Response to OWRB Comments:

Comment #1: A very generalized graphic of the lake model results would be very helpful. Possibly including relatively sized "In", "out", "up" and "down" arrows could help to convey the fate and transport of phosphorus in and out of the lake and the quantities deposited and released from the sediment.

Response #1: Here are the sources and sinks of nutrients to the water column in Lake Thunderbird EFDC model:

- Sources (inputs):
  - Watershed loadings
  - Atmospheric deposition
  - Sediment flux
- Sinks (Outputs):
  - Release flow at the dam
  - Water supply withdrawals
  - Settling loss to sediment bed

Watershed Loading. Time series of watershed loads for each tributary and NPS distributed sub-watershed were integrated and summed to compute the total external input of phosphorus from the HSPF model into the lake.

Atmospheric Deposition. EFDC model input data used to assign dry deposition and wet deposition of phosphate was used with the total lake surface area and precipitation data to compute the external input of inorganic-P across the air-water interface of the whole lake.

Sediment Flux. The sediment diagenesis model simulated the benthic flux of dissolved phosphate for each grid cell. The sediment flux model results were extracted as time series for each grid cell to derive an integrated sum total load of dissolved phosphate from the sediment bed to the bottom layer of the water column over the whole lake.

Release Flow at the Dam. Depth-averaged model results for organic-P (TOP), inorganic-P (PO4t) and algal-P were extracted as a time series to derive the integrated export of phosphorus from the lake accounted for by single grid cell defined for the release flow from the lake over the dam.

Water Supply Withdrawals. Depth-averaged model results for organic-P (TOP), inorganic-P (PO4t) and algal-P were extracted as a time series to derive the integrated export of phosphorus from the three water intakes accounted for by the single grid cell defined for the withdrawal of municipal water supply from the lake.

Settling Loss to the Sediment Bed. In the EFDC model, different settling velocities are assigned for the particulate form of (a) phosphate sorbed to solids (PO4p), (b) detrital organic matter (POP) and (c) algae-P (bluegreen and green functional groups). Settling velocities are also assigned for the 10 water quality zones developed for the model. Model results for each form of particulate phosphorus from the bottom water column layer were extracted in EFDC_Explorer as time series that were volume-weighted over each of the 10 spatial zones. Model results for suspended solids were also extracted so that the sorbed fraction of phosphate (PO4p) could be computed from total phosphate (PO4t), suspended solids and the partition coefficient assigned for model calibration. For each water quality zone, the time series for each form of particulate phosphorus was multiplied by the settling velocity and the surface area to compute the depositional load of particulate phosphorus to the bed for the zone. The results of the 10 zones were summed to derive the total depositional load of phosphorus from the bottom layer to the bed over the whole lake.

These sources and sinks are quantified in Response 2 below.

Comment #2: Comparing the draft TMDL report to the OWRB 2008 report (http://www.owrb.ok.gov/studies/reports/reports_pdf/ThunderbirdWaterQualityReport2008.pdf) suggests an area that might ought to be clarified. In short it would be helpful to discuss how the settling rate of TP is handled in the model. Diagrams indicating sources and sinks with annualized (or daily) load values for each constituent is one method to clarify or perhaps reporting some metric of TP retention for the lake. The following is an attempt to diagram the request rationale.

Table 4-1 gives 59.7 kg TP/day of external (watershed load) ; extrapolating to annual load of some 21,800kg/yr

Table 4-2 gives 76.8kg OP/day of internal (in-lake load) ; extrapolating to an annual load of some 28,000kg/yr of active in-lake TP-flux from mid-May through September (4.5 months).

Tables 3 of the **Lake Thunderbird Water Quality 2008** report summarizes anoxic, hypolimnetic accumulation of TP attributable to 2 general processes; settling of TP and sediment release of P. Table 4 compares average monthly total phosphorus losses and gains as kg TP. Over the active modeled P-flux period (including all of May)

- Gains - lake TP mass increased roughly 1,700kg TP
- Losses - via releases and water supply accounting for approximately 2,000kg
- Balance - accounts for a net 3,700kg TP gain over the time period.

The balance, a net gain, is distributed between runoff (external) and sediment (in-lake). Assuming external load to be zero (ignoring monthly flood pool releases May -September) the sediment supports a ***NET*** release 3,700kg TP or some 13% of the modeled estimate of 28,000kg TP. Restated, should external load estimate over the 5 month time period exceed 3,700kg TP the net sediment yield becomes a neutral (zero) or negative value. Reporting settling rates, retention metrics or constituent balances would allow the reader to better understand how phosphorus (specifically) and other parameters were handled in the model.

Response #2: The results of the mass balance budget and analysis of the metric for P-retention are presented in Table 1. Phosphorus loads are computed as kg/yr.

This information was added to Part B.3.4 in Appendix B of the report.

Table 1-Mass Balance Budget and P-Retention Metric for Phosphorus in Lake Thunderbird

Phosphorus Source/Sinks EXISTING LOADS Annual, 365 days	**TP=PO4+ TOP+ALGPOP kg/yr**	**PO4 kg/yr**	**TOP kg/yr**	**ALGAE POP kg/yr**
INPUTS				
Watershed	23,087	2,887	20,188	11
Atm Deposition(wet+dry)	182	182	0	0
Sediment Flux	24,277	24,277	0	0
OUTPUTS				
Release flow at Dam	-2,800	-1,760	-736	-303
Water Intake Withdrawals	-1,174	-830	-217	-127
P-RETENTION FACTORS				
Net Sedimentation	43,353			
P-Inputs	47,546			
P-Exports	-3,974			
P-Retention (R)	0.92			
Mass @ t=25 April 2008 (kg)	6,645			
Mass @ t=25 April 2009 (kg)	6,865			
Net Mass (End -Begin) (kg)	220			