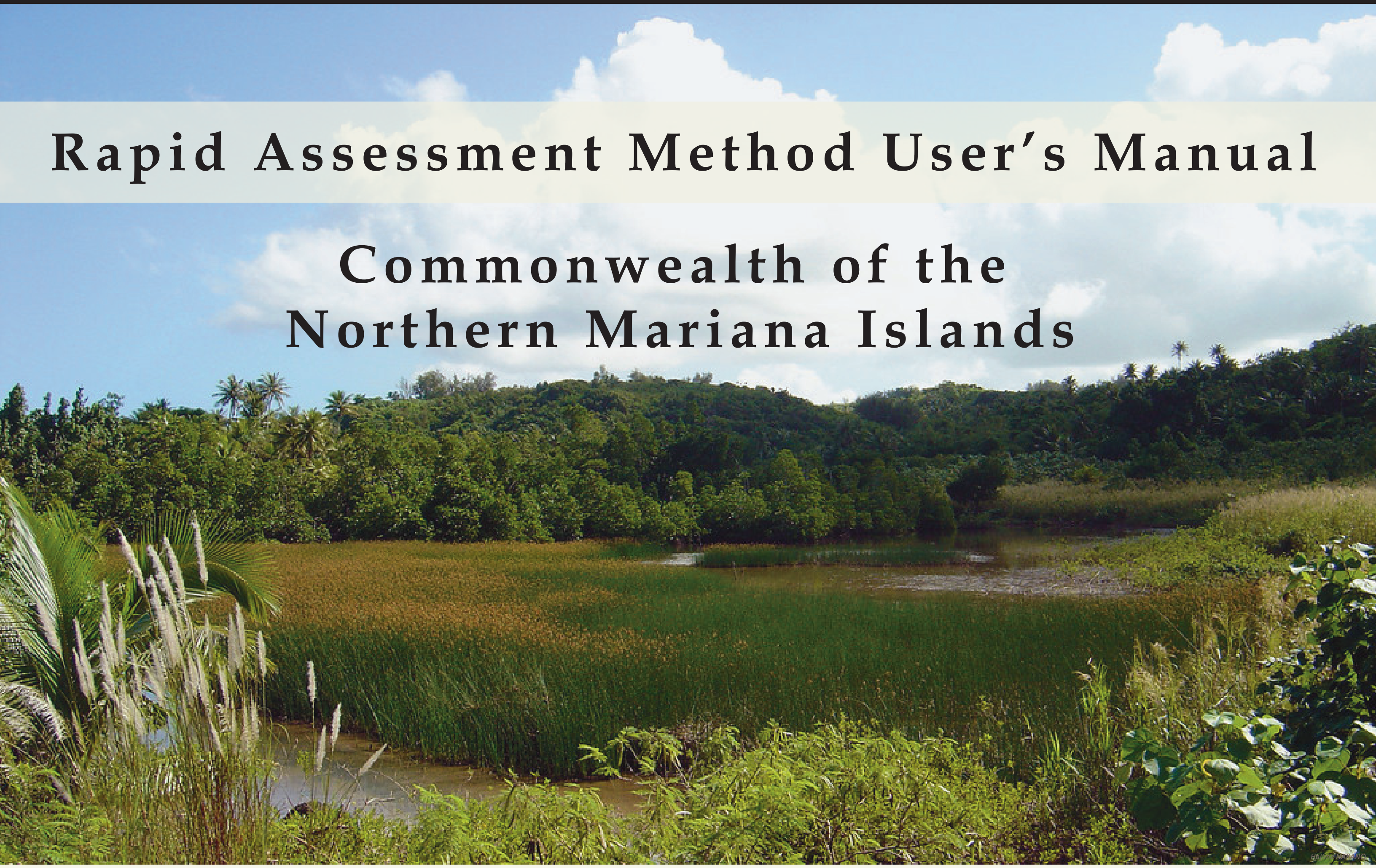
Rapid Assessment Method User's Manual

Commonwealth of the Northern Mariana Islands



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Prepared for:

Commonwealth of the Northern Mariana Islands
Office of the Governor
Bureau of Environmental and Coastal Quality
Division of Coastal Resources Management
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2015 Rapid Assessment Method

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CONTENTS

Contents

ABBREVIATIONS

CNMI	Commonwealth of the Northern Mariana Islands
DBH	diameter at breast height
DLNR	Department of Land and Natural Resources
EPA	U.S. Environmental Protection Agency
ERCE	ERC Environmental and Energy Services
ft	feet
GPS	Global Positioning System
HGM	hydrogeomorphic
m	meters
NA	Not applicable
NWI	National Wetland Inventory
OBL	Obligate Wetland Plants
RAM	Rapid Assessment Method
UPL	Obligate Upland Plants
USFWS	U.S. Fish and Wildlife Service
UTM	Universal Transverse Mercator
WAA	Wetland Assessment Area

1.0 INTRODUCTION

This document presents a Rapid Assessment Method (RAM) for field evaluation of wetlands in the Commonwealth of the Northern Mariana Islands (CNMI). The RAM is composed of two parts: (1) a wetland assessment form and (2) a guide explaining the ranking method and assessment criteria with supporting documentation.

1.1 Rapid Assessment Method

A RAM is part of the three-level approach used in wetland monitoring and assessment, as recommended by the U.S. Environmental Protection Agency (EPA 2006). The RAM is Level 2 within this system and is an effective tool for assessing wetland conditions, monitoring wetland impacts over time, and making planning and permitting decisions. A rapid assessment involves evaluating the general condition of individual wetlands using relatively simple field indicators and is often based on the characterization of stressors known to limit wetland functions.

1.2 CNMI RAM - Background

This new CNMI RAM builds on the wetlands assessment criteria originally proposed in the *Saipan Comprehensive Wetlands Management Plan*, completed in 1990 and updated in 1991 (ERCE 1991). One of its primary purposes is to provide an improved methodology for developing an updated master wetlands map covering all of CNMI. A wetlands map for Saipan was created from aerial photographs in the *Saipan Comprehensive Wetlands Management Plan*. Since this time, however, development and construction projects in CNMI have altered existing wetlands and mitigation efforts have created new wetlands. Furthermore, the 1990 wetlands map only covered Saipan. Wetland areas on other CNMI islands remain poorly recorded or not recorded at all. Mapping of wetland areas is especially important on the developing islands of Tinian and Rota and updated maps and assessments are needed on Saipan in order to meet the management goals of achieving “no net loss” of wetlands and protecting their critical functions.

Understanding both the current location and relative values of all CNMI wetlands is essential to support the Bureau of Environmental and Coastal Quality–Division of Coastal Resources Management’s permitting process and comprehensive management objectives. Development and implementation of this CNMI RAM is intended to facilitate wetlands and mangrove evaluation and, by extension, support ecologically sound permitting, management, and mitigation efforts.

1.2.1 Design Approach

The goal of the CNMI RAM is to provide a ranking system that is simple, easy to complete, accurate, and requires minimal training to use. It should provide output data on wetland conditions and functions that are pertinent to regulatory decision making. The CNMI RAM was designed with reference to the advantages and limits of different wetland assessment methods as presented by Fennessy et al. (2004, 2007), Stein et al. (2009a), and Sutula et al. (2006). These reviews identify common pitfalls to be avoided and best practices to be followed. The CNMI RAM was developed in accordance with the following design stipulations:

1. The CNMI RAM will provide index numbers that reflect wetland conditions and functions in selected indicator metrics. This approach ensures that evaluation of different wetland functions can be tracked separately.
2. The CNMI RAM will not use weighting when calculating the overall rating index. Use of weighting is not currently justified due to the lack of knowledge on the relationship between, and relative importance of, wetland indicators. This may change in later versions of the CNMI RAM as the knowledge base improves.
3. The CNMI RAM will not use value-based indicators that are not directly linked to wetland condition and function. This approach aims to exclude indicators that are subject to opportunity and context, thereby increasing inconsistency. A separate analysis for the social and economic value of subject wetlands is recommended.
4. The CNMI RAM classifies wetland condition according to three rating categories based on index scores. After validation and calibration, these categories may be used for permitting and comprehensive resource management planning purposes.
5. Assessment of wetland functionality in hydrology, water quality, and habitat is performed by calculating wetland function indexes using selected indicator metrics that reflect each wetland function.

In order to facilitate ease of use for the CNMI RAM it was determined that a two-tiered assessment was appropriate. The Primary Assessment is designed to be implemented by users who have minimal training in wetland ecology. The Secondary Assessment is designed to be used by wetland ecologists and trained agency staff or consultants who are capable of performing wetland delineation. This approach provides flexibility for CNMI RAM users and allows for the efficient generation of preliminary wetland condition rating. If necessary, this can be followed by a more elaborate assessment by completing the Secondary Assessment. Completion of the Secondary Assessment involves one additional page on the CNMI RAM Data Form (see Appendix A).

1.2.2 Indicator Metrics

Indicator metrics are the building blocks of the CNMI RAM. Each indicator metric consists of a set of criteria that rank wetland conditions from high to low and give respective scores. The CNMI RAM adopts indicator metrics from various available RAMs that are either very widely used or provide specific advantages for the assessment of CNMI wetlands. Wetland condition indicators and ranking metrics were selected according to the following principles:

1. The indicators should reflect condition types that are associated with wetland functions and that are scientifically defensible.
2. The indicators should not require complicated equipment or extensive time to identify.
3. The ranking criteria should be readily identifiable and unambiguous to users after brief training.

Wetland condition is ranked by indicators that reflect stressors and disturbance, hydrologic function and integrity, and habitat value for supporting biodiversity with emphasis on threatened or endangered species. The CNMI RAM adopts many of these ranking criteria with some modifications.

The *Saipan Comprehensive Wetland Management Plan* (ERCE 1991) proposed ranking criteria for CNMI wetlands which include hydrophytic vegetation dominance, structural diversity, proportion of native to non-native plant species, extent and frequency of disturbance, wetland-dependent wildlife use, presence of endangered species, wildlife corridor, drainage system, open water component, size significance, and degree of isolation. These criteria are consistent with most rapid assessment methodologies.

The Comprehensive Wetland Management Plan recommends a "minimum buffer of 50 feet" for all "preserved/conserved wetlands; however, High Value wetlands will require a much larger buffer (minimum = 100 feet)" (at page 6-4, ERCE 1991). The objective of buffers is to allow for an expanded range of uses while controlling indirect impacts associated with development to sensitive wetlands. The 1991 Plan ranked wetlands as "Class 1, 2, or 3" - this guide attempts to clarify this ranking by classifying wetlands as "high, medium, or low" value.

Wetland functions are assessed using the three categories of wetland functions: hydrologic, water quality, and habitat. Hydrologic functions include water retention, flood control, groundwater recharge, and shoreline stabilization. Water quality functions include sedimentation, absorption, and chemical conversion and degradation of nutrients and pollutants. Food, shelter, and specific breeding conditions for plants and wildlife evidence the habitat function of these systems.

The wetland condition indictor metrics and the associated wetland functions used by the CNMI RAM are summarized in Table 1 below. Each indicator may reflect one or more wetland function. Applicability of indicators for each function category is also given.

Table 1. Applicability of Wetland Function Indicators

		Wetland Functions		
Indicator Metrics		Hydrology	Water Quality	Habitat
1	Hydric Soil	x	x	NA
2	Surface Water	x	NA	x
3	Hydrologic Alteration	x	x	x
4	Water Quality	NA	x	x
5	Saturated Soil	x	x	
6	Native Wetland Plants	x	NA	x
7	Invasive Wetland Plants	NA	NA	x
8	Vegetation Alteration	NA	x	x
9	Wetland Size	x	x	x
10	Average Buffer Width	NA	x	x
11	Water Connectivity	x	NA	x
12	Upland Vegetation	NA	x	x
13	Substrate Disturbance	NA	x	x
14	Vegetation Layers	NA	x	x
15	Invasive Upland Plants	NA	x	x
x= applicable; NA= not applicable				

1.2.3 Wetland Classification

Although it would be convenient and useful to have a universal wetland rating system that applied to all wetland types, this approach has long been recognized as problematic, if not impossible, due to the wide range of wetland characteristics among different wetland types. Alternatively, designing and using a rating system for a specific wetland type produces scientifically valid results. This approach has been recommended in recent rapid assessment method reviews (Fennessy et al. 2004, 2007). Therefore, the first step is to classify the assessed wetlands. Two major wetland and freshwater habitat classification systems are widely used for wetland condition assessment.

The CNMI RAM utilizes both the U.S. Fish and Wildlife Service's (USFWS) National Wetland Inventory (NWI) system (Cowardin et al. 1979) and hydrogeomorphic (HGM) classification system (Brinson 1993; Smith et al. 1995) to characterize wetlands. Due to the scarcity of perennial streams and lakes, most wetlands of CNMI are classified as Palustrine in the NWI classification and Depressional in the HGM classification. The current version of the CNMI RAM does not differentiate between indicator metrics and rating specifications according to wetland types. The use of both wetland classification systems as a reference would increase the applicability of its data to a larger pool of wetland studies that are based on either of the classification system, which can later be used to improve the rapid assessment method.

1.2.3.1 National Wetland Inventory (NWI) Classification

The NWI system classifies wetlands and deepwater habitats using a hierarchy of wetland characteristics. Five types of wetland systems are recognized based on hydrodynamics and the influence of saltwater. These include Marine, Estuarine, Riverine, Lacustrine, and Palustrine systems. The five systems are further divided into subsystems, classes, and subclasses according to tidal influence, substrate, and/or dominant life forms. Modifiers that describe water regime, water chemistry, and soil are also employed. The NWI classification has been adopted by various U.S. federal agencies.

1.2.3.2 Hydrogeomorphic (HGM) Classification

The HGM wetland classification system also has wide acceptance in the wetland science community. HGM was popularized after the publication of two seminal U.S. Army Corps of Engineer technical reports (Brinson 1993, Smith et al. 1995). The HGM classification has three components: (1) geomorphic setting, (2) water source and its transport, and (3) hydrodynamics. Geomorphic setting is the topographic location of the wetland within the surrounding landscape. Water source types include precipitation, surface or near-surface flow, and groundwater discharge. Hydrodynamics refers to the direction of flow and strength of water movement within the wetland. HGM assumes that wetland functions and ecological significance are predominantly determined by local geomorphic and hydrodynamic settings. HGM therefore provides a model that links wetland classification with wetland function and value. Many recently developed wetland rapid assessment methods reference the HGM model as a basis for using indicators to estimate wetland function (Fennessy et al. 2007; Sutula et al. 2006).

2.0 CNMI Wetlands RAM Development and Field Testing

Intensive consultation with local experts and prospective end users was an important part of the development process for this RAM. The consultation effort was conducted primarily through cooperative field tests of the initial draft RAM. This produced valuable feedback on the structure and content of the RAM and resulted in a more streamlined and user friendly methodology. The main objectives of the field tests were to:

1. assess the applicability of the indicator metrics;
2. obtain site specific information to adjust ranking specifications for the indicators;
3. identify issues that the intended users may encounter during field assessment;
4. gather input from local area experts; and
5. verify the overall validity and sensitivity of the RAM.

2.1 Field Testing Methods

An initial draft version of the CNMI RAM was field tested between August 31, 2015 and September 4, 2015 on the island of Saipan. The field test included conducting a series of rapid assessments at 13 wetlands selected for their variability in characteristics and conditions. Local area experts and potential users of the CNMI RAM were active participants in the assessments to provide input and help troubleshoot any problems encountered with the proposed method. Personnel involved in the field testing including DCRM staff in planning, permitting, and enforcement sections, wildlife biologists and wetland specialists from Division of Fish and Wildlife, and a consultant experienced in delineating wetlands in CNMI.

The location, HGM wetland class, and dominant vegetation for the 13 assessed wetlands is summarized in Table 2.

Table 2. Wetlands Assessed During CNMI RAM Field Testing

Name	Coordinates (UTM 55P)	HGM Wetland Class	Dominant Vegetation
Bird Island	372153 m E 1686948 m N	Depressional	kangkun
Landfill*	373087 m E 1688693 m N	Depressional	California grass
Plumeria North	367877 m E 1686055 m N	Depressional	pago, karisu
Handson	365843 m E 1684354 m N	Depressional	karisu
Micro	365611 m E 1684412 m N	Depressional	Pago, karisu
MIHA*	362822 m E 1682138 m N	Depressional	pond apple, bulrush, marsh cyperus, torpedo grass
Chalan Laolao (CLL)	362111 m E 1678044 m N	Depressional	karisu
Costco Mitigation Site (CMS)**	361906 m E 1677565 m N	Depressional	pago, karisu
Route 31 South	362067 m E 1676626 m N	Depressional	pago, karisu
Lake Susupe West (LSW)	361438 m E 1675658 m N	Depressional	pago, bulrush, langayao
Kingfisher Golf Course *(KGC)	369184 m E 1683299 m N	Depressional	California grass, kangkun
Lower Base Drive (LBD)	364569 m E 1683662 m N	Tidal Fringe	mangrove
American Memorial Park* (AMP)	362366 m E 1682684 m N	Tidal Fringe	mangrove, karisu, water hyacinth

*Constructed wetlands

** Mitigation site with water impoundment

2.2 Issues Identified and Corrective Actions

During the first stage of field testing, comments and feedback were solicited from the DCRM staff and local area expert participants. Feedback revealed a number of issues that had not been identified during development of the draft RAM. Major issues and comments had to do with the applicability of some indicators to the CNMI, the amount of wetland ecology training necessary to properly evaluate some indicator metrics, language ambiguities in the ranking specifications, overly complicated ranking methods for some indicators, and the overall length of the data form. Most critically, field testing revealed that some of the indicators required a level of technical knowledge not appropriate to the target users. User feedback highlighted the importance of striking a balance between ease of use and comprehensiveness for the RAM. The draft CNMI RAM enabled comprehensive data capture but fell short in its applicability and ease of use.

Based on this initial feedback, a major revision was made to the draft CNMI RAM during the fieldwork. Specific significant revisions are as follows:

1. Structure: To address the issue that some of the indicators requires substantial knowledge in wetland ecology to assess correctly, the CNMI RAM was re-structured with a two-tier approach. The revised CNMI RAM has a Primary Assessment which requires minimal expertise to perform. If a higher level of information is required, a more technical Secondary Assessment can be completed by a trained wetland ecologist and/or agency staff trained in the RAM and wetland delineation techniques. To further simplify the documents, technical jargon was replaced with plain language as much as possible and operational definitions and supporting materials were included where appropriate and available.
2. Indicators: Indicator metrics that required either too much background knowledge or too much field effort for a rapid assessment were replaced with more applicable indicators and a simplified ranking system. Examples of indicators that were abandoned include the identification of organic soil and counting numbers of native plant species in the WAA.
3. Ranking Specifications: Results from the field test were used to adjust the ranking specifications for certain indicators. Ranking specifications that were either not applicable or inadequate were adjusted. For example, the ranking specifications for wetland size were reduced after it was discovered that the majority of wetlands

found in CNMI are smaller in size compared to the continental United States.

4. Scoring: An Average RAM Score was included as an alternative way to classify wetland conditions when there is significant missing data. It was found that some indicators may not be adequately assessed due to lack of access or limited visibility. This would effectively result in an incomplete assessment and misleading Total RAM Score. The Average RAM Score, however, uses a simple average of indicator metric scores to classify the wetlands, allowing completion of the assessment despite missing data.

2.3 Assessment Results

Assessment results for 10 of the 13 test wetlands are summarized in Tables 3a and 3b. The test subjects included eight depressional wetlands and two tidal fringe wetlands. Both Primary and Secondary assessment were completed. Six of the wetlands were determined to be in ‘medium’ condition and four wetlands were in ‘high’ condition.

Average RAM Scores ranged from 2.00 to 3.40 with a mean of 2.83 and standard deviation of 0.47. The 10 wetlands have a mean Average Primary Assessment Score of 2.88, and a mean Average Secondary Assessment Score of 2.77. The correlation coefficient between the Primary Assessment Scores and Average Secondary Assessment Scores is 0.87, showing a strong correlation between the Primary Assessment and Secondary Assessment scores. This indicates that the quicker, less intensive Primary Assessment produces scores largely in agreement with the more intensive Secondary Assessment.

2.4 Discussion

Fielded testing was conducted for the Draft CNMI RAM in order to gain feedback from potential users and area experts. This feedback was used to revise the Draft CNMI RAM and make necessary corrections. The updated CNMI RAM was then used to assess ten wetlands and gauge its general applicability, validity, and sensitivity. Although the scores from the ten assessed wetlands were higher than expected, there is no reason to believe that the sampled wetlands have been misrepresented in terms of their condition rating. At present there is no outstanding evidence to justify further modification of the CNMI RAM. It is, however, highly recommended that further testing be conducted on small sized wetlands and those that are significantly impacted. It is also important to, at some point, conduct in-depth investigation of representative wetlands to obtain level three data. This high-level data is necessary to objectively verify whether CNMI RAM condition scores are accurate and reflective of wetland functions performed.

Table 3a. CNMI RAM Field Test Results for Five WAAs

Indicator Metrics		Bird Island	Landfill *	KGC*	Handson	Miha*
1	Hydric Soil	1	1	4	4	1
2	Surface Water	3	3	4	2	2
3	Hydrologic Alteration	4	1	1	3	2
4	Water Quality	4	2	3	3	3
5	Saturated Soil	4	1	1	4	4
6	Native Wetland Plants	1	1	3	3	3
7	Invasive Wetland Plants	1	4	1	1	1
8	Vegetation Alteration	4	4	3	3	4
Primary Assessment Score		22	17	20	23	20
Average Primary Assessment Score		2.75	2.13	2.5	2.88	2.5
Primary Assessment Ranking		*Medium*	*Medium*	*Medium*	*Medium*	*Medium*
9	Wetland Size	1	2	4	4	3
10	Average Buffer Width	4	4	4	3	1
11	Water Connectivity	1	1	1	2	1
12	Upland Vegetation	3	2	1	3	1
13	Substrate Disturbance	4	1	4	4	3
14	Vegetation Layers	2	1	2	3	4
15	Invasive Upland Plants	2	2	2	2	2
Secondary Assessment Score		17	13	18	21	15
Average Secondary Assessment Score		2.43	1.86	2.57	3.00	2.14
Total CNMI RAM Score		39	30	38	44	35
Average CNMI RAM Score		2.60	2.00	2.53	2.93	2.33
Overall CNMI RAM Ranking		*Medium*	*Medium*	*Medium*	*Medium*	*Medium*
*Constructed wetland						

Table 3b. CNMI RAM Field Test Results for Additional Five WAAs

Indicator Metrics		CLL	CMS**	LSW	LBD	AMP*
1	Hydric Soil	4	4	4	4	4
2	Surface Water	2	2	4	2	2
3	Hydrologic Alteration	3	2	3	2	1
4	Water Quality	3	3	3	3	2
5	Saturated Soil	4	4	4	4	4
6	Native Wetland Plants	3	4	4	3	4
7	Invasive Wetland Plants	4	4	1	4	1
8	Vegetation Alteration	4	4	3	4	4
Primary Assessment Score		27	27	26	26	22
Average Primary Assessment Score		3.38	3.38	3.25	3.25	2.75
Primary Assessment Ranking		*High*	*High*	*High*	*High*	*Medium*
9	Wetland Size	4	4	4	4	2
10	Average Buffer Width	3	4	3	3	4
11	Water Connectivity	3	2	4	3	3
12	Upland Vegetation	3	2	3	4	1
13	Substrate Disturbance	4	4	4	4	3
14	Vegetation Layers	2	3	4	3	3
15	Invasive Upland Plants	2	2	3	3	3
Secondary Assessment Score		21	21	25	24	19
Average Secondary Assessment Score		3.00	3.00	3.57	3.43	2.71
Total CNMI RAM Score		48	48	51	50	41
Average CNMI RAM Score		3.20	3.20	3.40	3.33	2.73
Overall CNMI RAM Ranking		*High*	*High*	*High*	*High*	*Medium*
*Constructed wetland ** mitigation site with water impoundment						

3.0 PROCEDURES AND PROTOCOLS FOR IMPLEMENTING THE CNMI RAM

This section describes the four-step procedure required to complete the CNMI RAM. Initial work consists of defining the assessment area and performing a pre-field assessment of maps and technical literature. This is followed by collection of field data, scoring of the data, and performing quality control checks on the results. The data form and step-by-step guidelines to complete the data form are provided in Appendix A and Appendix B respectively.

3.1 Determination of Assessment Intensity

The first step in planning an assessment is to determine its intensity level. It will either be a less rigorous Primary Assessment or a more intensive Secondary Assessment. Importantly, the Primary Assessment can be used as a stand-alone approach or, alternatively, as the first step of a two-step assessment process. As discussed above, Primary Assessment uses eight simple indicators to assess wetland condition by assigning scores ranging from 1 to 4. The eight indicators were selected for their clarity and ease of use for assessors with minimal training in wetland ecology. The Secondary Assessment expands on the Primary Assessment and includes seven additional indicators. These additional indicators require a higher level of knowledge and training to interpret and score correctly. The Secondary Assessment should be conducted by assessors that have been trained in this assessment technique by an expert with the ability to perform wetland delineation, at a minimum.

3.2 Pre-Field Assessment

Once the intensity level has been determined, pre-field background research should begin. This desktop assessment involves obtaining all maps and technical literature relevant to the project area and identifying the formal Wetland Assessment Area (WAA). The assessor should attempt to locate any available information about the subject wetland and any other pertinent information that may aid in understanding the ecology and land use history of the WAA. Data that can be gathered at this stage include background information of the WAA (Wetland assessment area ID, project name, landownership, location, HGM wetland class, NWI wetland class, and coordinates), the first two metrics of the primary assessment (hydric soil and surface water), and the first three metrics of the secondary assessment (wetland size, average buffer width, and water connectivity). Based on the desktop assessment, a provisional score is made for the landscape setting metrics prior to field assessment. These data should be verified during the field assessment.

3.2.1 Defining the WAA

A critical step in the pre-field assessment is defining the boundary of the WAA. The WAA is typically identified by abrupt changes in the hydrology of the subject wetland due to natural or artificial features that are capable of altering the source, direction, velocity, and volume of water flow. Local hydrodynamics may be affected by vegetation, topography, or man-made features. Aerial imagery and topographic maps are useful references for locating these features.

All boundaries derived from desktop assessments should be verified during field investigation. If the WAA boundary is not identifiable during the desktop assessment, it should be determined in the field. The following rules should be adhered to when defining the WAA boundary.

1. Interconnected wetlands that have a high degree of hydrologic interaction should be included in the same WAA, regardless of the vegetation community.
2. Separate WAA boundaries should be defined for interconnected wetlands whenever hydrologic changes are abrupt.
3. Man-made structures that are capable of altering local hydrology are suitable WAA boundaries.
4. Features that are not capable of altering hydrology (e.g., wire fences or trails) should not be used to define WAA boundaries.
5. Subdivide wetlands larger than 2 acres, if necessary, to capture variation in wetland conditions.

3.2.2 Classifying the WAA

Provisional wetland classification based on both the NWI and HGM systems is also performed during the desktop assessment. A flow chart is used to classify the WAA into major HGM classes. Mapping data from the USFWS' National Wetland Inventory should be reviewed to determine the wetland classification of WAA if available, however, the NWI assessment should not be considered comprehensive, especially for small or isolated wetlands. The determination should be verified during field assessment.

3.3 Field Assessment

Permission to access the WAA should be requested early in the fieldwork planning process. Prior to fieldwork, the assessment team should ensure that all equipment and materials needed for the investigation are available. These include items such as maps and data forms printed on all-weather paper, a digital camera, a drain shovel, and a GPS receiver or similar geospatial data collection device.

Upon arriving, the lead assessor should verify the WAA boundaries. If necessary, the WAA boundary should be modified to accurately represent field conditions; the use of a GPS unit to ground-truth boundaries and features is encouraged. An overview reconnaissance survey of the WAA is recommended to identify the range of ecological variation within the WAA. Special attention should be paid to hydrodynamic characteristics including, but not limit to, water source, flow direction, flow restriction, and hydrologic alteration. Only after these steps are completed should the assessor begin collecting data and filling out the data form.

3.3.1 Data Collection

Data collection starts with entering basic information including date of assessment and assessors' contact information. The assessor should then record location information and conduct photo documentation of the WAA and take waypoints to ground-truth geospatial data.

Wetland classification and landscape setting metrics are provisionally entered during desktop assessment. The field assessment should verify the accuracy of data derived from maps and aerial photos. Any inconsistencies should be noted even when metric scores remain unchanged.

Instructions and guidelines for each indicator metric are provided in Appendix B. Assessors should always refer to the instructions and guidelines whenever in doubt. Notes should be taken to justify the ranking when necessary.

3.4 Scoring and Interpretation

After all categories are ranked and scored, the scores for each are subtotaled. The subtotal scores are then summed to generate the overall CNMI RAM score. No weighting or additional calculation of the scores is required.

The CNMI RAM scores range from 15 to 60 when all the metrics were used. Scores are comparable within the same wetland and higher scores indicate better overall wetland conditions. It is, however, inappropriate to compare scores between different wetland types. The wetlands are then classified into one of the three wetland conditions, high, medium or low based on the total score.

In the case that some of the indicators are either not applicable to the wetlands being classified or are too difficult to assess due to adverse field conditions or other constraints, an "Average CNMI RAM Score" is calculated in order to classify the

WAA. The Average CNMI RAM Score is the sum of the scores of every applicable indicator divided by the total number of indicators used. The wetland condition class is then selected based on the Average CNMI RAM Score.

3.5 Functional Assessment

Functional assessment uses the scores of selected indicator metrics to calculate the *Wetland Function Index* for the three main wetland functions (hydrology, water quality, and habitat) of the WAA. The *Wetland Function Index* is derived from the average score of selected indicator metrics that can reflect the functionality of the wetland in terms of providing hydrologic (e.g., flow control, and groundwater recharge), water quality (e.g., sedimentation and biochemical processes), and habitat (e.g., feeding, breeding, or shelter) functions. For example, increased wetland size is expected to positively correlate with improved wetlands hydrologic, water quality, and habitat functionality. Wetland size is therefore included in the calculation of the *Wetland Function Index* for all three functions. In addition to the CNMI RAM scores, *Wetland Function Index* indicates the wetland's capacity in performing specific wetland function.

3.6 Quality Control

CNMI RAM quality control procedures are simple and should always be performed to ensure accuracy and consistency of assessment results. Quality can be assured by a thorough review of CNMI RAM data and scores. This should be performed before results are accepted. Ideally the reviewer should not be a member of the wetlands assessment team, but should be someone who is familiar with wetlands assessment generally and the CNMI RAM specifically. This independent assessor should review the assessment data and scores and make certain that:

1. No data are missing and all data are correctly recorded and scored according to guidelines.
2. The scores in the worksheet match the field data form.

Additionally, the reviewer should check the WAA boundary and its supporting rationale to ensure that it is correctly defined.

4.0 STAFF TRAINING

Training for DCRM staff was performed on September 4, 20l5. The purpose of the training was to familiarize the staff with the assessment method and provide them with first-hand experience in collecting assessment data in the field. The training also provided an opportunity to receive user feedback on the applicability and performance of the RAM from a broader audience.

DCRM staff training was facilitated by a representative from the Department of Lands and Natural Resources (Figure 1). Two wetlands representing the most prevalent CNMI wetland types (Depressional and Tidal Fringe) were selected for the field training. The first wetland visited was Chalan Laulau (CLL), a depressional wetland that is in good condition. The second wetland was located in American Memorial Park (AMP) and represented a constructed tidal fringe wetland that has been degraded by invasive aquatic plants and has water quality issues.

Training involved an explanation of the CNMI RAM, demonstration of the procedures and protocols for completing both the primary and secondary assessments, and practice completing the primary assessments. At the end of the training, staff members were asked to independently complete the data forms for the Primary Assessment and rank wetland conditions based on total and average scores. The results showed broad agreement in ratings (medium) with minimal discrepancy (less than 2 points in primary assessment scores) between the staff members. This consistency in results between a broad range of users after only a brief training is an encouraging outcome and demonstrates the utility of the methodology.

Figure 1. Participants of the CNMI RAM training at American Memorial Park.

5.0 Recommendations

Implementation of the CNMI RAM will support DCRM’s mission to protect coastal resources by providing consistent, scientifically defensible, and cost efficient evaluations of wetland conditions. The CNMI RAM provides users with an analytical tool that is unbiased and transparent. This will promote sound decision making in planning, permitting, and enforcement, as well as facilitate consultation with outside parties.

To ensure the consistency and quality of rapid wetland assessments, it is advisable that users of the CNMI RAM be provided with periodic training. Such training is known to significantly reduce observer-to-observer variability (Herlihy et al. 2009). Training will help to improve repeatability between users. Training modules should be developed to ensure content consistency and to reduce long-term costs. An internal certification process based on training completion may help to encourage participation and uniform application of this methodology.

5.1 Wetlands Inventory Update

One pressing need for the management of wetlands in CNMI is updating the incomplete and outdated wetland inventory. Importantly, the *Saipan Comprehensive Wetland Management Plan*’s (ERCE 1991:D1–D8) wetlands list does not include information on other CNMI islands. The USFWS’s NWI does include the four larger southern islands of CNMI, but provides little data on wetlands other than the location, size, and NWI classification. The wetland boundaries of the NWI were derived from old aerial photos with limited resolution and accuracy.

Updating the wetland inventory will be a major step forward for the management of CNMI’s wetlands. During the inventory process, an up-to-date baseline of wetland conditions can be established using the CNMI RAM, which would require minimal investment. Most effort will be expended on ground-truthing the information derived from current aerial imagery. The wetland inventory baseline data will facilitate long-term monitoring of changes. It will also greatly increase DCRM’s ability to establish and periodically readjust management priorities.

5.2 Further Testing and Adjustment

Although the CNMI RAM was field tested during development, it would benefit from testing on a larger scale and with a greater intensity. Such testing would serve to objectively validate the method and highlight problem areas. Appropriate modifications can then be made.

Implementing the CNMI RAM in a broad range of wetland types and conditions will also provide important feedback. To date, the CNMI RAM has only been tested on depressional and tidal fringe wetlands—the most prevalent type of wetland in CNMI. Although the CNMI RAM is designed to be applicable to other types of wetlands, such as riverine wetlands, these applications have not been field tested at the time of publication of this guide.

Ultimately, validation and calibration of the CNMI RAM will involve comparing assessment results derived from the RAM's customized wetland indicators with directly-measured data on wetland function. This comparison will effectively test how well the CNMI RAM results reflect the actual functional capacity of the wetlands. The conceptual framework and method for performing this type of validation are outlined in Smith et al. (1995) and Stein et al. (2009b). Essentially, correlation analysis is used to test how well the indicator metrics, the CNMI RAM scores, and the functional indexes reflect the actual measured functional capacity of the wetlands. A high correlation between the CNMI RAM results and the wetlands' measured functional capacity validates the assessment method. If there is a poor correlation, indicator metrics and their rating criteria can be adjusted and then retested. As a last resort, indicator metrics can also simply be removed when adjustments are not successful. In either case, a long-term testing and validation program will provide feedback necessary to continually update and improve the CNMI RAM. Periodic reassessment and updates are recommended.

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GLOSSARY

Buffer	Buffers are vegetated zones located between natural resources and adjacent areas subject to human alteration. In wetland ecology, a buffer may be referred to as a vegetated filter strip that removes sediments and other waterborne pollutants from surface runoff.
Clay	Fine grained soil that consist of at the minimal of 40% of particles that are smaller than 0.002 mm in diameter.
Disturbance	A temporary change in environmental conditions that causes a pronounced change in an ecosystem.
Depressional	A HGM wetland class. Depressional wetlands are located within topographical lows (depression) that usually do not have outflowing surface drainage except during flooding and heavy rainfall events.
Flats	**A** HGM wetland class. Flat wetlands are located on topographic flat and has precipitation as the dominant water source. Generally formed by impermeable substrate that limit vertical water movement on low gradient area. Flats differ from depressional wetlands by the lack of groundwater connection.
HGM Wetland Class	Accepted wetland classification types within the Hydrogeomorphic Wetland Classification System that are reflective of the geologic location and setting of a wetland. Classes include: Depressional, Estuarine, Flats, Lacustrine, Riverine, and Slope.
Hydrologic Alteration	Any change in hydrology that significantly alters soil chemistry and plant and animal communities including the deposition of fill for development, draining for development, dredging and channeling for navigation; development; and flood control, diking and damming, diversion of flow to and/or from wetlands, addition of impervious surfaces that increase water and pollutant runoff into wetlands, et cetera.

Hydrogeomorphic/HGM	A classification system developed for the functional assessment of wetlands based on hydrographic and geologic principles rather than other characteristics such as vegetation to define wetlands.
Hydroperiod	Period of time during which a wetland is covered by water.
Impoundment	The result of a dam creating a body of water.
Lacustrine Fringe	A HGM wetland class that occurs around the edges of a lake that is formed by impoundment.
Landscape Setting	The relationship between a wetland and the surrounding landscape scale environments, such as topography, land use, watershed condition, and vegetation.
Open Water	An area of surface water in a wetland that is not covered by vegetation or other man-made structure. For the purposes of the CNMI RAM, open water should be equal or larger than 100 square feet or for small wetlands at least 50% of the total area of WAA to be considered.
Organic Soil	Soils that predominantly consist of organic matter. Organic soils are generally formed under saturated, anaerobic conditions.
Palustrine	An inland wetland that lacks flowing water, contains ocean-derived salts in concentrations of less than 0.5%, and is non-tidal.
Riverine	Riverine wetlands are characterized by having the dominant water sources from surface water flow or occasional over-bank flow from a channel.
Saturated Soil	A condition when water fills the space between soil particles and the soil can no longer absorb water.
Sediments	Naturally occurring materials broken down through weathering and erosion, and is subsequently transported and deposited by wind, water, or ice, and/or by the force of gravity acting on the particles.
Slope	A HGM wetland class. Slope wetlands occur on slight to steeply sloping land and are associated with the

	discharge of groundwater to ground surface or at sites with saturated overflow with no channel formation.
Stratum	A continuous layer of vegetation. For the purpose of CNMI RAM a stratum must cover 5% or more of the WAA.
Stressor	A chemical or biological agent, environmental condition, external stimulus, physical alteration, or an event that can cause decline in wetland function.
Substrate Disturbance	Natural and man-made alteration to the natural subsurface soils underlying or adjacent to a wetland. Examples include erosion, dredging, excavation, filling, grading, and farming.
Tidal Fringe	A HGM wetland class. Tidal fringe wetland is characterized by having the main water source influenced by sea level changes.
Wetlands	A land area that is permanently or seasonally saturated with water so that it forms characteristics of a distinct ecosystem. For the purpose of CNMI RAM wetland is identified by having any of the three wetland indicators (hydrology, hydric soil, and hydric vegetation) as defined by the U.S. Army Corps of Engineers.
Wetland Assessment Area (WAA)	A wetland area identified for formal assessment defined by abrupt changes in the hydrology due to natural or artificial features that are capable of altering the source, direction, velocity, and volume of water flow.

APPENDIX A: CNMI RAM DATA FORM

WAA ID ____________

CNMI Wetlands Rapid Assessment Data Form

General Information

Wetland Assessment Area ID: ______________________________

Project Name: ______________________________

Land Ownership: ______________________________

Location (Island, Village): ______________________________

HGM Wetland Class: ____________________ **NWI Wetland Class:** ____________________

Coordinates of the Four Corners of the WAA (WGS84, UTM 55N)

North: ____________ **mN,** ____________ **mE; East :** ____________**mN,** ____________ **mE**

South: ____________ **mN,** ____________ **mE; West:** ____________**mN,** ____________**mE**

Date of Field Assessment ____________________

Is the climatic/hydrologic condition typical for the time of the year? ____ Yes ____ No (explain):____________________

____

Assessor 1. (name, affiliation, phone, email)

____

Assessor 2.

____

Stressor and Disturbance	Notes
___ landscape wide disturbance ___ localized disturbance ___ water pollution ___ excessive sediments ___ hydrologic alteration ___ invasive plants ___ invasive animals ___ other (specify)	

Photo ID	Direction	Description	Coordinates

WAA ID ____________

CNMI Wetlands Rapid Assessment Data Form

Primary Assessment	Score
1. Does the WAA overlap the known distribution of hydric soils? (pre-field, use hydric soil map or Google Earth) __ Yes (4 points) ; __ No (1 point)	
2. Is surface water present in the WAA? (pre-field) __ Surface water is visible from satellite image year round (4 points) __ Surface water is visible from satellite images seasonally (3 points) __ Surface water is not visible from satellite image but observed during field investigation (2 points) __ Surface water was not found during field investigation (1 point)	
3. Is there any man-made structure that affects water flow of the WAA? (pre-field) __ No evidence of hydrologic alteration caused by man-made structure (4 points) __ Man-made structure causes minor change (<20%) of water flow (3 points) __ Man-made structure causes significant change (20–50%) of water flow (2 points) __ Man-made structure causes more than 50% change of waster flow (1 point)	
4. Is there any evidence of impacted water quality? __ No evidence of point-source or nonpoint source discharge that may affect water quality (4 points) __ Evidence of impacted water quality is likely (e.g., road runoff) (3 points) __ Evidence of impacted water quality is noticeable (e.g. excessive algae and sediment) (2 points) __ Evidence of impacted water quality is severely (e.g., spill, odd odors) (1 point)	
5. How deep is the saturated soil? (sample where topography begin to transition into upland) __ Soil is saturated within 6 inches below the surface (4 points) __ Soil is saturated at 6.1 to 12 inches below the surface (3 points Jul-Nov, 4 points Dec-Jun) __ Soil is saturated at 12.1 to 16 inches below the surface (2 points Jul-Nov, 3 points Dec-Jun) __ Soil is not saturated within 16 inches below the surface (1 point)	
6. How many of the following wetland plants occur in the WAA? (a minimum of 10 square ft coverage) __ 3 or more (4 points) __ 2 (3 points) __ 1 (2 points) __ 0 (1 point) Tree: __ mangle machu (*Brugiera gymnorrhiza*); __ pago (*Hibiscus tiliaceus*); Reed: __ karisu (*Phragmites karka*); Sedge: __ bulrush (*Schoenoplectus subulatus*) ; __ marsh cyperus (*Cyperus javanicus*) Fern: __ langayao (*Acrostichum aureum*); __ swamp shield-fern (*Cyclosorus interruptus*)	
7. Do any of the following invasive plants occur in the WAA? __ Yes (1 points); __ No (4 points) __ pond apple (*Annona glabra*) __ water hyacinth (*Eichhornia crassipes*) __ kangkun (*Ipomoea aquatica*)	
8. Is there evidence of vegetation disturbance by intentional removal of biomass during the last ten years? __ No evidence of vegetation disturbance (4 points) __ Evidence of minor or localized vegetation disturbance (e.g., cutting firewood and cultivation) (3 points) __ Evidence of significant or widespread vegetation disturbance (e.g., grazing) (2 points) __ Vegetation was completely removed during the last ten years (1 point)	
Classifying based on Primary RAM Score (when all indicators were scored) **___ 24–32 points (High) ___ 16–23 points (Medium) ___ 8–15 points (Low)** **or Classifying based on Average Primary RAM Score** (when ≤ 3 indicators were not scored) **___ 3–4 points (High) ___ 2–2.99 points (Medium) ___ 1–1.99 points (Low)** Primary RAM score = Sum of all scored indicators of the primary assessment Average Primary RAM Score = Primary RAM score / No. of scored indicators	**Primary RAM Score:** _____

WAA ID ____________

CNMI Wetlands Rapid Assessment Data Form

Secondary Assessment	Score
9. What is the size of the entire wetland? (pre-field, not limited to the size of the WAA) __ > 2.5 acres (4 points); __ 1.1–2.5 acres (3 points); __ 0.5–1 acres (2 points); __ <0.5 acres (1 point)	
10. What is the average width of upland vegetation (buffer) around the WAA? (pre-field) __ > 200 ft (4 points); __ 50–200 ft (3 points); __ 25–49 ft (2 points); __ < 25 ft (1 point) N ________ + E ________ + S ________ + W ________ = ________ / ____ = ________	
11. Does the wetland connect to adjacent wetlands or aquatic habitat? (pre-field) __ Readily connected through permanent flow (4 points) __ Connected through restricted or seasonal flow (3 points) __ Connected through groundwater indicated by proximity to wetlands or aquatic habitats (2 points) __ Not connected (1 point)	
12. What is the upland vegetation surrounding the WAA? __ Majority of the buffer is covered by forest (4 points) __ Majority of the buffer is covered by scrub-shrub community (3 points) __ Majority of the buffer is covered by herbaceous community (2 points) __ Majority of the buffer is only sparsely vegetated (1 point)	
13. Is there evidence of substrate disturbance in the WAA? __ No evidence of substrate disturbance within the last 10 years (4 points) __ Evidence of soil disturbance in <20% of the WAA (3 points) __ Evidence of soil disturbance in 20%–50% of the WAA (2 points) __ Evidence of soil disturbance in >50% of the WAA (1 point)	
14. How many of the following vegetation layers (strata) occur in the WAA? (minimum of 5% coverage) __ 4 or more (4 points) __ 3 (3 points) __ 2 (2 points) __ 1 or unvegetated (1 point) __ Tree (>3 inches DBH) __ Shrub (>1 meter) __ Herb (<1 meter) __ Floating	
15. How many of the following invasive species occur within 20 ft of the wetland boundary? __ 0 (4 points) __ 1–2 (3 points) __ 3–4 (2 points) __ 5 or more (1 point) Tree: __ orchid tree (*Bauhinia monandra*); __ tangan tangan (*Leuceana leucocephala*); __ African tulip (*Spathodea campanulata*); __ Java plum (*Syzigium cumini*) Vine: __ coral vine (*Antigonon leptopus*); __ ivy gourd (*Coccinia grandis*); __ blue morning-glory (*Ipomoea indica*); __ mile a minute (*Mikania scandens*); __ velvet bean (*Mucuna prurient*); __ alalag (*Operculina ventricosa*); Shrub: __ lantana (*Lantana camara*); __ giant sensitive plant (*Mimosa diplotricha*) Herb: __ beggarticks (*Bidens pilosa*); __ Siam weed (*Chromolaena odorata*) Other (not previously reported on form): ____	
Classifying based on Total RAM Score (when all indicator were scored) **___ 45–60 points (High); ___ 30–44 points (Medium); ___ 15–29 points (Low)** **or Classifying based on Average RAM Score** (when ≤ 3 indicator were not scored) **___ 3–4 points (High); ___ 2–2.99 points (Medium); ___ 1–1.99 points (Low)** Secondary RAM Score = Sum of all scored indicators of the secondary assessment Total RAM Score = Primary RAM Score + Secondary RAM Score Average RAM Score = Total RAM score / No. of scored indicators	**Secondary RAM Score:** ________ **Primary RAM Score:** ________ **Total RAM Score:** ________

WAA ID ____________

CNMI Wetlands Rapid Assessment Data Form

Wetland Function Index Worksheet				
Indicator Metrics		**Hydrology**	**Water Quality**	**Habitat**
1	Hydric Soil			NA
2	Surface Water		NA	
3	Hydrologic Alteration			
4	Water Quality	NA		
5	Saturated Soil			NA
6	Native Wetland Plants		NA	
7	Invasive Wetland Plants	NA	NA	
8	Vegetation Alteration	NA		
9	Wetland Size			
10	Average Buffer Width	NA		
11	Water Connectivity		NA	
12	Upland Vegetation	NA		
12	Substrate Disturbance	NA		
14	Vegetation Layers	NA		
15	Invasive Upland Plants	NA		
	subtotal	_______	_______	_______
	Number of scored indicators	_______	_______	_______
	Wetland Function Index = subtotal/No. of scored indicators	**I_{HD}** = _____	**I_{WQ}** = _____	**I_{HB}** = _____
	Wetland Function **3–4 = High** **2–2.99 = Moderate** **1–1.99 = Low**	**Hydrology** ___ **High** ___ **Moderate** ___ **Low**	**Water Quality** ___ **High** ___ **Moderate** ___ **Low**	**Habitat** ___ **High** ___ **Moderate** ___ **Low**

APPENDIX B: GUIDELINES FOR COMPLETING THE CNMI RAM DATA FORM

Guidelines for Completing the CNMI RAM Data Form

The following sections provide guidance for completing the CNMI RAM data form (Appendix A). The data form is divided into four major sections. Section I contains a field for general administrative and tracking information as well as a broad characterization of the subject WAA in terms of HGM and NWI classification schemes and stressor identification. It also includes a field for tracking photographic documentation. Most of the information in Section I should be acquired during the desktop research phase.

Section II (Primary Assessment) and Section III (Secondary Assessment) cover various types of wetland characteristics that have been selected to rank the subject WAA. These include indicator metrics based on landscape setting, hydrology, substrate, and vegetation. Each metric contains a number of subsections covering variables of importance to the assessment. All of the fifteen individual metrics are to be ranked and scored according to the instructions below and the specification tables provided on the data form. When all of the metrics are scored, the sum total of the scores constitutes the overall score for the WAA.

Section IV (Functional Assessment) use scores from selected indicator metrics to obtain functional indexes that are used to rate the capacity of the wetland to perform hydrologic, water quality, and habitat functions.

SECTION I. GENERAL INFORMATION

Wetland Assessment Area ID

- Assign a unique identification number ID to the WAA under investigation. Consult the CNMI Division of Coastal Resource Management for naming conventions and numbering systems prior to entering the field.

Project Name

- Enter the name of the project that has stimulated the assessment, if any.

Land Ownership

- Enter the name and address of landowner.

Location

- Enter the island name as well as the nearest village and/or any local place name.

HGM Wetland Class

- Use the HGM classification flow chart in B-3 (Figure 1) to determine the HGM wetland class of the WAA.

NWI Wetland Class

- Use the NWI website (USFWS 2015) or the NWI's *Wetland and Deepwater Habitat Classification* chart in B-4 (Figure 2) to obtain the WAA's NWI class designation.

Coordinates

- Enter UTM coordinates for the boundaries of the WAA in each of the four cardinal directions. Recreational grade GPS is acceptable. Note the geospatial reference system if UTM coordinates are not used.

Date of Field Assessment

- Enter the date or dates on which the field assessment was performed.

Assessor Information

- Enter the name, phone number, email address, and affiliation of each assessor on the team.

Stressor and Disturbance

- Identify any evidence of stress or disturbance occurring in the WAA. Note the origin of the stress (i.e., the stressor) or disturbance and make notes on the location and extent of its influence.

    - *Landscape wide disturbance*: Record evidence of large-scale disturbance that is occurring or have occurred in the WAA (e.g., logging, farming, fire, golf-course)
    - *Localized disturbance*: Record evidence of small-scale disturbance that is occurring or have occurred in the WAA (e.g., trails, construction, vehicle travel)
    - *Water pollution*: Record evidence of point-source and non-point source pollutants that may affect the wetland. Include water sources outside of the WAA.
    - *Excessive sediments*: Record evidence and sources of any above normal sedimentation.
    - *Hydrologic alteration*: Record evidence of hydrologic alteration such as dams, ditches, or engineered stream banks.
    - *Invasive plants*: Identify and record invasive plants in the WAA.
    - *Invasive animals:* Identify and record presence of invasive species observed in the WAA.
    - *Other*: Specify any other stressors or disturbance that may negatively affect wetland function or condition.

Photo-documentation

Overview photos of the WAA should be taken and coordinates of photodocumentation points recorded. If possible, photos should capture the entire WAA. Information for each photo includes a consecutive photo ID number, cardinal direction, description, and UTM coordinates (recreational grade GPS is sufficient). The UTM coordinate can be used later to plot the photo location on a USGS quadrangle map or georectified aerial photo. Use of geospatial referencing of features and boundaries of the WAA is encouraged.

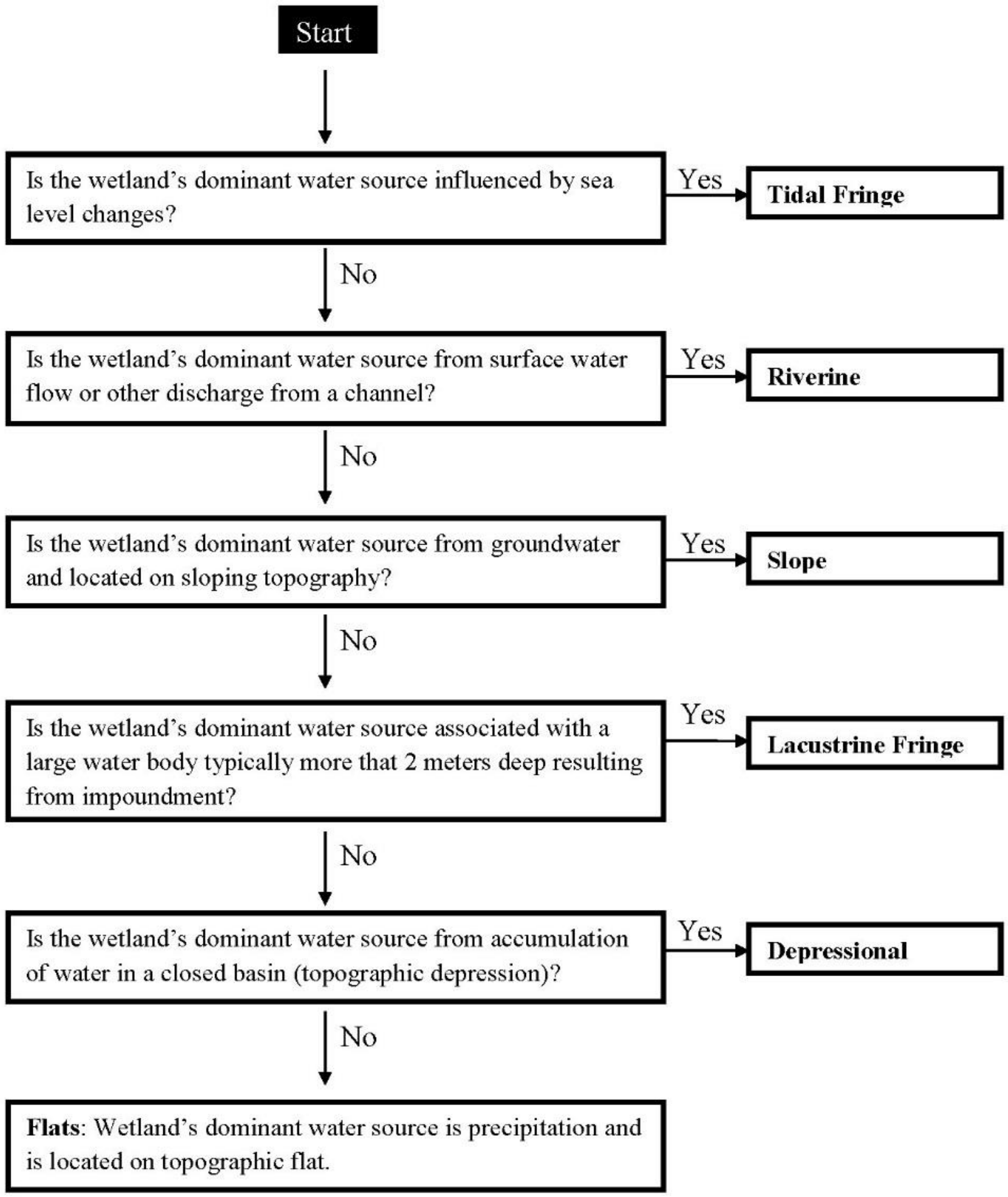


Figure 1. Flow chart for HGM classification (modified from USACE 2010).

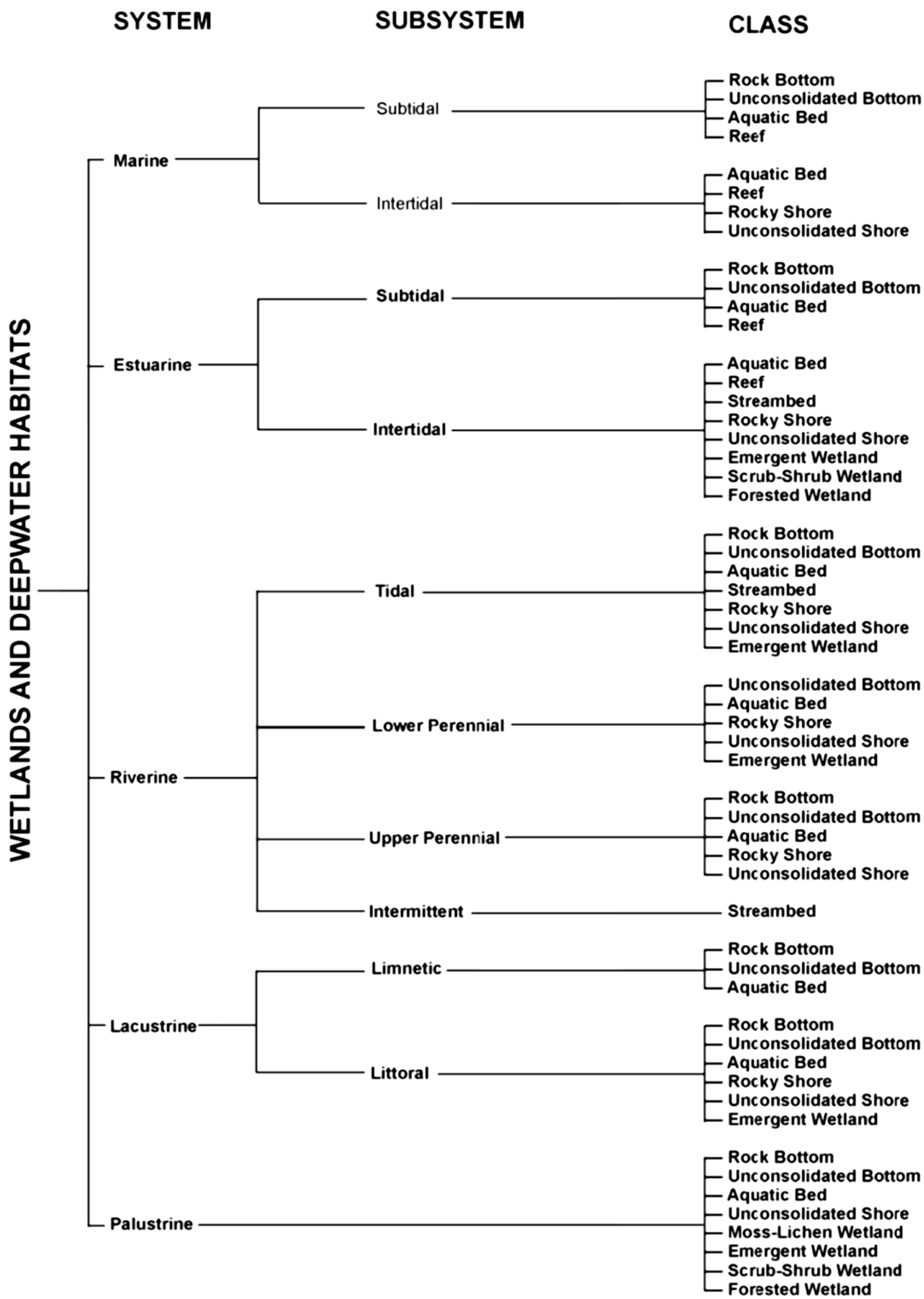


Figure 2. Classification hierarchy of National Wetland Inventory wetland and deepwater habitat classification system (from Cowardin et al. 1979).

SECTION II. PRIMARY ASSESSMENT

1. Hydric Soil

Does the WAA overlap known distribution of hydric soils?
__ Yes (4 points) ; __ No (1 point)

This indicator evaluates whether the WAA extends onto known hydric soils. The hydric soil map reflects areas where wetland are likely to be naturally occurring. Wetlands that do not overlap the known hydric soil distribution were likely created later in history or do not have the necessary wetland conditions to form hydric soils.

Reference soil maps that show the distribution of hydric soils (Appendix C). Locate the WAA on the map and determine if the WAA overlaps the distribution of hydric soil and score accordingly. If the soil maps have insufficient resolution, use Google Earth with the hydric soils layer or Web Soil Survey (http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm) to make the determination. The Soil map units that contain hydric soils include Mesei variant mucks (Map Symbol 41), Chacha Clay, drained, 0 to 5 percent slopes (Mam Symbol 9), Inarajan clay, 0-25 percent slopes (Map Symbol 25), Kagman clay 0 to 5 percent slopes (Map Symbol 26), Kagman clay 5 to 15 percent slopes (Map Symbol 27), Laolao clay 5 to 15 percent slopes (Map Symbol 31), and Saipan clay 0 to 5 percent slopes (Map Symbol 43).

2. Surface Water

Is surface water present in the WAA?
__ Surface water is visible from satellite image year round (4 points)
__ Surface water is seasonally visible from satellite images (3 points)
__ Surface water is not visible from satellite image but observed during field investigation (2 points)
__ Surface water was not found during field investigation (1 point)

This indicator evaluates the presence and persistence of surface water in a wetland. Surface water provides habitat for certain important aquatic wildlife species. For example, the federally listed Mariana common moorhen prefers wetlands with open water (Ritter and Savidge 1999). For the purposes of the CNMI RAM, surface water should be 100 square feet or more to be considered.

Surface water is ranked into four classes according to total percent coverage of open water within the WAA. Time sequenced aerial images from Google Earth is used to determine if the surface water is permanent (appears throughout the year) or seasonal (appears only part of the year). If the surface water is not visible from aerial images, it usually indicates that the surface water is either smaller in size or covered by vegetation. If surface water is not visible from aerial images, it should be identified during field investigation. Select from the four specifications and enter the score accordingly.

3. Hydrologic Alteration

Is there any man-made structure that affects water flow of the WAA?
__ No evidence of hydrologic alteration caused by man-made structure (4 points)
__ Man-made structure causes minor change (<20%) of water flow (3 points)
__ Man-made structure causes significant change (20-50 %) of water flow (2 points)
__ Man-made structure causes more than 50% change of water flow (1 point)

Hydrologic Alteration evaluates the extent of alteration to natural wetland hydrology by man-made structures. Hydrologic alteration associated with man-made structure may include drainage, dredging, stream channelization, ditching, levees, deposition of fill material, stream diversion, ground water withdrawal, and impoundment. Hydrologic alteration is expected to affect hydrodynamic, hydrologic stability, and overall wetland functions. The CNMI RAM assumes that wetlands with less hydrologic alteration are in better condition.

When making observations of hydrological alternation, the assessor should consider any hydrological alterations that may affect the WAA. For example diversion outside of the WAA boundary can still affect the hydrology of the WAA, and thus should be recorded and its impacts evaluated. Notes should be taken on the location, type, and effect of the hydrologic alternation, as well as the extent of its impact.

Select the appropriate ranking using the four specifications. Hydrologic alteration is ranked into four classes according to presence and extent of hydrologic alteration. Consider the effect of the man-made structure on volume of water flow when making the determination. Minor change is defined as causing less than 20 % of change in volume of water flow. Significant change is defined as causing between 20-50% changes in volume of water flow. Higher point reflects less alteration of hydrology in the WAA and hence a better wetland condition. The corresponding score will be the value for this wetland characteristic.

4. Water Quality

Is there any evidence of impacted water quality?
__ No evidence of point-source or nonpoint source discharge that may affect water quality (4 points)
__ Evidence of impacted water quality is likely (e.g., runoff from road, fertilizer from farm) (3 points)
__ Evidence of impacted water quality is noticeable (e.g., excessive algae and sediment) (2 points)
__ Evidence of severely impacted water quality (e.g., spill, odd odors) (1 point)

The Water Quality metric assesses the quality of the WAA's water and, by extension, its sources. A poor quality water source can be a major stressor to wetlands. The CNMI RAM assumes that higher quality water sources indicate less stress and disturbance on the wetland and a correspondingly higher capacity to perform wetland function and services.

Water quality is ranked into four classes according to the level of impact observed. After evaluating water quality indicators in the field, the assessor should select from the specifications provided

5. Saturated Soil

How deep is the saturated soil? (sample where topography begins to transition into upland)

__ Soil is saturated within 6 inches below the surface (4 points)

__ Soil is saturated at 6.1–12 inches below the surface (3 points Jul–Nov, 4 points Dec–Jun)

__ Soil is saturated at 12.1–16 inches below the surface (2 points Jul–Nov, 3 points Dec–Jun)

__ Soil is not saturated within 16 inches below the surface (1 point)

This indicator assesses how deep saturated soil is found near the wetland boundary. Soil is saturated when water fills the space between soil particles. Due to surface tension, saturation is usually encountered just above the water table.

Locate a sampling point near the edge of the WAA where the topography starts to transition into upland. Remove any organic litter from the soil surface, then use a narrow "ditch shovel" to dig a pit 16 inches deep or to the top of the water table. Saturation can be identified by the squeeze test. Take a handful of soil and squeeze. If water drips from the ball, the soil is saturated. Perform the squeeze test at 6 inches, 12 inches, and 16 inches, or until saturated soil is encountered. Select the depth where the saturated soil is first found and enter the score accordingly. Higher scores are assigned for the assessments conducted during dry season for the 6.1–12 inches and 12.1–16 inches selections.

6. Native Wetland Plants

How many of the following native wetland plants occur in the WAA? (minimum 10 square ft coverage)

__ 3 or more (4 points) __ 2 (3 points) __ 1 (2 points) __ 0 (1 point)

Tree: __ mangle machu (*Brugiera gymnorrhiza*); __ pago (*Hibiscus tiliaceus*);

Reed: __ karisu (*Phragmites karka*);

Sedge: __ bulrush (*Schoenoplectus subulatus*) ; __ marsh cyperus (*Cyperus javanicus*)

Fern: __ langayao (*Acrostichum aureum*); __ swamp shield-fern (*Cyclosorus interruptus*)

This indicator assesses the diversity of native wetland plants in the wetland. These species are the major components of native wetlands. A higher number of native species indicates a greater native habitat diversity within the WAA. Highly disturbed or recently created wetlands may lack these species.

Survey the WAA and determine if any of the listed native species occupy at a minimum of 10 square ft. Count the number of species observed and enter the respective score. See Plant Guide in Appendix D for visual references to support plant identification.

7. Invasive Plants

Does any of the following invasive plants occur in the WAA?
__ Yes (1 points); __ No (4 points)
__ pond apple (*Annona glabra*); __ water hyacinth (*Eichhornia crassipes*);
__ kangkun (*Ipomoea aquatica*)

This indicator evaluates whether the wetland has been invaded by any of the three invasive plants listed above. These species are aggressive invaders that can significantly affect wetland condition. The CNMI RAM assumes that wetlands invaded by any of these species are in a low condition.

Survey the WAA to determine in any of the listed species are present and occupy at a minimum of 10 square ft. Score 1 if any of the species are observed. Score 4 if none of the species are observed. See Plant Guide in Appendix D for visual references to support plant identification.

8. Vegetation Disturbance

Is there evidence of vegetation disturbance by intentional removal of biomass during the last ten years?
__ No evidence of vegetation disturbance (4 points)
__ Evidence of minor or localized vegetation disturbance (e.g., cutting firewood and cultivation) (3 points)
__ Evidence of significant or widespread vegetation disturbance (e.g., grazing) (2 points)
__ Vegetation was completely removed during the last ten years (1 point)

This indicator evaluates the extent of intentional biomass removal within the last ten years. Vegetation disturbance can be localized and minor, such as brush cutting, or widespread and significant, such as grazing or cultivation of crops in a significant portion (>25%) of the WAA. If the wetland was created within the less ten years, only vegetation disturbance occurring after its creation should be considered.

Identify any evidence of recent intentional vegetation. Determine the source and extent of vegetation disturbance. Aerial images and site history may be reviewed if large scale disturbance is suspected. Select between the four options and enter the score accordingly.

Scoring and Classifying the Primary Assessment

Classifying based on Primary RAM Score (when all indicators were scored)
___ 24–32 points (High) ___ 16–23 points (Medium) ___ 8–15 points (Low)

or Classifying based on Average Primary RAM Score (when ≤ 3 indicators were not scored)
___ 3–4 points (High) ___ 2–2.99 points (Medium) ___ 1–1.99 points (Low)

Primary RAM score = Sum of all scored indicators of the primary assessment
Average Primary RAM Score = Primary RAM score / No. of scored indicators

The *Primary RAM Score* for the WAA is calculated by totaling all of the indicator scores for items 1 through 8. After the *Primary Assessment Score* is calculated, use the score to rank the wetland condition into one of the three classes. A total score of 27–36 indicates a wetland in high condition. A total score of 18–26 indicates a wetland in moderate condition. A total score of 9–17 indicates a wetland in low/poor condition.

When up to three indicators cannot be score, an *Average Primary RAM Score* should be calculated as an alternative method for condition determination. Divide the total score by the number of indicator metrics used and round to two decimals places to obtain the average score. An average score of 3–4 indicates a wetland in high condition. An average score of 2–2.99 indicates a wetland in moderate condition. An average score of 1–1.99 indicates a wetland in low/poor condition.

If more than three indicators cannot be scored, the assessment is considered unreliable due to insufficient data. The assessor should consider conducting a more intensive Secondary Assessment investigation in order to complete the assessment.

SECTION III. SECONDARY ASSESSMENT

9. Wetland Size

What is the size of the wetland? (Size of the entire wetland if WAA only cover part of the wetland)
__ > 2.5 acres (4 points); __ 1.1–2.5 acres (3 points); __ 0.5–1 acres (2 points); __ <0.5 acres (1 point)

Size is an important characteristic of a wetland. Generally speaking, a wetland's capacity to perform beneficial functions increases as wetland size increases. A wetland's tolerance to stress and disturbance also improves as wetland size increases. The CNMI RAM therefore scores large wetlands higher than smaller wetlands.

Wetland size is ranked into four size classes ranging from high (>2.5 acres) to low (<0.5 acres). The size class specifications employ broad ranges and the assessor should be able to estimate the ranking visually. Ideally, wetland size should be estimated during the desktop assessment phase and confirmed during field investigation.

To determine wetland size, the wetland boundary should be delineated using recent aerial images and GIS software. Adjust the wetland boundary, if necessary, during field assessment and then calculate the area of the wetland. If multiple WAAs were identified within a large wetland, use the area of the entire, combined wetland. Select among the size classes and score accordingly.

10. Average Buffer Width

What is the average width of upland vegetation (buffer) around the WAA? (GIS/Google Earth)

__ > 200 ft (4 points); __ 51–200 ft (3 points); __ 25–50 ft (2 points); __ < 25 ft (1 point)

N ________ + E ________ + S ________ + W ________ = ________ / 4* = ________

*Assuming no open water boundaries. Divide only by number of terrestrially buffered sides present.

Upland vegetation surrounding a wetland (i.e., its buffer) functions to moderate anthropogenic stressors and provides the habitat necessary to sustain biodiversity. Cultivated vegetation, such as farmland and lawns that may release fertilizers, pesticides, and sediments to the wetland, is not considered buffer. Average buffer width evaluates the extent of the buffer surrounding a wetland. The CNMI RAM assumes that wetlands with wider buffers are less susceptible to stressors caused by development and associated human activities and are therefore in higher condition.

To calculate average buffer width, start by identifying the corner of the wetland in each cardinal direction. Measure the distance from the corner in the same cardinal direction (i.e., measure toward north from the north corner) for up to 400 ft until the line intersects a developed area or cultivated vegetation. Enter the distance for each cardinal direction and calculate the average buffer width. If one or more of the corners is bordered by open water, do not include the distance in calculation. Enter “open water” and divide only by the number of terrestrially buffered sides. Once the average buffer width is determined, select the appropriate ranking using the four specifications and score accordingly.

11. Water Connectivity

Does the wetland connect to adjacent wetlands or aquatic habitat? (pre-field)

__ Readily connected through permanent flow (4 points)
__ Connected through restricted or seasonal flow (3 points)
__ Connected through groundwater indicated by proximity to wetlands or aquatic habitats (2 points)
__ Not connected (1 point)

This indicator assesses the connectivity between the WAA and nearby wetlands and aquatic habitats (e.g., streams, ponds, lakes) through surface water connection. The CNMI RAM assumes that wetlands with higher surface water connectivity perform wetland functions better, such as sustaining biodiversity.

Surface water connectivity is ranked into four classes according to observed evidence of surface water connection between the WAA and its surrounding aquatic habitat. After evaluating surface water connectivity, the assessor should select from the specifications and score accordingly.

12. Upland (Buffer) Vegetation

What is the upland vegetation surrounding the WAA?
__ Majority of the buffer is covered by native forest (4 points)
__ Majority of the buffer is covered by non-native forest (3 points)
__ Majority of the buffer is covered by scrub-shrub community (2 points)
__ Majority of the buffer is covered by herbaceous community (1 points)

This indicator assesses the quality of the buffer in terms of its capacity to moderate stress and disturbance to the wetland. The maturity and structural complexity of vegetation comprising the buffer is expected to influence this capacity. The CNMI RAM assumes that wetlands buffered by native plant communities in later successional stages and with higher structural complexity are in better condition.

Buffer condition is ranked into four classes according to the vegetation type observed in the majority of the WAA. After evaluating the upland vegetation surrounding the WAA, the assessor should select from the four options and score accordingly.

13. Substrate Disturbance

Is there evidence of substrate disturbance in the WAA?
__ No evidence of substrate disturbance within the last 10 years (4 points)
__ Evidence of soil disturbance in <20% of the WAA (3 points)
__ Evidence of soil disturbance in 20%–50% of the WAA (2 points)
__ Evidence of soil disturbance in >50% of the WAA (1 point)

This indicator assesses the extent of natural and artificial disturbance to the substrate of the WAA. Substrate disturbance can impact wetland functions by affecting water quality, biochemical processes, and habitat value. Substrate disturbance is identified by exposed soils or atypical local topography. Examples of substrate disturbance include erosion, dredging, excavation, filling, grading, and farming. The CNMI RAM assumes that a WAA with less substrate disturbance is in better condition.

Substrate disturbance is ranked into four classes according to percent coverage of observed substrate disturbance in the WAA, including both natural and man-made disturbance. After identifying evidence of substrate disturbance and estimating its percent coverage (Figure 3), the assessor should select from the specifications and score accordingly.

14. Stratum Richness

How many of the following vegetation layers (strata) occur in the WAA? (minimum of 5% coverage)
__ 4 (4 points); __ 3 (3 points); __ 2 (2 points); __ 1 or unvegetated (1 points)
__ Tree (>3 inches DBH); __ Sapling/Shrub (≥1 meter); __ Herb (<1 meter); __ Floating Mat

This indicator assesses the complexity of biotic structures created by layers of vegetation (stratum). Undisturbed wetlands tend to maintain stratum diversity and high wetland function. The CNMI RAM assumes that greater stratum diversity indicates better wetland condition. For the purposes of the CNMI RAM, a stratum is a continuous vegetative layer that has a minimum of 5% coverage of the WAA. The CNMI RAM's definition of strata follows USACE's *Regional Supplement to the Corps of Engineers Wetland Delineation Manual*: *Hawaii and the Pacific Islands (Version 2.0)* (USACE 2012):

> *Tree stratum*: Woody plants 3 inches (7.6 cm) or more in diameter at breast height (DBH), regardless of height.
>
> *Sapling/shrub stratum*: Woody plants with less than 3 inch DBH and greater than or equal to 3.28 feet (1 m) tall.
>
> *Herb stratum*: All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants less than 3.28 feet tall.

Floating mats are continuous vegetation layers consisting of aquatic plants floating on the water surface.

Observed the WAA and note the types of strata present. Select among the four specifications and score accordingly.

15. Invasive Upland Plants

How many of the following invasive species are found within 20 ft of the wetland boundary?
__ 0 (4 points) __ 1–2 (3 points) __ 3–4 (2 points) __ 5 or more (1 points)
Tree: __ orchid tree (*Bauhinia monandra*); __ tangan tangan (*Leuceana leucocephala*);
__ African tulip (*Spathodea campanulata*); __ Java plum (*Syzigium cumini*)
Vine: __ coral vine (*Antigonon leptopus*); __ ivy gourd (*Coccinia grandis*);
__ blue morning glory (*Ipomoea indica*); __ mile a minute (*Mikania scandens*);
__ velvet bean (*Mucuna prurient*); __ alalag (*Operculina ventricosa*);
Shrub: __ lantana (*Lantana camara*); __ giant sensitive plant (*Mimosa diplotricha*)
Herb: __ beggarticks (*Bidens alba /B. pilosa*); __ Siam weed (*Chromolaena odorata*)
Other (not previously reported on form): ____

This indicator assesses the prevalence of invasive plants near the WAA boundary. The CNMI RAM assumes that invasive plants indicate disturbance and lower ecological integrity. The CNMI RAM invasive plant list only includes species that are considered high priority.

Determine which invasive plants occur within 20 ft of the wetland boundary by inspecting the tree, vine, shrub, and herb vegetation layers. The invasive plant should have minimum of 5 % coverage to be considered. Count the number of checked species and select from the four specifications to obtain the score. See Plant Guide in Appendix D for visual references to support plant identification.

Scoring and Classifying the Secondary Assessment – The Overall WAA Score

Classifying based on Total RAM Score (when all indicators were scored)

___ 45–60 points (High); ___ 30–44 points (Medium); ___ 15–29 points (Low)

or Classifying based on Average RAM Score (when ≤ 3 indicators were not scored)

___ 3–4 points (High); ___ 2–2.99 points (Medium); ___ 1–1.99 points (Low)

Secondary RAM Score = Sum of all scored indicators of the secondary assessment
Total RAM Score = Primary RAM Score + Secondary RAM Score
Average RAM Score = Total RAM score / No. of scored indicators

The Total Score for the WAA is calculated by totaling all of the individual scores from both Primary and Secondary Assessments. When all indicator metrics are scored the *Total CNMI RAM Score* is calculated, use the score to rank the wetland condition into one of the three classes. A total score of 45–60 indicates a wetland in high condition. A total score of 30–44 indicates a wetland in medium condition. A total score of 15–29 indicates a wetland in low/poor condition.

When up to three indicators cannot be scored, for whatever reason, an *Average CNMI RAM Score* should be calculated. Divide the total score (Primary plus Secondary Assessments) by the number of indicator metrics used and round to two decimal places to obtain the average score. An average score of 3–4 indicates a wetland in high condition. An average score of 2–2.99 indicates a wetland in medium condition. An average score of 1–1.99 indicates a wetland in low/poor condition. If more than three of the indicators cannot be scored, the assessor should consider more intensive investigation in order to score the missing indicators.

SECTION IV. FUNCTIONAL ASSESSMENT

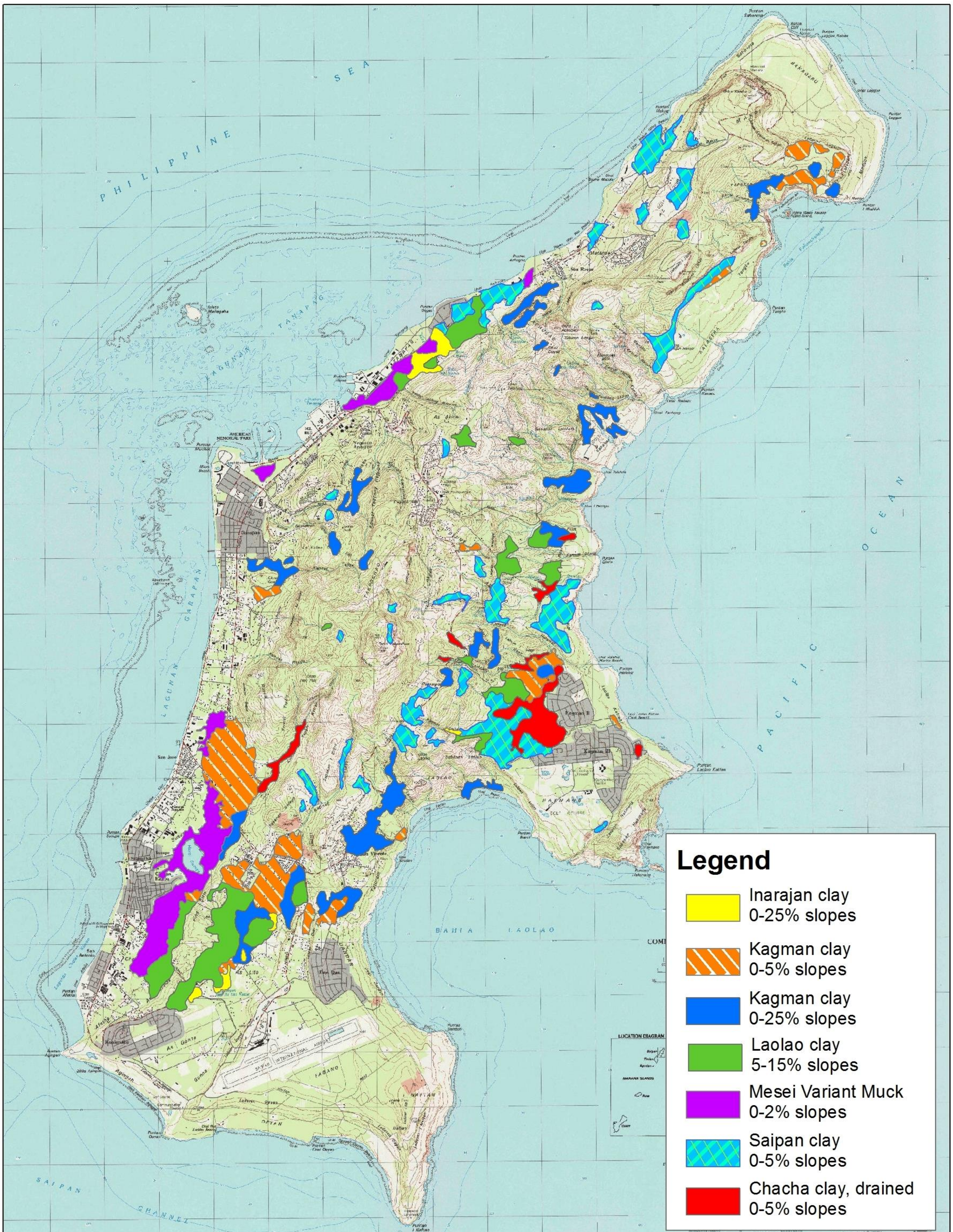
The Wetland Functional Index Worksheet is used to calculate the *Wetland Function Index*. Begin by entering each indicator metric score into the appropriate blank cell. As explained in the introduction to this section, some of the indicator metrics are not useful for evaluating certain wetland functions. No score is entered for these metrics. They are denoted with an "NA" in the table below.

After all of the scores are entered, the subtotal for each function is calculated and entered in the subtotal line. The subtotal is then divided by the number of metrics that were used to obtain the subtotal. The result is the *Wetland Function Index*. The index has a 1 to 4 range.

Finally, use the same table to rank the wetland's ability to perform services in each of the three major functional categories. A score of 3–4 indicates a high functioning wetland. A score of 2–2.99 indicates a moderately functioning wetland. A score of 1–1.99 indicates a poorly functioning wetland.

Wetland Function Index Worksheet				
Indicator Metrics		**Hydrology**	**Water Quality**	**Habitat**
1	Hydric Soil			NA
2	Surface Water		NA	
3	Hydrologic Alteration			
4	Water Quality	NA		
5	Saturated Soil			NA
6	Native Wetland Plants		NA	
7	Invasive Wetland Plants	NA	NA	
8	Vegetation Alteration	NA		
9	Wetland Size			
10	Average Buffer Width	NA		
11	Water Connectivity		NA	
12	Upland Vegetation	NA		
12	Substrate Disturbance	NA		
14	Vegetation Layers	NA		
15	Invasive Upland Plants	NA		
Subtotal		_______	_______	_______
Number of metrics used		_______	_______	_______
Wetland Function Index		**I_{HD}** = ______	**I_{WQ}** = ______	**I_{HB}** = ______
3–4 = High **2–2.99 = Moderate** **1–1.99 = Low**		**Hydrology** ___ **High** ___ **Moderate** ___ **Low**	**Water Quality** ___ **High** ___ **Moderate** ___ **Low**	**Habitat** ___ **High** ___ **Moderate** ___ **Low**

APPENDIX C: HYDRIC SOIL MAPS



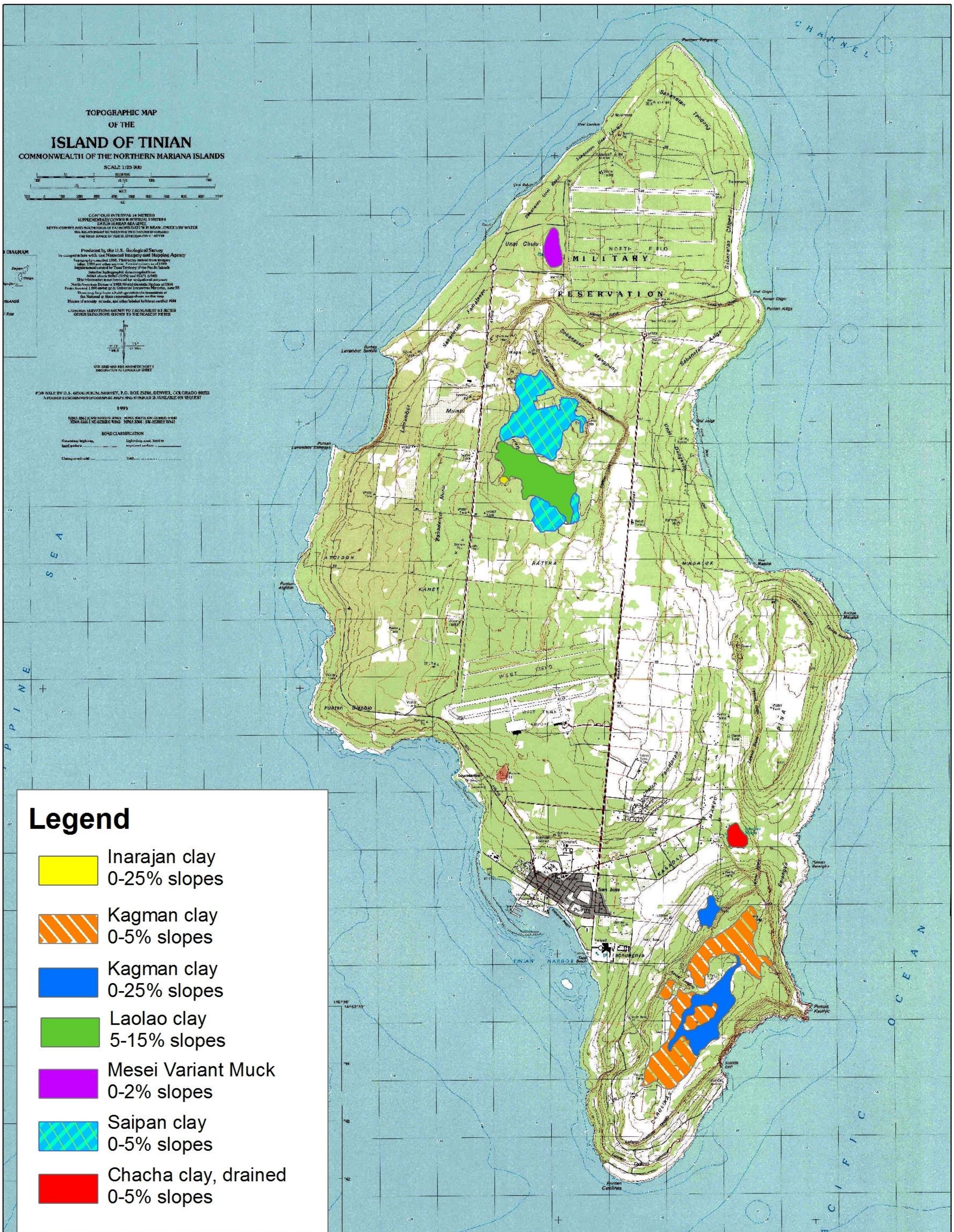
SAIPAN ISLAND
HYDRIC SOIL MAP UNITS
Commonwealth of the
Northern Mariana Islands

N
1:114,945

0 1,250 2,500 5,000 Meters

USGS Island of Saipan Quadrangle (1999)
1:24,000 scale

GANDA

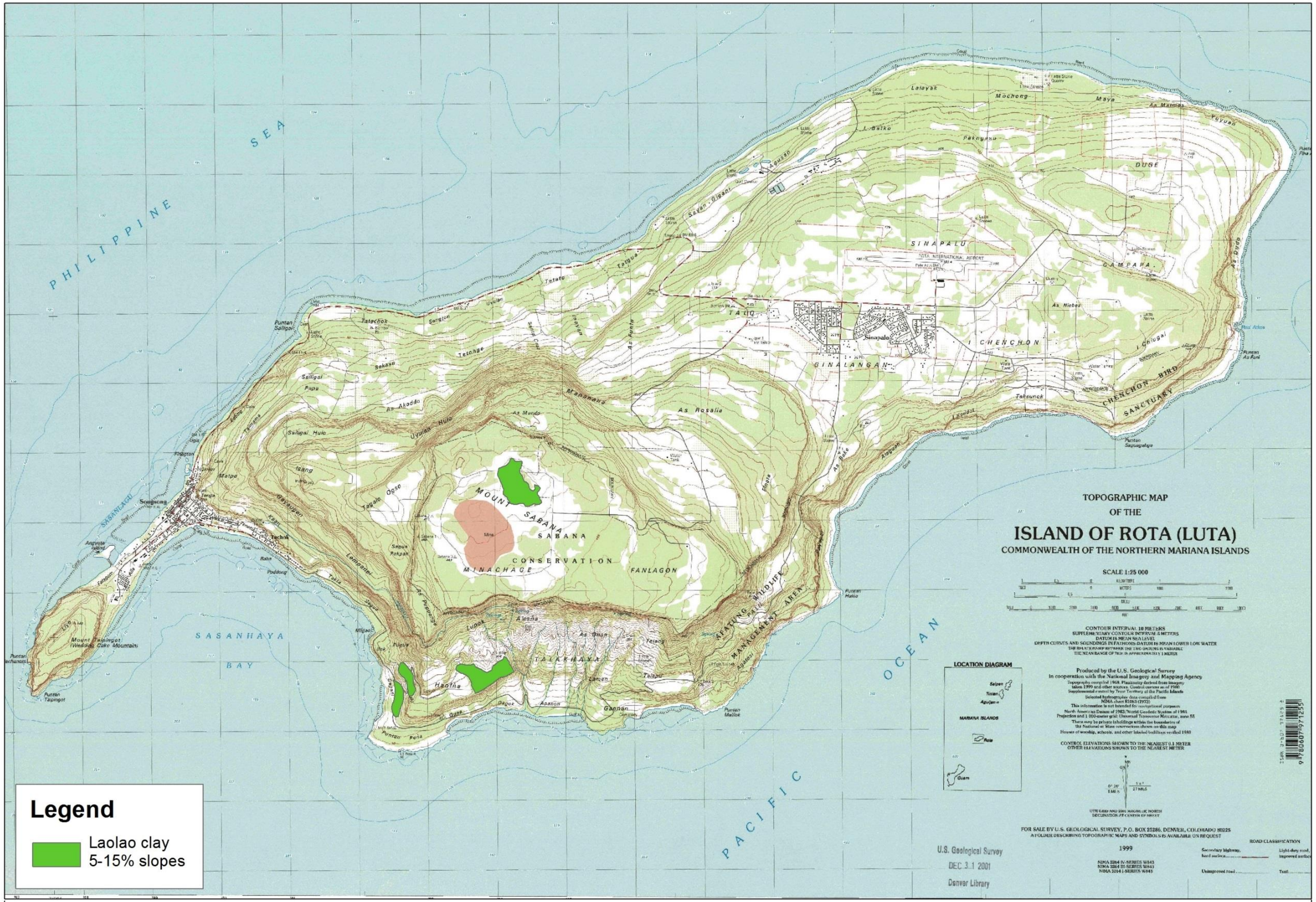


TINIAN ISLAND
HYDRIC SOIL MAP UNITS
Commonwealth of the
Northern Mariana Islands

N
1:110,000

Meters
0 1,000 2,000 4,000
USGS Island of Tinian Quadrangle (1999)
1:24,000 scale

GANDA



ROTA ISLAND
HYDRIC SOIL MAP UNIT
Commonwealth of the
Northern Mariana Islands

1:80,000

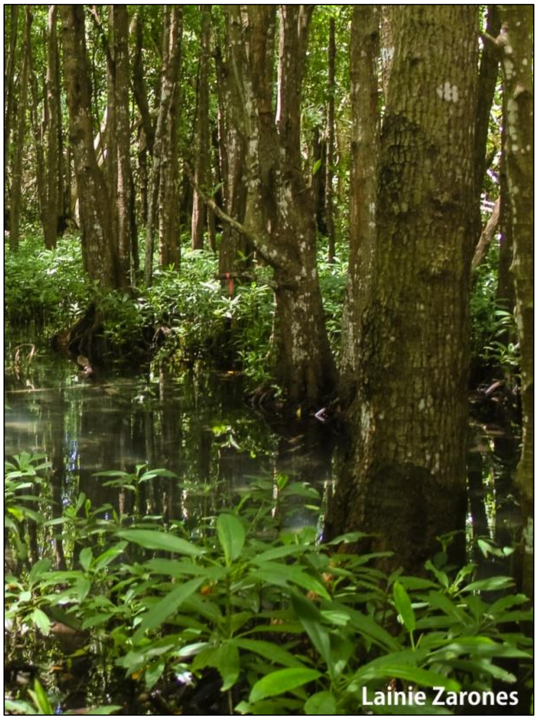
Meters
0 1,000 2,000 4,000

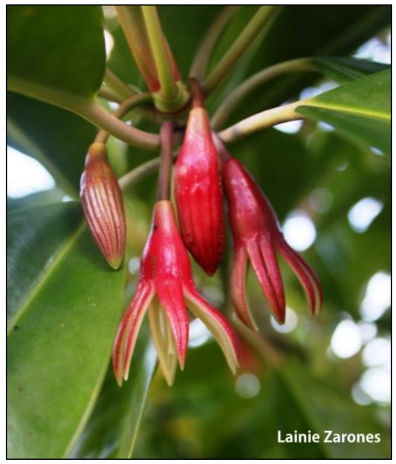
USGS Island of Rota Quadrangle (1999)
1:24,000 scale

GANDA

APPENDIX D: PLANT GUIDE

PART I. NATIVE WETLAND PLANTS



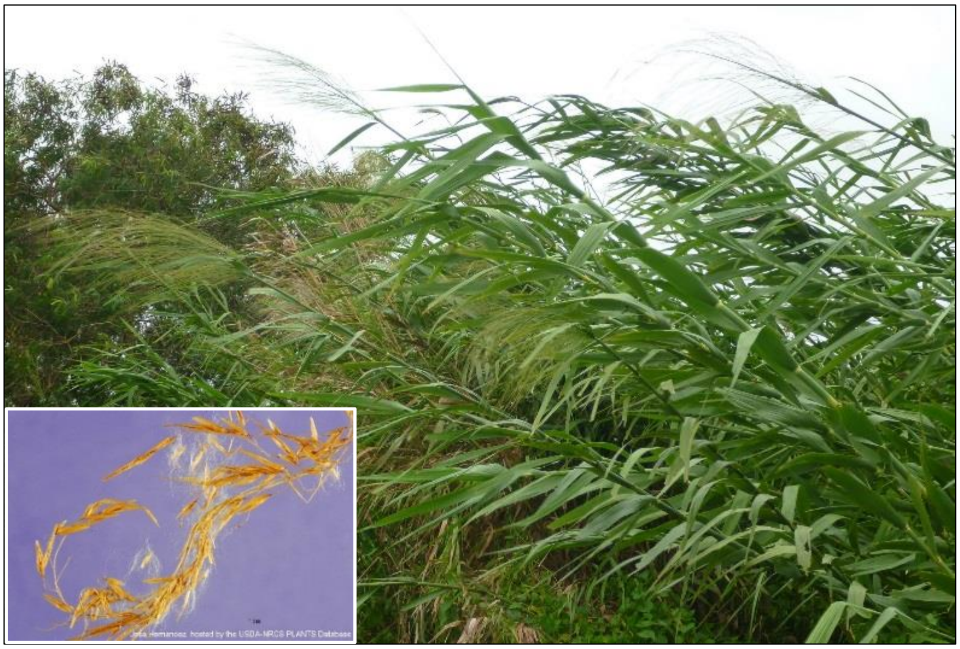


Bruguiera gymnorrhiza
Chamorro Name (CN): *mangle macho*
English Name (EN): large-leaved mangrove
Family: Rhizophoraceae
Habit: tree

A mangrove tree up to 25 m tall; leaves elliptic, leathery 9–20 cm long x 4–9 cm wide; flowers red, 3.0–4.5 cm across; young seedlings develop on mother tree, reaching 15–25 cm x 1.5–2.0 cm before falling.

Hibiscus tiliaceus
CN: *pago*
EN: sea hibiscus
Family: Malvaceae
Habit: tree

A small tree up to 15 m tall, often with tangled branches that form dense thickets; leaves heart-shaped 10–20 cm across; flowers yellow; five petals with maroon color at base; grows along streams, at mangrove margin, and in lowland swamps.



Phragmites karka
CN: *karisu*
EN: tall reed
Family: Poaceae
Habit: reed

A large reed up to 5 m tall; stems up to 2 cm in diameter; leaves 40–70 cm x 2–4 cm; inflorescences finely branched, 30–70 cm long; grows in freshwater or brackish water marshes. Insert shows close-up of the mature inflorescence and seeds.

Schoenoplectus subulatus
EN: bulrush
Family: Cyperaceae
Habit: sedge

A rush-like sedge with round stem 60–150 cm tall; leaves obscure, reduced to sheath at base of stems; inflorescence forms near the tip of the stem; spikelets rusty brown, 1.0–1.5 cm long, many on each stem; often found in brackish water marsh.

Cyperus javanicus

CM: ***chachukchuk***
EN: marsh cyperus
Family: Cyperaceae
Habit: sedge

A perennial sedge 40–100 cm tall; stems three-angled, leaves gray-green with rough serrate margin; inflorescences branching, up to 15 cm; spikelets 0.5–1.2 cm x 0.2–0.3 cm, having 6–12 scales each; often found in coastal marshes exposed to salt or brackish water.

Acrostichum aureum

CN: ***langayao***
EN: mangrove fern
Family: Pteridaceae
Habit: fern

A robust fern usually about 1.0–1.5 m tall; leaves pinnate, leathery; leaflets 12–35 cm x 2.5–3.0 cm, Spore-bearing leaflets golden brown in lower surfaces; found in coastal marshes, margins of mangrove swamp, and river mouths.

Cyclosorus interruptus
EN: swamp shield-fern
Family: Thelypteridaceae
Habit: fern

A fern with creeping rhizome; leaves stiff, erect, up to 1m long, pinnate with 20–50 pairs of leaflets (pinnae); leaflet average 12 cm x 1.2 cm, with round teeth; often found in previously disturbed freshwater marshes.

PART II. INVASIVE WETLAND PLANTS

Annona glabra
EN: pond apple
Family: Annonaceae
Habit: tree

A small tree up to 12 m tall; leaves ovate to oblong 8–15 cm x 4–6 cm; flowers solitary with three cream-white petals 1.5–2.5 cm long; fruits oblong to spherical 7–15 cm x 9 cm, often with >100 seeds; invades freshwater wetlands and mangrove swamp.

Eichhornia crassipes
CN: *lirion saduk*
EN: water hyacinth
Family: Pontederiaceae
Habit: herb

A floating herb up to 60 cm tall; leaves oval with inflated petioles; flowers light purple, born on an erect spike, the upper most petal with a yellow blotch; often found in slow moving steams and ponds; tendency to rapidly multiply and block waterways.

Ipomoea aquatica
CN: *kangkun*
EN: water spinach
Family: Convolvulaceae
Habit: herb

A creeping or floating herb with long, hollow stem; leaves arrow to heart-shaped 4–10 cm x 1.0–4.5 cm; flowers purple, funnel-shaped; often found in roadside ditches and cultivated wetlands.

PART III. INVASIVE UPLAND PLANTS

Bauhinia monandra
CN: *tronkon orket*
EN: orchid tree
Family: Fabaceae
Habit: tree

A small tree up to 7.5 m tall; leaves 7–20 cm x 7–20 cm, split into two lobes; flowers pale pink, with five petals, each 4.0–5.5 cm x 2–3 cm; seed pod elongated and flattened 15–22 cm x 2–3 cm; often found in forest edge or disturbed forests.

Leuceana leucocephala
CN: *tangan tangan*
EN: white leadtree
Family: Fabaceae
Habit: tree

A small tree up to 18 m tall; leaves finely dissected with small leaflet 0.8–1.6 cm x 0.1–0.2 cm; flowers numerous, in globose heads with diameter of 2–5 cm; seed pods brown, 14–26 cm x 1.5–2.0 cm; widespread on previously disturbed areas.

Spathodea campanulata
CN: *tronkon rosa*
EN: African tulip tree
Family: Bignoniaceae
Habit: tree

A large tree up to 25 m tall; leaves pinnate with 3–19 leaflets, hairy on lower surface; flowers scarlet orange 8.5–9.0 cm x 4.5–5.0 cm; capsules 17–25 cm x 3.5–7.0 cm; invades abandoned fields, disturbed forests, and forest margins; prefers wetter places.

Syzigium cumini
CN: *duhat*
EN: Java plum
Family: Myrtaceae
Habit: tree

A tree up to 20 m tall; leaves opposite arranged, 7–9 cm x 2.5–11.0 cm with smooth margins; flowers white with four petals and numerous stamens; berries dark purple to black, 1.2–3.0 cm x 1.3–3.0 cm, edible; often found along waterways and disturbed forest.

Antigonon leptopus
CN: *flores kádena*
EN: coral vine
Family: Polygonaceae
Habit: vine

A perennial vine that often climbs over trees; leaves ovate to ovate hastate, 2–13 cm x 2–9 cm, with conspicuous veins; flowers bright pink to white; often found in disturbed areas and forest margins.

Coccinia grandis
CN: *pipinon maka*
EN: ivy gourd
Family: Cucurbitaceae
Habit: vine

A perennial vine; leaves ivy-shaped 3–10 cm x 4–10 cm; flowers white, unisexual, 3.0–4.5 cm long; fruits ovoid to ellipsoid, 2.5–6.0 cm x 1.5–3.5 cm, bright red when mature; found in disturbed areas; dense growth can smother vegetation.

Ipomoea indica

CN: *fufgu, asa-gao*
EN: blue morning-glory
Family: Convolvulaceae
Habit: vine

A herbaceous vine, often more than 5m long; leaves broadly ovate, heart-shaped to 3-lobed, 5-9 cm long; flowers blue or purple, rarely white, funnel-shaped, 5-7 cm long, 6-8 cm in diameter; capsules brown, 1-4 seeds each; often found in coastal sites, moist forests and disturbed places.

Mikania scandens

CN: *flores mala'et*
EN: mile a minute
Family: Asteraceae
Habit: vine

A perennial vine; stems slightly four angled; leaves opposite, triangular to heart-shaped, 4–12 cm x 2–7 cm; flowers pink to white in small heads 0.5–0.7 cm long; small seeds dispersed by wind; found in forests, thickets, and wetlands with limited flooding.

Mucuna pruriens
CN: *akangkang dangkulu*
EN: velvet bean
Family: Fabaceae
Habit: vine

An annual vine, hairy throughout; stems with dense long fine hairs; leaves papery, up to 45 cm long, with dense short hairs on upper surface; flowers deep purple, 3.0–4.5 cm long; seed pods 9 cm x 1–2 cm; found in grasslands, bushland, riverine forest and forest edges.

Operculina ventricosa
CN: *alalag*
EN: paper rose
Family: Convolvulaceae
Habit: vine

A twining vine; leaves heart-shaped, up to 30 cm across; flowers white, funnel-shaped, ca. 5 cm long; capsule with four smooth black seeds; found in disturbed places, climbing in thickets and covering the ground in mats.

Lantana camara
EN: lantana
Family: Verbenaceae
Habit: Shrub

A shrub with branching, prickly stems; leaves ovate, 4–8 cm x 2.0–5.5 cm; flowers on head-like spikes, change color with age; fruits dark purple, 0.5–0.6 cm thick, slightly juicy; founds in thickets, plantations, on the edges of forest, and along roadsides.

Mimosa diplotricha
EN: giant sensitive plant
Family: Fabaceae
Habit: shrub

A prickly shrub up to 2 m tall, often forms a dense thicket; stems angled, with recurved spines up to 0.6 cm long; leaves finely divided with small leaflets 0.6–1.2 cm x 0.2 cm; flowers in pale-pink heads, ca. 1.2 cm in diameter; seed pods spiny, 0.1–3.5 cm long; often found in pastures, plantations, and roadsides.

Bidens pilosa

CN: *inifu meplu*
EN: beggarticks
Family: Asteraceae
Habit: herb

An annual herb 0.3–1.8 m tall; leaves 2.5–13.5 cm long with 3–5 leaflets each; flowers in heads, petal-like ray flowers white, 0–7 per head; seeds black, ca. 1 cm long, with 2- or 3-barbed awns at the tip that stick to fur and fabric; often found in pastures, plantations, and along roadsides.

Chromolaena odorata

CN: *masigsig*
EN: Siam weed
Family: Asteraceae
Habit: herb

A bushy herb or subshrub with long rambling branches; leaves three nerved, coarsely toothed, 5–12 cm x 3–6 cm; flowers in clusters, pale purple to dull off-white; often found in clearings and forest edges; forms dense thickets in disturbed areas.