

Crystal Springs Lake Temperature Model

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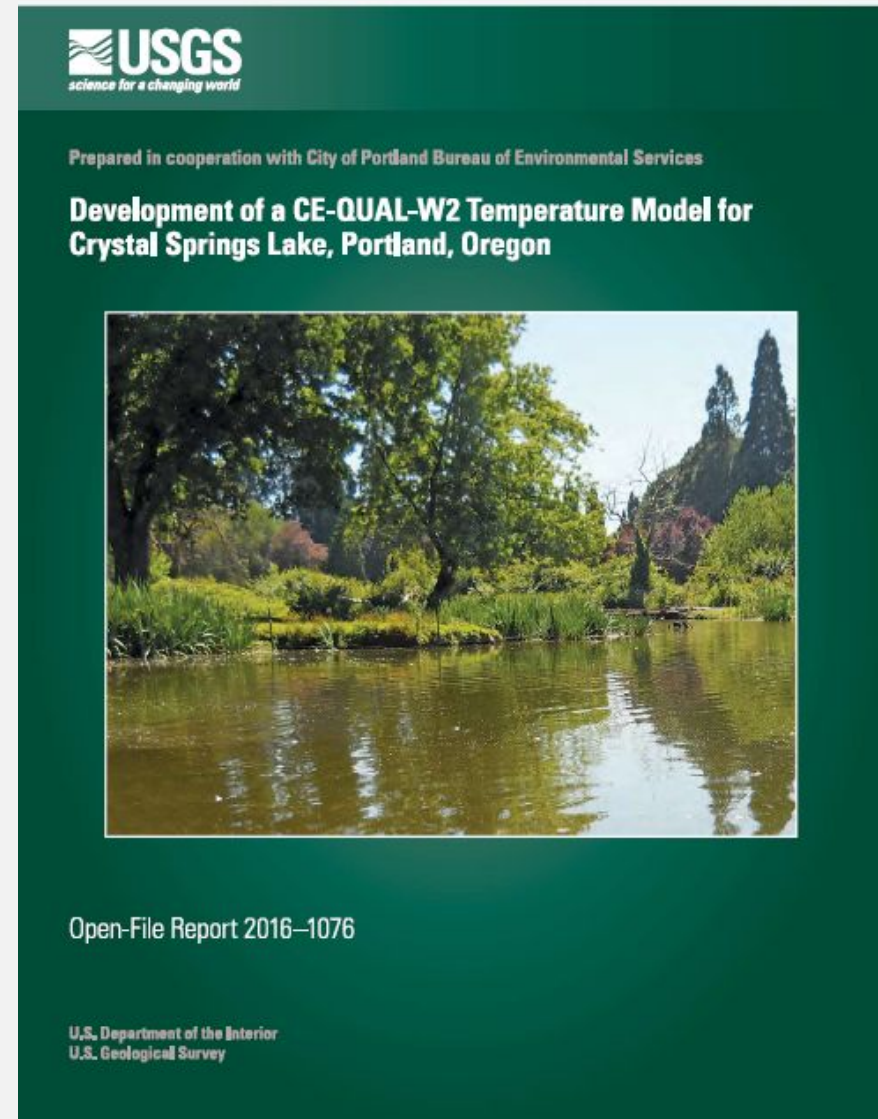
- Unless noted otherwise, all data, figures and tables from Buccola, N.L., and Stonewall, A.J., 2016, Development of a CE-QUAL-W2 temperature model for Crystal Springs Lake, Portland, Oregon: U.S. Geological Survey Open-File Report 2016–1076, 26 p., <http://dx.doi.org/10.3133/ofr20161076>.

Presentation overview

- 1. Background**
- 2. Objectives & Approach**
- 3. Data collection**
- 4. Model overview**
- 5. Model development**
- 6. Results**

Report

- Published in 2016
- Modeled pond temperature and levels for summer of 2014
- <https://pubs.er.usgs.gov/publication/ofr20161076>



Background

- Study funded by Portland Bureau of Environmental Services
- Recent improvements made to Crystal Springs Creek (culvert replacements and Westmoreland Park)
- The TMDL stipulates a 7-day average of the daily maximum stream temperature (7dADM) of 64.4 °F (18.0 °C), lower during spawning season
- Crystal Springs Creek (USGS streamgage 14211542) exceeded the TMDL by an average of 3.2 °F (1.8 °C) for 42 percent of calendar years 2003–13

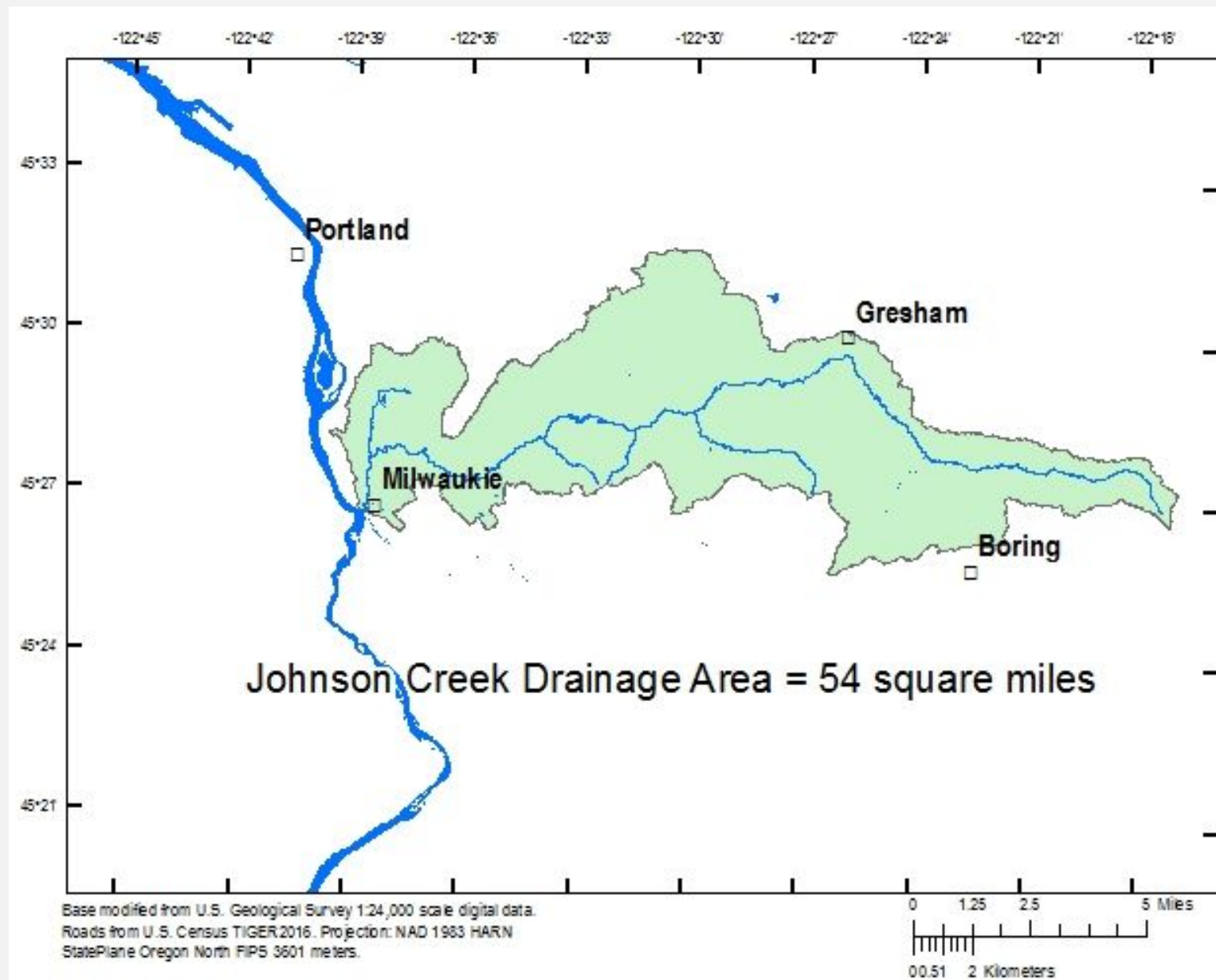
Culvert at SE 28th Avenue

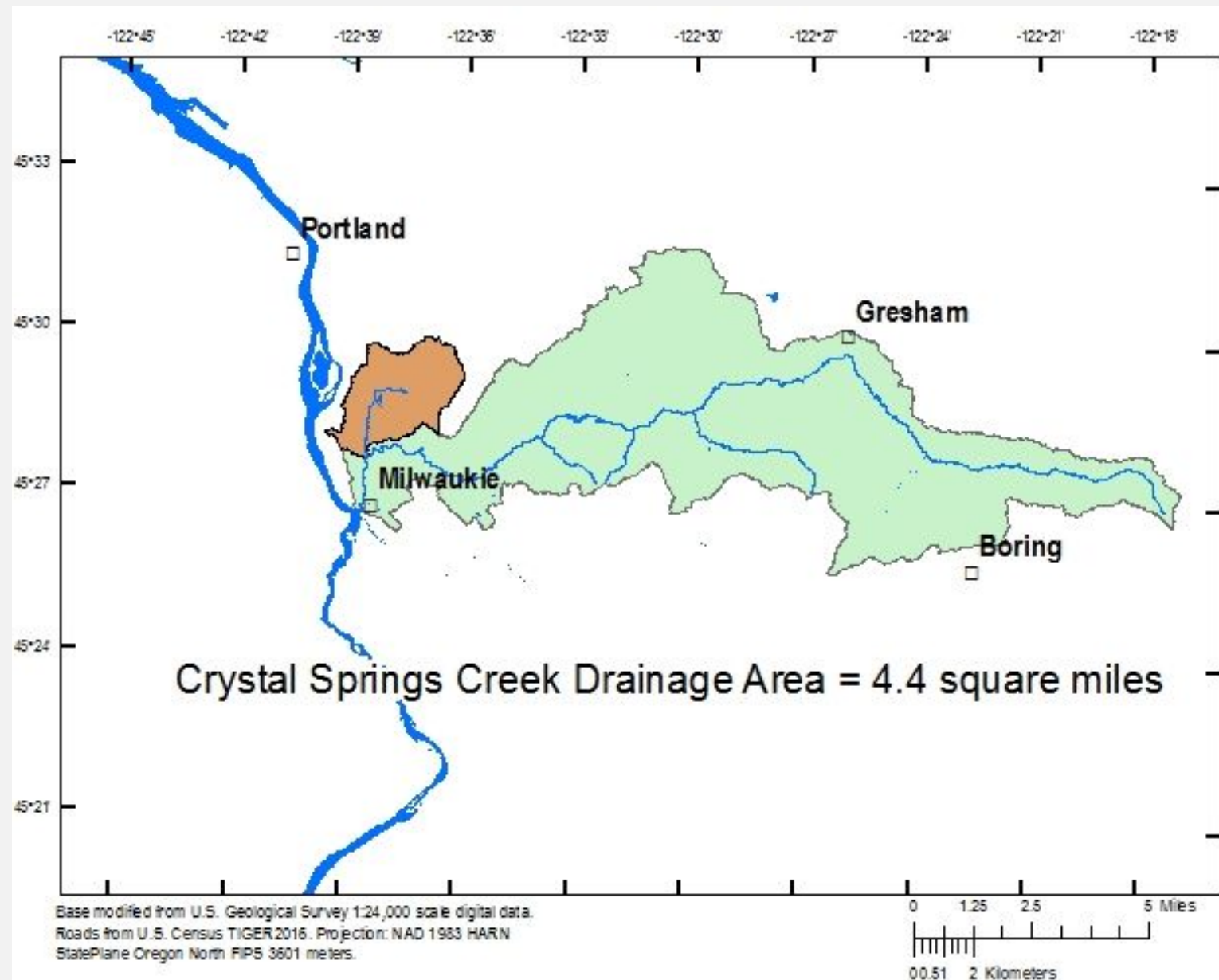
Before improvement

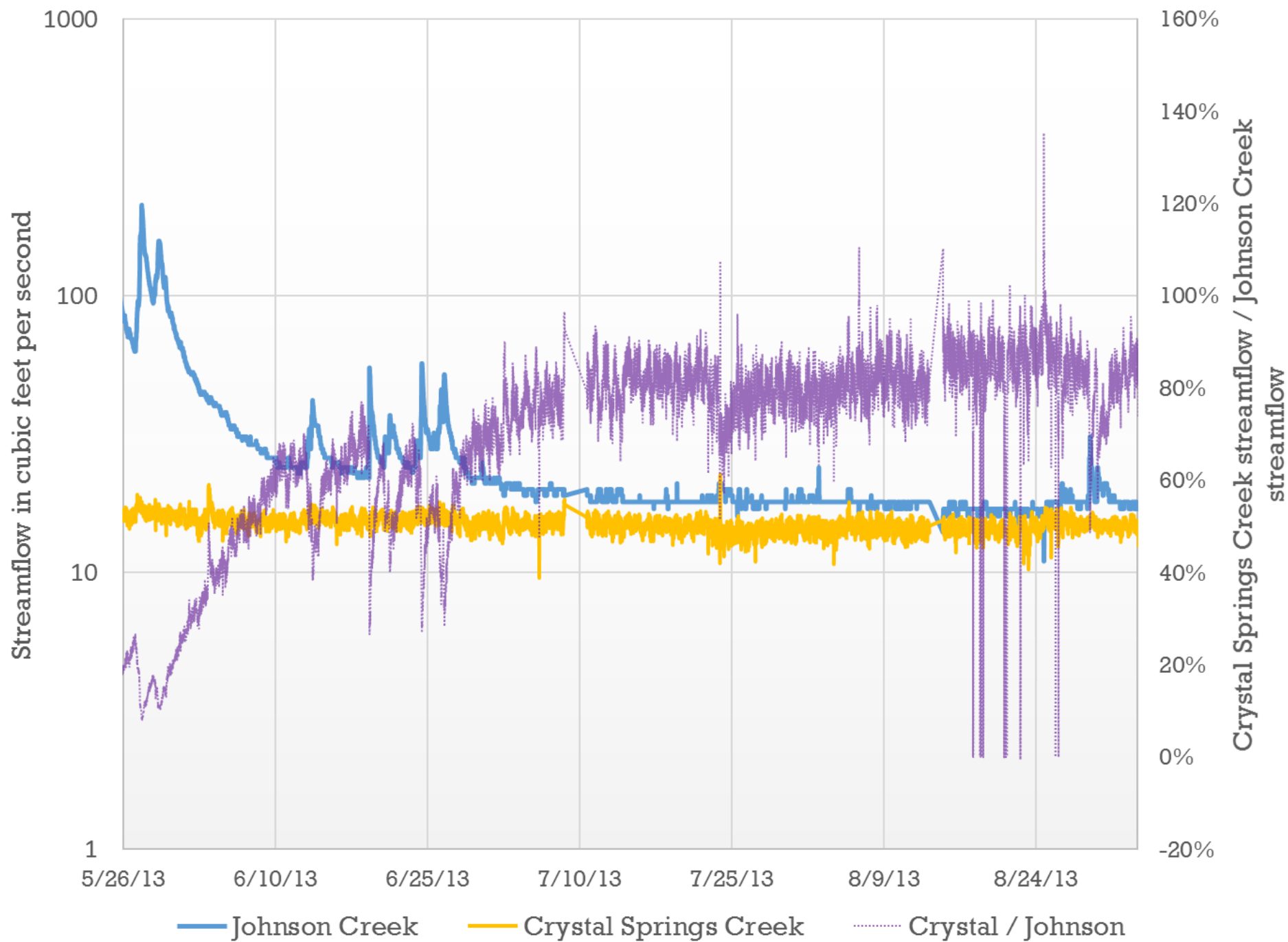


Improved crossing









Objectives

- Quantify temperature loading around Crystal Springs Lake
- Develop temperature model of lake and surrounding area
- Investigate improvement scenarios using model
- Develop rudimentary nutrient budget (not published)

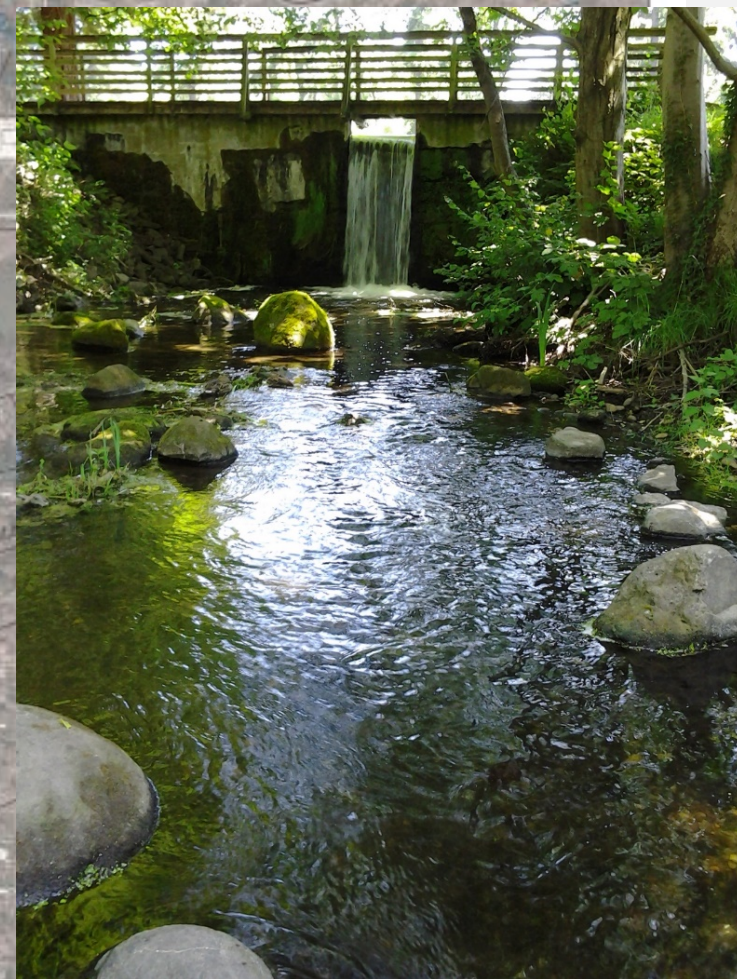


Figure 1. Map showing study sites at Crystal Springs Lake, the Golf Pond, and surrounding area, Portland, Oregon.



Approach

- All data collected during summer of 2014 (May – Oct)
- Water quality and streamflow data collected by BES and USGS
- Used CE-QUAL-W2 program to model temperature of lake and golf pond
- Modeled more shallow version of lake and additional shade to lake
- Golf pond left unaltered in model

Data collection

- **Hydrology – monthly measurement at key points (outflows, major inflows), one measurement at small springs (assumed constant)**
- **Surface water elevations – continuous data collected for both the lake and golf pond**
- **Water quality – continuous temperature and several key locations, two synoptic temperature runs, monthly water quality data at some sites**
- **Bathymetry – pond and lake bathymetry data collected by BES**

2014 Monitoring Sites



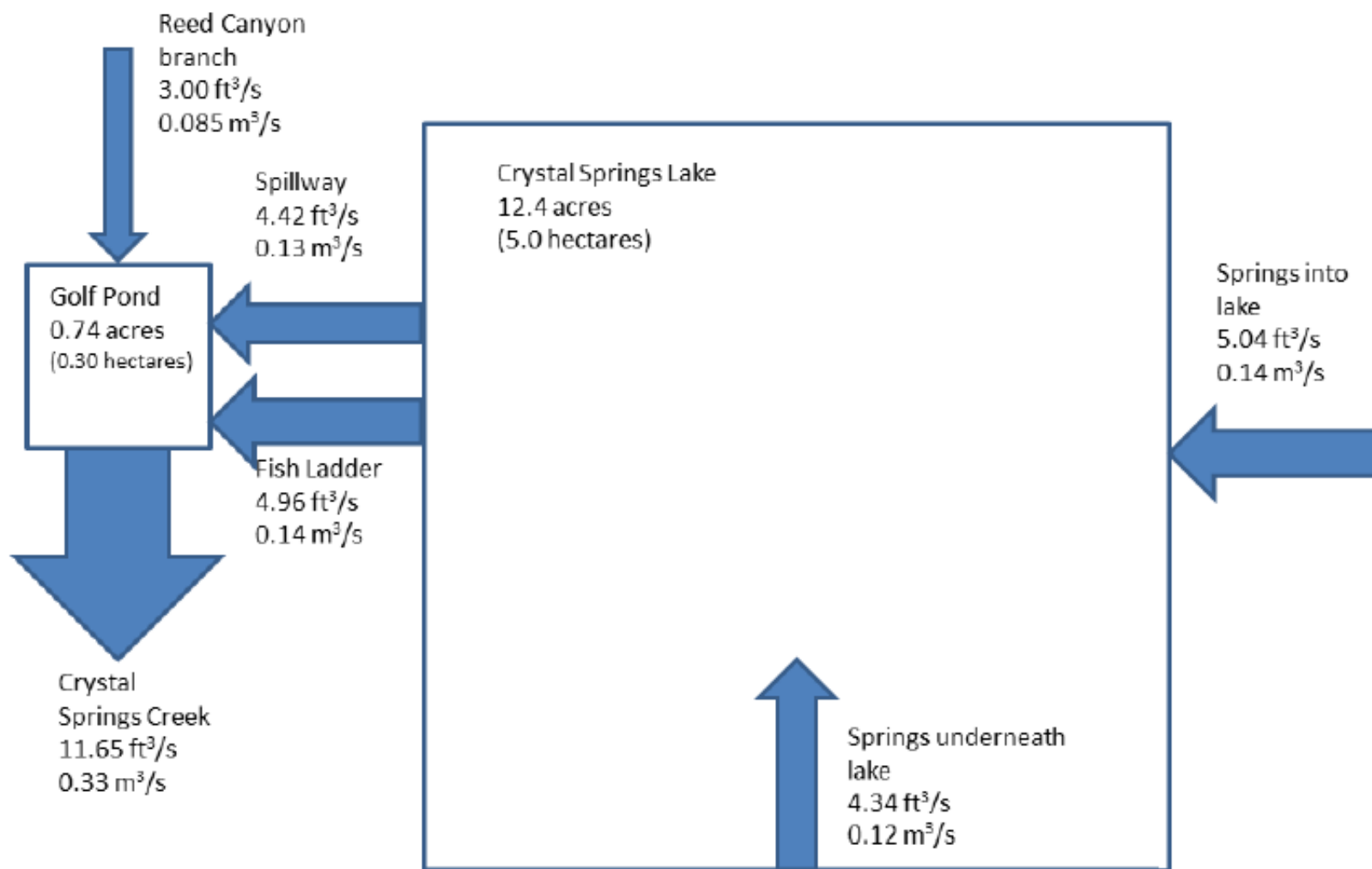


Figure 2. Schematic diagram showing streamflow to and from Crystal Springs Lake, the Golf Pond, and surrounding area, Portland, Oregon.

Temperature data

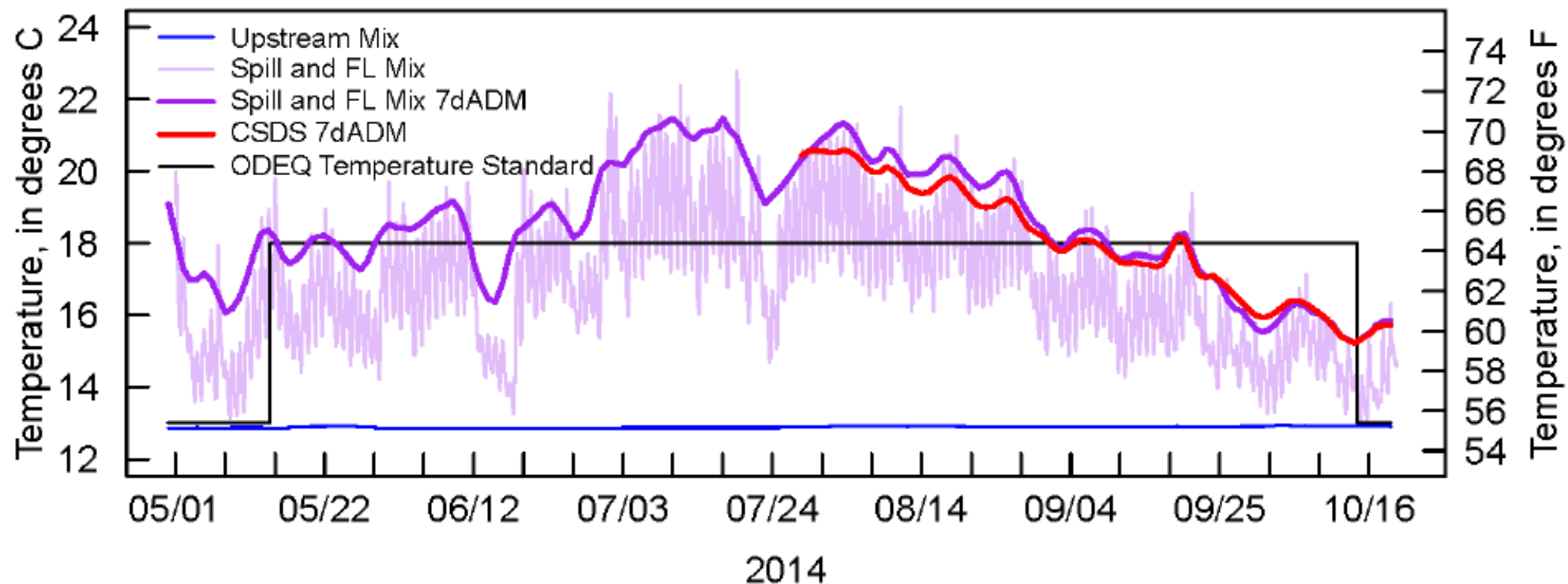


Figure 6. Graph showing measured summer inflow (“Upstream Mix”) and outflow (“Spill and FL Mix”) water temperatures at Crystal Springs Lake, Oregon. Spill data were used as a surrogate for FL data 09-29–10-20 due to sensor fouling. Abbreviations: 7dADM, 7-day average of daily maximum; ODEQ, Oregon Department of Environmental Quality; CSDS, site downstream of the Golf Pond.

Model background

- **CE-QUAL-W2, version 3.72, released April 2015 (Cole and Wells, 2015)**
- **Two-dimensional**
- **Laterally averaged**
- **Hydrodynamic**
- **Developed by the U.S. Army Corps of Engineers and updated by Portland State University**
- **Has been applied to river, lake, and reservoir systems around the world, including many in Oregon (Sullivan and Rounds, 2006; Sullivan and others, 2007, 2014; Buccola and others, 2013; Rounds and Buccola, 2015)**

Model development

- 1. Development of lake and pond bathymetry and other geometric data
- 2. Compilation or estimation of boundary conditions
- 3. Calibration of streamflow, water elevation, and water temperature measurements

Model grid

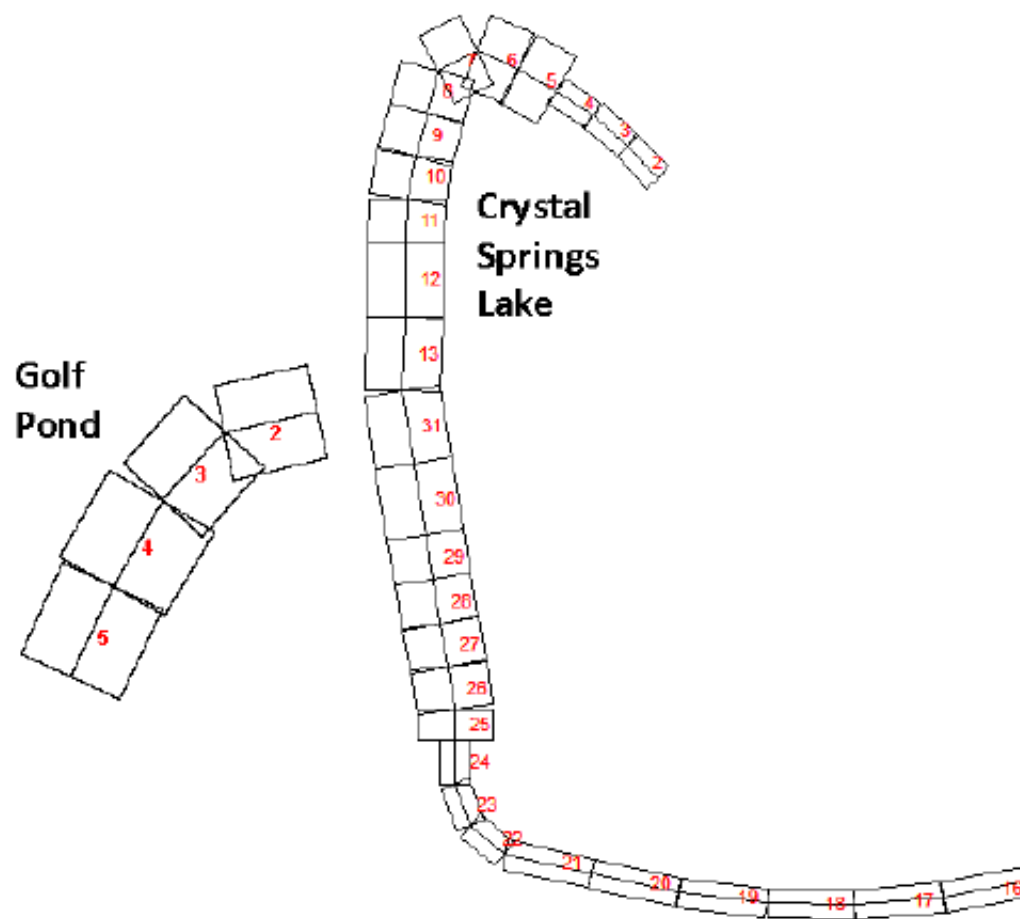


Figure 5. Diagram showing CE-QUAL-W2 model grid of Crystal Springs Lake and the Golf Pond, Portland, Oregon.

Model Calibration- temperature

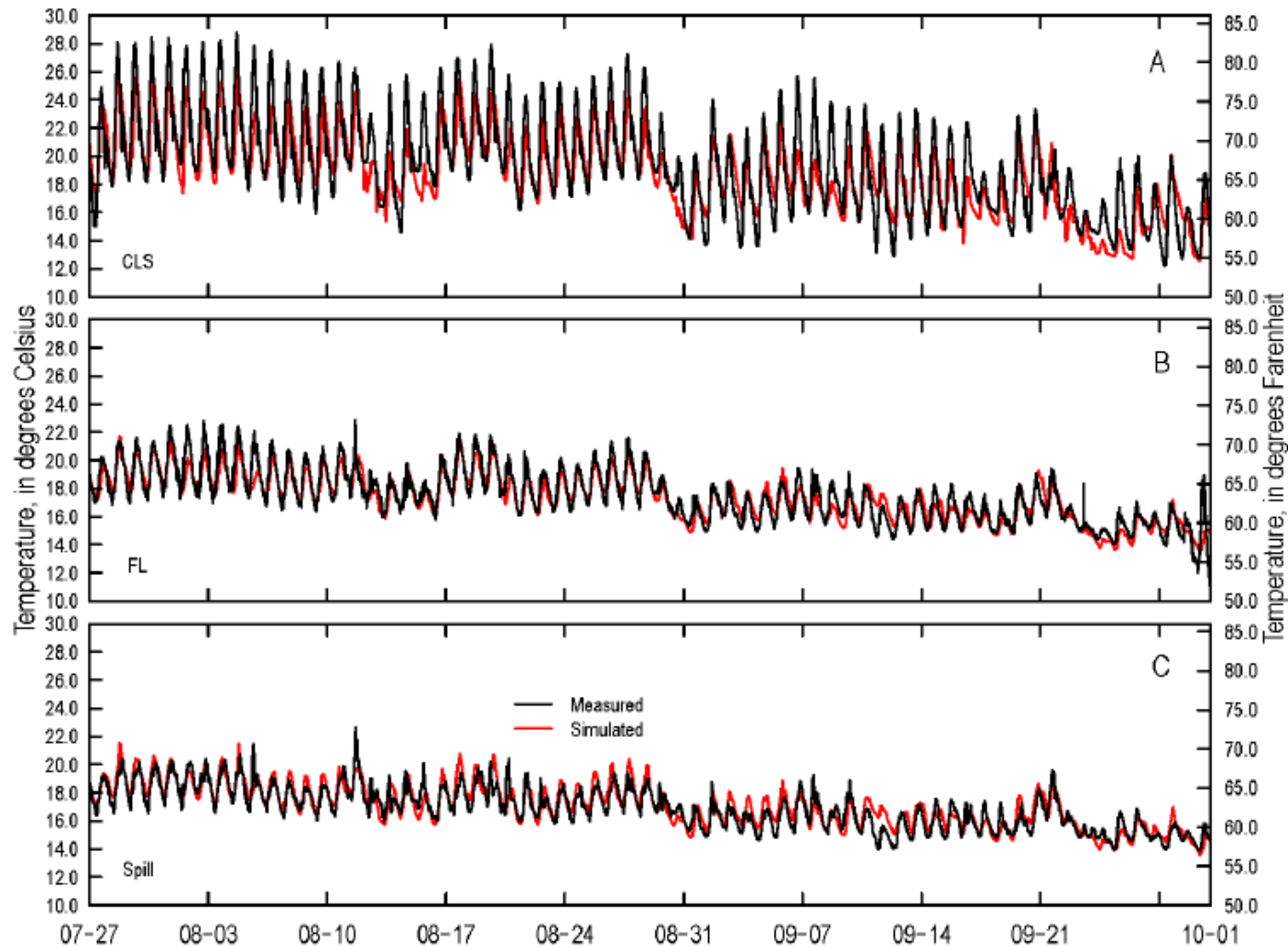


Figure 9. Graphs showing comparison of measured and simulated water temperature at sites (A) Crystal Springs Lake South (CLS), (B) fish ladder outflow (FL), and (C) spillway outflow (Spill), Crystal Springs Lake, Oregon.

Management scenarios

- **Changes in lake elevation (depth)**
 - Elevations of 18.1 meters (current conditions)
 - 17.7 meters
 - 17.3 meters
 - 17.0 meters
- **Changes in lake shade**
 - No effective shade (current conditions)
 - 20% shade, height of 10 meters around perimeter
 - 80% shade, height of 10 meters around perimeter
- **No dam (boundary condition, not real scenario)**

Management scenarios

Table 6. List of management scenarios evaluated for Crystal Springs Lake, Portland, Oregon.

	Management scenario	Lake elevation (feet)	Lake elevation (meters)	Lake shading (percent)
	2014 (current conditions)	59.4	18.1	none
	17.7	58.1	17.7	none
	17.3	56.8	17.3	none
	17.0	55.8	17.0	none
	UpstreamMix	no dam	no dam	none
	2014_dynshd0.2	59.4	18.1	20
	17.7_dynshd0.2	58.1	17.7	20
	17.3_dynshd0.2	56.8	17.3	20
	17.0_dynshd0.2	55.8	17.0	20
	2014_dynshd0.8	59.4	18.1	80
	17.7_dynshd0.8	58.1	17.7	80
	17.3_dynshd0.8	56.8	17.3	80
	17.0_dynshd0.8	55.8	17.0	80

Results

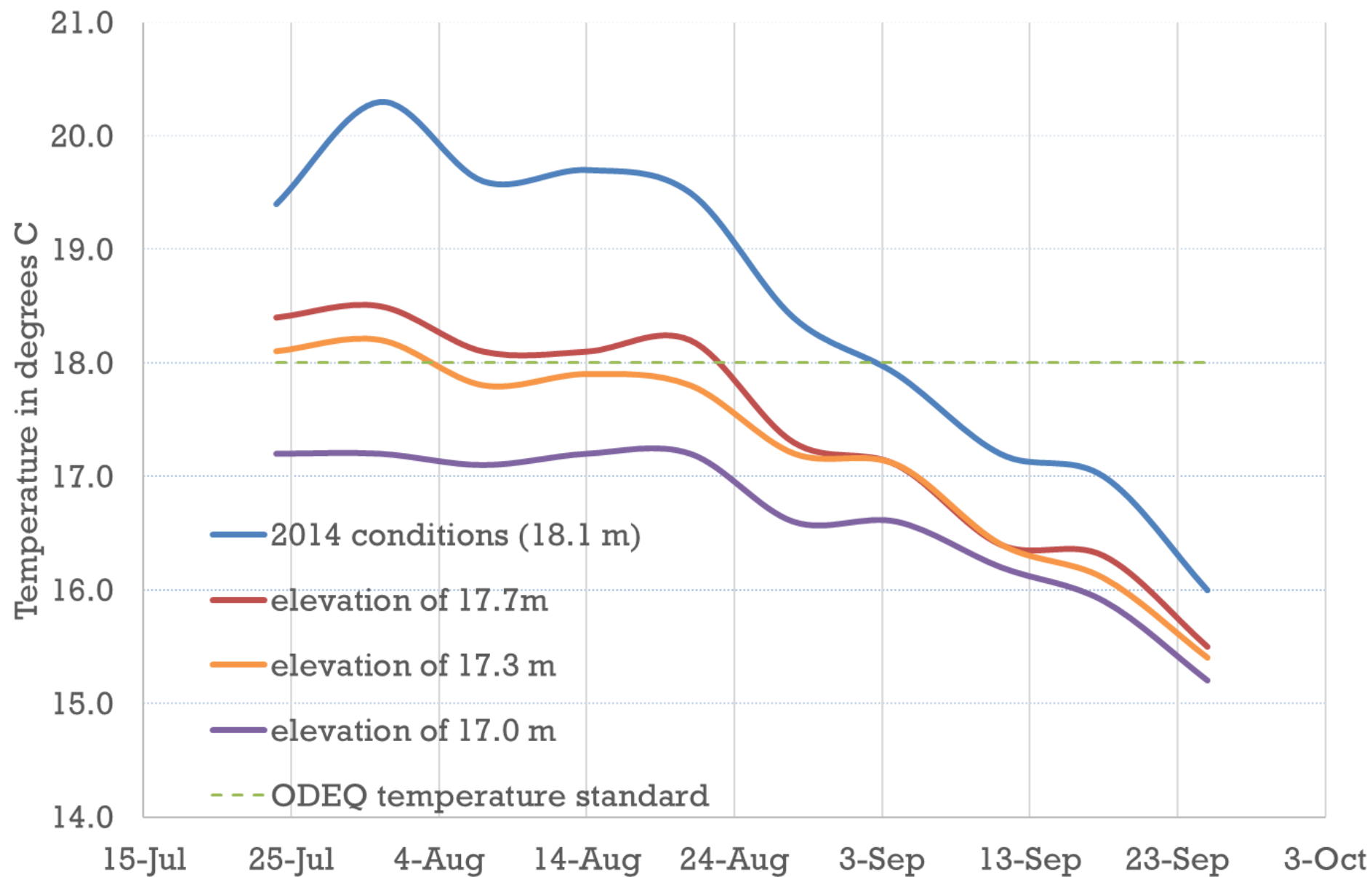


Table 7. Average residence times for Crystal Springs Lake and the Golf Pond, Portland, Oregon.

["Golf Pond" refers to the small pond just downstream of Crystal Springs Lake.
Abbreviations: ft, foot; m, meter; ft³, cubic foot; m³, cubic meter; ft², square foot; m², square meter]

Crystal Springs Lake			
	Water-surface elevation (ft)	Water-surface elevation (m)	Residence time (days)
	59.4	18.1	1.1
	58.1	17.7	0.5
	56.8	17.3	0.3
	55.8	17.0	0.1
Golf Pond			
	Water-surface elevation (ft)	Water-surface elevation (m)	Residence time (days)
	51.2	15.6	0.04

2014 Temperature at outflow of Crystal Springs Lake



2014 Temperature at outflow of Crystal Springs Lake

