Flood Warning Infrastructure Standard

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Download a copy of the *Flood Warning Infrastructure Standard* at: http://www.bom.gov.au/water/standards/index.shtml

Acknowledgments

This Standard was developed by the National Flood Warning Infrastructure Working Group, which was established by the Australia New Zealand Emergency Management Committee (ANZEMC). The Standard was administered and led by the Bureau of Meteorology, while a Technical Advisory Group (TAG) provided guidance for its development with substantive technical input. Individuals and their organisations, from the States and Territories releasing them to participate in this project, are acknowledged.

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NB: Some organisations had different names during the preparation of the report.

Foreword

The National Flood Warning Infrastructure Working Group was established in March 2016 on the recommendation of the Standardisation of Bureau of Meteorology Hazards Services Taskforce (May 2015). The recommendation was endorsed by the Australia New Zealand Emergency Management Committee (ANZEMC). As the lead agency in flood forecasting and warning the Bureau of Meteorology was given carriage of the project, providing the chair and secretariat to the Working Group. The Working Group was deputy-chaired by the Department of Home Affairs, and membership included representatives from relevant State and Territory emergency services agencies and water authorities.

The Flood Warning Infrastructure Standards Technical Advisory Group (TAG) was established to provide specific advice to the Working Group on a national technical standard for flood warning infrastructure. The Working Group oversaw the development of the Standard, and endorsed the scope, direction and style adopted by the TAG. This *Flood Warning Infrastructure Standard* took more than two years of development.

The Standard was made available for industry consultation for a period of three months in 2018. Many comments were received. The revised Standard reflected the input of the broader industry. The Standard was made available for a final public review in 2019. The Working Group recommended the Standard for endorsement by the ANZEMC in August 2019.

The Standard forms part of a set of measures intended to place flood warning services on a sustainable and robust footing for the long term. It presents non-mandatory industry-recommended performance requirements for the design, development and monitoring of fit-for-purpose flood warning infrastructure.

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Contents

1 Introduction

1.1 Background and context

Flood warning infrastructure provide the rainfall and river level data for flood forecasting models to predict water levels and flows at locations within a catchment.

The flood warning infrastructure is underpinned by a cooperative effort between Commonwealth, State, Territory and local governments as well as private agencies or enterprises. There are currently more than 100 organisations involved in collecting data for flood warning purposes and much of their infrastructure was established for purposes other than flood warning. This means that it is not necessarily fit for purpose.

Flood warning has specific requirements for data accuracy, range, special density and data availability. Even the best designed sites can be compromised during extreme weather, so flood warning networks are designed with a degree of redundancy to ensure services can continue if some sites are compromised.

Current hydrometric standards are tailored to meet the requirements of other primary means like climate and environmental monitoring, weather forecasting, water security, water supply and abstraction. This Standard was developed to ensure the sustainability of the flood warning network by providing the performance requirements for flood warning.

1.2 Purpose

This document identifies the specific performance requirement for infrastructure, sensing, collecting and communicating data for flood forecasting and warning purposes.

It can be applied to both existing and new infrastructure.

Other infrastructure, such as satellite and radar, contribute data for flood forecasting and warning purposes. However, they are not within the scope of this Standard.

This Standard also includes the criteria and verification required to assess performance and ensure consistency across the solutions developed to meet the requirements (AS-003-Standards Australia 2016).

This Standard is not intended for design specifications. Instead it can be used to assess design specifications and determine if these meet the standard for flood warning infrastructure.

1.3 Performance standard

Performance-based standards express requirements in terms of performance, i.e. outcomes to achieve. These are defined in terms of the function performed, and the minimum performance level to achieve for specified attributes.

Standards Australia (2016) provides the following example of a requirement for a hypothetical wall plug suitable for hanging a mirror:

- A **prescriptive standard** would state that the 40 kg wall fixing shall consist of a 2 cm expansion case in accordance with Figure x, together with a ¼ in. Whitworth mild steel zinc-plated nut and matching 3 cm threaded hook in accordance with Figure y.
- A **performance standard** would state that the wall fixing supports a weight of 40 kg when tested in accordance with the approved test method.

1.4 Relationship to other standards

The *Flood Warning Infrastructure Standard* (the standard) presents the performance requirements specific to flood forecasting and warning. The focus is on the 'what' and is independent of technology.

The National Industry Guidelines for hydrometric monitoring (NIGL) present recommended Australian best practice for all aspects of hydrometric monitoring. Its focus is on the 'how' and is dependent on the technology.

The NIGL prescribe actions in relation to measurement and provide specific guidelines for each technology solution. The NIGL is a useful reference for site set-up and sensor set-up, as well as site and sensor maintenance guidelines, to meet the requirements of the Standard.

1.5 Target audience

The target audience for this Standard includes a range of disciplines:

- Flood risk / flood hazard managers
- Flood forecasting and warning service providers
- Hydrometric data infrastructure providers
- Communication/network providers
- Civil engineering professionals

Effective application of the Standard requires these groups to contribute at different steps in the process.

1.6 Application of the Standard

The Standard presents non-mandatory, industry-recommended performance requirements for the design, development and monitoring of fit-for-purpose flood warning infrastructure.

1.7 Scope

Flood warning infrastructure involves field instruments and communications equipment, through to data ingest software for receiving, storing and displaying real-time flood data.

1.8 How to use this Standard

The application of the Standard involves five steps, which are separated into two parts.

The first part (Chapter 3) involves determining site-specific performance levels. The second (Chapter 4) involves verifying that the performance of the infrastructure meets the site-specific performance levels, followed by examples of infrastructure that meet the performance requirement in Chapter 4.

The workflow begins with gathering site/service input data, using that input data to characterise the site(Chapter 2), and then using the input data/site characterisation in conjunction with the performance requirement to evaluate the performance level.

To complete the assessment, infrastructure specifications are gathered. In conjunction with the verification methods these then verify that the infrastructure meets the performance level.

The answers are then inserted into the form (Appendix 1).

NB. The intention of the Standard is not to provide a design specification for a flood warning site, however, a design specification can be assessed against the Standard to determine if it complies.

1.9 Definitions

Unless otherwise indicated, all definitions can be found in the *Australian Water Information Dictionary* at www.bom.gov.au/water/awid.

2 Site characterisation for river response

This chapter describes the process of site characterisation when determining performance level.

River response is water level rise from base flow to peak flow, and is broadly estimated using:

- time to peak (TTP);
- time of concentration (TOC) rain-to-river peak time; or
- catchment area upstream of the site.

The TTP, TOC or catchment area for the site can be determined, or estimated, using the most appropriate method depending on data availability.

1. For TTP from the data record:
    a. Assess for a range of peaks including the highest on record to as low as out of bank conditions.
    b. Select the TTP that corresponds to the hydrograph that gives the shortest TTP.
    c. Add a factor of safety and determine the TTP (standard).
2. TOC from flood study.
3. TTP from the size of the catchment/sub catchment area.

For level, use the area upstream of the gauge. For rain, use the nearest downstream level gauge.

River response categories

TTP (hours)	TOC (hours)	Area (sq km)	River response category
<1	< 1	<100	Flash
>1 and <3	<6	>100 and <400	Flash
>3 and <8	<12	>400 and <10,000	Riverine
>8 and <36	<24	>10,000 <30,000	Riverine
>36	>24	>30,000	Riverine

Table 1. The river response categories are Rapid, Flash or Riverine.

3 Performance requirements and verification methods

This chapter sets out the performance requirements and the verification methods for a functional flood warning infrastructure. The performance requirements set the minimum acceptable levels necessary to achieve the purpose of the Standard. The verification method process determines if the solution meets the performance requirement.

3.1 Collectability

3.1.1 Data latency

Data necessary to set performance level

The river response category from Table 1.

Performance requirement

Data latency should correspond with the river response category from Table 1 to provide timely data to the end user.

Latency of reporting

River response	TOC	Latency (of reporting) (minutes)
Flash	<1 hour	5
	<6 hour	15
Riverine	<12 hours	15
	<24 hours	60
	>24 hours	1440 (24 hours)

Table 2. The river response from Table 1 corresponds with the latency of reporting.

Data necessary to verify performance

Instrument specifications and configuration of a response that relates to latency of reporting.

Verification method

Set performance level

Step 1. Identify the required latency of reporting (using Table 2).

Verify performance

Step 2. Identify the latency of reporting (the data transfer) from site to data user.

Step 3: Determine that the data transfer instrument can report up to the latency within Table 2.

3.2 Interoperability

3.2.1 Ingest interoperability

Data necessary to set performance level

Medium(s), language(s) and number of transfers from site to data-user agencies, including any medium and language conversions.

Performance requirement

- There is at least one medium to transfer data from the site.
- Data are transferred between any two nodes using a common language and medium (a node can be a site or an agency).
- Where data are transferred to data-user agencies, it is in a language and medium that can be received and ingested.
- Where data are received by an intermediate agency in a language and medium that cannot be received and ingested by the data-user agency, the intermediate agency is capable of converting that data into a language and medium that can be received and ingested.

Verification method

Step 1. Identify the medium(s), language(s) and number of transfers from site to data-user agencies, including any language and medium conversions.

Step 2. Confirm that data sent from the site are ingested by data-user agencies, for each identified language and medium.

3.3 Data transfer metadata

Data necessary to set performance level

Data transfer metadata elements for ingestion purpose.

Performance requirement

These data transfer metadata elements are available to data-user agencies and data providers:

- transfer method;
- data transfer details;
- data format; and

- data decoding.

Verification method

Step 1. Identify the data transfer metadata elements.

Step 2. Verify that the data transfer metadata elements are available to data users, and data-user agencies' systems can find, or extract, the information from the received data.

3.4 Interpretability

3.4.1 Range

3.4.1.1 Rain-range

Data necessary to set performance level

Design rainfall (maximum expected or recorded rainfall at site), and rainfall intensity (design rainfall converted to hourly rate).

Performance requirement

The maximum rainfall intensity is equal to or greater than the maximum design intensity.

Data necessary to verify performance

Sampling interval and maximum intensity specifications of the instrument.

Verification method

Step 1. Determine the maximum design intensity for the site.

Step 2. Determine the maximum rainfall intensity that the instrument can measure.

Step 3. Verify that the maximum rainfall intensity that the equipment can measure is equal to or greater than the maximum design intensity.

If not explicitly stated, determine the maximum design rainfall intensity for the site using the 2016 edition of Australian Rainfall and Runoff[1]. Unless otherwise stated, use the 1% annual exceedance probability (AEP) for the sampling interval (see Interpretability: Data resolution (rain resolution) requirement).

[1] http://arr.ga.gov.au/arr-guideline

3.4.1.2 Level-range

Data necessary to set performance level

1% AEP, length of data record, highest required level, existing or proposed flood classifications and highest known level or flow.

Performance requirement

The lower limit of the range is:

- sufficiently low so that the initial rise or the initial change in level or flow due to runoff that occurs during and after rainfall can be measured; or
- sufficiently below the lowest threshold of interest so that a rise can be detected and acted upon in accordance with service level requirements.

The upper limit of the range shall be higher than:

- the highest known level or flow;
- the highest required level or flow; and
- the highest anticipated flood level (AS3778:2.2 5.4.2e)[2].

Data necessary to verify performance

Cease to flow level, lowest required level, as well as highest known required and anticipated levels.

A flood frequency analysis that identifies the 1% AEP level is also needed. If there are insufficient data or resources available to undertake the analysis, then identify the highest anticipated flood level as a part of a topographic survey (AS 3778.2.2 5.4.2). Assume the highest anticipated flood level to be the equivalent of the 1% AEP until enough flood events have been recorded at the site to determine the 1% AEP.

Verification method

Determine that the instrument measurement range is equal to or exceeds both the upper and lower limits of the performance requirement.

Verification

<u>Set performance level</u>

Step 1. Identify the required lower limit of the range.

Step 2. Identify the required upper limit of the range. Consider all available information and document the reasoning for choice of upper limit.

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[2] Unless otherwise stated assume that the highest anticipated flood level is equal to the 1% AEP level.

Verify performance

Step 3. Identify the lower limit of the range of the measuring system.

Step 4. Determine that the lower limit of the range of the measurement system is less than or equal to the cease-to-flow level, or sufficiently below the lowest threshold of interest that a rise can be detected.

Step 5. Identify the upper limit of the range of the measuring system.

Step 6. Determine that the upper limit of the range of the measurement system is greater than the required level.

Step 7. Insert your answer into the form (Appendix 1).

3.5 Accuracy

3.5.1 Rain-accuracy

Data necessary to set performance level

N/A

Performance requirement

Rainfall data should be sufficiently accurate for the purposes of flood forecasting, based on the NIGL.

Rainfall accuracy classification

Accuracy	Instrument and siting		
	Calibration	Height of gauge orifice	Sheltering and exposure
High	y	y	y
Medium	y	Any one criterion nonconforming	

Table 3. instrument and siting compliance[3] contribute to the accuracy of rainfall data.

Data necessary to verify performance

Gauge calibration method/history, height of gauge orifice, exposure of gauge and representativeness of measurement.

Verification

Set performance level

Step 1. Rainfall accuracy equal to medium (Table 3).

Verify performance

Step 2. Identify the standard of raingauge calibration, the height of the raingauge orifice, the exposure of the gauge and the representativeness of the measurement.

[3] Compliance (y) refers to:

- The level of uncertainty given in the Bureau or World Meteorological Organization standards ~ ± 6% for calibration; and
- the standards defined in section 3.4 in the *National Industry Guidelines for hydrometric monitoring Part 2* for:
  - 3.4.1.2A Sheltering and exposure; and
  - 3.4.1.2B Height of gauge orifice.

Step 3. Determine that the raingauge is calibrated and compliant with at least one of the other two classifications.

3.5.2 Level-accuracy

Data necessary to set performance level

Design uncertainty, flood classifications and range.

Performance requirement

The uncertainty in the level data shall be equal to, or better than the;

- service owner specified uncertainty; or
- uncertainty equal to, plus or minus half of the least significant figure of the flood classification (if defined); or
- minimum uncertainty as defined in AS 3778 2.2 - 2001 5.2.4.

Data necessary to verify performance

Uncertainty of datum, uncertainty of instrument (e.g. pressure sensor), range and service owner specified uncertainty.

Verification method

Set performance level

Step 1. Identify the required level of uncertainty.

Verify performance

Step 2. Determine the uncertainty of the datum from:

- the site survey method and the achievable precision; and
- NIGL Part 2.2: Part 2.2: General— Establishment and operation of a gauging station, Primary gauge 3.2.2.1, as being equal to the greatest allowable change, provided the site complies with the NIGL.

Step 3. Determine the uncertainty of the instrument (e.g. pressure sensor) from the manufacturer specifications.

Step 4. Evaluate the combined primary uncertainty (datum and instrument) using Hydrometry—Water level measuring devices ISO 4373 2008E, 8.5 (extract below from ISO 4373 2008E, 8.5).

Step 5. Determine that the derived uncertainty of the combined primary measurement uncertainties (datum and instrument) in the level data is equal to or better than the level-accuracy performance level.

3.5.3 Flow-accuracy

Data necessary to set performance level

The data used in flood forecasting models, decision making and also for information only.

Performance requirement

- flow data accuracy known and available for the full range of flows; and
- the accuracy of the flow data is classified as at least medium (as defined in Table 3) for those sites informing flood forecasting models.

Flow accuracy classification

Data use	Required Accuracy	Discharge relationship established and maintained in accordance with NIGL across full range	Site established and maintained in accordance with NIGL
Flood forecasting models	High	Y	Y
Flood forecasting models	Moderate	Y	N
Decision making and Information	N/A	N	N

Table 4. the classification of flow accuracy and compliance[4] with NIGL.

The site is established and maintained in accordance with Part 2: 3.2.1.2E Stage/discharge sites.

[4] Compliance (y) refers to:
Discharge relationship established and maintained in accordance with NIGL:

- Part 4: Gauging (Velocity Area Method).
- Part 6: Stream Discharge Relationship Development and Maintenance.
- Part 8: Application of Acoustic Doppler Current Profilers to Measure Discharge in Open Channels.
- Part 9: Application of In-situ Point Acoustic Doppler Velocity Meters for Determining Velocity in Open Channels.
- Part 10: Application of Point Acoustic Doppler Velocity Meters for Determining Discharge in Open Channels.

Data necessary to verify performance

Highest gauging, flow measurement collection method, and discharge relationship development method.

Verification method

Set performance level

Step 1. Identify the data use (from Table 4).

Verify performance

Step 2. Determine that the flow data (stream discharge relationship) is established and maintained across the full range of flows in accordance with NIGL:

a. flow measurements collected in accordance with NIGL (Parts 4, 6, 8, 9, 10);

b. rating table developed in accordance with NIGL (Part 6);

c. rating extension (above highest gauging) to upper limit of range established in accordance with NIGL (Part 6, Section 8); and

d. site established and maintained in accordance with NIGL (Part 2).

3.5.4 Communications accuracy

Data necessary to set performance level

Documentation or specifications of data formats and telemetry systems.

Performance requirement

- Unfiltered, timestamped, primary measured data (SI units) are transferred from site to data user; and
- data are translated to SI units on receipt, provided the translation set metadata are maintained and updated in only one location.

Verification method

Step 1. Review data transfer format specifications to identify if data is unfiltered, timestamped, primary measured data in SI units.

Step 2. If data is not in SI units, confirm that translation set metadata is maintained and updated in only one location to enable translation of the data to SI units on receipt.

3.6 Sampling interval

3.6.1 Rain-sampling

Data necessary to set performance level

River response and 1%AEP rainfall rate.

Performance requirement

The time-based method and event-based method both apply to the performance requirement, sampling interval, and sampling volume.

Time- based method (discrete)

The sampling interval is less than or equal to the discrete sampling interval corresponding to river response (in Table 1). This is typical of site logger systems.

Event based method

The sampling interval shall be within the range of the event sampling interval corresponding to the river response (in Table 1). This is typical for radio ALERT systems.

Rainfall sampling interval performance levels

River response	Discrete sampling interval (minutes) e.g. site logger	Event sampling interval (mm) e.g. ALERT
Flash	5	<=1
Flash	15	<=1
Riverine	15 to 60	<=5
Riverine	1440 (24 hours)	>1%AEP

Table 5. Discrete and event sampling interval performance levels for rainfall according to river response.

Data necessary to verify performance

Instrument specifications and configuration need to correspond to the sampling strategy. This includes ALERT, increment, and change in state corresponding to an increment.

Verification method

Set performance level

Step 1. Identify the sampling strategy (discrete and/or event).

Step 2. Identify the river response and, if required, 1%AEP rainfall for site.

Step 3. Determine the required sample size (discrete or event depending on strategy being used) from the rainfall sampling interval performance levels in Table 5.

Verify performance

Step 4. Determine that the instrument is capable of sampling with a discrete or event sampling interval that is equal to or better than the performance requirement.

3.6.2 Level/flow-sampling

Data necessary to set performance level

River response and water level range.

Performance requirement

The sampling interval is less than or equal to the discrete sampling interval corresponding to the river response (in Table 5).

Discrete water level sampling interval performance levels

River response	TOC	Discrete sampling interval (minutes)
Flash	<1 hour	5
	<6 hour	15
Riverine	<12 hours	15
	<24 hours	60
	>24 hours	1440 (24 hours)

Table 6. Discrete water sampling interval performance levels for level/flow according to TOC.

AND/OR

The sampling interval shall be less than or equal to the event sampling interval corresponding to the water level range in mm (Table 5).

Event water level sampling interval performance levels

Water level range (m)	Event sampling interval (mm)

<5	25
>5 and <10	50
>10 and <20	100
>20 and <40	250

Table 7. Event water sampling interval performance levels (mm) for level/flow according to water level range (m).

Data necessary to verify performance

Instrument specifications and configuration need to correspond to the sampling strategy. This includes ALERT, sample time, increment, and change in state corresponding to an increment.

Verification method

Set performance level

Step 1. Identify the sampling strategy (discrete and/or event).

Step 2. Identify the river response and/or range of the instrument.

Step 3. Determine the required sample size. If discrete, then determine from the water level sampling performance level in Table 6. If event, then determine from the event water level sampling performance level in Table 7.

Verify performance

Step 4. Determine that the instrument is capable of sampling with a discrete and/or event sampling interval that is equal to or better than the performance requirement.

NB: Systems that use both discrete and event sampling comply with both the discrete and event performance requirements.

3.7 Data Resolution

3.7.1 Rain resolution

Data necessary to set performance level

Nil.

Performance requirement

The rain resolution is less than or equal to one mm or the sampling interval.

Data necessary to verify performance

Instrument resolution.

Verification

Set performance level

Step 1. Instrument resolution is less than or equal to one mm or the sampling interval.

Verify performance

Step 2. Identify the resolution of the instrument.

Step 3. Determine that the instrument resolution is less than or equal to one mm, or the sampling interval.

3.7.2 Level resolution

Data necessary to set performance level

Service owner specified resolution, flood classifications, and the Australian Standard for water level uncertainty (AS 3778 2.2 - 2001 5.2.4).

Performance requirement

The resolution of the level data shall be equal to, or better than:

- the service owner specified resolution (if defined);
- the resolution required to resolve flood classification (if defined); and
- the Australian Standard for water level uncertainty (AS 3778 2.2 - 2001 5.2.4).

Data necessary to verify performance

Resolution of the water level measurement system.

Verification

Set performance level

Step 1. Identify any service owner specified water level resolution requirements.

Step 2. Identify the water level resolution required to resolve flood classification (if any). Water level resolution matches the resolution of the least significant figure of the flood classifications.

Step 3. Determine the water level resolution is equal to the Australian Standard for water level uncertainty (AS 3778 2.2 - 2001 5.2.4).

Step 4. Set the water level resolution performance equal to the smallest resolution of steps 1, 2 & 3.

Verify performance

Step 5. Identify the resolution capability of the instrumentation.

Step 6. Determine that the water level resolution is equal to or better than the resolution performance requirement.

3.8 Metadata

3.8.1 Site-metadata

Data necessary to set performance level

All site metadata elements.

Performance requirement

That these site metadata elements are made available to data-user agencies and data providers:

- site name; and
- site ID.

Verification method

Ascertain that all site metadata elements are available to data users, and are stored in, or extractable from, received data by data-user agencies' systems.

3.8.2 Rain-metadata

Data necessary to set performance level

All rain metadata elements.

Performance requirement

That these metadata elements are made available to data-user agencies and data providers:

- measuring point name;
- measuring point ID;
- measuring point position;
- time series ID;
- data type;
- data decoding;
- measurement date and time;
- measurement unit; and
- duration of measurement.

Verification method

Ascertain that all rainfall metadata elements are available to data users and are stored in, or extractable from, received data by data-user agencies' systems.

3.8.3 Level-metadata

Data necessary to set performance level

All relevant level metadata elements.

Performance requirement

That these metadata elements are made available to data-user agencies and data providers:

- measuring point name;
- measuring point ID;
- measuring point position;
- measuring point elevation;
- time series ID;
- data type;
- measurement status;
- measurement date and time;
- measurement unit;
- stream gauging ID;
- stream gauging parameters;
- gauge zero;

cease-to-flow level;

- rating table name;
- rating table value pairs;
- minimum supply level;
- full supply level;
- total storage capacity;
- accessible storage capacity; and
- dead storage capacity.

Verification method

Ascertain all relevant level metadata elements are available to data users and are stored in, or extractable from, received data by data-user agencies' systems.

3.9 Availability

3.9.1 Reliability

3.9.1.1 Site-reliability

Data necessary to set performance level

Design reliability (if this is not available use reliability >= 99%).

Performance requirement

- The reliability of the infrastructure when exposed to the conditions/hazards at the site equal to or greater than the design reliability (or 99% unless otherwise stated).
- The infrastructure shall be designed to withstand and operate when exposed to hazards of up to a severity (defined in terms of likelihood) of rare (unless otherwise stated).
- Undertake a reliability assessment of the infrastructure when exposed to the conditions/hazards at the site.
- Assess for the conditions/hazards listed (and any other considered significant):
    - temperature;
    - humidity;
    - water intrusion;
    - biological, dirt and dust intrusion;
    - instrument level in relation to flood level;
    - landslip;
    - stock and wildlife;
    - wind loading;
    - lightning;
    - hail;
    - ice;
    - vandalism; and
    - fire.

Data necessary to verify performance

Reliability assessment.

Verification

Set performance level

Step 1. Identify[5] design reliability (=> 99% per year unless otherwise stated).

[5] The risk of failure of the infrastructure (defined as fit for purpose data being unavailable to the data user) when exposed to hazards with a severity (defined in terms

Step 2. Determine reliability of all components when exposed to hazard severity of up to and including rare (unless otherwise stated) for all listed hazards

Verify performance

Step 3. Reliability assessment of each component meets the performance level.

Step 4. Overall performance is equal to the least reliable component of the infrastructure.

3.9.1.2 Power-reliability

Data necessary to set performance level

Reliability.

Performance requirement

That the power system is capable of reliably supplying enough power to meet the power budget.

Data necessary to verify performance

Power system(s) type and specifications (demand and capability), and site conditions.

Verification

Set performance level

Step 1. Identify the level of power reliability required.

Verify performance

Step 3. Identify the power source(s), e.g. mains, solar, battery, power cell.

Step 4. If mains power is the primary power source, confirm that a battery backup power supply is also available.

For non-mains sources -

Step 5. Ensure a power budget is completed in accordance with manufacturer guidelines.

Step 6. Ensure consideration is given to the level of reliability required in the power budget.

3.9.1.3 Communications-reliability

Data necessary to set performance level

Minimum recognised standard or guideline defined for that communications technology.

Performance requirement

The data transfer system is capable of transferring data from a site to a network with a reliability that is equal to or better than the minimum recognised standard or guideline defined for that data transfer technology.

Data necessary to verify performance

Infrastructure design and exposure of communications equipment.

Verify Performance

Step 1. Identify the level of performance required.

Step 2. Ascertain that an appropriate assessment of exposure was undertaken for all communications components.

Step 3. Confirm that the infrastructure design is sufficient to ensure it can withstand the environmental exposures and provide a satisfactory operating environment for internal and external equipment.

Step 4. Determine that the measure of reliability is equal to or greater than the minimum standard.

If redundant data transfer is required, repeat steps 1 to 3 for redundant data transfer method.

3.9.1.4 Network-reliability

Data necessary to set performance level

Communications type.

Performance requirement

The data transfer network is capable of reliably transferring data received from a site to data-user agencies and data providers. This has a reliability that is equal to or better than the minimum recognised standard or guideline defined for that data transfer technology.

Data necessary to verify performance

Past network performance—particularly during flood events—and manufacturers specifications, taking note of reliability assurances provided from data carrier.

Verify Performance

Continual monitoring regime is in place and reliability is reported on.

3.9.1.5 Ingest-reliability

Data necessary to set performance level

Known service agreements and level of support.

Performance requirement

The data-user agency data receipt, ingest, storage and display systems are highly reliable.

Data necessary to verify performance

The assessment against service levels and return to service.

Verification

Assess that data-user agency systems are robust and/or redundant, and that documented support procedures are in place.

3.10 Site maintenance

Data necessary to set performance level

Performance levels for each requirement, which are determined using this Standard.

Performance requirement

The infrastructure and the performance of the infrastructure is maintained to the levels of performance determined in this Standard.

Data necessary to verify performance

Maintenance program details.

Verification

Set performance level

Step 1a. Identify performance levels for each requirement (determined using this Standard).

OR

Step 1b. Identify the required availability for external (third party) networks.

Verify performance

Step 2a. The site complies with this requirement provided the maintenance program includes:

- preventative, predictive and corrective (return to service) maintenance, and the capability/commitment to monitor infrastructure performance;
- standard operating procedures in accordance with NIGL Parts 2 (Site Operations Surface Water 3.2.2 and Precipitation 3.4.2) and 3 (Instrument and Measurement System Management); and
- a commitment to undertake annual and post-flood risk assessments to ensure that the maintenance program is adequately addressing site-specific risks to data collection and transfer processes.

OR

Step 2b. For external (third party) data transfer networks, the site complies with this requirement provided network availability is equal to or greater than the required availability.

3.11 Asset replacement

Data necessary to set performance level

Asset listings and asset replacement programs.

Performance requirement

Infrastructure assets are managed as a part of an asset replacement program that enables:

- assets exceeding their design life to be identified;
- planning for assets to be replaced at end of their design life; and
- funding availability for assets to be replaced.

Data necessary to verify performance

Documented asset replacement program.

Verification

Ascertain that the asset replacement program is documented, which must include:

- a listing of assets and consumables;
- asset age and design life;
- availability of funding when required to replace assets; and
- power contracts with utility providers.

3.12 Metadata latency

Data necessary to set performance level

The type of metadata.

Performance requirement

Metadata elements in each metadata type are only required to be available to data-user agencies when the element is given for the first time, or when it has changed[6]. The elements shall be provided to data-user organisations within the time interval listed below after the element has changed:

- site data transfer metadata: hour;
- metadata: day; and
- contextual information: month.

Data necessary to verify performance

Metadata distribution arrangements.

Verification

Ascertain that arrangements for metadata distribution are documented, which must include:

- each element; and

[6] Excludes metadata elements that must be provided with the data to enable the interpretation of data (metadata elements included in data file).

- the maximum allowable time interval between change and availability.

3.13 Contextual information

3.13.1 Site-context

Data necessary to set performance level

Site context metadata elements.

Performance requirement

This contextual information is available to data-user agencies and data providers:

- data provider ID;
- site description;
- site position;
- site elevation; and
- site affiliation to the flood warning network.

Data necessary to verify performance

The available site context metadata elements.

Verification

Ascertain that all site contextual information elements are available to data-user agencies and data providers.

3.13.2 Rain-context

Data necessary to set performance level

Rain context metadata elements.

Performance requirement

This contextual information is available to data-user agencies and data providers:

- data owner ID;
- measuring point description;
- time series description;
- maintenance description;
- calibration description;
- measurement procedure;
- measurement comments;

- height of raingauge
- measurement quality; and
- site geographic description.

Data necessary to verify performance

The available rain context metadata elements.

Verification

All rainfall contextual information is available to data-user agencies and data providers.

3.13.3 Level-context

Data necessary to set performance level

Relevant level context metadata elements.

Performance requirement

This contextual information is available to data-user agencies and data providers:

- data owner ID;
- measuring point description;
- time series description;
- maintenance description;
- calibration description;
- measurement quality;
- watercourse name;
- If rating table elements are available, then this contextual information shall also be available to data-user agencies and data providers
- stream gauging procedure;
- flow control type;
- rating table start date and time;
- rating table relationship; and
- rating table interpolation parameters.

Data necessary to verify performance

The availability of relevant level context metadata elements.

Verification

Ascertain that all water level and flow contextual information are available to data-user agencies and data providers. Storage elements are only required for sites with storage.

3.13.4 Communications-context

Data necessary to set performance level

Communication context metadata elements.

Performance requirement

This contextual information is available to data-user agencies and data providers:

- reporting; and
- latency.

Data necessary to verify performance

The availability of communication context metadata elements.

Verification

Ascertain that all contextual information is available to data-user agencies and data providers.

3.14 Performance indicators

Data necessary to set performance level

N/A.

Performance requirement

A sufficiently frequent indication of the status or performance of the infrastructure components is available to data users and data providers.

Data necessary to verify performance

N/A.

Verification

Confirm that:

- the indicator type provides an indication of the status or performance of all infrastructure components; and
- the frequency of indicator reporting is related to the consequences of a fault or issue occurring and how quickly those consequences develop.

4 Examples

This chapter provides examples of infrastructure that meet the performance requirement detailed in this Standard.

4.1 Collectability

4.1.1 Latency

4.1.1.1 Ingest-latency

This example is an automatic gauge consisting of a single bubbler unit and dry pressure sensor connected to both ERRTS (ALERT, analogue channel) and logger:

Step 1. Gather input data **All three methods are illustrated, however only one is required* Method 1: Upstream catchment area: 435 km^2 Method 2: TOC: 0.76 * A^0.38 (ref AR&R) = 7.7 hr Method 3: TTP: 0.4 * TOC (ref ??) = 3.1 hr
Step 2. Characterise site Method 1: River response (Area): Riverine (100 < 435 < 400) Method 2: River response (TOC): Riverine (6 < 7.7 < 96) Method 3: River response (TOC): Riverine (3 < 3.1 <36)
Step 3. Evaluate the performance level From Table 2, the latency of reporting corresponds to a riverine river response <60 minutes.

Step 4. Gather infrastructure specifications

System 1:

Instrument type: ERRTS (ALERT)
Lead in time: 1000millsec
Latency: approx. <5s (timing of test signals sent from site)

System 2:

Instrument type: logger/modem
Data record
Latency: approx. 5 min. (time difference between timestamped data and data availability to data user).

Step 5. Verify that the infrastructure meets the performance level

System 1:

The ERRTS latency capability (<5s) meets the performance level (<60min).

System 2:

The logger/modem latency capability (approx. 5 min) meets the performance level (<60min).

4.2 Interoperability

4.2.1 Ingest interoperability

Example 1. A field site transferring data to a local agency. The data is then onforwarded via FTP to the data-user agency:

Step 1. Identify number of transfers

Number of transfers: 2

Step 2. Identify mediums and languages

Mediums/languages: NextG (network provider) followed by file transfer protocol (FTP) (data provider).

Step 3. Confirm that the data sent from the site are ingested by data-user agencies, for each identified language and medium

Data ingested at data-user agency: confirmed.

Example 2. A field site transferring ERRTS data via two repeaters direct to the data-user agency:

Step 1. Identify number of transfers Number of transfers: 3
Step 2. Identify mediums and languages Mediums/languages: ERRTS.
Step 3. Confirm that data sent from the site is ingested by data-user agencies, for each identified language and medium Data ingested at data-user agency: confirmed.

Example 3. A field site transferring data via a satellite modem to a local agency. The data is then onforwarded via FTP to the data-user agency:

Step 1. Identify number of transfers Number of transfers: 2
Step 2. Identify mediums and languages Mediums/languages: Satellite (network provider) followed by FTP (data provider).
Step 3. Confirm that data sent from the site is ingested by data-user agencies, for each identified language and medium Data ingested at data-user agency: confirmed.

4.3 Data transfer metadata

4.3.1 Ingest metadata

Example 1. FTP data transfer between a local agency and a data-user agency:

Step 1. Identify data transfer metadata elements • Transfer method: FTP • Data transfer details: server address, folder path and password • Data format: HCS • Data decoding: no
Step 2. Verify that all data transfer metadata elements are available to data users, and data-user agencies' systems can find, or extract, the information from the received data. Data-user agencies' systems can find, or extract, the information from the received data.

Example 2. ERRTS transmission of data from a field site to a data-user agency:

Step 1. Identify data transfer metadata elements • Transfer method: radio telemetry • Data transfer details: ALERT ID • Data format: ALERT • Data decoding: yes
Step 2. Verify that all data transfer metadata elements are available to data users, and data-user agencies' systems can find, or extract, the information from the received data Data-user agencies' systems can find, or extract, the information from the received data.

Example 3. Transmission of data from a field site to a data-user agency via telephone telemetry:

Step 1. Identify data transfer metadata elements

- Transfer method: telephone telemetry
- Data transfer details: telephone number (data and voice for IP logger)
- Data format: logger format
- Data decoding: no

Step 2. Verify that all data transfer metadata elements are available to data users, and data-user agencies' systems can find, or extract, the information from the received data

Data-user agencies' systems can find, or extract, the information from the received data.

4.4 Interpretability

4.4.1 Range

4.4.1.1 Rain range

This example is a tipping bucket rain gauge:

Step 1. Calculate hourly rainfall intensity for the site

- Sampling interval: 15 minutes
- Design rainfall: 28.3 mm (15 minutes 1% AEP) at site
- Rainfall intensity: ~120 mm/hour

Step 2. Identify the maximum rainfall rate that the instrument can accurately measure

- Maximum intensity of instrument (0.2 mm tipping bucket rain gauge): ~600 mm/hour.

Step 3. Verify that the instrument can measure the hourly rainfall intensity at the site

Yes: 600mm/hour > 120mm/hour.

4.4.1.2 Level/flow range

This example is a site with both a reference and an automatic gauge. The automatic gauge consists of a single bubbler unit and dry pressure sensor connected to both ERRTS (ALERT, analogue channel) and logger:

Step 1. Gather input data

Site coordinates: -36.69, 146.89
Catchment centroid coordinates: -36.84, 146.83
Catchment area: 435 km2
Timeseries plot (1976-current)
Highest recorded level: 3.9m
Lowest recorded level: 0.81m
Rating table
Flood classifications: min 2.8m, mod 3.5m, major 4.2m

Step 2. Characterise site

1%AEP
Method1: Q 300 m3/s & WL 5.0m (water data online)
Method2: Q: 254m3/s & WL 4.7m (RFFE)

Step 3. Evaluate the performance level

Lower limit:

The lowest recorded level (0.81m) is sufficiently low to adequately capture base flow (visual inspection of the lower end of the timeseries) and it is sufficiently below the lowest flood classification (2.8m).

The lower limit of the range shall be equal to or less than 0.81m.

Upper limit:

The 1% AEP (5.0m) is greater than the highest flood classification (4.2m) and the highest recorded level (3.9m). The 1% AEP is then used to set the upper limit of the range.

The upper limit of the range shall be greater than 5.0m.

Step 4. Gather infrastructure specifications

Reference gauge: 6 off 1m gauge boards
Dry pressure sensor range: 20m
ERRTS range (config): 20m
Cease to flow: 0.23m

Step 5. Verify that the infrastructure meets the performance level

The lower limit of the range (0.23m) meets the performance requirement (0.81m).

The upper limit of the range (6.0m) meets the performance requirement (5.0m).

4.5 Accuracy

4.5.1 Level-accuracy

Step 1. Gather input data:

- Design requirement: Nil
- Flood classifications: 2.8, 3.5, 4.2m
- AS 3778 2.2 - 2001 5.2.4: the greater of +/- 10mm or 0.1% of the range
- Range: 5m

Step 2. Characterise site

Nil.

Step 3. Evaluate the performance level

The design uncertainty shall be equal to the lowest of:

- Service owner specified uncertainty: Nil.
- The uncertainty equal to plus or minus half of the least significant figure of the flood classification: **U = ± 50 mm**.
- The greater of +/- 10mm or 0.1% of the range (Range: 5m, 0.001 * range = +/-5 mm): **U = +/- 10mm**.

The uncertainty in the level data shall be equal to, or better than +/- 10 mm.

Step 4. Gather infrastructure specifications

- Uncertainty of datum: U = +/ 3mm.
- Site complies with NIGL's, Part 2.2: Part 2.2: General—Establishment and operation of a gauging station, Primary gauge 3.2.2.1.
- Uncertainty of instrument (pressure sensor): +/- 0.1% of range.
- Range: 5m.

Step 5. Verify that the infrastructure meets the performance level

Step 1. The uncertainty of the datum: **U (level datum) = +/- 3mm** (site complies with NIGL's, Part 2.2: Part 2.2: General— Establishment and operation of a gauging station, Primary gauge 3.2.2.1).

Step 2. The uncertainty of instrument (pressure sensor) from the manufacture's specifications: Range: **U (level measurement) = 0.1% of the range = 0.001 * 5 = +/-5 mm** (Range = 5m).

Step 3. The combined primary uncertainty (datum and instrument): **U (level) = 5.83 mm**

$$U(\text{level}) = \sqrt{u(\text{level datum})^2 + u(\text{level measurement})^2}$$

Step 4. The combined primary uncertainty in the level data is better than the level-accuracy performance level, (+/- 5.83 mm < +/- 10 mm). The uncertainty of the level measurement infrastructure complies with the level-accuracy performance requirement.

4.5.2 Flow-accuracy

Step 1. Gather input data

Location type: information but with significant predictive capability for downstream location (quantitative prediction).

Site priority: high.

Step 2. Characterise site

Nil.

Step 3. Evaluate the performance level

The flow accuracy is categorised as at least medium (Table 4) where:

- The accuracy of the flow data is known across the full range.
- The discharge relationship is established and maintained in accordance with the NIGL across the full range.

Step 4. Gather infrastructure specifications

Range: 5m
Highest gauging: 3.1m
Compliance with NIGL:

- Flow measurements are collected in accordance with NIGL (Parts 4, 6, 8, 9, 10).
- Rating table has been developed in accordance with NIGL (Part 6).
- Rating extension (above highest gauging) to upper limit of range has been established in accordance with NIGL (Part 6, Section 8).
- Site not established but maintained in accordance with NIGL (Part 2).

Step 5. Verify that the infrastructure meets the performance level

The accuracy of the rated flow is determined as medium, which meets the performance requirement.

4.5.3 Communications-accuracy

Example 1. Proprietary logger data transfer format:

Step 1. Inspect transfer files or messages or data transfer protocol specifications

- Data in SI units: yes.
- Timestamped: yes.
- Unfiltered: yes.

Step 2. If data is translated on receipt, determine that translation set metadata are maintained and updated in only one location

Not needed as data translation is not needed.

Example 2. Proprietary (site to server) telemetry system:

Step 1. Inspect transfer files or messages or data transfer protocol specifications • Data in SI units: no. • Timestamped: yes. • Unfiltered: yes.
Step 2. If data is translated on receipt, determine that translation set metadata are maintained and updated in only one location There is two-way communication between the data collection server (data provider) and the sites. Translation set changes at sites are controlled from the server (single point of contact). Data are transferred from site to data user via the server.

Example 3. ALERT1 messages (do not conform to this requirement):

Step 1. Inspect transfer files or messages or data transfer protocol specifications • Data in SI units: no (accumulation values that need to be translated). • Timestamped: no (timestamped on receipt). • Unfiltered: yes.
Step 2. If data is translated on receipt, determine that translation set metadata are maintained and updated in only one location Translation set metadata are maintained and updated in many locations. (Required to be maintained and updated in one location only).

4.6 Sampling Interval

4.6.1 Level/flow-sampling

This is an example of an automatic gauge consisting of a single bubbler unit and dry pressure sensor connected to both ERRTS (ALERT, analogue channel) and logger:

Step 1. Gather input data

Sample interval:

**All 3 methods are illustrated however only 1 is required*

Method 1: Upstream catchment area: 435 km^2
Method 2: TOC: 0.76 * A^0.38 (ref AR&R) = 7.7 hr
Method 3: TTP: 0.4 * TOC (ref ??) = 3.1 hr

Change of state (Level): Range: 4 m

Step 2. Characterise site

Sample interval:

Method 1: River response (Area): Riverine (100 < 435 < 400)
Method 2: River response (TOC): Riverine (6 < 7.7 < 96)
Method 3: River response (TOC): Riverine (3 < 3.1 <36)

Change of state (Level): Nil

Step 3. Evaluate the performance level

From Table 6, the discrete sample interval corresponding to a riverine river response is 60min.

From Table 7, the event sample interval corresponding to a riverine river response is 60mm.

Step 4. Gather infrastructure specifications

System 1.

Instrument type: ERRTS (ALERT)
Input: analogue
Sample time range: 5 to 3600s
Sample time configuration: 300s
Increment: 10 mm

System 2.

Instrument type: logger
Instrument sampling interval: 900s (identified from data record)

Step 5. Verify that the solution meets the performance level

System 1:

The ERRTS sample time (300s) is equal to the required performance level (60min). The system increment (10 mm) is less than the required performance level (60 mm). ERRTS (ALERT) meets this performance requirement.

System 2:

The logger sampling interval (900s) is less than the required performance level (60min). The Logger meets the performance requirement.

4.7 Data resolution

4.7.1 Level-resolution

Step 1. Gather input data: uncertainty of measurement = +/- 10 mm.

Step 2. Characterise site Nil.

Step 3. Evaluate the performance level

The level resolution shall be equal to or smaller than +/- 10mm (the water level uncertainty).

Step 4. Gather infrastructure specifications

Sensor resolution: 1mm
ERRTS canister resolution: 10mm
Logger resolution: 1mm

Step 5. Verify that the solution meets the performance level

The resolution of the logger/sensor water level measurement system complies with the performance requirement (1mm < 10mm).

The resolution of the ERRTS/sensor water level measurement system complies with the performance requirement (10mm = 10mm).

4.8 Metadata

4.8.1 Site-metadata

Step 1. Ascertain that all site metadata elements are available to data users, and are stored in, or extractable from, received data by data-user agencies' systems

- Site name: The Ovens River at Eurobin.
- Site ID: AWRC number 403250/Bureau number 082112.

4.8.2 Rain-metadata

Step 1. Ascertain that all rain metadata elements are available to data users, and are stored in, or extractable from, received data by data-user agencies' systems

- measuring point name: HAPPY VALLEY
- measuring point ID: 009988
- measuring point position: Latitude: -33.6808 Longitude: 115.6242
- time series ID: 009988.1
- data type: Rain Event
- data decoding: 0.2mm accumulation
- measurement date and time: WST
- measurement unit: accumulator
- duration of measurement: event measurement

4.8.3 Level-metadata

Step 1. Ascertain that all relevant level metadata elements are available to data users, and are stored in, or extractable from, received data by data-user agencies' systems

- measuring point name: Swan River at Barrack Street Jetty
- measuring point ID: 509440
- measuring point position: Latitude: -31.9597, Longitude: 115.8572
- measuring point elevation: 2m Chart Datum
- time series ID: 509440.2
- data type: River Event
- measurement status: as observed
- measurement date and time: WST
- measurement unit: metres
- stream gauging ID:
- stream gauging parameters;
- gauge zero: 0m CD
- cease-to-flow level: N/A tidal
- rating table name;
- rating table value pairs;
- minimum supply level;
- full supply level;
- total storage capacity;
- accessible storage capacity; and
- dead storage capacity.
- duration of measurement: 5 min

4.9 Availability

4.9.1 Reliability

4.9.1.1 Site-reliability

Step 1. Gather input data:

The design standard for reliability defined in terms of likelihood of failure is equal to rare.

Step 2. Characterise site: Nil.

Step 3. Evaluate the performance level

Design standard = rare.

Step 4. Gather infrastructure specifications: station file/site inspection, instrument specifications.

- Temperature: instruments range > anticipated site range.
- Humidity: instruments range > anticipated site range.
- Water intrusion: Cabinet IP rating = IP44.
- Biological, dirt and dust intrusion: Cabinet IP rating = IP44.
- Instrument level in relation to flood level.
- Landslip: Infrastructure installed on flat ground.
- Stock and wildlife: instruments within stock proof fence.
- Wind loading.
- Lightning: Instruments and cabinet earthed. Antenna isolated from instruments (lightning protection).
- Hail: instruments within cabinet, but raingauge susceptible to giant hail (likelihood of which is rare).
- Ice: Ice and snow unlikely as site elevation is well below likely snow level.
- Vandalism: Located on private land. Instruments in locked cabinet.
- Fire: Site cleared to approximately 50m/cables underground.
- Flood: instruments located above 1% AEP.

Step 5. Verify that the solution meets the performance level

The likelihood of failure of the infrastructure has been assessed by a trained practitioner and is considered to be at least rare so it meets the performance level.

The likelihood of failure assessment considers the hazards listed in step 4, and the workmanship and design of the infrastructure and installation is in accordance with manufacturers recommendations/best practise/Australian standards.

4.9.1.2 Power-reliability

Step 1. Gather input data

The design standard for reliability defined in terms of the likelihood of failure is equal to rare.

Step 2. Characterise site: Nil.

Step 3. Evaluate the performance level • If mains power is the primary power source, a backup power supply is also available. • For non-mains sources - - Ensure that a power budget has been completed in accordance with manufacturers guidelines. - Ensure that consideration has been given to the level of reliability required in the power budget.
Step 4. Gather infrastructure specifications Identify the power source(s): solar/battery.
Step 5. Verify that the solution meets the performance level • Primary power source not mains power. • Power budget has been completed in accordance with manufacturers guidelines. • Consideration has been given to the level of reliability required in the power budget. • The site meets the performance level.

4.9.1.3 Communications-reliability

Example 1. ERRTS site:

Step 1. Identify the level of performance required Alert1 industry standard fade margin > 15dB.
Step 2. Ascertain that an appropriate assessment of exposure was made for all communications components Yes, an appropriate assessment of exposure is complete.
Step 3. Confirm that the infrastructure design is sufficient to ensure it can withstand the environmental exposures and provide a satisfactory operating environment for internal and external equipment Yes, the site is assessed as sufficient.

Step 4. Determine that the measure of reliability is equal to or greater than the minimum standard

- Fade margin is > 15dB.
- Alert1 is considered highly reliable.

Example 2. Cellular data site:

Step 1. Identify the level of performance required

Cellular data industry standard RSSI > -80dBm.

Step 2. Ascertain that an appropriate assessment of exposure has been undertaken for all communications components

Yes, an appropriate assessment of exposure is complete.

Step 3. Confirm that the infrastructure design is sufficient to ensure it can withstand the environmental exposures and provide a satisfactory operating environment for internal and external equipment

Yes, the site was assessed as sufficient.

Step 4. Determine that the measure of reliability is equal to or greater than the minimum standard.

- RSSI > -85dB.
- The primary data transfer method does not satisfy the minimum standard for technology.

4.9.1.4 Network-reliability

Example not required.

4.9.1.5 Ingest-reliability

Example 1. Local council:

Step 1. Assess that data-user agency systems are robust and/or redundant, and that documented support procedures are in place

- Data-user agency: local council.

- Responsibility: monitoring.
- Reliability measures: robust systems.
- Documented support arrangements: yes.

Example 2. Prediction agency:

Step 1. Assess that data-user agency systems are robust and/or redundant, and that documented support procedures are in place

- Data-user agency: prediction agency.
- Responsibility: monitoring and prediction.
- Reliability measures: robust and redundant systems.
- Documented support arrangements: yes.

4.10 Maintenance

Example not required.

4.11 Asset replacement

Step 1. Ascertain that the asset replacement program is documented

- Assets and consumables are listed.
- Funding source is identified and available.
- Utilities and arrangements with utility providers are listed.

4.12 Metadata latency

Example not required.

4.13 Contextual information

4.13.1 Site-context

Example not required.

4.13.2 Rain-context

Example not required.

4.13.3 Level-context

Example not required.

4.13.4 Communications-context

Example not required.

4.14 Performance indicators

Example 1:

Step 1. Confirm that the indicator type provides an indication of the status or performance of all infrastructure components • Infrastructure: water level site (riverine flood TTP 12 hours). • Indicator type: water level check signal, battery voltage check signal. • Components: sensor, site infrastructure, power system, data transfer, ingestion, storage, display.
Step 2. Confirm that the frequency of indicator reporting is related to the consequences of a fault or issue occurring and how quickly those consequences develop • Indicator frequency: 3 hours.

Example 2:

Step 1. Confirm that the indicator type provides an indication of the status or performance of all infrastructure components

- Infrastructure: water level site (rapid response site TTP 3 hours).
- Indicator type: water level check signal, battery voltage check signal.
- Components: sensor, site infrastructure, power system, data transfer, ingestion, storage, display.

Step 2. Confirm that the frequency of indicator reporting is related to the consequences of a fault or issue occurring and how quickly those consequences develop

- Indicator frequency: 15 minutes.

Example 3:

Step 1. Confirm that the indicator type provides an indication of the status or performance of all infrastructure components

- Infrastructure: data collection system (large quantity of data collected in the order of seconds or minutes).
- Indicator type: heartbeats (between primary and secondary systems).
- Components: inactivity only (no indication of what is working or not working).

Step 2. Confirm that the frequency of indicator reporting is related to the consequences of a fault or issue occurring, and how quickly those consequences develop

- Indicator frequency: 5 minutes (notification only on handshake failure).

5 Glossary

accuracy (of measurement, representation and metadata)

The capability of measuring a value and that value being close to the true value.

The 'true value' is the result that would be obtained if a 'perfect' measurement or representation were made. However, all measurements have a degree of uncertainty regardless of accuracy. Factors that may contribute to uncertainty include limitations of measuring systems, measurement techniques and behaviours of the natural system being measured that cannot be controlled during the measurement.

availability

A measure of the percentage of time the infrastructure is in an operable state. Inoperable states include periods of time when the infrastructure is broken down and when it is being maintained.

In the *National Flood Warning Infrastructure Standard*, performance specifications for availability are defined in terms of reliability, maintenance, return to service, asset replacement and metadata latency.

assurability

The capability of being able to provide confidence in the integrity of unverified data.

In the National Flood Warning Infrastructure Standard, performance specifications for assurability are defined in terms of compliance, contextual information and performance indicators.

collectability

A measure of the data collection and supply attributes that affect the system's capability to provide data users with timely measurements of environmental conditions. The time interval or delay is important because it has a direct impact on warning time.

In the National Flood Warning Infrastructure Standard, performance specifications for collectability are defined in terms of latency (of reporting), temporal reporting period and interoperability attributes.

compliance

Adherence to relevant externally imposed requirements, or to broader notions of best practice, relevant to establishing, operating and maintaining instruments and structural components. These requirements and guidelines include the *National Industry Guidelines for hydrometric monitoring*, supplier design specifications, statutory requirements, regulations, rules, ordinances and directives. Non-compliance with these may have, or may have had, adverse economic, environmental or social effects.

contextual information

- Attributes of the infrastructure that are used to support data verification, infrastructure fault identification and diagnosis, such as site description, time series description, maintenance description; and measurement quality.

data

A measurement interpreted in conjunction with sufficient metadata.

data ingestion

The process of receiving, processing (decoding) and storing data collected from sites in data-user and data-provider systems.

data provider

An agency that provides data and metadata to a data-user agency. This includes (but is not limited to) an agency that ingests data from sites or other data providers and transfers that data to data-user agencies. Note: a data provider can also be a data user.

data resolution

The smallest change in the value of a quantity that causes a perceptible change in the measured value.

For example, the smallest change in water level that can realistically be determined is usually 1 mm. For flood monitoring and prediction purposes, the resolution is set to 10 mm.

data transfer

A process by which measurements and other data are transmitted via a data transfer network from a site to a data provider, or from a data provider to a data-user agency, in the form of signals, messages or files.

data transfer metadata

Metadata that is necessary to collect measurements from remote sites, such as data transfer formats and data transfer details.

data transfer network

A collection of spatially distributed devices that relay (receive and transmit) data using a common technology (for example, internet protocol (IP), telephone, satellite and very high frequency (VHF) radio) and language (for example, transmission control protocol (TCP), file transfer protocol (FTP), Automated Local Evaluation in Real Time (ALERT) protocol) from one geographic location to another.

data user

A user of flood warning data.

Data users include those supporting the Total Flood Warning System and the general public.

data-user agency

An agency that uses flood waning data in the provision of the Total Flood Warning System.

durability

The capability of an instrument or structural component to withstand the conditions to which it is exposed.

A component or subcomponent can be made durable by;

- being of robust design (e.g. an antenna);
- designing redundancy into the function (e.g. multiple Event Reporting Radio Telemetry System (ERRTS) repeater paths); and
- being stable, (e.g. downstream hydraulic controls).

Adverse conditions that instruments are designed to withstand include severe weather (such as high wind, extreme temperature, rain, hail and lightning), flash floods and vandalism.

environmental exposure

The degree to which a component or subcomponent of infrastructure is exposed to environmental influences.

For example, structural components (e.g. a cabinet) can be exposed to river flow, rainfall, wind and extreme temperatures, whereas a site instrument (such as a logger contained within a cabinet) will be only exposed to the conditions within the cabinet.

event

A change in state in terms of a depth of rain or a change in water level of a parameter (e.g. rainfall, river level or flow).

instrumentation

Measuring and communications instruments such as sensors, loggers (processors), modems (transmitters) and devices collectively in place at a site for measurement of a parameter or parameters, i.e. water depth, level or flow.

interoperability

The capability of systems at sites, data providers and data-user agencies to exchange and make use of data.

Systems that transfer data must share a common communication language and medium, which includes file and message formats, communication protocols and data transfer metadata. Sending data from a site to a data user can require multiple transfers. In that case, it is only required that each individual transfer must use a common communication language and medium.

interpretability

A measure of how well the data adequately represent the environmental conditions.

Accurate representation of environmental conditions, particularly during the extremes of flooding, is essential for the detection and prediction of river levels.

The data user must be able to resolve enough detail or identify the necessary information from the data to use it for monitoring and prediction purposes.

In the National Flood Warning Infrastructure Standard, performance specifications for interpretability are defined in terms of range of measurement, accuracy (of measurement, representation and metadata), sampling resolution and data resolution.

latency (of reporting)

The typical time between the completion of a measurement or collection of data and when those data are reported to, received, ingested and stored in a data-user agency's data collection system.

maintenance

The process of preserving the functionality of instruments and structural components to assure the quality of data.

This includes preventative, predictive and breakdown maintenances, such as monitoring system performance, inspecting, cleaning, lubricating, adjusting, calibrating, finding faults, repairing and replacing components.

measurement

The assignment of a value to a parameter characteristic (such as depth, level or flow). The value may or may not be interpretable.

metadata

Attributes that are necessary to interpret the data, such as site name, site identifier, measuring point position, measurement date and time, and data type.

monitoring site

A place where observations of the environment are made; typically, a physical location where sensors are used to measure the properties of one or more features of the environment (for example, depth of a river or temperature of the atmosphere).

operability

Infrastructure that is in functioning condition and so is capable of providing data that satisfies the collectable, interpretable, available and assurable performance requirements of the *National Flood Warning Infrastructure Standard*.

performance requirement

Specifies the minimum allowable performance to be achieved of a function of the flood warning infrastructure.

range of measurement

The variation between the highest value (upper limit) and the lowest value (lower limit) of a parameter (such as water level, flow and rainfall) that can be measured at a monitoring site.

reliability

A measure of the percentage of time the infrastructure is in an operable state. Inoperable states include only periods of time when the infrastructure is broken down. Alternatively, reliability is the probability of performing a defined function by a component of flood warning infrastructure while exposed to a range of defined environmental conditions for a given period.

In the *National Flood Warning Infrastructure Standard*, performance specifications for reliability are defined in terms of durability and operability.

return to service

The ease with which infrastructure can be returned to service within a defined environment over a defined period.

Return to service depends on the ease with which a site can be accessed and the ease with which components can be repaired or replaced. For example, this can be measured in terms of the time interval between failure notification and the return of the components to operational service (including travel for maintenance crews to reach the site and the time to repair the fault).

sampling resolution

The time interval between the beginning of consecutive sampling periods.

Defined in terms of a sampling interval, which can be regular for discrete sampling strategies (for example, temporal sampling interval) or irregular for event sampling strategies. For irregular sampling, the interval is dependent on the time it takes for a defined change in the measured value to occur.

sampling

Carrying out a process or method to measure a parameter.

station

see monitoring site

structural components

The basic physical structures and facilities at a site that support the operation of the measurement instruments and data transfer devices. They include gauge boards, control structure, instrument housing, enclosure, gauging facilities, the benchmark and the power systems.

temporal reporting period

A time period over which the measured parameter variable is reported; for example, hourly or daily.

time of concentration

The time needed for water to flow from the most remote point in a catchment to the catchment outlet or site.

time series

A sequence of measurements of a single parameter made over time at a given location.

Total Flood Warning System

An integrated flood warning system comprising six components:

- monitoring and prediction;
- interpretation;
- message construction;
- communication;
- protective behaviour; and
- review.

The Total Flood Warning System (TFWS) is defined in the Australian Emergency Manuals Series, Manual 21: *Flood Warning*, 2009, Australian Institute for Disaster Resilience. Accessible via https://knowledge.aidr.org.au/media/1964/manual-21-flood-warning.pdf.

unverified data

Data that have not been formally quality checked before being transferred to a data-user agency.

In the National Flood Warning Infrastructure Standard, operational flood warning data are unverified since the short latency period does not allow sufficient time to quality check.

verified data

Data that have been formally quality checked before being transferred to a data-user agency.

In the National Flood Warning Infrastructure Standard, verified data are not usually available for flood warning operations because of the time delay required for quality checking.

6 Appendix

Once infrastructure specifications are gathered, and verifications are complete, fill out the following form to complete the assessment.

7 Flood Warning Infrastructure Standard – Assessment Form

Performance Requirement	Site		Equipment		Meets Requirement?	Comment
	Requirement	**Value**	**Performance Verification**	**Value**		
3.1 Collectability						
3.1.1 Latency						
3.1.1.1 Data-Latency	Latency of reporting corresponding to river response type.		latency of reporting from site to data user is less than the required latency of reporting			
3.1.2 Interoperability						
3.1.2.1 Ingest-interoperability	At least one data transfer medium available Languages used can be received and ingested by data user agencies.	>= 1	Is there at least one data transfer medium available? Can the data sent from the site be received at the Data User Agencies?			
3.1.3 Data Transfer Metadata						
3.1.3.1 Ingest Metadata	All data transfer metadata elements shall be available to data users, and data-user agencies' systems shall be able to find, or extract, the information from the received data.		Identify data transfer metadata elements. Do all Data user agencies have metadata available to ingest the data?			
3.2 Interpretability						
3.2.1 Range						
3.2.1.1 Rain-range	Design Rainfall 1%AEP Rainfall Depth converted to hourly rate.		Rain gauge maximum hourly rate			
3.2.1.2 Level/flow-range	• Upper limit - Level/flow range • Lower limit - Level/flow range		• Upper limit of the range of the measuring system • Lower limit of the range of the measuring system			
3.2.2 Accuracy						
3.2.2.1 Rain- accuracy	Accuracy classification • The level of uncertainty given in the Bureau or World Meteorological Organization standards ~ ± 6% for calibration; • The standards defined in section 3.4 in the National Industry	Medium	Accuracy classification • Gauge calibration method/history • Height of gauge orifice			

	Guidelines for hydrometric monitoring Part 2 for: ○ 3.4.1.2A Sheltering and exposure; ○ 3.4.1.2B Height of gauge orifice.		• Exposure of gauge and representativeness of measurement Is accuracy classification equal or better than Medium?			
3.2.2.2 Level-accuracy	• Service owner specified uncertainty • Uncertainty equal to, plus or minus half of the least significant figure of the flood classification (if defined) • minimum uncertainty as defined in AS 3778 2.2 - 2001 5.2.4.		• Uncertainty of datum • Uncertainty of instrument (e.g. pressure sensor) • Range • Service owner specified uncertainty.			
3.2.2.3 Flow-accuracy	• Site priority • Data Use		• Highest gauging, flow measurement collection method • Discharge relationship development method.			
3.2.2.4 Communications-accuracy	Documentation or specifications of data formats and telemetry systems • Unfiltered, • Timestamped, • Primary measured data (SI units)	 Y Y Y OR N and translation set maintained	Is the data received at the Data User Agency via the primary data path? Unfiltered? Timestamped? Primary measured data in SI units OR not primary measured data but the translation set is maintained?			
3.2.3 Sampling Interval						
3.2.3.1 Rain-sampling	Maximum Allowable Sampling Interval if Discrete Sampling OR Event sampling interval if Event Triggered		Equipment max sampling period must be less than the Maximum Allowable Sampling Interval if Discrete sampling OR Event report size must be less than the event sampling interval if Event Triggered			
3.2.3.2 Level/flow-sampling	Discrete sampling interval based on river response. OR Event water level sampling interval performance levels		Discrete sampling interval sample rate OR			

			Sample time, increment, and change in state corresponding to an increment.			
3.2.4 Resolution						
3.2.4.1 Rain-resolution	Rain resolution	<= 1 mm	Rain Gauge Resolution <= 1 mm?			
3.2.4.2 Level/flow-resolution	• The service owner specified resolution • The resolution required to resolve flood classification (if defined) • The Australian standard for water level uncertainty (AS 3778 2.2 - 2001 5.2.4).		Resolution of the water level measurement system			
3.2.5 Metadata						
3.2.5.1 Site-metadata	The metadata elements listed in the standard shall be available to data-user agencies and data providers.		Are the metadata elements available to data-user agencies and data providers?			
3.2.5.2 Rain-metadata	The metadata elements listed in the standard shall be available to data-user agencies and data providers.		Are the metadata elements available to data-user agencies and data providers?			
3.2.5.3 Level-metadata	The metadata elements listed in the standard shall be available to data-user agencies and data providers.		Are the metadata elements available to data-user agencies and data providers?			
3.3 Availability						
3.3.1 Reliability						
3.3.1.1 Site-reliability	Assessment of Reliability of site infrastructure as described in the standard.	Design reliability Or >=99%	• Reliability assessment of each component meets the performance level?			
3.3.1.2 Power-reliability	level of power reliability required		• Power budget completed • Power budget meets reliability required			
3.3.1.3 Communications-reliability	Quality of service required for communication equipment		Has quality of service been measured and does quality of service meet the minimum requirement?			Perform for each communications method at equipment site if more than one.
3.3.1.4 Network-reliability	Network reliability based on past performance		Is network reliability sufficient?			Perform for each communications method if more than one.

3.3.1.5 Ingest-reliability	The data-user agency data receipt, ingest, storage and display systems are highly reliable		Are the data-user agency systems robust and/or redundant? and are documented support procedures are in place?			NA for an equipment site Perform for each data user agency
3.3.2 Maintenance						
3.3.2.1 Site-maintenance	For non-proprietary data transfer networks, the maintenance program shall include: • preventative, predictive and corrective maintenance, and the capability to monitor infrastructure performance; • standard operating procedures that accord with recognised standards or guidelines and manufacturer's recommendations or guidelines; and • conducting annual and post-flood event risk assessments to ensure that the maintenance program is adequately addressing site-specific risks to data collection and transfer processes.		Does the maintenance program comply with the requirements?			N/A for external (third party) data transfer networks
3.3.3 Asset Replacement						
3.3.3.1 Asset-replacement	Infrastructure assets are managed as a part of an asset replacement program that enables: • assets exceeding their design life to be identified; • planning for assets to be replaced at end of their design life; and • funding availability for assets to be replaced.		Does the asset replacement program comply with the requirements?			
3.3.4 Metadata Latency						
3.3.4.1 Metadata-latency	Ascertain that arrangements for metadata distribution are documented, which must include: • each element; and • the maximum allowable time interval between change and availability		Are the arrangements for metadata distribution documented?			
3.4 Assurability						
3.4.1 Contextual Information						

3.4.1.1 Site-context	The contextual information listed in the standard shall be available to data-user agencies and data providers.		Is the contextual information available to data-user agencies and data providers?			
3.4.1.2 Rain-context	The contextual information listed in the standard shall be available to data-user agencies and data providers.		Is the contextual information available to data-user agencies and data providers?			
3.4.1.3 Level-context	The contextual information listed in the standard shall be available to data-user agencies and data providers.		Is the contextual information available to data-user agencies and data providers?			
3.4.1.4 Communications-context	The contextual information listed in the standard shall be available to data-user agencies and data providers.		Is the contextual information available to data-user agencies and data providers?			
3.4.2 Performance Indicators						
3.4.2.1 Performance-indicator	A sufficiently frequent indication of the status or performance of the infrastructure components shall be available to data users and data providers.		Do the indicator types provide an indication of the status or performance of all infrastructure components? Is the frequency of indicator reporting related to the consequences of a fault or issue occurring and how quickly those consequences develop?			