DATA QUALITY ASSURANCE PLAN

California Rapid Assessment Method for Wetlands

CALIFORNIA WETLANDS MONITORING WORKGROUP

Version 7 – October 2018

Contributing Authors

Chris Solek	Southern California Coastal Water Research Project
Kevin O'Connor	Central Coast Wetlands Group at Moss Landing Marine Labs
Ross Clark	Central Coast Wetlands Group at Moss Landing Marine Labs

Quality Assurance Plan Authorization Memorandum

I have carefully assessed the Quality Assurance Plan for the California Rapid Assessment Method (CRAM) for Wetlands and Riparian Areas. This document has been completed in accordance with the requirements of the Wetland and Riparian Area Monitoring Program (WRAMP) and the California Wetland Monitoring Workgroup (CWMW).

MANAGEMENT CERTIFICATION - Please check the appropriate statement.

_____ The document is accepted.

_____ The document is accepted pending the changes noted.

_____ The document is not accepted.

Based on our authority and judgment, we fully accept the information contained in this Data Quality Assurance Plan for CRAM.

_____ _____
NAME DATE
Chair, Level 2 Workgroup

_____ _____
NAME DATE
Co-Chair, California Wetland Monitoring Workgroup

_____ _____
NAME DATE
Co-Chair, California Wetland Monitoring Workgroup

_____ _____
NAME DATE
Co-Chair, California Wetland Monitoring Workgroup

_____ _____
NAME DATE
Co-Chair, California Water Quality Monitoring Council

_____ _____
NAME DATE
Co-Chair, California Water Quality Monitoring Council

_____ _____
NAME DATE
Chief, State Water Board 401 Certification & Wetlands Unit

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1.0 GENERAL INFORMATION

1.1 Purpose

This document describes the quality assurance and quality control (QA/QC) plan to support consistent collection and reporting of data for the California Rapid Assessment Method (CRAM) for Wetlands and Riparian Areas (www.cramwetlands.org). Having adequate assurances and control on data quality are vital in order to produce reliable data that meet the needs of all wetland and riparian regulators and managers in terms of its representativeness, accuracy, and precision. This document does not constitute official guidance or policy by any single agency; rather, it addresses a set of general quality assurance issues and considerations for CRAM data acquisition and reporting that apply across a variety of state and federal agency wetland programs in California. This document cannot anticipate every situation or contingency that may arise in wetland regulatory or grant-funded restoration programs. As with other assessment methods, program or project-specific quality assurance plans will need to be developed for specific CRAM applications to meet a particular programmatic or project goal.

1.2 Scope

This document addresses all process and procedures related to all aspects of data QA/QC for CRAM as it can be applied to the assessment of all wetland types throughout California.

The four primary QA/QC tasks of CRAM include:

1. *Peer Review.* A peer review plan for CRAM will help to assure the scientific credibility of the method for wetland and riparian assessment. This includes the development of guidelines for establishing technical committees that incorporate informal peer review into their work, and defining the role of scientific publication of monitoring methods and results in the peer review process. The goal is to assure that all CRAM data generated are "consistent with scientific knowledge, methods and practice" to inform management and regulation of wetlands and riparian areas, and to assess the performance of policies, programs, and projects designed to restore and protect these natural resources.
2. *Calibration.* The goal of the Calibration process is to maintain the scientific integrity of CRAM by ensuring field practitioners use the method in a defined range of precision, identifying and correcting misuse and misapplication of the method, and identifying mechanisms to allow for the expansion of field team expertise, especially in the context of project design and regulatory decisions. The CRAM score review process will also contribute to the verification, validation, and improve upon the technical adequacy of CRAM.
3. *Data Reporting and Management*
    a. An online data management system has been developed for CRAM. It includes the CRAM website (www.cramwetlands.org), which houses all documents needed to conduct a CRAM assessment, and allows for the upload and download of CRAM data. Public CRAM data is also displayed on the California EcoAtlas (www.ecoatlas.org) along with other wetland data and associated GIS layers.

b. A generic CRAM Reporting Template has been provided which lays out all of the necessary information that should be included in a CRAM assessment report for a given site.

4. *Training*. Training for agency staff and practitioners in the proper use and application of CRAM, including data collection, data management, data analysis, data interpretation, and reporting are an important aspect of CRAM QA/QC. Training curricula and instructors need to be coordinated to ensure adequate and consistent training throughout the user communities. The goal is to develop a pool of qualified trainers and appropriate curricula that can be implemented through a large variety of educational programs.

This QA/QC plan is intended to support and build upon the technical bulletin produced by the California Wetland Monitoring Workgroup (CWMW) that provides recommendations on the use of CRAM for regulatory and management programs (CWMW 2009).

1.3 Overview

CRAM was developed by the California Wetland Monitoring Workgroup (CWMW; http://www.waterboards.ca.gov/mywaterquality/monitoring_council/wetland_workgroup) to be a standardized, rapid, and repeatable assessment method that can be used routinely for wetland monitoring and assessment throughout the State of California. CRAM assesses the overall condition of wetlands, the results of which can be used to infer the ability to provide various functions or services to which a wetland is most suited. CRAM can be used to characterize the ambient condition of wetlands throughout the State, and also has a number of potential applications for regulatory and management uses in California including, the evaluation of pre-project conditions at potential mitigation or restoration sites; assessment of performance/success of mitigation/restoration sites; assessment of mitigation compliance; and comparison of proposed alternatives for regulatory or restoration planning purposes. When used in combination with more intensive measures, CRAM can help to assist in the design of projects or assess particular aspects of condition or project performance.

The CRAM typology currently recognizes six major wetland types, four of which have subtypes (Table 1). For the purposes of CRAM, *condition* is defined as the state of a wetland assessment area's physical and biological structure, the hydrology, and its buffer and landscape context relative to the best achievable states for the same type of wetland. Condition is evaluated based on observations made at the time of the assessment, the results of which can be used to infer the ability to provide various functions, services, values and beneficial uses to which a wetland is most suited (CWMW 2013). Although these inferences to wetland services are not measured directly by CRAM, several studies have documented the statistical relationships between CRAM and other functions and services (Stein et. al, 2009). CRAM also identifies key anthropogenic stressors that may be affecting wetland condition, can help to identify causes of low CRAM scores, and assist in the development of hypotheses.

Table 1. CRAM wetland typology. See the CRAM website for the development status of each module of CRAM.

Wetland Type	Subtype
Riverine	confined
	non-confined
	ephemeral/episodic
Estuarine	perennial saline
	perennial non-saline
	bar-built
Depressional	perennial
	seasonal
	vernal pool/vernal pool system
Lacustrine	N/A
Slope	forested
	seep/spring
	wet meadow (channeled and non-channeled
Playa	N/A

1.4 CRAM Development and Implementation

1.4.1 State Monitoring Framework

The coordination of all aspects of CRAM development and implementation occurs within the operational construct of California's Wetland and Riparian Area Monitoring Plan (WRAMP; CWMW 2010; Figure 1). The WRAMP was prepared by the California Wetland Monitoring Workgroup (CWMW) and is modeled after USEPA's Level 1-2-3 framework for monitoring and assessment of wetland resources (USEPA 2006). The WRAMP is intended to serve all State agencies and support the State Water Resources Control Board's (SWRCB) Wetland Area Protection Policy

(WAPP). The CWMW facilitates communication and coordination among the Regional Programs, Workgroups, and partner agencies that participate in the WRAMP. All activities of the CWMW (including implementation of the WRAMP) are subject to the overall guidance and approval of the California Water Quality Monitoring (SB1070) Council (CWQMC; Kehoe 2006).

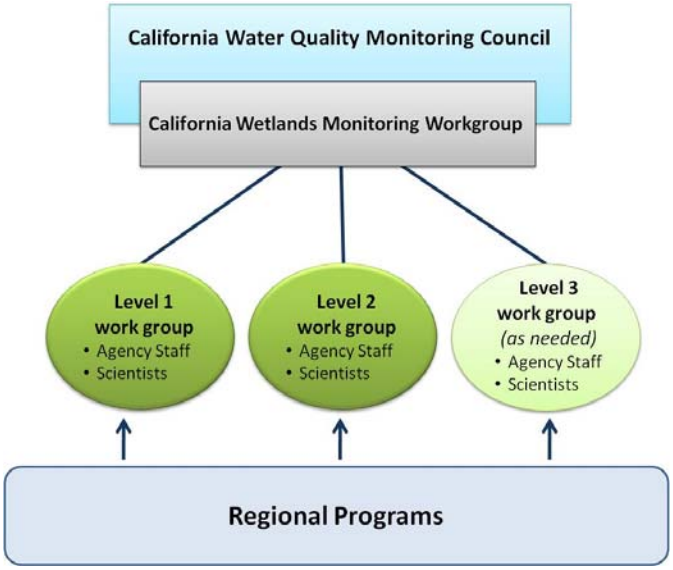

Figure 1. Organizational structure of the WRAMP. The Level 2 Workgroup oversees all aspects of CRAM QA/QC for California.

The Regional Programs serve as the primary focus for implementing the WRAMP and provide a forum for local coordination. Regional programs involve cooperating federal, state, and local agencies that have primary responsibility for protecting and managing wetlands, streams, and riparian areas within a region. Technical project leads, scientists, and members of local non-governmental organizations also participate in the regional programs. These programs provide local quality control, training, and assessment reviews. They may also identify areas for future technical or program development and may produce products that can be reviewed and vetted through the CWMW for potential statewide adoption.

The Level 1, 2, and 3 Workgroups of the CWMW coordinate consistent statewide mapping and assessment. These Workgroups are led by senior technical agency staff directly involved in statewide or inter-regional implementation of wetland, stream, and riparian policies and programs. Membership includes environmental scientists from academia, not-for-profit science organizations, and the private sector with appropriate expertise across regions. The workgroups receive input and suggestions from the regional programs and will ultimately recommend changes to all methodologies, training, quality control, and data management. The workgroups will support agency programs by identifying opportunities and constraints for implementing WRAMP and will serve as a forum for identifying common priorities for future technical or policy development activities within their focal areas.

1.4.2 Coordination of Rapid Assessment Method

The Level 2 Workgroup oversees all development, testing, validation, and implementation and training of CRAM tools. It provides a forum for agency staff to discuss policy issues as they relate to

application of CRAM (and other rapid assessment methods as they are developed) in a regulatory context, coordination of which is provided by staff of the State Water Board. Working in conjunction with the original developers of CRAM, the L2 Workgroup also provides input on additional module development (as appropriate), training, and related QA/QC (e.g. reviewing of practitioners). Regional Program representatives from each region, respectively, comprise the membership of the L2 Workgroup and report on regional CRAM activities. Regional representatives make up the core of the L2 Committee, specifically to ensure that CRAM development and management accurately reflects the unique needs and distinct wetland characteristics of each region. The Chair of the L2 Workgroup reports on its activities at meetings of the CWMW.

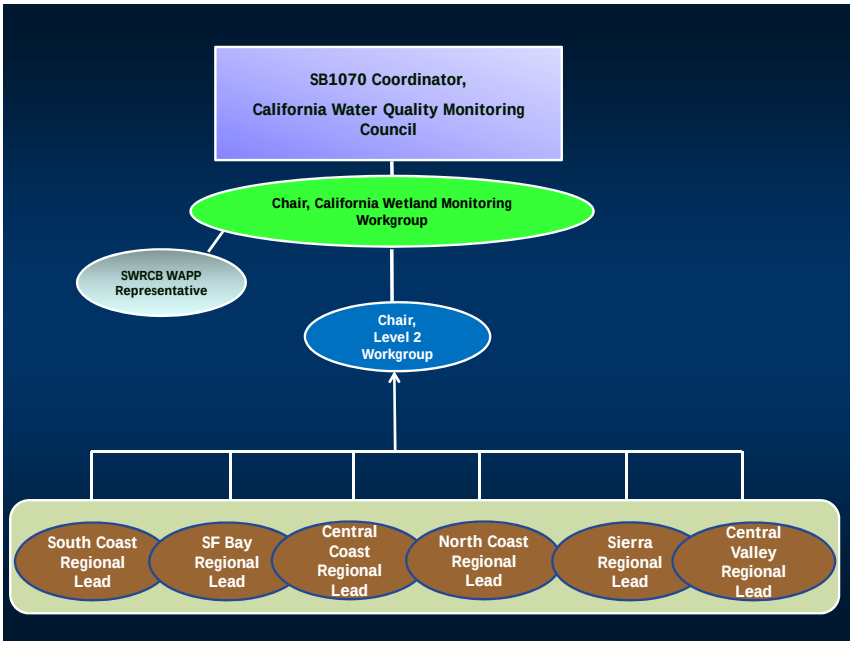

Figure 2. The hierarchy and L2 reporting process of the WRAMP. Regional representatives comprise the L2 Workgroup and report on regional CRAM activities. The Chair of the L2 Committee attends meetings of the CWMW and provides L2 status updates. The Chair of the CWMW attends meeting of the CWQMC (SB 1070 Council) and makes recommendations on behalf of the L2 Committee. A representative of the SWRCB 401 Certification & Wetlands Unit is a member of the CWMW and ensures that the Wetland Area Protection Policy (WAPP) is coordinated with the activities of the CWMW.

1.4.3 Status of CRAM Development

The CRAM developmental process is organized into three phases: basic design, verification, and validation. The basic design phase of CRAM involved creating conceptual models of wetland form and function, defining key terms, developing the wetland typology, identifying the attributes, and formulating metrics that describe each attribute. Version 2.0 of CRAM marked the completion of the basic design phase.

CRAM verification involves iterative adjustments to the classification system and the metrics during multiple field tests by regional development teams. The amount of revision has declined steadily, but

minor changes are expected to continue as the number of CRAM users and the amount of its use increases.

Validation of CRAM involves an assessment of the overall performance of CRAM by regressing metric scores and attribute scores on Level 3 data (e.g. benthic invertebrates, riparian birds, plant richness and diversity) to represent expected relationships between condition and function or service. The validation phase for estuarine wetlands and riverine/riparian systems was completed with CRAM version 4.0 (Stein *et al.* 2009) and is in-process for several additional modules. This has resulted in refinement of the metrics for these wetland types and provides for a higher level of confidence in the ecological meaning of CRAM scores.

CRAM is intended for application to all kinds of wetlands throughout California and method validation efforts have indicated that CRAM is broadly applicable throughout the range of conditions commonly encountered. However, it is recognized that expected physical and biological conditions for other wetland types may deviate from those used at the sites that were used to validate CRAM. Because CRAM emphasizes the functional contribution of structural complexity, the current version of the method has the potential to yield artificially low scores for systems that do not naturally appear to be structurally complex. CRAM may be systematically biased against such naturally simple systems, and thus may represent a limit to the method's applicability. For this reason, refinement of CRAM for these multiple subclasses of wetlands is ongoing.

1.4.4 Contact Information

Below are the primary points of organizational contact (POCs) that may be needed by the document user for informational and troubleshooting purposes. These contacts will be periodically updated and listed on the CRAM website (www.cramwetlands.org)

POC Name*	**Role/Position**	**Telephone**	**E-mail**
Nick Martorano	Cal EPA Director, SB1070 Water Quality Monitoring Council	(916) 341-5514	Nicholas.Martorano@waterboards.ca.gov
Kris Jones	Resources Agency Assistant Director, SB 1070 Water Quality Monitoring Council (Natural Resources Agency)	(916) 654-4926	Kristopher.Jones@water.ca.gov
Beth Payne	State Water Board 401 Program Coordinator – Permitting and Policy	(916) 341-5579	Elizabeth.Payne@waterboards.ca.gov
Jessica Nadolski	State Water Board 401 Program Coordinator – Permitting and Enforcement	(916) 341-5290	Jessica.Nadolski@waterboards.ca.gov
Josh Collins	Co-Chair, CWMW (SFEI)	(510) 746-7365	josh@sfei.org
Shakoora Azimi-Gaylon	Co-Chair, CWMW (Delta Conservancy)	(916) 375-2086	Shakoora.Azimi-Gaylon@deltaconservancy.ca.gov
Melissa Scianni	Co-Chair, CWMW (USEPA)	(213) 244-1817	scianni.melissa@epa.gov
Cliff Harvey	Chair, L2 Committee	(916) 558-1709	charvey@waterboards.ca.gov
L2 Regional Reps.	**Region**	**Telephone**	**E-mail**
Josh Collins	San Francisco Bay	(510) 746 7365	josh@sfei.org
Lindsay Teunis	South Coast	(858) 444-3906	Lindsay.Teunis@icfi.com

Ross Clark	Central Coast	(831) 771-4411	rclark@mlml.calstate.edu
vacant	North Coast		
vacant	Central Valley		
vacant	Sierra/Cascade		
CRAM Development	**Module**	**Telephone**	**E-mail**
Kevin O'Connor and Cara Clark	Bar-built Estuarine, Seasonal/Perennial Depression, Vernal pool	(831) 771-4495	koconnor@mlml.calstate.edu cclark@mlml.calstate.edu
Sarah Pearce	Slope, Tidal Riverine, Stress Index	(510) 847-3976	sarahp@sfei.org
Eric Stein	Episodic riverine, Seasonal/Perennial Depression	(714) 755-3233	eric@sccwrp.org

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1.6 Acronyms and Abbreviations

CCWG	Central Coast Wetlands Group
CRAM	California Rapid Assessment Method for Wetlands and Riparian Areas
CWMW	California Wetland Monitoring Workgroup
CWQMC	California Water Quality Monitoring Council
MLML	Moss Landing Marine Laboratories
QA/QC	Quality Assurance/ Quality Control
SFEI	San Francisco Estuary Institute
SCCWRP	Southern California Coastal Water Research Project
SWAMP	Surface Water Ambient Monitoring Program
State Board	State Water Resources Control Board
USFS	United States Forest Service
WRAMP	Wetland and Riparian Area Monitoring Program
WAPP	Wetland Area Protection Policy

2.0 CRAM MODULE DEVELOPMENT

The purpose of this section is to assure that all new CRAM modules are developed using a standard approach and procedure that has been approved by the California Water Quality Monitoring Council and subject to the peer review process of the California State Water Resources Control Board and California Environmental Protection Agency. Because new modules may be developed by different teams of wetland scientist through different funding sources, it is important that each new module of CRAM be developed with oversight and guidance provided by the statewide Level 2 Committee of the California Wetland Monitoring Workgroup (CWMW) of the California Water Quality Monitoring Council (Fig 2), which is charged with the oversight of Level 2 assessments including CRAM.

2.1 New CRAM Module Development

The process for CRAM module development includes: 1) a definition phase; 2) a basic design phase; 3) a verification phase; and 4) a validation phase. Teams will report results for each of these steps to the L2 and CWMW for comment and approval.

Once a CRAM module has been designed, teams conduct field testing and correlative analysis of CRAM results with other data resources. The process involves the evaluation of the module in terms of its performance with regard to a suite of Verification and Validation parameters: 1) *responsiveness*, a measure of the ability of the method to discern good *vs.* poor condition, 2) *range* and *representativeness*, the ability of the method to appropriately capture the distribution of condition states that exists in nature, 3) *redundancy*, the degree to which multiple metrics measure the same elements of condition, 4) *integration*, the effect of different means of combining CRAM's component metrics of condition to generate an overall index score, and 5) *reproducibility*, the proportion of total variance attributable to user error (Stein *et al.* 2009).

Once these development steps are complete, a finalized module is produced and submitted to the L2 Committee for review. Additional support materials that are produced in addition to a field guide and data sheets include photo dictionaries and training documents. This finalized version of the module can then be used by practitioners that have demonstrated their expertise using the tool. To encourage the use of the new module, it should be a task of each development team to complete an ambient survey to produce a state or regional population of scores from which local and regional assessments can be compared.

2.1.1 Definition Phase

The purpose of the Definition Phase is to develop and adopt a standard definition for the wetland type for which a new CRAM module is proposed (either a new class of wetland or a subclass of an existing wetland class). This definition must be adopted by the L2 Committee and integrated into the statewide wetland classification system. It is the responsibility of the module development team and the L2 Committee to determine that a new module is necessary and that other current modules are inadequate for state needs.

If it is decided that a new CRAM module is needed, a statewide development team in partnership with the L2 Committee will be created to administer the below defined module development process. A development team leader is selected as liaison to the L2 Committee. Teams will develop CRAM modules using the phased approach described below.

2.1.2 Basic Design Phase

Within the Design Phase, the module team will develop a conceptual model of the natural processes and anthropogenic stressors that control the form, structure, and function of the proposed wetland class or sub/class. This model should be designed to guide the development of metrics of condition and stressor checklist. Once complete, the model must be vetted through the L2 Committee.

Based on the conceptual model, the team takes the initial step to develop the "Verification version" of the module. This version reflects the Best Professional Judgment (BPJ) of the development team. Once complete, the module must be vetted through the L2 Committee.

The team then selects a "test gradient" or sample set of wetlands representing a range of conditions along which the efficacy of the verification version of the module will be tested. The test gradient should encompass the range of field conditions that is likely to be encountered in California and should consist of sites from different regions of the state. Once complete, the test gradient should be vetted through the L2 Committee.

2.1.3 Verification Version Phase

The purpose of the Verification Phase is to generate numeric scaling of metrics and to strengthen correlative relationships between CRAM results and quantitative data (Level 3 data) for the wetland class across a gradient of condition. Key objectives of the verification process are to ensure 1) that metrics describe a full range of conditions that exist in nature (*range*), 2) that metrics focus on key indicators of condition for that wetland class (*responsiveness*), and 3) that condition grades represent the true condition for the metric (*representativeness*). Through verification, adjustments (where needed) are made to improve the method's ability to discern differences in wetland condition and meet the key objectives. The verification process leads to improved support documentation, guidance, instructions, revised narratives for metric scoring, rescaled metrics, rescored or rebinned of metrics, eliminated or combined metrics, and the creation of new submetrics (to address *range*, *responsiveness* and *redundancy*).

The team will use team BPJ to select 30+ test sites along test gradient. These "verification sites" should collectively represent the statewide range of condition of the targeted wetland class, including least-impacted reference sites for multiple eco-regions that together represent range of least-impacted conditions statewide. The verification version of the module is then run consistently at each selected verification site. If multiple teams are used, it is required to conduct inter-team calibration exercises to assure adequate QA/QC.

Initial data analysis will test results to determine if any of the metrics exhibit strong bias (always low, always high, or otherwise skewed distribution of scores across the condition gradient). A metric is biased if it fails to generate different scores across the full range of the conditions it is intended to assess. For metrics that exhibit bias, revisions may involve removing, adding, or changing metric descriptions to improve their sensitivity to the range of conditions along the test gradient. The development team and the L2 Committee must work together to decide if more verification is needed, or if the development process can proceed to the Validation Phase. Once the Verification Phase is completed, the results are presented to the CWMW by the L2 Committee for review and approval. This step yields the Validation Version of the module.

2.1.4 Validation Phase

The Validation Phase is the process of documenting relationships between CRAM results and independent measures of condition (Level 3 data) in order to establish CRAM's defensibility as a meaningful (*integrative*) and repeatable (*reproducible*) measure of wetland condition. The analysis of CRAM relative to Level-3 data sources does not fit the traditional definition of validation. True validation of assessment models of natural systems is impossible because available Level-3 data sets are themselves merely indices of wetland condition based on quantitative data regarding single indices of condition such as floral and faunal community composition. Assessment models (like CRAM) can only be evaluated in relative terms, and based on heuristic evidence from multiple independent measures of condition.

To complete Validation, the team will identify existing and/or preferred Level 3 (L3) data to regress newly collected CRAM (L2) data against to complete the validation of the module. Development teams should confer with the L2 Committee about the criteria for selecting L3 validation data. One

criterion will be that the data represent a broad range of condition as assessed using one or more metrics of condition.

The CRAM module team will create conceptual models of the expected correlations between CRAM metrics of condition and the selected L3 validation data. These models should predict the shape of the validation curves (linear or other) and their slope (positive or negative correlation).

Validation sites are then selected that represent a broad range of condition and where L3 validation data are available. Validation sites should include the least-impacted reference sites and can include sites used for the verification phase. Validation sites might be sites where the L3 data were previously collected, CRAM sites selected for validation at which new L3 data will be collected, or a combination of these choices. Once fieldwork is complete, the team will analyze the validation data through analysis of L2 and L3 correlations as predicted by the conceptual models.

Based on the validation results, CRAM teams will identify module limitations and make any metric changes deemed appropriate to improve the overall performance of the module. It is important that teams consider that the conceptual models might not be correct, and that altering metrics to maximize any one particular correlation is likely to affect (usually reduce) other correlations. Furthermore, no single set of L3 data are likely to represent all of the likely processes or stressors assessed using CRAM, which means that altering the metrics with regard to the available L3 data might reduce the performance of CRAM with regard to processes and stressors not represented by the available L3 data. Finally, there is no gold standard for the validation; team expertise is also critical in determining whether or not the module is performing adequately, based on the weight of evidence provided by the validation effort. Once the Validation Phase is completed, the results are presented to the CWMW by the L2 Committee for review and approval. This step yields the Final Version of the module.

2.1.4.1 QA/QC for new modules

Reproducibility is a measure of the proportion of total variance attributable to the user. It is a reflection of the precision of CRAM results. It is critical that the development and implementation of CRAM modules strive to reduce user error to within the range described by the Data Quality Objectives. Metric descriptions, field data sheets, and other support materials should be developed that ensure that all practitioners understand and interpret each metric similarly. As a part of module development, numerous duplicate CRAM assessments should be collected to determine the sampling error of the method including the potential sources of the resulting error: (1) within-team variability (the same team conducted two CRAM assessments of the same assessment area within a month), (2) between-team variability (two teams completed a CRAM assessment within the same assessment area within a month), (3) among-region variability (CRAM teams from each of the regions evaluated the same assessment area within a month), and (4) temporal variability (the same team returned to conduct a second CRAM assessment 4-5 months later). Inter team results should be compiled and interpreted as describe in Stein et al (2008) to ensure precision error meets DQO guidelines.

Once complete, the team will submit the validation results to the L2 Committee for review. The L2 Committee will work with the team to decide if additional validation is required before the module

can be implemented, and what limitations should be imposed on its implementation. This step yields implementation version 1 of the module.

The L2 Committee encourages replication of previous validation studies and creation of new validation models for previously validated modules whenever possible, via regulatory and academic opportunities, to build confidence in validation results, find patterns in correlations between CRAM and Level 3 parameters, and avoid "decline effect" issues.

2.1.5 Module Production

The module is finalized when it is converted to a field book with an online version (eCRAM version) for data management. These steps are not usually conducted by the module development team. However, the development team should assist in developing all necessary illustrations and tables to guide module use in the field and incorporate them into a field book. These steps are coordinated by the L2 Committee to assure standardization among CRAM tools and integration of newly derived methods with other monitoring efforts.

2.2 Revisions to Existing CRAM Modules

CRAM development involves iterative adjustments to the classification system and the tool metrics over time based on comments collected during multiple field tests by regional teams. The amount of revision to existing modules has declined steadily as the tools and support materials have been refined, but minor changes are expected to continue as the number of CRAM users and the amount of its use increases.

QA/QC products associated with periodic updates to adopted versions may include:

- Clarification and revision of the Metrics and narrative descriptions of alternative states based on regional team input and inter- and intra-team comparisons;
- Revision(s) of checklist to identify stressors
- Testing and selecting methods of scaling and weighting Attributes and Metrics
- Testing and selecting formulas for calculating Attribute scores and Index cores

2.3 Guidance regarding CRAM Module changes

Once a CRAM module is validated, trainings have been hosted and ambient and project data have been compiled, it is the role of the L2 Committee to ensure that future changes to the CRAM module do not undermine the utility of previously collected CRAM assessments using that module. Because the State invests significant resources into the collection of ambient data that produce distributions of conditions from which individual assessments can be compared, it is prudent to minimize method changes that could diminish the utility of these previously collected data.

Routine manual updates and changes to the modules will be made annually by the L2 Committee. Modifications will strive to improve practitioner use of the method through clearer guidance, improved figures and photos and other enhanced textual information. Changes can be made that re-bin metric grades without concern of jeopardizing previous data if those data can be rescored post hoc. Changes that will lead to the generation of new scoring should be made infrequently and with caution. If such changes are deemed necessary, the L2 Committee will orchestrate the revisions and will provide guidance for how to interpret previous version data and support the collection of new ambient data to ensure long term reliability of the CRAM method.

3.0 PEER REVIEW

CRAM has been subject to extensive iterative refinement for all CRAM wetland types (Stein *et al.* 2009). Peer review has been completed for the CRAM development process (e.g. Klimas 2008; SWRCB 2011). Numerous individuals from all levels of government, academia, and the private sector with different expertise and perspectives have been and continue to be involved in various aspects of CRAM development and testing.

Continued peer review will help to assure the scientific credibility of CRAM for wetland and riparian assessment. The goal of the peer review process is to assure that all data generated with CRAM are "consistent with scientific knowledge, methods and practice" to inform management and regulation of wetlands and riparian areas, and to assess the performance of policies, programs, and projects designed to restore and protect these natural resources.

3.1 Types of Peer Review

Peer review of new and existing CRAM wetland modules shall occur at several levels and may include:

1. Technical development of existing and proposed methods/modules via existing workgroups;
2. Review of the existing methods via outside technical advisory teams and application by practitioners and agency staff
3. Publication of methods and results of applications in peer reviewed journals
4. External scientific review of existing and proposed methods;

For CRAM module development peer reviewers must indicate that they understand the intent of their review, are qualified to conduct the review, and that their reviews were adequately supported by any materials they were provided. This process should be coordinated within the organizational structure of the WRAMP as described in subsection 1.6.1 of this document.

3.1.1 Technical Review on Method/Module Development by existing workgroups

As stated in section 2.1, the Level 2 Committee of the CWMW provides the primary technical forum for CRAM method/module development, refinement, and testing. Additionally, Technical teams will be established for each wetland class module. The teams will be composed of state and regional experts for the defined wetland systems. These teams will implement all steps defined in section 2.

3.1.2 External Technical Review

At the present time, CRAM has been used in numerous assessments of program performance, ambient monitoring efforts, and has supported several project-specific permit evaluations (CWMW 2009). Feedback from these pilot efforts will help to refine and improve upon CRAM for future applications.

Informal peer review can also occur via technical committees that are established for special projects and regional efforts where CRAM is included as a monitoring and assessment tool. Any technical committee that wish to provide informal review of CRAM must include members that are qualified to conduct a review of the method, demonstrate a basic understanding of CRAM, and provide evidence that they referenced the appropriate CRAM supporting materials in their reviews.

3.1.3 Publication of Methods

Multiple peer reviewed journal articles describing the development and use of CRAM have been submitted and accepted for publication (Sutula 2006, Stein 2009, Solek 2012). It is encouraged for development teams to publish their findings upon completion of the verification and/or validation step of CRAM module development.

3.1.4 Scientific Review

Once a CRAM module is formally complete and reviewed by the L2 Committee, it will be submitted to the CWMW for adoption. Once formally adopted by the CWMW, the State will have the opportunity to complete an external scientific peer review as defined by guidelines developed by the State Board pursuant to Health and Safety Code Section 57004. These guidelines clearly lay out the responsibilities of the reviewers and of the regulatory agencies responding to them (Bowes 2006). In accordance with this process, it is the reviewers' responsibility to determine whether the scientific portion of the proposed method is based upon sound scientific knowledge, methods and practices. In addition, the principal authors of CRAM are given the opportunity to respond to the technical comments of the reviewers. It is at the discretion of the reviewing agency to share the response of the CRAM principal authors with the peer reviewers or any other audience.

A summary of the key steps for setting-up and obtaining external scientific peer reviews via the State Board process are provided in Appendix 1 of this document. The detailed process is described in Exhibit F of an Interagency Agreement between Cal/EPA and the University of California (Bowes 2006). A January 7, 2009 Supplement to the Guidelines, in part, provides guidance to ensure confidentiality of the process (Bowes 2009). Both of these documents are available at http://www.waterboards.ca.gov/water_issues/programs/peer_review/.

3.2 Synthesis of Module Review Documents

Any summaries and official reports produced from peer review of CRAM modules will be made available on the official CRAM website (www.cramwetlands.org), as appropriate. Formal and informal peer review recommendation and/or actions as they pertain to CRAM development will be tracked by the CWMW. This will help to identify priorities for future development of CRAM.

4.0 STANDARD DOCUMENTS AND SUPPORT MATERIALS

Each CRAM wetland module will be supported by a complete set of CRAM technical documents, including the following:

1. CRAM User's Manual
2. Wetland class conceptual model
3. CRAM module field workbook (SOP)
4. Wetland class-specific data sheets
5. CRAM photo dictionary
6. Online data upload/download capability (eCRAM)

4.1 CRAM User's Manual

A single CRAM User's Manual for all wetland classes was completed in September 2008 and has since been revised and updated several times. It describes the need, scope, key terms and concepts, and general procedures for conducting a CRAM assessment. It also provides scientific backing for the main assumptions inherent in all CRAM assessments.

4.2 Wetland Class conceptual model

A conceptual model of the natural processes and anthropogenic stressors that control the form, structure, and function of each wetland class or sub/class is developed during the creation of each CRAM module. This model is designed to guide the development of metrics of condition and the stressor checklist.

4.3 CRAM module field book

For each wetland class a field book is created which describes, in detail, the standard operating procedures necessary to properly conduct an assessment. Included in the field books are the narratives for each metric along with examples to assist in the standard application of the method across the state by multiple practitioners.

4.4 Wetland class-specific data sheets

Data sheets unique to each wetland class are provided. While the overall structure of CRAM is uniform across all wetland types, individual metrics and submetrics may vary between wetland classes. Additionally, the basic information collected differs among wetland types.

4.5 Photo dictionaries

A CRAM photo dictionary is provided to CRAM practitioners via the CRAM website (www.cramwetlands.org). This dictionary includes examples of multiple levels of condition for metrics, examples of physical patch types, buffer and non-buffer land cover types, etc. This document assists practitioners in more uniformly applying the method across the state.

4.6 Online data upload/download capability (eCRAM)

An online CRAM score entry and upload tool will be provided for all modules that have completed the verification and/or validation steps (depending on the individual circumstances of the wetland class) at the CRAM website. The tool provides quality assurance, preventing scores from being

uploaded incorrectly. It also allows for uniform reporting and accumulation of data corresponding to multiple wetland classes for across the state in a single location.

5.0 CONDUCTING PROPER CRAM FIELD ASSESSMENTS

An overview of the proper equipment and personnel necessary to conduct a CRAM assessment are included in this section. For a more detailed description see the CRAM User's Manual and the field book for a specific wetland module.

5.1 Field equipment

5.1.1 Minimum Field Equipment

The minimum equipment necessary to conduct a CRAM assessment varies according the wetland type to be assessed. However, the following should be brought to all site assessments:

- CRAM User's Manual
- CRAM Field Book for appropriate wetland module
- CRAM data sheets for appropriate wetland module
- 100-meter tape
- Digital camera (required for photo documentation)
- GPS unit
- Small field calculator

5.1.2 Additional field equipment

Additional equipment that some practitioners may find useful but is not necessary to conduct a CRAM assessment includes the following:

- Stadia rod (riverine)
- Laser range-finder
- Kayak (for sites requiring boat access)

5.1.3 Office Site Evaluation Information

The CRAM User's Manual provides guidance on what information should be collected prior to visiting a site in person. Office derived site information includes:

- Aerial image with 250, 500, and 2000 meter measurements
- Information on watershed land uses and hydrologic modifications
- Site access contacts, phone numbers, lock combinations, and permits

5.2 Team members

The Data Quality Objectives and Procedures laid out in this Plan are based on having two trained practitioners complete each CRAM assessment. A trained practitioner is a person who has completed a 5-day CRAM practitioner training course or an equivalent course of study that has been approved by the Level 2 Committee of the CWMW. An ideal CRAM assessment team has a mix of expertise in wetland ecology, botany, geology, geomorphology, biology, or other aspects of wetland science. Several CRAM metrics require interpretation of subtle differences in field condition based on indicators that cannot be mastered without supervised practice. Discussion of scoring

decisions among members of an assessment team will improve the accuracy and reliability of the CRAM results by helping to bridge gaps in experience and by encouraging close examination of field conditions.

6.0 DATA REPORTING AND MANAGEMENT

The goal of the California Wetland and Riparian Area Monitoring Plan (WRAMP) is to produce regular reports on trends in wetland extent and condition and to relate these trends to management actions in a way that informs future decisions. This goal will be facilitated by the large amounts of data that would ultimately be generated on an ongoing basis by many partner agencies throughout the State. For this reason, consistent quality control on CRAM metadata is important.

At this time, the basic criteria for secure data management for CRAM are met through administration of the CRAM web site (www.cramwetlands.org) and supporting database (*e*CRAM) at the San Francisco Estuary Institute as a Regional Data Center (RDC) of the California Environmental Data Exchange Network (CEDEN). The *e*CRAM software, the CRAM database, and its supporting web sites are open source. No aspect of CRAM programming is proprietary. The CRAM database incorporates numerous measures to assure accurate data entry and processing (see CWMW 2013 for a complete list of these). Expansion of data management to include other regional data centers (e.g. SCCWRP, MLML) is expected.

The *e*CRAM database has been merged with the California EcoAtlas (www.ecoatlas.org) to provide a seamless interface for the viewing of public CRAM scores and associated project data. EcoAtlas was developed by the CWMW as a mechanism to help improve communication about extent and condition of California's aquatic resources, including wetlands and riparian areas. In addition to being a system for data management and visualization of information using a common aquatic resources base map, it provides the ability to track projects and makes information and reports (including CRAM data) readily available to agencies and the public. Limited syntheses of CRAM data can be automated by the EcoAtlas website for a variety of scales from watersheds to regions and statewide.

6.1 Data Quality Objectives and Procedures

6.1.1 Data quality objectives (DQO)

Ensuring that multiple practitioners of CRAM are correctly applying the method in the field is an important aspect of CRAM QA/QC. An uncertainty analysis of multiple calibration events of the CRAM Development Team, CRAM trainers and State agency staff from 2010 to 2013. The resulting measures of the variance and standard error of CRAM scores can be used to answer a variety of practical questions raised by the CRAM user community, such as:

- **Q1**: how much greater does one score have to be than another to be significantly greater at selected confidence levels (this question arises when comparing one site to another or when assessing change over time);
- **Q2**: Does the score represent a poor, fair, or good condition (this question arises when summarizing conditions for a population of wetlands or when any decision is based on the condition category).

Results

Q1: Is one score greater than another? The following table can be used to answer this question for any two Index or Attribute scores.

Type of Score	90% Confidence Level	Examples
Index	7	You can be 90% sure that one final score is higher than another if their difference ≥ 7 points.
Buffer & Landscape Condition	4	You can be 90% sure that one final score is higher than another if their difference ≥ 4 points.
Hydrology	10	You can be 90% sure that one final score is higher than another if their difference ≥ 10 points.
Physical Structure	17	You can be 90% sure that one final score is higher than another if their difference ≥ 17points.
Biological Structure	11	You can be 90% sure that one final score is higher than another if their difference ≥ 11 points.

Q2: Does a score represent poor, fair, or good condition? The following table can be used to answer this question for any Index or Attribute score, assume that the threshold between poor and fair condition is 50 points, and the threshold between fair and good condition is 75 points. These threshold scores are simply the values that evenly subdivide the full range of possible scores into three equal groups. Any other threshold scores can be substituted for these scores in the table provided below.

Type of Score	90 % Confidence Level	Examples
Index	5	**You can be 90% sure that a final score represents:** poor condition if the score is ≤ 55 (i.e., 50+5); fair condition if the score is > 55 and ≤ 80 (i.e., 75+5); good condition if the score is > 80 (i.e., 75+5).

Buffer & Landscape Condition	3	**You can be 90% sure that a final score represents:** poor condition if the score is ≤ 53 (i.e., 50+3); fair condition if the score is > 53 and ≤ 78 (i.e., 75+3); good condition if the score is > 78 (i.e., 75+3).
Hydrology	7	**You can be 90% sure that a final score represents:** poor condition if the score is ≤ 57 (i.e., 50+7); fair condition if the score is > 57 and ≤ 82 (i.e., 75+7); good condition if the score is > 82 (i.e., 75+7).
Physical Structure	12	**You can be 90% sure that a final score represents:** poor condition if the score is ≤ 62 (i.e., 50+12); fair condition if the score is > 60 and ≤ 87 (i.e., 75+12); good condition if the score is > 87 (i.e., 75+12).
Biological Structure	8	**You can be 90% sure that a final score represents:** poor condition if the score is ≤ 58 (i.e., 50+8); fair condition if the score is > 58 and ≤ 83 (i.e., 75+8); good condition if the score is > 83 (i.e., 75+8).

Higher precision at the Index score level results from the internal redundancies and "smoothing" of variability associated with combining attributes into an overall index score. These are the most current available error estimates and will be updated as additional data becomes available. Additionally, the analyses will be updated in the future for each CRAM module as more data are available.

In general, practitioners should be expected to produce CRAM scores that are within the known precision of CRAM for the type of wetland being assessed. Precision between independent assessment teams can be improved when the teams are adequately trained (see Section 7) and the teams conduct calibration exercises. In addition to receiving the appropriate training and inter-team calibration exercises, the precision of CRAM is expected to improve over time with successive refinements of the manual and assessment forms to increase their clarity, and by refining the metrics so they more clearly reflect common field conditions.

Regarding the concept of accuracy, it should be noted that, unlike a laboratory analytical method where the result can be compared to a standard of known concentration, there is no "gold standard", per se, for any metric against which CRAM can unequivocally be compared. Therefore,

accuracy is not a meaningful parameter against which to judge CRAM assessments, and as such is not included in this QC document. Accuracy of CRAM was evaluated during calibration exercises in 2005 through correlation with level 3 data sets (Riverine macro-invertebrate IBI, Riparian bird surveys, EMAP estuarine vegetation surveys). While no accuracy estimate could be made through comparisons to single trophic level data, the correlations met program-defined objectives (Stein et al. 2009).

6.1.2 Team calibration procedures

Inter-team calibration exercises should always be conducted among multiple teams that are pooling their independent assessments into a collective survey.

The California Wetland Monitoring Workgroup has established several ways to ensure practitioner aptitude and inter team repeatability. Practitioners can 1) visit regional Reference and Self Training Sites to increase their field experience using the CRAM tool and familiarize themselves with wetland nuances within various regions of the state, 2) watch online training videos that have been produced by qualified experts, or 3) conduct a formal intercalibration exercise among regional CRAM practitioner teams.

6.1.2.1 Regional Reference and Self Training Sites

Regional Reference and Self Training Sites have been established for several wetland classes within most regions of the state (Figure 3). Additional reference/training sites will be created and documented on the California EcoAtlas website (www.ecoatals.org). These training sites provide the opportunity for CRAM practitioners to practice using the CRAM wetland module they have used during previous CRAM trainings and expand their skill with the method on their own. To familiarize oneself to the full range of conditions for each metric, it is recommended that teams visit numerous designated Reference and Self-Training Sites within as broad a geographic area as possible. Practitioners should use training sites as teams of two or three.

Each site is accompanied by a Training Site Guide that provides the "official" score for the site and a specific explanation of how each metric score was generated. This information provides the practitioners with an understanding of how regional teams derived the reported scores. This information enables the team using the site to determine if site changes since last assessed (e.g. due to fire, flood, or land use changes) have led to the discrepancy in scores. After assessing a site, trainees will compare their scores to the scores in the Training Sites Guide and determine their proficiency with the tool and their team's precision error. Trainee teams should continue to visit reference sites until they achieve the quality assurance standard.

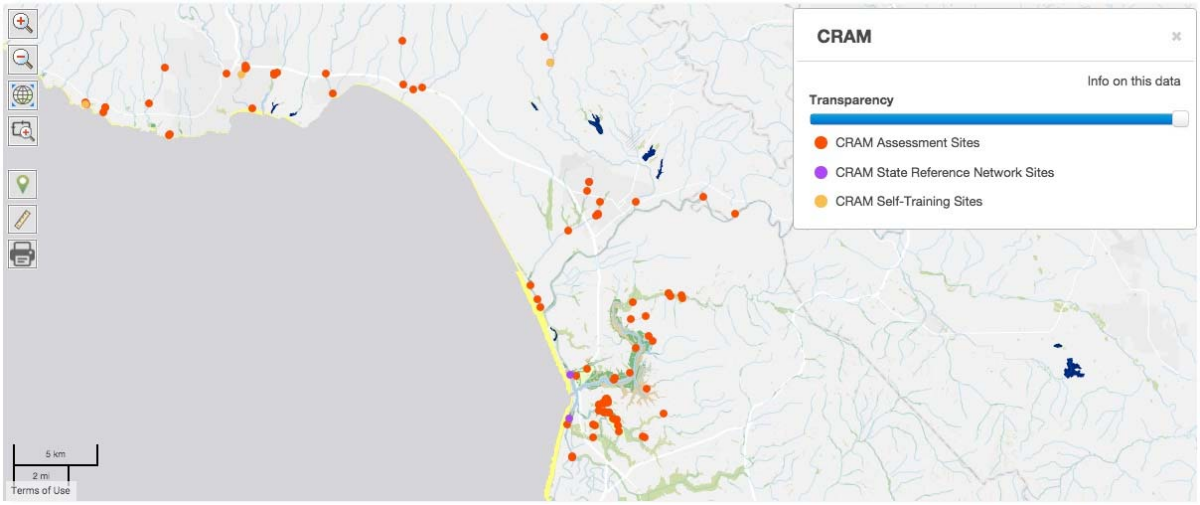


Figure 3. Screenshot from California EcoAtlas portal displaying CRAM assessment areas (red), CRAM Reference Sites (purple), and CRAM Self Training Sites (orange) in the Monterey Bay area.

6.1.2.2 Online Training Videos

Training videos have been produced for four wetland modules of CRAM (riverine, depressional, perennial estuarine and bar-built estuarine). These videos are made available on the CRAM website under Resources and Documents. Please note these videos are not intended as a stand-alone CRAM training. They have been developed to help refresh practitioners after having taken a break from doing CRAM assessments; to assist new trainees before or after a training; or to inform practitioners that have completed a 5-day training about how other wetland modules work.

6.1.2.3 Intercalibration Exercises-Trainers

The purpose of conducting formal intercalibration exercises for CRAM trainers is to document the precision of CRAM scores among regional teams of CRAM trainers, ensure consistent training practices, and identify areas in which corrective action is needed to meet precision targets.

Intercalibration exercises should be structured as separate 1-day events. On each of these days, each assessment team is taken to a pair of wetland sites (representing both poor and good condition). Each team will independently conduct CRAM and then compare scores. The rationale for metric scores for each of the CRAM sites should be well documented with text and photos so that assessment team members can receive additional training, if necessary. If scores differ by any amount, then discussions and corrective actions should take place to improve inter-team consistency. Corrective actions may include additional training in conducting CRAM AA delineation, interpretation of metric ratings, and identification of field features assessed in CRAM.

6.1.2.4 Intercalibration Exercises-Practitioners

Intercalibration exercises can occur as part of the CRAM development process, as part of a standardized training program, or as an element of a particular project or grant activity.
The purpose of conducting formal intercalibration exercises for project teams is to document the precision of CRAM scores among teams of CRAM practitioners and identify areas in which corrective action is needed to meet precision targets for a specific project.

Intercalibration exercises should be structured as separate 1-day events. On each of these days, each assessment team is taken to a pair of wetland sites (representing both poor and good condition). Each team will independently conduct CRAM and then compare scores.

Any CRAM field team that does not meet the precision targets corrective actions should be taken. The discussion among teams can begin with whether the information collected is accurate, what were the cause(s) leading to the deviation, how the deviation might impact data quality, and what corrective actions might be considered. Corrective actions can include additional training in conducting CRAM AA delineation, interpretation of metric ratings, and identification of field features assessed in CRAM.

The rationale for metric scores for each of the CRAM sites should be well documented with text and photos so that assessment team members can receive additional training, if necessary.

6.2 CRAM Reporting Template

In general, all submitted CRAM assessments should meet the minimum requirements as described in the CRAM User's Manual (CWMW, 2013) and, if a project assessment, the CRAM Technical Bulletin on using CRAM to assess wetland projects (CWMW 2009) or they should be rejected by the approving agency/entity and returned to the author for correction. When conducting a CRAM assessment, at least two practitioners must have conducted the assessment, and at least one member of the assessment team must have successfully completed a formal CRAM training course. Successful completion of CRAM training for an individual is verified via the list of trained practitioners that is currently maintained on the CRAM website.

6.2.1 Minimum reporting information for all sites

- Aerial photograph(s) showing location and boundaries of all AAs
- Existing conditions for site
    - Includes habitat type, attribute-metric scores, data sheet, length/area

6.2.2 Minimum reporting criteria for sites with multiple CRAM assessment areas (AAs)

- Metric/Submetrics and Attribute scores for each AA must be reported, not simply the average score across all AAs (averages can be used as a summary in the conclusions/interpretation section. Sites may be very large and one or several AAs could be failing and need remedial actions while others may be doing very well. If only averages are used, the failing AAs could be overlooked/scores muted. Separate scores will allow sufficient review or direct/require additional management measures).

All CRAM data should be accompanied by information on the source of the data, estimates of confidence in the accuracy of the data, and any notations or explanatory information from the source agency. This will aid in data interpretation and compilation and allow for appropriate qualification of the data sufficient to be able to determine whether data from multiple sources can be combined in broader assessment efforts. A recommended template for reporting CRAM data from a project site is outlined below.

6.2.3 CRAM Summary Report

Preparation of CRAM: Summarize the purpose/objective of the CRAM assessment and project history, if any. What does this CRAM assessment hope to achieve?

Project Site: Summarize location of the project site, general aquatic resources, and project description, if known. If mitigation is currently proposed, summarize mitigation plan.

Summary of Methods and Results: Summarize methodology and results. Which features were evaluated and what were the results? Which resources, based on the assessments, are in good condition, which are in poor condition? Include a table here with name of assessment area, existing condition score, and post-project implementation score, if applicable.

Methodology for Defining Assessment Areas: Discuss delineation of assessment areas and any project boundary issues. Include a table with name of assessment area, existing length, and post-project length, if applicable. Include a section generally describing the assessed features, i.e. if a particular riverine wetland (Drainage X) contains seven assessment areas, describe Drainage X as one feature – range in width, channel substrate, general vegetation community, etc.

General Scoring Methodology: How was information collected? In the field, office, GIS? Is there a mitigation plan driving post-Project implementation scoring? Is there a shift in plant communities in the post-Project condition? If so, include a table with the assessment area, existing plant community, and post-Project implementation plant community.

Basis for CRAM Scoring: As needed, describe metric by metric how the metric was evaluated for both the existing condition and post-project implementation. Include detail regarding mitigation assumptions. Describe the scoring of each metric in detail where appropriate (note: the scoring of some metrics calculated with GIS may be self-explanatory). Include typical existing cross-sections and typical mitigation cross-sections, if applicable, to demonstrate scoring for Hydrologic Connectivity/Entrenchment.

Conclusions: Discuss the conclusions of the CRAM assessment. Which resources are in good condition, which are in poor condition?

6.2.4 Recommended Map Exhibits for CRAM Reports

- Regional and vicinity maps;
- Map depicting assessment areas and photo location/direction;
- Map depicting assessment areas with project footprint overlay, if applicable;
- Map depicting assessment areas GIS buffer analysis;
- Map depicting assessment areas GIS buffer analysis with impact footprint overlay, if applicable;

6.2.5 Recommended Appendices for CRAM Reports

- Table with assessment areas and attribute scores. If applicable, include an existing column, post-Project implementation column, and a change in score column. Include a column for overall CRAM score for each assessment area. If applicable, include a column for change in length and change in width.
- "Master" table with assessment areas and each individual metric score, as well as attribute score and final CRAM score. Include length of reach and/or area. Include a post-Project implementation table, if applicable.

- Attach all fully completed CRAM data sheets. Note that all submetric, metric, and attribute scores must be provided as well as copies of the CRAM worksheets used to score metrics (where relevant). A complete data packet includes:
- CRAM Basic Information Sheet
- CRAM Scoring Sheet
- Worksheet for Landscape Connectivity
- Worksheet for calculating average buffer width of AA
- Worksheet for Assessing Hydroperiod/Indicators of Altered Hyrdoperiod
- Riverine Wetland Entrenchment Ratio Calculation Worksheet, if applicable
- Structural Patch Type Worksheet
- Plant Community Metric
- Completed Stressor Checklist Worksheets

- If plant community classifications were used in discussing mitigation scoring, include a "Sample Species List for Plant Community Classifications" to list plants typically found in the plant communities within the proposed mitigation site(s). For example, a discussion of the plant community could include assumptions regarding the types of structural patch richness that would be achieved within that community.

It may be best to scan the data sheets from multiple CRAM assessments onto a CD to reduce paper load.

6.2.6 Site Photographs

Supply ground-level photographs of the site illustrating key aspects of the wetland being assessed on a CD. Photographs should be clearly associated with specific locations on the ground and should conform to the Standard Procedures for Stream Assessment provided by the SWRCB (http://www.waterboards.ca.gov/water_issues/programs/swamp/cwt_guidance.shtml) and summarized in *Appendix B: Standard Procedures for Photographs* of the CRAM Technical Bulletin (CWMW 2009).

6.3 CRAM Data Management

Data management involves maintaining various types of data and information, including hardcopy and electronic imaging and other background information for sites to be assessed using CRAM, as well as completed field data sheets. Routine backups of the computing systems and databases should be performed daily, along with measures to assure network and computer security. Backup files containing CRAM data should be stored in fireproof facilities. In addition, hardcopies of the data should be maintained and, if the data are only in electronic form, printouts of these data should be stored separately from the electronic versions.

6.3.1 Process for Submitting CRAM Data

All CRAM scores and worksheets (as described in Subsection 6.3.3) should be uploaded into the *e*CRAM database, accessible via the CRAM website (www.cramwetlands.org). Anyone who wants to enter data into the database must register on the CRAM website to obtain a database log-in name and password. At this time, results for hardcopy versions of CRAM must be transcribed into the electronic version on the web site. The CRAM data entry database is only accessible to registered users, and they can only access and edit their own data. All results that are made public on the data

entry database can be viewed and downloaded by the public through interactive maps on the EcoAtlas website (www.ecoatlas.org).

If a CRAM assessment(s) is performed as a requirement of a permit, hardcopies of a complete CRAM data packet (as described in Subsection 6.3.3), sites aerials, site photographs, and other supporting information should be submitted to the Agency who requested it.

7.0 TRAINING

Training is a key QA element of CRAM implementation. A programmatic framework that includes high quality and standardized training materials will provide a consistent understanding of CRAM concepts and procedures to trainees. This will ultimately produce wetland assessments that reflect actual wetland condition, are reproducible, and are accepted by the greater community of wetland professionals.

Training is required for both field practitioners of the method and agency staff that need to evaluate CRAM information related to permit actions and associated mitigation proposals, monitoring reports, and impact assessments. Practitioner trainings are intended to equip individuals with the skills needed to conduct a complete assessment using CRAM. Agency trainings provide targeted training for agency staff (e.g. Water Boards, Corps, DFG) in the appropriate application of the method and interpretation of results.

7.1 Practitioner Training

CRAM is relatively rapid but it is not necessarily easy to apply. CRAM involves a systematic, detailed examination of wetland structure at various spatial scales. For this reason, a training program for field practitioners of the method has been developed. According to the CRAM User's Manual, accurate completion of a CRAM assessment requires expertise comparable to that necessary to conduct a wetland jurisdictional delineation. However, additional expertise in wetland botany and geomorphology is helpful in many cases.

The CRAM Training curriculum for practitioners consists of a "General CRAM Training" structure; a 5-day format that provides a broad understanding of the methodology, assumptions, and background to conduct field assessments for multiple types of wetlands. Sessions will equip practitioners with overall knowledge of how CRAM is used to assess multiple types of wetlands, and also details specific to each type. However, the field portion of each session will focus on two specific wetland types (e.g. estuaries, rivers/streams, etc.), so that practitioners gain experience in accurately and consistently conducting assessments using these two CRAM modules.

To ensure a quality learning environment, practitioner courses will be taught by at least two instructors and will be limited to 30 participants. Class sizes of 20 or more will require three instructors. Courses will be taught by the Principal Investigators who developed CRAM or by qualified trainers that have been intensively trained by the P.I.s (see Section 7.3).

Evaluation of CRAM practitioner trainees consists of both an office evaluation and two field-based practicums. Both elements must be passed for a trainee to successfully complete the five-day practitioner course. Teaching and mastering of the concepts will occur through group discussion, instructor feedback and positive reinforcement.

7.1.1 Office Evaluation

The office evaluation consists of a written take-home test that covers key concepts contained in the CRAM User's Manual and CRAM field books. The test is structured to provide feedback to trainers as to concepts mastered by trainees and identification of problem areas where additional instruction may be necessary. Questions will be a combination of multiple choice, true/false, and short answer format, organized by the topics covered in the five chapters of the current version CRAM User's Manual (available on www.cramwetlands.org).

The written test covers the following:

- Conceptual structure and methodological approach used in CRAM;
- Appropriate uses vs. inappropriate uses of CRAM;
- Technical application of CRAM (through examples scenarios):
    - Appropriate wetland classification and typology;
    - Determining seasonal and other timing aspects of field assessment;
    - Delineation of the CRAM assessment area using maps;
    - Office assessment procedures;
- CRAM quality assurance procedures (site map quality, summary data, scoring, and stressor worksheets);
- Elements of CRAM guidelines for project and regulatory applications.

The questions for the written test will be distributed electronically to all course participants on the first day of the training and participants are required to hand in their answers to the written test on the morning of the 2nd day of instruction. Participants are encouraged to familiarize themselves with the basic concepts and structure of CRAM before the first day of instruction.

7.1.2 Field Evaluation

The field practicums are administered on the last day of the 5-day training. Trainees are evaluated at two field sites where trainers have previously conducted a CRAM assessment and documented scoring of metrics and rationale for each score. Trainees will work in teams of 2-3 and conduct a complete CRAM assessment (including scoring of all metrics and completing the CRAM stressor checklist). Elements of CRAM that will be evaluated include:

- Determination of assessment area boundaries;
- Buffer assessment;
- Metric and attribute scoring;
- Stressor checklist;
- Completeness of field sheets and scoring materials;

A group "debriefing" session will be conducted in the classroom after all participants have completed by the field evaluation.

7.1.3 Successful Completion of Training

To successfully complete a 5-day CRAM training, a trainee must pass both the written test and the field practicum portions. For the written test, a trainee must answer at least 80% of the questions

correctly. For the field practicum, a trainee should meet or exceed the quality assurance standards described earlier in this plan.

Trainees who attend an entire class but do not pass the evaluation phase will have the opportunity to re-test at a future CRAM training (without having to repeat the course). Once a network of regional test sites has been established, practitioners will have the opportunity to re-test at a test site. If a re-test is necessary, both the written and field portions must be repeated, regardless of which element the trainee failed during the initial testing.

All trained practitioners are encouraged to complete additional self-guided CRAM evaluations once the training is complete to further develop their understanding of the method and to reinforce the expertise gained through the 5-day training.

7.1.4 Documentation of Trainees

A list of practitioners who have successfully completed CRAM training will be maintained on the CRAM website (www.cramwetlands.org/training/participants). The following information will be recorded:

- Name and contact information;
- Date that course was completed;
- CRAM wetland class(s) and region in which training was received;
- Name of lead instructor (including email);

The next version of eCRAM will also track practitioner QA information including additional self-guided field training and QA test runs. Recorded information may include:

- Completion of CRAM Self-Testing Sites (with answers) for different wetland classes and geographic regions

7.2 Agency/Manager Training

The CWMW has developed a curriculum for a series of 2-day courses that provide targeted training for agency staff and managers in the appropriate application of CRAM and interpretation of results. The target audience for these trainings is State and Federal agencies, including the USACE, Regional Water Boards, CDFW DWR and Caltrans. Grant administrators for projects that entail restoration projects and watershed planning (e.g. staff funded by grants administered by the Water Boards through WMI and NPS programs) are also encouraged to attend.

Interagency participation in these trainings would:

- Lead to better coordination of Regional 401-Surface Water Protection and DFG SLA (1600) regulatory programs by providing a common regulatory language for site assessment of projects and mitigation efforts;
- Allow agency applicants (e.g. Caltrans, DWR, local watershed groups) to better provide information for 401 applications;
- Contribute to ambient monitoring program goals under SWAMP;

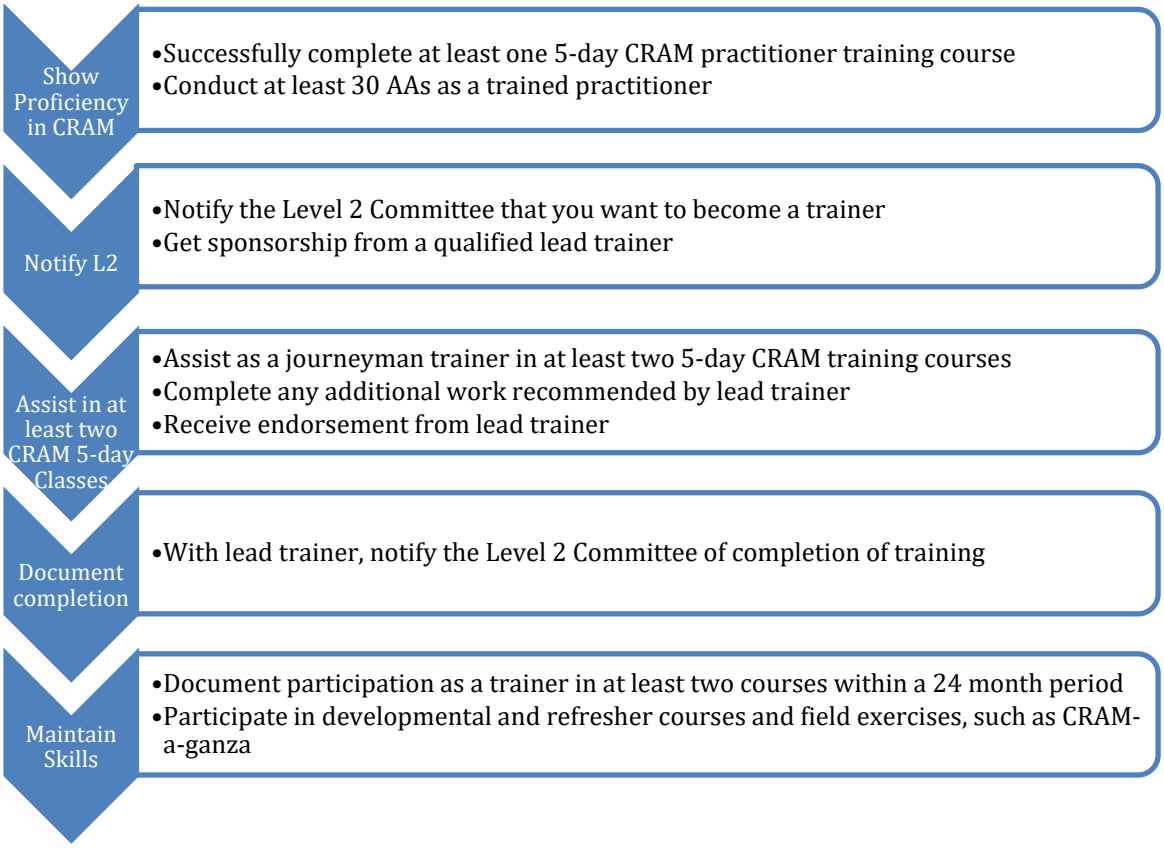
Courses have been structured to combine 1-day of classroom study and 1-day of site visits/field exercises. Each 2-day course would address one or two CRAM wetland types depending on Regional interests. Specific CRAM implementation issues and applications would be highlighted to make these courses relevant to agency staff.

Courses will be limited to 30 participants and be primarily taught by the Principal Investigators who developed CRAM, or by staff that have been intensively trained by the P.I.s, using core curricula and materials that have been successfully developed through previous courses.

7.3 Instructor Training

Qualified CRAM Trainers are needed to assure that adequate numbers of trained CRAM practitioners are available to meet the needs of public agencies and other organizations using CRAM. A CRAM Trainer Program has therefore been developed. The primary goal of the program is to provide self-selected CRAM practitioners from throughout California with the necessary skills to train CRAM practitioners, while helping to maintain the levels of CRAM precision and accuracy specified in the CRAM guidelines for data quality assurance and control. Regional pools of qualified instructors are utilized to meet regional training demands.

OVERVIEW: STEPS TO BECOMING A CRAM TRAINER



To begin the journeyman process, visit http://cramwetlands.org/training/trainers **and contact a current CRAM Trainer or CRAM PI member in your region.**

7.3.1 Becoming a New CRAM Trainer

The California Wetland Monitoring Workgroup (CWMW) welcomes experienced practitioners who wish to become qualified as CRAM Trainers through the qualification process described below. This training program includes office and field components that involve a combination of coursework, supervised applications of CRAM, and co-instructing at least two 5-day practitioner courses. All steps must be completed for an individual to become qualified to teach CRAM for a particular wetland type(s).

The CWMW does not "register" or "certify" CRAM practitioners and trainers. Through the CWMW's Level 2 Committee (L2), CWMW does provide recommendations on how CRAM should be taught. These recommendations are designed to help ensure that CRAM practitioners are given consistent, high quality instruction throughout California, so that the best possible CRAM data will be produced for all users. The CWMW does maintain a list of those who are qualified to teach CRAM, as demonstrated by completion of the steps and meeting the minimum standards described below.[1]

Key Terms:

- Journeyman Trainer: Trained CRAM practitioners who meet minimum qualifications and are pursuing qualification as a CRAM trainer.
- Lead Trainer: Qualified CRAM trainers who are supervising the training of journeyman trainers.
- Sponsoring Trainer: The lead trainer that oversees a journeyman's nomination and training.
- CRAM PI team: The group of scientists, the "principal investigators," who are charged with the technical development and adaptive management of CRAM. Many of the PI's serve on the L2 Committee.
- The "Level 2 Committee," or "L2" serves as the technical advisory committee on all Level 2 assessment methods, including CRAM, for the California Wetland Monitoring Workgroup.
- eCRAM: The CRAM website (www.cramwetlands.org) where users can view lists of trainers, trained practitioners, upcoming training courses, downloadable documents, and can enter, edit, and view CRAM data.
- Active trainer: A qualified trainer who has participated in at least three of the following in the previous 36 months, including at least one of each: (a) CRAM training courses (including 5-day general CRAM training courses, refresher courses, manager level trainings, or other specialty courses; (b) CRAM-a-ganza field exercises.

Step 1: Meet Minimum Qualifications for CRAM Trainers

To become a journeyman CRAM trainer, practitioners must:

- Successfully complete at least one full 5-day CRAM training course in modules of interest.

[1] The sequence of steps outlined below is recommended, but CWMW and L2 recognize that exceptions to this sequence may be acceptable in some cases. Journeyman trainers and their sponsoring lead trainers may propose steps to qualification to L2 for consideration, and L2 may accept such proposals if it is clearly demonstrated that the alternate process is at least equivalent to the recommended steps described below.

- Document in eCRAM competent participation in at least 30 AAs as a trained practitioner (typically by being listed as part of the AA team in the assessment entered in the database).
- Request and obtain sponsorship from one or more qualified CRAM trainers (or request assistance from the L2 Committee in identification of a lead trainer.)
- Notify the L2 Committee of the intent to become a journeyman trainer, and identify the journeyman's sponsoring trainer(s).

Prospective journeyman trainers should have attended a five-day course that covers modules that the journeyman wishes to train. For example, a 5-day course that uses riverine and depressional modules as the two training modules would not qualify a prospective trainer to be a journeyman trainer for the estuarine module; see "additional modules" steps below.

Step 2: Complete Formal Classroom Training Requirements:
Upon meeting the minimum requirements listed in Step 1, a prospective journeyman CRAM trainer must:

- Participate in at least two five-day CRAM practitioner training courses (for a total of 10 training days) as a journeyman trainer under the supervision of a qualified CRAM trainer. At least 2 training days should be completed with a lead trainer other than the sponsoring trainer.

- Journeymen may participate as a co-instructor for CRAM modules in which they have officially received training, or in which they have demonstrated equivalent skill and experience to the satisfaction of the lead trainer(s) and L2.

Journeyman trainers must work under one or more lead trainers to gain the experience and skills needed for teaching CRAM; journeyman training with at least one other lead trainer is required. Journeyman trainers are expected to assist in all phases of course preparation, presentation and follow-up, including: preparation of the course materials, presentation of classroom lessons, assistance in field exercises, compilation of trainee scores, and analysis of trainee performance.

Step 3. **Performance Review**: Meet with your lead trainer(s) from Step 2 to discuss your performance as a journeyman. The performance review will cover your technical understanding of CRAM, your technical skills as a CRAM practitioner, and your ability to teach CRAM using the standard CRAM training materials. Your sponsoring trainer may recommend that you complete further training before proceeding with the CRAM Trainer Program, or that you proceed while sharpening particular skills.

Step 4: Notify L2: When a lead trainer finds that a journeyman has met the minimum qualifications to be CRAM trainer, the lead trainer will notify the Level 2 Committee and the newly qualified trainer will be added to the roster of qualified trainers posted at www.cramwetlands.org. That posting will include the date of qualification, sponsoring lead trainer, and modules in which the new trainer is qualified to teach.

Trainers should only teach the CRAM module(s) for the wetland type(s) in which they have been trained and in which have demonstrated expertise.

The Level 2 committee may accept without comment the journeyman's qualification, or may recommend additional supervised training or future self-training on particular aspects of CRAM. In such cases, journeyman trainers may continue work with a lead trainer to develop the additional skills needed.

7.3.2 Follow-up Training and Active Trainer Status

It is expected that all qualified trainers, but especially newly qualified trainers, continue to improve their skills as practitioners and trainers.

Annual field workshops for qualified CRAM trainers are scheduled around the State at times that vary with season, weather and opportunity. Trainers are strongly encouraged to attend these meetings, at least once every two years. These workshops (colloquially called the "*CRAM-a-ganza*"), typically take place over a two or three day period with members of the established CRAM PI/training team leading the workshop. Attendance will be monitored on the CRAM Training page of the CRAM website. The objectives of this workshop are:

- To provide an opportunity for CRAM trainers to work closely with the CRAM PI team on teaching skills, improving participant's technical understanding of CRAM, and inter-team calibration at a minimum of two wetland types;
- To refine the content and use of teaching tools (PowerPoint presentations, field books, photo-dictionaries, etc.) in both classroom and field settings;
- To ensure trainers fully understand eCRAM and data quality issues;
- To provide an opportunity for all participants to review, refine, and improve the CRAM training material and presentations.

A trainer's status as "active" or "inactive" will be maintained on the CRAM website. To maintain status as an active trainer, qualified trainers must participate in at least three CRAM events every 36 months. These events can include a) one CRAM-a-ganza and two trainings, or b) two CRAM-a-ganzas and one training. During trainings, the trainer may be a lead or an assistant trainer, but must participate in and lead a significant portion of the course.

A trainer becomes "inactive" if these requirements are not met. However, they can reactivate their "active" status by participating in at least 2 trainings as an assistant trainer and one cram-a-ganza during an 18 month period, and have the lead trainers verify their competency in the current field practice and course content.

7.3.3 Becoming a Trainer for Additional CRAM Modules

Individuals who are qualified trainers in CRAM (by following the above steps), may become trained in additional modules of CRAM. To become qualified to train in additional modules, trainers should take the following steps:

- Step 1: The trainer formally notifies the L2 chair and the lead trainers of their interest in pursuing qualification for as trainer in a new module. If a sponsoring lead trainer for the new module is not identified by the prospective new trainer, the notification to L2 should request that a lead trainer offer their sponsorship.

- Step 2: The L2 chair acknowledges receipt, which starts a qualification period which may not exceed 24 months.

- Step 3: During this qualification period, the trainer must conduct at least 10 CRAM assessments in the new module. A trainer qualified in that module should participate with the trainer for at least two assessments to provide feedback, calibration, and a recommendation to the L2. The AAs must be entered into the eCRAM database. These 10 AAs should NOT include sites prepared or used for training course purposes.

- Step 4: During the qualification period, and after the 10 AAs are recorded, the trainer should participate as a journeyman trainer in at least one CRAM training course that covers the additional CRAM wetland type in which they would like to become a qualified trainer. Participation would be the same as with initial qualification as a trainer, and includes attending all 5 days, preparing for the course, pre-course site visits, leading the PowerPoint presentation for the module of interest, and leading the site and de-brief in the field for at least one site.

- Step 5: It is the journeyman's responsibility to document the initial letter date, the 10 AAs (date, name, module, eCRAM ID, and participants), the training dates and responsibilities, and the name(s) of the lead trainers that have provided oversight. The journeyman should then submit the documentation to the L2 chair. The L2 chair will confer with the lead trainers to verify that the journeyman trainer has qualified to train in the additional module within the qualification period.

To evaluate the quality of assessments reported in Step 4, the L2 Committee may also compare the assessments to a population of other assessments for the same wetland type(s) in comparable landscapes settings. The purpose of such comparisons is to reveal any significant systematic misapplication or misunderstanding evident in the assessments. Such evidence may be used to customize the trainer's continued training.
The Level 2 committee may accept without comment the journeyman as trained in the additional module, or may recommend additional supervised training or future self-training on particular aspects of CRAM. In such cases, journeyman trainers may continue work with a lead trainer to develop the additional skills needed.
Upon verification of qualification by L2, the additional wetland types will be added to the online listings of the qualified CRAM Trainer[2].

[2] http://cramwetlands.org/training/trainers

7.3.4 Documentation of Qualified Trainers

A directory of qualified CRAM Trainers will be maintained by the CWMW and the L2 Committee on the CRAM website[2]. The purpose of this directory is to help anyone interesting in being trained as a practitioner or Trainer, or seeking help with CRAM assessments or other technical aspects of CRAM locate appropriate technical expertise. The L2 Committee recognizes that technical expertise is a combination of training and experience. The directory of Trainers therefore includes the following information about each registered Trainer, all of which is available through the eCRAM database:

- Trainer name and email address;
- Wetland types for which the Trainer has been registered;
- Date(s) of qualification for each wetland type;
- Number of assessments conducted for each wetland type;
- Number of trainings conducted for each wetland type;
- Active status, including attendance at "CRAM-a-ganza" and other CRAM developmental events.

To begin the journeyman process, visit http://cramwetlands.org/training/trainers **and contact a current CRAM Trainer or PI member in your region.**

8.0 REVIEW OF SUBMITTED CRAM SCORES

Part of the value of CRAM is its ability to yield reproducible results for wetlands of similar condition, regardless of the data collector. CRAM score reviews are needed to assure that the data collectors or assessors are using the same approach and are obtaining information accurately when conducting CRAM assessments. A CRAM score review is a comparison between a CRAM assessment of unknown quality and a CRAM assessment of certified high quality for the same Assessment Area and time period.

The review process will maintain the scientific integrity of CRAM by identifying and correcting misuse and misapplication of the method, especially in the context of project design and regulatory decisions. It will also contribute to the verification, validation, and improve upon the technical adequacy of CRAM. As with any assessment method, discussion and debate on some elements of CRAM and its application are ongoing. As a result, it is expected that CRAM will continue to evolve in response to new data and changing needs of the user community. The review process will permit this ongoing dialogue on differing viewpoints and perspectives with a goal of continuing to improve the utility of CRAM for project assessment.

8.1 Goals and Objectives of CRAM Score Review

Each CRAM review is the evaluation of the quality of one set of CRAM scores for a single Assessment Area and a single date. The basic goal of a review is to determine the quality of the assessment being reviewed. The definition of the Assessment Area is provided in the CRAM User's Manual (CWMW 2013). Two or more assessments are assumed to represent the same period if they occurred during the same two-year time span during the same season. The period might be longer or shorter depending on case-specific circumstances. The high-quality assessment is certified by having

been produced by an independent review team that includes at least two experts in CRAM for the kind of wetland for which the review is being conducted. The expertise of the members is assured by the level and timeliness of their CRAM training, as documented on the CRAM website. The review team is "independent" because none of its members who contribute to the review score has any direct responsibility for the score being reviewed, nor has a financial or political interest in the outcome of the review. Further information about the composition of a CRAM score review team is provided below in the section titled Review Team Composition.

Reviews may be conducted in three regards: (1) ambient monitoring programs that employ CRAM; (2) routine assessments of CRAM reference sites; and (3) restoration or mitigation plans and projects for which CRAM results are incorporated into performance standards. The review process for ambient monitoring programs and reference site monitoring that incorporates CRAM is important because these programs provide the baseline measures of condition that are likely to inform project designs and performance standards. Reviewing CRAM assessments of projects is important to help assure the correctness of decisions about project performance and compliance.

The specific objectives of CRAM reviews may vary from agency to agency, depending on the differences in their missions and responsibilities. However, all organizations using CRAM are expected to need CRAM score reviews to assure the integrity of their CRAM data. The recommended standardized review process should be complementary across the CRAM user community.

8.2 Review Team Composition

As stated above, CRAM reviews should be conducted by two or more CRAM experts who do not have any financial or political interests in the outcome of the reviews. These are the primary criteria for selecting reviewers. A reviewer can be anyone who meets the criteria for independence and expertise. Observers who do not meet these criteria can accompany reviewers but should not have any influence on the review scores. A given practitioner who meets the expertise criterion might also meet the independence criterion in some cases but not in others. In each case, each reviewer will need to declare their independence as defined above.

The success of a review depends on the competency of the reviewers. They must be proficient in CRAM. This means that a reviewer must be able to correctly identify any difference between a review score and its corresponding reviewed score that is due to error in the latter. The minimum training that must be successfully completed to qualify a CRAM reviewer is the same training required to qualify a CRAM trainer, and is described in this CRAM Quality Assurance Plan. It is recommended that CRAM practitioners who are recognized as trainers by the L2 Committee should be considered as candidate reviewers. In addition, it is helpful but not mandatory that reviewers have general familiarity with the CRAM score review process and procedures, and have a working understanding of the purposes of the CRAM scores that are being reviewed.

The roles and responsibilities of the review team leader and other team members must be clearly identified. The responsibilities of the team leader are outlined below. The team leader:

- Is responsible for the overall conduct of the review team, including but not limited to scheduling reviews, selecting team members for specific reviews, managing changes in membership, and holding and managing team meetings;
- Serves as the liaison between the review team and the organization requesting the review;

- Leads the technical interpretation of review scores, especially with regard to the assessment of score accuracy and the identification of bias;

As explained below in the section on reporting, the review team leader and the review team are responsible for transmitting review scores or final review reports to the sources or sponsors of the scores that are reviewed.

8.3 Scope and Content of a CRAM Score Review

A CRAM review is a comparison between a CRAM assessment of unknown quality and a CRAM assessment of certified high quality for the same Assessment Area and time period. The high-quality assessment is certified by having a review team as its source.

Every CRAM review addresses the following four topics, each of which is discussed below:

1. Qualification of the CRAM practitioner(s) responsible for the reviewed assessment;
2. Level of preparedness of the practitioner(s);
3. Completeness of the assessment; and
4. Accuracy of the assessment.

8.3.1 Qualification of the CRAM practitioner(s)

All CRAM practitioners should adhere to the minimum requirements for assessment team composition as described in the CRAM User's Manual (CWMW 2013), the technical bulletin on using CRAM in the context of regulatory and management programs (CWMW 2009), and the CRAM Data Quality Assurance Plan. In brief, each CRAM assessment should be the product of a field team that meets the following requirements:

- The assessment team includes at least two practitioners working together in the field at the same time;
- At least one member of the assessment team has completed a 5-day CRAM training course within the past 5 years and is proficient in the module being used in the assessment;
- The assessment team leader is registered as CRAM practitioner in the CRAM database (registration as a trainer suffices as registration as a practitioner).

The review team will use the CRAM database and interviews with the assessment team leader to ascertain whether or not the assessment team has met each of these three minimum requirements for practitioner qualification.

8.3.2 Level of Practitioner Preparedness

Practitioner preparedness refers to the degree to which the assessment team undertook the background check of site-specific existing information that is often (but not always) needed for an accurate assessment. This evaluation requires the review team to conduct its own background check, and to determine to what degree the reviewed scores are consistent with the background information.

8.3.3 Assessment Completeness

An assessment is complete is it meets the following five requirements:

- There is map of the Assessment Area that follows the guidance for such maps in the CRAM User's Manual and on the CRAM website;
- All worksheets in the CRAM data sheet are completed such that they provide adequate justification for the related metric scores;
- All data fields in the CRAM data sheet have all the entries needed to compute the scores for each CRAM metric;
- The stressor checklist is completed for each CRAM attribute;
- Appropriate explanations, site photographs, and supporting materials, including any voucher specimens used to verify plant species, are readily available and/or the correct contact person for them is clearly identified.

The CRAM database will automatically report whether or not the first four requirements listed above have been met. To determine compliance with the last requirement listed, the review team will need to search the database and may also need to try to contact the person(s) identified in the assessment as responsible for supporting materials that are not included in the database.

8.3.4. Assessment Accuracy

The accuracy of an assessment will be determined by comparing the metric scores, attribute scores, and index score of the assessment to the metric scores, attribute scores, and the index score produced by the review team. In each case, the assessment score should not differ from the review score by more than the target precision of the metric, attribute, or index score, as determined by the L2 Committee and reported in this CRAM QA Plan. The target precision values are determined by the L2 Committee based on the calibration exercises of the CRAM PI Team, CRAM Trainers, and established practitioners (see Section 6.1.1).

Site Visits: Most reviews will require a site visit by a review team to determine the accuracy of field-based metric scores and submetric scores. The practitioners responsible for the reviewed assessment can accompany the review team on the site visit to help explain the assessment and to receive technical advice from the reviewers. However, the review must proceed to its independent conclusion based on the assessment being reviewed, without any modifications to the assessment during the review. CRAM scores that are based on aerial imagery or other remote sensing data can be reviewed apart from the site visit (Table 2).

Remote Verification: If a site visit by review teams is not feasible, the competency of CRAM practitioners can be verified remotely through practitioner "self-review" at field sites that have been previously assessed with CRAM by at least two independent practitioner teams that are fully trained and proficient in CRAM (e.g. CRAM trainers, PIs, reviews teams, etc.).

The practitioners being reviewed would be required to conduct CRAM at least two of these locations and generate scores that are within the known precision of CRAM for the type of wetland being assessed, as well as meet the minimum data quality objectives for CRAM for practitioner preparedness and data completeness. The practitioners can submit their CRAM results to organization requesting the review via paper field forms or through eCRAM where these scores can be verified by the responsible review team.

8.4 Timing, Frequency, and Number of Reviews

The L2 Committee recommends that CRAM reviews should be conducted as an integral part of regulatory or management agency efforts to use CRAM to assess impacts, plan mitigation, assess mitigation or restoration projects, or to assess ambient or baseline conditions. The number of individual assessments to review will vary with the number of possible assessments and available funding, and will need to be determined by the agencies responsible for any decisions that will be based on the assessments. The following scenarios are presented to help guide the review planning.

- In general, reviews should be conducted concurrent with, or soon after, the assessments that will be reviewed. Shortening the time between assessments and their reviews will minimize the cost of redoing assessments.
- For any project having thirty or more CRAM assessments for any wetlands class, at least 10% of those assessments should be reviewed. For example, if an impact analysis, mitigation plan, or ambient survey involves 30 or more CRAM assessments for three wetland classes, then at least 10% of the assessments for each wetland class should be reviewed. In such cases, assessments will be randomly selected for reviewing.
- If it is determined from the CRAM database that a practitioner or trainer may be biased in their assessments or training, then the database will be used to select possibly biased assessments for reviewing. At least five assessments should be reviewed in each case. The reviewed cases must not be more than two years old.

8.5 Review Process and Procedures

It is recommended that all results be recorded in the standardized review form (Appendix 2). Each CRAM review should be conducted following four sequential steps: (1) pre-review activities and planning; (2) preliminary office-based review using information in the CRAM database, CRAM website, and other supporting materials; (3) on-site activities (for field-based reviews); and (4) post-review activities (including a review report with any recommended corrective actions). Figure 4 provides a schematic overview of the review process.

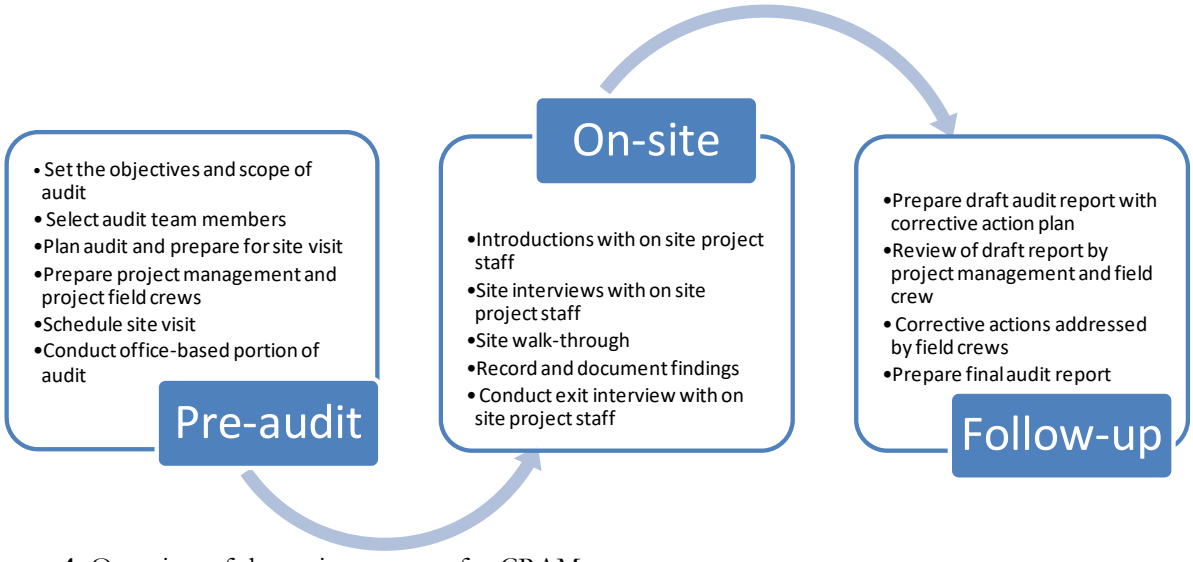


Figure 4. Overview of the review process for CRAM.

8.5.1 Pre-Review Activities

Careful preparation helps to ensure that the review team accomplishes its goals while using the least possible resources and labor time. Pre-review preparation involves activities.

8.5.1.1 Setting the objectives and scope of the review

The objectives define the purpose of the review and establish performance criteria for the review team. For CRAM reviews, the overall objective is to evaluate how effectively CRAM practitioners comply with the QA/QC specifications for CRAM. However, specific objectives may vary from review to review depending on the purposes of the CRAM assessments.

After the review objectives are determined, it is necessary to define the scope of the review. The scope of a review includes its geographic extent, the particular classes of wetlands that will be covered, and the number of assessments that will be reviewed.

8.5.1.2 Planning and preparing the review team for the site visit

Careful planning is crucial to ensuring that the limited time typically available for the site visit is used most effectively. Careful planning also minimizes the time necessary for follow-up activities after the site visit. Some of the factors to consider when planning a site visit are:

- Goals and scope of the review;
- The review team's familiarity with the assessment sites (site background);
- Resources available for conducting the review;
- Site accessibility and security.

As part of review planning, the review team leader should ensure that all members of the review team understand:

- The goals and scope of the review;
- The review team's roles and responsibilities;
- The purposes of the CRAM assessments being reviewed;
- Signed statements of independence and technical qualifications as a reviewer;
- Any potential health and safety risk and how to minimize them;
- Correct CRAM modules and other supporting materials; and
- The review process and schedule.

In addition, each member of the review team will provide a signed statement that they are technically qualified to conduct the review and that they have no political or financial interest in its outcome.

8.5.1.3 Communication with parties responsible for the reviewed assessments

In the case of a review pertaining to a regulatory or management agency's action or plan, the agency will decide whether or not the practitioners who conducted the assessments should be contacted about the review and whether or not they should accompany the review team. A positive relationship with the responsible agency is vital to the success of these kinds of reviews. To ensure their success, the review team leader should communicate the following to the agency:

- How the review will proceed and how the results will be used;

- The names of persons who will be interviewed, including perhaps the practitioners responsible for the assessments being reviewed and any persons identified in the assessments as having pertinent information or supporting materials;
- A list of information needed for the review that is not available in the CRAM database, including perhaps aerial imagery, on-site photographs, and other supporting information (as described in the CRAM QA/QC Plan); and a detailed agenda and schedule for the review.

8.5.1.4 Office-based Portion of Review

Each CRAM review will require a site visit by a review team to determine the accuracy of the assessment being reviewed. However, practitioner preparedness, data completeness, and some of the CRAM metric and submetric scores can be reviewed apart from the field to determine if some of the minimum reporting requirements were met. Information that can be gleaned from the CRAM database includes:

- The number of practitioners who conducted the assessment;
- Whether or not at least one member of the assessment team completed a formal CRAM training course within the past 5 years for the wetland type being assessed;
- There is a map of the Assessment Area that follows the guidance for such maps in the CRAM User's Manual and on the CRAM field book for that wetland type;
- All worksheets in the CRAM data sheet are completed such that they provide adequate justification for the related metric scores;
- All data fields in the CRAM data sheet have all the entries needed to compute the scores for each CRAM metric;
- The stressor checklist is completed for each CRAM attribute; and
- Appropriate explanations, site photographs, and supporting materials, including any voucher specimens used to verify plant species, are readily available and/or the correct contact person for them is clearly identified.

Table 2. List of CRAM attributes, metrics, and submetrics for Riverine CRAM. Metrics or submetrics suitable for an office-based review are highlighted in grey.

Attribute	Metric and Submetrics	Office or Field Review	Information Source
Buffer and Landscape Context	Stream Corridor Continuity (m)	Office	Aerial imagery and NWI
	Buffer (m):		
	Percent of AA with Buffer (s)	Office	Aerial imagery
	Average Buffer Width (s)	Office	Aerial imagery
	Buffer Condition (s)	Field only	
Hydrology	Water Source (m)	Office	Watershed reports; aerial imagery
	Channel Stability (m)	Field only	
	Hydrologic Connectivity (m)	Office (for non-riverine wetlands only)	Aerial imagery
Physical Structure	Structural Patch Richness (m)	Field only	
	Topographic Complexity (m)	Field only	
Biological Structure	Plant Community (m):		
	Number of Plant Layers Present (s)	Field only	

	Number of Co-dominants Plant Species (s)	Field only	
	Percent Invasion (s)	Office	Cal-IPC
	Horizontal Interspersion and Zonation (m)	Field only	
	Vertical Biotic Structure (m)	Field only	

8.5.2 On-site Review Activities

8.5.2.1 Site Walk-through

The review team should reconnoiter the entire, exact same Assessment Area that was subject to the assessment being reviewed. The Assessment Area map will guide this reconnaissance, and it can be further assisted by the practitioners who conducted the assessment, if they are available. This walk-though should precede the evaluation of any CRAM metrics. Its purpose is to for the review team to gain a basic understanding of the form and structure of the Assessment Area.

8.5.2.2 Field-based Portion of Review

The review team will proceed as trained to conduct the field-based portion of the CRAM assessment as usual. All data fields will be completed for the Assessment Area defined for the reviewed assessment. However, the review team should assess the accuracy and suitability of the Assessment Area map. The team will have in hand the results of the reviewed assessment, and will compare the review scores to the reviewed scores for each metric and submetric as the review proceeds. Reviewers should document in writing any explanations for differences in review scores and reviewed scores that exceed the target score precision, as defined by the L2 Committee. These explanations should be recorded while on-site (i.e. reviewers should not wait to return to the office to record their explanations). The review team should also take any photographs needed to support the review.

The review team leader should conduct a brief exit briefing with the review team members before leaving the Assessment Area. The purpose of the briefing is to ensure that the field-based portion of the review is complete, or to identify and assign any follow-up actions necessary to complete this part of the review. The Reviewers should revise and complete any preliminary explanations for observed discrepancies between the review scores and the reviewed scores. In some cases, it may be necessary for review findings to be kept confidential until the responsible agency has an opportunity to address any problems revealed by the review. It is important that the review team confine its scope of discussion to technical issues and concerns relating to the quality of the assessment being reviewed. The review results should be treated as preliminary and not public until they are transmitted to the organization responsible for initiating the review.

8.6 Reporting

Each review is the evaluation of the quality of a CRAM assessment. There is one review per assessment, which is the set of CRAM scores for a single Assessment Area and a single date. The report should follow a standard template (Appendix 2).

A review report can cover one or more reviews. The scope of the report will depend on the purpose of the review. Reports for ambient surveys and large projects involving many individual Assessment Areas (and therefore many CRAM assessments), or that pertain to tests of practitioner or trainer bias will include the results of multiple reviews.

A review report should highlight any evidence of systematic error among CRAM assessments. For example, a set of reviews for a single ambient survey or large mitigation plan might reveal a preponderance of unacceptable low or high scores for particular metrics, perhaps in the context of a particular time-of-year, wetland class, or practitioner. Such findings can be helpful for identifying problems with a module, with training, or possible bias. The review report should also highlight any clear and obvious explanations for discrepancies between review scores and reviewed scores that can be used to guide corrective actions.

The review team should use the guidelines presented in section 8.4 to assess the quality of the assessment based on information apart from the field site visit. All results must be recorded in the standardized review form (Appendix 2).

8.6.1 Corrective Actions

Assessments that are categorized by the CWMW as either fair or poor may warrant corrective actions. The appropriate actions will vary depending on the cause of the categorizations.

In general, the differences between good and fair assessments are the consequence of minor practitioner error, miscalculations, and transcription errors. These problems can usually be remedied by minimal additional training of the responsible practitioners. It is expected that fair assessments will not usually warrant any replacement assessments, although the assessment team leader might be contacted for targeted retraining.

Poor assessments can indicate pervasive and persistent errors, including systematic bias that might require extensive retraining. They can raise serious questions about the quality of other assessments conducted by the same practitioners. A preponderance of poor assessments for ambient surveys or projects can warrant replacement assessments by more qualified practitioners. This is an extreme remedy that can incur considerable costs. The CRAM PI Team will strive to minimize poor assessments by continuing to improve training, encouraging the use of expert practitioners who have completed certified training programs, encouraging the use of the statewide CRAM database by all practitioners, and by using the database to assess and improve the performance of CRAM practitioners, trainers, and modules.

8.7 Future Review Processes

8.7.1 Regional Review Teams

Regional teams may be established by the CWMW to review CRAM scores used in regulatory decisions. This would include scores used in alternatives analyses and project feasibility studies, scores used in mitigation planning, scores used to establish performance standards for projects or used to define baseline conditions against which project performance is assessed. Each team would service one or more Regional Water Quality Control Boards (RBs). Reasons for the regional approach, and for using the RBs to define the regions are given below.

- Scores used in regulatory decisions will need the highest level of QA/QC. The continuity and consistency of a single review team will help meet that need. The use of different teams to review scores for any state program administered regionally would tend to introduce statistical variability and therefore uncertainty into the reviews. This could be avoided by frequent inter-team calibration, but with significant additional costs.
- A single statewide team would have to either focus on regions sequentially over years and thus not be able provide timely reviews in all regions every year, or would have to be divided into sub-teams, which would effectively be the same as regional teams.
- The Regional Water Boards (RBs) have been identified by the CWMW as the administrative regions for the WRAMP.
- There are ecological, climatological, and political/sociological differences among the regions as generally defined by the boundaries of the RBs that need to be reflected in the applications and interpretations of CRAM scores.
- The RB boundaries are generally consistent with watershed boundaries and thus support the watershed approach to aquatic resource protection that is gaining prominence through state and federal policies and programs including 404, 401/WDR, and many TMDLs.
- It is expected that most of the CRAM reviews will pertain to regulatory decisions involving the RBs.
- The review scores will be stored with other CRAM data in the Regional Data Centers that service one or more RBs.

Regional teams are not necessarily the only source of CRAM reviews. As explained below, reviews might be done by the same or other reviewers working apart from the regional teams for non-regulatory purposes.

It is recognized that the formation of a regional review team is likely to happen in phases, as describe below. Table 3 provides a summary of the status of regional review team development.

Phase I: Development Team. At this phase, some regional and local regulatory and management agencies have some experience with CRAM but none are using it as a regular part of wetland or stream assessment. The pertinent Regional Water Board has recognized the need for a regional review team, however, and has asked the CWMW to assist with its formation. Members of the development team must include at least one member of the L2 Committee and should also include CRAM trainers with enough expert understanding of the particular nature of wetlands within the region to discern how the regional nature of wetlands might influence CRAM scores. The development team can also include representative staff from agencies that will be using CRAM scores. The development team coordinates the regional roll out of CRAM.

Phase II: Regional CRAM Roll Out. At this phase, the Regional Water Board has begun to explore the use of CRAM for ambient surveys or other applications, and/or recognizes the benefits of CRAM to other agencies within the region. The development team is led by a member of the L2 Committee, is recognized by the CWMW as a growing concern, and is working with the L2 Committee to develop CRAM trainers who mainly operate within the region and who qualify as candidate reviewers.

Phase III: Advanced Training. At this phase, the Regional Water Board has decided to proceed with the establishment of a regional review team, based in part on the outcomes of Phases 1 and 2. The development team now transitions into the review team. A pool of 5-10 qualified candidate reviewers is created based on the training that happened in Phase 2 plus additional training. All candidates will have accomplished the training for CRAM trainers as implemented through the L2 Committee. Candidates can be recruited from neighboring regions as appropriate.

Phase IV: Review Team. At this phase, CRAM is an integral part of project assessment and/or ambient surveys of wetland and stream condition. There is a regional pool of 5-10 reviewers who work through the L2 Committee to maintain their qualifications by being re-trained on new or revised CRAM modules and by serving as trainers. Ideally, the Regional Water Board has one or more staff serving on the review team, and at least one person serving as a liaison between the review team and the Regional Water Board.

Table 3. Status of CRAM review teams for the Regional Water Boards and corresponding USACE Districts.

Regional Water Board	Corresponding USACE District	Phase I: Development Team	Phase II: Regional Assessment Team	Phase III: Qualified Training Team	Phase IV: Formal Review Team
North Coast (Region 1)	San Francisco	Y	Y	Y	N
SF Bay (Region 2)	San Francisco	Y	Y	Y	N
Central Coast (Region 3)	San Francisco	Y	Y	Y	N
Los Angeles (Region 4)	Los Angeles	Y	Y	Y	N
Central Valley (Region 5)	Sacramento	Y	Y	Y	N
Lahontan (Region 6)	Los Angeles	N	N	N	N
Colorado River (Region 7)	Los Angeles	N	N	N	N
Santa Ana (Region 8)	Los Angeles	Y	Y	Y	N
San Diego (Region 9)	Los Angeles	Y	Y	Y	N

8.7.2 CRAM Database Review

It is expected that the CRAM database will enable the L2 Committee to identify systematic error suggesting bias among CRAM scores for any project, registered practitioner, trainer, or CRAM module. The intent is to enable the L2 Committee or other entities selected by the CWMW to test for systematic bias so that it can be remedied through improvements in CRAM modules or in CRAM training. The indicators of bias will vary depending on the purpose of the CRAM scores. The following scenarios are presented to illustrate how the database might be used to explore possible bias due to the selection of assessment areas, the CRAM module, or the practitioners.

Reference sites are elected to represent very high-quality condition. There should not be low scores for reference sites. Scores for ambient surveys involving large areas should be broadly distributed around relatively abundant mid-range scores. The distribution of scores should not be positively or negatively skewed due to a preponderance of low scores or of high scores.
In mitigation planning, impact sites tend to have low scores relative to reference sites due to efforts to avoid or minimize impacts to high-quality areas. There should not usually be a preponderance of high scores for impact sites.

Newly created mitigation sites and newly restored sites tend to have low or moderate initial scores because their conditions have not yet fully developed. There should not usually be a preponderance of high initial scores for newly restored sites or for newly created or purchased mitigation sites.

9.0 GLOSSARY

CRAM Score Reviews - Reviews may be used to evaluate how effectively CRAM practitioners comply with the minimum QC specifications outlined in the QC plan. It is important that the reviewer be independent of the sponsoring agency as much as possible as to be able to provide an objective assessment of the processes and data evaluated.

***e*CRAM** – refers to the online, password-protected system for entering CRAM assessment data, downloading data, and generating pdf summary reports.

Expert peer review - consists of a review of assumptions by experts in relevant technical fields. The objective of the expert peer review is to ensure that the assumptions and general approach of CRAM are reasonable as judged by those knowledgeable in the specific field.

QA/QC plan – is an internal document to organize, plan and implement QA/QC activities. The plan should, in general, outline QA/QC activities that will be implemented, and include a scheduled time frame.

Quality assurance (QA) - activities include a planned system of review procedures conducted by personnel not directly involved in the CRAM development process to verify that data quality objectives are met, ensure that the data produced represent the best possible estimates of wetland condition given the current state of scientific knowledge and data available, and support the effectiveness of the overall quality control (QC) program. QA activities include reviews and expert peer reviews.

Quality control (QC) – is a system of routine technical activities, to measure and control the quality of the data produced. The QC system is designed to:

- Provide routine and consistent checks to ensure data integrity, correctness, and completeness;
- Identify and address errors and omissions;
- Document and archive inventory material and record all QC activities.

QC activities - include general methods such as accuracy checks on data acquisition and calculations and the use of approved standardized procedures for emission calculations, measurements, estimating uncertainties, archiving information and reporting. Higher tier QC activities include technical reviews of source categories, activity data and emissions factors, and methods of estimation.

Quality Objectives - The objectives of QA/QC activities for CRAM are to improve transparency, consistency, comparability, completeness, accuracy, confidence in all CRAM data produced.

Transparency - the assumptions and methodologies used should be clearly explained to facilitate replication and assessment of the data by users of the reported information. The transparency of inventories is fundamental to the success of the process for the consideration, communication and dissemination of information;

Consistency - an inventory should be internally consistent in all its elements over a period of years. An inventory is consistent if the same methodologies are used for the base year and all subsequent years and if consistent data sets are used to estimate emissions or removals from sources or sinks. The inventory using different methodologies for different years can be considered to be consistent if it has been recalculated in a transparent manner, in accordance with the IPCC GPG;

Comparability – CRAM data should be comparable among all practitioners of the method. For this purpose, practitioners should use the methodologies and formats recommended by the L2 Committee of the CWMW

Accuracy – is a relative measure of the exactness of a CRAM score. Estimates should be accurate in the sense that they are systematically neither over nor under the true score, as far as can be judged, and that uncertainties are reduced as far as practicable;

Timeliness - submission of the complete inventory by the deadlines specified in the relevant decisions or other documents.

Verification – verification processes are intended to help establish the reliability of the data produced. These processes may be applied at either national or global levels of aggregation and may provide alternative information on annual emissions and trends. The results of verification processes may:

- Provide inputs to improve the method;
- Build confidence in estimates and trends in wetland condition;
- Help to improve scientific understanding related to the data produced.

APPENDIX 1. SUMMARY OF KEY STEPS FOR OBTAINING SCIENTIFIC PEER REVIEW

Summary of Key Steps for Setting Up and Obtaining External Scientific Peer Reviews
(Detail provided in Exhibit F)

1. Cal/EPA organization writes request for reviewers to Cal/EPA Program Manager for External Scientific Peer Review (in draft first). The request consists of four parts, all described in detail in Exhibit F :

    a) Cover letter providing brief context for request, schedule for review, and expertise needs.
    b) Attachment 1 - Plain English Summary of regulatory proposal or other initiative subject to review.
    c) Attachment 2 - Listing of scientific conclusions or assumptions subject to review, placed in regulatory context.
    d) Attachment 3 - Listing of participants developing proposal or initiative. By statute, they cannot serve as reviewers.

2. Cal/EPA Program Manager forwards final request to University of California (UC) for action.

3. UC solicits reviewer candidates and identifies those willing to participate. Candidates are sent complete letter of request with its three attachments during this solicitation process. Willing candidates are asked to complete Conflict of Interest Disclosure form and forward it to Cal/EPA-designated independent entity for review.

4. After vetting of candidates, Cal/EPA Program Manager writes formal response letter to requesting organization identifying approved reviewers.

5. Cal/EPA organization writes each approved reviewer separately to initiate the review, and provide instructions.

6. Reviewer sends completed review to Cal/EPA organization which requested it.

APPENDIX 2: CRAM REVIEW FORM TEMPLATE

Worksheet I. Basic Review Information

1. **Date of Review/Site Visit(s):**_____
2. **Review Team Leader and Affiliation:**
   _____
3. **Additional Review Team Members and Affiliations:**_____
4. **Agency(s) Requesting Review:**_____
5. **Date(s) of Original CRAM Assessment(s)** _____
6. **Project Name/Geographic Location**: _____
7. **Individual(s) being evaluated (list all names and affiliations)**:
   _____
8. **List all site(s) that were reviewed as part of the project (if applicable). Provide the site name, unique site IDs, the type of wetland assessed, and GPS coordinates for each review site. The CRAM AA code (from eCRAM) can be used as the unique site ID. Use a separate review form for each site reviewed.**

	Site Name/ID No.	Wetland Type/ Subtype	Latitude	Longitude	Special Notes
1					
2					
3					

Worksheet II. Practitioner Qualifications and Preparedness

Answer the following questions below to determine if the assessment team was sufficiently prepared to conduct the CRAM assessment(s). Use space below each question for any explanation/special circumstances. 0 (no requirements have been met); 1 (one requirement has been met); 2 (two requirements have been met); 3 (three requirements have been met); or 4 (all three requirements have been met).

a. At least two practitioners conducted the CRAM assessment □ yes □ no
b. At least one assessment team member completed a 3-day training within the past five years for the wetland type being assessed □ yes □ no
c. The assessment team leader is registered as a CRAM practitioner (or trainer) in the CRAM database □ yes □ no
d. Most recent CRAM User's Manual, field book, and field forms were used □ yes □ no

Score _____

Worksheet III: Assessment Completeness

Evaluate the following aspects of the CRAM assessment(s) for completeness and correctness for all sites reviewed to determine if the meet the minimum QA/QC requirements were achieved? *Use space below for any explanation or special circumstances.*

Was the correct wetland class and subclass identified? □ yes □ no
Were CRAM assessment window considerations properly noted and guidelines adhered to? □ yes □ no
Was the CRAM Assessment Area properly identified? □ yes □ no
Was the boundary between the CRAM Assessment Area and the buffer properly demarcated? □ yes □ no
Was the CRAM stressor checklist completed for each CRAM attribute? □ yes □ no
Were the CRAM basic information form, score sheets, and worksheets properly completed? □ yes □ no
Appropriate explanations, photographs, and any supporting materials were provided □ yes □ no
If applicable, a relationship to similar or nearby sites with similar conditions (e.g. reference sites) was established. □ yes □ no □ NA
Special Notes:

Score _____

0 (no requirements have been met or there is no suitable map of the assessment area); 1 (in addition to providing a suitable map, one requirement has been met); 2 (in addition to providing a suitable map, two to three requirements have been met); 3 (in addition to providing a suitable map, three to four requirements have been met); 4 (in addition to providing a suitable map, four to five requirements have been met); or 5 (**all** requirements have been met).

Worksheet IV: Suggested Corrective Actions

Practitioner Preparedness	
Final Score	
Corrective Action or Additional Information Requested	□ yes □ no
Corrective Action(s) requested (list)	
Completeness of Assessment	
Final Score	
Corrective Action or Additional Information Requested	□ yes □ no
Corrective Action(s) requested (list)	

Worksheet V: Assessment Accuracy. Use as many tables as necessary if multiple sites are being reviewed.

Index Scores			
Assessment	Review	Difference	Target Precision

Landscape/Buffer Attribute Scores			
Assessment	Review	Difference	Target Precision

Hydrology Attribute Scores			
Assessment	Review	Difference	Target Precision

Physical Structure Attribute Scores			
Assessment	Review	Difference	Target Precision

Biological Structure Attribute Scores			
Assessment	Review	Difference	Target Precision

Metric Scores				
Metric (replace numbers with metric names)	Assessment	Review	Difference	Target Precision
1				
2				
3				
4				
5				
6				
7				
etc.				

Notes for any problematic metrics and/or sites:_____

Overall Assessment Quality. Check best-fit description.

- o Good (meets all of the on-site and off-site procedural requirements, and meets the accuracy requirements for all attribute scores and the overall index score)
- o Fair (meets the accuracy requirements but does not meet all of the on-site or off-site procedural requirements).
- o Poor (does not meet the accuracy requirements for one or more attributes or for the overall index score)

Review Lead Signature_____

Date_____

Review Member Signature_____

Date_____

Final Review Checklist (check if attached)

- Review team members' statements of independence and qualification (required)
- Completed review report and worksheets (required)
- Review site visit photos (optional)
- Records of contacts with non-team experts or sources of supporting materials, including location of voucher specimens used to verify plant species and/or the correct contact person for them is clearly identified. (optional)
- Additional supporting materials (optional)

Suggested causes for inaccurate scores or other shortcomings of the assessment (optional)