

## Abstract

CE-QUAL-W2 (W2) is a 2D, laterally averaged hydrodynamic and water quality model developed by U.S. Army Corps of Engineers and Portland State University. The W2 model can simulate a range of water quality constituents, from general constituents and inorganic solids to bacteria, nutrient cycles, and eutrophication processes. W2 has been successfully applied to hundreds of rivers, lakes, and reservoirs both in the U.S. and internationally.

This presentation offers an overview of the latest capabilities of the W2 model, with a particular focus on its application to the F.E. Walter reservoir and riverine system. Given specific storage and flow conditions, various selective withdrawal strategies were conducted to evaluate cold-water storage utilization and downstream water quality during the reservoir release season. These strategies allow resource managers to evaluate how reservoir operations align with environmental objectives.

## F.E. Walter CE-QUAL-W2 Model

The F. E. Walter reservoir and Lehigh River W2 model domain consists of two water bodies with three branches comprising 38 active segments and a maximum of 179 layers. Segment widths varied from 5 to 710 m. The Dam is located in W2 model segment 9.

Modeled constituents include:

- Temperature
- Dissolved Oxygen
- Total Suspended Solids
- Algae/Chlorophyll a
- Organic Matter
- Nutrients (TP, PO<sub>4</sub>, TN, NH<sub>4</sub>, NO<sub>3</sub>)
- Organic Carbons (TOC, CBOD)
- Sulfate, Sulfide, Methane
- Metals (Fe, Mn)
- pH

F.E. Walter and Lehigh River W2 model (V4.5) calibration periods were 2001(171 - 310), 2003(135 - 272), the validation period was 2002(141 - 277).

Three scenario (A, B, C) analysis were conducted for 2001 and 2003.

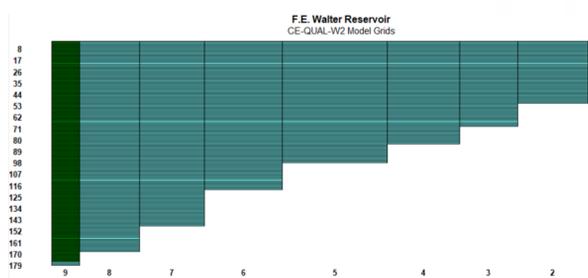


Fig. 1. FE Walter reservoir W2 model grids



Fig. 2. W2 model domain with stations

## W2 Model Calibration and Baseline Results

The upgraded F.E. Walter and Lehigh River W2 model (V4.5) underwent recalibration and validation specifically for temperature and a broader range of water quality constituents, using previously available observed datasets spanning all three simulation years, namely 2001, 2003, and 2002.

The calibrated W2 models for both 2001 and 2003 were successful in reproducing observed data and their trends over both space and time for a wide range of water quality constituents, including temperature, DO, TDS, Chl-a, PO<sub>4</sub>, NH<sub>4</sub>, NO<sub>3</sub>, CBOD, TOC, TIC, Alkalinity, and pH.

Figures 3 and 4 provides a visual comparison between the W2 model's simulated constituents (DO, Chl-a) and the observed data at station LH02 on the Lehigh River. Figures 5 and 6 show a series of W2 model calibration profile results for DO at station WA02 for the years 2001 and 2003.

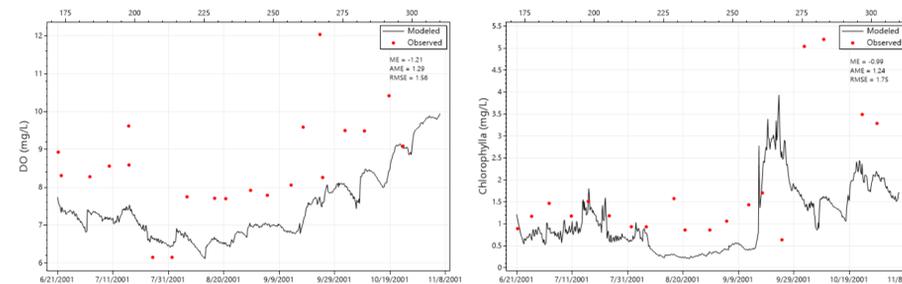


Fig. 3

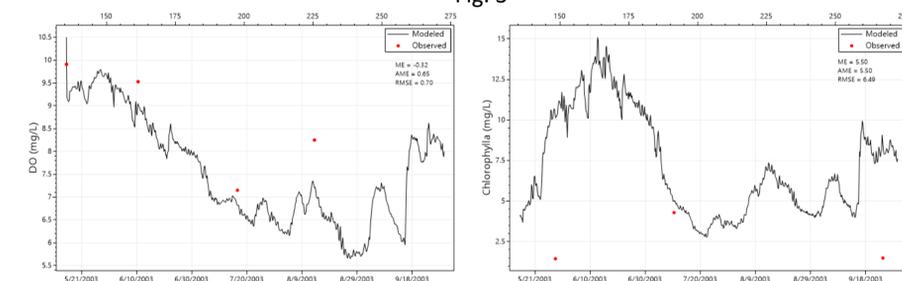


Fig. 4

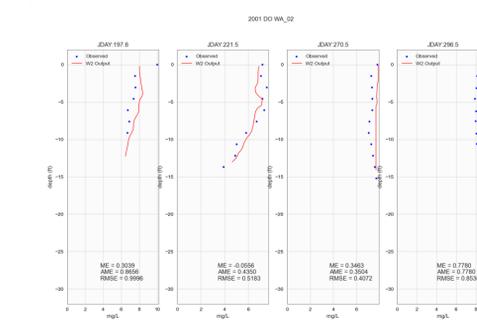


Fig. 5

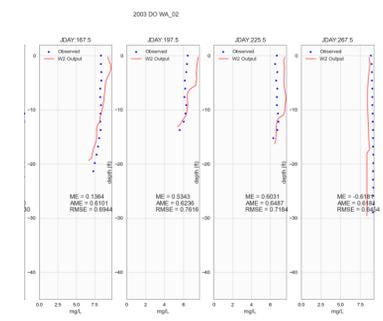
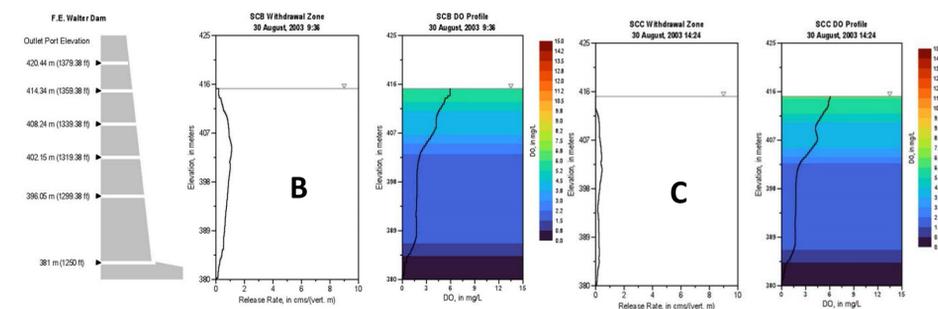
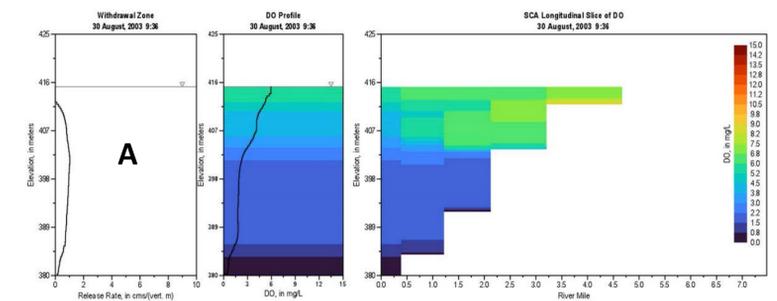


Fig. 6

## Proposed Reservoir Operation Scenario Analysis

Calibrated W2 models for the F.E. Walter Reservoir + Lehigh River for the years 2001 and 2003 were used to analyze three proposed reservoir operation scenarios, labeled as A, B, and C.

- Scenario A represents the current release schedule from the F.E. Walter Dam without any structural modifications to the project.
- Scenario B involves the operation of the current release schedule at F.E. Walter Dam with a selective withdrawal structure that includes portals at various elevations.
- Scenario C involved the same selective withdrawal structure with multiple portals as in scenario B.



## Conclusions

The calibrated W2 model demonstrated a reasonable ability to replicate seasonal and spatial trends for various water quality parameters, including water temperature, dissolved oxygen.

For all three scenarios (A, B, C), the F.E. Walter reservoir experienced a period of summer hypolimnetic anoxia in the years 2001 and 2003, characterized by low dissolved oxygen levels in the lower layers of the reservoir.

Controlling the selective withdrawal device to adjust the outflow from the F.E. Walter reservoir can improve the water temperature and dissolved oxygen in downstream reach of the dam on Lehigh River. Selective withdrawal discharge regulation alone is insufficient to improve in-pool anoxic conditions in the reservoir.

## Contact

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## References

1. Tillman, D.H. and Lewis-Coker, C.T. (2012) "Water Quality Model of F.E. Walter Reservoir and the Lehigh River: Evaluating the effects of changing operational pool heights and release scenarios on downstream fisheries conditions and recreational opportunities in the Lehigh River Phase II" ERDC/EL Tech Report.
2. Zhang, Z., Mudge, I.J., Steissberg, T.E., Wacik, G.A. and Lewis-Coker, C.T. (2024) "Updated CE-QUAL-W2 Water Quality Modeling Study for F.E. Walter Reservoir and Downstream Lehigh River." ERDC EL Tech Report.