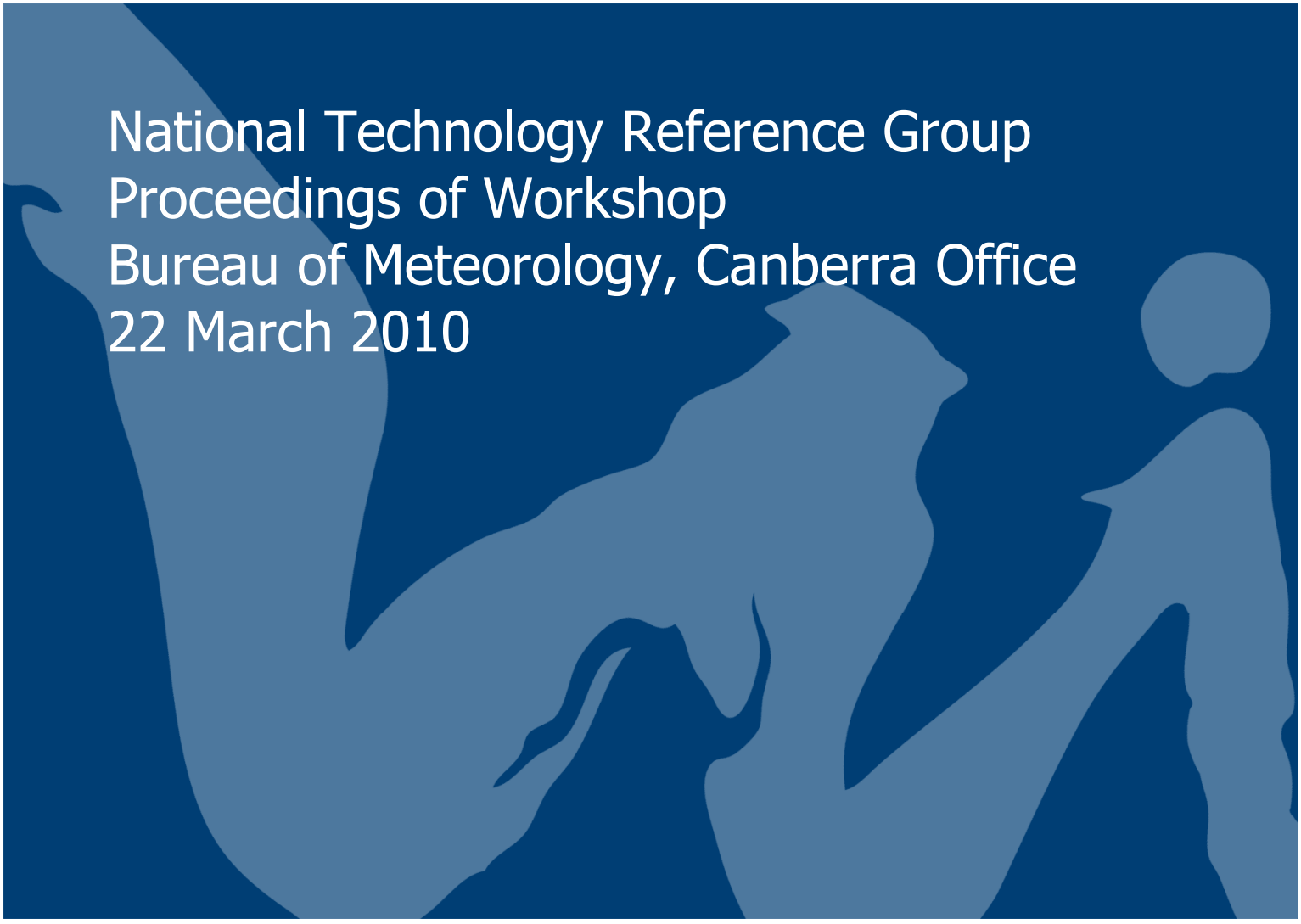
Water Information
DATA › INFORMATION › INSIGHT

National Technology Reference Group
Proceedings of Workshop
Bureau of Meteorology, Canberra Office
22 March 2010



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Acronyms list

Acronym	Description
AHA	Australian Hydrographers Association
CMA	Catchment Management Authority
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DECCW	Department of Environment, Climate Change and Water, NSW
DII	Department of Industry and Investment, NSW
DoW	Department of Water, Western Australia
DWLBC	Department of Water,. Land and Biodiversity Conservation, SA
GUI	Graphical User Interface
HWC	Hunter Water Corporation
JRGWI	Jurisdictional Reference Group on Water Information
MHL	Manly Hydraulics Laboratory
NOW	NSW Office of Water
NRM	Natural Resource Management
SCA	Sydney Catchment Authority
SCADA	Supervisory Control and Data Acquisition
SEQC	South East Queensland Catchments
SWB	State Water Board, NSW
SWC	State Water Corporation, NSW
SWIC	Strategic Water Information Coordinator
WDTF	Water Data Transfer Format

Foreword

The Bureau of Meteorology hosted the National Technology Reference Group (NTRG) workshop at its Canberra offices on 23 March 2010.

The idea of a workshop came from the desire to expose projects that had been undertaken as part of the Modernisation and Extension of Hydrologic Monitoring Systems (M&E) program, and to share technology improvements in water data collection. New South Wales introduced a similar group during 2009/10, coordinated by the NSW Strategic Water Information Coordinator (SWIC), David Malone. That group formed the basis of the NTRG.

The aims of the full day workshop were to:

- transfer knowledge about key technological projects across jurisdictions
- encourage collaboration between cross-jurisdictional named entities with regard to projects funded under the M&E program
- provide a forum for agencies to discuss the application of the latest and most cost-effective technology in water resources monitoring and management and also to encourage industry wide adoption
- discuss future specialised workshops or expert panels concentrating on specific technology areas.

Invited attendees came from Lead Water Agencies, other state government departments, the Murray-Darling Basin Authority (MDBA) and private companies.

This document

This document outlines the presentations given on the day and other general discussions. It is intended to be a reference for interested parties to learn more about activities funded through the M&E program, and particular projects or technological innovations that are related to the Bureau's water information collection functions.

A technical writer documented each presentation during the workshop. Full copies of the presentations can be downloaded from www.bom.gov.au/water/regulations/fundingProgram/ntrg.shtml.

In addition, two papers were handed out at the workshop. Copies of these can be found on the Bureau's website at www.bom.gov.au/water/regulations/fundingProgram/document/ntrg/ADVM_discussion_paper.pdf
www.bom.gov.au/water/regulations/fundingProgram/document/ntrg/DoW_IP_Telemetry_trial.pdf.

This document follows the workshop presentation agenda.

M&E program

The five-year, $80 million Australian Government M & E program is administered by the Bureau. The program's objective is to assist data collectors to modernise and extend their water monitoring systems and to enhance the accuracy and transfer of real-time data to the internet. At the time of this workshop, three rounds of funding—totalling approximately $50 million—had been allocated to persons named in the Water Regulations 2008. Many of the funded projects have cross-jurisdictional benefits, and the NTRG workshop enabled information sharing and a way of encouraging collaboration between named persons in future rounds of the M&E program.

More information about the M&E program, including who can apply and the full list of projects funded to date, can be accessed on the Bureau web site at http://www.bom.gov.au/water/regulations/fundingProgram/index.shtml.

Workshop agenda

Opening

Welcome	Tony Boston Bureau of Meteorology
NSW TRG - aims and outcomes	David Malone Office of Water, NSW

Session 1 - Data QA/QC

TAS2.1 Collaborative automated trials - QA/QC algorithms	Mike Ross Hydro Tasmania, Tas
WA6.2 Implementation of a data cleansing and annotation tool	Ian Scott Water Corporation, WA
Discussion and questions - session 1	

Session 2 - Time Series data management systems implementation and enhancement

WA4.4 Semi-automated data validation process for HYDSTRA	Glen Terlick Department of Water, WA
NSW1.11 HYDSTRA enhancements	John Hayes Office of Water, NSW
TAS3.2 Implementation of Aquarius Time Series DMS	Lance Stapleton Southern Water, Tas
Discussion and questions - session 2	

Session 3 - Water quality and related data management systems

QLD3.1 Management of water quality data	Gavin Sigley uniDap, QLD
NSW1.20 Database upgrade for 27 rural utilities	Graham Whyte Office of Water, NSW
Discussion and questions - session 3	

Session 4 - Implementation of acoustic Doppler technology

VIC1.6 In-situ Doppler velocity metering	Nurullah Ozbey Theiss, Vic
Provision of real time IP telemetry solutions	Neil Chapman Department of Water, WA
Discussion and questions - session 4	

Session 5 - Telemetry

Bureau wide telemetry developments	Bryan Hodge Bureau of Meteorology
Flood warning telemetry developments	Robert Thompson Bureau of Meteorology
Discussion and questions - session 5	

cont…

Wrap-up

Discussion and development of strategies for facilitating:

- areas of possible collaboration between organisations including joint M&E bids
- identification of special interest forums/expert panels
- identification of possible gap areas with respect to technology and standards
- strategies for maintaining momentum in key activity areas

Collation of key workshop outcomes and action items

Acknowledgements

This report is compiled from presentations and discussions from the workshop. Images used in this report are as supplied.

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Cathy Nicoll, technical writer.

Kirsten Adams, Linton Johnston, Alan Baker, Stephanie Holden editors.

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- John Cameron, Vic Department of Sustainability and Environment
- John Hayes, NSW Office of Water
- Bryan Hodge, Bureau of Meteorology
- David Malone, NSW Office of Water
- Nurullah Ozbey, Theiss services
- Graham Parsons, NSW Office of Water
- Mike Ross, Hydro Tasmania
- Ian Scott, WA Water Corporation
- Gavin Sigley, UniDap
- Lance Stapleton, Southern Water (Tas)
- Glen Terlick, WA Department of Water
- Robert Thompson, Bureau of Meteorology
- Graham Whyte, NSW Office of Water

Opening session

Welcome

Tony Boston, Assistant Director, Water Data Services, Bureau of Meteorology

Welcome to all those who are participating in today's workshop. The aims of this group are:

- knowledge transfer between people/groups undertaking key technological projects to other agencies and across jurisdictions
- collaboration between cross-jurisdictional named entities with the aim of maximising benefits of projects funded under the Bureau's Modernisation and Extension (M&E) of Hydrologic Systems Program
- encourage the development and submission of high value cross-jurisdictional and/or cross-agency Round 4 M&E proposals
- provide a forum for agencies to discuss the application of the latest and most cost-effective technology in water resources monitoring and management and to encourage its industry-wide adoption
- to facilitate discussion on future specialised workshops or expert panels concentrating on specific technology areas (e.g. adoption of water data transfer format or acoustic Doppler current profiling standards).

NSW technology reference group

David Malone, NSW strategic water information coordinator, NSW Office of Water

In NSW, there are nine major state agencies that collect, manage and share water resources data with other state and federal organisations. This represents around 95% of the water data collected in NSW. Another 70 organisations (catchment management authorities, local government, irrigation corporations, and power utilities) are also involved in some level of water data monitoring.

The Bureau's $80 million M&E program has provided the Australian water resources industry with an opportunity to make quantum improvements in key areas of water monitoring, especially instrumentation, data acquisition, transmission, data management and QA/QC processes. This significant cash stimulus has allowed the NSW state agencies to upgrade much of their ageing and outdated instrumentation and software systems.

To manage the M&E program and related Bureau activities, NSW established two committees:

- the SWIMP Steering Committee (SC)—to addresses strategic planning issues of water information planning

- the NSW technology reference group (TRG)—to coordinate technology issues by providing a focus for technology adoption, facilitating communication between organisations, and assisting information sharing in key areas of water resource monitoring.

With so much activity taking place as a result of Bureau initiatives, a knowledge management approach was considered essential to achieve full benefit of the investments being made. As a result, the NSW TRG was formed to provide a focus for this.

The areas of special interest in NSW include telemetry, instrumentation, Doppler technology, real-time Quality Assurance/Quality Control (QA/QC) processes, and data management, sharing and dissemination. External speakers with knowledge in these areas are to be invited to meetings. The groups aim to look at the challenges that will arise in the next five to ten years.

The TRG does not:

- deal with the development of Standards—this takes place in other forums
- dictate instrument selection or databases, which is up to individual agencies
- duplicate areas already well covered by the Australian Hydrographers Association (AHA) or the Bureau.

The NSW TRG aims to have a strong focus on the Bureau's M&E projects, especially in the area of cooperative funding applications, and looks to develop links with the AHA where appropriate.

To date there have been three meetings of the SWIMP SC and the NSW TRG. These are held about two weeks after the Bureau SWIC and JRGWI workshops. Generally the morning sessions are devoted to SWIMP SC matters and the afternoons to the NSW TRG. There is some change in personnel attending the two sessions.

Attendance is open to nominated officers of state agencies involved with water monitoring activities including DECCW, NOW, SWB, DII, MHL, SWC, HWC, SCA, Bureau NSW, Snowy Hydro Ltd. Attendance at meetings may vary depending on the topics being discussed and the technical expertise and interest of members.

A draft Terms of Reference for the NSW TRG has been proposed:

- provide a forum for agencies to discuss the application of technology in water resources monitoring
- share knowledge and experience in the areas of instrumentation, telemetry, data transfer and management
- identify cost effective solutions to water monitoring activities (e.g. cost savings in new telemetry)
- link with similar committees established by the Bureau and other jurisdictions
- develop joint funding applications for the M&E program
- report to the SWIMP SC.

Some suggestions for extending these actions at a national level, if supported include:

- half-yearly, Bureau-sponsored, national TRG meetings for the duration of the M&E program,
- the Bureau establishing a web site for dissemination of project information that:
  - lists all 'projects of interest'
  - provides project aims, outcomes and 'lessons learned'
  - includes PowerPoint presentations and reports (if available)
  - provides a blog space for Q & A communication
- establish special interests groups in areas of key technologies, such as Doppler systems and telemetry options.

It is also proposed to link to other jurisdictions. There are around 120 approved M&E projects in 2009–10, of which only 35 are in NSW. To be effective, the NSW TRG decided that it needed to link its work to similar groups in other states. This was discussed at the last SWIC workshop and has led to us being here today. The concept of a National TRG seems well supported around the states and territories. Is its future worth discussing further at this workshop?

Session 1 Data QA/QC

Automated quality assurance and control systems

Mike Ross, senior systems engineer, Hydro Tasmania, Tasmania

M&E project TAS2.1

Hydro Tasmania started developing automated quality assurance and control (QA/QC) systems in Round 2 of the M&E program to investigate whether it was feasible to clean and check data using automated processes.

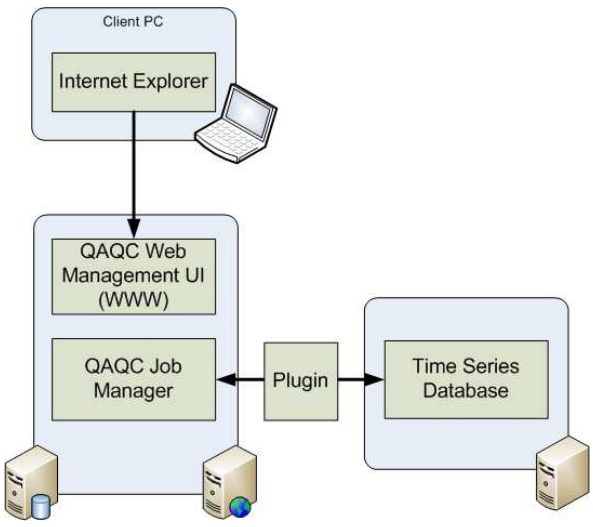
Project 2.1 is a continuation of this, with objectives to:

- develop visualisation tools to aid in the review and interpretation of algorithm outputs
- develop a new robust software framework, designed for scalability and volume throughput
- trial a new system on DWLBC's Hydsys time series database
- survey water agencies for suitability of inclusion in further trials, and how useful automated QA/QC tools would be to each organisation
- hold workshops to develop ideas and to present trial results.

The QA/QC system is shown in Figure 1. It is designed to:

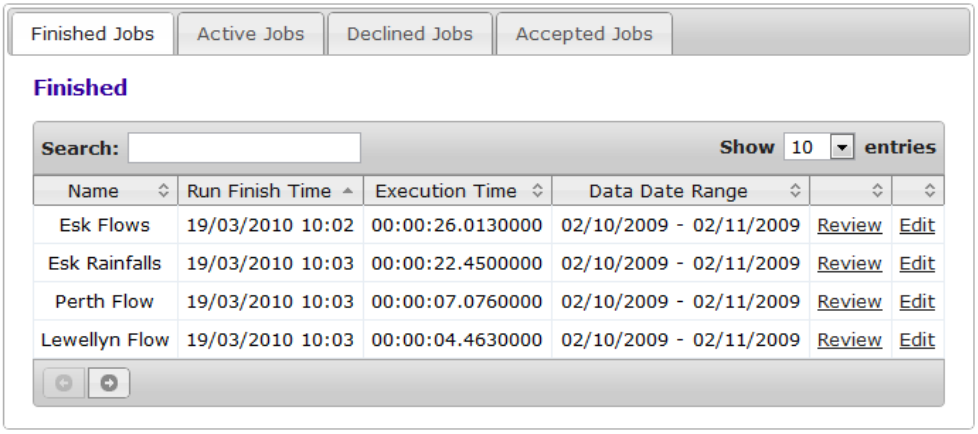
- have a low impact on existing systems
- use background processing for faster user interfaces
- rely on automatic job scheduling
- use a plug-in integration with Time Series stores—using WISKI, HYDSYS, ADMS, TIMESTUDIO.

Figure 1: System architecture



The system manages the data to be checked. It schedules the automatic analysis then notifies the user as jobs are finished.

Figure 2: Example of completed QA/QC jobs as they appear to the user

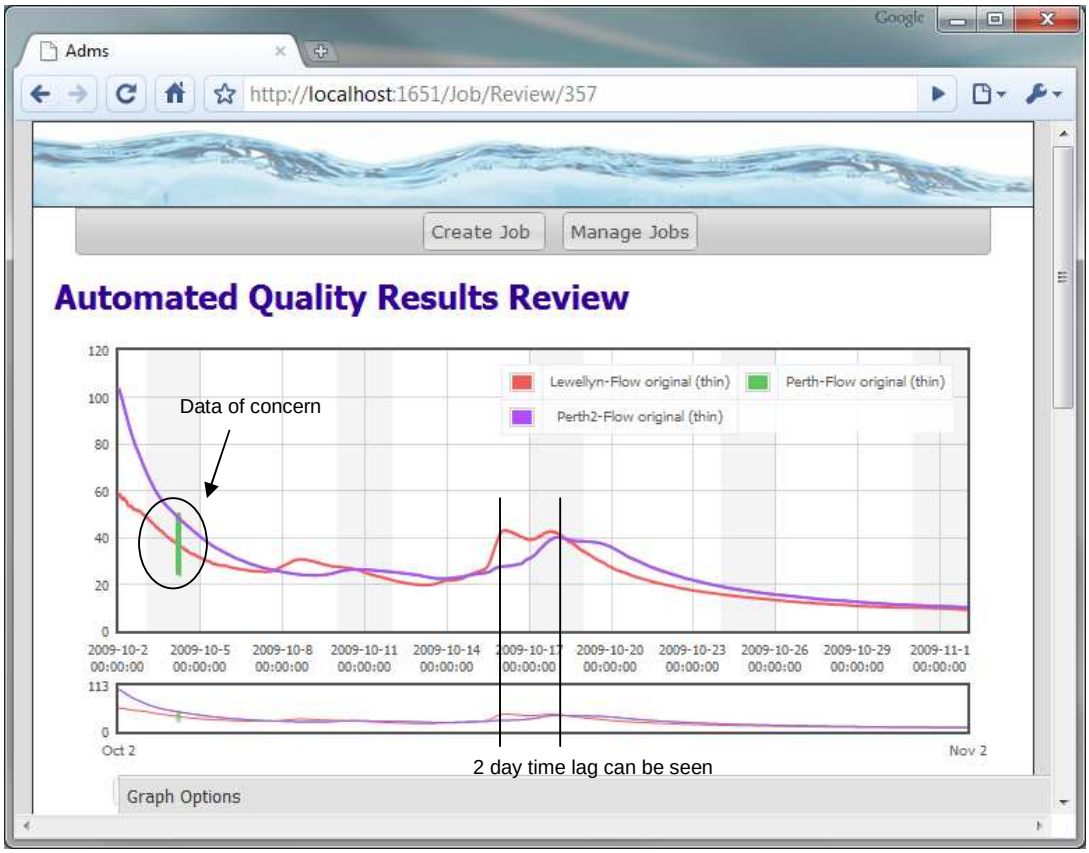


CSIRO, in consultation with hydrologists at Hydro Tasmania, developed the algorithms used by the application. The four algorithms currently in use have been designed to analyse water flow data. The algorithms are:

- temporal – uses lag detection in the training data to determine expected lags in raw data
- spatial – uses the distance between sites to determine the effect of lag between data collection sources
- spatial/temporal – a combination of the above
- multi-variant spatial/temporal – analyses one time series at a time by using rainfall and upriver flow to analyse downriver flow.

Figure 3 gives an example of how the QA/QC process highlights data of concern for the South Esk at Perth flow (marked with a circle). The graph shows a two day delay for peaks to flow from Llewellyn to Perth. Note that Llewellyn data are fairly erratic.

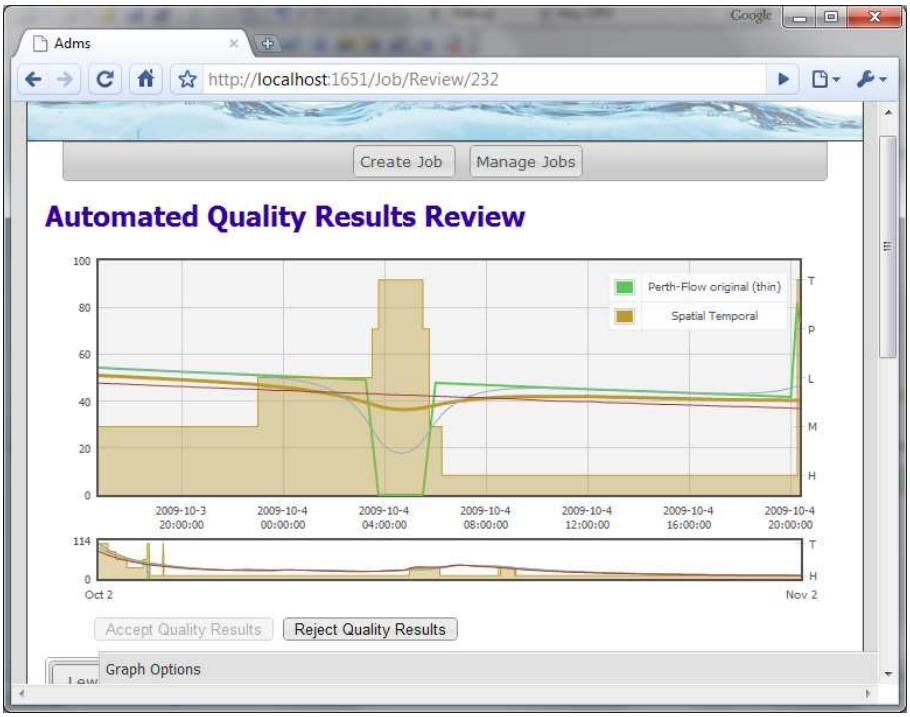
Figure 3: Example of flow data



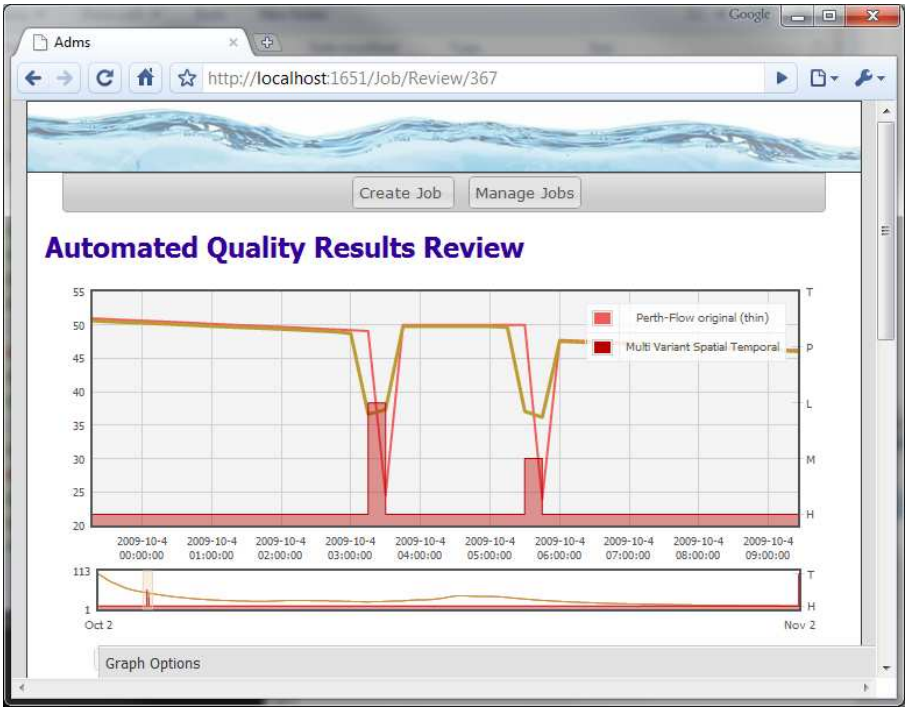
Further examples are given within Figure 4. In Figure 4(a) the problem area for the South Esk at Perth flow circled in Figure 3 is focused on (the green 'spike'). The QA/QC system has attempted a correction. The manager can check this and also manually correct if necessary. In Figure 4(b) the red bars show an automated attempt to correct data, but clearly manual correction is still needed.

Figure 4: Highlighting problem areas

(a)

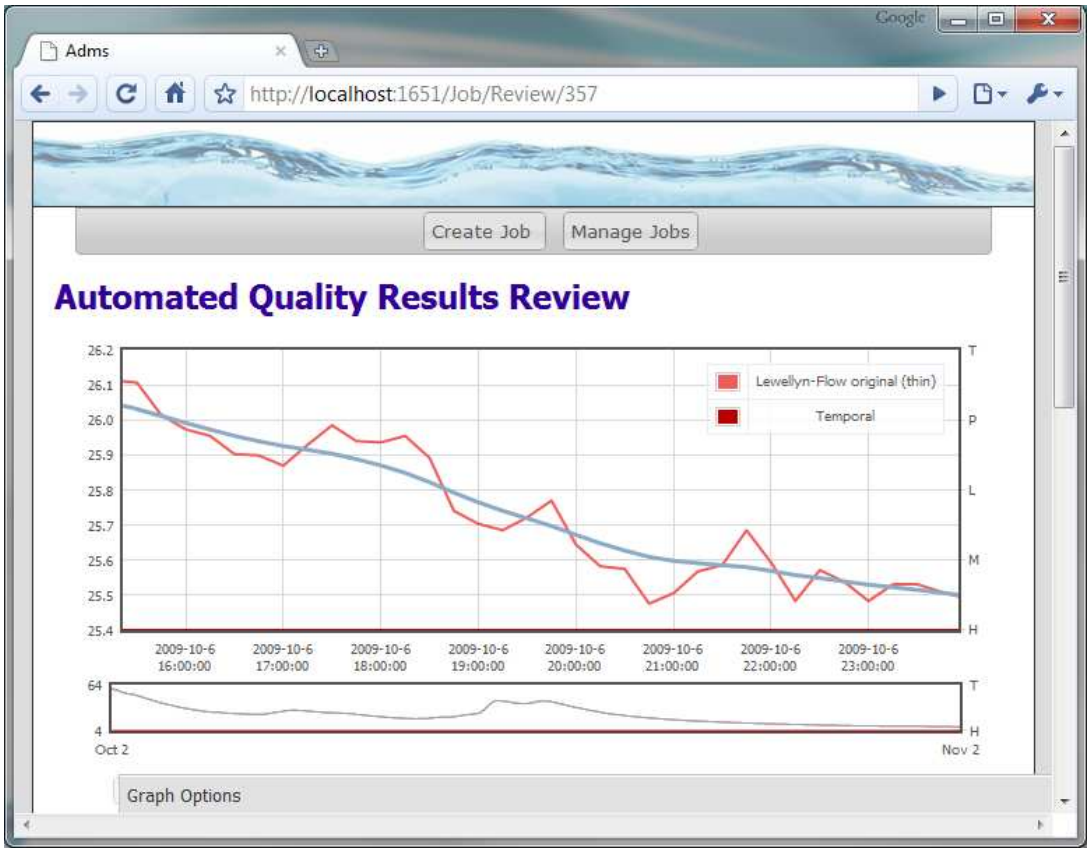


(b)



The QA/QC process is also suitable for smoothing out erratic data (Figure 5). In this example, the data can be erratic due to surges at the weir. The algorithm here provides a smoothed form of the data.

Figure 5: Smoothing out erratic data



Data cleansing and annotation tool

Ian Scott, Senior Technical Officer, WA Water Corporation, Western Australia

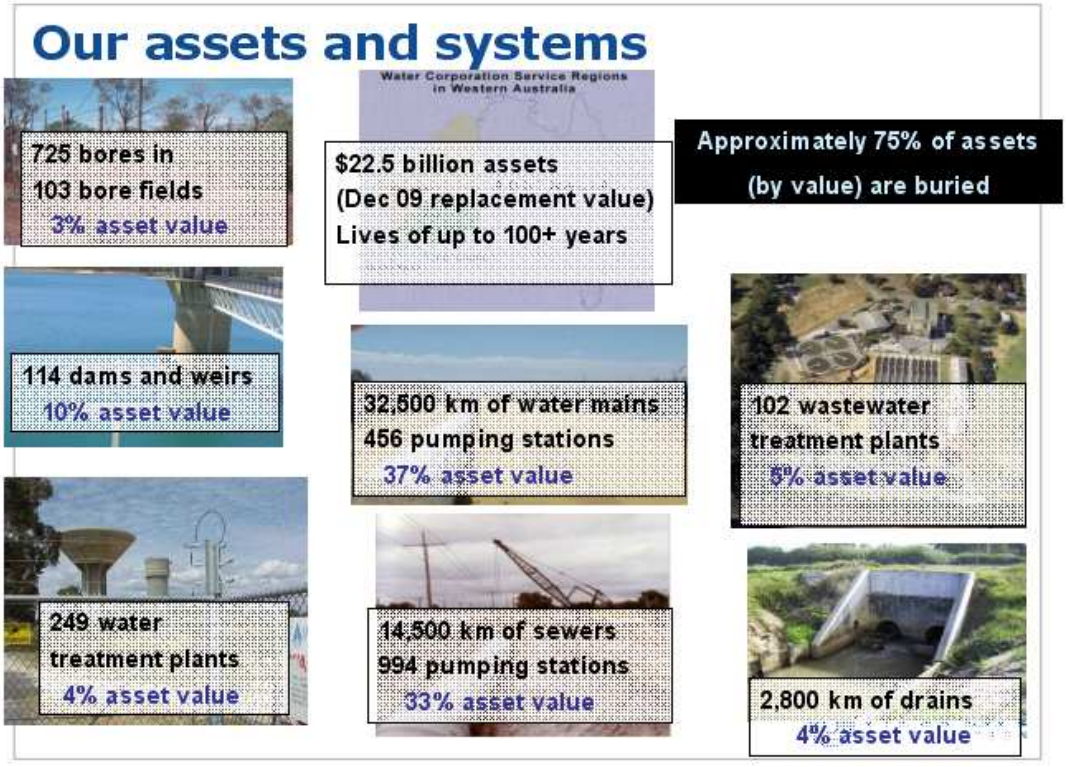
M&E project WA6.2

This presentation describes the data cleansing and annotation tool developed for the Western Australia Water Corporation (the Corporation). The Corporation is one of Australia's largest water service providers. It has state-wide responsibility for 1.8 million people in an area of more than 2.5 million square kilometres which is the world's largest water supply area. The Corporation provides water to more than 300 cities and towns, and it manages wastewater for 100 cities and towns.

The Corporation employs more than 2000 people and its asset base is worth more than $22 billion (Figure 6). The portfolio of assets is located across diverse geography from Wyndham in the north to Esperance in the South. They are technologically diverse and range from simple wastewater treatment ponds to sophisticated water and wastewater treatment plants.

- About 40% of the assets, by value, are related to the water transport and conveyance system.
- About 40% of the assets, by value, are related to the wastewater collection and conveyance system.
- 75% of the asset base (by value) is buried—out of sight but definitely not out of mind.

Figure 6: Water Corporation's asset base and systems



Strategic challenges

The Water Corporation considers it is in the 'Forever business'. Sustainability is a significant challenge and planning is now focused on changing climate rather than on an extended drought period. Factors such as increasing population and the need to minimise the environmental footprint are also important. Other challenges are:

- changing economy
- significant capital program
- difficulty in accessing skilled staff
- increasing costs
- increasing customer and stakeholder expectations
- increasing regulator requirements
- pressures for change in industry structure.

Solutions to some of these problems revolve around the use of technology to improve information gathering across the state and improve efficiency by using tools to disseminate the data.

To meet some of the challenges, System Control and Data Acquisition (SCADA) was seen as a cost effective way to control and monitor the distributed asset base. OSIsoft PI software is the system of storage for SCADA-sourced data for the Corporation. The primary data collection method uses flow totalisers to gather volumes over time. Manual data collection will eventually be replaced with SCADA.

Growth in SCADA is projected to increase from 10% asset coverage in 2005–06 to 80% by 2012–13. SCADA installs have been so quick that the business has struggled to implement data quality processes and proper commissioning procedures. Data errors have been identified for example due to power spikes.

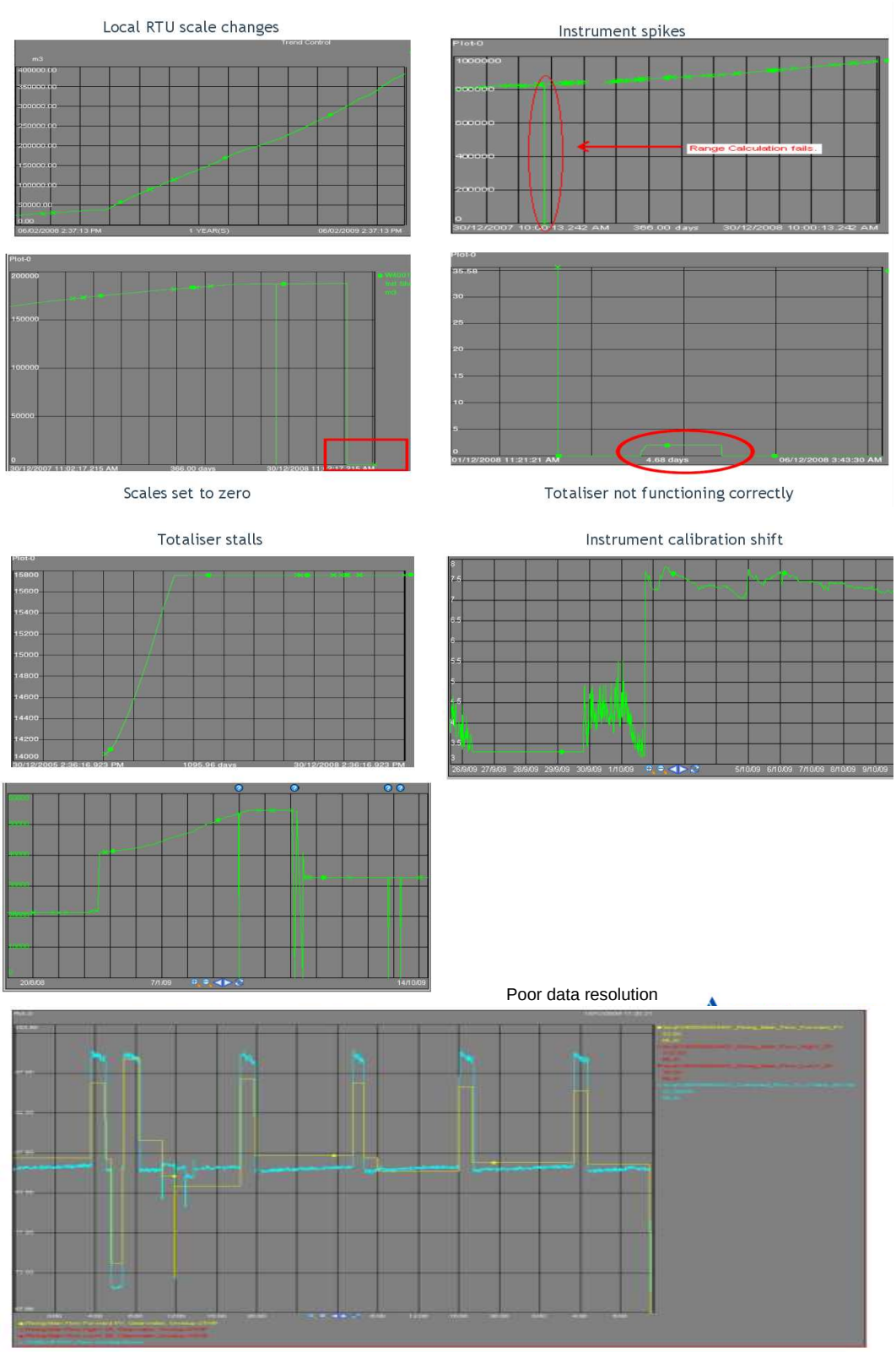
There is a corresponding challenge for data delivery to the Bureau, with only the high frequency data being provided (some 5000 sites, see Table 1).

Table 1: Data delivery breakdown

Category	Site Count
Water Course	335
Groundwater	2,290
Surface Storage	290
Weather Data	110
Basic Water Quality	1,950
Total	4,975

More than 90% of data are not 'quality gathered' in that they do not attract the same degree of rigour. For example, a hydrographer may not have collected this data. The types of errors are shown in Figure 7. Poor data resolution is of particular concern.

Figure 7: Data error examples



The solution to dealing with data quality issues must:

- keep raw data safe and secure
- include an automated way to identify data errors, including notifications
- include editing capability, both automatic and manual
- not necessarily consider quality tagging because data are bad or good
- include comments to be used to indicate levels of confidence
- be modular and expandable—customisable to any environment
- use core PI software to minimise future support and maximise longevity of solution
- be workable for any PI-based system
- allow for external funding (thank you to the Bureau! Note that part of the funding was to share the solution).

Proposed Solution

The proposed solution has two parts: PI-AANT application and the development of business processes surrounding data quality and control.

The implementation of PI-AANT (Aggregation, Annotation and Notification Tool) is underway. The tool provides users with a consistent analysis approach to the data, and enables a user to audit both business logic modifications along with the data. Data is aggregated into corporately acceptable intervals, and notifies users when something goes wrong. The tool also allows for auto analysis of the raw data for quality issues and then flags the aggregated data as questionable, users can then modify the questionable data to establish the corporate truth.

Process modifications are required to avoid the culture of data complacency that can come with SCADA. There is also a need to develop new process threads embedded in the Planning phase to deal with data quality along with asset creation. As this is a change to business processes it is necessary to engage with the business areas to define new process threads and determine what it means to them.

Alongside the development of business processes is the proposal to add personnel to monitor and co-ordinate data solutions, which include SCADA instrument fixes—this aims to fix data errors at their source.

The architecture for proposed solutions is shown in Figure 8.

Figure 8: Solution architecture

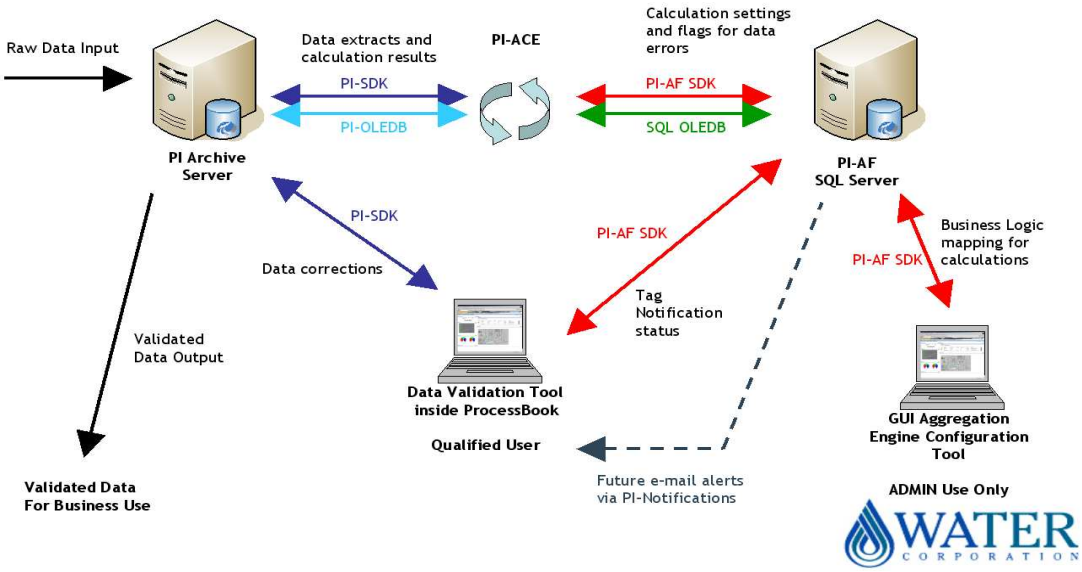
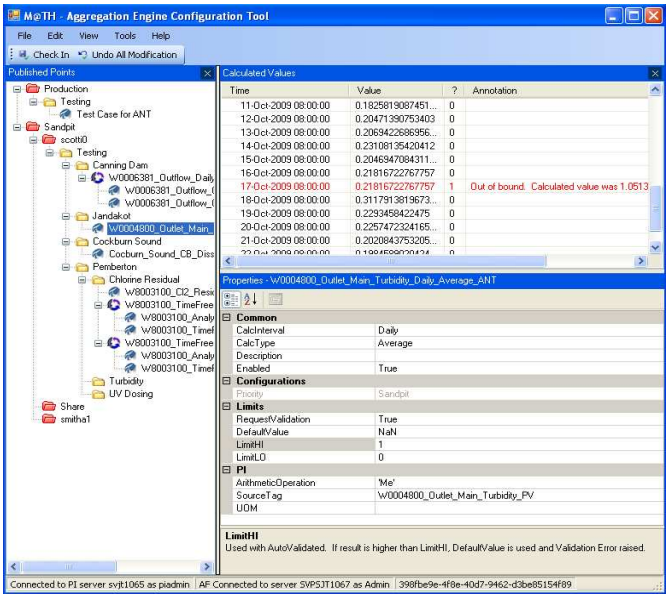


Figure 9: Aggregation Engine Configuration Tool

Solution Deliverables:

1. Aggregation engine configuration tool



This consists of a GUI tool to interact with PI-AF 2.1 and the PI Server, which has the following features:

- production and sandpit areas
- create or rename tags
- base points
- reporting points
- configure the calculations, set alert levels and establish complex formulas.
- define hierarchies to arrange information
- ability to copy existing rules to new tags
- uses weak references in PI-AF
- manual recalculation of any rule in the hierarchy.

It also includes the following audibility functions:

- configuration changes stored in tables in PI-AF, using native version control
- three PI tags used per calculation for data auditing
  - validated tag with one value per timestamp
  - audit tag with multiple data per timestamp
  - annotations stored in string tags to allow multiple entries per timestamp and scalable.

2. PI-ACE Aggregation Engine

The development of the engine utilises a modular approach to allow for future calculation modules. This also makes for easy expansion to new calculations.

The engine reads the configuration of the PI-AF system for tag configurations and regularly scans the PI-AF structure for new sites and setting changes without stopping the system.

Summary statistical functions are calculated such as average, minimum, maximum, standard deviation and delta. There are BatchON and BatchOFF functions which tell the system how to calculate event frame times. Calculation intervals can be set at 15 mins, 30 mins, hourly or daily.

The code allows changes to base data to be made via mathematical functions. The engine has the concept of hierarchical calculations to ensure all reporting points are re-calculated when base data is modified.

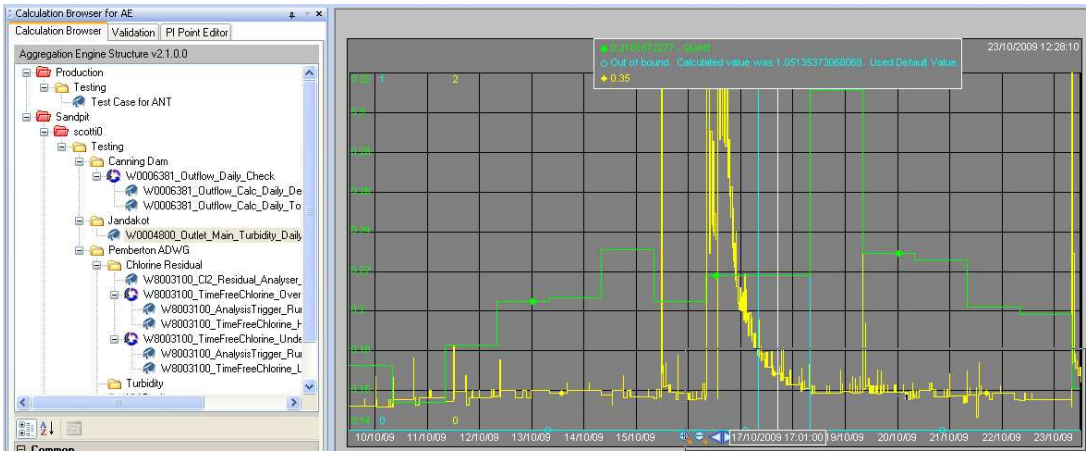
3. Validation Add-in to ProcessBook 3.2

Features of the ProcessBook add-in are:

- ability to scan the hierarchy for the tags of interest
- configuration panel shows the business logic for the tag
- trend displays source, validated and comment tags for base points. Reporting points include source tags for calculation
- validation panel to focus on the data with quality issues
- PI Point panel for cleansing any tag.

The add-in identifies only when the data may be wrong (Figure 10).

Figure 10: Validation add-in to ProcessBook 3.2



Example Application of the System - Canning Dam Flows

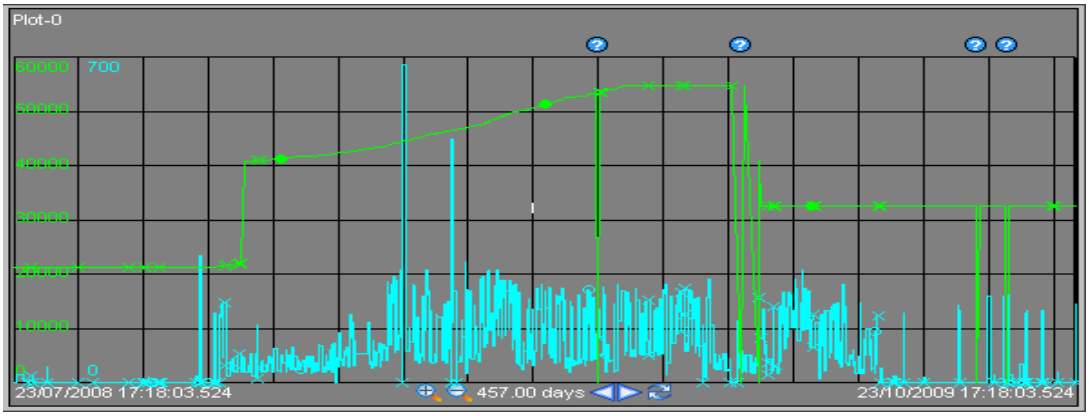
Problem:

- Monitoring of flow volumes critical to report to the Department of Water for licence purposes.
- Poor change management of SCADA equipment resulted in wrong data being stored in reporting systems.

Solution:

- Have daily figures calculated from both the flow rate and the flow totalisers.
- Compare the two daily figures for variations greater than 5%.

Figure 11: Example case—Canning Dam Flows



Summary

- The Corporation has a changing environment for data gathering:
  - instrumentation is changing manual data collection
  - too much data to manually check
  - not everyone who installs and configures the instruments understand why, and the business case for doing so
  - not everyone understands the data.
- Without the human element, automation is needed to monitor the automatic data gathering system
  - the solution aggregates, validates and notifies corporately acceptable data against business logic.
- Business culture has to move with technology.
- Business needs to focus on outcomes at implementation.
- The National Water Initiative has been a catalyst to review poor data practices.
- The Corporation is entering discussions as to how the solution can be distributed.

Session 2 Time series DMS implementation and enhancement

Semi-automated data validation process for HYDSTRA

Glen Terlick, WA strategic water information coordinator, Department of Water (DoW), Western Australia

M&E project WA4.4

The process described in this presentation aims to do automatically in HYDSTRA what has been done manually for the past 20 years (using HYDSTRA).

Aims:

- To streamline the import of hydrologic time series data files presently downloaded manually from field sites by developing automated systems. An initial target is ~700 data loggers being installed at groundwater sites across Western Australia. Currently only 350 stream gauging stations are in the system.
- To radically improve the calibration and validation process by semi-automating time calibration, data spike removal, rainfall calibration and the simpler sloping corrections.
- To drastically reduce, and ultimately eliminate, the regular occurrence of data backlogs, and to introduce a robust automated preliminary validation system to be applied to telemetered data as it is imported prior to publication to the web.

DoW currently processes raw data files and field calibration readings to apply quality codes and standards criteria as well as following a data commenting procedure. All these processes are aimed at delivering datasets to an archive that are fully quality assured. For data downloaded in the field, most of these processes are carried out manually.

WA 4.4 is intending to streamline these processes by:

- importing multiple raw files (as presently occurs for telemetered sites)
- conducting time checks
  - automatically calculate logger vs. true time differences
  - compare differences to preset criteria
  - if criteria are satisfied, make the adjustments
- checking values:
  - automatically calculate logger vs. check reading differences
  - compare differences to preset criteria

  - if criteria is satisfied, automatically make the adjustments.

Implementation will be as follows:

- value and time checks:
  - stored within a simple database
  - where possible, data entry to be performed in the field
  - this auto routine will simply refer to the values
- quality code criteria:
  - stored within a simple database
  - totally configurable by the user or data manager
- process control
  - database fields include options for the operator to halt the auto-validation, based on preset criteria.

In addition, the routine will make use of existing HYAUDIT options through comparisons with the existing archive. For example comparisons to absolute maxima or minima, and the maximum rate of rise and fall of existing record will be used to determine the data point's validity. Data found to be invalid with be automatically deleted.

Progress so far indicates that QA processes can be used to check that logger times are within bounds and that values are within bounds. Depending on the answer to these checks ('yes' or 'no') the system either applies adjustments and assigns a quality code or halts the auto-processing.

Validation of time series hydrological data has always demanded very high standards. Historically, an experienced operator may be able to complete and archive data from 10–15 downloads in a day. The main advantage of this approach for DoW is that, for 'clean' datasets, this process is aiming for validation and archival of about 30 downloads in 5–10 minutes.

The next steps are to:

- automate data comments
- trial other parameters
- add a 'Peak' field to calibration database
- build a friendly front-end onto calibration database.

HYDSTRA enhancements

John Hayes, Manager Water Data Systems, NSW Office of Water (NOW)

M&E project NSW1.11

The original bid to the Bureau for HYDSTRA enhancements had three components:

- To provide a WDTF importer/exporter for HYDSTRA and a web data scraper (the scraper has been deferred until Bureau work on this area is further developed)
  - to allow water agencies to access data being supplied to the Bureau in WDTF from other agencies and to transfer data between agencies
  - to allow the creation of a 'state' archive
  - to enhance water management decision making processes by adding to the knowledge and understanding of the natural processes in action in the state.
- To work towards a national approach to instrument management and to enhance the Hydstra Instrument database system. NOW staff realise that instrument performance directly relates to data quality. An enhanced instrument database would enable better asset management, and allow the storage of more information related to the instruments. It would also enable access to calibration records when editing and use when processing data. The database will also allow NOW to be consistent with other agencies.
- To provide a generic tool to allow WDTF export from Excel spreadsheets or Access databases. As a lead agency, many requests were coming from smaller organisations, for example local councils, looking to acquire data management systems or build WDTF exporters to be able to send data to the Bureau. These organisations are generally too small to need specialised data management systems.

Progress so far

Considerable work has been done building a WDTF importer/exporter for HYDSTRA using work from previous projects. Kisters will continue to work on this.

A national workshop on instrumentation management was held on 3–4 March 2010. Chaired by Michael Whiting Secretary of AHA, it included 31 attendees from all states, the Bureau, major hydrometric consultants and Kisters. Attendees talked about systems and issues.

From this workshop, four major issues were identified and examined in more detail: instrument classification, asset information, quality information, and reporting requirements.

Each group examined and made recommendations on these areas. A report with recommendations is to be compiled from the workshop along with copies of the presentations. Also, workshop recommendations have led to project funding being available to have enhancements made to the Hydstra Instrument database.

A working prototype for the export of data in WDTF from Excel or Access has been developed. The initial system review has been completed and improvements suggested. Other external reviews are yet to be done and work continues on linking data with WDTF export requirements.

Implementation of Aquarius TS DMS

Lance Stapleton, Leader Process Engineering, Southern Water

M&E project Tas3.2

This presentation describes the state-wide water and sewerage industry water information management system.

Tasmanian Water Reform

- Water and sewerage reform was driven by the state government.
- Four corporations were created on July 1 2009: Southern Water (south), Ben Lomond Water (north), Cradle Mountain Water (north-west), Onstream (common services).
- Southern Water (for example) was created from Hobart Water and 12 councils' water and sewerage departments.

The concept design for the water information management system is shown in the diagram below.

Data Sources

Inline	• SCADA • Ajenti
Field	• Forms • Toughbooks
Lab	• Quality • Water and Wastewater

Clients

Internal	•Operational •Technical •Exec and board
Regulators	•Local – Councils EHO •State – EPA, DPIPWE, Health •Federal – BoM, NGERS, NWI
Public	•Commercial •Stakeholders •Residential

The vision is for a state-wide system that is a single database platform across all three water corporations. Ideally it would be centrally managed. This requires consolidation of field, laboratory and key SCADA data. Full transparency and public or regulator web-based access is also needed to allow for accessibility for a range of user capabilities. A range of data management and reporting tools are being developed to support key performance indicators and compliance.

The scale of water management operations has increased dramatically with the restructuring in Tasmania. Before reform, Hobart Water was responsible for supplying bulk water only. It included one drinking water treatment plant, four intakes, about 12 subsystems and some contracted services. Through the reform, Southern Water took control of the water and sewerage functions of 12 councils to manage 34 drinking water systems, 48 wastewater systems, 18 reuse systems, 50 raw water intakes, plus reticulation and biosolids etc.

The water corporations' state-wide water information management system was delivered using a staged approach:

- stage 1 (07–08): data transfer tools developed such as TimeStudio and Citect
- stage 2 (08–09): transition to Aquarius; development of laboratory, field and SCADA links
- stage 3.1 (09–10): transfer to Southern Water, expansion of scope, development of further links and telemetered intakes
- stage 3.2 (09–10): rollout to Cradle Mountain and Ben Lomond Water.

Stage 2: system acquisition, was implemented in 2008. It included a pre-qualification tender process (16 applicants), which was followed by a shortlisted tender process with three pre-qualified companies—OSISoft (PI), Kisters (Wiski), Greenspan (Aquarius). The Aquarius product supplied by Greenspan was selected through this process. The software has been installed and basic services, such as the web data portal, reporting system, and STARS, integrated. Expansion and further integration is still ongoing.

Table 2: Key features of the Aquarius/SWIMS model

	Data generation	→	**Data storage and management**	→	**Reporting**
Implemented:	STARS systems linking toughbooks to database links built with three laboratories Citect SCADA links (12 Citect systems to come together)		Aquarius is used as the backbone Greenspan support is used		Direct reporting to: Bureau EPA Internal Web data portal available
Future (short-term)	tough book support more SCADA links Ajenti data link more instrumentation		improving server linkages, building DBA support, providing training		finalise reports e.g. external agencies (DPIPWE, NWI, NGERS), internal operational and board reports build extra features in the web data portal

In the longer term, Southern Water is looking forward to:

- more internal resourcing dedicated to support
- development of a 'user community' for the Aquarius product
- expansion of monitoring systems and programs
  - catchment, wastewater and reuse—Ajenti
  - storage instrumentation
- further tools:
  - quality systems linkages (HACCP, Aquality, ISO etc)
  - real time asset performance tracking
  - full public access
- collaboration and potential to expand platform to other public sector organisations.

The main lessons from this exercise are:

- biting or chewing misalignment—never attempt a big software system project during major industry reform
- conservative is not conservative enough—when estimating resourcing or $$$ for integration, think of a number and double it
- computer says no—system → system linkages, crucial and difficult

- help vs. support—in house database expertise is essential. A committed supplier makes a big difference (get IT support upfront and committed)
- it never ends.

Discussion, Session 2

Question or comment from the floor: Cleaned data become standardised data in the archive. If the process of cleaning loses noise from data, then it could be actually removing natural variation (e.g. in-stream wave acting with hydraulic characteristics), but once the data is cleaned, it may not be possible to go back and do future studies. The point is that noise isn't always electronic noise.

Question or comment from the floor: Systems and standards should be designed to accommodate future needs. The technology exists, such as cheap storage, to allow for this.

Question or comment from the floor: The Bureau is not dictating that entities named in the Water Regulations define what purpose the data they provide is fit for—it is up to the end user to make that assessment. There is likely to be a future need to develop uncertainties around the data, as users usually just take whatever they can get.

Question or comment from the floor: There can be unusual error sources, for example from instruments, operator failure, systematic sources. Is there a way to 'open the gate' to search for error sources in long-term data processes?

Response: Glen Terlick—just now getting HYDSTRA to do what we want manually, with the field operator having total control.

Response: Lance Stapleton—too many gates can result in too many error logs. It is better to identify common causes and let data in, and clean later

Response: John Hayes—we have two data streams, (a) public, which is real time data, smoothed to remove real spikes but not necessarily cleaned and (b) archive, which is QA data, copy of raw data with check readings applied. We try to avoid systemic issues.

Question or comment from the floor: Is import/export for WDTF a manual process?

Response: The process is part of the data processing system. The HYDSTRA and Aquarius systems keep the raw data and the derived datasets.

Question or comment from the floor: How do you use QA systems in Tasmania?

Response: Lance Stapleton-We use HYDSTRA for that because of the sheer number of sites—over 3000. We have a lot of users who want detailed data, and other users just want to be able to scan through the data without finding major flaws.

Question or comment from the floor: How automatic is the system in Western Australia?

Response: When the operator goes to a site, our aim is that they know why and they have a checklist of what to do such as check that the readings are stored and recorded.

Session 3 Water quality and related data management systems

Management of water quality data

Gavin Sigley, CEO, uniDap Solutions

M&E project Qld3.1

"What we do not measure we cannot manage" this comment has been taken from Ross Young's opening remarks at the Bureau's National Water Information Seminar held in Brisbane in September 2009.

This statement resonated strongly and it has been re-iterated by all the partners in the project. It is a simple yet strong statement and from it the project partners have formed a view that the Bureau is serious about measuring and managing.

First impressions of the Bureau's Water project were 'great this needs to be done' and 'Yes it is ambitious'. But every grand accomplishment in the history of human endeavour was once a grand ambition. Compliments go to the original architects of the *Water Act 2007* and the subsequent architects of the Water Regulations 2008 and compliments to the Bureau in taking on what is a mammoth task. The statement does beg the question why, what, how and who in terms of measurements and management!

Before discussing the project details a brief background to the organisations and people involved in the project will be presented. The project is under the auspices of SEQC and UniDap is contracted to deliver products and services to SEQC.

Out of 56 NRM/CMA regions across Australia, 19 are involved with this project. They fall under category G in the Regulations. The people involved are passionate about the environment and natural resource management. They are also structurally fragmented by project-based funding. They have a history of being employed on contract and having to reapply for their own jobs on a regular basis. They are primary coordinators and executors of local on-ground environmental works. They are also instrumental in coordinating the activities of and the funding to the army of volunteer groups such as Landcare, Streamcare, Saltwatch, Dune Care, Ribbons of Blue, Waterwatch, Frogwatch and so on. They regularly measure things including water quality of streams and make groundwater observations. These observations are reportable to the Bureau.

Challenges

The uniDap WaterQ project began in 2005 to resolve a number of problems:

- Data security—most data are collected by a project officer on paper forms and all or some of that information is transferred to spreadsheets for analysis. Sometimes these spreadsheets are transferred to a server somewhere. This may be an improvement in terms of backup and disaster recovery but now the information resides in two places and it is subject to change in either—down the track who would know which version is correct?

- Data fragmentation—the observation data were rarely stored in context with the metadata associated with their collection. It was also considered likely that over time the datasets would become fragmented, lost or destroyed. The measurements we cannot find don't help with management either.
- Volunteer management—who is accredited to sample? How do we contact them? Who has the sampling equipment? All of these became unanswerable questions as soon as the project officer shuts the lid of their laptop!
- Real time reporting of results to volunteers—to keep the volunteers motivated to turn up they need to see that what they are doing is valuable. They need to know that they are making a difference, and 6–12 month reporting cycles simply do not cut it with them. They want to see the data point they collected appear on management graphs immediately with a single click of the mouse.
- Linking calibrations results to observations—this was a major QA problem. Every month the monitoring equipment was routinely calibrated with the calibration results going into yet another spreadsheet. The observation data and the calibration data were manually and painstakingly checked by the project officers to ensure data integrity. It was taking 20 hours a month to do. It comes as no surprise to find that the process was way behind schedule.

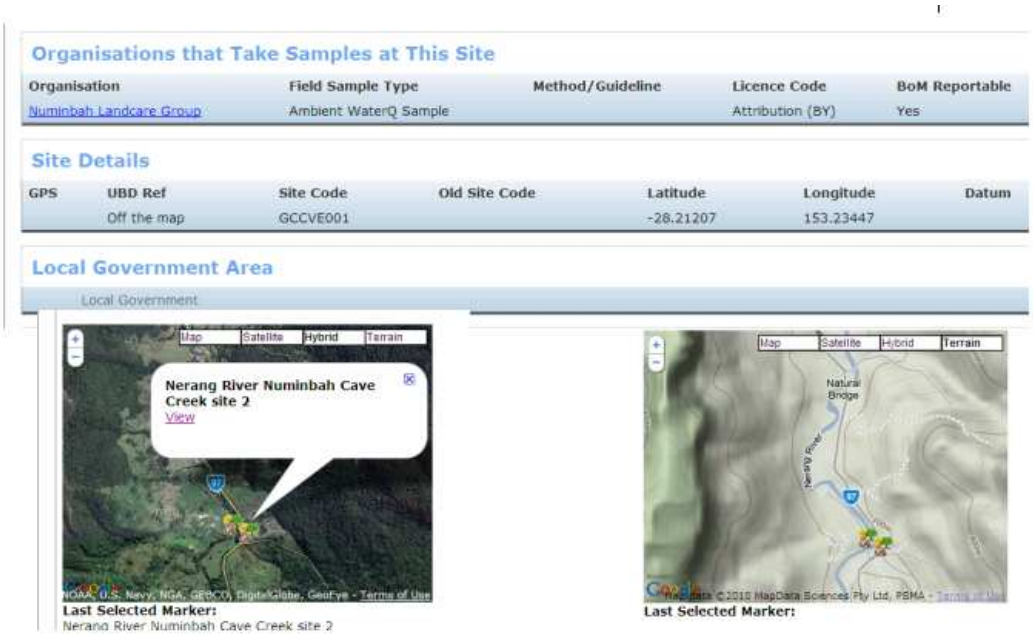
The web-based solution, uniDap WaterQ, resolved these problems by the end of 2008. For example, the calibration and observation process now takes around 20 minutes a month.

All of the project partners have exhibited these problems to varying degrees—of course their access to the solution via the M&E program resolves this.

The M&E funding effectively 'pressed the accelerator', giving more partners. It also saw that:

- a WDTF transfer engine was successfully built—WDTF files have been 'going over the fence' since mid-January. Once the XML schema was understood, the process was pretty straightforward
- an intelligent data import mechanism was built—this has been a very clever piece of work. Most of the historic data reside in spreadsheets, which can be a nightmare to ingest into other database systems. For Example 'John Jones', 'John', 'JJ' all appear in the sample taker column and they are all the same person
- further QA/QC was incorporated into the software—the Bureau quality codes have been incorporated and are recorded against Method, Equipment, and People fields. Metadata associated with sampling methods can now be entered. There is sound business process logic around volunteers entering the data, running transcription checks, and having coordinator approval etc.
- geospatial metadata were improved via Google Map integration and Google Map site location (Figure 12)—Most of the sites have local names such as 'Cave Creek No 2' or 'Boiling Pot 5'. These mean something locally but not nationally.

Figure 12: uniDap WaterQ example site record



The real success of this project is not the software. It is in matching volunteer goals to regional goals:

- volunteer and regional goals
  - maintaining and improving river and environment health—and more than happy to share the data
  - making a difference locally
  - ready and willing measurement takers—provided they see the data being used
- national ambition
  - national water management plans
  - national reporting and coordinated good decisions
- align local goals with national ambition
  - support the measurement takers
  - continue to improve the metadata and standards
  - offer geospatial support.

The goodwill that the Bureau has out there with the Australian population is amazing.

Problems and challenges included:

- project announcement delay, which led to the user conference and training being delayed by six weeks. Critical items ran into Christmas, which led to more delays. The software development was also rushed because of this
- reduced funding over 19 regions affecting continuity of supply—partners were struggling to resource adequately. There is still a wait and see approach with some
- Logistics around coordinating 19 regions (called a 'cat muster' by some).

Question from the floor: Did you consider any method for water quality standards in this project?

Answer: Gavin Sigley—We were able to assign Bureau quality code to values for each site, and then to compare values against guidelines and thresholds. The Bureau likes this approach because the data providers can subscribe to this as a service.

Database upgrade for 27 rural utilities

Graham Whyte, Manager Performance Monitoring, NSW Office of Water

M&E project NSW1.20

NSW has 110 water utilities providing water and sewerage services:

- four metropolitan utilities (Sydney Water, Hunter Water and the Hawkesbury and Sydney Catchment Authorities)
- 106 non-metropolitan utilities (generally local councils).

The NSW Office of Water (NOW) is involved with the 106 non-metropolitan utilities. NOW oversees and monitors the performance of these utilities and encourages best practice through statutory approvals, provision of guidelines and manuals, development of software and technical support, and provision of inspections and training.

The 106 NSW non-metropolitan utilities provide 290,000 megalitres of water to 1.8 million people (790,000 properties). Some supply water to only 200 properties and some to more than 60,000 properties.

The National Water Initiative has extended the 1994 Strategic Framework for Water Reform to provide for national performance reporting. It commits water utilities to effective, efficient and accountable water management.

NOW works closely with these non-metropolitan utilities to develop best practice guidelines. In line with the National Water Initiative, the NOW has developed the Best Practice Management Water Supply and Sewerage Guidelines (BPMG). BPMG are key drivers for reform and performance improvement.

The BPMG incorporate six best-practice criteria:

- annual performance monitoring by each utility (since 1986)
- strategic business and financial plans
- regulation and pricing of water supply, sewerage and trade waste
- demand management
- drought management
- integrated water cycle management.

Annual performance monitoring

NOW monitors performance data and prepares an annual NSW Performance Monitoring Report and also a NSW Performance Benchmarking Report (published on the NOW website). These reports enable utilities to monitor and improve performance through analysis of trends and also through benchmarking. NOW also provides:

- annual triple bottom line Performance Reports and Action Plan templates to each utility (this is a snapshot of performance against similarly sized utilities)
- annual performance data to the National Water Commission for the larger utilities (required under the National Performance Framework). These data are audited.

NOW has collected performance data since 1986. Previously, data were collected annually and stored using Excel. NOW has now developed a MSL SQL server based relational non-transactional database. The database provides storage and performance indicators and report processing for utility water supply and sewerage data.

Each utility is able to input data via the Internet through password secured access. The database enables utilities to view historic data and for them to enter current data during the data collection period.

The database uses a web-based portal (Web Central database) that acts as a front end to the NSW database. Web Central enables the collection of data from utilities. The process requires utilities to log in to the portal and access screens relevant to their required indicators. The database currently has only basic data validation (e.g. ensuring that fields contain numerical values and mandatory fields have been entered). There is no sophisticated validation performed. Once submitted, the data is loaded via SQL scripts to the database tables.

The Bureau requirements

The *Water Act (2007)* requires that organisations listed in the Water Regulations 2008 must report to the Bureau any water data specified in the regulations that are currently being electronically captured by the organisation. There are nine categories of data, of which only Category 7 data relate to the volume of urban water sourced and supplied or discharged. Category 7 includes 15 subcategories, which are the only data proposed to be reported via the NSW Database. Weekly data are required, but they are reported annually. 27 NSW utilities are required to report such data to the Bureau.

At present, utilities are required to report urban water data to:

1. NOW under the BPMG (approx 180 indicators)
2. National Water Commission under the National Performance Framework (117 indicators)
3. the Bureau under Category 7 (Table 3).

NOW has combined requirements 1 and 2 by ensuring the NSW indicator definitions agree with the National Water Commission definitions. NOW collects state-wide data and reports all 117 indicators to the National Water Commission. Thirteen of these national indicators match the data required by the Bureau. It is sensible for NOW to also include requirement 3.

Proposed data enhancements

In order to capture weekly data, the NSW database must be upgraded. A sample for Category 7 data is in Figure 13. Further screens are proposed to enable utilities to

enter data with options for different time periods (e.g. daily, weekly, monthly etc). Options are being investigated for input of large datasets (including Excel templates, pseudo excel screens, copy and paste facilities). The data must be transferred to the Bureau in the required format.

Table 3: Category 7 data

No.	Category 7 Data to be Reported	NPR Indicator
7a	Total weekly volume of water from surface water	W1
7b	Total weekly volume of water from ground water	W2
7c	Total weekly volume of water from desalination	W3
7d	Total weekly volume of water from recycling	W4
7e	Total weekly volume of water from bulk suppliers	W5
7f	Total weekly volume of bulk recycled water purchased	W6
7g	Total weekly volume of water taken	W7
7h	Weekly volume of water supplied - residential	W8
7i	Weekly volume of water supplied – commercial, industrial, municipal	W9
7j	Weekly volume of water supplied – other	W10
7k	Total weekly volume of urban water supplied	W11
7l	Total weekly volume of bulk water exports	W14
7m	Total weekly volume of bulk recycled water exports	W15
7n	Total weekly volume of sewage discharges into a water course	
7o	Total weekly volume of stormwater discharges into a water course	

Figure 13: Example screen specifically for Category 7 data

Other database enhancements include:

- metadata—an additional screen may be required to capture metadata for each scheme.
- data transfer to the Bureau—it is envisaged that notification will be sent to both the NOW and to the utility to advise that the data has been transferred to the Bureau.

The data will be converted to WDTF files, which are then sent via FTP to the relevant NOW folder in the Bureau site. The data will not be audited or checked for errors prior to forwarding to the Bureau.

NOW is organising workshops with the 27 NSW utilities in April/May. The main purpose of the workshops is to prepare the utilities for the National Water Commission audit requirements. At the same time, it is proposed to explain the Bureau requirements and the enhanced database facility.

Issues that are to be considered in the future are:

- timing—currently NSW utilities are required to report performance data by 15th of September. However, data is often not received till October or November (e.g. unable to be extracted, data incorrect etc). To report data in July, as required by the Bureau, may be difficult
- data period—data are required weekly, but some data (e.g. household metered usage) are collected irregularly
- reporting responsibility—NOW will provide a reporting tool for utilities. However, the responsibility for reporting must remain with the utility
- data audits—data will be transferred without evaluation (error checking) or auditing

There are benefits in consolidating data collection:

- it continues the present 'one stop shop' approach in NSW
- utilities are familiar with the database
- it facilitates data transfer to the Bureau by utilities
- it removes the need for each utility to develop their own WDTF functionality
- it leverages off the similarity of data required by the National Water Commission and the Bureau
- it may be possible in the future to incorporate more sophisticated data error evaluation and increase the frequency of reporting
- there are benefits to the Bureau and the National Water Commission to have a single source for the NSW data.

Conclusions

NOW already collects a large volume of NSW state-wide data in a single database, which is used by all 106 NSW utilities. It is a familiar interface and is strongly supported by utilities. It is relatively straightforward to enhance the NSW database to incorporate current Bureau requirements. There are significant benefits to NSW utilities in having NOW undertake data collection and transfer.

Discussion, Session 3

Question or comment from the floor: 106 utilities is a lot. Will they stay on after the review?

Response: Graham Whyte—They are discrete utilities, so it would be very difficult to combine them.

Question or comment from the floor: Are utilities benchmarked against each other?

Response: Graham Whyte—NOW provides data to utilities and encourages them to benchmark, but uptake is not good. One reason is that the utilities are all very different from each other, so it is hard to benchmark. NOW encourages them to monitor their own performance.

Question or comment from the floor: Is the Bureau planning to review the timing of data lodgement requirements in some categories?

Answer: Alan Baker—Updating is actually hourly for some of the other data categories. Residential data is an issue because they can't be collected even on a weekly basis.

Session 4 Implementation of acoustic Doppler technology

In-situ Acoustic Doppler Velocity Metering (ADVM)

John Cameron, Victorian strategic water information coordinator, Department of Sustainability and Environment, Victoria

Nurullah Ozbey, Hydrology Manager, Thiess Services

M&E project Vic1.6

References: TRG ADVM discussion paper www.bom.gov.au/water/regulations/fundingProgram/document/ntrg/ADVM_discussion_paper.pdf

This project aimed to determine improvements in the reliability of surface water flow estimates. The objectives of the project were to:

- monitor flows at 12 challenging streamflow monitoring sites
- improve the accuracy of moderate and high flow discharge estimates at those sites
- virtually increase the total number of stage–discharge observations obtained at each site (96 per day)
- identify variances in the stage-discharge relationship on falling and rising legs of a hydrograph
- reduce uncertainty in flow estimates
- evaluate the effectiveness of utilising acoustic technologies to develop improved discharge monitoring
- develop a methodology and work procedures to identify and eliminate error sources

Twelve sites were initially selected for the study:

- Latrobe R @ Swing Bridge
- Latrobe R @ Kilmany South
- Thomson R @ Bundalaguah
- Mitchell R @ Rosehill
- Avon R @ Stratford
- Snowy R @ Jarrahmond
- Macalister R @ Licola
- Macalister R D/S Lake Glenmaggie
- Goulburn R @ Murchison
- Goulburn R @ McCoys Bridge
- Murray R @ Euston
- Gellibrand R @ Burrupa

Each provided one or more of the following challenges:

- access difficulties during high flows
- subject to surge in an estuarine lake
- subject to variable back-up
- downstream from a controlled storage/s
- resource intensive manual stage–discharge observations required
- break-out point to a floodplain
- meeting key business driver needs.

For further site detail a background paper is available from www…. The rest of the presentation focused on streamflow hydrology and the potential for an acoustic Doppler velocity meter to resolve some monitoring issues.

Acoustic Doppler Velocity Meter (ADVM)

A significant problem in streamflow monitoring has been getting accurate measurements in unsteady flow conditions as hysteresis can lead to inaccurate readings. If flow conditions (such as depth and velocity) do vary with time at a discrete location, the flow is classified as unsteady. The hysteresis effect occurs where discharges for a given water level on the rising limb of the hydrograph differ from discharge for the same level on the falling limb. Its magnitude is significant:

- at sections affected by tide
- where backwater effect occurs during a flood
- where the flow conditions are controlled by a lock or a gate
- where the flood plain impact on the main stream is significantly variable—the magnitude of the impact before and after the peak varies significantly
- where flow is regulated constantly
- where water surge occurs.

The interaction between the main channel and the flood plain or inundated valley is one of the most important factors affecting flood propagation. The impact of a flood plain on wave celerity where the flood wave progresses more slowly in an inundated valley is illustrated in Figures 14 and 15.

Figure 14: River with a floodplain and unsteady flow

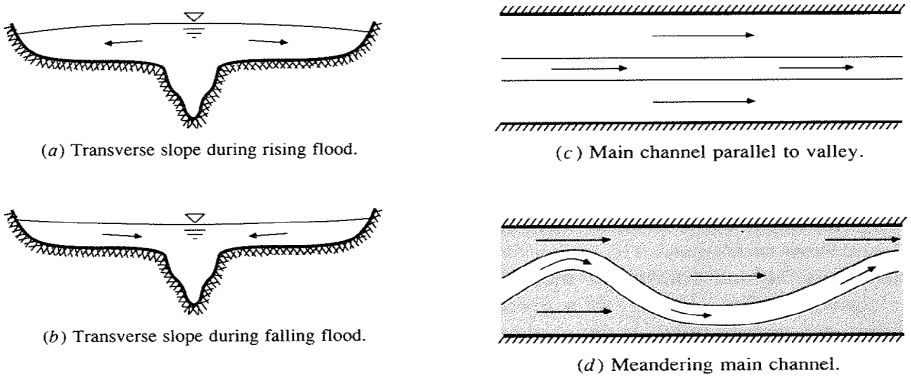
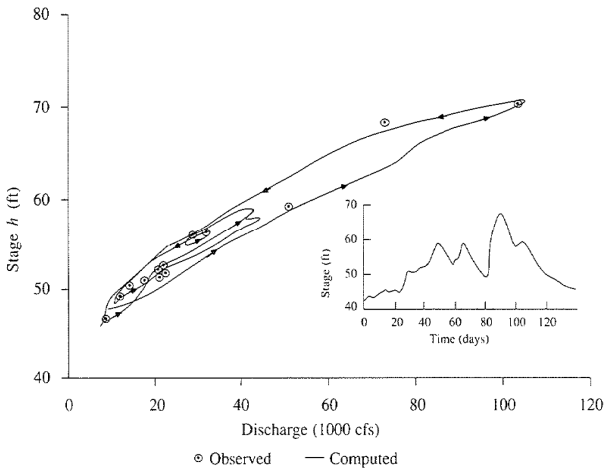


Figure 15: Loop rating—hysteresis



Indirect discharge estimation methods for unsteady flow include:

- estimation methods based on stage measurements at a single section—Jones, Henderson, Di Silvio, Fread, Faye and Cherry, Fenton formula,
- approaches based on simultaneous stage measurements—Chow, Fenton and Keller formula, the stage-fall-discharge method by Hershey,
- a dynamic rating curve approach to indirect discharge measurement; based on water level collected from two sections on the reach.

The equations in these methods are derived from the one-dimensional shallow water momentum equation by disregarding one or more terms:

$$\frac{\delta z}{\delta x} + \frac{1}{2g}\frac{\delta(\beta\frac{Q}{A^2})}{\delta x} + \frac{1}{g}\frac{\delta(\frac{Q}{A})}{\delta t} = -\frac{Q}{K^2}$$

(i.e. Slope + Convective acceleration + local acceleration= friction slope terms)

In these formulas, assumptions are made and a number of coefficients are used, such as momentum coefficient, kinematic wave celerity, which might be varying from the section to section, depending on physical features of reach, slope and resistance coefficient, according to the St Venant equation.

The ability of the different equations to estimate discharge depends on the channel geometry, hydraulic parameters such as roughness and flood wave characteristics

Use of ADVM is supported by the strong relationship between point or line velocity and mean velocities in a cross section.

- The installation is fit for purpose if:
  - it is cost effective—monostatic Doppler current meter; the same transducer is used as both transmitter and receiver
  - it has practical and cost effective installation and housing—dismantling the instrument after the flood reduces the risk of vandalism due to exposure of the instrumentation
  - it can be deployed during a flood; allowing for relatively easy mobilisation of the team and early flood warnings from the Bureau
- There is a need to identify the limitation of instruments, requirements for deployment, and error sources due to environmental conditions.
- Work procedures for QA need to be developed.

Random error sources arise from the nature of ADVM, which measures velocity by looking at the reflections of an acoustic pulse from particles in the water. The magnitude of the reflection is called signal strength, which varies with the amount and type of suspended material (called scatterers) and the distance from the transducers. Each velocity sample recorded by the ADVM is the average of a number of pings. ADVM pings once per second over the period of time specified by the averaging interval.

The system records the standard error of velocity based on data from individual pings. Standard error is the standard deviation of the velocity measurement from each ping, divided by the square root of the number of pings. Standard error is a direct, statistical measure of the accuracy of the mean velocity data. Measured standard error includes instrument-generated noise and real variations in velocity.

Choosing an averaging interval for sampling that is long enough to eliminate instrument noise and real variations in flow is essential. It is not recommended to use averaging interval settings of less than 60 seconds. 840 seconds averaging interval was chosen in our project—60 seconds is used to transfer the data into logger. A diagnostic test embedded in the instrument is used to evaluate the reliability of data.

The technology was developed for military purpose for vessels and submarines. It has been used for hydrographic purpose in the USA since mid-1980s, but it is only an emerging technology for Australia, having been introduced in the past four to five years. The technology is used at some very challenging sites.

We are currently comparing the results with data collected by different techniques and technologies. We are taking measures to eliminate the error sources, in deployment, usage and data analysis, and developing stringent work procedures to reduce the uncertainty in data collected by acoustic instruments. These are the areas in which ADVM provides reliable solutions.

The benefits of ADVM are that:

- accurate flow is collected when flow is unsteady at significantly lower costs. Conventional methods were very expensive but are even more costly today and require many teams of experienced hydrographers to undertake flood measurements
- personnel safety is enhanced
- the estimated flow for a high flow can now be quantified, providing the data to the user with an improved confidence interval; talking to the scientist in a scientific language
- access the real time flow data during a flood
- salt and sediment load transportation is estimated with higher accuracy; see Swing Bridge Study in background paper available at www….

Future initiatives include:

- continue to improve ADVM indexing at all sites
- implement salt wedge and suspended load monitoring at Latrobe R @ Swing Bridge as an addendum to the primary study
- commission a study into the statistical analysis of ADVM results and comparison of data collected traditionally and that collected utilising the ADVM
- assess the effectiveness of long-term operation of ADVM's at each study site
- identify additional sites requiring ADVM technology in Victoria
- optimise the application of ADVM technologies across Victoria
- there are no standards yet (worldwide). This is an area to focus on in Australia.

Conclusion

Initial studies indicate that acoustic technology offers an opportunity to enhance discharge accuracy and reduce streamflow data uncertainty more effectively than traditional processes. Scientific analysis of the data derived from acoustic technologies will enable hydrologists to make informed decisions about future deployment of them. Employment of ADVMs reduces resource commitments during times of high demand (streamflow) and enhances operator safety.

Session 5 Telemetry

Provision of real time IP telemetry solutions

Neil Chapman, Senior Technical Officer, WA Department of Water (DoW)

Reference:.DoW IP Telemetry Trial
www.bom.gov.au/water/regulations/fundingProgram/document/ntrg/DoW_IP_Telemetry_trial.pdf

WA DoW had an extensive network of dial-up monitoring systems across Western Australia. These used: Mini Sat M, Iridium, NextG, GSM, landline, and point-to-point technologies. These monitoring systems had significant set up and service issues. IP telemetry helped solve some of the problems for managers and field staff.

The trial started in 2008. The original plan was for the department to set up its own systems, as suppliers wanted to retain ownership/operation of servers and just supply the data, which was not acceptable. As IP telemetry became more widely available, the options for the department increased, so a tender for development and supply of a system compatible with existing DoW systems was released.

Initially five NextG and five Satellite systems were used. Halfway through the trial there were issues with hardware, this led to a second model being trialled with five additional satellite sites in the Kimberly. Issues included:

- the antennae used were GlobalStar, which had only a 200 mm lead. This was very limiting as there was a need to be able to separate the antenna and modem from the logger.
- the site has a dynamic IP, so the serial number of the equipment is needed to communicate to the server.
- GlobalStar connections drop out, but the system is designed around that (to continue when the connection re-establishes), so it works.

Configuration with NextG can now be done onsite with a laptop, which is much easier. Units were initially tested in the yard before field deployment.

Because the current network of loggers is halfway through its replacement cycle, the aim is to keep the existing logger fleet and slowly upgrade as maintenance is required.

Capital costs of satellite are high, as they include the cost of the logger. But the running costs make the system more cost-effective:

- NextG—$7 per month plan, includes 5 MB, OK at 10 min
- Globalstar—$30 per month plan; Hourly ~ $20 per month call costs; Average total cost $50/month.

The systems are designed to retain data integrity. Data packets are sent in binary (not ASCII). Data are highly compressed (to reduce transmission times and to increase

security) and pushed every hour to the GlobalStar satellite. There is constant data checking to ensure there are no gaps, using UDP (User Datagram Protocol, designed for speed with application error checking). The units use a SIM card and a private APN.

The data go to HYDSTRA, where they are archived, and a copy is sent to the Bureau.

Question or comment from the floor: Others had tried Globalstar but it didn't work, partly because of supplier issues.

Question or comment from the floor: The costs of IP telemetry are high, but there are distinct advantages, especially in flood monitoring systems (e.g. sending flood alerts).

Question or comment from the floor: There are systems out there that aren't dependent on a particular brand of logger.

Question or comment from the floor: There are a lot of issues, and a better forum is needed to present the information more comprehensively.

Bureau-wide telemetry developments

Bryan Hodge, remote data communications manager, Bureau of Meteorology

There has been substantial change in the past 2–3 years in the Bureau organisational structure around communications management, with four staff now managing much of the workload (two communications experts, one technical administrator, one technical installer) with the support of contractors as required (mobile, technical writer).

The Bureau is now collecting data from 530 automatic weather stations, 482 co-operative weather observers, 75 staffed sites, 2800 online rainfall stations, and 150 marine observation platforms. This all relies on a network that is 75% PSTN/cellular, 10% satellite, 5% radio, 5% locally connected, and 5% internet/external.

The vision for the next 2–3 years is to have the entire automatic weather station network reporting at 1-minute intervals to a centralised system (rather than the regional model we now use). Ideally, the entire network will be IP-based within 2–3 years, with built-in redundancy, and the legacy network disconnected in that same timeframe. This is expected to lower operating costs in the order of $250,000 to $600,000 each year—a reduction of about 30%. For example, average PSTN costs are $80 per month (for hourly data) while a Next G solution costs less than <$5 per month (for 1 minute data).

A technology review found a cellular network to be most effective for our needs. Its characteristics are:

- Telstra IPWAN Dual Gateways
- privately segmented on wireless side
- in-house authentication and static address management (IPV4)
- IPV6 Migration trial with Telstra in the third quarter of 2010
- software development done on cell modem to parallel stream from serial

L/C band satellite networks were used to complete coverage maps. Combinations of cellular and satellite were used to compensate for Service Level Agreement issues with cellular networks.

The Bureau's operational philosophy is to maintain private and secure networks with sufficient redundancy in processing sites and infrastructure via parallel data streams and parallel systems. In particular, sites of high importance have communications redundancy. See Figure 16 and Figure 17.

Figure 16: Redundant strategy cellular

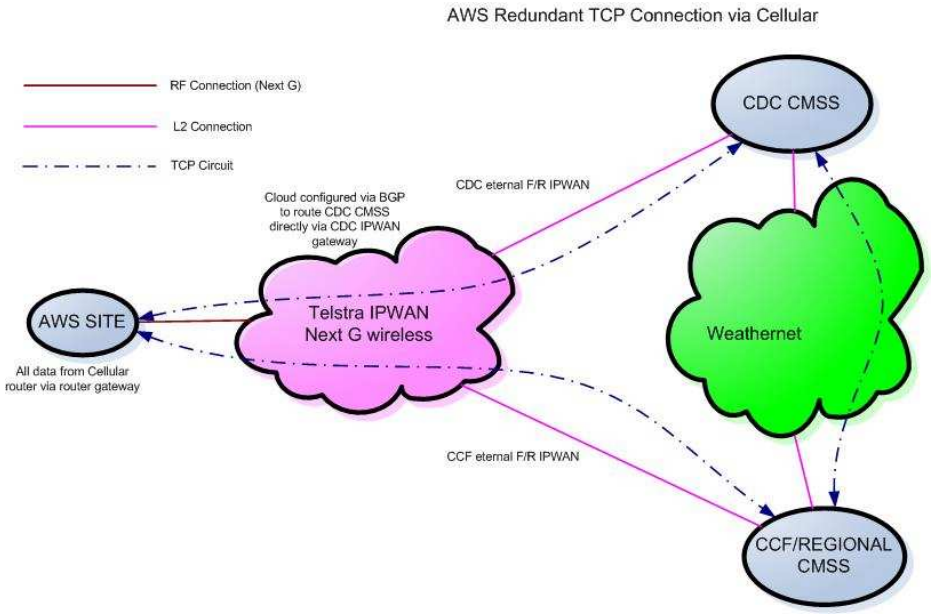
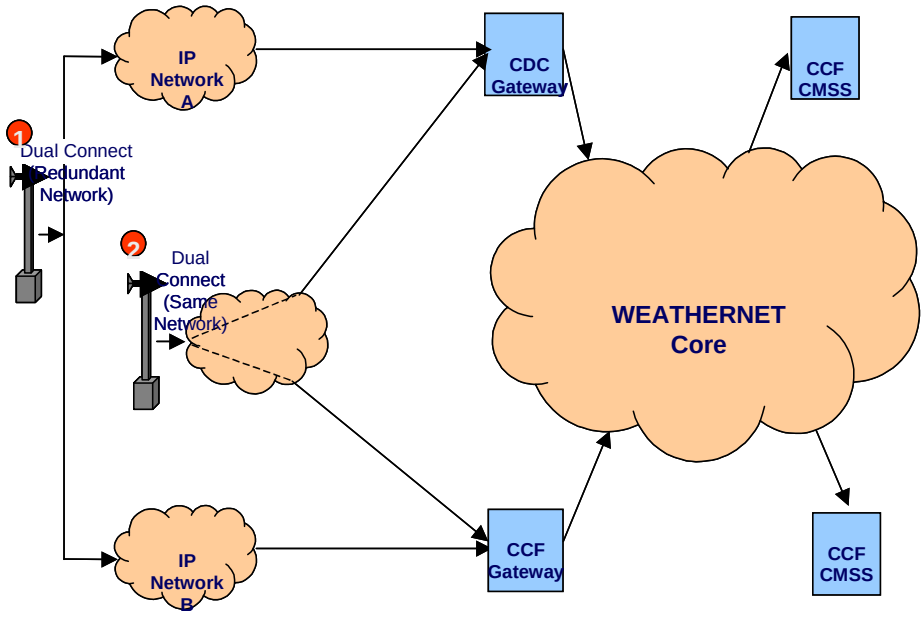


Figure 17: Redundant strategy combined



For water data collection by cellular, on Telstra plans, 10 minute reporting would cost approx $2-3 per minute (on aggregate plan) or $5 per minute (on individual plan).

- Power requirements are:
  - in wake-up mode—less than 1 Watt average
  - in always-on mode—1 to 2 Watts average.

Telstra aggregate contracts are a cost effective method of setting up an IP network.

For water data collection by satellite, the system uses Iridium SBD – provisioned by the Bureau. It costs approximately $30–$50 per month. THISS satellite solution (C band) had been dimensioned for 10 minute mode with low power. Thuraya and BGAN are under testing/development (L band).

Monitoring of data streams is carried out through:

- Bureau Netmon application for end to end monitoring
- SatSeeker SNMP application for IP monitoring
- full IPWAN/Cellular gateway monitoring
- combination of Statseeker into Netmon to overlay end-to-end delivery to comms SLA.

Potential opportunities in relation to this forum are:

- to develop joint telemetry networks or clouds
- satellite networks become very efficient at 1000s not 100s
- Telstra introducing aggregates is an opportunity to save, especially in small payload monitoring.

Flood Warning Telemetry Developments

Robert Thompson, Supervisor Water Information Systems, Bureau of Meteorology

Building a robust infrastructure for the Water Division of the Bureau requires a flexible architecture to host the flood warning environment. The environment to build systems quickly is needed—sometimes there may be only a matter of hours to notify of an impending flood.

The components are:

- identifying service level requirements—define early what will or may affect end-to-end design
- redundancy - disaster recovery or full business continuity?
  - at field level—redundant sites or redundant communications
  - communication layers—multi-vendor, multi-transport
  - collection and management systems
  - support
- identifying what is developing in flood warning.

To do this, a virtual infrastructure has been built, and it is hosted on VMWare Enterprise Edition, using Enterprise class fibre channel SAN disk arrays. There is full redundancy of network and storage paths, with dual power sources. The system is hosted in an award-winning data centre in Canberra, using high-end Enterprise Class servers with 4 slot (CPU) multi-core Nehalem processors. A Stage 3 upgrade in progress will add 200 terabytes (growing to 500 terabytes) of open storage, with backup capability via automated tape library. This uses the additional latest Nehalem-EP servers. Telemetry servers will run in fault tolerant mode (lock-step).

Flood warning telemetry

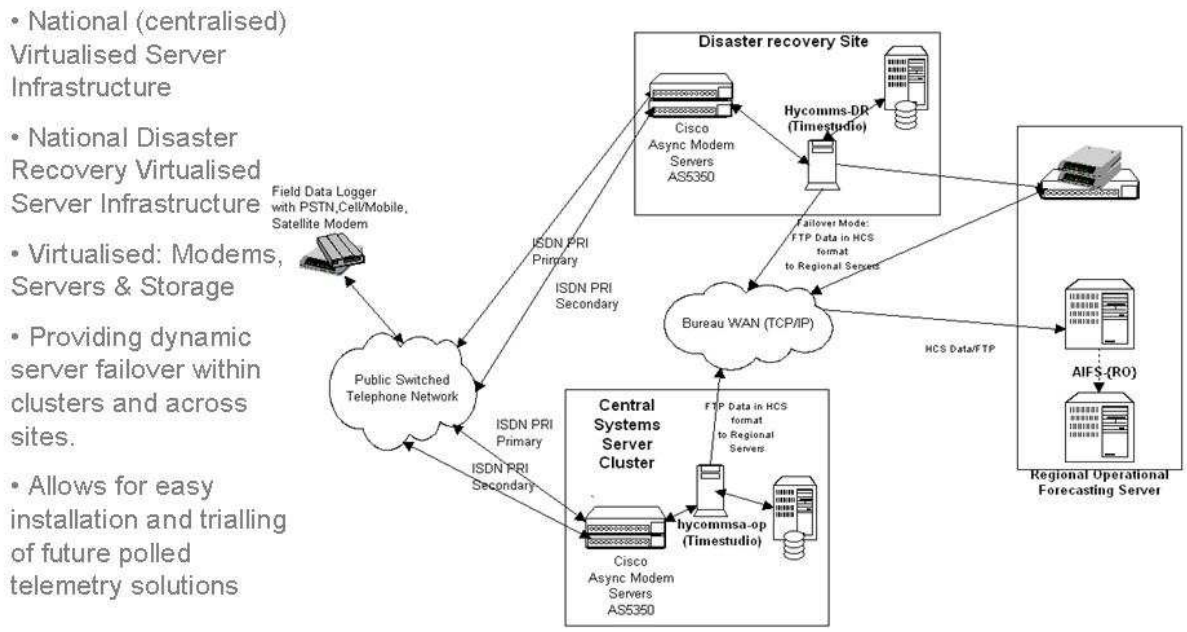
The Bureau manages a large number of flood warning sites, which provide rainfall and river data (Table 4). There are two ways data is obtained: Figure 18 outlines the polled sites, while the event-based monitoring is discussed below.

Table 4: Summary of flood warning sites

Region	Rainfall Sites	River Sites
QLD	1098	872
WA	208	2
NSW	465	567
VIC	167	307

Region	Rainfall Sites	River Sites
TAS	55	87
NT	36	23
SA	79	44
Total	2108	1902

Figure 18: Flood warning telemetry – polled (pull/get)



Flood warning telemetry—event (push/accept)

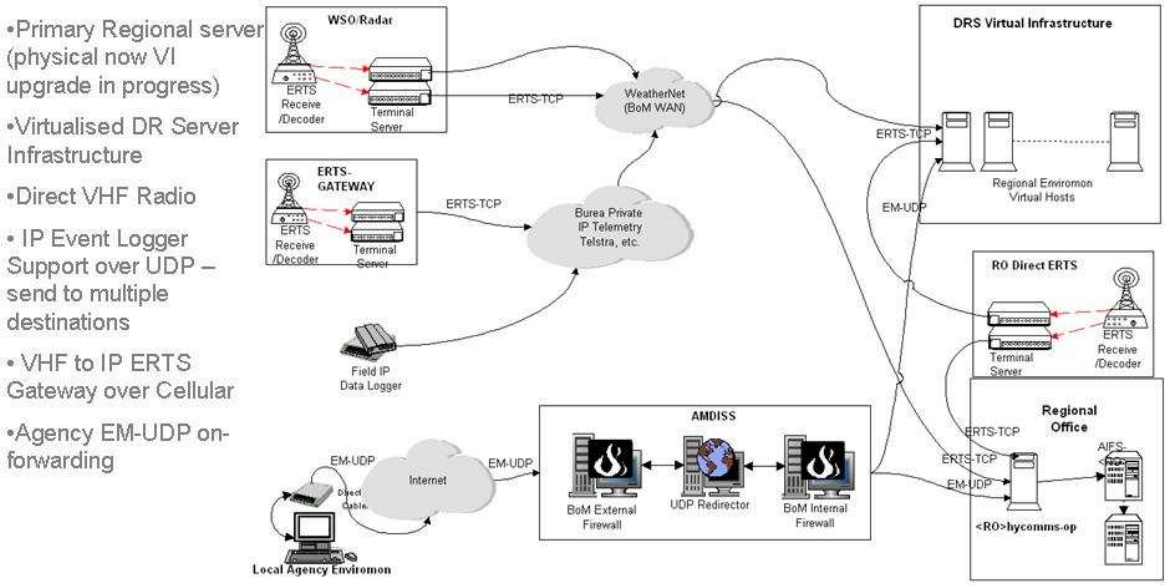
This uses:

- FTP in HCS format from Agencies
- event telemetry
  - VHF Radio (ALERT),
  - VHF Radio to IP,

– HYEVENT (over Iridium Satellite and over cellular).

The Event Reporting Telemetry System—Enviromon—is built on the ALERT concept from the National Weather Service in the USA. It allows the Bureau to provide services to more than 130 agencies, including local agencies and emergency services. The Bureau provides direct storage, analysis and display of rain and water level data. Features of the system include real-time and off-line continuity and bounds filtering. Alarms are triggered via SMS, e-mail and custom methods in response to pre-specified rainfall rates, threshold water levels, and sensor inactivity. The data formats have recently been modified to ingest HYEVENT message. See Figure 19 more further detail.

Figure 19: Event Reporting Telemetry System—VHF/UDP/TCP



Looking forward

No single way is the best way, unless there is guaranteed 100% continuity of systems end-to-end, which is unattainable. Systems are built on the basis of this premise to ensure diversity of communications for critical sites.

Large costs are involved in the integration of backend systems, support and data management. It covers more than just field installations; it is the whole end-to-end data flow.

The current focus for the Bureau's flood warning system upgrade is to migrate data collection systems infrastructure ensuring business continuity across 'national operations'.

Specific initiatives are:

- implementing redundant alternate communications paths, radio with additional radio repeaters, additional Radio to IP gateways, IP over Cellular and Iridium-SBD
- next version of ERTS (ALERT) Gateway in progress, utilises Radio modem and customised cellular router, low cost and simple without proprietary legacy components
- next generation multi-purpose field telemetry device—COTS logger, Plug in single or multiple communications to suit e.g. VHF-Radio, Cellular, Satellite; Multi-protocol capability
- implementing direct TCP interface from Iridium gateway to Enviromon input plug (listener)
- ALERT v2 protocol in development. This utilises a modern network layer approach to radio protocol, separating application payload (with site id and data) to network layers (device id). Protocol will repeat existing ALERT but also new ALERT2 payloads with higher bit rates, extended message length with error correction. Optionally uses time division multiplexing with time offset part of new message standard
- national broadband, Telstra WLL caused problems.

On a final note, polled telemetry allowed for multiple agencies to interrogate devices which usually enforced a single approach based on proprietary protocol. Event devices introduce issues such as:

- messaging standards—decodeable
- time referencing
- meaning of data values
- meaning of what is an event
- sending (access to) multiple destinations for redundancy but timeliness of use for real-time users.

Session 6 Discussion and wrap up

Discussions and comments from the floor have been summarised below.

Future workshops were proposed for:

- Doppler—fixed and moving
  - need to clarify how to move from current metering systems to Doppler
  - what is the accuracy of Doppler in a moving boat?—this is currently being verified in the Darling system
  - Doppler is not replacing existing methods

- telemetry
  - a dialogue with the Bureau is needed to develop a joint approach to enable bill aggregation. There should be some discussion about who the more appropriate people to run it are—should it be led by a state agency (e.g. NSW) or a national body (a person within the Bureau)? Any such system would also require a lot of infrastructure, which raises the question of who owns or manages it. Bill aggregation makes sense in terms of cutting costs, but no one wants all of Australia to 'go offline' for hours as a result of the associated infrastructure arrangements
  - event telemetry over IP needs further investigation regarding Internet protocols, accessibility, standards of observations, messaging standards (i.e. the data stream, not the sensors)
  - this could be further explored through a teleconferencing style forum

- rating curve development:
  - a workshop of rating table development could be combined with a Doppler technology workshop
  - there is more scope for taking environmental conditions into account in developing rating curves to improve accuracy
  - there are no concrete standard procedures on how to measure and reduce uncertainty

- M&E projects—details are on the web. Most agencies are so busy doing the projects they are not communicating. There was consensus that it is not appropriate to make milestone reports public (e.g. by publishing to the web) because it might lead agencies to self-censor. Further communications on projects may come from a 'Lessons Learned' on projects considered to be of wide interest. The Bureau will prepare a template for these reports, and use SWIC assistance to complete them.

Discussions were held on the following topics:

QA/QC issues

- QA/QC checks need to be independent of the platform
- What will the Bureau do with 1-minute data, and how will this data be used by other sections of the Bureau? Will it publish the data to the web?
  - after being QA (screened on entry and checked), data are published to a public website, and they are also added to the climate database, which is used for global climate forecasts
- There is a need to develop uncertainty limits on the data to allow the Bureau (and others) to identify fitness-for-purpose of various datasets
- Similar QA projects are happening on different platforms. The challenge is to make them platform independent. This would allow some of the same tests to be run on the data, which would remove inefficiencies. This was one of the aims of the Tasmanian project.

Standards

- Should a there be a Bureau standards expert panel?
- Shouldn't we be defining a method that anyone can implement and apply on their platform rather than focusing on specific software?
- More success in the long-term is achieved by adopting similar standards in deliverable data products as agencies will never be convinced to all use the same product, and define what standard they should comply with and what an acceptable error band is.
- From the software in use, the agencies must already have design documents that have been used to build the software. Why not all sit down and look at these documents as a basis for developing rigorous standards?
- Once a standard has been developed, how should it be enforced and implemented?
- The Bureau could just develop a standard, prepare a regulatory impact statement and make the entities named in the Water Regulations comply. However this is likely to lead to resistance as agencies currently collect the data for themselves and they do this to their own standards (in theory).
- In the long run, and as more data comes in, the Bureau is likely to start flagging data. If an agency submits unacceptable data this will become more transparent.
- Queensland standards should be published as an M&E project and results.

Water Information
DATA › INFORMATION › INSIGHT

Through the *Water Act 2007*, the Australian Government has given the Bureau of Meteorology responsibility for compiling and delivering comprehensive water information across Australia.

For more information
Visit our website at www.bom.gov.au/water
Send an email request to waterinfo@bom.gov.au

Australian Government
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