Air Valve Basic Training

OWEA Collection System Specialty Conference

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Ohio Water Environment Association
Preserving & Enhancing Ohio's Water Environment

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Overview

- Why Air Valves?
- Types of Valves
- Valve Locations
- Sizing Valves
- Valve Specifications
- Installations
- Questions

Overview

- Information based on:
  - AWWA Manual of Water Supply Practices M51 Air-Release, Air/Vacuum & Combination Air Valves
  - Manufacturers' published information
  - Our experience in design and the field

Why Air Valves?

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Why Air Valves?

Effects of Air and Vacuum Pockets in Pipelines

- Higher Headloss and Binding
- Pipe Breaks
- Erratic operation of pumps, meters, and control valves
- Collapsed pipes

Why Air Valves?

Sources of Air Entry in Pipelines

- Dissolved Air or Gas (2% at 1 atm)
- Air Valves
- Pumps
- Filling Empty Pipelines

Why Air Valves?

Sources of Vacuums in Pipelines

- Draining Pipelines
- Water Hammer

Types of Air Valves

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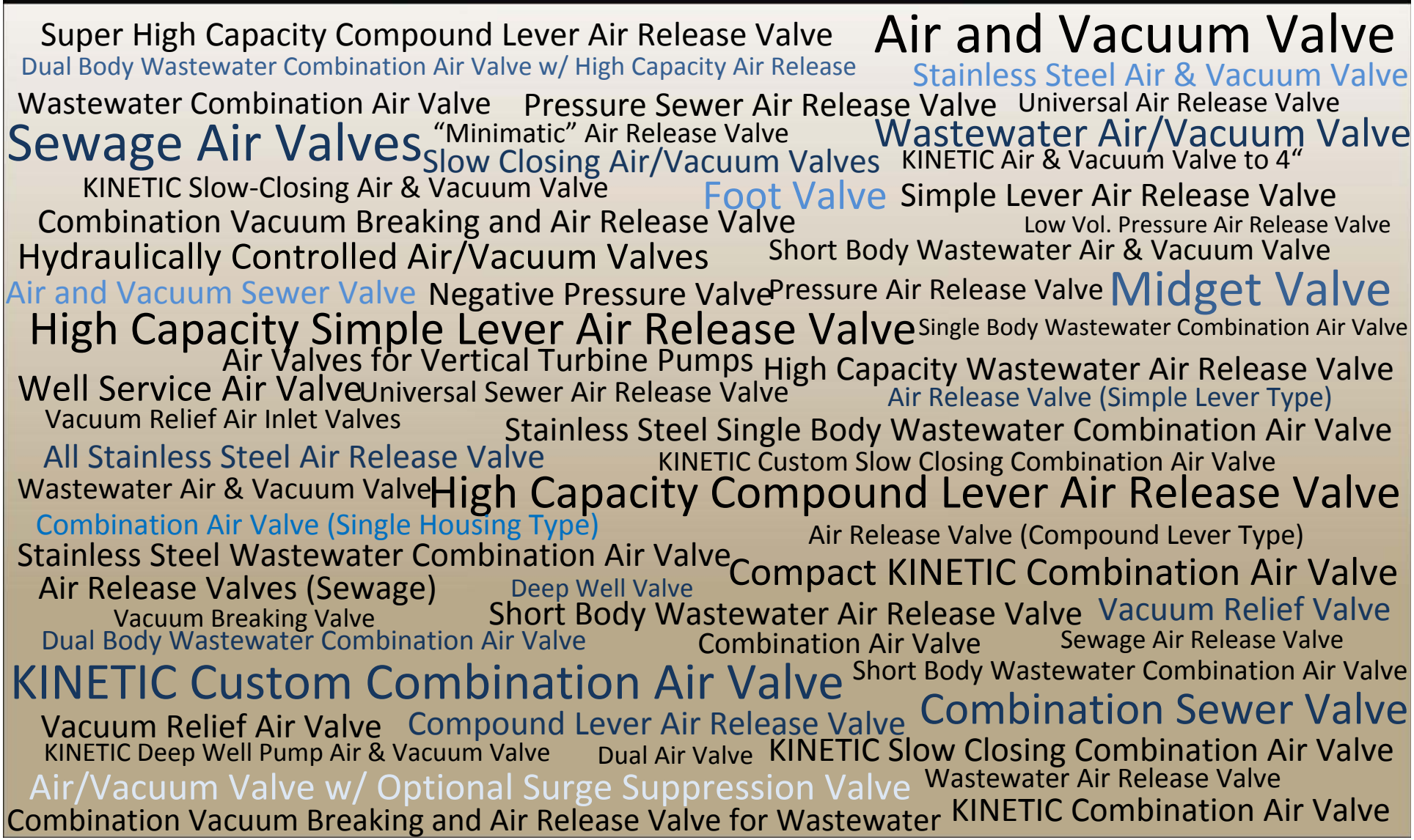
Simple, right?



Types of Air Valves

Three Basic Types

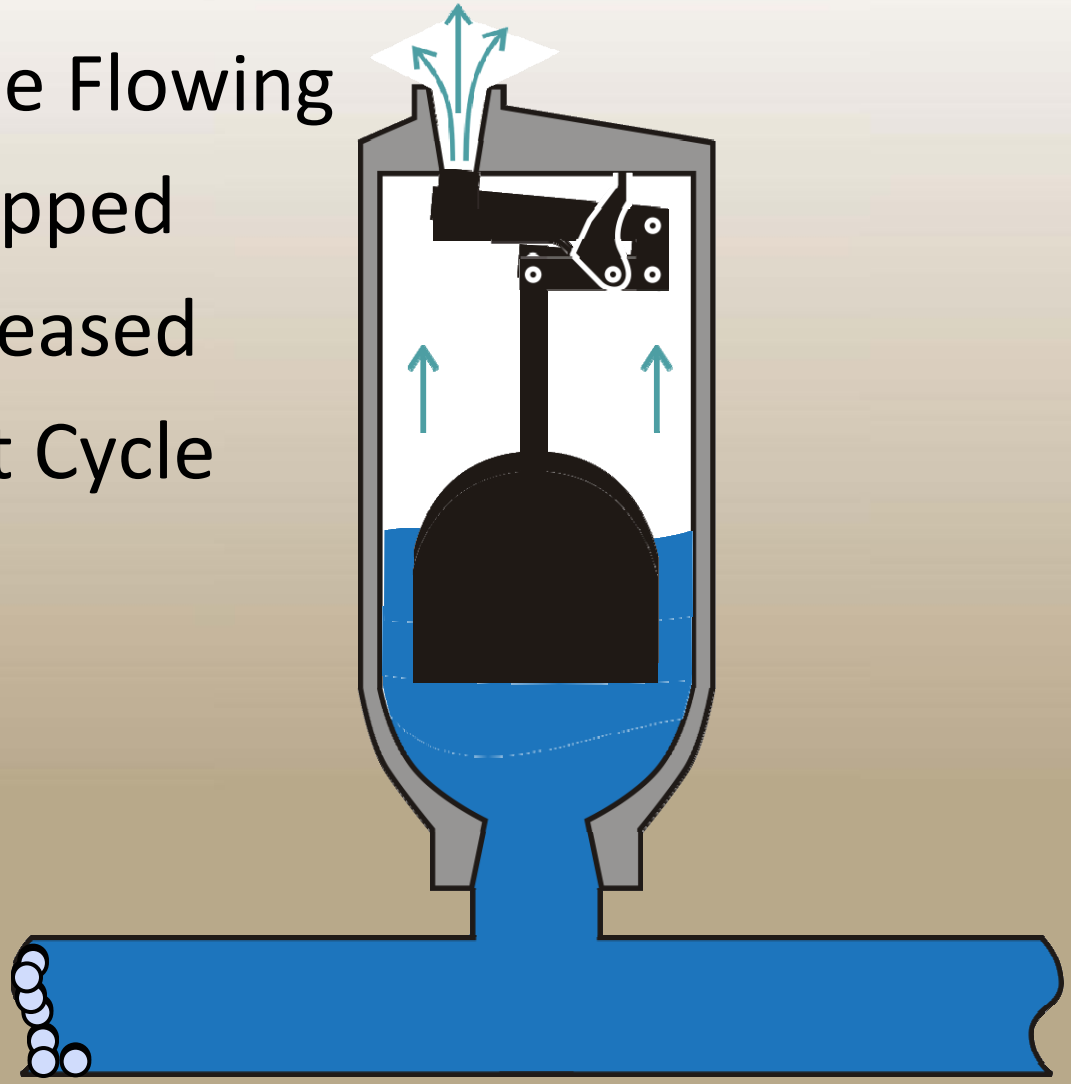
- Air Release Valves
- Air / Vacuum Valves
- Combination Air Valves

Air Release Valves

- Automatically releases ***small*** pockets of accumulated air while the pipeline operates ***under pressure***.

Air Release Valve Operation

- Pipeline Flowing
- Air Trapped
- Air Released
- Repeat Cycle

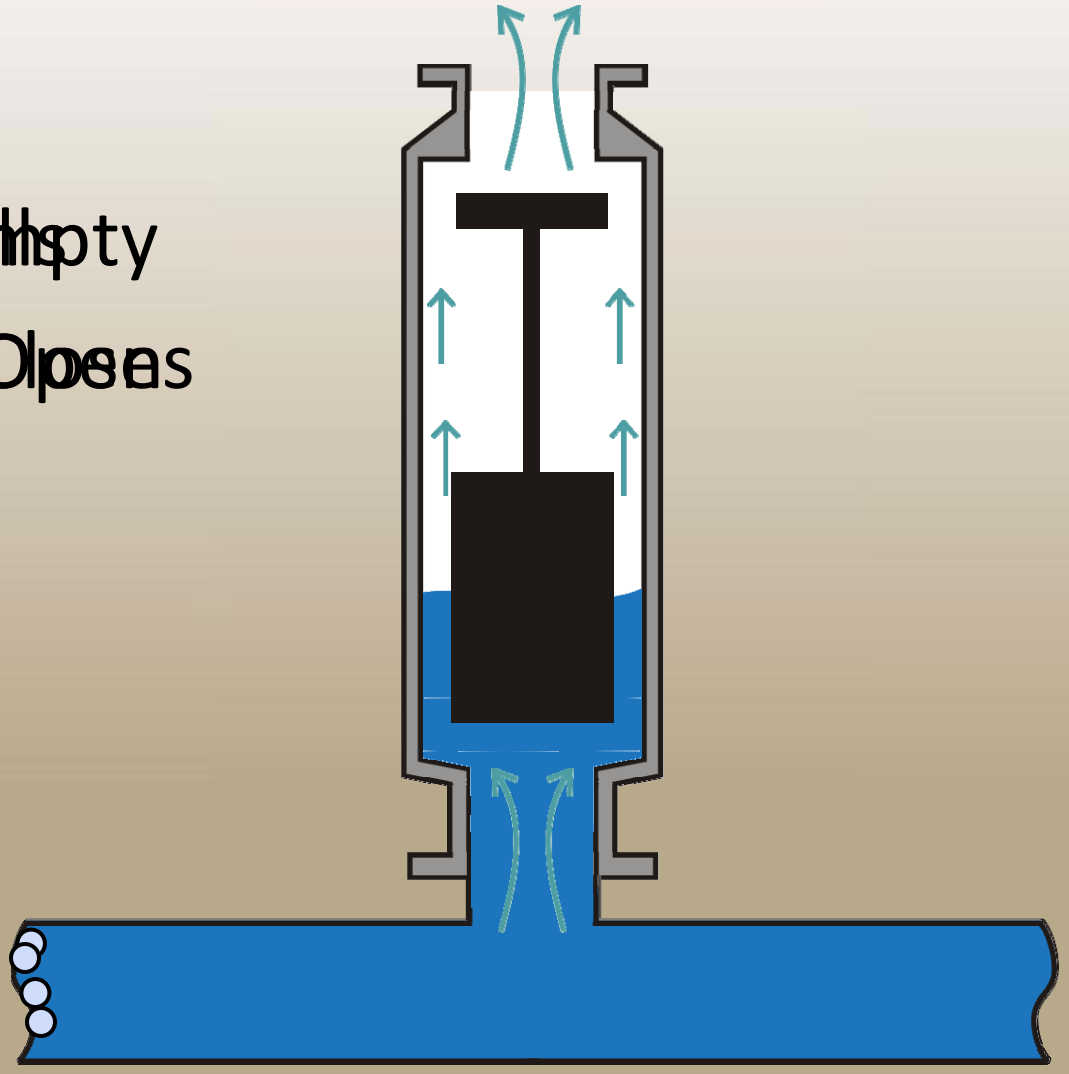


Air / Vacuum Valves

- Designed to automatically:
  - Exhaust ***large*** quantities of air during pipeline filling.
  - Admit ***large*** amounts of air when the internal pressure drops below atmospheric.

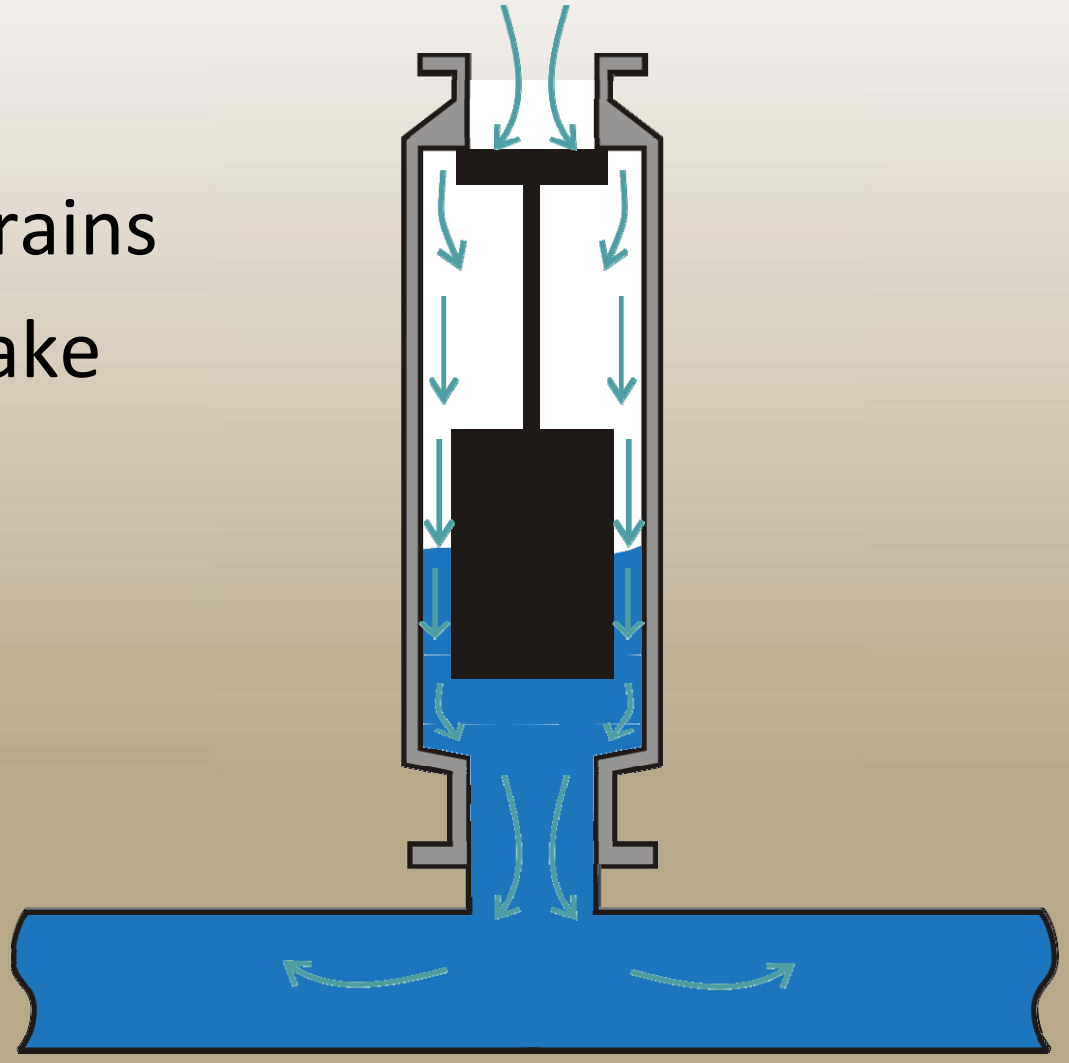
Air / Vacuum Valve Operation

- Pipe Empty
- Valve Open



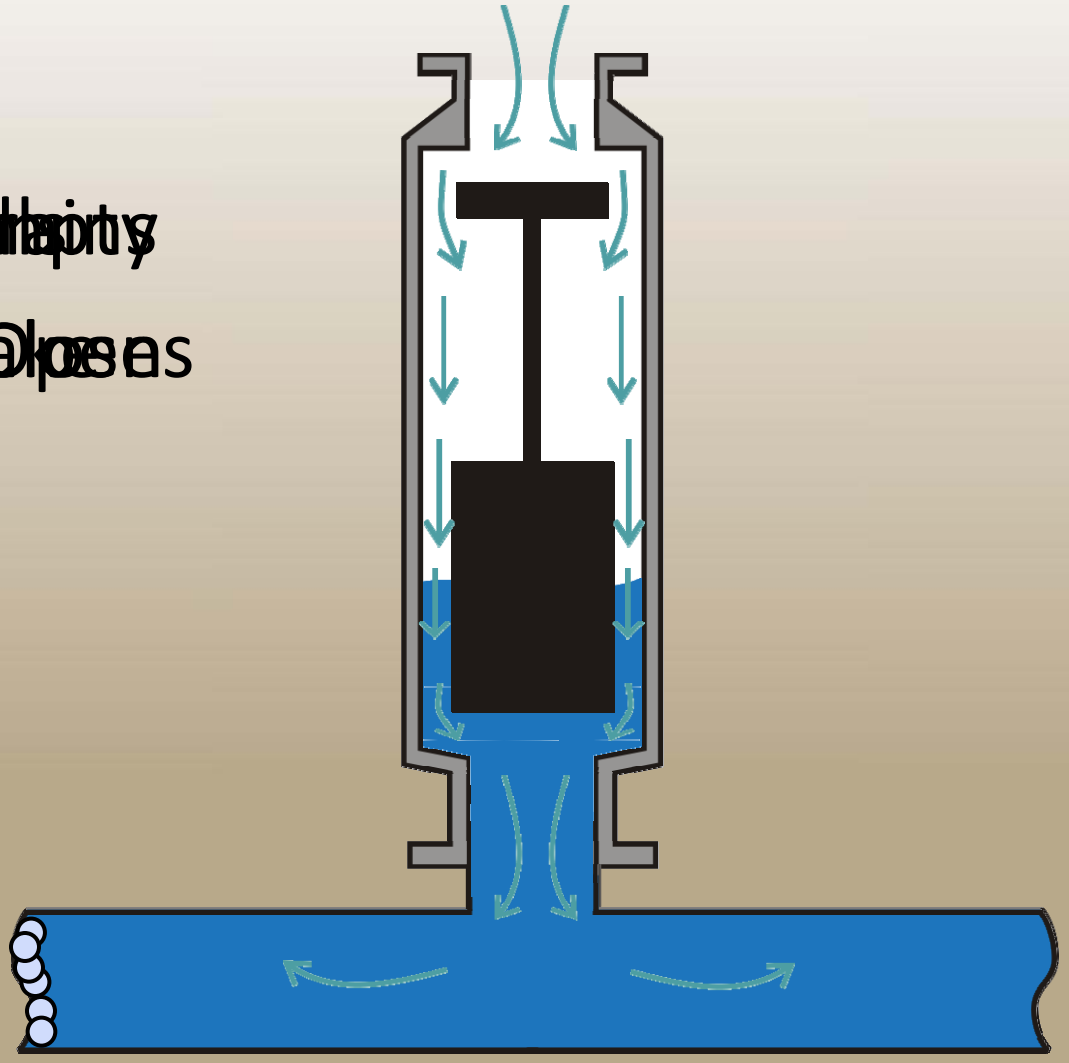
Air / Vacuum Valve Operation

- Pipe Drains
- Air Intake



Air / Vacuum Valve Cycle

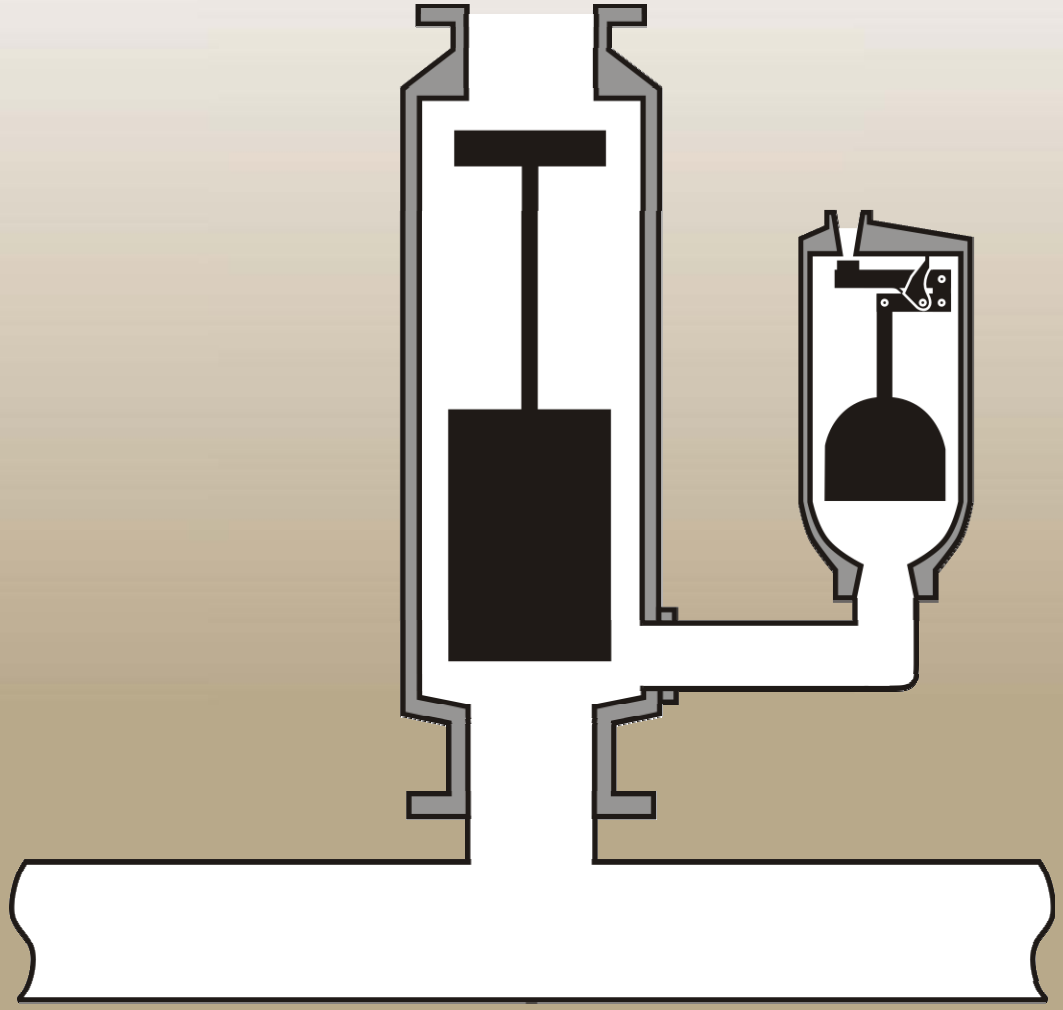
- Pipe Empty
- Water Enters
- Valve Opens
- Air Vacuum Valve Closes



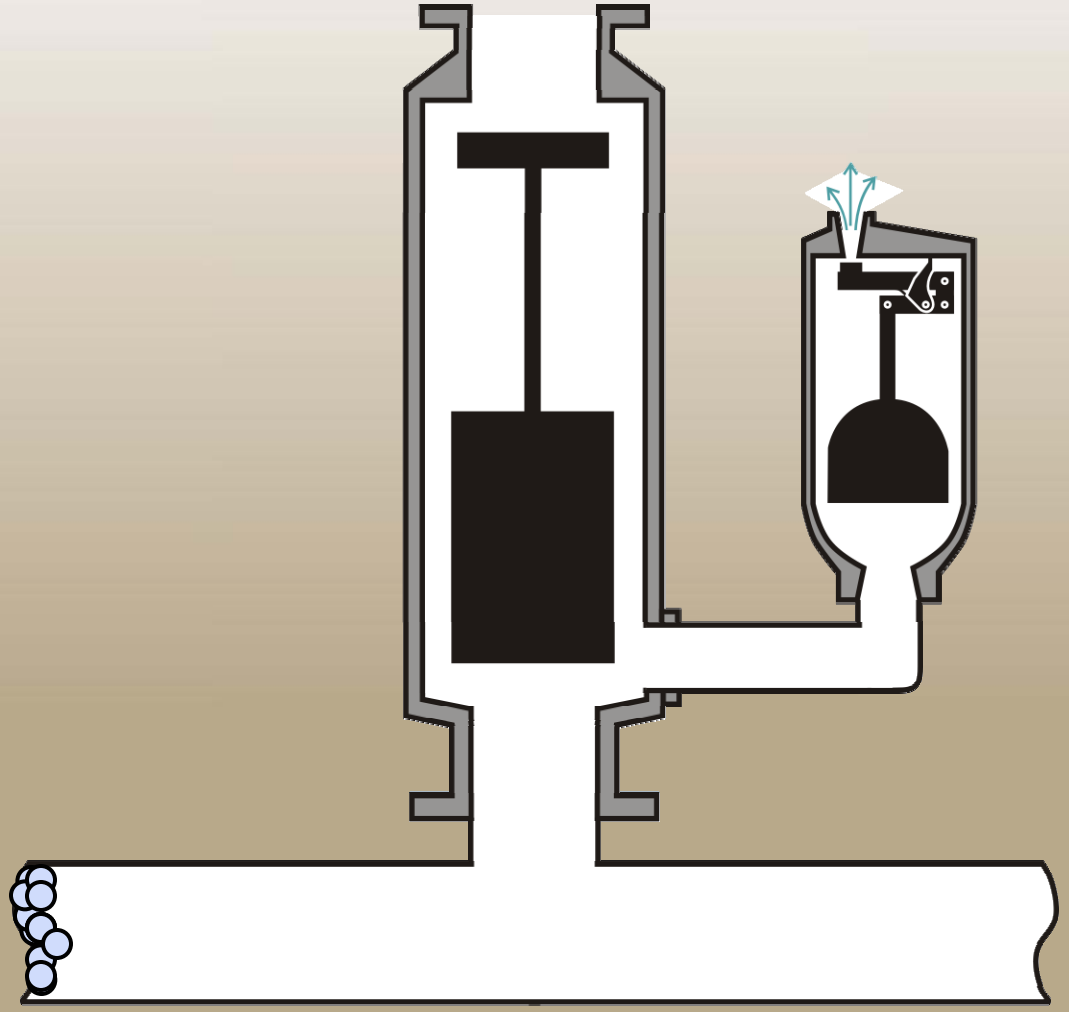
Combination Air Valves

- Perform both as air release and air/vacuum valves.

Combination



Combination Air Valve Operation



Locating Air Valves Along a Pipeline

(Or Thinking like an Air Bubble)

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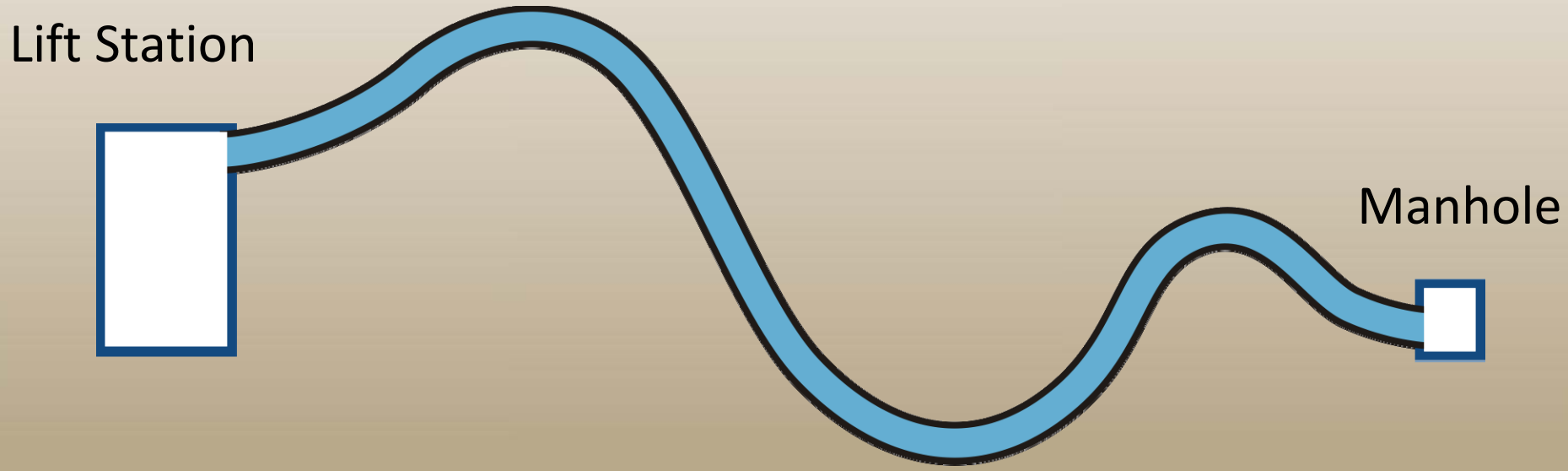
Locating Air Valves

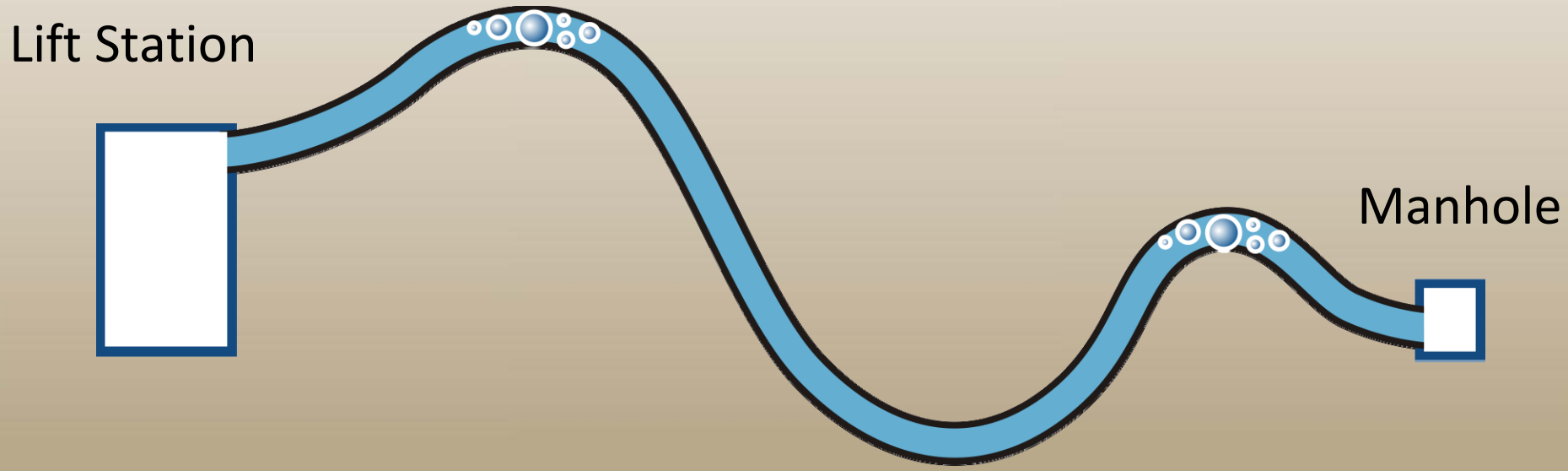
Install valves where air will be trapped or vacuum pockets will form!

Locating Air Valves Along a Force Main



Pumps Operating and Line is Full

Locating Air Valves Along a Force Main



Pumps Operating and Line is Full

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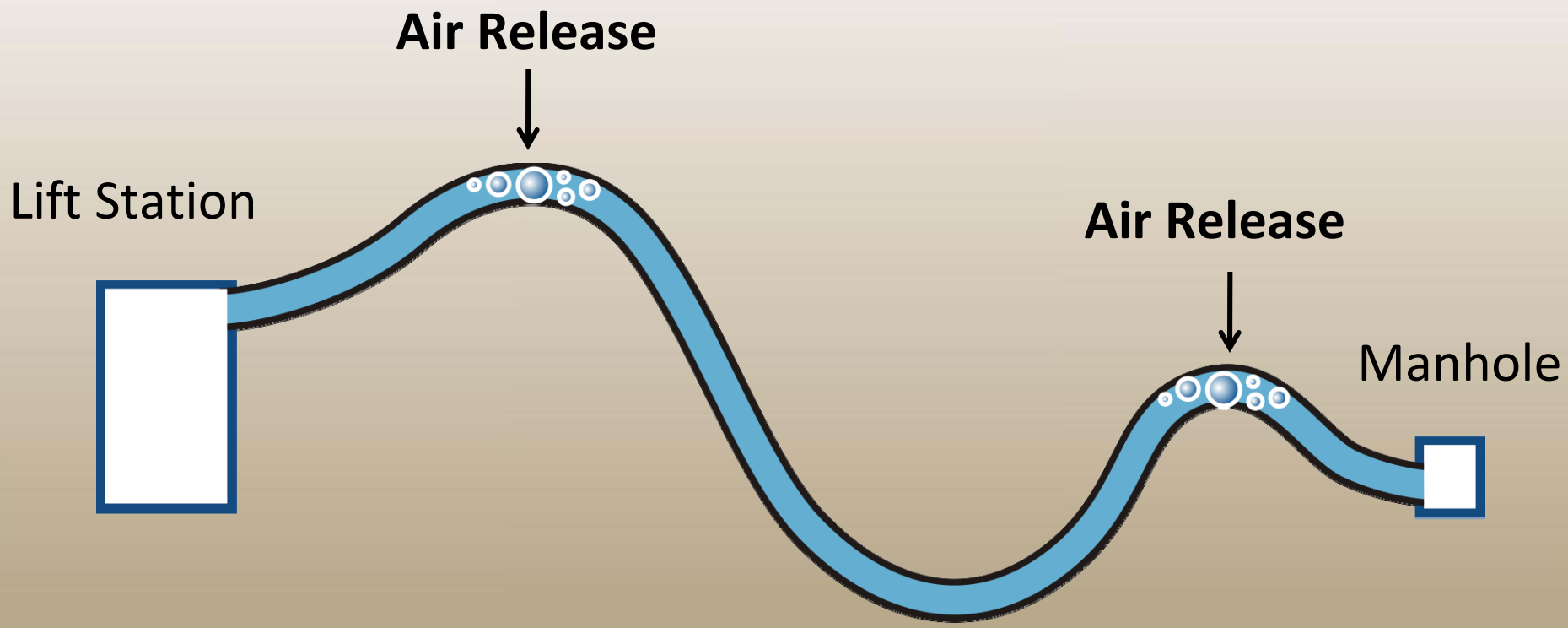
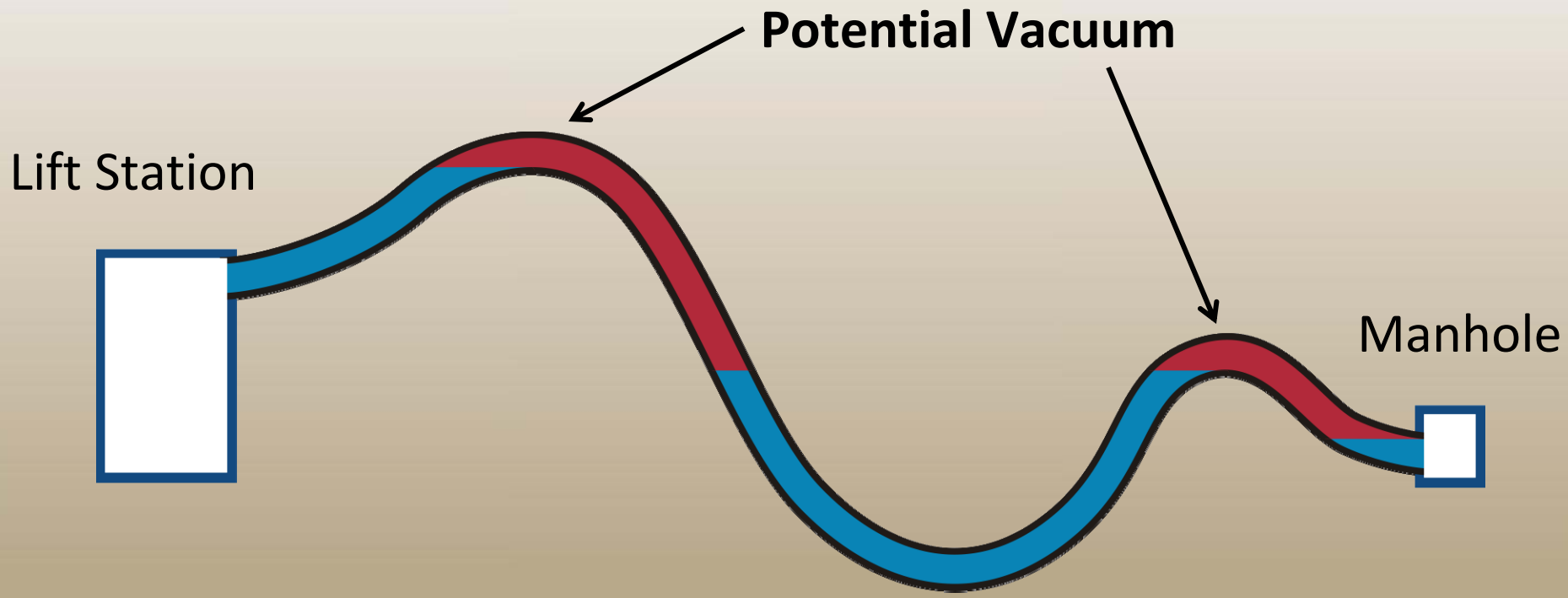


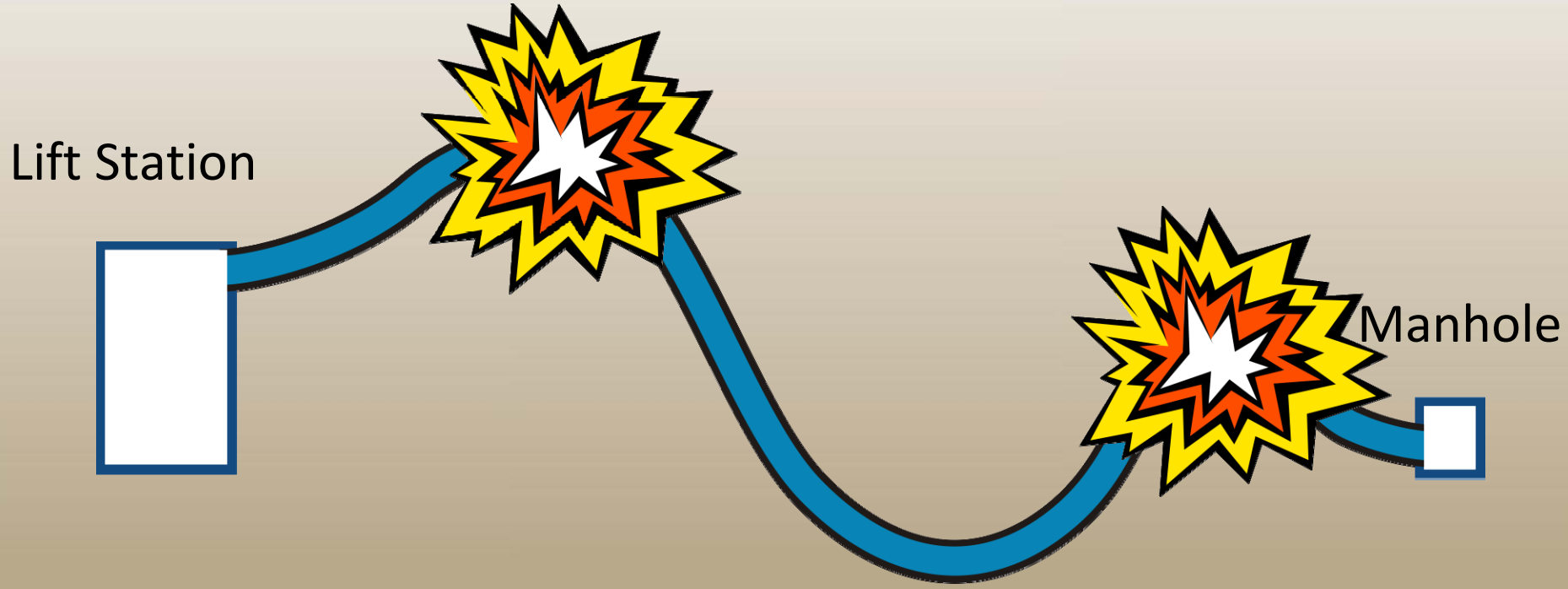
Pumps Operating and Line is Full

High Points



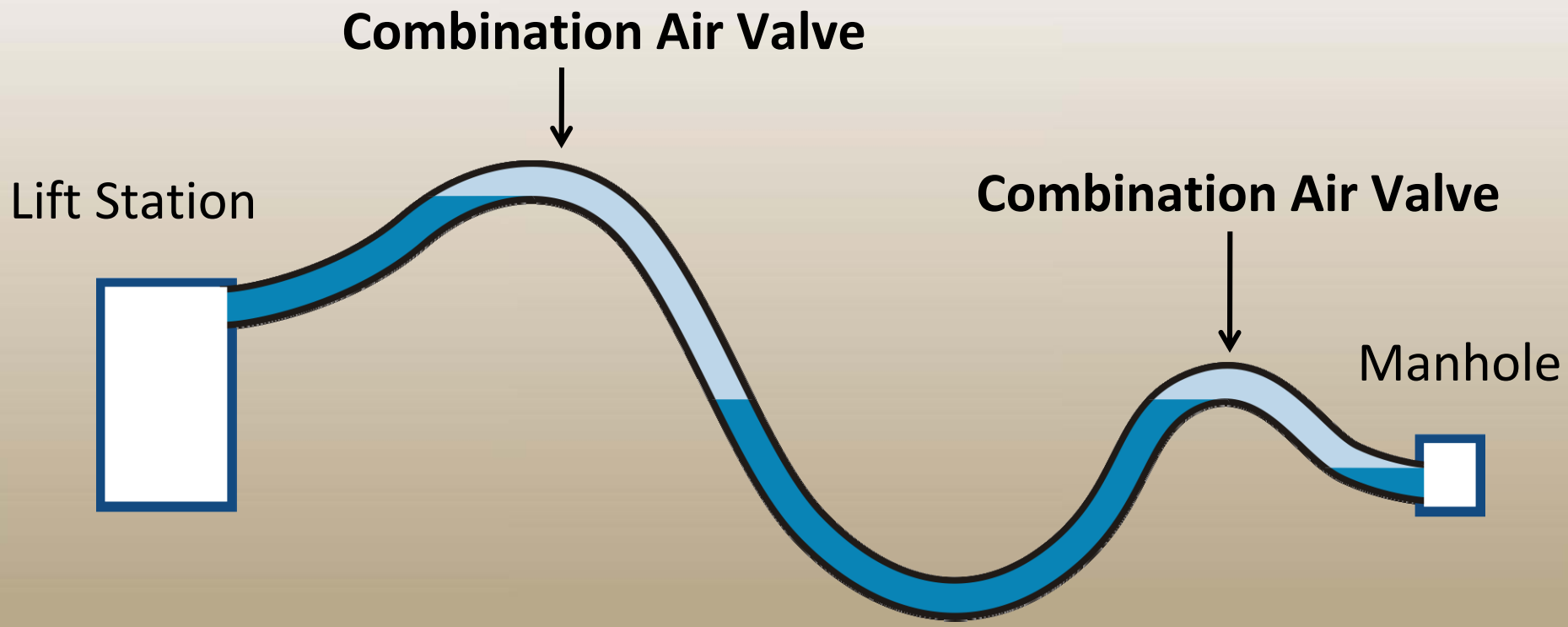
Pumps Stopped and Line is Draining

High Points



Pumps Start and Vacuum Pockets Close with Pressure Spikes

High Points

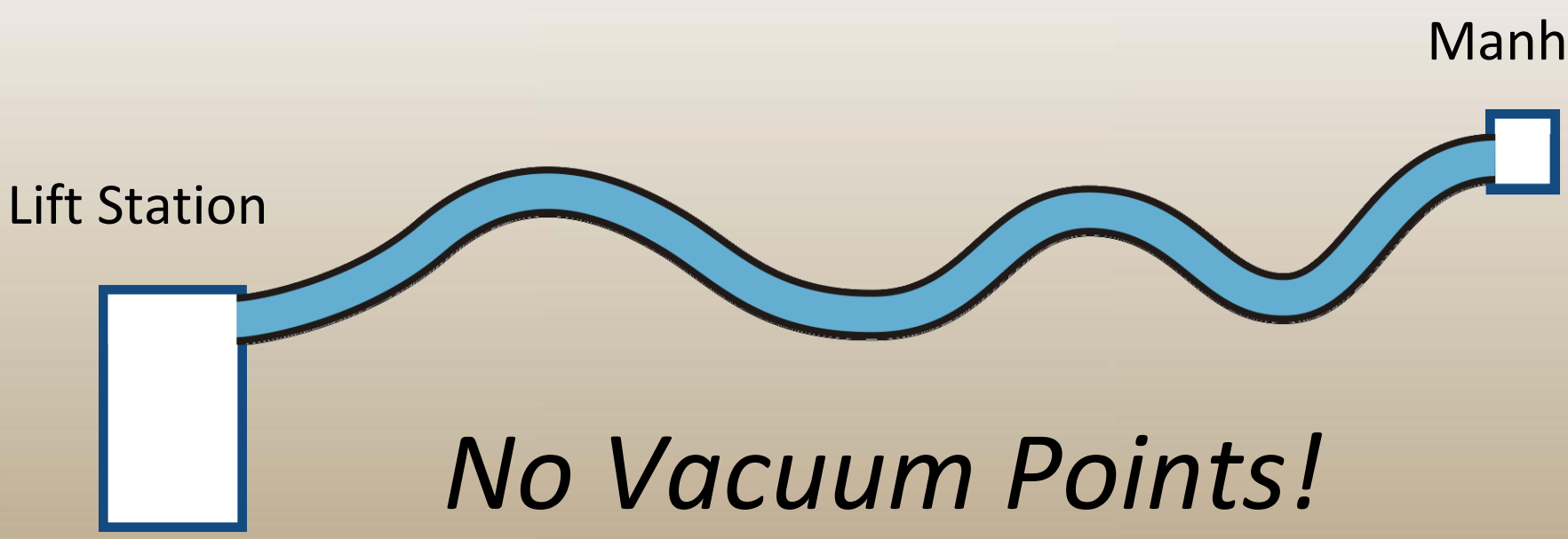


Pumps Stopped, Line is Drained, and High Points are Full of Air

High Points

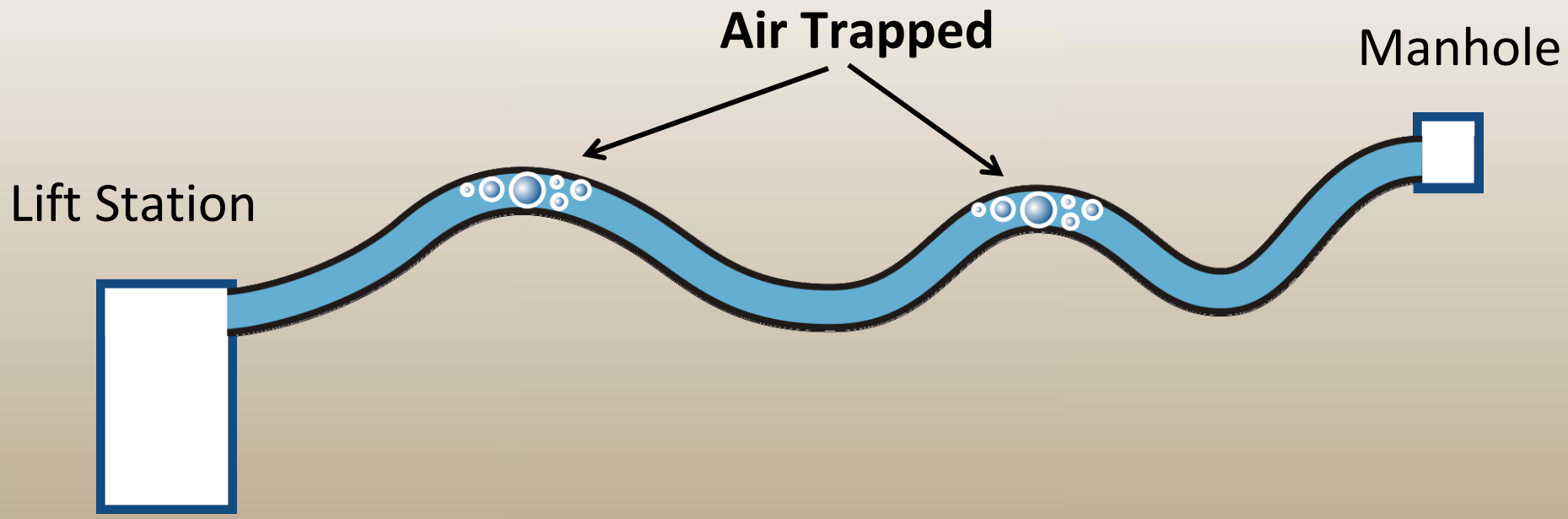
Any Air Valves?

High Points

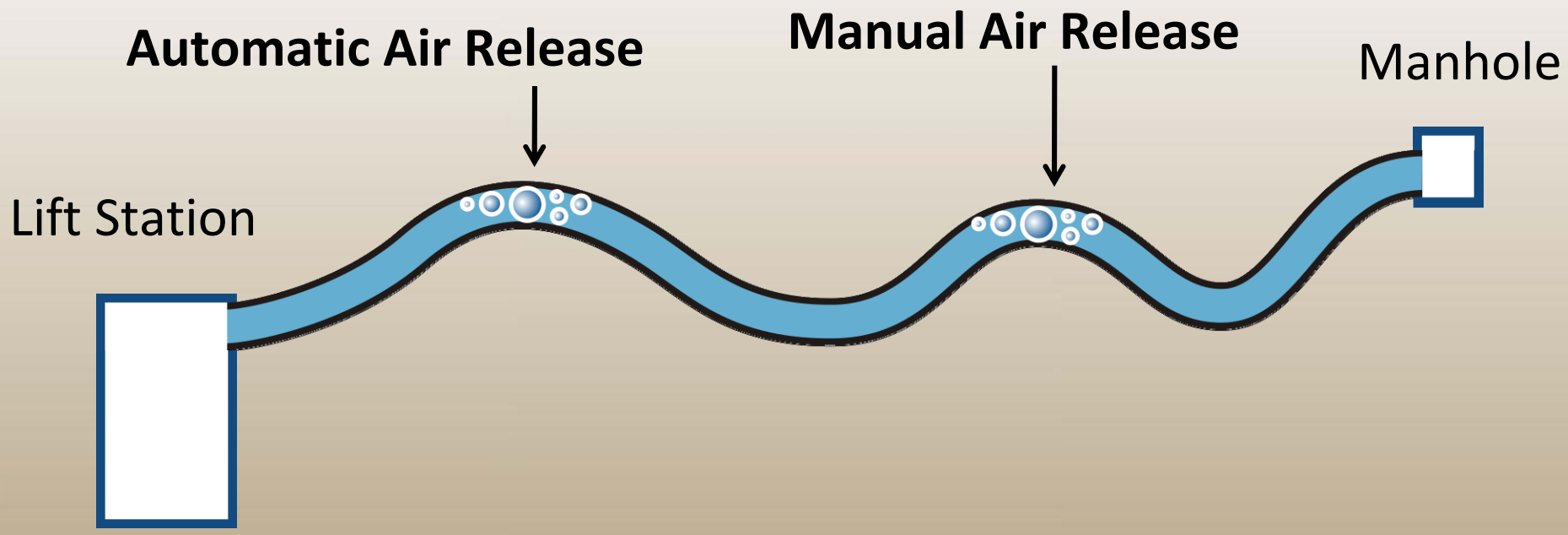


No Vacuum Points!

High Points



High Points

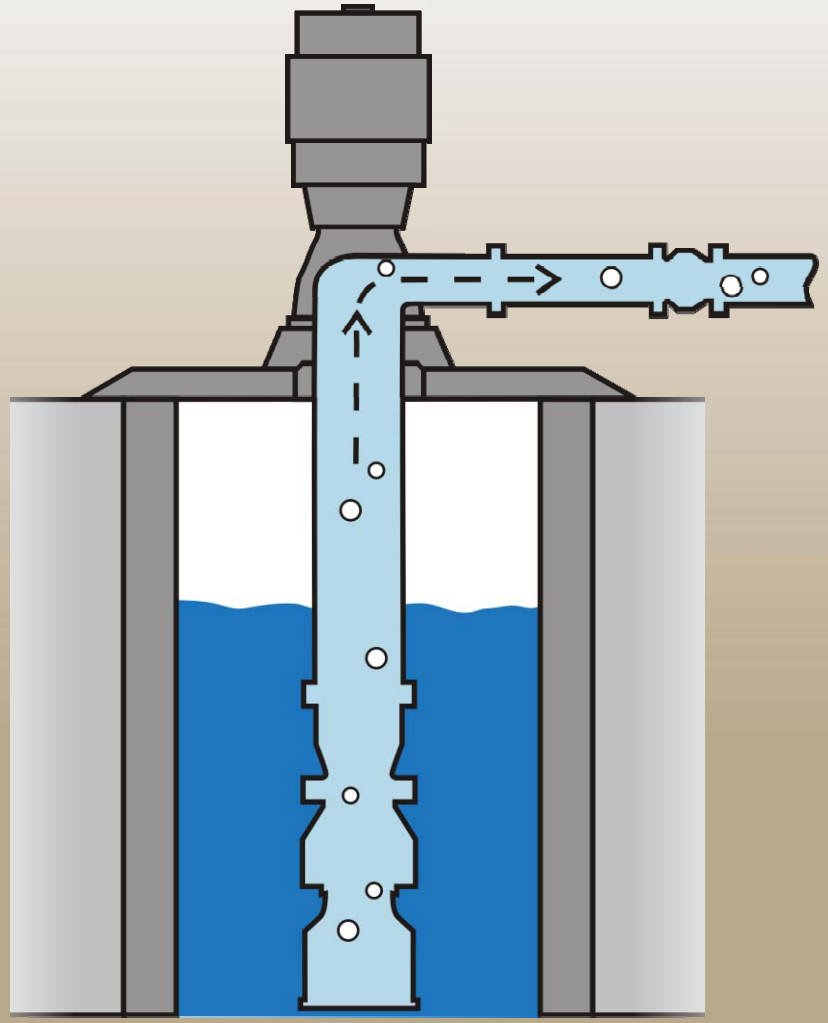

Automatic Air Release
Manual Air Release
Manhole
Lift Station

Pumps

- Carefully review deep pump installations when over 20 feet deep.
- May need Air/Vac valve
- Examples include: vertical turbines and deep submersibles.

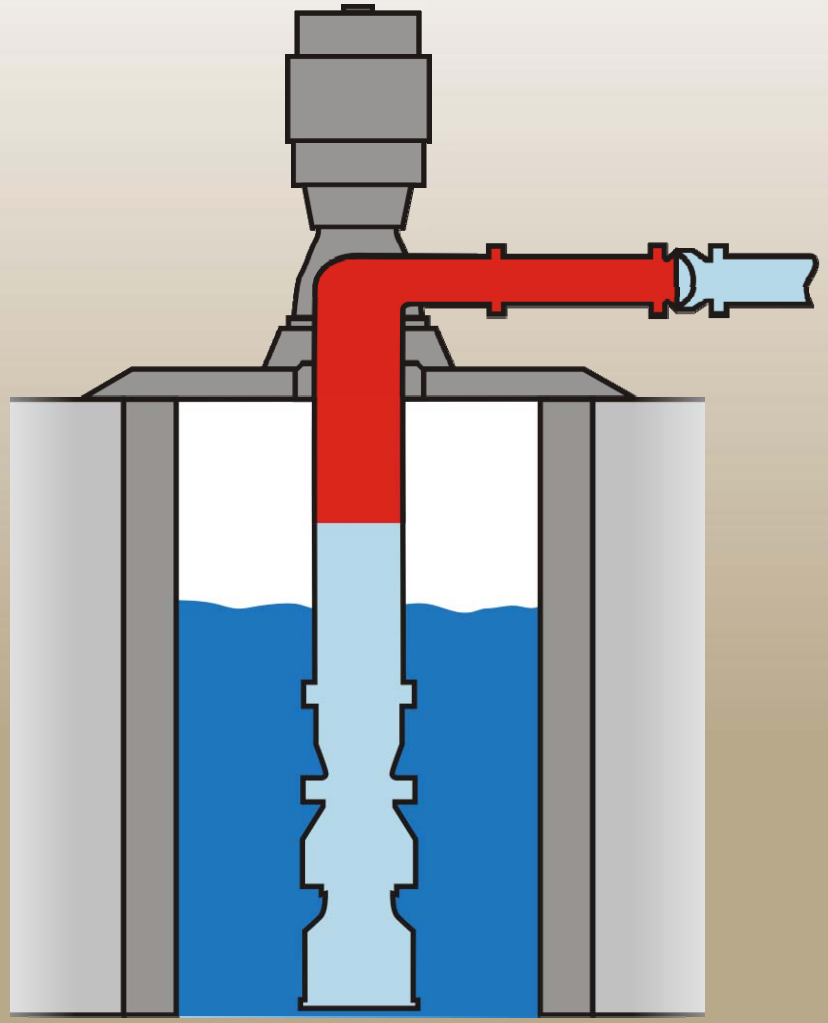
Pumps

- Line Full
- Pump On



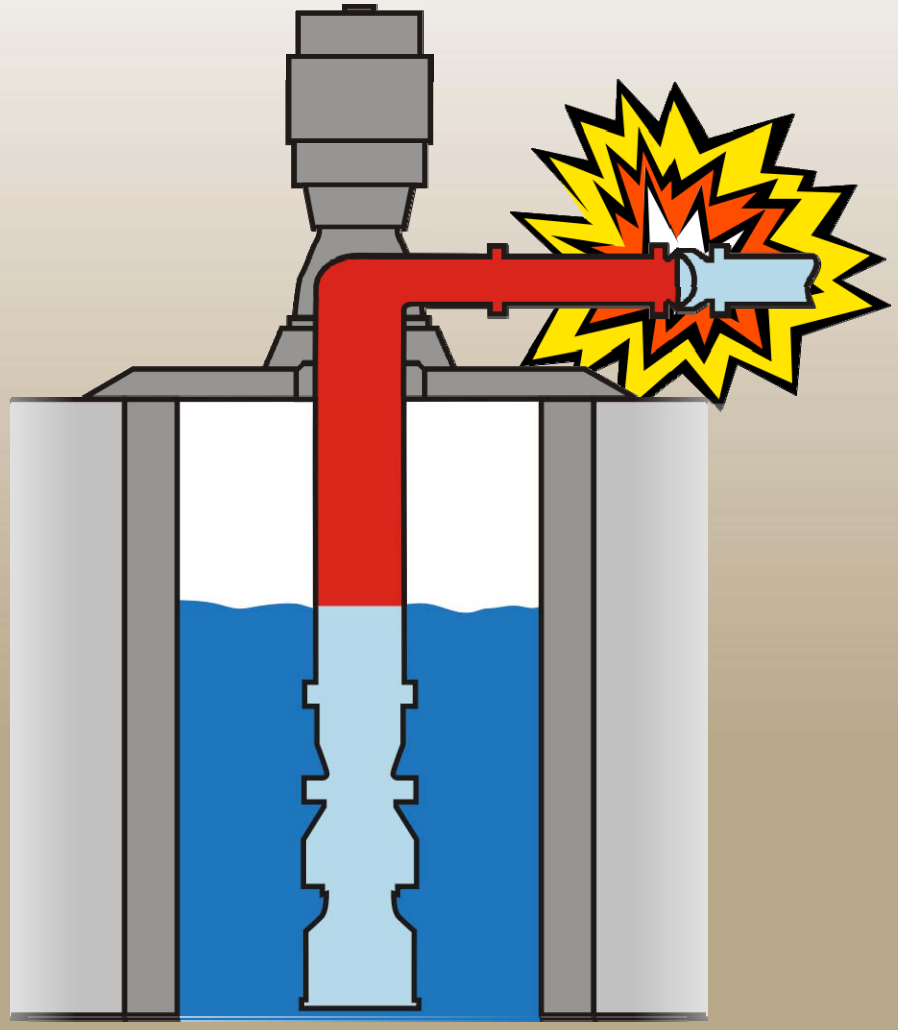
Pumps

- Pump Off
- Vacuum Develops



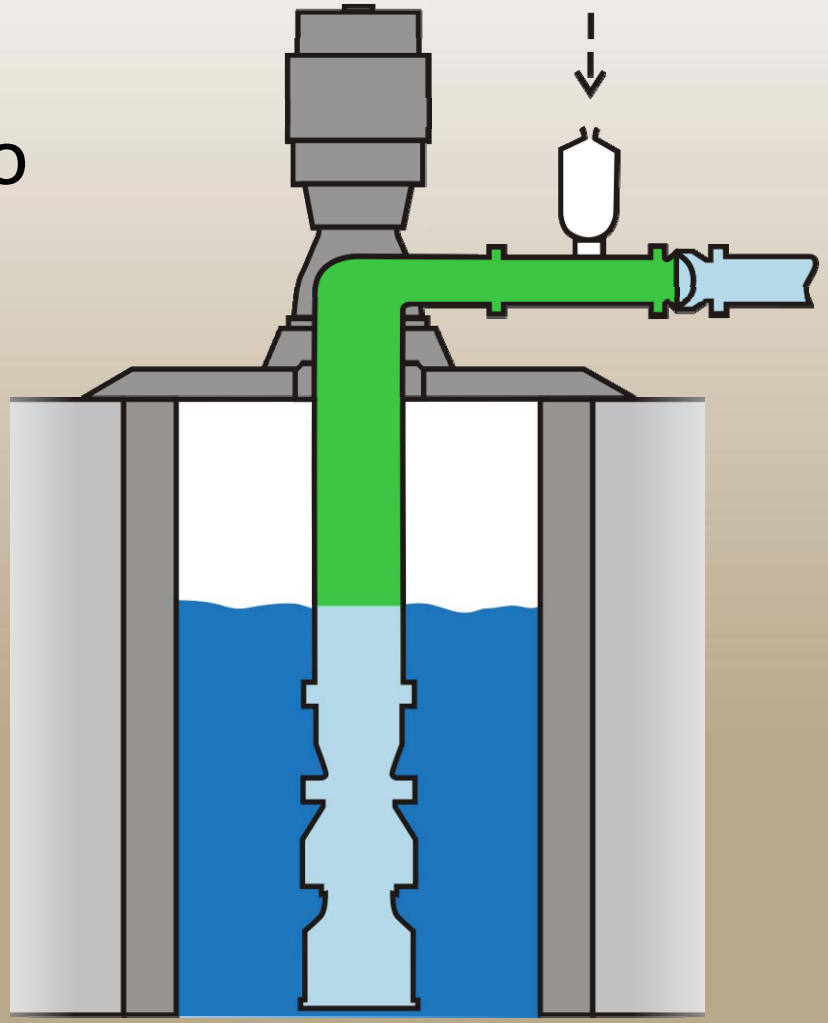
Pumps

- Pump Turns On
- Pumps Against Vacuum
- Slams Check Valve



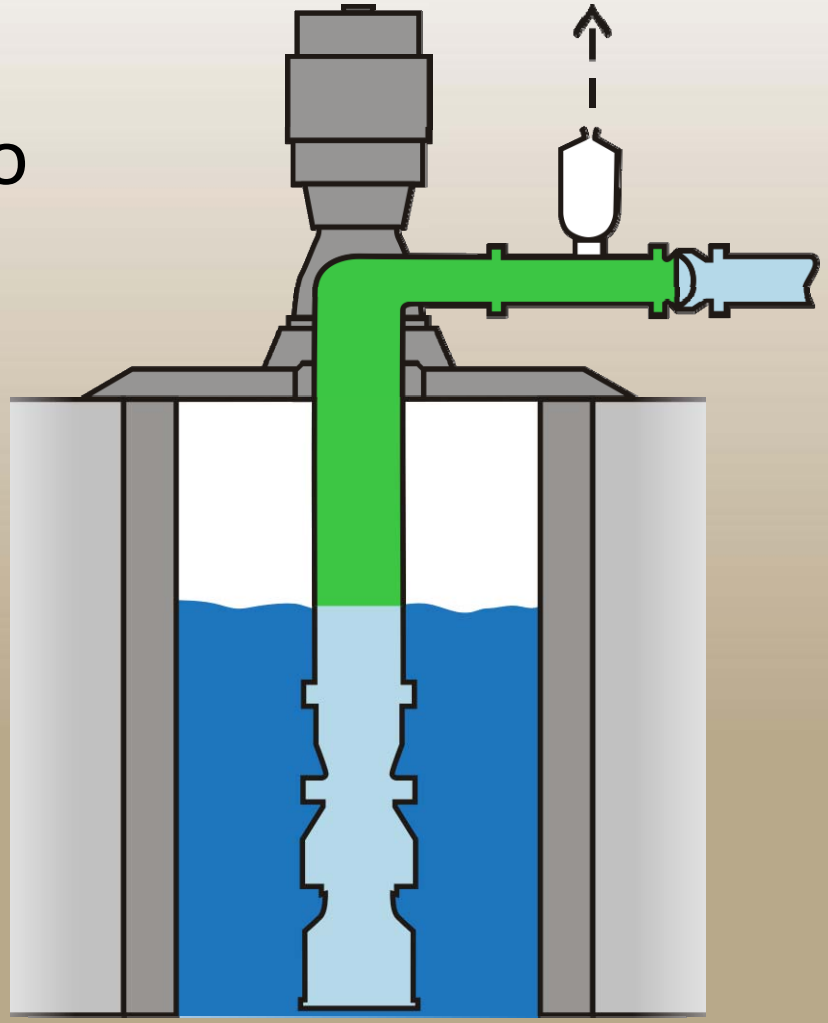
Pumps

- Add Air/Vac Valve
- Air Enters System to Eliminate Vacuum



Pumps

- Add Air/Vac Valve
- Air Enters System to Eliminate Vacuum
- Air Released at Controlled Rate



Sizing Valves

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Air Release

- Convert pipeline flow rate to Cubic Feet per Minute (CFM).
- Multiply CFM by 0.02 to estimate dissolved air in water.
- Determine the working pressure at the valve.
- Refer to Orifice Air Capacity Table in AWWA manual or manufacturer tables.

Air Release

Table 4-1 Air capacity table of air-release valve orifices (C_d = 0.7)

Pressure (*psi*)	Orifice Diameter, *In.*									
	1/16	3/32	1/8	3/16	1/4	5/16	3/8	7/16	1/2	1
25	1.6	3.5	6.3	14.2	25.2	39.4	56.7	77.1	100	400
50	2.6	5.8	10.3	23.1	41.0	64.1	92.3	126	164	656
75	3.6	8.0	14.2	32.0	56.9	88.9	128	174	228	910
100	4.5	10.2	18.2	40.9	72.8	114	164	223	291	1,160
125	5.5	12.5	22.2	49.8	88.6	138	199	271	354	1,420
150	6.5	14.7	26.1	58.8	104	163	235	320	418	1,610
175	7.5	16.9	30.1	67.7	120	188	271	369	481	1,920
200	8.5	19.2	34.1	76.6	136	213	306	417	545	2,180
225	9.5	21.4	38.0	85.5	152	238	342	466	608	2,430
250	10.5	23.6	42.0	94.5	168	262	378	514	672	2,690
275	11.5	25.8	45.9	103	184	287	414	563	735	2,940
300	12.5	28.1	49.9	112	200	312	449	611	799	3,200

NOTE: Metric conversions—in. × 25.4 = mm, cfm × 0.4719 = L/sec, psi × 6.89476 = kPa.

Air/Vac Valves

- Determine required valve size for both filling and draining independently
- Use the larger diameter for air/vac valve sizing

Pipeline Filling

- Calculate the venting flow rate in CFM.

  Venting Flow Rate = Fill Rate (CFM) * [(Pressure Differential across valve + 14.7 psi)/14.7 psi]

- Refer to sizing tables to select Air/Vac valve diameter.
- Use a 2 psi differential generally.

Pipeline Filling

Table 4-2 Air discharge table of large orifices (C_d = 0.7, T = 60°F, sea level)

Differential Pressure (psi)	Orifice Diameter, In. 1	2	3	4	6	8	10	12	14	16	18	20
1.0	79	317	712	1,270	2,850	5,070	7,910	11,400	15,500	20,200	25,600	31,700
1.5	97	387	870	1,550	3,480	6,190	9,670	14,000	18,900	24,700	31,300	38,600
2.0	111	445	1,000	1,780	4,010	7,120	11,100	16,000	21,800	28,500	36,100	44,500
2.5	124	497	1,120	1,990	4,470	7,950	12,400	17,900	24,300	31,800	40,200	49,600
3.0	136	543	1,220	2,170	4,890	8,690	13,600	19,500	26,600	34,700	44,000	54,300
3.5	146	585	1,320	2,340	5,270	9,370	14,600	21,100	28,700	37,500	47,400	58,500
4.0	156	625	1,410	2,500	5,620	10,000	15,600	22,500	30,600	40,000	50,600	62,500
4.5	165	662	1,490	2,650	5,960	10,600	16,500	23,800	32,400	42,300	53,600	66,200
5.0	174	697	1,570	2,790	6,270	11,100	17,400	25,100	34,100	44,600	56,400	69,700

NOTE: Metric conversions—in. × 25.4 = mm, cfm × 0.4719 = L/sec, psi × 6.89476 = kPa.

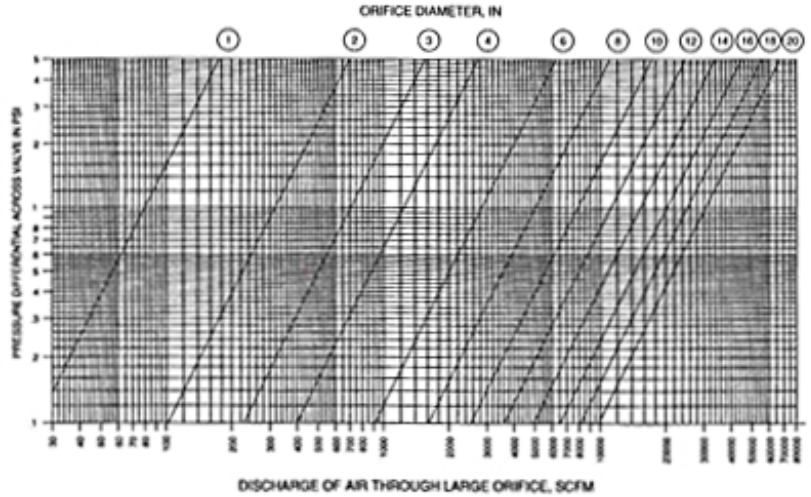

Figure 4-2 Air discharge graph of large orifices (C_d = 0.7).

Pipeline Draining or Vacuum Prevention

- Determine the allowable negative pressure for the pipeline with a safety factor. Assume 5.0 psi for a max.
- Calculate the slope of the pipeline in ft/ft.
- Use following figure to determine the required CFM.
- Refer to table to select the required air/vac valve diameter.

Pipeline Draining or Vacuum Prevention

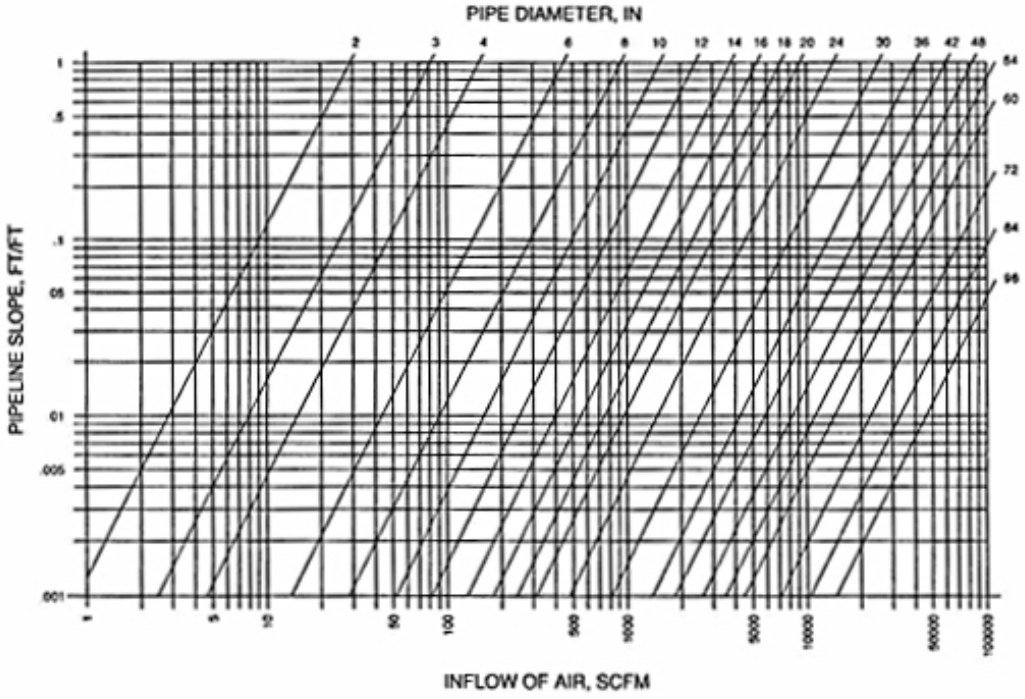

Figure 4-3 Inflow of air for gravity flow

Table for Determining Air Flow when Draining Pipelines

Pipeline Draining or Vacuum Prevention

Table 4-3 Air inflow table of large orifices (C_d = 0.7)

Differential Pressure (*psig*)	Orifice Diameter, *In.*											
	1	2	3	4	6	8	10	12	14	16	18	20
1.0	76	306	688	1,220	2,750	4,890	7,650	11,000	15,000	19,600	24,800	30,600
1.5	92	366	824	1,470	3,300	5,860	9,160	13,200	17,900	23,500	29,700	36,700
2.0	103	414	931	1,660	3,720	6,620	10,300	14,900	20,300	26,500	33,500	41,400
2.5	113	452	1,020	1,810	4,070	7,230	11,300	16,300	22,100	28,900	36,600	45,200
3.0	121	484	1,090	1,930	4,350	7,740	12,100	17,400	23,700	31,000	39,200	48,300
3.5	127	510	1,150	2,040	4,590	8,160	12,700	18,400	25,000	32,600	41,300	51,000
4.0	133	532	1,200	2,130	4,780	8,510	13,300	19,100	26,100	34,000	43,000	53,200
4.5	137	550	1,240	2,200	4,950	8,800	13,700	19,800	26,900	35,200	44,500	55,000
5.0	141	565	1,270	2,260	5,080	9,030	14,100	20,300	27,700	36,100	45,700	56,500

NOTE: Metric conversions—in. × 25.4 = mm, cfm × 0.4719 = L/sec, psi × 6.89476 = kPa.

Table for Sizing Air/Vac Valves when Draining Pipelines

Valve Specifications

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Air Release Valves

- Orifice Size (1/16” to 1”)
- NPT Inlet size (1/2” to 3”)
- Maximum Working Pressure (75 psi and up)
- ***Minimum Sealing Pressure*** (softer seats needed when under 25 psi)
- Valve Materials (Ductile or Cast Iron, St. Stl)
- Accessories (check valve, back flush, flow regulators, etc.)
- ***Service*** (Wastewater or Clean Water)

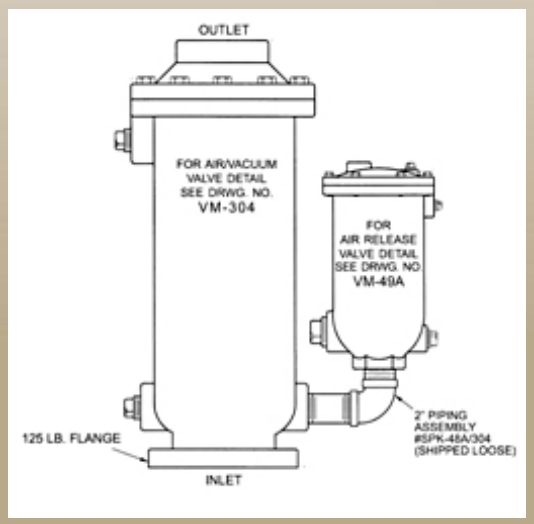
Air/Vac Valves

- Similar to Air Release Valves
- Inlet/Outlet sizes (1” to 20”)
- Type of Connections (NPT and Flanged)
- Maximum Working Pressure (150 to 300 psi)

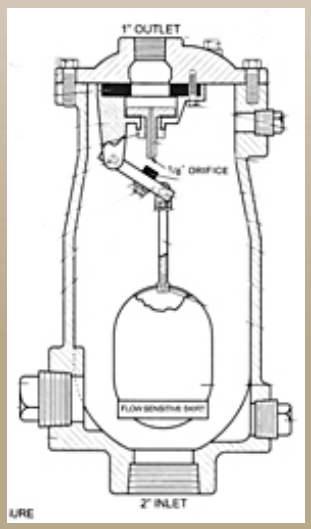
Combination Air Valves

- All of the above
- Body Configuration (Single versus Dual)

Dual Body



Single Body



Installation and O&M

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Installation

- Connections
  - Inlet piping and isolation valve should be same size as valve inlet
  - Short Inlet Piping and Vent Lines

Installation

- Location
  - Need protection from freezing, contamination, flooding, and vandalism
  - Needs access
  - Watch valve clearances

Operation and Maintenance

- Inspections and Flushing
  - At least annually
  - More often for valves that operate continuously
  - Watch for external leakage

QUESTIONS

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