

# Short Cut Nitrogen Removal – Design for Full Scale Implementation at Melbourne Water’s Western Treatment Plant

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## Introduction



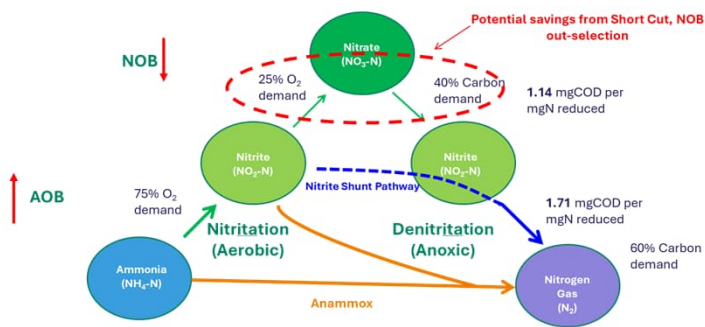
Western Treatment Plant (WTP) in Melbourne, Australia treats ~550 ML/d in a process which includes:

- Primary covered anaerobic lagoons (~2.5 day HRT, ~50% COD reduction)
- Biogas produced sufficient for 80-100% site energy neutrality with existing processes
- Three activated sludge plants: 1 x MLE, 1 x Step-feed plant, 1 x A/O (designed for SCNR)
- Aerated lagoons and facultative lagoons
- Class C (on site) and Class A (UV, chlorine) recycled water production
- Discharge to Port Phillip Bay limited to <3,100 tN/year (3 year rolling average)
- Internationally significant RAMSAR Wetland site

There is challenging low carbon Anaerobic Lagoon effluent for denitrification, with a COD:TKN ratio ~4-7.

Melbourne Water identified short-cut nitrogen removal (SCNR) as a potential option to enable WTP to achieve the tighter effluent TN quality requirements more efficiently. SCNR, via ‘Nitrite shunt’ – short cuts the conventional nitrification/denitrification process.

The short-cut allows for the nitrate step to be ‘short cut’, providing a potential 40% carbon savings for nitrogen removal. To short cut the process, nitrite oxidising bacteria (NOB) need to be ‘out-selected’ so that the nitrite produced by the ammonia oxidising bacteria (AOB) is not further oxidised to nitrate, before the denitrifiers can reduce the nitrite to nitrogen gas.



## Demonstration trial to test SCNR at WTP

As SCNR is an emerging process, a trial was undertaken to test the process in the WTP conditions.

The trial operated for 2.5 years and demonstrated:

- 40% reduction in the carbon required for nitrogen removal, with a lower feed COD:TKN than typically fed to the existing activated sludge plants
- Effluent quality targets, including effluent ammonia <1 mg N/L and nitrite <1 mg N/L were met without effluent polishing.



## Demonstration Trial to Full Scale

Based on the results of the successful demonstration trial, the key findings have been adopted in the design of a 150 ML/d activated sludge plant augmentation, called the 5W Nutrient Removal Plant (NRP) at Western Treatment Plant. Designed by Jacobs for Melbourne Water and constructed by BMD.

The process adopted is an A/O process with intermittent aeration. The plant has been designed with flexibility to operate to promote SCNR, as well as conventional full nitrification and denitrification and operate across a relatively wide range of influent quality due to the variability in the effluent quality observed from the covered anaerobic lagoons.

## Process Commissioning

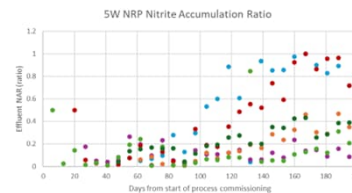
- January 2025: seeding commenced from 25W ASP – low DO MLE with some presence of commamox
- April 2025: All 5 bioreactor/clarifier trains operational
- May-June 2025: plant Proof of Performance and Reliability Testing undertaken before handover to Melbourne Water



## Early Results

Some early operational results are now available, with current operational focus on achieving and maintaining NOB out-selection and improved denitrification. Plant NOB out-selection is being monitored through:

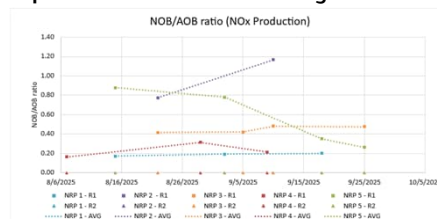
- Effluent Nitrite Accumulation Ratio (NAR)



A typical conventional ASP would have a NAR of close to 0 (i.e. no effluent nitrite).

Promising results - but not the only indicator of NOB out-selection.

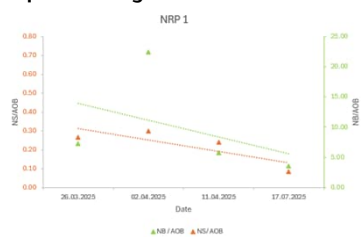
- Specific nitrification rate testing



A good level of NOB out-selection observed in 4 of the 5 NRP.

Note consistent with effluent NAR results.

- qPCR testing



Ratio of the copies/1mLMLSS of AOB, NB and NS.

A general reduction in the ratio of NB/AOB and NS/AOB observed over 4 months in NRP 1.

## Acknowledgements

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