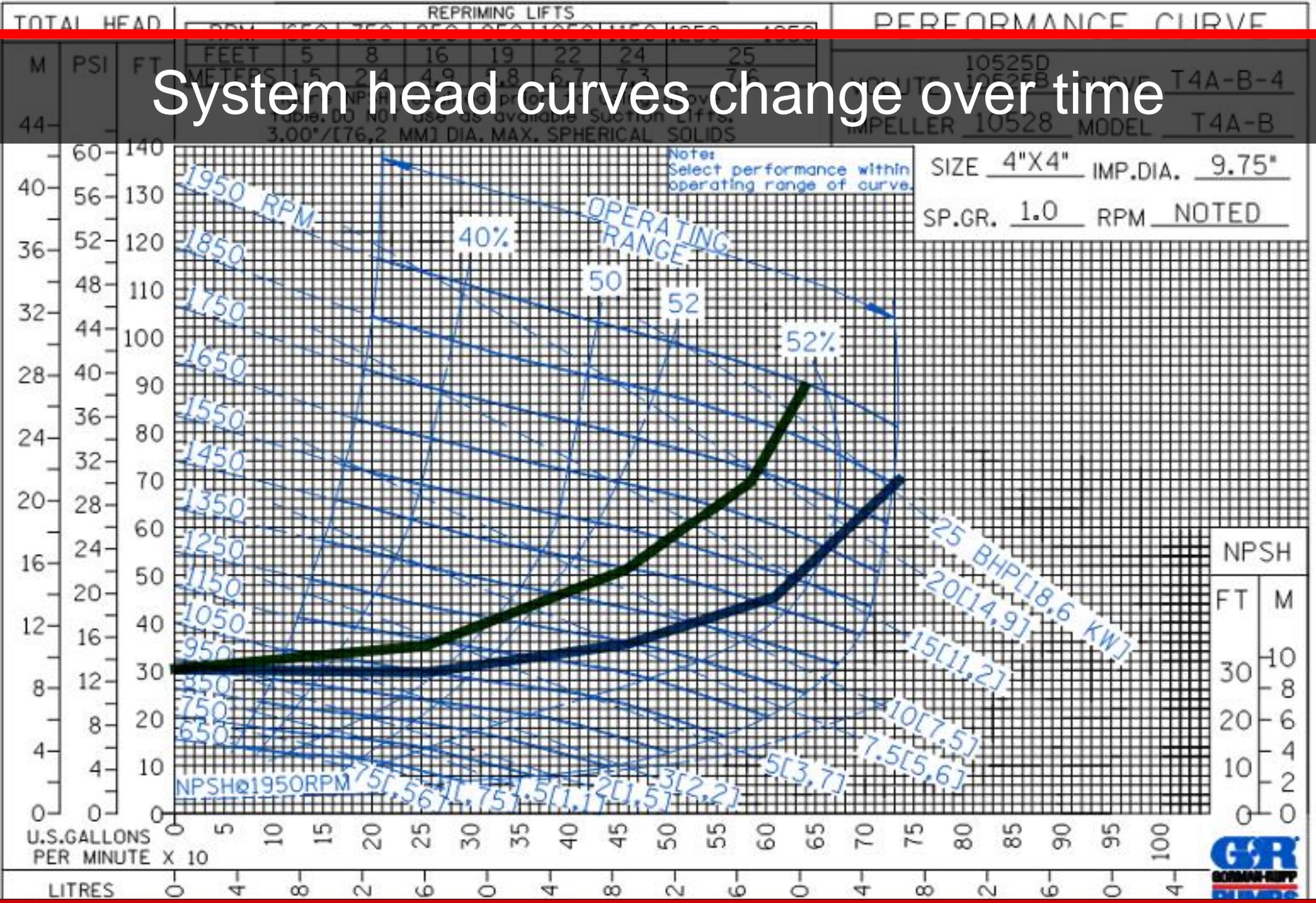
*Don't waste a good crisis
that was widely experienced*

Ask: Are we using the right enclosures?

Problem #8: System changes

8

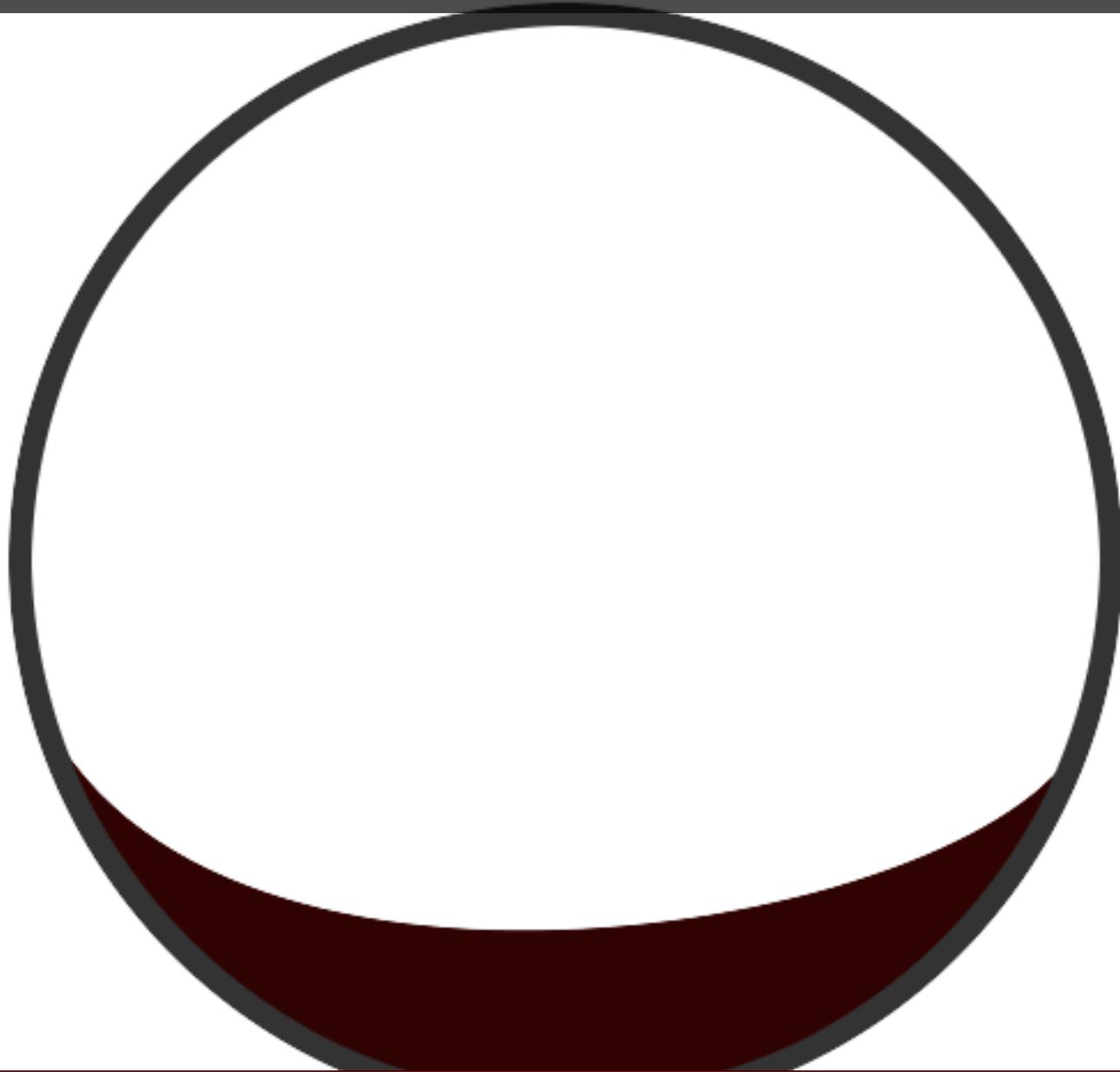
System head curves change over time



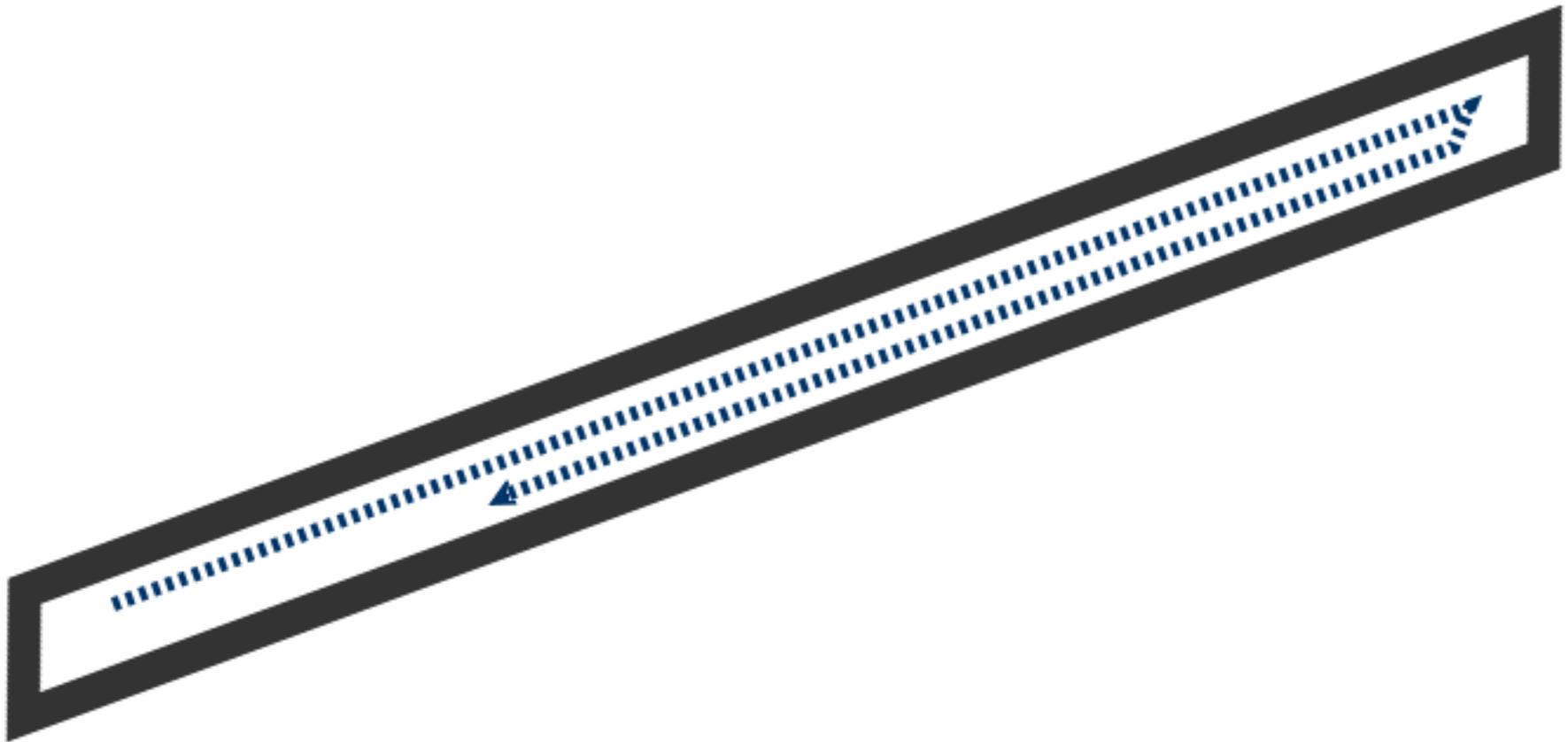
Wear can cause pump performance to change



Sedimentation adds to friction losses

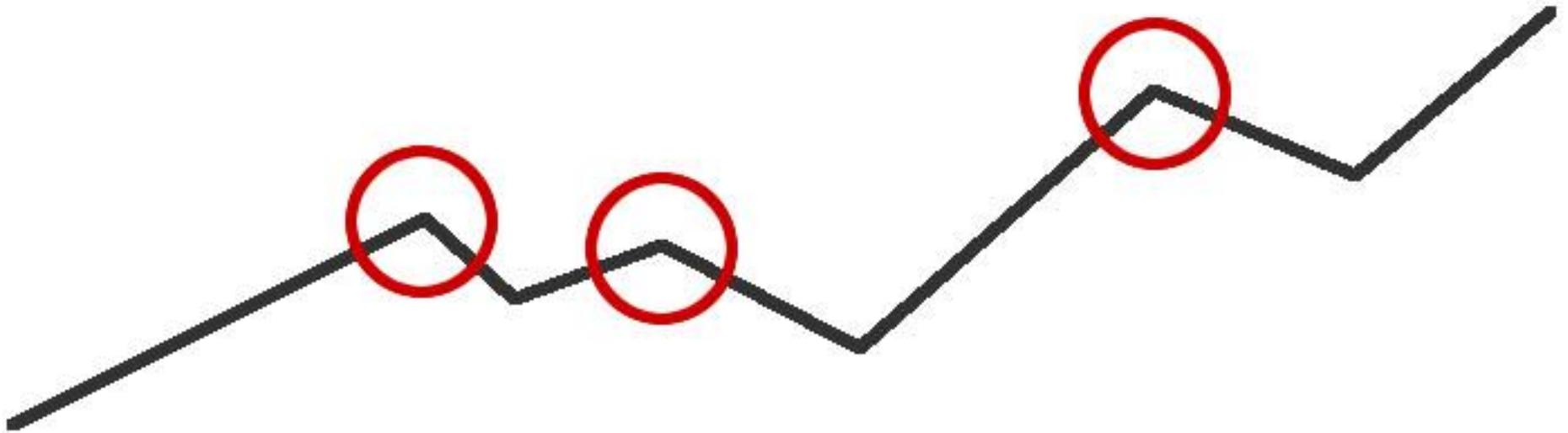


Water hammer can break valves and pipes

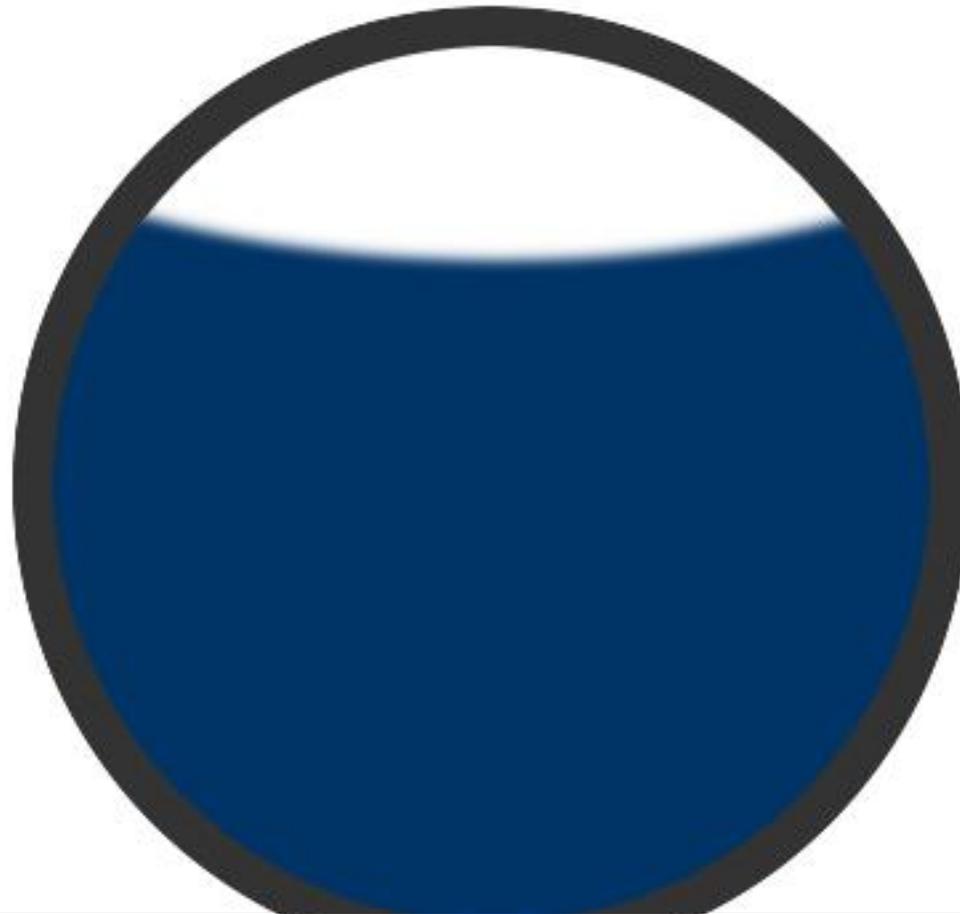


Ask: Is the system protected against surges?

Air buildup where ARVs should be installed



ARVs can fail, raising discharge heads



Ask: Do we have ARVs and surge valves?

Document performance on a pump curve

Problem #9: Vortexing and air entrainment

9

All centrifugal pumps are susceptible



Pumps are meant to move water



If you need to move air, get a fan

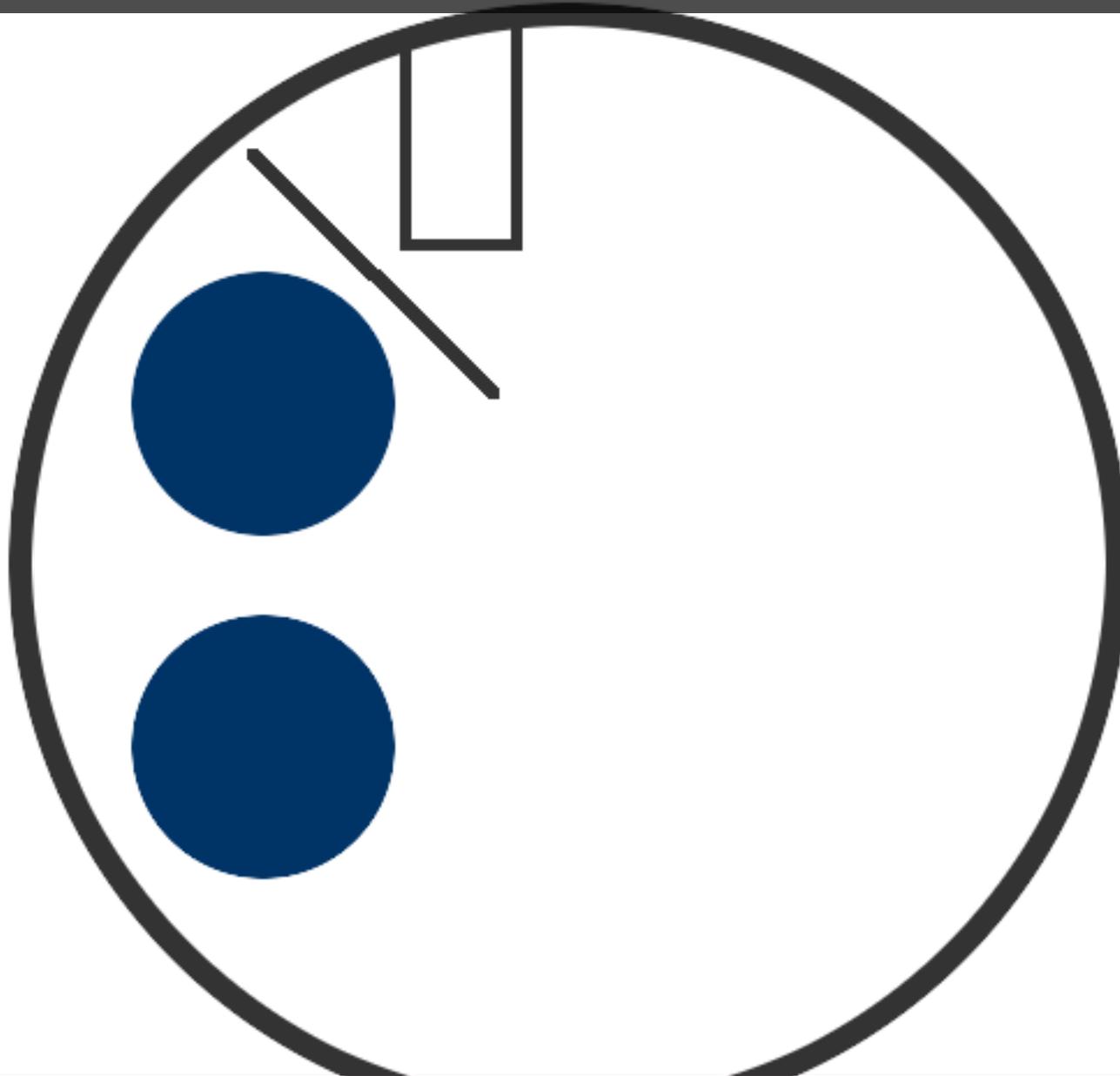
Air leads to irregular shaft loads



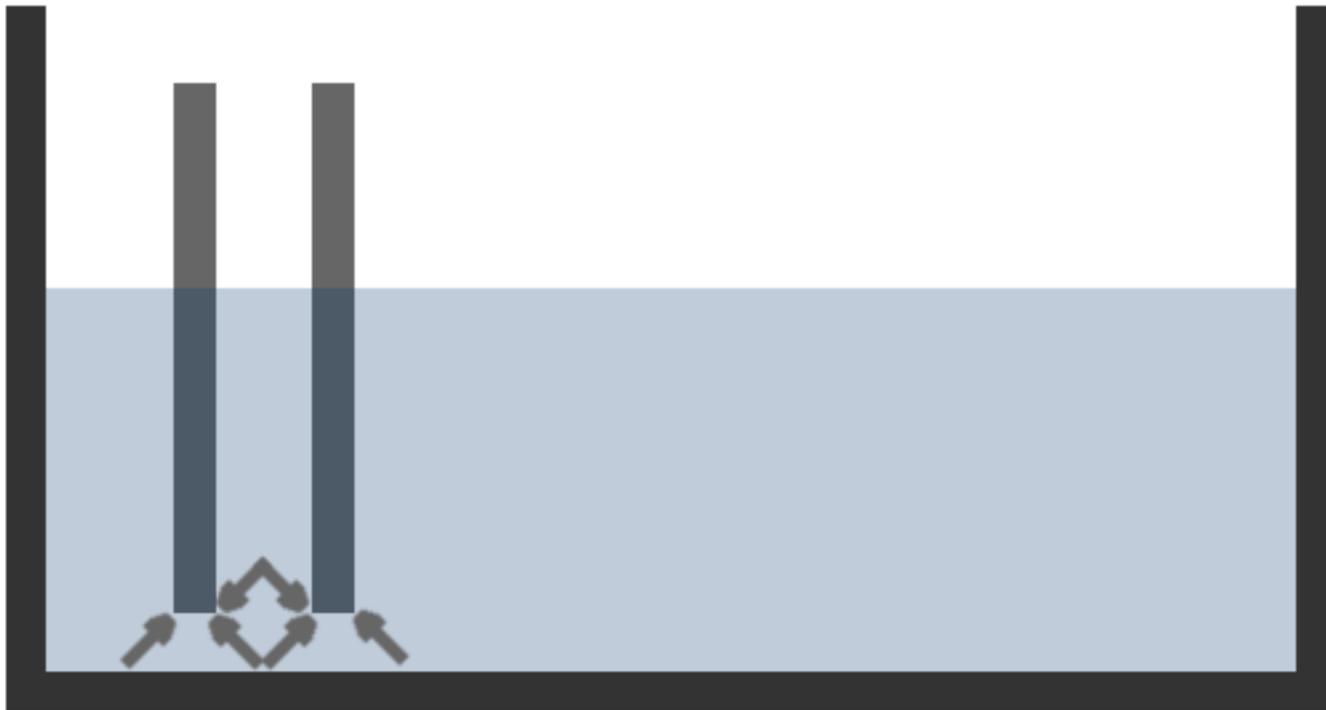
Inlet main failures

- Can explain surprise low-water alarms

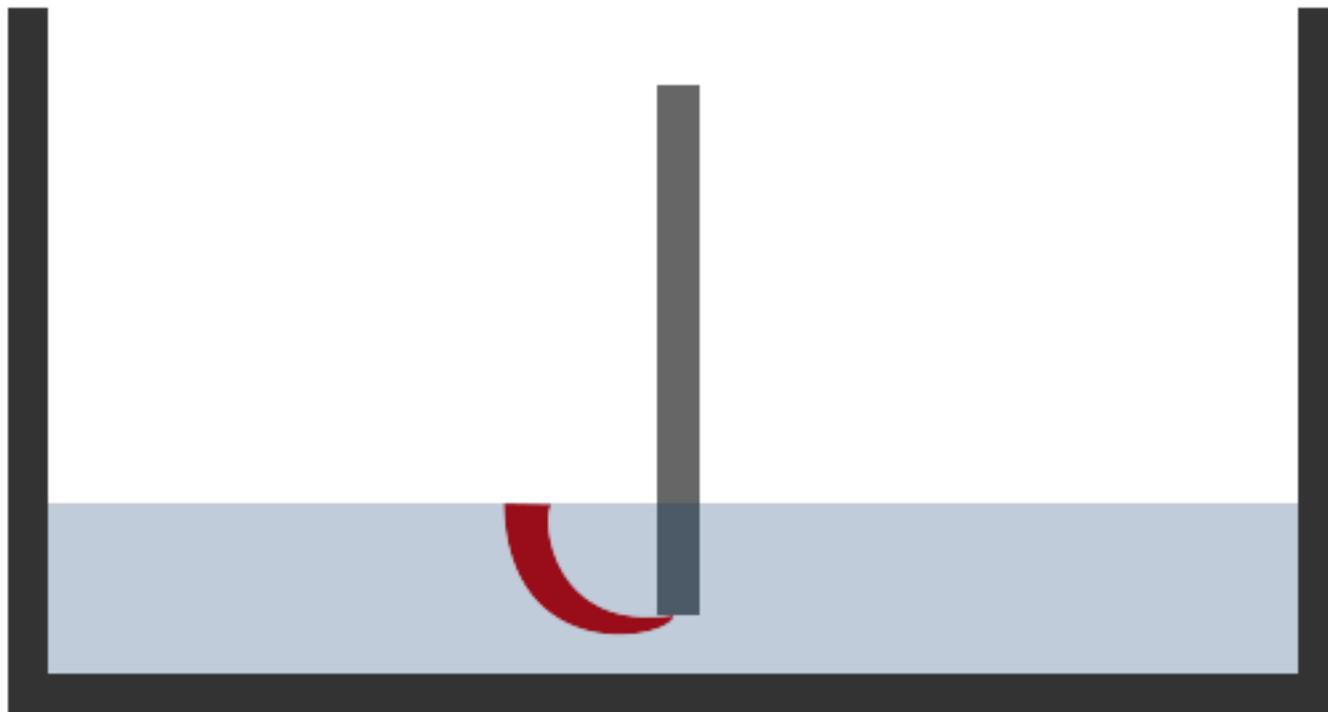
Fix air entrainment with baffles



Fix vortexing with proper pump spacing



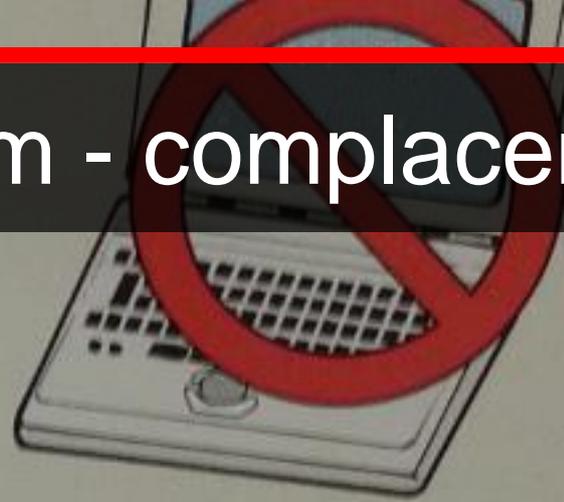
Fix vortexing with added submergence



Problem #10: Inattention to safety

10

Safety isn't the problem - complacency is



Safety always starts at the top



Nobody will watch out for your safety like you



**ALL TRADESMEN
CHECK IN WITH
PEPPER
SAFETY OFFICER
FOR SAFETY VIDEO
ORIENTATION
PRIOR TO
STARTING WORK**

You are not paid enough to risk life and limb



Ask: Is there a safer way?



A common thread

Recordkeeping!

ARCHIVES OF THE UNITED STATES OF AMERICA

You're probably a hands-on person



\$6,237.54	\$7,252.72	\$970.75	\$18,263.70	\$2,340.80	\$791.70	\$679.00	\$1,771.71	\$647.00	\$0.00	\$668.66	\$0.00	\$0.00	\$0.00	\$4,699.85
\$6,738.68	\$7,811.11	\$1,066.38	\$17,893.88	\$2,381.68	\$817.30	\$738.00	\$1,830.30	\$738.68	\$0.00	\$873.73	\$0.00	\$0.00	\$0.00	\$1,698.85
\$6,559.58	\$7,690.04	\$1,079.13	\$17,544.00	\$2,200.80	\$753.00	\$745.00	\$1,803.31	\$771.00	\$0.00	\$768.87	\$0.00	\$0.00	\$0.00	\$4,735.03
\$7,129.75	\$8,251.51	\$1,156.48	\$19,620.00	\$2,611.60	\$871.90	\$802.00	\$2,553.42	\$825.40	\$0.00	\$877.27	\$0.00	\$0.00	\$0.00	\$4,741.82
\$7,111.27	\$8,083.62	\$1,111.83	\$19,131.00	\$2,491.00	\$811.00	\$811.00	\$2,404.48	\$821.00	\$0.00	\$871.00	\$0.00	\$0.00	\$0.00	\$4,748.06
\$7,317.17	\$8,393.11	\$1,163.70	\$22,827.00	\$2,412.80	\$768.40	\$815.50	\$2,776.15	\$842.40	\$0.00	\$957.44	\$0.00	\$0.00	\$0.00	\$1,493.15
\$7,417.47	\$8,478.48	\$1,170.51	\$22,855.00	\$2,492.80	\$791.20	\$847.50	\$2,706.83	\$941.00	\$0.00	\$990.69	\$0.00	\$0.00	\$0.00	\$1,493.16
\$7,903.17	\$8,840.51	\$1,244.88	\$23,466.10	\$2,588.80	\$814.50	\$942.50	\$3,210.75	\$970.40	\$0.00	\$1,046.26	\$0.00	\$0.00	\$0.00	\$1,493.17
\$7,926.93	\$9,203.82	\$1,290.38	\$23,002.00	\$2,712.00	\$841.60	\$909.50	\$3,159.29	\$967.00	\$0.00	\$1,057.16	\$0.00	\$0.00	\$0.00	\$1,139.26
\$7,750.07	\$8,951.52	\$1,341.84	\$30,164.00	\$2,702.40	\$799.40	\$939.50	\$3,291.38	\$963.00	\$353.00	\$1,101.44	\$0.00	\$0.00	\$0.00	\$7,222.17
\$7,955.97	\$9,385.48	\$1,367.57	\$32,764.00	\$2,797.60	\$736.40	\$887.50	\$3,298.28	\$998.80	\$1,500.00	\$1,074.05	\$0.00	\$0.00	\$0.00	\$5,010.32
\$8,378.31	\$9,748.79	\$1,465.35	\$32,660.00	\$2,843.20	\$804.90	\$854.00	\$3,484.52	\$1,020.60	\$1,960.00	\$0.00	\$1,000.00	\$0.00	\$0.00	\$5,217.10
\$8,555.17	\$10,142.37	\$1,519.38	\$33,337.00	\$2,694.40	\$776.90	\$845.50	\$3,612.13	\$972.40	\$2,164.47	\$0.00	\$1,041.71	\$0.00	\$0.00	\$3,159.69
\$7,636.57	\$9,197.09	\$1,349.56	\$29,860.50	\$2,403.20	\$715.20	\$749.50	\$2,957.24	\$908.00	\$2,124.31	\$0.00	\$975.36	\$1,170.00	\$0.00	\$980.19
\$7,306.61	\$9,526.97	\$1,292.52	\$33,494.25	\$2,304.00	\$687.00	\$711.50	\$2,686.93	\$948.80	\$1,987.78	\$0.00	\$954.51	\$799.59	\$0.00	\$989.20
\$8,014.04	\$10,131.35	\$1,422.46	\$33,966.00	\$2,634.40	\$720.40	\$774.00	\$3,272.60	\$1,000.00	\$2,064.03	\$0.00	\$990.52	\$892.47	\$0.00	\$1,004.11
\$7,707.84	\$9,702.20	\$1,362.85	\$34,386.75	\$2,704.00	\$688.30	\$814.00	\$2,971.86	\$1,055.20	\$1,543.99	\$0.00	\$957.35	\$839.97	\$0.00	\$1,012.94
\$8,570.40	\$10,431.75	\$1,409.17	\$35,151.75	\$2,879.20	\$718.00	\$859.00	\$3,237.80	\$1,072.44	\$1,628.65	\$0.00	\$1,001.90	\$938.91	\$0.00	\$1,032.28
\$8,864.60	\$10,639.17	\$1,454.63	\$33,957.50	\$2,746.40	\$696.30	\$881.00	\$3,587.37	\$1,088.00	\$1,451.27	\$0.00	\$1,002.85	\$1,043.91	\$0.00	\$1,057.77
\$9,047.77	\$11,279.30	\$1,483.36	\$34,289.00	\$2,981.60	\$795.80	\$835.00	\$3,765.05	\$1,100.60	\$1,475.46	\$0.00	\$1,043.60	\$1,110.54	\$0.00	\$1,057.78
\$9,548.73	\$11,880.10	\$1,643.19	\$34,174.25	\$3,201.60	\$794.30	\$884.00	\$4,062.35	\$1,186.23	\$1,459.33	\$0.00	\$1,070.47	\$1,305.58	\$0.00	\$1,081.57
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\$9,833.10	\$12,412.96	\$1,618.16	\$37,094.00	\$3,495.20	\$933.00	\$962.00	\$4,315.52	\$1,131.85	\$16.59	\$0.00	\$0.00	\$1,293.36	\$0.00	\$4,244.57
\$10,005.95	\$13,067.40	\$1,586.76	\$35,564.00	\$2,945.60	\$805.10	\$1,019.00	\$4,402.62	\$1,145.20	\$22.32	\$0.00	\$0.00	\$1,425.76	\$0.00	\$4,295.95
\$10,231.78	\$13,264.09	\$1,566.74	\$36,044.80	\$3,131.20	\$801.60	\$1,051.00	\$4,800.96	\$1,249.40	\$22.39	\$0.00	\$0.00	\$1,299.47	\$0.00	\$3,092.52
\$9,902.80	\$12,809.91	\$1,452.97	\$33,915.20	\$3,031.20	\$815.00	\$1,052.50	\$4,076.29	\$1,271.80	\$22.51	\$0.00	\$0.00	\$943.04	\$0.00	\$3,127.88
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\$9,713.22	\$12,681.17	\$1,414.75	\$33,747.35	\$3,182.40	\$819.20	\$962.50	\$4,049.58	\$1,275.00	\$0.00	\$0.00	\$0.00	\$947.43	\$996.75	\$986.26
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\$8,252.33	\$10,614.13	\$1,041.61	\$32,577.90	\$2,299.20	\$669.70	\$866.50	\$2,498.03	\$1,082.60	\$0.00	\$0.00	\$0.00	\$757.94	\$837.50	\$311.71
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\$9,381.45	\$12,573.88	\$1,138.08	\$36,181.65	\$2,527.20	\$657.20	\$1,001.50	\$3,201.80	\$1,129.60	\$0.00	\$0.00	\$0.00	\$998.92	\$958.25	\$340.74
\$9,589.40	\$12,438.16	\$1,094.18	\$35,479.50	\$2,444.00	\$661.30	\$1,082.00	\$3,340.00	\$1,154.20	\$0.00	\$0.00	\$0.00	\$1,000.88	\$941.25	\$371.11
\$10,016.79	\$12,893.26	\$1,210.46	\$36,442.05	\$2,724.00	\$734.80	\$1,070.00	\$3,891.64	\$1,150.60	\$0.00	\$0.00	\$0.00	\$1,263.07	\$932.75	\$400.14
\$10,512.11	\$13,167.82	\$1,387.23	\$36,632.70	\$3,075.20	\$830.70	\$1,074.50	\$3,960.16	\$1,228.00	\$0.00	\$0.00	\$0.00	\$1,206.88	\$980.75	\$400.14
\$10,869.16	\$13,382.21	\$1,439.69	\$38,055.60	\$3,107.20	\$866.90	\$1,129.50	\$4,061.19	\$1,267.20	\$0.00	\$0.00	\$0.00	\$1,077.87	\$1,009.25	\$426.22
\$10,778.23	\$13,303.22	\$1,457.18	\$37,878.90	\$2,822.40	\$801.50	\$1,139.00	\$3,931.12	\$1,230.80	\$0.00	\$0.00	\$0.00	\$1,023.77	\$1,037.25	\$482.68
\$9,823.45	\$12,291.47	\$1,208.09	\$36,744.30	\$2,457.60	\$748.10	\$0.00	\$3,525.82	\$1,131.00	\$0.00	\$0.00	\$0.00	\$873.95	\$2,493.40	\$35.74
\$10,509.70	\$12,953.44	\$1,363.60	\$38,897.25	\$2,741.60	\$801.80	\$0.00	\$3,659.37	\$1,200.00	\$0.00	\$0.00	\$0.00	\$1,129.50	\$2,665.65	\$71.39
\$10,598.28	\$0.00	\$1,307.82	\$39,348.30	\$2,416.80	\$767.10	\$0.00	\$3,402.71	\$1,223.00	\$0.00	\$0.00	\$0.00	\$1,015.92	\$2,564.25	\$108.55
\$10,849.74	\$0.00	\$1,431.18	\$39,176.25	\$2,529.60	\$787.30	\$0.00	\$3,326.07	\$1,240.60	\$0.00	\$0.00	\$0.00	\$1,053.78	\$2,651.35	\$126.25

You need the help of numbers people

\$11,376.13	\$0.00	\$1,522.88	\$43,338.00	\$3,068.80	\$959.90	\$0.00	\$3,838.22	\$1,330.60	\$0.00	\$0.00	\$0.00	\$1,139.43	\$2,699.45	\$239.63
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Appeal to their way of thinking, not your own

Your inconveniences mean little to them



Learn to quantify your troubles

*Make pumping hassles
a matter of dollars and cents*

Take gauge readings and record them



Document spills and leaks...look for patterns



Record smells, sounds, temperatures



Get comfortable with spreadsheets

	A	B	C	D	E	F	G	H
1	<u>Date</u>	<u>Gallons</u>	<u>CPG</u>	<u>Miles</u>	<u>Odometer</u>	<u>Ethanol</u>	<u>Octane</u>	<u>Store</u>
640	11/5/2013	16.819	\$ 2.80	367.9	35335	Yes	87	<u>Bucky's Express</u>
641	11/8/2013	17.058	\$ 2.80	365.3	35701	Yes	89	Flying J
642	11/14/2013	15.7	\$ 2.90	328.5	36029	Yes	87	<u>Kum & Go</u>
643	11/18/2013	17.368	\$ 2.90	383.7	36413	Yes	87	<u>Kum & Go</u>
644	12/1/2013	17.258	\$ 2.95	359.5	36772	Yes	87	<u>Kum & Go</u>
645	12/7/2013	16.017	\$ 3.06	301.7	37074	Yes	87	The Mill BP
646	12/14/2013	17.437	\$ 3.30	312.4	37387	No	91	<u>Kum & Go</u>
647	12/23/2013	17.743	\$ 3.00	329.1	37716	Yes	87	<u>Kum & Go</u>
648	1/3/2014	17.48	\$ 3.13	282.2	37998	Yes	87	<u>Kum & Go</u>
649	1/9/2014	17.235	\$ 3.05	320.8	38319	Yes	87	Casey's
650	1/15/2014	17.424	\$ 3.00	363.3	38682	Yes	87	<u>Hy-Vee</u>
651	1/25/2014	15.896	\$ 3.00	256.1	38939	Yes	87	<u>Kum & Go</u>
652	2/7/2014	11.449	\$ 3.03	198	39137	Yes	87	<u>Kum & Go</u>
653	2/11/2014	16.145	\$ 3.10	334.6	39471	Yes	87	<u>Quik Trip</u>
654	2/13/2014	17.745	\$ 3.18	358.7	39830	Yes	87	<u>Kum & Go</u>
655	2/24/2014	14.487	\$ 3.20	269	40099	Yes	87	<u>Kum & Go</u>
656	2/25/2014	17.001	\$ 3.30	354.8	40454	Yes	87	<u>Sparky's One Stop</u>
657	3/2/2014	16.879	\$ 3.20	312.5	40766	Yes	87	Casey's
658	3/9/2014	16.823	\$ 3.38	324.1	41092	Yes	87	<u>Quik Trip</u>
659	3/12/2014	15.206	\$ 3.46	311.1	41403	Yes	87	Flying J

Officials and managers need hard evidence



Engineers need actionable observations

Equipment suppliers need feedback

Spare parts

Availability of replacement pumps, motors, and parts is essential to maintenance

Spare parts



*Your shelf
+ supplier's shelf
+ manufacturer's shelf*

Don't put it off

*Deferred maintenance costs
aren't any less real
just because we defer them*

Compounding interest can make you rich



Deferred maintenance costs compound, too



Compounding costs can ruin a great system

- Decide what you need
- Measure the total costs
- Document
- Quantify, quantify, quantify
- Make the case to get what you need to serve the public

Questions?

- Thank you for coming!
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References

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