WATERDATA
Consultants Pty. Ltd.
A.CN. 70 084 264 380
Environmental Data Collection Specialists

30 Kiap Road.
South Yunderup. WA. 6208.
Phone and Fax: (08) 95378183
Mobile: 041 4538 167.
Email: iantite@ozemail.com.au

Starflow Firmware Tests. Urban Stormwater Drain. 10/6/2008 to 8/7/2008.

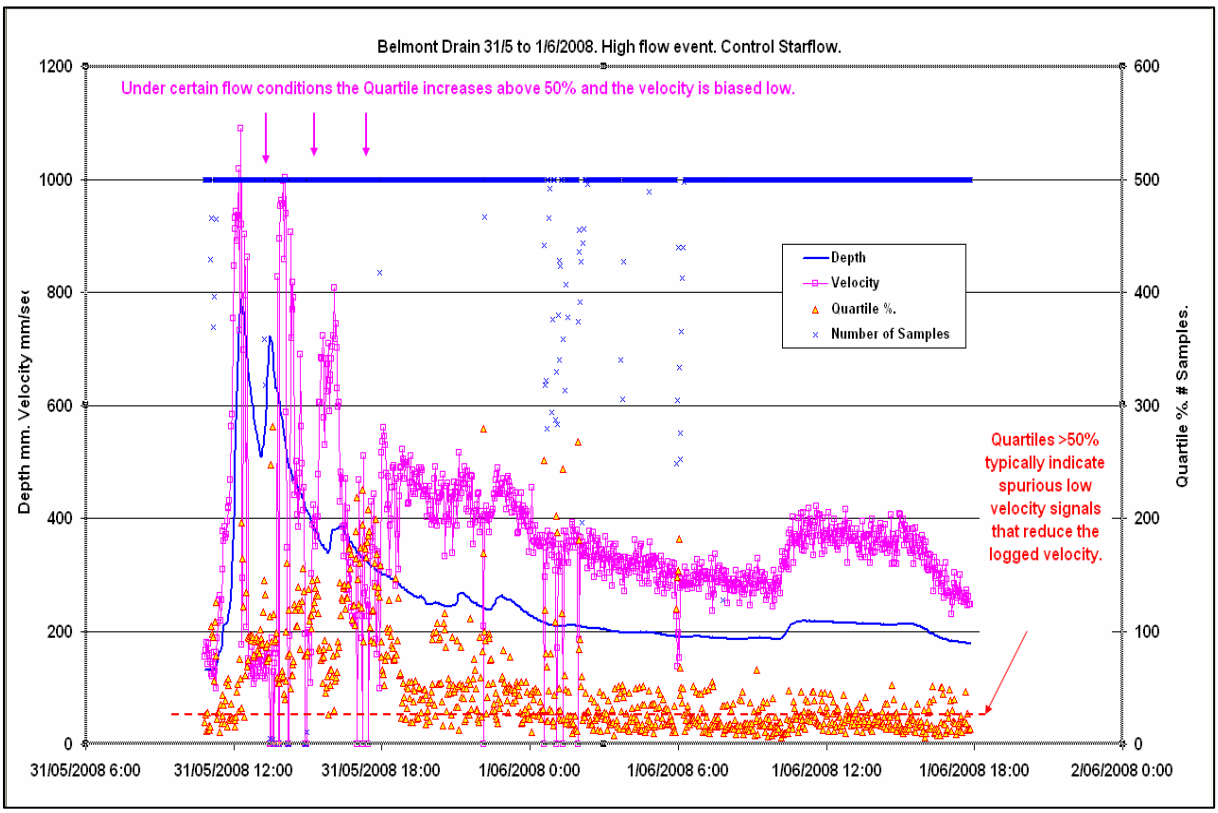
1. Overview.

Starflow instruments have been operated at this site for several years as part of an urban stormwater drain monitoring project. Some velocity data has been erratic.

The site has been used for a series of Unidata tests carried out by Waterdata, to try and understand the cause and solutions for these limitations.

One significant problem was tendency of the instrument to under-register velocities during some flow conditions. This characteristic has also been noted at many other sites.

The following plot shows the details of a typical high flow event where the velocity data sometimes fails to record correctly. The data shown is the logged depth and velocity measured each 5-minutes. The signal details from each acoustic velocity measurement are also shown.



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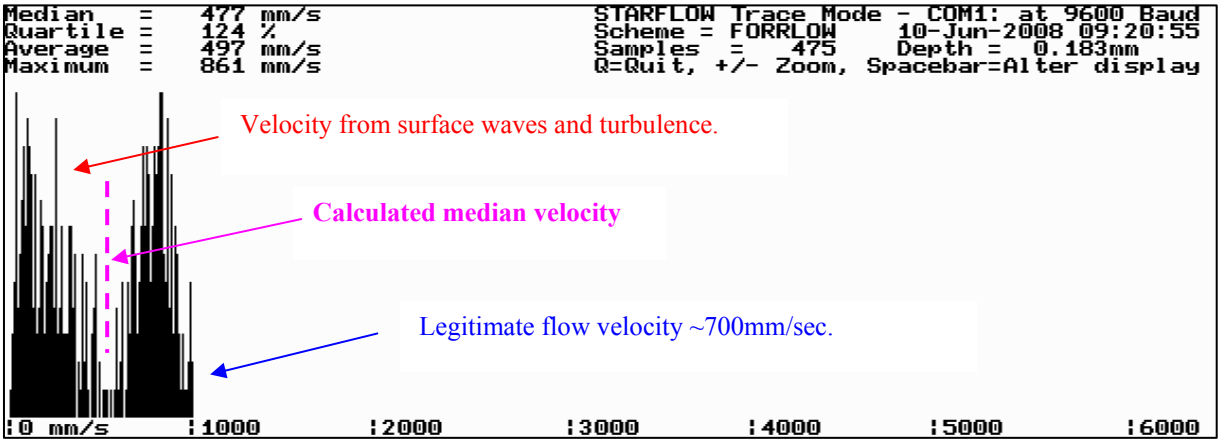
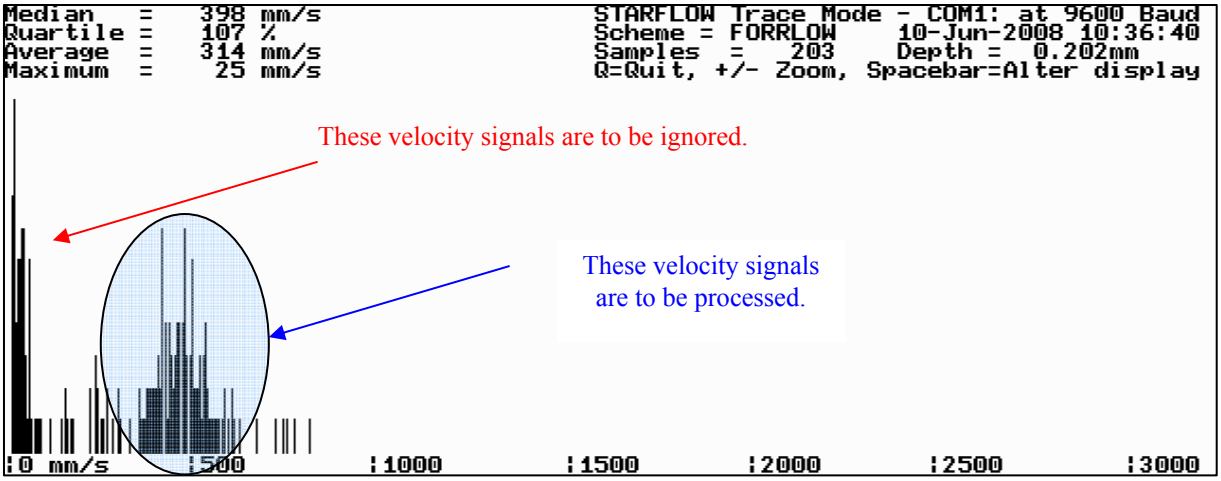
Waterdata tests at a range of sites identified that the cause of the reduced velocity was the Starflow detecting the boundary velocities from surface wave conditions and bed turbulence, as well as from the actual water velocity. These boundary conditions are acoustically reflective and can be over-represented in the measured signal spectrum. When this happens the calculated median velocity is biased low.

The following plot shows a typical "Velocity Test" screen where the acoustic signals detected from each measuring scan can be displayed. The Starflow is clearly measuring two different groups of velocity signals. The logged median velocity is calculated as lying between these groups. However the slower "velocities" are not representative of the water velocity.



This problem has been recognised at a range of other sites. A proposed solution was to modify the velocity processing within the Starflow firmware, to provide the option to remove these slow velocities from the median velocity calculation. As part of this calculation the signal spread is calculated as the "quartile". Good velocity measurements typically have quartiles <50%. The processing was modified to allow a target quartile to be specified. Slow velocities are progressively excluded from the median calculation until the desired quartile is reached.



This "new firmware" solution was field-tested by Waterdata and a range of flow conditions were measured. This report summarises the results.

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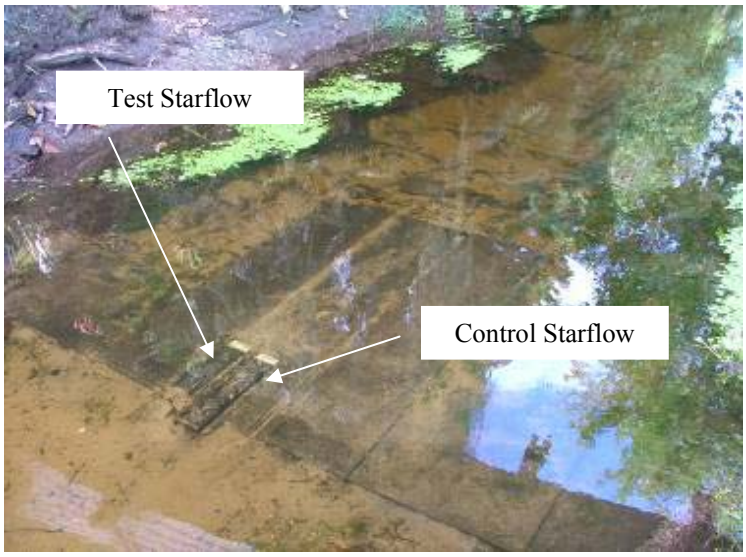
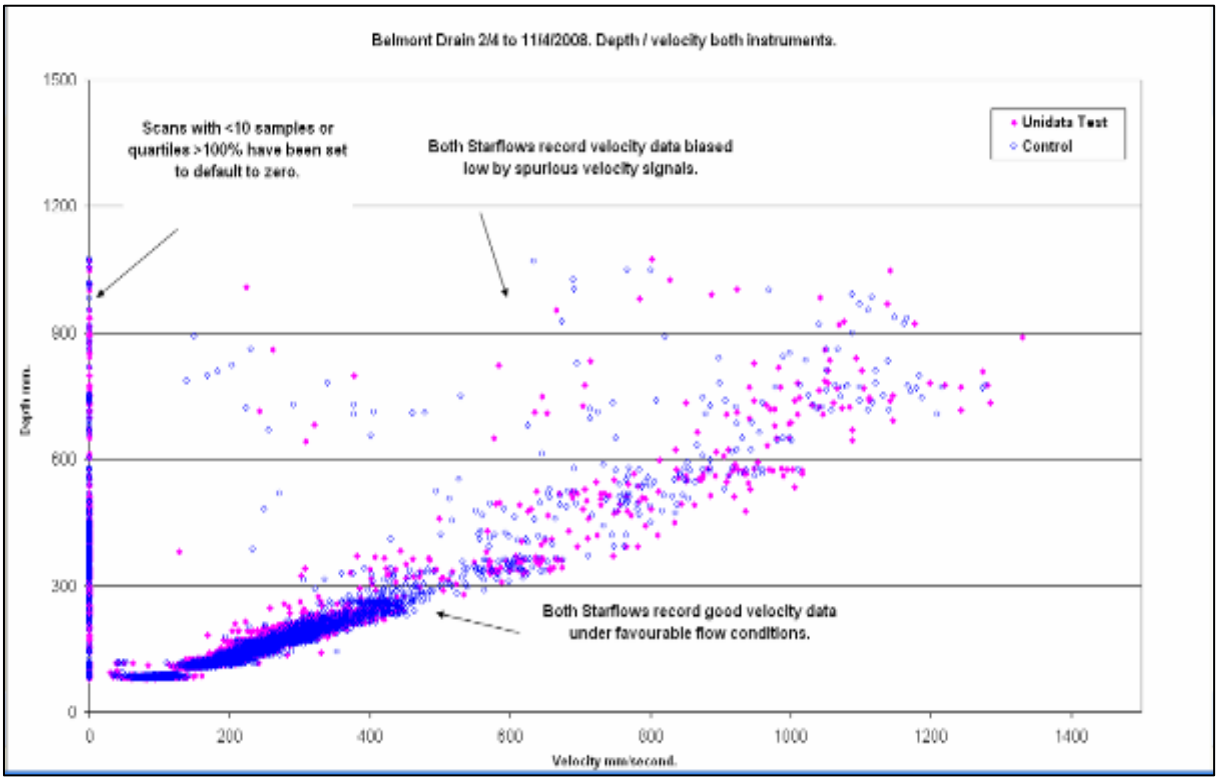
2. Control tests.



An existing Starflow that continuously logged the site depth and velocity was adjusted to include the signal Q and sample #, and used as the control throughout the tests.

A second Starflow, using the same firmware and logging the same data was installed alongside the control instrument. Both were operated from 5/3/2008 to 10/6/2008 to collect a reference data set through a range of flows.

Data from 5/3/2008 to 10/6/2008 indicated both instruments were measuring similar velocity data under various flow conditions. The following plot compares the depth / velocity relationship for data points logged by the two instruments at the same time, during a typical period. Deeper analysis confirms both record similar results.



On 10/6/2008 the modified firmware was installed in the test Starflow. This was operated until 8/7/2008. A full range of flows were measured during this period.

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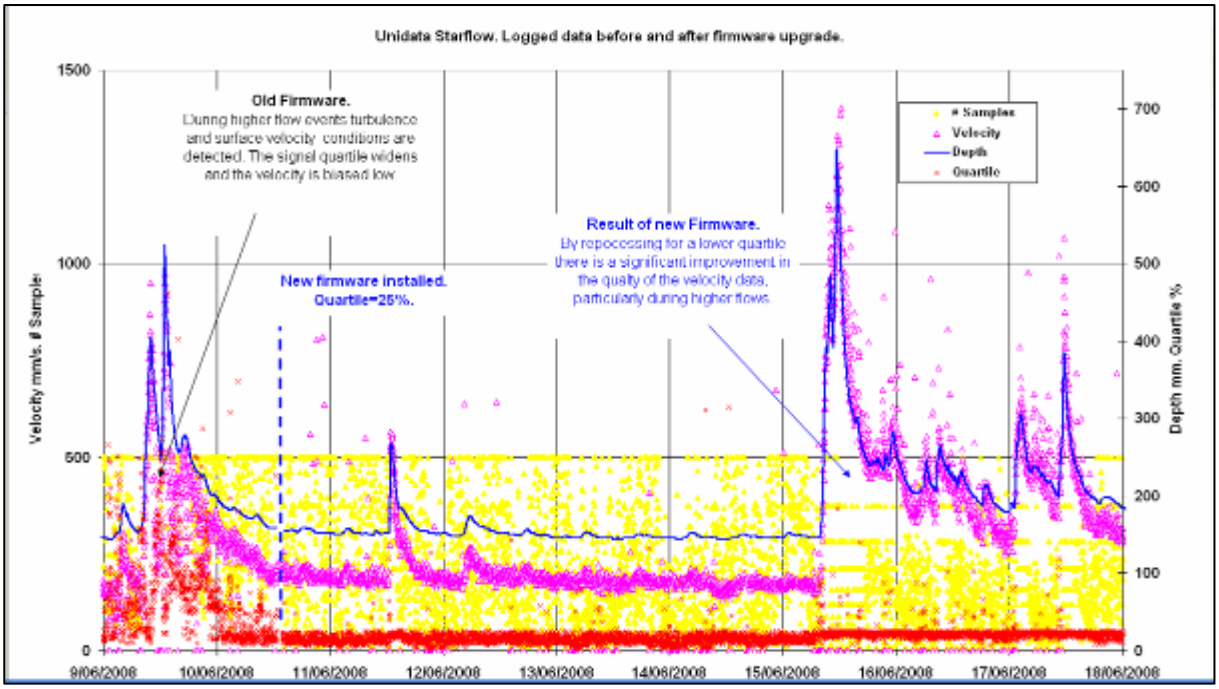
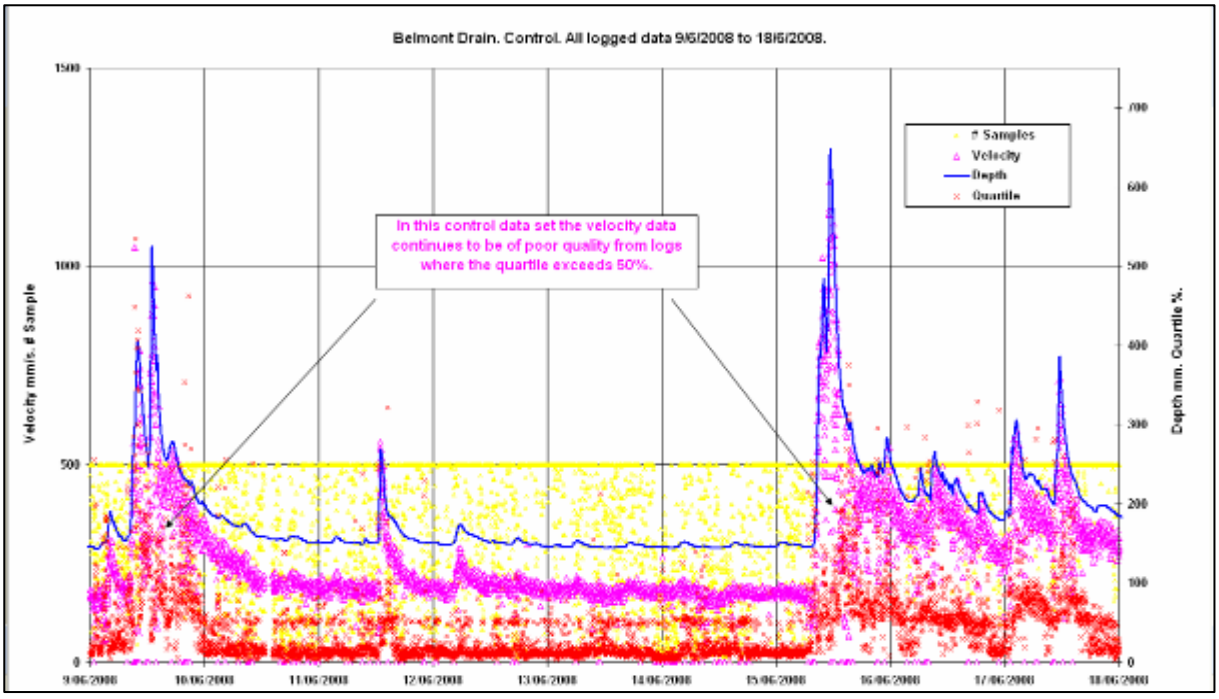
3. Results of tests of new firmware.

On 10/6/2008 the firmware of the test instrument was upgraded to the modified version. The following plot shows the immediate improvement of the quality of the velocity data.



This compares with the continued poor quality of some velocity data logged by the control Starflow, shown on the following plot. The new firmware has significantly improved the quality of all, and particularly the higher velocity data.



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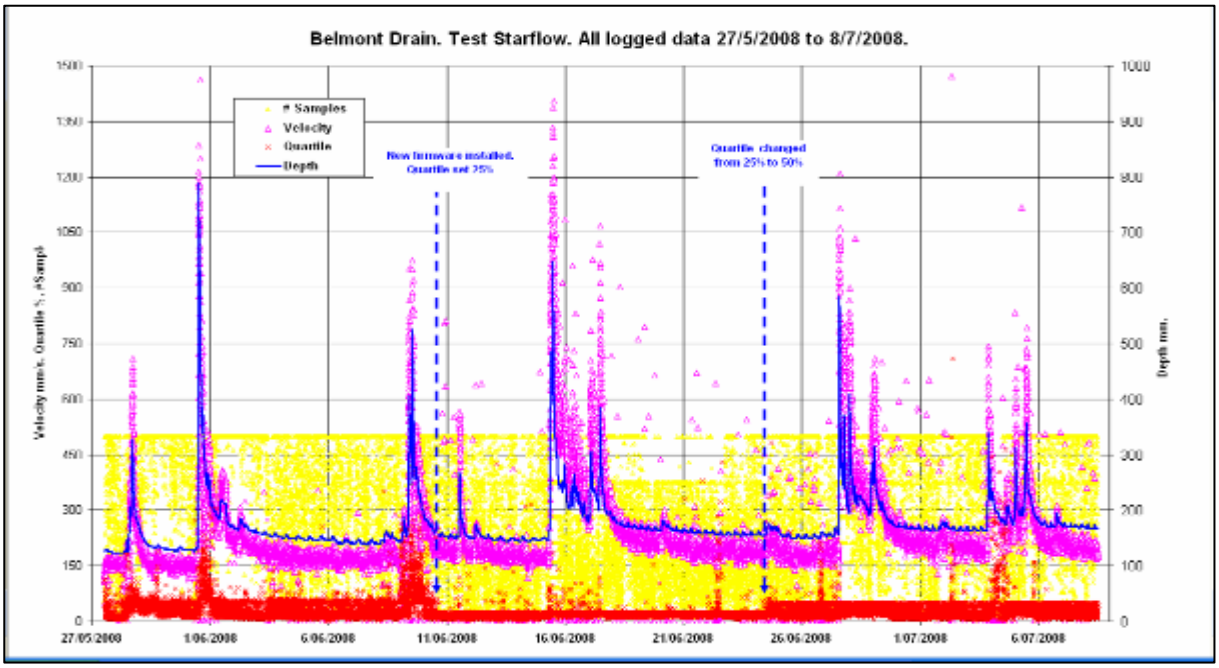
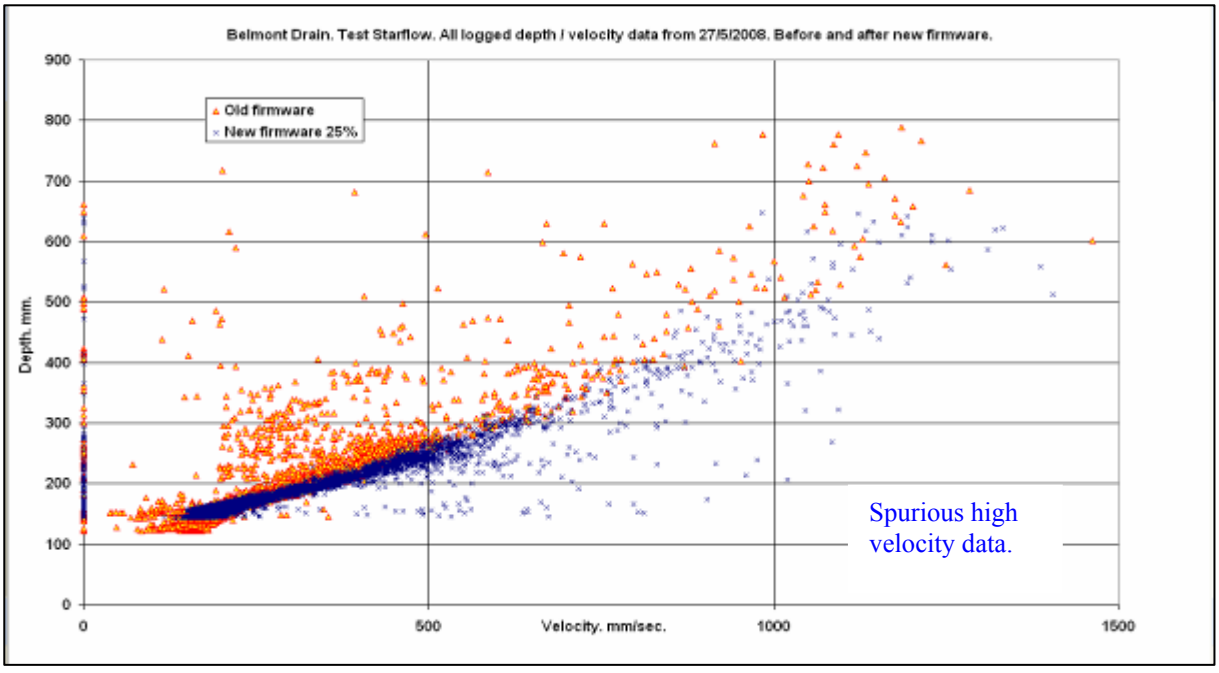
4 Firmware settings and issues.

During the initial tests the target quartile for the new firmware was set to 25% from 10/6 to 24/6. It was noted that this resulted in some spurious high velocity data being logged. The target quartile was changed to 50% for the period from 24/6 to 8/7. These changes are shown in the following plot of all data for the period.



The following plot compares the depth / velocity relationship of data points with the old and new firmware to 24/6. Using the 25% quartile setting the new firmware generates some scattered and spurious high velocity data. This occurs when the algorithm is focussed too far onto the high velocity end of the signal spectrum.



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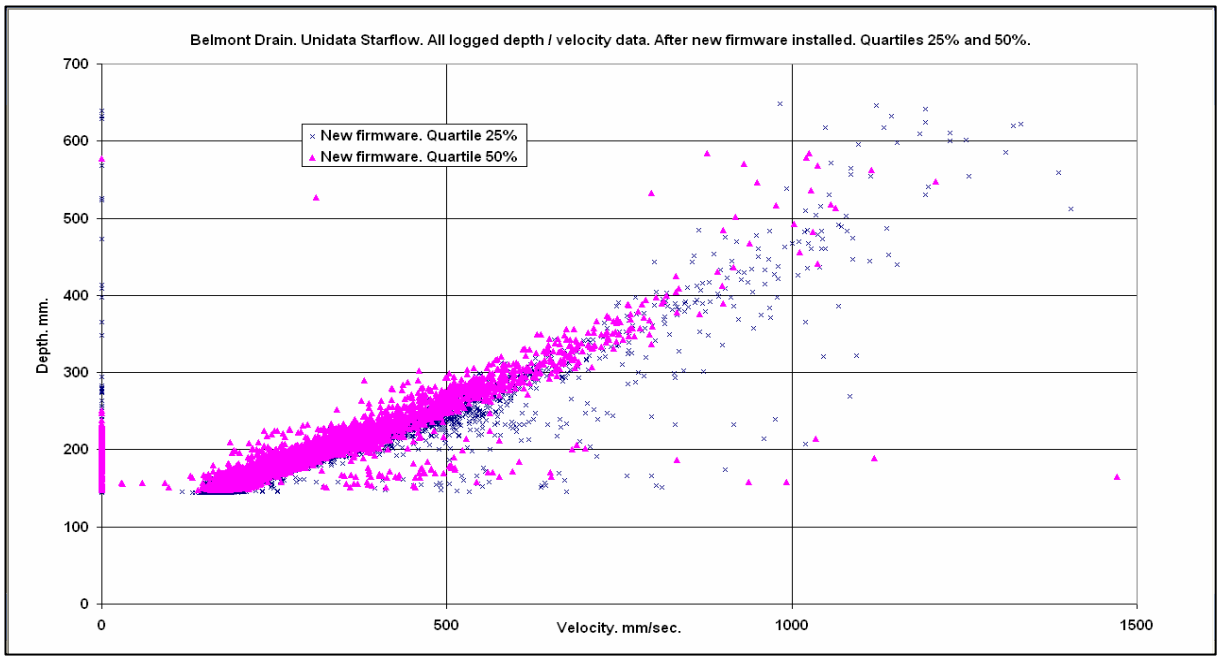
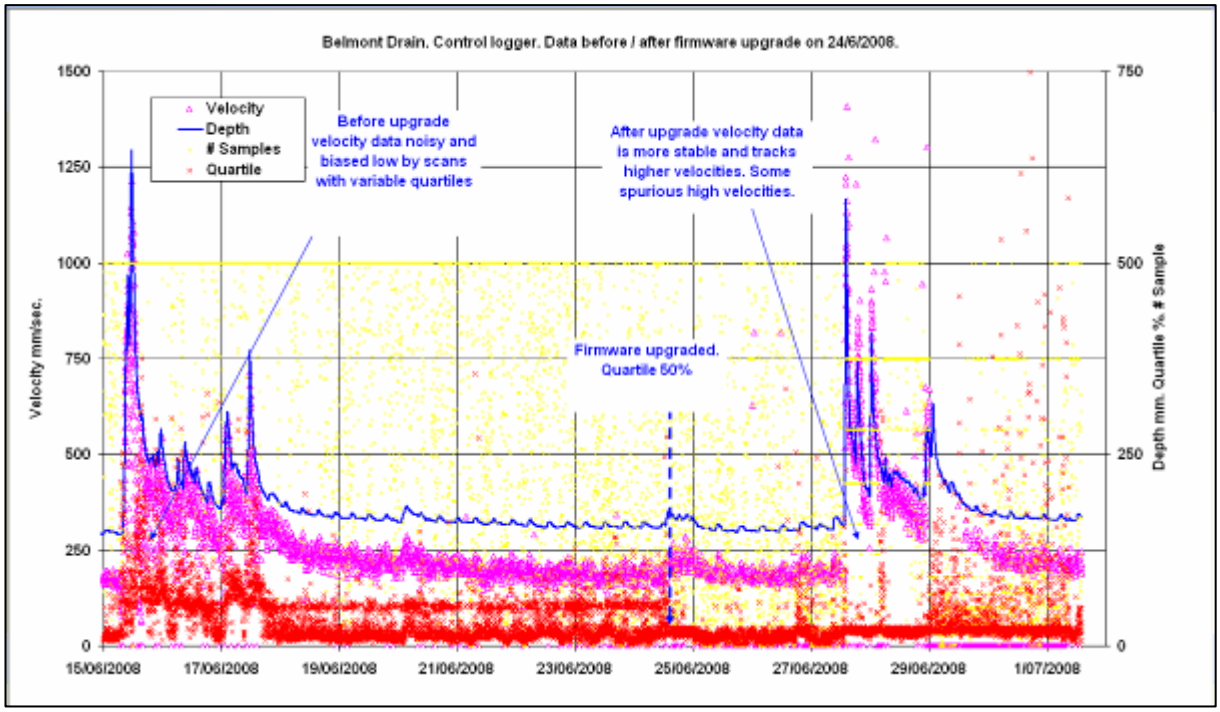
On 24/6/2008 the quartile was adjusted to 50%. The following plot shows the depth / velocity relationship of the data recorded with both the 25% and 50% quartile. The 50% quartile setting generally reduced the scattered high velocity spiking, except for a period where a debris blockage at low flow caused some signal distortion.



5. Control Logger. Firmware upgrade.

The control logger was upgraded to the new firmware on 24/6/2008. The following plot shows the effect on the velocity data was a significant improvement of the quality of all velocity data, and particularly of higher velocities.



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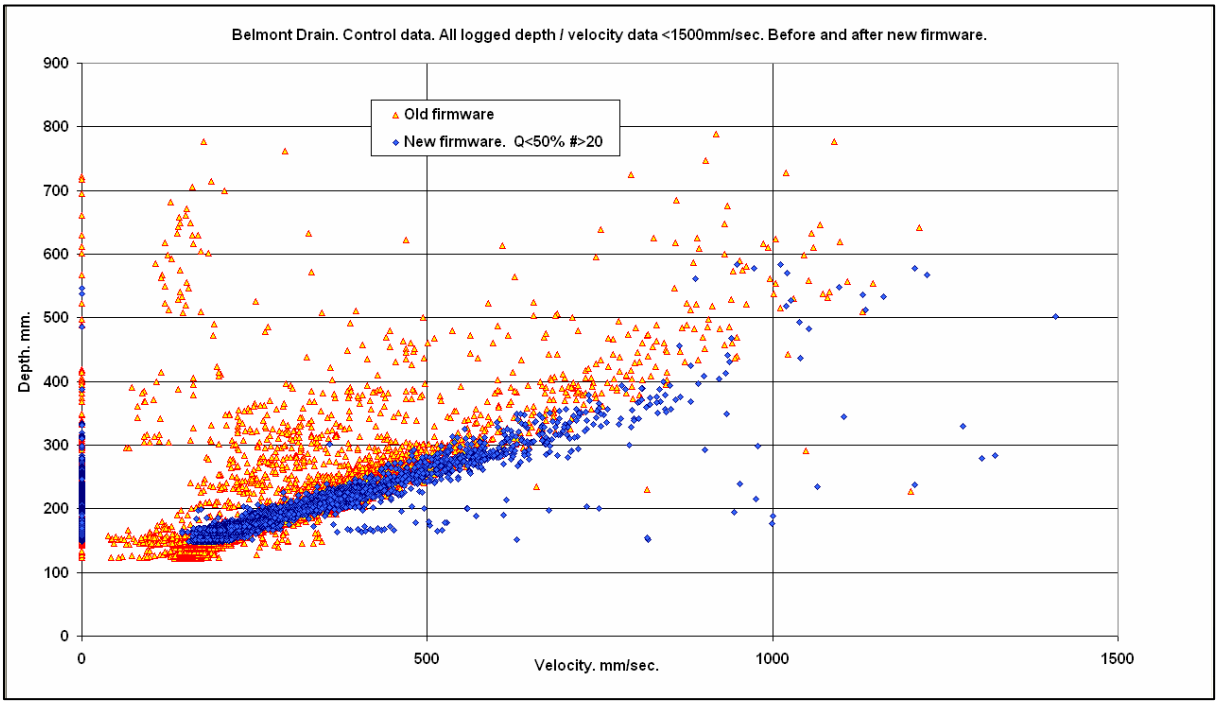
The following plot of all data from the control logger the shows the relationship between depth and velocity, before and after the firmware upgrade. The new firmware significantly improves the integrity of the velocity within the normal velocity range of the site.



7. Summary.

This report concludes the field trial of the new Starflow firmware at the Belmont Drain site. The two Starflows that were used in these tests worked well and continuous data was recorded for the full period. The initial data with both Starflows running the original firmware produced velocity data typical of the intermittent poor quality seen at this and other sites.

The “test” Starflow was then upgraded to the new firmware and operated for 2-weeks alongside the conventional control Starflow. During this period a wide range of flow conditions were measured. The new firmware resulted in a significant improvement in the quality of the velocity data under all conditions.

The new firmware uses quartile driven processing and users can select the target quartile. The best results were found with a 50% quartile setting, consistent with the results of previous tests. Targeting a 25% quartile caused the logging of spurious high velocity data under some conditions.

For the last two weeks of the test the new firmware was loaded into the control Starflow and both Starflows were now running the new firmware. This significantly improved the quality of the velocity data logged by this instrument and both instruments logged similar, good quality data.

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8. Conclusions and recommendations.

The new firmware appears to work as specified under the test conditions of a natural stream with velocities in the range of 150 to 1200mm/second. It makes no difference to the processing of good quality velocity measurements. It successfully reprocesses most poor quality measurements to remove the effects of spurious low velocities.

The new firmware significantly improves the quality of the velocity data from the sites where it has been tested. Using the recommended Quartile of 50% and a minimum sample size of 20 has made a large difference in the velocity integrity from this site. Similar good results have been obtained from a second test site.

Waterdata recommends that the new firmware should be used at all sites to overcome the deficiencies of the present instrument under some velocity conditions.

Ian Tite.
Consultant Hydrographer,
Waterdata Consultants Pty Ltd.
31/7/2008.