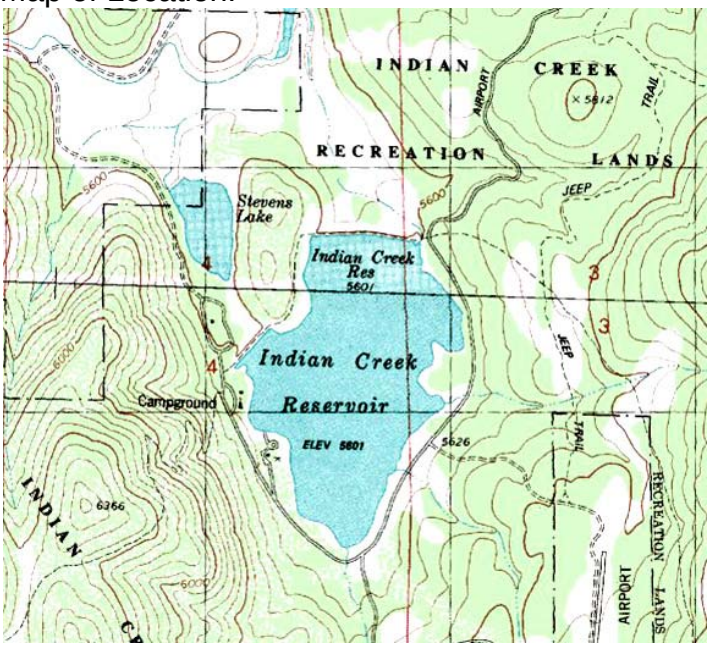
| Waterbody: **Indian Creek Reservoir** | TMDL: **Phosphorus** | Updated: 2/19/2014 Jorge Orozco |
|---|---|---|

Map of Location:




TMDL Summary Information:

- *Date of approval:* July 2002 (Lahontan); July 1, 2003 (USEPA)
- *Basis for TMDL:* The South Tahoe Public Utility District disposed of South Lake Tahoe area wastewater to Indian Creek Reservoir from 1967-1989 with the residual effect of symptoms of eutrophication including blooms of blue-green algae, low transparency, and depletion of dissolved oxygen in the hypolimnion
- *Responsible parties:* The responsibility of STPUD (for control of internal phosphorus loading) and the U.S. Bureau of Land Management, Alpine County, STPUD, and other land owners and land managers in the watershed (for control of external sources)
- *Target:* The primary numeric target is an annual mean concentration in the water column of 0.02 mg/L total phosphorus.The interim target is 0.04 mg/L.
- *Attainment of TMDL:* standards projected to occur within 21 years after final approval of TMDL (2024)

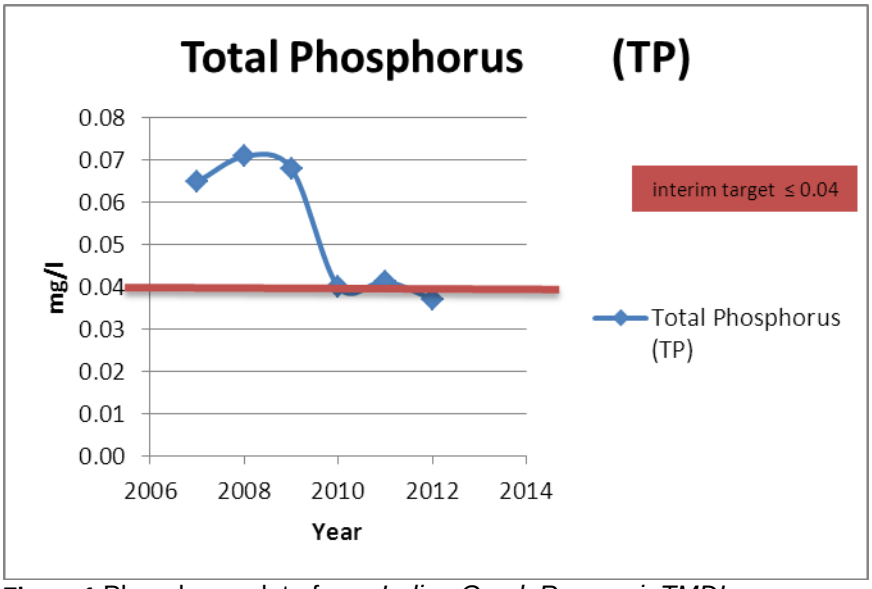



**Figure 1** Phosphorus data from: *Indian Creek Reservoir TMDL Progress Report for 2012* by South Tahoe Public Utility District, February 27, 2013

*Permits that include TMDL implementation measure*s: no permit was issued to South Tahoe Utility District, however they voluntarily provide a TMDL Progress Report annually

*Grant/contract that includes TMDL implementation measures:* CWA 319(h) non-point source grant [06-244-556-0]

*Period of evaluation*: 2007-2012

*Additional Information*: Indian Creek Reservoir (ICR) consists of an inreservoir Oxygen Delivery System (Speece Cone), on-site oxygen generation system and underground and submerged utilities connecting the oxygen generator to the Speece Cone. In June 2008 work for the on-site Oxygen Generation System began with the construction of the equipment building. In December 2008 the Speece Cone was installed in the deepest portion of ICR (approx. 32 feet). The Hypolimnetic Oxygenation System operates during the late spring and summer to deliver oxygen for water quality and aquatic improvements, since late spring 2009.

| Indicator | Target Value | Evaluation Schedule | Source Reported | Compliance |
|---|---|---|---|---|
| Total Phosphorus (TP) concentration | (Interim[1]) No greater than 0.04 mg/L, annual mean<br>(Long term[2]) No greater than 0.02 mg/L, annual mean | Annual mean of samples collected from all depths from all sites over the reporting period. | *Indian Creek Reservoir TMDL Progress Report for 2012*, by STPUD (2/27/13) | Yes, TP was higher than the objective until the installation of the hypolimnentic system, where levels have consistently met the objective since 2010. Please refer to Table 1 and Figure 2. |
| Dissolved oxygen (DO) concentration | (Interim[1]) 30 day mean 6.5 mg/L; 7 day mean minimum 5.0 mg/L; 1 day minimum 4.0 mg/L<br>(Long term[2]) Shall not be depressed by more than 10 percent, below 80 percent saturation, or below 7.0 mg/L at any time, whichever is more restrictive | Mean of samples collected from all depths at each site measured monthly over the reporting period. | *Indian Creek Reservoir TMDL Progress Report for 2012*, by STPUD (2/27/13) | Yes, DO concentrations were less than 4.0 mg/L at ICR-1 during August 2007, August 2008 and August 2011. Daily mean DO concentrations were greater than 4.0 mg/L at all sites during 2009, 2010 and 2012. Please refer to Figure 3. |
| Secchi depth (SD) | Summer mean no less than 2 meters | Mean for all readings collected over the reporting period. | *Indian Creek Reservoir TMDL Progress Report for 2012*, by STPUD (2/27/13) | Yes, since 2009 summer SD mean levels have been increasing and have consistently met the objective since 2010. Please refer to Figure 4. |
| Chlorophyll *a* (chl-a) | Summer mean no greater than 10 µg/L | Mean for all samples collected over the reporting period. | *Indian Creek Reservoir TMDL Progress Report for 2012*, by STPUD (2/27/13) | Yes, Chl-a levels were consistently above 10 ug/L until 2011 when levels showed a significant decrease and met the target value. Please refer to Figure 5. |
| Trophic State Index[3] - Secchi Disk [TSI(SD)] | Composite index no greater than 45 units | Mean of all TSI (SD) derived from SD readings (in meters) collected from all sites over the reporting period. | *Indian Creek Reservoir TMDL Progress Report for 2012*, by STPUD (2/27/13) | Yes, TSI (SD) averages in the reservoir have been decreasing since 2009, and met the objective for first time in 2012. Please refer to Table 2 and Figure 6. |
| Trophic State Index[4] - Chlorophyll-a [TSI(Chl-a)] | Composite index no greater than 45 units | Mean of all TSI (Chl-a) derived from Chl-a concentrations (in ug/l) collected from all sites over the reporting period. | *Indian Creek Reservoir TMDL Progress Report for 2012*, by STPUD (2/27/13) | Yes, TSI (Chl-a) averages in the reservoir have shown decreasing trend since 2009, and met the objective for first time in 2012. . Please refer to Table 2 and Figure 6. |
| Trophic State Index[5] - Total Phosphorus [TSI (TP)] | Composite index no greater than 45 units | Mean of all TSI (TP) derived from TP concentrations (in ug/l) collected from all sites over the reporting period. | *Indian Creek Reservoir TMDL Progress Report for 2012*, by STPUD (2/27/13) | Yes, since 2009 the average reservoir TSI (TP) has been on a decreasing tread although not yet less than 45 units. Please refer to Table 2 and Figure 6. |

[1] Interim targets are expected to be attained by 2013.
[2] Long term targets are expected to be attained by 2024.
EPA calculations for Carlson Trophic Status Index (http://www.epa.gov/bioiweb1/aquatic/carlson.html):
[3] Secchi depth calculation = 60 – 14.41 * (natural logarithm (Secchi depth in meters))
[4] Chlorophyll *a* = 9.81 * (natural logarithm Chlorophyll *a* (ug/L)) + 30.6
[5] Total Phosphorus = 14.42 * (natural logarithm TP (ug/L)) + 4.15
ICR = Indian Creek reservoir, mg/L = milligrams per liter, ug/L = micrograms per liter (equivalent to milligrams per cubic meter)

| Implementation Measures | | | |
|---|---|---|---|
| **Internal Loading** | **Responsible Party** | **Schedule** | **Status** |
| After approval of TMDL, Regional Board staff will request a report from STPUD on the method(s) it intends to use to reduce internal loading of phosphorus to ICR to meet TMDL target. | STPUD | Due 2003 | Met requirements: Grant from 319 (federal grant) to implement the Hypolimnetic Oxygenation System. Implemented in 2007. |
| By 15 months after final approval of TMDL, STPUD will submit a plan for approval by the Regional Board for management measures to meet TMDL target. | STPUD | Due October 1, 2004 | Met requirements: Regional board accepted 319 grant plan and monitoring plan. The plan has been implemented and is being utilized and monitored. |
| STPUD will fully implement controls for internal phosphorus loading | STPUD | Due 2013 | Met requirements: Hypolimnetic Oxygenation System. |

| External Loading | Responsible Party | Schedule | Status |
|---|---|---|---|
| By one year after approval of the TMDL, Regional Board staff and stakeholders will identify sites in the watershed *contributing direct surface runoff* to ICR that need Best Management Practices (BMPs) for phosphorus control. | Lahontan and stakeholders | Due July 1, 2004 | Did not meet requirements: Stakeholders Group Kickoff Meeting October 22, 2003 to discuss ICR TMDL implementation. This led to the ICR external phosphorus loading field tour with Hal Byrd (STPUD) to get a preliminary idea of sites to visit for the planned Stakeholder Group field tour/meeting March 23, 2004. On March 3, 2004, ICR TMDL implementation letter – Invitation to March 23, 2004 Stakeholders field tour, to identify sites needing external phosphorus loading reduction BMPs – Alpine County. Scheduled for March 23, 2004 from 1:30-4:30PM. There is no other information regarding the Stakeholder Group. |
| By one year after approval of the TMDL, Regional Board staff and stakeholders will identify sites on public and private lands within the watershed *tributary to the irrigation ditch that provides inflow to ICR from Indian Creek and the West Fork Carson River* needing BMPs. | Lahontan and stakeholders | Due July 1, 2004 | Did not meet requirements: Refer to letters and meetings regarding Stakeholders Group stated above. There is no other information in the file regarding current efforts if any. |
| By three years after final approval of the TMDL, staff will consider the need for regulatory action to ensure implementation of BMPs to control external sources of phosphorus loading to ICR. | Lahontan | Due July 1, 2006 | Did not meet requirements: No information stating this has been completed |
| BMPs will be fully implemented for nonpoint sources of phosphorus loading to ICR within the subwatershed affected by the TMDL. | stakeholders | Due 2013 | Have not met requirements: Not completed |

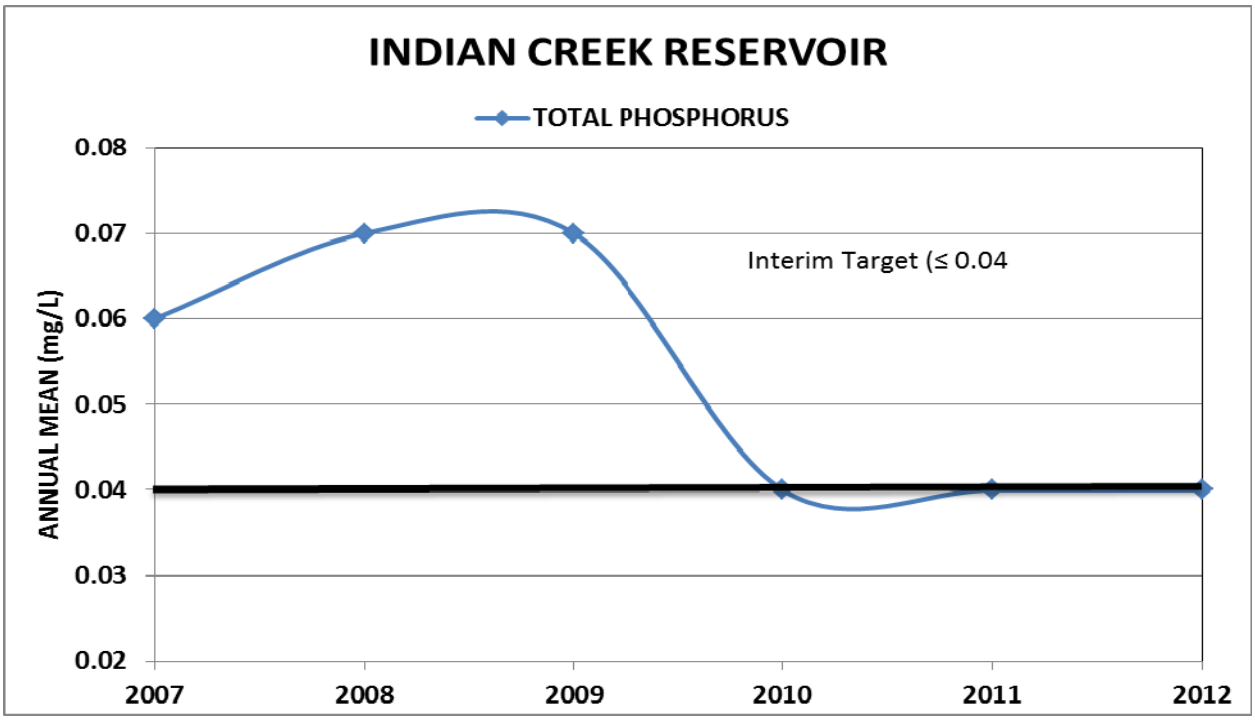



**Figure 2**. Total phosphorus levels at ICR, plotted as an annual mean, in milligrams per liter (mg/L). In order to evaluate TP levels in the reservoir, all available data for sites ICR-1, ICR-3 and ICR-5 were combined and analyzed as an annual mean.

**Table 1**. Total phosphorus at ICR. In order to evaluate TP levels in the reservoir, all available data for sites ICR-1, ICR-3 and ICR-5 were combined and analyzed as an annual mean.

| | | Annual Mean |
|---|---|---|
| YEAR | PERIOD | TOTAL PHOSPHORUS mg/L |
| 2007 | Baseline | 0.06 |
| 2008 | Baseline | 0.07 |
| 2009 | Year 1 | 0.07 |
| 2010 | Year 2 | 0.04 |
| 2011 | Year 3 | 0.04 |
| 2012 | Year 4 | 0.04 |
| ***2013 interim Target*** | | ***<0.04*** |

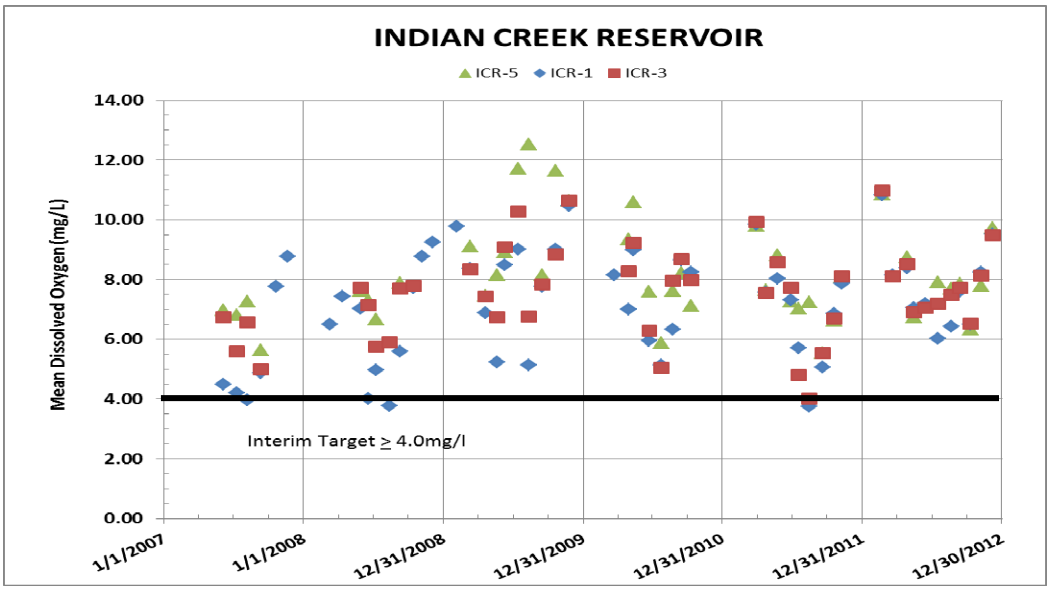



**Figure 3**. Daily mean dissolved oxygen levels measured at ICR, in milligrams per liter (mg/L). In order to evaluate DO levels in the reservoir, the data were analyzed by averaging DO readings collected through the water column at each site (ICR-1, ICR-3 and ICR-5) and plotted as a daily mean for each month of the year.

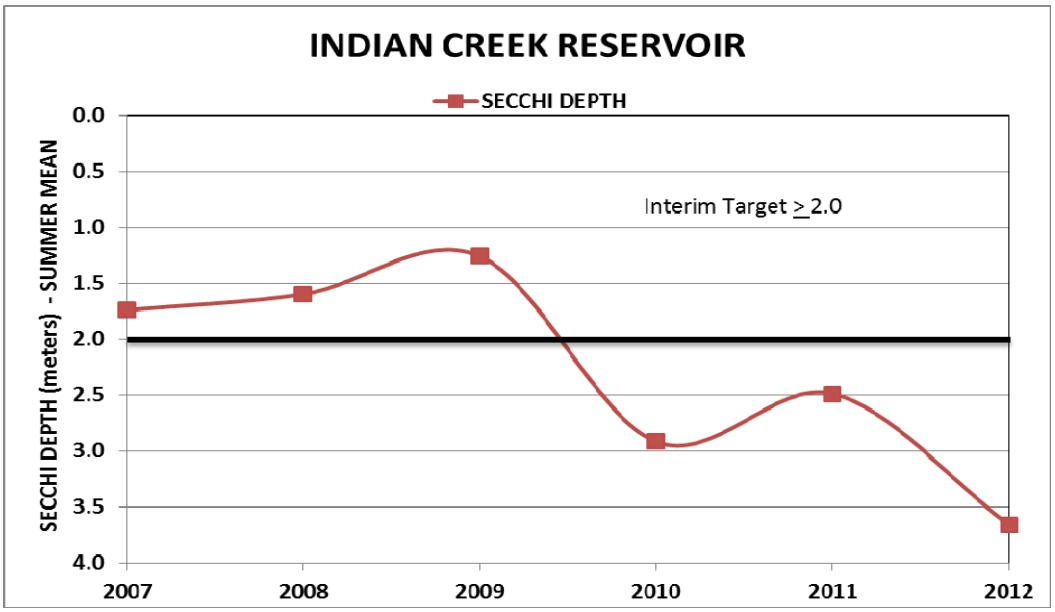



**Figure 4**. Summer mean Secchi depth (SD) readings measured at ICR during June, July and August 2007 through 2012, in meters. In order to evaluate SD levels at ICR, the data were analyzed by averaging the SD readings measured during the summer (June, July and August) at ICR-1, ICR-3 and ICR-5 and plotted as a summer mean for each year.

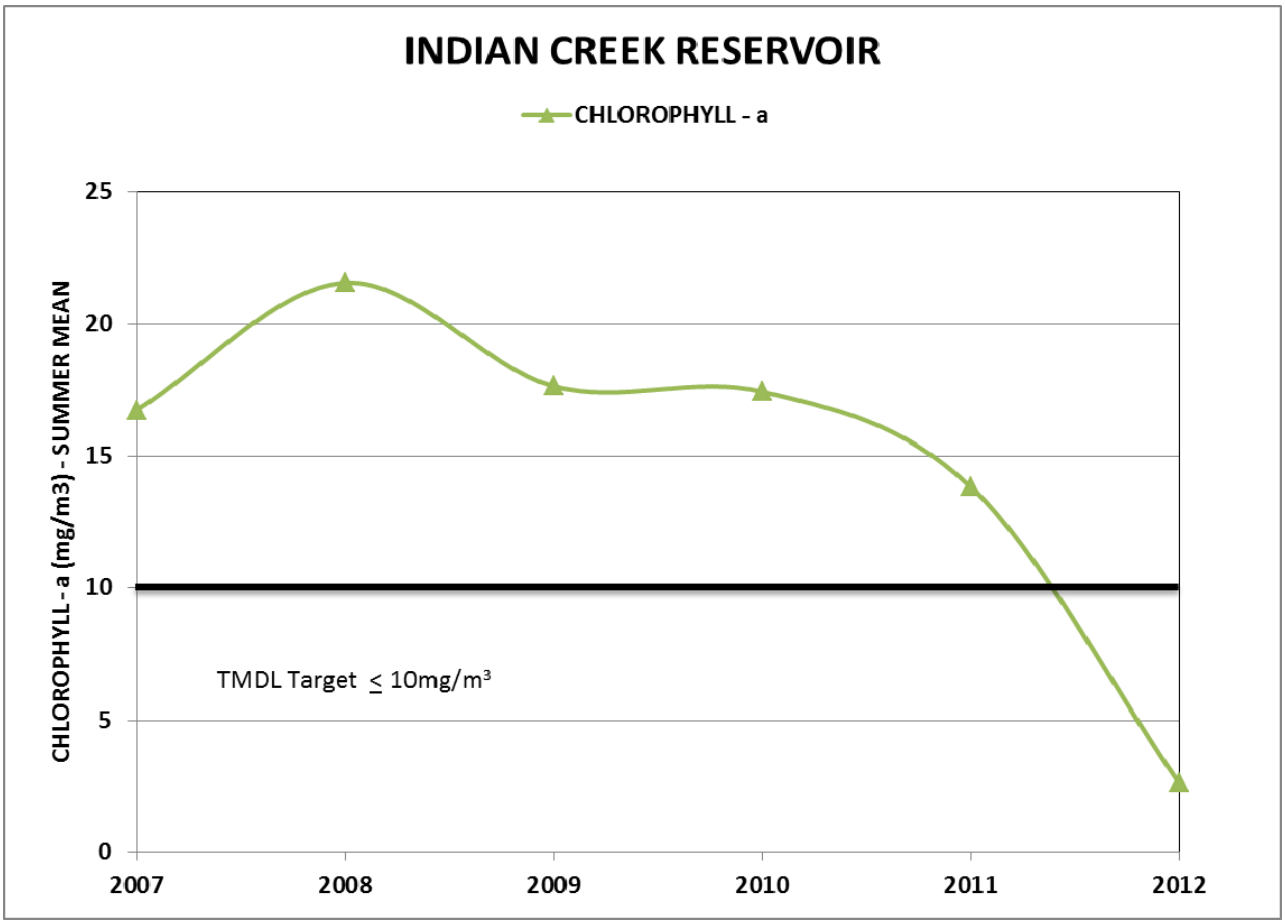



**Figure 5**. Summer mean chlorophyll-a concentrations measured at ICR during June, July and August 2007 through 2012, in milligrams per cubic meter (mg/m3). In order to evaluate Chl-a levels at ICR, the data were evaluated by averaging the Chl-a values measured during the summer (June, July and August) at ICR-1, ICR-3 and ICR-5 and plotted as a summer mean for each year.

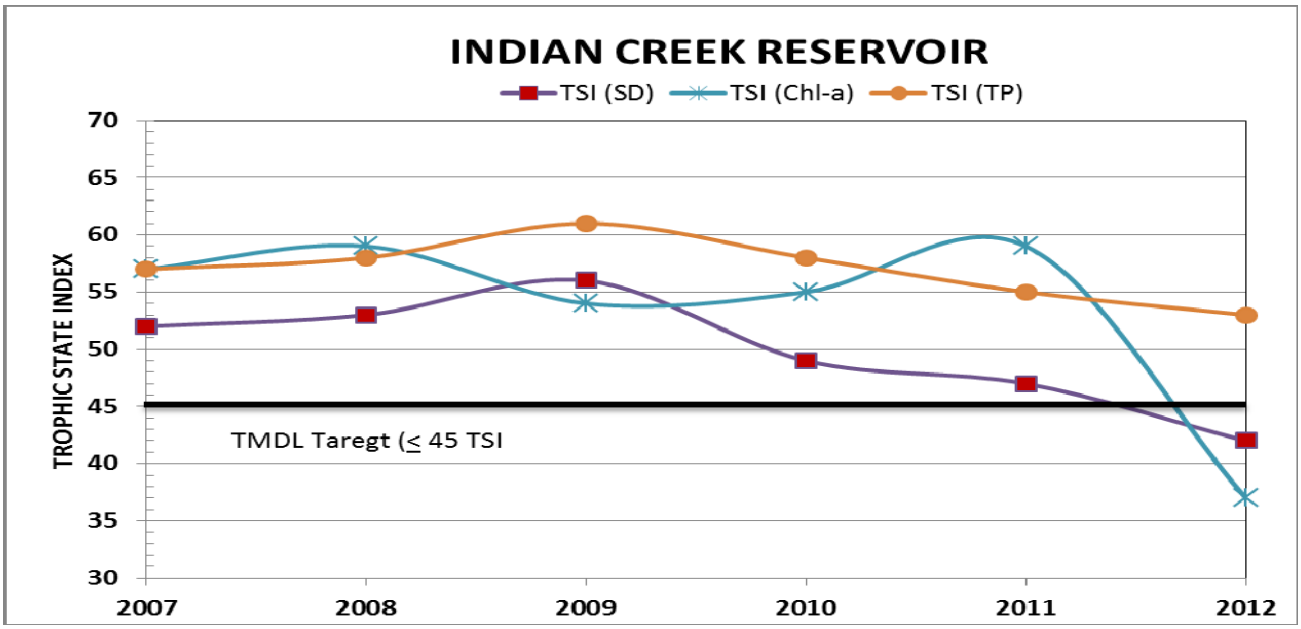



**Figure 6**. Carlson trophic state index (TSI) values for sechhi depth, chlorophyll-a and total phosphorus, during June, July and August 2007 through 2012, in TSI units. In order to evaluate TSI, a TSI for each parameter value [TSI(TP), TSI(SD) and TSI(Chl-a)] was calculated. The TSI for all values were then used to produce an average reservoir TSI for each parameter.

**Table 2**.Chorophyll (Chl), Secchi depth (SD), and Total phosphorus (TP) with the values of the Trophic Status Index (TSI) as evaluated by EPA (http://dipin.kent.edu/tsi.htm).

| **A list of possible changes that might be expected in a north temperate lake as the amount of algae changes along the trophic state gradient.** | | | | | | |
|---|---|---|---|---|---|---|
| **TSI** | **Chl (ug/L)** | **SD (m)** | **TP (ug/L)** | **Attributes** | **Water Supply** | **Fisheries & Recreation** |
| **<30** | <0.95 | >8 | <6 | **Oligotrophy:** Clear water, oxygen throughout the year in the hypolimnion | Water may be suitable for an unfiltered water supply. | Salmonid fisheries dominate |
| **30-40** | 0.95-2.6 | 8-4 | 6-12 | Hypolimnia of shallower lakes may become anoxic | | Salmonid fisheries in deep lakes only |
| **40-50** | 2.6-7.3 | 4-2 | 12-24 | **Mesotrophy:** Water moderately clear; increasing probability of hypolimnetic anoxia during summer | Iron, manganese, taste, and odor problems worsen. Raw water turbidity requires filtration. | Hypolimnetic anoxia results in loss of salmonids. Walleye may predominate |
| **50-60** | 7.3-20 | 2-1 | 24-48 | **Eutrophy:** Anoxic hypolimnia, macrophyte problems possible | | Warm-water fisheries only. Bass may dominate. |
| **60-70** | 20-56 | 0.5-1 | 48-96 | Blue-green algae dominate, algal scums and macrophyte problems | Episodes of severe taste and odor possible. | Nuisance macrophytes, algal scums, and low transparency may discourage swimming and boating. |
| **70-80** | 56-155 | 0.25-0.5 | 96-192 | **Hypereutrophy:** (light limited productivity). Dense algae and macrophytes | | |
| **>80** | >155 | <0.25 | 192-384 | Algal scums, few macrophytes | | Rough fish dominate; summer fish kills possible |