

Making our world more productive



# SOLVOX<sup>®</sup> oxygen for water

Helping to re-establish the natural balance in rivers and estuaries





A view of Perth city centre from Swan river.

## Introduction

Linde has been working with the Government of Western Australia on the design and operation of artificial oxygenation plants on the Swan and Canning Rivers since 1998. This project is a partnership between the Department of Water and Environmental Regulation and the Department of Biodiversity, Conservation and Attractions.

## Challenge

The Swan and Canning Rivers run through metropolitan Perth, joining in an open basin near the city before flowing out to sea at Fremantle. The Rivers now receive significantly more organic matter, nutrients and other pollutants than they did prior to development of the local area. Land that was once covered in native vegetation is now farmland, commercial and industrial plots or residential housing. The opening of the Fremantle sand bar, water extraction, modification of drainage, the loss of fringing wetlands and river regulations have changed how the water passes

through the landscape. As is the case with many urbanized estuaries around the world, the Swan Canning system is susceptible to algal blooms, low dissolved oxygen levels and periodic fish kills.

Low oxygen concentrations in the water occur when the natural process of oxygen replenishment is unable to keep up with the increased demand associated with eutrophication, i.e., where an excess of nutrients, such as phosphate, ammonium or nitrate, may lead to excessive plant growth and algal blooms. The Swan and Canning oxygenation plants are engineered interventions designed to supplement the oxygen supply. Oxygen concentrations are retained at a level that can sustain healthy ecosystem functions and support the many recreational and aesthetic uses of this iconic waterway.

The project objectives were to:

- Increase viable water column and benthic habitats for aquatic organisms through the provision of adequate dissolved oxygen.



The Swan river, with Bassendean Bridge in the distance. A monitoring station (indicated by the buoys) tracks the levels of dissolved oxygen in the water and triggers the plant to turn on and off.

- Enhance nitrogen removal through the natural processes of nitrification and denitrification.
- Retain phosphorus in sediments by binding it with iron under aerobic conditions, thus making it unavailable for algal growth.
- Reduce stored organic matter through the promotion of aerobic degradation of organic carbon.
- Reduce odors resulting from the production of hydrogen sulfide gas frequently associated with anaerobic environments.

## Solution

Designing an oxygenation plant for these applications has some challenges. The target areas for oxygenation are very shallow, making in-river dissolution difficult. This problem was overcome by utilizing a Linde-designed side-stream dissolver system, where river water is pumped to a plant on the bank and pure oxygen is added under high pressure to achieve very high concentrations of oxygen in the side-stream flow, before being returned to the bottom waters of the river. The highly oxygenated water is rapidly diluted,

maximizing the efficient use of oxygen and its impact on the river.

The differences between the Swan and Canning rivers also needed to be considered in the plant design. The Swan River is estuarine, and as such is tidally influenced for much of the year. Oxygenated water is distributed up and downstream by the tide. In contrast, the Canning oxygenation plants are located upstream of a weir in a stationary pool. In-river distribution pipework is used to inject oxygenated water at key locations along a 5km stretch of river. The two oxygenation plants on the Canning were constructed most recently (between 2014 and 2016), replacing the two original plants constructed between 1998 and 2000. Linde and the Department of Water and Environmental Regulation worked together to incorporate technological advancements in the plant design, building on a more detailed understanding of the receiving water body and how it responds to artificial oxygenation.

The Canning oxygenation plants utilize Linde's SOLVOX® oxygenation solution, a cone-shaped



SOLVOX C-110 installation at one of the four oxygenation plants on the Canning and Swan rivers.

pressurized dissolver where pure oxygen is mixed with water, complemented by an on-site liquid oxygen storage unit and vaporizer, and an electronic control panel supporting automatic operation and remote access. The Department of Water and Environmental Regulation's water quality probes positioned in the river monitor dissolved oxygen continuously, and trigger the plants to turn on or off according to preset thresholds defined by the operator. The Department is able to modify oxygen flow rates and operational modes remotely, greatly improving their ability to respond to real-time changes in water quality in the rivers. The unique design of Linde's SOLVOX® C110 oxygen cone ensures complete dissolution of gaseous oxygen for maximum process efficiency.

## Results

The oxygenation plants are very successful at maintaining dissolved oxygen concentrations above 4 mg/L, supporting a suitable habitat for the majority of the year for aquatic fauna, and substantially reducing the incidence of

fish kills. Aerobic bottom waters also support more efficient chemical processes at the sediment surface, helping to reduce nutrient concentrations which drive algal growth. Improvements in water quality allow locals and tourists to enjoy the natural beauty of the rivers and estuaries.

## Benefits at a glance

- Dissolved oxygen concentrations in-river respond immediately to plant operation.
- Maintenance of ideal dissolved oxygen levels under nearly all conditions.
- Easy plant monitoring and adjustment of operational settings thanks to remote control features.
- Complete dissolution of gaseous oxygen through proprietary Linde SOLVOX C110 cone design.



*“We have been working with Linde since 1998 in the development and delivery of artificial oxygenation systems for the Swan and Canning Rivers. The unique design of Linde’s oxygenation technology optimizes the dissolution of gaseous oxygen for maximum process efficiency.”*

Malcolm Robb, Branch Manager, Department of Water and Environmental Regulation

# Getting ahead through innovation.

With its innovative concepts, Linde is playing a pioneering role in the global market. As a technology leader, it is our task to constantly raise the bar. Traditionally driven by entrepreneurship, we are working steadily on new high-quality products and innovative processes.

Linde offers more. We create added value, clearly discernible competitive advantages, and greater profitability. Each concept is tailored specifically to meet our customers' requirements – offering standardized as well as customized solutions. This applies to all industries and all companies regardless of their size.

If you want to keep pace with tomorrow's competition, you need a partner by your side for whom top quality, process optimization, and enhanced productivity are part of daily business. However, we define partnership not merely as being there for you but being with you. After all, joint activities form the core of commercial success.

**Linde – ideas become solutions.**

## **Linde Aktiengesellschaft**

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