Flocculation and Sediment Capping – Fact Sheet

Linking lake restoration with end users for positive environmental outcomes

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Flocculation and Sediment Capping for Managing Lake Water Quality

Sediment capping and flocculation are in-lake techniques designed to reduce internal nutrient loads from the bottom sediments of lakes. These loads are roughly equivalent in magnitude to external loads. Case studies of the Rotorua lakes (Figure 1) show that with careful design and management, sediment capping and flocculation can reduce nutrient concentrations and the likelihood of algal blooms. Relevant actions can include: (i) reducing bioavailable phosphorus in stream inflows through continuous addition of the active material to the stream, (ii) removing bioavailable phosphorus, and flocculation and sedimentation of nutrients, and (iii) altering sediment composition so that nutrients are more efficiently retained within the bottom sediments.

Flocculation removes both dissolved and particulate nutrients from the water column. It often produces immediate improvements in water quality. However, unless there is a concurrent reduction in external nutrient loads its effect can be short-lived and further treatments are likely to be required.

Sediment capping materials (Figure 2) are designed to blanket the lake bed and prevent release of phosphorus from lake sediments, particularly during periods of deoxygenation. These materials can have a more persistent effect than flocculants, but may need to be applied in large quantities to deal with the sediment phosphorus pool. The capping layer needs to be spread across the lake bed according to the distribution of phosphorus (Figure 3).

Figure 2. Modified zeolite, a sediment capping agent with a grain size of 1-3mm

Figure 1. Lake Okaro (Te Arawa lakes of Rotorua) has been treated with Aqual-P and alum to reduce phosphorus release from the bottom sediments.

Figure 3. Application of Aqual-P to Lake Okaro.
Photo: Andy Bruere (Bay of Plenty Regional Council).

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Lake Nutrient Dynamics

Suspended microscopic algae (phytoplankton) require nitrogen (N) and phosphorus (P) to grow. These nutrients may come from natural sources (e.g. rainfall, local geology) and through human activities. In agricultural systems, N is typically leached as nitrate into groundwater and eventually transported to surface waters (Figure 4). Phosphorus is more often attached to the surface of sediment particles, resulting in much of the loss of P to waterways through erosion during storm events. During summer, lakes deeper than about 10 m stratify. During stratification warm, buoyant water at the surface is prevented from mixing with cooler, denser bottom water. In eutrophic systems, bacteria deplete the oxygen in the deeper waters of the lake during stratification periods. Under these conditions, phosphate and ammonium are released from the bottom sediments and may ultimately promote the formation of algal blooms when these nutrients are mixed into the well-lit surface layer during windy conditions.

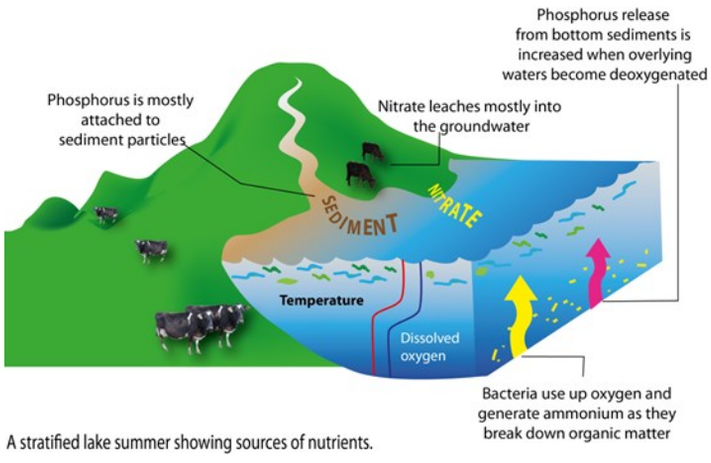

Figure 4. Sources of nutrient loading to lakes.
Image: Wendy Paul

Figure 5. Aluminium sulphate was the first chemical flocculent trialled in Lake Okaro, in December 2003.

Photo: Wendy Paul.

Flocculants and Capping Materials

Application of flocculants such as aluminium sulphate (alum) is intended to flocculate, sediment out and lock up phosphorus in the water column. Capping materials such as modified zeolites and clays are applied mostly to sequester phosphorus by providing a 'cap' on the bottom sediment that prevents release back into the water column.

Aluminium sulphate (Figure 5) and modified zeolite have been tested in Lake Okaro and a modified clay has been applied to Lake Okareka. Continuous dosing of aluminium sulphate is currently being carried out in the Utuhina and Puarenga Streams that discharge to Lake Rotorua, and in Waitangi Soda Spring entering Lake Rotoehu. While alum dosing has improved water quality by driving down phosphorus concentrations in Lakes Rotorua and Rotoehu, its effects have been marginal in Lake Okaro where very high pH during of algal bloom periods appears to have re-released bound phosphorus and limited the expected improvements in lake water quality.