

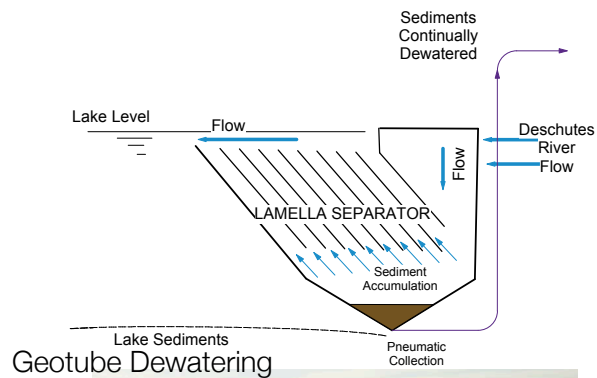
# An Engineered Plan to Solve the Capitol Lake / Budd Inlet Water Quality Deficiencies

Burke, June 2016

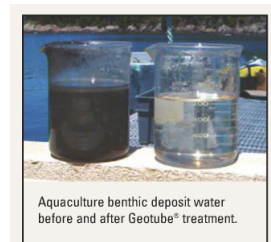
This plan will keep the Capitol Lake dam and the reflecting pool, solve the pH, DO, nutrient, phytoplankton, and sediment water quality problems, eliminate the low DO problems in Budd Inlet all for less than 10% of the cost of any other concept put forward to date. The plan consists of the following elements:

A. Install submerged liquid / solid separators at the entrance of the Deschutes River to Capitol Lake, north of I-5. The liquid / solid separators will be similar to Lamella plate separators commonly used in river water intakes and waste treatment facilities. The separators capture essentially all of the influent sand and silt as well as fine colloidal material. The precipitated solids that are removed are then lifted from below the Lamella separators using permanent pneumatic section assemblies that deliver the sediment by underwater piping to Geotube fabric filters that will concentrate the solids for topsoil sales. These facilities will be installed permanently and remove substantially all of the sediment delivered to Capitol Lake. The solids will have considerable value since they will not have been degraded by salt water, toxic algae, or toxins similar to those that reside in Budd Inlet.

Lamella Separator with Pneumatic Collection



B. Install nutrient harvesting facilities north of the sediment removal facilities but south of the RR bridge (out of sight). Nutrient harvesting consists of a photobioreactor or series of photobioreactors laid across the lake that efficiently grow phytoplankton, cyanobacteria, or other photosynthetic organisms such as duckweed. The cultured organisms can out-compete<sup>1</sup> existing Lake autotroph's for the nutrients passing through the



<sup>1</sup> The photobioreactors have the advantage because of CO<sub>2</sub> and light management and maintenance of optimum growth rates.

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Lake and thereby consume available nutrients. The autotrophs are then continuously harvested with the nutrients thereby depleting the Lake of its nutrients. The harvested nutrients are removed by vacuum collection, concentrated, and anaerobically digested to produce renewable energy or biofuel. The nitrogen and phosphorous are recovered from the digestate as inorganic nutrients such as struvite, ammonium bicarbonate solid crystals, or calcium phosphate (hydroxyapatite) and sold to organic farms that are in desperate need of certified organic fertilizers. (See attached publication "Opportunities Created by Engineered Solutions to the Capitol Lake / Budd Inlet 303 d Water Quality Dilemma" Burke, June 2016)

**Figure 1**  
**The Rotating Photobioreactor**



Those two simple facilities, installed in Capitol Lake at low cost, will solve all of the water quality problems described in DOE Publication 15-030026 by removing: 1) the sediment thereby removing substantial phosphorous inputs, 2) the nutrients thereby stabilizing the pH fluctuations, 3) algae and toxic algae the organic material that deplete Budd Inlet of its dissolved oxygen.

The plan is sustainable since it reclaims valuable topsoil, essential phosphate that is in limited worldwide supply but required by future generations for sustenance, nitrogen that would otherwise be degraded through denitrification to produce nitrous oxide (N<sub>2</sub>O) a powerful GHG.

The current plans are not sustainable but simply move the water quality problems downstream. Downstream Puget Sound and Ocean toxic algae blooms will increase because of increased availability of nutrients. Sediment will continue to accumulate in Budd Inlet and blend with the existing polluted sediments requiring confined disposal sites for both sediment streams. Topsoil flowing from the Deschutes river will be polluted with salt water and cyanobacteria toxins thereby requiring expensive disposal.

## **An Engineered Plan to Solve the Capitol Lake / Budd Inlet Water Quality Deficiencies**

The existing plans will place an undo financial burden on the State and Community. The previously proposed plans will lower the attractiveness index for Olympia and thereby substantially reduce commercial and recreational visitations.

This plan will continue to provide the Capitol lake benefits to the community while producing income by recovering valuable products.

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### **Benefits of the Nutrient Harvesting System**

The proposed Nutrient Harvesting System will meet the water quality objectives by harvesting nitrogen and phosphorus nutrients from Capitol Lake, hereby eliminating the dissolved oxygen deficiencies in Budd Inlet and Capitol Lake. Removal of the nutrients will also eliminate toxic algal blooms and minimize the growth of invasive plant species. Fish habitat will be improved. Ecosystem function will be enhanced along with improved wildlife habitat. The system will not adversely impact fish passage. Swimming, boating, and other recreational opportunities will be provided by the proposed improvements. In addition to the public and ecological benefits the proposed system may provide substantial economic benefits through the harvest of nitrogen, phosphorus, bioenergy, and topsoil. Most importantly the system will be far less expensive than any of the demolition alternatives proposed to date.