AUSTRALIAN HYDROGRAPHERS ASSOCIATION

Australasian Hydrographer

Are ultrasounds bad for your health?

Photo Courtesy S. Buckland

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THIS ISSUE

EDITORIAL

Water use and how to supply the increasing demand around Australia has been in the news in recent months. Water supply issues were a dominating topic in the Western Australian State election with a proposal to build a canal for taking water from the Kimberleys to Perth being paraded in the run-up to the election. This is on top of decisions to investigate the feasibility of desalination plants. Desalination plants have also been a topic in Sydney where private property owners along Sydney Harbour foreshore are submitting development applications for private desalination plants!

The importance of being able to accurately measure and account for water resources can only increase. Robust and valid measurement and accounting from source to use (and then waste/reuse), has to be an essential part of any responsible authority's or company's business plan.

The phrase has been around for some time – "To manage it you need to measure it". Think of this - this is actually being done in many areas of industry. Manage employees by measuring their performance, manage shareholder returns by measuring profits and so on.

Funny how measuring the major input, and in some cases a major waste product, for many industries and public utilities, water, may not be treated with the same degree of diligence!

Water resources have been, and will always be, a political trigger for action, when resources are stressed but can even be a trigger for inaction! Inaction occurs when the resource appears plentiful. Long term measurement and accounting is essential in identifying the warning signs that the resource is moving from plentiful to not so plentiful.

Perhaps politicians and company executives need to be on the very last tap of the supply line – perhaps that would raise the level of support and funding for performance monitoring and measurement of Australia's water resources!

The cover photo shows what can go wrong – even with the best technology. It is believed that the possum was asleep in the structure before it was raised. That is the thing about measuring the things that we do – the set and forget mentality of the latest technology cannot factor in 'natural' variabilties.

Out in the real world our monitoring can be affected by many factors that cannot be controlled, kids build walls on weir crests to make that swimming hole deeper, mica flakes in the water cause overestimation of turbidity, birds nest over the solar panel providing our power supply to a site. These are only three – I am sure many of you have know of many others!

Mic Clayton, Editor and Publicity Officer

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

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New river level detection system in place

A radar sensor is being used near Katherine to record river levels.

The radar instrument is the first time the Department of Infrastructure, Planning and Environment's Hydrographic Unit has used such technology.

The recently completed gauging station (where the device is located) is on an embankment of the Alice Springs to Darwin railway.

DIPE's Hydrographic Manager, Simon Cruickshank, said the gauging station can measure and record information, without having to physically inspect river levels.

"The gauging station measures water levels in the Cullen River, 100 metres upstream of the Stuart Highway road bridge, about 65 kilometres north of Katherine," Mr Cruickshank said. "The sensor measuring instrument is a new design for the Hydrographic unit, consisting of a radar suspended from the new railway bridge. Changes in river level are detected by the radar which relays the measurements to a data logger, which also records rainfall."

The device was installed late last year at a cost of $35,000. Mr Cruickshank said the implementation of this technology can allow early provisions to be put in place when rivers rise and flooding becomes imminent.

"The river height and rainfall data is transmitted via CDMA data modem back to the Flood Forecasting centre in Palmerston," Mr Cruickshank said. "The data logger is programmed to send an SMS message to DIPE's Road Projects Division staff, warning them of rising river conditions that could cut the Stuart Highway.

"With this technology we can provide sufficient warning to DIPE staff from Katherine, who are able to close the Stuart highway, reducing the risk to motorists and infrastructure."

Mr Cruickshank said along with other existing river sites, the data from the device will allow the flood forecasters to improve their flood predictions for the lower Daly River.

There are approximately 180 gauging stations throughout the NT operated by the Hydrographic Unit, although this is the first to use a radar for data recording. Gauging stations collect data for a variety of reasons, not just flood forecasting and alerting, such as water quality monitoring, river yield and extraction monitoring purposes.

(Source: Northern Territory Government Media Release)

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Wind Monitoring Investigations

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Presented at the 12th Australian Hydrographic Congerence, 2004

Abstract
When identifying the viability of a potential wind power site there are a number of issues to consider and obstacles to overcome. The successful design and implementation of a wind monitoring investigation and the delivery of a good solid data set are crucial. With this information effective decisions can be made on the viability of a site that includes interpolation of wind shear to hub height, expected turbulence, estimation of the capacity factor, the distribution of wind direction and risks associated with the specific site. Attention to accuracy and detail has always been a basic principal in the role of a hydrographer. What has changed is how diverse the field has become and the extent to which wind data is now analysed and validated.

1. Wind Farms - General
There is no question on the growing need to move towards the production of clean and renewable energy. Presently the federal government subsidises the development of wind farms, in an effort to attract companies and investors to commit money and resources that will result in the promotion of technological development in this area.

Mandated Renewable Energy Targets (MRET) commenced in April 2001 as a commitment to producing 9500 GWh of renewable generation by 2010 with the program to extent out to 2020. This includes the production of renewable energy from new projects and from the escalation in generation from existing developments with respect to a baseline. Baselines were set by the Renewable Energy Regulator to encourage the upgrade of existing infrastructure to facilitate the production of renewable energy. Companies that commenced generation after January 1997 received a baseline of zero. Those that commenced generation prior to this date received a baseline equivalent to the average of historic annual production. Renewable Energy Certificates (RECS) issued for the production of renewable energy, are acquitted by electricity retailers and wholesalers. (C.K. HTC 2003). The recent government decision not to extend MRET (the capacity from 9500 GWh or date from 2020 to 2030) may affect the rate of development within the wind power generation industry. The white paper policies favors diesel fuel subsidies with respect to the disposal of emissions.

Hydro Tasmania's first dedicated wind monitoring tower was installed on Tasmania's west coast in 1982 and consisted of a single set of sensors at 10m. Since then monitoring our natural resources has played an important role in defining the potential for renewable energy generation. Hydro Tasmania Consulting has been heavily involved in the investigations for prospective wind farms, as well as their development and implementation.

Our first commissioned site was a small wind farm on King Island in 1998 that significantly reduced the reliance and expense of diesel power generation. The wind farm used ground breaking battery technology (Vanadium Redox battery and control system, 200KW capacity) to reduce the effects of a variable wind supply (HT1. 2003a). With a total capacity of 64.5 Megawatts Woolnorth wind farm (Figure 1.1 and 1.2), located on the north west coast of Tasmania was commissioned earlier this year (HT2. 2003). Other more commonly known prospects in Tasmanian include Musselroe on the north east coast (HT4. 2003), Heemskirk on the central west coast (HT2. 2003) and the extension of the Woolnorth farm to 131MW capacity. Cathedral Rocks Wind Farm in SA is due to progress to implementation phase shortly. There are also a number of other interstate prospects in which initial investigations and monitoring are currently underway.

Figure 1.1 Woolnorth Wind Farm Construction

Figure 1.2 Woolnorth Wind Farm in Operation

2. Stages of Development

To clarify the role and importance of Wind Monitoring Investigation and its links to other components within the context of developing a Wind Farm, a brief description of the process and stages involved has been provided below. Of these stages this paper will concentrate on the practical tasks involved in obtaining the maximum quality and quantity of data and the downstream implications/ drivers that are influenced by this data.

2.1 Identifying a Prospective Site

• Desktop study of possible wind resource and the use of broad scale wind modeling to identify likely investigation sites. Other means of gathering information on the site include local knowledge, use of existing data sets, general aspect of a site i.e. topography, obstacles and distance to the grid and existing grid capacity potential, extent of environmental issues;

• Secure land lease agreement with property owner and make contact with the local council;

2.2.Development Application / Design Monitoring System Configuration

• Application is made to the local council for a permit to build the monitoring tower. This includes all associated works i.e. production of mast engineering drawings, the construction of mast, excavation of footings, access tracks, heritage area considerations, local air traffic regulations and requirements and other site-specific aspects of environmental or cultural significance;

• Application specifies a fixed period for monitoring and outlines requirements for decommissioning and rehabilitation of the site;

• Monitoring system design takes into account the nature of the landscape, the presence of obstacles (obstructions within 1km) and the degree of 'roughness' (quantitative factor used in the calculation of wake and wind shear);

• Number of monitoring levels (between 2 and 4 levels), height of mast (between 30 and 100m), type of mast, (tiltup or lattice mast);

• Additional features/ requirements based on conditions of DA;

2.3 Installation of Monitoring System

• NATA calibration of anemometers, assembly and testing of instrument system;

• Engineering design and fabrication of mast, excavation and installation of mast anchors, erection of the mast, guys and brackets, dressing of the structure with conduit and cabling;

• Commissioning of monitoring system including telemetry and remote software, compliance notification of local and federal air traffic authorities;

2.4 Data Review

• Data is automatically downloaded regularly and quality coded. Data analysis is carried out on the new data set to provide an up to date picture of the viability of the site as a prospective wind farm;

• Primarily the latest derived capacity factor for the site and secondly, the wind shear and turbulence information are of greatest concern;

2.5 Wind Farm Design

• Depends on the average wind speed results from the data recorded and how it correlates with near by long term sites data in relation to turbulence and wind shear. (Picture of how typical the period of record was on a larger time scale);

• Depends on the nature of the landscape and includes consideration of 'hill effects' (the localised increase of wind speeds due to the wind being compressed on the windy side of the hill and then speeding up as it moves towards the low pressure area on the other side), 'tunnel effects' (air becomes compressed on the side of obstacles facing the prevailing wind and its speed increases considerably as it passes between the obstacles), roughness effects on both the leeward and prevailing wind sides of the site (DWIA. 2003b);

• Depends on estimated losses of potential energy due to the 'park effect' and 'wake effect' (discussed later) and the spacing of turbines. (Seven rotor diameters in the prevailing wind direction and four rotor diameters in the direction perpendicular to the wind) (DWIA. 2003b);

• Selection of turbine specification based on wind shear and turbulence data;

2.6 Business/Financial/Investment case for Wind Farm & Environmental Management Plan (DAEMP)

• The ability to demonstrate due diligence relies on a good quality data set, equipment and installation procedures on which figures for capacity factors are derived and on which decisions on the viability of the projects can be made with a high degree of confidence;

• Presentation of comprehensive business case including predicted revenue, return and project risks analysis;

• Consultation with land owners, local, state and federal governments;

• Provision of Development Proposal and Environmental Management Plan (HT2. 2003);

2.7 Construction of Wind Farm

• Installation of long term monitoring towers for use in confirming 'Power Curves' (Plot of power in kilowatts by wind speed in meters per second) for the wind generators;

• Roads and infrastructure construction;

• Construction of links to the grid/upgrades to existing electricity transmission facilities;
• Installation of substations;
• Turbine footing installation and construction of towers;
• Installation of turbines and rotors;
• Commissioning of generators;

3. Wind Monitoring Configurations – HTC

3.1 The Mast

The mast selection is based upon the proposed duration of the monitoring period, the height and number of levels of wind monitoring, the natural characteristics of the site, the outcome of the preliminary study and the perceived economic potential for the development of a wind farm. If time is a critical factor in obtaining wind monitoring data, lattice type towers are used so that monitoring at high levels can be achieved. They also facilitate the ease of servicing and exchange for recalibration for longer term monitoring sites.

The standard mast currently used is a 450mm face 80m high, guyed lattice mast that is designed for an average wind loading of 180km/hr or 50m/s. It consists of 6 anchor points in pairs at 120 degrees apart and has a footprint of 100m in diameter. The mast footings and anchors consist of 15 to 20 m3 of 25mpa concrete depending on the nature of the ground conditions of the site and climatic factors (AM. 2004). The top of the mast is marked with aircraft warning balls. The masts are also fitted with fall arresting cables (ladsafe) and a climbing restriction cover around the base.

Masts are checked by riggers each visit prior to climbing and annual inspections of ladsafes are completed by qualified, 'advanced riggers'. Stringent safety policies and procedures are followed with respect to working on or around the masts. In addition to the standard PPE, JSA's are carried out during both the construction phase and on routine service and calibration field operations (Figure 3.1).

Figure 3.1 Monitoring Tower Construction

3.2 Mast Variations

Variations on the standard configuration include stock proof fencing, air craft navigation warning light painting of masts alternate red and white, structural modifications to cater for excessive wind or ice loadings or extra loading due to ancillary monitoring equipment. (Monitoring at one site includes, wind speed, wind direction (using standard cup anemometry and vanes) and temperature at three levels, 3D wind speed and direction at two levels and barometric pressure at ground level. There are also seven, 65 watt solar panels all mounted on the one mast).

3.3 Equipment and Instrumentation

Data logging, telemetry and power supplies used in standard instrumentation configurations are fairly typical as far as what is used in monitoring systems in our industry today. The standard system usually includes a Unidata logger, solar power supply with 12 volt regulator and sealed lead acid battery, Vaisala temperature and humidity sensor and barometric pressure sensors at ground level, Vaisala cup anemometers (Figure 3.2), wind vanes and interface (WAA 151, WAV 151 and WAT12) (VUG. 2002) at 40, 60 and 80m levels and temperature at 80m level. (80m being hub height of prospective turbine)

Figure 3.2 Anemometer and Vane from top of 70m mast in SA.

3.4 Equipment Variations

Wind monitoring instrument and equipment variations to the standard system include;
• Event logging of 2 and 3D ultrasonic monitoring used for specialised studies where a high degree of detail is required to confirm/understand specific conditions;
• Telemetry options, GSM, CDMA, satellite, radio or a hybrid system;
• The use of heated wind heads to overcome icing effects on anemometers;
• Implications of providing reliable power to high power consumption configurations (points above)

including 400watt micro wind turbine generators, micro hydro generator, modified solar arrays, combination of small diesel generators and wet cell battery systems;
• Intense logging regimes on 3D ultrasonic sensors (logging at a frequency of 10Hz, with 100MB per week memory demand);

4. Data and Wind Farm Design

4.1 Measured Parameters/Variables

Parameters measured at a standard monitoring site include Wind Run, Wind Direction (WD), average Wind Speed (WS) and Maximum wind speed. (Hunter RS. 1999). Each parameter is scanned every 2 seconds, logged every 2.5 minutes and downloaded regularly. Data is given a preliminary quality code until it is validated using the multivariant editor. This function of HYDSTRATSM enables multiple parameters to be quality coded simultaneously. KPI reports are generated automatically to provide statistics on the percentage of data quality coded, recovered and useable by parameter and site. New data is incorporated into the data statistics for each investigation site to provide current information on average wind speeds for each site, wind shear, turbulence and to update capacity factor calculations. The key measurable parameters in the wind monitoring investigation are average wind speed (figure 4.1) and distribution of wind direction.
(DWIA. 2003b)

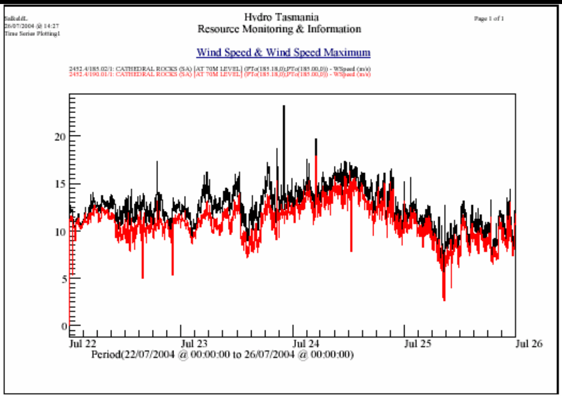

Figure 4.1 Plot of average Wind Speed and Maximum Wind Speed Data.

4.2 Average Wind Speed

Accurately measuring the average wind speed is the single most important factor in wind monitoring investigations as it is related to the amount of energy a wind turbine can convert to electricity. The energy content varies with the cube of the average wind speed. (DWIA. 2003b)
IE. If average WS doubles, WS * 2, the potential energy goes up $2^3 = 8$ times.
For example Av. WS 8m/s can produce 314 Watts/m²
Av. WS 16m/s can produce 2509 Watts/m² (8 times)
This relationship is governed by the equation (DWIA. 2003b);

$P = \frac{1}{2} \rho v^3 \pi r^2$	where;	P	is Wind Power (watts)
		ρ	is (Rho) Density of dry air (1.225 kg/m3) @ sea level +15deg
		v	is Velocity of Wind (m/s)
		π	is 3.142
		r	is ½ * blade diameter

4.3 Wind Shear

At heights below 1000m from the ground the friction of the earth's surface affects wind speeds. The degree of roughness of the surface i.e. the terrain contours natural or man made obstacles or features on the ground, affects the relationship of how wind speed changes with the profile of height. The relationship that defines this change in wind speed with height is known as 'wind shear' (DWIA. 2003b).

As it is not always practical to monitor actual wind speed measurements at a height equivalent to the top of the rotor (120m at a hub height of 80m) average wind speeds must be derived from actual measurements taken at lower levels. There are a number of similarities between the extrapolation or extension of the wind shear relationship from known points to that of a water level / flow rating extension.

The following formula is used to derive wind speeds above the ground from a known wind speed and height (DWIA. 2003b).

$$V = \frac{vref \ In(z / Zo)}{In(zref / Zo)}$$

where;

V	is Wind Speed at height z above the ground
vref	is reference speed at correlating location and at height zref
In	is the natural logarithmic function
z	is height above ground level for desired wind velocity
Zo	is roughness length in current wind direction
zref	is the height where we know the exact wind speed

Wind Shear calculations are used not only to derive a capacity factor for a site but are a crucial component in the selection of specification for the wind turbine. The value that is placed on collecting good quality wind speed data 'vref' used to derive 'V' has a direct effect on both the efficiency of the turbine and the amount of electricity that can be produced.

Eg. A 'cheap n nasty', damaged or uncalibrated wind speed sensor with an error of 10% can have the following effect.
Using the cube rule, 10% error in the measurement of Average wind speed equates to 33% error in power. If there is a correlation involved from 10m to 50m a 10% error in speed at 10m can equate to a 75% error in energy potential. Note; in practice the relationship between wind speed and energy is dependent on site specific characteristics, the wind speed regime and the type of turbine selected.

4.4 Wind Speed Variance
The variability in wind speed is a function of both the weather and the local site characteristics such as surface conditions and obstacles. The energy output from a turbine varies with the wind except for the extremely rapid variations that are compensated for by the inertia of the rotor. Turbulence or irregular gusts of wind decrease the possibility of using the energy in the wind efficiently. The working life of a turbine is also significantly reduced when exposed to turbulence due to uneven or irregular loading of turbine components (DWIA. 2003b).

4.5 Wind Direction Distribution
Generally wind will come from a particular direction depending on a combination of localised and regional influences. There are a number of reasons why the accurate measurement of wind direction, the percentage of time wind blows from that direction and its average speed in each direction play such an important part in the wind farm design. The orientation and placement of turbines in a wind farm should maximise the energy that can be produced and effectively minimise the losses associated with the 'wake effect' caused by the leading row of turbines.

The 'wake effect' describes the resulting loss of otential energy as the wind passes through the rotor of the turbine and a portion of the energy is transferred to kinetic energy through the torque generated by the movement of the rotor (DWIA. 2003b). The result of the wake is an increase in turbulence and a drop in average speed. The speed of the air slowly increases back to that of the surrounding air. When turbines are placed to minimise infrastructure costs (links to the grid and spatial extent of farm) in rows the turbines behind the front row to the prevailing wind can experience a reduction in energy output of between five and eight percent. The effective placement (exact distance and offset) of turbines in relation to each other and the direction of the prevailing wind rely heavily on a good understanding of the prominent wind direction.

Data collected from wind monitoring sites is usually displayed as a wind rose (Figure 4.2) where the distribution of wind speeds and the frequency of wind directions are divided into 8 to 12 sectors of 30 to 45 degrees of the horizon. The radius of the outer most wedges provides the relative frequency of each of the individual directions as a percentage. The second wedge provides the same information but is multiplied by the average wind speed in each sector and then normalized so the all the sectors equal 100%. Some wind roses have a third wedge which is the same as the second but indicates the energy content in each sector. Information displayed on a wind rose provides a clear picture of the relative wind speeds in different directions for a particular site distinct from the actual level of the mean wind speed.

STIL Flow Monitor and Logger

To manage increasing demand for limited water resources, consent authorities throughout New Zealand are introducing mandatory monitoring and logging of all water use – surface and groundwater.

STIL have developed a Flow Logger to meet the needs of both consent holders and consent authorities. The Flow Logger is compatible with standard water meters (contact closure) and typically operates in conjunction with the water meter mechanical total. The logger normally displays flow (l/sec or gal/sec according to setup), but can also display total, as a cross check against the mechanical meter.

The construction of the flow logger is particularly robust. All electronics are encased in solid epoxy resin and under normal use the battery has an operational life of 10 years.

The Flow Logger is equipped with a waterproof infrared port so PCs or PDAs with standard IRDA and Flow Logger software can be used to recover the store memory of up to 200,000 date and time stamped data points.

In addition to physical security, the logger is designed with software security. Anybody may download data from the logger, but only those in possession of a password (over 14 million possible combinations) can reset the logging or modify the configuration.

Data security extends to the recovered ASCII data file (csv), with the last line including a 3DES encrypted file check value. Any subsequent changes to the file text will invalidate the check value.

This arrangement allows consent holders to email data files to regional authorities (as a condition of their consent). The authorities can process the data, secure in the knowledge that it is valid.

The STIL Flow Logger is well established, with units installed in Canterbury, Otago, Hawkes Bay and Taranaki – mainly for water bore use.

Developing and testing is also well advanced for units with cellular telemetry, using GPRS and CDMA networks. This will ultimately provide users and authorities with near real time data. These cellular units are expected to be released for general distribution in Australia in early 2005.

STIL Gauging Logger – The standard for river gauging in Australia and New Zealand.

- **Measures Velocity Directly**
- Records and Stores Whole Gaugings
- **No Paper, Pencils, Calculators needed**
- **Improved Gauging Quality**
- **Instant Discharge Results**
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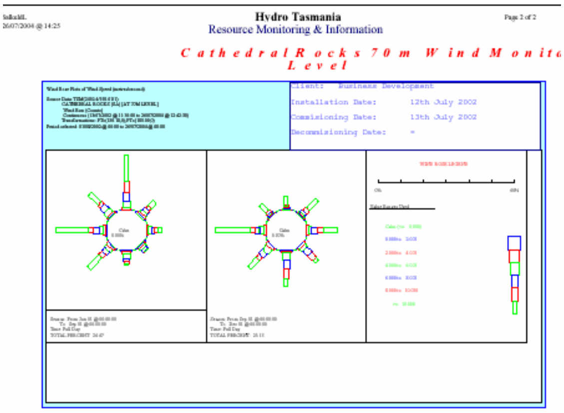

Figure 4.2 Plot of wind rose with 45 deg sectors highlighting seasonal change in predominate wind direction.

Poor quality or substandard instrumentation can result in an error in the placement or orientation of turbines. Under estimation of wind energy losses through wake induced turbulence and the subsequent miscalculation of capacity factors for a portion of turbines significantly affects the viability of a farm. A miscalculation of wake induced turbulence also adds cost to the operation and maintenance of a wind farm.

5. Summary

The use of wind farms as an alternative source of power generation is only going to increase.

Australia, particularly the southern regions, is fortunate to have such a renewable source so readily available. Hydro Tasmania along with other companies have certainly seen the potential as demonstrated by the resources that have been committed within the industry in recent times. The demand for the collection and validation of good quality data is driven by its link with an effective design and accurate prediction of the energy capacity for the wind Farm.

The nature of Wind Monitoring Investigations is another example of how the industry is changing to include an ever-increasing range of variables, issues and specialisations. However the approach to monitoring through the use of high quality components and the emphasis on the effort dedicated to collecting a full and useful data set has not changed.

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FLOWTRACKER - An Evaluation

An internal report prepared by Arran Corbett, Natural Resources and Mines, Queensland. Presented here with permission.

1.0 **Introduction**

1.1 **Authorisation**

This report has been prepared for the Supervising Hydrographer, Hydrographic Support unit, Queensland Department of Natural Resources (NRM).

1.2 **Aim**

The aim of this report is to investigate the operational application and effectiveness of the SonTek YSI FlowTracker Acoustic Doppler Profiler (ADP). This report is also intended to form a basis for discussion amongst Hydrographers on the issue of moving towards an acoustic Doppler alternative to streamflow measurement.

1.3 **Scope**

This report is intended to provide suitable information for the Supervising Hydrographer when making an informed decision with regards to the future purchase of handheld streamflow measurement devices. Other devices of a similar nature will be assessed as they become available.

FlowTracker testing activities, details of all findings and recommendations will also be included. Tables of all results and associated graphs will be included either in the body of the report or as appendix, as is appropriate.

As this report is a published evaluation of the suitability of the FlowTracker to carry out the same function as standard current meters, a cost appraisal will be included.

1.4 **Methodology**

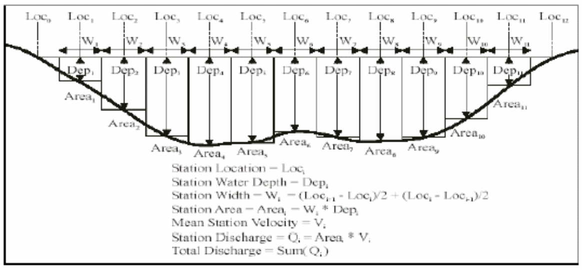
A programme of part-time testing of the FlowTracker commenced in the second week of October 2004, using a model loaned to NRM Brisbane Hydrographic section by SonTek YSI.

The FlowTracker calculates streamflow following ISO 748 (1997), 9196 (1992) and standard USGS guidelines. These standards and practices describe a technique very similar to that found in Discharge Measurement by Current Meter, L. Ezzy 1974, revised by R. Bird (1992), which is the work practice used within NRM. This has made data collection and result comparison very straightforward. A brief description of the standard streamflow measurement method follows.

The standard NRM streamflow measurement technique calls for the erection of a tag line or measuring tape perpendicular to a uniformly distributed flowing stream of a regular cross-sectional area. The cross-section is then divided in to approximately twenty columns each containing less than 10% of total flow. The depth is recorded at each of these verticals and the velocity is measured at one, two or more points on that vertical. This process is repeated through each vertical. Once complete the area and velocity for each section is calculated, when multiplied together the discharge for that section is given. The sum of the discharges yields total flow.

1.4 **Methodology cont.**

The following diagram illustrates this method of streamflow measurement:



1.4a ***Streamflow measurement calculation.***

NRM currently uses one of two types of mechanical current meter to carry out a streamflow measurement. NRM sources each type of meter from two different manufacturers, OTT and Hydrological services. These are the OTT C31 (C31) or the OSS B1 (OSS B) and the OTT C1 (OTT Minor) or the OSS PC1 (HS Pygmy). The C31 and OSS B are larger of the two meters and they are the most commonly used.

The OTT Minor and the HS Pygmy are used for the lowest of flow conditions and are less commonly used than their bigger counter parts. As the FlowTracker is capable of carrying out the function of both the larger and smaller mechanical current meter distinction between the two sizes will be omitted from the rest of the report.

For the purpose of this evaluation, a standard streamflow measurement was collected at various sites using both the FlowTracker and a mechanical current meter. When possible, two operators carried out each method simultaneously starting from opposite ends of the tag line. This method reduced the possibility of error due to flow variation over time but introduced the variable of two separate operator styles. On the majority of occasions a lone operator would collect one measurement and then follow this up with a measurement using the second instrument. Whilst the

possibility of flow variation over time was introduced the conflict of varying operator styles was removed.
The results from both measurement techniques were then compared with each other.

This comparison took the form of a percentage variation of the FlowTracker result from the mechanical current meter result. The variation of the FlowTracker from mechanical current meter was chosen as the mechanical current meter is the standard instrument used by NRM at this time. A full discussion of all findings is included in the results section of this evaluation report.

1.4 **Methodology cont.**
The USGS has used a similar technique to carry out a series of "informal field tests", comparing 29 FlowTracker measurements with 26 mechanical and 3 electromagnetic current meters. 4 of the 26 mechanical measurements were made below those instruments' low velocity threshold. Morlock and Fisher state that "Ideally, The FlowTracker and comparison meter would be used at the same horizontal stations and the same depths from the wading rod would be used to compute channel subsection areas." Without maintaining similar stations and depths a different area would be used to compute total discharge, causing variation in the results. Despite this Morlock and Fisher state, "While not rigorous, the tests were useful". The results of the USGS trials are discussed in the results section of this evaluation.

A second possible source of error lies in the mechanical frailty of the current meter. These instruments have several weak points, including oil, internal bearings and reed switches. The complete instrument set-up includes a removable connection cable and a counter, both of which are open to their own failings. Correct use of NRM calibration standards and work practises can minimise impact from these potential failings but they still exist.

The FlowTracker on the other hand has no moving or removable parts; the only potential problems lie in water entering the handheld controller via the communications connector or from physically damaging the probe. Either of these faults will cause the FlowTracker to fail completely, therefore removing the opportunity to unwittingly collect erroneous data.

Version 9 of Hydstra – NRM's database software, has a programme for the calculation and plotting of streamflow measurements. The programme, called Hygauge, was used in this evaluation to provide a visual comparison of the data collected. Appendix 2 and 3 contain examples of Hygauge plots, one Flowtracker and the other mechanical current meter.

Included in each Hygauge plot are data relevant to the percentage distribution of flow, velocity profile\distribution and area. Hygauge plots are primarily for visual assessment of individual measurements. Hygauge proved to be an effective method of comparing mechanical current meter measurements against those of the FlowTracker. The author believes that with direct import of FlowTracker files in to Hydstra that it may be possible to automatically generate a Hygauge plot for visual verification and storage with the measurement text file.

2.0 **Discussion**
2.1 **FlowTracker operational considerations**

The FlowTracker collects velocity data by using a form of the Doppler principle to collect a velocity estimate of a cylinder of water at a fixed distance from the probe. A series of short sound pulses or "pings" are fired from the acoustic transmitter. The acoustic receivers measure the return signals change in frequency (See figure 2.3b, below). This Doppler shift is proportional to the velocity of the particulate matter along the bistatic axis of the transmitter and receivers. By knowing the geometric location of this axis and the rate of Doppler shift the FlowTracker can calculate water velocity.

The FlowTracker fires a series of ten pings per second (10Hz). Each of these onesecond bursts is averaged in to a single value, known as a sample. A group of samples are then averaged to provide a velocity measurement. The user can define the number of one-second samples to use for each measurement in the range of ten to ten thousand samples. Standard streamflow measurement practise as discussed earlier dictates that the optimal measurement time is forty seconds.

Quality control data for each sample is also collected to aid in the accuracy of calculation. The quality control variables are; Signal to noise ratio (SNR), standard error of velocity, boundary adjustment, spike filtering, and flow angle. A brief description of each of these variables follows:

- SNR is a measure of the return signal strength. SNR is a function of the amount and type of particulate matter within the water column. SNR is considered by SonTek to be the most important quality control data. Whilst SNR cannot be directly linked to sediment concentration it can with proper calibration be used to estimate suspended sediment load. It is important to note that water that may look clear and have a low measured turbidity can still have a high SNR value due to particulate matter consisting of gas bubbles or biological material.

- Standard error of velocity is a measure of deviation of any one sample from the population mean. It is calculated by dividing the standard deviation of each sample by the square root of the number of samples. When the FlowTracker is used in discharge mode, as will most often be the case within NRM, standard error of velocity gives an indication of error in velocity measurement on the horizontal plane.

- Boundary adjustment is a measure of compensation for acoustic interference caused by the sampling volume being placed to close to a submerged reflective surface. This value has direct impact on the range of velocity capable of being measured by the FlowTracker. An onscreen evaluation of this variable can be used by the operator to decide if the measurement has sufficient value.

- Spike filtering of velocity data is carried out against two pre-set considerations. If a single measurement is greater than three standard deviations or more than three centimetres per second from the mean it will be filtered. This filtering is nonpermanent as the operator can reinstate the value during post processing.

- Flow angle is calculated as a deviation of flow on the horizontal axis, the only axis used for discharge measurement. Therefore, it is very important that the tag line is perpendicular to the flow. The FlowTracker can compensate for this deviation of flow but a good measurement should not contain a flow angle greater then +\- twenty degrees.

The FlowTracker is described as being capable of measuring a velocity range of +\- 0.001 to 5m/s at a resolution of 0.0001m/s with an accuracy of +\- 1%. Tow tank tests by the United States Geological Survey (USGS) found that the FlowTracker was accurate to 1% of known velocity for 14 of 21 trials between 0.030 and 1.524m/s.

Stated range of velocity possible with an OTT C31 mechanical current meter using the standard NRM props 1 and 2 is 0.025m/s to 6m/s. The OTT C2, using standard NRM props 1 and 2 can measure velocity from 0.025m/s to 2m/s. The Hydrological Services OSS B1 and Pygmy have a similar range.

From this velocity range comparison it can be seen that the FlowTracker can measure to a lower velocity than the mechanical current meters. Lower velocity measurements comprise the majority of measurements here in Queensland. The mechanical current meters can measure faster velocities, which may make it the better instrument for some areas.

A further consideration of measuring range is the minimum depth of water in which the instrument can operate. Common practise within NRM is to have slightly more than half of the prop submerged during a measurement. Given that the OTT C2 has a prop diameter of 50mm, the minimum depth measurable is 26-27mm. The OTT C31 has a prop diameter of 125mm, giving a minimum depth of 63-64mm. The FlowTracker has a stated minimum measurement depth of 25mm. It was used at such depths prior to this evaluation. Further investigation of performance at such small depth should be investigated.

The FlowTracker is powered by 8AA rechargeable or alkaline batteries. SonTek state that typical battery life for alkaline batteries is 30+ hours continual use. One set of batteries was replaced during this evaluation. The original set had been in the unit for an undetermined time so it is not possible to comment on battery life in this evaluation. The handheld controller provides access to battery status; this should be checked prior to commencing a streamflow measurement.

The counter used in conjunction with the mechanical current meter used in this evaluation can be recharged directly from a 12v battery. The counter, StreamMaster brand, also gives an indication of low power battery warning light. It is possible in the right conditions to use a mechanical current meter without a counter. Both the 12v and AA batteries are routinely carried in NRM hydrographic vehicle.

The non-volatile internal memory of the FlowTracker is capable of storing 80,000 individual velocity measurements. However, the author advises that at the end of the day the Hydrographer downloads all measurements and then clears the FlowTracker memory. Similar to logger data downloaded to laptop computer, the FlowTracker files should be backed up to CD, USB stick memory or floppy disc.

2.2 **FlowTracker deployment**

Deployment of the FlowTracker in standard streamflow measurements for this trial was undertaken with a Hydrological Services (HS) top setting wading rod. This rod has a custom made mounting socket for the FlowTracker. The top setting rod is ideally suited to the task, with the top setting feature helping to reduce human error in calculation of correct measurement depth. The fact that the operator does not have to move the rod from it's position to alter the meter depth once the water depth was measured reduces the chance of placing the rod in deeper or shallower water. This helps to achieve correct velocity measurement depth.

The HS top-setting wading rod comes in two lengths, 1.2m and 1.8m. The rod made available to the author was a 1.2m rod, which was adequate for most of the measurements conducted. There were, however, a couple of sites where the 1.2m rod was not sufficient but these were on the upper limit of wading measurements. The main concern with conducting measurements in such conditions was keeping the Handheld Controller out of the water. Although it is described as waterproof it is recommended that the Handheld Controller not be submerged. It should be noted that on more than one occasion the trial unit was accidentally submerged with no adverse effects.

Many of the features of a standard streamflow measurement can be applied in the use of the FlowTracker. Edge estimation, multi-point gaugings, comments and remeasuring of a suspect velocity are all possible. It was found that the field operation of the FlowTracker was very logical.

On the riverbank the operator enters the details of the site including gauge height, file name and rated discharge - if available. The rated discharge can be entered to provide an instant comparison with measured discharge, alerting the operator to a possible change in rating.

The operator interfaces with the FlowTracker through the Handheld Controller, issuing commands through the Keypad and receiving prompts on the LCD screen. The following figure extracted from the FlowTracker Technical Documentation, Operation Manual p. 10 is an illustration of the keypad.

2.2a FlowTracker handheld controller keypad

2.2 **FlowTracker deployment cont.**

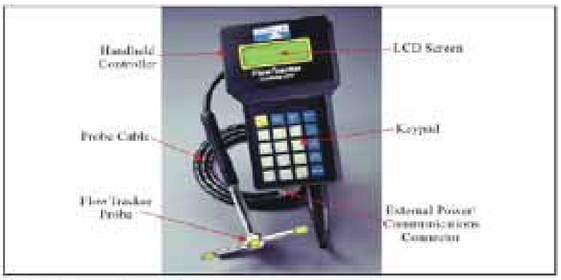
Upon completion of the measurement the total discharge is displayed giving the operator instant access to the information. This removes any need to spend time calculating the gauging and have another person check those calculations, as is currently the case. This process has recently been made faster with the use of a gauging calculation spreadsheet. The FlowTracker also enables a single operator to easily carry out a measurement by themselves without having to book and conducting a measurement at the same time.

Another very helpful feature of the FlowTracker is the ability to review each velocity point (commonly known as a vertical) from the measurement prior to its finalisation. Included in this review is the percentage of total discharge, if any single vertical exceeds ten percent of the total discharge an extra vertical can be added.

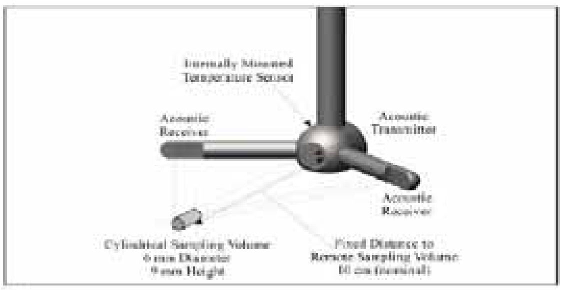
It is noted on page seven of FlowTracker Technical Documentation Operation Manual that it may be possible to estimate suspended sediment with the FlowTracker. If possible and practical NRM may be able to begin collecting time series suspended sediment data for low flows. This capability could have a significant impact on environmental monitoring of sediment transport rates.

2.2b ***FlowTracker deployment in Central Queensland.***

2.3 **FlowTracker Hardware**
The following figures extracted from the FlowTracker Technical Documentation, Operation Manual p.1&2 best illustrate the hardware components that make up the FlowTracker unit. Whilst the first figure gives a good indication of the complete FlowTracker unit the second figure provides more detail of the probe.



2.3a *The FlowTracker unit.*



2.3b *The FlowTracker probe detail.*

2.4 **FlowTracker Software**
The FlowTracker trial unit supplied by SonTek was accompanied with a CD containing an electronic copy of the FlowTracker manual and a full copy of the FlowTracker licensed software.

2.4a ***FlowTracker software screenshot.***

Upon completion of a days work the operator can connect the Handheld Controller to their laptop or PC via the serial port and download the data files. This function is carried out using the Recorder programme. Once retrieved from the Handheld Controller the data is exported to an ASCII format using Data Export. Post export, it is possible to view a text file containing the full details of a measurement. A copy of a data file collected during this evaluation is attached in the appendix 6.4 of this report.
It may be possible to export each measurement directly in to Hydstra – the NRM database. More work in this area will have to be carried out by a NRM Hydstra system administrator. If possible, this will remove the possibility of human error in manually entering the data from a field sheet. There would be a considerable time saving involved with this direct input, especially given the need to have a second person validate the manual entry.

Also included in the software is a probe diagnostic programme called ADVCheck. This programme is used to verify the functionality of the probe. ADVCheck graphs signal return strength from each receiver giving a visual indication of the status of the probe.
Differing problems produce varying graphical results; this is a very user-friendly approach to problem solving. The usual operator of the FlowTracker unit can quickly and effectively carry out regular diagnostic verification of the probe. A standard mechanical current meter requires being sent away for calibration, which is a costly and time consuming process.

2.5 **Cost appraisal**
An important consideration in any evaluation of new equipment is the budget impact that any purchases will have. Whilst a new instrument may be ideally suited to a task it would not be practical to recommend that the transition should be made unless it could be done for an equivalent cost or that the extra cost can be fully justified.

(*From page 14)*
The author has collected costing information on the equipment included in this report to assist in the assessment of the direction of future NRM spending. The quotes and prices given are valid only at the time of publication of this report.

Hydrological Services
OSS B1 Current meter $6435
This includes a high speed and low speed propeller, current rating, tools, carry case, connection cable, 3m wading rods and a counter.
OSS PC1 Current meter $5871
This includes a high speed and low speed propeller, current rating, tools, carry case, connection cables, rods and a counter.
Hydrological services total: **$12306**

OTT
OTT C31 $10786
This includes a high speed and low speed propeller, current rating, tools, carry case, connection cables, rods, relocating device, ground pin, direction pointer and a counter.
OTT C2 $10072
This includes a high speed and low speed propeller, current rating, tools, carry case, connection cables, rods, relocating device and a counter
OTT total: **$20858**

SonTek
FlowTracker $12006
This includes FlowTracker unit, carry case, tools, software, 1.8m Hydrological Services top-setting rod, PC\serial connection cable and airfreight\insurance from the USA.
SonTek total: **$12006**

It is possible to see from this cost appraisal of initial purchase prices that the FlowTracker has the advantage. This appraisal has not taken in to account the on-going cost involved in maintaining a mechanical current meter. These costs include calibration every three years at a cost of $270 for a low speed prop and $320 for a high-speed prop. As we use two meters that is four props at $1180 every three years. There is also the cost of oil, which currently costs $215 for 5l. At this stage it is to early to assess any costs involved in the maintenance of the FlowTracker.

2.6 **Results**
The expected results from this form of evaluation must allow for some variation due to the number of independent variables present. It is likely that human error would be the largest contributing factor to this variation. In smaller flows this human error translates to a much greater percentage variation between flows. Conversely, this percentage variation between flows decreases as flow increases. This trial retains its value in that it can demonstrate a repeatability of consistent measurement between the two instruments types.

Thirty-five comparative streamflow measurements (trials) were collected during this evaluation of the FlowTracker. Two of the trials had a significant change in stage during measurement, making a comparison impossible. Each trial included in the calculation of averages consists of one FlowTracker streamflow value and one mechanical current meter value at the same site and gauge height. The comparison between the two values of each trial is used as an indication of the variation between the two instruments.

The results of the trials initially indicate that a percentage variation of 9.05% is to be expected between the mechanical current meter and the FlowTracker. Upon closer examination of the results, a clear line between those flows less than 0.1cumecs and those above that value can be drawn.

Using 0.1cumecs as a division, the percentage deviation of the FlowTracker from the mechanical current meter gives a more telling result. Those flows above 0.1cumecs have an average percentage variation of 4.42%. The average percentage deviation of those flows below 0.1cumecs is 20.26%.

The USGS trials, as described by Morlock and Fisher produced the following results:
"For the remaining 25 measurements (4 were below mechanical instrument threshold) 15 FlowTracker measurement discharges were within 5% of the comparison measurement discharges and 20 were within 10%. The maximum difference between FlowTracker and comparison measurements was 13%; the mean difference (absolute value) was 5.2%".

It is the firm belief of the author that the larger percentage deviation between the lower flows is attributed to human error. Any slight error in depth reading has a significant effect on total area and hence a significant impact on the resulting discharge. This is true for both instruments. It is likely that any comparison carried between two mechanical current meters in such conditions would produce equivalent results. Another possible factor contributing to the larger deviation of lower flows is the crossing of the mechanical current meter velocity thresholds.

Tow tank tests undertaken by the USGS using their standard calibration procedures for mechanical current meters provided the following results. Morlock and

Fisher state in Hydroacoustic Current Meters for the measurement of Discharge in Shallow Rivers and Streams state, "The mean departure of FlowTracker velocity from tow-cart speed was –0.27%… For most runs (the) FlowTracker met Price AA (mechanical current meter) and manufacturer accuracy limits."

2.7 **Advantages and disadvantages summary.**

By adopting the FlowTracker any hydrographic groups will be able to harness the following advantages:

- Save money.
- Save time in data processing.
- Reduce human error from the processing process.
- Save space by removing the need to store hard copies of each measurement.
- Reduce field time taken to manually calculate a measurement
- Improve measurement quality through instant on-site assessment of the
- measurement.
- Reduce on-going maintenance costs.
- Gain the potential to measure suspended sediment as part of a gauging.

Moving to the FlowTracker will incur the following disadvantages:

- Expenditure of time and money to train staff.
- Initial outlay.
- These disadvantages should be qualified by stating that in the longer term the initial
- cost and time impact may be repaid many times over by the benefits.

3.0 **Conclusion**

In conclusion, this evaluation has proved the high rate of correlation between data produced by the FlowTracker and that produced by a mechanical current meter. These findings are reinforced by USGS finding as stated in this report.

Investigation of cost considerations has proved that the FlowTracker is the more cost effective method of streamflow measurement.

Time expenditure has been shown to be less intensive with the use of the FlowTracker when considering the processes involved with storage and validation of data.

4.0 **Recommendations**

Such a successful demonstration of a low percentage variation evidenced by both this evaluation and that carried out by the USGS indicates that hydrographic agencies should move towards adopting the FlowTracker.

Throughout this evaluation the author has found the FlowTracker to be a reliable, useful tool. This rugged reliability has to be yet proven over an extended period. Many beneficial factors have been established and documented in this evaluation report. Consequently, any agency carrying out hydrographic investigations should move to incorporate the FlowTracker in to their use.

5.0 **References**

S. Morlock and G. Fisher, 2002, Hydroacoustic Current Meters for the Measurement of Discharge in Shallow Rivers and Streams http://hydroacoustics.usgs.gov/reports/SEMpaper.pdf

L. Ezzy 1974 (revised R. Bird 1992), Discharge Measurement by Current Meter http://insite.dnr.qld.gov.au/staff/depbus/rsk/ids/hydro/water_monitoring/work_practices/wm4.pdf (NRM Insite access only)

SonTek\YSI, 2004, FlowTracker Handheld ADV Technical Documentation

OTT, 2004, Small Current Meter C2, Promotional Publication

OTT, 2004, Universal Current Meter C31, Promotional Publication

6.0 Appendices

6.1 FlowTracker Evaluation

Field trial results

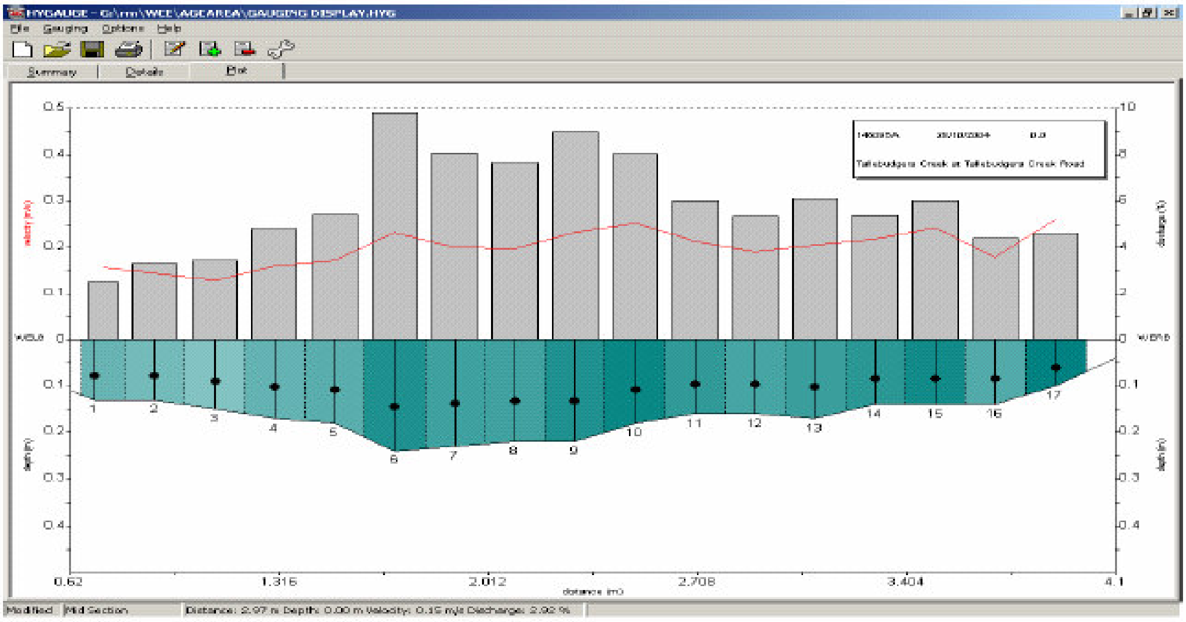
Ght	Date	GS	FT Q	MC Q	Comment	%dev. FTQ from MQ
0.72	23\11\2004	130223A	4.859	4.174	SunWater current meter	16.41%
0.65	22\11\2004	130223A	4.0487	4.090	SunWater current meter	1.01%
-0.07	25\10\2004	145102B	0.0356	0.040	Very low flow conditions	11.00%
1.18	15\10\2004	145014A	0.0852	0.102	Very low flow conditions	16.47%
0.44	22\10\2004	145010A	0.203	0.196	Consistent results	3.57%
0.69	19\10\2004	145020A	0.2948	0.306	Consistent results	3.66%
0.69	01\11\2004	145020A	0.2711	0.255	Consistent results	6.31%
0.66	20\10\2004	145103A	0.0092	0.013	Very low flow conditions	29.23%
1.18	15\10\2004	145014A	0.0852	0.087	Very low flow conditions	2.07%
2.04	13\10\2004	145008A	NA	0.648	Rapidly changing stage	NA
2.03	13\10\2004	145008A	0.5825	NA	Rapidly changing stage	NA
0.65	21\10\2004	145020A	0.1417	0.138	Consistent results	2.68%
0.49	26\10\2004	145025A	0.1753	0.171	Consistent results	2.51%
0.7	09\11\2004	145010A	2.2926	NA	Rapidly changing stage	NA
0.67	09\11\2004	145010A	NA	2.153	Rapidly changing stage	NA
0.29	02\11\2004	146020A	0.0075	0.012	Very low flow conditions	37.50%
0.38	01\11\2004	145010A	0.0331	0.035	Very low flow conditions	5.43%
0.89	28\10\2004	146095A	0.1101	0.110	Consistent results	0.09%
0.22	27\10\2004	145107A	0.0658	0.079	Very low flow conditions	16.71%
0.22	29\10\2004	146002B	0.0353	0.046	Very low flow conditions	23.26%
0.1	26\10\2004	145105B	0.0209	0.026	Very low flow conditions	19.62%
0.53	19\10\2004	145011A	0.0025	0.004	Very low flow conditions	37.50%
0.76	20\10\2004	145101D	0.3337	0.358	Consistent results	6.79%
1.8	08\12\2004	145014A	5.6276	5.352	Consistent results	5.15%
1.27	08\12\2004	145003B	4.9222	5.288	Large boulders in sect.	6.92%
1.5	08\12\2004	145020A	7.2265	7.267	Consistent results	0.56%
0.95	08\12\2004	145103A	0.8357	0.840	Consistent results	0.51%
0.85	09\12\2004	145103A	0.4194	0.421	Consistent results	0.38%
1.02	10\12\2004	145103A	1.2455	1.317	Consistent results	5.43%
0.58	09\12\2004	145107A	3.3198	3.345	Consistent results	0.75%
0.34	09\12\2004	146014A	0.668	0.619	Large boulders in sect.	7.92%
1.22	09\12\2004	146010A	5.549	5.627	Consistent results	1.39%
0.44	09\12\2004	145105B	2.0719	2.017	Consistent results	2.72%
0.72	10\12\2004	145107A	6.1791	6.107	Consistent results	1.18%
1.27	10\12\2004	143033A	0.3213	0.304	Consistent results	5.69%

Average:	9.05%
Average for flows greater than 0.1cumecs:	4.42%
Average for flows less than 0.1cumecs:	20.26%

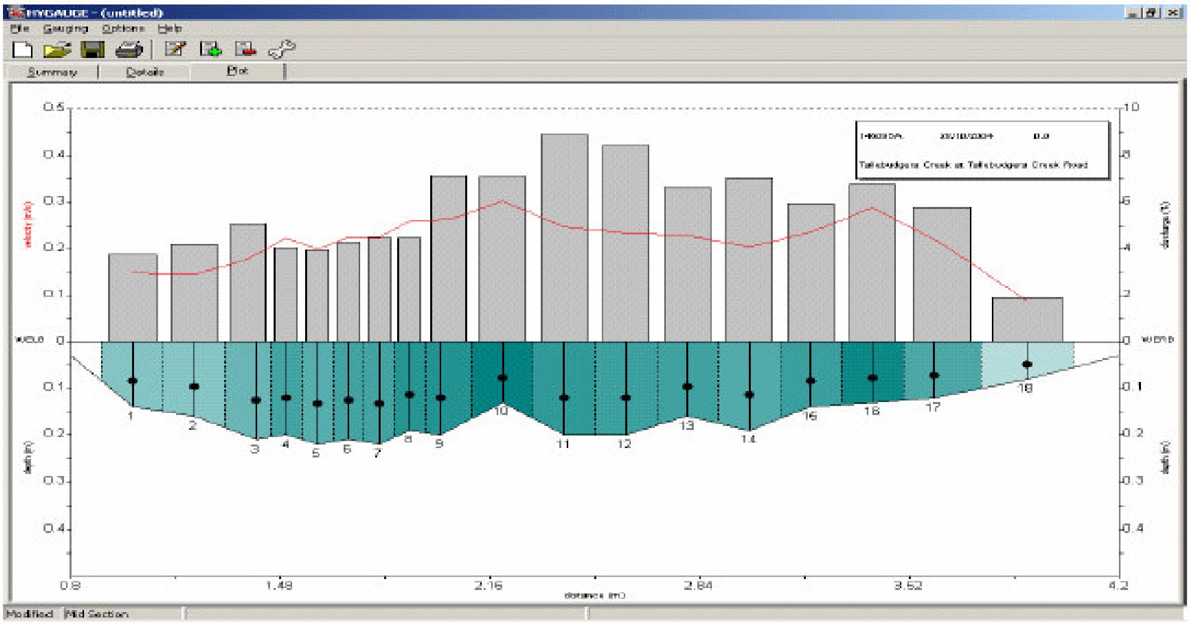
Legend:
Ght = Gauge height
GS = Gauging Staion

6.1 **FlowTracker Evaluation**
Field trial results

6.2 Hygauge measurement plots (FlowTracker)



6.3 Hygauge measurement plots (Mechanical current meter)



6.4 FlowTracker text file example

```
File ---------------------- 146095A.40.WAD
Start Date and Time ------- 2004/10/28 15:29:44
Sensor Type --------------- FlowTracker Handheld ADV
SerialNumber -------------- P628
FlowExporter Version ------ 1.30
CPU Firmware Version ------ 2.5
Averaging Time ------------ 40 sec
Units System -------------- METRIC
Staff Height -------------- 0.000 m
Gauge Height -------------- 0.896 m
Rated Discharge ----------- 0.0000 cms
Starting Edge of Water ---- LEW
Number of Stations -------- 19
Total Width --------------- 3.45 m
Total Area ---------------- 0.569 m^2
Total Discharge ----------- 0.1101 cms
Mean Velocity ------------- 19.34 cm/s
Mean SNR ------------------ 19.6 dB
Mean Std. Error of Vel. --- 0.5 cm/s
Mean Boundary Conditions -- 0 (BEST)
Boundary Condition (Bnd) -- 0: BEST
                            1: GOOD
                            2: FAIR
                            3: POOR
```

St.	Loc. (m)	Depth (m)	IceD (m)	%Dep (*D)	Clock	#pts	Spike	Vel (cm/s)	SNR (dB)	Angle (deg)	Verr (cm/s)	Bnd	Temp (degC)	Corr Fact	MeanV (cm/s)	Area (m^2)	Flow (cms)
0	0.65	0.110	0.000	.0	00:00	0	0	0.00	0.0	0	0.00	0	0.00	0.50	7.84	0.003	0.0002
1	0.70	0.130	0.000	.6	15:29	40	0	15.68	18.9	-6	0.30	3	26.29	1.00	15.68	0.016	0.0025
2	0.90	0.130	0.000	.6	15:30	40	0	14.37	18.4	-19	0.30	0	26.31	1.00	14.37	0.026	0.0037
3	1.10	0.150	0.000	.6	15:31	40	0	12.95	18.9	-10	0.30	0	26.32	1.00	12.95	0.030	0.0039
4	1.30	0.170	0.000	.6	15:33	40	0	16.00	19.3	1	0.60	0	26.35	1.00	16.00	0.034	0.0054
5	1.50	0.180	0.000	.6	15:34	40	0	17.11	19.7	-8	0.70	0	26.35	1.00	17.11	0.036	0.0062
6	1.70	0.240	0.000	.6	15:35	40	1	23.20	19.7	-1	0.50	0	26.37	1.00	23.20	0.048	0.0111
7	1.90	0.230	0.000	.6	15:37	40	1	19.92	19.3	2	0.60	0	26.38	1.00	19.92	0.046	0.0092
8	2.10	0.220	0.000	.6	15:38	40	1	19.77	20.2	2	0.70	0	26.37	1.00	19.77	0.044	0.0087
9	2.30	0.220	0.000	.6	15:39	40	0	23.16	21.5	1	0.70	0	26.37	1.00	23.16	0.044	0.0102
10	2.50	0.180	0.000	.6	15:40	40	1	25.31	19.7	8	0.50	0	26.37	1.00	25.31	0.036	0.0091
11	2.70	0.160	0.000	.6	15:41	40	0	21.26	20.6	-3	0.60	0	26.37	1.00	21.26	0.032	0.0068
12	2.90	0.160	0.000	.6	15:42	40	0	19.04	21.5	2	0.70	0	26.35	1.00	19.04	0.032	0.0061
13	3.10	0.170	0.000	.6	15:44	40	0	20.39	19.7	1	0.90	0	26.32	1.00	20.39	0.034	0.0069
14	3.30	0.140	0.000	.6	15:46	40	1	21.88	19.3	12	0.70	0	26.28	1.00	21.88	0.028	0.0061
15	3.50	0.140	0.000	.6	15:47	40	2	24.31	19.7	0	0.60	0	26.25	1.00	24.31	0.028	0.0068
16	3.70	0.140	0.000	.6	15:48	40	1	17.82	18.4	2	0.30	0	26.23	1.00	17.82	0.028	0.0050
17	3.90	0.100	0.000	.6	15:49	40	0	9.51	17.6	5	0.30	0	26.14	1.00	9.51	0.020	0.0019
18	4.10	0.040	0.000	.0	00:00	0	0	0.00	0.0	0	0.00	0	0.00	0.25	2.38	0.004	0.0001

UNIDATA Pty Limited – revitalising the WA business.

Over the last year, Unidata, a supplier of loggers and sensors to many Australian companies and Authorities underwent a period of ownership and management change.

In **April 2004**, a revitalized Unidata environmental instrumentation company was established. The newco, Unidata Pty Ltd, remains solidly an Australian based Company, but supported by NIWA (National Institute of Water and Atmospheric Research, NZ), as a shareholder.

At the 12th Hydrographic Conference, the new entity supported the event with a booth and fielded many questions from attendees as to what was happening in the world of Unidata

As many groups are interested in what the plans are of the new Unidata I approached Unidata and Graham Elley of NIWA (now the major shareholder of UNIDATA Pty) for information and if I could share this with other members of our Association.

NIWA, like many AHA members, has been a long-term Unidata equipment user (early 90's) and with the Unidata-Australia business issues of late 2003, were concerned about the future for its installed base of some 1300 loggers.

What has been done over the last year or so?

Since April the major focus has been on stabilisation of the organisation, with a particular focus on re-establishing production of the traditional product range and improving product performance and reliability.

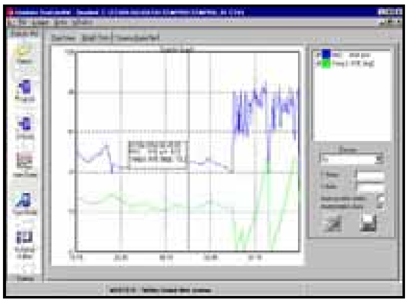
During this period there has been managerial changes with operational management taken over by Nick Efthyvoulos, who has been with the organisation for a number of years. There have also been number of the new appointments to strengthen engineering and customer support areas.

Unidata Pty Staff (Jan 2005)

What are Unidata's R&D Plans?

With stabilization plans well underway the management team is now starting to focus on short and long-term product Research and Development. This will address a list of product improvements that have been identified by users, for many of the traditional items such as the water/level encoder, Star/Prologger, Starflow, and Micrologger based products.

A top priority is the provision of a generic, Windows compliant, datalogger support package, which will complete the redevelopment of the Starlite 4W programming work. This product is presently under test with a projected release date in late March 2005.



Concurrent with these initiatives will be continued long-term R&D investment to ensure that Unidata equipment users continue have access to affordable, and highly useable products for the range of environmental monitoring work that are we all have to complete.

While NIWA, a New Zealand organization, is now the major shareholder what other involvement will NIWA have in the day to day running of UNIDATA?

NIWA involvement is primarily in a management and support role with Unidata being operated entirely as a subsidiary organization and remaining based in Perth. The extensive technical expertise of NIWA researchers is available to Unidata R&D processes as required.

Along the way it is planned, where applicable, that the Unidata product range can be complemented with some of the many tools and accessories that the NIWA instrument group has provided to NZ hydrographic groups, for the last 30+ years.

This could include basic hydrographic accessories such as gauging boards, gauging tools, reels, current meter calibration services, wave gauges, electric fishing equipment, and a variety of Hydrological software, much of which has been supplied into some Australian agencies for a number of years. Unidata will continue to be an important supplier of some of the hydrographic and general environmental monitoring systems that are important to Australasia's research and consultancy operations as well as wider activities particularly in the South Pacific and parts of Asia.

12th Conference Review Part 2

The second day saw presentations by Simon Cruikshank (NT), Alex Springall (ex DLWC), Charlie Thurgood (NZ), Brian Chester (WA), Tony Spandler Hydro Tas), Michael Sievers (Qld NRME), Scott Walker (Sydney Water), Stephen Bird (Tyco), Ken Klaasen (Qld NRME), Andrew Skinner (MEA), Hening Huang (RDI), Chris Ward (Sontek), Geoff Carlin (CSIRO) and Parker-Gordon-Drake (Qld NRME).

Simon dealt with the development of a reservoir profiling and mapping setup that he stuck together with some bits and pieces he'd found in the kitchen at his offices in Darwin! (Paper appeared in last issue of the Journal)

Rating analysis was further dealt with by Alex Springall as he outlined the further use of statistical tools from HYDSYS for objective analysis of gauging and rating sets.

Charlie Thurgood brought us a short history of his career as a hydrographer, particularly in the wilds of New Guinea. Much of the technology seen in this presenatation is still in use, as well as in many other areas of the less developed regions of the world, showing the robustness of the older technologies after many years of service.

In depth could best describe Brian Chester's presentation. A mathematical feast dealing with stream roughness co-efficients was dealt with here, investigating the history of the use of roughness co-effients and some organistions are developing visual guides for estimating and compensating for roughness.

Dizzying heights were experienced by all with Tony Spandler as he explored the world of wind monitoring for the wind farm projects that Hydro Tasmania is involved in around Australia

South East Queensland Water have implemented a Catchment to tap approach on drinking water quality. Michael Seivers outlined the approach and methodologies to identify and improve monitoring of catchments and the event based sampling program that has been implemented.

Understanding consumer patterns of water usage around the home was the topic presented by Scott Walker which outlined a pilot program of intensive monitoring of water use in the urban household. One of the eventual outcomes would be that Sydney Water could better manage water demand through a better understanding of their customer behaviour – almost Big Brother stuff!

Stephen Bird from Tyco/Greenspan detailed trials of the Greenspan Mini Analyser undertaken in conjunction with the Department of Infrastructure, Planning and Natural Resources in northern New South Wales.

Queenslands developing quality system was the theme of Ken Klaasen's presentation. An important aspect of Kens presentation was that the environments in which hydrographic monitoring is undertaken are wide and varied, implementing quality assurance thus needs to be undertaken via an objective process and in many cases may be site specific.

Andrew Skinner, from MEA, continued on his theme of challenges and developments in technologies and processes in the hydrographic industry over the years using the development of MEA over the years to show how the present has developed and then projecting a view(s) of the future world.

Hening Huang (RDI) and Chris Ward (SonTek), gave technical presentations on the potential uses of ADCP units, Hening on Index Velocity development of ratings and Chris delved in to aspects of ACDP units.

Geoff Carlin (CSIRO) explained the development of a portable water quality system that CSIRO have been using around an acid-sulphate affected area in north Queensland – and on a small budget

And some experience with flood gauging in northern Queensland was shared by the trio of Parker-Gordon-Drake.

The enthusiasm and professionalism of presenters on this day, and on the first day as well, was appreciated by all attendees.

Mic Clayton

Obituary – Pat Pauling

The death has occurred on 13th October 2004 of Pat Pauling, retired NSW Water Conservation & Irrigation Commission Hydrographer, after a long illness.

Pat was born in Leeton in 1918. One could almost say he was born into the WC&IC, as his father, Tom, worked for the Commission, and later became Weir Superintendent at Warren Weir. His brother, Maurice, also worked for the WC&IC.

Pat enlisted in the AIF in June 1940, and saw active service as a front-line infantryman with the 2/31 Battalion in Syria, the Kokoda Track, Gona and the invasion of Balikpapan, where he was wounded. Meeting with his many old friends and commemorating Anzac day remained important to Pat for all his life.

On his return from the war, Pat joined the Hydrographic branch of the WC&IC in 1949 as a Hydrographic Assistant in Sydney, where he travelled the state with hydrographers on gauging trips. In 1950, he joined the installations section, where he worked with Don Lunn, Bill Meggitt and Ricky Rickman. At this time, there was a growth in interest in the hydrology of the state, and the crew were kept busy installing recorders and cableways across NSW, particularly in the Snowy Mountains and in Northern NSW.

He later transferred to the district office at Albury, and when this office closed, returned to Sydney. In 1960, he was appointed OIC of the installations section, where he undertook many major installations.

In 1967, Pat was appointed Hydrographer, based in Sydney, and continued in this position until his retirement in 1978. During his long career with the WC&IC, Pat covered most areas of the state, including the Snowy Mountains, the Murray & Murrumbidgee Rivers the Western Plains and the Border Rivers.

Belying his reputation as a soldier, Pat at work was a placid man. I had the good fortune to be taken on my first hydrographic trip by Pat, and learned quickly that he could forgive almost anything in his assistant – lack of knowledge, inability to keep up with him – except lack of cooking and conversational skills. Pat was never one to cut corners, and was painstaking in every aspect of his work. He was always happy to spend time teaching new assistants the job, and his broad experience, both in the Army and later, came to the fore in difficult construction work.

For all his life, Pat was a keen sportsman and sports follower, with a prodigious memory for sporting facts. No matter what the sport, he could recall not only the result, but the stars and bit players. In Leeton and in the army, he played rugby league, rugby union and Australian Rules. In the WC&IC rugby league team, he played as fullback, and in an Albury team on the wing. He was also a very keen A grade tennis player, swimmer and first class cricketer. Later in his life, with his wife Thelma, he took up lawn bowls, which he also umpired.

Pat Pauling was a man for whom the phrase "nature's gentleman" was invented. His friends and former colleagues send their sincere condolences to his wife Thelma, children Shirley and Robert and his grandchildren.

Alex Springall (Information kindly supplied by Thelma Pauling & Don Lunn)

Vale – John Webster

1932 - 2004

On June 18 2004, John Webster (aka Webbo, The Bo, Dayo) passed away on the north coast of NSW.

Born in 1932 and spending his early years in the Tumut/Adelong area of New South Wales as well as Geelong, John led a life of excitement and fit fun and adventure. Many hydrographers who had the pleasure to work with him were amazed how fit and energetic he remained in the later years of his hydrographic career.

John was not always a hydrographer. In the early years he worked as a driller in the steamfields north of Taupo, New Zealand, worked as a steward on a ship or two and in the goldmines of Johannesburg for a couple of years as well. When working in the mines he wasn't a 'white boss man', he was at the face drilling and digging alongside native South Africans, and as a result was treated no better than his fellow workers by those who ran the mines. Then after all that he came back to Oz, got married to Helena and ran a fruit shop in Maitland for a time and even worked as a fireman/stoker on the steam engine 3801!

After a flood went through Maitland ending the fruit enterprise he began at the Metropolitan Water Sewerage and Drainage Board in Sydney in 1969, at a time when the hydrographic network was in expansion with the recent completion of Warragamba Dam and the commencement of developments in the Shoalhaven and Southern Highlands catchments.

As crew leader of the hydrographic installations and maintenance group of the MWS&DB, John worked across all the Sydney catchments, underground in the sewers and in trade waste installations. Those who worked in the bush with him got to learn the intricate melody of the Banana Boat Song by Harry Belafonte as each morning began!

If anything needed to be secured John had the knot for the occasion – a skill he picked up in his seafaring days. He loved the 'art' of knots, and enjoyed passing on his knowledge to others of this craft. He also enjoyed that pastime of putting big ships in little bottles!

His skill in knots of course led to an obvious connection for something to do on the weekends and he became a Venturer leader in the Parramatta region with 1st Wentworthville until the 90's. What better thing to do after a week camping in the bush for work installing gauging stations than to get home on Friday afternoon and head off into the Blue Mountains on another bush trip!

In the mid 1990's John accepted one of the early offers of packages from the Water Board and continued to pursue his outdoor pursuits.

Over the years he trekked in Nepal, partook in the Great Bike Rides even after a mishap on the Sydney to the Gong ride that resulted in a pelvis broken in three places!

Cycling had been a youthful passion, his hero being Victorian Russell Mockridge, with John having been involved in track racing in his youth as well as cycle touring in Europe, in particular travelling over the Alps before it became trendy (and a sealed road).

Personally I enjoyed his company and companionship at work and in outdoor pursuits, particularly bushwalking and cycling. Bushwalking in the Blue Mountains, west of Sydney, involved many destinations in the Cox's River /Kanangara walls area – an area of which he had an intimate knowledge.

Unfortunately in later years John slowly developed Parkinsons disease, though he managed to continue with exciting activities into the late 1990's including partaking in a Tall Ships events from Sydney to Hobart in 1998.

With his passing it his hoped that many will remember his early morning signature tune , "Dayo, Dayo. daylight come and I wanna go home".

Mic Clayton (With assistance from Paul Lytwyn)

Contributions to the Journal and Newsletter

Member contributions to the Journal and newsletters are encouraged. You are the Association and hence it is helpful if you provide input into it.

Contributors and advertisers are requested to supply copy in Word format, but if PDF is supplied please ensure that protection features are disabled so that cut and pasting can occur as required for AHA use.

I look forward to getting summaries of papers from the conference from those who have indicated that they are willing to provide them. Summaries of the summaries are also welcome as I can use them as a precursor in the newsletters for items appearing in the next Quarterly Journal.

Photographs are also welcome for the cover of the newsletter - final use of a submitted photo will depend on how well the image transposes onto the cover of the Journal, so the clearer the better. With improvements in digital technologies and the ease of its use, there should be no shortage of interesting photos for the cover!

Hydro Acoustic Work Shop

At the 12th Conference delegates broke up into discussion groups to throw around ideas, concerns and knowledge on the emerging technologies in the stream gauging area, in particular the potential use of acoustic Doppler systems. The following is a summary of discussions points from the groups, summarised by the convenors. Groups tended to be led by a hydrographer with experience or exposure in the group topic. Thanks to those who led groups and shared their experience with others.

Group 1: The StreamPro

(This group was based on sharing information in regards to Queensland trials of the Stream Pro unit, hence is biased towards this brand – it is not an endorsement of the specific brand)

Observations:

- Depth limitations
- Viability\applicability of use due to limitations
- Improved safety
- One man operation possible
- Possibly best used where there is a fast rate of rise and fall

Questions:

- Do we need to use it at all?

Ideas:

- Delay any purchases until technology matures.
- Increase maximum depth of operation.
- Increase maximum velocity.
- Sharing of information and data between users.
- Provide feedback for RDI with a view to have them develop an instrument suitable for our conditions.

SMART opportunities:

- Use StreamPro where wading or boat gauging is impractical.
- Take advantage of workplace health and safety improvements.
- Purchase when the StreamPro has had some performance improvements carried out.

Group 2: Doppler Sediment Measurement

(The possibility of using this technology as another method of determining sediment loads was discussed in this group)

Observations:

- Existing data sets may be mined for suspended sediment load data.
- Calibration will be required for each site.
- Calibration will also be required after a period of time at each site.
- Calibration is a complex process. Nominally requiring one month of office work per site!
- The paper by Kent Davis is the current benchmark for the calibration process. Sediview uses this approach to calibration.
- Single frequency ADCP's cannot measure particle size.
- Bed load requires good differential GPS and compass calibration.

Questions:
Not recorded.

Ideas:

- Calibration runs could use alternative mediums to reduce lab costs eg. Optical backscatter. "backscat" test/multiple frequency.
- 1200 & 600 frequency ADCP runs would be of benefit on calibration runs.

SMART opportunities: *Not recorded.*

Group 3: Doppler Field Procedures

(Larger srteam/flood/floodplain monitoring tended to be the focus of this group)
Observations:

- Unless the ACDP is mounted over the bow and the bow is pointed directly in to the flow a variation between measurement collected from LB to RB and vice-versa will occur.
- Variations in user configurations will cause differences in discharges recorded.
- The rate of transect must be less than the velocity of the flow being measured.
- Loss of bottom track due vegetation can have a major impact on the final result.
- Edge estimations are another source of potential variation.

- Electromagnetic interference can have a distorting effect on the data collected.
- Procedure documentation requires refinement.

Questions:

- Not recorded.

Ideas:

- Carry out an even number of transects.
- Standardise modes and configurations.
- Develop coxswain skills.
- Set wet season priorities and clear Doppler measurement sections.
- Attempt to stabilise position at starting 2 bins.
- To avoid electromagnetic interference move at least 50m from overhead powerlines.
- The sharing of information between agencies that are developing ADCP procedures could lead to a single national set of guidelines.
- Share information on levels of accuracy obtained (all transects within 5%, good comparison with established rating etc.) and how this was achieved.

SMART opportunities:

Not recorded.

Group 4: Doppler Data Processing and Software

Observations:

- Cross-sections require planning and maintenance.
- Clearly label all data.
- XML file format is good for complex data and easy to operate.
- Use of a plotting function is important for quickly checking measurement runs.

Questions:

Not recorded.

Ideas:

- Plan and maintain priority ADCP sections.
- Standardise all labelling of data files.
- Check results in the field compare against current rating for that site.
- Processing of data should occur in the field
- Avoid automode.
- Subsection edges as necessary to begin at two good bins.

SMART opportunities:

- Establish an Australia wide Doppler users group to keep all interested parties up to date and facilitate the sharing of ideas.
- Get it right in the field.

Group 5: Doppler instruments and GPS or sounder data

(This group tended to focus on larger scale gaugings where other locating and sounding methods could be used to overcome bottom tracking errors in systems)

Observations:

- Problems with loss of bottom track can be overcome with integration of a DGPS unit.
- DGPS can also help negate the effects of a mobile bed.
- Depth sounders may have accuracy trouble in shallow or vegetated water.
- GPS is only worthwhile if it is differentially corrected – DGPS, but even DGPS require a clear line of site to the satellites.

Questions:

- Is it possible to collect bottom track and GPS data?
- Should we survey Doppler sections for comparison with bottom track?
- Have there been any problem integrating laptops with GPS?

Ideas:

- Record both DGPS and bottom tracking. Integrate results in post processing.

SMART opportunities:

Not recorded.

Group 6: Doppler Modes

Observations:

- The concept of profiling modes is brand specific; SonTek and Nortek use one mode while RDI uses many.
- The use of different modes during gaugings results in variations in results.
- Uncertainty exists concerning the correct use to produce the most accurate results – different people use various numbers of runs etc.
- Calibration\performance checks remain unclear

Questions:

- What are the legal implications of operating without an Australian Standard?

- How can we go about storing mode\configuration information with the measurement on a database such as HYDSTRA?
- What are the various users basing their selected number of runs that comprise a single gauging on – statistics?
- With regards to calibration\performance – can we use a tow tank, should we be conducting comparison tests and how often should these practises be carried out?

*Idea*s:

- The Australian Hydrographic Association should be involved in developing a best practise standard.

SMART opportunities:

Not recorded.

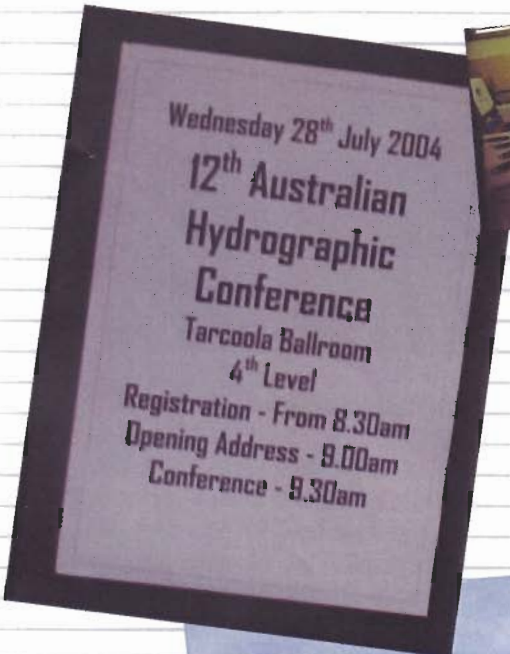
History Shot *(Alex Springall)*

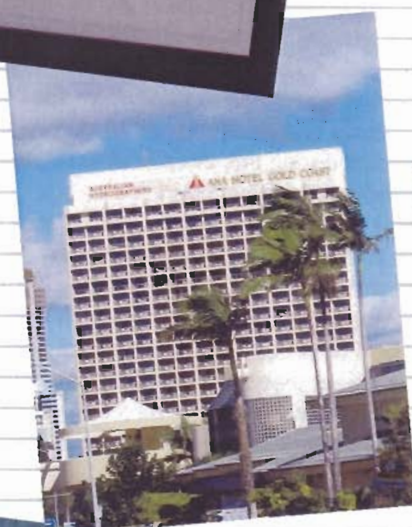
Bega Street

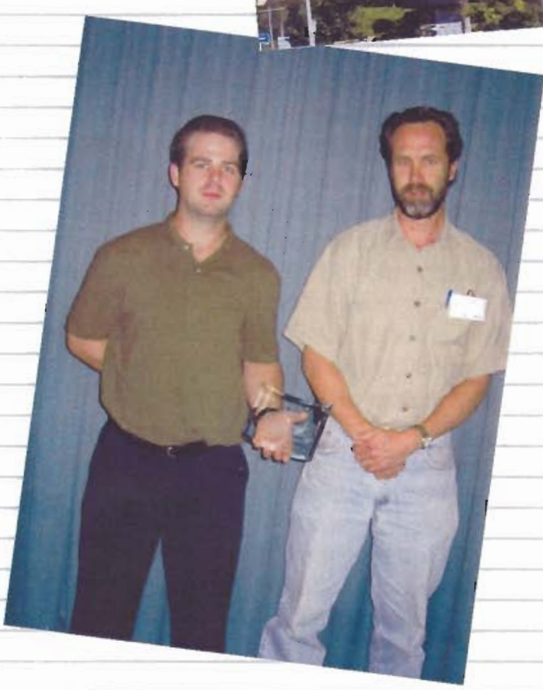
The only house on the southern side of Bega Street, between Gipps and Church Streets.

When flood peaked, windows were completely obscured. Debris in foreground indicates peak level of flood.

Gold Coast Album

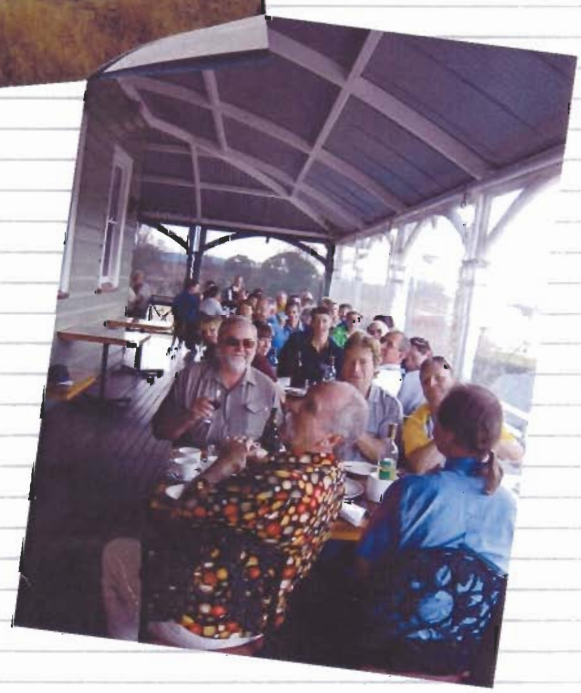


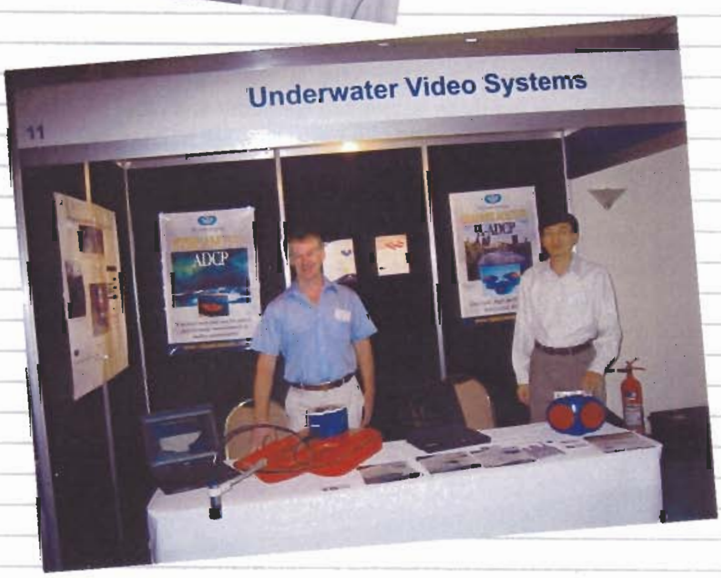




***Clockwise from top left:** Tarcoola Room sign, Venue, Test Flume Rocklea,Getting wet on the field trip*
***Luke and Aaron** receive the A.J. Miller Award, The ANA Hotel*

12th Conference 2004





Clockwise from top left: Test tank at Rocklea, the Bus waiter,Rainbow end to a conference, Albert River Winery, Underwater Video Systems, Aaron at the podium,