

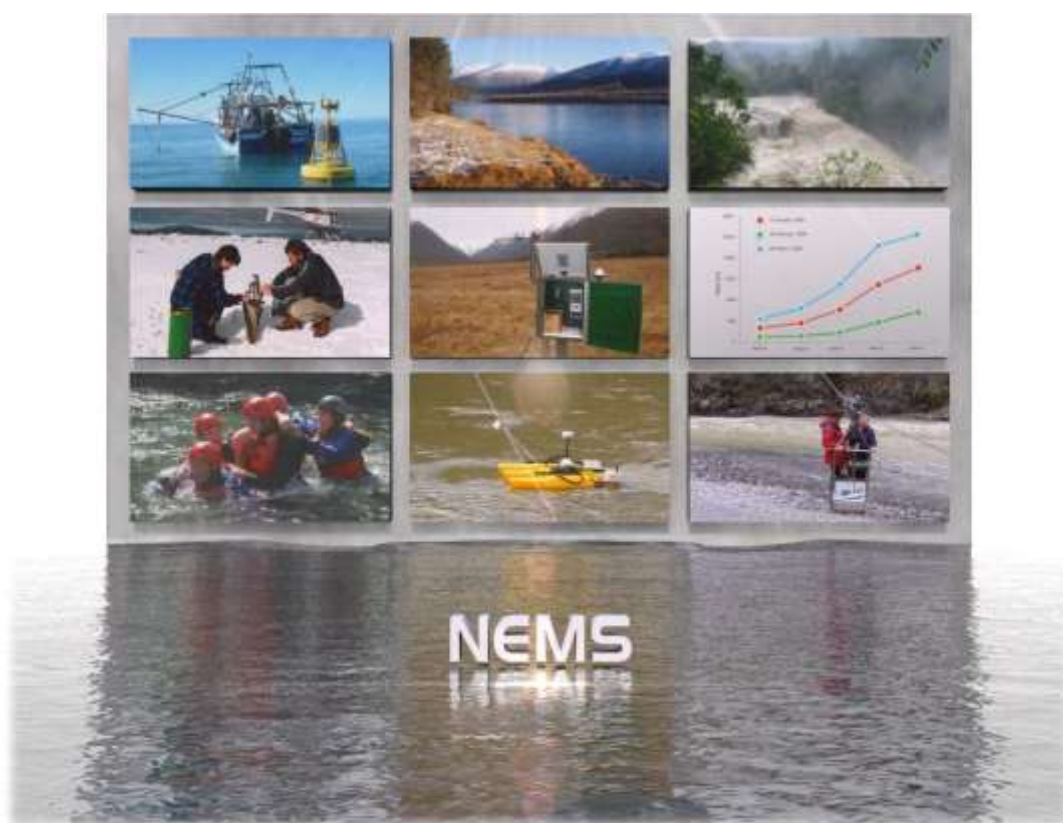
National Environmental Monitoring Standard

Water Metering

Measurement, Processing and Archiving of Water Meter Data

Version: 2.0

Date of Issue: November 2017



The National Environmental Monitoring Standards

The complete set of National Environmental Monitoring Standards (NEMS) documents to date is available at www.nems.org.nz.

Implementation

When implementing the Standards, current legislation relating to health and safety in New Zealand and subsequent amendments and the NEMS Codes of Practice shall be complied with.

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.

The documents do not relieve the user (or a person on whose behalf it is used) of any obligation or duty that might arise under any legislation, and any regulations and rules under those Acts, covering the activities to which this document has been or is to be applied.

The information in this document is provided voluntarily and for information purposes only. Neither NEMS nor any organisation involved in the compilation of this document guarantee that the information is complete, current or correct, and accepts no responsibility for unsuitable or inaccurate material that may be encountered.

Neither NEMS, nor any employee or agent of the Crown, nor any author of or contributor to this document shall be responsible or liable for any loss, damage, personal injury or death howsoever caused.

Development

The National Environmental Monitoring Standards (NEMS) steering group has prepared a series of environmental monitoring standards on authority from the regional chief executive officers (RCEOs) and the Ministry for the Environment (MfE).

The NEMS initiative has been led and supported by the Local Authority Environmental Monitoring Group (LAEMG), to assist in ensuring the consistency in the application of work practices specific to environmental monitoring and data acquisition throughout New Zealand.

The strategy that led to the development of these Standards was established by Jeff Watson (Chair) and Rob Christie (inaugural Project Manager), and the current Steering Group comprises Phillip Downes, Martin Doyle, Michael Ede, Glenn Ellery, Nicholas Holwerda, Jon Marks, Charles Pearson, Jochen Schmidt, Alison Stringer and Raelene Mercer (Project Manager).

The development of this Standard involved consultation with regional and unitary councils across New Zealand, 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 to facilitate data sharing. The degree of rigour with which the Standards and associated best practice may be applied will depend on the quality of data sought.

The lead writer of this document was Evan Baddock of NIWA, with significant input from Paul Peters (Horizons RC), and working group members 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.

Funding

The project was funded by the following organisations:

- Auckland Council
- Bay of Plenty Regional Council
- Contact Energy
- Environment Canterbury Regional Council
- Environment Southland
- Genesis Energy
- Greater Wellington Regional Council
- Hawke's Bay Regional Council
- Horizons Regional Council
- Marlborough District Council
- Meridian Energy
- Mighty River Power
- Ministry for the Environment
- Ministry of Business, Innovation and Employment – Science and Innovation Group
- National Institute of Water and Atmospheric Research Ltd (NIWA)
- Northland Regional Council
- Otago Regional Council
- Taranaki Regional Council
- Tasman District Council
- West Coast Regional Council
- Waikato Regional Council.

Review

A review of this document was completed by the NEMS Steering Group in November 2017, and will be reviewed thereafter once every two years.

TABLE OF CONTENTS

Terms, Definitions and Symbols	v
About this Standard.....	vi
The Standard – Water Meter Data.....	ix
Quality Codes – Water Meter Data	xi
1. Water Measuring Devices	1
1.1. Installation of Water Measuring Devices	1
1.2. Stationarity of Record	1
1.3. Water Meter Requirements	1
1.4. Water Meter Installation	2
1.5. Records of Water Taken.....	2
1.6. General Inspection Requirements	2
1.7. Performance	2
1.8. Verification of Accuracy	3
2. Data Processing and Preservation	4
2.1. Performance	4
2.2. Data Transfer	4
2.3. Missing, Synthesised and Modified Records	4
2.4. Metadata and Comments.....	7
2.5. Preservation of Record	8
2.6. Quality Assurance	9
2.7. Quality Coding Water Use Data	10
Annex A – List of Referenced Documents	11

Terms, Definitions and Symbols

Relevant definitions and descriptions of symbols used in this Standard are contained within the NEMS *Glossary* available at www.nems.org.

Normative References

This Standard should be read in conjunction with the following references:

- Irrigation NZ. (2016). *New Zealand Water Measurement Code of Practice*
- ISO 772:2011 *Hydro – Vocabulary and symbols*
- ISO 4046B:1999/OIML R 49 *Water meter meteorological and technical requirements for cold potable water*
- NEMS *Glossary*
- NEMS *Quality Code Schema*
- *Resource Management (Measurement and Reporting of Water Takes) Regulations* (2010).

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 via electronic methods. The document provides additional information to the existing Water Measurement Code of Practice by Irrigation NZ.

This data will be used for resource management, catchment science, and compliance and enforcement purposes. These purposes may require different accuracies and frequency of data. This document provides a standard that enables the data requirements for water resource management, and monitoring against both resource consent conditions and *National Regulations on Water Use Measurement and Reporting* (2010) to be achieved.

The *New Zealand Water Measurement Code of Practice* (Irrigation NZ, 2016) is utilised as a reference document and provides further information relating to meter selection and installation.

Objective

This document has been developed to:

- provide a standard approach for measuring, quality coding and archiving of water meter data
- promote consistent measurement standards for water takes to assist in the monitoring process for water permit compliance and enforcement as well as science needs.

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 compliance monitoring, plan development, naturalising flows and determining water allocation frameworks.

This Standard is limited to closed pipe systems.

Exclusions

The following areas are not covered by this Standard:

- water measurement systems for open channels and partially full pipes, or
- calibrated structures.

Note: For guidance with any open channel or partially full system, refer to the relevant NEMS on Water Level and Open Channel Flow Measurement or to the New Zealand Water Measurement Code of Practice (Irrigation NZ, 2016) as dictated by the appropriate consenting authority's measurement requirements.

Data fit for purpose

This Standard requires all data to be assigned a quality code.

Data that are collected, processed and archived in a verifiable and consistent manner according to this Standard can meet the highest quality code (QC 600).

Data that do not meet QC 600 shall be coded appropriately. These data are deemed acceptable for specific, often secondary, purposes that only require data of a lesser quality.

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	$\pm 1\%$
Stationarity	Stationarity of record shall be maintained.	

Requirements

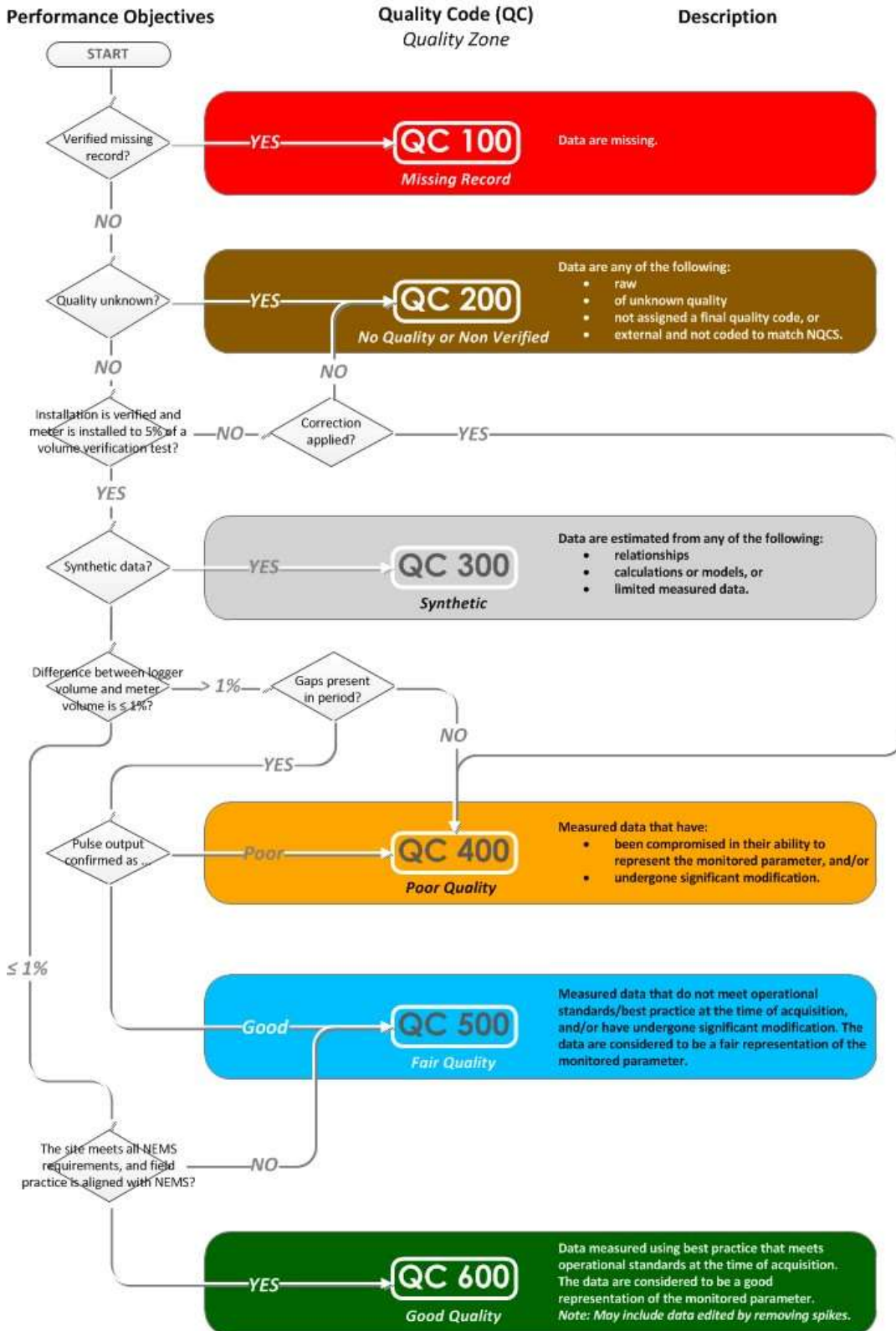
As a means of achieving the Standard, the following requirements apply:

Instrumentation	Accuracy class	The meter must not exceed 2% permissible error for the upper Flow rate zone ($Q_2 \leq Q \leq Q_4$)
Units of Measurement		m ³
Resolution		Ability to resolve to 1% of normal hourly volume <i>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.</i>
Timing of Measurements	Maximum recording interval	<ul style="list-style-type: none"> Hourly, or Where Heart Systems or SCADA technologies are used, hourly during pumping and time and date stamped "0's" at least once per day
	Measurement	Volume in the interval
	Resolution	1 s
	Accuracy	± 90 s/month
	Time zone	Express time as New Zealand Standard Time (NZST). <i>Do not use New Zealand Daylight Time (NZDT).</i>

Validation Methods	Pre-deployment	Wet Lab Certificate
	Primary reference measurement	Flow meter totaliser
Verification	Frequency	Verify: <ul style="list-style-type: none"> • within the first water year of installation, and • at a maximum interval of five years thereafter.
	Method	Blue Tick Approved Method
	Accuracy	± 5%
Metadata		Metadata shall be recorded for all measurements.
Processing of Data		All changes shall be documented. All data shall be quality coded as per the Quality Coding Schema.
Validation Methods	Inspection of recording installations	Sufficient to ensure the data collected are free from error and bias, both in volume and time. Site inspected within each water year.
Archiving	Original and final records	File, archive indefinitely and back up regularly: <ul style="list-style-type: none"> • raw and processed records • primary reference data, and • supplementary measurements. • validation checks • site inspections • verification results, and • metadata.

Quality Codes – Water Meter Data

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



1. Water Measuring Devices

1.1. Installation of Water Measuring Devices

The selection and installation of an appropriate water meter is critical to the accurate measurement of water use. It is important to ensure that the meter not only satisfies the manufacturer's recommended installation requirements but also any additional and local requirements set out by the consenting authority. This may limit the types of meter for installation and impose additional pipe requirements further to the manufacturer's minimum recommendations.

For information on the site selection, installation and operation of water measuring devices please read the *New Zealand Water Measurement Code of Practice* (Irrigation New Zealand, 2016) or the relevant technical documents for the local authority that issued the consent.

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; for example, moving the flow meter to an unsuitable location.

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 use data remain without bias over the lifetime 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. For water meter data, this means the totaliser screen/dials of the meter must be retained to gather audit readings.

1.3. Water Meter Requirements

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

The meter shall:

- be manufactured in accordance to either ISO 4064B:(1999) or OIML R49
 - or have a maximum error of 2% over its design operating range
- be supplied with a wet-lab certificate of conformance, and
- have a pulse output for electronic recording.

1.4. Water Meter Installation

A water meter and any ancillary apparatus shall be installed according to the manufacturer's instructions. This ensures that the meter achieves the required in permissible error of 2% of the actual flow.

To ensure measurement accuracy, any operational limitations identified by the manufacturer with respect to the in situ conditions shall be complied with; that is, water quality and pipe configurations.

1.5. 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

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

For more information on data management, see Section 2: 'Data Processing and Preservation'.

1.6. General Inspection Requirements

For all meters, the site shall include the 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 one inspection per year is required to give the necessary confidence in the record.

1.7. Performance

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

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

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.

1.8. Verification of Accuracy

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

Installations are to be verified on commissioning, significant changes to the installed meter and on a 5 year cycle.

Note: some consenting authorities may require a higher frequency of verification checks dependant on the type of meter installed

For verification methods and their applied uncertainties, please refer to the *New Zealand Water Measurement Code of Practice* (Irrigation NZ, 2016) or the relevant local authority's own technical documents.

2. Data Processing and Preservation

This section contains information on the handling of data for processing and editing, to final archiving.

It defines the standards relating to:

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

2.1. 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. Data Transfer

The key requirements for data transfer are:

- data are recorded on a minimum of hourly 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
- if the data is to be processed by a third party, the data and QA record for a water year must be provided at an interval determined by the consenting authority.

2.3. Missing, Synthesised and Modified Records

2.3.1. 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 identified, then future analyses of the record becomes difficult, and the data can be of limited value.

2.3.2. Responsibility for Synthesising Records

Where practicable, the consenting authority or agency with delegation from the consenting authority shall:

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

2.3.3. Percentage of Record Required

The goal shall be zero missing record but acceptable performance will involve a managed amount of lost data. However, data loss in excess of 5% should result in a process to determine and rectify the root cause of the failure to ensure that the problem is not ongoing.

2.3.3.1. Data Logger or Pulse Output Failure

When a data logger or pulse output failure occurs, then daily manual flow meter readings shall be provided to meet the recording obligations of the consent holder.

2.3.3.2. 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.

2.3.3.3. Power and System Maintenance Interruptions

Some consenting authorities allow that systems may be offline in the off-season because of power interruptions or system maintenance. These events are acceptable in the record when defined and documented and the recording devices are operational upon recommencing abstraction.

2.3.4. 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 because the data is outside the standard for time accuracy.

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.

2.3.5. Modifications to Data

Data modification shall only be permitted where a site set-up 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.

2.3.6. Synthetic and Interpolated Data

2.3.6.1. 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 where it was identified as an instrument set-up error.
Corrections cannot be applied where it is an error caused by degradation of the meter.

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.

2.3.6.2. On-Site Trained Personnel

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

2.4. Metadata and 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.

2.4.1. Site-Specific Details

Site-specific details include the following:

- site purpose
- recording agency/agencies
- site location in standard and documented coordinate system (NZTM)
- 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.

2.4.2. 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; for example, 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.

2.4.3. Equipment Details

Equipment details include the following:

- logger and telemetry details
- sensor details (meter type-mechanical, electro-magnetic, ultrasonic)
Preferably through an agency instrument management system.
- calibration and verification records
Preferably through an agency instrument management system.
- any relevant comments in document vocabularies that future users will understand, and
For example, terms shall be defined and instrument types referred to, not brands.
- recorder comments.

Note: 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.

2.5. Preservation of Record

2.5.1. Performance

The following data shall be archived and retained indefinitely:

- final checked and processed data
- unedited raw data, and
- associated metadata, including:
 - data comments
 - site details
 - recording accuracy and resolution
 - site 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*
- *become corrupted, or*
- *be lost.*

2.5.2. Data Archiving

The archiving procedures, policies, and systems of the archiving body shall consider:

- any future system upgrade
- off-site duplication of records, and
- disaster recovery.

2.6. Quality Assurance

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

2.6.1. 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, and
The plots will show the level of compliance for the abstraction and detail the periods of use.
- comparative plots if possible with neighbouring takes.

2.6.2. Site Inspections

The following shall be included in the audit report:

- a copy of the meter inspection forms, and
The meter inspection should have been carried out within two years of the audit date.
- a copy of the latest verification report.

2.6.3. Other Requirements

2.6.3.1. Outputs

Recommended report outputs include:

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

2.6.3.2. Audit Certification

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

2.6.4. 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.

2.7. Quality Coding Water Use Data

2.7.1. Performance

All data shall be quality coded in accordance with the NEMS Quality Coding Schema.

Note: The National Quality Coding Schema permits valid comparisons within a data series and across multiple data series.

Annex A – List of Referenced Documents

International Organization for Standardization (ISO). (1999). *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* (ISO 4064B:1999/OIML R 49). Geneva, Switzerland: Author.

International Organization for Standardization (ISO). (2011). *Hydrometry – Vocabulary and symbols* (ISO 772:2011). Geneva, Switzerland: Author.

Irrigation NZ. (2016). *New Zealand Water Measurement Code of Practice*. Available from <http://irrigationaccreditation.co.nz/watermeasurement/>

Ministry for the Environment. (2010). *Resource Management (Measurement and Reporting of Water Takes) Regulations 2010*. <http://www.mfe.govt.nz/fresh-water/regulations-measurement-and-reporting-water-takes>



NEMS

