Australasian Hydrographer
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AUSTRALIAN HYDROGRAPHERS ASSOCIATION

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JACQUIE BELLHOUSE

Editor's Introduction

Welcome to the March 2018 issue of the AHA Journal.

Just recently I was scrolling through Facebook when I saw a cute little video from the Water Corporation (of WA) introducing Nevae one of their trainee Hydrographers. The video was filmed to showcase one of the many talented women working in the field in celebration of International Women's Day.

While it was lovely to see as another female in the field (literally), it also got me thinking about my start in the profession over twenty years ago and how much has actually changed.

This issue is therefore a celebration of some of the advances we have made in recent times. From how we are now influencing the direction of our collection standards, educating our potential future water scientists, working with the cloud and designing and using smart phone applications we, now more than ever before, are using the ever changing technologies to find more efficient ways to achieve the desired outcome.

And back to Nevae, for anyone who is interested I have posted the video on my good friend's (Hydro Grapher) Facebook timeline.

A change in direction

AHA has gradually been changing the way it communicates with members.

Over the last few years, we have moved to Social Media, embracing Facebook, Twitter and LinkedIn, and begun regular eNews, once or twice in most months.

At the same time, we have been working on improving the presentation of the *Australasian Hydrographer*, the AHA journal.

Moving forward AHA sees the role of the journal is to develop the hydrographic discipline. To help us with this we invite articles that include:

- reviews of hydrographic equipment and techniques, including trial and production implementations;
- development of national standards, techniques and protocols;
- profiles of leading hydrographers.

Because we understand timely hydrographic news is also important to our members, we will start to deliver more news stories via our eNews. If you think you have a news item of interest to our members please submit with photos to AHA Services (services@aha.net.au).

Regards
Jacquie Bellhouse
Journal Editor

BILL BARRATT

From the President

Last issue I wrote about *extreme events* and their impact on society.

Hydrographers need to respond effectively to extreme events, with expertise in surface water and ground water; understanding the effect of events on water quantity and water quality.

Extreme events will be the theme of the AHA 2018 Conference, the signature event of the inaugural AHA Hydrography Week from 12-16 November in Canberra. Highlights of the week include:

- The AHA 2018 conference;
- Training covering AHA hydrography subjects, which include the requirements of units of competency required for the Diploma of Water Industry Operations (Hydrography);
- User Groups and training delivered by AHA Corporate Partners.

We look forward to a week of training, learning and building professional connections.

Hydrographers need expanding skills to respond effectively to extreme events. Responding to employer feedback that the existing Diploma syllabus and AHA certification product do not deliver the required skillset, AHA has begun identifying the fundamental principles and competencies required for routine and extreme event hydrography. These build on the National Industry Guidelines overseen by the Water Monitoring Standards Technical Committee (WaMSTeC) convened and published by the Bureau of Meteorology.

The new training packages will reflect these fundamentals and principles, and be developed in consultation with industry. The intermediate level will include, but likely exceed the requirements of the current Diploma. The three levels of professional certification will reflect appropriate training and experience.

In 2018 AHA has welcomed three new Committee members: Vice President Mark Pickles (Ventia Vic), Ryan Ford (WaterNSW) and David McPhee (Vic. Dept of Environment, Land, Water and Planning). The Committee is now reviewing the Ends Policies of AHA, which define what we plan to deliver to members over the coming year.

I look forward to your active participation in Hydrography Week 2018.

Regards
Bill Barratt
AHA President

AHA Member Profile - Linton Johnston

Describe your current role.

My role in the Bureau of Meteorology's Water program is focused on bringing together Australia's vast range of water information, collected by hydrographers across the country.

What hydrographic or other qualifications — relevant to your role — do you have?

I left university in the 1990s with a degree in Civil Engineering, and from there my career gravitated toward the water engineering side, into hydraulics and hydrology.

What are your major career achievements?

Flood warning – being part of the Queensland flood warning team during the La Niña seasons between 2008 and 2011, including the Brisbane floods of Jan 2011.

Another highlight has been helping manage the $80 million Modernisation and Extension (M&E) grant fund – funding projects with hydrographers from each state and territory to improve monitoring networks and kick start other important activities, like the National Industry Guidelines for hydrometric monitoring.

Where has hydrography taken you in the world?

Up and down the Queensland coast and throughout South Australia, including the beautiful Gammon Ranges.

How did your career related to hydrography commence?

My first taste of hydrography was designing and instrumenting a project to monitor the quantity and quality of freeway runoff into stormwater detention basins south of Adelaide.

Was there anyone who had a major influence on your career?

Chris Wright, a veteran flood warning manager in South Australia, inspired me to pursue hydrology and showed me the importance of working collaboratively. David Malone who worked as the NSW Strategic Water Information Coordinator has been another guiding influence on my career.

What has been the most memorable experience in your career?

Probably making my way through a deserted Brisbane CBD, to the Bureau's office, for a flood warning shift in January 2011. Parts of the city were shut down due to the major flooding on the Brisbane River and it was an eerie experience walking through an Australian capital city without a car in sight.

What makes hydrography interesting?

The down-to-earth people, and the opportunity to access amazing natural environments that I otherwise would not have seen.

What do you do when you are not at work?

I'm lucky enough to have a family with two fantastic young children so there is never a dull moment. I like to get my hands dirty in the garden and occasionally steal honey from bee hives or take in a quiet moment on the back porch.

Where do you see hydrography in 50 years?

Hydrography will be more important than ever as we balance competing and increasing demands for water. We will all expect more and more information, so hydrographers will be tapping into emerging technologies to make data available at our fingertips, anytime and anywhere.

Snowy Hydro Hydrographers Educate Potential Future Water Scientists!

Mic Clayton, Snowy River Hydro

In early November a group of enthusiastic International Baccalaureate program students from Canberra Grammar visited the Snowy Mountains region, undertaking a geography project down the Thredbo River. Their project required them to measure a variety of river characteristics (shape, water velocities, depths, widths etc.) to understand how the hydraulics of the stream changed down the catchment, from the headwaters above Thredbo down to just near where it flows into Jindabyne Dam.

The group also visited Jindabyne Dam to further understand its role in the Snowy Scheme, how this century's dam upgrades are benefiting the Snowy River downstream of Jindabyne Dam and how the emergency spillway was designed to operate in an extreme event following ANCOLD (Australian National Committee on Large Dams) reviews and implementation.

Figure 1. Students from Canberra Grammar visiting Jindabyne Dam.

Figure 2. Canberra Grammar students undertaking a variety of measurements and observations upstream of Thredbo.

As part of their monitoring activities they undertook an ADCP discharge measurement, with the assistance of Mic Clayton and Shane Mogg from Snowy Hydro at the Thredbo River gauging station just out from Jindabyne. The group also discussed the mathematical theory of how a discharge measurement is "put together" as well as discussing why monitoring and measuring stream flows accurately is so important to Snowy Hydro, how in-stream hydraulics can influence and generate the stream morphology over time, how stream health is influenced by stream flow variations, the impact of human activities on river systems and similar catchment related topics.

The ADCP gauging they undertook was compared to the techniques they had been using during previous activities upstream and also referenced to the National Hydrometric Guidelines. They were very excited to learn that their measurement was consistent with recent measurement trends and its relationship to the discharge rating for the site and would become part of the gaugings database!

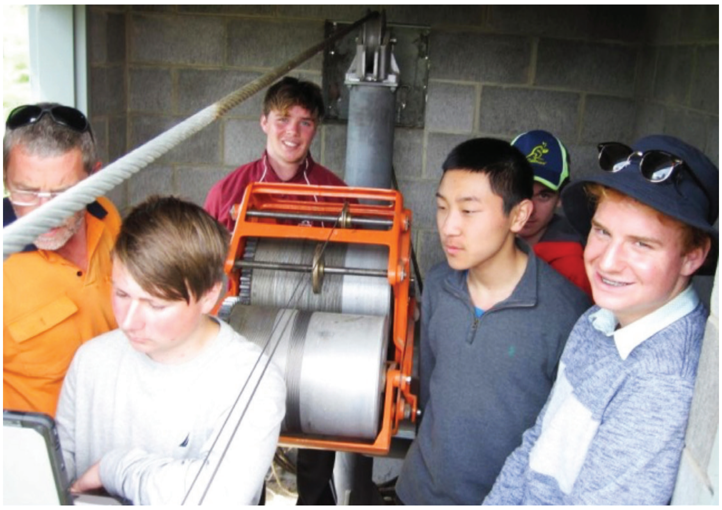

Figure 3. Gauging using the traveller at Thredbo River.

Figure 4. Undertaking surface velocity measurements at the Thredbo River gauging station.

The students quickly grasped the variations in stream velocities and depth and its importance in accurate flow measurement. Putting the measurement in the context of Snowy Hydro water accounting obligations also highlighted the importance of measuring flows consistently and to a standard/guideline. Other discussions highlighted how hydrometric data is used by engineers, water managers and others in a wide range of applications in the wider world, broadening their appreciation of the work undertaken in the field by field hydrologists and hydrographers.

An important aspect about engaging in this type of community education opportunity is the potential of engendering an interest in a hydrographic career for the "next" generations to embark upon. Exposure to the traditional methods of hydrological field measurements and the newer innovative technologies and techniques being used, displays an innovative profession worthy of involvement.

Water in the Cloud

Ben Starr, eagle.io, Brisbane Qld.
Paper presented to 18th Australian Hydrographers Association Conference Canberra. 24-27 October 2016.

Abstract

Surface water in Queensland is a valuable resource that creates value for landholders when it is extracted and irrigated on crops and for aquatic ecosystems when it is left in-situ.

In Queensland, DNRM is the agency responsible for balancing the conflicting needs of these two stakeholders. Historically, this has been achieved by compromise, by limiting extraction to preserve environmental base flows.

There is growing scientific knowledge of the needs of aquatic ecosystems which indicates that the timing of flows is as important as the volume of flow (DNRM 2016).

This paper describes a method by which ecosystem flow needs can be managed using a combination of sensors and visual inspection, and allowing flows to be dynamically varied by applying complex rule systems discharged through a cloud platform to maximise the health outcomes for aquatic ecosystems without reducing the total water available for seasonal irrigation.

Introduction

We propose a method of allocating surface water to landholders and aquatic ecosystems (water stakeholders) to maximise value gained from this fixed resource by both. The method involves dynamic variation of flows using the Internet of Things (IoT) and cloud computing.

The needs of these two water stakeholders (landholders and aquatic ecosystems) are in conflict. If unconstrained, landholders may seek to extract excess water for irrigation, to the detriment of aquatic ecosystem health. Conversely, to maximise the health of aquatic ecosystems, all extraction of water for irrigation would cease. This would be at the expense of a 12 billion dollar industry in Queensland (QGSO 2016).

In Queensland, the Department of Natural Resources and Mines (DNRM)[1] is responsible for balancing the needs of industry and community for access to safe and reliable water supplies, restoring natural flow regimes to support high value ecological assets[2] and ecosystem functions. DNRM is restricted in its ability to manage ecosystems, specifically aquatic health through flow assessment only, using application of rules on the capture and take of water by landholders (DNRM 2016).

This paper seeks to achieve the following:

- Review the historic method of balancing the positions of water stakeholders and highlighting some issues with this strategy.
- Outline the emerging scientific knowledge of specific flow needs of Ecological Assets, being produced as a result of directed research by the Queensland Government.
- Set out how sensors and cloud computing could be utilised to allow for dynamic variance of flow (by modifying the timing and rate of extraction, and releases from regulated creeks) to better meet the newly identified needs of aquatic ecosystems to maximise health outcomes with available water rations, all while not reducing allocations of water to landholders. A case study of current use of a cloud system by DNRM Toowoomba is provided as a feasibility study.

1. Renamed as the Department of Natural Resources, Mines and Energy after delivery of this paper.
2. Ecological assets are an ecosystem component that occurs naturally in the Water Resource Plan area, is critically linked to flow and dependent on the conditions provided by flow to support its long-term integrity. It may be a species, a group of species, a biological function, an ecosystem or a place of natural value.

Interests vs Positions

When considering the problem of balancing needs of landholders and aquatic ecosystems to surface water access, it is useful to consider the conflict in a negotiation framework. Specifically, the aim is to identify the interests and positions of each party and the differences between them.

Interests and positions explained: what a party says they want in a negotiation is their position (both landholders and aquatic ecosystems want water), why each party wants it is their interest (landholders want water to help their crops grow, aquatic ecosystems want water to maximise their health). The differences between interest and positions are demonstrated by this short story.

There was once only one orange left in a kitchen and two prominent chefs were fighting over it when preparing a meal for visiting dignitaries.

"I need that orange!" One chef shouted.

"Yes, but I need that orange as well!"

They decided on a compromise, splitting the orange.

One chef squeezed the juice from the orange and poured it into the special sauce he was making. It wasn't quite enough, but it would have to do. The other grated the peel and stirred the scrapings into the batter for his famous cake. He too didn't have as much as he would have liked, but given the situation what else could he have done?

Had both chefs understood why the other wanted the orange (their interest), and had not focused on their position of just wanting the orange (their position), both could have had their needs met completely. As it was neither achieved a satisfactory result. Compromise in this and in all scenarios where interests are not understood result in shared value being neglected.

The Landholders' position is that they need water. Their interest in water is for irrigation of crops to increase yield (or achieve growth). Water, rather than land, is the limiting factor for production in traditional agricultural systems. An increase in availability and reliability of water can be expected to result in increased yield and profitability for farmers. Considering that Queensland's agricultural production has a value of approximately $9.2 billion[3]. An increase in availability of water yields a direct and quantitative financial benefit to farmers and to Queensland more generally through food security, tax revenue, and lower cost produce.

Their primary interest is the total volume available on a seasonal basis. The timing of extraction of waters is of low interest to landholders as they have largely invested in assets (ring tanks) that allow them to effectively buffer water demand.

Aquatic ecosystems also have the position that they need water, but their interests are more complex. They seek flows that maximise ecosystem health, including protection of instream and riparian habitats, stable creek morphology, flushing of nutrients, connectivity of pools, some disturbance to keep introduced species at bay, and cues for breeding behaviour. These needs vary between waterways, and reaches within waterways depending on the factors limiting ecosystem health. To complicate issues, impacts to the health of aquatic ecosystems does not have the quantifiable economic marker that impacts to farm yields have, affecting comparisons of the equity of any negotiated outcome.

Developing research indicates that aquatic ecosystems are very sensitive to the timing of flows, with certain flows (such as those that are required cues for spawning) yielding significantly greater health benefits, than say continued base flow.

The primary difference between interests of the two parties is that land users are less concerned about when water is able to be extracted due to the ability to buffer supply and demand with ring tanks, whereas ecosystems are much more concerned about when flows occur. This difference in interests forms a strong case for value creation.

3. https://www.environment.gov.au/climate-change/climate-science/impacts/qld accessed 21 Sep 2016

Past Flow Management Strategy

Past flow management strategies have been based largely on compromise of positions of landholders and aquatic ecosystems, or cutting the orange in half.

The long term extraction limits applied by the Queensland government are largely focused on preserving base flow, and do not have a focus on identifying or addressing the dynamic flow needs of aquatic ecosystems.

These outcomes are achieved through the combined effect of the following rules contained in resource operation plans:

- Water sharing rules.
- Infrastructure operating rules.
- Flow event management rules.

The long-term, integrated, rule based approach that Queensland has taken means that there is limited opportunity for active management of flow to target the specific needs of environmental assets and ecosystem function at a more granular time frame (seasonal or flow based).

As our understanding of the variable needs of these environmental assets grows, so will the need for dynamic water extraction regimes to match system hydrology with asset and ecosystem needs.

Understanding of Needs of Aquatic Ecosystems

By understanding when flows create the most benefits for each specific ecosystem, and varying the total flow volume to maximise these benefits – aquatic health can be maximised without reducing the total volume available for agricultural applications.

To understand when environmental flows are (or are not) required in different ecosystems, some examples found in Resource Operations Plans and scientific studies are provided below.

- To manage the Narran Lakes Ramsar wetland site filling: Water harvesting entitlements are reduced to 90% of the daily entitlement, when a flow event occurs that would be sufficient to fill the lakes between 1st April to 31st August. Water allocations are reduced again if a subsequent ‘filling flow’ occurs within 4 months of this first event.
- Studies in the Condamine and Balonne regions found that contrary to expectations, there was little evidence of a boom in the individual body condition of fish in response to floods, and the extent of floodplain inundation did not influence the food base or the energy transfer through food webs.
- Some native fish rely on high flows during winter and spring as cues to begin migration and spawning; without these seasonal high flows, breeding can be severely affected.
- Some species rely on combinations of water temperature and rises in water level as cues for spawning. The Golden Perch, which is one of the Keystone species in the Murray Darling system (DoE 2013) spawns following a rise in river height when the temperature is approximately 23°C. If river rises do not occur, spawning is delayed until the following season.
- Alterations in base flow rates in heavily regulated waterways (such as occurs at the base of the Murray River) can have impacts on flora and bank stability, causing the drowning of riparian vegetation and wetlands which are adapted to only temporary inundation.

Implementation will require Technology

Understanding the specific flow needs of aquatic ecosystems will be insufficient to achieve positive health outcomes for Ecological Assets. Active management will be required to allow detection of conditions when flows are needed or may be forgone without impact, and to administer increases or decreases in flow, ideally

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automatically. Flow management can be achieved by DNRM through flow releases in regulated waterways, or by temporarily limiting extraction by landholders.

To achieve active management, DNRM will need to make use of a range of real-time sensors to monitor current status of waters, have a solution to ingest and analyse data from these sources to determine when environmental watering is required, and to automate controls on flow.

The fundamental ingredients to deliver a completely automated solution are:

- Sensors or monitoring to collect data on the needs of aquatic ecosystems, which may include:
  - Height of water in wetlands,
  - Temperature of water,
  - Flows,
  - Breeding cycle or times (manual inspection),
  - Trends in abundance of pest fish (manual sampling);
- Cloud connected gates on regulated creeks;
- A cloud platform that can:
  - Ingest data that is needed to make a decision when extraction should occur.
  - Host decision making rules developed as interests of ecosystems become better understood;
- Send instructions to pumps (allowing landholders to override these instructions when water is not wanted);
- In the future, smart pumps (pumps connected by gateways), that are configured with a gateway to receive control instructions to provide a completely automated solution.

Case Study – DNRM Use of Cloud Software

DNRM in Toowoomba is using a cloud based platform to ingest flow data from five weirs in Oakey Creek and to automate sending of notifications to 41 landholders with water extraction permits.

Currently the notifications are based on simple rules; they are issued when flows at the nearest upstream weir of the landholder exceed a height nominated in their licence, which permits them to start extraction. A second message is sent when flows drop below this height, notifying that extraction must stop.

Users can login to the system to view real time flows and take limits, as shown below in Figure 1.

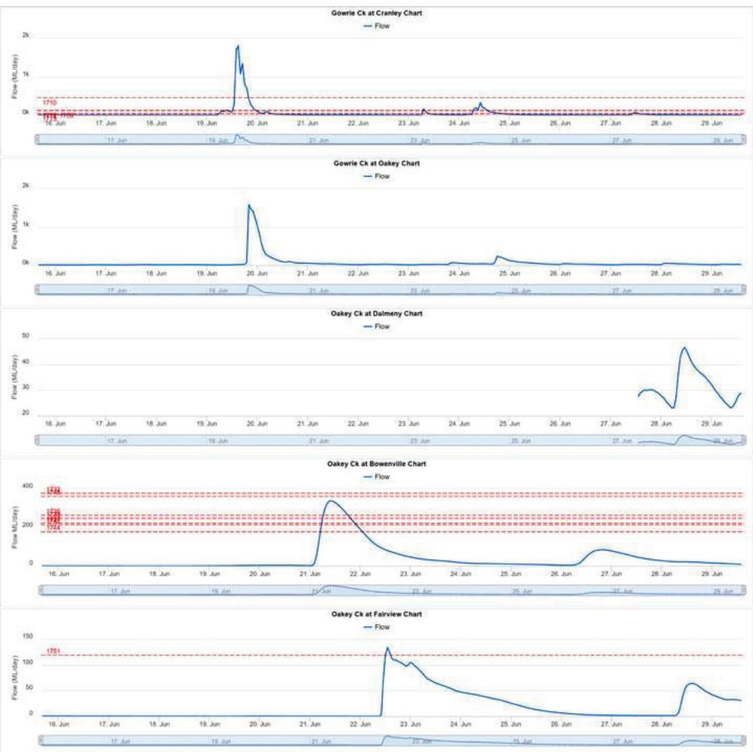

Figure 1.
Dashboard showing flows and extraction triggers, Oakey Creek.

Although the current system uses only simple rules for triggering extraction, a cloud software system such as the one employed by DNRM could allow for more complex rules to be applied based on real time sensor data to match flow with ecosystem needs more closely. Examples of these dynamic systems include.

- Restriction on extraction based on antecedent flow conditions, such as those described for the Narran Lakes Ramsar site above.
- Restrictions on water extraction based on sensor data. This could be used to restrict extraction during the first flow event after water temperature reaches 23°C to cue the spawning of Golden Perch in the Murray River.
- The system could also keep a tab on the water that was withheld for agricultural uses, and increase availability at times that did not yield strong environmental benefits.
- The system could be automated further if a landholder's pumps were connected via remote gateways to allow remote instructions. Either party could stop extraction; DNRM with automated rules to time environmental watering, and the landholder when they sought water. This final stage would allow a diverse range of assets owned by different parties to work in concert to achieve maximum value for both.

Conclusions

Compromise on flows by simply conserving baseflow in systems does not allocate flows in a way that maximises ecosystem health.

An active management program that allows administrators to detect the needs of ecosystems for flow in near real time, and respond to these needs dynamically by restricting extraction or releasing waters increases health without reducing availability of flows for irrigation over an annual time scale.

The feasibility of implementing a dynamic flow control system such as this is being demonstrated with DNRM application of cloud data monitoring and notification at Oakey Creek in Toowoomba.

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SiteRunner – An on-site data collection application

Jessica Littlejohn, Ventia Pty Ltd, Melbourne, VIC
Paper presented to 18th Australian Hydrographers Association Conference Canberra. 24-27 October 2016.

Abstract

Ventia has developed a number of custom built standalone in-house smart phone applications. SiteRunner is the surface water data collection app, which replaces the need for paper forms to be used when collecting data onsite. Data collected using the app includes SHEQ information, water quality readings, site conditions, site maintenance and photographs. The use of the app has streamlined collection of data in the field ultimately improving data quality.

Introduction

Advancements in hand held smart phones have placed data collection and connectivity literally in the palm of our hands. Utilising smart phone capabilities allows better management of water resources through the use of technology in the field. Traditional paper based data collection techniques have historically been time consuming and required multiple people handling the data creating opportunities for human error and data to be lost. Ventia has developed a number of custom built standalone in-house smart phone applications. SiteRunner is the surface water data collection app, which replaces the need for paper forms to be used when collecting data onsite. The app has been developed together with an admin website whereby collected data stored on a central sever can be easily viewed and downloaded. The app can be used on both iPhones and Android devices. Examples of the login screen and home screen are shown in Figure 1.

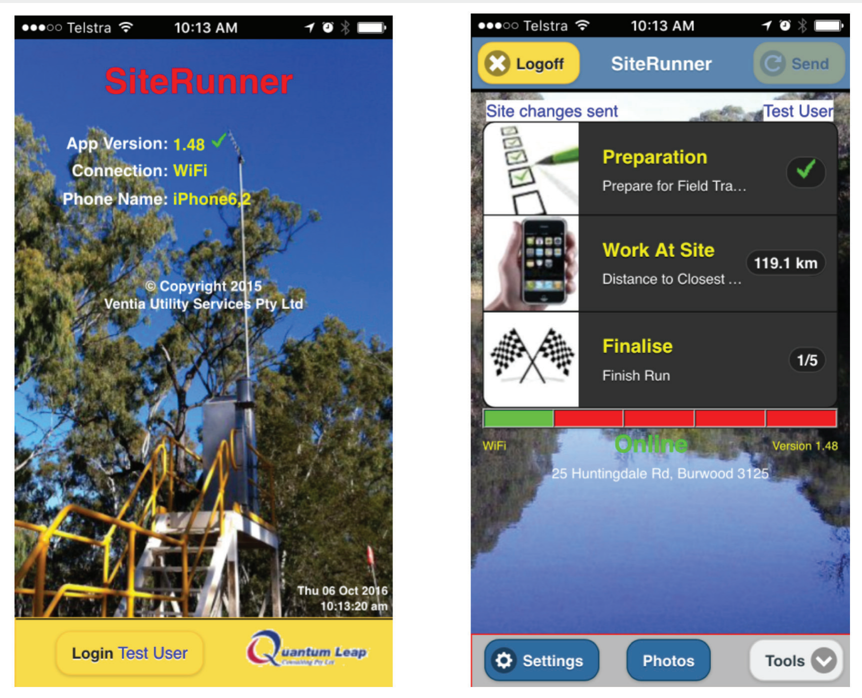

Figure 1. The SiteRunner app login screen and home screen.

Data collection

Safety, Health, Environment and Quality (SHEQ) data

Safety is one of the cornerstones of Ventia's operations, so the app was designed as a one stop shop for recording and storing SHEQ information as well as prompting field staff to consider hazards at every site. Start cards have been built into the app which users are required to complete before using the app's other functionality, for example entering water quality data. Continual improvement is forefront at Ventia so the app is flexible enough to be tailored to key safety initiatives as they arise. For example, analysis of near hits across the business indicated that hand injuries were on the rise. Together with a business wide communication campaign about the importance of wearing the right glove for the task, a reminder was built into the app which prompts users to consider glove usage prior to starting work. Furthermore, traffic management plans have recently been developed for each monitoring site and functionality has been added to the app to display the traffic management plan required at each site.

Water Quality data

A wide range of data is collected via the app, including spot water quality parameters. The app is also used for managing calibrations of portable water quality instruments. Prior to work at site, users select the water quality meters to be used from the list that is uploaded into the app. The app displays if the meter is in calibration to alert the user if any instruments cannot be used until they are calibrated. If the meter is calibrated, the app also prompts the field staff to undertake an additional calibration on site. Once calibrated on site, the app will allow the user to enter *in situ* water quality readings. There are three sections within the app where water quality conditions, water quality readings and comments can be added. To allow users to enter information easily in the field, voice input can be used to speak the numbers into the screen if required. The last five water quality readings per parameter can be viewed to allow users to compare current values with historical values. This first step data review is important to make sure no errors are introduced at this stage.

Photographs

Photographs of monitoring sites are integral to capture changes over time and help identify site specific conditions for staff that are not frequently visiting the site. On a daily basis, Ventia collects upwards of 20 photographs creating a very large historic record of sites over time. The app has a built in photo function whereby the user can take a photo of a specific site aspect, name and save the photograph within the app itself with no need to open the phone's photo app (refer to Figure 2). Our centralised data team periodically download the photographs stored on the admin website into our Hydstra database. Using the photo function in the app has eliminated the need for photos to be transferred via email to a central storage location and enables Ventia to communicate site specifics more clearly to the site owners.

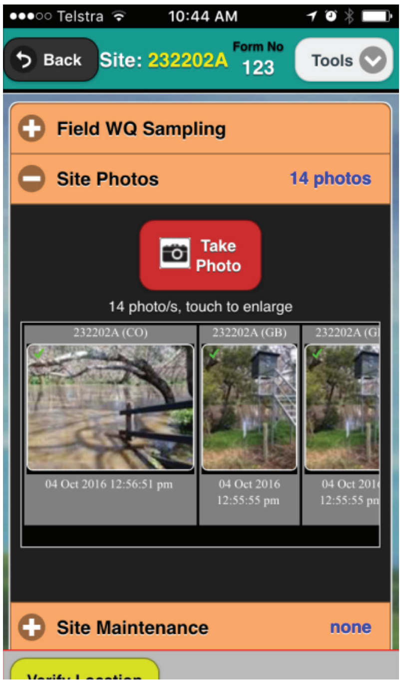

Figure 2. Collecting site photos.

Site maintenance

A newly developed section of the app lets users record typical site maintenance activities carried out and the time taken to undertake them. Photographs can also be captured in this section to record pre and post maintenance. These photos are integral in communicating to Clients the task completed and allows for desktop auditing of works if required. Collecting this data also allows internal analysis of operations, leading to improved service to our Clients.

Maps and coordinates

The app has mapping functionality which will plot all the sites in the run on a map as colour coded pins to indicate whether the site has been visited or not. Users can touch any pin to find out which site it is and can get directions drawn on the map from their current location to the site. You can also request a "Street view" of the site if supported. The app also has a radar and compass functionality to assist with locating sites. GPS coordinates can be viewed and updated as required within the app.

Data management and systems

Data collected in the app and stored on the admin website is transferred to our time series software, Hydstra, with data flowing both into and out of Hydstra. Data uploaded from Hydstra includes site lists, GPS coordinates and portable water quality meter information including calibrations. Whilst these processes are at this point in time semi-manual, by doing this, we can ensure that our systems are connected and one single source of data is managed in one place.

In the majority of cases, water samples are collected at the same time as *in situ* spot water quality readings. These samples collected by Ventia are sent to a laboratory and analysed for a number of parameters. Ventia manages both the lab results and the *in situ* readings and therefore a specialised matching process was developed within the app to match the spot data with the laboratory data. This matching process is highly efficient and outputs a spreadsheet of results that is directly uploaded into Hydstra. Prior to the app, this process was highly administrative and manual and was prone to human error.

Challenges

Building an app that meets the needs of the business as well as being user friendly and fit for purpose brings with it some challenges. Working in geographically diverse and often remote areas poses an interesting challenge with connectivity. Whilst the coverage of mobile networks has improved over the past five years, mobile networks still do not access all of the State and therefore we needed a solution that was still workable when communications were not possible. The app allows its users to download data onto the phone for sites that are to be visited during the field run. This task is undertaken in the office prior to mobilisation. After this is done, the app can be used in offline mode in the field. This allows the app to function normally, even when out of reception, and stores any data collected locally on the phone. Once back in reception, the app can then be placed in online mode and data is pushed to the admin website for easy viewing.

Creating an app that was user friendly and easy to use in all field conditions was a challenge. Ventia currently supplies all field staff with an iPhone on which to run the app from, however there is also an Android version as well. The display therefore had to be clear and concise to be functional on a small phone screen. The use of drop down menus throughout the app assisted in this area.

Conclusion

The SiteRunner app has brought many benefits to Ventia's business including continuously improved safety awareness, improving efficiency of data processes, streamlining collection of data in the field and ultimately improving data quality. Its flexibility in design provides opportunities for continual improvements and allows Ventia to be agile in responding to changing Client requirements.

Innovation in Compliance Monitoring: Combining fit for purpose hardware with customised IOT solutions to streamline monitoring data collection and information reporting

Richard Campbell, HydroTerra, Melbourne, VIC
Daniel Condon, HydroTerra, Melbourne, VIC
Paper presented to 18th Australian Hydrographers Association Conference Canberra. 24-27 October 2016.

Abstract

Compliance monitoring forms a major component of environmental monitoring in Australia. Strong regulatory and licensing structures in most states underpin the need for the activity. The costs to industry of compliance are recurring and often costly. Traditional compliance has involved a component of sampling, manual field measurement, some automated telemetered data provision and reporting. With the rapid changes in monitoring technologies (sensors, telemetry and data management packages) the traditional approaches are in many cases no longer best practice, efficient or cost effective. Inefficiencies in compliance monitoring are common as monitoring requirements tend to grow iteratively and there is seldom the time to assess the overall costs of compliance monitoring and to look at more efficient ways to achieve the desired outcome.

Introduction

HydroTerra has developed a systematic approach to assessing compliance monitoring requirements and providing optimised monitoring solutions. This requires understanding of regulatory requirements, measurement technologies and their accuracy and maintenance/calibration and installation requirements. A cost benefit analysis is required to look at choices of measurement and reporting methodologies. This approach has been applied at many sites. The systematic methodology used is outlined in this paper.

Three case studies are presented across key industries:

1. Property Development.
2. Mine site – Rehabilitation.
3. Landfill Compliance.

Each case study demonstrates challenges that hydrographers may face (i.e. diversity of skills required to effectively implement measurement technology, regulatory requirements, IT/software skill requirements and other emerging technologies) and how a staged approach can improve efficiencies for the client.

Background

HydroTerra offer practical, cost effective solutions to increase operational efficiencies and meet compliance requirements. There are significant costs to industry in achieving monitoring and reporting compliance. The costs whilst variable between projects can be generalised as follows:

- **Project Management**: System Design, Fabrication, Installation, Data Collection & Customised Reporting;
- **Customised Data Management and Reporting**: Efficient provision of environmental information. Includes telco charges & hosting charges, software licences, report customisations, IT support with scripting sensors to data storage, 3rd party data routing to central storages, designing & configuring overall data management and reporting systems;
- **Field Data Collection**: Field based equipment maintenance, data down load, sampling and factual reporting in accordance with SOPs[4];
- **Environmental Monitoring Training**: Technology, software, application, regulation, SOPs, data management & reporting;
- **Monitoring Technology & Software CAPEX**[5];
- **Monitoring Technology Rental & Leasing (OPEX)**[6];
- **Ongoing Equipment Maintenance & Repair**: Workshop based monitoring and sampling equipment clean, calibration and repair;
- **Consultancy Design**: Monitoring plans and systems, utilising specialist applied knowledge and technology awareness to assess and identify opportunities to optimise environmental management;
- **Consultancy Interpretation**: Interpret significance of observed results. Reporting these results.

Significant cost savings can be achieved by considering the project holistically, considering each of the above points in the integrated monitoring approach. Figure 1, 2 and 3 illustrate the hierarchy of costs to achieve compliance.

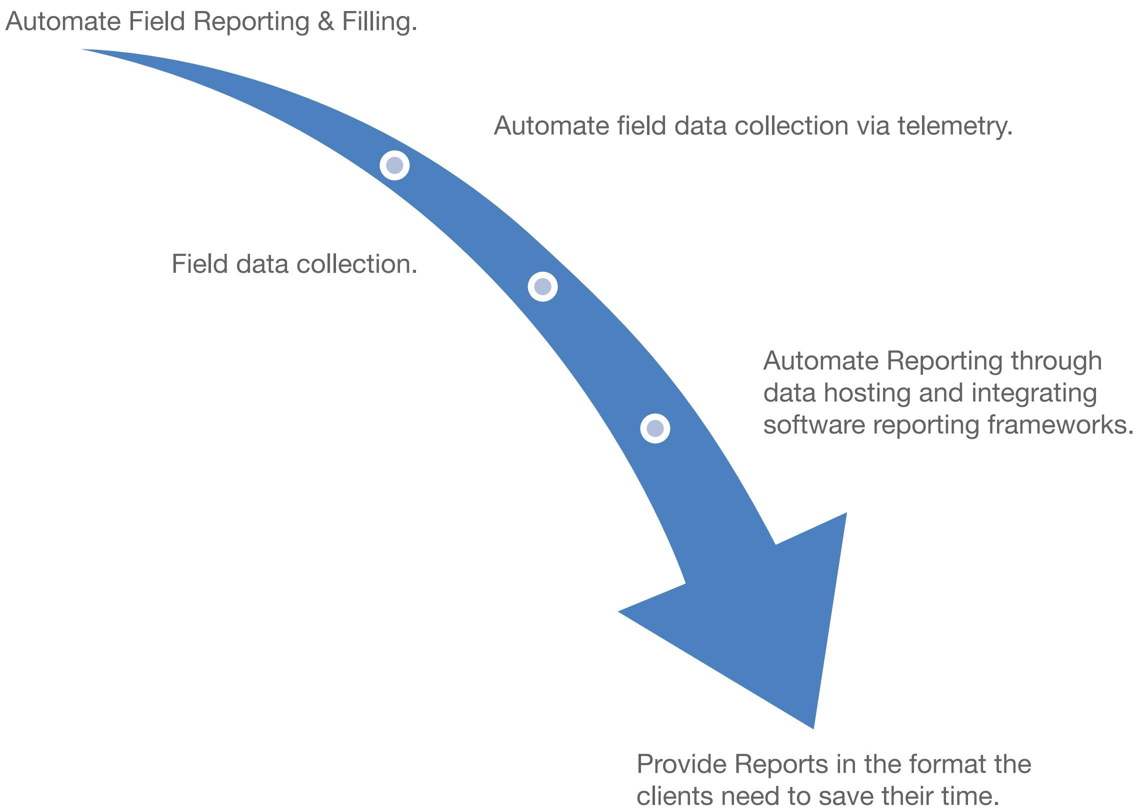

Figure 1. The components of an automated monitoring program.

4. SOP: Standard Operating Procedures.
5. CAPEX: capital expenditure.
6. OPEX: operational expenditure.

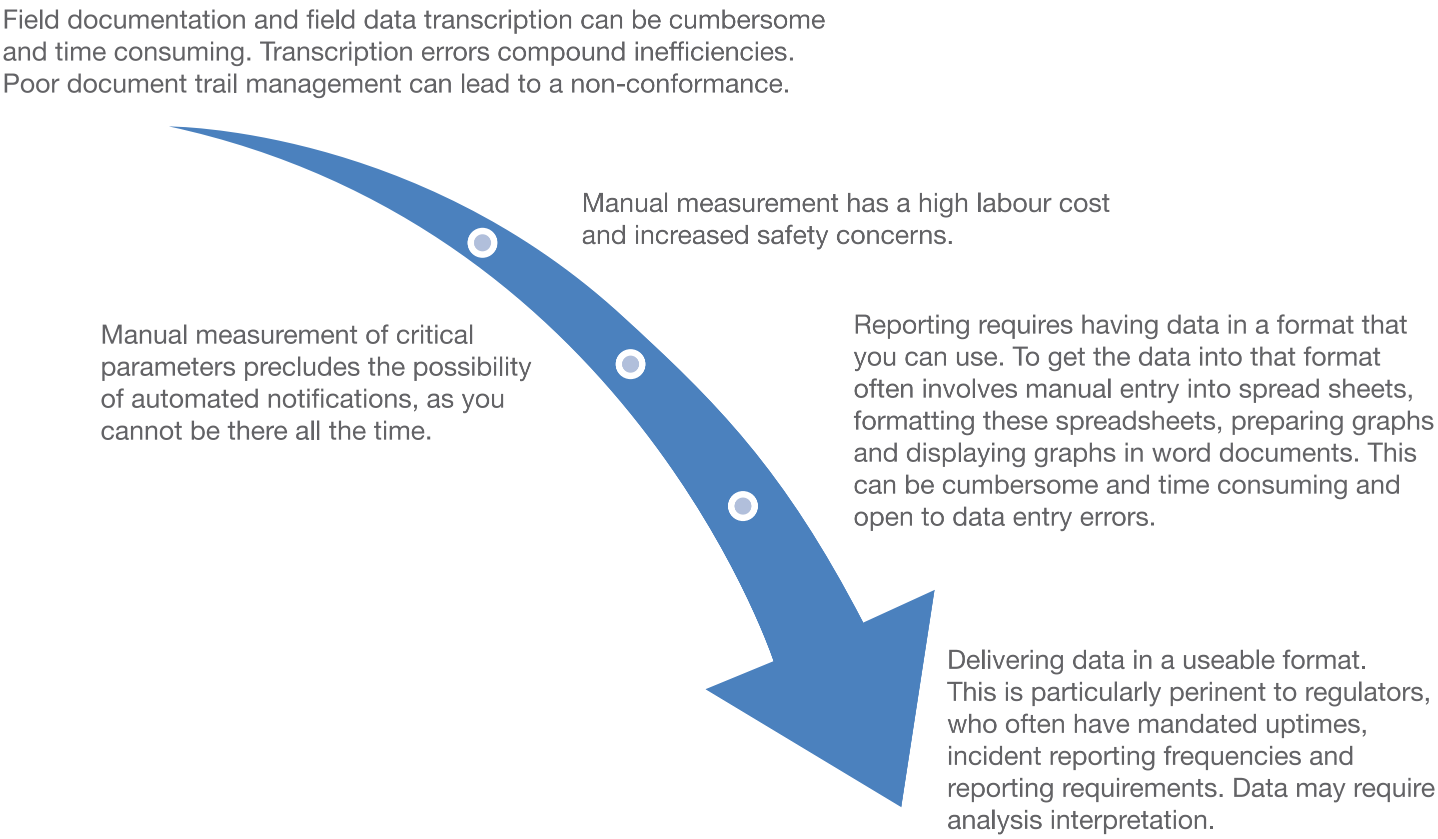

Figure 2. Inefficiencies in manual compliance monitoring.

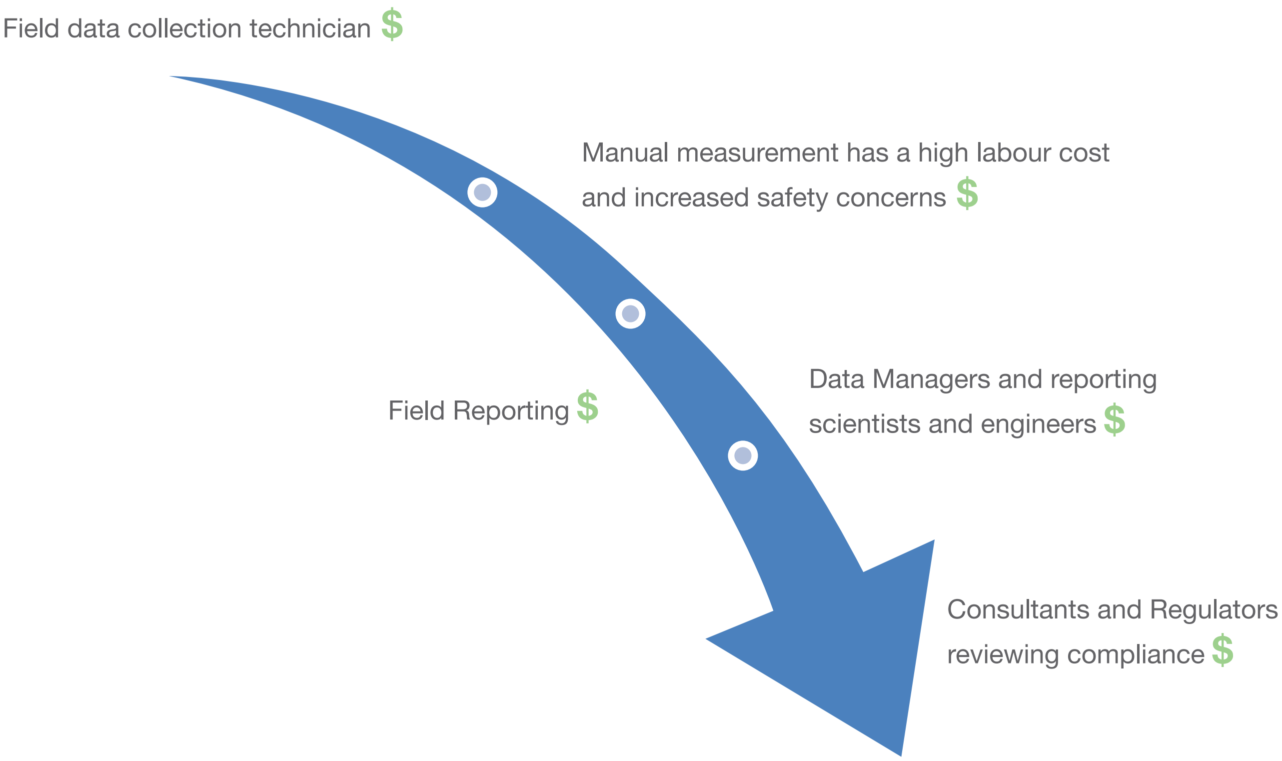

Figure 3. Relative labour costs of different stages of compliance monitoring and reporting.

Inefficiencies in monitoring processes compound along the compliance pathway (Figure 3) causing significant costs. For example it is common to allocate reporting responsibilities to the more experienced and expensive resources rather than automating reporting earlier in the compliance pathway, saving costs.

Optimised monitoring system design therefore needs to balance technical and economic considerations: this involves both a design phase matching SOPs and equipment specifications to environmental conditions and parameters to be measured. A cost benefit analysis is then required which compares alternative approaches to collect the same data.

System design

HydroTerra employs a 5 stage approach to each application:

Stage 1. Review compliance requirements. Typically, this entails reviewing the licence and approved monitoring plans and reviewing the operational monitoring and reporting requirements. This stage involves liaison with amongst others, the site operators, regulators and if appropriate, accredited Environmental Auditors and/or consultants.

Stage 2. Collate and document an inventory of site monitoring infrastructure, purpose, parameters collected, frequency of measurement and reporting.

Stage 3. Review of the cost basis of the current monitoring approach, calculation of bench mark costs for specific monitoring activities.

Stage 4. Review alternative approaches to monitoring and reporting and quantify in a cost benefit analysis the optimum method for monitoring and reporting.

Stage 5. Develop monitoring system specification including: Standard operating procedures (SOPs) for field data collection, manual measurement templates, automated monitoring infrastructure and automated reporting templates as required. This specification describes in detail the monitoring system and forms the basis for implementation.

Turn key Data Provision and Reporting

When stage 5 is completed the monitoring program will be implemented. This will include provision of monitoring equipment, installation, telemetry, data management, hosting and customisation of reporting. It is important to note, that the process drives the most cost effective outcome – this is not always automation.

Key Advantages

- The turn key approach produces more cost effective collection of compliance information and significant improvements in the reporting of both incidents and compliance reporting.
- Automated reporting significantly reduces reporting time and associated costs.
- Tender specifications for required sampling and data collection become standardised and more efficient.
- Integration of third party data sources, allows data to be collated in one location;
- Increased access to data by the public to maintain a certain degree of transparency with certain data.

Case Studies

Three case studies are discussed which illustrate the diversity of environmental compliance regulation, and the need to have a flexible approach to achieve efficient solutions. Table 1 summarises the application of the five stage approach to each of these projects.

Property Development

Baseline wetland characterisation in Bellarine Peninsula in Victoria involving flow and water quality characterisation.

Data was displayed in real-time view on the DataStream platform for analysis, review and some display to public.

Staff gauge, in situ level and water quality

Flow monitoring

Weather station, near sales office

1. Lake Victoria
2. Channel connecting Lake Victoria and Stockland Point Lonsdale site
3. Stockland site waterway in deeper part of flow path between Lake Victoria and Bellarine Highway
4. Water inlet/outlet pipe inside site adjacent Bellarine Hwy
5. Channel 100m north of Bellarine Hwy
6. Head of Lakers Cutting about 50m east of Fellows Road
7. Swan bay end of Lakers cutting, on west side of the bar

Figure 4. Wetland characterisation site on Bellarine Peninsula.

Key Objectives:

- To undertake continuous water quality monitoring at an interval of 15 minutes, and to collect water quality samples once a fortnight to verify baseline water quality conditions at five (5) locations.
- Using a handheld flow tracker, undertake continuous flow measurements on a 2 weekly frequency.
- Weather conditions monitored every 15 minutes.
- DataStream was used as a data management platform to monitor telemetry data from all five locations form the Point Lonsdale site.

Industrial Discharge

Salt mine rehabilitation: environmental discharge monitoring and automated control measurements for brine discharge to the open channel network in South Australia, involving pipe, open channel and estuary monitoring approaches.

Figure 5. Discharge monitoring site overview, South Australia.

Key Objectives:

Optimise the monitoring and pump control processes associated with the rehabilitation plan for the salt works. Including:

- Optimising the pumping regime, and provide costs associated with that plan and a schedule to complete.
- Increasing reliability of the pumping system to minimise the risk of exceeding the compliance criteria at the weir, yet allow pumping rates to be optimized; ensure it is possible to reliably and efficiently report data (flow rate, water level, pump status) by DataStream for compliance reporting purposes.
- Improve functionality of sensors at the weir to reduce maintenance requirements and to the maximum extent possible provide representative measurement of EC[7] and ultimately TDS[8] concentrations at the weir in concentration units of parts par thousands.
- Minimise the effort required to trouble shoot the system in the event of failure, to improve the 24/7 reliability, rate of response and adequacy of reporting.

Landfill Compliance

Landfill compliance monitoring (integrated system across 11 landfills in Victoria): bringing in third party data sources from Laboratories, field observations, third party telemetry providers into a common platform, DataStream.

7. EC: electrical conductivity.
8. TDS: total dissolved solids.

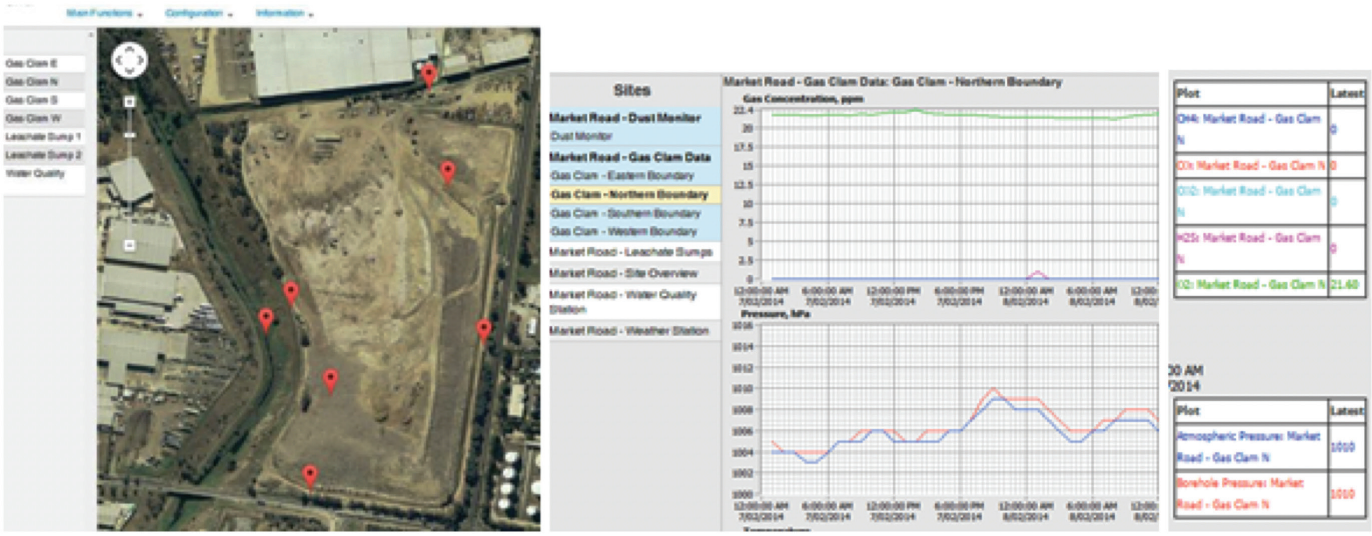

Figure 6. Example of DataStream dashboard with graphs and google maps views.

Key Objectives:

Improve efficiency of compliance monitoring and reporting. The following critical requirements were to be met:

- Compile all environmental monitoring data into one centralized location. This collection of data is taken from 11 landfills across Victoria with over 750 monitoring locations.
- Display all groundwater, leachate, perimeter gas, structure, service pit and wind data in an easily accessible webpage.
- Create alarms for certain parameters to notify staff of potential environmental exceedances.
- Display bore locations (nodes) in a simple and functional way to easily access data from a network of over 750 environmental monitoring locations.
- Creation of iPad field templates for field/environmental staff to collect data for automatic upload into DataStream.
- Creation of automated environmental reports.

	Property Development	Industrial Discharge	Landfill Compliance
Stage 1 **Compliance Requirements.**	The waterway component of a residential and waterway development project required approvals both under State Planning and Environmental legislation and also under the Commonwealth *Environment Protection Biodiversity Conservation Act*[9]. Conditions attached to the Commonwealth approval, required further modelling of water flows and water quality in the proposed waterway, with the modelling calibrated using synchronised monitoring of water flows and quality in the existing waterway at the project site and also in its adjacent, connected, water bodies. The results of the modelling and monitoring have been reported, peer reviewed and submitted to the Commonwealth and have satisfied the relevant conditions attached to the Commonwealth approval.	A salt works required ongoing discharge of brine to a canal which ultimately discharges to a marine conservation zone. The discharge was to assist with a rehabilitation effort for the salt works. In order to be allowed to discharge from the lagoons approval was required from the relevant regulatory authorities (DMITRE[10]; EPA[11] ; DEWNR[12] and PIRSA[13]). Relevant compliance activities included: A formal Change of Process Application in accordance with the operator's licence under the *Environment Protection Act*; A s77 Application for Exemption for marine discharge to an Aquatic Reserve under the *Fisheries Act*; Operation of the site in the "Holding Pattern" in accordance with the conditions of approval of the Change of Process and of exemption under s77 of the *Fisheries Act*; and transition to an outcomes-focused regulatory arrangement as required by the *Mining Act*.	As part of their ongoing right to operate/ manage operating and closed landfills, landfill owners are required to comply with a range of regulation. Specifically, compliance is required with the EPA licences issued under the *Environment Protection Act* 1970 in Victoria, and as part of their long term EPA Post Closure Monitoring requirements specified in Post Closure Pollution Abatement Notices (PC-PANS) issued by EPA. The environmental monitoring and auditing component of landfill management comprises: 1. risk assessment, 2. environmental monitoring program, and 3. environmental audit program. The environmental monitoring programs drive the need for compliance. *The specific compliance monitoring guidance can be found in the Victorian EPA* ***Landfill Licensing*** *Guidelines*[14]

9. https://www.legislation.gov.au/Details/C2016C00777 accessed 22 October 2016.
10. DMITRE: Former SA Dept Manufacturing Innovation, Trade, Resources and Energy.
11. EPA: Environment Protection Authority.
12. DEWNR: SA Dept Environment, Water and Natural Resources.
13. PIRSA: Dept of Primary Industries and Regions, SA.
14. http://www.epa.vic.gov.au/our-work/publications/publication/2016/september/1323-3 accessed 22 October 2016.

	Property Development	Industrial Discharge	Landfill Compliance
Stage 2 **Monitoring infrastructure available & measurements required.**	Collection of a 4-month duration simultaneous time series of water level, water flow and water quality data for the water flowing into the site, through site and from the site. The 4-month period started in the winter to capture higher rainfall events that might generate water flows.	The regulatory objective of the system required measurement of salinity at a weir immediately upstream of discharge to the estuarine environment. Regulation of discharge pumping using variable SA Water outflow (measured by SA Water ultrasonic flow meter) blended with brine water being discharged from custom built outfall. This involved in pipe flow measurement utilising ultrasonics and continuous electrical conductivity measurements (EC) of brine, converted to Parts Per Thousand (PPT) using a custom algorithm (based on lab and conductivity measures). Utilising and interfacing with existing SCADA system and radio telemetry infrastructure wherever practicable.	A comprehensive summary table of monitoring locations, frequency requirements, parameter requirements and compliance levels was documented and reviewed. This included each of the key parameters, groundwater level, landfill gas, leachate level and dust.
Stage 3 & 4 **Cost benefit analysis & optimisation of design.**	The Scope of Works required was derived in part from the GHD (2011) Baseline Water Quality Report. The most cost effective approach was a combination of manual measurements utilising IPad functionality combined with cloud based data hosting and templated data storage on DataStream, with high frequency measurements undertaken using 3G modem telemetry routed into DataStream. Reporting was optimised with customised graphing etc.	Cost benefit analysis indicated that it was most cost effective to utilise a new 3G telemetry system with standalone multi-parameter water quality sondes. In the case of pump control, it was most cost effective to interface with the existing MOSCAD – SCADA communications systems. Data management and compliance reporting was optimised by bringing this to a centralised repository and utilising DataStream software and IPad functionality.	Cost benefit analysis completed of current ongoing manual monitoring program in conjunction with regulatory requirements on site. Assessment of optimum method for measuring perimeter landfill gas, leachate sump levels, leachate pond levels, dust and odour.

Key Learnings

Stage 1 of the process 'compliance regulatory review' is absolutely key. This is where most people go wrong and inevitably end up with a solution that doesn't actually fulfil their needs.

A client's needs will, inevitably shift over the lifetime of the project so flexibility is important.

Maintenance of sensors can be a significant cost and should be factored in to all real time monitoring projects.

Automated reporting can significantly reduce overall compliance reporting costs.

Conclusion

Compliance monitoring is costly. It can however be optimised. The costs relate both to data collection and reporting activities. A holistic assessment of overall monitoring and compliance reporting programs can identify significant savings utilising an IOT based approach such as DataStream.

References

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