Hydrometric System to improve flood warning in the Sarakata catchment

2023

Vanuatu Meteorology and Geo-Hazards Department

GREEN CLIMATE FUND

SPREP PROE

NIWA
Taihoro Nukurangi

Supply, installation and commissioning of a hydrometric system to improve flood warning systems in Vanuatu

Project final report - Contract deliverables 2, 3, 4

Prepared for SPREP Climate Information Services for Resilient Development in Vanuatu (CISRDP) - Vanuatu Klaemet Informesen blong Redy, Adapt mo Protekt (Van KIRAP), on behalf of Vanuatu DoWR

December 2023

Climate, Freshwater & Ocean Science

Prepared by:
Graham Elley, Evan Baddock, Tony Hill

For any information regarding this report please contact:

Evan Baddock
Principal Technician - Environmental Monitoring
Environmental Information
+64 3 471 7762
evan.baddock@niwa.co.nz

National Institute of Water & Atmospheric Research Ltd
PO Box 8602
Riccarton
Christchurch 8440

Phone +64 3 348 8987

NIWA CLIENT REPORT No: 2023364EI
Report date: December 2023
NIWA Project: SPR24901

Revision	Description	Date
Version 1.0	Final version sent to client	20 December 2023

Quality Assurance Statement		
	Reviewed by:	Charles Pearson
	Formatting checked by:	Rachel Wright
	Approved for release by:	Charles Pearson

Contents

Figures

1 Project Background

Vanuatu is among the most vulnerable countries on Earth to increasing impacts of climate change, including climate-related natural disasters and the effects of slow-onset events such as sea-level rise and ocean acidification. As the effects of global warming manifest and the hazards of climate change arise at accelerating rates, there is a need to shift the paradigm towards the standardised and mainstreamed use of science-based climate information, at multiple timescales, to support resilient development pathways.

The 'Climate Information Services for Resilient Development in Vanuatu' (**known locally as Van-KIRAP – *Vanuatu Klaemet Infomesen blong Redy, adapt mo Protekt***) project is supporting this paradigm shift through the strengthening and application of **Climate Information Services (CIS)** in five targeted development sectors: tourism; agriculture; infrastructure; water; and fisheries. The Project is funded by the Green Climate Fund (GCF) and managed by the Secretariat of the Pacific Regional Environment Programme (SPREP)

The project aims to address information gaps and the priority needs of target beneficiaries, at national, provincial, and local community levels, across the five priority sectors, through four core components:

1. Strengthening the Vanuatu Meteorology and Geo-hazards Department (VMGD) platform to provide quality climate data and information for CIS.
2. Demonstrating the value of CIS at the sectoral and community levels.
3. Developing CIS tools and engaging with stakeholders through outreach and communications.
4. Strengthening the institutional capacity for long-term implementation of CIS in decision-making.

The Project is also expected to deliver and mainstream climate information to the **Department of Water Resources (DoWR) within the Vanuatu Ministry of Lands and Natural Resources.** The Department of Water Resources has co–led the installation of an automatic river gauge, river staff gauges and several groundwater level loggers. There is no active and robust system for the long-term archiving, managing, and analysis of the hydrological data from this new data collection infrastructure. Data management in Vanuatu has previously been reliant upon 'Tideda', a custom software program developed by the National Institute of Water and Atmospheric Research (NIWA) from New Zealand, for processing and archiving of time-dependent data, particularly hydrological data, however this software has not been utilised operationally within DoWR for some time.

As part of the project, NIWA has been invited to:

- restore the structure of DoWR Tideda time series software and related hydrological data processing systems,
- provide operational training to Water Resources Technical Staff,
- and to supply telemetry systems to automate data collection from its groundwater level loggers directly into the restored Tideda hydrological archive.

There were several challenges encountered during the delivery of this project that required some adaptive management to enable the successful completion.

This report follows on from an earlier Project Inception Report during which the proposed work programme was developed and revised with DoWR and SPREP.

The Final Report overviews the outcomes of and in-country work programme, undertaken by NIWA, to address the scope of work for the supply, installation and commissioning of hydrometric monitoring, data management and processing systems, to improve flood warning systems in Vanuatu, including the provision of TIDEDA and hydrometric monitoring training for DoWR staff.

2 Overview of NIWA Project: SPR24901

Provision of consultancy service for the supply, installation, and commissioning of a

hydrometric system to improve flood warning systems in Vanuatu.

Project Objectives:

The key objectives identified for the project included:

1. Establish online operation of the **DoWR TIDEDA hydrological server** to enable visualisation, retrieval and automated reporting of surface and ground water data.

2. **Supply, install and commission of telemetry equipment** for the Van KIRAP groundwater monitoring network in Luganville, Santo.

3. Provide a **10-day TIDEDA software training** course, manuals as well as field and office procedures for the DoWR and VMGD technical staff.

Project achievements (deliverables):

1. The installation and commissioning of the **upgraded DoWR TIDEDA system**, and its integration with the NEON telemetry system (as used by VMGD), was completed by Mr Tony Hill, a senior NIWA Environmental Information technicianThe results of this work are overviewed in **Appendix B.**

2. Due to customs clearance problems with freight into Port Vila, the arrival of the new monitoring equipment into Santo for the **planned groundwater installation work** around Luganville, was delayed. With NIWA staff programmed to be in Santo, they adapted the planned work programme and continued to prepare all Luganville groundwater sites, concreting equipment mounting post, adding new groundwater well head adaptors, in preparation for the equipment installation when it did arrive.

While awaiting the equipment arrival, as well as the groundwater site preparations, time was spent reviewing the nearby SPREP funded Sarakata Water Level station, further up the Sarakata catchment, including clearing of the site that had quickly become overgrown.

The Sarakata river site had recently stopped communicating when Campbell Scientific staff attempted a remote update of the logger Operating System. The new OS was corrupt and stopped the datalogger program, also making it difficult to connect directly to the logger. Eventually the logger was removed and returned to Port Vila for repair, and from where a spare was available. The spare was installed in a later trip. (Note: these spares should be stored in Luganville DoWR to enable rapid response to any additional system outages).

Following a further delay with the freight clearance, and arrival of bad weather, NIWA staff decided to return to Port Vila to begin the training component, by which time the equipment had been cleared and relocated to the DoWR Port Vila office.

To provide DoWR users with the equipment training that was intended during the Luganville installation all four sites were set up in the DoWR office, powered, and tested with Vodafone SIM cards, and the loggers initialised to simulate the installed systems. The loggers were left on test over the week during which we identified unreliable network performance and irregular data downloads, using the Vodafone network. An upside of the extended testing was that DoWR staff could practice connecting and communicating with the data loggers as part of their hands on training.

To advance the work programme, a plane was chartered by SPREP to return NIWA staff to Espirito Santo for a day trip to install two of the four Groundwater stations and to complete replacement of the datalogger at the Sarakata River station. This trip was completed on 1 November, and all three sites were installed, commissioned, and successfully communicated with the NEON network and transferred data to the DoWR TIDEDA archive.

The remaining two groundwater sites are scheduled to be installed by the DoWR team, with remote assistance provided by NIWA, as required. DoWR have indicated that this should happen in the next few weeks, along with testing of new Digicel SIM card to improve site communications. The SIM exchange has since been completed and remote communications has proven reliable on Digicel's network.

The 10-day Tideda field and office training course started on schedule on Monday 23 October 2023. Severe weather was forecast, so we further adapted the original programme to carry out the field exercises on the first day of training, and visited the La Colle flow site, located behind the airport, and completed a site inspection, sensor exchange exercise and completed training in flow gauging.

The field programme ran as planned until the **Cyclone Lola lockdown occurred** on the Tuesday afternoon through to Wednesday, preventing further training work. We resumed training on Thursday with a revised programme, to make sure all the basic features of the Tideda and TDGauge and telemetry software were covered.

The following week we revisited the TIDEDA training with further exercises using DoWR data (Teouma Site), including, data editing, graphing, archiving etc. On the final day we covered the basics of site flow rating development and the generation of flows using Tideda. This included several hands-on exercises, which staff indicated they enjoyed.

Because of the numerous challenges encountered during the project, our staff had to be adaptive with the delivery of the program, but overall, managed to complete the training programme, as identified in the inception meetings, on the operation and management and use of DoWR Tideda hydrometric software, data processing and archiving, field hydrology operations, and NEON telemetry integration, completing the program, albeit on a tighter schedule.

As well as the one-on-one training, DoWR were provided with copies of all training material, PowerPoints, manuals, forms, and draft Standard Operating Procedures for DoWR later use. These were all copied to the new DoWR Virtual Server for reference by all staff.

Copies of all photos and video from the three weeks of training were also copied here. Example data processing Registers for Water Level, Rainfall and Gaugings were all created and archived on the server.

Several customised operational procedures were created and are stored on drives on the DoWR hydrology Virtual Machine server:

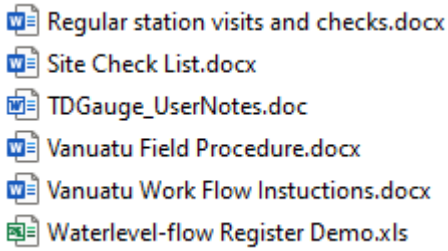


Figure 2-1: Operational procedures created on the DoWR hydrology Virtual machine server.

Appendix A Summary of Training Programme and Achievements

Week 1:

- Mr Tony Hill, Mr Evan Baddock, Mr Graham Timpany (NIWA team) arrived in Vanuatu from NZ on Saturday 14 October 2023.
- Evan and Graham flew to Santo on Sunday 15 Oct and met with DoWR Santo staff.

Monday 16 October – supplies were sourced from hardware stores for installation ground works; all four Groundwater (GW) sites were visited, and site preparations begun. Mounting posts were installed where needed and adaption pipes were cut to suit each existing well head.

Figure A-1: Installing post – Sarakata School.

Figure A-2: Final job, ready for housing & gear.

Tuesday 17 October – The morning was spent in the office of DoWR, organising freight, checking over stored gauging equipment and servicing of this.

- In the afternoon the Sarakata River flow site was visited for flow gauging training. The river was too high following recent rain and so training was not possible. Site inspection training was completed.

Wednesday 18 October – Morning visit to Sarakata site with keys and cables to connect to logger – found site in good condition, power fine, but there was an issue with the data logger. It was resolved that this had stopped when Campbell Scientific attempted an Operating System upgrade over the telemetry system, and this corrupted the logger.

- Campbell Scientific was consulted from the site, and we tried everything Campbell could suggest to resolve the connection issue. A new program was provided but still had similar issues, so the logger was removed to Port Vila for testing and if required to be replaced with a spare logger there. Campbell staff were updated. Sarakata site is shown in Figures 3 and 4.

Figure A-3: Left image: Sarakata site enclosure. Right image: Logger/Sensor enclosure & testing.

Thursday 19 October – Reviewed progress in the morning and returned to Port Vila in the afternoon.

Friday 20 October – Two Sarakata Campbell loggers were tested, and new OS and programs were installed.

- We set up all 4 Luganville GW sites on the bench with DoWR staff, installed SIM cards and established configurations. We got these online with sensors connected and demonstrated this as part of equipment training for staff.

Figure A-4: Four groundwater sites on test at the DoWR office Port Vila. .

Week 2:

Monday 23 October – Severe weather was forecast, and the training programme was rearranged to provide field training before the weather arrived. We visited the DoWR La Colle river flow site out behind the airport.
The training included:

- Typical site inspection, filling out the recorder logbook, making observations.
- Removal of faulty PumpPro with a spare found in the office, however this didn't work so we put the other back in. This worked for about an hour and gave us good stage readings which we could relate to the staff gauge and offset. It failed again after this. A new replacement arrived in Vila, to be installed on Mon/Tue the following week.
- Checking and reading the Staff Gauge and bubbler orifice – measured the offset of the orifice to the ESG (electronic staff gauge). We looked at maintenance required, with a new staff gauge plate needed.
- We discussed the site location in the river reach, good and bad characteristics, where the site Controls were and how stable and sensitive these are (and other hydraulic features).
- We reviewed the gauging equipment and how to prepare it for the measurement.
- We discussed the best gauging location, looked up and downstream and then carried out a Current Meter gauging with all involved (2.25 m^3/s flow was measured).
- We photographed the training.

Figure A-1: Left image: Sarakata Water Level Site. Right image: Gauging exercise – small Ott current meter.

Tuesday 24 October – The Tideda office training was started on Tuesday morning with an introduction to Tideda and related software, with an overview of recommended office practices and the forms/registers required for data processing. Copies of training material were provided to DoWR.

- Due to the arrival of Cyclone Lola, the DoWR office was locked down at 2pm and we ended training for the day.

Wednesday 25 October – Port Vila was in lockdown for the day, no training was possible (further exercises were developed using the DoWR data).

Thursday 26 October –Tideda training resumed, including:

- **Data filing systems**, recommended Tideda file structures for DoWR use, accessing these (some issues with slow connections to server).
- **Graphing and Table (list)** options – hands on exercises were completed.

- **Copying data** and creating own files.
- Setting up trainee's own **registers for Water Level data**.
- **TDGauge introduction** and use – we entered the gauging from the Monday field trip.


Figure A-2: Tideda training.

Friday 27 October – Further Tideda training and fault-finding Campbell logger issues were carried out:

- **Moving data** around, checking and updating.
- **Using NEON telemetry for data checking.**
- Adding new user/pw allocated to key staff.
- Looking at the **Site Comments with Tideda**, with examples.
- **Importing data to Tideda** – hands on exercise by all.
- The Spare Campbell logger and cabling arrived, we spent the afternoon fault finding on the 2 loggers, resetting them with new OS and loaded new NIWA program (to allow remote telemetry access). Campbell Scientific provided assistance to reset the faulty logger. This required rolling back to the previous OS version– both loggers were repaired and programmed and are available for the Sarakata site.

Week 3:

Monday 30 October:

- Data processing from DoWR field data sheets was continued to update/archiving of data.
- The basics to Tideda were reinforced using DoWR river data that were loaded into Tideda.
- Hands on training on the use of Campbell equipment was provided, using CSI software to communicate and monitor equipment (using trainee laptops).
- Starlog NEON support software and hands on training using the 4x GW sites under test in the building was provided.

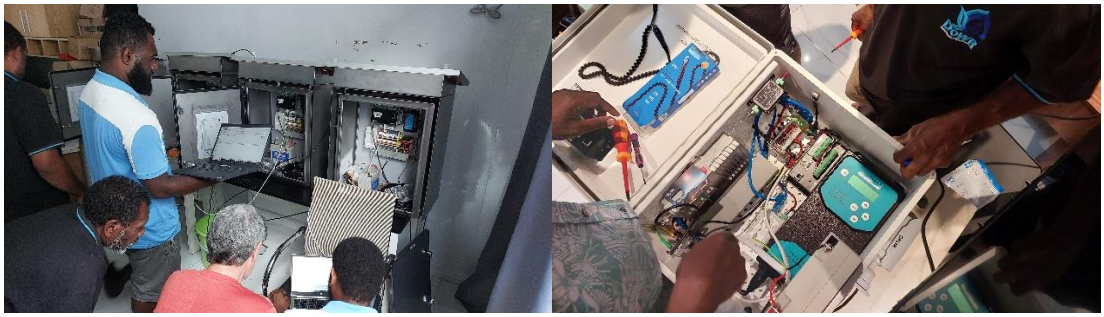


Figure A-1: Left image: Using Starlog software to test GW sites. Right image: Practice replacing the Campbell logger.

Tuesday 31 October:

- Examples of Station History forms and their use were provided, filling these out and the importance of them to provide site metadata (templates and examples provided).
- Finished updating site attributes (site numbers and names in the system including Tideda).
- Reviewed the Neon telemetry system and inspected the new data now coming through to Tideda – daily and weekly checking methods.
- Started training in the development of flow Ratings – PowerPoint presentation and exercise provided with graphing demo data and input to Tideda. Rating changes and Quality Assurance (QA) discussed and how these are handled (more remote help will be needed with this).
- Prepared gear for next day's charter flight and installation.
- Graham Timpany returned to New Zealand earlier the next morning.

Wednesday 1 October:

- Early charter flight back to Santo with 2x GW sites and 5 persons on board.
- Both GW sites were installed and successfully tested, and the Sarakata River site repaired – the new Campbell logger was installed and successfully tested. Data were integrated from the site directly into the NEON telemetry from where they can be automatically transferred into the Tideda archive.


Figure A-2: Left image: Sarakata School install. Right image: Site commissioning..

- We returned to Santo Airport to find the charter plane was called away on a medivac and we may be delayed until next day. Erie and Jonah managed to get Evan back to Vila that night, and they remained in Luganville.

Thursday 2 October:

- Due to Jonah and Charles being left in Santo they missed the training session.
- A demonstration of the procedure for replacement of the La Colle water level sensor was provided, including how to add an offset to the sensor – a video of how to do this was provided.
- Time was spent with DoWR IT on server issues and installing Team Viewer for remote connection with NZ.
- Additional data processing and field documents were provided as procedures for the field team to follow. This included development of a ground water inspection document.
- All photos, videos, presentations, forms, and documents were copied to the DoWR virtual server for future reference.
- Before returning Evan to the airport, Hedley (IT) visited the DoWR office to review the river gauging equipment that had previously been provided.

Gauging Equipment on site with DoWR:

Figure A-1: Left image: Bridge gauging crane and winch Right image: Sediment bomb – new.

Figure A-2: Left image: Sediment bomb – new Right image: Gauging weight (34kg) – new.

Additional work:

- Complete trial of the alternative Digicel Sim card to improve communications – **already actioned**.
- Arrange for supply of pricing for a permanent GW Well Dipper for the Luganville office – **already actioned**.
- DoWR to install the final two Groundwater sites as soon as possible, with remote help from NIWA if required.
- Swap out the faulty PumpPro at the La Colle site with the new replacement – **Completed**.
- Add the offset to the PumpPro as shown after checking the staff gauge and sensor readings.

Future recommendations:

- Plan routine site visits to the three river stations and four groundwater stations monthly if possible or at least every quarter.
- Carry out flow gaugings on all occasions, if possible (wading only at present), using NIWA Small Ott or DoWR new Large Ott up in the stores. Gaugings are needed before we can start constructing Ratings for each site and therefore continuous flow via Tideda.
- Use either NEON or Tideda to check telemetry data each morning or at least weekly for any missing record, suspect record, or low voltage issues:
- Future general hydrology training, either through a further local visit or in NZ working alongside a field team or, perhaps both options.
- Yearly 1 week (minimum) follow up Tideda training in-country as more data start to come in and gaugings need rating work.
- Ongoing remote support in all areas as required.
- Purchase of new gauging equipment, starting with a FlowTracker ADV for wading gaugings.
- Introduction to ADCP gauging equipment and training around this.

Example data plots from telemetered groundwater stations

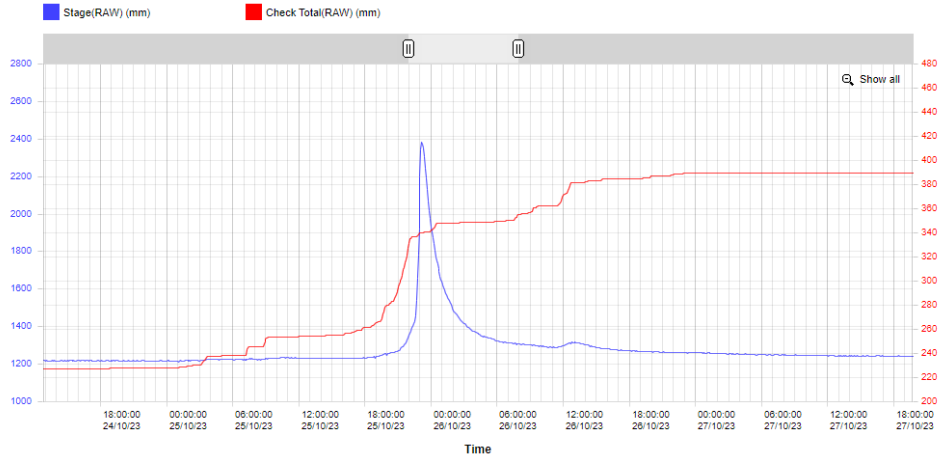


Figure A-1: Teouma River water level vs Rainfall over an event.

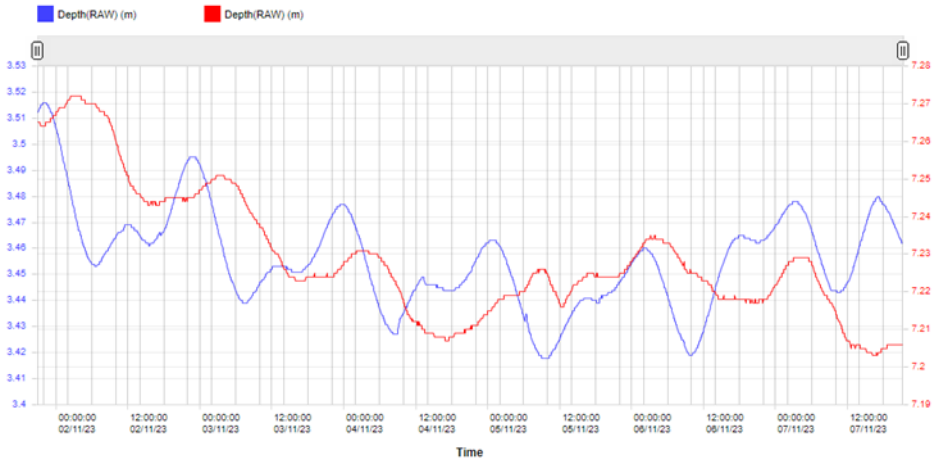


Figure A-2: Sarakata and Pump Station water levels over 1 week..

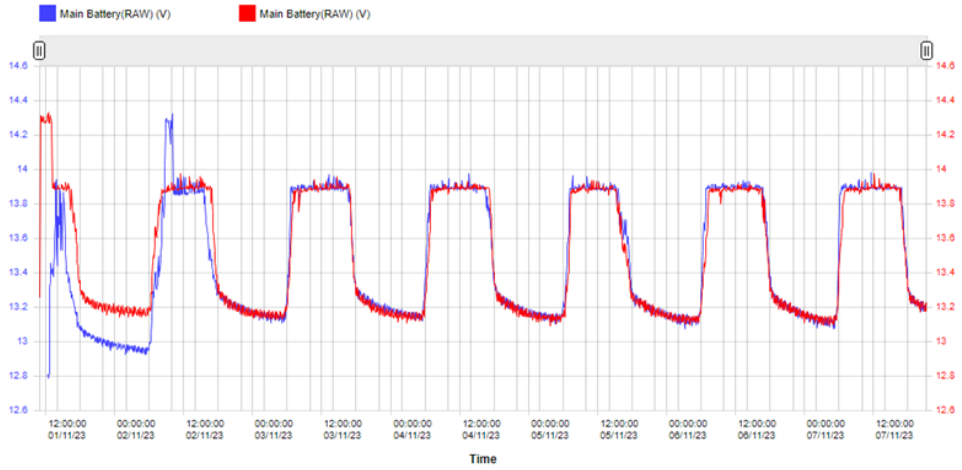


Figure A-3: Sarakata and Pump Station voltages over 1 week....

Appendix B Configuration of Servers and Software for Vanuatu Department of Water Resources Installation and Training Project

This report documents work completed in the Port Vila DoWR office by Tony Hill to configure data management machines, install Tideda and related software, establish remote data transfer from Sarakata River Guage, and prepare the office for the upcoming Tideda and hydrological training course.

1. Hardware Delivered

- Intel NUC mini desktop computer:
  - Model NUC13ANHi5
  - Serial No BTAN32800FXJ
  - Intel i5 processor
  - 16GB RAM (SODIMM)
  - 512 GB NVMe SSD disk
  - Wi-Fi
  - USB Mouse
  - Keyboard and 24-inch monitor have been freighted, but not yet delivered to DoWR (as of 18th October)
  - Windows 11 Pro 64-bit with DVD media and product key
  - Copy of the Windows OS media on USB drive for easy installation

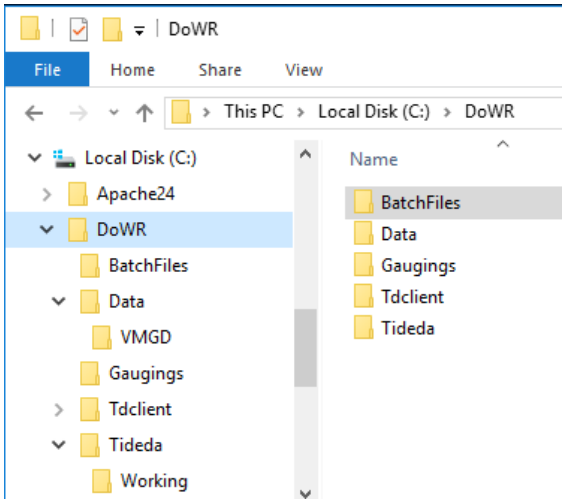
2. Intel NUC configuration

- Windows 11 Pro installed and activated with supplied product key (X3QVK-FNFB2-MG96V-F98J3-XHJXF)
- Local user account “DoWR” is the administrator and is the only user account on this machine.
- Initial password is “Vanuatu2023”, but DoWR may change this if required.
- Network driver installed from Intel download (LAN_I225-Win11-2.1.3.3)
- NIWA Software installed:
  - Tideda version 4.4.17
  - TDGauge version 1.17.1
  - Tdclient (Tideda Tdserver client)
- Other Software installed:
  - Putty 0.79 64 bit (for testing TCP connection to NIWA Tdserver)
  - vcredist_x86 (Visual-C++ run-time. Required by Tideda)
  - Net Framework 3.5 (Required by Tideda)
  - See related section below for installation method.

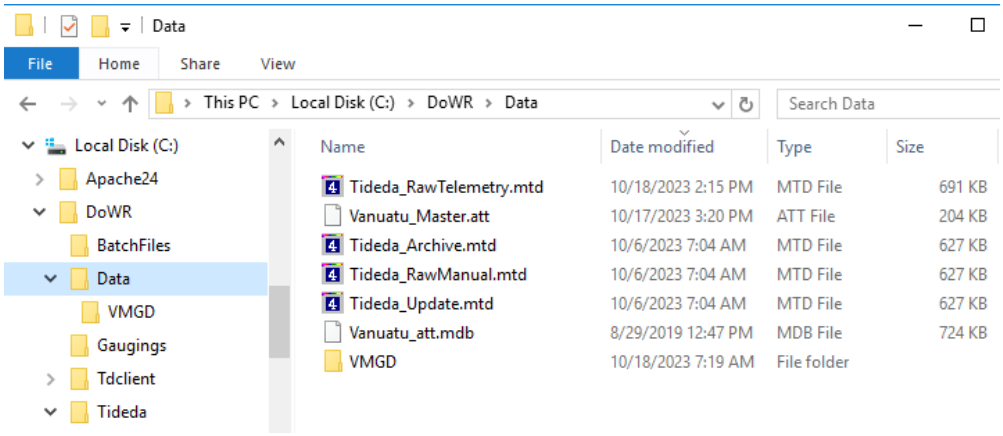
3. DoWR Virtual Server Configuration

- DoWR, IT have decided to use a VM for the initial test operation and we have now configured this as the primary Tideda Server for the DoWR training course.
- IP Address: 10.12.16.65
- Log in with Remote Desktop as Administrator, dowr123
- Windows Server 2016, initially this VM is a minimal single processor with 4GB RAM.
- The same “NIWA” and “Other” software as above are now installed on here. The installers for these are on a USB drive supplied to DoWR for reference and future use.
- Firewall rule created by Govt IT to allow VM server 10.12.16.65 to reach NIWA Tdserver at 202.36.29.65, port 8001.
    - Tested with Putty raw TCP connection. Tdserver connection response show that the firewall rule is sufficient and NIWA is letting the connection reach Tdserver (Success)
    - The DoWR external IP address is 103.7.197.11 (this is the IP Address that TDserver sees when the DoWR client connects to port 8001)
- TDClient on this server is configured to download the data from the NIWA TDServer for one logger on Neon (see “client.cfg”). Other logger sites can be added as they become available.

3.1 Operational folder structure on this server:

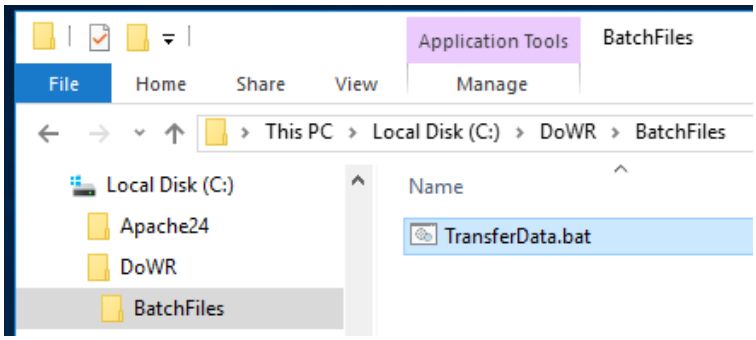


- The “Data” Folder contains the Tideda data files and attribute files:



- On this server the relevant data file is "Tideda_RawTelemetry.mtd." This file receives the Neon logger data from the NIWA Tdserver using the Tdclient software.

- The "BatchFiles" folder contains the "TransferData.bat" file used to run the TDClient command from an hourly scheduled task (in Windows Task Scheduler).

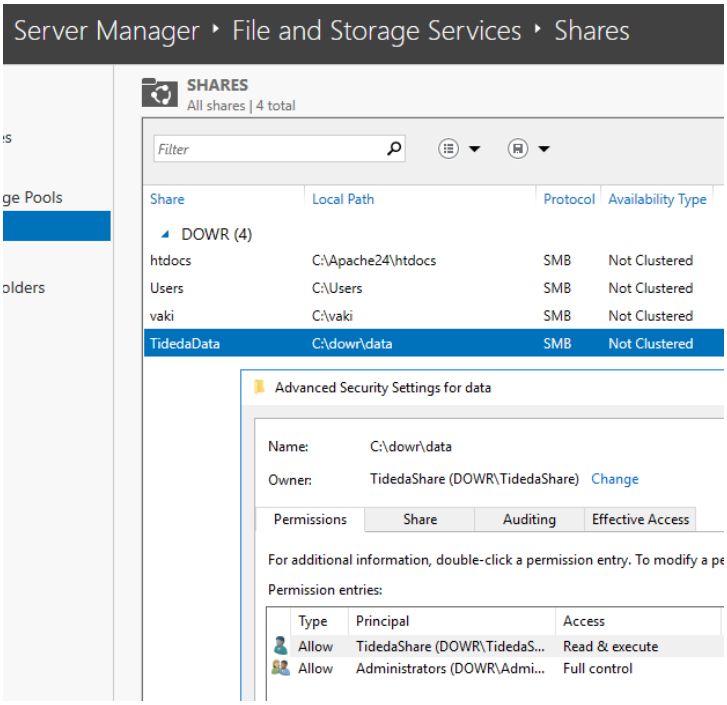


- TransferData.bat includes this command to do the transfer:

19dclient.exe -p 8001 -m 10000 DoWR-from-Neon where:
"-p 8001" directs Tdclient to connect to remote Tdserver TCP port 8001.
"-m 10000" limits the transfer to a maximum of 10,000 data points per transfer.
"*DoWR-from-Neon*" is the section in "client.cfg" that contains the download details (a list of Tideda sites to update).

3.2 Drive share on VM server to allow access to Tideda data files:

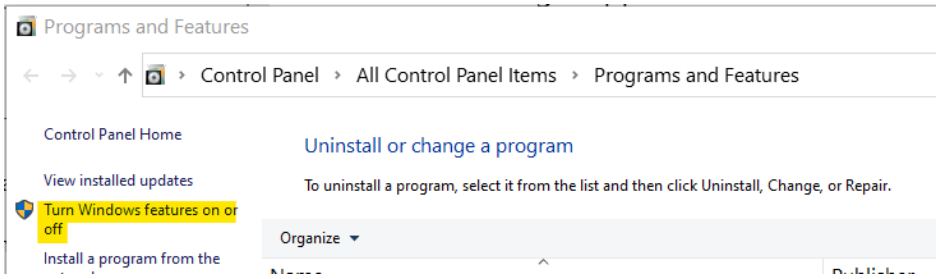
- Created "TidedaData" Drive share on 10.12.16.65
- With new local user account "TidedaShare," password "Tideda2023"



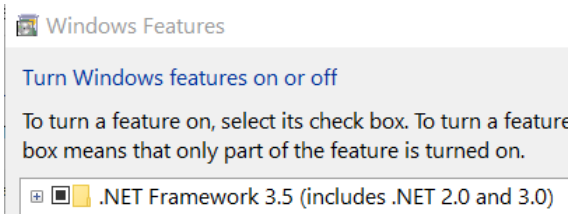
- The share gives read-only access to data under the"\DoWR\Data" folder for now.
- DoWR can review this later and restructure it as required.

4. Microsoft .Net 3.5 Offline installation

On some machines the installation of the Microsoft .Net Framework 3.5 can be done through the Windows configuration of Programs and Features in the Windows Control Panel:



Then



Unfortunately, this is difficult on many machines as it needs access to the Windows OS installation media.

We have now provided a self-contained offline installation method, and this is provided on the NIWA software installation media in the "Net35 Offline Installer" folder.

- This contains the .Net Framework 3.5 installation ".cab" file and a batch file to install this from the local folder using a command line.
- Copy this folder to the local machine and run the batch file in an Administrator Command Prompt (search cmd, open as administrator, Change Dir to the folder where the Install batch file is located).
- The install may take several minutes to complete.

4.1 You can now Install the Tideda and TDGauge Applications:

- Install VCRedist_x86.exe from the Tideda 4.4.17 installation folder.
- Install the Tideda application using "TidedaInstaller" from the Tideda 4.4.17 installation folder.
- Install TDGauge with Software Installers\TDgauge\TDGauge_1.17.1\ TDgauge Installer.

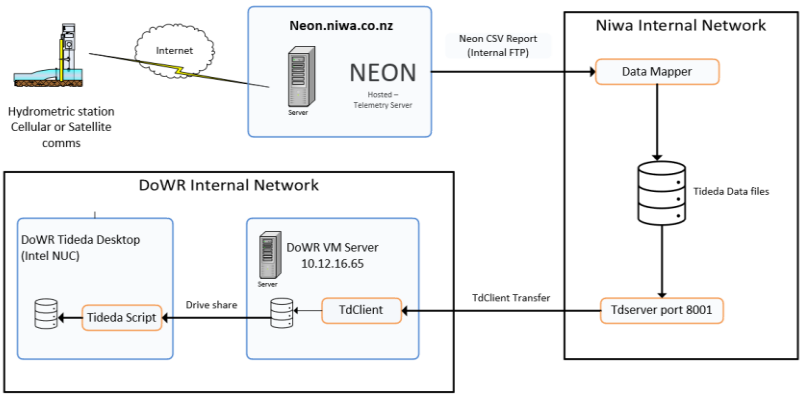
5.0 Neon configuration

5.1 Neon User Accounts

- Jonah's Neon web login (Jonah.Taviti) was activated.
- Jonah is a "Node, TS & User Administrator" for the Vanuatu Department of Water Resources nodes in Neon. This allows configuration of most features for these nodes, including User Admin.

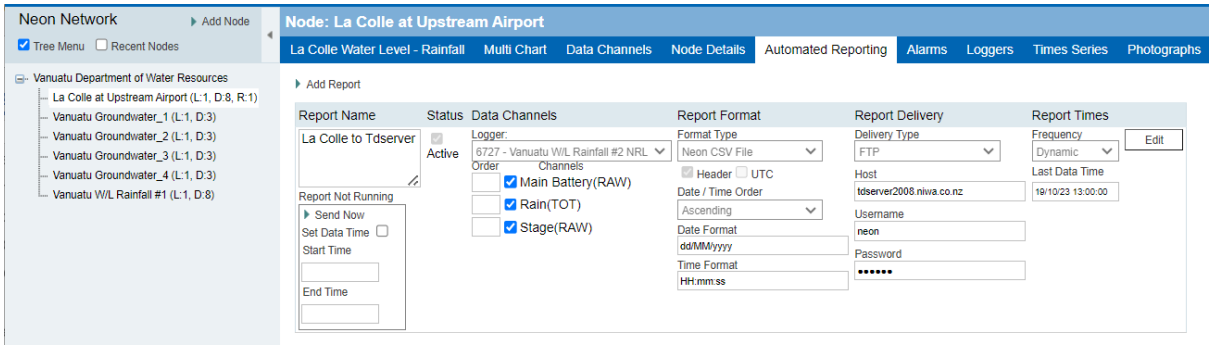
5.2 Neon Report configuration and mapping to Tideda

- Once a field logger is sending data into the NIWA Neon Server a Neon Report to send data updates from the Neon logger channels can be configured.
- Initially this is being configured to map the data into the NIWA Tdserver files where it can be transferred to the DoWR Tideda server using the TDClient utility. This will be the current data path but may change in the future as data transfer technology develops.



DoWR Vanuatu Data Transfer Paths

- Other users can also view the Tideda data directly by connecting to the "TidedaData" Drive share on 10.12.16.65



Example Neon CSV report configuration.

Note that this is something that NIWA Telemetry Support staff would need to be involved in to set up the internal mapping path.

To add a logger to the mappings, we need to know the primary site ID number for the location. This is required for Tideda and Tdserver. It is best to know the Tideda site number before creating the Neon report so the downstream mapping can be completed quickly by NIWA.

6. Outstanding Issues

- Remote support access to VM Server (the server running Tdclient transfers)
  - TeamViewer or AnyDesk to be configured by DoWR.
- Sarakata Campbell station data supply
  - Logger needs to be reinstalled before transfer can be set up.