OPERATOR PERSPECTIVES OF THE FABRIC MEDIA FILTRATION TRIAL AT CRAIGIEBURN STP

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Yarra Valley Water

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ABSTRACT

Yarra Valley Water trialled a pilot scale Fabric Media water filtration plant at the Craigieburn Sewage Treatment Plant between May and December 2007. The trial was undertaken to assess potential for economic and labour related savings that could be applied for future upgrades at STP's.

Observations with treatment of overflow from the secondary clarifiers, processing between 10 and 25m^3/hr depending on the setup were conducted with fully automated filtration equipment on a 24/7 basis. The huge quantity of data collected and the high proportion of plant flow filtered provide strong confidence in the project conclusions.

The results of the trial indicated that:

- Fabric Media is considered an attractive option for the filtration of clarified secondary treated water as the technology provides a 90% reduced footprint in comparison to sand type filters and this correlates with a significantly reduced capital cost for similar filtrate quality.
- Highly predictable filtrate quality, typically being turbidity less than 2 NTU, BOD less than 5 mg/L and suspended solids less than 3mg/L, from a wide spectrum of water, climate and operational conditions provides greater assurance of UV disinfection performance.
- The Fabric Media technology provides operators with significantly reduced labour requirements in comparison to Craigieburn's existing up-flow pebble bed Clarifiers.
- The Fabric Media equipment provides greater on line time availability and lower backwash volume than alternatives.
- In tertiary filtration mode, with sensible coagulant application, the Fabric Media technology has potential to deliver reliable and effective phosphate removal capability.

Victorian water utilities are facing demands for increased volume and higher quality of recycled water, along with tighter environment regulation on discharged water and improved occupational health standards for operators. In situations where a plant upgrade is proposed or new treatment facilities are being considered, judicious review of available filtration technologies by water utility operators provides hands on information that ultimately benefits the financial objectives of a water utility by enabling sensible decisions making. The lessons learnt in the field are the most reliable form of assistance from operators, for the best practise decisions of in house and contract engineers responsible for process design.

The YVW STP Operations team became interested in the Fabric Media water filtration technology after learning of it during the 2006 WIOA Bendigo conference and the potential benefits of the technology justified the completion of a meaningful trial at a YVW plant earmarked for a future potential filtration upgrade.

The Craigieburn project involved a short commissioning period commencing May with 24/7 observations commencing in early June.

During continuous observations, Hach brand turbidity instruments with data logging at one minute intervals were utilised to record feed water and filtrate turbidity, with several hundred samples and composite bottles forwarded to either in house or a contract laboratory for supporting water quality information and confirmation of instrument calibrations.

The project duration enabled real life comparisons with existing plant equipment across a full spectrum of wastewater and climate conditions, plus operational circumstances. Observations covered mostly regular wastewater conditions but several quite different non routine events ranging from a drought breaking stormwater flow of 8.5ML/day (3.4 x ADWF), days of extreme winter cold and summer heat waves, and other situations relating to equipment and process challenges within the STP itself.

The Fabric Media test units processed between 10 and 25m^3/hr representing a statistically meaningful 10 to 25% proportion of Craigieburn's ADWF. During the trial, a tertiary filtration treatment with an alum dose prior to the Fabric Media filtration was also performed.

1.0 CRAIGIEBURN STP

The Craigieburn STP, pictured here is located in the northern outskirts of Melbourne. The plant consists of four biological treatment tanks operated in parallel and each with an inbuilt centrally positioned secondary clarifier. The treatment represents a typical sequenced aeration reaction with activated sludge retention followed by 400 m^2 of pebble bed type filtering, prior to a UV channel disinfection.

The Craigieburn STP discharges UV sterilised water with an ADWF of 2.5Ml/day. During the project, peak flows witnessed a 4 to 5 fold increase in flow demand and on occasions feed water to the filters of up to 100NTU. YVW have recently constructed a Sewerage Flow Control Facility for the Craigieburn STP and improved filtration remains under consideration.

Figure 1: ***The Craigieburn STP***

2.0 THE FABRIC MEDIA WATER FILTERING TECHNOLOGY

The Fabric Media technology applies an up-flow filtration technique hereby briefly described. Feed water enters the filter tank at the bottom, passing up through a unique textile media bed with filtrate exiting the tank at the top. The technology applies small wads of a sheet textile woven from machine washable fibres with an example pictured to

the right. Each of the 600mm diameter Fabric Media filter tanks applied at the Craigieburn study contained roughly 200 litres of these textile wads restrained between the top outlet and bottom inlet strainers, which are simple mesh screens located at top and bottom of the filter tank.
Under a high filtration flux, the upward flow compresses the floating textile against the top outlet strainer forming a tightly packed filtering bed. The tight packing forces water to filter through the textile, not around the wads.

As per all automated filters, options to commence a backwash include critical backpressure, elapsed filtration time, preset daily time, assessment of the accumulated total mass of filterable solids suspended in the feed water by turbidity measurement, or measurement of filtrate turbidity. When a backwash is required, typically once a day during the Craigieburn trial a washing sequence akin to a household laundry machine cleans the Fabric Media wads, however the small wad size enables application of much greater agitation forces providing the benefit of a significantly reduced washing time.

Completion of a backwash cycle took 15 minutes. No detergent or other chemicals were required to enhance the Fabric Media wash. As per the diagram below, the backwash sequence involved 4 minutes of motor driven wash agitation only (1), followed by 4 minutes of back rinse with the agitation maintained (2) and 4 minutes of forward rinse without agitation (3) whereby the media filtering bed is reformed. Please note, no compressed air is required for the backwash. High quality water is not required for the rinse and the valve manifold redirects and reduces the raw water flow during the back rinse.

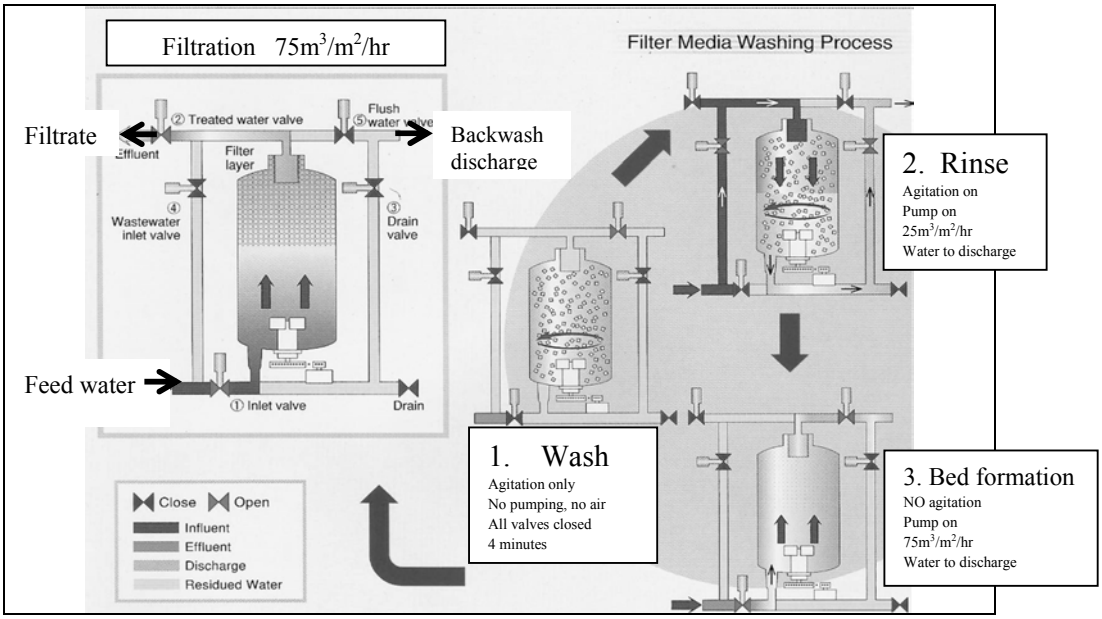


Figure 2: ***The backwash cycle***

3.0 FILTRATION APPLICATION COMPARISONS

Two Fabric media filtration units each of 600mm diameter enabled a true bona fide comparison against Craigieburn's pebble bed clarifiers with raw water to both Fabric Media filters extracted from the feed well of the pebble bed clarifiers. The second Fabric Media filter enabled observation of a dedicated tertiary filtration with an alum coagulant process.

3.1 Filtration Flux

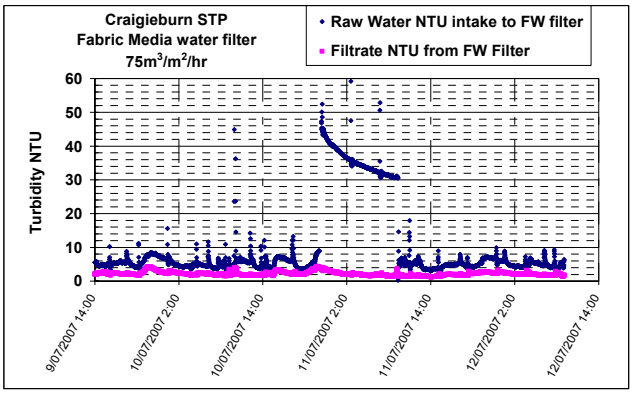
The ability of any separation technology to operate at high filtration flux is advantageous because capital cost decreases as the operating flux increases.
Filtration flux between 30 and 100$m^3/m^2/hr$ were studied during the project with a process optimum observed at 75$m^3/m^2/hr$ for filtration of the clarified secondary treated wastewater. To view this in perspective, the Craigieburn STP gravel bed filters are 400m^2 and operate with a flux of 0.25$m^3/m^2/hr$ during routine plant flow. Indications are that a 1.4 metre diameter Fabric Media filter tank will provide equivalent filtrate quality or better for the 2.5ML/day flow.

Table 1: ***Filter types and estimated costs***

	Flux	Likely installed Craigieburn cost (2007)
Fabric Media filters	75 $m^3/m^2/hr$	$550,000
Sand Media filters	12 $m^3/m^2/hr$	$1,400,000
Micro Membrane filters		$2,350,000

3.2 Filtration during non routine conditions

Under ideal plant conditions and design filtration flux, each filtration technologies filtrate would be otherwise identical. It is when non routine conditions occur that the robust benefits of the Fabric Media become most apparent. The following graph from July 2007 provides an example of this. It highlights a 12 hour period of non routine plant performance caused by mechanical malfunction of a secondary clarifier.



This type of solids inundation on the gravel beds creates filtrate related concerns, plus introduces unscheduled operator labour requirements. Likewise, sand filters will experience a similar immediate and lasting adverse side affects in such conditions.

Figure 3: ***Fabric Media performance at variable raw water quality***

The pleasing aspects of the Fabric Media performance are that during the episode filtrate quality remained consistently at or about the 2 NTU target providing Class A treated water quality, and after the incident no unscheduled operator tasks where required. Operators would expect this type of filtration performance from a membrane barrier, not from a media bed filter.

During the malfunction, turbidity of secondary treated water overflowing the clarifiers ranged from an initial peak above 60NTU to a minimum of 30NTU, whilst turbidity of the Fabric Media ranged from the initial peak at 4.4 NTU reducing with time to a minimum of 1.4 NTU. The automated logic of the Fabric Media filter was able to sense the need for additional backwash operations during the episode and adjust its cycle time to the conditions at hand.

The pleasing operational aspect is that, the high turbidity secondary treated wastewater caused no apparent long term blinding of the Fabric Media. After the incident, unscheduled maintenance by manual cleaning was required to service the gravel bed clarifiers but the situation did not create a need for any urgent additional maintenance to the Fabric Media filter.

4.0 OPERATIONAL COSTS

There are two significant operational cost items associated with a media bed or membrane type water filter, being the pumping energy and the media replenishment exercise. The power requirement of the Fabric Media filter was not quantified during the Craigieburn trial but indications are that it is perhaps one third to one fifth that required by a low flux low pressure sand filter. In addition, expensive membrane cleaning chemicals were not required.

4.1 Fabric Media Replenishment

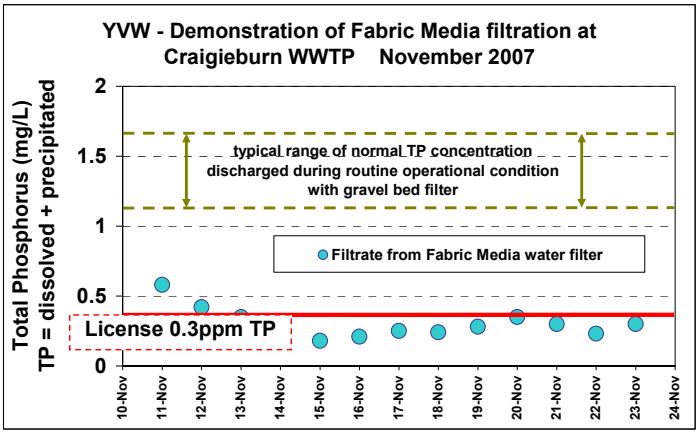
During the Craigieburn trial, the secondary textile was subjected to the equivalent of more than 660 wash events. With a full scale application, this indicates a media life in the 10 to 15 year region. A small 30 litre media replenishment top up was conducted in late October and that exercise required less than 20 minutes with one operator. This is an attractive advantage in comparison with the adverse costs and down time of several days associated with routine maintenance requirements for gravel and sand media type filters.

5.0 TERTIARY FILTRATION - NUTRIENT AND PATHOGEN REMOVAL

Tertiary treatments such as coagulant precipitation and filtration are well recognised methods when higher nutrient removal and greater pathogen reduction are required for wastewater treatment. During the Fabric Media project, a manually set dosing regime operated to the tertiary Fabric Media filter and the basic set up generated impressive results. Clearly, there is expectation of much better performance with a laboratory optimised and instrument controlled dosing regime, with feed water turbidity assessed and optimal pH conditions applied.

Dosing a minute volume of full strength alum solution into a $20m^3$/hr stream of clarified

secondary treated wastewater initially created an operational issue with unequal chemical distribution and inconsistent filtrate. The resolution required a tenfold pre dilution of the alum and higher dose pump speed providing consistent coagulation of the raw water.



The need for homogeneous mixing of the coagulant chemical with the feed water should not prove a design obstacle to any filtration technology, and the filtration performance indicated at Craigieburn can confidently extrapolate to larger flows with stronger coagulant dosing.

5.1 Phosphate removal

Figure 4 displays confident potential for full scale application of the Fabric Media technology to enable any wastewater plant to attain a licence condition with regard to the concentration of phosphate discharged in treated effluent. Plant records report operational conditions over the November period were routine for the Craigieburn STP.

Figure 4: ***The potential for P removal from various filter types***

The Fabric Media textile applied for the tertiary filtration was appropriate for the turbidity range of Craigieburn's clarified secondary treated wastewater. If superior nutrient removal is required in other plant locations, an alternative textile with finer aperture may be considered.

5.2 Pathogen removal

The table below displays typical analysis of auto sampler composites from two Fabric Media filters operating side by side, with feed aluminium sulphate dosed to the tertiary

filter application. The results demonstrate that Fabric Media filtration will generate filtrate of low nutrient, low turbidity and low E coliform pathogen content. Coliform and Phosphate analysis was by the NATA certified laboratory.

Table 2: ***Typical analysis of sampler composites from two fabric media filters***

26 June 07, 10:00		NTU	E.coli	Reactive P	Total P
	Raw Water→	8.4	51000	1.26	1.5
Filtrate from secondary textile	No alum	2.1	41000	1.0	1.1
Filtrate from tertiary textile	With alum	0.8	160	0.10	0.15

6.0 CONCLUSIONS

The Fabric Media water filtration technology warrants serious consideration for filtration upgrades at YVW STP's as it delivers incremental improvement in treated effluent quality in comparison to older media bed filtration techniques.

The small footprint capability of the Fabric Media concept provides for an attractive installation budget with a low cost filtration alternative.

The Fabric Media technology benefits operators by providing a higher benchmark in robustness and predictable filtration performance, lower labour requirements, and reduced exposure to OH&S related risk.

7.0 ACKNOWLEDGEMENTS

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