

Development of temperature criteria for marine discharge from a large industrial seawater supplies project in Western Australia

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Abstract

A multi-user industrial water supply system is under construction on the Burrup Peninsula in Western Australia, 1400 km north of Perth, to support a number of gas-processing plants that convert natural gas into ammonia, dimethyl-ether, methanol or liquid fuels. At full design capacity, the project will abstract 280 000 m³/day of seawater from King Bay. Seawater will be conveyed by pipeline to each processing plant and used for cooling (using evaporative systems) and process feed water (after desalination). The total return flow (comprising cooling tower blow-down and desalination concentrate) will amount to 210 000 m³/day. A pipeline collects the return flow from each industry and discharges into a submerged marine outfall in King Bay. As part of the project environmental approvals process, the Department of the Environment (DoE) prescribed discharge criteria for the temperature of the return flow entering King Bay. DoE requires the return flow, at the end of the outlet pipe, to be less than 2°C above the temperature of the intake (calculated over a 24-hour period and expressed as an 80 percentile). For the remainder (20% of the time), the return flow must not exceed 5°C above intake temperature. As more information from the project proponents became available, it was realised that industrial evaporative cooling systems could not comply with the temperature criteria proposed by DoE under certain climatic conditions. Key findings of this study show:

- the DoE temperature limits proposed in the Ministerial Condition are too stringent,
- practical design of evaporative cooling systems on the Burrup will yield a discharge of 6°C above intake temperature,
- discharge at 6°C will not influence the biota in proximity to the diffuser or the corals located 700 m from the diffuser,
- marine organisms in King Bay are exposed and tolerant to large natural variations in seawater temperature,
- relaxation of the return flow temperature from 2 to 6°C (above intake) will not influence the biota of King Bay, and
- environmental management systems are being developed to monitor and manage the temperature of the return flow.

Introduction

Natural gas reserves located off the north-west shelf of Western Australia are connected by deep-sea pipeline to processing facilities on the Burrup Peninsula, situated 1400 km north of Perth. New processing plants are under construction on the Burrup Peninsula to convert natural gas to ammonia, di-methyl ether, methanol and liquid fuels.

This region of Western Australia has a low rainfall (<300 mm/year) and insufficient water resources to meet the new industrial water demand. To minimise the use of scheme water, a major seawater project, the Burrup Peninsula Industrial Water Supplies Project (BPIWSP), is under development by the Water Corporation on behalf of the State Government of Western Australia. The project comprises an ocean intake and pumping facility connected to a 1400 mm diameter seawater delivery pipeline. The pipeline provides seawater to six development sites within an industrial precinct. Each developer discharges return flow into a common pipeline (1100 mm diameter) that transports it to an ocean outlet diffuser, located 1300 m offshore in King Bay (Fig. 1). When the project is operating at full capacity, 280 000 m³/d (3.2 m³/s) of seawater is abstracted from King Bay, and 210 000 m³/d (2.4 m³/s) discharged back through the ocean outlet. The new industries will

use seawater for cooling and desalination. Return flow comprises cooling tower blow-down, desalination concentrate and a small volume of treated wastewater. The system is being built to full capacity although there is only one developer at this stage.

The local environmental regulator, the Department of the Environment (DoE), approved the project in terms of the Environmental Protection Act (1986) of Western Australia (EPA, 2001; 2002). The environmental approvals include a set of Ministerial Conditions. One of the seventeen conditions specifies the temperature of the return flow discharged into King Bay. DoE requires all return flow to be less than 2°C above the temperature of the intake seawater (referred to as ΔT of 2°C) at the end of pipe. This criterion is a 24-h average, expressed as an 80 percentile. For the remainder (20% of the time), the return flow must not exceed 5°C above intake sea-water temperature.

A review of evaporative cooling system design carried out by the Water Corporation shows humidity (expressed as air wet bulb temperature) governs the thermal efficiency of these cooling systems. From the onset of the project, the project team and developers were aware that compliance with the DoE temperature criteria was not possible during periods of high humidity. Through the agency of the Burrup User Group (BUG) comprising the developers, DoE, Office of Major Projects and the Water Corporation, it was agreed to undertake a study looking at the environmental, engineering and economic constraints to determine sustainable and achievable temperature criteria. This paper describes a process used to develop temperature discharge criteria, and assesses their influence on the biota of King Bay.

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