Recommendations

1. Determine the toxicity (microcystin) level of cyanobacteria blooms (HABs) in Parker Horn and south lake (TS5/6) and main arm (TS11/12) by collecting near shore samples of scums and sending samples to Department of Ecology for analysis.
2. A minimum of 100 x 10^{6} m^3 (81 x 10^3 AF) of CRW annually is needed to dilute external and internal TP loading to Parker Horn and south lake (TS5/6) and provide acceptable water quality (TP < 30 µg/L) and minimize HABs.
3. Propose constructing facilities to transport another 40 10^{6} m^3 of CRW to the main (Rocky Ford) arm from TS3 to the Connelly Park area (TS11) to dilute the high TP (180 µg/L) entering from Rocky Ford Creek. That should roughly reduce TP in RFA to about half the current 80 µg/L. If delivered over 6 months, the flow would be about 2.5 m^3/sec or 90 cfs over a distance of about 4 miles. That quantity may not be possible given constraints on CRW availability and construction costs. More in-depth analysis is necessary to further design such a project, considering ground water sources of P and lake response. Delivering CRW to upper main arm was originally in the Clean Lakes Project.
4. Treat the anoxic area in Parker Horn and/or south lake (TS5/6) with alum to inactivate sediment mobile P and reduce internal P loading that contributes to poor water quality in late summer as DO gradually depletes over the deepest area promoting the release of mobile P. This source can be substantial, especially with increased wind mixing that entrains bottom P-rich water into the lighted zone. Such instability produced the highest internal loading in 1985 that occurred during the 1970s-1980s; 19,845 kg, which was 3 times the 11-year average. To further consider an alum treatment to this area, DO/temperature profiles should be determined at TS 5, 6, and 7 at 1 m intervals from surface to bottom during 2018, in order to determine the anoxic area. A bathometric map of lower Parker Horn and south lake is also needed to accurately determine the area for treatment.

Additional comments (3/1/2019):

Cyanobacteria (blue-green algae) begin to become dominant at about 30 µg/L average total phosphorus (TP) concentration during summer. That is also the border between eutrophy and mesotrophy. Thus, that concentration should be the goal for Moses L. Our goal was 50 µg/L after the dilution project started, which was met in 1986-1988 (41 µg/L) and also DOE's tmdl goal. However, 50 µg/L is too high to avoid toxic blooms. Average summer TP in lower Parker Horn and south lake during 2017 and 2018 were 25 and 40 µg/L, respectively. TP concentration in upper Rocky Ford Arm was 83 µg/L during summer 2018.

Recommendation of addition of low-TP Columbia River Water (CRW) to upper RFA could also includes the alternative of a siphon from the W-20 canal about 2 miles west of the head of RFA.

The area of anoxic sediment in lower Parker Horn, Cascade and south lake is roughly the area of the hypolimnion, which is about 1,260 acres or about 18% of the total lake area. Laboratory study of phosphorus release from anoxic sediment showed that area could contribute about 3,000 kg of internal loading to the lake during the summer. That estimated TP load would be about 1/3 of the average internal load to the whole lake, as determined during 1984-1988, and about half the estimated internal load in 2017. Internal load is an important source of phosphorus causing summer blooms of cyanobacteria, as pointed out in no. 4 above, and was probably the cause for higher TP and chl in Parker Horn and south lake during 2018 than in 2017. A properly dosed alum treatment should inactivate about 80% of that internal load and the treatment should last on order of ten years. Alum is the proven most cost-effective way to reduce internal loading. However, low-phosphorus Columbia River water dilutes the internal as well as the external load.