

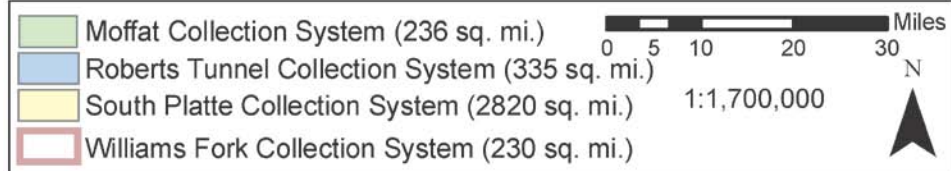
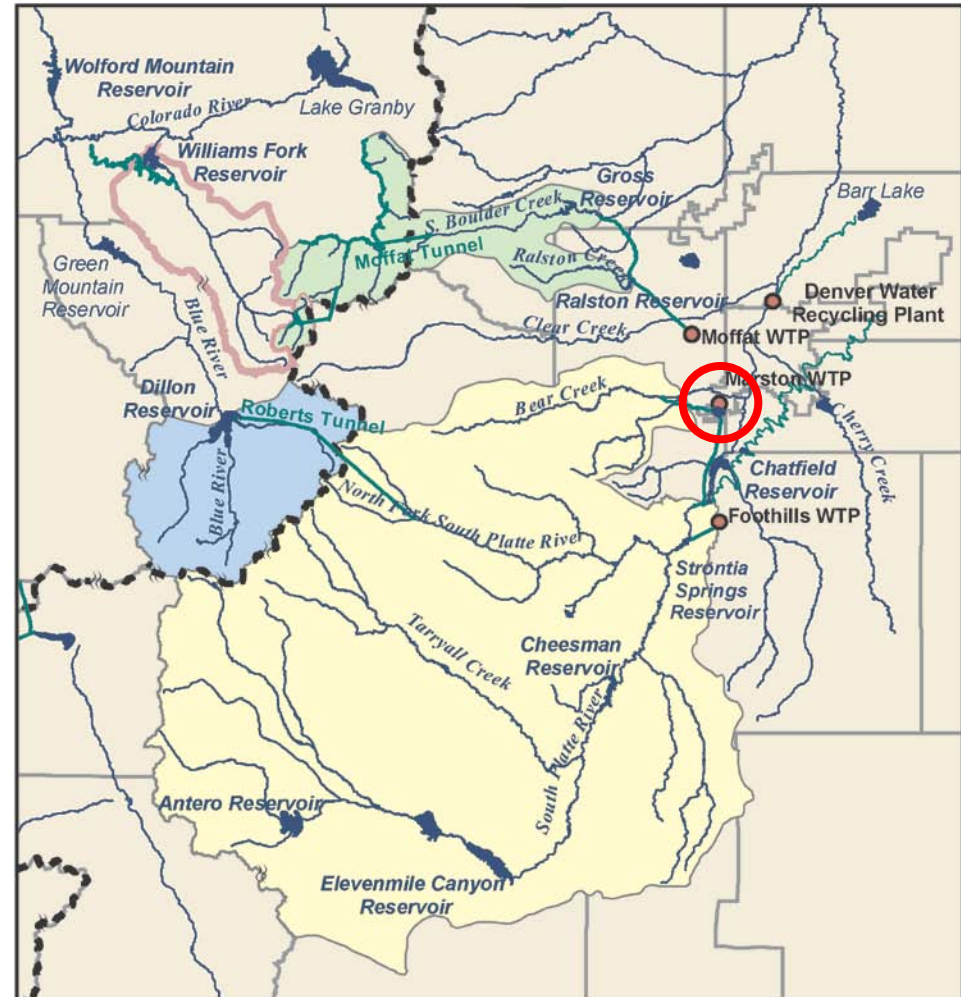
# Life After the Speece Cone

Oxygenation doesn't solve everything

# Denver Water's System

- ▶ 1.3 Million Customers
- ▶ Three Potable Water Treatment Plants
- ▶ Three Terminal Reservoirs

Denver Water Collection System





# Water Quality Concerns at Marston Reservoir

- ▶ Late Summer and Fall Episodes of Taste and Odor Complaints
  - Reservoir monitoring began in 1990
  - Revealed formation of anoxic hypolimnion
- ▶ In 1995, Eurasian Watermilfoil appears
  - Aquatic Invasive Species

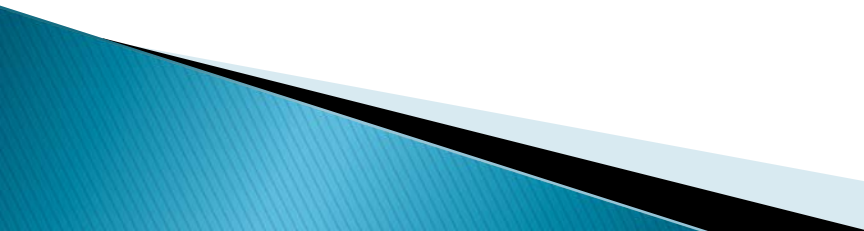


# Existing Methods for Handling Taste and Odor Complaints

- ▶ Shutdown Marston
- ▶ Feed Powder Activated Carbon
- ▶ Change Intake Level in the Reservoir
- ▶ Go on the By-pass



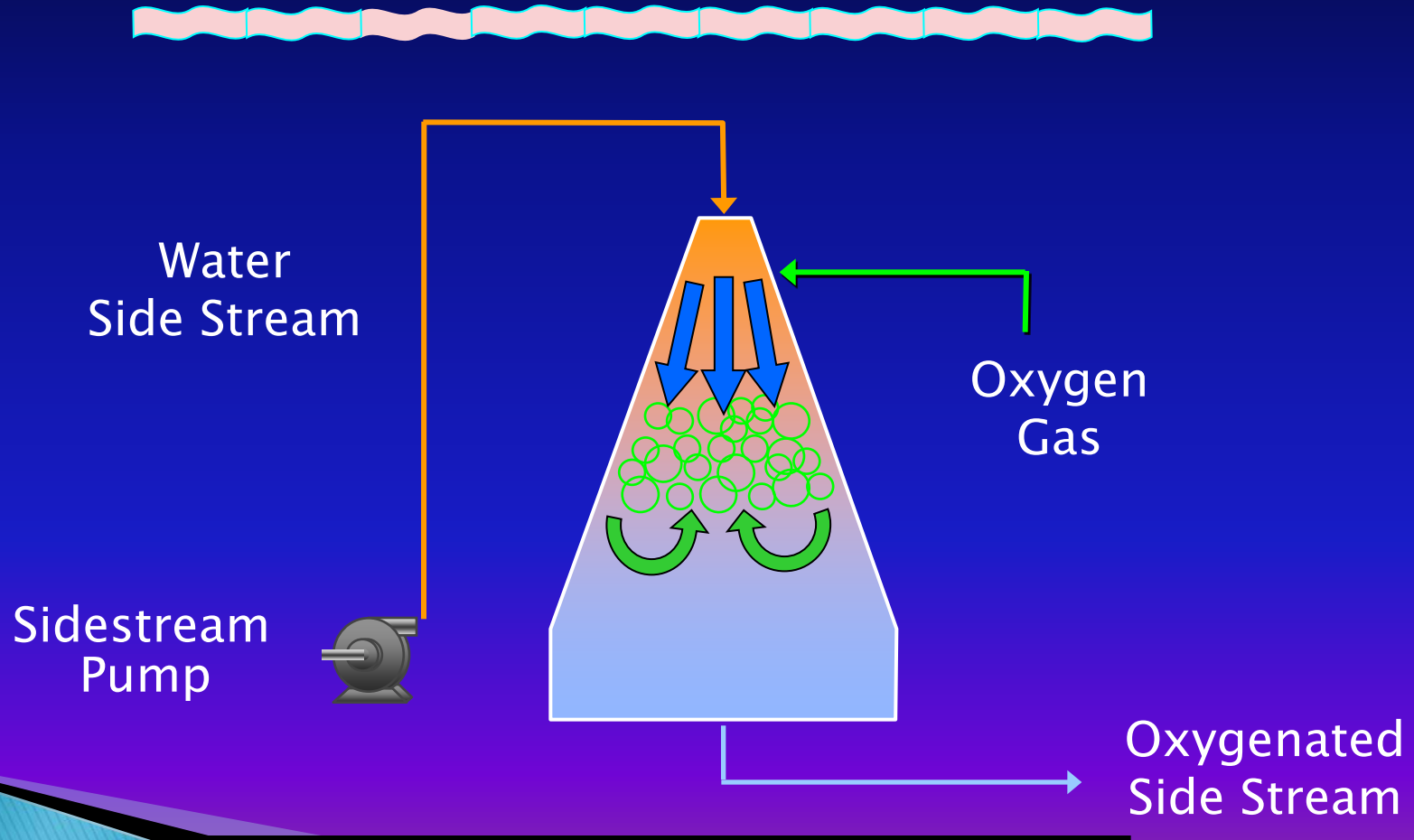
# Nothing Happens Quickly at Denver Water

- ▶ In 1996, a study was done looking at benefits of aeration but no action was taken
  - ▶ By-pass provided a means to work around the problem but not a fix
  - ▶ In 2006, a new focus on improving water quality in Marston Reservoir
    - Speece cone chosen as best option
- 

# Technology Overview



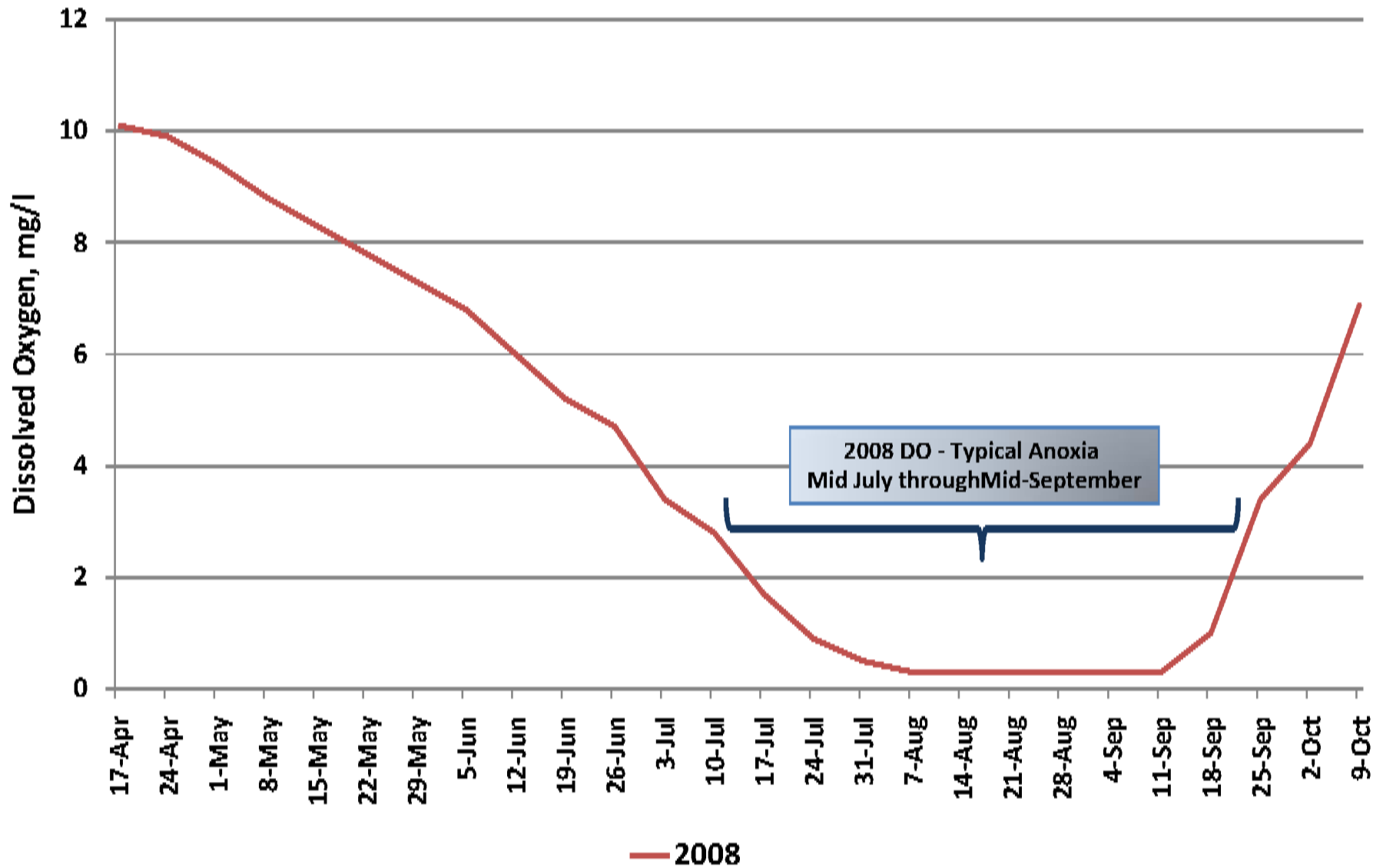
Marston Reservoir



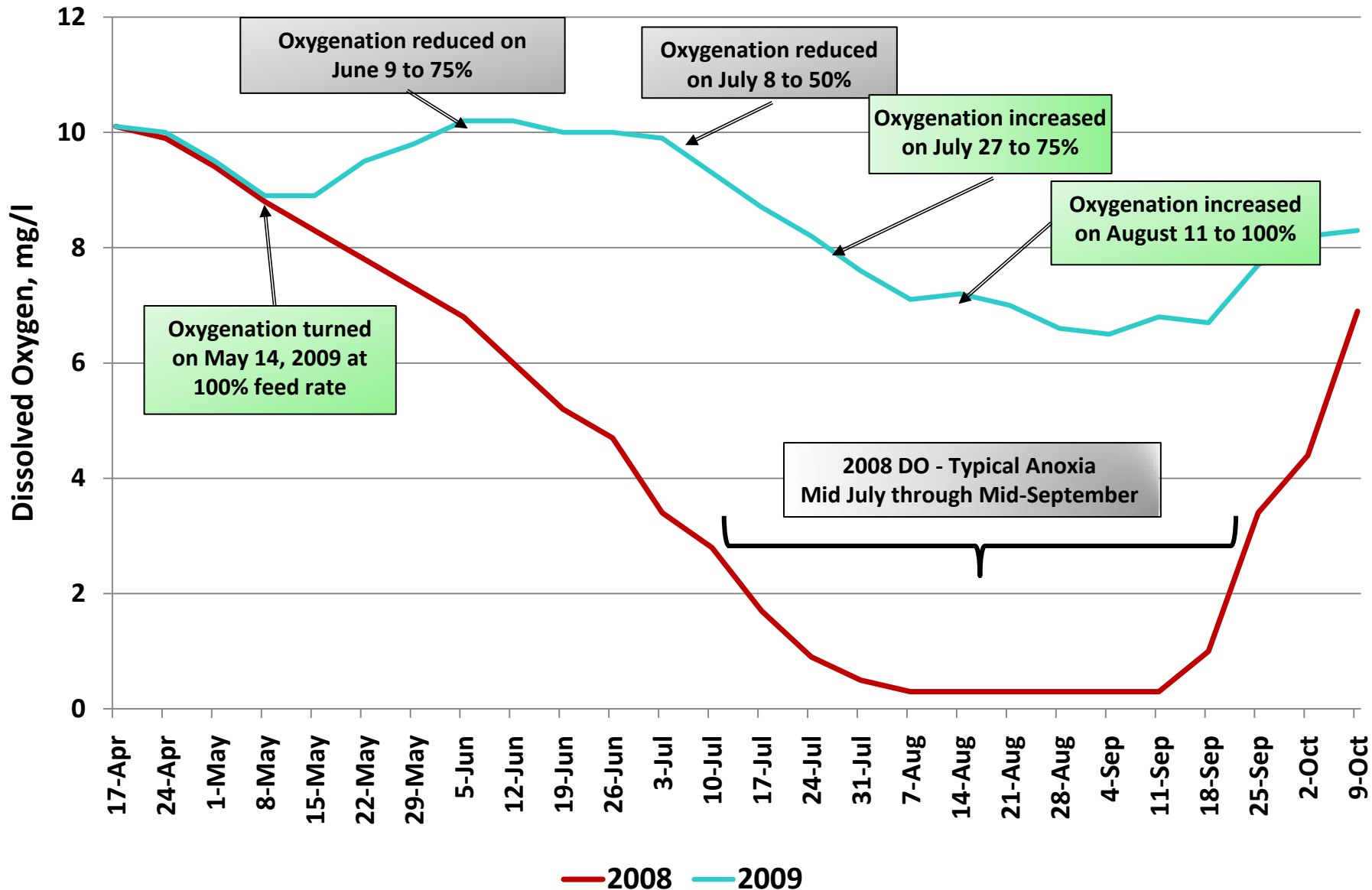
# YSI Monitoring Platform



# Marston Reservoir Bottom Dissolved Oxygen 2008

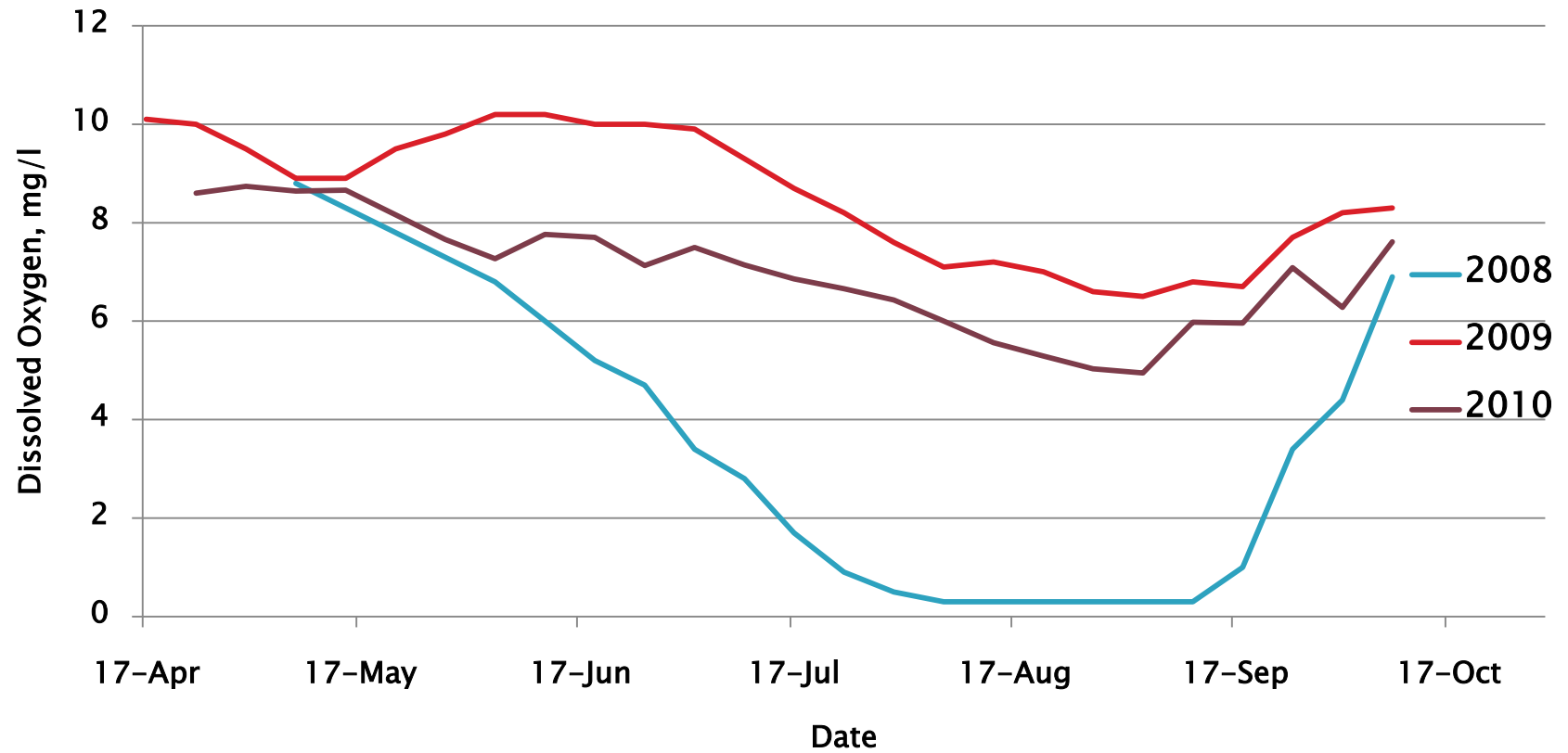


# Marston Reservoir Bottom Dissolved Oxygen 2008 vs. 2009



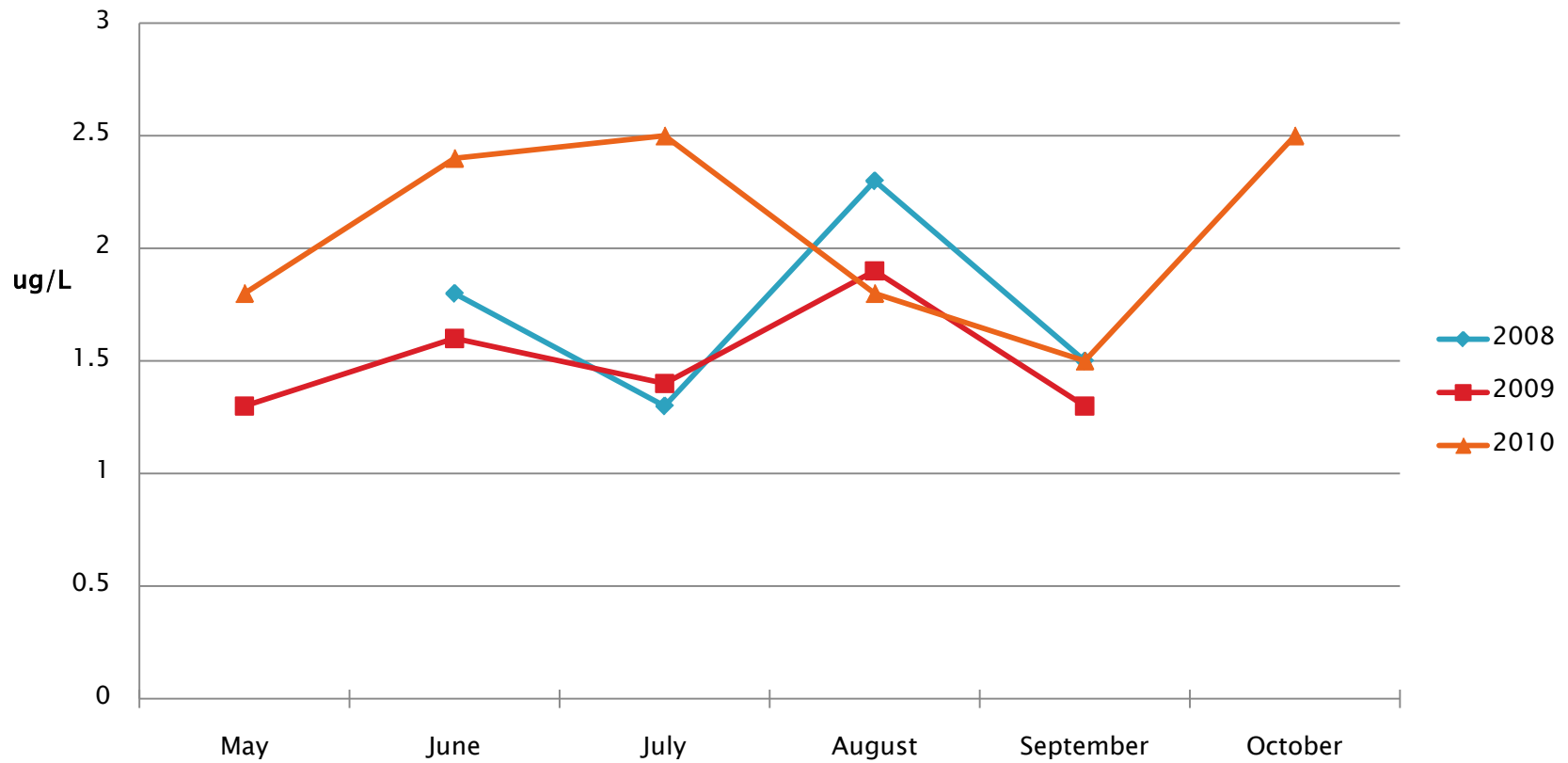


# Marston Reservoir Bottom Dissolved Oxygen 2008 vs. 2009 vs. 2010

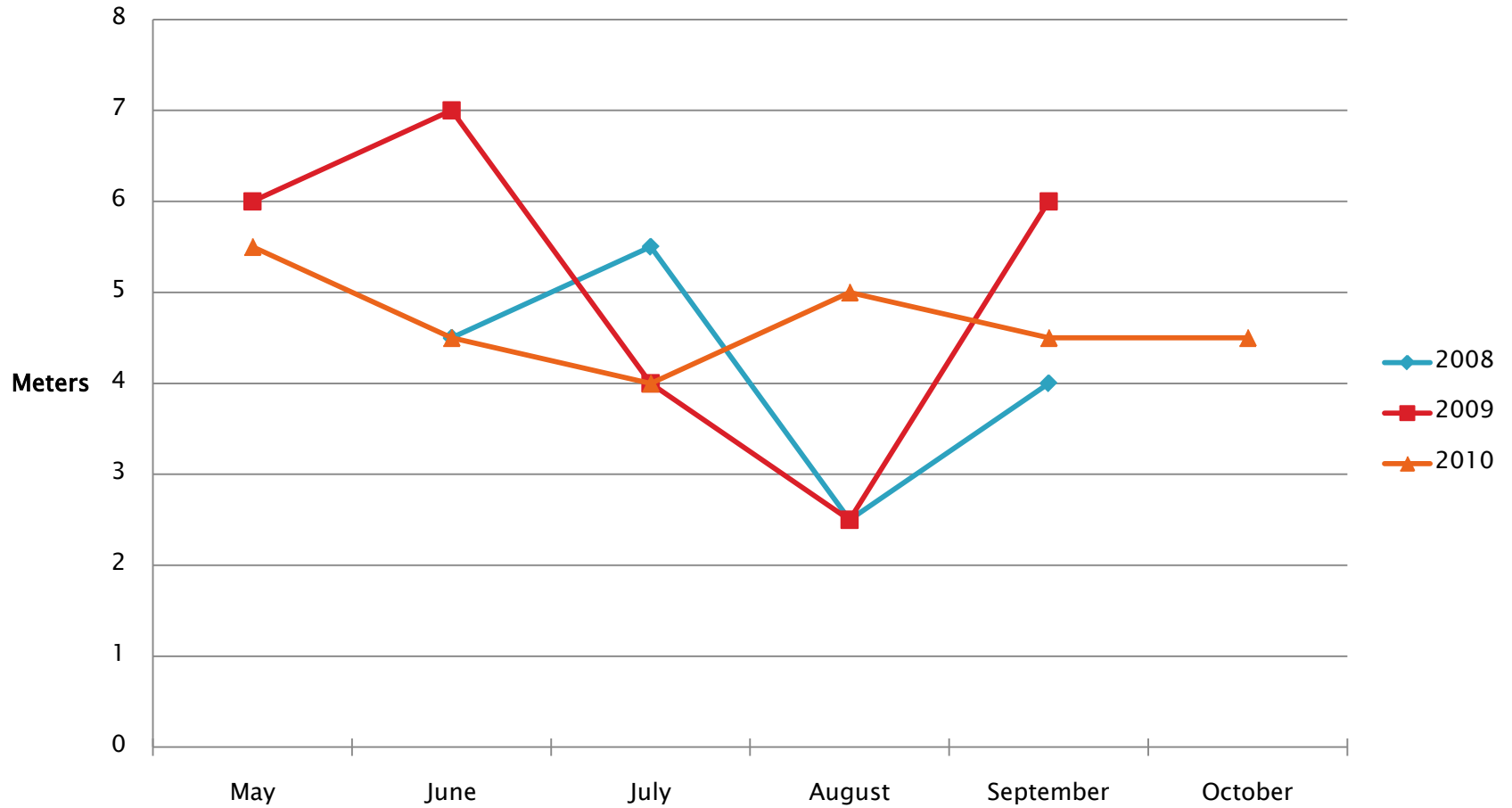


# Chlorophyll Concentrations in Marston Before and After Speece Cone Start-up

## Chlorophyll Concentration



# Secchi Depth Comparisons





# Life With Oxygen is Good, Right?

- ▶ No episodes of taste and odor complaints in 2009
- ▶ We didn't use the by-pass in 2009
  - Of course, Marston was taken off-line before turnover
- ▶ In late July, we see geosmin levels going up in Marston effluent samples



# Geosmin Results in $\mu\text{g}/\text{L}$

Date	Marston, 5 M	Marston, 10 M	Influent	Effluent
6/15	1.04	1.11	2.04	1.18
7/12	1.16	0.73	0.59	1.13
7/20			0.6	2.31
7/27			1.71	4.97



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8/3	23.91	5.2	3.96	9.28



Did I forget to mention that in 2010 we saw the return of an old friend?





# Plankton Results for August 10, 2010

Location	Predominant Organism	Count/mL	Total Organisms Count/mL
Marston Reservoir, main site	Anabaena	266	308
Marston Reservoir, milfoil grove	Anabaena	2128	2198
Influent to treatment plant	Melosira	154	196

# Geosmin Results in ng/L

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8/3	23.91	5.2	3.96	9.28
8/10	7.99	3.72	5.91	6.97



# What else did we do besides take more samples?

- ▶ Based on the geosmin results, we shut off our top intake
  - The top intake was approximately five meters deep
- ▶ With the Speece cone operating, we were able to use water from the deeper levels
  - The main intake was at roughly 10 meters below the surface
- ▶ The complaints stopped

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8/10	7.99	3.72	5.91	6.97
8/17			2.03	4.19
8/24			1.72	3.99
8/31			0.33	1.67
9/7	2.47	0.91	1.06	2.65
9/14			0.59	2.68
9/21			0.55	2.35
10/5	3.18	2.66		



# What's next for Marston and the Speece Cone?

- ▶ We have yet to use water from Marston during and after turnover
- ▶ How to deal with Eurasian Watermilfoil is an ongoing issue
- ▶ We won't be doing away with our T&O analyses