

# Bärensee, Hanau, Germany

Application dates: 12-13 June 2007

## Summary

**Aim:** Decrease in blue green algae concentrations through phosphorus reduction

**Description:** Former sand excavation pit used for recreation

**Size (ha):** 6  
**Max. depth (m):** 3.8  
**Average depth (m):** 2.63  
**Conductivity ( $\mu\text{S}/\text{cm}$ ):** 380

**Dosage:** 11.5 ton Phoslock® (12-13/06/07)

## The Lake



Aerial view of Bärensee

The lake Bärensee is located within the largest camping area in the Federal German State of Hessen and is managed by the City of Bruchköbel. It is a popular lake for swimming and fishing. The shallow lake has a total area of 6 ha and a water volume of 156,000 m<sup>3</sup>. The lake has sandy beaches to the north and south, is bordered by a forest to the west and camping grounds on all other sides. The other nearby lakes (seen in the areal view in the top right corner) are not open for swimming.

The lake has a limited catchment area, with inflow derived primarily from direct precipitation and groundwater.

The lake is classified as a non-stratifying gravel lake according to the LAWA "Baggersee" Directives.

The reference mesotrophic state has never been attained in the past and the lake was considered highly eutrophic. The heavy nutrient loadings in the lake were previously countered with external

systems for phosphate elimination and the use of macrophytes or floating islands. These measures did lead to a stabilisation of the nutrient content in the water for a while, however intensive blooms of blue green algae could not be prevented (80  $\mu\text{g}$  Chlorophyll-a/L in February 2007). In the sediment of the Bärensee there was approx. 700 mg phosphorus/kg dry weight, of which nearly 20% was biologically available.



## The Treatment

On 12 and 13 June 2007, 11.5 tonnes of Phoslock® were applied to the lake to bind phosphate. The application was performed by Bentophos GmbH (the exclusive licensee for Phoslock in Germany) from a motorized pontoon. Phoslock® was mixed with in situ water and sprayed over the lake surface.



During the application, the areas of the lake within 2m of the shore were not treated, as required by the authorities. The depth of the area being treated was monitored using a depth-sounder and the route taken was marked by means of a differential GPS receiver (picture to the right: application pattern on first day).

This measure was necessary as a result of the regular heavy blooms of blue green algae preventing the use of the lake for swimming and recreation and was aimed at immobilizing phosphorus, which is a limiting nutrient in water bodies such as the Bärensee. The dosage of Phoslock® was calculated after comprehensive pre-treatment monitoring of the water and sediments by Bentophos GmbH. The monitoring results demonstrated that most of the phosphorus in the lake was

used constantly for primary and secondary production. It was however the request of the City of Bruchköbel for the application to take place before the main swimming season and as a result, the application took place in June. All necessary permits for the application were obtained.



## Results

The optimal point in time for an application of Phoslock® is when most phosphorus is present as ortho-phosphate. However as Phoslock® remains active until the lanthanum binding sites become saturated, an application can also be undertaken when most phosphorus has been taken up into the biomass (as was the case prior to the application of Phoslock® to the Bäreensee). In these circumstances, reductions in phosphorus occur more gradually as algae complete their life cycle, decompose and phosphorus is released in the form of phosphate. The results of the Bäreensee application confirm this. Figure 1 shows the concentrations of total phosphorus and ortho-phosphate in the lake before and after the application. Total phosphorus concentrations dropped from an average of 80 µg P/L in the two months prior to the application to an average of between 30–35 µg P/L in the two years since the application.

Importantly, these levels were maintained during the summer months, despite the increase in water temperature and anoxic conditions in the sediment, suggesting that phosphorus remobilization from the sediment has so far been completely prevented.

A short-lived increase in total phosphorus concentrations was observed in the lake in July 2008, however this increase coincided with fish removal from the lake and is believed to have been caused by a temporary resuspension of sediments.

At the time of publication, a similar increase in total phosphorus had been recorded. This time, no fish removal activities had been undertaken,

suggesting that the increase in phosphorus concentrations was a result of new inputs of phosphorus and the possible saturation of the Phoslock® capping on the sediment layer.

For this reason, a small follow up application of 3 tonnes is currently planned for spring 2010.

Chlorophyll a concentrations have also remained low since the application (Fig

2). Although blooms of blue green algae were not completely avoided during the first year after the application, they were significantly smaller than in previous years and no scum forming (blue green algal) blooms were recorded. Furthermore, it has not been necessary to impose any swimming bans on the lake since the application of Phoslock®.

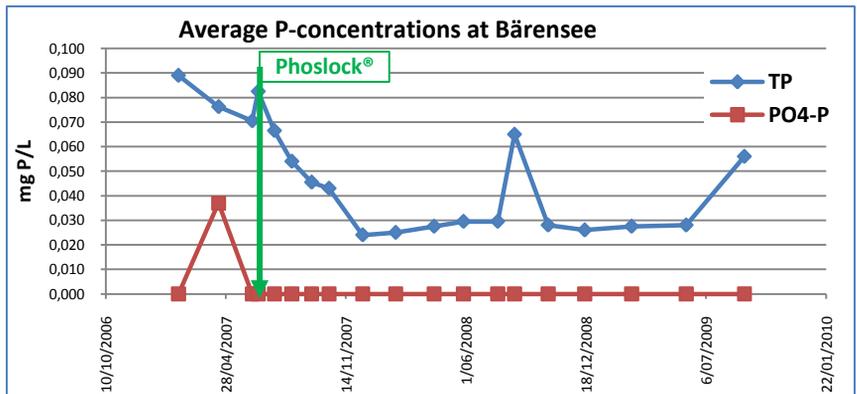


Figure 1: Average (throughout the water column) phosphorus concentrations at Bäreensee

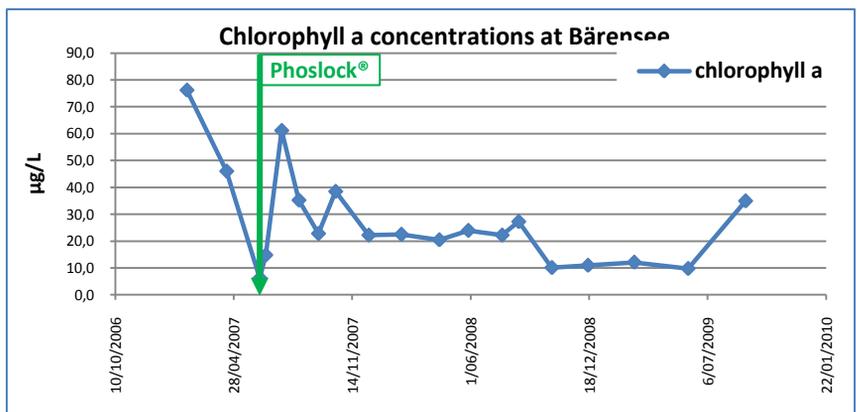


Figure 2: Average chlorophyll a concentrations at Bäreensee. NB. Chlorophyll a concentrations dropped from 80 µg/L immediately prior to the application due to grazing of phytoplankton by zooplankton ("clear water state").

## Conclusion

The treatment of Bäreensee did not result in an immediate reduction in total phosphorus due to the low availability of dissolved phosphates. However a gradual and sustained effect on the lake's appearance and ecological status was clearly noticeable. It appeared that Phoslock® was able to prevent phosphorus release from the (anoxic) sediment by binding of phosphate

from the sediment pore water.

Although algal blooms could not be completely prevented, there was a clear shift in the dominant species (from blue green algae to diatoms). As a result of this there was no need to close the lake for swimming. Therefore the treatment of Bäreensee with Phoslock® can be considered a success.

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Additional information can be found on our website or can be provided on request.