

AUSTRALIAN HYDROGRAPHERS ASSOCIATION

Australasian Hydrographer



Crews in the north west of the country battling the elements to get to flood gauging locations in the north west regions of Australia, March 09.

Thanks to Duncan Palmer, DoW, for supplying the photo and article inside.



May, 2009

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Editorial

As ever a land of extremes continues to be demonstrated to us.

For some of us it seems the rain might never stop while for others it seems the rains might never come again!

Is it one of the smaller cycles inside the bigger cycle? Is it a result of global warming? Are we the cause of it? Is it only an aberration of no statistical significance? These are just some of the questions that can be asked about our climate and water availability today.

But just asking a single question to suit a single argument is not the correct way to go. We, as hydrographers and field hydrologists, understand that water is a complex relationship of many factors, some of which may not immediately obvious to the lay person.

We collect data and information about water, but only at a limited amount of points in any given system. From there we make assumptions (sometimes very big assumptions!) about water behaviour across the wider system we are interested in.

Anyone will admit though that we probably don't collect enough information about our water cycle to cover every situation. Water information collection has historically focussed on anthropogenic extraction, use and disposal of the resource.

Economists and accountants are now playing water games on paper to make rivers flow again – to keep them alive and to also met the demands on the system. It is now more important than ever that the water data and information that we collect is of the best accuracy and quality. We also need to provide professional commentary with our data sets. Sets of quality numbers are good but numbers with an understanding of the system the numbers are coming from is even better.

Earlier this year in *The Weekend Australian* (March 7-8) in a report feature on Water, it was stated that water data is in poor shape. This statement is in error in that the data being collected is generally in good shape but there is not enough of it being collected to adequately represent the complex systems we are 'interfering' with to suit our needs and wants!

Let's continue to hope that the investment in improving these data sets isn't just to buy the shiny things that go ping, but to also to invest in the human input for data collection and analysis – supporting the custodians of the nations water data, the hydrographer, out there in the rain, heat and snow collecting this raw material for our management systems.

Mic Clayton

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Visit our **Web Site** at: <http://www.aha.net.au> to download a Membership application and to find contact details for your state representative.

Editorial and advertising enquiries should be directed to the Association's **Publicity Officer**, Mic Clayton.

Journal editions are generally produced February, May, August and November. Copy is requested to be with the Publicity Officer by the previous month.

e - mail publicist@aha.net.au , or
PO Box 843, COOMA, NSW, 2630.

The views expressed in this publication are those of its contributors and do not necessarily represent those of the Australian Hydrographers Association Inc or its office bearers.

Queenslander wins AHA “First In Course Award”

Michael Auf der Maur, a trainee with the Queensland Department of Natural Resources and Mines, was awarded the 2008 ‘First In Course’ Award, Hydrography Certificate IV, at the recent OTEN Graduation Ceremony in April.

The ‘First in Course Award’, Hydrography Certificate IV is an annual award sponsored by the Australian Hydrographers Association.

Michael’s award highlights the advantages and flexibility of enabling trainee hydrographers to undertake training and education in a qualification such as the Hydrography certificate available through Distance Education and Training programs. Even though Michael is based in Mareeba in far north Queensland and required to undertake the extensive hydrographic field work trips in that part of Australia, Michael was still able to undertake and complete his studies.

The AHA believes strongly in encouraging new blood to enter the hydrographic profession and the AHA is the sponsor of the ‘First in Course Award’ for the Hydrography Certificate which is presented to the award winner at the ceremony for graduating OTEN students. The First in Course Award comprises a trophy and award prize for the highest achiever in the Hydrography Certificate for the graduating year.

The AHA extends its congratulations to Michael and wishes him well in his future hydrographic endeavours.

Win Free Registration to the 15th Australian Hydrographers’ Association Conference in Perth, 2010!

Australian Hydrographers Association Photographic Competition.

Australian Hydrographers cover every nook and cranny of Australia in their day to day work as hydrographers. Many images have been recorded over time by hydrographers in their working travels of where they work and what they do.

Over the next few months the AHA will be running the Australian Hydrographers Association Photo competition. With a prize of a **complimentary**

registration¹ for the 15th Australian Hydrographers’ Association Conference in Perth. 2010.

More details will be made available shortly and a judging panel formed, but preliminary information and guidelines for the competition are as follows:

- The submitted image should pertain to a hydrographic/hydrologic theme and/or be related to work that AHA members or other hydrographers are involved in.
- All images must be submitted in digital format, in either JPEG format or TIF format. Images may be in colour or black & white and should accurately represent conditions at the time the images were captured; do not edit or alter content. Images may be from a digital camera or may be scanned from traditional print, slide, or negative media. For best results, use the highest quality your digital camera supports. Use the highest density when scanning images
- Submitted images are to be the photographers own work.
- Where an image has been taken while involved in the activities for an employer, it is the responsibility of the entrant to ensure that there are no copyright restrictions on the use of the image by the employer or seek appropriate permissions to release its copyright to the public domain
- Where an image is submitted containing persons other than the photographer, it is assumed that the submitting photographer has sought, and received, permission from the subject to use the photo in this competition. The entrant will provide a statement with the image to this effect to the Judging Panel
- Images submitted and accepted for the competition are submitted on the understanding that the image enters the public domain for copyright purposes at that point in time and is available for unrestricted use by the AHA in (but not limited to) promotional material, publications, website etc. Where used in AHA publications every effort will be made to acknowledge the photographer where appropriate. The AHA will not monitor or enforce the image’s acknowledgements outside AHA use once in the public domain.

¹ *The prize is a full 2010 Conference registration fee only (1 Only). Travel, accommodation and ancillary costs are the responsibility of the prize winner. The prize may be transferred to another person if required but only after written application to the Committee of the AHA.*

- The judging committee reserves the right to reject an image from entry in the competition considered to contain unsuitable or inappropriate content.

Membership Renewals, 2009.

After careful consideration the Committee has agreed to a small increase in membership fees commencing with the next membership year 2009/2010. Renewal of memberships are due at the beginning of July, 2009.

Membership fees have remained unchanged since the early 2000's (when they were slightly reduced!) but with an increase in activities of the Association members and the Committee in recent times there is a need for a small fee increase to support the continuation of these activities on behalf of the Association's membership into the future

The Fee structure from July 2009 will be as per the table below:

Membership Grade	Annual Cost	Included Membership
Individual	\$100	1
Student/Retired*	\$35	1
Corporate Bronze	\$550	1
Corporate Silver	\$1,100	6
Corporate Gold	\$1,650	12
Corporate Platinum**	\$2,200	20

*Student – Currently enrolled in Hydrographic study course and/or employed as a trainee or cadet in an organisation.

** Additional memberships >20 are at \$100 per membership

Current financial members will receive reminder notices in June and you will notice that the hard work is done for you and the information you last provided to the Association is already filled in!

All you have to do is to review the information, correct if necessary so that our records can be kept up to date and return the form with your payment (or payment information if paid by EFT) to:

The Treasurer
Australasian Hydrographers' Association
14 Kosciusko St,
Traralgon,
Victoria 3844

Payment Options

The Association accepts payment of subscriptions by:

- Cheque (made payable to the Australian Hydrographers Association)
- Credit card or
- Electronic Funds Transfer. The AHA account details are printed on your renewal form. (If using this option please reference your payment as AHAXXX where 'XXX' is your member number if renewing.)

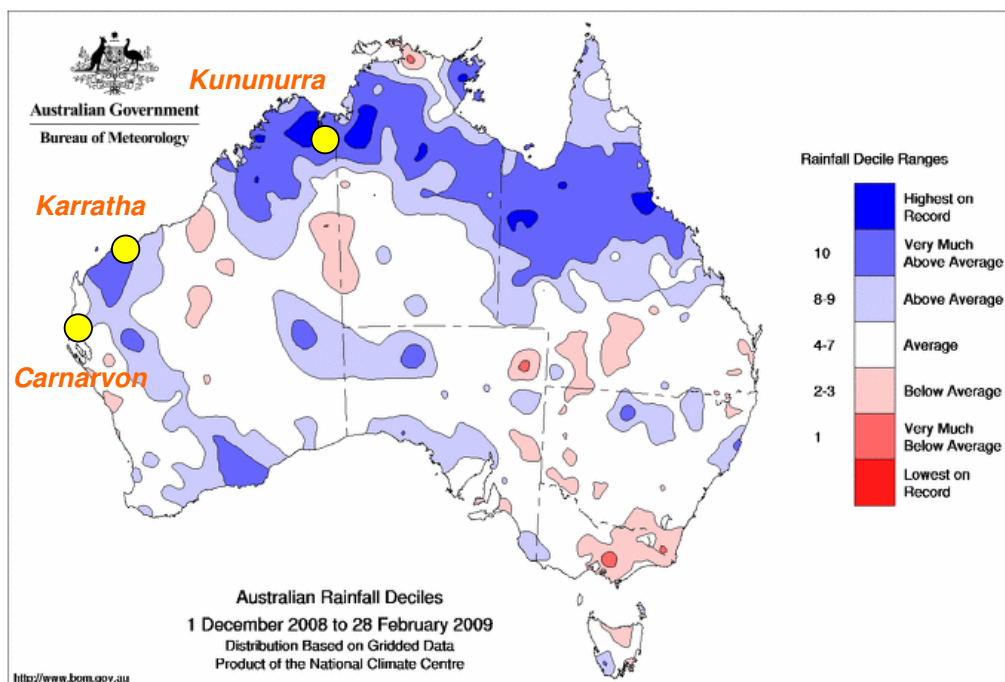
Some features of Australian Hydrographers' Association Membership (for both Individual and Corporate) include:

- Knowledge and information sharing amongst peers.
- Opportunities to participate in national hydrographic conferences and workshops
- Promotion and sponsorship opportunities at a biennial conference for Corporate members.
- Four journals, *Australasian Hydrographer*, per year.
- Association Website and peer group mailing list with discussion threads.
- Commitment to supporting the continuing education of Hydrographers (Certificate IV Hydrography, development of the new Hydrography Qualification).
- Travel and educational grant assistance scheme for student/cadet members to attend conferences.
- Career advertisement network
- Investing resources for educational support and development for training and education in the hydrographic industry. (Member of the Hydrographic Technical Reference Group, National Water Commission)
- Annual subscriptions are tax deductible under professional organisation/associations section.

Getting Wet Up North!

The northern wet season produced a series of flooding episodes in many parts of Australia this year. As this Bureau of Meteorology map confirms, Queensland, the NT, and smaller pockets of WA

experienced rainfall well above average for the three summer months. The Queensland events deservedly received significant media coverage, but several WA river flows also caused problems.



KIMBERLEY (KUNUNURRA)

Duncan Palmer

As we approach the end of March, there is a definite feeling in the air that the wet season for 2008/09 is coming to a close. The river levels have dropped, the nights are cooling off, the dragonflies have arrived, and the easterlies are starting to blow.

The end of the wet comes with some relief to the Kimberley hydrographic team, as the rains started in mid December and have continued without any significant breaks until the end of February. The Fitzroy catchment had extensive rainfall with a total of 1030mm falling at Dimond Gorge and 774mm at Fitzroy Crossing between December 08 and March 09. This rainfall resulted in the Fitzroy River swelling to over 10m deep at the main road bridge at Fitzroy Crossing, and staying that high for over a week. Flows at this level equate to over 250 Gigalitres per day. This is equivalent to Perth's annual water usage per year.

The heavy rain and flooding caused a number of dramas for local communities. The Great Northern Highway was cut at numerous locations due to deep

water over the road or sections of road washed away. To add to the drama, Broome, Derby, Fitzroy Crossing, and Kununurra communities lost all forms of telecommunications when the Telstra optical fibre cable was severed by floodwaters. A temporary cable had to be run along the highway to restore services.

The Ord Catchment was also the recipient of extended rainfall. However, it was concentrated mainly in the lower half of the catchment. Kununurra received over 1300mm while Halls Creek received only 306mm. Flows this wet down the Ord River, upstream of Lake Argyle, have been just over 1200 GL. This was sufficient to fill the Lake by early January.

This wet season has been a good opportunity for the hydrographic staff to utilise new ADCP stream gauging technology. This equipment enables staff to measure the flow rate of a river at a point in time. The biggest advantage of this new equipment has been its versatility in a range of flow conditions, as it

can be attached to a boat or a rope to be traversed across a river. Radio communications allow the equipment to record and transmit data, whilst the

operator can remain safely on the bank, an important feature in the Kimberley given the presence of saltwater crocodiles.



Fitzroy River boat gauging



We have also been able to trial our new BoM acquisitions – mobile flood gauging units, otherwise know as sea-containers. This year, before the rains began, we placed a sea container at Flying Fox Hole on the Dunham River, filled with a complete set of flood gauging equipment (boat, motor, fuel, safety equipment, ADCP mounting poles). Once the rains commenced, and access to the site was cut, we chartered a helicopter to visit the station and undertake the discharge measurement. This proved very effective, and for the first time we were able to gauge a 4 metre range of the rating curve, that had previously been unattainable.

This wet season has also been a good reminder to field crews of the difficulties in measuring river flows amidst prolonged rainfall. One field crew spent close to 24 hours extracting their vehicle from the soddened ground after an isolated storm dropped

over 100mm on their camp over night. Others spent hours at highway floodways patiently watching flash flood levels rise and fall.

Although we are glad to have some dry weather again, we know that come November when the temperatures are up over 40 degrees, we will again be praying for another good wet.

PILBARA (KARRATHA)

Infrastructure damage due to floods in the Pilbara is common, but each occurrence results in considerable financial losses due to the subsequent disruptions. The mining town of Karratha is the node of activity in the region. The images below show:

- an undercut rail line used by one of the many iron ore mining ventures of the region;

- a broken pipeline that supplies Karratha with its water; and
- one of many roads that were either damaged or cut during the flows.



Flood damage in the Pilbara

Karratha's water supply situation is unique. In dry periods aquifers from Millstream 100 kilometres to the south are used as the water source. The broken pipeline above is the Millstream one. Fortunately, the rainfall also replenished the Harding Dam, Karratha's alternate water source.

MID WEST (CARNARVON)

Further south, the Gascoyne River catchment accepted the remnants of cyclone Dominic. A dry river bed at 0700 became a seven metre river less than 10 hours later. Carnarvon is a major supplier of fresh fruits and vegetables for WA. Growers cluster around the river bed to draw water from the river sand aquifers. When the river flows it is often a mixed blessing. Low flows require the growers to remove their pumps from the river bed but the water also replenishes the aquifers. However, flows

breaking the river banks flood into the plantations eroding top soil and causing damage to infrastructure.

Flood remediation work in Carnarvon has been partly implemented. The bottom right image shows the new bridge that replaced the old single lane bridge (with spectators on) in 2002. With an extra metre or so of height, the new bridge is no longer overtopped, but the approaches are still cut and prevent traffic flow. From a hydrographic aspect, the change in bridge structure has also raised the possibility of a rating change. The dangers of measuring a flow of this nature and the opportunity of it occurring have prevented the collection of sufficient high flow gaugings to complete this task to date.



Gascoyne River flows

Flood Gauging in the Burdekin River 2009

Morgain Sinclair, Department of Natural Resources and Water, Queensland

The 2009 wet season has been a big one for North Queensland. The rain started at the end of December 2008 and by the end of January up to 60% of the state was inundated and the mighty Burdekin River was in full flood. The guys (and girl) of the Ayr Hydrographic team took this opportunity to collect some valuable flood measurements at the Burdekin R at Inkerman Bridge. In all, 17 doppler measurements ranging from 1787 to 18354 cumecs were collected between 02.02.09 and 23.02.09.

Geoff Pocock drove the boat (even the boss came out and got wet!), allowing me to concentrate on the doppler. I was keen to try the GPS setup and bottom track commands I had spent my Australia Day long weekend reading up on. The job of third crew person was taken in turns by Hydrographic team members Phil Kerr, Scott Hibberd and Scott

Aulsebrook and Groundwater team member Scott McKenna.

Towards the peak, the Burdekin R broke out and cut the highway at Plantation Ck. We waded through the knee-deep water on two days to access the boat and a vehicle which were left on the other side.

The Burdekin River has the usual run of flood hazards. While no one was put off by sunburn, the logs or huge whirlpools and boils racing down the 900m wide river, less enthusiasm was shown for the large 'log' (probably a giant croc) that was spotted from the bridge, swimming upstream against the current.

120001A Burdekin R at Inkerman Bridge is a BOM (Bureau of Meteorology) flood warning station and a water sampling site for the Runoff to the Reef sediment and nutrient loads monitoring project. It is located on the Bruce Highway and is the best boat access point into the lower Burdekin River.



120001A Inkerman Bridge, Sugar Mill on right bank



120001A, looking downstream at boat

At only 22 km below 120006B, the most downstream gauging station operated by the Department of Natural Resources and Water, it is possible to use flood measurements at 120001A to check the rating at the gauging station.

The flow measurements are also useful to BOM for their flood warning models and to the Reef Monitoring project. The proximity of the site to the office allowed us to test our boat setup and equipment before tackling more remote sites.

Located downstream of the Burdekin Dam, which spills every year, has a storage volume of 1.86 million megalitres and covers an area of 22000 ha at capacity, the Burdekin R at Inkerman Bridge is a formidable site.

With a catchment area of 129760 km² at Inkerman Bridge, the Burdekin is relatively swift flowing for a river of its size. Maximum velocities of 5.7 m/s and a mean velocity of 2.5 m/s were encountered in the highest measurements.

The Burdekin is a difficult River to measure. The size of the channel, up to 970m wide and around 8 m deep (11.2 m at the deepest point) combined with high velocities and turbulence creates a dynamic environment. Each transect took 10 minutes, leaving plenty of opportunity for debris to be caught on the Doppler or other problems to occur.

The bed and banks are composed of highly mobile sand which constantly reconfigures the channel geometry. Moving bed, combined with high turbidity, can cause such difficulties for dopplers that measurements have previously been attempted in the upper Burdekin where no velocity data was obtained at all.

We used a 600 kHz TRDI Workhorse Rio Grande ADCP with the latest firmware upgrade, a Garmin Map 76 GPS with WAAS (Wide Area Augmentation System) enabled and a Garmin Marine antenna. The antenna was freighted down from Townsville only a day before the highway was cut by flooding.



Bow

Mounted Doppler with GPS antenna

The doppler was bow mounted on the centreline of a 4.3m console steer Quintrex v-bottom dinghy. A 40 hp Yamaha outboard provided the power.



Ayr Flood Gauging Boat 'Caketaker' with crew

As we were operating in the rain, a waterproof Panasonic Toughbook Laptop computer, with Winriver II, was used.

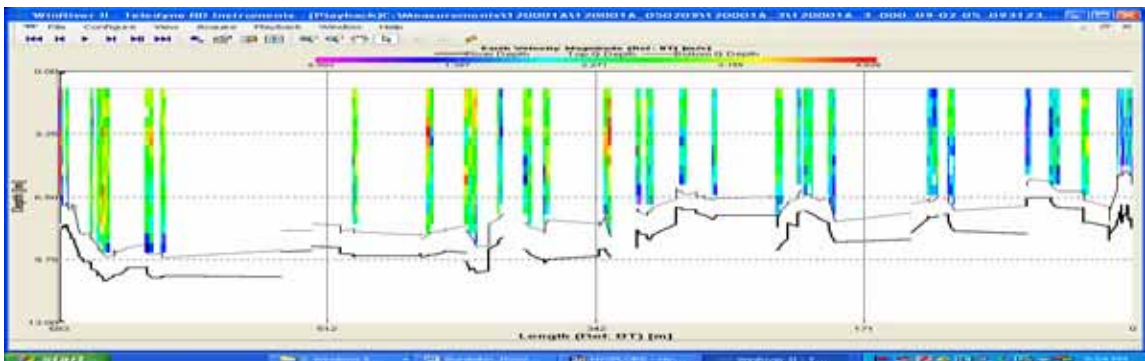
The Garmin GPS was considered adequate given the scale of the section, though a more accurate GPS will be used at other sites

The GPS went a long way to solving our moving bed problems. However, at higher flows, we were still encountering difficulties with high signal absorption due to increased depth and turbidity.

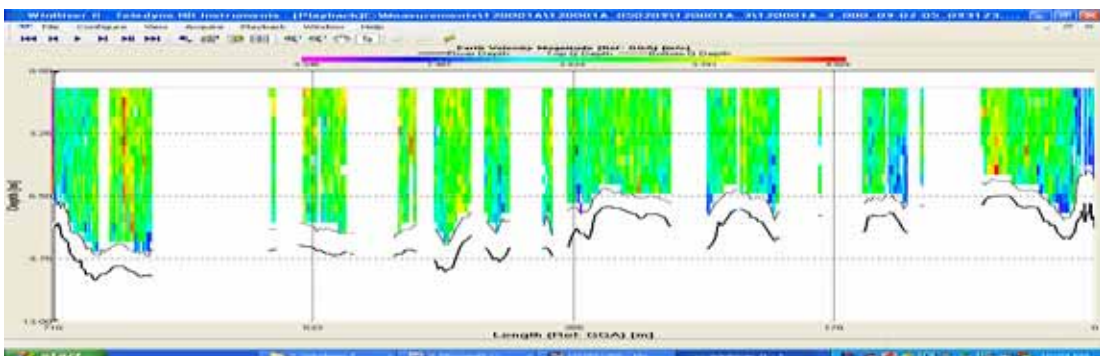
Extremely fluid bed conditions also led to the rejection of a significant proportion of the bottom track and velocity data. We were able to overcome this by using the 3 Beam Solutions and altering the BA, BC and WC values in the Commands page.

The discharge was 25% less without the GPS and commands and 4.5% less with the GPS only.

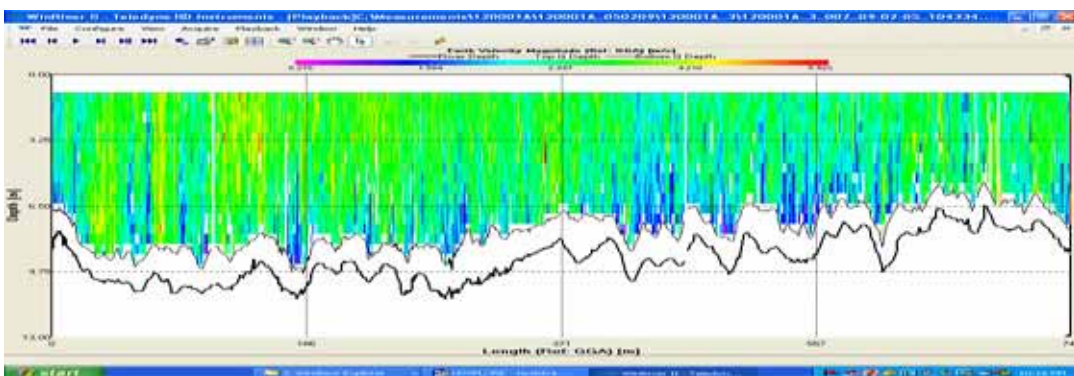
This discrepancy would be greater in a less uniform section. Transects were generally within 2% of the mean despite changing stage.



120001A 05.02.09 Transect 0 with no GPS and no Additional Commands



120001A 05.02.09 Transect 0 with GPS only



120001A 05.02.09 Transect 2 with GPS and BA, BC and WC commands and 3-beam solutions

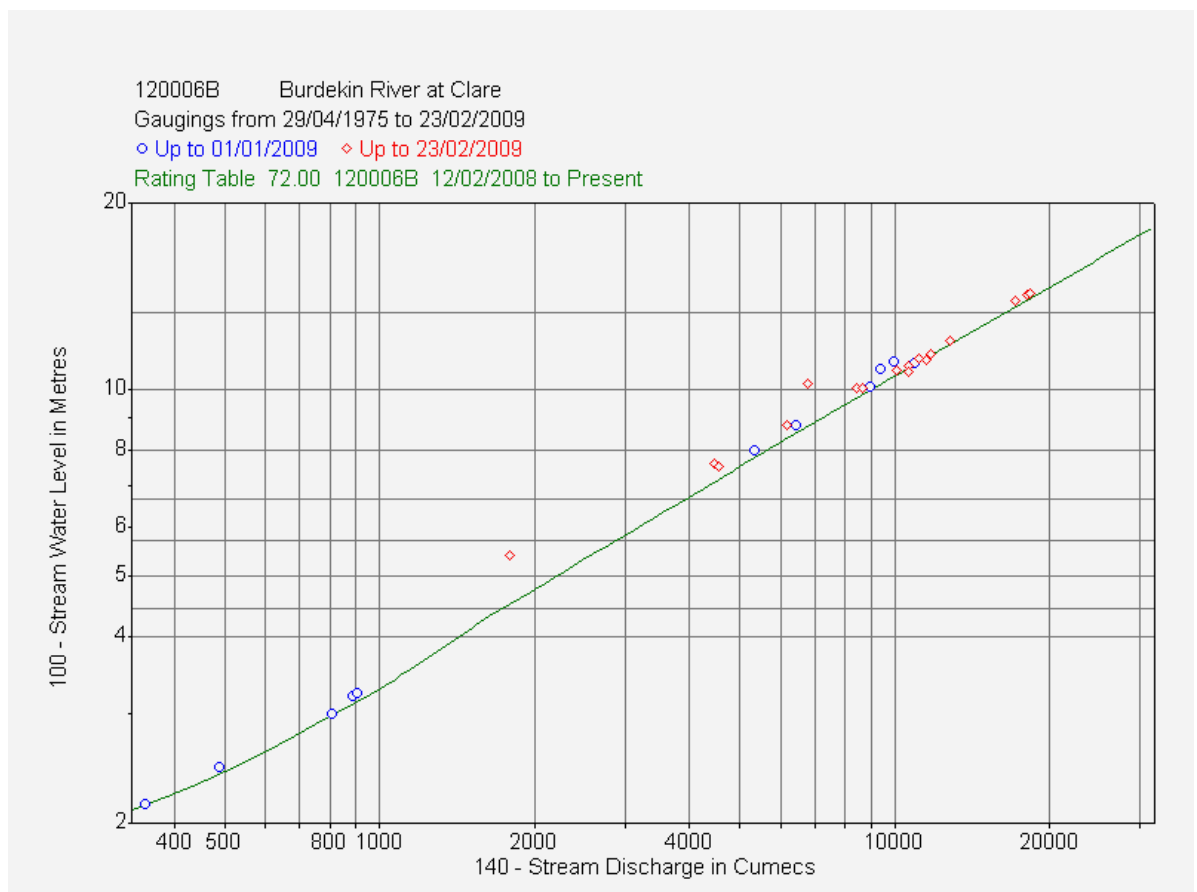
BA, or Bottom Elevation Amplitude, sets the minimum value for valid bottom detection. Decreasing BA can improve bottom track range in adverse conditions but can also increase false bottom detections. I used a value of between BA 15 and BA 20 with no problems.

BC and WC are the Bottom Correlation and Water Correlation thresholds below which bottom track and water velocity data is flagged as bad and not included. I used values of between BC 125 and BC 150 and WC 025 and WC 050. I selected Water Mode 1 and Bottom Mode 4 as they are the most robust modes in turbulent, high flow conditions.

We were able to check the rating at the Burdekin R at Clare. We determined the gauge height at Clare by calculating travel time from mean velocity and distance between the sites. There is an outlier around 7000 cumecs which was disregarded.

The lowest measurement in the series also plots off the curve, though the other measurements suggest a possible change in slope of the curve in this area. Further measurements are required in the 1000 to 4000 cumec range.

The two older measurements that plot off the curve were 2008 doppler measurements affected by moving bed error.



We also collected backscatter data and concurrent sediment samples using a P61 point sampler from the bridge, which can be used to calculate sediment loads.

Finally, the experience we have gained during this exercise will stand us in good stead for future flood events. So bring on the next wet season!



Australian Government
Bureau of Meteorology



The Bureau of Meteorology – Improving Water Information

The Bureau of Meteorology is Australia's national authority on weather and climate information.

Through the Australian Government's \$450 million Improving Water Information Program, and supported by the *Commonwealth Water Act 2007*, the Bureau is now responsible for providing leadership on water information. Its new role will see the Bureau providing a single, reliable source of water data and knowledge to help the water industry secure the nation's water resources.

Water shortages, climate variability and climate change pose serious threats to Australia's economy and way of life. The Bureau – in cooperation with the water industry – will use state-of-the-art technology to help answer:

- How much water is available in different parts of the country today and how does this compare with the past?
- Who is entitled to use water and how much are they using?

- How much water is being allocated and how is the security of particular water entitlements changing?
- How much water is being traded and to where?
- How much water is the environment getting?
- How much water is being intercepted by farm dams and land management changes?
- How is flood risk changing in response to climatic and land management changes?
- How is the quality of water in rivers and aquifers changing?

The Bureau will also provide insights on the status of Australia's water resources and usage patterns, forecast future water availability, compile and maintain the National Water Account and issue National Water Information Standards. The new program will also enable the Bureau to improve its national flood forecasting and warning services.

www.bom.gov.au/water

HYDROGRAPHY – A CONTINUOUS IMPROVEMENT TOOL.

Scott Crozier, Hydrographer, Snowy Hydro Ltd.

The following is an abridged version of Scott's final Project, undertaken as part of his studies in the OTEN Hydrography Certificate. Finer details of a secondary system analysis are excluded from this version but summary outcomes included. The full version of the paper is on the 2008 14th Australian Hydrographers Association Conference proceedings DVD. Its original title is "Assessment of the Volume and Value of Lost Water from Aqueducts in the Murray Development of the Snowy Hydro Scheme".)

ABSTRACT

Bourkes Gorge/Bogong Creek and Geehi River Aqueducts are large aqueducts that contribute to inflows for the operation of Snowy Hydro Ltd (SHL), hydroelectric plant in the Murray operational region. The region has endured one of the longest and worst drought sequences of recent times and the efficient used of water is becoming of increasing importance. The drought sequence has led to a low number of medium to high inflow events to analyse, only one in the Bourges Gorge Aqueduct through the period of study.

To determine what events occur at the intakes to the aqueducts, several representative sites had water level monitoring instrumentation installed. Sites selected were Three Rocks Creek and Watsons Creek/Gorge intakes on the Geehi aqueduct and Bourkes Gorge/Bogong Creek intake on the Bourkes Gorge aqueduct.

It has been found through the course of this investigation that water is lost from the aqueduct system when there is capacity for water to be carried in aqueducts. For the single event in the Bourkes Gorge Aqueduct 93% of the volume spilt could have been accommodated in the aqueduct. Geehi aqueduct results varied more and were difficult to evaluate due to the aqueduct configuration containing multiple intakes. There was, however, significant scope for gains during some precipitation events.

On Geehi Aqueduct, the Three Rocks Creek intake has been found to have discharge over the spillway much earlier than that at Watsons Creek and earlier than the flood peak that

reaches the aqueduct metering station. The time difference has been recorded as on average between 5-6 hours or greater and as such has the potential to be a valuable site as an early flood warning station for maintenance crews to visit sites.

Data from Three Rocks Creek on the Geehi Aqueduct also revealed small spill events occurring in fair weather. This differs from the general belief that spills occur only in inclement weather. It also adds to the potential use for the site as an early warning station as if the intake is blocked and spilling from increased flows due to snow melt a precipitation event under the same conditions would result in a much higher percentage loss of water.

Data suggests that when spill events occur there is a significant loss and the volumetric and monetary potential for gains is substantial and if appropriate water saving options were employed they would pay for themselves in a relatively short period of time (several years). Large scale engineering solutions would currently be expensive and would take a long time for them to pay for the capital and installation costs.

PROJECT OUTLINE

Water is important to Snowy Hydro Ltd (SHL) as it is used to drive the hydroelectric power stations and as such has a dollar value associated with its ability to do so.

The community values water for recreation, irrigation and domestic water supply. The long drought sequence the region is enduring has reduced dam storages and inflows to low levels, reducing the availability of this resource.

Analysing the system to determine if there are any inefficient processes is now required to determine if there is any way to increase the availability of this resource for all users. This project is designed to determine how much is lost and what appropriate technology (based on value of lost water) should be employed to address the situation.

The fate of water entering aqueduct catchments in the Snowy Hydro Scheme can be simplistically depicted in Figure 1.

The main concern of this project is to determine if there is any potential to gain

efficiencies by capturing a percentage of the water currently spilt from aqueducts when

aqueducts are not running at full capacity.

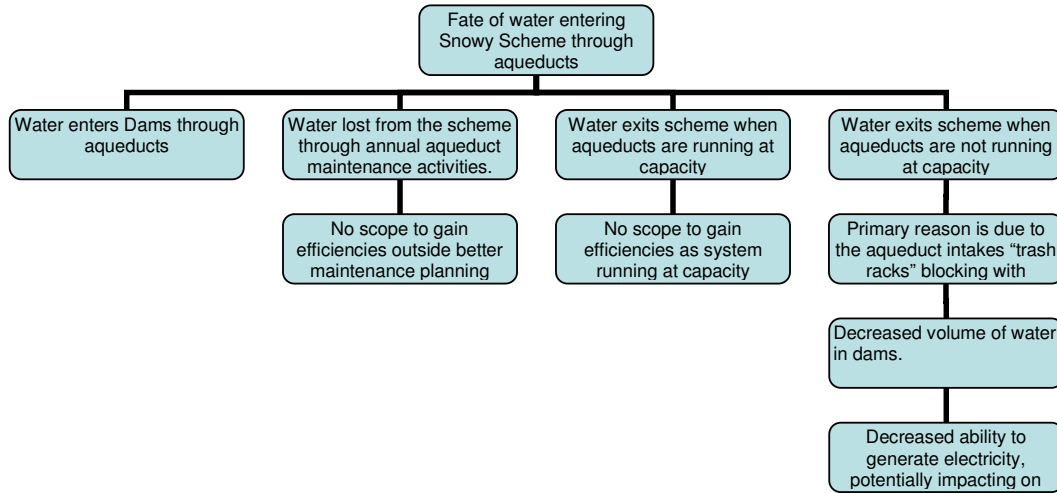


Figure 1: Flow Chart of Fate of Water Entering Aqueduct

To determine if an aqueduct has potential for gains in efficiencies, several things must be known:

- Discharge capacity of the selected aqueduct, &
- Instantaneous discharge through the aqueduct from a metering station

This allows a calculation of the remaining capacity in the aqueduct at any given time.

This does not however equate to inefficiencies unless water is being lost from the scheme while there is still capacity in the aqueduct.

To determine if water is being lost from the scheme while there is capacity in the aqueduct water level monitoring equipment was installed at selected sites and theoretical discharge ratings created to give an estimated discharge over intake spillways. This data provides enough information to determine if there is potential for efficiency gains.

Project Methodology

- Select representative aqueducts for the investigation.
- Install water level monitoring equipment on intake structures
- Use HYDSTRA applications to analyse and adjust data

- Determine when aqueducts spill and what level the water reaches over the spillway.
- Derive a theoretical rating table for each intake structure spillway under investigation.
- Using water level data, technical drawings and theoretical rating tables, determine the theoretical volume discharged over spillways during spill events.
- From existing aqueduct water level monitoring stations and their rating tables determine instantaneous flow through aqueducts.
- Using aqueduct design capacity, calculate remaining aqueduct capacity.
- Determine the amount spilt that could have potentially been captured by examining the volumes spilt and remaining capacity.
- Total the amount of water spilt for the period of the study and apply a dollar value assigned by water accounting for the water per ML.
- Look at options to capture water lost due to spilling.

Site selection.

The first prerequisite was that aqueducts had to have water level/metering stations installed and be rated.

Aqueducts in the Murray/Khancoban were then selected as at the beginning of the project/trial these were geographically closest and of most relevance to the work group I was involved in. Of the possible sites, the Geehi and Bourkes Gorge/Bogong creek Aqueducts were strongly recommended as anecdotally (M. Zuino Pers. Comm.) they have been believed to be the areas where the greatest losses occur.

Bourkes Gorge (Figure 2) was selected as it was identified as a site with potential for large losses if it were to spill as it has the largest catchment area in the target area. It is also an important site as downstream of the intake is a colony of Southern Corroborree frogs (M. Zuino Pers. Comm.) which conditions in their habitat is of great interest.

The final reason for it being of importance to our workgroup is that it is a catchment that is part of a cloud seeding trial and the determination of total water/runoff from the catchment, including spilt water is of high importance.

Of sites on the Geehi aqueduct (Figure 2), the largest three were Three Rocks Creek, Lady Northcote Creek and Watsons Creek. Lady Northcote is the most remote and according to field maintenance staff one that spills readily but usually when the pipe is at full capacity. Lady Northcote diversion structure is accessed through a tunnel which delivers water to the aqueduct. For any maintenance the tunnel would need to be turned out/dewatered and water lost which is the opposite aim of the project, therefore this site was excluded. Three Rocks Creek and Watsons Creek were selected on the Geehi Aqueduct as they have the largest area, potentially greatest runoff and highest potential for spills.

Two instrument systems were made available for this project comprising Unidata Starloggers coupled with Unidata pressure transducers. This configuration was found to be most suited to this study because of its low power requirements, as mains power or good solar exposure were not available for battery charging at the sites. The power supply was a small 12V12AH SLA and this was found

Error!

sufficient for powering and maintaining the systems for 9 - 12 months during the project.

It was decided that initially the instruments would be run in tandem on the two sites on the Geehi aqueduct to determine their relationships. Then the instrument installed at Watsons Gorge would be relocated to Bourkes Gorge/Bogong creek to collect data for at least a 12 month period.

Derivation of Theoretical ratings.

This involved the review of technical drawings to acquire relative levels for spillways and diversion structure dimensions which were then converted to metric measurements. Following this surveys were carried out to check the drawings accuracies before creating rating tables.

Each site had a basic rating table developed, using Hydstra to initially create sites in the sites database and then using HYRATED and the discharge equation below to create an assumed, theoretical rating table.

$$Q=1.84*[(L-(0.2*H))*((H)^{3/2})]$$

(Haestead Methods Inc, 2002).

Each rating table used the level indicated by the instrument at spillway height as the cease to flow (CTF) level. Therefore data adjusted to the reference datum could be used without adjusting water level data to make spillway level zero.

Determining the potential value of 'spilt water fom the system

Every ML of water has the capacity to produce a certain amount of electricity and depending on market conditions at the time of generation a value can be assigned to water for generation purposes.

$$\text{Value} = \text{ML} * \$X/\text{MWH}$$

X=Variable dollar value that every ML has the capacity to produce.

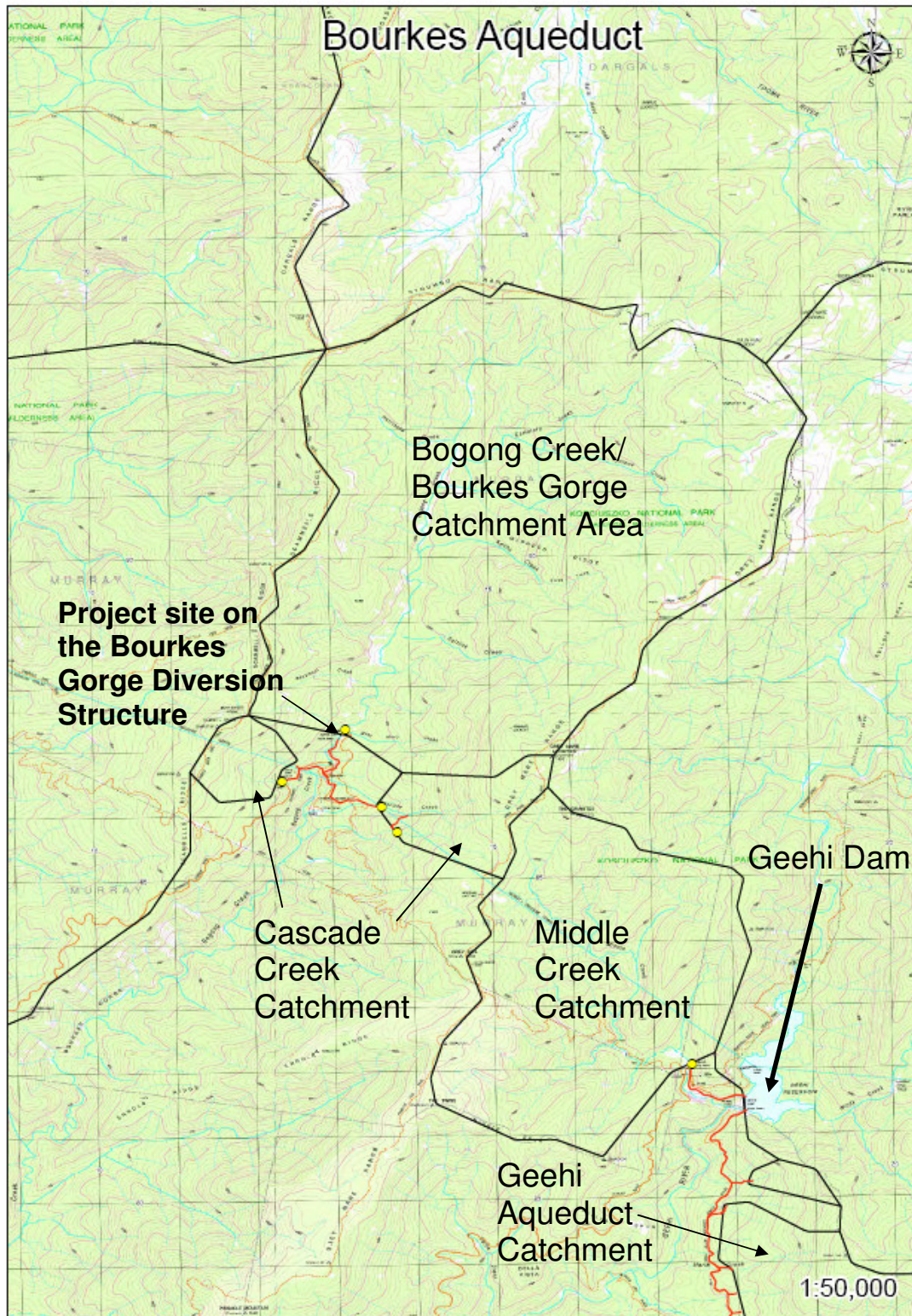
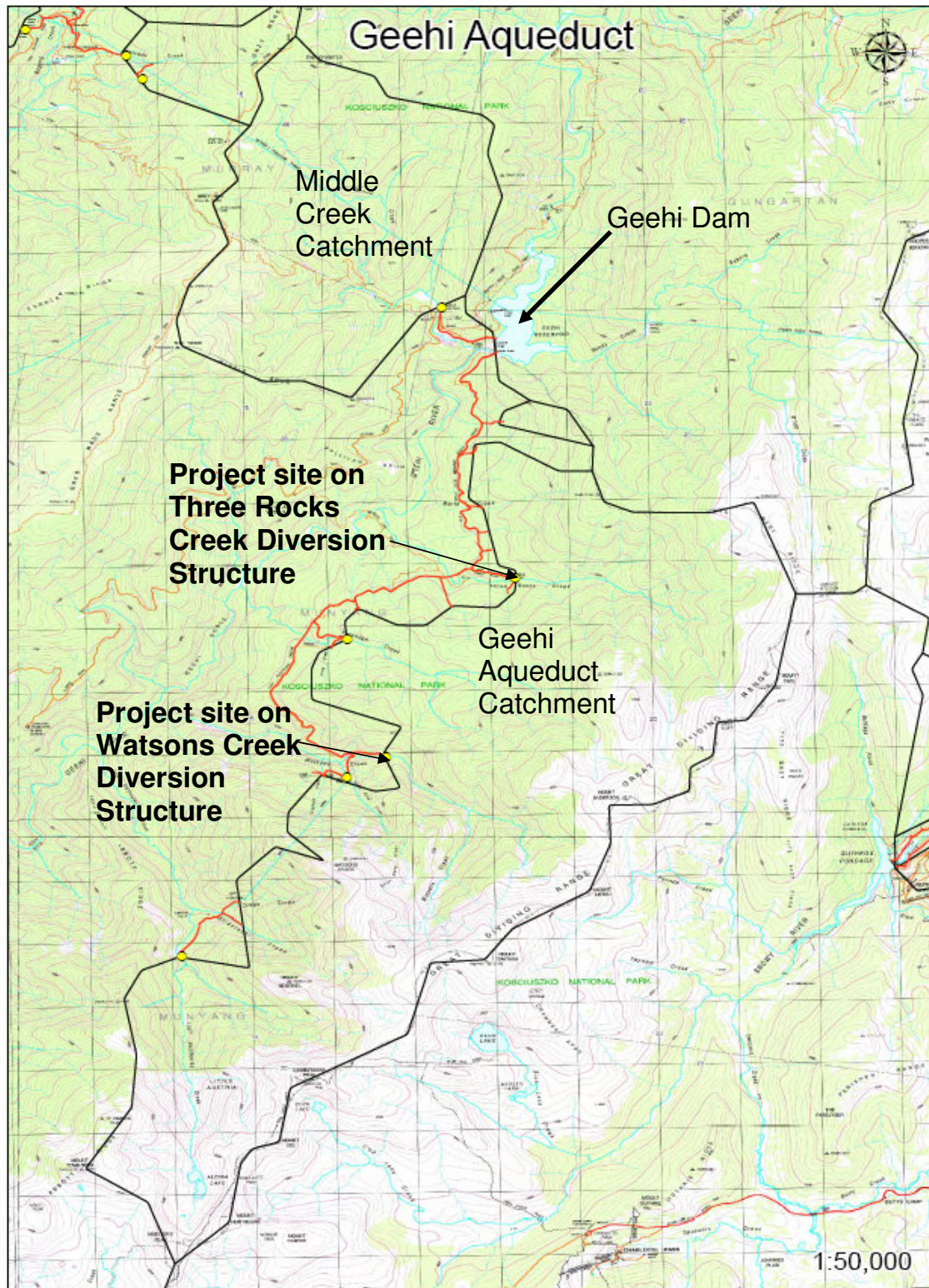


Figure 2: Geographical location of Project Site on Bourke's Gorge Aqueduct



Synthesis of Bourke's Gorge Site Data

The Bourkes Gorge Aqueduct diversion structure (Figures 4) is arranged with an intake structure that impounds water from the Bogong and Grey Mare creeks. The water is then diverted through the trash racks into the settling tank. Water flows through the settling tank and under a floating weir which regulates the amount of water flowing into the meter chamber. The water level in the meter chamber is regulated by a large v-notch weir which has a rating table that was derived upon construction. The rating table is used to determine flows entering the aqueduct.

Through the structure water can be lost over the diversion structure spillway which is the focus of this study.

Water can also be lost over a side channel spillway located in the settling tank. The

floating weir regulates the level of water in the settling tank and is designed to allow water up to the capacity of the aqueduct into the meter chamber. Therefore any spill over the side of the settling tank is outside the capacity of the aqueduct and would not have been able to have been diverted.

Water can finally be lost from this structure over the side of the outfall chamber (final chamber before entering the aqueduct). This only occurs when the aqueduct is full and no more water could enter.

Through the whole structure, water spilt over the diversion structure spillway when the aqueduct is not running at full capacity is the only water that has any potential to be saved. The water level instrumentation was therefore installed in the intake structure where water level was recorded and relative levels surveyed to identify spillway level.

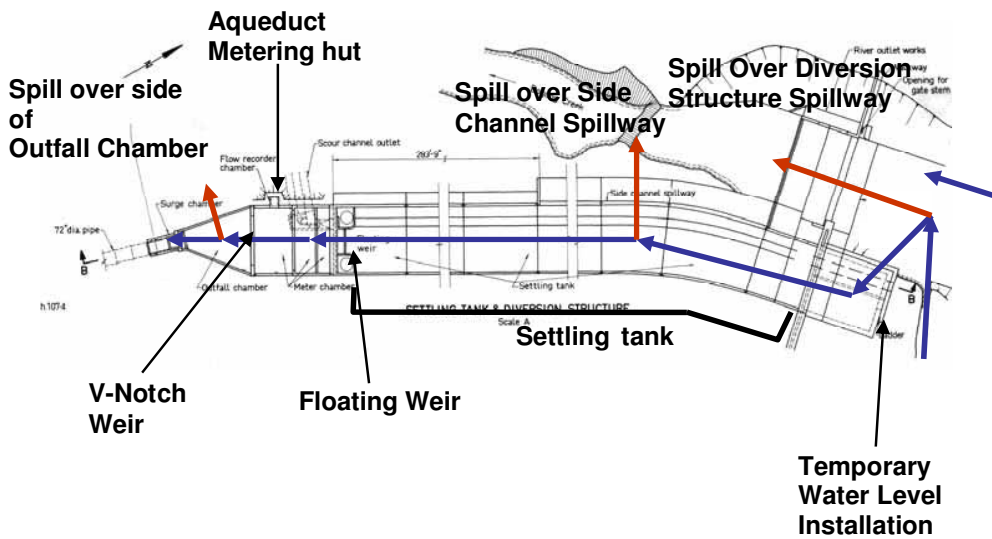


Figure 4: Bourke's Gorge Diversion Structure and Settling Tank Arrangement
 Source: SHL Drawing No # 34502A, 1966

Water level was recorded continuously, related to and adjusted to a datum on the intake wall. The relative levels of the datum and spillway wall were surveyed and the spill level of the instrument determined. This was later used as the zero level for the spillway rating table. Flow data was derived from the level data using a basic weir equation to create a theoretical rating table for spillway flows.

$$Q=1.84*(L-(0.2*H))*(H^{3/2})$$

Q = Discharge (Cumecs)

L = Length of spillway (m)

H = Height of water over spillway (m)

(Haestead Methods Inc, 2002).

Flow data for discharge over the diversion structure spillway was then added to the diverted flows, giving a total flow for that part of the catchment.

The result is a discharge hydrograph which essentially has three parts;

1. Water diverted,
2. Water spilt that could have been diverted and
3. Water spilt that is outside the capacity of the diversion structure/aqueduct.

During the period of data collection there was only one instance where a spill over the diversion structure spillway occurred. Below is a summary of the event.

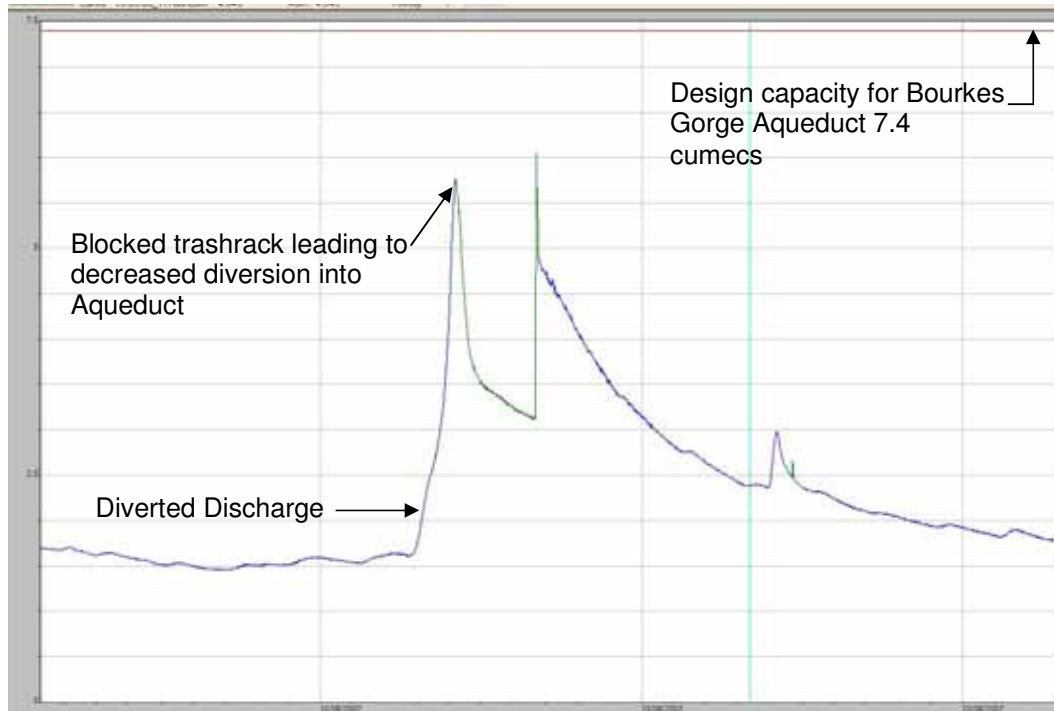


Figure 5: Discharge Hydrograph of water diverted into Bourkes Gorge Aqueduct. Generated from HYDMWB for aqueduct monitoring station (600175).

Figure 5 shows the discharge hydrograph of the spill event that occurred on 12 August 2007. Several features of the event are evident:

- An initial rapid rise in diverted discharge with increased runoff
- Rapid reduction of flow into the aqueduct line following trash racks becoming blocked with debris
- Flow in the aqueduct remained well below the aqueduct capacity
- Spill event lasted for 31 hours.
- Once trash racks were cleaned, the diverted discharge rapidly increased

Figure 6 below shows the discharge for diverted water and discharge over spillway as separate traces and Figure 8 combines the

two traces to represent a total flow through the catchment for the precipitation event.

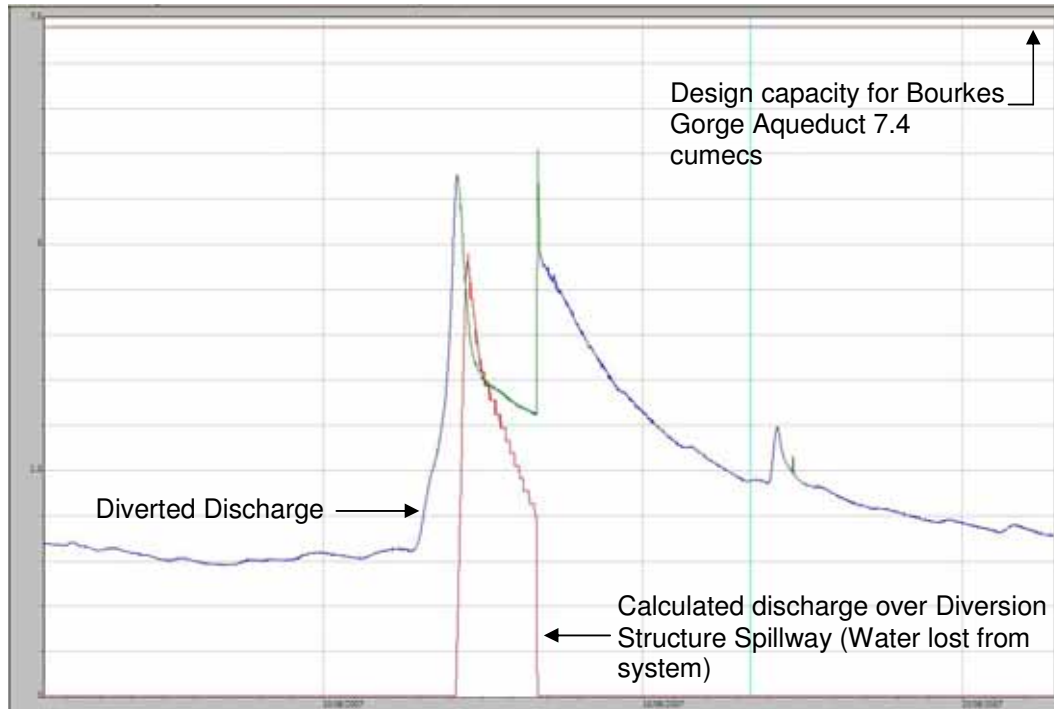


Figure 6: Discharge Hydrograph for Rainfall Event Bogong Creek 12 August 2007 - Diverted and Spill Discharges shown.

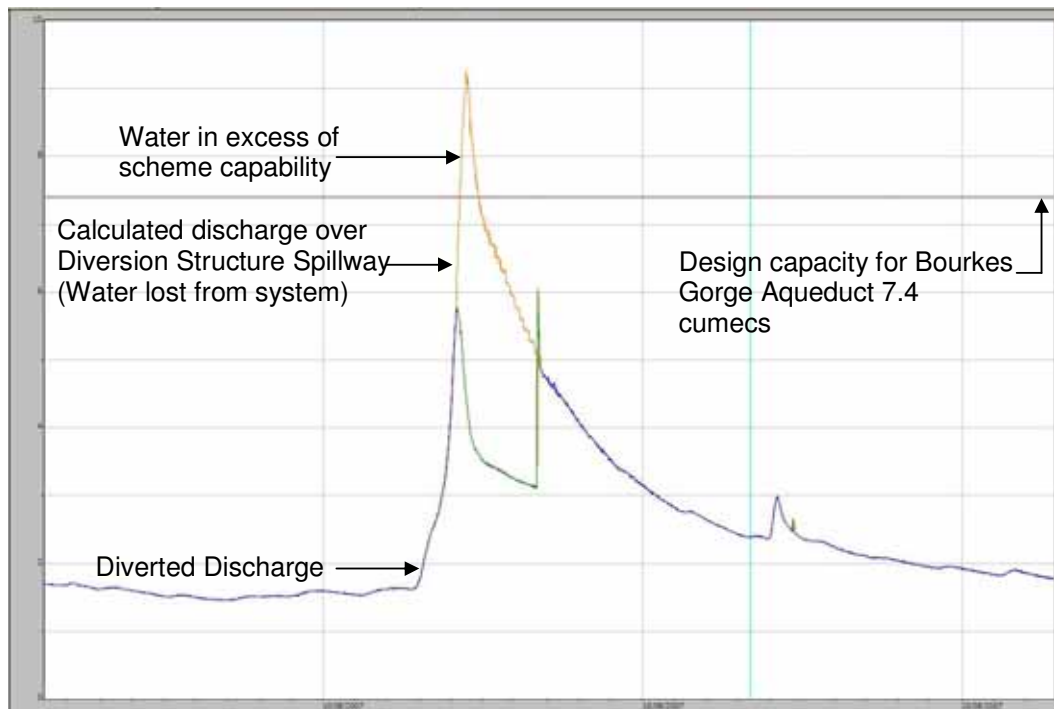


Figure 7: Total Discharge Hydrograph for Rainfall Event Bogong Creek 12 August 2007 - Diverted and Spill Discharges combined

Figure 7 shows a trace combining diverted and spilt water, creating an instantaneous total discharge for water that would be entering the intake structure before the trash racks.

For this event:

- Total discharge exceeded aqueduct capacity
- Part of the flow would have been unable to have been diverted for SHL purposes.
- A large percentage of discharge was spilt and lost from the system.

To separate the parts of the flow, the total discharge hydrograph for Bogong creek as seen in Figure 8 has all flow below capacity subtracted from the total, leaving the part in excess of aqueduct capacity. This is then subtracted from the spill hydrograph, using HYCRSUM, resulting in a hydrograph for diverted water, spilt water that could have been diverted and spilt water that was in excess of the scheme capacity (see Figure 8 below).

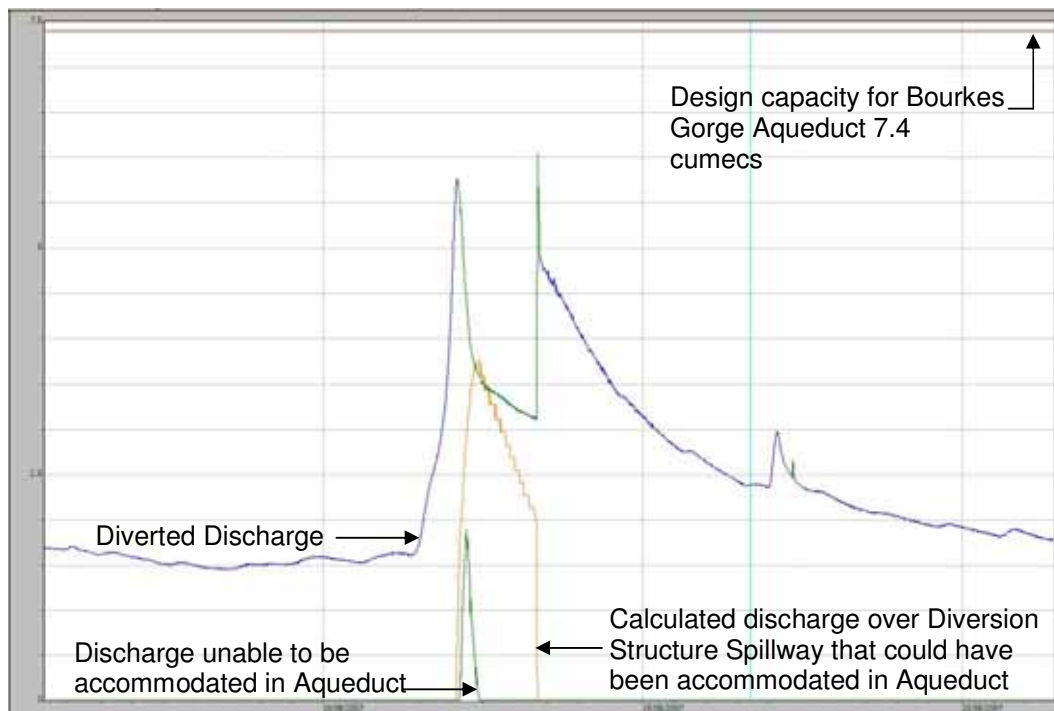


Figure 8: Discharge Hydrograph for Rainfall Event Bogong Creek 12 August 2007

By running a HYDAY on the separate segments of Figure 8 above, daily volumes for the period of the spill event were determined as:

- 332ML was the total discharge spilt
- 308 ML in total lost that could have been diverted
- 24 ML Outside Structure Capacity/would have occurred as natural spill.

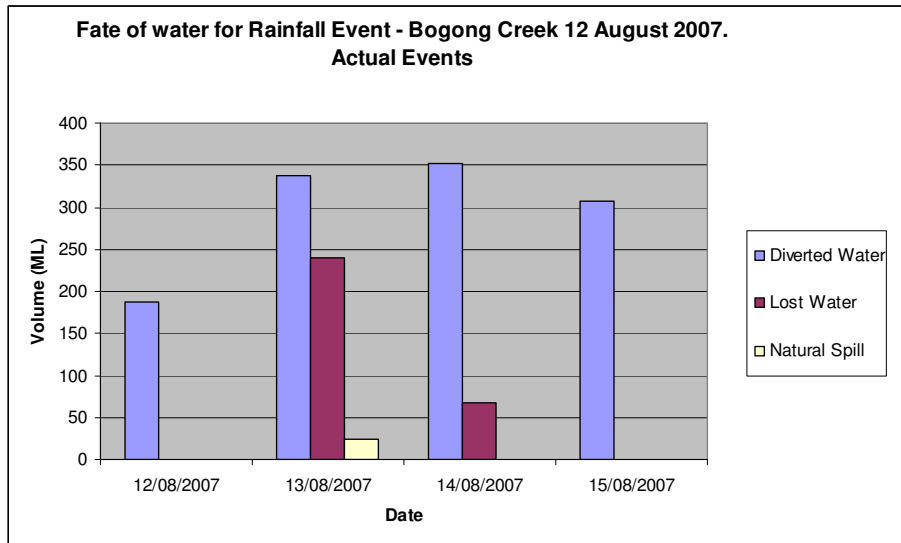


Figure 9: Daily Discharge Volumes, Separated into Final Destination

Every ML of water has the capacity to produce a certain amount of electricity and depending on market conditions at the time of generation a value can be assigned to water for generation purposes.

$$\text{Value} = \text{ML} * \$\text{X/MWH/ML}$$

(MWH=Mega Watt Hour)

$$\text{Value} = 308\text{ML} * \$49.85 = \$15353.80$$

NB: Price based on an average 2009 ICAP contract forward price estimate
 ICAP is an UK based brokering company.

Part of this volume could have been saved as the duration of the spill was over 2 days. If cleared, possibly half the lost volume could have been saved, reducing value of lost water to approximately \$7600.

Analysis of Geehi Aqueduct

(This secondary analysis has been abridged to primary results and outcomes. The full paper is available in the conference proceedings- Ed)

The sites selected on the Geehi Aqueduct were Three Rocks Creek and Watsons Creek/Gorge.

Geehi Aqueduct consists of 13.9km of pipeline and 4.9 km of spurlines. Theoretical discharge capacity is 10.8 cumecs (*Snowy Hydro Ltd, 2003*), however the highest recorded is 10.03 cumecs.

Determining losses from individual intakes on the Geehi aqueduct is difficult as the aqueduct metering station is located just before the outfall into Geehi dam but has multiple diversion structures contributing to the final flow measured at the metering station.

The only accurate estimation is of discharge over diversion structure spillways using the same theoretical weir equation as for Bourkes Gorge/Bogong creek to derive a rating table and then integrating this data with water level data.

Total volume spilt however, can be used to determine a worst case scenario of water lost. This can be done by using water level data from the aqueduct monitoring station with its existing rating table to create a discharge hydrograph for flow in the aqueduct

Table 1: Summary of Volume Spilt During Yearly Period of Operation

Year	Three Rocks Creek	Watsons Gorge
2005	2466 ML	984 ML
2006	393 ML	0 ML
2007	303 ML	N/A

Source: HYDAY results from Three Rocks and Watsons data.

NB: Data from year 2005 only commenced August 2005 (4 months of data) and for year 2006 Watsons was removed in late July (7 months of data). Of note is that following removal of instruments from Watsons, no large spills occurred at Three Rocks intake.

The analysis describes the worst case scenario of the aqueduct not running at full capacity when there is excess runoff while having an intake fully blocked.

This scenario makes the assumptions that;

1. Geehi Aqueduct is not running at capacity
2. The quoted maximum discharge (untested, historically not reached) for the Geehi aqueduct is 10.8 cumecs (*Snowy Hydro Ltd, 2003*).
3. The diversion structure intake being studied is fully blocked and no water is

entering Geehi aqueduct through this diversion/spur line.

4. If the trash racks were blocked and then cleared the full capacity of the spur line would be available.

This creates the worst case scenario, however, in reality the aqueduct would not be fully blocked. The diversion structure may in fact be running at capacity and the diversion line has no scope for further gains. As such the resulting information represents a purely theoretical value when looking at actual spill losses from individual intakes.

Table 2: Summary of Volume spilt during Period of operation in each year and potential for gains

Year	Three Rocks Creek	Three Rocks Creek	Watsons Gorge	Watsons Gorge
	Total spilt	Potential Gains	Total spilt	Potential Gains
2005	2466 ML	1128 ML	984 ML	361 ML
2006	393 ML	160 ML	0 ML	0 ML
2007	303 ML	183 ML	N/A	N/A

Source: HYDAY results from Three Rocks and Watsons data.

NB: Geehi Aqueduct really only has capacity to capture one of these. For example if Three Rocks were to take the spare capacity there would be no room for water from Watsons.

From table 2 it is clear that of the total volumes spilt, even if the aqueduct intakes were completely blocked and then cleared, allowing the entire capacity to be utilised, less than half the volume spilt would be able to be captured. The diversion lines would only have a percentage of capacity unavailable and therefore much less than half the volumes spilt would be able to be accommodated.

It is of note that although I put the proviso that the potential gains listed are purely theoretical and only applicable under a certain set of conditions it is a fact that there is water being lost from the system at the same time as there is spare capacity in the aqueduct. The two project sites spilt simultaneously during large

rainfall events and it would be reasonable to assume that other diversion structures would be experiencing the same conditions. Therefore if there was a way to determine early that spills were occurring before flood peaks reached the metering station it could be possible to deploy maintenance staff and save some of the lost water.

This is where information gathered from the Three Rocks diversion structure was very informative. This site has the largest catchment area of all sites on the aqueduct but has a smaller carrying capacity than others and as such spills more frequently and more importantly earlier than others. From the data obtained, during large spill events Three

Rocks Spills much earlier than Watsons (5-6 hours on large spills) as illustrated in Figures 10 and 11 below. Figures 10 and 11 both show the timing of events and Elapsed Time

(ET) between peaks in the hydrograph. They also highlight the ET between onsets of spilling at the two sites.

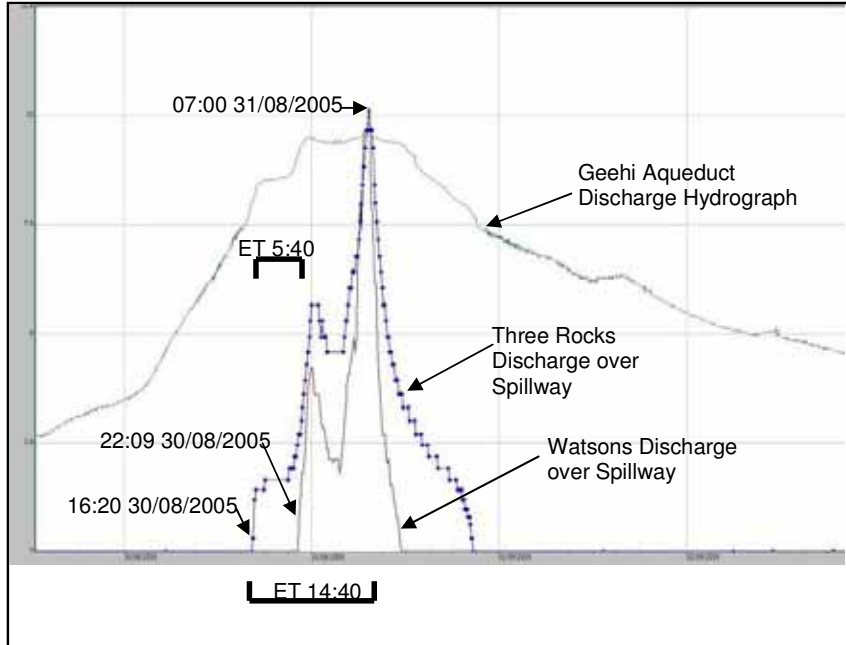


Figure 10: Geehi Aqueduct Discharge Hydrograph and Timing of Diversion Structure Spills.

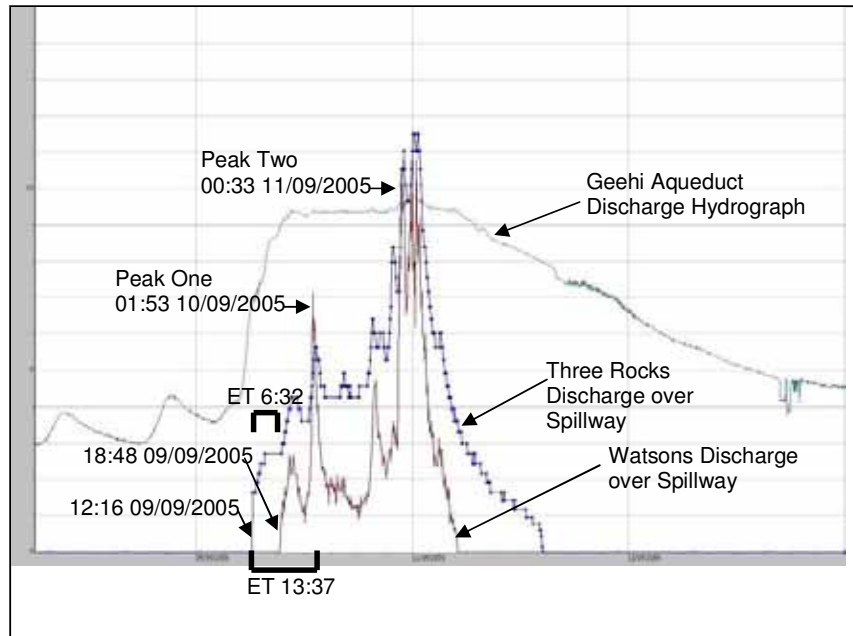


Figure 11: Geehi Aqueduct Discharge Hydrograph and Timing of Diversion Structure Spills

Project Conclusions

Water Saving Options

Installation of water level monitoring equipment and telemetry to alarm spill events

- Approximate cost \$2K telemetry and similar for instrument, manufacturing and installation, so total less than \$10K

Installation of automatic trash rack cleaners

- High setup cost
- Automatic cleaners approx \$100-150K
- Mains Power supply in excess of \$300K (estimate from job where Geehi River Gauging Station was connected to mains power)

Automatic trash rack cleaners in vicinity of \$100 000 - \$150 000 (A. Blair Pers. Comm.) each and then would either need mains power connection to power such large devices or standby diesel generator. All would be very costly for any site as nearby Geehi River Gauging station was connected to mains power at a cost of approx \$300 000. The distance would be similar to Three Rocks from the nearest mains supply and possibly twice that distance to Watsons, leaving double the cost of connection and two cleaners. The result of this is an estimated cost of approx \$1,000,000 for the sites on the Geehi aqueduct. Bourkes Gorge has no mains power in the area and as such would require either a large generator or a long connection to mains power. Ongoing maintenance would be required, putting this installation to \$300 000 + bracket. This puts this solution out of the price range for acceptable technology.

Therefore the low cost, water level monitoring station and telemetry option linked to an existing radio telemetry system, triggering alarms to alert maintenance crews is preferred and justified. In the one spill event in Bourkes Gorge, if half the water could have been saved, the instruments would pay for themselves. On the Geehi River, if an early warning station was to be installed on Three Rocks intake it could result in significant reduction of losses from aqueduct spills.

Future directions

- Further investigations on Geehi Aqueduct required.
- Pressure transducer or Starflow in spur lines to determine flow characteristics during spill events and actual losses
- Install water level monitoring and telemetry at Bourkes Gorge site.
- Set up temporary instruments on other Geehi Aqueduct intakes simultaneously with Three Rocks to confirm use for early flood station.
- Possible use of Three Rocks Spill level with a telemetry station as early alert/high flow station.
- Gauge Geehi aqueduct flows to determine if theoretical maximum is possible.

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Australian Hydrographers' Association Educational Grant

The Committee of the Australian Hydrographers' Association has instituted a number of awards/grants to encourage younger (and not so young) cadets and hydrographers to undertake studies in the Hydrography Certificate IV. This has been implemented since 2006 and the following information is provided about the AHA Educational Grant.

AHA members are also encouraged to make their employers and others aware of this Educational Grant and that the Association wishes to support the development of cadetships and traineeships within the industry, this grant being one aspect of the Associations support.

The following describes the requirements and conditions for the Educational Grant.

PURPOSE

The purpose of the Educational Grant is to:

- promote the principle objective of the Association to further the development of the science of hydrography/field hydrology and its application to the understanding monitoring and management of Australia's water resources, and
- assist students undertaking the Hydrography Certificate IV (accredited under the Australian Qualifications Framework to undertake the final year Project (Subject 8004AA) as required in the course

THE GRANT

The Grant will be of a value of up to \$1000 to assist the students undertaking studies in the Hydrography Certificate IV to purchase material/equipment and services necessary to undertake the Project in the final year of the course.

CONDITIONS

- The recipient will supply an initial abstract paper and a final project paper for publication in the Association's Journal "Australasian Hydrographer", and win advanced consideration for the right to present

the Project paper (describing the work undertaken) at the Australian Hydrographers' Association Conference (at a future date) upon applying for the Conference Educational Travel Grant.

- The recipient will be a financial member of the Australian Hydrographers' Association.
- The recipient will normally be enrolled in the Hydrography Certificate IV (AQF).
- The recipient's project will have been approved by OTEN and/or the recipients employer as an appropriate project activity meeting the requirements of the Project (Subject 8004AA) in the Hydrography Certificate IV.
- Applications will include the approved Project proposal, a budget detailing other sources of financial/material support (for example from the employer/supervisor).
- Application for a Grant does not infer automatic gaining of the grant by the applicant but will be assessed by the Association's Committee who may invite advice from appropriately qualified people. The Committee may liaise with the employer where necessary. More than one grant may be awarded annually, at the Committee's discretion.
- The grant will take the form of a reimbursement to the awarded value, paid to the individual, or may be considered as a rebate to the employer that has initially covered the recipients costs incurred, after presentation of proof of purchase of items/services.
- Items purchased with the Grant will become the property of the recipient's institution/employer or in the case of a stand alone student, the student.
- Proof of purchase of the items/services must be supplied to the Treasurer prior to reimbursement if this grant is awarded.

Further information and application forms can be found on the Associations website at www.aha.net.au



A hydrographer's life in Australia is celebrated in the 'Eternity' Exhibition at the National Museum of Australia, Canberra.

Tommy Tomasi came to Australia from Italy in 1949 following World War Two at the age of 23.

An earlier career as a member of the Italian Junior National Ski Team was cut short by the outbreak of the war and Tommy fought with the partisans against the Nazis. His 'work experience' included sabotage and working with explosives in blowing up bridges. On his arrival in western Australia his "CV" gained him a job in Kalgoorlie in drilling and explosives in the mines!

He soon discovered, when walking down St Georges Terrace in Perth, that Australia had snow when he spied a photo of Kosciusko Chalet in a tourist bureau window, and

immediately drove from Perth to Cooma to seek out the cold!

His arrival in Cooma coincided with the height of construction on the Snowy Hydro Electric Scheme. He didn't care what job he took as long as he got to the snow and asked for a position in the Kosciusko region.

In the mid 1950's, after stints in construction and as a linesman on the Snowy, he became a field hydrologist in the Snowy Mountains Authority, covering much of the southern areas of the Authority's area. Tommy worked on the Snowy with other hydrographers that some readers may have worked with over the years including, Danny Collman, Mel Stefanic and Doug Thatcher to name but a few.

Work involved travelling to the edge of the deeper snow line by 15 and 20 horsepower Land Rovers (part of one of the largest Land Rover fleets in the world at the time) and then skiing to the Authority's investigation stream gauging and meteorological stations. Those Italian National Ski Team skills were certainly put to good use!

In this period the hydrographic network included 132 stream gauging stations and 57 snow courses with the Hydrology team also involved in meteorological monitoring in the region as well as working on a cloud seeding program in conjunction with the CSIRO.



Tommy Tomasi at Carters hut after a day of stream gauging in the Tin Mine area (Tomasi Collection)

Being a keen skier saw Tommy involved with Danny Collman (himself a representative skiing prospect) in the establishment of the Thredbo Ski Patrol (a volunteer team in those days).

In 1963 he left the Snowy and field hydrology, to take up another chapter in his life revolving

around ski shops and ski touring around the world.

The exhibition at the Museum includes other short stories about Tommy's life as well as a rotating collection of ex SMHEA items including cup gauging meters and wading rods.



Gauging in the Snowy Mountains Alpine catchments. (SMA Collection)

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