UPGRADING WEST WODONGA BNR WASTEWATER TREATMENT PLANT

Paper Presented by:

Peter Tolsher

Author:

Peter Tolsher,
Supervisor Operator

North East Region Water Authority

62nd Annual Water Industry Engineers and Operators' Conference
Civic Centre - Wodonga
8 and 9 September, 1999

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P. Tolsher, *Supervisor Operator*, North East Region Water Authority.

ABSTRACT

Two major wastewater treatment plants, the Howard Street Treatment Plant and West Wodonga BNR Plant, currently service the township of Wodonga. West Wodonga BNR Plant treats the entire industrial load and approximately a quarter of the domestic load generated by the township of Wodonga. Howard Street Treatment Plant, an older trickling filter secondary standard plant located within the township itself, treats the rest of the domestic load. For various reasons a decision was made to close down the Howard St plant and divert all flows to West Wodonga.

The nominal capacity of the West Wodonga BNR plant is exceeded under existing loading conditions, and with the continued tightening of EPA requirements on effluent quality and the increased load expected from Howard St Plant before 2001, a significant upgrade of the West Wodonga Plant is required immediately. This paper describes the current as well as the future operating conditions at the plant and also outlines the upgrade strategy developed and adopted for implementation.

KEY WORDS

Biological nutrient removal (BNR), activated sludge, upgrade, Modified University of Cape Town (MUCT)

1.0 INTRODUCTION

The Wodonga waste water system consists of two treatment plants, a trickling filter plant at Howard St, and a BNR (activated sludge) plant at West Wodonga.

The trickling filter plant at Howard St was built in the early sixties to cater for the increasing population and at the time was a state of the art plant for sewage treatment. With new technology, EPA discharge standards becoming increasingly more stringent and the need to be environmentally conscious, it was decided that a new system should be built at a location out of town.

1.1 The West Wodonga Purification Plant (WWPP)

This plant is located on Old Barnawartha Road, Wodonga West. Stages 1 and 2 consisting of an oxidation ditch were commissioned in 1986. During 1989, Stage 3 was constructed, adding biological nutrient removal facilities. Stages 4A and 4B were implemented during 1992 to 1994. This involved augmentation of the aeration capacity, modification of the BNR process to the University of Cape Town process, addition of chemical dosing facilities and construction of 2 additional clarifiers.

After completion of stage 4B in 1994 the plant has a capacity of about 81,000 equivalent population (EP) on a biochemical oxygen demand (BOD basis).

WWPP is an activated sludge plant with major components consisting of an inlet structure, pre-fermenter, oxidation ditch together with anaerobic and anoxic zones, three clarifiers, maturation lagoons, sludge lagoons, sludge drying pans, supernatant lime treatment facilities, tertiary treatment with chemical dosing facilities and an effluent reuse pump station.

2.0 WASTEWATER CHARACTERISTICS

Howard St receives inflows of 5,000 to 6,000 kL/d (ADWF) being predominantly domestic waste with typical domestic loadings.

WWPP has a total inflow of 5,000 to 6,000 kL/d (ADWF). This is made up of 4 different types, strengths and volumes of waste. These flows are from : an abattoir (2,000 kL/d), a pet food factory (1,500 KL/d), a rendering plant (100 kL/d) and the balance being domestic wastewater.

Data showing monthly characteristics of the load entering WWPP, and average monthly effluent quality:

RAW INFLUENT

MONTH	PO_4 mg/L	NH_3 mg/L	SS mg/L	COD mg/L
Jul-98	15.2	75.2	563	1250
Aug-98	12.7	75.4	527	1766
Sep-98	16.5	71.7	466	1977
Oct-98	11.5	81.1	515	1523
Nov-98	13.5	79.5	497	1562
Dec-98	13.4	85.0	537	1823
Jan-99	13.5	88.3	526	1661
Feb-99	17.8	108.5	562	2021
Mar-99	16.0	97.4	493	1810
Apr-99	17.6	72.7	456	1593
May-99	11.6	97.9	605	2174
Jun-99	14.9	102.7	529	2291

CLARIFIER DISCHARGE

MONTH	PO_4 mg/L	NH_3 mg/L	SS mg/L	COD mg/L
Jul-98	3.6	3.6	37.7	72
Aug-98	1.1	1.0	9.0	33
Sep-98	4.9	1.2	8.5	119
Oct-98	1.2	6.2	18.4	51
Nov-98	0.8	0.8	7.5	23
Dec-98	2.2	4.7	5.9	65
Jan-99	4.5	1.6	4.1	43
Feb-99	3.7	0.8	3.4	43
Mar-99	2.1	0.8	6.4	53
Apr-99	0.9	0.5	9.4	62
May-99	0.3	1.1	26.0	58
Jun-99	0.3	0.9	23.7	52

Around 80% of total daily inflow is of high strength (in BOD load) from industry, and is delivered in a 10/12-hr period during weekdays (these industries close over the weekends). The WWPP has been overloaded for quite some time and struggles to cope with the high organic load, during peak periods. The aeration system was unable to provide the necessary amount of dissolved oxygen to effectively treat the peak load and was having an adverse affect on the efficiency of the nutrient removal process. This necessitated augmentation of the aeration system.

2.1 Aeration System Upgrade

The WWPP was originally configured as a race track oxidation ditch. This was further modified and augmented to biologically reduce nitrogen and phosphorus discharges.

The oxidation ditch is supplied with compressed air by two duty Spencer multi stage blowers with a third blower as a standby unit. Each blower has a maximum discharge capacity of 1,560 L/s or 5,616 m3/h at standard inlet conditions of 20 deg C and 101.3 kpa. Air is delivered to 22 aeration grids currently fitted with 48 Roediger Roeflex fine bubble diffusers giving a total of 1,056 diffusers. Additional oxygen is transferred into the ditch by four horizontal brush aerators that also provide circulation of the mixed liquor.

The output from the diffusers was limited due to their size and number and only 2 blowers could be operated at once. To achieve optimum oxygen levels in the ditch for treatment much more DO was required. The aeration upgrade was completed by doubling the amount of diffuser heads per bank which allows all three compressors to be run at once. The PLC program was also altered as it only allowed 2 compressors to start simultaneously as a safety precaution. These changes allow all three blowers to be utilised during peak loading times. With three blowers running and the new diffuser heads fitted, a delivery of 16,848 m3/h of compressed air is possible and this is adequate to cope with peak loads.

2.2 Anoxic System Upgrade

Following the aeration system upgrade, the characteristics of DO in the ditch changed. The increased aeration capacity meant that due to its location in the ditch, the anoxic return pump was now delivering DO into the anoxic zone and causing a detrimental effect on nitrogen removal. A new anoxic return line and pump was required and installed in a more strategic location in the ditch where the DO was at its lowest point. This meant that the aeration system now meets peak demands and aids the nutrient removal process.

Improved aeration of the ditch has caused a greater mixing effect and the mixed liquor suspended solids (MLSS) have risen drastically from the normal value of 5-6,000 mg/L to around 8 - 9,000 mg/L. The most obvious strategy to reduce the suspended solids level is to increase wasting, but this is not possible due to a bottleneck within the solids handling system.

3.0 BIOSOLIDS MANAGEMENT

3.1 Current Biosolids Management.

The current biosolids management involves wasting directly from the oxidation ditch to facultative sludge lagoons (FSL) where the sludge is digested and thickened, followed by drying in sludge drying pans and stockpiling of the dried product. Supernatant from the FSL is dosed with lime to remove soluble phosphorus. The lime sludge is settled out in lime sludge lagoons where it is removed to another drying pan then stockpiled on site.

The ditch has a 20 day sludge age with a 5 - 7,500 mg/L MLSS operating range. There are two FSL's with a capacity of around 10 ML each. Traditionally they would take all of the waste activated sludge for a twelve month period but with the increasing production from the high organic loads to the plant, the lagoons are reaching capacity in around 8 months. Once the sludge has digested long enough it is pumped to sludge drying pans where it relies on the elements to dry further. The capacities of these pans are not large enough to handle the increased loads.

The biosolids management strategy is designed to cope with current and future increased loads up to 2021. The proposal is focused mainly on agricultural markets for reuse, which comply with EPA guidelines, a system which is cost effective, and is operator friendly.

3.2 New Biosolids Management Strategy

Four methods of sludge dewatering were considered including sludge drying pans, centrifuge, employing the services of an external mobile dewatering plant and construction of a permanent dewatering system in the form of a belt filter press.

Sludge Drying Pans is similar to the current system at WWPP. The plant is in a sensitive location near the Murray River and there is a risk of groundwater contamination through leaching. Additionally, relying on dry weather conditions to dewater the sludge was not considered an acceptable option in the long term.

Centrifuging involves the construction of a permanent mechanical dewatering facility with 2 no x 40-m3/h centrifuge. This has a disadvantage of relatively high power consumption, substantial wear and tear on bowls and scrolls and operators cannot see the operation of a centrifuge as easily as a belt filter press. A major positive of this system is it is not effected by the weather.

Contracting out to a mobile dewaterer is subject to availability of mechanical plant and the cost of dewatering is more dependent upon lagoon sludge solids concentration.

Construction of a permanent mechanical dewatering facility involves 2 no x 2-m belt filter presses. This system is not affected by the weather, minimises odour production and requires little space.

The preferred option for the new solids handling system facilities is:

- waste to a DAF sludge thickener
- aerobic digestion
- belt filter press,
- on-site stockpiling for one year and a disposal strategy focussing on agricultural reuse and landfill cover.

The influencing factor for this decision was the NPVs, which indicated that this option was the best for our site due to our location near the Murray River.

4.0 PROBLEMS AT WWPP TO BE UPGRADED BY 2001

There are a number of existing operational problems at WWPP which may be made worse following the closure of Howard St plant. Theses problems and possible solutions are discussed below.

4.1 Inlet works

The existing pump well is in good condition although due to the increased potential ADWF of 194 L/s (2021) and peak WWF 609 L/s (2021) the pumps will need to be upgraded. Adopting a criteria for maximum flows of 3 x ADWF the influent pumps will need a maximum discharge capacity of approximately 582 L/s. The proposed strategy is to install 4 pumps.

The options for configuring the pumps is either all 4 pumps working simultaneously at 145 L/s capacity; or increasing the output of each pump to 194/Ls capacity which then allows three duty pumps and one on standby to provide the ultimate PWWF of 582 L/s.

4.2 Inadequate screening facilities

The existing screen is old and inefficient and is due for replacement. The new screening system will need to be adequately sized to cope with increased flow; be able to dewater, wash, press and then discharge waste into a bin; and limit labour requirements. Three options were considered including drum screens, rotating spiral screens and step screens.

Of these three options a step screen was preferred because of the high solids removal efficiency which could be obtained.

4.3 Grit removal.

There are no grit removal facilities at WWPP presently and three options were considered.

A horizontal flow chamber was not deemed practical as it suffers from an accumulation of organic material since selectivity of grit particles is less effective due to type of waste treated at WWPP.

An aerated grit chamber was also deemed not practical as the dissolved oxygen which is injected into the aeration tank may cause problems within a BNR plant by reducing the phosphorus removal performance.

The third and recommended option fro grit removal is a vortex grit chamber which is widely used and offers high grit removal efficiencies. This system offers low head loss and low turbulence thus minimising odour emissions.

4.4 Odour control

The main source of offensive odours is the pretreatment area as the rest of the plant is an aerobic process which does not usually emit odours.

Again, three options were considered - no treatment; sparging foul air through BNR reactor; and the use of a biofilter. The first two options may not meet with the EPA policy of ground level odour concentrations beyond the site boundary, to be no greater than 1.0 odour dilution units.

The third and recommended option of the use of a biofilter has the ability to reduce hydrogen sulfide emissions of up to 95%. With this sort of efficiencies by the biofilter the ground level concentrations will not exceed EPA requirements.

4.5 Inadequate biosolids capacity

This problem has been previously discussed in Section 3 under the biosolids.

4.6 Inadequate process capacity

In order to achieve effective and consistent removal of Nitrogen and Phosphorous it is essential to have adequate amount of readily biodegradable COD (RACOD) along with recognised rules-of-thumb ratios of COD/TKN=9 (minimum) COD/TP=50(minimum).

A simple upgrade of the existing BNR process is a logical option. A duplication of the oxidation ditch in parallel with the existing one is a simple solution. Due to the characteristics of the trade waste flows at Wodonga and the availability of RACOD within the wastewater, this means that all ratio requirements are well in excess of the rule of thumb and it will ensure good support of the BNR process.

4.7 Algal problems in maturation lagoons, disinfecting and stormwater balancing storage

The current system of maturation lagoons is appropriate for disinfection of treated waste but there is a problem with production of algae. Disinfection is required to reduce pathogen concentrations prior to reuse or off-site discharge. The disinfection options investigated were ozonation, chlorination/dechlorination (which were both too expensive), and Ultra Violet (UV). The UV system was preferred by EPA as no toxic by-products are produced. This is a key factor considering the plant discharges directly into the Murray River.

The UV disinfection system works best when solids are kept to a minimum. Options investigated to stop the solids from affecting the UV system were clarification, dissolved air flotation (DAF) and filtration. The DAF of system was too expensive and clarification left a high chance of carry over floc particles which will affect the disinfection system. This leaves the filtration method as the preferred option. It is the most reliable method of solids remove and provides an effluent of EPA class A or B standards suitable for re-use.

It is best practice and important to have available emergency storage capacity as a contingency to cover power outages, equipment failure or to collect storm flows which exceed maximum plant inflow. The adoption of UV for disinfection at WWPP will make the maturation lagoons available for alternative uses such as emergency storage. These lagoons are well situated and sized which means the utilisation of them is a low cost solution for such emergencies.

5.0 CONCLUSION.

After these augmentations works are completed, there will be extra flexibility built into the plant and the operator will have better control of the process in order to aid nutrient removal. This will mean more consistent compliance with our EPA discharge licence.

It is important to have operator input at the design stage of any upgrade works as there is a lot of knowledge and hands on experience which if utilised in the early stages can benefit both the designers and Authority.

NERWA had input into the design process from all levels of the organisation which has produced a proposal that will meet EPA requirements, be operator friendly and will deliver high quality effluent well into the next millennium.