

UTILISING THE POWER OF TECHNOLOGY TO ENHANCE OPERATIONAL MONITORING CAPABILITIES

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ABSTRACT

Timely delivery of treatment performance analyses is crucial to be able to operate treatment plants effectively and efficiently, particularly during times of process upset. These analyses are often time and labour intensive and not easily available in one place to the operations staff who need it most. Many hours, if not days, are spent extracting and collating data from numerous sources, including inline sources (e.g. SCADA flowmeters), internal tests and external laboratory results, and then manipulating it into a useable form. The process is static and must be repeated every time new data is needed.

Prompted by the current expansion of the Warrnambool Sewage Treatment Plant (STP) and the significant public scrutiny placed on the plant performance, it was suggested that a tool be developed to provide an ongoing, updateable platform where plant performance could be quickly and easily monitored. Power BI has been used to create a report to suit not only this purpose but also be expanded to monitoring all Wannon Water STPs. Several efficiencies have been achieved when the report is working properly but this hasn't been without teething issues. Flow meter change management protocols, accurate data recording and a clear understanding of the dataflows are all key requirements for the report to be an accurate and trustworthy tool.

1.0 INTRODUCTION

The desire for analytical data to be readily available and easily accessible to inform process improvement decisions is important to many industries. If the data and analysis isn't provided in a timely manner the information recorded is essentially useless except for historical analyses. With the increasing public scrutiny on water and wastewater treatment plants from both a health and environmental perspective, being able to provide reliable and robust data quickly is critical.

Finding ways to make the data analysis process more efficient is also beneficial. Time is especially of the essence when an issue occurs at a treatment plant. The data is usually required as soon as possible and yet it can take hours, if not days, to not only extract the information from numerous sources, but also collate and analyse that data into a useable form. The data provided is then static, with no quick or easy way to update it as new laboratory results or plant trends become available. While existing data can be added to, and templates can be made up based on previous extractions, the fact remains that time is wasted having to do the same steps repeatedly to obtain the information and then manipulate the analyses to incorporate it.

The Warrnambool Sewage Treatment Plant (STP) is currently undergoing a \$85 million expansion. Consultants involved in the project suggested it would be beneficial to develop a monitoring tool which could be continually updated to help facilitate commissioning of the new plant section, as well as better understand the existing plant performance. The initial suggestion was for a spreadsheet-based approach; however, this would still involve a large amount of manual extraction work which would not be particularly efficient long term.

2.0 DISCUSSION

Wannon Water collates data from various sources together to analyse treatment plant performance. This includes SCADA and/or CITECT for flowmeter, level and other online parameters, and Aquantify for internal and external laboratory results. Historically this data is exported into spreadsheets and then manually brought together before being analysed as needed. For an ongoing analysis, as required for the Warrnambool STP, the new data is intermittently extracted and then added to an existing file. The analyses are then adjusted to incorporate the new information and a new report is generated as required.

Discussions in mid-2020 about possible ways to automate some, or all, of the extraction process brought up more questions than solutions. How would the proposed spreadsheet function as more and more data was added? How often would the data be extracted and what would happen if the data was suddenly needed when the most recent extraction report hadn't been generated yet? How many hours would still be required each week to take the extracted data, add it to the spreadsheet and then adjust the analyses to incorporate the new data?

These questions showed that a spreadsheet was not going to be robust enough for the desired outcome. It would quickly become clunky, slow to load and wouldn't really make the process more efficient. A spreadsheet also would not be easily expandable to the other 17 STPs operated by Wannon Water.

2.1 Power BI: The Potential Answer to the Problem

Use of Microsoft Power BI entered the discussion. With some connections made to the Azure Data Factory (ADF), Power BI would be automatically updated at a desired frequency, complete any required calculations (or have them completed upstream in the ADF), and then be designed to create easy to read tables and charts summarising the data.

Consultants Discover EI were engaged to provide a scope for setting up the dataflows required and designing the report interface based on a provided brief. They were also engaged to provide Power BI training to Wannon Water personnel on how to design reports from scratch and enter additional data tags to existing dataflows for future expansion and other project ideas.

2.1.1 Connecting Power BI to the Data

There are a number of steps involved to end up with the required data being populated in Power BI as summarised in Figure 1. SCADA and CITECT data that have been flagged for backup are stored in the Wonderware database under their associated tag names. Aquantify data is stored separately with unique sample point and parameter numbers assigned. The Master Data Services (MDS) are used to capture information, including data display names, calculation requirements and the monitoring frequency, for each individual location and performance parameter combination required. These are called meters.

The ADF and Azure SQL connects to the data sources, conducts the complex calculations and data transformations that have been stored as SQL stored procedures and then stores the processed Wonderware and Aquantify timeseries data and MDS in Azure SQL. Power BI is then connected to a dataflow which links to the data tables in Azure SQL.

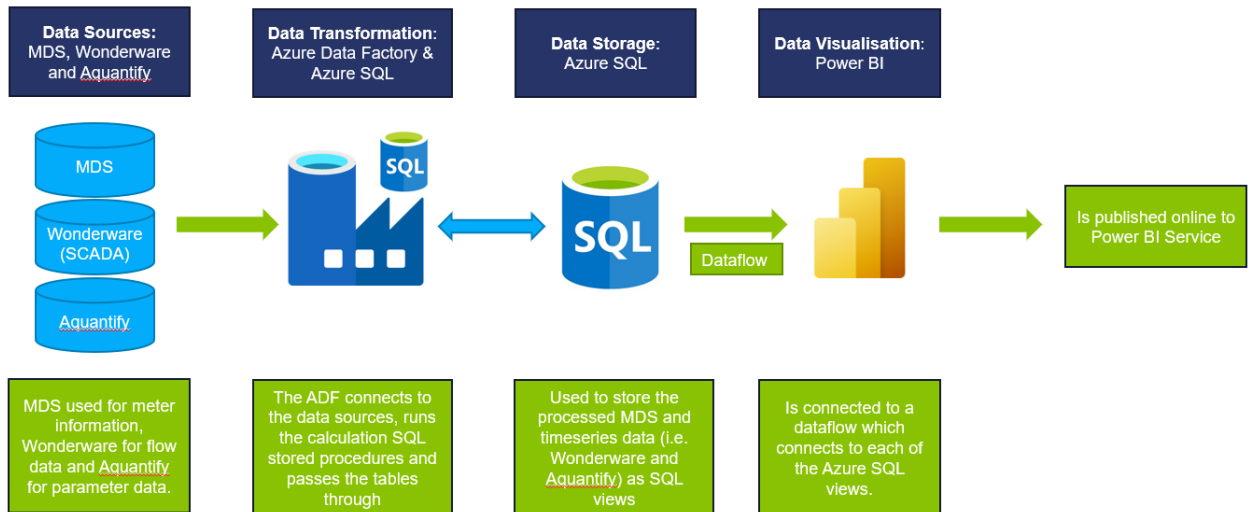


Figure 1: *STP Dashboard Dataflow*

Further data transformations are conducted in the Power Query editor in Power BI to organise datasets for modelling and visuals in the Power BI report. Simple calculations for statistics, aggregations and exceedances are also performed in Power BI.

2.2 Creating the STP Dashboard Report

The STP Dashboard consists of 10 pages which contain summary text and interactive charts and tables:

- Snapshot – Provides an overview of key plant parameters and licence compliance, highlighting parameters which are outside compliance limits.
- One Parameter – Comparison of multiple locations linked to a plant for a single parameter, e.g. comparing total nitrogen results for trade waste sites versus plant influent.
- One Location – Comparison of multiple parameters for a single location linked to a plant, e.g. all parameters for the effluent
- Any Parameter & Location – Allows for comparison of single or multiple parameters and locations to be compared, e.g. influent BOD and total nitrogen vs effluent nitrate.
- Detailed Page – Provides information on where the data is sourced from, monitoring frequency and useful statistics for each parameter and location combination at the chosen Facility
- Exceedances – Counts the number of exceedances of trade waste limits and EPA discharge licence medians and maximums. Also shows a more in depth analysis of tracking against the licence median for the chosen financial year in both table and graphical forms.
- Missing Data Points – Identifies data integrity or MDS input issues by counting any data that is missing for a specified performance parameter and location, based on the monitoring frequency stated in the MDS.
- For Checking - Missing Meters – Another way to understand missing data based on the meters created in the MDS.
- Data Sources – Provides information on where the original source data is located. Particularly useful for users of the report who don't have access to the MDS to trace back where the data is coming from, especially if there is an error in the data or the data appears to be missing
- Report Information – Provides information on the report owner, underlying data

sources and supporting information for users to understand the purpose and function of the report.

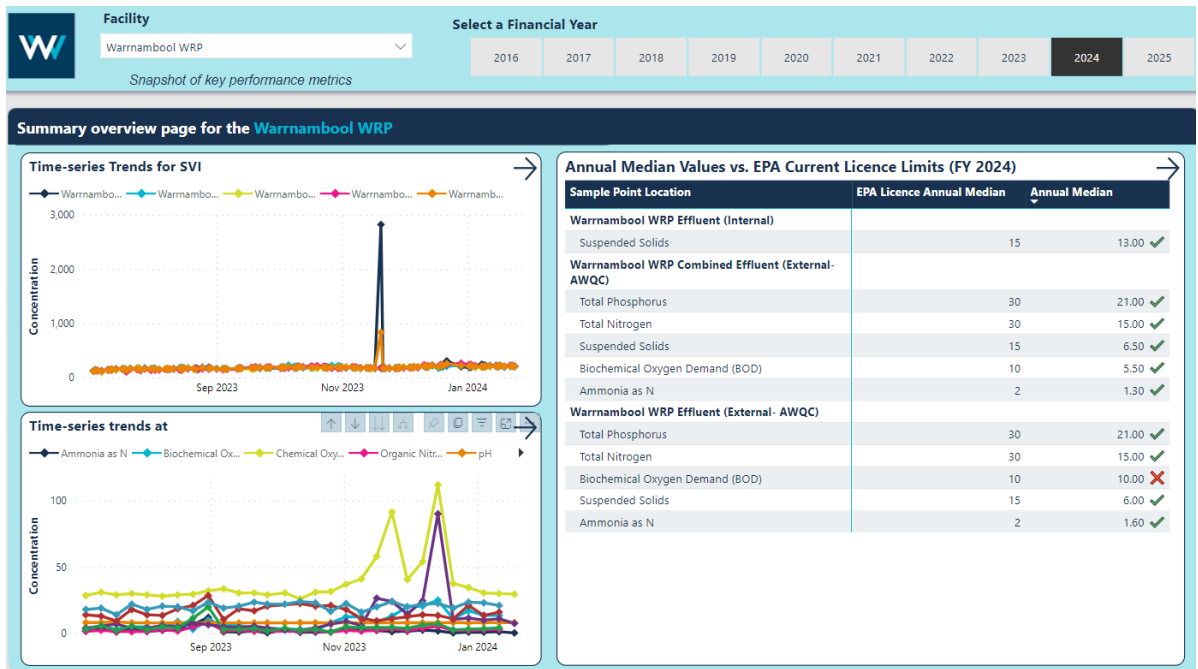


Figure 2: STP Dashboard Summary Page Example

Each page is linked to the Facility dropdown at the top left of each page – if a different facility is chosen on one page it will also change it on all the others. Most of the data can be displayed in table or chart formats and is downloadable for the specified date range.

2.3 Roadblocks Along the Way

Once the STP Dashboard pilot was finalised for the Warrnambool STP the dashboard was put into production. Data was set to update and refresh every morning at 8:30 am to include data from the previous day. For the first couple of months the dashboard worked well and provided the data needed. Work was begun to update the MDS with new meters to bring the other Wannon Water STPs into the report, one at a time. During this time the Warrnambool STP data was used to summarise regular performance checks that were conducted.

Several issues appeared when using the STP Dashboard. Some were user error related with mistakes in calculation formulas, while others were related to the data backup to Wonderware. Most of these backup issues were due to the particular data tag names not being included in the Historian system.

2.3.1 The Importance of Data Integrity and Change Management Procedures

Another significant problem identified was related to the integrity of the flowmeter data being utilised in the report. There were two issues that became apparent over time, the recording and transformation of the data from Wonderware into the dataflow pipeline for the report and changes made to the flowmeters themselves. The Wonderware issues have been a conundrum to Wannon Water data analysts as there does not appear to be a particular reason for why these issues occur or when. As an example of Wonderware data issues, there was a step change in influent volume data in mid-November 2023 as shown in Figure 3. This issue is still being investigated at the time of writing this paper. Also visible in Figure 3 is a gap in data in the first half of 2022, caused by a data backup failure which

wasn't picked up for some time.

Time-series trends at Warrnambool WRP Influent (Internal)

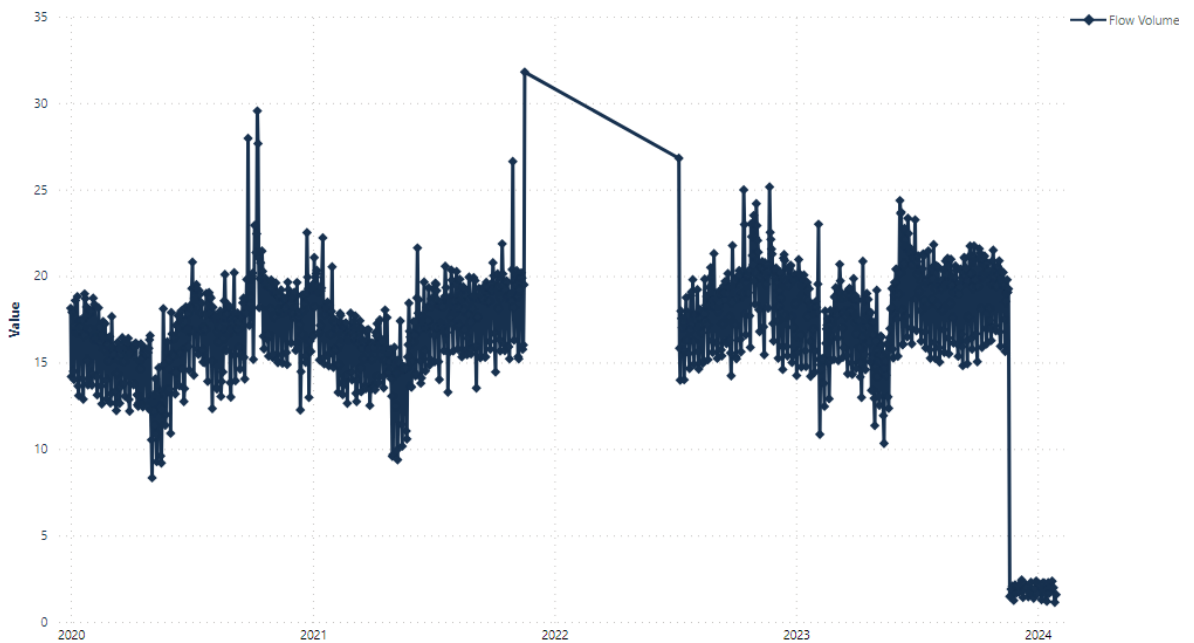


Figure 3: *Changes in Warrnambool STP Influent flow trends over time*

Until recently, if a flowmeter was repaired or replaced, the maintenance team doing the repair would not necessarily reinstate the same settings or use the same tag name. This can result in data no longer refreshing in the STP Dashboard as the tag name the MDS is looking for has ceased to exist from the changeover date. Other issues encountered involve the data coming in at a different order of magnitude to previous, e.g. coming in as ML instead of kL. In the past this had not been a problem as the name was just updated in SCADA and polling and trending continued as normal with no one linking reports to the underlying source data.

Investigation into these issues identified that there were no current change management procedures in place. This meant there was no requirement for settings to be maintained across equipment changeovers or for any unavoidable or needed changes to be communicated to stakeholders. The stakeholders themselves were also unclear as it had not been communicated effectively that the data was now being utilised in different ways to how it had been historically. For the electrical and SCADA teams suddenly things that weren't thought about before had become important.

Wannon Water is currently working through updating and implementing change management procedures which will include a section on data integrity and updating any data stakeholders on changes that have been made.

It is recommended that other water authorities looking into ways to automate data collation ensure there are robust change management and data integrity procedures in place prior to beginning the creation of reports. Having these in place first, thereby knowing the data can be trusted and utilised properly, will make the process more straightforward and minimise future problems.

2.4 The Future of the STP Dashboard

Work is ongoing to iron out the issues found with the STP Dashboard. Until these are

completed the dashboard unfortunately has limited value for the purpose it was initially designed for. With the Warrnambool STP currently experiencing operational issues due to being at capacity while awaiting the expansion to be completed, there is some urgency to fix these issues and get the dashboard working as intended.

Once the data integrity issues are resolved, the Snapshot page will be updated to provide the most useful summary parameters for each STP. The information displayed can be tailor made to suit, for example, parameters displayed for sites which discharge to the environment will be different to those which recycle water for irrigation. Having a live summary of each plant's data readily available to management will be very valuable for Wannon Water.

3.0 CONCLUSION

Despite the issues faced with the implementation of the STP Dashboard and the lack of change management procedures that have exacerbated some of the problems faced, Power BI has proven to be a very helpful tool to have in Wannon Water's operational monitoring arsenal and will continue to be utilised in the future. Once the data integrity problems are ironed out, the efficiencies made by utilising the STP Dashboard will enable more time to be spent optimising wastewater treatment plant performance and addressing process upsets and less time extracting and analysing the data. It will be especially helpful during the commissioning process of the Warrnambool STP expansion as it was initially designed for.

4.0 ACKNOWLEDGEMENTS

Christian Borovac, Alice Drummond and Daniel Marsh-Patrick from Discover EI for taking on the project and helping to get it up and running.

The Wannon Water Operations Support and Projects, Operational Monitoring and Reporting and Treatment Operations teams for all their help in pulling data source information together for the STP Dashboard MDS, providing feedback on the report interface in Power BI and being willing to embrace a new way to visual data which will hopefully make it easier to have process performance information readily available in future.

The Wannon Water SCADA and Information Services teams for their ongoing help with ironing out the issues that are still ongoing for the report.