MONITORING AND EVALUATION OF CALIFORNIA NATURAL RESOURCES AGENCY INVESTMENTS

Proposed Steps Toward a Consolidated Project Management and Fiscal Accountability System

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Colleagues,

Climate change is driving extreme conditions that threaten the resources, people, and wildlife of California. These threats, which include wildfire, drought, flood, sea level rise, and rising temperatures, demand that we continue to improve our stewardship of our state's natural resources. Toward this end, we are prioritizing building science-based tools to optimize the policy and management decisions we make each year.

In coming months we are developing a centralized way to track effectiveness of our bond-funded projects and learn from these investments. This includes establishing pragmatic, informative scientific metrics to measure projects' effectiveness and building a system to track how projects perform over time. We believe these tools will enhance science-based decision-making, guide future Agency investments, and strengthen partnerships across and beyond our agency.

To shape this effort and to make sure it hits the mark, we need your help. We are excited to invite you as our Agency's granting entities to join us in developing this coordinated monitoring and evaluation network. As a first step, we are pleased to share a white paper here that outlines proposed steps toward this monitoring and evaluation network. Next, we request your participation in upcoming workshops to further shape this network. Our first workshop will be held in April, and our team will follow up soon with more information about that convening.

I'm passionate about enhancing our ability to deliver environmental improvements across the state, which is part of our "Cutting Green Tape" initiative. I believe this effort to strengthen our monitoring and evaluation will contribute to this important priority. I believe that it will also help us communicate how public investments are improving California and help us make a strong case for sustained natural resources investment into the future.

I look forward to your participation as we advance this important work.

Wade Crowfoot
Secretary for Natural Resources

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GLOSSARY of COMMON TERMS

Adaptive Management: a phased approach to developing, learning from, improving or maintaining the outcomes of a project or program reflecting the following phases: Plan, Design, Implement, Monitor and Evaluate.

Baseline monitoring: preliminary documentation of the status and condition of a resource or area used for future comparisons over time.

Compliance monitoring: monitoring to verify that environmental regulations or statutory requirements are aptly applied and followed.

Effectiveness monitoring: a comprehensive analysis conducted to understand the extent to which management practices or project features are effective at meeting their performance objectives.

Evaluation: the organization and analysis of data to build context that provides value or understanding.

Goal: a concise description of a problem and the desired state or status of a situation that depicts realistic outcomes.

Implementation monitoring: an assessment of a project area or design feature to evaluate whether the project features or deliverables were completed as planned.

Indicator: a general gauge used to evaluate, and answer questions related to the achievement of an objective.

Long-term: A period of at least 10 years.

Maintenance period: the length of time a project site is expected to be maintained. These can be 10 years (for grants up to $100,000), 20 years (for grants up to $1 million), 25 years (for grants over $1 million), or in perpetuity (for acquisitions or conservation easements).

Metric: a unique parameter of interest that can be measured to obtain information about the subject(s) of study.

Monitoring: the collection of data taken at regular time intervals and/or locations.

Objective: a goal that explicitly details a project feature's expected results and allows for comparison of what was originally intended with what the project verifiably achieves.

Performance measures: the indicators and associated metrics used to track the status or condition of a given resource over time.

Quality Assurance/Quality Control (QA/QC) protocols: a system of pre-determined checks to ensure consistency across diverse data sources, and corrective actions to manage varied management processes.

Trend monitoring: an assessment of identical measurements of an attribute over time or space.

Validation monitoring: an assessment of the soundness and rationality of research assumptions, models, methods, and proposals.

I. INTRODUCTION

DOCUMENT OVERVIEW

This document describes the history, establishment, and role of the California Natural Resources Agency (CNRA) Monitoring and Stewardship Unit (MSU), lays out a methodological approach for program implementation, and proposes a process to integrate stakeholder priorities into the program development. It was assembled primarily for the network of bond management staff at the State of California who are responsible for the implementation of Proposition 84, the Safe Drinking Water, Water Quality and Supply; Flood Control, River and Coastal Protection Bond Act of 2006, Proposition 1E, the Disaster Preparedness and Flood Prevention Bond Act of 2006; Proposition 1, Water Quality, Supply, and Infrastructure Improvement Act of 2014, and Proposition 68, the California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access For All Act of 2018 and any future bond acts requiring the monitoring of project performance post-completion for work relating to the management of California's natural, cultural, and historical resources. It was also assembled with the expectation that future stakeholder input (from program and project managers, policy- and law-makers, academic and scientific institutions, and the general public) would create the basis for a wider network of information sharing. This paper does not include a mandate or rule, nor is it a template for grants management or a monitoring plan guide. This document is an educational and informational resource that includes a suggested approach for the development of a statewide coordinated monitoring system.

PURPOSE

The Monitoring and Stewardship Unit intends to develop partnerships and coordinate bond program and project informational resources across all CNRA departments, boards, conservancies, councils and commissions administering bond funding (herein referred to as *offices*), to enable more efficient and effective fulfillment of their missions and goals. At the onset, the program aims to derive a common suite of performance metrics to better understand the long-term outcomes of bond-funded projects across a variety of themes and types *[see Tables 1 & 2, below]*. This process will include establishing standard protocols for the collection, storage, and management of project-level data. The application of these performance metrics and protocols may lead to analytical advances that could fill knowledge gaps, increase the State's understanding of the condition of

natural resources, determine and maintain best practices for resources management, and develop strategies to accommodate changes according to commonly accepted adaptive management principles *[see Adaptive Management section below]*.

Current efforts such as AB 1492 (which directs the establishment of ecological performance measures for the State's timberlands and forest ecosystems), and AB 1755 (which implements an 'open and transparent water data platform for California') already address some of the primary and fundamental policy questions related to the management of California's natural resources. These existing efforts, together with the development of more refined monitoring and evaluation protocols for CNRA bond-funded projects, can be leveraged to stimulate better stewardship of California's natural, cultural, and historical resources.

VISION

*The MSU envisions****: a consolidated project performance tracking system used to inform and improve decision-making for policy, investments, and adaptive management, by evaluating the statuses and conditions of the State's investments in California's natural, cultural, and historical resources.*** The system would promote collaboration among CNRA offices, provide a clearinghouse for project data, expand coordination of program resources on areas of statewide importance, advance learning and information sharing, and help increase the cost effectiveness of the State's investments in natural, cultural, and historical resources. Project-level data would be collected based on suites of common metrics and data management protocols (determined through a stakeholder-driven process) that can be systematically applied depending on the project type or theme *[see Tables 1 & 2]*.

The envisioned system would be scalable such that additional funding sources or monitoring data could be applied to bolster its analytical utility over time. For example, remotely sensed landscape data, water quality data, and other research-based or monitoring information that are already collected across various jurisdictions may be incorporated into the monitoring assessment. State decision-makers need tools that can quantify and explain the interactions between State-led investments and ecosystem impacts. This proposed system, which will gather information and provide a mechanism for analytical processes, will be fundamental to ensuring that the most appropriate strategies guide the achievement of the State's policy goals.

Table 1: Project Types

Project Types	
Acquisition / Easement	Acquisition of land for a conservation easement or other purpose
Capital Outlay	New development projects or projects related to infrastructure
Emergency	One-time emergency funding
Operations & Maintenance	Projects designed to improve or maintain the State's natural, historical, and cultural resources (including those related to restoration, water management, fuels reduction, invasive species eradication, vegetation enhancement, etc.)
Planning	Projects related to the development of planning strategies, including permitting, design, etc.
Research	Projects related to research, evaluation of design alternatives, baseline studies, monitoring of resources, etc.

**The above project types generally describe the range of work that is funded by various CNRA programs. Some projects (particularly multi-phased projects) involve more than one project type.*

Table 2: Project Themes

Project Themes	
Agriculture	**Flood Risk**
Air Quality	**Habitat & Ecosystem**
Climate	**Human Health**
Community Engagement/Education	**Recreation & Public Access**
Drought Risk	**Water quality**
Energy	**Water Supply (groundwater)**
Fire Risk	**Water Supply (surface water)**

**The above project themes indicate the topic(s) of focus that narrow(s) the scope of work for the project types described in Table 1. Multiple project themes may be assigned to a single project to portray the complexity of its scope of work.*

BACKGROUND

The State Legislature tasked twenty-two offices[1] with the implementation of the Public Resources Code through the development of programs, procedures and guidelines for the administration of bond-funded programs investing in the conservation, protection, enhancement of and equitable access to natural, cultural, and historic resources across California. Since 2006, these offices have invested over $21 billion in bond funds through the implementation of Propositions 1E (2006), 84

[1] Baldwin Hills Conservancy, Department of Fish and Wildlife, Department of Food and Agriculture, Natural Resources Agency, California Water Commission, California Conservation Corps, California Department of Forestry and Fire Prevention, California State Parks, California Tahoe Conservancy, Coachella Valley Mountains Conservancy, Department of Conservation, Department of Public Health, Department of Water Resources, San Diego River Conservancy, San Gabriel and Lower LA Conservancy, San Joaquin River Conservancy, Santa Monica Mountains Conservancy, Sierra Nevada Conservancy, Sacramento-San Joaquin Delta Conservancy, State Coastal Conservancy, State Water Resources Control Board, and the Wildlife Conservation Board.

(2006), 1 (2014), and 68 (2018) to achieve goals aligning with the CNRA mission and legislative priorities *[see Appendix A for more details]*.

Language in currently implemented Propositions has provided opportunities for post-project monitoring of bond-funded projects. Beginning with Proposition 84, Division 43 of the Public Resources Code, post-project monitoring was mainly associated with implementation of a restoration project, which could, "include the planning, monitoring and reporting necessary to ensure successful implementation of the project objectives" (PRC §75005(n)). Additionally, projects were required to carry out the objectives of the Integrated Regional Watershed Management Plan (IRWMP) or a "functional equivalent" for the project region; the required performance measures and monitoring were conducted at the regional level. Proposition 1 emphasized the collection and reporting of water quality data to the State Water Resources Control Board (SWRCB), and watershed monitoring data to the Department of Conservation (DOC). Although guidelines for competitive grant and loan programs funded under Proposition 1 were encouraged to include monitoring and reporting requirements, no specific guidance indicating how monitoring and evaluation should be included and utilized was developed. Proposition 68, passed in June of 2018, built upon these earlier bond acts, adding that "monitoring may include measuring greenhouse gas emissions reductions and carbon sequestration associated with program expenditures." Proposition 68-funded projects that are currently underway have a means to report on the specific project components that contribute to carbon sequestration or a reduction in greenhouse gas emissions, though further refinement of reporting processes may continue over time.

Partly in fulfillment of Executive Order S-02-07 (Increase Accountability and Ensure Bond Funds are Spent Efficiently by State Government, Schwarzenegger, 2007), the DOF, in partnership with the CNRA, drafted a guidance document, the Bond Accountability and Audits guide, to help bond programs develop more consistent monitoring and evaluation processes. The document advises State agencies to track long-term investments through annual monitoring reports and site visits (when feasible) to ensure that expenditures were made according to the established criteria and processes, were consistent with all legal requirements, and achieved the intended outcomes for the duration of the project life cycle[2]. As summarized in the guide, Executive Order S-02-07 further requires departments to develop strong oversight controls over each project stage in a 3-Part

[2] According to the Bond Accountability and Audit Guide, project life cycle includes five phases: pre-award, award, interim monitoring, closeout, and post-close monitoring.

Accountability Plan. Programs were advised to ensure that post-completion monitoring protocols included at least four components:

1) Results of annual monitoring visits performed,
2) Annual project photos,
3) Signed and approved annual monitoring reports, and
4) Updates on status of corrective actions planned or taken if a project were not in compliance with the agreement purpose.

The implementing offices and their program managers are thus responsible for identifying what project features are monitored, which form of monitoring most appropriately explains the project's return on investment, who conducts the monitoring, and how data would be collected, analyzed, and used. Because each bond-funded program develops guidelines and grant management protocols that align with their appropriating section of the bond statute, these protocols vary from one program to the next. In some cases, monitoring and evaluation protocols are tied to statutory and regulatory frameworks that address public health and safety requirements (i.e. the federal Clean Air Act, California Health and Safety Code, Porter-Cologne Water Quality Control Act, California Environmental Quality Act, California Endangered Species Act, or Lake and Streambed Alteration Agreements). Monitoring and evaluation might also track indicators of climate changes such as the social, economic, and environmental impacts from the increased frequency and magnitude of droughts, wildfires, floods, heat waves, coastal erosion, and/or habitat conversion.

Capital improvement projects are intended to sustain maintenance and operation processes for 10 years (for grants up to $100,000), 20 years (for grants up to $1 million), or 25 years (for grants over $1 million) following project completion, and in perpetuity for acquisitions or conservation easements. However, bond dollars for these maintenance and operations costs may be unavailable, or in the case of Proposition 1 (though this may also hold true for other propositions as well), are only eligible for support during the first two years after the project is complete (PRC §79724(a)(2))[3]. According to bond statutes, monitoring costs are not eligible for reimbursement via bond funding after the close-out of a project contract. Thus, projects receiving bond funds can only support post-completion monitoring beyond the first two years post-completion with funding from non-bond sources.

[3] This option is exercised only at the discretion of the individual bond program managers.

Even if all projects could attain funding to support the long-term monitoring of project performance, there are no standard protocols in place to ensure that monitoring data are collected using similar methods, units, or performance metrics across funding programs. **Lacking consistent and comparable monitoring data, the status and long-term performance of bond investments, after bond-supported grants are fully expended, remain largely unknown or are not easily deducible.** Moreover, the grant programs that do collect post-completion monitoring data have no central hub to deposit and access monitoring information. Without project- and program-specific monitoring protocols and a consistent statewide system for data collection and analysis, **the State lacks access to the data necessary to evaluate the economic, environmental, and social returns on billions of dollars of natural resources investments.**

THE MONITORING AND STEWARDSHIP UNIT

The legislative direction for monitoring (as noted in Propositions 1, 1E, 68, and 84), Executive Order S-02-07 leading to the Bond Accountability and Audit Guidance, and the recognition that project performance monitoring protocols and data availability deviate across State programs or are lacking altogether, contributed to the development of a centralized monitoring coordination program, the MSU. Since its creation in the Fall of 2018, the MSU has been working to fulfill its mission: ***to track and assess the outcomes of resources-related projects using performance-based criteria to inform California's investments in communities and nature.***

Those efforts include:

1) Identifying an inventory of existing natural resources monitoring and evaluation tools in California (including, but not limited to, water supply and quality, wildlife, forest, marine and air quality monitoring programs and their policies, databases, datasets, data management tools, and models).
2) Conducting literature review to discover gaps in the publicly available and accessible data and information across Natural Resources Agency programs.
3) Coordinating a stakeholder-driven approach to developing an agency-wide integrated database for the management and tracking of bond-funded projects.

BOND EVALUATION

As part of a preliminary assessment to understand the status of completed bond-funded projects and inform the development of statewide monitoring protocols for future bond investments, the MSU evaluated a random sample of 389 completed projects[4] across Propositions 84, 1 and 1E. Baseline financial information and other related project details were extracted from the Agency Bonds Consolidated Reporting System (ABCRS) and compared against the official project files obtained (if feasible) from the respective program. The sample is statistically representative of the project population funded by the three aforementioned bonds as of October 2018. It did not include Proposition 68-funded projects since none were yet complete when the sample was derived.

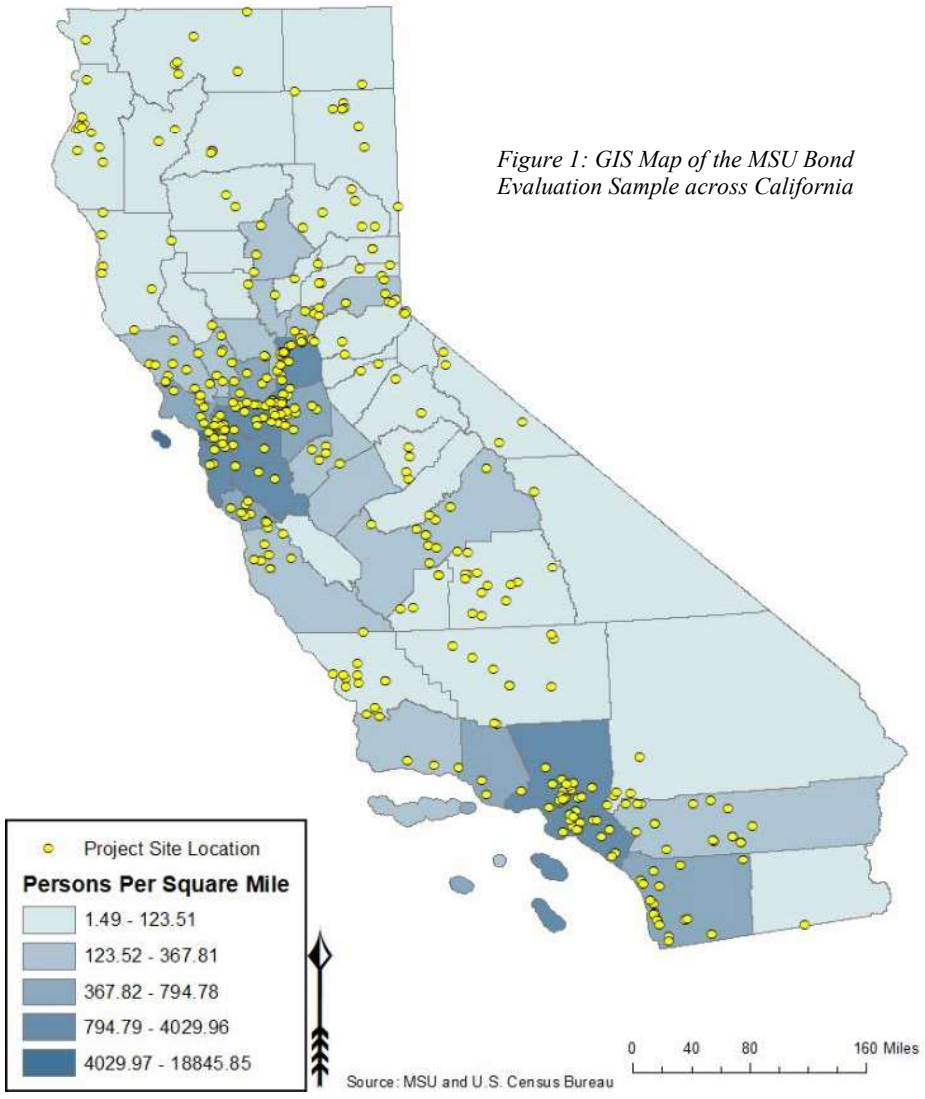
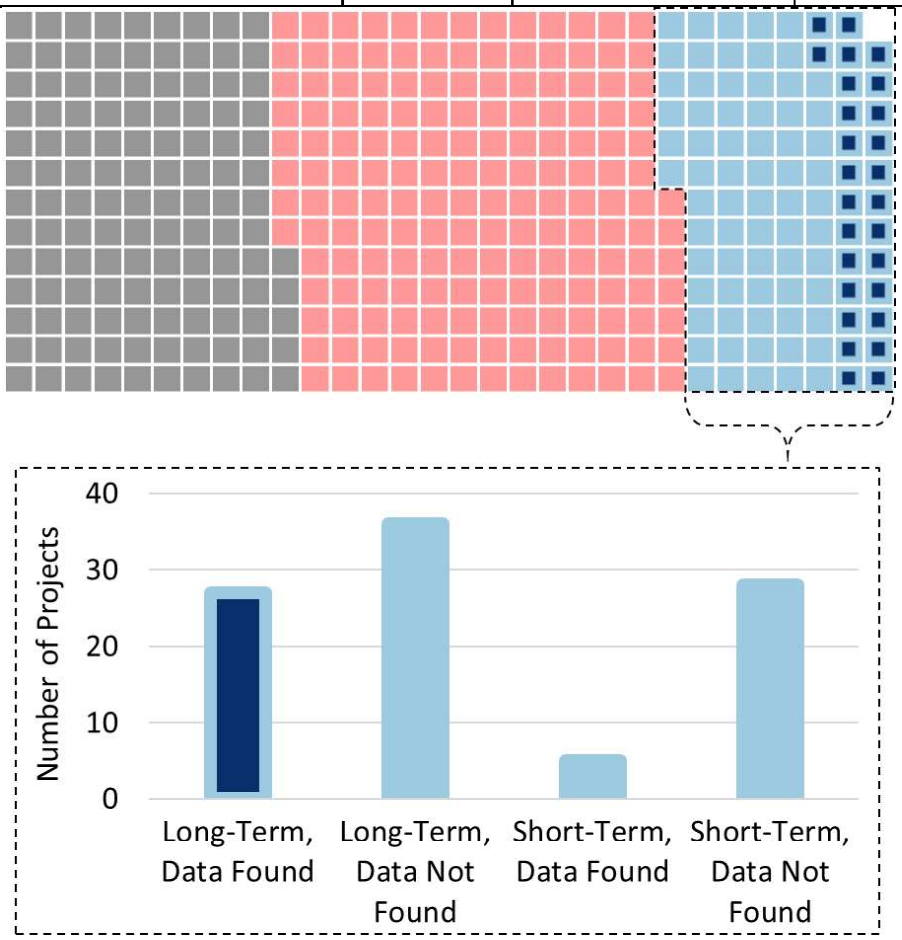


Figure 1: GIS Map of the MSU Bond Evaluation Sample across California

[4] The original sample size was 400 projects. After initial review, 3 of the sample did not represent an actual project and were thus removed from the analysis. An additional 8 projects were determined to have received $0 in bond funds and were excluded. The sample included grants and loan projects, and those that fulfilled program delivery or statewide requirements.

Figure 2: Bond Evaluation-Monitoring Reporting Outcomes

KEY	% of Sample	Mentioned in Bond Statute	Mentioned in Grant Agreement
Expected Long-Term Monitoring: Data Found	**7%**	**Yes**	**Yes**
Expected Long-Term Monitoring: Data Not Found	**9%**		
Expected Short-Term Monitoring: Data Found	**2%**	**Yes**	**Yes**
Expected Short-Term Monitoring: Data Not Found	**7%**		
Planning/Research: Monitoring Not Applicable	**31%**	**No**	**No**
Capital Improvement/Other: No Monitoring Evident	**44%**	**Yes**	**No**



Top: Grey (31%) consists of research, planning or other projects where monitoring plans were not applicable because the work involved did not include any on-the-ground change. Pink (44%) shows capital improvement or other projects where no monitoring plan was evident throughout the available documentation, whereas, light blue (25%) shows the proportion of projects where some plan for monitoring was stipulated in the relevant documentation. The dark blue box (7%) denotes projects within that light blue subset where long-term monitoring data was evidently collected. Bottom: Number of projects where some plan for monitoring was apparent, broken down by the length of monitoring and whether monitoring data was found.

Figure 2, above, shows the number of projects that had specified monitoring plans and the number of projects where a post-completion monitoring plan was evident *[top]*. Among the completed projects evaluated, 25% of the sample (light blue squares on the right-hand side, including those with a nestled dark blue square) had a plan for either short-term or long-term post-completion

monitoring (based on requirements in the grant agreement, program guidelines, scope of work, etc.). A further 44% of the sample projects did not mention monitoring plans and include those for which files were inaccessible or incomplete, or no formal requirement for monitoring was articulated in the relevant documents (e.g. the project's grant agreement). The remaining 31% of the total sampled projects did not yield physical on-the-ground changes to some natural resource (e.g. projects funded to develop a plan or produce a written report). Though this subset of projects may collect data that could be used to inform future analysis, these investments are not expected to include plans for post-completion monitoring. The bar graph breaks down projects where a monitoring plan was available into categories, based on whether the post-completion monitoring was long-term or short-term and whether monitoring data was evident and available to MSU or not throughout the evaluation process *[bottom]*. No evidence of data may reflect a lack of accessibility to such documents due to the way information has been stored, a lack of monitoring conducted for some projects altogether, or some other factor inhibiting access to post-completion monitoring data of projects funded by bond dollars. Altogether, only 7% of the projects in the bond evaluation sample showed evidence of long-term monitoring.

This analysis illuminated the range both of policies and standards that were developed according to bond statutes and accountability guidance documents and of the application of those procedures at the project and program levels. Some programs maintain consistent standards for monitoring and reporting and use those findings to revise management protocols, where appropriate. However, most bond-funded projects in the sample followed project-specific monitoring protocols (if monitoring and evaluation were evident). In other words, **protocols for the collection, storage, management, and analysis of natural resources data are not standard across the collective sample of bond-funded projects evaluated**. Perhaps a result of these wide-ranging data storage and management processes observed, the MSU could not obtain complete project files for 66 cases (17% of sample). This lack of complete information does not necessarily suggest that the documents do not exist, nor imply that projects were not satisfactorily accomplished; it merely detects the current barrier to obtaining what should otherwise be publicly available information.

Much of the information used throughout the bond evaluation process was extracted from the ABCRS, while the official project files (if attainable) for each of the sample projects were referenced to supplement informational gaps in the system. The proportion of projects with

discrepancies[5] in data between ABCRS and the official project files is not unreasonable given that **the database currently has no formalized Agency-wide quality assurance and quality control (QA/QC) protocols for data entry and management**. Thus, there is a statistically significant coincidence of errors in both the amount of total project funding and the collective amount allocated from bond funds ($p = 4\times10^{-8}$, Fisher's Exact Test) suggesting an inconsistency in the proficiency of the ABCRS users to assure and control for the quality of their own data entry. This means it is possible to improve an already functional system by:

1) Augmenting existing QA/QC protocols on the input of data,
2) Providing the requisite training to Grant Managers and other personnel responsible for data entry on these improved QA/QC protocols, and
3) Developing an interface that communicates information across existing databases as a means of reducing redundant data entry by individual users and thereby decreasing the possibility of human error.

[5] Within the 389 complete project evaluations, 40 (10%) showed a difference in total project cost, 38 (10%) showed a difference in the grant or loan amount, and 32 projects (8%) showed discrepancies in both total project funding and amount of bond funding encumbered.

II. MONITORING & EVALUATION

OVERVIEW

Monitoring *is the collection of data taken at regular time intervals and/or locations.* The type of monitoring conducted *[as defined in Table 3]* depends on the questions that the monitoring and evaluation process is designed to help explain. For example, baseline monitoring establishes a starting point for future comparison. Trend monitoring can then be used to understand how a management practice affects the area in question by comparing changes to the area over time with the original (baseline) condition. ***Evaluation*** *is the organization and analysis of data to build context that provides value or understanding.* Together, monitoring and evaluation (M&E) can identify changes and/or trends regarding the status and condition of the natural environment (as compared with a baseline scenario) and help measure the success or performance of an applied management practice. The evaluation of monitoring data accumulated over time can explain long-term trends, inform the application and outcomes of management activities, assess the achievement of compliance requirements, and generally capture an understanding about the status of resources, habitat, wildlife, fisheries, and other public values.

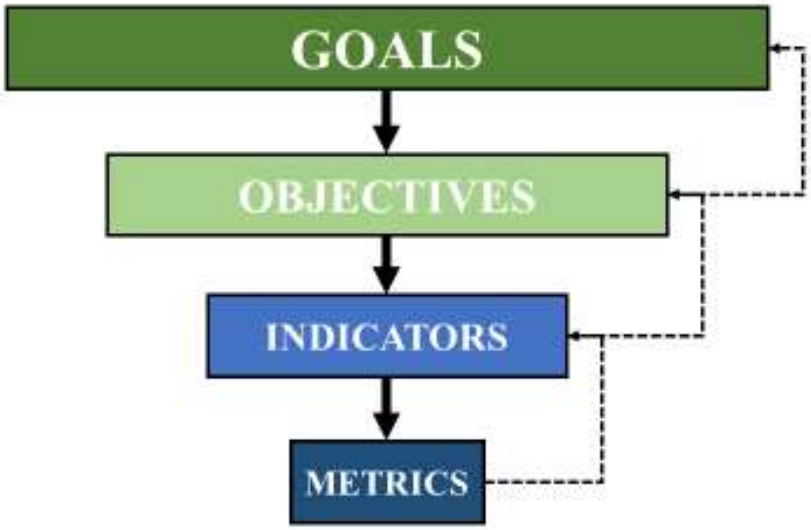
Table 3: Types and Definitions of Monitoring and Evaluation applicable to CNRA projects

Monitoring & Evaluation Types and Definitions	
Baseline	Baseline monitoring establishes a preliminary understanding about a given resource or project area by its condition prior to the application of a management activity. Baseline Monitoring is a common starting point for projects and long-term monitoring efforts when similar measurements can be taken over time or across locations. By understanding and documenting the original conditions of a given site, it is possible to understand how management practices are corollary or potentially causational of changes to that site over time.
Implementation	Implementation monitoring is an assessment of a project area or design feature to evaluate whether the feature or deliverable is completed as planned. Implementation tends to be more limited in term, considering the project components directly before and after a project is complete.
Trend	Trend monitoring includes the assessment of consistent measurements taken over time to determine the condition of attributes. Trend monitoring considers the differences between two or more sampling events of the same feature taken over a period of time. It may also consider different geographical areas evaluated across the same timeframe.
Effectiveness	Effectiveness monitoring comprehensively analyzes the function of specific project features and the extent that a management practice is effective at meeting its performance objectives. Effectiveness monitoring considers causal relationships between management activities and the conditions of resources.
Compliance	Compliance monitoring is a verification that environmental regulations or statutory requirements are aptly applied and followed.

**Adapted from MacDonald et al. (1991).*

A typical monitoring program relies on four main elements: goals, objectives, indicators, and metrics, all of which are driven by some management-related question (i.e. *What is the return on investment for the State of California's bond-funded projects?)*. A ***goal*** *broadly describes a problem and the desired state or status of a situation or project area yet depicts realistic outcomes.* Objectives then call attention to a specific feature of the problem or proposed solution based on the feature of a goal they explain. ***Objectives*** *are practicable goals that explicitly detail a project's expected results and allow for a comparison with what the project verifiably achieves*.

Figure 2: Key Elements of a Monitoring Program

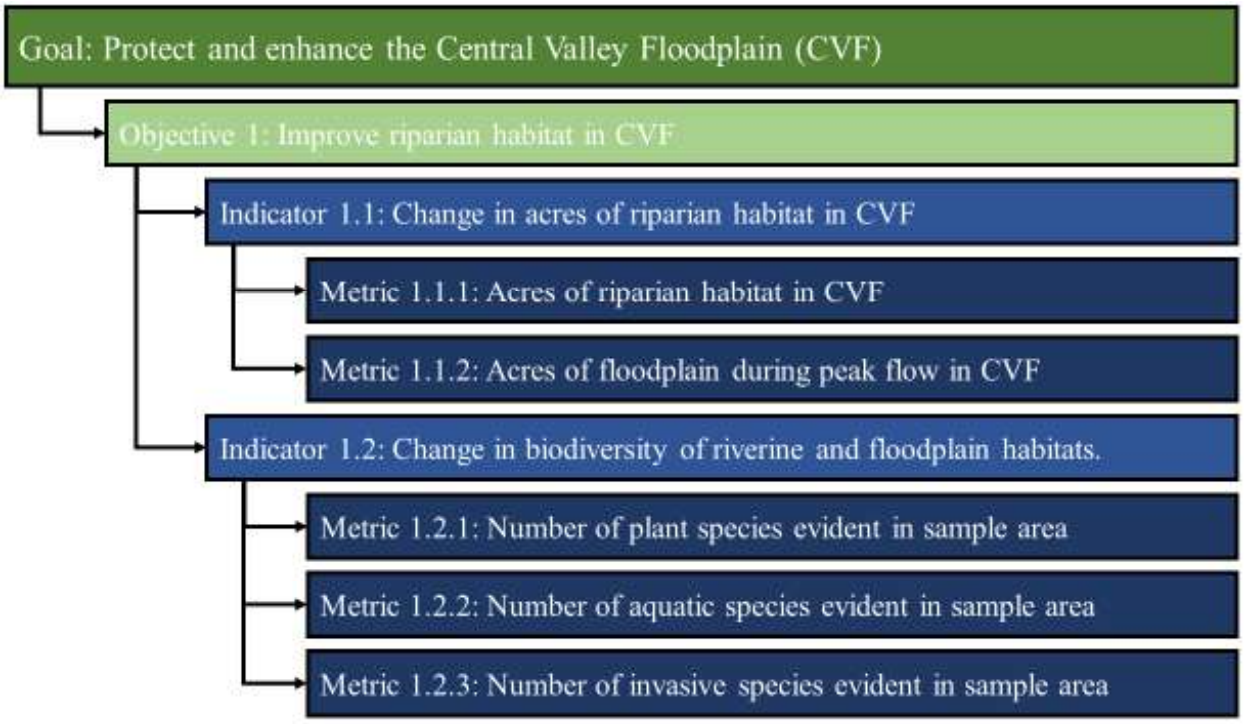


Measuring and tracking objectives includes the development of indicators and metrics. *An* ***indicator*** *is a carefully selected gauge used to evaluate and answer questions related to the achievement of an objective*. Indicators rely on the deliberate selection of specific metrics which, taken together, can elucidate information about a project's performance. *A* ***metric*** *is a unique parameter of interest that is measured to obtain information about the subject(s) of study*. One or more metrics make up an indicator and can be evaluated collectively to inform about the performance of an activity or status of a project element. Metrics are fundamental to informing indicators, and accordingly, the objective(s) and goal(s) that inspire them.

Figures 3 and 4, below, show how two different goals can be broken down into measurable parameters by first recognizing a targeted objective that can achieve the goal in question and determining more specific attributes (indicators and metrics) used to track how those goals are achieved. Each example does not comprehensively show all the potential objectives, indicators and metrics that could be derived from the original goal. A rigorous screening process *[see Criteria for Effective Program Design, below]* should be applied to ensure that only the most appropriate and measurable indicators and metrics are used to guide the monitoring and evaluation process.

Figure 3: Example—Urban Forestry Climate Change Adaptation

Figure 4: Example—Adapted from Central Valley Flood Protection Plan



CRITERIA FOR EFFECTIVE PROGRAM DESIGN

The strength of a monitoring program depends on adequate funding, personnel capacity, and carefully derived measurement parameters used to inform an adaptive management process. Monitoring programs can fail when one or more of these elements are strained or not clearly defined. Those failures are only compounded by inadequate questions, inappropriate study design (Lindenmayer and Likens 2010), failure to consider the complexity of ecological systems, vaguely defined monitoring goals and protocols (Dale & Beyeler 2001), blindly adopting uniform protocols across diverse ecosystems or project sites (Unnasch 2008), inaccessibility of appropriate expertise, alternative political priorities and many additional challenges. Because data collection protocols and periods of monitoring can vary, "many long-term research initiatives suffer from inconsistencies that do not allow for integrating data among sites," (Haase et. al 2017). Therefore, it becomes difficult to compare the outcomes of one project to another unless data needs are considered and included in the project design before the data collection process even begins.

The successful development of a monitoring and evaluation process requires requisite funding and infrastructure, properly-trained personnel, and a system for collecting, evaluating, and using monitoring information. The process should include the identification of long-term goals and objectives that are, "sufficiently representative and at the same time easy to understand and measure on a routine basis" (Shomaker 1996). Objectives should be SMART, or **Specific, Measurable, Achievable, Representative, and Time-Sensitive** *[see Table 4]***.** Indicators should also adhere to the SMART framework and provide direction toward a unique feature of a project that can be measured over time. From there, management questions will help pare down which indicators and metrics should be considered for the collection and analysis of quality data. Some suggest that selection criteria should include: *policy relevance, analytical soundness, measurability* (Niemeijer & Groot 2007, OECD 2001). Others recommend considering indicators that are sensitive, cost-effective, relevant, scientifically valid, easily understood and communicated, and applicable with a known response to disturbances, anthropogenic stressors, and changes over time (Baldera et. al 2018; NRC 2000 p.7; Dale & Beyeler 2001). The final metrics and the process for monitoring them should be specific enough that regardless of the time or location measurements are taken, and irrespective of the individual conducting the monitoring, data are collected consistently.

Table 4: SMART Criteria for Developing Objectives

Criteria	Consideration
Specific	Does the objective focus on a single feature of the project?
Measurable	How easy will the objective be to measure? Can it be measured without extensive expertise and equipment? Does it consider one single attribute that nearly any individual could consistently measure?
Achievable	What are the funding needs, personnel expertise and capacity that will be required to measure the objective?
Representative	How will measuring the objective represent the performance of a project feature?
Time-sensitive	Is it possible to measure the objective repeatedly over time?

**The SMART Framework was originally introduced by George T. Doran in 1981 and adapted widely thereafter.*

Data collection should start with a sampling design that defines the measurement parameters, research methodology, and intended times and locations for recording measurements, as well as how the data will be reported and stored and where interested parties could access the ensuing information. It should be further informed by deductive consideration of the resource management questions that the collected data will help address as well as the statistical and/or numerical methods that will test hypotheses of interest in a scientifically defensible way. Proper data management necessitates stringent QA/QC protocols. ***QA/QC protocols*** *are a system of pre-determined checks to ensure consistency across diverse data sources, and corrective actions to manage varied management processes*. They should initiate early in the project design process to ensure the highest quality data and, in the case of a statewide integrated reporting system, create a process by which all information stored can feed into a larger network. QA/QC protocols applied consistently across all monitoring and evaluation efforts help ensure that data are valid, defensible, and of recognized quality.

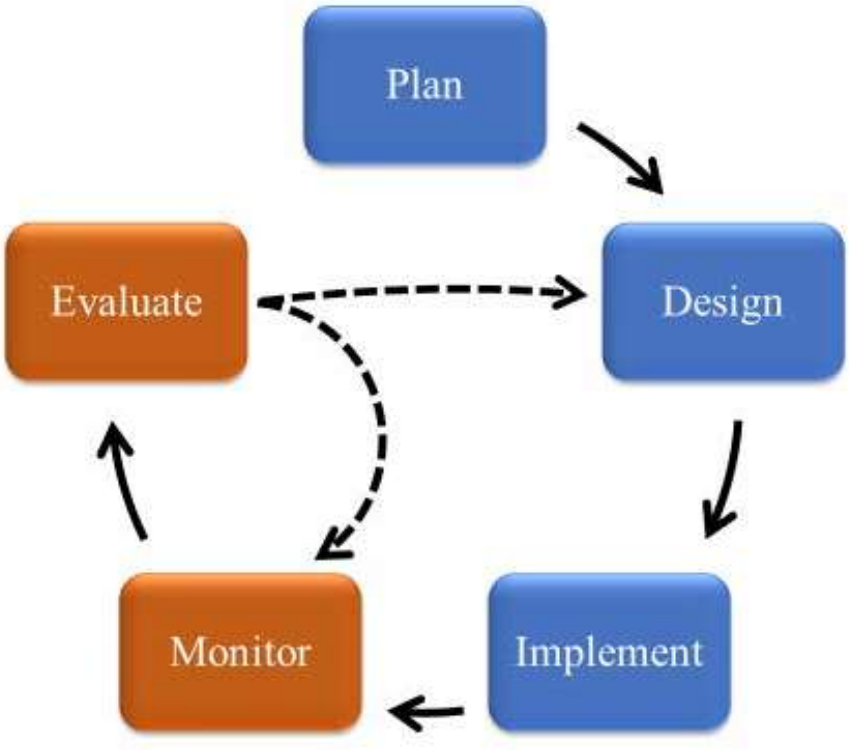
Monitoring and evaluation protocols vary necessarily project to project. The appropriate professionals with expertise relating to the resource, area, or proposed practice in question (planners, managers, engineers, statisticians, ecologists, biologists, and maintenance professionals) should be consulted during the project/program design phase to ensure that monitoring and evaluation protocols are designed appropriately to consider distinct project elements. Ideally, indicators, together with the metrics used to measure them, would be uniquely designed for a project's unique features; however, **the comparability of project-specific data at a statewide scale will depend on establishing common metrics that can be applied to similar project types and/or themes**.

For example, consider two projects that were both designed to restore native wetland habitats. The first restored wetland, upland and riparian habitat for wintering, migratory, and breeding birds. The second restored wetland habitat in an area that had been conventionally farmed for decades by removing anthropogenic toxins and debris from the site and planting a variety of native plant species, such as Willow, Harrow Manzanita, and Coastal Live Oak. Though both projects generally identified the same goal to *restore riparian habitat*, the approaches for tracking those restoration efforts differed based on site-specific conditions and programmatic priorities. Metrics for the first project reflected observed counts of: the number of birds, and eggs laid and hatched at specific nesting locations across regular time intervals in addition to other local species of interest (including predators). Though the first site was planted with perennial grasses and cereal grains, only changes in the observed counts of the wildlife species of interest were used to track success of the restoration effort. Conversely, the second project was not designed to track wildlife species but rather indicators concerning water quality, soil health, and plant species diversity surrounding the project site. Both monitoring approaches are legitimate, yet the raw data collected from the two sites are incomparable since there are no common metrics associated with both projects. If each project were alternatively tracked to collect data for a common metric or suite of metrics, those data could be used to inform the analysis of restoration practices across a wider geography, compare restoration strategies, and assess how site conditions and management practices relate.

ADAPTIVE MANAGEMENT

Adaptive management *is a phased approach to developing, learning from, and improving or maintaining the outcomes of a project reflecting the following phases: Plan, Design, Implement, Monitor and Evaluate*. In adaptive management, data collected in the monitoring phase and outcomes generated through the evaluation process are used to decide whether a project will continue to be managed according to the original project management strategy or will require a revision in the design of the management plan (i.e., cycle back to the design phase) *[as shown in Figure 5]*.

Figure 5: Adaptive Management Cycle



The Adaptive Management *planning phase* includes research about the environment and problem at hand, and eventually prescribes general solutions to the identified problem. The *design phase* establishes specific features of the future project, including the materials, timeline, budget, personnel requirements necessary for implementing a successful project. Once the project designs are complete, the project enters the *implementation phase* whereby the prescribed solutions or actions are physically applied.

Though monitoring and evaluation are key to the cycle of adaptive management, monitoring and evaluation are not always included in the long-term maintenance plan. Lacking documentation, it is not possible to know with confidence whether a prescribed solution to a problem in fact achieves its intended purposes, or what adjustments to the management strategy are necessary to accomplish a project's goals. An adaptive management system should include an ongoing *monitoring phase* whereby data are collected using pre-determined metrics. Those data inform the *evaluation phase* where a determination is made: either the project is functioning or performing as intended, in which case the monitoring phase will begin again, or the monitoring data indicates an adjustment to the management process is needed to achieve the project objectives and goals. In this case, the project would then return to the design phase and continue around the cycle.

Natural and/or human factors can affect the outcomes of an intended project objective at any point throughout a project lifecycle. For example, the effects of drought or flooding can degrade the conditions of a restoration project during the early phase of plant establishment. If that project site is not regularly monitored, the drought and/or flood can eradicate the established vegetation before project managers have a chance to adapt the site management strategy to be more resilient to such events. **Lacking access to consistent project performance information, decision-makers are missing a fundamental means to inform investment and management choices**. With an adaptive management feedback loop in place, however, project managers gain access to data that can inform more effective stewardship of natural resources, even amid potential stressors.

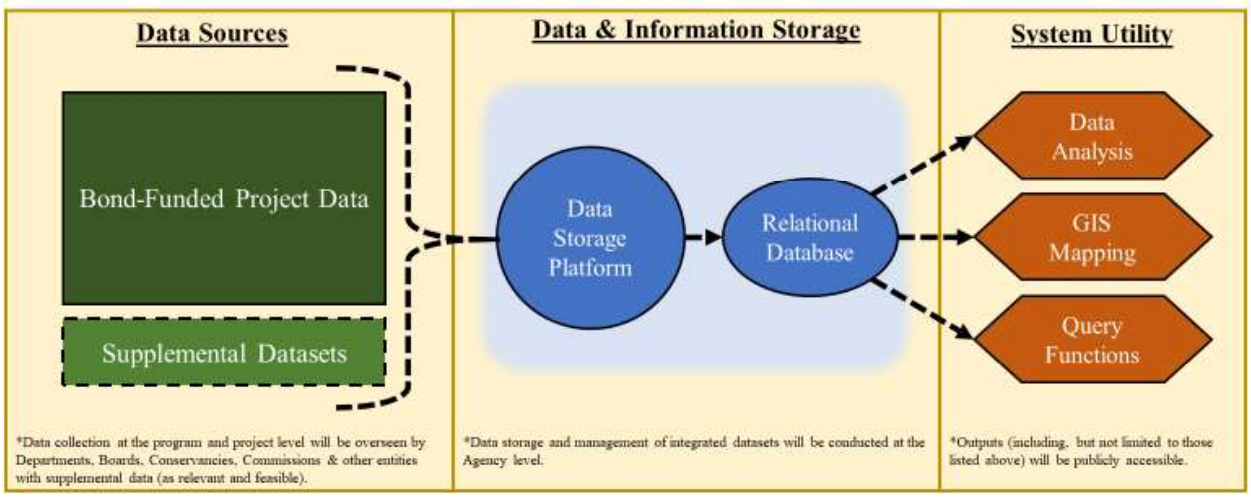
III. PROPOSED STRATEGY

MSU, collaboratively with stakeholders, and with support from the California State University Sacramento Consensus & Collaboration Program, intends to lead and facilitate two concurrent processes:

1) The identification of common suites of metrics across CNRA project themes and types to track the long-term performance of bond-funded projects.
2) The development of a relational database system and data management and QA/QC protocols that will enable spatially explicit analysis at multiple scales.

While the exact tool design and development will require future stakeholder input, project-level data (collected in keeping with the forthcoming stakeholder-derived metrics and more stringent QA/QC protocols) could be uploaded and hosted on a publicly accessible data storage platform such as the CNRA Open Data Platform (ODP). The resulting relational database would aggregate information from these and possibly other supplemental datasets hosted on the data storage platform into a single location. This would generate the ability to compare, combine, and produce a variety of analytical functions including spatial analytics and query functions using keywords or other pre-defined search criteria. The future system may additionally offer lifecycle grant management capabilities and the ability to extract relevant data from existing data sets stored within other systems. This could vastly reduce the instances of data entry errors, contributing stronger and more reliable data and analytical opportunities.

Figure 6: Relational Structure of Proposed Data Collection and Management System



Project-level data alone may not be sufficient for capturing the full suite of metrics needed to understand the performance of management strategies at a landscape scale. As envisioned in *Figure 6*, above, the future system may leverage supplemental data to enhance the data collected from bond-funded projects. Water resources monitoring data, for example, is currently collected through the California Statewide Groundwater Elevation Monitoring (CASGEM), California Environmental Data Exchange Network (CEDEN), Surface Water Ambient Monitoring Program (SWAMP) and other state data repositories that are aggregated within the CNRA ODP. Other programs that capture a variety of data related to the state's biodiversity include: the California Natural Diversity Database (CNDDB), A California Cooperative Anadromous Fish and Habitat Data Program (CalFish), Eco-regional Biodiversity Monitoring (EBM), and Vegetation Classification and Mapping Program (VegCAMP). Wide-spread assessments related to land types and forestry inventory leverage the collection and evaluation of data across the Fire and Resource Assessment Program (FRAP), Sierra Nevada System Indicators Network (SNSIP), Forest Inventory and Analysis (FIA) Program, and the forthcoming implementation of the Timberland Ecosystem Monitoring and Assessment (AB 1492 Timber Fund Program), among many more. Depending on the project type(s) and theme(s) in question, the availability of project-level data, and the management questions driving the analytical process, these supplementary datasets may fill informational gaps and enhance the overall analytical capabilities of the entire proposed system.

The collection and integration of these diverse datasets particularly necessitates stringent QA/QC protocols to ensure comparability when relating information from one dataset to another. With stakeholder input, the MSU will help develop these QA/QC protocols, identify realistic and appropriate performance metrics, and incorporate known data management, informational, and analytical needs into the design of the final system.

OUTREACH & STAKEHOLDER PARTICIPATION

The MSU will coordinate and, with support from the California State University Sacramento Consensus & Collaboration Program, facilitate stakeholder engagement opportunities, in the form of a series of workshops and focused working group meetings, to guide a collaborative and consensus-driven program development process. Stakeholders, including bond program managers, technical and scientific staff, academics, representatives from partner agencies, non-profit

organizations, etc., will be invited to comment on the proposed project tracking and data management system throughout key steps of the system development process. For example, program-level users should be consulted to determine program goals and priorities, the feasibility for program staff to either conduct or oversee project-level monitoring, and the functional needs and desired outputs of the final system. Other subject matter experts (ecologists, biologists, engineers, foresters, etc.) should help determine and/or refine the appropriate metrics based on the project or ecosystem in question. The proposed process aims to build consensus on common practices, outstanding needs, and potential solutions, and to achieve a more coordinated monitoring and evaluation network across CNRA and its many offices. The MSU will lead general meetings and workshops and help coordinate the formation of more focused interest groups to derive specific metrics and monitoring and evaluation protocols.

Stakeholder considerations should include (but will certainly not be limited to) the following:

- What data are necessary for assessing project performance?
- What data do programs have the capacity and expertise to reasonably collect?
- Should all bond-funded projects be tracked? Or should a subset (i.e. 10%) be tracked based on risk-based selection criteria?
- Who should be responsible for conducting the monitoring at a specific site (grantee, third party or program staff)?
- Who should be responsible for entering data into the system?
- What datasets already exist that can help answer resources management questions?
- What functions and analytical capabilities should the system serve?

Consensus on the proposed strategy will drive the long-term development and future utility of the program. Including initial feedback issued in response to this paper and throughout forthcoming workshops, stakeholders will be guided through a process to develop consensus on the range of input parameters, analytical outputs, data management processes and technological needs that will be included in the final system. Stakeholders will help derive the common goals, objectives, indicators and metrics for each associated project theme. Once a short list of metrics is determined for each project theme, stakeholders will help prioritize the functional attributes of the final product. The MSU, in partnership with IT experts, will design the system and work with bond programs on an ongoing basis to fine tune specific system features.

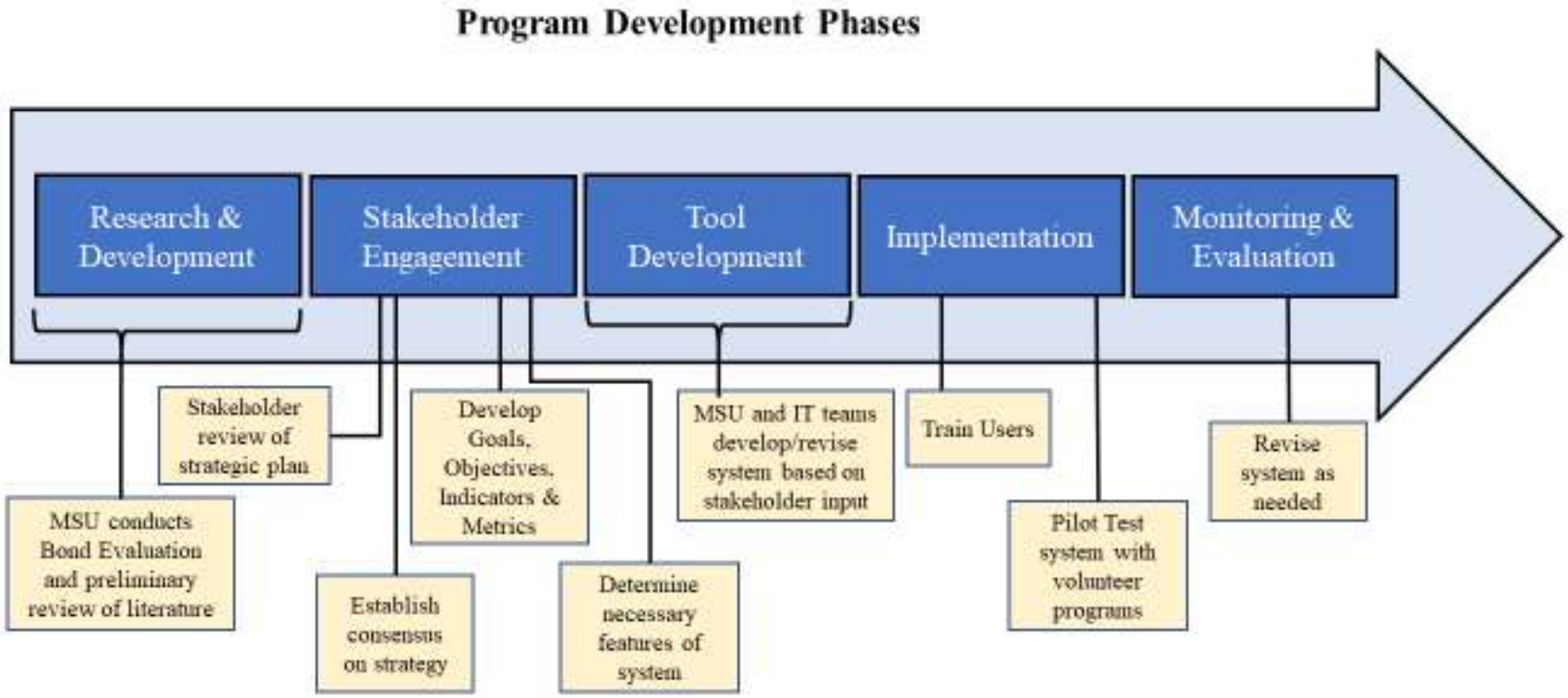
Table 5: Stakeholder Engagement Phases

Stakeholder Engagement Phases	Anticipated Outcomes
Process Overview & Priority-Setting: Building Consensus	-Develop consensus on program strategy -Identify stakeholder priorities
Goals: Establishing Common Priorities	-Develop common goals based on the priorities outlined in statewide plans, legislative statute, and program guidelines
Objectives: Establishing Common Priorities	-Refine the determined goals to actionable objectives with reference to the SMART criteria and other selected screening criteria
Indicators: Creating Common Protocols	-Generate a list of indicators based upon the pre-determined objectives
Metrics: Creating Common Protocols	-Specify specific measurement parameters based on the final suites of indicators
Screening Criteria: Creating Common Protocols	-Apply screening criteria throughout various stakeholder engagement steps to determine the most cost-effective, measurable, and representative objectives/indicators/metrics and associated protocols for data management for each project type
Solutions: Inventing Options for Mutual Opportunity	-Determine necessary system features, and analytical outputs -Identify technological alternatives and constraints

CONCLUSION

A system to monitor and evaluate the vast investments across California to restore, protect, and manage the State's natural, historical, and cultural resources depends on a collaborative process among diverse stakeholders. Working with those stakeholders, the MSU will lead the development of a consolidated and open monitoring data tracking and reporting system to help ensure the best, most informed and scientifically rigorous resources management work ahead. The MSU will continue working to advance these efforts by facilitating stakeholder engagement opportunities and inter-agency coordination meetings to identify project monitoring and evaluation protocols across bond-funded programs. Together, stakeholders will determine the practices, data needs, and technology alternatives that will bolster more reliable and scientifically-derived information across natural resources-related programs. The continuous integration of data will only increase the system utility over time; by fostering a more connected understanding of the condition of resources, decision-makers, investors, program managers, and the general public will gain the means to better steward the state's natural resources and support a more sustainable California now and into the future.

Figure 7. Program Development Phases



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APPENDIX A: Propositions 84, 1, 1E, and 68 Summary

Proposition 84

The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 (Prop 84) was approved by voters in the general election on November 7, 2006. Funding from Prop 84 is intended to support projects that: 1) Ensure that all Californians have access to safe drinking water; 2) Protect the public from catastrophic floods; 3) Protect rivers, lakes and streams of the state against pollution, loss of water quality, and destruction of fish and wildlife habitat; 4) Protect beaches, bays and coastal waters of the state for future generations; and 5) Revitalize Californian communities and make them more sustainable and livable. The statute allocates $1.525 billion for water quality projects, $800 million for flood control and flood subventions, $65 million for statewide water planning and design, $928 million for the protection of rivers, lakes and streams, $450 million for forest and wildlife conservation, $540 million for the protections of beaches, bays and coastal waters, $500 million for state parks and natural education facilities, and $580 million for sustainable communities and climate change-related efforts. The Natural Resources Agency and some of its departments, boards, commissions and conservancies are allocated portions of these bond funds to develop and enhance programs that enable projects across the state that fulfill the proposition's goals.

Proposition 1

The Water Quality, Supply, and Infrastructure Improvement Act of 2014, approved by voters on November 4, 2014, authorizes $7.545 billion in general obligation bonds that provides funding to address water quality, supply, and infrastructure improvement issues in California. Proposition 1 directly funds state water supply infrastructure projects, including public water system improvements, surface and groundwater storage, drinking water protection, water recycling and advanced water treatment technology, water supply management and conveyance, wastewater treatment, drought relief, emergency water supplies, and ecosystem and watershed protection and restoration. Proposition 1 allocates $520 million towards clean, safe and reliable drinking water; $1.495 billion for protecting rivers, lakes, streams, coastal waters and watersheds; $810 million for regional water security, climate, and drought preparedness; $2.7 billion for statewide water system operational improvement and drought preparedness; $725 million for water recycling; $900 million for groundwater sustainability; and $395 million for flood management.

Proposition 1E

The Disaster Preparedness and Flood Prevention Bond Act of 2006 was passed by voters on November 7, 2006. The Act is intended to rebuild and repair California's most vulnerable flood control structures to protect homes and prevent loss of life from flood-related disasters, including levee failures, flash floods, and mudslides and to protect California's drinking water supply system by rebuilding delta levees that are vulnerable to earthquakes and storms. A total of $4.09 billion were disbursed, $3 billion for flood control structural management, $500 million for flood preventions across all regions in California, $290 million for the Identification of risks and the protection of flood corridors, and $300 million for stormwater flood management efforts. Through levee repairs and improvements, upgraded urban flood protection, and improved emergency response capabilities, this act is helping the state manage and prepare for flooding.

Proposition 68

The California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access For All Act of 2018 was passed by voters on June 5, 2018, authorizing $4,000,000,000 to finance a drought, water, parks, climate, coastal protection, and outdoor access for all program. Bond funding would support the following categories: Investments in Environmental and Social Equity, Enhancing California's Disadvantaged Communities; Investments in Protecting, Enhancing, and Accessing California's Local and Regional Outdoor Spaces; Restoring California's Natural, Historic, and Cultural Legacy; Trails and Greenway Investment; Rural Recreation, Tourism, and Economic Enrichment Investment; California River Recreation, Creek, and Waterway Improvements Program; State Conservancy, Wildlife Conservancy Board, and Authority Funding; Ocean, Bay and Coastal Protection; Climate Preparedness, Habitat Resiliency, Resource Enhancement, and Innovation; Clean Drinking Water and Drought Preparedness; Advance Payment for Water Projects.