# REMOTE MONITORING TO REDUCE WASTEWATER OVERFLOWS IN OUT-OF-SIGHT PLACES

*Heather Kikkert (Hamilton City Council)*


## ABSTRACT

Wastewater overflows in heavily vegetated gullies can be out of sight and may therefore go unnoticed. As part of protecting Hamilton's waterways, Hamilton City Council wished to monitor the wastewater network in remote locations to respond before overflows occurred, preventing wastewater from manholes entering gully streams.

A six-month trial was initiated in Ranfurly Gully using Hynds Smarterwater sensors. Success factors of the trial included: prompt, accurate data in a variety of weather conditions; consistent identification of overflow risk; alert notifications to allow response before an overflow occurred; the sensors needed to be robust to withstand tampering/vandalism; and a monitoring dashboard. The trial period would allow time to test performance in different weather conditions and possibly capture either a blockage or partial blockage.

Four monitoring locations were selected along the main pipeline in Ranfurly Gully based on known previous overflows due to network blockages. The sensors were retrofitted to existing manhole lids rather than swapping out the existing lid and frame to use special Hynds lids with pre-fitted sensors. This decision was largely made due to the access difficulties that required manual handling of all materials down the steep bank, though reduced costs was also a factor.

A monitoring dashboard was created by Hamilton City Council's Information Services Team using the PowerBI online platform to pick up the cleaned data from Hynds API (Application Programming Interface). The dashboard showed a timeline of all four sensors, with the maximum level reached within the time period selected. A second page allows the sensors to be overlapped to see their interrelationships. Developing the dashboard in-house allows greater flexibility to make additions at minimal cost, plus has the flexibility to add specialized pages for interrelated sites. Emailed alert notifications were also created from the dashboard to notify the Operations Team to monitor the dashboard more closely when pre-set trigger levels were reached.

During the first rain event of the season, all the sensors responded with alerts. The level data showed two peaks that coincided with two peaks in rainfall intensity. The sensor levels and alerts provided visibility of the situation in Ranfurly Gully, without risking staff safety to visit the sites, though the wet weather reduced options to act to prevent an overflow. Throughout the trial, rainfall intensity correlated well with the level sensor data and indicated that the sensors were providing prompt, accurate readings.

During the trial, data coming back from one of the manhole sensors started to read consistently above zero, though lower than the alert levels, suggesting that a block may have been forming. Investigation discovered that this manhole had been accessed and the lid not put back in the same orientation, thus the sensor was sending false level readings. The sensors are very sensitive to orientation, which must be communicated to maintenance staff and contractors.

A blockage has yet to be detected in the line during dry weather, but the sensors have shown that they respond during high levels and alerts are sent out. The trial was considered a success.

**KEYWORDS**

**Wastewater Network Performance, Reticulation Operation, Remote Monitoring, Environmental Protection**

**PRESENTER PROFILE**

Heather Kikkert is a chartered engineer with over 14 years of experience with water and wastewater in three countries. Heather has a passion for environmentally sustainable solutions, and she currently works for the Hamilton City Council working to improve the operational efficiency of Hamilton's three-water networks.

# INTRODUCTION

As natural low points in the terrain, streams often have wastewater pipes running beside them with pump stations to lift and convey wastewater from homes and businesses further along the reticulation network to a treatment facility. When blockages or overloading occurs in a wastewater network, the wastewater will follow the path of least resistance, backing up and eventually overflowing at the lowest point in the network. This will typically be from a manhole and often this will be close to a stream or other waterway.

Hamilton City has five major streams with several tributaries that all feed into the Waikato River that flows through the centre of the city. Many of these waterways are in gullies that were too steep to build on and so remain shrouded by dense vegetation and scrub. This means few people are able to see or access the streams in certain parts of the city. Some of these gullies are owned by the City Council, but many are privately owned, creating a challenge for council staff to access council assets such as wastewater pipes.

Wastewater overflows in such locations can be out of sight and may therefore go unnoticed. As part of protecting waterways, Hamilton City Council wished to monitor the wastewater network in remote locations to respond before overflows occurred, preventing wastewater from manholes entering gully streams. This paper aims to share real world learnings with other councils, by describing the process, results, and conclusions of a trial to monitor a challenging site with remote sensors.

# BACKGROUND

## THE CHALLENGE OF WASTEWATER PIPELINES IN GULLIES

### INTRODUCTION TO HAMILTON'S WASTEWATER NETWORK

Hamilton's wastewater network is a separate system (i.e., stormwater and wastewater have separate conveyance reticulation) and there is one wastewater treatment plant in the suburb of Pukete, in the north of the city. Gravity is used wherever possible to convey the wastewater, so the wastewater network is strongly influenced by topography. With many gullies feeding into the Waikato River that flows through the centre of the city from South to North, there are a number of low points where pump stations are required to lift wastewater and convey it further along the reticulation to the treatment plant. Hamilton has more than 130 wastewater (sewerage) pumping stations (SPS), most of which are close to streams and gullies.

### THE CHALLENGE IN RANFURLY GULLY

Ranfurly Gully in the East of Hamilton is one such low point that has a wastewater pipeline running through it towards a pump station.

The earthenware pipeline in Ranfurly Gully was installed in 1983-1985 and part of the pipe has been lined with a HDPE sleeve. Using a liner as the renewal method stops water passing into/out of cracks in the pipe, but downsides are a slight capacity reduction and it retains any dips and humps that were in the existing pipeline.

Dips and humps in a pipe can cause problems as these become places were solids and fat can settle and potentially cause blockages. Due to these concerns the pipeline in Ranfurly Gully was on a six-monthly clean cycle. The routine cleaning could not be carried out during wet conditions, due to the slippery slopes causing safety concerns and so sometimes the cleaning interval is longer.

Despite this precautionary work, residents near Ranfurly Gully have called in at times to report a sewage odour. Upon investigation of the issue reported by the customer, wastewater overflows were found to occur within the gully. Ranfurly Gully is steep and covered by dense vegetation and scrub (described as "tiger country" by some Council staff), meaning that few people can see or easily access the stream. The only way Operations staff could pick up overflows was by residents notifying Council of overflows or odours, or if there was a blockage that sufficiently reduced flow at the pump station so that it would be picked up in daily monitoring of the pump station trends.

In 2020 several wet weather and dry weather overflows occurred which were reported to the Waikato Regional Council as part of routine monthly reporting practices. The repeated overflows prompted an investigation into a long-term solution to prevent overflows. The solution with the best outcome is to replace the pipe. However, optioneering, detailed design and construction means this solution is unlikely to be in place for a few years.

An interim solution was required to reduce the number of wastewater overflows to the gully stream until the long-term solution is implemented. The routine cleaning was increased to every three months and weekly visual inspections were started. However, weekly checks meant that an overflow could occur immediately following the inspection and not be picked up until the following week. An automated solution was desired to improve safety, gain increased visibility and allow for a quicker response to reduce and prevent overflows.

# DISCUSSION

## REMOTE MONITORING - CHALLENGES AND CHOICES

The effectiveness of the monitoring equipment needed to be trialed over an extended period of time to test performance in dry and wet weather conditions and, if possible, capture either a blockage or partial blockage. This would allow the Operations Team to determine how effective the equipment and set-up was at showing high levels and increased risk of overflow.

For safety, staff conducted weekly site walkovers in pairs which placed demand on staff time. Plus, Ranfurly Gully is privately owned which required permission and notification prior to site visits, reducing flexibility around timing. Given the duration of the interim solution, the monitoring process needed to change to reduce demand on staff time and reliably provide more frequent information.

Automated, remote monitoring sensors is the proposed solution. The sensors will need to be able to cope with overhead vegetation (potentially blocking signals), be self-powered, robust, and resistant to vandalism.

Success factors of the trial include: The data needs to be received promptly (i.e., close to live) and provide accurate level measurements in a variety of dry and wet weather conditions. The level measurements need to consistently identify the overflow risk through alert notifications. The team will monitor these alerts and actively respond when required. Alert notifications need to be sent and received so that the team can respond before the level is critical (i.e., before an overflow occurs). The sensors need to be robust, withstand outdoor conditions and any potential tampering/vandalism. Lastly, a monitoring dashboard needs to allow for accurate, remote monitoring of Ranfurly Gully to prevent overflows in this area and reduce the need for walkovers.

Hamilton City Council started working with Hynds to trial their new Smarterwater manhole sensors. These sensors were trialed for a six-month period to see whether they met the success factors desired. The aim was to be able to respond before an overflow occurred by utilising alerts when surcharging in the manhole reached pre-set trigger levels.

The monitoring locations were selected based on known previous overflows, all of which were due to network blockages. Four locations were selected along the main pipeline (*Figure 1*), based on the chance that a drop or increase in level would be picked up. Once the hydraulic interaction between the selected locations was better understood, the number of sensors would be reduced. The removed sensors would then be redeployed and reinitiated to monitor elsewhere.

*Figure 1: Ranfurly Gully showing location of wastewater network and monitored manholes*


Signal strength for the Smarterwater sensors was initially determined a desktop assessment by Hynds. All sites considered were determined to have reasonable signal strength that could be confirmed on site before installation.

## REDUCING RISK BY UNDERSTANDING LEVELS OF EXPLOSIVE GASES

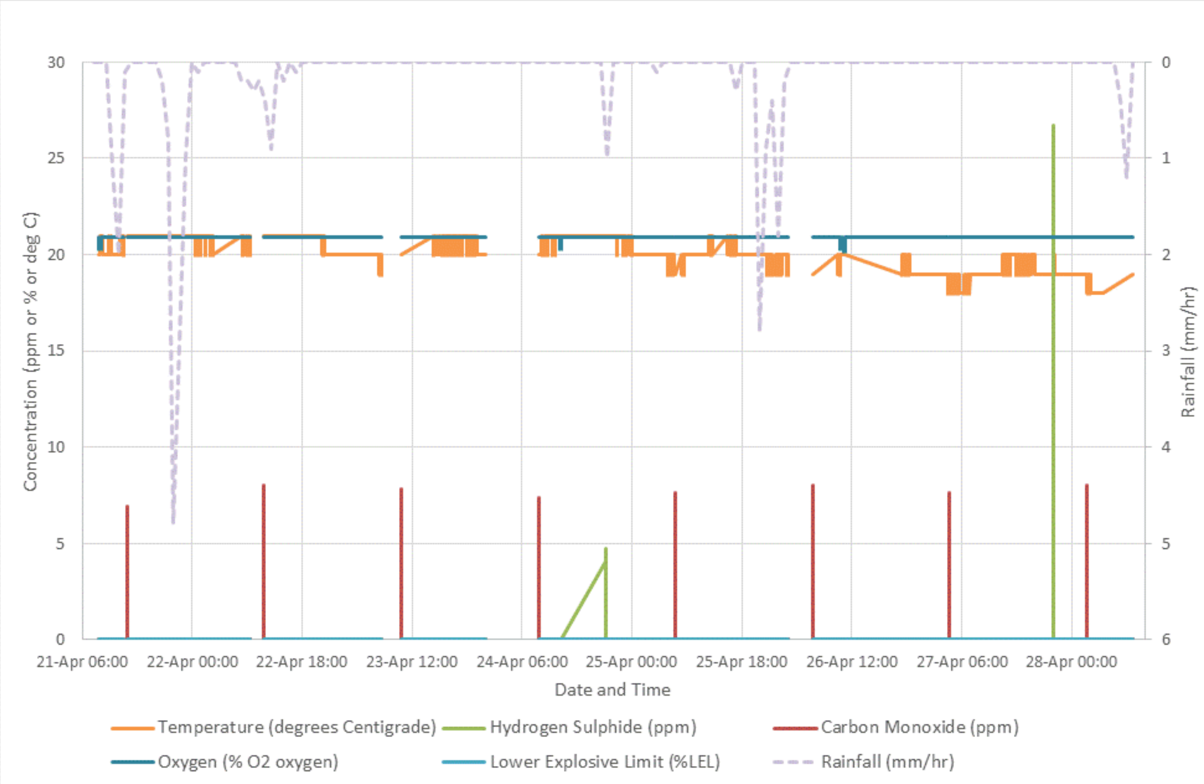
The prototype of the Smartwater sensor had not passed certification tests to confirm safety when working in an environment with potentially explosive gases. This was a major concern for the Health, Safety and Risk Team. Therefore, as a precaution, gas monitoring was carried out at each end of Ranfurly Gully.

Initially, spot readings were taken by lowering a gas monitor into each manhole. The spot readings found no detectable hazardous gases. Given the high level of the hazard – a potentially destructive explosion - further gas monitoring was undertaken. For a week, levels of hydrogen sulphide, carbon monoxide and oxygen, the Lower Explosive Limit (LEL) and temperature were measured using a gas detector at a 10-minute interval. Logging frequency increases when gas levels rise above a set level. A week was chosen to get an indication of whether there was any variation in gas levels over the day or over different days of the week. The gravity-fed wastewater catchment is largely residential, with a handful of commercial properties, so weekend variations were possible.

The gas measurements showed no obvious changes over the weekend (23 and 24 April 2022), with the exception of a spike in hydrogen sulphide (*Figure 2*). The maximum reading was 4.7 ppm. Levels of 5 ppm are considered low.

A larger spike in hydrogen sulphide was observed on 27 April, peaking at 21:00 at 26.7 ppm (*Figure 2*). The hydrogen sulphide level rose from 5 ppm to 26.7 ppm in 1 minute and dropped back to 4.1 ppm over 4 minutes. The cause of this spike to medium levels is unknown and is assumed to be something passing along the pipe.

*Figure 2: Gas monitoring at a wastewater manhole in Ranfurly Gully over a week*




The gas logging also indicated a cycle of carbon monoxide spikes at fairly regular intervals, with the peak level observed at a low 8.0 ppm (*Figure 2*). The cause of these spikes is unknown.

Rainfall was plotted to compare with the gas levels, in case this was the cause of spikes in gas concentrations. As shown in *Figure 2*, rainfall did not seem to impact the gas levels.

The gas logging was also undertaken at a wastewater manhole that had a constructed overflow to the stormwater network as these locations are considered potential monitoring sites for the future. This location was assumed to have lower chance of explosive gases due to the ventilation from the connection to the stormwater network. Results from this location were also logged over a week in 10-minute intervals. The results showed the same regular spikes in carbon monoxide, with maximum levels of 6.5 ppm, and all other levels were low. Hydrogen sulphide stayed at 0 ppm throughout the monitoring period, however note that this location was at the head of the wastewater line and therefore would not have old or potentially septic sewage passing through it.

The gas logging determined that the risk of explosive gases in Ranfurly Gully pipeline was very low under normal operating conditions and gave the Health, Safety and Risk Team at Council confidence to approve the trial, even though the prototype sensors were not certified as intrinsically safe.

## SITE SCOPING TO PREPARE FOR INSTALLATION

Hamilton City Council decided to retrofit the sensors to existing manhole lids rather than swapping out the existing lid and frame to use Hynds specially made manhole lids that are pre-fitted with the sensors. This decision was largely made due to the access difficulties that required manual handling of all materials down the steep bank, though reduced costs was also a factor. Retrofitting the manhole lids meant that a battery-powered, heavy-duty drill and drill bit were required to drill through the 5-10 mm thick cast iron lids. Therefore, a preliminary survey was required to understand whether the sensors would fit under the existing lids to confirm whether this was a viable option. The preliminary survey would also inform whether a battery-powered grinder would be required to smooth any large lumps on the top of the manhole lid so the aerial would sit flat.

To prepare for the installation, the potential sites were scoped (including a couple of extras, in case some locations were unsuitable). Site scoping including checking the manhole lids. This included the surface texture so the sensor would sit flat and the webbing under the manhole to ensure the sensor would fit. Even though each lid checked was different, the sensor was able to fit between the webbing. Refer to *Figure 3* and *Figure 4* for photos from the preliminary site survey of two of the manhole lids with the sensor located between the webbing.

*Figure 3: Example 1 from preliminary site survey: photos showing, from left to right, alignment of channel, sensor placement, manhole surface*

*Figure 4: Example 2 from preliminary site survey: photos showing, from left to right, alignment of channel, sensor placement, manhole surface*

At each site the alignment of the channel under the lid was also checked (e.g. central versus off-set, see *Figure 3* and *Figure 4* for examples) to determine whether it may be possible to measure water level within the channel in addition to measurements of the water level when the level rises above the benching. Any incoming connections were also noted in case these interfered with the reading.

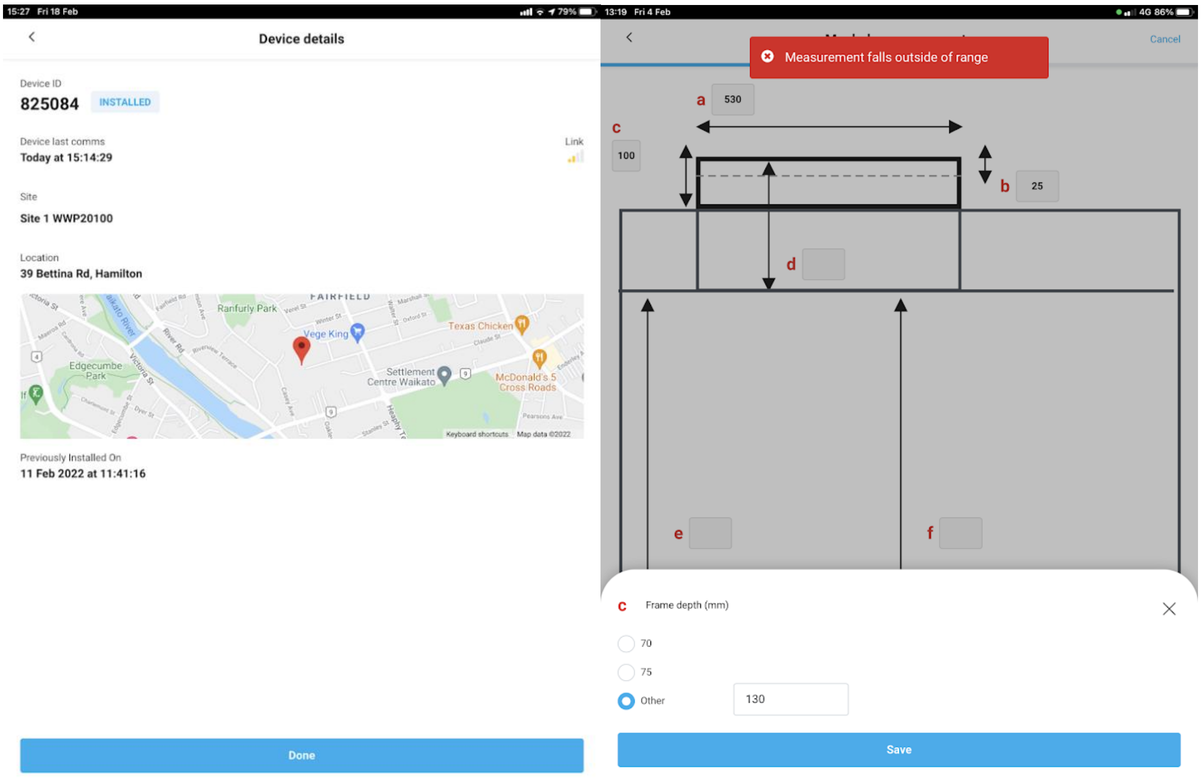
With site preliminary scoping and checks completed, four monitoring locations were selected for installation of the manhole level sensors.

## SENSOR INSTALLATION AND SET-UP

On 4 February 2022 the sensors were installed. An intrinsically safe version for wastewater applications had been developed by this time, although still uncertified, and this was installed for the trial. The signal strength was confirmed onsite by Hynds during installation.

Each sensor was set-up using a prototype app. The app stepped through set-up of the devices, prompting the user for data required to set-up the device, such as depths (see *Figure 5* for screenshots). This data was forwarded to Hynds to complete the device setup remotely. At the time of installation, the app was only available for Apple devices. The app was easy to use, and the feedback staff provided was able to feed into further development of the app, such as Android capability.

*Figure 5: Two screenshots from the Hynds Aquanect installation app*




The manhole lids and frames were marked with blue spray paint to denote the correct orientation of the lid within the frame (refer to *Figure 6* and *Figure 13*). The correct alignment is essential as the sensor learns the shape of the manhole chamber and uses this to measure when the level is rising in the chamber. If the manhole lid is rotated, the sensor loses its benchmark bearings and resulting in false readings.

*Figure 6: Manhole with sensor installed and staff preparing to mark manhole alignment. Note uneven terrain and dense vegetation in the background.*

## CREATION OF A MONITORING DASHBOARD

While Hynds did offer a dashboard product to complement their sensors, Hamilton City Council chose to go with an in-house dashboard created by their Information Services Team. The sensor devices sent data to Hynds, which was analysed automatically and cleaned data sent out via an API (Application Programming Interface). The data received was the device number, time stamp, and level reading.

Because the dashboard needed to display live data, the PowerBI online platform was used rather than the desktop version of PowerBI. This created some limitations in what was possible, for example the choices for visual displays were limited and the customization of those available was much reduced. This makes the dashboard look less professional than the reports that team was used to producing. However, the key parameters were able to be displayed in a way that the Operations Team could quickly interpret what was happening, so the dashboard met the key criteria.

Another challenge with the online PowerBI platform is that the Information Services Team manage a subscription to this platform. When the subscription lapsed, the dashboard dropped offline and the Operations Team lost visibility of the sensor data. Given the importance of this monitoring work, losing visibility is not acceptable. The Information Services Team are working to improve their processes to ensure this doesn't happen again.

The dashboard showed a timeline of all four sensors, with the maximum level reached within the time period selected (*Figure 7*). A second page allows the sensors to be overlapped to see their interrelationships more easily (*Figure 8*). If more locations were monitored in the future, the dashboard can be easily amended at minimal cost to show further sites, plus has the flexibility to add specialized pages for interrelated sites.

*Figure 7: Screenshot of the monitoring dashboard main page showing the four trial sensors*

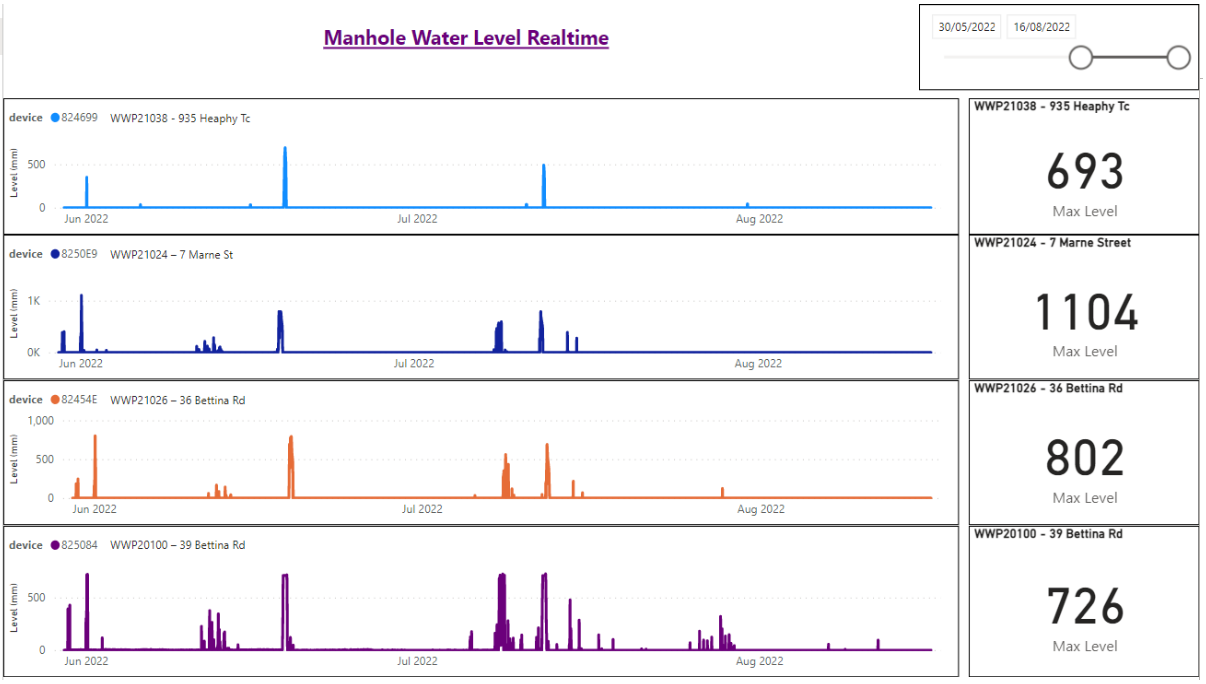
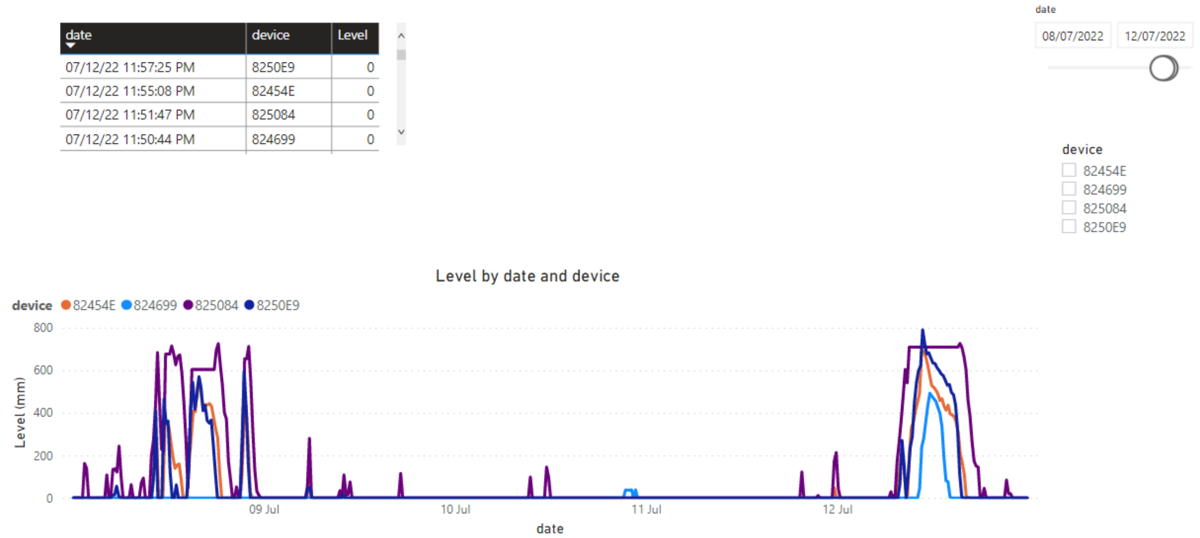



*Figure 8: Screenshot of the monitoring dashboard with sites in Ranfurly Gully overlapped and a summary table of the last call-in within the period*




The City Waters Unit at Hamilton City Council manages a number of rain gauges across the city, six of which return data via an API, meaning this data could be added directly into the dashboard. It was decided not to incorporate rainfall into the dashboard at that time, leaving the dashboard to focus on manhole levels. Manhole levels could be compared with rainfall later in other software to analyze the impact of rainfall intensity.

The data can be easily exported from the dashboard into Excel to perform further analyses.  This allows rainfall to be compared and levels to be extrapolated to other locations using relative elevations.

### ALERTS AND ALARMS

Alarms were generated from the online PowerBI platform as emails. These emailed alarm alerts were then automatically forwarded from the person in the Information Services Team who created the dashboard to the Operations Team using automated rules in Microsoft Outlook (*Figure 9*). The email listed the site, the current level value, and the threshold that it had passed. A link to the dashboard was also included in the email to provide quick, easy access to investigate further.

*Figure 9: Example of an alert email showing key site information and a highlighted yellow link to the dashboard*

**From:** Microsoft Power BI <no-reply-powerbi@microsoft.com>
**Sent:** Monday, 11 July 2022 3:48:07 pm (UTC-08:00) Pacific Time (US & Canada)
**To:** [redacted]
**Subject:** WWP21024 - 7 Marne Street - ALERT

Microsoft **Power BI**

**WWP21024 - 7 Marne Street - ALERT**

- Dashboard: SmartWaterSensor_Alerts
- Measure: WWP21024 - 7 Marne Street - ALERT
- Current value: 790
- Threshold: 749

**Go to dashboard >**

Alert levels were set at 'rising' and high for each manhole. The levels were set independently for each manhole. Each manhole has a similar depth; therefore the trigger levels were set as the same for each for simplicity. The rising trigger level is at 750 mm and the high trigger level is 1000 mm. Each of the four manholes monitored is approximately 1400 mm deep and this would be the level at which they would overflow. Thus, if colour coding was to be used, less than 750 mm was considered 'green', less than 1000 mm was considered 'amber' and greater than 1000 mm was considered 'red'.

The automated alerts are intended to prompt monitoring by the Operations Team. The dashboard and alerts cannot recognize short spikes. As soon as the sensor reading reaches the trigger level, an alert will be sent irrespective of what the readings are immediately following the trigger level.

Alerts in the online PowerBI platform were restricted to one per hour. This had the advantage of reduced nuisance alerts, but also meant that Operations Engineers needed to monitor the situation after the first alert email was received to determine how quickly the level was rising and the cause of action. If the level was still above the alert trigger levels after one hour, then another email would be sent. Each site generates alerts independently.

## RUNNING THE TRIAL

After installation, Hamilton City Council realized that the Smarterwater sensors measure the level of water above the manhole benching. Thus, it was not possible to see whether an upstream blockage had reduced or stopped the flow at the monitored manhole. Given the focus of the trial was to reduce overflows, only knowing when the level was rising was deemed acceptable.

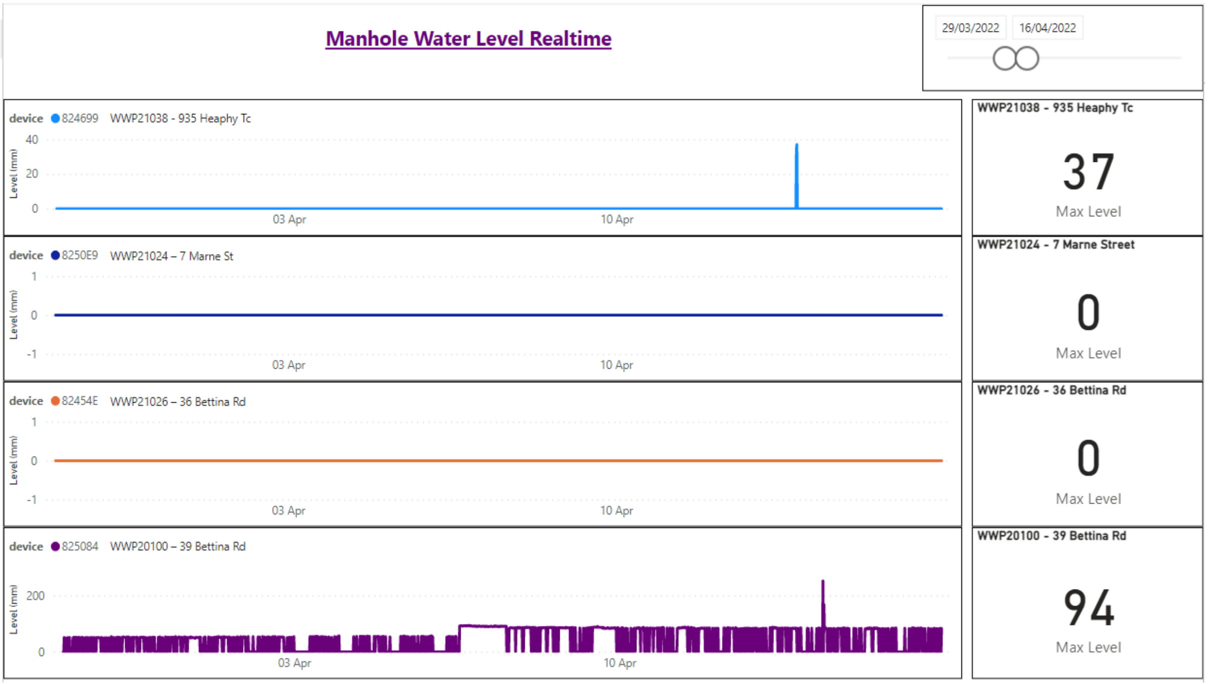
The dry summer of 2021-2022 meant that initially the new dashboard showed a flat line of zero level. This caused some people to wonder whether the sensors were in fact reading at all. To alleviate that fear, the dashboard showed the date and time of the last call in for each sensor (*Figure 8*), showing that they were calling in every 15 minutes as programmed.

During the first rain event of the season, all the sensors responded with alerts. This gave confidence that the sensors and alert system were working. The level data showed two peaks that coincided with two peaks in rainfall intensity (*Figure 11*). The manhole level data suggested that two would have been close to overflowing. Unfortunately, during heavy rain there is little that could be done to prevent an overflow in Ranfurly Gully as there is nowhere for the wastewater to go, plus access is dangerous during wet weather due to the slippery banks of the gully. The sensor levels and alerts provided visibility of the situation in Ranfurly Gully, without risking staff safety, though wet weather reduced options to act to prevent an overflow.

After seeing the sensors respond, it was noted that the sensor in the furthest downstream manhole seemed to show a flat maximum level, much lower than expected (*Figure 11* purple line). The data shows that the sensor read the same value each time it called in and the flat line was genuine readings rather than a gap in the data. It was speculated that the downstream levels were causing this level to back up but stay steady. It could also be that this manhole is slightly shallower than the others (perhaps an error in the depth measurement recorded) and the level reaches the sensor blanking distance, where the level is so close to the sensor it cannot read any higher. The blanking theory is speculative, as *Figure 8* shows that the flatline occurs at different levels, adding greater weight to the impact of some downstream factor.

During the trial, data coming back from one of the manhole sensors started to read consistently above zero (*Figure 10*), though lower than the alert levels, suggesting that a block may have been forming. Investigation discovered that the programmed cleaning work had been started without approval from the Operations Team and this manhole had been accessed. The newly appointed contractor was still learning the correct procedures and had bypassed the opportunity for the Operations Team to inform them of hazards or monitoring equipment in the vicinity of their work. The manhole had not been put back in the exact same orientation, causing the false readings. This prompted the Operations Team to contact all internal and external contractors to proactively inform/remind them about these sensors.

*Figure 10: Screenshot of the monitoring dashboard showing false high readings at 39 Bettina Rd manhole (purple) due to incorrect sensor orientation*



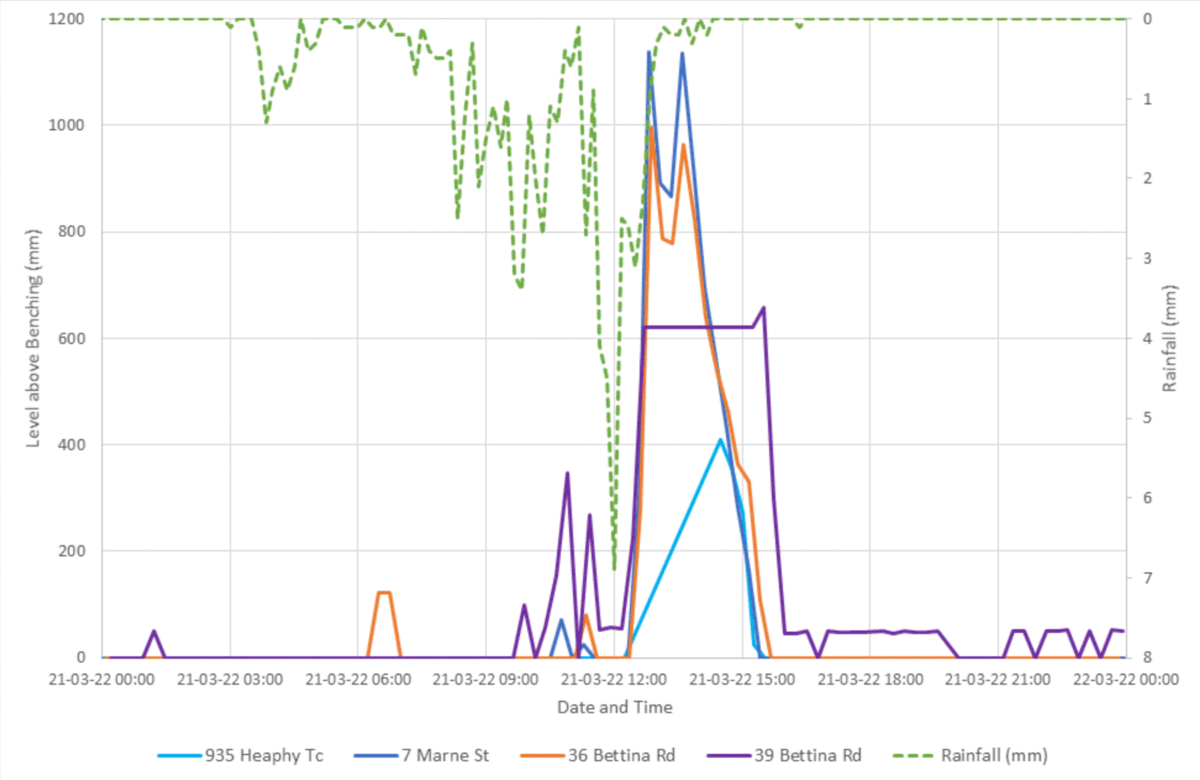

## RESULTS FROM THE TRIAL

There were at least three major rain events during the trial, which gave a good response from the sensors. Rainfall intensity has been compared with the response of the level sensors and shows level in the manholes rises approximately one-hour after peaks in rainfall intensity (*Figure 11*). This indicates that the sensors are providing prompt, accurate readings and has provided confidence in the accuracy of the sensors and the alert system.

Receiving prompt data throughout the heavy rain events proved that the sensors could sent data reliably through vegetation and the signal was not impacted by heavy rain, as radio waves can be.

The close correlation between high rainfall intensity and the wastewater level rising indicates an issue with stormwater inflow in this catchment. This was previously unknown, though suspected. Therefore, the sensors can be used to monitor the impact of future inflow and infiltration reduction work in this catchment. Such reduction work can provide a way to reduce wet weather overflows. This is considered to be an unexpected positive outcome of the trial.

*Figure 11: Manhole level compared with rainfall intensity, showing an hour between a change in rainfall intensity to a change in wastewater level*

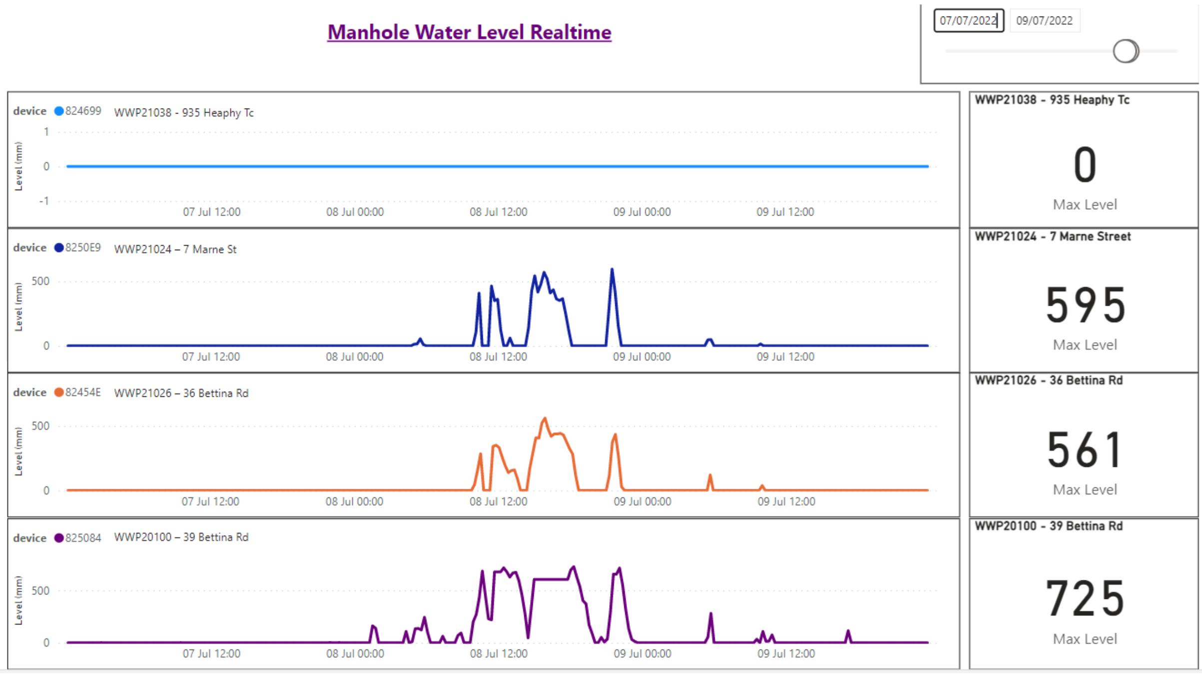



Rising levels are yet to be seen during dry weather. The increased frequency of the routine cleaning has reduced the likelihood of a dry weather overflow caused by a blockage. However, the sensors have responded well under wet weather conditions, which gives confidence that they are reading correctly and should detect rising levels in dry weather.

## AN OVERFLOW MISSED BY THE SENSORS

On 9 July 2022, a customer reported that a manhole in the gully behind 7 Marne Street was overflowing during wet weather. This manhole is two manholes upstream from the closest monitored site, yet the dashboard did not indicate an overflow or a concerning high level. *Figure 12* shows the dashboard on that day, with all levels below 750 mm, indicating that the situation was 'green' and not being closely monitored.

*Figure 12: Monitoring dashboard readings during a wet day when an overflow was reported in the gully behind 7 Marne Street. Note overflow levels are greater than 1200 mm.*




Field staff were deployed in response to the customer notification to assess the situation and clean up the overflow. They confirmed an overflow at this manhole and another nearby. They also noted a hole in the ground immediately upstream of the reported manhole, with a broken wastewater pipe underneath. A repair was carried out as soon as weather allowed.

Review of relative manhole elevations suggests that a high level at the overflow location should have been picked up at the monitoring manhole downstream. However, this hole may have been the reason that a high level was not detected, as wastewater was escaping from the network and preventing the level from building up.

While the sensors failed to alert the Operations Team to the overflow, this was not a failing of the sensors, but showed the limitations of remote monitoring.

## LEARNINGS FROM THE TRIAL

The Hynds Smarterwater sensors were relatively easy to install, were EX-rated (though not certified) to reduce explosive risks, lightweight, and easy to manage. The sensors came in recyclable cardboard and paper packaging that reduces the negative environmental impact.

The sensors were robust and should be resilient to vandalism due to minimal equipment above ground. Based on the good correlation between the levels and rainfall intensity, the data reliably sent through overhead vegetation and heavy rain.

The trial showed that the sensors are very sensitive to orientation. The data sent back can become false if the manhole lid containing the sensor is not put back in the exact same orientation. To prevent future issues with this, maintenance staff and contractors that may work in this area have been provided with information about the location of the sensors, what they look like, and the need to orientate the manhole lid according to markings on the lid and frame (*Figure 13*). Future reminders may need to be sent to cover changes in staff and ensure the integrity of data collection.

*Figure 13: Image sent to contractors to explain sensors and to request the correct alignment is maintained*


The dry summer of 2021-2022 meant that initially the new dashboard showed a flat line of zero level, causing some people to wonder whether the sensors and dashboard were working. The history of dry weather overflows meant that there was concern that something could be being missed. While wet weather proved the sensors and alert system were working, a function to test the unit by forcing the device to communicate may have alleviated this initial fear.

The sensors do not measure level in the channel and therefore can't capture a blockage upstream reducing the level or flow. This may reduce monitoring location options if the aim is to measure overflows during dry weather. Hynds Smarterwater staff have indicated that this may be possible, but the quality of the data received is lower.

The blanking distance of the sensor means that they cannot be reliably used to estimate the volume of a wastewater overflow. While desired, determining the volume was not required from this project.

A blockage has yet to be detected in the line during dry weather, but the sensors have shown that they respond during high levels and alerts are sent to prompt Operations Engineers to monitor the manholes more closely and prepare to respond to prevent an overflow.

## NEXT STEPS TO REDUCE OVERFLOWS

The trial was considered successful, and more sensors have been purchased to install in locations where historic constructed overflow pipes that connect to the stormwater network cannot be safely removed. The new sensors will provide visibility and evidence about whether these locations actually overflow. This information may be used to help inform future discharge consent requirements.

Hamilton City Council is also looking to trial a simpler sensor that produces a yes/no signal when a certain level is reached. These sensors are more suitable for monitoring areas without vehicle traffic and will provide an alternative monitoring method where details on the change in level are not required.

The Operations Team is considering options to integrate the monitoring dashboard into the SCADA system to improve the alarm function and reduce the number of computer applications needed to remotely monitor the wastewater network.

As previously mentioned, the Smarterwater sensors measure the level of water above the manhole benching and do not record the level in the channel. Hamilton City Council is considering a future trial where the specific shape of the manhole and location of the channel would allow the sensor to be adjusted to measure the level in the channel. Hynds Smarterwater staff say that there is more noise in the signal as the water level is less distinct in the view of the sensor, but that this should be possible at some of the monitoring sites.

# CONCLUSIONS

The trial of the Hynds Smarterwater sensors in Ranfurly Gully was considered successful. The sensors were relatively easy to install, sent data reliably through overhead vegetation, and the data showed good correlation with rainfall intensity suggesting the readings are prompt and accurate. As the sensors have minimal equipment above ground, they are less prone to vandalism; though they are very sensitive to orientation and the manhole lid must be returned to the exact same orientation.

The in-house dashboard using PowerBI online gave Hamilton City Council flexibility in what was displayed and for future development. This tool is checked daily by the Operations Team and used by council staff who liaise with the Waikato Regional Council. The data can be easily exported from the dashboard to perform further analyses, such as comparison with rainfall intensity. Alert emails are sent when trigger levels are reached, informing the Operations Team to start actively monitoring the dashboard.

A blockage has yet to be detected in the line during dry weather, but the sensors have shown that they respond during high levels and alerts are sent to prompt Operations Engineers to monitor the manholes more closely and prepare to respond to prevent an overflow.

More sensors have been purchased to install in locations where historic constructed overflows to the stormwater network cannot be safely removed. Wastewater overflows in such locations are out of sight, much like gullies, and may therefore go unnoticed. Greater visibility of what is happening in the network will allow the Operations Team to respond promptly to prevent or minimise overflows in the future.


## ACKNOWLEDGEMENTS

The author wishes to acknowledge the following people: Chris Miller from Hynds Smarterwater for working with Hamilton City Council to trial and develop the sensors; colleague Nick Young who oversaw the project to improve monitoring in Ranfurly Gully; colleagues Kin Chan and Vaughan Anderson who oversaw the smooth installation and the initial set-up of the trial sensors; colleague Daniel Hishon who provided a sounding board during preparation of this paper; and Gustaaf Kikkert for his patience and ongoing support.