

# **GBON National Contribution Plan of Papua New Guinea**

Systematic Observations Financing Facility

Weather and climate data for resilience



## GBON National Contribution Plan Papua New Guinea

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#### Introduction

The Global Basic Observing Network (GBON) was agreed at the World Meteorological Congress in 2019 and came into force in January 2023. The GBON is a surface-based weather observing network designed at a global scale to support Numerical Weather Prediction. It aims to address global variability in network density and reporting frequency to improve global weather forecasting and resilience.

In recognition of the challenges for WMO members from Small Island Developing States (SIDS) and Least Developed Countries (LDCs) in meeting GBON requirements, the Systematic Observations Financing Facility (SOFF) was established alongside GBON. SOFF is a United Nations Multi-Partner Trust Fund established by the WMO, the United Nations Environment Programme and the United Nations Development Programme. SOFF provides funding to uplift weather observations in SIDS and LDCs to meet GBON requirements.

The SOFF model is to partner each beneficiary country with a peer advisor country to provide peer support, and with an implementing entity to implement and oversee the SOFF investment. Papua New Guinea (PNG) has chosen the Australian Bureau of Meteorology (Bureau) as peer advisor and the United Nations Environment Programme (UNEP) as implementing entity.

In the first phase of the SOFF project, the Readiness phase, the beneficiary and peer advisor work together to assess the existing weather networks against GBON requirements, identify gaps, and develop plans for filling these gaps. The peer advisor and beneficiary country then document these plans together in a GBON National Contribution Plan, which supports an investment proposal for the next SOFF Investment Phase.

*This document provides the GBON National Contribution Plan (NCP) for Papua New Guinea.* It has been developed together by the PNG National Weather Service (NWS) with the Australian Bureau of Meteorology (Bureau) as peer advisor, and the United Nations Development Programme (UNDP) as implementing entity. It draws on a review of existing documentation and engagement with NWS and other PNG weather stakeholders during a visit to PNG between 1-10 November 2023. This visit was supplemented by information from co-incident visits to Port Moresby and provincial regions previously performed by other officers from the Bureau, and other site information provided by NWS.

The document:

- outlines the current state of weather observations in PNG, highlighting the gaps between the existing network and capabilities and the GBON requirements;
- proposes the planned future state for PNG weather networks to become GBONcompliant; and
- details the recommended activities needed to reach this future state.

This plan was developed together with the Country Hydromet Diagnostics report for Papua New Guinea and strongly relies on that document's content, with some of the material taken and adapted from it.

### Module 1. National Target toward GBON compliance

#### **1.1 Summary of Current State**

The current observing system of Papua New Guinea consists of the following stations, which are shown on the map below in Figure 1:

NWS-operated stations:

- 14 telegraphic manual
- 10 AWS
- 3 automated rainfall
- 3 hydrological
- 8 decommissioned upper-air

Third-party stations:

- 9 AWS, operated by Niusky Pacific Ltd<sup>1</sup>
- 1 x marine sea-level station (not shown)

PNG National Weather Services has been responsible for hydrometeorological forecasting (except for flood warnings) since Papua New Guinea's independence in 1975. Throughout that period, the budget and relative capacity has tended to decline. The observations network and supporting infrastructure currently requires substantial uplift and investment to return it to a functional service. The NWS observation network comprises only few reliable but incomplete surface observations and no upper-air observations performed. Forecasting services have low visibility within the country and are compromised by the state of the observations network, as are numerical modelling approaches, which lack ground, sea, or upper-air validation.

More details about the current status of the NWS and the implications are provided below in section 2.1 and Module 3.

<sup>&</sup>lt;sup>1</sup> Niusky Pacific Limited (NSPL), is a State Aviation Entity (SAE) which was registered as an independent company in July, 2007 however begun its official operations later on in January, 2008. NSPL had evolved from a government agency, formally known as Civil Aviation Authority PNG (CAA), into a self-funding commercial entity. See: <u>https://www.niuskypacific.com.pg/</u>



Figure 1. Map of existing surface and upper-air stations, with 200km buffers for operating surface stations.

#### **1.2 Principles for GBON Targets**

Papua New Guinea occupies the eastern half of the large island of New Guinea and an archipelago to the east towards Solomon Islands in the southwest equatorial Pacific Ocean. Its land mass of 462,840 km<sup>2</sup> comprises approximately 600 offshore islands together with the mainland. The topography of New Guinea is extreme, with rugged mountain ranges towering over coastal plains and a dominant central spine rising above 4,500 m on the Papuan side (Figure 2). The major offshore islands to the east of New Guinea (New Britain, New Ireland, Bougainville) are also mountainous.

The Exclusive Economic Zone of Papua New Guinea is 2,402,288 km2 (16<sup>th</sup> largest in the world) and extends slightly north and south of the Solomon Islands. To the south lies the continent of Australia, which is relatively flat by comparison.

Climate and weather intelligence is critical for Papua New Guinea, with rain, drought, riverine and flash flooding, severe storms, tropical cyclones, tsunamis and storm surges all affecting the country. Papua New Guinea is also highly exposed to climate change, with sea level rise, increase in rainfall and tropical cyclone intensity, temperature changes, and any variation in seasonal drivers such as ENSO particularly important.

While the above weather and climate aspects of Papua New Guinea are drivers for the future development of a more comprehensive national composite observing system for PNG, the plan for the GBON network is focused on reestablishing a reliable minimum-density network of surface and upper-air stations in accordance with the GBON National Gap Analysis targets below. Given its uniquely large land and ocean area within its Economic Exclusion Zone and also its large climatological and topological variation across the country, a functional GBON network is critical to both global and regional NWP. With this as its basis, it is recommended that the development should be focused through the application of the following principles, which are derived largely from consideration of the findings of the visit of the Peer Advisor staff to PNG in November 2023 and the Country Diagnostics Report for Papua New Guinea (November 2023).

#### Principles

In addition to those principles imposed by the guidance relating to both SOFF and GBON documentation, the principles for GBON targets and the development of the Contribution Plan are:

Figure 2. An aerial view of PNG depicting the challenges presented by the topography and environment.

- The recommended solution generally for PNG GBON surface networks is for continued manual observations programs with collocated AWS in support of automated surface observations and upper-air stations. GBON support should strongly prioritise the continued staffing of GBON station sites where possible, along with the continuance of manual observations made to supplement the AWS outputs. This staffing of sites is particularly critical for the more remote sites with less security and also because of the harsh, chiefly coastal/maritime tropical environments in which the observing systems will operate, and in which ongoing, routine maintenance will be very important.
- 2. To ensure sustainability of the PNG GBON observing networks, commitment to funding for the GBON stations infrastructure and its ongoing maintenance must necessarily provide support for, and uplift of the critical and key elements of NWS operations required to ensure ongoing data management and exchange functions, as detailed further in section 2.3 describing the business model.
- Given past experience and documentation of the rapid degradation and ultimately
  malfunctioning of observing systems historically arising from theft and vandalization of
  observing systems equipment in PNG, sites and systems should be installed in
  secure locations, for example within airport compounds and enclosed with extrasecure fencing.

- 4. While it is less than ideal that the GBON network cannot immediately take better advantage of third-party sites and data, particularly the Niusky Pacific Limited AWOS network at airport locations, mooted to be upgraded in the near future, it is recommended that overlap of these networks will be necessary and desirable for redundancy. Sharing between the two parties of their respective surface network data is a priority that the NWS will pursue and is welcomed by Niusky Pacific Limited.
- 5. While there are one or more third-party partnerships that have the potential to result in funding support for some aspects of the PNG GBON sites and infrastructure, the current lack of certainty of these potential funding sources, means that they have not been taken into account in the plan, but are identified within the report below. For the purposes of this report therefore, the plan is developed under the presumption that SOFF will be the sole funding support for this programme, but clearly notes that an early activity of the Investment Phase implementation should be to revise the status of other developmental projects impacting the GBON network and adapt the plan and resource requirements accordingly.
- 6. The mountainous nature of mainland Papua New Guinea and resource challenges have resulted in a lack of surface observations coverage over the climatologically important Highlands region. It is recommended that SOFF support should include coverage in this region where possible and, through the resourcing of refurbishment and ongoing maintenance of more accessible sites, allow NWS and possibly other resourcing to be directed toward future increased observations coverage in the PNG Highlands.
- 7. Where possible and necessary, SOFF should support the undertaking of a period of over-lapping observations with new and old sites in accordance with WMO-No. 100, Chapter 2.1.

#### 1.3 GBON Targets

The GBON National Contribution Target as determined under the GBON National Gap Analysis is shown in Table 1. These targets for the land-based component of GBON are discussed below in relation to the current state of PNG observing networks as established in section 1.1.

Turne of	Baselin	e (Results of the ( Analysi	GBON National Contribution Targe			
station	Target (# of	GBON- compliant	Gap New To improve		To improve	New
Surface	12	o stations (#)	0	12	12	0
Upper-air	3	0	1	2	2	1
Marine	*when applicable					

Table1. GBON National Contribution Target

 $<sup>^2</sup>$  For SIDS, for the WMO GBON Global Gap Analysis in June 2023, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations.

Based on the principles above, the recommended stations nominated for GBON implementation and uplift are listed in Table 2, section 3.1, along with the variables to be monitored and exchanged internationally and the short description of the implementation proposed to be supported by SOFF. The stations are also shown on the map in Figure 7.

In summary, it is recommended that the SOFF Investment Phase would therefore support:

- Uplift and improvement of 12 surface sites including restoration or replacement of the AWS facilities to enable hourly observations to be exchanged internationally and to enable integration of AWS outputs with manual observations.
- Improvement of 2 jointly funded upper-air stations by SOFF and the Bureau of Meteorology, with SOFF to support the improvements required to enable processing and management of data for international exchange and ongoing maintenance and consumables costs in line with the requirements for the 3<sup>rd</sup> upper-air station.
- Implementation of 1 new upper-air station.

#### **1.4 Exemptions**

With full implementation of the GBON National Contribution Plan, PNG is anticipated to comply with the GBON requirements. No exemptions to the GBON requirements will therefore be required for PNG.

### Module 2. GBON Business Model and Institutional Development

## **2.1. Assessment of national governmental and private organizations of relevance for the operation and maintenance of GBON**

#### National Weather Service

The National Weather Service (NWS) of Papua New Guinea will be the primary custodian and operator of the GBON land network.

Prior to its independence from Australia in 1975, meteorological operations were undertaken in PNG in accordance with the Australia Meteorology Act and under the authority of the Bureau of Meteorology.

Following independence, the NWS was officially established under the Civil Aviation Act (2000, amended in 2010, 2016) and, in addition to other responsibilities, as detailed in section 2.5, has responsibility for arranging the making, collection, recording, archiving, analysis and dissemination of meteorological information and observations. Under this Act, it also has a role in ensuring PNG's compliance with WMO provisions relating to international meteorology.

The NWS is administered under the governmental Department of Transport, receiving its annual budget allocation from the department. Based on the findings in the Country Hydromet Diagnostics report, the NWS is in need of capital funding and a boost to its operating budget to adequately resource basic hydrometeorological functions and responsibilities. Both the department and the NWS have plans and are working hard to overcome this shortcoming. Following the recent Peer Advisor visit and discussion with NWS and departmental management, some confidence can be held that financial resourcing will be increased over the coming four years. This, in addition to partnerships with other funding and partnering agencies as mentioned below, suggests that the NWS will in the future become better-placed to manage the GBON network, although there are significant risks related to this assumption, as detailed in Modules 3 and 5.

NWS' responsibilities in the implementation and operation of the PNG GBON network, subject to both the increased support as indicated above and support from SOFF being provided, would be the following:

- In consultation with the Implementing Entity and implementing partners, plan for and manage the implementation and uplift of GBON sites and infrastructure and its transition to ongoing operation and maintenance during the Compliance Phase.
- Plan, manage and oversee the implementation of related and required infrastructure and the training of required personnel to support both the implementation and ongoing maintenance of the GBON sites.
- Develop and implement the required internal processes to ensure oversight of the following activities to support GBON during both the Investment and Compliance phases:
  - Project management staff resourcing for GBON.
  - Additional security measures for personnel and infrastructure at GBON sites.

- Training of additional and ongoing technical staff in weather observing and station and communications equipment maintenance and repair.
- Uplift of central and GBON site infrastructure required for maintenance and repair of observing system infrastructure.
- Integration of data into NWS data systems and applications.
- o Improvement to data quality control and management systems and processes.
- Development of an international data exchange system and processes in support of GBON and related WMO requirements.
- Develop and foster required and appropriate partnerships with those entities below in support of GBON development and operation.

#### United Nations Development Programme (UNDP)

The UNDP will be the Implementing Entity for PNG for the SOFF Investment Phase and will develop and oversee implementation of the Investment Plan in partnership with NWS and the appointed peer advisor.

The UNDP has recently contributed to a development project in PNG, jointly undertaken with NWS and the PNG Conservation and Environment Protection Authority (CEPA), in which four river height gauges were installed in the Bumbu catchment on the north-east region of mainland PNG<sup>3</sup>.

A meeting of the peer advisor and the UNDP SOFF coordinator was held on 17 November 2023 during which the governmental and stakeholder environment of the NWS was discussed with a view to determining prospects for success of a SOFF initiative for GBON. It was agreed that the implementation needs to be well planned and managed and that the NWS administering department must be fully supportive of the initiative. Ideally resources for NWS infrastructure and its primary functions and activities should be significantly increased in the coming years to ensure PNG and the NWS can continue to support and build upon SOFF GBON implementation.

#### Civil Aviation Safety Authority (CASA), PNG

As the legislated authority in PNG responsible for aviation safety under the governmental act which also establishes the NWS as the agency responsible for meteorological services to aviation, the relationship of NWS with CASA is critical.

Currently, due to observations infrastructure and personnel training issues within NWS, the certification of NWS by CASA for provision of meteorological services has been reduced to a 3-month only period and CASA have formally advised NWS of those aspects of operations that must be improved to certify for a longer period between auditing, which include improvements to observing infrastructure. For this reason and, given the location of most GBON surface stations at airports and the role they will play in providing observations in support of required services to PNG aviation, the relationship between the two agencies is critical and would be positively impacted by a successful SOFF outcome for PNG.

<sup>&</sup>lt;sup>3</sup> See: <u>https://reliefweb.int/report/papua-new-guinea/bumbu-gets-country-s-first-early-warning-flood-system</u> and <u>https://niwa.co.nz/news/solutions-early-warning-of-png-floods</u>

#### National Airports Corporation (NAC)

The NAC<sup>4</sup> is a particularly important national partner for the NWS given it is the government appointed corporation responsible for managing PNG's airports infrastructure, on or nearby which the majority<sup>5</sup> of the NWS GBON sites are located.

Currently, NWS staff are unable to access observations sites at several airport locations controlled by the NAC. This is currently being addressed between the managements of NWS and NAC and is expected to be resolved in the coming months under a new access agreement and MoU.

For SOFF and GBON, it is crucial that this partnership be strengthened and any differences resolved to assure access of staff to maintain GBON sites and to continue to make required manual observations.

#### NiuSky Pacific Limited (NSPL)

NSPL is the state appointed corporate identity of the former PNG Air Services Limited and is the sole provider of Air Navigation Services for Papua New Guinea. NSPL official operations commenced in January, 2008. The Company evolved from a government agency, formally known as the PNG Civil Aviation Authority (CAA), into a self-sustaining commercialised entity as intended by the Government. NSPL provides air traffic management and air navigation services to the Aviation Industry in PNG for both domestic and international air operators. Its area of responsibility spans 1.6 million square kilometres of airspace, extending from the sea level up to 60,000 feet.

The relationship between NWS and NSPL is cordial, however, in recent years, there has been little tangible evidence of coordination, and this is expected to be improved in the coming years as airport facilities in the country are upgraded and efforts are made to ensure NWS better meets aviation requirements.

#### Australian Department of Foreign Affairs and Trade and the Bureau of Meteorology

The NWS has a long-standing relationship with the Australian Bureau of Meteorology and, recently and in conjunction with Australian Department of Foreign Affairs and Trade, a 'twinning' partnership has been established, allowing for staged assistance activities.

The Bureau of Meteorology is the nominated Peer Advisor to PNG under the SOFF GBON development program and will likely play a continued role in the Investment and Compliance Phases of the PNG SOFF GBON implementation.

Under the twinning arrangement, plans and agreements have been established between the Bureau and NWS to install two upper-air stations, one at Port Moresby and the other at Momote, Manus Island. This activity needs to be monitored and the Contribution plan adapted as an early action of the Investment Plan implementation, given that these two sites are nominated as GBON upper-air sites.

#### Other Entities

Other entities that may have a less important role and connection as a stakeholder in this program, include:

<sup>&</sup>lt;sup>4</sup> National Airports Corporation, PNG - <u>https://www.nac.com.pg/aboutus-our-history/</u>

<sup>&</sup>lt;sup>5</sup> The only station outside this arrangement is Port Moresby, with the instrument enclosure located at nearby Jacksons International Airport

- Conservation and Environment Protection Authority (CEPA) as the government agency responsible for water resource management in PNG, there are strong linkages between it and the NWS, and there is good willingness to cooperate and share data in the interests of their respective responsibilities, as evidenced by the aforementioned UNDP-sponsored project. An improvement in NWS observations networks will potentially benefit the flood warning capabilities and activities of the two agencies.
- National Maritime Safety Authority (NMSA) has responsibility for PNG coastal and marine safety and coordination of search and rescue activities. An improvement in NWS observations networks and resulting improvements to marine and ocean forecast capabilities, will benefit the work of the NMSA. Mutual data sharing arrangements should also be established in the interests of both agencies (Figure 3).



Figure 3. Briefing at the National Maritime Safety Authority.

• National Disaster Centre (NDC), Provincial Disaster Centres, and Civil Society Organisations. The NDC leads PNG's emergency response capability, with Provincial Centres and Civil Society Organisations playing major roles. An improvement in NWS observations and forecasting capabilities will assist these organisations in undertaking anticipatory actions aimed at avoiding disasters, and planning response for any disasters that do occur.

#### 2.2. Assessment of potential GBON sub-regional collaboration

Coordination was undertaken with peer advisors for neighbouring countries during development of the National Contribution Plan. The proposed station layout, especially for upper-air, takes into account other regional SOFF activities. The proposed stations will contribute to a broader well-distributed multi-country network across a critical region for Numerical Weather Prediction (NWP), taking into account SOFF-funded and other stations in nearby countries including Northeast Australia, Solomon Islands, as well as Indonesia on the western border of PNG.

The National Contribution Plan has also been structured to be flexible to accommodate future regional coordination initiatives such as regionally-focused equipment calibration services, training, procurement of common equipment types, and maintenance services. These will be pursued through several forums in which NWS is an active participant (Activity 2.1) including:

- Regional SOFF coordination workshop held in April 2024
- WMO RA V WG-Infrastructure committee
- Collaboration with RA V Regional Instruments Centre to ensure a calibration program for GBON station sensors is established and maintained.
- Pacific Meteorological Council and its committees, including Pacific Islands Communications and Infrastructure (PICI) panel
- South Pacific Regional Environmental Programme (SPREP)
- Pacific Community (SPC<sup>6</sup>).

During the Investment Phase, the NWS and UNDP will also pursue opportunities for regional synergies for maintenance services that can be implemented during the Compliance Phase, such as coordinated procurement of spare parts and calibration services.

**Activity 2.1** - NWS to review its membership of regional working groups and activities and ensure future regional collaborations are focused on ensuring obtainment of and contribution to GBON-related calibration, training, data management and station maintenance.

#### 2.3. Assessment of a business model to operate and maintain the network

As outlined in the PNG Country Hydromet Diagnostics (CHD) Report, the most recent budget (for 2022-23) provided 4.5 million PNG Kina to the NWS, with 82% allocated for staffing costs. The long-term budget trend is negative in actual and real terms, and this has resulted in station closures, staffing impermanence, the cessation of upper-air flights and the degradation and near disintegration of much of the observations network infrastructure. Station inspection trips are rarely performed. A quality manager position, present in 2014, was made redundant. Training cannot be internally funded and there has been significant deterioration of physical facilities.

Under the new Medium Term Development Plan<sup>7</sup> of the PNG Department for Transport, NWS is allocated an additional 10 million Kina each year for the next four years (2024 – 2027) and an additional 10.2 million Kina is expected to be sourced from an Asian Development Bank grant, to be used for improving NWS facilities at provincial airports.

While this promised government and development partner investment reflects the intentions of the NWS and parent Department under the NWS Strategic Plan and its alignment to PNG's broader strategies, it does not fully address the lack of resource support for the observations program that has led to its current state of disrepair. The funding would be expected to be directed into addressing critical building infrastructure, staff recruitment and training gaps, but would also require operational supplementation for a basic observations programme to operate successfully.

## Recommendations for Activities and SOFF support for GBON during the Investment and Compliance Phases

<sup>&</sup>lt;sup>6</sup> Formerly South Pacific Commission. The Pacific Community (spc.int)

<sup>&</sup>lt;sup>7</sup> https://mtdp.gov.pg/download-mtdp-iv/

For the above reasons and in this budgetary environment, it is strongly recommended that, for the PNG GBON network to succeed, SOFF funding will be required to fully support the implementation of the infrastructure and required communications and data management systems for GBON networks.

Additionally, taking into account the degraded state of NWS operations generally, it should be assumed that, during the Compliance Phase, SOFF will be required to support NWS in operating their GBON networks, under a financial framework that might be expected to resemble the following:

Operational GBON role, functions	Phase	% NWS	% SOFF
Planning for implementation & operations	Investment Phase	25	75
Purchase and implementation of infrastructure, communications and data management systems, built facilities for CRON	Investment Phase	0	100
network			
Operation of GBON stations (observing staff)	Investment Phase & Compliance Phase	50	50
Maintenance & repair (weather stations, IT systems, facilties, etc.)	Investment Phase & Compliance Phase	20	80
Ongoing supporting services and logistics (Consumables, communications, travel, fuel, spare parts, freight, etc.)	Investment Phase & Compliance Phase	0	100
IT support, data management, quality control	Investment Phase & Compliance Phase	20	80

It should be noted that this proposed financial framework is aspirational and would need to be continually reviewed and revised depending upon the development of the NWS operational capability and capacity over the Investment and Compliance phases.

It is also strongly recommended that the plan for the Investment Phase for allocation and use of SOFF funding for GBON should include the following critical activities and components as part of the development of the business model required to support or complement SOFF resourcing and implementation in the Investment Phase:

- Activity 2.2 UNDP and NWS to engage with other key partners to develop a plan for managing and disbursing SOFF funding.
- Activity 2.3 NWS to actively plan and monitor expenditure of the allocated Department of Transport MTDP funding to ensure that capital expenditure is allocated over the 4-year period, to address resourcing and infrastructure improvements, including:
  - Improvements to NWS building infrastructure, as far as they relate to the successful undertaking of GBON observations.
  - Additional security measures for personnel and infrastructure at GBON sites.
- While it is expected that the business model for ownership and operation of the GBON network is the *Public model Full State/NMHS owned and operated*, it is recommended that consideration is given to a private sector role in service provision for:
  - Site preparation and infrastructure installation.
  - On-site maintenance of observations equipment and sensors.
  - Technical training in calibration, maintenance and repair of GBON equipment.
  - $\circ$   $\;$  Development of processes for management of spares and supplies.
- Activity 2.4 Business Model and Plans for GBON implementation and operation to incorporate national and international private sector contractual involvement for

supply, implementation and transition to operation during the SOFF Investment and Compliance Phases.

- Activity 2.5 Department of Transport to plan for and implement expansion of NWS budget, personnel and functionality as required for NWS to be able to support:
  - Eventual transition to full annual budgetary support for sustained GBON network operation and maintenance.
  - Training of additional and ongoing technical staff in weather observing and station and communications equipment maintenance and repair.
  - Operation of data quality control and management systems and processes.
  - A broader and capacity-enhanced NWS role in national meteorological responsibilities, particularly those that benefit from the GBON observations network.
- Activity 2.6 NWS to update its Strategic Plan to incorporate GBON implementation and operation in partnership with key international entities.
- The NWS will also:
  - Adjust its strategic and operational planning to incorporate GBON.
  - Ensure that key regional international and national partner agencies are engaged in relevant aspects of the GBON implementation plan, particularly including the Bureau of Meteorology under the Twinning arrangement with the NWS.
  - Through WMO and other international fora, engage actively with other countries in the region to investigate and take advantage of bilateral and multilateral arrangements and approaches to ensuring continued efficiencies in operation, expansion and enhancement of GBON and other stations. This includes potential cooperative arrangements for ensuring supply and quality of operational equipment and sensors, including calibration.

## 2.4. Assessment of existing national strategies and projects related to observing networks

As outlined in more detail noted in section 2.3, the administrative body of the NWS, the Department of Transport, has developed its Medium Term Development Plan IV 2023-2027 (MTDP IV). The Plan sits under the 2050 Vision, which sets out 7 Pillars for development. The MTDP IV has several priority spending areas directly relevant to NWS operations and where improved NWS functionality would create tangible benefits:

- transport safety,
- multi-hazard early warning systems and disaster management,
- strong economic growth, and
- climate

The additional 40 million PGK allocated over 2023 – 2027 to the NWS is being provided under the transport safety priority. While none of these funds have yet been transferred to the NWS, in meeting with the Department Secretary, the Peer Advisor was assured that they were targeted in the plan for infrastructure development for the NWS. However, given the degraded and aged state of the various building infrastructure and staff accommodation (see Country Hydromet Diagnostics Report), it would be expected that the vast majority of these funds, should they be realized, would realistically be expected to be consumed in building infrastructure renewals and upgrades, increased staffing and related expenditures.

SOFF funding of the GBON network would likely be seen by the PNG government as a strong demonstration of international support for the PNG NWS and be synergistic to these funds being made available within the NWS budget.

Other projects and developmental activities that will be expected to support or impact GBON development in PNG include:

- Bureau of Meteorology, Australia The Bureau is engaged with the NWS in a meteorological twinning arrangement, as part of Australia-PNG Government relationships. Development activities are primarily aviation-focused, but will also strengthen the weather and climate technical capability of the NWS through support for some meteorological infrastructure, capacity-building and training for meteorological staff. Under this arrangement the developments that will most impact the GBON network operations are funding support for implementation of two upper-air sites at Port Moresby international airport and at Momote, Manus Island.
- Asian Development Bank 10.2 million Kina is expected to be sourced from an Asian Development Bank grant<sup>8</sup>, to be used for improving NWS facilities at provincial airports as part of a broader modernization development of PNG airport infrastructure focused primarily on five provincial airports.
- Climate and Oceans Support Program in the Pacific (COSPPac<sup>9</sup>) this Australian government program is supporting Pacific Island countries, including PNG, to adapt to and mitigate the impacts of climate variability.
- Weather Ready Pacific<sup>10</sup> This is a broader, planned regional multi-donor initiative to comprehensively strengthen the full hydro-meteorological system across the whole value chain in the Pacific region. Weather Ready Pacific can leverage the improved observations from SOFF investment as part of its broader focus on hydro-meteorological services. Weather Ready Pacific currently only has seed funding and full funding is not guaranteed.

The NWS is currently revising its strategic plan for 2024 to 2027, which will include planning for utilisation of this capital fund injection in broader support of GBON sustainable operation.

Opportunities to leverage these initiatives have been considered in the Module 3 Infrastructure Development below. As development programs in the region are dynamic, it is also recommended that at the start of the Investment phase, UNDP and NWS undertake a comprehensive environment scan of planned development activities related to GBON to identify any other opportunities for leverage and to ensure the planned works will be complementary (see Activity 2.3).

#### 2.5. Review of the national legislation of relevance for GBON

The Papua New Guinea National Weather Service is established under the Civil Aviation Act (2000, amended 2010)<sup>11</sup>, and has the following functions:

- a) maintaining and operating a service to be called the National Weather Service; and
- b) ensuring the provision of a meteorological warning service in Papua New Guinea; and

<sup>&</sup>lt;sup>8</sup> Papua New Guinea : Civil Aviation Development Investment Project II, <u>https://www.adb.org/projects/52201-001/main</u>

<sup>&</sup>lt;sup>9</sup> See: <u>http://cosppac.bom.gov.au/</u>

<sup>&</sup>lt;sup>10</sup> See: <u>https://www.pacificmet.net/</u>

<sup>&</sup>lt;sup>11</sup> Civil Aviation Act 2000 - <u>https://casapng.gov.pg/admin/images/Civil-Aviation-Act-2000.pdf</u>

- c) arranging for the provision of, and the making of and issuing of forecasts of the weather; and
- d) arranging the making, collection, recording, archiving, analysis and dissemination of meteorological information and observations; and
- e) engaging in scientific analysis and research of benefit to Papua New Guinea; and
- f) providing assistance to the Minister for the purposes of giving effect to the WMO Convention or otherwise for purposes relating to meteorology including participating in the work of the WMO.

Of these, functions d) and f) are most relevant and best reflect the NWS's role in, and responsibility for meteorological observations within PNG and a contribution to GBON through its participatory role in the work of WMO.

It should be noted that the Deputy Secretary of the Department of Transport provides the role of PNG Permanent Representative to WMO.

The NWS receives its budgetary allocation through the Department of Transport, which has administrative oversight of the NWS. This needs to be taken into account in the development and implementation of the Investment Plan and for ongoing activities under the Compliance Phase. It is recommended that the Investment Entity, UNDP:

- Obtains agreement with the Government of PNG around the management of the use of SOFF funds for their intended purpose of GBON implementation;
- Obtains agreement from the Department of how routine allocated NWS budget will support the implementation and ongoing operation of the PNG GBON observing network.

Procurement processes are governed by an act of parliament and overseen by the National Procurement Commission (NPC) of PNG<sup>12</sup> and the NPC Board.

Under the Act, PNG's procurement requirements are handled by the implementing agency, the Department of Finance, which works in close consultation with the NPC. PNG's procurement law applies to all public and statutory bodies with exceptions for state-owned enterprises (SOEs). Importantly for SOFF, for procurement arrangements under international agreements, the agreement supersedes the procurement law. This extends to procurements that involve co-funding, where the law only applies to funding portions involving the Government of Papua New Guinea<sup>13</sup>.

Many internationally funded projects have been undertaken and implemented within PNG, so it is not anticipated that government procurement oversight should restrict SOFF, which will be implemented subject to an international agreement through the Department of Transport and established by the UNDP.

<sup>&</sup>lt;sup>12</sup> National Procurement Commission: <u>https://www.npc.gov.pg/governing-framework/national-procurement-commission/</u>

<sup>&</sup>lt;sup>13</sup> From USA, International Trade Administration, *Selling to the Public Sector*, August 2022 - <u>https://www.trade.gov/country-commercial-guides/papua-new-guinea-selling-public-sector</u>

### Module 3. GBON Infrastructure Development

## 3.1. Design of the surface and upper-air observing network and observational practices

As reported in Module 1, NWS-operated stations:

- 14 telegraphic manual
- 10 AWS
- 3 automated rainfall
- 3 hydrological
- 8 decommissioned upper-air

Third-party stations:

- 9 AWS, operated by Niusky Pacific Ltd<sup>14</sup> (for example, see Figure 5)
- 1 x marine sea-level station (not shown)



Figure 4. NWS manual synoptic observation site at Port Moresby (0-20000-0-92035), overlooking Jackson International airport.

Based on the principles and targets described in Module 1, the recommended list of stations nominated for GBON implementation and uplift are listed in Table 3, section 3.1, along with the variables to be monitored and exchanged internationally and the short description of the implementation proposed to be supported by SOFF. In summary, it is recommended that the SOFF Investment Phase would support:

• Uplift and improvement of 12 surface sites, including full replacement, upgrade or addition of the AWS facilities as necessary, to enable hourly observations to be exchanged internationally and integration of AWS outputs with manual observations.

<sup>&</sup>lt;sup>14</sup> Niusky Pacific Limited (NSPL), is a State Aviation Entity (SAE) which was registered as an independent company in July, 2007 however begun its official operations later on in January, 2008. NSPL had evolved from a government agency, formally known as Civil Aviation Authority PNG (CAA), into a self-funding commercial entity. See: <u>https://www.niuskypacific.com.pg/</u>

- Relocation, upgrade or site refurbishment to 12 manual sites and instrumentation to support integrated input of manual variables to AWS output.
- Improvement of 2 jointly funded upper-air stations by SOFF and the Bureau of Meteorology at Port Moresby and Momote, Manus Island, with SOFF to support the improvements required to enable processing and management of data for international exchange and ongoing maintenance and consumables costs in line with the requirements for the 3<sup>rd</sup> upper-air station.
- Implementation of 1 new upper-air station at Misima.

A map of these stations is provided below in Figure 7.



Figure 5. A third-party Niusky Pacific Vaisala AWS at Jackson International Airport.

#### **GBON Surface Network**

#### **Existing State**

## Significant issues impacting the surface network

Following are the significant issues currently impacting the operational state of the PNG surface network of 14 manual stations in particular:

• In summary, nearly all 14 existing manual surface stations, many of which have in the past had operational AWS, are in a state of severe neglect arising chiefly from lack of site access arrangements, resourcing and prioritisation.

• Currently of the 14 manual stations, 3 are operational and 4 are partly operational but none of these are fully equipped to provide all observations required by GBON under the manual program.

• Of the 10 AWS stations, 6 have been

completely vandalised or degraded. Of the 4 remaining NWS AWS at sites, none are salvageable or able to be upgraded to support an observations program. An upgrade of the AWS network in support of GBON must support a homogeneous infrastructure to ensure efficiency of operation.

- NWS currently have 34 staff employed by the NWS under the observations program, although 19 of these are located at the headquarters in Port Moresby, of which only a proportion are responsible for observing and observational data functions. Staff at non-operational sites have not been maintaining sites and, more generally, staff are not being paid for overtime necessary to fulfil the observations program due to an administrative issue.
- PNG has been undergoing a major Airports redevelopment program under the Civil Aviation Development Investment Program (CADIP), which has led to nearly all of the airports at which the stations are located having been through an airport redevelopment, are in the process of redevelopment, or will be redeveloped in the coming years. Unfortunately, NWS staff accommodation, instrument enclosures and

related observing facilities have been neglected from the scope of works and negatively impacted by CADIP redevelopment works and have not yet been prioritised for relocation and refurbishment. In some cases, access by NWS staff to observations sites has been denied due to enhanced airport airside security arrangements.

- While the NWS is expected to obtain a capital injection via CADIP of approximately PGK50 million over the coming 4-year period, this is as yet unallocated. Additionally, this is unlikely to be sufficient to accommodate all the capital works required to satisfactorily and reasonably accommodate all the various staff office rebuilding and refurbishments, accommodation and other related infrastructure much needed by the NWS main office in Port Moresby. Therefore, in addition to observing system infrastructure, SOFF should also provide support for GBON-related building infrastructure as necessary, including maintenance and calibration facilities.
- The above means that, for all intents and purposes, the restoration of the surface and upper-air networks is effectively the full replacement of the network with new or refurbished sites, systems, sensors and related infrastructure.
- Additionally, NWS will require ongoing SOFF financial support to assure the ongoing operation and sustainability of its GBON networks in the longer-term.

#### Target State and recommended activities

General recommendations related to the design of the network of 12 nominated surface stations are:

- The network will be operated and supported by the NWS as a public asset. Annual maintenance and level 3 repair (as per Table 2) will be provided by contractors or equipment providers.
- To comply with the requirement for 24 hourly observations per day, sites will require installation with a new AWS.
- SOFF should support the continuance of the manual observations at all the GBON sites, including incorporation of manual observations into a single communications solution, where possible, and with backup through at least one alternative communications solution. The collocation of manual observations, or at least operational staffing, is particularly important for PNG stations for the following reasons:
  - Maintenance of unattended AWS to GBON reliability standards is challenging in PNG due to major logistical challenges (lack of roads, requirement for boat and aviation access, harsh tropical environmental conditions, rapid vegetation growth, etc.). Having staff on-hand to maintain as required is essential to ensure sufficient up-time to meet GBON standards.
  - Having both manual and automatic observations will provide redundancy for down-time of the AWS equipment (e.g. due to delays in shipping parts). When the AWS is down, the frequency of manual observations can be temporarily increased to hourly.
  - The presence of skilled staff on-site will provide quality control and allow for quick, reactive maintenance in the event of equipment problems.
  - Staff on-site will be able to provide security and grounds maintenance (e.g. vegetation mowing) to ensure the site complies with WMO siting requirements.
- The 14 manual stations of PNG are well sited and provide a baseline coverage across the country. Given the extreme topography of PNG and number of micro-

climate zones, it is important that all 14 of these sites should be supported for continuance of observations through both SOFF and by the NWS, and that this network remains the foundation of efforts to greatly expand observations in support of developing the national and regional observing program. However, for SOFF, it comes down to which 2 stations are to be deprioritised in recommending 12 of these stations to be nominated as GBON stations and supported with funding. These 2 stations are recommended as:

- Vanimo this station is at the far northwest of the country and two nearby Indonesian stations (JAYAPURA/SENTANI 0-20000-0-97690; JAYAPURA/DOK II 0-20000-0-97698<sup>15</sup>) are in close proximity to ensure that the regional requirements of GBON are satisfied. This allows the important sites of Wewak and Madang to be supported.
- Misima given this site will be a GBON upper-air site, it will necessarily be supported with the installation of an AWS as part of the upper-air equipment suite, therefore, the strategically located site of Gurney at the southeast tip of mainland PNG can be nominated and supported for uplift by SOFF.

A detailed summary of the operational status and state of each of the 12 nominated surface sites and proposed improvements required to make them GBON compliant is provided within Annex 1 and summarised in Table 3 below. A map of the nominated GBON surface sites is provided below in Figure 7.

#### Recommendations for observations facilities upgrade/renewal

Recommended site works and related observations facilities to be supported for upgrade or new implementation are detailed in Table 1. These activities will lead to a robust GBON for PNG that is based on complementary manual and automated surface observing systems, with collocated manual upper air systems at two locations, with a third upper air system locate at a NWS staffed location.

In relation to the above, it should be noted and incorporated in planning timelines, that airport redevelopments are planned to occur at the following sites:

- Misima
- Wewak
- Tokua.

#### **GBON Upper-air Stations**

#### Existing State

In the past, PNG and the NWS have operated a well-spaced network of up to 8 upper-air sites, which are now all closed. A longer-term aim, beyond SOFF and GBON, should be to restore more of these upper-air sites which would complement the GBON upper-air network for national and regional purposes.

However, of these, 3 upper-air sites, Misima, Momote and Port Moresby, are recommended to be re-implemented and nominated as GBON stations. These are listed and below in Table 2 along with a summary of required activities to be undertaken at each site.

<sup>&</sup>lt;sup>15</sup> The two Indonesian stations are currently reporting 8 and 6 times per day (as at December 2023)

A detailed summary of the status of each of the nominated upper-air sites and related information is provided in Annex 1.

#### Target State and recommended activities

The 3 recommended upper-air stations should be implemented in line with the general and specific recommendations below.

General recommendations related to the network of 3 nominated upper-air sites are:

- Two of three GBON upper-air surface stations will also be GBON surface stations (Figure 4), apart from Misima, which will be upper-air only, but will require an AWS and meteorological console to support the upper-air system operation as part of the NWS National network.
- Given that the GBON nominated upper-air stations of Port Moresby and Momote will also be supported, at least in part, by the Australian Government and the Bureau of Meteorology, during the SOFF planning and costing process undertaken by the Implementing Entity, consultation should be made with the Bureau to determine the status of implementation and how best to collaborate. In the event that uncertainty for funding and implementation exists, it is recommended that SOFF should fully fund all 3 upper-air sites.
- From a regional network perspective, a GBON upper-air site proposed for Solomon Islands at Taro will provide some coverage in close proximity to the north-eastern part of PNG.



Figure 6. Decommissioned upper air site at Misima. Complete replacement required.

• Ideally, at least a 4<sup>th</sup> upper-air site should be considered as a national implementation to cover the South-western portion of the country.

Upper-air stations will be manual and operated by the NWS observing staff rostered on shift at each of the stations. A hydrogen generator will be required due to the logistical challenges of sourcing and delivering hydrogen, especially to the 2 remote island stations.

Access to reliable 24/7 power and communications will need to be a major consideration for siting of all 3 stations and particularly for the Momote and Misima sites.

The proposed instruments and observing systems for these stations are summarised within the activities outline below (Table 1).

Selection and installation of instruments must be compliant with WMO-No. 8 Guide to Instruments and Methods of Observation.

Recommended activities associated with site works and related observations facilities to be supported for upgrade and/or new implementation are:

Activity	Details			
3.1 GBON Site	Travel to sites for inspection and detailing works to be			
selection and	undertaken for GBON sites			
surveying	Planning to include, as required:			
	<ul> <li>Manual observations</li> </ul>			
	<ul> <li>Automated observations</li> </ul>			
	<ul> <li>Collocated upper-air systems.</li> </ul>			
	Secure land and access for upper-air stations for Misima, Port			
	Moresby and Momote (if required, depending on other			
	Investment projects)			
	Identify access to office and storage facilities			
	Office facilities for surface observations console for 12 sites			
	<ul> <li>Office facilities for upper air console for 3 sites</li> </ul>			
	(combined with surface facilities)			
3.2 Surface	Instrument enclosure to meet WMO requirements (Class 1 or 2)			
works	readings (WMO 25 x 25m BOM 18 x 18m)			
WOINS				
	Footings and conduits for cables			
	Security fencing and access gates suitable for preventing			
	vandalism and theft			
	<ul> <li>Signage to inform or deter the public.</li> </ul>			
3.3 Manual Surface	1) Manual instrumentation refurbishment and upgrade			
observing system	Upgrade of manual observations equipment and sensors at 12			
refurbishment and	sites, including replacement of missing or faulty sensors.			
installation	<ul> <li>Post to 0.7 m to support rain gauge as required.</li> </ul>			
	Instrument shelter (Stevenson style), gloss white			
	and double louvered, with stand to achieve sensor			
	neight of 1.25-2m.			
	Required mountings for other manual sensors.			
	Other manual observations as required -			
	evaporation, sunsnine, soli temperatures.			

Table 1. GBON activities to support PNG infrastructure uplift.

	<ul> <li>Specification, development and installation at NWS offices of 12 manual observations consoles with automated AWS output integration. This will meet the following requirements: <ul> <li>PC workstation with visualisation and data entry peripherals for synoptic data.</li> <li>Telemetric reception of AWS data and a local display for visualising AWS data, including recent historical data for QC purposes.</li> <li>User interface to enter and integrate manual data with automated data for hourly synoptic messages.</li> <li>Internet, mobile or satellite IP connection to enable communication of coded messages.</li> <li>Software to support data storage/archival, visualisations, message encoding and transmission, etc.</li> <li>Batteries to support solar power, and/or to act as UPS.</li> </ul> </li> </ul>
3.4 AWS Surface observing system procurement and installation	<ul> <li>2) Automated instrumentation installation (AWS) Tendering, purchase and installation and configuration of 12 AWS, automated sensors and additional manual sensors as required, including power and communications connection, noting that a 13<sup>th</sup> AWS will be required for the upper-air only site, Misima.</li> <li>Facilities include: <ul> <li>Tilting counterweighted 10 m mast for anemometer.</li> <li>Housing for the AWS processor, barometer and power supply separate from other sensors.</li> </ul> </li> <li>Instruments will include: <ul> <li>Resistance Temperature Device (RTD) dry bulb probe and relative humidity probe @1.25m - 2m, with digital readout for manual observation.</li> <li>Wind speed and direction sensors @10m with digital readout for manual observation.</li> <li>Standard 8-inch (203mm) automatic reporting rain- gauge.</li> <li>Standard electronic barometer with digital readout for manual observation.</li> <li>AWS processor to collate data (preferably with a 7- 30 day buffer) and send messages at the required intervals.</li> </ul> </li> <li>Communications: <ul> <li>Cellular or WIFI telemetry from AWS to office meteorological console.</li> <li>Robust cellular and internet or satellite communications from office to ensure regular, timely message transmission.</li> <li>Redundant communications system where feasible.</li> </ul> </li> </ul>
3.5 Upper Air site works and	Building and facilities to house UA system, hydrogen generation and storage, manual launch facility.
CONSTRUCTION	

	<ul> <li>Balloon shed or remote balloon launcher where manually constructed balloon trains can be safely inflated and released.</li> <li>Separate (or partitioned) Hydrogen generation shed (or storage shed if bottled H2 is available).</li> <li>Fencing, adequate for the required security of the site.</li> <li>Exclusion zones (painted lines), beacons/lighting and paths within the site.</li> <li>An enclosure sufficient to ensure exclusion of the public and obstacles that may impact or be impacted by balloon releases.</li> <li>Installation to conform with Hydrogen safety requirements.</li> </ul>
3.6 Upper Air system installation	<ul> <li>Tendering, purchase and installation of required facilities and structure to support the upper-air programs at Misima, Momote and Port Moresby (as required), including <ul> <li>Nearby facilities, planned in harmonisation with surface station requirements, to house upper-air consumables, cleaning materials, various computer and communications systems supporting the upper-air observations, and a workstation for the manual observer to assemble balloon trains.</li> <li>A local display for the radiosonde profile and access to sensors for ground check data (T/RH/WS/WD/press).</li> <li>A power supply to enable H2 generation and monitoring, constant communication with the radiosonde and the transmission of coded messages.</li> <li>A hydrogen generation system (HOGEN) and H2 storage facility to ensure adequate supply for the anticipated upper-air program.</li> <li>An uninterruptable power supply to ensure the above.</li> <li>Supply of clean water for hydrogen generation.</li> </ul> </li> </ul>
3.7 Upper air consumable purchase	<ul> <li>Tendering, purchase and supply of consumables, including spares as required and appropriate for all 3 stations:</li> <li>Instruments/consumables</li> <li>Radiosondes (environmentally sustainable model)</li> <li>Balloons (environmentally sustainable model)</li> <li>'Met' string (environmentally sustainable model)</li> <li>Parachutes (as required)</li> <li>Personal Protective Equipment (PPE) suitable for dealing with explosive environments.</li> </ul>
3.8 Communications infrastructure	<ul> <li>Tendering, purchase, installation and integration of any communications infrastructure additionally required to the surface observations and Upper Air requirements, as depicted in Figure 8, which are: <ul> <li>Robust cellular and internet or satellite communications from the office to ensure regular, timely message transmission.</li> <li>A redundant communications system where feasible.</li> </ul> </li> </ul>

#### **GBON Marine Stations**

The Australian Bureau of Meteorology supports the operation of a sea level monitoring station at Manus Island at Lombrum<sup>16</sup>.

Given PNG's large EEZ and large expanses of marine and ocean areas without observation coverage, and given the country's susceptibility to coastal flooding and tidal inundation risks and tsunami, future SOFF funding programs should prioritise support for PNG to establish and operate a significant marine and ocean GBON network. Hundreds of fatalities are thought to occur in PNG local waters each year in adverse weather conditions, and the existing observations network does not allow precise enough forecasts to be especially useful for local mariners.

#### Maintenance and calibration plan

The ongoing operation of the observing equipment requires both preventative and corrective maintenance. This is important to maintain routine operations, address faults as they arise and ensure the safety of the staff. Examples of maintenance tasks are shown in Table 2.

The SOFF investigation highlighted that maintenance is a significant challenge for meeting GBON requirements, although NWS is well-placed to support this activity if staffing of all observations sites with permanent employees is continued. This means that the challenge for the NWS will be to ensure that the planned maintenance regime is maintained with required resourcing for staff and staff training.

The planned approach is for the procurement contracts for upper-air, AWS and manual weather station equipment to be "Supply & Support" contracts, in place until such time as PNG is itself able to fully support the observing network operation. These supply contracts should also include the following elements, harmonised and in line with the activities detailed within section 2.3:

- Supply and installation (where relevant) at stations of all required equipment, including all required calibration equipment (e.g. transfer standards).
- Training of NWS staff, including:
  - Regular training in detailed maintenance and calibration methods for the NWS technical team (12-18 month intervals).
  - Regular training in basic equipment maintenance for the NWS field observers so they can make basic repairs on-site without needing a costly trip by a technician (24 month intervals).
  - Regular training for field staff in operation of upper-air equipment (12-18 month intervals).
- Access to on-demand advice service via phone or teleconference to support NWS staff when problems arise.
- Sufficient supply of spares to be held in-country noting logistical and supply constraints. Supply to be proactive based on estimated replacement frequencies.
- Required calibration and maintenance services to initially be contracted to a 3<sup>rd</sup> party supplier, with a training program for NWS staff and transition to NWS operation.

It is critical that the NWS staffing and relevant operational infrastructure be augmented and maintained to be able to support the required observations staffing level and the ongoing resources costs associated with the maintenance and calibration program required to ensure

<sup>&</sup>lt;sup>16</sup> Real-Time Data Display (bom.gov.au)

the GBON networks continue to meet WMO compliance requirements. Funding for ongoing essential services such as logistics, travel and communications is a key requirement.

Operational funds must include freight and travel costs to ensure NWS technicians can visit sites for the regular proactive maintenance and for reactive repairs when required. Operational funding must also include resourcing to maintain communications systems for the GBON stations (e.g. satellite and cellular provider).

The observations maintenance and calibration planning and resourcing must ensure that the maintenance tasks described in Table 2 below are able to be routinely completed by observations or technical staff, either contracted, on-site or visiting from head office or, in some cases (Level 4) with intervention by manufacturer repair or replacement.

Activities within combined sections 3.2 and 3.3 incorporate the requirements to develop a plan for data management and quality assurance, including a centrally managed GBON sites maintenance and calibration plan and procedures as depicted in Figure 8.

Level	Description	Surface tasks (examples)	Upper-air tasks (examples)
1	For upper-air basic tasks requiring few consumables or parts carried out by local personnel based on either basic instruction or in accordance with standard operating procedures (SOPs).	<ul> <li>Clean Stevenson screen</li> <li>Change wet-bulb wick</li> <li>Cut grass/ vegetation</li> </ul>	<ul> <li>Attach sondes and launch balloons</li> <li>Change over hydrogen cylinders with specific instruction on hydrogen safety.</li> </ul>
2	Technical tasks carried out by staff following SOPs. Tools, parts and consumables may be required.	<ul> <li>Collect station metadata</li> <li>Replace sensors</li> <li>Verify performance of sensors</li> </ul>	<ul> <li>Collect station metadata</li> </ul>
3	Specialised maintenance actions carried out by trained staff. Procedures are complex and fault-finding is a required skill with some requiring advanced meteorological technician training	<ul> <li>Replace infrastructure</li> <li>Set up and configure new equipment and sensors</li> <li>Advanced fault- finding</li> </ul>	<ul> <li>Annual maintenance of UA system</li> <li>Advanced fault-finding</li> <li>Set up and configure new equipment and sensors</li> <li>Install data communications system</li> </ul>
4	Specialised repair or replacement by manufacturer or agent	<ul> <li>Return to agent/ manufacturer of component</li> </ul>	<ul> <li>Return to agent/manufacturer of component</li> </ul>

#### Table 2. Example maintenance tasks for GBON stations

Station name	Station (S/UA)	Owner	Facility	Funding source	Variables measured	Obs / soundings per day	Current Status & Implementation to be supported by SOFF
Madang	s	NWS	Manual, AWS	SOFF	SLP , T, H , W, P	24	Current: degraded operation, no AWS SOFF: Activities 3,1, 3.2, 3.3, 3.4
Momote	S, UA	NWS	Manual, AWS, UA	SOFF, Bureau	S: SLP , T, H , W, P UA: AP, T, H, W	24 / 2	<b>Current</b> : degraded operation, no AWS <b>SOFF</b> : Activities 3,1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7
Kavieng	S	NWS	Manual, AWS	SOFF	SLP , T, H , W, P	24	<b>Current</b> : degraded operation, non- operational AWS <b>SOFF</b> : Activities 3,1, 3.2, 3.3, 3.4
Goroka	S	NWS	Manual, AWS	SOFF	SLP , T, H , W, P	24	Current: degraded operation, no AWS SOFF: Activities 3,1, 3.2, 3.3, 3.4
Nadzab	S	NWS	Manual, AWS	SOFF	SLP , T, H , W, P	24	<b>Current</b> : degraded operation, non- operational AWS <b>SOFF</b> : Activities 3,1, 3.2, 3.3, 3.4
Hoskins	s	NWS	Manual, AWS	SOFF	SLP , T, H , W, P	24	Current: Closed station (2014) SOFF: Activities 3,1, 3.2, 3.3, 3.4
Tokua	S	NWS	Manual, AWS	SOFF	SLP , T, H , W, P	24	Current: degraded operation, no AWS SOFF: Activities 3,1, 3.2, 3.3, 3.4
Gurney	S	NWS	Manual, AWS	SOFF	SLP , T, H , W, P	24	<b>Current</b> : degraded operation, no AWS <b>SOFF</b> : Activities 3,1, 3.2, 3.3, 3.4
Port Moresby	S, UA	NWS	Manual, AWS, UA	SOFF, Bureau	S: SLP , T, H , W, P UA: AP, T, H, W	24 / 2	<b>Current</b> : degraded operation, no AWS <b>SOFF</b> : Activities 3.2, 3.3, 3.4, 3.5, 3.6, 3.7
Daru	s	NWS	Manual, AWS	SOFF	SLP , T, H , W, P	24	Current: closed station (2004) SOFF: Activities 3,1, 3.2, 3.3, 3.4
Kiunga	S	NWS	Manual, AWS	SOFF	SLP , T, H , W, P	24	Current: degraded operation, no AWS SOFF: Activities 3,1, 3.2, 3.3, 3.4
Wewak	S	NWS	Manual, AWS	SOFF	SLP , T, H , W, P	24	Current: degraded operation, no AWS SOFF: Activities 3,1, 3.2, 3.3, 3.4
Misima	UA	NWS	Sonde/MBL	SOFF	UA: AP, T, H, W	2	Current: closed station SOFF: Activities 3.1, 3.2, 3.5, 3.6, 3.7

#### Table 3. PNG GBON stations nominated, current status and proposed activities under SOFF.



Figure 7. – PNG GBON nominated sites, with 200km buffers indicated at surface stations and 500km buffers at upper-air stations.

#### 3.2. Design of the ICT infrastructure and services & 3.3 Data management system

#### Existing State

#### Data Collection and Transmission

The observing network data collection and transmission system is essentially manual, with data communications for AWS non-operational.

Data obtained at site are currently manually recorded in the station observations synoptic log using a standard A8 form. Observations are relayed to head office via email, text or by audio (telephone) where they are entered into an email. An email with all hourly observations are sent to the Australian Bureau of Meteorology CMSS account where the messages are added to a Bulletin and issued to the GTS. The data is entered (manual data entry) either from the station observations log or email records into a local copy of CliDE.

#### Data quality control and quality assurance systems and processes.

Basic quality control is performed mainly focussed on synoptic message format control for real-time data; and non-real-time quality control is performed during data entry into CliDE.

#### Target State and Activities

Figure 8 below shows a high-level depiction of the end-to-end primary data flows associated with the required data communications and management systems infrastructure to be implemented to support PNG GBON network data and quality management processes.



## Figure 8. Envisaged high-level communications and data flow solution for end-to-end management of data.

The solution for the entire GBON network will need to address the following considerations and activities in relation to ICT infrastructure and data management process and systems.

#### Data Collection and Transmission

- Activity 3.9 Observation data transmission from field to Data Reception server
  - Development and implementation of a plan for solutions for data relay from observing systems and network stations that incorporates:

- AWS and upper-air system telemetry of data from observing system to local PC work station (Activity 3.3).
- Relay of data from GBON local site to central Data Reception Server (Figure 3).
- Satellite data communications will be required for some remote sites as either a primary or back-up solution.
- Requirement for a site communications redundancy solution where possible and, for the majority, expected to be resolved with use of both mobile/LAN/internet and WIFI/satellite telemetry and communications.
- Activity 3.10 Procurement and implementation of a Data Reception Server.
  - Procurement/development and/or implementation of the Data Reception Server (see Figure 8) and software, which will support reception of data from the surface and UA observing network systems and handling of related network health and performance information and data.

#### Data quality control and quality assurance systems and processes.

Central site infrastructure and systems will need to be developed and maintained at NWS headquarters to support requirements for quality assurance aspects of GBON networks, including data quality management and calibration, inspections, maintenance and repair of observing system infrastructure.

- Activity 3.11 Preparation and implementation of an Observing Systems Management Plan.
- During the Investment Phase, an observations systems management plan incorporating both technology systems and data management will be developed to support the operation of the GBON network and other national stations. This will incorporate:
  - Requirements for real-time data monitoring, quality control and management.
  - Ability to manage requirements for consumables and stock on-hand, tools and calibration facilities and systems.
  - Development and implementation of a financial and operational plan that includes consumables, calibration tools and facilities and maintenance of all equipment and facilities at all sites.
  - Development of a staffing and travel plan to support data management, calibration, inspection and maintenance requirements, taking into account needs for staff training, as well as 3<sup>rd</sup> party contracted support.
- Activity 3.12 Procurement/development and/or implementation of the computer system/server and software to run the meteorological and climate data management systems (Figure 8, MDMS, CDMS), which will support:
  - Incoming network data processing, quality control, reformatting and handling for internal and external delivery and exchange.
  - Database archival in support the Climate Data Management System functions.
  - WMO Information System 2.0 application processes to support handling of incoming and outgoing WIS data via a HTTP service.
  - The CDMS should be compliant with WMO No. 1131 Climate Data Management Systems. The CDMS will be used to store, view and extract all climate data and metadata collected by NWS. Appropriate processing to produce quality-controlled data and statistics for climate purposes will be performed in the CDMS.

- Pushing and/or serving of data to internal and external client systems and applications including:
  - CliDE
  - NWS information management system
  - External NWS webpage
  - NWS forecast centre applications
  - National stakeholders
- Activity 3.13 Installation of national maintenance and calibration facility.
  - The facility to be located at NWS headquarters, Port Moresby, for the following purposes and functions. This may be a dedicated building funded by SOFF if suitable accommodation cannot be allocated in current or planned buildings.
    - Provide central holding of network spares and maintenance and calibration equipment.
    - Contain and maintain the national calibration instrumentation and systems.
    - 1-2 network computers and software to support network management functions, including software and applications for the functions of:
      - Maintaining and use of calibration equipment.
      - Recording of stock and equipment centrally and at stations.
      - Recording of calibration results and records.
      - Maintenance of stations metadata with possible integration with and use of the CliDE database.
    - NWS to allocate staffing and training to support this activity.

#### 3.4. Environmental and sustainability considerations

Environmental and sustainability considerations will be included in the procurement process, as a selection criterion for suppliers. This will enable UNDP and NWS to consider opportunities for reusable instruments or biodegradable materials such as:

- biodegradable string (e.g. biotwine) for radiosondes;
- biodegradable balloons and parachutes (coloured blue or green to reduce ingestion by turtles and marine birds);
- reduction in size of radiosondes, incorporating biodegradable materials where feasible;
- environmentally sustainable packaging such as cardboard and paper;
- ensuring instruments do not contain mercury;
- careful use of batteries to reduce toxic waste.

**Activity 3.14** – An environmental management plan to support site development and facilities.

In addition, prior to site works for upgrading stations or installing new stations, an environmental management plan will be prepared considering local conditions and approaches to minimise the environmental impact of construction activities such as:

- use of solar or wind power at sites;
- sustainable materials used for construction, including reduction in site footprint;
- sites should be maintainable with basic tools (i.e. use of ladders and climbing harnesses should be avoided);

• plan for safe removal of waste at end of construction.

### Module 4. GBON Human Capacity Development Module

#### 4.1. Assessment of human capacity gaps

The NWS staffing profile is shown below in Table 4 and Table 5.

NWS has 74 staff in total, The male:female ratio of 60:15 is not unusual in the region but is a long-term concern.

There are no female forecasters or nightshift observers in the NWS. Women have historically not been able to work 24/7 shift roles in the unsafe and insecure buildings of the NWS, severely limiting their career opportunities and contributing to the gender imbalance.

Staffing at observations sites follow similar patterns and has similar although varied concerns relating to safety and well-being, while the degraded condition of office and accommodation at most sites make them unattractive propositions for all staff, but particularly for female staff.

This situation makes the NWS a less attractive place to work for female employees and graduates seeking science careers.

## Table 4. Staffing profile of NWS. Source: Staff list provided by NWS during Peer Advisor Visit (as at November 2023).

Branch	Doctorate/ MSc/BIP-M/BBM	Bachelor/ Diploma	Bachelor / Diploma IT	Other	Total	Male	Female
Administration	1			2	3	3	
Forecast and warning	2	10		4	16	16	
Climate	2	5			7	4	3
Field Observations	1	4	1	28	34	25	9
Facilities & Observations	3	3	2	2	10	7	3
Total	9	22	3	36	70	55	15

#### Table 5. Staff compliment at observing stations

Daru – 0	Kavieng – 1	Wewak – 1
Port Moresby – 19	Hoskins – 0	Vanimo – 1
Madang – 1	Tokua – 1	Nadzab – 2
Kiunga – 1	Goroka – 2	Misima – 0
Momote – 4	Gurney – 1	

There are currently 34 NWS staff supporting the observations program of which 19 are located at Port Moresby with the remainder at network stations.

Key gaps in human capacity necessary to ensure GBON compliance of observations are:

- The training program across all disciplines is limited and requires significant boosting to enable the required level of IT and technical and observations expertise at stations and at head office.
- There is a lack of qualified project management professionals within the Facilities and Observations department.
- None of the engineering, technical or observing personnel currently have BIP-MT qualifications which are considered essential to ensuring the sustainability and quality of observations.

- The technical personnel have no formal training in cellular and satellite communications which are critical to transmission of real-time data for GBON compliance.
- For the upper-air stations, only Momote has the minimum required number of 4 staff required.
- All surface-stations require at least 2 staff to ensure that manual observations can be made continuously while maintaining the enclosure, equipment and sensors as required.
- In all, up to 42 observations staff (3 x 4 upper-air & surface, 10 x 3 surface) are possibly required to be deployed to adequately provide the observations and maintenance functions at GBON stations, depending on the rostering arrangements determined under Activity 4.1. The whole of the observations program currently has only 34 staff.
- Observers require basic automatic and manual observing equipment maintenance skills to address equipment problems at stations in a timely manner to ensure reliability of observations.

The operational and financial plan for NWS's staff capacity contribution to the operation of the proposed new / rehabilitated GBON stations is as follows:

- The GBON stations will be staffed with observers by restructuring the location of existing NWS-funded observing staff supplemented with new observing staff to be funded through SOFF Investment and Compliance funding.
- With about 42 observers required, and about 20 existing NMHS-funded observing staff that could potentially be deployed to these stations, the initial financial split for supporting observing staff will be about half NWS and half SOFF.
- Over time NWS should work with its parent Department of Transport to identify opportunities to secure ongoing PNG government resourcing to increase its level of support for the observing staff at GBON stations
- The NWS and SOFF-funded observers will provide first-in basic maintenance. Any other repairs, calibration, and more complex maintenance activities will be overseen by NWS-funded technical staff in Port Moresby but undertaken by SOFF-funded private sector maintenance contractors under the 'build and support' contracting arrangements.
- Operation and maintenance of IT, data and communication systems will be undertaken by a SOFF-funded IT professional in coordination with SOFF-funded private sector contractors under the 'build and support' contracting arrangements.

#### 4.2. Design capacity development activities for technical staff

The following capacity development activities are proposed to address the gaps identified above:

- Activity 4.1 Observing staffing capacity augmentation.
  - Over the Investment Phase, NWS staffing should be augmented in number, with SOFF support, and restructured by location as necessary to ensure the following observations staffing at stations:
    - Upper-air stations 4 staff at Misima and Momote, including 2 staff with BIPM-MT qualifications.

- Surface stations 2 or 3 staff, including 1-2 staff with BIPM-MT qualifications.
- Activity 4.2 Observing staff initial and refresher training.
  - Provide required training in automatic and manual weather and upper-air station verification and maintenance at the start of the Investment Phase for all NWS observers, with ongoing training through the Compliance Phase. The training should be specific to the equipment types that will be installed. This would ideally be included in a 'supply and support' contract as part of the equipment procurement, addressing at least those aspects summarised in the table below.

Manual observations systems	Upper air observations system operation	Upper air systems basic maintenance		
<ul> <li>Entry of manual observations into observations console</li> <li>Editing of synoptic and aviation messages</li> <li>Submitting meteorological messages</li> <li>Site and equipment basic maintenance</li> </ul>	<ul> <li>Hydrogen and general safety procedures</li> <li>Preparation for radiosonde launch</li> <li>Monitoring of radiosonde launch in console</li> </ul>	<ul> <li>Hydrogen generation system maintenance</li> <li>Hydrogen storage cylinder exchange/ coupling</li> </ul>		

- Activity 4.3 Access requirements (Security passes) for required airports.
  - Provide support to obtain required training, certification and access cards for all NWS and contracted staff requiring access to airport facilities to support GBON operational functions.
- Activity 4.4 Cellular and satellite data communication training.
  - Provide training in cellular and satellite communications and router configuration during the Investment Phase to all NWS technical and engineering personnel. Similarly, this training could be included in a 'supply and support' contract as part of equipment procurement.
- Activity 4.5 BIP-MT training for Observing staff.
  - Offer training leading to BIP-MT qualifications to all of NWS observing personnel. This could be organised through the Bureau of Meteorology, NZ Met Service or Fiji Met Service.
- Activity 4.6 WMO OSCAR/Surface and WDQMS training and Incident Management system.
  - Provide training in OSCAR/Surface and WDQMS operation to selected members of the Facilities and Observations teams.
- Activity 4.7 ICT Capacity for National Observations office.
  - NWS to be supported by SOFF to recruit at least one new ICT professional, skilled in network, database and communications technology critical to WIS2.0, MDMS and CDMS. Support will be required both during Investment and Compliance phase. Training in WIS2.0, MDMS and CDMS may also be required.

#### 4.3. Design capacity development activities for senior management

The following capacity development activities are recommended to address the gaps identified above:

- Activity 4.8 Business management, planning & finance development capacity.
  - At the beginning of the Investment Phase and continuing throughout the Compliance Phase, SOFF should support the employment of a suitably qualified business strategy and planning professional to augment this capacity within the NWS. This individual should lead at least the strategic financial and planning tasks associated with SOFF, including:
    - Advice to Department and Director/NWS on augmentation of the NWS Strategic Plan to accommodate SOFF development activities and departmental funding.
    - Responsibility for and oversight of all planning and resource related aspects of SOFF GBON implementation, including staff training and augmentation.
- Activity 4.9 Project managers.
  - As early as possible and preferably before the commencement of the Investment Phase, at least one and possibly two SOFF-dedicated, funded project managers should be appointed to manage the GBON stations implementation, with preferably one employed before the Investment Phase to assist in developing the implementation plan and one to continue to be employed throughout the Compliance Phase.

#### 4.4. Gender and CSOs considerations

While the gender imbalance evident in the staffing profile of NWS is not unusual for Pacific nations, measures and activities should be undertaken to address this imbalance.

Activity 4.10 – Physical security review to support Gender balance.

NWS to undertake a whole of organisation review of physical security at all sites and stations and plan for and implement increased security and improved processes and facilities where necessary, including:

- Secured fencing, security system installation, lockable doors and windows and adequate external lighting for office, observing site and accommodation facilities.
- At remote and less secure sites, support for transport of staff, and particularly female staff, to and from work.
- Equipping with or ensuring access to basic amenities for all staff work places, including toilets, kitchen, fridge, stove, etc.

Activity 4.11: - CSO engagement to support gender balance.

Organise stakeholder engagement consultations with civil society organisations (CSOs) focused on women's empowerment. This could include:

- Direct contact with NGOs working with women and girls in PNG to promote employment opportunities.
- Presentations at Community meetings.
- Presentations to school groups.

Activity 4.12: Develop a Gender Gap Analysis and Gender Action Plan.

Develop a Gender Gap Analysis and Gender Action Plan during the Investment Phase to guide the mainstreaming of gender and social inclusion initiatives into SOFF investments. The Gender Action plan could include the following:

- Targets for female participation in the role areas associated with SOFF Investment and Compliance phases in PNG.
- Inclusion of gender targets in procurement documents where human resources are part of the procurement,
- Annual reporting of achievement of the above targets.
- Development of ongoing campaign in schools and communities to promote female participation in roles linked to NWS.

### **Module 5. Risk Management Framework**

#### 5.1 Assess the risks of the observing network and propose mitigation measures

As part of the development of the National Contribution Plan, a high-level risk assessment has been undertaken, focusing on risks that were identified during the Readiness phase, with planned mitigation measures (Table 6). The mitigation measures will be implemented during the Investment Phase (**Activity 5.1**).

Table 6. Risk analysis				
Element	Identified Risk	Mitigation Measures	Responsibility	Monitoring and Evaluation
Business Model	Lack of required ongoing staffing and financial resources to operate GBON and deliver benefits to PNG.	<ul> <li>Capital input to NWS over 2024 – 2027 to uplift the infrastructure and capacity of the agency.</li> <li>Commit to increased operational budget of the NWS and improvement to staff profile to support NWS capacity development and improvement.</li> </ul>	Department of Transport, UNDP	Quarterly financial and staff status reporting during Investment Phase. Annual human and budgetary resources audit by NWS .
Business Model	Lack of sound financial and planning support for GBON leads to poor plans for implementation and operation.	Staff profile of NWS to be improved, with particular emphasis on employment of financial and planning and project management professionals. See Activities 4.8 and 4.9.	Department of Transport, NWS	Regular reporting of staff profile to SOFF during Investment Phase. Annual human and budgetary resources audit by NWS.
Business model	Lack of adequate financial control and budget management leads to inadequate expenditure of funds to complete designated Activities	Routine monitoring and reporting of financial expenditure by NWS finance support staff. Funds release aligned with planned expenditure outcomes	Department of Transport, UNDP	Regular reporting of budget and expenditure.

Element	Identified Risk	Mitigation Measures	Responsibility	Monitoring and
				Evaluation
NWS Capacity	NWS reduced capacity and lack of public standing impacting GBON operation.	<ul> <li>Build public and government support for NWS to ensure its budget is supported by: <ul> <li>Improved visibility of observations through stakeholder dissemination via uplifted data management.</li> <li>Improved weather services through access to modelling centre products during compliance phase.</li> <li>Sound financial, resource and staff planning.</li> </ul> </li> </ul>	Department of Transport, NWS	Quarterly financial and staff status reporting during Investment Phase. Annual human and budgetary resources audit by NWS .
GBON Implementation	Lack of training of NWS staff and capacity to support GBON implementation during the Investment Phase.	<ul> <li>Investment Pan to plan for contracted implementation of GBON stations, including project management and engineering staff resourcing.</li> <li>Commencement of training program for NWS to commence early during the Investment Phase.</li> </ul>	UNDP, NWS	Regular reporting of staff profile to SOFF. Annual human resources audit by NWS.
GBON Operation	Lack of equipment maintenance due to lack of spare parts and infrastructure leads to equipment malfunction.	Procurement of equipment and maintenance infrastructure under supply contract, including continuous supply of spare parts.	UNDP	Monthly spare parts inventory reporting.
GBON operation	Lack of equipment maintenance due to lack of funding for travel and logistics.	NWS budget increased by SOFF to support required travel and logistics of maintenance program.	Department of Transport, UNDP	Monthly planning and budgeting of logistic needs and activities. Regular quality audit.
GBON Operation	Loss of data due to long lead-times for repairs due to travel distance, complicated logistics.	<ul> <li>Co-locate automatic weather stations with manual weather stations.</li> <li>Manual observers to provide basic maintenance and redundancy</li> </ul>	UNDP and NWS	Monthly review of WDQMS and GBON compliance.

Element	Identified Risk	Mitigation Measures	Responsibility	Monitoring
				and Evaluation
GBON Operation	Vandalism of sites leading to station system outages and data loss.	<ul> <li>Collocation of observing staff at stations and installation of improved security measures for GBON infrastructure</li> <li>Routine daily QC and monitoring of data to be implemented.</li> <li>Sufficient contingency funds to enable repair and replacement</li> </ul>	UNDP, NWS	Monthly review of WDQMS and GBON compliance.
GBON Operation	Lack of access to observing stations leading to loss of GBON data.	<ul> <li>NWS to ensure agreement in place with NAC and other relevant agencies to allow staff access to sites.</li> <li>All NWS staff to be trained and obtain required certification for access to airport sites.</li> </ul>	NWS	Monthly review of WDQMS and GBON compliance.
GBON Operation	Poor staff satisfaction leading to lack of staff required to undertake observations and maintenance resulting in data loss and station performance degradation.	<ul> <li>Ensure staff have suitable, secure accommodation to ensure staff well-being.</li> <li>Staff are paid appropriately and promptly and fairly remunerated for overtime.</li> <li>AWS configurable/implemented to ensure continued operation in absence of staff.</li> </ul>	Department of Transport, NWS	Annual human resources audit by NWS.
GBON Operation	Insufficient human resources or technical skills to install or maintain stations and ICT system.	SOFF to provide support for training of technical and observing staff during Investment and Compliance phase. SOFF to fund recruitment of additional skilled staff during both Investment and Compliance Phase as outlined in Module 4.	UNDP and NWS NWS	Annual human resources audit by NWS.
GBON Communications	Poor internet connections & other communications outages lead to data transmission delays.	Equip all stations with redundant cellular and/or satellite communications.	UNDP	Monthly review of WDQMS and GBON compliance.
GBON Communications & Power Supply	Unreliable power at some sites leads to communications outage and data delay.	Where necessary, equip stations with batteries, uninterruptible power supply and/or solar/wind power generators.	UNDP	Monthly review of WDQMS and GBON compliance.

### Module 6. Transition to SOFF investment phase

The activities outlined in this National Contribution Plan will provide the basis for developing the Investment Proposal for Papua New Guinea's National GBON Network. The Investment Proposal will be developed by UNDP and NWS, with input from the Bureau (**Activity 6.1**).

## Summary of GBON National Contribution Plan

Components	Recommended activities	
	1. NWS to review its membership of regional working groups and activities and ensure future regional collaborations are focused on ensuring obtainment of and contribution to GBON- related calibration, training, data management and station	
<b>Module 2.</b> GBON business model and	<ol> <li>UNDP and NWS to engage with other key partners to develop a plan for managing and disbursing SOFF funding.</li> <li>NWS to actively plan and monitor expenditure of the allocated Department of Transport MTDP funding to ensure that capital expenditure allocated over the 4-year period, appropriately addresses resourcing and infrastructure improvements necessary to support and complement SOFF funded development of GBON in PNG.</li> </ol>	
institutional development	4. Business Model and Plans for GBON implementation to incorporate national and international private sector contractual involvement for supply, implementation and transition to operation during the SOFF Compliance Phase.	
	5. Department of Transport to plan for and implement expansion of NWS budget, personnel and functionality as required to be able to transition to full ongoing support for GBON and to benefit from it.	
	6. NWS to update Strategic Plan to incorporate GBON implementation and operation in partnership with key international entities.	
	1. Site selection and surveying, including travel to sites for inspection and detailing to be undertaken at 11 of 12 sites	
	<ol> <li>Site works of varying requirements to be undertaken in preparation for systems installation including instrument and AWS enclosure at 12 sites.</li> </ol>	
	3. Manual Surface observing system refurbishment and installation	
	4. AWS Surface observing system procurement and installation	
	5. Upper Air site works and construction.	
Module 3.	<ul> <li>Opper Air system installation.</li> <li>7 Upper air consumable purchase</li> </ul>	
GBON infrastructure	8. Communications infrastructure tendering, purchase,	
development	Installation and integration. 9 Development and implementation of a plan for network	
	solutions for data relay from network stations	
	10. Procurement/development and/or implementation of the Data Reception Server (see Figure 8) and software.	
	11. Development of an observations management plan and program to support the operation of the GBON network and the other national stations.	
	12. Procurement/development and/or implementation of the computer system/server and software to run the meteorological and climate data management systems (Figure 8, MDMS, CDMS)	

	<ul> <li>13. Procurement and installation of a central maintenance and calibration building structure and facilities at NWS headquarters, Port Moresby.</li> <li>14. Preparation of environmental management plan considering.</li> </ul>
	local conditions and approaches to minimise the environmental impact of construction activities.
<b>Module 4.</b> GBON human capacity development	<ol> <li>Observing staffing capacity augmentation.</li> <li>Observing staff initial and refresher training.</li> <li>Provide support for obtainment of required training and certification of all NWS and contracted staff requiring access to airport facilities to support GBON operational functions.</li> <li>Provide training in cellular and satellite communications and router configuration during the Investment Phase to all NWS technical and engineering personnel.</li> <li>Offer training in OSCAR/Surface and WDQMS operation to selected members of the Facilities and Observations teams.</li> <li>Recruit at least one new ICT professional, skilled in network, database and communications technology critical to WIS2.0, MDMS and CDMS.</li> <li>Employment of a suitably qualified business strategy and planning professional to augment this capacity within the NWS to lead strategic financial and planning tasks associated with SOFF</li> <li>Employ at least one SOFF-dedicated, funded project manager</li> </ol>
	to manage the GBON stations implementation. 10. NWS to undertake a whole of organisation review of physical security at all sites and stations and plan for and implement increased security where necessary
	<ol> <li>Organise stakeholder engagement consultations with civil society organisations (CSOs) focused on women's empowerment.</li> <li>Develop a Gender Gap Analysis and Gender Action Plan during the Investment Phase to guide the mainstreaming of gender and social inclusion initiatives into SOFE investments.</li> </ol>
<b>Module 5.</b> Risk Management	<ol> <li>Implement risk mitigation measures outlined in the NCP risk management framework.</li> <li>Develop required monitoring and evaluation tools to monitor risk levels during the Investment and Compliance Phases.</li> </ol>
<b>Module 6.</b> Transition to SOFF investment phase	UNDP and NWS to develop Investment Phase Plan, with input from the Bureau of Meteorology.

## **Report completion signatures**

Peer Advisor signature
Dr Andrew Jones General Manager International Development Bureau of Meteorology
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Version 1.0

Final version for signing

### **Annex 1 – GBON Stations Detailed Description**

#### **GBON Surface Network**

#### Daru, 9.08S, 143.2E, 6m

Daru is located on Daru Island at Daru Airport, just off the coast at the southwest part of mainland PNG around 445km to the west of Port Moresby.

The station was a manual site, and has been closed since 2004, so will require a new AWS to be installed to enable hourly observations.

Daru airport will be upgraded in the future but plans are very uncertain at the current time and likely will/should not impact GBON implementation plans.



While the site is not likely to be as prone to vandalism and theft as others and is located within the airport, the station would strongly benefit from resumption of the manual observations, which would assure that staff was available for maintenance and repair. This is particularly important because of the remoteness of the site and difficulty in servicing.

Given the current site at the airport has been closed since 2004, this is essentially a new installation that will require the following considerations:

Item	Aims / Details	Activities
Existing site	Site closed since 2004	<ul> <li>NWS to determine whether old site remains suitable or whether new site to be attained/leased.</li> </ul>
Site leasing	Require site, power and security within the airport and within good proximity to the runway.	<ul> <li>NWS to ensure site available and determine lease requirements and costs, if any.</li> </ul>
Site works	<ul> <li>Installation of new AWS system, sensors, maintenance facility and communications system.</li> <li>If required, additional secure fencing to protect from theft, vandalism.</li> </ul>	<ul> <li>NWS to ensure access to site for site works.</li> <li>NWS to ensure availability of power.</li> <li>NWS to determine optimal communications from the site, prioritising uniform solution and practice across the network.</li> </ul>
Staffing	If possible, support staffing on-site with a 8-hour manual observations program.	<ul> <li>NWS to determine requirements to support staffing of the site and manual observations.</li> </ul>
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for AWS.</li> <li>System solution should include a manual data entry console integrated with the AWS to support seamless input and sending of manual and automated observations.</li> </ul>

ltem	Aims / Details	Activities
Communications	Establishment of communications infrastructure, including redundancy.	NWS to determine optimal communications solution from the site
Maintenance & calibration	Maintenance and calibration to be performed primarily by staff located on- site, with back-up plan for unavailability of staff. Calibration to be performed in accordance with GBON requirements. Facility to be installed for on-site undertaking of maintenance and repair and including storage of spares.	<ul> <li>NWS to determine if staffed site is feasible and if not determine other option, which will serve as alternative and redundancy measure.</li> <li>Calibration to be undertaken at least annually.</li> </ul>
Other considerations	Considerable uncertainly around the timeline for redevelopment of the airport.	<ul> <li>Undertake review of plans for airport upgrade ahead of finalising</li> </ul>

#### Goroka, 6.076S, 145.393E, 1587.0m

Goroka is located at the Goroka airport in the PNG central highlands at an altitude of around 1587m and around 425km to the northwest of Port Moresby. It is the only nominated GBON site in the highlands and is therefore an extremely important station.

Goroka airport was redeveloped under the CADIP program with the new terminal opened in 2018.

The station is a manual site with staff currently temporarily housed. Synoptic reports are transmitted to headquarters.

NWS previously operated an AWS at Kundiawa, around 54 km to the west of Goroka, which is now not operating and non-serviceable due to vandalism. Another AWS on the Airport grounds has never operated.



Existing site• Site operating at a location close to the temporary control tower. • Sensors are in need of replacement. • Staff are temporarily housed at the airport in shipping container accommodation. • Site Is manual, with all instruments in need of replacement.• Determine whether old site remains suitable or whether new site to be attained/leased.Site leasing• A new site to the northwest of the airport has been proposed which• Ensure site available and determine lease requirements and costs.	Item	Aims / Details	Activities
Site leasing         A new site to the northwest of the airport has been proposed which         Ensure site available and determine lease requirements and costs.	Existing site	<ul> <li>Site operating at a location close to the temporary control tower.</li> <li>Sensors are in need of replacement.</li> <li>Staff are temporarily housed at the airport in shipping container accommodation.</li> <li>Site Is manual, with all instruments in need of replacement.</li> </ul>	<ul> <li>Determine whether old site remains suitable or whether new site to be attained/leased.</li> </ul>
	Site leasing	<ul> <li>A new site to the northwest of the airport has been proposed which</li> </ul>	Ensure site available and determine lease requirements and costs.

Itom	Aims / Dotails	Activities
	<ul> <li>would provide for station site, offices and staff residence.</li> <li>Require site, power and security and ideally should be representative of the airport terrain and microclimate.</li> </ul>	<ul> <li>Contingency to be made in the event that the new site is not available.</li> <li>Site to be surveyed and all metadata updated and recorded.</li> </ul>
Site works	<ul> <li>Installation of new AWS system, sensors, maintenance facility and communications system.</li> <li>Staffing accommodation, offices and maintenance facilities to be built.</li> <li>If required, additional secure fencing to protect instrument enclosure from theft, vandalism.</li> </ul>	<ul> <li>Full site design to be developed including instrument enclosure, staff accommodation, maintenance facilities.</li> <li>Ensure availability of power.</li> </ul>
Staffing	Support staffing on-site with a 8-hour manual observations program.	<ul> <li>Determine requirements to ensure continued staffing of the site and manual observations.</li> </ul>
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for AWS.</li> <li>System solution should include a manual data entry console integrated with the AWS to support seamless input and sending of manual and automated observations.</li> <li>Requirements for manual instrumentation to be specified and included in site design.</li> </ul>
Communications	Establishment of communications infrastructure, including redundancy.	<ul> <li>Determine optimal communications from the site, prioritising uniform solution and practice across the network.</li> </ul>
Maintenance & calibration	<ul> <li>Maintenance and calibration to be performed primarily by staff located on-site, with back-up plan for unavailability of staff.</li> <li>Calibration to be performed in accordance with GBON requirements.</li> <li>Facility to be installed for on-site undertaking of maintenance and repair, and including storage of spares.</li> </ul>	<ul> <li>Include maintenance facility in site design and planning.</li> <li>Calibration to be undertaken at least annually performed by on-site staff.</li> </ul>
Other considerations	Determine if necessary and possible to do an overlap comparison with old site for climate purposes.	Determine in consultation with NIWA if an overlap comparison is of value and is feasible to be done.

#### Gurney, 10.32S, 150.33E, 27m

Gurney is located at the Gurney airport at the tip of the southeast peninsula of mainland PNG at the top of Milne Bay.central highlands at an altitude of around 27m and around 365kmn to the southeast of Port Moresby. It is 270km to the northeast of proposed upperair site, Misima.

Gurney Airport will be upgraded as part of the 2<sup>nd</sup> tranche of airport redeveloped under the CADIP program, but timelines are currently not well known or publicised.

The station is a manual site with staff currently housed in "condemned" accommodation (2 sites). The office is in a similar state and clearly requires upgrading. Manual synoptic reports are transmitted to headquarters.



ltem	Aims / Details	Activities
Existing site	<ul> <li>Site Is manual, with all instruments in need of replacement.</li> <li>Site is located at the airport at which the terminal will be demolished and rebuilt along with the observing site.</li> <li>Issues with fuel supply causes outages and disruption to communications.</li> <li>New site and new instrument enclosure required.</li> </ul>	Determine whether old site remains suitable or whether new site to be attained/leased.
Site leasing	<ul> <li>Require new site and new instrument enclosure, preferably supporting accommodation and maintenance facility.</li> <li>Require new office and equipage.</li> <li>Require site, power and security and ideally should be representative of the airport terrain and microclimate.</li> </ul>	<ul> <li>Find alternative site and determine lease requirements and costs.</li> <li>Site to be surveyed and all metadata updated and recorded.</li> <li>Dept of Transport and NWS to support accommodation if manual observations are to continue as preferred.</li> </ul>
Site works	<ul> <li>Installation of new AWS system, sensors, maintenance facility and communications system.</li> <li>Staffing accommodation, offices and maintenance facilities to be built.</li> <li>If required, additional secure fencing to protect instrument enclosure from theft, vandalism.</li> </ul>	<ul> <li>Full site design to be developed including instrument enclosure, staff accommodation, maintenance facilities.</li> <li>Ensure availability of power and redundancy measure, e.g. generator.</li> </ul>

ltem	Aims / Details	Activities
Staffing	Support staffing on-site with a 8-hour manual observations program.	<ul> <li>Determine requirements to ensure continued staffing of the site and manual observations.</li> </ul>
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for AWS.</li> <li>System solution should include a manual data entry console integrated with the AWS to support seamless input and sending of manual and automated observations.</li> <li>Requirements for manual instrumentation to be specified and included in site design</li> </ul>
Communications	Establishment of communications infrastructure, including redundancy.	Determine optimal communications from the site, prioritising uniform solution and practice across the network.
Maintenance & calibration	<ul> <li>Maintenance and calibration to be performed primarily by staff located on-site, with back-up plan for unavailability of staff.</li> <li>Calibration to be performed in accordance with GBON requirements.</li> <li>Facility to be installed for on-site undertaking of maintenance and repair, and including storage of spares.</li> </ul>	<ul> <li>Include maintenance facility in site design and planning.</li> <li>Calibration to be undertaken at least annually performed by on-site staff.</li> </ul>
Other considerations	If this site is not considered feasible, then Misima AWS at the upper-air site could alternatively be nominated as GBON site. Planning for SOFF redevelopment of the station will require consideration of plans	Determine feasibility of continuing to operate this site. Review and take into account airport redevelopment plans as part of the Investment Phase planning and the timing
	for redevelopment of the airport.	of the station upgrade under SOFF.

#### Hoskins, 5.458S, 150.404E, 23m

Hoskins is located on the northern side of the crescent shaped and largest Island of PNG of New Britain at Hoskins Airport. The airport is located 570km to the northeast of Port Moresby at an altitude of around 23m. A second manual station, Tokua, is located around 250km to the east at the eastern end of the island.

While Tokua is still operational, Hoskins has been closed since 2014, due to upgrade of the



## airport, completed in 2015, under the ADB, CADIP program<sup>17</sup>.

The closure was associated with issues with airport access of NWS staff that prevented access to the observing site to make observations.

Item	Aims / Details	Activities
Existing site	Site closed since 2014	
Site leasing	Require site, power and security, preferably within the airport and within good proximity to the runway.	<ul> <li>NWS to ensure site available and determine lease or agreement requirements and costs, if any.</li> </ul>
Site works	<ul> <li>New office and accommodation required to support staffing requirements.</li> <li>Installation of new enclosure, AWS system, sensors, maintenance facility and communications system.</li> <li>If required, additional secure fencing to protect from theft, vandalism.</li> </ul>	<ul> <li>Ensure access to sites for site works.</li> <li>Ensure availability of power.</li> <li>Determine optimal communications from the site, prioritising uniform solution and practice across the network.</li> </ul>
Staffing	If possible, support staffing on-site with a 8-hour manual observations program.	<ul> <li>Determine requirements to support staffing of the site and manual observations.</li> <li>Ensure site access for observations including airport entry certification for staff as necessary in negotiation with NAC.</li> </ul>
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for AWS.</li> <li>System solution should include a manual data entry console integrated with the AWS to support seamless input and sending of manual and automated observations.</li> </ul>
Communications	Establishment of communications infrastructure, including redundancy.	Determine optimal communications     solution from the site
Maintenance & calibration	<ul> <li>Maintenance and calibration to be performed primarily by staff located on-site, with back-up plan for unavailability of staff.</li> <li>Calibration to be performed in accordance with GBON requirements.</li> <li>Facility to be installed for on-site undertaking of maintenance and repair, including storage of spares.</li> </ul>	<ul> <li>Determine if staffed site is feasible and if not determine other option, which will serve as alternative and redundancy measure.</li> <li>Calibration to be undertaken at least annually.</li> </ul>

<sup>&</sup>lt;sup>17</sup> See: https://www.adb.org/news/hoskins-airport-opens-after-adb-supported-upgrade

#### Kavieng, 2.58S, 150.80E, 4.6m

Kavieng is located at Kavieng Airport, at the northern tip of the 2<sup>nd</sup> largest of the islands in the Bismarck Archipelago, New Ireland. The airport is located at an altitude of around 4.6m and around 870km to the northeast of Port Moresby and 325km to the north of Hoskins.

Kavieng Airport upgrade was completed in 2022 under the CADIP program and government support, with promised additional local initiatives, including a new port and Kavieng Town expansion.

The station is a manual site that transmits synoptic reports to headquarters.



ltem	Aims / Details	Activities
Existing site	<ul> <li>Site Is manual, with 2 staff with 3 building facilities for accommodation and office.</li> <li>Instruments for manual observations seem to be in reasonable condition, with some spares available.</li> <li>An AWS is installed but appears not to have been functional for some time due to vandalism.</li> <li>Site is located at the airport at which the terminal will be demolished and rebuilt along with the observing site.</li> <li>Issues with fuel supply causes outages and disruption to communications.</li> <li>New site and new instrument enclosure required.</li> </ul>	Determine whether old site remains suitable or whether new site to be attained/leased.
Site leasing	<ul> <li>Require new site and new instrument enclosure, preferably supporting accommodation and maintenance facility, and preferably with the instrument site located within the airport confines.</li> <li>Require new office and equipage.</li> <li>Require site, power and security and ideally should be representative of the airport terrain and microclimate.</li> </ul>	<ul> <li>Find alternative site and determine lease requirements and costs, negotiated with NCA.</li> <li>Site to be surveyed and all metadata updated and recorded.</li> <li>Dept of Transport and NWS to support accommodation if manual observations are to continue as preferred.</li> </ul>
Site works	<ul> <li>Installation of new AWS system, sensors, maintenance facility and communications system.</li> <li>Staffing accommodation, offices and maintenance facilities to be built.</li> <li>If required, additional secure fencing to protect instrument enclosure from theft, vandalism.</li> </ul>	<ul> <li>Full site design to be developed including instrument enclosure, staff accommodation, maintenance facilities.</li> <li>Ensure availability of power and redundancy measure, e.g. generator.</li> </ul>

ltem	Aims / Details	Activities
Staffing	Support staffing on-site with a 8-hour manual observations program.	<ul> <li>Determine requirements to ensure continued staffing of the site and manual observations.</li> </ul>
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for AWS.</li> <li>System solution should include a manual data entry console integrated with the AWS to support seamless input and sending of manual and automated observations.</li> <li>Requirements for manual instrumentation to be specified and included in site design.</li> </ul>
Communications	Establishment of communications infrastructure, including redundancy.	• Determine optimal communications from the site, prioritising uniform solution and practice across the network.
Maintenance & calibration	<ul> <li>Maintenance and calibration to be performed primarily by staff located on-site, with back-up plan for unavailability of staff.</li> <li>Calibration to be performed in accordance with GBON requirements.</li> <li>Facility to be installed for on-site undertaking of maintenance and repair, and including storage of spares.</li> </ul>	<ul> <li>Include maintenance facility in site design and planning.</li> <li>Calibration to be undertaken at least annually performed by on-site staff.</li> </ul>
Other considerations		

#### Kiunga, 6.08S, 141.18E, 33m

Kiunga is located at the western, central part of PNG mainland, to the south of the mountain ranges of Pengunungan Maoke, at around 33m of altitude and 755km to the northwest of Port Moresby.

The airport is currently under redevelopment under the CADIP program and expected to be completed later in 2023.



The station is a manual site, with limited information regarding the condition of facilities and information available, but with only rainfall instrumentation in operation and reporting. Therefore, it is clear that there is a requirement for relocation, refurbishment and reaccommodation of all facilities in the wake of the airport redevelopment.

ltem	Aims / Details	Activities
Existing site	<ul> <li>Site Is manual, with all instruments in need of replacement.</li> <li>Site is located at the airport at which the terminal is nearing completion of redevelopment.</li> <li>New site and new instrument enclosure required to be located and implemented.</li> </ul>	Determine whether old site remains suitable or whether new site to be attained/leased, preferably within the airport confines.
Site leasing	<ul> <li>Require new site and new instrument enclosure, preferably supporting accommodation and maintenance facility.</li> <li>Require new office and equipage.</li> <li>Require site, power and security and ideally should be representative of the airport terrain and microclimate.</li> </ul>	<ul> <li>Find alternative site and determine lease requirements and costs.</li> <li>Site to be surveyed and all metadata updated and recorded.</li> <li>Dept of Transport and NWS to support accommodation if manual observations are to continue as preferred.</li> </ul>
Site works	<ul> <li>Preparation of new site.</li> <li>Installation of new AWS system, sensors, maintenance facility and communications system.</li> <li>Staffing accommodation, offices and maintenance facilities to be built.</li> <li>If required, additional secure fencing to protect instrument enclosure from theft, vandalism.</li> </ul>	<ul> <li>Full sites design to be developed including instrument enclosure, staff office and accommodation, maintenance facilities.</li> <li>Ensure availability of power and redundancy measure, e.g. generator.</li> </ul>
Staffing	Support staffing on-site with a 8-hour manual observations program.	<ul> <li>Determine requirements to ensure continued staffing of the site and manual observations</li> </ul>
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for AWS.</li> <li>System solution should include a manual data entry console integrated with the AWS to support seamless input and sending of manual and automated observations.</li> <li>Requirements for manual instrumentation to be specified and included in site design.</li> </ul>
Communications	Establishment of communications infrastructure, including redundancy.	Determine optimal communications from the site, prioritising uniform solution and practice across the network.
Maintenance & calibration	<ul> <li>Maintenance and calibration to be performed primarily by staff located on-site, with back-up plan for unavailability of staff.</li> <li>Calibration to be performed in accordance with GBON requirements.</li> <li>Facility to be installed for on-site undertaking of maintenance and repair, and including storage of spares.</li> </ul>	<ul> <li>Include maintenance facility in site design and planning.</li> <li>Calibration to be undertaken at least annually performed by on-site staff.</li> </ul>
Other considerations	Remote location requires careful consideration of staffing, resupply and site access.	

#### Madang, 5.22S, 145.78E, 9.1m

Madang is located at Madang Airport, on the northern central coast of mainland PNG. The airport is located at an altitude of around 9.1m, 505km to the north of Port Moresby and 220km to the northwest GBON station, Nadzab (Lae).

Madang airport upgrade was commenced in early 2019 and was due for completion in mid-2022 under the CADIP program, jointly funded by the ADP and the World Bank.

The station is a manual site and is operational but not reporting a full suite of observations.



14 and	Aime / Deteile	Activities
Item	Aims / Details	Activities
Existing site	<ul> <li>An AWS is present at the site but has not been functional for some time due to vandalism.</li> </ul>	<ul> <li>Determine whether old site remains suitable or whether new site to be attained/leased, preferably within the airport confines.</li> </ul>
Site leasing	<ul> <li>Require new site and new instrument enclosure, preferably supporting accommodation and maintenance facility.</li> <li>Require new office and equipage.</li> <li>Require site, power and security and ideally should be representative of the airport terrain and microclimate.</li> </ul>	<ul> <li>Find alternative site and determine lease requirements and costs.</li> <li>Site to be surveyed and all metadata updated and recorded.</li> <li>Dept of Transport and NWS to support accommodation if manual observations are to continue as preferred.</li> </ul>
Site works	<ul> <li>Preparation of new site.</li> <li>Installation of new AWS system, sensors, maintenance facility and communications system.</li> <li>Staffing accommodation, offices and maintenance facilities to be built.</li> <li>If required, additional secure fencing to protect instrument enclosure from theft, vandalism</li> </ul>	<ul> <li>Full sites design to be developed including instrument enclosure, staff office and accommodation, maintenance facilities.</li> <li>Ensure availability of power and redundancy measure, e.g. generator.</li> </ul>
Staffing	Support staffing on-site with a 8-hour manual observations program.	<ul> <li>Determine requirements to ensure continued staffing of the site and manual observations.</li> </ul>
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for AWS.</li> <li>System solution should include a manual data entry console integrated with the AWS to support seamless input and sending of manual and automated observations.</li> <li>Requirements for manual instrumentation to be specified and included in site design.</li> </ul>

Itom	Aime / Dotaile	Activitios
Communications	Establishment of communications infrastructure, including redundancy.	Determine optimal communications from the site, prioritising uniform solution and practice across the network.
Maintenance & calibration	<ul> <li>Maintenance and calibration to be performed primarily by staff located on-site, with back-up plan for unavailability of staff.</li> <li>Calibration to be performed in accordance with GBON requirements.</li> <li>Facility to be installed for on-site undertaking of maintenance and repair, and including storage of spares.</li> </ul>	<ul> <li>Include maintenance facility in site design and planning.</li> <li>Calibration to be undertaken at least annually performed by on-site staff.</li> </ul>
Other considerations		

#### Momote, 2.05S, 147.42E, 4m

Momote is located at Momote Airport, on the eastern side of Manus Island, well to the north of PNG mainland and is the northernmost station in the PNG GBON network. The airport is located at an altitude of around 4m and around 840km to the northeast of Port Moresby and 390km to the west of Kavieng.

Momote Airport upgrade was carried out over 2017 to February 2022 under the CADIP program.

The station is a manual site but has not been operational for more than 2 years due to prohibition of entry to NWS staff due to airport certification issues.



Item	Aims / Details	Activities
Existing site	<ul> <li>Office is in unusable state and needs relocation and complete rebuild and refurbishment.</li> <li>Staff prevented from accessing existing manual weather site due to certification for access.</li> <li>Site Is manual, with 4 staff.</li> <li>Instruments for manual observations are likely in poor condition due to lack of maintenance over a long period.</li> <li>Staff accommodation is located at the airport, NAC owned, and while in reasonable condition is in need of some renovation and refurbishment.</li> </ul>	NWS to resolved access issues with NAC.

ltem	Aims / Details	Activities
	<ul> <li>Site is located at the airport at which the terminal will be demolished and rebuilt along with the observing site.</li> <li>Issues with fuel supply causes outages and disruption to communications.</li> <li>New site and new instrument enclosure required.</li> </ul>	
Site leasing	<ul> <li>Require new site and new instrument enclosure at the airport.</li> <li>Require new site for office and equipage at the airport.</li> <li>Likely require a new arrangement with NAC for more convenient accommodation of staff with NAC residential compound.</li> </ul>	<ul> <li>Negotiate with NAC for instrument, office and staff accommodation locations and arrangements.</li> <li>Site to be surveyed and all metadata updated and recorded.</li> <li>NAC, Dept of Transport and NWS to support accommodation if manual observations are to continue as preferred.</li> </ul>
Site works	<ul> <li>Installation of new AWS system, sensors, maintenance facility and communications system.</li> <li>Staffing accommodation, offices and maintenance facilities to be built.</li> <li>If required, additional secure fencing to protect instrument enclosure from theft, vandalism.</li> </ul>	<ul> <li>Full site design to be developed including instrument enclosure, office and maintenance facilities.</li> <li>Ensure availability of power and redundancy measure, e.g. generator.</li> </ul>
Staffing	Support staffing on-site with a 8-hour manual observations program.	<ul> <li>Determine requirements to ensure continued staffing of the site and manual observations.</li> </ul>
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for AWS.</li> <li>System solution should include a manual data entry console integrated with the AWS to support seamless input and sending of manual and automated observations.</li> <li>Requirements for manual instrumentation to be specified and included in site design.</li> </ul>
Communications	Establishment of communications infrastructure, including redundancy.	<ul> <li>Determine optimal communications from the site, prioritising uniform solution and practice across the network.</li> </ul>
Maintenance & calibration	<ul> <li>Maintenance and calibration to be performed primarily by staff located on-site, with back-up plan for unavailability of staff.</li> <li>Calibration to be performed in accordance with GBON requirements.</li> <li>Facility to be installed for on-site undertaking of maintenance and repair, and including storage of spares.</li> </ul>	<ul> <li>Include maintenance facility in site design and planning.</li> <li>Calibration to be undertaken at least annually performed by on-site staff.</li> </ul>
considerations		

#### Nadzab, 6.56S, 146.72E, 72.5m

Nadzab is located at Nadzab Airport, servicing the nearby city of Lae on the northeast coast of mainland PNG. The airport is located 35km to the northeast of Lae at an altitude of around 72.5m and around 328km to the north of Port Moresby.

Nadzab Airport upgrade was completed in October 2023 an aid project sponsored by the Japan International Cooperation Agency (JICA).

The station is a manual site and had an AWS that was non-operational due to vandalism. Manual synoptic reports are transmitted to headquarters.



ltem	Aims / Details	Activities
Existing site	<ul> <li>Office at the airport requires relocation due to airport redevelopment. Site proposed by NAC next to the NAC fire station.</li> <li>Instrument enclosure is in good condition but expect will need to be relocated.</li> <li>All sensors working except evaporation pan.</li> <li>NWS AWS onsite and functional.</li> <li>2 staff provide the manual observations program.</li> </ul>	
Site leasing	<ul> <li>Expect new site required for instrument enclosure at the airport.</li> <li>Require new site for office and relocation of equipment at the airport.</li> <li>Require a new arrangement with NAC for more convenient accommodation of staff</li> </ul>	<ul> <li>Complete negotiate with NAC for instrument, office and staff accommodation locations and arrangements.</li> <li>Site to be surveyed and all metadata updated and recorded.</li> <li>NAC, Dept of Transport and NWS to support accommodation if manual observations are to continue as preferred.</li> </ul>
Site works	<ul> <li>New instrument enclosure located and completed.</li> <li>Upgrade or renewal of AWS system and sensors with priority on network harmonisation of equipment.</li> <li>New maintenance facility and communications system.</li> <li>Staffing accommodation, offices and maintenance facilities to be provided or built.</li> <li>If required, additional secure fencing to protect instrument enclosure from theft, vandalism.</li> </ul>	<ul> <li>Location of instrument enclosure, staff office and accommodation and maintenance facility to be determined with leasing arrangement agreed.</li> <li>Full site design to be developed and implemented, including instrument enclosure, office and maintenance facilities.</li> <li>Ensure availability of power and redundancy measure, e.g. generator.</li> </ul>

ltem	Aims / Details	Activities
Staffing	Support staffing on-site with a 8-hour manual observations program.	<ul> <li>Determine requirements to ensure continued staffing of the site and manual observations.</li> </ul>
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for AWS.</li> <li>System solution should include a manual data entry console integrated with the AWS to support seamless input and sending of manual and automated observations.</li> <li>Requirements for manual instrumentation to be specified and included in site design.</li> </ul>
Communications	Establishment of communications infrastructure, including redundancy.	<ul> <li>Determine optimal communications from the site, prioritising uniform solution and practice across the network.</li> </ul>
Maintenance & calibration	<ul> <li>Maintenance and calibration to be performed primarily by staff located on-site, with back-up plan for unavailability of staff.</li> <li>Calibration to be performed in accordance with GBON requirements.</li> <li>Facility to be installed for on-site undertaking of maintenance and repair, and including storage of spares.</li> </ul>	<ul> <li>Include maintenance facility in site design and planning.</li> <li>Calibration to be undertaken at least annually performed by on-site staff.</li> </ul>
Other considerations		

#### Port Moresby, 9.45S, 147.2E, 38m

Port Moresby is located at NWS headquarters very close to Jacksons International Airport Port Moresby. The airport is located at 38m elevation on the south coast of the eastern peninsula of mainland PNG.

The station is a manual site and is maintained by staff located at the NWS.

An NWS AWS is located at the airport but does not transmit data due to a communications issue.



ltem	Aims / Details	Activities
Existing site	<ul> <li>Instrument enclosure at the NWS headquarters and therefore well- maintained in comparison to other</li> </ul>	

ltem	Aims / Details	Activities
	<ul> <li>sites and as facilities and staffing allows.</li> <li>AWS located at the airport but not well-maintained and no comms from the site to the NWS.</li> <li>A new facility to support cyclone watch and other multi-hazard functions of NWS has been built but other NWS buildings and facilities, including maintenance and repair infrastructure are in much need of renovation and rebuild.</li> <li>The NWS headquarter is expected to remain at current location where the proposed upper-air site is also to be located.</li> </ul>	
Site leasing	<ul> <li>Not an issue for this site for manual observations.</li> <li>For the AWS and related maintenance facilities, determination of location needs to be made, with consideration given to location of the AWS at the NWS, with Niusky to provide an AWOS at Jacksons Airport.</li> </ul>	Determine location for AWS and, if required, negotiate location and leasing arrangements with owner, Jacksons Airport.
Site works	<ul> <li>Possible reconfiguration of site enclosure for inclusion of AWS and/or reduction in manual observations program.</li> <li>Installation / relocation of AWS, maintenance facilities and calibration facilities.</li> <li>Development and implementation of central systems facilities and software.</li> </ul>	<ul> <li>Full site design to be developed and implemented, including changes to instrument enclosure, AWS location, and maintenance facilities.</li> <li>Improvements to NWS building facilities so as to optimally support GBON and related programs of NWS to be planned and implemented.</li> <li>Upper-air siting and works.</li> </ul>
Staffing	<ul> <li>Observations staffing requirements to address all aspects of GBON network operation along with national needs, including:         <ul> <li>Technical and observations staff, including inspections and calibration.</li> <li>IT and communications.</li> <li>Data management.</li> <li>Training of observations staff.</li> </ul> </li> </ul>	<ul> <li>Determine requirements for staff to ensure continued staffing of the Port Moresby site and operated the wider GBON network.</li> <li>Ensure staffing plans are developed for SOFF/GBON implementation and ongoing maintenance.</li> <li>Recruit and train new contracted and ongoing staff.</li> </ul>
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for AWS.</li> <li>System solution should include a manual data entry console integrated with the AWS to support seamless input and sending of manual and automated observations.</li> <li>Requirements for changed configuration of manual instrumentation to be specified and included in site design.</li> </ul>
Communications	Establishment of communications infrastructure, including redundancy.	Determine optimal communications     from the site, prioritising uniform

ltem	Aims / Details	Activities
		solution and practice across the network.
Maintenance & calibration	<ul> <li>Maintenance and calibration to be performed primarily by staff located on-site, with back-up plan for unavailability of staff.</li> <li>Calibration to be performed in accordance with GBON requirements.</li> <li>Facility to be installed for on-site undertaking of maintenance and repair, and including storage of spares.</li> </ul>	<ul> <li>Include maintenance facility in site design and planning.</li> <li>Calibration to be undertaken at least annually performed by on-site staff.</li> </ul>
Central Systems	<ul> <li>Develop, implement, update central systems to support the required functions, including:         <ul> <li>Network health and data communications monitoring.</li> <li>Metadata management, including inspection and calibration data.</li> <li>Data processing and quality control.</li> </ul> </li> </ul>	• Design, develop, and implement central systems architecture under the Investment Phase.
Other considerations		

#### Tokua, 4.33S, 152.22E, 15m

Tokua is located at Tokua Airport, Kokopo, at the eastern end of New Britain. The airport is located at 15m elevation, around 810km to the northeast of Port Moresby and 250km to the east of Hoskins.

Tokua Airport upgrade is still indeterminant with expectations it will go ahead in the future under the CADIP program with financing from the ADP and or JICA, which requires careful consideration and alignment in planning the GBON site works.

The station is a manual site and had an AWS that was non-operational due to vandalism but is currently operational.



ltem	Aims / Details	Activities
Existing site	<ul> <li>Observations office and enclosure currently on land targeted for airport development which will require a new site to be determined.</li> <li>Current enclosure is not fenced and provides observations of rainfall, temperature and humidity.</li> <li>No separate office space for NWS staff.</li> <li>1 staff member only.</li> <li>Staff accommodation status is unknown.</li> </ul>	
Site leasing	<ul> <li>Require new sites for office, enclosure and maintenance in alignment with plans for airport upgrade.</li> </ul>	<ul> <li>Complete negotiate with NAC for instrument, office and staff accommodation locations and arrangements.</li> <li>Site to be surveyed and all metadata updated and recorded.</li> <li>NAC, Dept of Transport and NWS to support accommodation if manual observations are to continue as preferred.</li> </ul>
Site works	<ul> <li>New instrument enclosure located and completed.</li> <li>New AWS system and sensors.</li> <li>New maintenance facility and communications system.</li> <li>Staffing accommodation, offices and maintenance facilities to be provided or built.</li> <li>If required, additional secure fencing to protect instrument enclosure from theft, vandalism.</li> </ul>	<ul> <li>Location of instrument enclosure, staff office and accommodation and maintenance facility to be determined with leasing arrangement agreed.</li> <li>Full site design to be developed and implemented, including instrument enclosure, office and maintenance facilities.</li> <li>Ensure availability of power and redundancy measure, e.g. generator.</li> </ul>
Staffing	Support staffing on-site with a 8-hour manual observations program.	<ul> <li>Determine requirements to ensure continued staffing of the site and manual observations.</li> <li>Recruit and train required staff.</li> </ul>
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for AWS.</li> <li>System solution should include a manual data entry console integrated with the AWS to support seamless input and sending of manual and automated observations.</li> <li>Requirements for manual instrumentation to be specified and included in site design.</li> </ul>
Communications	Establishment of communications infrastructure, including redundancy.	<ul> <li>Determine optimal communications from the site, prioritising uniform solution and practice across the network.</li> </ul>

Item	Aims / Details	Activities
Maintenance & calibration	<ul> <li>Maintenance and calibration to be performed primarily by staff located on-site, with back-up plan for unavailability of staff.</li> <li>Calibration to be performed in accordance with GBON requirements.</li> <li>Facility to be installed for on-site undertaking of maintenance and repair, and including storage of spares.</li> </ul>	<ul> <li>Include maintenance facility in site design and planning.</li> <li>Calibration to be undertaken at least annually performed by on-site staff.</li> </ul>
Other considerations	<ul> <li>Given uncertainty surrounding airport redevelopment plans and financing consideration will need to be given to delaying implementation of this site until plans are clearer.</li> </ul>	<ul> <li>Develop plans in alignment with airport upgrade plans.</li> <li>Ideally, infrastructure requirements for NWS should be incorporated as much as possible in airport plans.</li> </ul>

#### Wewak, 3.58S, 143.67E, 5m

Wewak is located at Wewak international airport, on the northern coast of mainland PNG. The airport is located at 15m elevation, around 770km to the northwest of Port Moresby and 300km to the northwest of Madang.

Work on the Wewak (Boram) airport redevelopment was commenced in 2020 and is still underway, financed by the second tranche of CADIP funded by the ADP and the PNG government. Completion data of the upgrade is still indeterminant with work on the new terminal and runway extension still not underway.



This means that there will be uncertainty for some time around location and refurbishment of NWS facilities.

The current station is a manual site and observations have recently resumed transmission to headquarters due to challenges with facilities. The station had an AWS that has been non-operational since 2019 due to vandalism.

Item	Aims / Details	Activities
Existing site	<ul> <li>Observation enclosure still at the existing site.</li> <li>There is no office space hence officer is unable to remit observations over to HQ. Only recording them in A8.</li> <li>AWS installed as part of the NIWA rolled out climate programme.</li> <li>AWS last observation date 20.02.2019</li> </ul>	

ltem	Aims / Details	Activities
Site leasing	•	<ul> <li>Complete negotiate with NAC for instrument, office and staff accommodation locations and arrangements.</li> <li>Site to be surveyed and all metadata updated and recorded.</li> <li>NAC, Dept of Transport and NWS to support accommodation if manual observations are to continue as preferred.</li> </ul>
Site works	<ul> <li>New instrument enclosure located and completed.</li> <li>New AWS system and sensors.</li> <li>New maintenance facility and communications system.</li> <li>Staffing accommodation, offices and maintenance facilities to be provided or built.</li> <li>If required, additional secure fencing to protect instrument enclosure from theft, vandalism.</li> </ul>	<ul> <li>Location of instrument enclosure, staff office and accommodation and maintenance facility to be determined with leasing arrangement agreed.</li> <li>Full site design to be developed and implemented, including instrument enclosure, office and maintenance facilities.</li> <li>Ensure availability of power and redundancy measure, e.g. generator.</li> </ul>
Staffing	Support staffing on-site with a 8-hour manual observations program.	<ul> <li>Determine requirements to ensure continued staffing of the site and manual observations.</li> <li>Recruit and train required staff.</li> </ul>
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for AWS.</li> <li>System solution should include a manual data entry console integrated with the AWS to support seamless input and sending of manual and automated observations.</li> <li>Requirements for manual instrumentation to be specified and included in site design.</li> </ul>
Communications	Establishment of communications infrastructure, including redundancy.	Determine optimal communications from the site, prioritising uniform solution and practice across the network.
Maintenance & calibration	<ul> <li>Maintenance and calibration to be performed primarily by staff located on-site, with back-up plan for unavailability of staff.</li> <li>Calibration to be performed in accordance with GBON requirements.</li> <li>Facility to be installed for on-site undertaking of maintenance and repair, and including storage of spares.</li> </ul>	<ul> <li>Include maintenance facility in site design and planning.</li> <li>Calibration to be undertaken at least annually performed by on-site staff.</li> </ul>
Other considerations	<ul> <li>Given uncertainty surrounding airport redevelopment plans and financing consideration will need to be given to delaying implementation of this site until plans are clearer.</li> </ul>	<ul> <li>Develop plans in alignment with airport upgrade plans.</li> <li>Ideally, infrastructure requirements for NWS should be incorporated as much as possible in airport plans.</li> </ul>

#### **GBON Upper-air Network**

#### Misima, 10.67S, 152.83E, 8m

Misima is located at Misima Island Airport (Bwagaoia), on Misima Island, around 240km to the southeast of the mainland eastern peninsula of PNG. The airport is located at 8m elevation, around 650km to the east of Port Moresby and around 280km to the east of Gurney.

Misima airport will be redeveloped under the CADIP program, with work expected in the coming years.



The current station is a manual site but has ceased providing observations since 2019. The station had an AWS that has been non-operational since late 1990s due to vandalism.

The upper-air station was abandoned and ceased operation in the 1970s (estimated date). While the station will not be nominated as a GBON station for SOFF upgrading, staffing of the site for upper-air will be critical and should additionally include provision of the functions necessary for manual surface observations.

ltem	Aims / Details	Activities
Existing site	<ul> <li>Surface observation ceased in 2021.</li> <li>AWS vandalised and likely not salvageable – assume new replacement required.</li> </ul>	• Determine whether old site remains suitable or whether new site to be attained/leased, preferably within the airport confines.
Site leasing	<ul> <li>Siting for following infrastructure required:         <ul> <li>Upper-air ARBL and related facilities.</li> <li>Instrument enclosure and AWS.</li> <li>Maintenance and calibration facility.</li> <li>Staff Office</li> <li>Staff accommodation for X staff.</li> </ul> </li> </ul>	<ul> <li>Complete negotiate with NAC for upper-air, instrument enclosure, AWS, office and staff accommodation locations and arrangements.</li> <li>Site to be surveyed and all metadata updated and recorded.</li> <li>NAC, Dept of Transport and NWS to support accommodation if manual observations are to continue as preferred.</li> </ul>
Site works	<ul> <li>New instrument enclosure located and completed.</li> <li>New upper-air radiosonde system</li> <li>New AWS system and sensors.</li> <li>New maintenance facility and communications system.</li> <li>Staffing accommodation, offices and maintenance facilities to be provided or built.</li> <li>If required, additional secure fencing to protect instrument enclosure and systems from theft, vandalism.</li> </ul>	<ul> <li>Location of instrument enclosure, staff office and accommodation and maintenance facility to be determined with leasing arrangement agreed.</li> <li>Full site design to be developed and implemented, including, upper-air system and facilities, instrument enclosure, office and maintenance facilities, communications and power infrastructure.</li> <li>Ensure availability of power and redundancy measure, e.g. generator.</li> </ul>

ltem	Aims / Details	Activities
Staffing	Support staffing on-site with a 12-hour manual and upper-air observations program.	<ul> <li>Determine requirements to ensure continued staffing of the site and manual and upper-air observations ensuring provision of 2 soundings per day.</li> <li>Recruit and train required staff.</li> </ul>
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud Upper air: AP, T, H, W	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for upper-air and AWS.</li> <li>System solution should include a manual data entry console integrated with the AWS to support seamless input and sending of manual and automated observations.</li> <li>Manual instrumentation to be specified and included in site design.</li> </ul>
Communications	Establishment of communications infrastructure, including redundancy.	Determine optimal communications from the site, prioritising uniform solution and practice across the network.
Maintenance & calibration	<ul> <li>Maintenance and calibration to be performed primarily by staff located on-site, with back-up plan for unavailability of staff.</li> <li>Calibration to be performed in accordance with GBON requirements.</li> <li>Facility to be installed for on-site undertaking of maintenance and repair, and including storage of spares.</li> </ul>	<ul> <li>Design maintenance program and schedule for both upper-air and surface.</li> <li>Include maintenance facilities for both surface and upper-air in site design and planning.</li> <li>Calibration to be undertaken at least annually performed by on-site staff.</li> <li>Establishment of system and sensor spares for upper-air and surface are established and maintained.</li> </ul>
Other considerations	Given uncertainty surrounding airport redevelopment plans and financing consideration will need to be given to delaying implementation of this site until plans are clearer.	<ul> <li>Develop plans in alignment with airport upgrade plans.</li> <li>Ideally, infrastructure requirements for NWS should be incorporated as much as possible in airport redevelopment plans.</li> </ul>

#### Momote, 2.05S, 147.42E, 4m

For information regarding location and status of surface network, see above details under GBON Surface Network.

The upper-air development of Momote will be undertaken in cooperation with the Australia Bureau of Meteorology, International Development program which has agreed with the Department of Transport to fund the installation of the upper-air system at Momote. It is recommended that SOFF funding support should therefore be channelled into the following activities related to this site:

- Ensuring homogeneity and harmonisation of systems and processes across the network of 3 stations.
- Development of systems and processes to support exchange of data internationally on the WMO Information System.
- Additional functions in line with NWS responsibilities to support the upper-air system at Momote, which include:

- o Maintenance and calibration of the surface-based systems and sensors
- Maintenance and calibration including provision of equipment and sensor spares.
- Data management systems development and implementation and integration into NWS management functions and processes.
- Staff training and development.

ltem	Aims / Details	Activities
Existing site	<ul> <li>See details under surface observations</li> <li>Issues with fuel supply causes outages and disruption to communications.</li> <li>Upper-air site non-existent and a site needs to be found and approved.</li> </ul>	<ul> <li>NWS to resolved access issues with NAC.</li> </ul>
Site leasing	<ul> <li>Inline with requirements for surface observations, determine location of upper-air site.</li> </ul>	<ul> <li>Plans, agreements for surface observations to include provision for upper-air site.</li> <li>Site to be surveyed and all metadata updated and recorded.</li> </ul>
Site works	<ul> <li>Installation of upper-air system and related operational and maintenance facilities.</li> <li>Staffing accommodation, offices and maintenance facilities to be built.</li> <li>If required, additional secure fencing to protect instrument enclosure from theft, vandalism.</li> </ul>	<ul> <li>Full site design to be developed including instrument enclosure, office and maintenance facilities.</li> <li>Ensure surface-based observations system is integrated as necessary with upper-air system.</li> <li>Ensure availability of power and redundancy measure, e.g. generator.</li> </ul>
Staffing	Support staffing on-site with a 12-hour manual and upper-air observations program.	<ul> <li>Determine requirements to ensure continued staffing of the site and manual and upper-air observations to include 2 soundings per day.</li> </ul>
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud Upper air: AP, T, H, W	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for upper-air systems.</li> <li>Determine requirements and processes for consumables and spares.</li> </ul>
Communications	Establishment of communications infrastructure, including redundancy.	<ul> <li>Determine optimal communications from the site, prioritising uniform solutions for both upper-air and surface system and practices across the network.</li> </ul>
Maintenance & calibration	<ul> <li>Maintenance and calibration to be performed primarily by staff located on-site, with back-up plan for unavailability of staff.</li> <li>Calibration of sensors to be performed in accordance with GBON requirements.</li> <li>Facility to be installed for on-site undertaking of maintenance and repair and including storage of spares.</li> </ul>	<ul> <li>Include upper-air maintenance facility in site design and planning.</li> </ul>

Item	Aims / Details	Activities
Other considerations	<ul> <li>Ensure that supply to island location is able to be supported by suppliers and maintenance/repair staff or contractors.</li> </ul>	<ul> <li>Upper-air planning to ensure support for operational and maintenance logistics.</li> </ul>

#### Port Moresby, 9.45S, 147.2E, 38m

For information regarding location and status of surface network, see above details under GBON Surface Network.

The upper-air site will be located within the compound of the NWS headquarters.

The upper-air development of Port Moresby will be undertaken in cooperation with the Australia Bureau of Meteorology, International Development program which has agreed with the Department of Transport to fund the installation of the upper-air system at Port Moresby. It is recommended that SOFF funding support should therefore be channelled into the following activities related to this site:

- Ensuring homogeneity and harmonisation of systems and processes across the network of 3 stations.
- Development of systems and processes to support exchange of data internationally on the WMO Information System.
- Additional functions in line with NWS responsibilities to support the upper-air system at Momote, which include:
  - Maintenance and calibration of the surface-based systems and sensors
  - Maintenance and calibration including provision of equipment and sensor spares.
  - Data management systems development and implementation and integration into NWS management functions and processes.
- Aims / Details Item Activities **Existing site** See details under surface NWS to resolved access issues with • observations NAC. Old upper-air site at NWS • headquarters is non-operational. Site leasing • Upper-air system to be located at Site to be surveyed and all metadata ٠ updated and recorded. NWS headquarters at site already determined Site works Installation of upper-air system and Ensure surface-based observations • • related operational and maintenance system is integrated as necessary with facilities. upper-air system. If required, additional secure fencing Ensure availability of power and • to protect instrument enclosure from redundancy measure, e.g. generator. theft, vandalism. Staffing Support staffing on-site with a 12-hour Determine requirements to ensure • manual and upper-air observations continued staffing of the site and program. manual and upper-air observations to include 2 soundings per day.
- Staff training and development.

Item	Aims / Details	Activities
System & sensors	AWS system Variables: SLP, T, H, W, P Additional automated: terrestrial temperature, visibility Manual observations: evaporation, sunshine hours, visibility, present weather, cloud Upper air: AP, T, H, W	<ul> <li>Specification of requirements based on GBON requirements.</li> <li>Tendering for supply consistent and ensuring network-wide solution using WMO recommended tendering specification for upper-air systems.</li> <li>Determine requirements and processes for consumables and spares.</li> </ul>
Communications	Establishment of communications infrastructure, including redundancy.	<ul> <li>Determine optimal communications from the site, prioritising uniform solutions for both upper-air and surface system and practices across the network.</li> </ul>
Maintenance & calibration	<ul> <li>Maintenance and calibration to be performed primarily by NWS staff located on-site</li> <li>Facility to be installed for on-site undertaking of maintenance and repair and including storage of spares.</li> </ul>	<ul> <li>Include upper-air maintenance facility in site design and planning.</li> </ul>
Other considerations		