AN OPERATIONAL DASHBOARD FOR REAL-TIME STORMWATER OPERATIONS

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ABSTRACT

What if we knew, in real time, where flood related incidents were occurring, what was causing them, who was attending to them and what rainfall was approaching. Putting the customer at the heart of what Healthy Waters does identified a need to integrate several high value data streams into a single operational dashboard to support on call operational team(s) with actionable insights of real-time events.

Leveraging the existing Storm-I platform a real-time business intelligence dashboard was developed which integrated request for service (RFS) data direct from the call centre, real time rain and flow monitoring data, contractor (or first response) assignments, RFS status and future rainfall forecasts.

Assimilating RFS location and issue types with actual rainfall totals across the region allows operational teams to quickly understand the current scale and scope of flooding related issues during an event. In addition, access to short term rainfall forecasts, computed from advanced rainfall radar nowcasting analytics, allows event management teams the ability to see the unseen and better focus resources to where they might be needed next. This additional insight helps event managers facilitate response activities to ensure customers safety and wellbeing is prioritised and storm water services are delivered to the highest level.

The dashboard is geospatial first, providing a heat map style visualisation on a regional basis but the dashboard also includes custom analytics and summary statistics for the region and surfaces key performance indicators of the first response teams to the on call operational coordinator during the event. Hosted in Storm-I, a fully web-based application, allows the information to easily be disseminated to all stakeholders during the event. Healthy Waters is also looking to connect the dashboard with other emergency response organisations such as the fire department and civil defence to enable a richer view as the event unfolds.

In addition to real time data visualisation, event management statistics and future rainfall predictions the dashboard allows authenticated users full access to historic data so detailed retrospective event analysis and reporting can be undertaken. The dashboard has driven the time commitment, and subsequent cost, of post event reporting down from 1 day to 10 min and includes a richer

set of insights for all stakeholders to communicate the story to customers and their representatives.

Understanding historic incidents also provides insight into the future. Having a single consolidated data environment with all relevant data allows Healthy Waters to start exploring statistics and correlation in the data using modern machine learning techniques to help identify hot spots and prioritise maintenance work with the aim of transitioning from reactive response towards flood prevention.

KEYWORDS

REQUEST FOR SERVICE, RAIN-RADAR, FLOODING, FORECASTING

PRESENTER PROFILE

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Alex Osti is Mott MacDonald's Business Manager – Smart Infrastructure and leads a team of programmers and data scientists delivering insights to clients across NZ's water sector. He is a member of Water NZ's Smart Water Interest Group and represents that group on the Technical Committee for Water NZ.

1 WHAT IF WE KNEW?

The Lifecycle Management Team (LMT) of Auckland Council's Healthy Waters (HW) Department are responsible for the maintenance and operation of Auckland's stormwater infrastructure comprising 6000km of pipelines; 145,000 manholes, 115,000 catchpits and more than 900 stormwater detention and treatment facilities. This responsibility includes responding to flood-related requests for service (RFSs) from Auckland residents raised through the Council's online, phone or social media channels.

In 2018 there were over 9,000 stormwater related RFSs raised across Auckland that LMT responded to, consolidated through its four operational zones in greater Auckland. These RFSs tended to be clustered in space and time, localised responses to localised phenomena that are difficult to predict and understand in real-time. The inability to predict and understand the storms that were driving RFSs meant that any action taken was by necessity responsive and potentially suboptimal in terms of response time and ultimate customer outcome.

In order to achieve the best possible outcome for the customer, LMT needed to know, in-real time, where flood related incidents were occurring, what was causing them, who was attending to them and what rainfall was approaching.

An opportunity was identified to deliver better outcomes for residents of Auckland by leveraging HW's development of the Storm-I platform to combine world-leading stormwater management information (see, e.g. Sutherland-Stacey et al., 2017; 18; Brown & Schollum, 2018; Couper et al., 2019) with RFS specific data streams to deliver insights across three time horizons:

1. Observed: An event (storm or series of storms) or specific time window (week, month, year, etc) for retrospective event analysis or reporting.
2. Real-time: Tracking a live event to provide on-call teams with actionable insights.
3. Predicted: Forecast rainfall, informed by relationships between RFS type/count and rainfall observed from historic record to transition from reactive response towards proactive maintenance and flood prevention.

Through integrating RFS data, real-time rain and flow monitoring data, contractor (or first response) assignments, RFS status and future rainfall forecasts in the Storm-I platform, it was possible to construct an operational dashboard that delivers actionable real-time business intelligence to the Lifecycle Management Team.

2 THE PORTAL

The Operational Dashboard consists of a proprietary web-based geographic information system (GIS) portal and embedded Microsoft PowerBI dashboard. The GIS portal is built on Mott MacDonald's MOATA, the engine that drives Storm-I and SafeSwim (e.g. Neale et al., 2018). MOATA is designed to be as user friendly as possible from the outset and does not require users to have expensive GIS software licenses, only an internet browser and reasonable internet connection. It was important to the LMT that the dashboard be accessible on any device in any location as successful real-time decision making tends to be distributed and as close to the action as possible. The dashboard has the same functionality when viewed on a tablet in a maintenance vehicle or on a mobile device on the side of the road as on a dedicated machine in an office environment.

Functionality of the portal has been designed in consultation with HW team members. For a given time horizon, customisable through a date picker, the Operational Dashboard portal is set up to display:

- Monitoring information: including active and inactive rain, level and flow gauges.
- RFS information: Clustering is represented by a heat map style hex grid, with a colour ramp corresponding to RFS density within a grid cell (Figure 1).
- Auckland Council asset information: including street numbers, manhole and chambers, stormwater assets and waterways.
- Radar information: including depth grids and play-back functionality

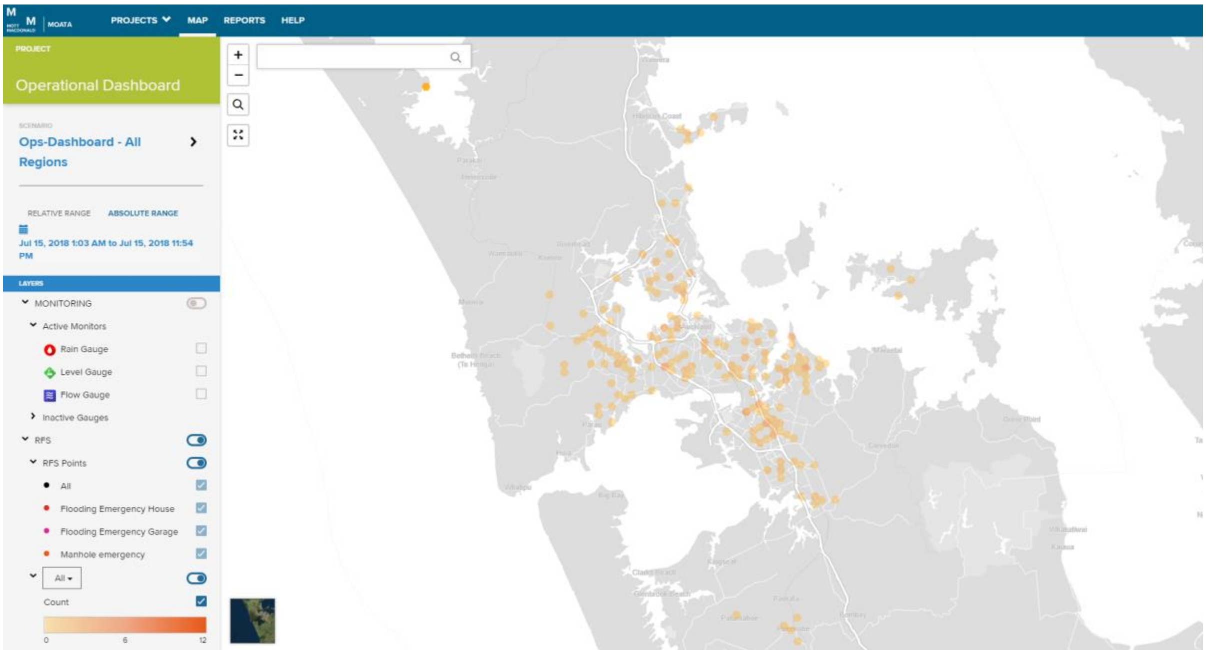

Figure 1: *Display of RFS*

The data displayed in Figure 1 correspond to a single storm occurring over one day and can be filtered by class, including allowing RFS to be filtered by type, such as flooded garage and manhole emergencies (Figure 2 and Figure 3), to give instantaneous understanding and the most relevant information possible to the operations team.

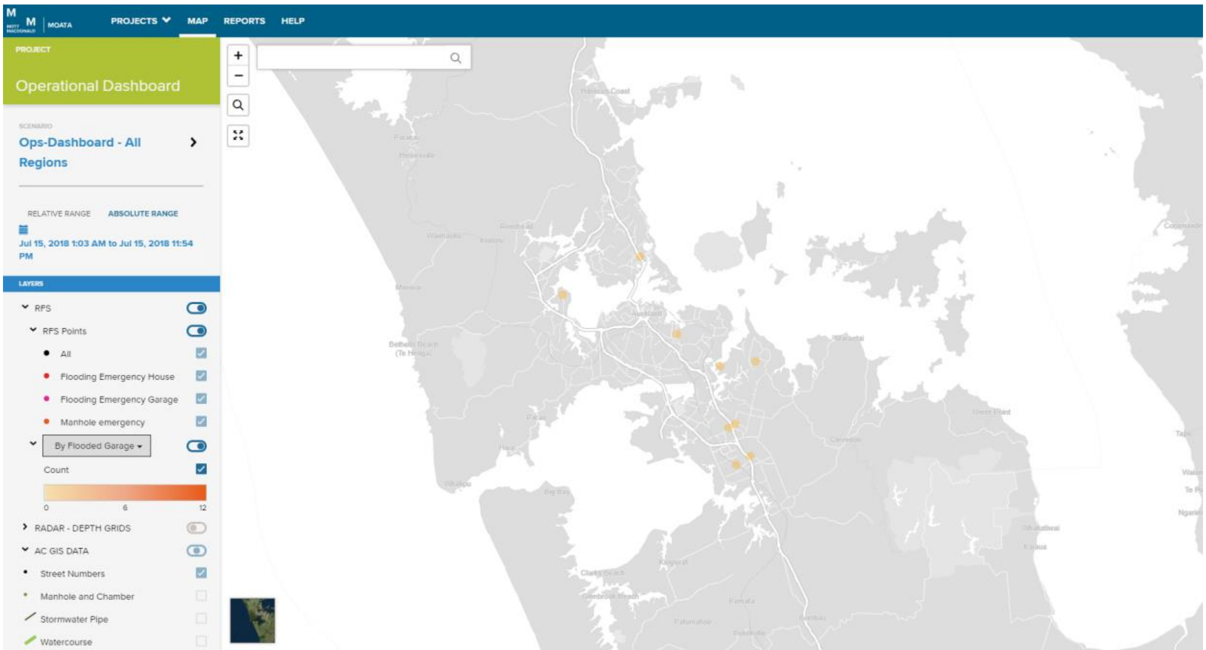

Figure 2: *Flooded garage RFS*

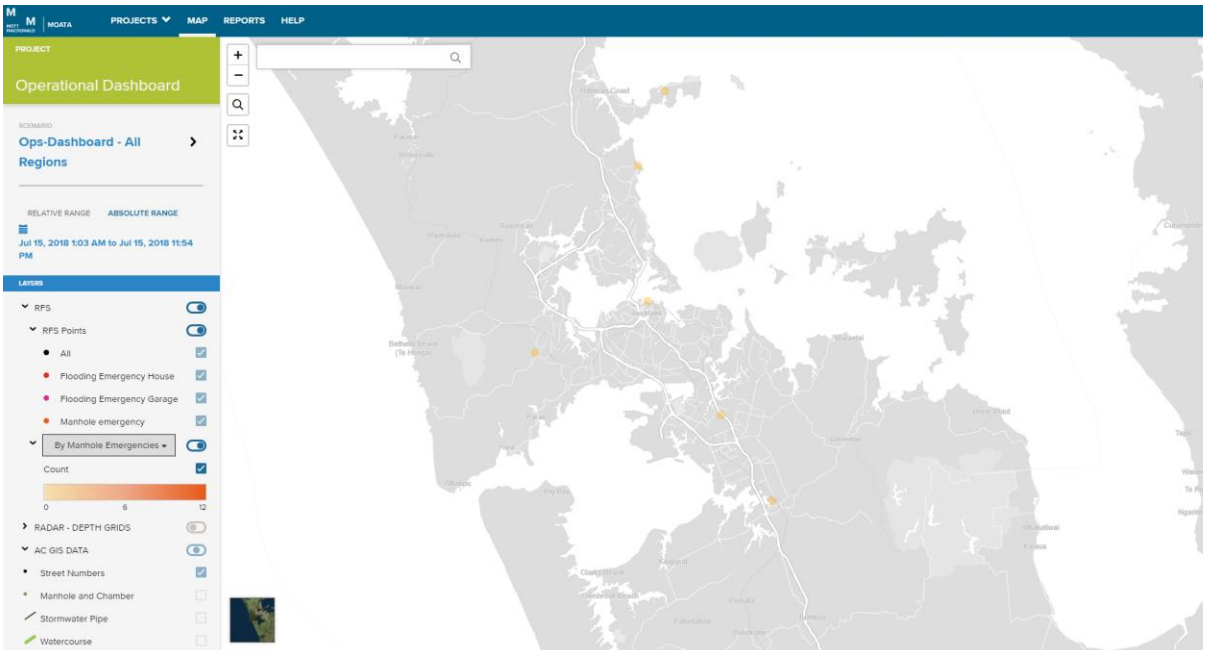

Figure 3: Manhole emergency RFS

At large spatial scales, the information portal is particularly useful in identifying trends. Although RFS clustering might not be immediately obvious from inspection of the hex grid, it is much clearer when considering the rainfall accumulation, shown in Figure 4. The dark bands seen in Figure 4 correspond to areas of higher rainfall. It can be seen that the distribution of RFSs clusters more closely along and immediately beside this dark banding, suggesting that RFSs are correlated with rainfall. This is particularly noticeable for specific classes of RFS like habitable floor flooding as seen in Figure 5. It is expected that RFS types like habitable floor flooding will be more strongly correlated with rainfall depth than most RFS types as they require much greater activation rainfall to occur – whereas blockages can be initiated by a relatively small amount of rainfall, habitable floor flooding requires significantly greater rainfall to take place.

Establishing and quantifying these relationships will not only enable better understanding of historical events and events as they unfold in real-time, but also enable meaningful predictions to be made on the basis of the relationship between rainfall and RFS characteristics.

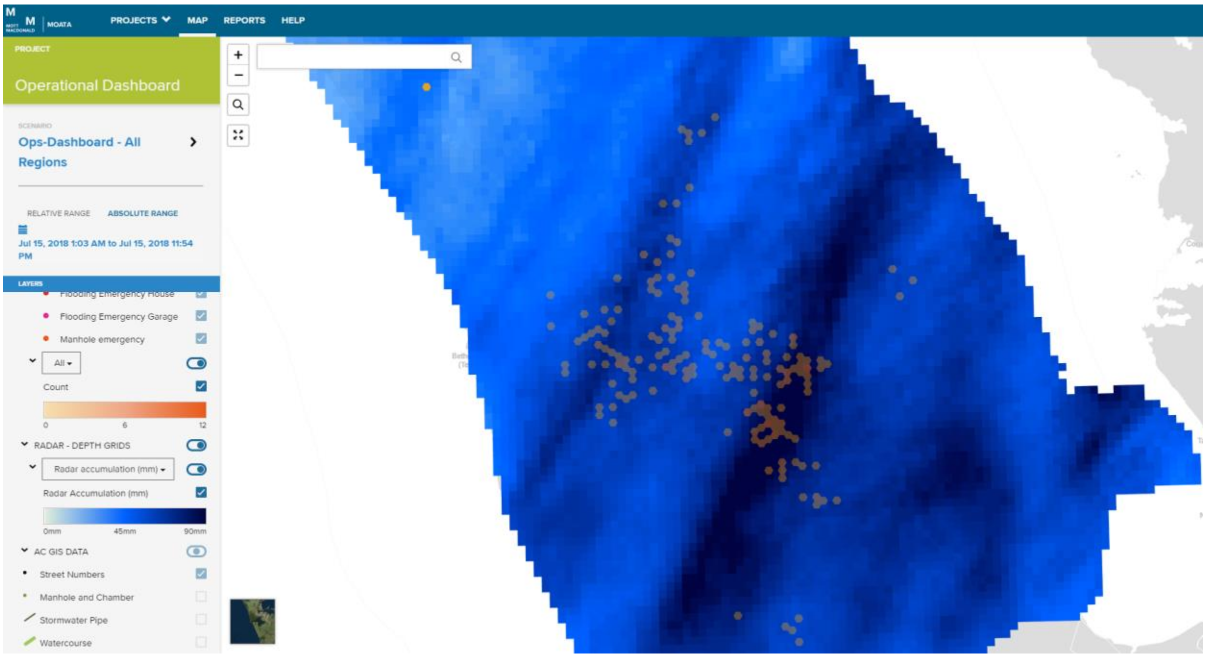

Figure 4: RFS and aggregate rainfall depth

When a user of the operational dashboard portal zooms in, individual RFSs become visible and relevant information associated with an individual RFS is made visible with a click, causing the information window to open as seen on the far right of Figure 6. This information is populated as soon as a RFS is logged, initiating the workflow that will push relevant information through a dedicated application program interface (API) into the MOATA database. This information is tractable through all associated systems and enables users to consider and track RFSs individually, as well as in the aggregate. The most relevant of this information is summarised in the associated Microsoft PowerBI dashboard.

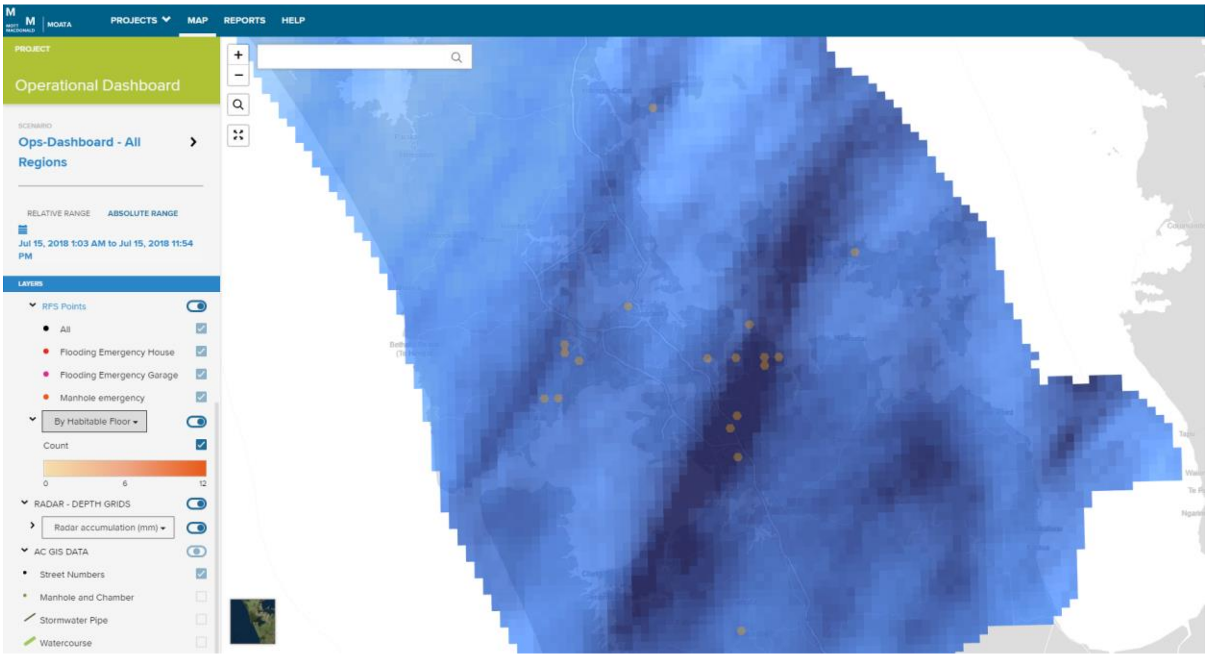

Figure 5: Habitable floor flooding

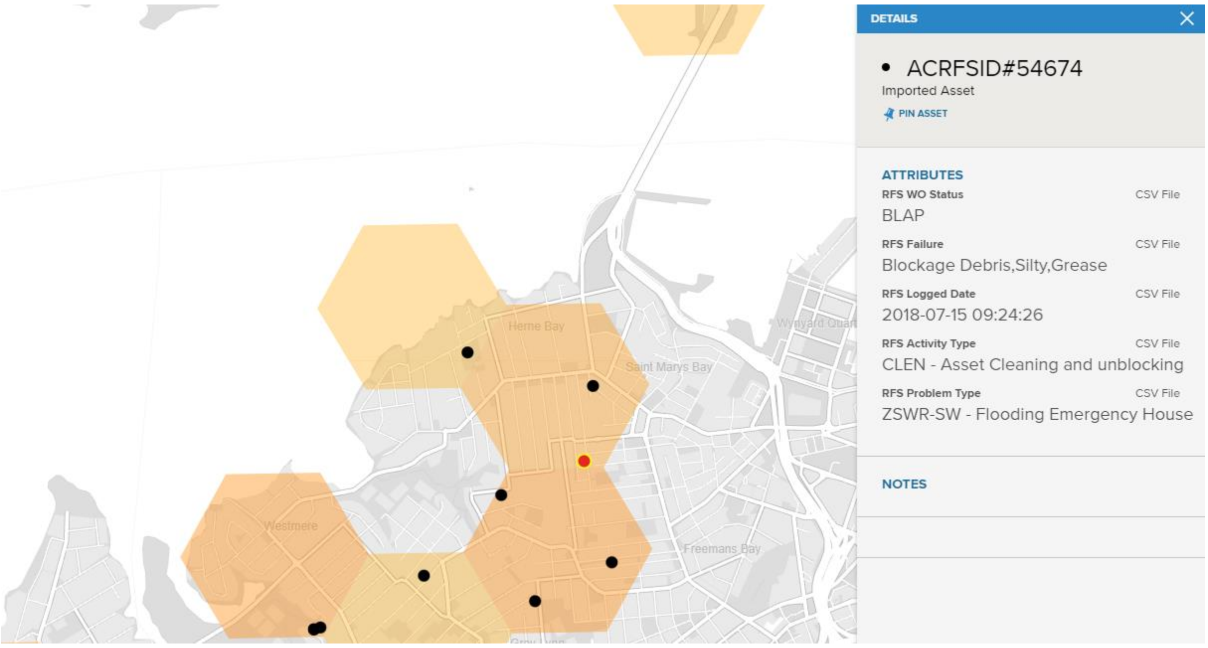

Figure 6: Individual RFSs

3 THE DASHBOARD

The Operations Dashboard, built in Microsoft PowerBI, was created to unlock the value of the data displayed in the portal. It enables real-time data visualisation and event management statistics, whilst also providing authenticated users full access to historic data, so detailed retrospective event analysis and reporting can be undertaken.

Similar to the GIS portal that was created to allow users access without requiring expensive GIS software licenses, the dashboard has been set up to enable authorised users to access the full functionality of the Operational Dashboard without requiring a Microsoft license.

The Dashboard is accessed through the Reports tab seen at the top of the page in Figures 1 to 6. The first page of the Dashboard is shown in Figure 7 and provides the management level breakdown of RFS information. For a selected time period, RFSs are summarised in terms of:

- Issue type (Flood Area Investigation, Asset Cleaning, etc.)
- Problem type (Flooding Emergency, Blockage Response, etc.)
- Number per day
- Time of day occurred
- Location (North, Central/West, South operational zones)
- Status
- Outcome

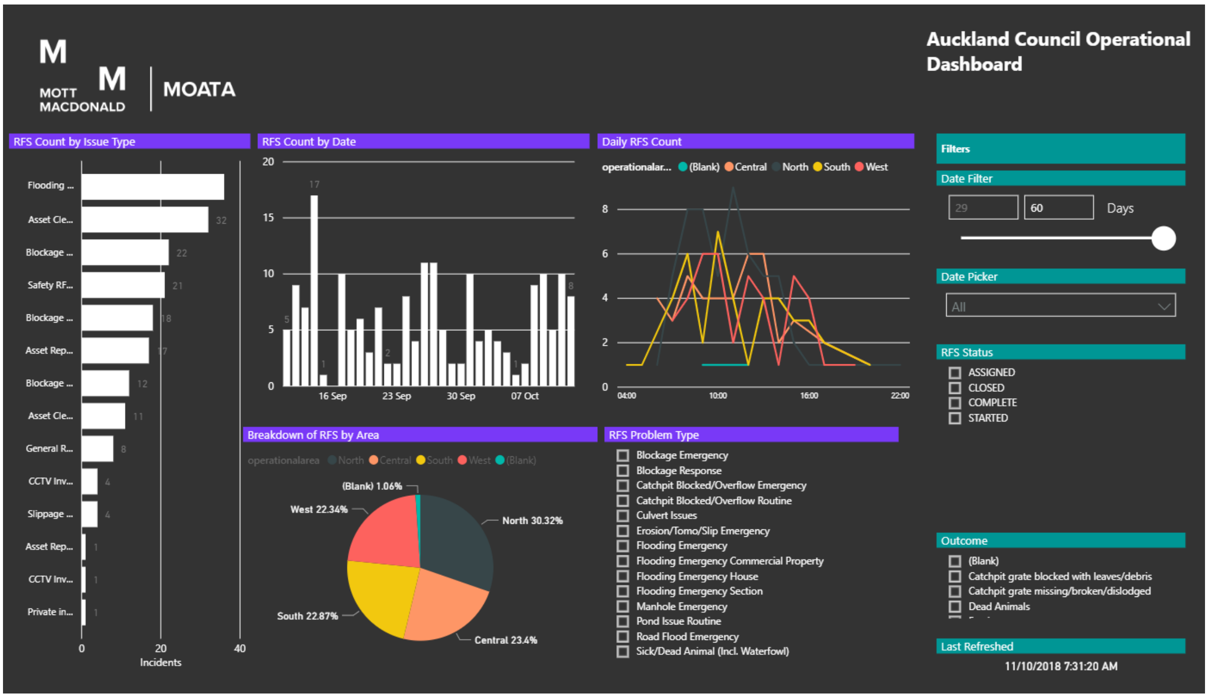

Figure 7: Operational Dashboard – Management View

By setting the date picker to a desired time horizon – either event duration or reporting period – the dashboard will become an interactive reporting tool. Static reports can be printed from the Dashboard and specific categories can be interrogated as shown in Figure 8, where manhole emergency problem types have been selected. This has proven to be a useful tool in reconciling RFS outcomes.

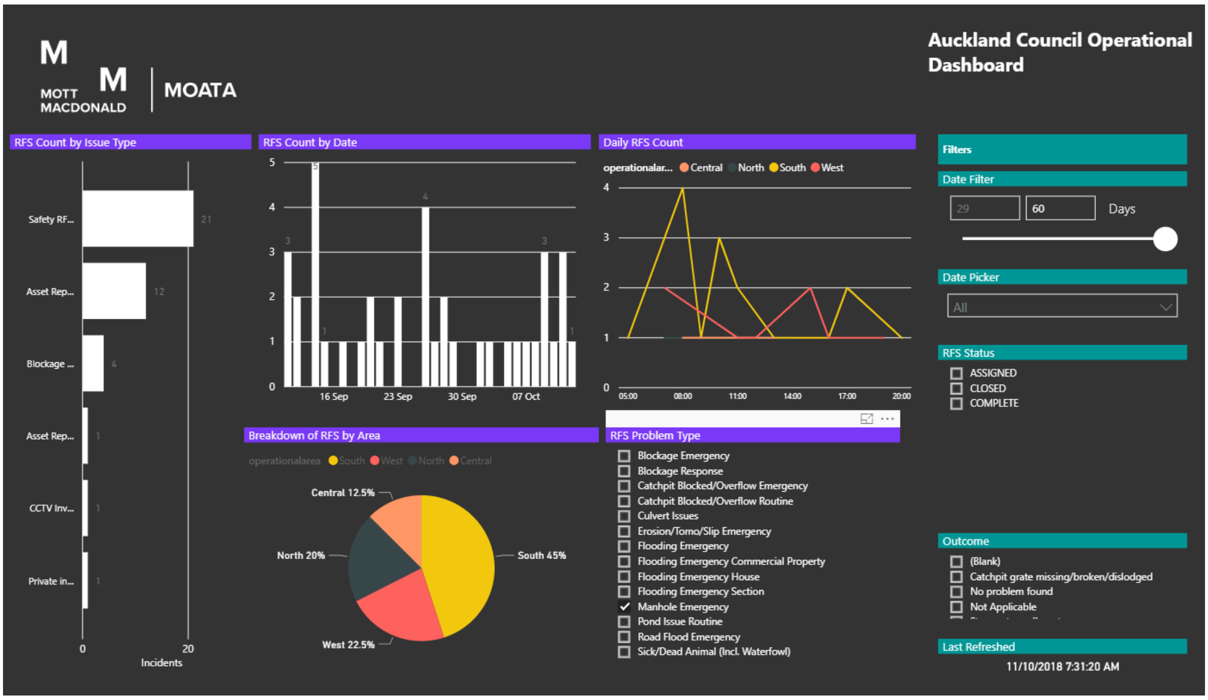

Figure 8: Operational Dashboard – Management View – Manhole Emergency

The second aspect of the Operational Dashboard is the breakdown table shown in Figure 9. It links to the management level dashboard, presenting specified information in a tabular view for legibility and including specific information such as Work Order Number and, importantly, KPIs. It picks up selections from the management level page as seen in Figure 10. This report is particularly useful in efficiently tracking individual RFSs in addition to reporting on success metrics as part of mandated reporting requirements.

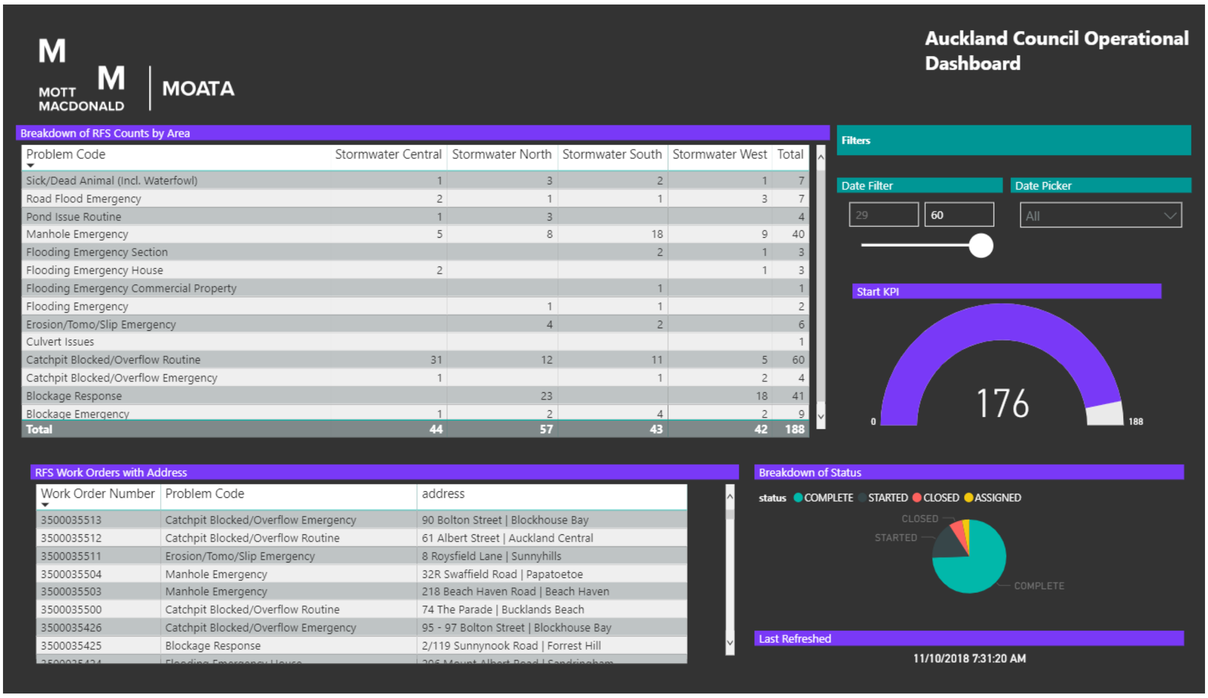

Figure 9: Operational Dashboard – Breakdown Table

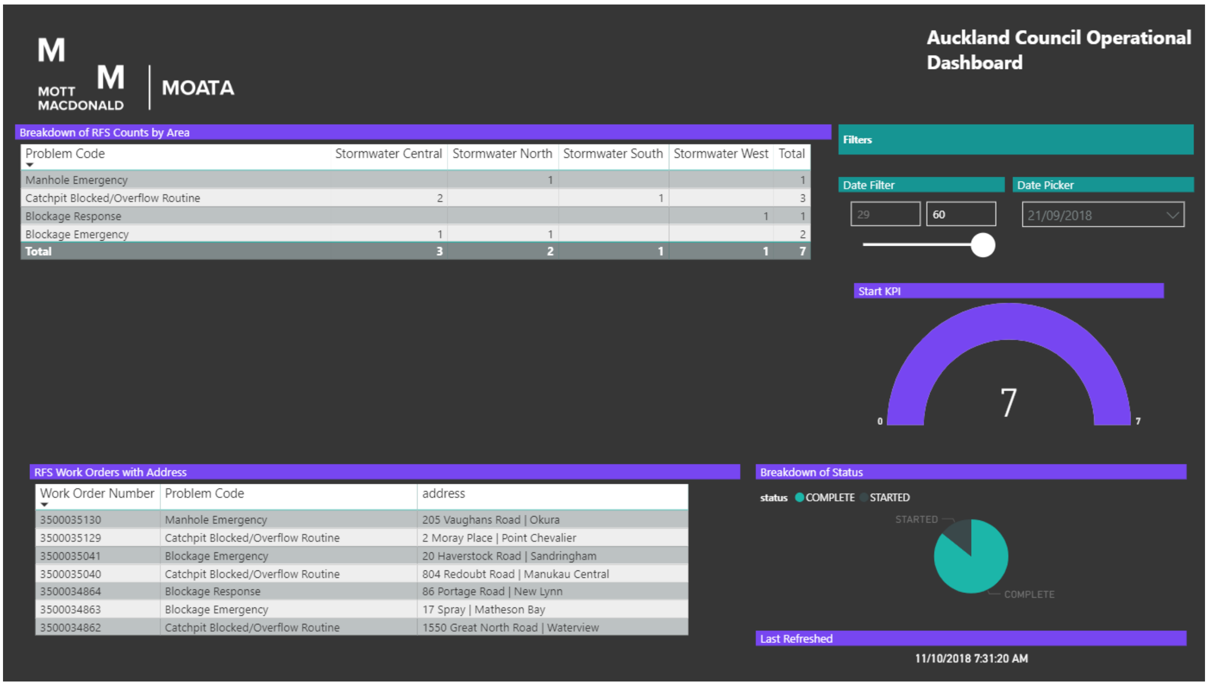

Figure 10: Operational Dashboard – Breakdown Table – Manhole Emergency

4 FURTHER DEVELOPMENT

Insights delivered by the Operational Dashboard will be enhanced by planned future works commencing in early 2019 to further investigate the relationship between rainfall and RFS characteristics. Preliminary analysis indicates that RFS location, count and type are strongly correlated with rainfall statistics. Quantifying these relationships through Machine Learning techniques will enable construction of a predictive model that will inform preventative maintenance schedules and deliver better outcomes to the citizens of Auckland.

Healthy Waters is also looking to enhance the dashboard with contractor vehicle movement as well as connecting the dashboard with other emergency response organisations such as the fire department and civil defence to enable a richer view as the event unfolds.

5 CONCLUSIONS

The Operational Dashboard represents the first time a stormwater asset manager has integrated as it happens RFS information with market-leading rainfall analytics to deliver real-time business intelligence to operational decision makers.

The Dashboard enables events to be tracked in real-time and ensures all stakeholders and decision makers have the most up to date information possible. Implementation of the dashboard has driven the time commitment and subsequent cost of post event reporting down from 1 day to 10 min and includes a richer set of insights for all stakeholders to communicate the story to customers and their representatives.

These comprehensive insights help event managers facilitate response activities to ensure customers safety and wellbeing is prioritised and storm water services are delivered to the highest level.

Most significantly, the Operational Dashboard is designed to be a dynamic tool and will evolve as the Lifecycle Management Team priorities and responsibilities change and as information capture techniques and associated technologies develop.

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