# DESIGN ASPECTS OF THE BURGOWAN WATER TREATMENT PLANT

*Paper Presented by :*

**Peter Beswick**

*Author:*

**Peter Beswick,** *Manager, Treatment & Process,*

Cardno Pty Ltd

*31st Annual Qld Water Industry Workshop – Operations Skills*
*University Central Queensland - Rockhampton*
*4 to 6 July, 2006*

# DESIGN ASPECTS OF THE BURGOWAN WATER TREATMENT PLANT

**Peter Beswick,** *Manager, Treatment & Process*, Cardno Pty Ltd

**ABSTRACT**

The design of a new 20 ML/d augmentation to Wide Bay Water's Burgowan water treatment plant resulted in several innovative features incorporated into the design. Along with conventional design for turbidity and colour removal, the plant incorporated treatment units for the treatment of taste and odour and iron and manganese and with lime/carbon dioxide stabilisation of the treated water.

It was a requirement that the plant utilised existing raw and treated water storage lagoons and eliminated any intra-process pumping.

## 1.0 INTRODUCTION

Wide Bay Water operates two treatment plants at Howard (20 ML/d) and Burgowan (10 ML/d) to supply drinking water to Hervey Bay and surrounding areas. The Hervey Bay region in general is growing rapidly placing increasing demands on all utilities including potable water. To answer the need for increased supply, the decision was made to augment the existing treatment plant at Burgowan, to provide an additional 20 ML/d treated water.

In addition to the usual unit processes, the upgraded plant would include specific treatments for algal taste and odour, iron and manganese and stabilisation of the low alkalinity water with a residual alkalinity in the order of 50 mg/L.

The Burgowan plant was selected for augmentation rather than Howard because of the land available at Burgowan for the expansion and the somewhat remote location of the site.

## 2.0 DISCUSSION

### 2.1 Existing Treatment Plant at Burgowan

The existing treatment plant at Burgowan is based on chemical dosing and a bank of eight continuous backwashing filters (Dynasand). The raw water feed to the plant is from either a small dam (Cassava Dam) or from the Burrum River - which is also the main feed to the Howard treatment plant. The quality of treated water produced is good with turbidities generally in the range 0.3 – 1.0 NTU, but like other continuous backwashing filters, the quality can be upset by changes in flow.

Water from the river can be pumped either to the Cassava Dam where it is mixed with the water in the Dam or it can be pumped direct to the treatment plant. In addition, raw water arriving at the treatment plant can be sent directly to the treatment plant or to the raw water storage lagoon that is an earthen lagoon with a plastic liner and cover.

Treated water from the plant is discharged to a lined and covered earthen lagoon.

## 2.2 Design Brief

Wide Bay Water presented a comprehensive brief for the Project. The main requirements relating to the process design and treated water qualities included:

- The augmentation would produce 20 ML/d treated water;
- The new treatment plant would be capable of treating raw water from three distinctly different sources and qualities with a seamless change over from one source to another or any combination of the three sources;
- The treated water must meet the requirements of the Australian Drinking Water Guidelines;
- Taste and odour problems in two of the raw waters have been problematic due to algae and the presence iron and manganese
- Treated water alkalinity of 50 mg/L or Langellier Saturation Index (LSI) in the range -0.5 - +0.5 to produce a stabilised treated water;
- The existing raw water and treated water storage reservoirs were to remain in use with the new plant, and
- No intra-process pumping, in particular filtered water to the Ozone/BAC process

The three raw water sources to be treated produced the full spectrum of quality issues:

***Burrum River:*** This source is characterised by low turbidity (<10 NTU) and high organic colour which is generally in the order 80 – 100 TCU but can reach values over 250. The colour was defined as being mainly tannin based.

***Cassava Dam:*** This is predominantly a small surface catchment with moderate turbidity and colour.

***Mary River:*** Looking to the long-term future, the Mary River is seen as one of several possible alternate raw water supplies for the Hervey Bay area. The river water is characterised by low colour and high turbidities.

The new treatment plant must be capable of treating each of these supplies either individually or in any combination or ratios.

## 2.3 Treated Water Quality

The target treated water quality was to comply with the Australian Drinking Water Guidelines, and in particular;

| | |
|---|---|
| Turbidity | ≤0.3 NTU |
| Colour | ≤5.0 TCU |
| Iron | ≤0.2 mg/L |
| Manganese | ≤0.02 mg/L |

### 2.4 Process Design

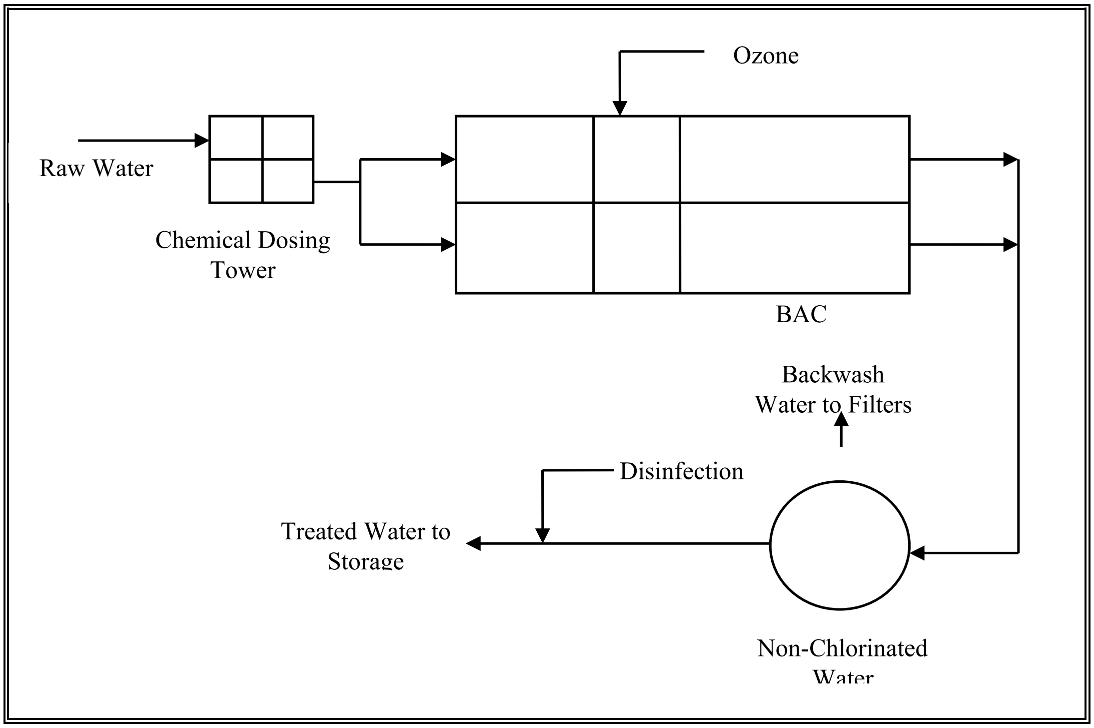


**Figure 1:** ***Simplified Process Schematic***

The main challenge with the design of the treatment plant was to incorporate the necessary unit processes within the hydraulic head available between the operating limits of the raw and treated water storage lagoons. The head available was determined as 6.0 m between the Low Level in the raw water storage to the High Level in the treated water storage. Between these two levels the plant had to operate at full capacity.

The process would be based on the standard format chemical dosing, clarification, filtration and disinfection. Laboratory tests had shown that the colour in the Burrum River supply could be broken at a pH in the range 5.0 to 5.5 and this had been verified by treatment at the Howard plant. Ozone/biological activated carbon (BAC) would be used for treatment of taste and odour and ozone for iron and manganese oxidation. Lime and carbon dioxide was preferred for stabilisation of the water.

To fulfill the requirements to work between the raw water and treated water lagoons and eliminate intra-process pumping, ozone injection was positioned between the clarifier and filter with the BAC included as part of the multi-media mix in the filter rather than a separate process.

***Hydraulic profile***
The maximum static head available between the Low Level of the raw water storage and High Level of the treated water storage was 6.0m. The up-flow restrained media clarifier selected requires 4.5m head for operation.

The head loss through the treatment plant was calculated as 5.8m in total including pipeline losses to the treated storage lagoon. After discussion with Wide Bay Water the Low Level in the raw water storage was lifted by 0.5m to provide a margin of safety through the plant.

***Chemical dosing***

The aim of the chemical dosing system adopted was to improve the coagulation/flocculation process by raising the alkalinity to the required level before treatment.

***Up-flow restrained media clarifier***

Up-flow restrained media clarifiers were selected as the preferred clarification process. Although not a common process in Australia, there are numerous plants using these clarifiers in New Zealand treating a wide range of raw water qualities. The clarifiers are designed to operate nominally at a hydraulic loading rate of 24 $m^3/m^2$.h. – This is significantly faster than conventional clarifiers and gives a much smaller footprint than conventional units.

The design clarified water quality was specified as 0.5 NTU turbidity and <5 TCU colour.

The up-flow restrained media clarifier uses as bed of floating plastic pellets held in place by stainless steel screens. Chemically dosed raw water enters at the bottom of the clarifier and flows upwards through the plastic media. As the water passes through the media, flocculated impurities are trapped and retained in the media. Clarified water exits at the top of the clarifier and passes to the ozonation tank. Similar to a conventional sand filter, a point is reached where the solids must be removed from the clarifier media in a process termed "flushing". The flushing process is similar to the backwashing process for sand filters. Firstly scour air is used to agitate the media and release the trapped solids then flush water washes the solids from the clarifier to waste. The flushing process is fully automated based on head loss across the clarifier takes 6 – 8 minutes. The number of flushes per day will depend on the quality of the raw water.

A major advantage of the clarifier is that it can be stopped and started instantaneously.

***Ozonation***

Ozone is introduced after the clarifier. The ozone is injected into the flow as it enters the retention tanks. The tank has a retention time of 15 minutes and is designed with water seals to prevent ozone escaping to the atmosphere. Ozone destructors destroy any free gas.

***Multi-media filter***

The filter was designed with multi-media sand over direct retention underdrains that eliminate the need for support gravels. Backwashing was designed for air scour and rinse water. The filter was designed at a nominal filtration rate of 12 $m^3/m^2$.h. The filter was to operate at constant level controlled by an ultra-sonic level sensor linked to a positioner on the filtered water valve. Filter backwashing is initiated by a signal from the positioner. When a 20 mA signal has been steady for 60 seconds, a backwash would be initiated.

The original media mix was designed to produce a filtered water to meet the turbidity requirements for the 2000 New Zealand Drinking Water Guidelines that requires a turbidity ≤0.1 NTU for 95% of the time and <0.3 NTU at all times.

The media bed comprised:

460 mm of 1.0 – 1.2 m dia Filter Coal
240 mm of 0.55 – 0.65 mm diameter Filter Sand
90 mm of 0.18 Garnet Sand

The bed was later changed to replace the Filter Coal with BAC with an Empty Bed Contact Time (EBCT) for the BAC of 15 minutes. This required modifications to the air scour and backwash rates to prevent loss of the BAC which is much lighter than Filter Coal.

Because of the BAC component in the filter, the filter must be backwashed with non-chlorinated water. A filtered water balance tank was included in the process prior to disinfection.

***Disinfection***
Disinfection uses sodium hypochlorite. The process is automatically controlled with an on-line chlorine monitor.

***Process Control***
The process is designed for fully automatic operation either from the plant control room or from a remote location via the SCADA system.

Alum dosing is controlled by a Streaming Current Detector (SCD).

## 2.5 Layout

The main process elements of the plant are contained in a single, compact concrete structure located close to the plant buildings and chemical dosing shed.

All of the various plant rooms were design to provide plenty room around the equipment for maintenance. Similarly, the chemical dosing shed was designed with ample room to work around the storage tanks and dosing pumps with all dosing pumps mounted on stands clear of the floor.

## 3.0 ACKNOWLEDGEMENTS

To Wide Bay Water for the opportunity to be part of this challenging Project, and for the input Wide Bay Water's engineers during the design process.

Special thanks to Quentin Ryder, Wide Bay's commissioning engineer for the treatment plant, the team of Operators at Burgowan and other members of the commissioning team for their excellent work in commissioning the plant.