National Environmental Monitoring Standards

# Glossary

## Terms, Definitions and Symbols

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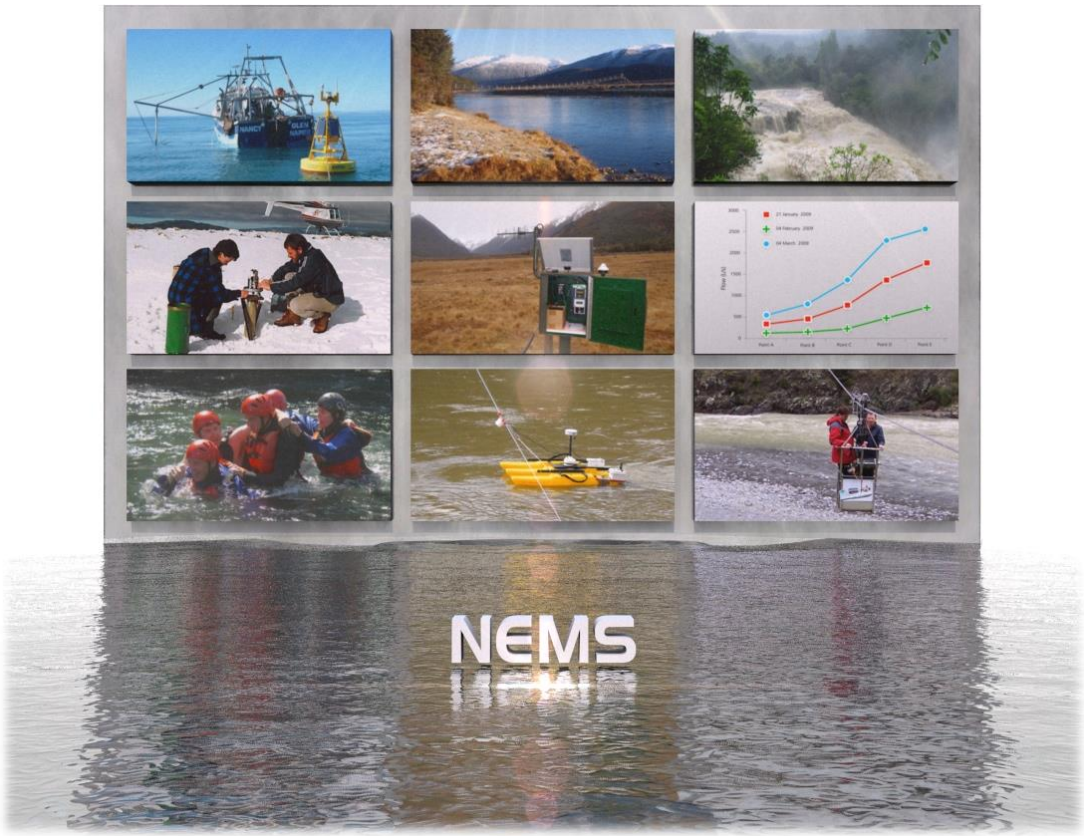

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# The National Environmental Monitoring Standards

The current suite of National Environmental Monitoring Standards (NEMS) documents, Best Practice Guidelines, *Glossary* and *National Quality Code Schema* can be found 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.

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## 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), now known as the Environmental Data Special Interest Group (ED SIG), 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 (Project Manager), and the current Steering Group comprises Phillip Downes, Michael Ede, Glenn Ellery, Jon Marks, Charles Pearson, Jochen Schmidt, Abi Loughnan, Ged Shirley, representatives from MfE and StatsNZ, and Raelene Mercer (Project Manager).

The development of these Standards 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 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.

This document was prepared by Marianne Watson (Hydronet Ltd) under contract to the NEMS Steering Group, and in collaboration with lead writers and working groups developing the various NEMS.

## Funding

The primary funders of the National Environmental Monitoring Standards project are Ministry for the Environment, and New Zealand regional councils and unitary authorities. Other financial and in-kind support to the overall NEMS project has been provided by the following organisations:

- National Institute of Water and Atmospheric Research Ltd (NIWA)
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- StatisticsNZ
- Meridian Energy
- Ministry of Business, Innovation and Employment – Science and Innovation Group
- Genesis Energy
- Contact Energy
- Mercury New Zealand Limited

## Review

This document will be assessed for review by the NEMS Steering Group as new NEMS documents are completed, or otherwise approximately once every two years. Further details on the review process can be found at www.nems.org.nz.

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# About this Glossary

## Introduction

A common vocabulary and set of symbols is essential to successful integration of the various Standards into a manageable quality programme, and to clear and consistent understanding and application of the requirements of each Standard.

## Objective

The objective of this document is to ensure a common vocabulary and symbology across the NEMS suite of documents.

## Scope

This document includes definition of technical terms, explanation of acronyms, and a list of symbols not normally encountered in common usage. It also includes common-use terms that have specific meanings in environmental monitoring.

The terms, acronyms and symbols in this Glossary apply to all other NEMS documents and may appear in any of the NEMS applicable to the measurement of any variable covered by the suite.

### Exclusions

The NEMS Glossary does not include comprehensive coverage of quality management terms that may be encountered in referenced documents. Where conflict arises between definitions in referenced documents and this Glossary, the definitions in the Glossary shall prevail.

## Formatting

Variables are italicised when used in the NEMS suite of documents, but for readability, they are not italicised in this Glossary.

# Definitions

**ABS (acoustic back-scatter sensor)** An instrument that measures the near-field intensity of sound back-scattered by suspended material within a single 'bin' (small sample volume) of water beside the sensor. (See also 'back-scatter').

**absolute soil water content** The weight of water per weight of soil; for example, grams of water/grams of soil.

**absolute turbidity** Turbidity data measured by a primary reference instrument, or converted from standard turbidity so that they are numerically equivalent to those measured by a primary reference instrument. The relationship applied is calibrated using paired measurements from the primary reference and in situ field instruments. (See also 'standard turbidity', 'calibration (of a relation or model)' and 'primary reference instrument').
*Note: The converted data are stored as records of 'Absolute turbidity'.*

**accuracy** Closeness of agreement between measurements of a quantity and the quantity's true (unknown) value. Accuracy includes a combination of both precision and bias. (See also 'uncertainty' and 'observation accuracy').

**acoustic profiler** An instrument, either side-looking (measuring laterally across channel) or vertical-looking (measuring between water surface and stream-bed (or vice-versa)), that measures the intensity of sound back-scattered by suspended material in water from a series of ranged 'bins', and usually integrated with acoustic current profilers, which use the Doppler shift of the back-scattered sound to measure the current velocity. (See also 'ADCP' and 'back-scatter').

**ADCP (Acoustic Doppler Current Profiler)** An instrument that uses acoustic signalling and Doppler principles to measure water velocity, direction, depth and boat speed when deployed periodically across a water body to perform a discrete discharge measurement (gauging), or to continuously measure acoustic back-scatter intensity when permanently installed submerged, either side-looking or up-looking, to provide a surrogate record for suspended sediment concentration. (See also 'acoustic profiler' and 'back-scatter').

**ADV (Acoustic Doppler Velocimeter)** A family of instruments that use acoustic signalling and Doppler principles to measure water velocities. Some devices may be used as a current meter to measure point velocities during a gauging while others are deployed in situ to measure velocity continuously.

**adjacent station (or site)** A nearby site on the same water body, often operated by a different agency, that is sufficiently close to be recording the same or almost the same data. If the data are effectively the same, the adjacent station may function as the backup recorder.

**adjusted intensity gauge data** The rainfall intensity gauge data that have been rescaled to reconcile it with the primary reference gauge total.

**affiliated monitoring** The collection of complementary data that inform on the variable of interest without being essential for correct measurement of the variable or for calculating derived measures from the variable. (See also 'associated monitoring').
*Note: The complementary data may comprise observations, photographs, hydraulic data or the sampling of other variables that may be influenced by the variable of interest, and they may be supplementary measurements or contribute to metadata.*

**alpha** A coefficient applied in surface velocity methods of discharge measurement, being the ratio between mean velocity and velocity at the water surface.

**analyte** A substance whose chemical constituents are being identified and measured. (See also 'variable').

**anion-cation balance** The balance within a water sample of the number of positively charged ions in solution (cations) and the number of negatively charged ions (anions). Calculated by comparing the total charge of the cations with the total charge of the anions.

**anode** An electrode at which electrons leave a cell and oxidation occurs. (See also 'cathode').

**APHA method** or **APHA equation** Method or equation listed in the reference textbook "*Standard methods for the examination of water and wastewater"* published by the American Public Health Association (APHA), the American Water Works Association (AWWA) and the Water Environment Federation (WEF).

**archive rating** A rating stored indefinitely as part of the historic hydrological record for a site; deemed to suitably define the relation, constructed using all possible relevant calibration data, quality assured, assigned a period of applicability consistent with the period of stable control it represents, and appropriately transitioned to prevent discontinuities being generated in the derived flow series.
*Note: New data at any time, typically a new gauging of extremely high or low flow, may initiate review of and change to any or all archive ratings for a site, which may include adding new ratings and/or deleting ratings previously stored, or change to the period of applicability and/or transition period of a curve. The archive update process must ensure that no remnants of superseded curves remain in the data set nor unintended overlap of curves arise as they are applied.*

**archiving agency** The agency that is responsible for data archiving, quality assurance and control for data sets.

**associated monitoring** The collection of supplementary measurements that are essential for correct measurement of the variable (such as non-vented groundwater head needing barometric compensation to provide groundwater level) or for calculating derived measures from the variable (such as load determined from concentration of the analyte and water discharge).

**auto-sampler** A sampling device that automatically collects water samples from a water body and stores them for later collection in an array of one or more sample bottles.

*Note: Generally used to describe 'active' electrically driven auto-samplers, which pump a sample on a schedule that can be time-controlled or controlled via a data logger. 'Passive' auto-samplers are stationed in-stream and collect a sample as water level rises past the intake.*

**averaging interval** The period over which samples from a sensor are statistically summarised prior to logging the result as the value of the variable being measured. The statistic is usually the arithmetic mean but may be a geometric mean or median.

**avulsing** A term used to describe a river or stream prone to rapid abandonment of all or part of its channel in favour of formation of a new channel.

**back-scatter** The diffuse reflection of waves, particles or signals back in the direction of their source.
*Note: The measured acoustic back-scatter intensity from suspended material in water depends on instrument design, sediment concentration, and sediment composition (notably size grade) hence its use as a surrogate for suspended sediment concentration once calibrated to the sediment composition.*

**backsight (BS)** A reading 'looking back' along the line of progress to a position of known elevation when surveying. Since a survey progresses from a point of known elevation to points of unknown elevation, the first reading of almost any survey should be a backsight onto a fixed point of known elevation, usually a benchmark of some sort.

**backwater** Water held up or pushed back by some downstream obstruction to free flow. Also known as the backwater effect.

**bankfull stage** The level in terms of gauge height below which discharge is confined to the active channel and above which water spills onto berms and/or a floodplain.

**baseline drift** A continuous and gradual change in the measured background response.

**bed load** The coarser fractions of the stream sediment load that are too heavy to be suspended by turbulence but are tumbled, slid, or saltated (i.e. "skipped") over the bed by the near-bed current.

**benchmark** A fixed permanent reference point of known or assigned elevation used when levelling to determine elevation of other points in a circuit or traverse.

**bias** The systematic difference between true values and those values measured by an instrument or estimated by a predictive relation. Measurement bias (error) affects the accuracy of a measurement and is often due to the measurement process.

**biofilm** A thin resistant layer of micro-organisms; for example, bacteria and their secretions that stick to each other on a hard hydrated surface and may adhere or attach to the surface.

**biofouling** An accumulation of living organisms that has an adverse effect on measurements; for example, unwanted algae, on equipment such as a sensor lens.

**blank sample** A water sample containing little to no analyte of interest, usually collected for instrument calibration or quality assurance purposes. Blanks may be collected in the field using de-ionised or distilled water under field conditions (field blanks) or in the laboratory (laboratory blanks).

**blanking distance** The area near the transducers of an ADCP in which no measurement is taken. Also known as the blank.

**blue tick** An accreditation program administered by IrrigationNZ.

**bottom tracking** An acoustic method used to determine boat speed and direction by computing the Doppler shift of sound reflected from the stream bed relative to the ADCP.

**box coefficient** A term commonly used in the United States to represent the ratio of the all-of-cross-section discharge-weighted sediment concentration to the sediment concentration of an index sample.

**bubbler** An instrument used to measure fluid levels in streams, lakes, groundwater and tanks by way of sensing the pressure required to produce a constant flow of bubbles out the end of an air tube submerged in the fluid, against the pressure head of that fluid over that orifice.

**bulk density** The mass of the soil particles divided by the volume occupied by soil and voids in the sample.

**calibration (of an instrument)** The process of comparing the response of a measuring device or instrument (e.g. field meter) to known values of a traceable standard or standard solution of the variable of interest, over a defined range and in controlled conditions. (See also 'standard solution', 'traceable standard', 'validation' and 'verification'.)
*Note: Results may indicate a need for repair or adjustment of the device or instrument so that it displays the correct reading when compared to the known values. Calibration is repeated after servicing, when the device or instrument is in good working order, to demonstrate a proper response has been re-established ready for deployment.*

**calibration (of a relation or model)** The process of estimating then adjusting the values of parameters, constants and coefficients in a mathematical or numerical model to best represent the real-world processes of interest and optimise agreement between observed data and the model's predictions. Agreement is usually determined by tests of goodness-of-fit. (See also 'validation').
*For example: Calibration of relationships to transform relative measurements to their absolute form (e.g. soil water content and turbidity) or surrogate measurements to the target variable (e.g. stage to discharge or turbidity to suspended sediment concentration).*

**calibration range** The range over which the calibration has been made.

**calibration standard** A traceable standard used for calibrating water and air quality instruments that may be a standard solution, or a suspension in the relevant medium. (See also 'standard solution' and 'traceable standard'.)

**cathode** An electrode at which electrons enter a cell and reduction occurs. (See also 'anode'.)

**cease to flow (CTF)** The lowest elevation of a hydraulic control below which water will be retained and therefore not flow.

**censoring** Replacement of a raw measurement value by the laboratory with a rounded value to take account of the detection limit (left censoring or <) or upper calibration value (right censoring or >) appropriate to the test method.

**change point (CP**) A point of fixed location and elevation used as a temporary reference when the survey instrument must be moved to sight additional points in a circuit or traverse; for example, a nail in a tree or fencepost, a mark on a curb, or a sturdy stake driven in an out-of-the-way area of a site. A CP is read first as a foresight, then again as a backsight after the instrument has been moved.

**channel** An open natural or artificial watercourse that periodically or continuously contains moving water.

**check data** A term used to describe reference values and their dates and times of observation particularly when applied to the verification and processing of logged data.
*Note: For a water level series, the check data may be staff gauge or EPB readings; for a rain gauge, the check data are rainfall totals recorded from the primary reference gauge.*

**chemical fouling** An accumulation of inorganic substances that have an adverse effect on measurements; for example, unwanted salts and oxides on equipment such as a sensor lens.

**circuit** In surveying, also known as a traverse. (See 'traverse'.)

**clay** Mineral grains that have a diameter less than 0.004 mm (4 μm). (See also 'mud', 'silt', and 'sand').

**closing error** The difference between the elevation determined by leveling and the expected 'known' elevation of the end-point of a survey. Also known as misclose. Closing error cannot be calculated for an open traverse. (See 'traverse'.)

**comments file** A metadata file associated with the data file that provides time-stamped descriptive information about the site and data.
*Note: For a flow series, the comments file may include information about the gaugings, ratings and extreme flows.*

**commissioning agency** The agency that initiates data collection.

**complex rating** A relation intended to transform one variable to another, where the predicted variable is dependent on more than one input variable and/or may not be unique for a given input value.

**composite samples** Two or more discrete water samples mixed together to provide an average representation of a sampling location or time.

**consent (resource consent)** Authorisation granted under the Resource Management Act and Amendments to use or modify a natural or physical resource.

**consent holder** The person or entity who has been granted authority to use or modify a natural or physical resource (i.e. a resource consent) and to whom any associated regulations apply.

**consenting authority** An organisation charged under the Resource Management Act and Amendments with managing the resource consent process; usually a regional, unitary or territorial council.

**control** The physical properties of a cross-section or reach of an open channel, natural or artificial, which determine the relationship between stage height and discharge at a location in the channel.

> **artificial control** A hydraulic structure, e.g. a weir or flume, installed in an open channel to create a cross-section of reduced area in order to induce critical flow through or over the structure. In most cases discharge can be derived from the upstream water level. In some cases it may be a pre-calibrated structure.
>
> **bed control** A structure installed in an open channel to create a section control and/or improve stability of the channel in the recording reach; for example, a timber weir or rocked grade control.
>
> **channel control** Where the relationship is governed by the geometry and features of a reach of channel, in almost all cases downstream of the recorder. In the absence of confining structures, e.g. a bridge, high-flow controls are usually channel controls.
>
> **permanent control** A natural or artificial control that remains unchanged for a long period of time.
>
> **section control** Where the relationship is governed by the geometry and features of a particular cross-section downstream of the recorder; these are usually low-flow controls.
>
> **shifting control** A section or channel control that changes form and/or location frequently due to mobilisation of the stream bed and/or banks in alluvial or sand channels, or cycles of material such as weed or ice accumulating.

**control limit** The upper or lower bound of expected variation in data of or from a process, determined statistically, and used to judge the significance of variation in the data and/or whether the process is operating satisfactorily.

**Coriolis coefficient** The ratio of mean of velocity head to theoretical velocity head used to correct energy equations if velocity varies across the section. Also known as the kinetic energy correction coefficient.

**coverage factor** A multiplier applied to a standard uncertainty to determine expanded uncertainty to a desired level of confidence.
*For example: A coverage factor of 2 represents an interval of two standard deviations within which the true value might be found; that is, there is 95% probability that the true value is contained in the interval described by twice the standard uncertainty of the*

*estimate. A coverage factor of 2 therefore provides for 95% level of confidence that the true value is contained within the expanded uncertainty calculated for the measurement result.*

**cross-section** A specified section of a water body bounded by a straight line across the free surface and the corresponding wetted perimeter.
*Note: For the calculation of area of discharge, the line across the free surface must be normal to the mean direction of discharge; that is, the shortest width across the flowing channel.*

**C-tick certification** A third-party declaration of compliance with standards for performance with respect to radio frequency and/or electromagnetic interference.

**current meter** An instrument for measuring water velocity.

**custodian** The agency responsible for ensuring the preservation and dissemination of data.

**CV (coefficient of variation)** A statistical measure of the dispersion of measurement results around the mean.

**daily manual gauge** A type of a primary reference rain gauge; usually read at the same time each day.

**data element** One or more simultaneous values and their associated date and time, a chronological sequence of which constitutes a time series. (See also 'time series' and 'timestamp'.)

**data filter** A collective term for various methods of resampling, censoring, or statistically smoothing data for the purpose of reducing unwanted noise in the data. (See 'noise'.)

**datum** A reference level from which elevations are measured. It may be relative to some known level, e.g. mean sea level, or assumed. It should be used to determine elevation of station benchmarks.

**depth** The vertical distance below the free surface of a stream to a point of interest; for example, the position of a measuring instrument, or the bottom of the stream at any point on a cross-section.

**depth cell or bin** A truncated cone-shaped volume of water at a known distance and orientation from the ADCP transducers.

**depth-integrated sample** A composite sample collected over a predetermined part or the entire depth of the water column in a body of water.

**depth-integrating sampler** An isokinetic sampling device that, when traversed at a steady rate through a sampling vertical between the water surface and streambed and back again, collects a sample that is velocity-weighted. It has a concentration the same as would be obtained by integrating the product of local velocity and local concentration over the water depth.

**depth profile samples** A series of water samples or measurements taken at various depths from a body of water at a specific location; may be discrete or continuous samples.

**DGPS (Differential Global Positioning System)** An enhanced GPS system that uses a network of fixed ground-based reference stations to broadcast the difference between measured satellite ranges and actual satellite ranges to roving receivers.

**diel** Pertaining to a 24-hour period, particularly a regular daily cycle, that includes day and night, as opposed to a diurnal (day) or nocturnal (night) phenomenon.

**discharge** The outflow of a conduit or drainage basin, expressed as the volume of liquid flowing through a cross-section in a unit time.

**discharge coefficient** The ratio of actual to theoretical discharge, used to account for irrecoverable energy losses arising from the resistance to fluid flow posed by structures and equipment.

**discharge rating** A curve, equation or table that expresses the relation between the surrogate measured variable and the discharge in an open channel or conduit at a given cross-section.

**discharge-weighted mean (or average) concentration** The instantaneous load of an analyte or particulate passing through a nominated zone, divided by the corresponding water discharge through the same zone.
*Note: The nominated zone may be a cross-section or vertical or unmeasured area. Units are mg/L or g/m$^3$, which are equivalent.*

**discrete sample** A sample or set of samples taken from a body of water at a defined time (as opposed to continuous sampling). A discrete sample may be collected once, or regularly (e.g. weekly or monthly), or irregularly (periodically).

**dissolved oxygen (DO)** The amount of gaseous oxygen present in water.

**drawdown** The effective lowering of surface water or groundwater levels relative to the surrounding water body; for example, near the outlet of a natural or artificial structure**,** such as a dam or lake outlet, or the lowering of the water table caused by pumping of groundwater from a well.

**drift** A continuous and gradual change in the response from an instrument referenced to some known or demonstrably stable condition. (See also 'baseline drift'.)

**edited data** Data that may have been altered to correct for changes in baseline drift, or been smoothed, or changed as a result of calibration or validation checks.

**effective stage** The height of the water surface above an orifice, stilling well intake, or other point of exposure of a sensor to the water body.

**effective water's edge** A position on a cross-section that is a boundary between flowing and non-flowing water.

**electric plumb bob (EPB)** See 'internal plumb bob'.

**electrochemical sensor** An instrument comprised of electrodes (anode and cathode, and possibly reference) housed in liquid electrolyte. When the substance to be measured makes contact with one electrode, a chemical reaction occurs that results in an electric current proportional to the concentration of the substance.

**electrolyte** A substance, usually a soluble salt, acid or base, that ionises when dissolved in a suitable solvent; for example, water.

**electromagnetic** Pertaining to the interaction between electricity and magnetism; specifically magnetism caused by an electric current, or induction of an electric current by changing a magnetic field.

**elevation** The vertical distance above a datum.

**ensemble** A single profile of the water velocity through the water column consisting of one or the mean of multiple acoustic measurements collected from an ADCP instrument.

**equal discharge increment (EDI)** Involves locating isokinetic sampling verticals at the centroids of sub-sections carrying equal portions of total water discharge.

**equal width increment (EWI)** Involves locating isokinetic sampling verticals at the midpoints of sub-sections of equal width.

**exposure** The degree to which the environment of a rain gauge's location affects its catch. The most significant influences are speed and distortion of airflow across the gauge and possible entry of additional water.

**external staff gauge (ESG)** A graduated scale mounted as permanently as possible either vertically or inclined in a water body, used to read water level in terms of the recording datum, in most cases as an independent check on an in situ sensor.

**FAU (Formazin Attenuation Units)** The units of turbidity assigned to readings from turbidimeters calibrated with reference suspensions of formazin. (See 'turbidimeter').

**ferrous** Of or containing iron, particularly as bivalent Fe2+.

**field calibrator** A portable device used at site to independently validate performance of the in situ measuring instrumentation.

**field capacity** The water content held in soil after gravitational drainage from a saturated condition falls to a rate that is insignificant (i.e. drainage rate ≤ 1 mm/day). *Note: This is usually estimated in the field by measuring the soil water content two to three days after heavy rainfall, or by measuring the water content of soil cores in the laboratory after they have been equilibrated at a soil matric potential. In New Zealand, the laboratory estimation of field capacity is measured at the nominal −10 kPa soil matric potential, but direct field measurements show that it can vary between −2 kPa and −30 kPa, depending on soil texture.*

**firmware** Software for hardware; for example, the control program embedded in a device.

**flood** A high river flow event that fully occupies the active river channel and may spill out onto the floodplain inundating land that is normally dry.

**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, and to the time series that results from applying a discharge rating to a record of stage. (See also 'discharge'.)

**flow cell** An enclosed vessel into which water is pumped, that also houses water quality sensors, to isolate the fluid from the surface environment and ensure minimal aeration.

**flow meter (water meter)** See 'water meter'.

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

> **minimum flow rate, *Q*1** The lowest flow rate at which the water meter is required to operate 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.
>
> **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.
>
> **transitional flow rate, *Q*2** The flow rate that occurs between the permanent flow rate, *Q*3, and the minimum flow rate, *Q*1, which divides the flow rate range into two zones, the upper flow rate zone and the lower flow rate zone, each characterised by its own maximum permissible error.

**fluvial** A collective term for processes in a river or stream associated with movement of sediment, and creation or alteration of landforms, by the action of the river or stream; that is, by erosion or deposition.

**FNU (Formazin Nephelometric Units)** The units used to report turbidity measured with instruments that meet the ISO 7027 Standard.

**formazin** A compound used to create reference solutions of suspended material that are used to calibrate turbidity sensors.

**foresight (FS)** A reading 'looking forward' to the next position along the line of progress when surveying. Since a survey progresses from a point of known elevation to points of unknown elevation, the last reading before moving the instrument during or at the end of any survey is a foresight.

**FRE3** The frequency of flows greater than three times the median flow; used as an index of flow variability particularly with respect to the frequency of events likely to disturb periphyton accumulation (Clausen and Biggs, 1997). Usually an exclusion period of five days is applied from the end of each event before the next event can be counted.

**fresh** An elevated river flow event, occurring relatively often and large enough to carry a suspended sediment load but too small to be regarded as a flood.

**full flood extent** The extremities to which water will spread at the conceivable highest stage.

**full pipe flow** Flow in a closed pipe or conduit that is full of water; that is, has no free surface.

**full-scale error** Absolute error divided by the measurement range of the device, often expressed as a percentage of full scale (%FS). The error is a fixed value and therefore less by proportion when the device is operating near its maximum range than when operating lower in its range. In contrast, error expressed as percentage of measured value (reading) (%RD) is the same proportion of the flow throughout the measurement range.

**gauge height** The water level measured at a water monitoring site, typically when read from a staff gauge. (See also 'water level' and 'stage or stage height'.)

**gauging** The physical act of measuring discharge. May also be used to refer to the combined result of the measurement, including the stage, date and time representative of the measurement.

**geometric sequence** A mathematical progression in which the ratio of successive terms is constant; for example, 100, 300, 900… .

**GPS (Global Positioning System)** A space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.

**gravimetric method** A procedure for quantitative determination of an analyte by weighing the mass of collected solids.

**gravimetric water content** The mass soil water content relative to the mass of oven-dry soil; it is given in units of kg, $kg^{-1}$ or other consistent mass units.

**groundwater** Water that occurs below the ground surface in the pore spaces between the grains of unconsolidated sediments (e.g. sand or gravel) and in the fractures of consolidated rock, within the saturated zone.

**height of collimation** The elevation of the optical axis of the levelling instrument, determined by sighting onto a staff placed on a benchmark then adding the staff reading to the benchmark elevation. Also known as height of instrument (HI) or line of collimation.

**HDOP (horizontal dilution of precision)** A measure of the geometric quality of a GPS satellite configuration that is a factor in determining the relative accuracy of a horizontal position. A smaller dilution means better accuracy.

**height of instrument (HI)** See 'height of collimation'.

**homoscedasticity** When the error term is the same across all values of the independent variable(s) in a relationship, i.e. there is no systematic change in the spread of the residuals over the range of the measured values.

*Note: Homoscedasticity is a fundamental assumption of ordinary least squares regression.*

**hydraulic mean depth (mean depth)** The ratio of area to top-surface width of a cross-section.

**hydraulic parameters** The set of measureable factors that describe the behaviour of water when static and when conveyed in a pipe or channel.

**hydraulic radius** The ratio of area to wetted perimeter of a cross-section.

**hysteresis** The dependence of a system not only on its current environment but also on its past environment, producing values of physical properties that are looped or that lag behind changes in the effect acting on the system.

**hysteresis** The dependence of the present state of a system on its previous states, usually resulting in a delayed response to changes acting on the system, and values of its physical properties that are looped or that lag behind the changing inputs.

**index sample** A sample, collected manually or by auto-sampler from a fixed point over the stream cross-section, usually beside the stream bank, that after calibration may be used to represent the discharged-weighted concentration for the whole cross-section.
*Note: For suspended sediment, equivalence is achieved by applying a box coefficient.*

**in situ** Deployed continuously on site at a fixed location.

**instantaneous measurement** A measurement or average of a series of measurements (or alternative central statistic, e.g. median or mode) spanning a period no greater than 20 seconds.

**instantaneous value** The result of instantaneous measurement, or the average of a series of measurements (or alternative central statistic, e.g. median or mode) spanning a period of less than 5 minutes that is taken to represent the quantity at the instant of time that the value is recorded.

**intensity gauge** A rain gauge that provides a record of the onset, rate and cessation of rainfall.

**intermediate (sight) (IS)** Readings to determine elevation of additional points of interest aside from those that form the main traverse or circuit of a survey. Intermediate readings are not backsight-foresight pairs and therefore not verified unless observed twice from two different instrument positions during the survey, and are not used in the circuit close; that is, to determine closing error.

**internal plumb bob** A non-recording gauge that is normally used to measure the water level in a stilling well. Also known as an electric plumb bob or EPB.

**invert** The lowest part of the cross-section of a conduit or pipe, including an intake pipe, or the underside of a recorder housing.

**isokinetic sampling** When the water velocity entering a sampling device matches the ambient water velocity.
*Note: This is important when sampling suspended sediment load to ensure efficient sampling of all size fractions, particularly the sand fractions.*

**Kainga primary reference gauge** A type of a primary reference rain gauge.

**kinetic energy correction coefficient** See 'Coriolis coefficient'.

**Lidar** A remote sensing technology that analyses light reflected from a laser-illuminated target to measure distance. Capable of producing high-resolution maps and 3-D images from which profiles and sections can be extracted.

**limit of detection (LOD)** The lowest quantity (often a concentration) that can be measured within a stated confidence limit. Also known as the method detection limit (MDL).

**logarithmic bias** A bias that occurs when a function is fitted statistically to the logarithms of data and is subsequently re-transformed back to the original scale of the data.

**logger volume** The volume of metered water extracted, as recorded on the logger between verification visits.

**LOWESS/LOESS (Locally Weighted Scatterplot Smoothing / Locally Weighted Smoothing)** Non-parametric regression methods that combine multiple non-linear regression models to create a smooth line through a scatterplot. They are computationally intensive methods.

**macro-fouling** Interference caused by solid objects snagged on or caught within a sensor or its housing, or invading a sensor's detection volume; for example, suspended debris, loitering aquatic animals, or growing in-stream vegetation.

**mag flow** or **magnetic flow meter** A meter in which a magnetic field applied to the metering tube results in a potential difference proportional to the flow velocity perpendicular to the flux lines. Also known as a mag meter.

**metadata** A set of data that describe and give information about other data. Metadata may describe the content, quality, condition, location or other characteristics of the data, and operations on or modifications to that data.

**meter volume** The change in incremental volume of metered water extracted between inspections, as derived from the meter display.

**method detection limit (MDL)** The lowest quantity (often a concentration) that can be measured within a stated confidence limit. Also known as the limit of detection (LOD).

**metrological** Of or pertaining to the science of all theoretical and practical aspects of measurement.
*Note: Not to be confused with 'meteorological', the study of the atmosphere, especially weather and weather conditions.*

**moving bed** Of or pertaining to the mobilisation of sediments on or near the bottom of a river or stream.

**MSL (mean sea level)** The level frequently used as datum for traditional survey levelling of station benchmarks. True elevation of MSL varies around New Zealand and over time.

**mud** Mineral grains finer than 0.063 mm (63 µm). Includes clay grains (finer than 4 µm) and silt grains (4 µm to 63 µm). (See also 'clay, 'silt', and 'sand').

**nephelometer** A type of turbidity sensor that measures the light scattered back from suspended material in the water using a detector set to one side of the source beam (most often at an angle of 90°).

**noise (noisy data)** The excessive fluctuations in a variable's measurement results that alters or obscures the signal representative of the variable.
*Note: Typically, the variability is high frequency, occurring between the values of consecutive samples, and is sometimes referred to as 'painting' or 'hunting'.*

**non-volatile memory** A computer chip that holds its content without power applied.

**normative reference** A reference considered to be an indispensable and prescriptive part of a Standard, that should be read and implemented in conjunction with the document containing the reference; in effect becoming part of the requirements of the Standard from which it is referenced.
*For example: The requirement "Turbidity sensors deployed in situ for continuous monitoring shall meet the ISO 7027:1999 Water Quality – Determination of Turbidity Standard." makes this ISO Standard normative for NEMS turbidity measurement.*

*Note: Normative reference is made to an identified and dated issue of the referenced document. Normative reference should not be made to a document used only in preparation of a NEMS or intended only for information.*

**NPS-FM** National Policy Statement for Freshwater Management.

**NZDT (New Zealand Daylight Time)** New Zealand (except Chatham Islands) summer time when clocks are moved forward 1 hour to UTC + 13 hours, to effect more 'daylight activity' hours. Usually begins around the first Sunday in October and ends on the last Sunday in April. Historically, different periods have applied. (See also 'NZST'.)

**NZGD2000 (New Zealand Geodetic Datum 2000)** The official geographic reference system for New Zealand, adopted in 1998, from which latitude, longitude and ellipsoidal height of any physical location are determined. It is compatible with GPS so positions between the two systems are equivalent for most practical purposes.
*Note: Coordinates from GPS are generally referenced from the World Geodetic System 1984 (WGS84) or International Terrestrial Reference Frame (ITRF) global datum, which do not apply a tectonic plate deformation model and thus vary from NZGD2000 over time (up to 5cm/year since 2000).*

**NZMG (New Zealand Map Grid)** The unique NZGD1949 projection, based on the New Zealand Geodetic Datum 1949 (NZGD1949) using the International 1924 reference ellipsoid, that provides the coordinate system used for the NZMS260 1:50,000 topographic map series, applicable for New Zealand except the Chatham Islands. NZMG was replaced by NZTM2000 in 2001.

**NZST (New Zealand Standard Time)** New Zealand (except Chatham Islands) normal time when clocks are set to UTC + 12 hours. (See also 'NZDT'.)

**NZTM2000 (New Zealand Transverse Mercator 2000)** A Transverse Mercator projection, based on NZGD2000 datum using the GRS80 reference ellipsoid, that provides the coordinate system used for the Topo50 1:50,000 topographic map series, applicable for the main New Zealand island group (North, South, Stewart and the smaller coastal islands) as formally defined in the Land Information NZ (LINZ) Standard LINZS25002. NZTM2000 replaced NZMG in 2001.
*Note: Transformation of coordinates between NZMG and NZTM2000 is not straight forward and it is not possible to have NZMG coordinates in terms of NZGD2000 or vice versa.*

**NZVD2009 (New Zealand Vertical Datum 2009)** The official vertical datum for New Zealand and its offshore islands as defined by the NZGeoid2009 reference surface that relates normal-orthometric height, i.e. elevation of the land surface, to ellipsoidal height given by the NZGD2000 datum, and formally described in the Land Information NZ (LINZ) standard LINZS25004.
*Note: Offsets are also defined to enable transformation of heights between NZVD2009 and 13 major existing local mean sea level (MSL) datums. In New Zealand, ellipsoidal height and sea level can differ by over 35 metres.*

**OBS (optical back-scatter sensor)** An instrument that measures the near-field intensity of light back-scattered by suspended material within a sample volume of water beside the sensor. (See also 'back-scatter').
*Note: Location of the sample volume depends on the instrument type and measurement protocol.*

**observation accuracy** The maximum expected difference between the in situ sensor measurement and the traceable reference value; that is, the sum of the observation tolerance and the precision of the reference sensor.

**observation tolerance** The range of variance between in situ sensor and reference measurements that is permitted or which defines agreement.

**octapent** A type of primary reference rain gauge with a 5″diameter orifice and 8″ diameter receiver canister.

**ODBC (Open Database Connectivity)** A standard application programming interface (API) for accessing database management systems (DBMS) intended to be independent of database systems and operating systems and therefore make it possible for applications to access data from a variety of DBMS.

**off-season** The part of the year in which a particular activity, e.g. irrigation, reduces or ceases.

**open channel flow** The flow driven by gravity, exposed to the atmosphere in a conduit that does not completely enclose the fluid such as a canal, flume, ditch or race.

**operational rating** A rating stored indefinitely as part of an ongoing record of real or near-real time determination of flows for a site; deemed to suitably define the relation, constructed using best available calibration data at the time of determination, quality assured, and applicable from the date of publication forward.
*Note: Operational ratings are often used to assess compliance with consent rules and may*

*be required for evidence, so while possibly provisional they are rarely retrospectively altered. If new data indicate an existing operational rating should be amended, it is usual to implement the alteration as an entirely new rating so as to not disturb the integrity of prior compliance tests.*

**optical backscatter (point) sensor (OBS)** A type of in-situ at-point turbidity sensor that measures the light scattered back from suspended material in the water at an angle greater than 90° (typically at 140° to 160° from the source beam direction).

**optode** An optical sensing device used to measure a specific substance, usually with the aid of a chemical transducer.

**overall accuracy** The combined uncertainty of all errors in a composite measurement, e.g. a gauging, or a result, e.g. a rated flow series.

**over-ranging** When an instrument returns a value outside of the range for which it is calibrated or designed to measure.

**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.

**peak clipping** Failure to record the actual values of a measured variable in excess of some upper limit of the recording system; the data are truncated at the limit.

**permanent wilting point** The soil water content at which plants can no longer extract water from the soil and the plant is permanently wilted.
*Note: The actual soil water potential at which permanent wilting point occurs varies between plant types, but in New Zealand it is nominally estimated in the laboratory by measuring the soil water content at –1500 kPa soil water potential.*

**pipe nominal diameter (DN)** A sizing system for pipe based on its internal diameter. Also known as nominal bore (NB), and is related to nominal pipe size (NPS) in North America for diameters up to 12 inches.

**POEM (Pressure Operated Electronic Meter)** A depth and velocity measuring instrument that uses a forward-facing pitot tube on the front of a streamlined weight that houses velocity and depth sensors.

**point-pair** A coordinate pair of unrated and corresponding rated values that lie on the rating curve. An appropriately selected set of point-pairs and an interpolation method define a rating curve in most time-series software used in New Zealand.

**point-sampler (point-integrating sampler)** An isokinetic sampler that has a remotely controlled valve that allows a water sample to be collected at a discrete point (i.e. depth) in a sampling vertical. It may also be used to collect a depth-integrated sample over a discrete range of depth in the sampling vertical.

**point velocity** A sample of velocity measured at a specific location on the cross-section and in the vertical.

**pool** The part of a flowing channel with deep, slow-flowing water and a smooth water surface, usually where the stream widens and/or deepens, often on the outside of bends. (See also 'riffle' and 'run'.)

**precipitation** Any form of water in liquid or solid form falling from the atmosphere to the surface of the earth, including rain, snow, sleet, hail, drizzle and dew. Fog is not considered precipitation because the water is suspended.

**precision** Closeness of agreement between repeated independent measurements of the same quantity under unchanged conditions. Depicted by the random error in results of repetitions of the same test performed on the same sample. (See also 'reproducibility').
*Note: In "NEMS Measurement of Fluvial Suspended Sediment Load and its Composition" precision includes reproducibility.*

**primary reference gauge** A gauge that allows measurement independent of the sensor and directly in terms of the measurement reference.
*For example: A storage rain gauge deployed long-term at standard orifice height, or a staff gauge or electric plumb-bob with gauge zero in terms of the station datum.*

**primary reference gauge data** One or more measurements from a primary reference gauge that is independent of the sensor. For rainfall, this data is often referred to as check gauge data. (See also 'check data'.)

**primary reference instrument** An instrument of a given brand and specification that is designated as a common reference for a network of deployed in situ instruments and/or a series of in situ instruments over time. Measurements, once in terms of the common reference, are comparable across the network and over time. (See also 'stationarity of record').
*For example: A neutron probe used for field calibration of a network of soil moisture sensors or a specific brand of ISO 7027-1:2016 compliant turbidity instrument used for measuring or derivation of absolute turbidity.*

**procedure** The series of ordered steps, i.e. the detailed method followed to execute a process. (See 'process'.)
*Note: Procedure should be written down if it is poorly understood, or people are confused and/or interpreting it in different ways.*

**process** A set of actions directed toward a defined end result (the objective). Process is related to procedure in that often, procedure is required to execute a process. (See 'procedure'.)
*Note: Procedure is needed when process is lengthy, complex, routine but everyone must follow the rules, demands consistency, involves documentation and/or significant change, or has serious consequences.*

**processing (data processing)** Quality control procedures applied to the data including actions that verify, validate, qualify, adjust and/or repair data, trace those decisions and actions, and record a summary of the decisions and actions with the data.

**profile** A contoured vertical cross-section of a structure; for example, characteristics of a soil, distribution of temperature in a lake, or the velocity distribution of a stream, or the act of measuring that distribution. (See also 'velocity'.)

**profile available water (PAW)** The amount of water that a soil can hold for plant growth. It is defined as the water held in the soil profile between field capacity and

permanent wilting point to a depth of 0.9 m, or to the potential rooting depth (whichever is the lesser). Values are weighted averages over the specified profile section (0–0.9 m) and are expressed in units of mm of water; for example, PAW 200 mm.

**propeller current meter** A current meter whose rotor is a propeller rotating around an axis approximately parallel to flow. Also known as a horizontal axis meter.

**provisional rating** A phase of rating development where the relation is still being determined, and/or the curve lacks the required minimum evidence, and for which collection of additional calibration data remains possible under normal circumstances; that is, notwithstanding opportunity to measure a relatively rare low or high flow extreme that may then initiate review of all ratings for a site.
*Note: A provisional rating may be altered and refined as new calibration data becomes available, thus flows derived from the relation may change after each iteration. Provisional ratings are therefore quality coded QC 200 'of unknown quality', 'not assigned a final quality code'. The code(s) for all or part of the rating range may be revised subsequently when the rating is adopted for the record.*
*Both operational and archive ratings may be provisional until deemed suitably defined (adopted), or until superseded by a subsequent rating shift that prevents collection of more calibration data representing the prior state of control.*

**pulse output** A switch closure output from a meter or gauge that represents a set volume of water.

**QC** An abbreviation for quality control or, where followed by a number, an abbreviation for quality code. For example, a quality code of 600 may be referred to as QC 600.

**quality assurance (QA)** Checking to ensure procedures have been followed, so that an acceptable product is likely to be achieved.

**quality codes** A series of defined codes attached to the data that convey information about the quality of the data.

**quality control (QC)** Evaluating conformity of the product by testing it, or samples of it, against the specification.

**quality control (QC) sample** In a laboratory, a synthetic sample made from chemicals from a different source to those used for calibration, or a bulk sample that has been analysed many times to obtain control limits (e.g. bulked supply waters to provide a QC sample for fluoride analysis).

**range of expected flow rates** With respect to water metering, the range from 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.

**rainfall** Precipitation that falls as drops greater than 0.5mm in diameter.

**rainfall intensity** The rate of rainfall.

**rating** A relation intended to transform one variable to another, or the process of determining and applying the relation.

**rating change** A major change in the relation between two variables necessitating a change in shape of the rating curve; that is, the new curve does not conform to the shape of an established 'family' or 'type'.

**rating model** The complete set of rating definitions and associated periods of applicability necessary and the rating interpolation and transition method(s) applied to transform a record at a site from one variable to another; for example, stage to discharge or flow to sediment concentration.

**rating (curve) segment** A contiguous portion of a rating curve with consistent shape and/or application over a particular range of flows; for example, can be described by a single equation, or is regarded as covering, for example, only the low flow range.

**rating shift** A minor change in the relation as a result of a relatively small change in stream bed and/or control level, where the overall shape of the rating does not change and the new curve conforms to the established 'family' or 'type'.

**raw data** Data sourced directly from a data logger.

**raw intensity gauge data** The record of rainfall logged from the intensity gauge and sourced directly from the data logger.

**raw measurement value** Unadjusted or uncensored data; the value may be positive or negative.

**reach** A defined length of river channel.

**receiver canister** The receptacle within a storage rain gauge that holds precipitation and can be removed from the gauge.

**recorder inspection** Verification actions carried out at a site. (See 'site' and 'verification'.)

**recording agency** The agency responsible for carrying out the monitoring that results in a given data set.

**recording zero** Reduced level of zero gauge height adopted for the station.

**reduced level (RL)** The surveyed elevation above datum of a particular object or location.

**reference point** Objects at a recording station whose elevation above or below an adopted datum is known; for example, an electric plumb bob, external staff gauge, underside of recorder hut, etc.

**reference thermometer** Any thermometer used to perform a field check. This thermometer is validated against the traceable reference thermometer.

**relative error (or relative difference)** The arithmetic difference between an observed and estimated value relative to the observed value, expressed as a percentage.

**relative soil water content** An estimate of the soil water content relative to the true soil water content. It normally refers to estimates of soil water content from remote sensing but may be used for uncalibrated data where only the relative changes in soil moisture content are of interest.

**relevant regional council** The regional council or unitary authority that granted consent to use or modify a natural resource under the Resource Management Act and Amendments.

**replicate sample** Two (duplicate) or more samples taken under comparable conditions in time or space.
*Note: Replicate samples are collected and analysed to establish the amount of variability in the data contributed by some part of the collection and analytical process.*

**reporting limit (RL)** The lowest level at which an analyte should be reported, usually taken as twice the method detection limit (MDL).

**representative sample** A sample, collected from one point over the stream cross-section, that has a concentration (and size grading if SSC) that matches the discharged-weighted concentration (and size grading if SSC) for the whole cross-section. A representative sample is an index sample that requires no calibration.

**reproducibility** Closeness of agreement between results of measurement of the same variable on the same sample, carried out under changed conditions of measurement. (See also 'precision').
*Note: Reproducibility represents the ability to replicate the findings of others. Example situations are controlled inter-laboratory test programmes, field regattas, or two different technicians side by side measuring dissolved oxygen in the same water mass in the field.*

**residual** A statistical term meaning the difference between an observed value and the corresponding value of the same variable when predicted by a function.

**resistance temperature detector (RTD)** A temperature sensor that operates on the measurement principle that a material's electrical resistance changes predictably with temperature. A constant current is applied and the voltage drop across the resistor is measured. For RTDs, the resistor is typically formed using pure metals. (See also 'thermistor'.)

**resolution** The smallest change in a measured variable that a particular instrument can detect and/or represent.

**response time** The time required by an instrument to respond completely to a change in input.

**riffle** The part of a flowing channel of shallower depth and moderate to fast velocity over larger bed material, with mixed currents and a rippled and largely broken water surface. (See also 'pool' and 'run'.)

**rotating cup current meter** A current meter whose rotor is composed of a wheel fitted with cups turning on a vertical axis that is perpendicular to flow. Also known as a vertical axis meter.

**roughness coefficient** A factor representing the resistance to flow (largely friction) exerted by irregularities in the surface of the conduit or channel.

**run** The part of a flowing channel intermediate between, and often connecting, riffles and pools; with low to moderate depth, slow to moderate water velocity, uniform to slightly variable current, and a smooth-rippled unbroken surface. (See also 'pool' and 'riffle'.)

**S Map** Web-based soil maps on a site hosted by Landcare Research. (http://smap.landcareresearch.co.nz/home).

**sacrificial anode** A metal of more 'active' electrochemical potential attached to another metal object, such as a boat, that is consumed in preference to the object, thus inhibiting the object's corrosion.

**salinity** A measure of the concentration of dissolved salts in water.

**sample** A representative, small amount of substance collected from a larger body of the same substance, on which measurement of a variable(s) will be made.

**sample splitter** A device used to split a sample into sub-samples that have the same sediment concentration and size mixture as the original sample.

**sampled zone** The portion of a vertical that is sampled by a depth-integrating sampler.
*Note: When depth-integrating samplers contact the streambed their intake nozzles are typically 10 cm above the streambed, so the sampled zone spans the depth between water surface and this point above the bed.*

**sand** Mineral grains with intermediate axis diameters in the range 0.063 mm to 2 mm (63 µm to 2000 µm). (See also 'clay', 'mud', and 'silt').

**saturation** The degree or extent to which something is dissolved or absorbed compared with the maximum possible.

**scan rate** The frequency at which a data logger is able to, or is programmed to, measure and process signals from connected sensors then store the data received.

**scatterers** Suspended particles that reflect an incident beam of sound (acoustic instruments) or light (for example, back-scattering turbidity sensor). The incident and returned signals are compared for the purposes of measurement.

**SDI-12 (Serial Data Interface at 1200 baud)** An asynchronous ASCII serial communications protocol that was developed for intelligent sensory instruments that typically monitor environmental data.

**seiche** A wave that oscillates in lakes, bays or gulfs from a few minutes to a few hours, typically as a result of atmospheric disturbances; that is, water sloshing to and fro.

**sensitivity** The degree of change in a measured variable, induced or indicated by an object or feature, relative to either the background signal or the change in the actual variable of interest when the measured variable is a surrogate; for example, a control is sensitive if there is a relatively large change in stage for the corresponding increase in flow.

**sensor** A device that detects or measures a physical property and records, indicates or otherwise responds to it.

**signal to noise ratio (SNR)** A measure of signal strength relative to background noise, defined as the ratio of signal power to noise power.

**significant figures** The digits of a real number that are known with some degree of reliability and are therefore meaningful to expressing the quantity.

**silt** Mineral grains that have a diameter ranging between 0.004 mm and 0.063 mm (4 μm to 63 μm). (See also 'clay', 'mud', and 'sand').

**simple rating** A relation intended to transform one variable to another, where the predicted variable is dependent only on the other variable.

**site** The geographical location where monitoring takes place. (See also 'station'.)

**site identifier** A unique label for a site, which may be numeric or alphanumeric.

**site inspection** A collective term for at-site verification (recorder inspection) and/or checks of site integrity such as for the purposes of safety and upkeep. (See also 'site' and 'verification'.)

**site number** A unique numeric station identifier usually derived from a national numbering system such as Catchments of New Zealand or a map grid.
*For example: site number 75207, where 752 = Clutha River, and 01 = Balclutha Station, or modified from a MetService Network Number; for example 941301 for C94131, Tarata.*

**site visit** The act of going to and spending time at a site for the purposes of one or more of measurement, observation, inspection and/or maintenance. (See 'site' and 'site inspection'.)

**SoE (State of Environment) monitoring** A programme of observations intended to provide information about environmental conditions, trends and pressures.

**soil horizon** A distinct layer of soil that has a unique combination of soil attributes, different to the soil immediately above and below.

**soil matric potential** A measure of how tightly water is held in the soil. Water is held more tightly in smaller pores as the potential decreases (becomes more negative).

**soil moisture content** The mass or gravimetric soil moisture content is the mass of water in a soil relative to the mass of oven-dry soil and has units of kg, $kg^{-1}$ or other consistent mass units. Alternatively, it can be defined as the volume of water per bulk volume of soil expressed as a percentage, or the depth of water per unit depth of soil.
*Note: For the purposes of NEMS soil moisture and soil water are equivalent terms.*

**soil profile** The combination of soil horizons to a defined depth of interest. In soil survey, this is typically to 1 m depth.

**sonde** A complex instrument that continuously and unattended measures and records in situ a range of physical variables associated with water quality.

**sounding** The operation of measuring the depth of water from the free surface to the bed.

**specific conductivity** Electrical conductivity corrected to a specific temperature. *For example: 25°C for Parts 1 to 4 of the NEMS Discrete Water Quality Standards.*

**spike** Sporadic spurious high or low values in a time series; usually of no more than one or two successive logging intervals.

**spin test** An on-site reliability check of performance of a mechanical current meter to ensure the meter is rotating freely. The meter is held in a sheltered position out of the water, the rotating element set in motion manually (usually by blowing on it), and the duration timed until rotation stops.

**SSC (suspended sediment concentration)** The amount of sediment present in a given volume of water, usually expressed in units of mg/l or the equivalent $g/m^3$, but may be reported in parts per million (ppm) by weight, which are equivalent up to concentrations of approximately 12,000 mg/l. (See 'suspended sediment'.)

**stable channel** A waterway contained between banks and bed that change very little over time; that is, the shape of bends and banks do not change and the bed is not subject to scour or deposition.

**stage-area relationship** The relationship between stage height and cross-sectional area of the stream at or near the location where stage is measured.

**stage-discharge rating curve** The curve that results from plotting the relationship between stage height and discharge.

**stage or stage height** The elevation of the free surface of a water body relative to a known fixed datum. (See also 'water level' and 'gauge height'.)

**standard error (of the regression)** A measure of how well a model fits the data; specifically an estimate of the average error associated with predictions made using the model, calculated as the root-mean-square of the residuals.

**standard solution** A solution of precisely known concentration of an element or substance into which the sensor(s) of an instrument are immersed to perform calibration and/or validation of the instrument.

**standard turbidity** Turbidity data collected from any in situ instrument that is ISO 7027-1:2016 compliant (with the NEMS *Turbidity* permitted extension of instrument range) and standardised to factory specification. (See also 'absolute turbidity', 'FNU' and 'FAU').
*Note: The data are stored as records of 'Standard turbidity' or 'Turbidity' in units of FNU, or FAU if measured by turbidimeter. Standard turbidity data collected in the field by different brands of ISO 7027 compliant instruments may show different values. 'Turbidity' data measured and stored in other units, e.g. NTU or FBU are not 'Standard turbidity'.*

**standpipe gauge** A type of primary reference precipitation gauge; generally used without a receiver canister.

**station** The collective term for sensors at a particular site.

**stationarity of record** A property of the data whereby variation in the data over time is not a result of how the data were collected. It is achieved when variability in the measurements over time is only caused by changes, natural or man-made, in the environmental processes directly associated with the variable being measured.
*Note: Complete stationarity, i.e. the absence of any trend or step-change however induced, is a fundamental assumption of some analyses such as frequency analysis, but may be impossible to assert, hence the need to record all known influences and events to enable data interpretation to take these into account.*

**step-change** A break in the continuity of pattern of a data series, characterised by a sudden shift in value up or down between successive logging intervals, usually associated with some change in recording datum.

**stilling well** A chamber, usually a tower of one or more steel or concrete pipe sections, connected to the water body by a much smaller diameter inlet pipe. The intake dampens the effect of waves and surge in the main flow so there is a still water surface in the chamber on which the float can ride.

**storativity** The volume of water released from storage with respect to the change in water level (head) and surface area of the aquifer. Also known as the storage coefficient.

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

**supersaturation** When dissolved oxygen of the water body is greater than for atmospheric equilibrium.

**suspended load** The part of the stream sediment load that is suspended within the flow by turbulence and is carried downstream by the current. (See also 'wash load').

**suspended sediment** Mineral sediment grains suspended in moving water by turbulent eddies.

**suspended sediment concentration (SSC)** The mass of sediment in a unit volume of water (mg/l, equivalent to $g/m^3$), measured by filtering the entire field sample. (See also 'total suspended solids (TSS)').
*Note: SSC is more reliable than TSS when rapidly settling particles, e.g. sand, are present.*

**suspended sediment gauging** The physical act of measuring, usually by depth-integrated sampling at multiple sampling verticals, the suspended sediment load passing a cross-section, and from that and the water discharge, the discharge-weighted (cross-section mean) suspended sediment concentration ($SSC_{Qm}$). May also be used to refer to the combined result of the measurement, including the stage and/or water discharge, and date and time representative of the measurement.

**suspended sediment load** The mass rate at which suspended sediment is transported through a river or stream cross-section. Usually reserved for the instantaneous load (kg/s) derived from the product of concentration in $g/m^3$ and flow in $m^3/s$. Time-

averaged loads are distinguished by qualifiers. For example: daily load (t/day); annual load (t/year); mean annual load (t/year).

**suspended sediment surrogate** Some instrument-measurable property of a stream that relates to its suspended sediment concentration, and hence can be used as a proxy for suspended sediment concentration once a calibrated relationship has been established.

**suspended sediment yield** Suspended sediment load integrated over some specified period of time. May be expressed as a total (in kg or tonnes), or as a mean for the period per unit area of the catchment upstream from the measurement site (usually reported as t/km$^2$/year (t/km$^2$·yr) but sometimes as t/ha/year (t/ha·yr)).

**synthetic data (record)** An estimated time series usually derived from relationships and/or calculations and/or limited measured data, typically created to fill a gap in a continuous time series of measured data.

**target characteristic** The variable to be observed and its spatial and temporal resolution.

**telemetry** A system of automated measurement and transmission of data from a network of remotely deployed instruments to a centralised data management facility.

**temperature compensation** Generally, the adjustment of measurements to minimise or eliminate the influence of changes in water temperature on the measured values, and may be done in the instrument. Specifically, for water quality variables, adjustment to a common temperature, e.g. pH and conductivity to 25°C (NEMS Discrete Water Quality Parts 1 to 4).

**thalweg** A line joining the lowest points down a length of stream bed or valley, thus defining the deepest channel and therefore marking the natural direction; that is, the profile, of the watercourse.

**thermal response** The time needed by an instrument or device to reach a desired threshold of temperature change; for example, achieving equilibrium with the contact fluid.

**thermistor** A type of resistor, usually ceramic or polymer, whose resistance varies significantly with temperature, more so than in standard resistors. (See also 'resistance temperature detector (RTD)'.)

**time series** A set of values measured sequentially at successive intervals of time (not necessarily regular) and for which the chronological ordering is an essential characteristic of the resulting data.
*Note: The essential characteristic of a time series is that the observations are ordered by, and can be analysed against, time. This differs from other data sets that are ordered against some other property (such as magnitude) or no property at all (random observations).*

**time-series manager (TSM)** A database management system optimised for time-series data. Variable values are stored as a sequence at known intervals of time (not necessarily regular), are indexed by time, and able to be analysed with respect to time.

**timestamp** The date and time of a time-series data element. (See also 'time series' and 'data element'.)

**timestep** The time interval between successive timestamps. (See 'timestamp'.)

**tolerance** See 'observation tolerance'.

**total suspended solids (TSS)** The mass of sediment in a unit volume of water (mg/l, equivalent to $g/m^3$), measured by filtering a volumetric sub-sample of the field sample. (See also 'suspended sediment concentration (SSC)').
*Note: TSS is not as reliable as SSC when rapidly settling particles, e.g. sand, are present.*

**totaliser** A device that computes and displays a running tally of some incremental activity.

**traceable reference thermometer** A thermometer that has a unique identifier and a valid certificate documenting its calibration against another traceable reference thermometer.

**traceable standard** A primary reference measure of the quantity of interest, maintained by a national standards body and related to the measurement results from an instrument or device by an unbroken chain of comparisons. For New Zealand the standards body is the Measurement Standards Laboratory of New Zealand (MSL).

**transect** One sweep across a water course from one bank to the opposite bank with an ADCP on a moving boat.

**transform** A process within time-series software that enables data to be modified with respect to values or time or both.

**transformation matrix** An array of functions used to convert vectors from one coordinate system to another.

**transmissivity** The rate at which water moves horizontally through the entire thickness of an aquifer, being a measure of the amount of water that may be delivered to a pumped well. It is determined usually by pump test with results expressed as the flow through an aquifer section of unit width under unit hydraulic gradient.

**traverse** A line or path of travel along which survey stations are placed so previously surveyed points may be used as a base for observing subsequent points. A closed traverse either ends (closes) back at its starting point, or begins and ends on stations of known positions. An open traverse does not close on either itself or a station of known position. As such, an open traverse does not provide any means for checking for errors and mistakes so should generally be avoided. Also known as a circuit.

**turbidimeter** An instrument that measures the turbidity of water by determining the attenuation of a beam of light between its source and a receiver due to material suspended in the water. (See also 'turbidity' and 'turbidity sensor').

**turbidity** An optical property of a solution; the degree of loss of transparency, i.e. cloudiness, caused by the effect of suspended particulate and colloidal material.

**turbidity sensor** An instrument that measures light scattered by suspended material in water. The measured turbidity depends on instrument design, sediment concentration, and sediment composition (notably size grade); hence it may be used to provide a surrogate record for suspended sediment concentration once calibrated to the sediment composition.

**turbulence** The space-time variability in water velocity caused by three-dimensional eddies.

**uncertainty** An estimate of accuracy. Express as expanded uncertainty, i.e. as an interval about the result, at a stated level of confidence. (See also 'accuracy'.)
*Note: The level of confidence is the fraction of the distribution of values likely to be obtained from measurement of the quantity that is encompassed by the interval.*

**uncertainty of measurement (UoM)** An estimate of the variability inherent in a measurement based on instrument and equipment calibrations, purity of chemicals used for making calibration standards, and human factors. (See also 'calibration standard').

**unit discharge** Discharge per unit channel width, typically measured at a sampling vertical where it equals the product of water depth and depth-averaged velocity of flow in the vertical

**unit suspended sediment load** Suspended sediment load per unit channel width, typically measured at a sampling vertical where it equals the product of unit discharge and depth-integrated, velocity-weighted suspended sediment concentration.

**unsampled zone** The small, near-bed area of water that cannot be sampled by a depth-integrating sampler because of the vertical offset between the base of the sampler and the sampling nozzle.

**unstable channel** A waterway contained between banks and bed that change over time; that is, the shape of bends and banks alter and/or the bed is affected by scour and/or deposition of sediments.

**USGS OSW** The Office of Surface Water of the United States Geological Survey.

**UV (ultra-violet) light** Electromagnetic radiation with a wavelength shorter than that of visible light, but longer than X-rays; that is, in the range between 400 nm and 10 nm.

**validation (of an instrument or procedure)** A check to determine if a device is performing to specification, an instrument is performing to calibration, or a defined procedure is being followed. If validation of a device or instrument fails or cannot be performed, calibration is required. (See also 'verification' and 'calibration'.)
*Note: Validation of a device may be similar to calibration except for lack of traceability and/or controlled conditions, e.g. using a field calibration device to check a tipping bucket rain gauge, or a Druck hand-held pressure calibrator to check a pressure transducer, or pre-deployment bench-testing of a FlowTracker ADV. When water quality sampling, validation includes measuring the given variable in a standard solution using a calibrated instrument to ensure there is no drift in calibration.*

**validation (of a relation or model)** The process of establishing the credibility of a calibrated relation or model by assessing its ability to replicate actual process results. Some calibration data are usually set aside from calibration for this purpose. (See also 'calibration').

**variable** A property, parameter, determinant or analyte to be measured in situ or from a sample (e.g. flow, water level, water temperature, chloride concentration).

**velocimeter** An instrument used to measure velocity of a fluid, either submerged or non-contact. Most employ Doppler shift, either of radar, laser or acoustic signals. Other techniques process images to measure particle movement.

**velocity** The speed at which water flows in a given direction; specifically the rate of displacement of a fluid particle from one point to another.

**verification** Routine inspection and testing of the measurement system to determine and document whether it is operating normally, meeting expected accuracy and performing as required. (See also 'validation' and 'calibration'.)
*Note: The measurement system includes the instrumentation, the on-site installation, the means of data collection and the data collected. Testing usually involves comparisons between independent at-site measurements obtained using some form of reference gauge and the corresponding values logged from the sensor. If results of those comparisons are outside tolerance, validation of components of the measurement system, e.g. the sensor, may be necessary to identify the cause of the anomaly. Examples of verification processes are a field site inspection and data processing.*

**verified data** Data that have been processed to the required standard, and peer reviewed.

**vertical** The water column at a location on a cross-section in which depth and velocity are measured when gauging~~,~~ in order to determine discharge, or from which a sample may be taken.

**volumetric water content** The volume of water per bulk volume of soil.

**wash load** The finer fractions of the suspended load (typically silt and clay grades) that are found only in trace proportions in the stream bed material. (See also 'suspended load').

**water level** The elevation of the free surface of a water body without reference to a known fixed datum; for example, water level read from a staff, i.e. gauge height, is not stage unless it can be directly related to the known site datum. (See also 'stage' and 'gauge height'.)

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

**water year** A period during the term of the water resource consent:

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

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

**wetted length** The length of line immersed in the water when sounding depths and/or carrying out a gauging using cable-suspended equipment.

**wetted perimeter** The total length of stream banks and bed in contact with the water that forms the non-free surface boundary of a cross-section.

**WGS84 (World Geodetic System 1984)** The datum used by the Global Positioning System (GPS), defined and maintained by the United States National Geospatial-Intelligence Agency (NGA). For most practical purposes it is coincident with the New Zealand Geodetic Datum 2000 (NZGD2000), which is the official geodetic datum for New Zealand (www.linz.govt.nz).

**WMO (World Meteorological Organization)** The global body that advises on the state and behaviour of Earth's climate and atmosphere.
*Note: The WMO promotes international cooperation and knowledge sharing. Their published information includes standards and best-practice guidance for observation systems and networks, technical advice and resources for learning.*

**working file** An electronic file containing a copy of a period of data collected from a site. Data in the working file is then processed, i.e. compared and possibly edited and/or adjusted to reference data, prior to archiving.

**WS16** A standard form developed by the Water and Soil Division of the Department of Scientific and Industrial Research (DSIR) used to record station history metadata. Earlier versions of this form were known as SCC16's or Form 16's.

# Symbols

| | |
|---|---|
| **α** | Coriolis coefficient, a factor in velocity head formula, estimated from conveyance and area |
| **A** | cross-section area |
| **A(λ)** | absorbance, a measure of the capacity of an analyte to absorb light of the given wavelength λ nm e.g. A(440) |
| **$\bar{A}$** | mean cross-section area |
| **$A_1$** | upstream cross-section area |
| **$A_2$** | downstream cross-section area |
| **$A_c$** | contracted cross-section area |
| **$A_{mb}$** | area of section with moving bed |
| **$A_p$** | area of intake pipe |
| **$A_w$** | area of stilling well |
| **b** | cross-section width |
| **$b_n$** | cross-section width from initial point to vertical *n* |
| **c** | a concentration (may be suffixed for parts of a whole, e.g. $c_i$ for concentration in a vertical, $c_{os}$ for sand organic concentration) |
| **c(λ)** | light beam attenuation coefficient, the sum of the light absorption and scattering coefficients, as a function of wavelength λ nm, e.g. c(550) |
| **C** | Chezy's channel roughness coefficient |
| **C** | conversion factor for converting ppm to mg/l |
| **$C_D$** | discharge coefficient (Matthai (1967)) |
| **$C_d$** | coefficient of discharge to correct for head loss and contraction |
| **$C_s$** | equilibrium (saturation) dissolved oxygen concentration |
| **Δ** | a difference |
| **d** | water depth (sounded), depth of water column |
| **ø** | diameter |
| **$d_n$** | water depth at vertical *n* (sounded) |
| **D** | depth (in general terms) |
| **$D_p$** | diameter of intake pipe |
| **e** | effective gauge height of zero flow, stage height at zero flow, an offset |
| **$E_d$** | down-welling light |
| **$E_o$** | scalar irradiance |
| **$F_r$** | Froude number |
| **g** | gravitational constant, acceleration due to gravity = 9.81 $m/s^2$ |
| **$G_f$** | gauging frequency |
| **$h_{alt}$** | altitude |
| **h** | stage, stage height, gauge height (of the water surface) |
| **$\bar{h}$** | mean gauge height |

**h-e** effective stage

**H** head of water, measured head (in general terms)

**$H_e$** effective head

**$H_u$** upstream measured (gauge) head

**$H_v$** velocity head

**ΔH** head loss, change in elevation of water surface between upstream and downstream cross-sections

**$\Delta H_v$** change in velocity head between upstream and downstream cross-section

**K** conveyance

**k** a constant, or factor

**$k_h$** correction applied to compensate for effects of viscosity and surface tension

**$K_d$** irradiance attenuation coefficient (down-welling)

**$K_o$** irradiance attenuation coefficient (scalar)

**L** length of reach

**L** suspended sediment load (may be suffixed for parts of a whole, e.g. $L_j$ for incremental load)

**$L_p$** intake pipe length

**$L_{si}$** suspended sediment load increment obtained from flow-proportional composite sampling

**m** exponent in the general discharge equation

**M** sample mass (may be suffixed for parts of a whole, e.g. $M_i$ for sample mass in a vertical, $M_m$ for mud sample)

**n** Manning's channel roughness coefficient

**N** sample size

**$\rho_s$** density of sediment (typically assumed = 2.65 g/cm$^3$)

**$\rho_w$** density of water (typically assumed = 1.00 g/cm$^3$)

**p** a probability

**P** wetted perimeter

**$P_{atm}$** barometric pressure, atmospheric pressure

**$P_w$** pressure head (of water)

**π** pi, a constant, being the ratio of circumference to diameter of a circle

**Q** discharge, total discharge

**$Q_{corrected}$** discharge adjusted for moving bed (ADCP method)

**$Q_g$** gauged discharge

**$Q_i$** discharge of cross-section segment (sub-section) represented by vertical *i* (mid-section method)

**$Q_j$** mid-range value of j$^{th}$ discharge band, e.g. from a flow duration table

**$Q_{measured}$** discharge as measured (ADCP method)

**$Q_n$** discharge of cross-section segment (sub-section) bounded by verticals *n* and *n+1* (mean-section method)

**$Q_o$** discharge as a constant

**$Q_p$** event peak discharge

**$Q_r$** rated flow; that is, flow predicted from a stage series by application of a rating curve

**$Q_s$** time-averaged load of suspended sediment

**$Q_{se}$** event sediment load (suffixed 'i' for instances in a series, or 'j' for occurrence within a discharge band)

**$q_n$** an instance of discharge at time interval *n*

**r** radius

**$r^2$** regression coefficient

**$r_m$** mean time between detectable rating changes

**R** hydraulic radius (= A/P)

**S** salinity, or water surface slope (as indicated by context and units of measure)

**$S_e$** standard error of the estimate

**$S_f$** friction slope (approximates water surface slope in uniform reaches under uniform flow)

**$S_o$** water surface slope (corresponding to steady state discharge)

**SSC** suspended sediment concentration (may be suffixed for parts of a whole, e.g. $SSC_j$ for synchronous concentration in flow duration discharge band)

**$SSC_i$** suspended sediment concentration at vertical *i*

**$SSC_{index}$** index suspended sediment concentration

**$SSC_n$** an instance of suspended sediment concentration at time interval *n*

**$SSC_{Qm}$** cross-section mean suspended sediment concentration (may be suffixed for parts of a whole, e.g. $SSC_{Qmn}$ for an instance of cross-section mean suspended sediment concentration at time interval *n* in a time series)

**t** time, elapsed time, transit time (may be suffixed for a start or end time, e.g. $t_s$)

**$t_c$** Student's 't' correction

**$t_n$** duration of time in interval *n*

**$t_R$** transit rate

**T** temperature

**$T_r$** transmission (of light)

**θ** angle, notch angle (in degrees)

**U** uncertainty

**v** velocity

**$v_{0.2}$** point velocity at 20% of water depth from surface; etc. for other percentiles

**$v_{bed}$** velocity near stream bed

**$v_{boat}$** velocity of moving ADCP boat

**$v_c$** velocity at critical flow

**$v_{mb}$** average moving bed velocity

**$v_n$** mean velocity at vertical *n*

| | |
|---|---|
| $\mathbf{v_{surface}}$ | velocity near water surface |
| $\mathbf{v_w}$ | mean water velocity (ADCP methods) |
| $\overline{\mathbf{v}}$ | mean velocity |
| $\overline{\mathbf{v}}_\mathbf{1}$ | mean velocity in the upstream cross-section |
| $\mathbf{V}$ | volume (may be suffixed for parts of a whole, e.g. $V_j$ for incremental volume) |
| $\mathbf{V_t}$ | sample trigger volume (target volume) |
| $\mathbf{V_{ta}}$ | accumulated water volume (actual trigger volume) |
| $\mathbf{V_w}$ | volume of wash water added to a sample |
| $\mathbf{W}$ | width (in general terms) |
| $\mathbf{x_m}$ | minimum detectable value of x |
| $\mathbf{x_s}$ | characteristic size of x |
| $\mathbf{y}$ | mean depth, or distance |
| $\mathbf{y_{bd}}$ | black disk visual range |
| $\mathbf{y_c}$ | critical depth |
| $\mathbf{z}$ | depth in the water column (below the water surface), or stage change |
| $\mathbf{z_{eu}}$ | euphotic depth |
| $\mathbf{Z}$ | vertical height or elevation (in general terms) |

# Unit Abbreviations

**°** degrees of a plane angle (0 to 360)

**°C** degrees Celsius

**%** percent (parts per hundred)

**% Sat** percent saturation

**‰** parts per thousand (or **ppt**) (1000 ppm = 1 ppt)

**Bq/L** becquerels per litre or Bq $L^{-1}$
*Note: 1 Bq corresponds to one disintegration per second*

**cfu/100 mL** colony forming units per 100 mL

**cm** centimetre (100 cm = 1 m)

**$cm^2$** square centimetres (10000 $cm^2$ = 1 $m^2$)

**deg** degrees of a plane angle (0 to 360)

**FAU** Formazin Attenuation Units

**FBU** Formazin Backscatter Units

**fmol/kg** femtomoles per kilogram or fmol $kg^{-1}$ (1 fmol = $10^{-15}$ mol)

**FNU** Formazin Nephelometric Units

**g** gram

**$g/cm^3$** grams per cubic centimetre (1 $g/cm^3$ = 1 $tonne/m^3$)

**$g/m^3$** grams per cubic metre or g $m^{-3}$ (1 $g/m^3$ = 1 mg/l)

**ha** hectare (10000 $m^2$)

**hPa** hectopascal

**hrs** hours

**Hz** hertz

**K** Kelvin
*Note: There is no 'degree' symbol when using Kelvin.*

**kg** kilogram

**kHz** kilohertz

**$km^2$** square kilometres

**kN** kilonewtons

**kPa** kilopascals

**l** or **L** litres (1000 l = 1 $m^3$)

**l/s** or **L/s** litres per second or l $s^{-1}$ (1000 l/s = 1 $m^3$/s)

**l/min** or **L/min** litres per minute or l $min^{-1}$

**lbs** pounds (mass)

**ln** natural logarithm to base *e*

**m** metre

**$m^{-1}$** inverse metre (reciprocal metre)

**m/s** metres per second or m $s^{-1}$

**$m/s^2$** metres per second squared or m $s^{-2}$

**$m^2$** square metres

**$m^3$** cubic metres

**$m^3/h$** cubic metres per hour or $m^3$ $h^{-1}$

**$m^3/s$** cubic metres per second (cumecs) or $m^3$ $s^{-1}$

**mA** milliamps

**masl** metres above sea level

**mbar** millibar

**meq/L** milli-equivalent (ratio) per litre or meq $L^{-1}$

**mg/l** or **mg/L** milligrams per litre or mg $l^{-1}$ (1 mg/l = 1 g/$m^3$)

**$mH_2O$** metres head of water

**min** minute(s)

**ml** or **mL** millilitre (1000 ml = 1 l; 1000 000 ml = 1 $m^3$)

**ML/d** megalitres per day (1 ML = 1000 $m^3$; 1 ML = 1000 000 l)

**ml/s** or **mL/s** millilitres per second (1000 ml/s = 1 l/s)

**mm** millimetres (10 mm = 1 cm; 1000 mm = 1 m)

**mm/hr** millimetres per hour or mm $h^{-1}$

**mm/s** millimetres per second or mm $s^{-1}$

**MPN/100 mL** Most probable number per 100 mL

**mS/m** milliSiemens per metre or mS $m^{-1}$ (1 mS/m = 0.01 mS/cm = 10 µS/cm)

**mV** millivolts

**nm** nanometre (1000 000 nm = 1 mm; 1000 000 000 nm = 1 m)

**NTU** Nephelometric Turbidity Units

**pmol/kg** picomoles per kilogram or pmol $kg^{-1}$ (1 pmol = $10^{-12}$ mol)

**ppm** parts per million (1 ppm = 0.0001%; 1% = 10,000 ppm)

**ppt** parts per thousand (or **‰**) (1000 ppm = 1 ppt)

**psi** pounds (force) per square inch (1 psi = 6.894757 kPa)

**pt** pint (1 imperial pint = 568.26125 mL; 1 US wet pint (for liquid volume) = 473.176473 mL; 1 US dry pint (for non-liquid volume) = 550.6104713575 mL)
*Note: The imperial pint has mostly been replaced by metric units but is sometimes still used in the UK and Canada. The US pint remains in common use in the US and may also be encountered in Canada.*

**qt** quart (1 quart = 2 pints; 1 quart = ¼ gallon, hence the name)
*Note: The same variations and usage apply as for "pint".*

**RTU** relative fluorescence unit (0 to 100%)

**s** second(s)

**t** tonne (1t = 1000kg)

**TU** tritium unit

**µS/cm** microSiemens per centimetre or µS $cm^{-1}$ (1 µS/cm = 0.1 mS/m)

**µS/m** microSiemens per metre or µS $m^{-1}$

**yr** year

# Annex A – Bibliography

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The following web resources have been consulted to help construct the definitions:

- Campbell Scientific's web glossary
- Wikipedia and associated services
- online dictionaries, and
- various online tutorials and education resources published by recognised institutions, affiliations, and societies available in the .edu and .org domains.