National Environmental Monitoring Standards

Water Meter Data

Acquisition of Electronic Data from Water Meters for Water Resource Management

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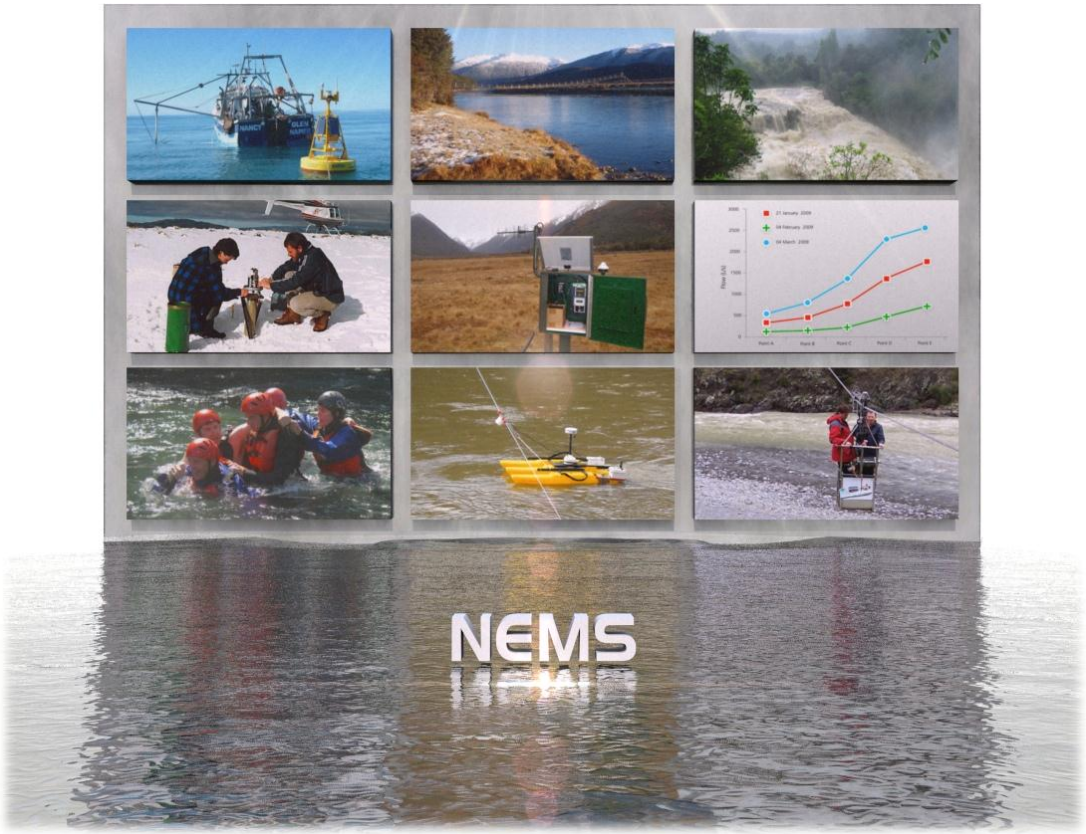

NEMS Standards Documents

The following standards can be found at www.landandwater.co.nz.

- National Quality Coding Schema
- Safe Acquisition of Field Data In and Around Fresh Water
  Code of Practice
- Dissolved Oxygen Recording
  Measurement, Processing and Archiving of Dissolved Oxygen Data
- Open Channel Flow Measurement
  Measurement, Processing and Archiving of Open Channel Flow Data
- Rainfall Recording
  Measurement, Processing and Archiving of Rainfall Intensity Data
- Soil Water Measurement
  Measurement, Processing and Archiving of Soil Water Content Data
- Turbidity Recording
  Measurement, Processing and Archiving of Turbidity Data.
- Water Level Recording
  Measurement, Processing and Archiving of Water Level Data
- Water Meter Data
  Acquisition of Electronic Data from Water Meters for Water Resource Management
- Water Temperature Recording
  Measurement, Processing and Archiving of Water Temperature Data

Limitations

It is assumed that as a minimum the reader of these documents has undertaken industry based training and has a basic understanding of environmental monitoring techniques. Instructions for manufacturer specific instrumentation and methodologies are not included in this document.

The information contained in these NEMS documents relies upon material and data derived from a number of third party sources.

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When implementing these standards, the following act, regulations and code of practice shall be complied with:

- Health and Safety in Employment Act 1992
- Health and Safety in Employment Regulations 1995
- NEMS Safe Acquisition of Field Data In and Around Fresh Water, Code of Practice 2012

National Environmental Monitoring Standards (NEMS)

The National Environmental Monitoring Standards steering group (NEMS) has prepared a series of environmental monitoring standards on authority from the Regional Chief Executive Officers (RCEO) and the Ministry for the Environment (MFE). The strategy that led to the development of these standards was established by Jeff Watson (Chairman) and Rob Christie (Project Director). The implementation of the strategy has been overseen by a steering group consisting of Jeff Watson, Rob Christie, Jochen Schmidt, Martin Doyle, Phil White, Mike Ede, Glenn Ellery, Lian Potter, Lucy Baker, Eddie Stead and David Payne.

The development of these standards involved consultation with regional and unitary councils across New Zealand, electricity generation industry representatives and the National Institute for Water and Atmospheric Research Ltd (NIWA). These agencies are responsible for the majority of hydrological and continuous environmental related measurements within New Zealand. It is recommended that these standards are adopted throughout New Zealand and all data collected be processed and quality coded appropriately.

The lead writer of this document was Evan Baddock of the National Institute of Water and Atmospheric Research Ltd, with workgroup members, Paul Peters (Horizons RC), John Young (Environment Canterbury), Colin Bird (Environment Canterbury), Kelvin Ferguson (Hawkes Bay RC) and Andrew Curtis (Irrigation NZ). The input of NEMS members into the development of this document is gratefully acknowledged; in particular the review undertaken by the NEMS Steering Group and non-technical editing by writer Chris Heath of Heath Research Services.

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- Tasman District Council
- West Coast Regional Council
- Waikato Regional Council

Review

This document will be reviewed by the NEMS steering group in February 2014, and thereafter once every two years.

Signatories

NEMS Project Director	NEMS Chairman	MFE	NIWA	Workgroup Leader

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Definitions

accuracy The degree of closeness of measurement to the actual value.[1] Expressed as the inclusive range of values that a reading might have, for example:

Example: ± 2 mm

benchmark A fixed reference point used to survey or tie a station to.

blue tick An accreditation program administered by IrrigationNZ

calibration The process of determining, checking, or rectifying the quantitative measurements of any instrument.

comments file A metadata file associated with the data file. The metadata provides relevant information about the site and data.

control The physical properties of a channel, natural and artificial, which determine the relationship between stage and discharge at a location in the channel.

datum A nationally or locally known survey level, e.g., mean sea level. It can be applied (where practicable) to station benchmarks.

discharge The volume of liquid flowing through a cross section in a unit time.

flow The movement of a volume of liquid. Used as a general term when referring to the movement of water, e.g., through a channel. See also: discharge

flow rate (Q) Quotient of the actual volume of water passing through the water meter and the time taken for this volume to pass through the water meter.

permanent flow rate, Q_3 The highest flow rate within the rated operating conditions, at which the water meter is required to operate in a satisfactory manner within the maximum permissible error.

overload flow rate, Q_4 The highest flow rate at which a water meter is required to operate, for a short period of time, within its maximum permissible error, whilst maintaining its metrological performance when it is subsequently operated within its rated operating conditions.

transitional flow rate, Q_2 The flow rate which occurs between the permanent flow rate Q_3, and the minimum flow rate Q_1, that divides the flow rate range into two zones, the upper flow rate zone and the lower flow rate zone, each characterized by its own maximum permissible error.

minimum flow rate, Q_1 The lowest flow rate at which the water meter is required to operate within the maximum permissible error.

full pipe flow The flow in a closed pipe or conduit that is full of water.

logger volume The volume recorded on the logger between inspections.

mag flow is the **magnetic flow meter**, also technically an *electromagnetic flow meter* or more commonly just called a *mag meter*. A magnetic field is applied to the metering tube, which results in a potential difference proportional to the flow velocity perpendicular to the flux lines

[1] http://en.wikipedia.org/wiki/Accuracy_and_precision

metadata Information about the data that may describe the content, quality, condition and/or other characteristics of the data.

meter volume The change in volume between inspection as derived from the meter display

MSL Abbreviation for mean sea level. Mean sea level is a common datum used to reference station benchmarks.

open channel flow The flow driven by gravity, exposed to the atmosphere, and in a conduit such as a canal, flume, ditch, or race.

partially full pipe flow The flow driven by gravity in a closed conduit where the conduit is not full, and the flow has a free surface subject to atmospheric pressure.

permit The water permit held by the permit holder.

permit holder The person who holds a water permit to which the Regulations apply.

precision The degree to which repeated measurements under unchanged conditions show the same results. Use in relation to how precise an instrument is.

pulse output A switch closure output from the meter that represents a set volume of water.

QC Abbreviation for quality code. For example, a quality code of 600 may be referred to as QC 600

quality codes An overlying set of associated information that provides the end user with information about the quality of the data.

range of expected flow rates The range of minimum to maximum flow rates that the specific conduit would be expected to convey under normal conditions. The maximum expected flow rate is not limited to the maximum permitted flow rate, but to the capacity of the intake structure/system.

recording zero The zero level of a station's datum.

Correct: recording zero

Avoid: recorder zero

reduced level (R.L.) A surveying term referring to datum level associated with a station.

relevant regional council The regional council or unitary authority that granted the water permit.

resolution The interval that is measurable by a scientific instrument.

site The geographical location of the measurement.

stage The elevation (water level) of the free surface of a stream relative to a datum.

station The collective term for sensors deployed/combined at a particular site.

stationarity of record The quality of a process in which the statistical parameters of the process do not change with time. Stationarity of record is maintained when variability, of the parameter being measured, is only caused by the natural processes associated with the parameter. Stationarity of record ceases when variability is caused or affected by other processes, e.g., moving the station, adjusting the height of the stations reduced level.

suitably qualified hydrologist A hydrologist with no less than 5 years of relevant practical experience and trained in the practical aspects of open channel flow measurement.

uncertainty A measure of accuracy of the readings. Express as a range of error at a stated probability.

validation a field check to determine if the device or procedure conforms to specifications.

verification The formal inspection and testing of the water metering device or system to establish and document that it meets the accuracy requirements of the Regulations.

See also: 'validation' and 'calibration'.

verified data Data that has been processed to the required standard and peer reviewed.

water level the elevation of the free surface of a stream, river or lake without any reference levels associated with datum's, e.g., the water level that is read off the staff is not necessarily the stage height, but the value from which is used to determine the stage height.

water meter All the components of the measurement configuration that measures and records the volumetric flow rate of water that passes through the conduit.

water year A period during the term of the water permit:

- starting on 1 July or, for the permit's first water year, starting on the first day on which the Regulations apply to the permit; and
- ending on the next 30 June or, for the permit's last water year, ending on the last day on which these regulations apply to the permit.

wet lab certificate A certificate of conformance from an accredited laboratory undertaking a volumetric analysis of the flow meter against a traceably calibrated reference

About this Standard

Introduction

The purpose of this document is to standardise and describe the methodologies to achieve the acquisition, processing, archiving and quality assurance of near real-time data from water meters. The document provides additional information to existing guidelines developed by IrrigationNZ.

This data will be used for resource management science and for compliance and enforcement purposes. These purposes will require different accuracies and frequency of data. This document provides a standard that enables the data requirements of both the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010 and resource management science to be achieved.

The IrrigationNZ 'Guidelines for the Measurement and Reporting of Water Takes' (2011) is utilised as a reference document and it provides further guidance relating to meter selection and installation.

Objective

This document has been developed to:

- provide a best-practice approach for measuring, quality coding and archiving of electronic water meter data.
- provide guidance on the selection, installation and verification of suitable water measurement devices/systems for the collection of data for resource management purposes.
- promote consistent measurement standards for water takes to assist in the monitoring process for water permit compliance and enforcement.

Scope

The intent is to provide a data set that can be used in a range of water management processes with a high degree of confidence, including plan development, naturalising flows and determining water allocation frameworks.

The document focuses on closed pipe systems.

Exclusions

The following areas are not covered by this water meter data standard:

- Water measurement systems for open channels and partially full pipes
- Calibrated structures

Note: For guidance with any open channel or partially full system refer to the relevant NEMS standard on water level measurement and open channel flow measurement.

The Standard – Water Meter Data

This standard applies to the measurement of abstraction data for closed pipe systems only.

For data to meet the standard the following shall be achieved:

Data Accuracy	Comparison to Fixed Meter	± 1 %
Stationarity	Stationarity of record shall be maintained.	

Requirements

As a means of achieving the standard (QC 600), the following requirements apply:

Units of Measurement		Express as m^3.
Resolution		Ability to resolve to 1% of normal hourly volume *If the flow rate is 100 m3/h then a minimum of 1 pulse per m3 is required but for a rate of 50 m3/hr then a pulse per 100 L is more suitable.*
Timing of measurements	Maximum Recording Interval	Hourly
	Measurement	Volume in the interval.
	Resolution	1 s
	Accuracy	± 90 s / month
	Time Zone	Express time as New Zealand standard time (NZST) *Do not use New Zealand daylight time (NZDT)*
Validation Methods	Pre-Deployment	Wet Lab Certificate
	Primary Reference Measurement	Flow meter totaliser
	Tolerance	± 1% between logger volume and flow meter totalizer
	Pulse Output Assessment	Free of error
Verification	Frequency	Verify: • within the first water year of installation, and • at a maximum interval of five years thereafter.
	Method	Blue Tick Approved Method
	Accuracy	Installed to ± 5%.

Continued on next page…

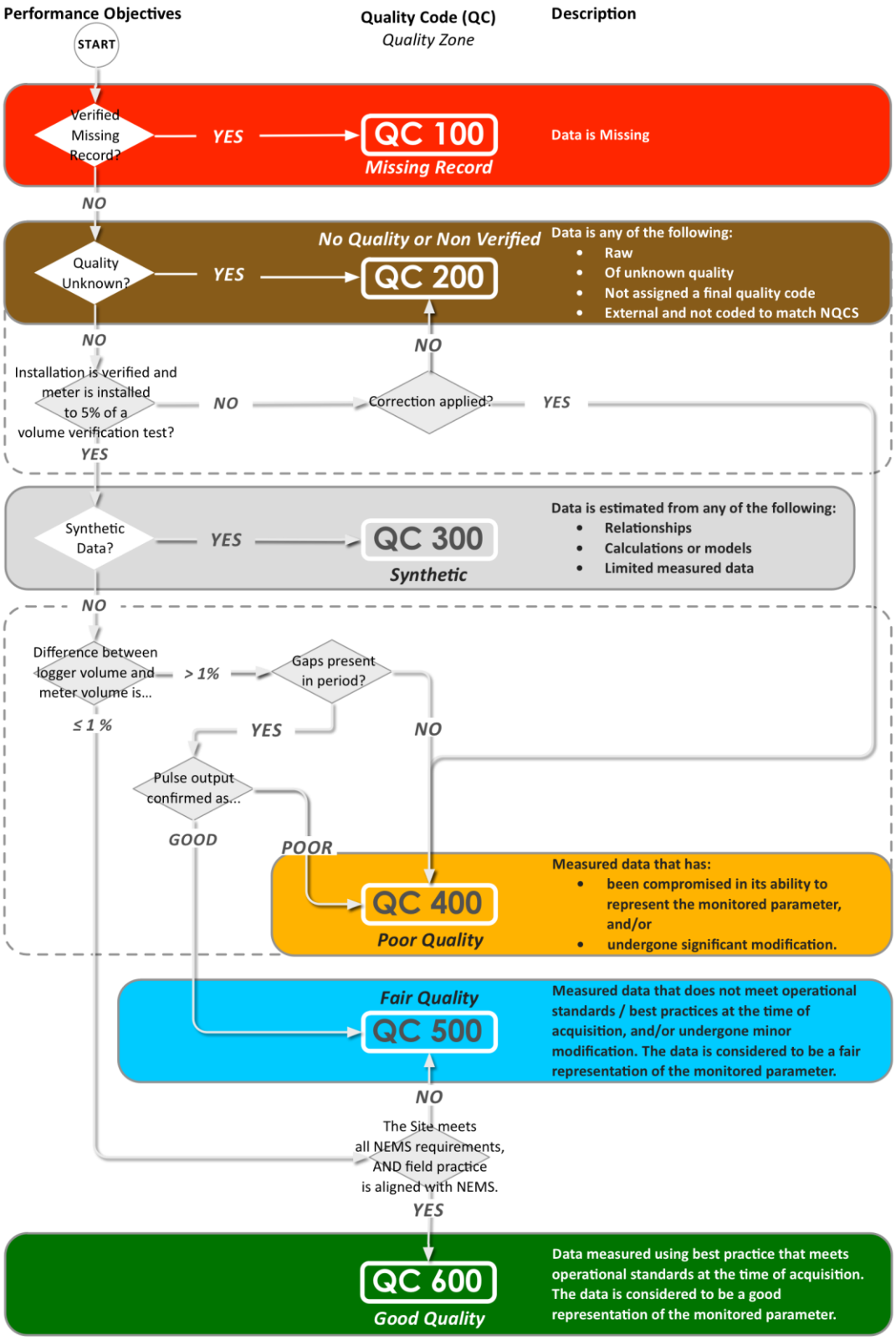
Metadata		Metadata shall be recorded for all measurements.
Quality Assurance		*Quality assurance requirements are under development.*
Processing of data		All changes shall be documented. All data shall be quality coded as per quality codes flowchart.

The following table summarises best practice and is not required for QC 600:

Validation Methods	Inspection of Recording Installations	Sufficient to ensure the data collected are free from error and bias, both in volume and time. Inspected within each water year.
Archiving	Original and Final Records	File, archive indefinitely and back up regularly: • Raw and processed records • Primary reference data • Supplementary measurements • Validation checks • Site inspections • Verification results • Metadata
Auditing		*Quality assurance requirements are under development.*

Quality Codes – Water Meter Data

All data shall be quality coded in accordance with the National Quality Coding Schema. The schema permits valid comparisons across multiple data series. Use the following flowchart to assign quality codes to all water meter data.



1 Water Measuring Devices

1.1.1 In this Section

This section contains information on site selection, and the installation and operation of water meter devices.

It defines the standards relating to:

- stationarity
- the requirement for full pipe water meters
- site selection
- deployment
- general inspection requirements
- verification of accuracy.

Note: This section provides information that compliments Irrigation New Zealand documents, and provides additional information necessary to obtain good quality data for water resource management.

1.1.2 Stationarity of Record

Stationarity of record:

- is maintained when variability of the parameter being measured is only caused by the natural processes associated with the parameter, and
- ceases when variability is caused or affected by other processes, e.g., moving the station or adjusting the height of the station's reduced level.

Without stationarity, a data record cannot be analysed for changes over time. While the accuracy of collection processes may change, it is critical that the methods and instruments used to collect water level record remain without bias over the life time of the record.

Because the methods of collecting continuous environmental data do change over time, an external reference should always be used against which the continuous data can be checked. In the case of water level, this is a staff gauge that is tied to a constant vertical datum, usually maintained by benchmarks.

1.2 Requirements for Full Pipe Water Meters

1.2.1 Water Meter Accuracy

It is important to select the correct meter relative to the conditions of the abstraction. A correctly installed, high quality meter will give the highest quality data record.

The meter shall:

- be manufactured in conformance to either ISO 4064B(1999) or OIML R49
  Note: This allows for mag flow and certain mechanical meters only and excludes insertion and ultrasonic meters
- have a maximum error of 2% over its design operating range
- be supplied with a wet lab certificate of conformance
- have a pulse output of suitable scale to resolve the hourly volume to a resolution of 1% relative to the normal abstraction rate
  Note: If the flow rate is 100m3/h then a minimum of 1 pulse per m3 is required but for a rate of 50m3/hr then a pulse per 100l is more suitable
  Note: It is ideal to have a pulse outputted every 10-60 seconds for testing and verification, avoid high frequency outputs as these can limit the methods of pulse checking and create issues with data logging and verification.
- meet the required accuracy standard.
  Note: When the meter is installed according to the manufacturer's instructions, the in-situ determination of water volume meets the accuracy limits (± 5%), to a confidence level of 95%. That is, 95% of instantaneous volumetric flow rate measurements are within ± 5% of the true volumetric flow rate.

1.2.2 Water Meter Display

The purpose of an on-site display is to provide a reliable and unambiguous visual indication of the real-time measurement data.

The display shall:

- have a non-resettable totaliser that will display the flow total in cubic meters (m^3), and be accessible, readable and protected from environmental effects.
- be tamper proof
- where practicable, have password protected settings to mitigate unintentional changes
- display the cumulative volume expressed in cubic metres (m^3), with:
  - sufficiently large registering range to record cumulative volume corresponding to 1 year at the maximum flow rate for which the meter is rated, without passing through zero, and
  - a scale interval such that verification can be completed in a practical and cost effective timeframe onsite. The least significant digit should ideally be small enough to ensure that the resolution error of the display does not exceed 0.5% of the equivalent volume passed at the minimum rated flow rate during a 15 minute period.
- display values that are proportional to values recorded in the data logger
- be of a size and type that is easy to read with clearly specified units, and
- resistant to corrosion and fogging.

1.2.3 Labelling of Water Meter

The meter shall:

- have a clearly identifiable manufacturer's serial number securely attached to or imprinted on the meter. This should be located in a position that is easily visible when taking manual readings from the meter display unit.
- be labelled so as to show the direction of flow, orientation and any other necessary installation information required to achieve the required accuracy

Note: Any certification specific to a meter type, such as C-tick certification for an electromagnetic meter, should be clearly visible.

1.2.4 Records of Water Taken

The permit holder shall:

- keep records that provide a continuous measurement of the water taken under a water permit, including any water taken in excess of the amount allowed under the permit, and
- record the cumulative volume (in cubic metres) of the water taken each hour

Note: This may be achieved through an approved third-party provider.

For more information on data management, see '2 Data Processing & Preservation'.

1.2.5 Data Logging

The water use data shall be stored as hourly volumes on a suitable data logger, configured correctly for the type of meter output.

Where practicable, the data logger should include or be paired to a suitable telemetry device. This will allow for real time monitoring of the record.

The data logger shall:

- have sufficient non-volatile memory to ensure that data loss does not occur
- store the data in a format which allows the derivation of volumes (cubic metres)
- store the data at a maximum of an hourly interval (on the hour)
- be tamper resistant or stored in a secure housing
- have a power supply that ensures data loss does not occur, and
- have non-volatile programming and firmware.

1.3 Site Selection

Where practicable, the water meter shall:

- be located at the point from which the water is taken, and
- be located in a position with suitable access.

The water meter shall measure the entire volume of water taken under the water permit.

1.3.1 Location of Water Meter

The water meter location shall be selected with consideration to the following:

- The meter shall be installed at the location from which the water is taken under the permit, or if approved by the consenting authority, as near as practicable to that location.
- There shall be no off-take (except those for permitted water takes e.g. domestic, stock water and fire-fighting), diversion, storage or branch between the meter and the location from which the water is taken.
- Where practicable, the meter shall be mounted in a way that allows for both easy access and manual reading of the display unit (without, for example, the use of a mirror or ladder).
- The meter should be installed in a location that allows for verification of the meter to occur in situ or for the meter to be readily removed to be transported to a wet lab for verification.

1.3.1.1 Below Ground

The preferred location of all meters is above ground. However, in instances where a meter needs to be installed below ground level, the following shall be considered:

- The meter shall be installed no deeper than 1.5 m below ground level;
- There shall be sufficient space to facilitate easy access for maintenance, inspection and reading at all time.
- If located up to 0.5 m below ground level, the meter shall be housed in a suitable meter box to protect the meter whilst still allowing full access to the meter;
- If located between 0.5 m and 1.5 m below ground level the installation shall include a suitable access pit.
- Measures shall be taken to:
  - prevent the entry of ground water and surface water, and / or
  - provide adequate draining of the access pit or meter box.
    Such measures could include a concrete apron graded away from a secure lid.

Note: Any meter installation located below ground level shall comply with the requirements of the ASNZS 2865: Confined Spaces.

1.3.2 Site of Water Meter & Safety

The meter shall be accessible at all times to allow for manual reading, inspection and verification.

The installation of the meter shall include the consideration of protective devices and fittings for the protection of the equipment, operators, the public and the environment from damage and harm.

The site of the meter and access to it shall:

- be kept clear of any oil, grease, noxious fumes and hazardous materials
- be kept clear of any unguarded moving machinery
- be kept clear of vegetation and other obstructions, and
- be safe and free from danger.

For more information, refer to: 'IrrigationNZ Inc (2011) *Guidelines for the Measurement and Reporting of Water Takes.'*

1.4 Practical Controls

1.4.1.1 Site Access

Site access shall be secure and safe for the complete period of deployment.

1.4.1.2 Safety

Hazards (for observers, the public, livestock, and wildlife) related to the location and the measurement activity shall be identified and minimised.

1.4.1.3 Hazard Review

On selection of a final site, a hazard review shall be carried out in accordance with relevant guidelines or best practise.

The potential for human activity affecting the measurement, e.g., vandalism, shall be minimised.

1.5 Deployment

A water meter and any ancillary apparatus shall be installed according to the manufacture's instructions. This is to ensure that the meter achieves the required in situ measurement uncertainty of ± 5% of the actual flow, to a 95% level of confidence.

To ensure measurement accuracy, any operational limitations identified by the manufacturer with respect to the in situ conditions shall be complied with.

For example: Water quality, water and ambient temperature.

1.5.1 Pre-Installation

Prior to installation, the installer shall obtain:

- a wet lab certificate, and
- the manufacturer's installation instruction manual.

The installation instruction manual shall detail:

- all installation requirements, e.g., rated operating flow range and conditions) to achieve the meter's stated accuracy and the type of fluid it is designed for, and
- any maintenance activities required for operation, whether a particular maintenance activity requires a certified technician to carry out the work, and when metrological performance can be affected by maintenance (and therefore requires recalibration in a laboratory).

1.5.2 Future Verification Requirements

It is necessary to consider the practicalities of the verification process of a water meter when selecting the installation and pipe-work configuration.

The meter installation configuration (including any enclosure) shall allow for the removal and dismantling of the meter so that inspection of the internal components by the verifier ensures on-going compliance.

The following are possible arrangements that could be installed with a water meter installation to allow for future in-situ verification testing:

- flow diversion devices to allow water to run through an independent meter (e.g. two testing tees fitted downstream of the meter and a valve between the tees for isolation purposes);
- an access valve to allow the insertion of the measuring probe of a portable meter;
- a section of suitable pipe to allow the use of a portable clamp-on independent meter;
- a section of pipe with flanges to allow an independent meter to be inserted in-line; or
- a valve to close off the downstream system and an outlet to allow the 'known volume' (in-situ volumetric or gravimetric method) system to be used.

1.5.3 Minimum Installation Requirements

A water meter shall not be installed in any configuration in which the required in situ accuracy cannot be achieved or accuracy adequately verified.

Flow disturbances can have a significant effect on the measurement accuracy of a water meter. Flow disturbances can be caused by proximity to pumps, elbow bends, valves and changes in pipe size.

Where possible, components that might cause flow disturbances shall be:

- eliminated
- installed in the pipe-work downstream of the water meter installation.

Unless the manufacturer instructions specify otherwise, the straight pipe lengths shall be as a minimum:

- ten times the pipe nominal diameter (DN) on the intake side of the meter, and
- five times the pipe nominal diameter on the discharge side of the meter.

Note: These minimum straight pipe lengths refer to straight, clean lengths of pipe of uniform cross-section that have the same internal diameter as that of the meter and have no fittings or obstructions.

For more information on this configuration and other others common within the industry refer to: 'IrrigationNZ Inc (2011) *Guidelines for the Measurement and Reporting of Water Takes.'*

Note: A water meter may be fitted onto a vertical pipe work (as usually found in wells) provided it is certified for that purpose by the manufacturer of the meter endorsing its installation on upward flow direction.

In circumstances where the meter is not located at a fixed point and is used in conjunction with a portable pump, the meter and associated pipe work shall be connected to the pumping equipment when in use, but may be disconnected during relocation.

1.5.4 Suited to Expected Conditions

The water meter used for monitoring the volume of water taken shall be suited to the qualities of the water that it is measuring. Such water qualities that should be considered include temperature, algae content, and sediment content.

1.5.5 Protection

The water meter shall be manufactured from sound, durable, corrosion resistant materials. All parts of the meter in contact with water shall be manufactured from materials that are non-toxic and both chemically and biologically inert.

Installations shall incorporate a degree of environmental protection required to ensure reliable operation in the installation environment.

The meter must also be suited for the expected environmental conditions of the locations with particular care to ensure flow totaliser displays and registers are not affected by UV and water.

Note: The environmental enclosure rating for the measuring mechanism of the meter should reflect the degree of protection required for the installation environment. For more information, refer to: 'Irrigation NZ Inc (2011) Guidelines for the Measurement and Reporting of Water Takes.'

1.5.6 Electrical Power Source

If a meter or any ancillary apparatus relies on mains power source it shall be installed, comply, and be operated with the relevant New Zealand electrical standards and any associated requirements.

The meter power supply shall be installed to avoid accidental and deliberate interruption.

Where an installed meter relies on an electrical power source, it shall have a non-volatile memory to ensure that recorded data is not lost in the event of a power or battery failure.

Note: The meter indication of volume immediately before failure is not lost, and remains accessible for a minimum of one year. Any other properties or parameters of the meter shall not be affected by an interruption of the electrical supply.

1.5.7 Security

The water measurement system shall be sealed and as tamper-proof as practicable.

Tampering would affect the credibility and hence the usefulness of the data collected. Therefore, the design and installation of the water metering system must take into account all practicable steps to protect the components of the water metering system from intentional tampering.

Note: This includes protection devices/seals for individual components that prevent tampering and/or indicate when tampering has occurred.

1.5.8 Maintenance

The meter shall:

- be maintained in full, accurate operating condition whenever it is in use
- be serviced and maintained in accordance with the manufacturer's specifications
  Any servicing that will affect the accuracy of the meter must be undertaken by a service provider approved by the meter manufacturer or agent.
- be periodically maintained over its working life such that there is an acceptable level of confidence that the meter continues to operate within its permissible in situ measurement uncertainty of ±5%, and
- be recalibrated in a laboratory if the maintenance activity undertaken was identified by the manufacturer as affecting the performance of the meter.
  If the maintenance activity undertaken interferes with the installation configuration, then in situ re-verification is required.

Note: Preventative maintenance generally includes checking the structural integrity of pipe-work and fittings, an assessment of components for wear or damage, and replacement of components at the appropriate time.

Water permit holders shall:

- retain copies of maintenance records and a logbook of any inspection works as evidence of the service record of the meter and include:
  - date and time of the works
  - agent undertaking the works
  - water meter reading
  - comments or report detailing the nature of the work
  - outline any further maintenance requirements with timeframes for completion.
- make these records and logbook available for inspection when requested.

1.5.9 Commissioning

Commissioning shall be conducted by the installer to ensure that the meter is ready for verification and subsequent use.

The commissioning procedure shall include the following checks:

- that all components have been installed according to the specific manufacturer's installation requirements
- that there are no leaks in the installation
- all tamper seals are fitted
- that all components are sufficiently protected from damage, and
- the installation is in accordance with any requirements of the consenting authority that are more stringent than those of the Regulations.

1.5.10 Submission of Installation Report

Upon completion of the meter installation, the installer shall submit the following installation information to the relevant Consenting Authority to aid in record keeping:

- a report providing specifications of the meter installation, signed by the installer
- the report should include the following information;
  - the installer organisation's name, address and contact phone numbers
  - installation date
  - the make, size, type, and serial number of the meter
  - permit holder's name
  - meter location description including Global Positioning System (GPS) coordinates
  - name and signature of the installer
  - any other information requested by the Consenting Authority
  - a detailed as-built diagram and photograph of the installation configuration, including dimensions and verification facilities provided.

For an installation report template, refer to: 'IrrigationNZ Inc (2011) *Guidelines for the Measurement and Reporting of Water Takes.'*

1.6 General Inspection Requirements

For all meters, the site shall include the following inspection steps to ensure that the meter measurements are reliable. All records shall be adequately collected and reported and available to the consenting authority upon request.

The water meter site shall be inspected at a frequency to ensure that all record collected is representative of the true water use. A minimum of seasonal inspections is required to give the necessary confidence in the record.

1.6.1 Water Meter

The water meter inspection shall check that:

- the meter is used in an appropriate manner
- the totaliser is non-resettable
- maintenance records and preventative maintenance plans are kept
- the readings on the display are clearly visible and unambiguous
- there was no interruption of pulse output between the measurement component and the recording component
- power supply is reliable
  For example, if the meter uses batteries, then the expected replacement date are marked and not due.
- tamper-proof seals are in place and unbroken
- there are no leaks that bypass the measuring point
- earthing and lightning arrestors, if installed, are sound
- for scaling or build-up of calcium, iron oxide or bacteria on the meter or pipe work
- filters/strainers/screens, if installed, are clean
- environmental element protection from weather and other damage are adequate; and
- meter usage is within stipulated design life, e.g., years, cumulative volume.

1.6.2 Data Logger

The data logger shall be checked and raw data recovered.

1.6.2.1 To check the data logger and recover raw data:

1. **Download the data logger raw data.**
2. **Check the logger time.**
   Ensure that any time drift is recorded and the logger is corrected.
3. **Check the data logger condition.**
   Include wiring and input checks.
4. **If present, check the telemetry device**
   Signal strength must be sufficient.
5. **Check the power supply.**
   Include battery condition, solar panel checks.
6. **Update any firmware or program changes to the logger.**

1.6.3 Performance

Check the site performance to ensure the recorded data reflects the actual abstraction use by:

- comparing the logger total with the change in water meter total since the last inspection to ensure adequate agreement (maximum limit of ± 1% error)
- checking the pulse output from the meter to ensure a clean uniform pulse.

If the pulse output is uncertain or the volumes do not agree then run the pump for a short period (5 minutes minimum) and compare the data logger to the flow total. This will confirm if the logger is reporting a correct abstraction volume. Alternatively the pulse output can be checked with an oscilloscope to confirm a clean pulse or help identify any pulse irregularities.

Note: Any discrepancies shall be resolved. Daily manual records shall be collected in the period until the correct pulse output can be restored. This is the responsibility of the permit holder.

1.7 Verification of Accuracy

1.7.1 Purpose of Verification

Verification gives confidence that a water meter meets the accuracy standard required in the Regulations, i.e. the in situ determination of water volume shall have a maximum permissible uncertainty of ±5% of measurement for the entire rated flow rate range under rated operating conditions.

1.7.2 Frequency of Verification

The verification process gives confidence that a meter meets the required accuracy standard.

The Regulations specifically require a water meter to be verified as suitably accurate:

- within the first water year of it being installed, and
- at a maximum period of no greater than 5 years thereafter

Note: The accuracy of all water meters must be verified every 5 years by a suitably qualified person. This can be performed either on-site or at an accredited laboratory. However, if the meter is verified in a laboratory, then the upstream and downstream pipe work lengths must be included in the test.

1.7.3 Approved Verifiers

Verification of the meter shall be carried out by:

- a person, who in the opinion of the relevant consenting authority that granted the water permit, is suitably qualified to verify the particular meter, or
- a relevant consenting authority or an external organisation, provided that the criteria are met.

1.7.4 Verification Methods

The verification of the meter requires an in-situ volumetric comparison to an external reference meter or system. This can involve:

- comparator meters, either inline or as an off-take, or
- volumetric / gravimetric analysis.

The methods shall conform to the following rules:

- The test instrument must have a maximum manufacturers stated accuracy of 2% with annual wet lab certificate.
- The comparator meter must be installed and operated to manufacturers specification.
- 3 repeated Volume test over suitable period of time (15 minutes initial with 5 minutes minimum).
- The test is performed at a flow representative of the expected flow rates of the system (above Q2).

Note: As at September 2012, the approved methods are yet to be finalized but will be incorporated into the Irrigation NZ Blue Tick accreditation program.

1.7.5 Verification Report

A verification report shall be:

- issued by the approved verifier for each meter verified, and
- provided to the consenting authority.

The verification report shall have as a minimum, the:

- verifier organisation's name, address and contact phone numbers
- verification date
- make, size, type, and serial number of the meter
- permit holder's name and permit number
- meter location description, including Global Positioning System coordinates
- meter reading (m^3) prior to verification
- flow rates tested and individual accuracy requirement compliance/non-compliance for each flow rate
- verification test procedure
- general inspection notes
- confirmation that the reference device is currently certified and is available on request, and
- name and signature of the verifier.

For a verification report template, refer to: 'IrrigationNZ Inc (2011) *Guidelines for the Measurement and Reporting of Water Takes.'*

1.7.6 Verification and Compliance

Because of the limitations of current test equipment and a pragmatic approach has been applied to the assessment of Verification compliance. Critical is the quality of meter and installation as this is accepted as being key to obtain representative water use data.

Any new installation should include the ability to verify with a system of maximum uncertainty of 3%. This excludes the likes of ultrasonic clamp on meters that are not capable of providing this level of confidence, but does direct the installation into the use of other comparator meters such as inline mag meters or off-takes to pump rigs and gravimetric tests.

Appreciating the design constraints of some installations and the limits of pump rigs for large pipe systems a pragmatic approach has been proposed on these systems.

The verification uncertainty of 5% for current installations is allowed for their initial installation test but the expectation is that they will be tested to 3% there after, allowing time for pipe modifications and assessment of verification methods.

This gives a compliance test of:

- 8% agreement in volume between the meter and verifier for new installations, and
- 10% agreement in volume between the meter and verifier for current installs but will be assessed subsequently to 8%.

2 Data Processing & Preservation

2.1.1 In this Section

This section contains information on the handling of data from the field, in its original form, to data processing and editing, to final archiving.

It defines the standards relating to:

- missing / synthesising / editing records
- metadata / comments
- quality coding of data
- preservation of record, and
- quality assurance.

2.1.2 Performance

The methodology used to process and preserve data shall be documented.

Note: The methodologies applied by each agency vary depending upon the software utilised for hydrological data processing and archiving.

2.2 Requirements for Records from Water Measurement Devices / Systems

In the majority of cases, the recording intervals for water measurement will be hourly, but where the consenting authority requires a shorter duration then this shall be followed.

To achieve consistency and uniformity, water take records shall be collected by a device or system that meets the following minimum requirements:

- have the ability to continuously measure the amount of water being taken
- have the capacity to record volumes in cubic metres to an accuracy standard of ± 5% for full pipes
- be capable of providing data output in a form suitable for electronic storage, and
- be capable of appropriately reporting information to meet the permit conditions imposed by the consenting authority

2.2.1 Requirements for Recording and Data Transfer

To achieve consistency, recording requirements need to conform to a minimum standard. Specific recording requirements imposed under a consent may exceed the minimum requirements of this standard, but shall not be less than the minimum standard.

2.2.1.1 Recording

The key requirements for recording data are:

- Hourly volumes in cubic metres are recorded in an auditable manner
- A permit holder must keep records that provide a continuous measurement of the water taken under a water permit, including water taken in excess of what the permit allows.

2.2.1.2 Data Transfer

The key requirements for data transfer are:

- Data is recorded on a daily basis and transferred to the consenting authority in raw form
- A permit holder must provide records that cover each water year of the permit to the Consenting Authority that granted the permit, and
- The processed and QA record for a water year must be provided no later than one month after the end of the water year.

2.3 Telemetry Data

Telemetry is a means of communication with a remote field station for retrieval of data from the site data logger back to a base or office system. This is achieved by various methods such as radio, cell and satellite systems.

A telemetry system offers the opportunity to remotely monitor many functions of a water meter station. It should be possible to detect the following very quickly:

- Instrument failures
- Electrical problems
- Changes in the abstraction use.

Note: The system should be used to its maximum capabilities in this respect as it can save on missing record and minimise expensive return trips to repair faulty equipment by identifying a fault early and then getting to the site quickly.

The following conditions apply to telemetered data:

- The data shall be coded as QC 200 (raw) until verified.
- The site may have automatic clock update capabilities.
- Periodical manual downloads of data should be undertaken to check for problems and inconsistencies.

Note: There could be multipliers in the data at the base/or field station which need documented and carefully controlled.

2.4 Missing, Synthesised & Modified Records

2.4.1 Introduction

Even with the best of equipment and field practices it is inevitable that some data will be lost, resulting in missing record.

If the gaps in the record are not filled, then future analyses of the record becomes difficult, and the data can be of limited value.

2.4.2 Responsibility for Synthesising Records

Where practicable, the agency and staff that collected the data shall:

- fill any gaps that occur in a station's record, or
- provide suitable comment in the metadata.

2.4.3 Percentage of Record Required

The goal shall be zero missing record but acceptable performance will involve a managed amount of lost data.

2.4.3.1 Datalogger or Pulse Output Failure

When a data logger or pulse output failure occurs then daily manual flow meter readings shall be provided to characterise the abstraction.

2.4.3.2 Flow Meter Failure

If the flow meter fails, the consenting authority shall be contacted immediately before further abstraction use.

If further abstraction occurs, then as a minimum during the water meter failure, the duration of pumping shall be recorded manually by the consent holder.

2.4.3.3 Power & System Maintenance Interruptions

It is appreciated that systems maybe offline in the off-season because of power interruptions or system maintenance. These events are acceptable in the record when defined and the recording devices are operational upon abstraction commencement.

2.4.4 Flow and Time Corrections

Data shall be stored as the recorded data set with no correction to the water meter data unless required because of the use of an incorrect multiplier, or is outside the standard for time.

Any changes to the raw record shall be documented and archived accordingly.

Note: Software packages provide many ways of modifying data. It is often impossible to know absolutely the source and effect of any data errors after the event and, although people may have theories, these may not be the only explanation.

2.4.5 Modifications to Data

Data modification shall only be permitted where a site setup issue has been observed, for example, an incorrect multiplier. The telemetered data should not be transformed or corrected to the meter readings but quality coded to represent discrepancies in the collected data.

2.4.6 Synthetic & Interpolated Data

2.4.6.1 Application

Synthetic data and interpolation shall only be applied to the abstraction record under the following conditions:

- Where a gap occurs, the data can be filled with:
  - manual water meter readings, either daily or start/finish readings within the day
  - zero flow when no abstraction has occurred, confirmed by meter readings, or
  - a derived volume from other meters in the same distribution network where the total abstraction and individual off-takes are known.
- Where the meter verification fails, the ratio of the failure can be applied to the record and quality coded accordingly.

A comment shall be filed (in the site metadata) that explains the reason for the missing record and comprehensively justifies the usage of synthetic data or interpolation.

A comment containing the details of the relationship between sites shall be filed.

2.4.6.2 On-Site Trained Personnel

Where trained personnel were on-site for the whole period, e.g., verification, maintenance and inspections, and recorded manual observations, the gap may be filled with these values and interpolated accordingly.

2.5 Metadata / Comments

Comments are very useful to explain unusual features or events in the record that users of the data should be aware of. In addition, routine comments are required for key information.

Where applicable, comments shall include and not be limited to:

- site specific details
- site data details, and
- equipment details

2.5.1.1 Site Specific Details

Site specific details include the following:

- Site purpose
- Recording agency/ies
- Site location in standard and documented coordinate system (prefer WGS 84)
- Site name and past and present aliases
- Names and/or indices of relevant environmental features (river, lake, coast)
- Information about legal requirements, confidentiality agreements, intellectual property, and any other restrictions related to data access

2.5.1.2 Site Data Details

Site data details include the following:

- Start and end date of site and record
- Related sites and records
- Reference to the standard used
- Original format details (e.g., chart, digitised)
- Comments relating to gaps, missing record, synthetic record, or any specific time related event.
  Note: Comments are required in a standard format. They should be filed one time interval (e.g. 15 minutes) into the missing (gap) or synthetic record period or at the time the specific event takes place.

2.5.1.3 Equipment Details

Equipment details include the following:

- Logger and telemetry details
- Sensor details (preferably through an agency instrument management system)
- Calibration and Verification records
- Preferably through an agency instrument/asset management system.
- Any relevant comments in document vocabularies that future users will understand
- For example: Define terms and refer to instrument types; not brands.
- Recorder comments
  Comments are required for abstraction sites, giving instrument and sensor types and their resolutions and accuracy.

Comments covering the accuracy of data and gaps in records should be informative, coherent and identify the period(s) for which the data are suspect or missing.

2.6 Preservation of Record

2.6.1 Performance

The following data shall be archived and retained indefinitely:

- Final checked and processed data
- Unedited raw data
- Associated metadata, including:
  - data comments
  - site details
  - recording accuracy and resolution
  - station inspections and verification checks
  - equipment calibration history
  - and any other factors affecting data quality.

All original records shall be retained indefinitely by the recording agency.

Note: The original raw data may be required at a later date, should the archive data:

- *be found to be in error*
- *becomes corrupted, or*
- *be lost.*

2.7 Quality Assurance

All agencies shall implement a standard methodology for data audit and review.

Note: This is to ensure standardisation of data-sets that enable meaningful analyses and comparison of abstraction data within regions, across regions and nationally.

2.7.1 Audit Cycle

Quality Assurance processes shall include at a minimum, an audit of the data at a frequency appropriate to the organisations and users' needs, or as defined by an organisations Quality management Systems documentation. This work shall be undertaken by a suitably qualified and experienced practitioner. Unaudited data that is released for use shall be identified as being unaudited.

2.7.2 Minimum Audit Report Requirements

As a minimum, analyses and information required for an audit report for abstraction stations shall cover:

- catchment/aquifer and site details
- comments and quality coding
- data tabulations
- data plots
- comparisons, and
- site inspections.

2.7.2.1 Catchment/Aquifer and Site Details

The following shall be included in the audit report:

- Catchment / Aquifer Details Summary
- A location map, with water meter location identified.

The catchment/aquifer details summary shall:

- identify the catchment, aquifer or region, and
- for each abstraction, identify:
  - the period of record covered
  - the consent/permit name and number
  - map reference
  - altitude, and
  - sensor type.

2.7.3 Data Tabulations

The following data tabulations shall be included in the audit report listing of gaps, this should be compared with the listing of comments.

2.7.4 Data Plots

The following data plots shall be included in the audit report:

- Abstraction plots (both daily and a hourly) for the review period plus the previous year.
  Note: The plots will show the level of compliance for the abstraction and detail the periods of use.
- Comparative plots if possible with neighbouring takes.

2.7.5 Site Inspections

The following shall be included in the audit report:

- A copy of the meter inspection forms.
  The meter inspection should have been carried out within 2 years of the audit date.
- A copy of the latest verification report.

2.7.6 Other Requirements

2.7.6.1 Outputs

Recommended report outputs include:

- an optional hard copy report
- a mandatory electronic report, and
- an electronic document that only identifies which periods of record have passed audit.

2.7.6.2 Audit Certification

The completed audit shall contain the name and signature of the auditor and the date that the audit was completed.

2.7.7 Comments and Quality Coding

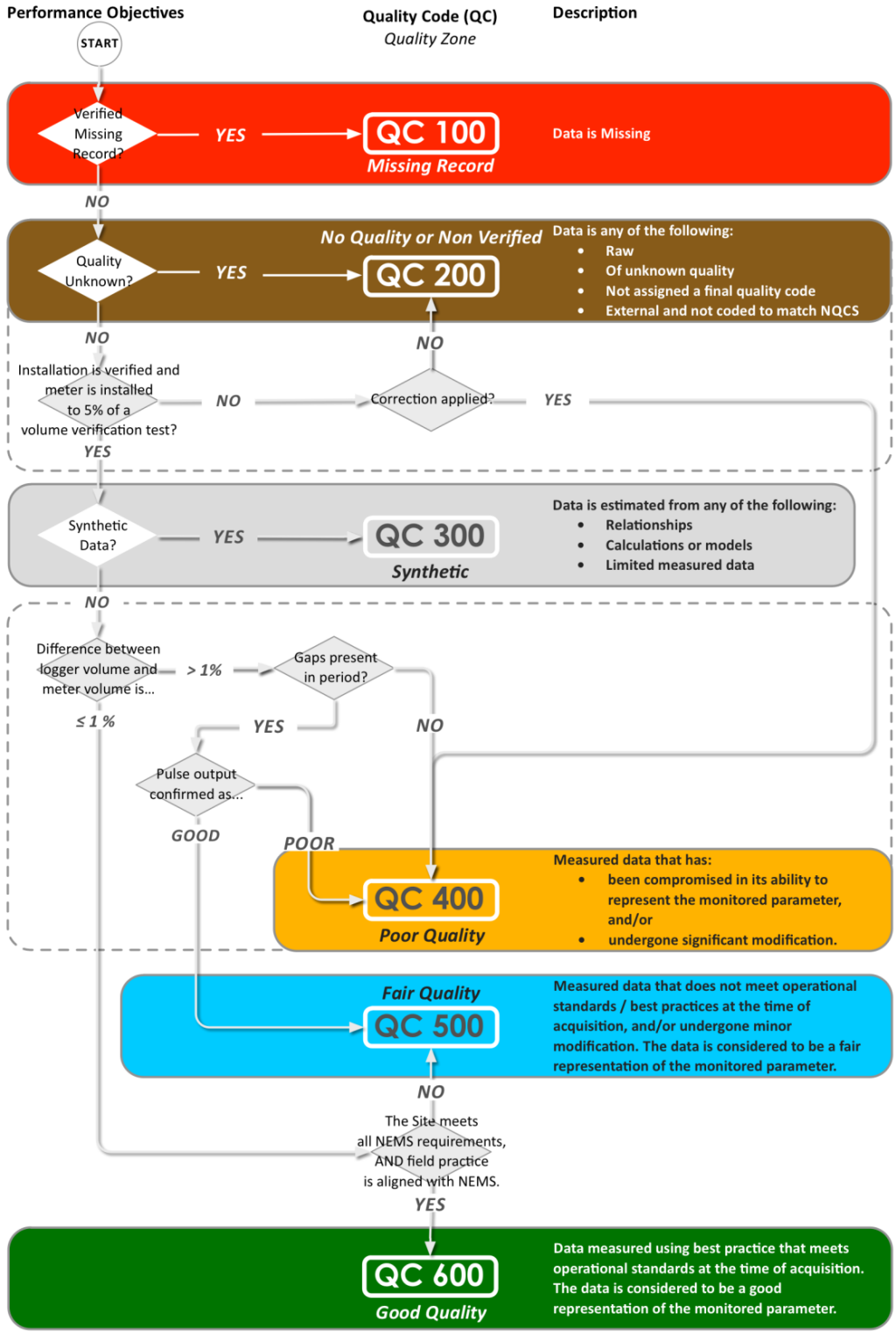
The following shall be included in the audit report:

- for each abstraction being reviewed, a copy of the filed comments for the total recorded period, and
- a copy of the quality codes that have been applied to the data being audited.

2.8 Quality Coding Water Meter Data

Water meter data shall have a quality code assigned. This quality code shall be based on the qualitative and quantitative performance objectives outlined in the flowchart below.

Figure 1 – Water Meter Data Quality Codes



Annex A – List of Referenced Documents

IrrigationNZ Inc (2011) *Guidelines for the Measurement and Reporting of Water Takes.*

NEMS (2012) *Open Channel Flow Measurement. Measurement, Processing and Archiving of Open Channel Flow Data.* National Environmental Monitoring Standards, New Zealand.

NEMS (2012) *Water Level Recording – Measurement, Processing and Archiving of Water Level Data.* National Environmental Monitoring Standards, New Zealand.

ISO 4373 (2008) *Hydrometry – Water Level Measuring Devices*.

ISO 772 (2011) *Hydro Terminology*.

ISO 4064B (1999) / OIML R 49 (Water meter meteorological and technical requirements for cold potable water sets out details of the test programme, principles, equipment and procedures to be used for the type evaluation and initial verification testing of a meter type.)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NAPIER
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