Natural Hazards Detection System

NSW GOVERNMENT

Challenge Statements

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www.chiefscientist.nsw.gov.au/nhds

Program Overview

The NSW Government is committed to advancing innovative technologies to enhance natural hazard detection, aligning with Recommendation 5 of the NSW Bushfire Inquiry (2020) and Recommendation 2 of the NSW Flood Inquiry (2022). Both inquiries highlight the importance of using new detection technologies to mitigate the impact of natural hazards by delivering timely warnings. As a result, the NSW Government made addressing technology development for early warning and detection of fire and floods an election commitment, leading to the development of the Natural Hazards Detection System (NHDS) program.

Before purchasing new technologies, it is crucial to evaluate whether they meet the specific needs of end users. The NHDS Program will test and trial technologies in high-risk or frequently impacted areas, assessing their ability to support informed decision-making for stakeholders.

The NHDS Program is a $3.3 million multi-phased competitive challenge grant aimed at testing innovative detection technologies. The goal is to improve early identification and warning systems for natural hazards such as floods and bushfires, providing residents with more time to evacuate and enabling emergency services to prioritise areas of highest risk.

The Program allows suppliers to demonstrate that their technologies are both fit for purpose and offer value for money, while also enabling emergency management agencies to evaluate their suitability and operational requirements. Challenges are developed by NSW Government agencies, with a focus on fire and flood detection, as outlined in NHDS Challenge Statement document. Companies are invited to submit proposals addressing these challenges, with successful applicants progressing to further phases, including a pilot of their technologies at scale.

Importantly, any data generated through any NHDS grants will be owned by the NSW Government, which will have the discretion to utilise the data in future related or unrelated projects. As this program is expected to generate significant data, all eligible solutions will need to be compatible with the data storage technology established for the project. This will be a modern web-based application programming interface (API) capable of receiving data from different technology platforms.

The NHDS Program has three phases:

- **Phase 1: Proof of Concept** – Organisations submit proposals to address specific challenges and funding will be allocated through a competitive process. This phase involves:
    - Collaborating with stakeholders to understand the problem
    - Developing detailed technical responses
    - Adapting the technology to best address the challenge
    - Testing the technology in a small-scale pilot to demonstrate its potential and feasibility.

Grant recipients of Phase 1 will be eligible to apply for Phase 2, through a competitive process. These guidelines are for Phase 1 – Proof-of-Concept. Separate guidelines will be released for Phase 2 and its terms, eligibility and criteria are at the discretion of OCSE.

- **Phase 2: Pilot (by invitation)** – This phase involves:
    - Deploying the technology in real-world scenarios at a pilot scale at a minimum of two sites (sites to be announced in the Phase 2 guidelines)
    - Working with relevant NSW stakeholders across government and industry
    - Establishing supplier networks and costings for potential full-scale deployment
    - Verifying the quality, accuracy and value of the technology in practice
    - Delivering new insights to agencies and stakeholders.

- **Phase 3: Post NHDS grant** – NSW Government will assess the solutions and may consider them for procurement. Note: participation in the program does not guarantee procurement.

The NHDS Program is administered by OCSE within the Premier's Department (the Department), in collaboration with the NSW Reconstruction Authority (RA).

More information on the Program, including Program Guidelines and an Application Form, is at https://www.chiefscientist.nsw.gov.au/nhds.

Agency Challenges

Agencies have provided challenges in a user story format describing the need and potential application of the technology, along with key technical or functional requirements. These challenges outline high-level functional needs without specifying the technology required to address them.

We encourage applicants to think creatively and propose innovative solutions that push the boundaries of conventional approaches. The technical and functional requirements outlined should be seen as the minimum or ideal expectations, not as the total requirement. The NHDS Program allows for further refinement and exploration of specific needs in collaboration with the agency once the grant has been awarded.

Each challenge includes a list of ideal and optional data requirements, detailing what is considered essential for addressing the challenge. However, any additional data, insights or features that the technology can provide will also be evaluated and welcomed.

NHDS Data API

The minimum deliverable for any proposed technology will be the mandatory attributes specified for each challenge, delivered through an Application Programming Interface (API) established as part of the NHDS. This API will be a modern, secure platform designed to aggregate and combine data into a time series format, enabling NSW Government agencies to access and use the information as needed. The platform will also manage information security and provide government user access to the NHDS data.

While each challenge defines the core attributes that need to be delivered, additional metadata will be required to ensure the data is properly contextualised and fit for purpose. This metadata may include details such as the technology's location, height, operational status, connectivity status and battery levels. The specific schema, technology and testing protocols for the API will be refined during the Proof-of-Concept (Phase 1).

Although the data transmission path to the API is not prescribed, consistency and reliability of data transfer are critical. Data may be transmitted directly from the sensor to the API, or via a server that interprets raw sensor data before sending it to the API. This intermediate step may be necessary to minimise bandwidth usage between the sensor and the cloud.

Some technologies may include features such as data storage, interpretation and visualisation as part of their solutions. These may be integrated into the NHDS project, but all collected or derived data attributes listed in this document must also be shared with the NHDS API.

The data stored in the NHDS API is expected to be shared with existing and new software systems used by state and local governments. Over time, the NHDS data repository may expand to include a broader range of environmental data for uses beyond the challenges listed in this document.

It is important to note that the NHDS is not intended to replace existing sensors or data sources. Instead, it aims to enhance and expand the range of sensors and data sources available to agencies. If successful and compliant with current standards, NHDS data sources may eventually be integrated into established datasets, such as the NSW SEED Portal, Bureau of Meteorology systems and Hazard Watch.

Data Connectivity requirements

NHDS technology will need to be connected to transmit data to the NHDS API. In the trial areas,

several connection options will be available. Some of these connection methods and access to them may be supplied as part of the NHDS project, and details about what is required and available will be explored as part of Phase 1. While no specific connection method is mandatory, the number and type of connections at each location will be influenced by various factors. Solutions that are cost effective, connection-agnostic or capable of using multiple connection methods will be highly valued during the assessment process.

The bandwidth requirements of your technology will determine the necessary connectivity options. The two categories of communication for NHDS and examples of each are:

- Category 1 – low bandwidth comms requirement (LoRaWAN, NB-IOT, ALERT2, IOT Satellite)
- Category 2 – high bandwidth comms requirement (Wi-Fi, 4G/5G, LTE, NBN, Satellite)

As part of the application, you will be asked to specify the minimum connectivity category required for your solution and the types of connections it supports. Additionally, you will have the opportunity to indicate other connectivity groups and methods your solution can use as alternatives, along with any impacts on data availability and frequency. The long-term ongoing cost of maintaining connections to the technology will be a consideration when evaluating the technology.

Compliance with existing standards

Wherever possible, technologies should ideally comply with relevant technical or industry standards or demonstrate the potential to achieve such compliance. This includes the capability to transmit data in the appropriate format and frequency. However, it is acknowledged that some technologies may not yet fall under existing Australian or industry standards.

A key objective of this program is to explore the balance between accuracy, cost and spatial resolution. While compliance with established standards may be ideal in certain challenges, it is not mandatory.

Common requirements to all challenges

Requirements listed in this document should be considered as the minimum necessary specifications.

The NHDS does not mandate specific technology solutions, however the following **mandatory requirements** apply to all challenges:

- All solutions must support remote data updates via IoT or equivalent technologies (i.e. no on-site visits required to retrieve data from an SD card).
- Solutions must have a reliable power source to ensure continuous 24-hour operation without the need for physical site visits. Ideally, the solution should be self-sufficient and not dependent on mains power. It should be able to operate for at least three consecutive cloudy days or three days without mains power, if that is the primary power source.
- Solutions should use one of the NHDS data and transmission technologies as the primary communication method, with the ability to switch to a secondary backup in case of failure.

The following **optional requirement** applies to all challenges:

- Solutions should be able to adjust data transmission frequency in response to event triggers. These triggers could be seasonal, sensor-based or activated via an API interaction with the NHDS. The ability to refine and update these triggers over time should be built into the solution, allowing end users to make adjustments during deployment or maintenance.

- Employ a simple and rapid deployment method that allows nearby technology to utilise common communication backhauls. This could involve using hub-and-spoke or mesh networking configurations between collocated technology.

List of challenge statements

Table 1 provides a summary of the challenges, with a full description of each challenge below.

Table 1: List of Challenges

Number	Area	Name
1	Flood	Water over Roads and Assets
2	Flood	Flash Flooding Water Levels
3	Flood	Water Level from Imagery
4	Flood	Rainfall/Soil Moisture Data
5	Fire	Ignition Detection
6	Fire	Fire Assessment and Monitoring
7	Fire	Local Fire Weather Monitoring
8	Fire	Bushfire Fuel and Soil Moisture Monitoring
9	Flood Fire	Existing Data

Challenge Statements

1. Water over Roads and Assets

Challenge area: Flood

User story

As a local or NSW Government agency, I need a cost-effective way to detect and monitor when water covers roads, water crossings and public spaces. This will allow us to close these areas or provide accurate messaging to the public without needing physical inspections.

Background

This challenge seeks reliable, low-cost sensors that can detect when water levels have risen to a point where surfaces become unsafe for passage. These sites are often located in areas without existing infrastructure such as power and connectivity.

Ensuring the safe movement of people and vehicles during emergencies is critical to protecting the community. During flash floods or riverine flooding, road and rail water crossings are gradually submerged. In some towns or local government areas, many crossings may be affected as flooding progresses. Once submerged, these crossings are dangerous to traverse. Those attempting to cross risk being swept away or stranded, requiring specialist rescue efforts and represent a leading cause of flood fatalities.

Mandatory Solution Requirements:

- The solution must be installed near key water crossings and locations prone to flooding from flash or riverine catchments. Installation should take into account both flood impacts and vandalism, ensuring long-term accuracy and functionality with minimal maintenance.
- The solution must be capable of transmitting required data from Table 2 to the NHDS data API.

Optional Solution Requirements:

- Solutions that can be mounted on existing infrastructure with minimal engineering modifications will be highly regarded.
- The solution should include or be able to integrate into local warning systems (e.g. warning lights, signs or gates) without needing a connection to the NHDS data API. This could be achieved through contact closures or similar mechanisms that activate when a crossing becomes unsafe.

Ability to report the water height over the crossing to inform the safety of the crossing to be used by different vehicle types and sizes.

Table 2: Challenge 1 Data Requirements

Mandatory/ Optional	Attribute	Measurement	Unit/s	Frequency No Event/ Event*
Mandatory	Water Over	Water has passed the level which would render the crossing or assets unsafe to use	Yes/No	1 Hour/ 5 mins
Optional	Water Over Height	Water level above/below the 'water over' level to show the depth of the water and provide a time series of the water level relevant to safe crossing level	Metres or fractions of a metre rounded to 2 decimal places	1 Hour/ 5 mins
Optional	Water Over Velocity	The velocity of the water flowing over the crossing or asset	Megalitres per day or fractions of a megalitre rounded to 2 decimal places	1 Hour/ 5 mins
Optional	Crossing Image	Still image or short video clip of the crossing at the time of the measurement	Image or link of the image/video	1 Hour/ 5 mins

2. Flash Flooding Water Levels

Challenge area: Flood

User Story:

As a local or NSW Government agency, we need a way to provide timely alerts when water levels rise in smaller waterways and catchments prone to flash flooding, especially near critical assets and infrastructure.

Background:

This challenge seeks cost-effective, reliable sensors capable of measuring water levels and/or velocity in creeks and streams vulnerable to flash flooding. These areas often lack existing water level monitoring and are typically not near infrastructure such as power and connectivity.

Flooding in NSW is classified into two types: flash flooding and riverine flooding. The key difference between them is the time from rainfall to its impact on assets or communities, referred to as the 'time of concentration'. Flash flooding occurs when the time of concentration is less than six hours, while riverine flooding generally occurs after six hours. NSW is divided into various catchments and sub-catchments, categorised based on this distinction.

In NSW, riverine catchment monitoring, alerts and warnings are managed by the Bureau of Meteorology (BOM) and the State Emergency Service (SES). For flash flooding, responsibility shifts to the SES and local councils. It's important to note that warnings and flood forecasts are handled by different agencies, depending on the type of catchment and flooding.

Mandatory Solution Requirements:

- Ability to measure water levels and/or velocity at a specific geographical location in an open channel.
- High accuracy of measurement, preferably in line with standards such as Flood Warning Infrastructure Standards
- Resistance to flood debris and vandalism, requiring little to no maintenance after flood events.
- Easily mountable or installable along creeks and waterways, with minimal environmental disturbance or impact on land users. These locations will be a mix of urban, rural and remote areas in both coastal and inland catchments.
- The solution must be capable of transmitting required data from Table 3 to the NHDS data API.

Optional Solution Requirements:

- Measurements and/or calibrations that comply with BOM, World Metrological Organisation (WMO) and the Flood Warning Infrastructure Standards.

Table 3: Challenge 2 Requirements

Mandatory/ Optional	Attribute	Measurement	Unit/s	Frequency No Event/ Event *
Mandatory	Water Level	The height of the water above a known height that will allow the overall water height to be determined in comparison to other water levels in the catchment	Metres or fractions of a metre rounded to 2 decimal places	1 Hour/ 5 mins
Optional	Water Velocity	The velocity of the water flowing over the crossing or asset	Megalitres per day of fractions of a megalitres rounded to 2 decimal places	1 Hour/ 5 mins
Optional	Water Image	Still image or short video clip of the crossing at the time of the measurement	Image or link of the image/video	1 Hour/ 5 mins

3. Water Level from Imagery

Challenge area: Flood

User Story:

As a local or NSW Government agency, how can we leverage existing camera imagery to reliably measure water levels at key locations or when other sensors fail?

Background:

This challenge seeks a low-cost, reliable technology solution that can measure water levels and/or water velocity in creeks, streams, rivers or other outdoor areas using existing or newly installed cameras.

In many flood-prone areas, cameras have already been installed for purposes such as traffic monitoring, security or general observation. By utilising technology that can extract data from these camera feeds, we can enable dual usage and expand monitoring coverage without the need for new infrastructure.

This technology could act as a critical backup to existing monitoring systems, which may fail due to flood impacts or other technical issues. It may also be able to measure water levels beyond the range of traditional sensors or provide additional data that cannot be gathered by other means. However, deployment may be limited to areas with high-bandwidth connectivity unless the solution can operate using edge computing.

Mandatory Solution Requirements:

- The technology must provide accurate measurements from imagery, with an associated confidence level indicating the accuracy of the readings.
- The solution must be capable of transmitting required data from Table 4 to the NHDS data API.

Optional Solution Requirements:

- The solution should be able to process imagery or video from cameras that may not have fixed direction, focal length or zoom, without requiring additional on-site equipment or site visits.
- The solution should be capable of consuming camera feed content via an API or remote connection for analysis.
- The solution could be a standalone system that processes camera imagery at the point of collection (e.g. using edge computing), transmitting measurements over a lower bandwidth connection if necessary.

Table 4: Challenge 3 Requirements

Mandatory/ Optional	Attribute	Measurement	Unit/s	Frequency No Event/ Event *
Mandatory	Water Level	The height of the water above a known height that will allow the overall water height to be determined in comparison to other water levels in the catchment	Metres or fractions of a metre rounded to 2 decimal places	1 Hour/ 5 mins
Optional	Water Velocity	The velocity of the water flowing over the crossing or asset	Megalitres per day of fractions of a megalitres rounded to 2 decimal places	1 Hour/ 5 mins
Optional	Water Over	Water has passed the level which would render the crossing or assets unsafe to use	Yes/No	1 Hour/ 5 mins
Optional	Water Over Height	Water level above/below the "water over" level to show the depth of the water and provide a time series of the water level relevant to safe crossing level	Metres or fractions of a metre rounded to 2 decimal places	1 Hour/ 5 mins
Optional	Water Over Crossing	The number of vehicles or people who transit the location after the 'water over' level has been reached	Count of people or vehicles since the last reported reading	1 Hour/ 5 mins
Optional	Crossing/ Stream Image	Still image or short video clip of the crossing at the time of the measurement with the value or measurement included on the image	Image or link of the image/video	1 Hour/ 5 mins

4. Rainfall/Soil Moisture Data

Challenge area: Flood

User Story:

As a local or state government agency, how can we cost effectively provide high-quality, localised rainfall and soil moisture data in near real-time?

Background:

This challenge seeks low-cost, reliable technology that can deliver localised measurements of rainfall and soil moisture in near real-time, while ensuring that the data is accurate, consistent and comparable to existing standards and datasets.

Australia and NSW have a network of rainfall and soil moisture sensors, both physical and derived. For accurate flood prediction and modelling, precise measurements of rainfall and soil moisture across catchments and sub-catchments are essential. This removes assumptions about rainfall intensity and soil conditions, which can significantly improve the accuracy of flood forecasting.

This challenge does not aim to replace existing technologies but to enhance or supplement data collection in areas with limited or no coverage.

Mandatory Solution Requirements:

- Consistent and reliable collection of rainfall data at the frequency required in Table 5
- Minimal maintenance, calibration or upgrading required over the operational life of the technology.
- Capacity to report rainfall totals and rain rates at intervals and volumes that exceed likely maximum rainfall for the installation location.
- The solution must be capable of transmitting required data from Table 5 to the NHDS data API.

Optional Solution Requirements:

- Ideally, the solution should be capable of reporting both rainfall and soil moisture data, or individually as needed.
- Measurements and/or calibrations that comply with BOM, WMO and the Flood Warning Infrastructure Standards.

Table 5: Challenge 4 Requirements

Mandatory/ Optional	Attribute	Measurement	Unit/s	Frequency No Event/ Event *
Mandatory	Flood Rainfall Total	Daily total accumulated rainfall that has fallen since 9am and reset on a daily basis	Millimetres or fractions of a millimetre to 1 decimal place	1 Hour/ 5 mins
Mandatory	Flood Soil Moisture	Measure of the soil moisture in the upper layer of soil (0-10cm) to inform flood and rainfall run off	Percent of moisture or fractions of a percentage to 1 decimal place	1 Hour
Optional	Flood Rainfall Intensity	The average volume of the current rainfall between the last measurement and the current measurement	Millimetres per hour or fractions of a millimetre to 1 decimal place	1 Hour/ 5 mins
Optional	Flood Soil Moisture Zones (Upper, Lower Deep)	Measurement of the soil moisture in the different zones of the soil profile to inform flood rainfall runoff. Upper – 0-10cm Lower – 10cm to 1m Deep – 1m to 6m	Percent of moisture or fractions of a percentage to 1 decimal place	1 Hour

5. Ignition Detection

Challenge area: Fire

User Story

As a NSW Government agency, how can we detect new fire ignitions across remote landscapes within 10 minutes of starting, with a spatial resolution of 100m^2, so that we can initiate an appropriate response?

Background

This challenge seeks to identify cost-effective technologies that can autonomously detect fire ignitions in remote and rural areas of NSW within 10 minutes, despite varying environmental conditions such as cloud cover, fog, mist, heavy smoke, rain, lighting conditions, and natural or man-made heat sources. The solution should minimise false positives and provide reliable data for timely decision-making.

NSW experiences on over 6,000 bushfires annually, many of which are ignited by both natural and human causes. Regardless of the source, early detection and rapid response are critical to minimising the impact of these fires. While populated areas benefit from fire reporting systems such as the emergency 000 number, fires in remote regions can go unnoticed for days, allowing them to grow and making suppression efforts more difficult.

While NSW has many current technologies to detect fires in remote areas including cameras, manned towers and satellite-based detections, these all have limitations and don't currently offer certainty that fires are detected within a short timeframe. The goal of this challenge is to test high-spatial-resolution detection technologies in high-risk, remote areas of NSW. Solutions may be based on current detection technologies or new and innovative approaches.

While space-based detection solutions are not excluded, they are unlikely to meet the requirements of this challenge due to known technological and environmental constraints.

Mandatory Solution Requirements

- Ability to detect new fire ignitions and report the likely location within 100m^2 of the actual ignition point.
- Provide a confidence rating for the ignition, allowing human operators to make decisions based on the likelihood of the event being a fire.
- Preference will be given to solutions that do not require placement on existing communication towers and can operate with minimal power, reducing the need for and impact of new structures in remote areas.
- The solution must be capable of transmitting required data from Table 6 to the NHDS data API.

Optional Solution Requirements:

- Transmit or provide access to imagery and contextual data used to detect the ignition, enabling human operators to apply local knowledge for decision-making.
- Leverage known fire locations, local vegetation types, and available weather and environmental data to improve the confidence of fire detection.
- Process data on-site (on the sensor or in the field) to minimise the need for transmitting high-bandwidth data over complex, power-intensive and costly connections.

Table 6: Challenge 5 Requirements

Mandatory/ Optional	Attribute	Measurement	Unit/s	Frequency No Event/ Event *
Mandatory	Fire Detection	Location of point that has a fire within 100m of its location including the confidence of the ignition being an actual fire	Latitude and longitude of the centre of the detection	As required when new detections are found
Optional	Fire Bearing/ Distance	The grid north bearing of the fire and an approximate distance from the sensors location stored in the NHDS	Grid north cardinal bearing to the closest full degree and the distance in kilometres or fractions of a kilometre rounded to 2 decimal places.	As required when new detections are found
Optional	Fire detection context data	Image, link or text information used to determine the detection of the fire transmitted in the 'Fire Detection' attribute	Image, link or HTML data that contains the contextual information.	As required when new detections are found

6. Fire Assessment and Monitoring

Challenge area: Fire

User Story

As a NSW Government fire agency, I need to identify fires of concern based on their proximity to assets, infrastructure and people, as well as relevant environmental conditions. I require real-time, accurate information on fire direction, affected area and fire intensity to make informed decisions.

Background

This challenge aims to identify cost-effective and potentially mobile technologies or systems that extend the scope of fire information beyond initial detection, providing time-critical insights as fires escalate near valuable assets.

Building on the requirements identified in Challenge 5, this challenge will focus on the ongoing detection and monitoring of fires as they progress through the landscape. The rapid escalation of fires can complicate efforts to quickly assess their extent and direction of travel. This information is crucial for directing resources and communicating effectively with the community.

Currently, deploying fire resources to gather this information diverts limited personnel and equipment away from actual fire suppression and the protection of people and assets. Therefore, this challenge should prioritise the development of solutions that enable data collection, analysis and transmission with minimal human input near the fire.

Given the unpredictable nature of fire ignition and behaviour, the technology should ideally leverage either pre-deployed technology or lightweight, easily transportable technology that first responders can quickly deploy in high-risk areas. This could include system that require little or no intervention to provide the information for large areas of NSW. This approach will enhance situational awareness and improve response efforts without overburdening fire resources.

Mandatory Solutions Requirements:

- Use the technology to monitor the fire and its progression after detection with minimal human intervention to generate the information required.
- Ability to withstand harsh operating conditions that exist during fires including heat, dust, wind and water.
- The solution must be capable of transmitting required data from Table 6 to the NHDS data API.

Optional Solution Requirements:

- Able to operate during the day and night and when the area is impacted by smoke cloud or other weather impacts.
- Have the option to be preinstalled in high-risk areas or be quickly deployed by staff or volunteers with little training in response to a new ignition.
- Able to monitor large areas of NSW for long periods of time.
- Able to operate for long periods (~24 hours) without the need for changing power sources or position of the technology if the fire grows significantly.

Table 7: Challenge 6 Requirements

Mandatory/ Optional	Attribute	Measurement	Unit/s	Frequency No Event/ Event *
Mandatory	Fire Direction	Cardinal direction of travel of the fire measured between 0 – 359	Degrees or fractions of a degree rounded to 1 decimal place	1 Hour/ 5 mins
Mandatory	Fire location	Current location of the fire edges expressed as a single or series of latitude and longitude	Latitude and longitude of the centre of the detection	1 Hour/ 5 mins
Mandatory	Fire Proximity	Distance from the fire edge to closest identified asset as a distance in kilometres	Kilometres or fractions of kilometres rounded to 2 decimal places	1 Hour/ 5 mins
Optional	Fire Intensity	Relative level of fire behaviour compared to the previous reported value expressed as value of None, Low, Medium, High	None, Low, Medium, High	1 Hour/ 5 mins
Optional	Fire Image	Image or series of images showing the fire and / or the associated smoke plume	Image or link to image	1 Hour/ 5 mins

7. Local Fire Weather Monitoring

Challenge Agency:

Challenge area: Fire

User Story

To effectively plan for hazard reduction burning and active fire management, there is a need for low-cost, portable weather stations that can measure temperature, relative humidity, wind speed (both average and gust), wind direction and precipitation.

Background

This challenge aims to identify cost-effective technology that provides real-time weather data across various locations in NSW, particularly in remote or regional areas where weather information is often lacking. Current Portable Automatic Weather Stations (PAWS) while fit for purpose require specific sites and skills to install correctly, the technology sought should offer a simple and compact way to collect the information.

Understanding current weather conditions and their variation is crucial for agencies as they plan for and respond to natural hazards in NSW. Deploying portable weather stations in areas of interest will enable agencies to accurately monitor hyper-local weather conditions, facilitating informed decisions regarding risk mitigation activities and responses to emerging natural hazards.

Data from these stations can play a vital role in simulation and prediction models, guiding the planning of mitigation activities. Key factors to consider in the selection of this technology include portability, ease of installation and measurement accuracy.

While these stations may not meet the stringent compliance requirements of BOM/WMO standards, they should still provide sufficiently accurate data to support critical decision-making with confidence.

Mandatory Solution Requirements

- Units must be portable, lightweight and easy to deploy and relocate by minimally trained staff or volunteers in remote areas of NSW.
- Provide high-quality measurements of temperature, relative humidity, wind speed (average and gust), wind direction and precipitation.
- Capable of transmitting data at intervals ranging from 15 minutes to 3 hours.
- The solution must be capable of transmitting required data from Table 7 to the NHDS data API.

Optional Solution Requirements:

- Ideally, the stations should require minimal or no maintenance during deployment and remain unaffected by environmental conditions like leaf litter and debris in forested environments.
- Ideally when appropriately located, devices should aim for compliance with Measurements and/or calibrations that comply with BOM and WMO Standards.
- The ability to report additional attributes listed in Challenge 8 (Table 9) or other related challenges will be highly regarded.

Table 8: Challenge 7 Requirements

Mandatory/ Optional	Attribute	Measurement	Unit/s	Frequency No Event/ Event *
Mandatory	Fire Temp	Ambient temperature measured before each data transmission	Degrees Celsius or fractions of degree rounded to 1 decimal place	1 Hour/ 10 mins
Mandatory	Fire Humidity	Relative humidity of the air expressed as percentage between 0-100, updated before each data transmission	Percent or fractions of a percent rounded to 1 decimal place	1 Hour/ 10 mins
Mandatory	Fire Wind Speed	Current speed of the wind measured and averaged over the last 10 mins and updated before each data transmission	Kilometres per hour or fractions of a kilometre per hour rounded to 1 decimal place	1 Hour/ 10 mins
Mandatory	Fire Wind Gust	Wind speed measured over 3 seconds updated before each data transmission	Kilometres per hour or fractions of a kilometre per hour rounded to 1 decimal place	1 Hour/ 10 mins
Mandatory	Fire Wind Direction	The magnetic bearing direction of the wind origin expressed as degrees between 0 to 359 and updated before each data transmission	Whole degrees between 0-359	1 Hour/ 10 mins
Mandatory	Fire Rainfall Total	Daily total accumulated rainfall that has fallen since 9am and reset daily	Millimetres or fractions of a millimetre to 1 decimal place	1 Hour/ 10 mins
Optional	Solar Radiation	The diffuse solar exposure is the total amount of solar energy falling on a horizontal surface from all parts of the sky apart from the direct sun	Megajoules per square metre or fractions of a megajoule per square metre rounded to 1 decimal place	
Optional	Dew Point	Dew point expressed as the temperature to which air must be cooled for dew to form	Degrees Celsius or fractions of degree rounded to 1 decimal place	
Optional	Vapour Pressure Deficit	The difference between the amount of moisture in the air and how much moisture the air can hold when it is saturated	Kilopascals or fractions of a kilopascal rounded to 1 decimal place	

8. Bushfire Fuel and Soil Moisture Monitoring

Challenge area: Fire

User Story:

To effectively plan for hazard reduction burning and active fire management, there is a need for cost-effective methods to collect localised bushfire fuel and soil moisture information, minimising the necessity for personnel to enter the field.

Background:

Building on the requirements of Challenge 7, this challenge aims to explore cost-effective technologies that can accurately determine the moisture content of bushfire fuels and soil moisture, either in conjunction with other weather readings or at different locations across NSW.

The types of bushfire fuel of interest are categorised by their size and arrangement within the overall fuel structure:

- Fine Fuel: Combustible materials found on or very close to the surface, measuring less than 6mm in diameter.
- 10-Hour Fuel: Combustible materials found on or near the surface, measuring between 6 to 25mm in diameter.

Understanding the moisture content of bushfire fuels is critical for assessing the risk of fire occurrence and its potential severity, as well as for determining the suitability of these fuels for hazard reduction burning. Accurate, high-resolution data on bushfire fuel moisture enables more efficient resource deployment for fire control and hazard reduction efforts.

Fuel moisture levels can vary significantly across small geographical regions due to environmental conditions such as rainfall, temperature and humidity, as well as site-specific factors like slope aspect and vegetation type. Currently, the most reliable method to determine fuel moisture involves physical destructive testing at representative sites.

Mandatory Solution Requirements:

- Capable of accurately determining fine fuel and/or 10-hour fuel moisture levels at the site.
- Ideally utilise non-destructive techniques and sample at intervals of no less than once per hour.
- Employ industry-recognised or peer-reviewed methodologies for sensor placement and moisture value assessment at each location.
- Utilise highly mobile technology or sensors that can be easily transported, installed and relocated among remote sites by staff with little to no training.
- The solution must be capable of transmitting required data from Table 7 to the NHDS data API.

Optional Solution Requirements:

- Require minimal to no maintenance or parts replacement during the technology's deployment.
- Ability to assess upper soil moisture content for the area.
- Capable of being deployed individually or integrated with the technology proposed in Challenge 7 (Table 8).

Table 9: Challenge 8 Requirements

Mandatory/ Optional	Attribute	Measurement	Unit/s	Frequency No Event/ Event *
Mandatory	Fire 10hr Fuel Moisture	The moisture content of combustible bushfire fuel with a diameter of 6mm to 25mm expressed as percentage between 0-100	Percent of moisture or fractions of a percentage to 1 decimal place	1 Hour/ 15 mins
Optional	Fire Fine Fuel Moisture	The moisture content of combustible bushfire fuel with a diameter of less than 6mm expressed as percentage between 0-100	Percent of moisture or fractions of a percentage to 1 decimal place	1 Hour/ 15 mins
Optional	Fire Soil Moisture	Measure of the soil moisture in the upper layer of soil (0-10cm) to inform the prediction of bushfire fuel moisture expressed as percentage between 0-100	Percent of moisture or fractions of a percentage to 1 decimal place	1 Hour/ 15 mins

9. Existing Data

Challenge Agency:

Challenge area: Fire and Flood

User Story:

As a local or NSW Government agency, how can we effectively leverage existing data and citizen-submitted data to gather information pertinent to flooding, such as water levels, rainfall and soil moisture?

Background:

This challenge seeks to identify innovative approaches to interpret or derive data from existing sources and publicly submitted information at higher spatial resolutions, particularly in areas where physical sensors are currently absent. This initiative is more aligned with big data analytics than traditional physical sensor deployment.

Today's smartphones, IoT devices, weather stations, smart home technologies and remote sensing generate and store vast amounts of data that typically are not utilised by agency staff for natural hazard responses. By harnessing this data, we can not only equip agency personnel with valuable information but also empower local communities to actively participate in data collection and sharing. This collaborative effort can lead to more tailored messaging and improved predictions regarding natural hazard impacts.

While some of this data is accessible and publicly available, concerns about location, accuracy, sensor quality and reliability often hinder its integration into natural hazard management strategies. However, numerous successful citizen science projects demonstrate that, with proper guidance, communities can significantly enhance data collection and verification processes creating greater confidence in the data.

Mandatory Solution Requirements:

- Capable of gathering and aggregating data from open data sources, citizen contributions and community-maintained sensors.
- Implement processes to ensure the quality and consistency of supplied data, including mechanisms to flag uncertainties regarding the accuracy of input data and the outputs generated.
- Provide derived or virtual sensor data sources to the NHDS data API as either point data or links to GIS/gridded layers of values derived from other sources.
- The solution must be capable of transmitting required or optional data from Tables 2 to 9 (inclusive) to the NHDS data API.

Optional Solution Requirements:

- Based on industry recognised standards or available peer-reviewed research to derive the data outputs.
- Delivery of the required or optional data from Tables 2 to 9 (inclusive) to the NHDS data API at frequencies lower than those listed.

Note: The final API specifications will include an additional attribute to indicate the derived nature of the data and its confidence level.