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DIY UPGRADE OF THE MORRINSVILLE WATER TREATMENT PLANT

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1.0 INTRODUCTION

The Morrinsville Water Treatment Plant (MWTP) is situated on Waterworks Road, Kiwitahi approximately 21.5km from the Township of Morrinsville. The water treatment plant was built in 1965 and is a typical Patterson Candy plant that consisted off 3 hopper clarifiers and 3 rapid sand filters. In 1980, an additional filter was built and a further filter and clarifier was added in 1991 giving a maximum flow rate off 330m^3/hr.

The MWTP supplies treated water to the township of Morrinsville and includes Fonterra Dairy Co and Greenlea meat processing works. There is storage at the plant of 3300m^3 and another reservoir of 3400m^3 at the town outskirts. The entire reticulation system operates by gravity with a pressure reduction valve on the outskirts of town.

The operation of the plant was all manual except alum dosing that was controlled by a Stream and Current monitor (SCM). We need to carry out some automation and additional monitoring to collect data that is required for the NZDWS Compliance.

After discussions with the Asset Manager it was decided to carry out the automation of the plant in-house and calling in other expertise when required. The upgrade would include the chemical dosing, flow control, automatic backwash control of filters.

It was decided that the project would be completed in stages to ensure the project all flowed well and limited the amount of interruption to the plant operation. We had to ensure we kept the plant producing water to keep the reservoirs above 75% at all times.

The project stages were:

- Inlet flow monitoring and flow control.
- Filter outlet flow Control.
- Filter backwashing.
- Chemical dosing.
- PLC and PC.

There was an existing 375mm AC water main with a dall tube installed inline with differential pressure sensor that would give the flow with a ballcock arrangement that controlled the plant inlet flow to filter level.

It was decided that we would install a 300mm magflow with a 300mm butter fly valve in the same area as the existing dall tube with an ultra sonic sensor in the settled water channel that would control the actuator to the level that was set in the sensor. This was installed before any PLC work was carried out and worked satisfactorily with the limited amount of control that we had.

2.0 FILTER CONTROL

Filter numbers 1 to 4 are controlled manually through the old Paterson Candy controllers which needed to be replaced due to old age and wear - they wouldn't turn off 100%.

Number 5 filter (installed in 1991) was controlled by a small Honeywell controller that allowed the operator to determine a flow and the controller kept the flow rate at the set point. This filter had an 80mm butterfly valve that had an actuator and 80mm magflow to carry out the control. It was decided to control the other four filters in a similar way.

We also needed to upgrade the pressure differential head loss gauges as the plant still had the original head loss gauges. Head loss is an important part of filters control.

We investigated the area we had in the backwash channel at the plant, as well as looking at other water treatment plants outside our district to see what they had done to upgrade their filters and modules. Some plants had carried on using the existing filter modules chambers having water still running up through the module. To get the correct pipe diameters required for the magflows the pipe work and fittings have been installed into the backwash channel of adjacent filter modules.

To determine what sized magflow meter we would use, (eg 80mm or 100mm), the first step was to discuss the flow with the magflow meter suppliers. Velocities where checked and it was determined that either size were OK to use. We were concerned about not having enough area to fit the control valve and the magflow into the old filter module and queried the magflow suppliers about the impact on accuracy of the magflow if we didn't have the correct diameters before and after the meter. They advised accuracy loss was minimal (0.3-0.4%) so we proceeded with installing the flow meter and valve in the same area.

The valve control for the filter was discussed as a group as butterfly valve are known to be very hard to control as 80% of the valves work happens in the first 20% of it being open. After discussing issues with suppliers, it was decided to install "V" notch ball valves that would give us better lineal flow for control. These valves where six times the price of a butterfly valve.

Investigations at other water treatment plants using air actuators for control indicated they continually vent air making the compressor work hard. Experience with an air actuator at one of our other plants meant this was not a preferred option of the operators. Electric actuators that would be mounted on an extension shaft so the operator would be able to manually operate them outside the old filter module pit in the interim while the other stages where being completed were chosen.

To ensure what we had planned and designed would work, we trialled the setup on one filter. We purchased a set of valves, actuator, extensions, magflow and pipework and installed it into filter Number 3. We installed all the gear and pipe work as per Figure 1 below and carried out daily checks on flows. This was all manual operation with the operator setting the flow at the required filter flow rate eg 38m^3/hr.

Checks where completed on daily flows and it didn't take long to determine that we had made the right decision. It was decided that we would change the remaining 3 filters and use the existing gear that was in filter number 5.

Some of the problems we encountered while doing the filter module upgrade were:

- Limited amount of space in the existing module (865mm) meaning concrete cutting gear needed to be cut down to drill the penetration holes for the pipe work.
- Filling the old spill over weir and still keeping the plant operational.

- Confined space entry - having to go up the filter water channel to ensure bends where upright.
- Finding out that the actuator in filter 5 didn't have a 4-20mA control (this was overcome by purchasing the same as the other filters)

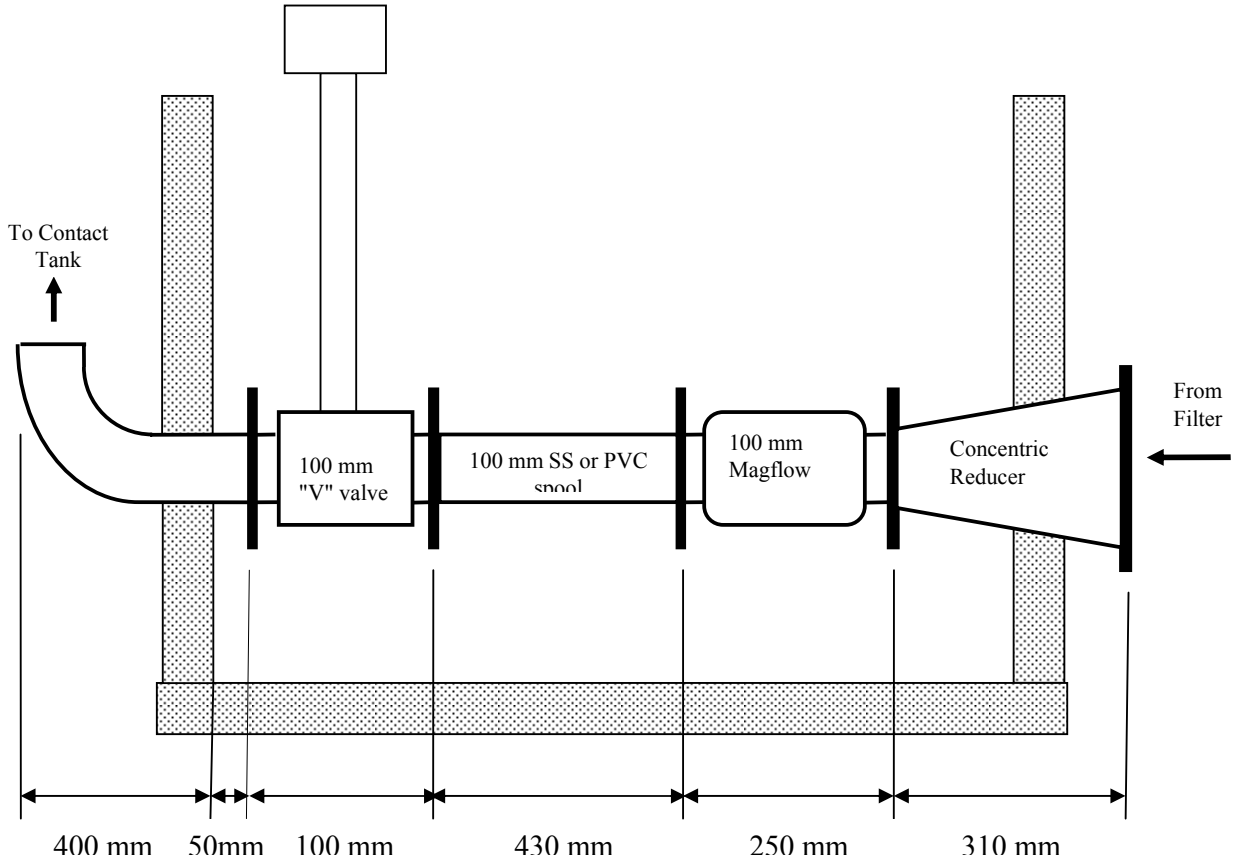

Figure 1: ***Morrinsville WTP Filter Control***

As we pre-chlorinate at the Morrinsville Water treatment plant before the filters, a lot odour that is produced by the chloramines that were in the plant filter gallery has been removed.

3.0 FILTER VALVES FOR AUTO BACKWASH

As discussed earlier, following looking at other filters that had been automated, we decided to go with V-notch valves and electric actuators. We observed that other plants didn't have valve indicators on them and the PLC was presuming the valve state was either opened/closed. To avoid future problems, valve indicators were installed on all valves including the old run to waste valves.

Investigations into the size of compressor required for the site and the likely operating pressures were necessary.

On site is a 384CFM hydro vane compressor used for aeration of the raw water storage. We investigated using some of the surplus air from this unit but found that it didn't have the required pressure to open/close the air actuators on the filters. This wasn't an option.

We looked into different types and sizes of compressors and it was decided a 33CFM would be adequate as there wasn't much price difference in going to a smaller compressor and it seemed good value for money.

We had some problems at another of our sites with air pressure failure. We decided that we would install either spring to close, or open, depending position we want the valve to be if the pressure should fail.

- Inlet valve Spring to open
- Air Scour Spring to close
- Up wash spring to close
- Run to waste spring to close.

The PLC will also look at the air pressure and valve position if they should change.

A magflow was installed on the backwash water line so we could look into back washing and flows at a later date.

Some of the problems encountered while doing the filter valves upgrade were:

- As we used lugged rather than wafer valves, we found that all the bolt hole sizes on existing cast flanges were table "D" not "E" like the lugged valves.
- Heavy lifting was a problem so we set up scaffold to lift the heavy cast old valves etc.

4.0 CHEMICAL DOSING

We reviewed the Alum, poly and lime dosing for the plant as we wanted to remove the need for the operator to fill the tanks daily.

The existing Alum solution was a 10% and was dosed with via a 105l/hr dosing pump and the operator was required to fill the tank daily in high flow situations.

The Alum dose rate is controlled by a Stream and Current monitor (SCM).

It was decided that we would dose straight Aluminium Sulphate (62%) as this would stop daily filling of the tanks

Two options were investigated:

- Option 1: Install new pipe work directly into the existing 10,000L bulk tank and dose Alum (62%) directly from the tanks after replacing the existing dosing pump.
- Option 2: Use the existing day tanks filling with straight Alum (62%) from the bulk tank and replace the existing dosing pump.

Option 2 was the chosen method.

Stroke controllers were also required on our pumps to control the pump speed on flow and stroke from the SCM.

Calculations to determine what sized pump was required at a maximum dose rate of $40g/m^3$ and a minimum of $15g/m^3$ was undertaken and suppliers were requested to supply quotations for appropriate pumps.

An 18L/hr dosing pump was purchased for the Alum with stroke adjuster and ultrasonic level indicators were also installed.

Dosing straight Alum required much better mixing at the injection point, and after investigating options, and it was decided to re-pipe the existing flash mixing pump to a new injection point in the 300mm main.

We installed a 20mm injection lance into the main coming off a 50mm "Tee". In the top of the "Tee" we installed a injection lance where the Alum entered the carry water from the old flash mixing pump.

We installed clear Polycarbonate covers over the Alum tanks to stop bugs (etc) entering the tanks and as a safety measure to stop anybody falling into the tanks.

Two day lime tanks existed on site with only one being used. The second one was being used for the mixing and dosing of polyelectrolyte.

We considered installing a 10,000L tank for lime dosing. It was decided against this as we had concerns that if there was a power failure, with no power back up on site, the lime slurry would set like concrete.

It was decided that we needed the poly tank for lime dosing so we made up an automatic poly mixing unit using two second hand dairy tanks and a dry feeder and controller supplied by others.

We looked at average dose rates for lime over the last year and decided that we would make a standard 5% lime solution at an average dose rate of $10g/m^3$. Quotations for appropriately sized pumps were sought as the existing pump was far to big (105L/hr). A 67L/hr dosing pump with stroke adjuster was purchased for the lime.

We installed the new lime pump, the tank ultrasonic and 24v valves so that when filling the tanks, the operator could walk away leaving the tank to fill. It was decided that we would install automatic changeover from tank to tank as this would mean it could change over any time throughout day.

To try and reduce lime dust, we installed a new shroud over the tanks to the existing extraction fan.

5.0 PLC AND PC AND ELECTRICAL WORK

This was an area where we required outside assistance. We contracted the service of Mes Electrical (Reni Mes). Reni is also a "B" grade operator and had a good understanding of what we required as an operator. For the Plant control computer, the new abbey system software Aspex was used and after looking around at a few different plants control screens, Control Systems (Eric Williams) developed all the display screens.

We had a number of meetings with all KVS operators working out control of the plant and what we required.

The PLC required --- inputs analog----outputs anlog ---inputs digital---- outputs digital---

- with some still going to the swamp fox.
One of the control options we had discussed was that the operator needs set points and options for the flow control. With the old control, the plant would overflow treated water back to the stream if the reservoir filled.

We decided that we would have two options.

- Option 1: Flow only control
- Option 2: Flow control on reservoir level.

6.0 CONCLUSION

This project was an enjoyable project and had a lot of input from all operators to ensure things would flow will.

It was a great way for the operators to gain an understanding of how their plant works (Finding the in's and Outs and flow limitations).

It was a cost effective project for the Matamata Piako District council rate payers.

In the short time that automation has been in place, we have saved money on chemicals and we do not have treated water overflowing back to the stream. Sometimes this was happening from the early hours in the morning and could be as high as 500m^3 per day. With the dry spell recently we need to preserve it!.

7.0 FUTURE IMPROVEMENTS

- Investigate replacement Turbidity meters for each existing turbidity meters on each filter.
- Investigate optimisation of filters backwashing to ensure we get maximum performance.
- Install a back up generator which has since been done

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