Seaport tide gauge calibration report

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Executive summary

A tide gauge was installed 28 June 2014 by University of Tasmania PhD candidate Ian Kidd at the Seaport Marina, Launceston, Tasmania. The gauge consists of two pressure data loggers, one (WL5) installed in the base of a steel stilling well measuring total pressure, the other (B2) mounted in the top of the well measuring barometric pressure. Data was logged at 60-minute intervals and uploaded monthly, except for two periods when the stilling well sustained damage. On 27 February 2018 the loggers were removed and tested to assess for sensor drift, and accuracy of the installation. The two loggers and a third identical logger (WL4) were tested in water at depth and in air. The test results suggested the WL4 logger required correction due to drift of -0.013m, and that the stilling well installation of B2 resulted in less sensitive and exaggerated pressure measurements equal to an error of -0.015m. As a result, the stilling well was modified to increase top ventilation, and the barometric logger was installed in a separate housing, completed 28 February 2018. Comparison of tide levels measured pre and post modification with a nearby gauge at Tamar Street Bridge show that the new installation improved accuracy.

1. Introduction

1.1 Purpose

To address a lack of available tide data for the Tamar River estuary, University of Tasmania PhD candidate Ian Kidd installed a gauge on a pile at the Seaport Marina on 28 June 2014. After PhD completion, management of the gauge was passed to this author in November 2017. During February 2018, four gauges were deployed throughout the estuary for an undergraduate final year research project, and the Seaport gauge re-deployed to match the needs of the study. This report details the calibration undertaken to check the performance of the Seaport gauge.

1.2 The sensors

Three loggers were used in the calibration:

1. WL4: HOBO U20L polypropylene pressure logger borrowed from Jenny Davis of Charles Darwin University, deployed in PVC stilling well under water at Tamar Island
2. WL5: HOBO U20L polypropylene pressure logger from Seaport gauge, installed in steel stilling well under water
3. B2: HOBO U20L polypropylene pressure logger from Seaport gauge, installed in steel stilling well above water

1.3 Location

The Seaport tide gauge is located at the marina pier C, located at the mouth of the North Esk River into the Tamar River estuary (fig. 1). The map grid reference for the Seaport gauge is GDA95 MGA55 511019E/5413136N.

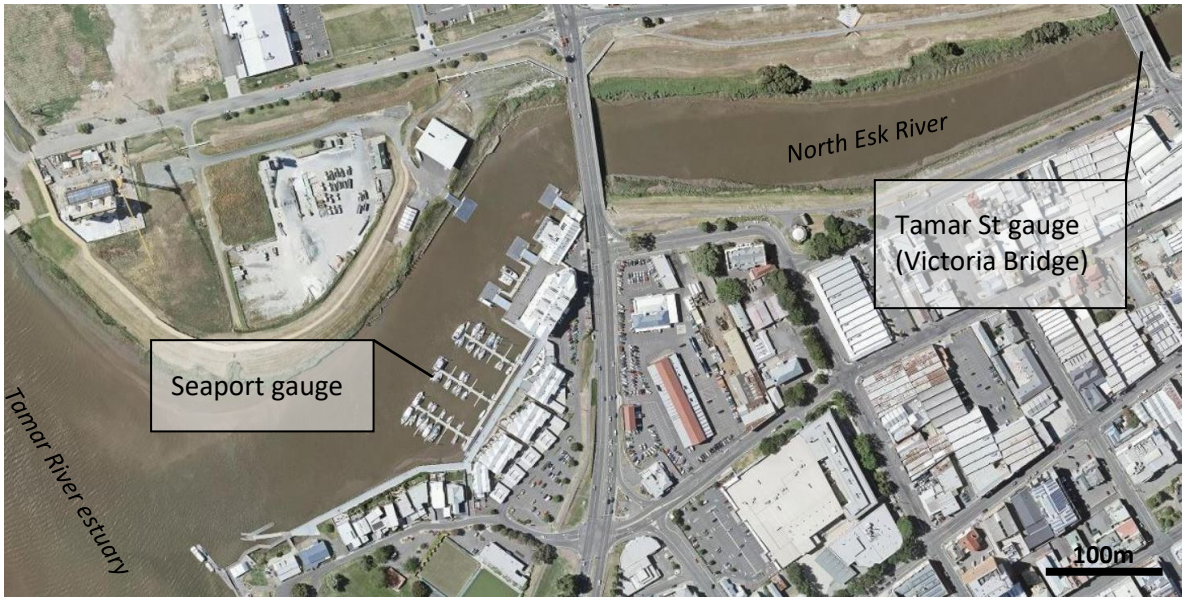

Figure 1. Seaport tide gauge location (https://maps.thelist.tas.gov.au/listmap/app/list/map)

2. Methods

2.1 Depth test

Loggers WL4 and WL5 were tested by attaching both to an angle plate suspended on steel cables to a flotation canister and lowering to fixed depths of 1m and 2m in fresh water at Trevallyn Dam (fig 2). B2 was suspended from a nearby tree to correct for atmospheric pressure. Prior to depth changes, loggers were tested for time taken to adjust to water temperature.

Figure 2. Left – depth test rig, flotation canister from PVC pipe connected with steel cables to a steel plate which is lowered to marked depths on the cables and held with clamps. Right – The rig in water, loggers were programmed to record at 5-min intervals for the temperature test, and 1-min intervals for the depth test.

2.2 Air test

B2 installation was simulated by placing WL4 in the PVC insert in the top section of the stilling well, which was submerged in a bucket of water (fig. 2). B2 and WL5 were suspended in air at the same approximate height. The test was run from 6pm to 7am to test over a larger temperature range.

Figure 3. Air test set up

2.3 Comparison with nearby gauge

A remote tide gauge is managed by TasWater at Tamar Street Bridge, approx. 750m from the Seaport installation. Tamar St data was provided by the data manager, Entura, with permission from the data owner, Launceston City Council, for the period 1 January – 28 May 2018. Tide levels were compared between Seaport and Tamar St gauges before the test (1 January – 27 February) and after the testing and modifications (28 February – 28 May 2018). The Tamar St data were corrected for an error in daylight savings adjustment from 2:00am 2 April – 28 May 2018 (fig. 4).

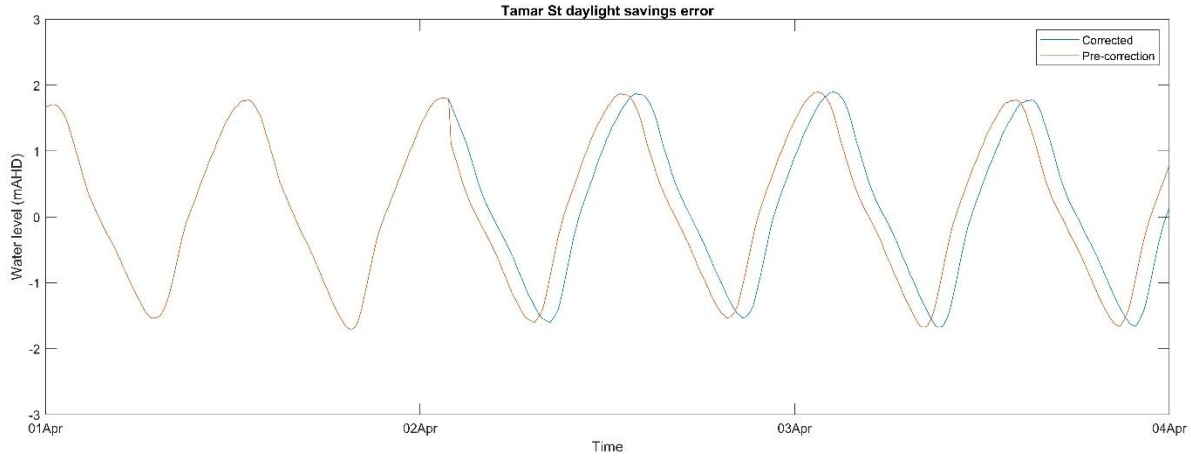

Figure 4. Plot showing the error in Tamar St data coinciding at the end of daylight savings and equal to one hour

3. Results

3.1 Depth test results

The water test for temperature confirmed that 30 minutes is an appropriate wait period for loggers to adjust to the water temperature (fig. 5), as advised in the HOBO user manuals.

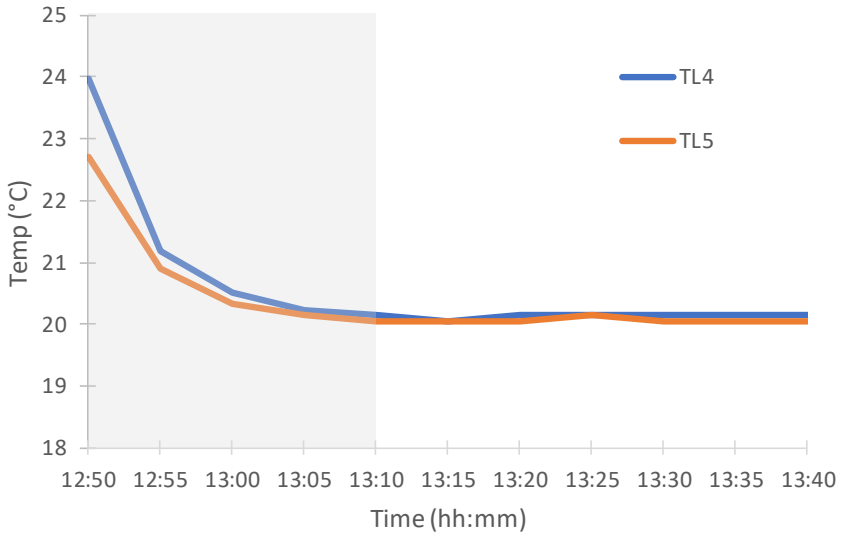

Figure 5. Temperature adjustment period of 30 minutes is justified

The depth test recorded two measurements each at 1m and 2m depth (fig. 6).

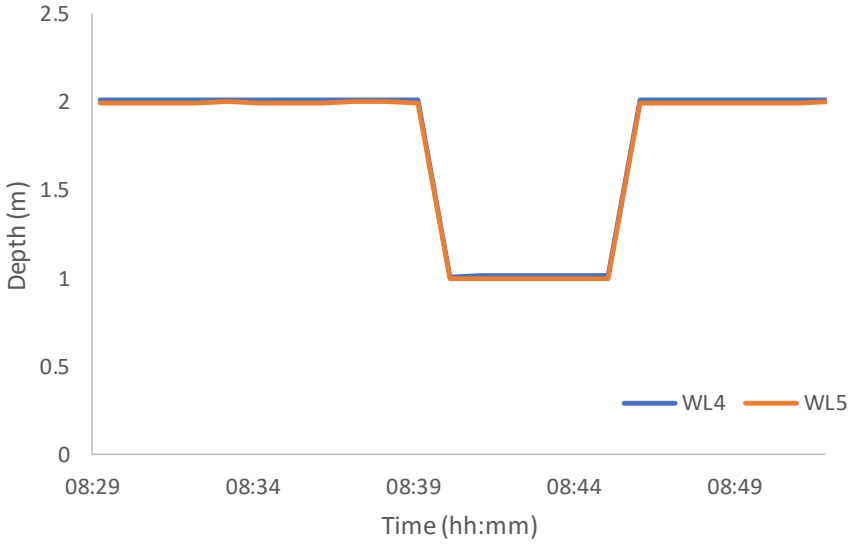

Figure 6. WL4 and WL5 lowered to 1m and 2m depths in the depth test

Analysis of WL4 and WL5 performance showed WL5 to be measuring accurately, but WL4 measurements to have a mean error of +0.013m (fig. 7). This was assumed to represent sensor drift, common with aging loggers. This error can be corrected in post-processing of data, or by ongoing water level depth calibration.

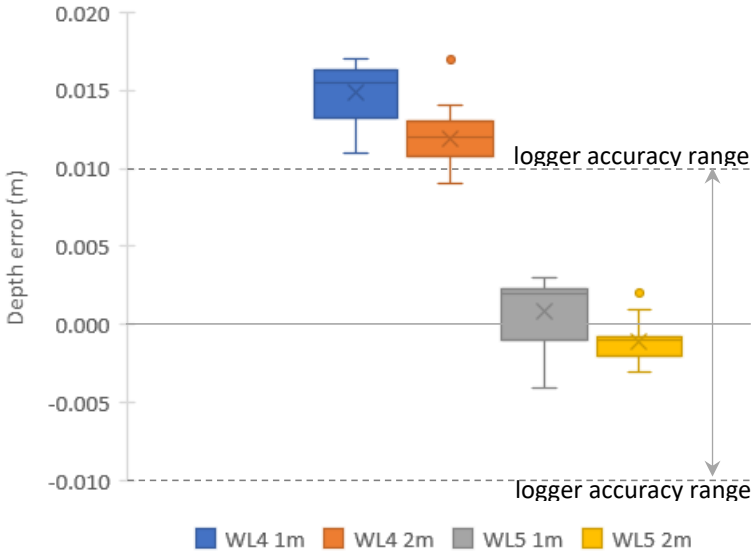

Figure 7. Box plot showing logger accuracy outside of factory specified tolerance of +/-0.010m for WL4, but WL5 well within.

3.2 Air test results

Comparing the installation of the WL4 logger in the stilling well with WL5 in open air, a calibration was applied to WL4 equivalent to -0.132kPa to account for the sensor drift found from the water test. Even with the correction, atmospheric pressure measured in the stilling well installation was higher than in open air, and more stable (fig. 8). This suggested that the installation itself exerted pressure on the logger, and reduced sensitivity to variation in atmospheric pressure.

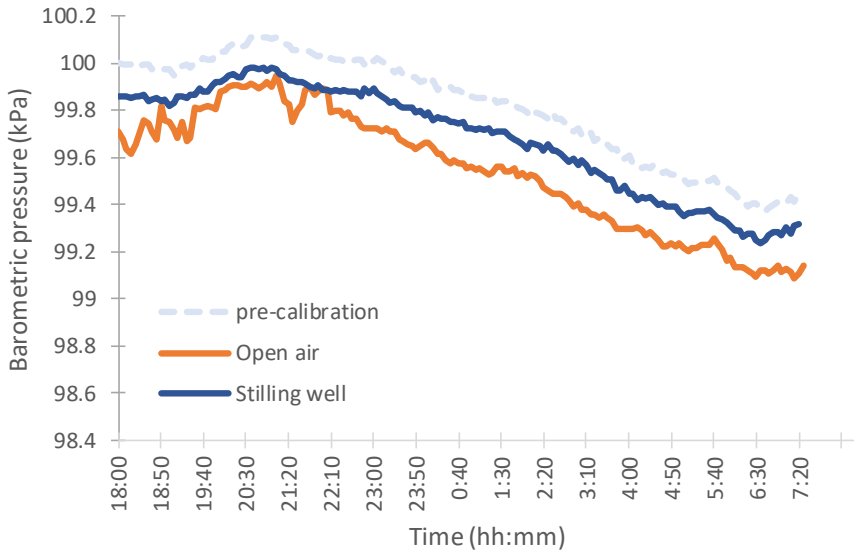

Figure 8. Results from the air test suggest the stilling well measurements may be inflated, and less sensitive to fluctuations in atmospheric pressure. Calibration for sensor drift in WL4 shown.

From these results, the installation was modified, as descibed in section 4.

3.3 Results of Tamar St comparison

Increasing the logging rate to 5 minute intervals would be expected to improve the similarity between the two tide gauges. It can be seen from fig. 9 that prior to modifications, the Seaport gauge results showed consistently lower high tides (~-0.015m), whereas low tides were close to equal, suggesting a scaling error rather than error from larger logging intervals. The data from the Seaport gauge after modifications matches the Tamar St data extremely well. Since the Tamar St gauge is not a pressure sensor type, recording tide levels instead by ultrasonic sensor at random intervals, and the data were measured and calibrated independently, this comparison provides good confidence for the accuracy of not just Seaport but also the Tamar St gauge.

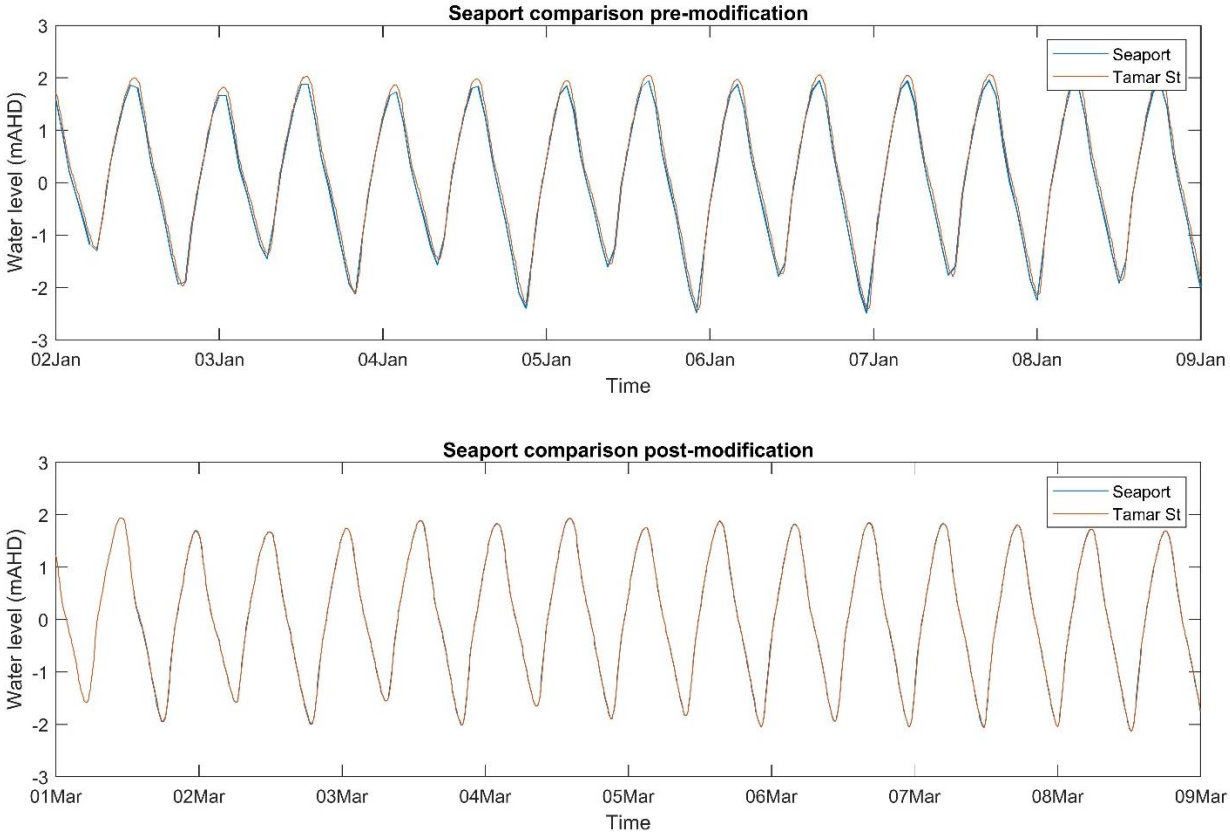

Figure 9. Comparing Seaport tide data before and after modifications with a nearby gauge at Tamar St Bridge

4. Modifications

Figure 10. Re-deployed tide gauge at Seaport Marina

From these results, the tide data calibration method was reviewed to ensure WL4 sensor drift was not a source of error. Each month at a time coinciding with a logger recording, the water level is read off a tide board at Tamar Island where WL4 was deployed, referenced to the Australian Height Datum (AHD83). Therefore, the logger does not provide the actual depth but a relative depth to a known datum.

The installation of the Seaport gauge was modified by removing the B2 logger from the stilling well (fig. 10) and suspending in a separate vented PVC housing (fig. 11). The stilling well was capped with a PVC cap and ventilation holes drilled in the top section (fig. 11). The Seaport data are adjusted to a reference water level during post processing, rather than measured as depth by the logger itself. The depth of the stilling well base was measured at -2.521m AHD, but the reference depth according to water level measured against height datum is -2.505m AHD. The same correction (2.505m) was applied during post-processing of both Seaport datasets before and after modifications.

Figure 11. Seaport Marina showing locations of water level and barometric pressure loggers

Figure 12. Left - PVC housing for B2 logger fixed to boardwalk structure out of sight. Right – modified stilling well setup, the WL5 logger is attached to the same Kevlar line, long enough to allow logger to rest on stilling well base, with galvanised chain fixed to PVC end cap, and ventilation holes drilled in top of stilling well pipe.

Data from the Seaport tide gauge are freely available at:

http://metadata.imas.utas.edu.au/geonetwork/srv/eng/metadata.show?id=488&currTab=advanced