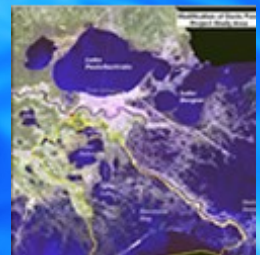
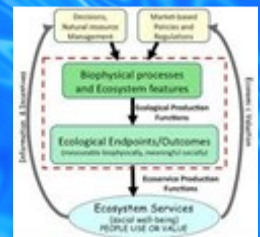
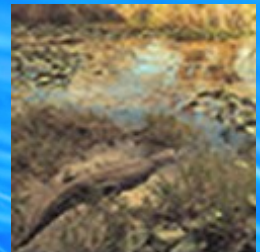


December 2014

Fostering Sustainability

*A Conceptual Framework for Achieving
Environmental Sustainability in the Project
Footprint of the Army Corps of Engineers Civil
Works Program*

2014-R-05



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In 2002, the U. S. Army Corps of Engineers (Corps) announced its Environmental Operating Principles (EOP), which committed the Corps to strive for environmental sustainability. The Corps reaffirmed and revised the EOP in 2012. But after 13 years of significant progress, achievement of environmental sustainability remains hobbled by incomplete management of eleven major issues, which are addressed here in a conceptual framework for improved issue management. The EOP recognized the importance of the U. N. sustainable development concept (development that meets present needs without compromising the needs of future generations) in its own concept of environmental sustainability. Since sustainable development requires each generation to sustain the natural, cultural, and economic heritage that preserves options for the next generation, environmental sustainability is distinguished from social (cultural) and economic sustainability, and defined here as the options and opportunities sustained in natural aspects of our national heritage. The eleven major impediments to maintaining natural heritage in the Corps footprint were identified through close examination of EOP implementation guidance and other Corps sources. The presentation of issue management description, history and needs starts with five core issues addressed in the following order: 1) specifying an achievable objective, 2) developing a systematic and adaptive management process, 3) inventorying conditions relevant to objective achievement, 4) developing visions of sustainable environments, and 5) developing strategies for achievement. Management of these five core issues contributes to the systematic development of strategies for achieving environmental sustainability with feedbacks to further framework refinements. The process is iterative. As they are managed, feedbacks from issues lower in the sequence of actions not only support a continuous process of refinement and adaptation, but also aid management of issues higher in the framework. Three peripheral issue-management actions support the core actions through integrative processes. They include unifying environmental benefits measurement into a minimum number of metrics, integrating policies for effective sustainability guidance, and improving collaboration and integrated resource management. Three other peripheral actions improve the systems-context planning for management actions. They include developing a multi-activity, regional assessment process; a systems-context project planning process; and the tools and training for a systems approach. The management issues are best approached concurrently, but with more effort placed at the core issues and higher levels until they are conceptually well developed. Past progress has shown that conceptual development of management approaches to the five core issues can be improved by concurrent development of management concepts for the six peripheral issues. Past progress also reveals that, in fact, this ideal approach is difficult to implement and that flexibility which takes advantage of opportunities as they occur is desirable. Therefore, the issue management framework can be approached in various ways. The framework is intended to resist management fragmentation and planning uncertainty by organizing both framework-guided and opportunistic improvements into a more coherent, systematically planned, but flexible approach to guiding environmental sustainability achievement.

Disclaimer: The contents of this report have been developed and reviewed for factual accuracy, logic and clarity but remain the authors' interpretations and views, and do not necessarily reflect the views of the U. S. Army Corps of Engineers or the Institute for Water Resources.

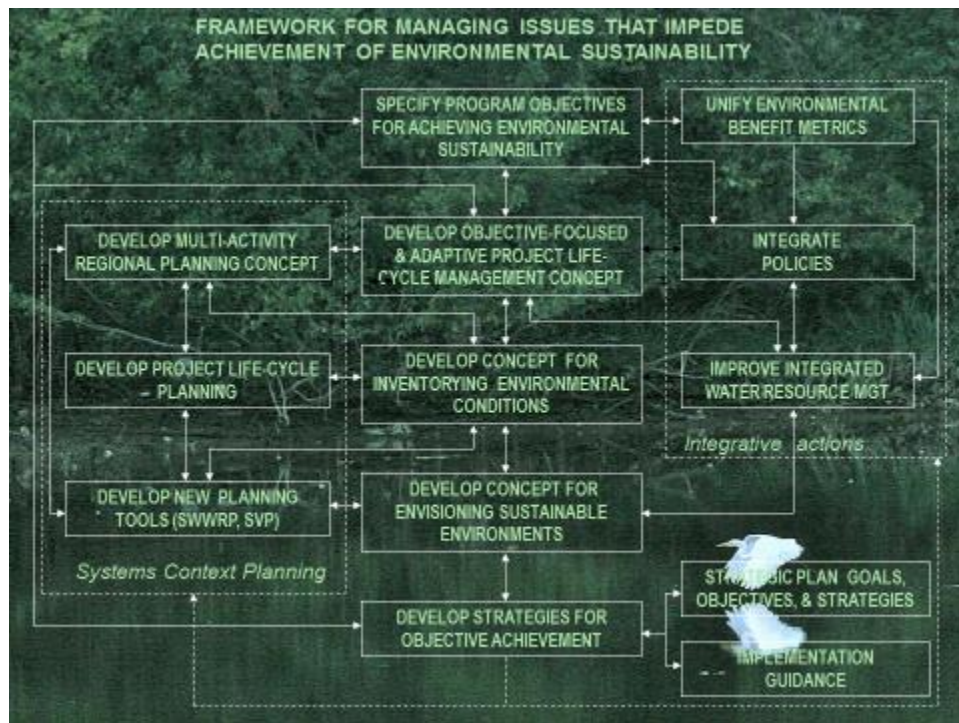
Fostering Sustainability

A Conceptual Framework for Achieving Environmental Sustainability in the Project Footprint of the Army Corps of Engineers Civil Works Program

by

Richard A. Cole

Institute for Water Resources
U. S. Army Corps of Engineers



December 2014

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EXECUTIVE SUMMARY

Report Purpose and Context

The costly impact of extreme storms, floods, and fires; growing awareness of global environmental change; and continuing pressure on federal budgets are constant reminders of the challenges presented by the U. S. Army Corps of Engineers (Corps) Environmental Operating Principles (EOP) and the difficulty of achieving sustainability. First announced in 2002, the EOP committed the Corps to strive for achievement of environmental sustainability as guided by seven principles. Subsequent events required the Corps to reconsider sustainability and the agency's role in its achievement. A decade after the EOP were first announced in 2002, the Corps leadership confirmed that "the concepts embedded in the original principles remain vital to success and its missions" (USACE undated), but required revision in response to new needs and to invigorate commitment to sustainability. But the process remains slow and fragmented and requires a more coherent, strategic approach.

The revised EOP expand the goal to achieve environmental sustainability to a sustainable development goal that also includes economic and social aspects of sustainability. This report discusses the differences between economic, social and environmental sustainability and how they relate to the Corps in its pursuit of sustainable development. But the primary intent of the report is on managing strategic issues that have chronically impeded achievement of environmental sustainability in the environmental footprint of Civil Works projects.

The definition of environmental sustainability that is accepted for this report is consistent with the international definition of sustainable development, which is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable development requires each generation to not only pass on the wealth it inherited to future generations, but to add to it. That wealth is grounded in the material condition of the natural environment left to future generations but also includes economic and social aspects of sustainability that derive in part from the natural environment and in part from human innovation, conventions, and institutions. While humans are of nature, natural here means the material world not obviously shaped by humans. Natural heritage excludes human artifacts comprising cultural and economic wealth, which is passed on in social and economic heritage. A slightly modified version of the definition of environmental sustainability recently recommended for acceptance by the Corps is used here: "Environmental sustainability is the maintenance of a heritage held in natural resources that sustain options and opportunities for present and future generations of human beings."

The report demonstrates how Corps leadership has shown its commitment to achieving environmental sustainability since the EOP were first announced. It also shows that more needs to be done to achieve success. The results of the study reported here identify eleven strategic issues that have contributed importantly to impeding sustainability achievement in Corps Civil Works project planning and management. They stem from not clearly resolving the answers to two fundamental questions: What is environmental sustainability, and how is it to be achieved?

The heart of the report is a proposed framework for more fully and systematically addressing major impediments to objective achievement. The objectives of this study were to 1) review the original and revised EOP, as well as other sources, for strategic issues that pertain specifically to Civil Works project planning and management, 2) articulate strategic issues that continue to confound the achievement of environmental sustainability in the Civil Works environmental footprint and 3) outline the framework for proceeding with the management of risk and uncertainties facing achievement of environmental sustainability in Civil Works activities. The intent is to establish a conceptual foundation for future development of the issues management concepts and implementation guidance. The perennial need for a bigger Civil Works budget is well known and is not addressed here. Many improvements can be made within existing budget constraints.

The ultimate hope for this effort is for framework concepts to contribute to improved Civil Works strategic plans and to more specific policy and technical guidance. The primary audience for whom the report is written is the body of Corps strategists and program managers most responsible for moving the Corps toward achievement of environmental sustainability.

Issues Raised by the EOP and Other Sources

The issues impeding achievement of environmental sustainability in the Corps Civil Works footprint have deep roots, but were raised to higher levels of importance by pronouncement of the original EOP in 2002 and EOP revision in 2012. The explanations of EOP meaning and implications for the revised EOP and the Implementation Guidance for the original EOP raise these issues to the surface of Corps sustainability policy, either directly or by implication. Other sources of information pertaining to the issues include Corps authorities, policy guidance, and reports; Civil Works strategic plans; National Research Council reports; critical reviews, and other relevant literature. The issues raised by each of the seven revised principles are described separately.

Principle 1: *Foster sustainability as a way of life throughout the organization.* The explanation for revised Principle 1 expresses the need to continue to achieve sustainability and establishes a sustainable development goal with economic, social and ecological aspects of sustainability. It does not, however, address the need for separate sustainability objectives and measures of achievement. Symptomatic of an unclear environmental sustainability objective is an unexplained separation of natural systems from the environment in the new sustainability goal and two entirely different definitions provided for environmental sustainability in the original Implementation Guidance. While the explanation for revised Principle 1 indicates that sustainability requires biological systems to remain diverse and productive, neither it nor the Implementation Guidance clearly identifies the biggest threats to environmental sustainability in the various causes of biodiversity loss. In addition, neither clearly states that achievement of environmental sustainability requires maintenance of biodiversity through environmental improvement and protection. In sum, Principle 1 raises fundamental issues about unclear objectives, achievement metrics, and appropriate strategic, planning, and management processes for achieving environmental sustainability.

Principle 2: *Proactively consider environmental consequences of all Corps activities and act accordingly.* The explanation for Principle 2 emphasizes Corps leadership, early engagement with others, impact mitigation needs, and accounting for changing environmental conditions. Proactive consideration of environmental consequences requires knowledge of existing environmental condition in the environmental footprint of water resources development and strategies for addressing unsustainable conditions. The Implementation Guidance focuses proactively on asking what kind of planet we ultimately want. It recognizes the importance of species decline, especially in freshwater ecosystems, and the need to set priorities, which raises the issue of how to measure project effects on sustainability in ways that can be readily compared. Collectively, the explanations and Implementation Guidance raise issues about possible impediments to environmental sustainability associated with deficiencies in planning process, sustainability metrics, knowledge of existing sustainability conditions, visions of desired future conditions, collaboration, and strategies for sustainability achievement.

Principle 3: *Create mutually supporting economic and environmentally sustainable solutions.* Principle 3 clearly distinguishes economic and environmental sustainability and implies that both complementary and antagonistic interactions affect achievement of their objectives, whatever those may be. The explanation for revised Principle 3 reflects the economic development, environmental and restoration missions of the Corps, as well as the importance of social protection constraints. It requires evaluation of ecosystem services to humans. The explanation also reiterates the sustainable development goal of the Corps and emphasizes the need to protect quality of life, but does not connect that need explicitly to social sustainability. The sustainable development goal implies a necessary tradeoff between maintenance of existing natural systems and new development of water resources. Not discussed, however, is how to determine the proper mix of natural and developed systems for long-term human benefit. The explanation also directs measurement of benefits in monetary and non monetary units, but not the determination of when to use each. The Implementation Guidance for the original EOP indicates that measures of benefits pertaining to environmental sustainability must be understandable and attainable. Principle 3 reiterates concerns about sustainability objectives, achievement metrics, and possible deficiencies in planning and management process, including possible shortcomings in policy guidance and strategic planning.

Principle 4: *Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.* Principle 4 suggests that compliance with environmental law is a fundamental Corps strategy for achieving sustainability. It confusingly separates human and natural environments even though the needs of the natural environment must ultimately satisfy human needs to be consistent with NEPA and the concept of environmental services. It also directs employment of all available tools to avoid and resolve conflicts. The Implementation Guidance suggests a need to do more than the absolute minimum defined by law and executive orders to sustain viable natural systems. It reiterates the importance of the National Environmental Policy Act (NEPA) in “providing the strongest basis for achieving environmental solutions”, but neither it nor the explanation for the revised principle describe strategies for Corps improvement other than to assess compliance early in planning process. Principle 4 once again raises issues about the environmental sustainability objective and objective measurement as well as strategies for objective achievement, collaboration, and tool research and development (R & D).

Principle 5: *Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.* Revised Principle 5 implies the need for more spatially and temporally comprehensive and adaptive “systems approaches” to achieving environmental sustainability through risk management and risk communication. The explanation emphasizes conceptual models and adaptive risk management instead of “overdesign”. The Implementation Guidance for the original Principle 5 emphasizes the need to assess and account for cumulative effects, but is not explicit about the spatial and temporal dimensions required or deeper analysis of unaccounted tradeoffs between the needs of this generation and future generations. Issues are raised pertaining to insufficient guidance for an adaptive planning process, project life-cycle analysis, and regional systems assessment of environmental condition.

Principle 6: *Leverage scientific, economic, and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.* The explanation for Principle 6 indicates that leveraging knowledge is an active pursuit of the best available science, wherever it may be found. It affirms that the Corps workforce and laboratories are well positioned for environmental learning. The explanation directs development of methods and tools that assure a healthy environment and implies that R & D laboratories should be well aware of knowledge gaps in order to set informed research priorities. While it emphasizes the need for effective training, including collaborative training with other agencies, the explanation does not point out the need for a workforce that fully understands a systems approach to risk assessment and management and the limitations of most planning and management methods and tools. Nor does it recognize the need for researchers to understand the basics of Corps authorities, policies, and policy constraints in addition to the systems approach to risk management. The Implementation Guidance emphasizes a need to develop reliable assessments of environmental benefits. Issues raised by Principle 6 include the need for tool R & D and better training, improved collaboration, and better integration of resource management across agencies.

Principle 7: *Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.* Revision of Principle 7 focuses on the need for transparency and stakeholder inclusion in Corps planning and management. This principle improperly implies that the Corps has been the only participant lacking in transparency and respect for the views of others. Explanations for both the original and revised principle do not emphasize enough the responsibilities of all participants in the process, including Corps partners and stakeholders. Emphasis needs to be placed on thorough two-way communication between the Corps and participants. Too much “listening” by the Corps without feedback to other participants can overwhelm careful consideration of the national interests and concerns. The Corps needs to be clear about the national interest in environmental heritage and avoid dependency on others to assure the protection of heritage for future generations. Principle 7 raises issues about the deficiencies in objective statements, shared knowledge, a shared approach to integrated and adaptive resource management, and the importance of transparency for effective collaboration.

The Issues Identification and Management Framework

The EOP raised eleven important strategic issues in total. The most frequently raised issues pertained to unclear objectives, metrics for achievement, planning and management process, and strategies for achievement. Other issues pertain to more specific impediments to more effective

planning and management. Each of the issues addresses program level uncertainty and risk of not achieving environmental sustainability. Thus uncertainty and risk is a recurrent aspect of all issues and is not identified separately. Recent efforts to address the issues are summarized in the issue descriptions.

Core Issues

Five primary issues form a central core of the issues management framework. The actions taken to manage these issues are judged to be most necessary to cost effectively achieve environmental sustainability. They include:

1. Specify an achievable objective. The Civil Works Program does not have an objective that explicitly serves quantified achievement of the environmental sustainability goal despite a strong hint in the revised and original EOP that it occurs when natural systems are restored and protected, that “biological systems remain diverse and productive”, and that “life-support systems are maintained in a “healthy, diverse, and sustainable condition”. Protecting all natural life-support systems from future development would unacceptably stop beneficial development. However, many ecosystems are unacceptably eroding away, species by species, and those species and their support systems need restoration and protection. The objective should generally determine what and how much of environmental life support systems must be sustained to avoid irreversible damage to irreplaceable aspects of biological diversity. The goal served by the objective should be clearly linked to an agency mission based in the concept of sustainable development. To be consistent with that concept, an environmental sustainability objective needs to focus on leaving the same natural resource development and use options this generation had to future generations. These options collectively comprise a national natural heritage separate from social-cultural and economic heritage. The following objective statement is offered for consideration: *The objective of environmental sustainability achievement is to leave future generations the natural diversity and productivity essential to sustain all of the potential resource development and use options inherited by this generation.*

2. Develop a systematic adaptive management process. Even with clearly stated goals and objectives, achieving environmental sustainability is frustrated by uncertainty about project and program outcomes for all Civil Works purposes. Systematic and adaptive problem management is essential. Permanent solution of problems is impractical under changing and uncertain social, economic, and environmental conditions, including rapid climate change. While technical guidance has improved, a collaborative, programmatic framework at the national scale and over ecologically relevant time frames has yet to be developed to guide the achievement of environmental sustainability. The issue needs to be addressed by developing the framework and enhancing technical guidance for implementation. Uncertainty needs to be managed using a systems approach to scenario or other alternative-futures approach to life-cycle planning. The reversibility of a project, once implemented, is a critical consideration for adaptive management planning. Assuring sustainability requires program-level adaptive management for all Civil Works projects, despite required transfer of newer projects to non-federal project operation.

3. Inventory conditions relevant to objective achievement. There is no programmatic inventory of natural resource conditions in the project footprint of the Corps to provide insight

into priority needs and no way for the Corps to competently respond to specific questions about its environmental stewardship. Claims that the Corps has been environmentally irresponsible often cannot be quickly rebutted with evidence of effectiveness. Nor is there sufficient information to reorient management toward a sustainable state. The lack of documentation fuels claims of Corps hypocrisy about serious pursuit of sustainability. The issue can be addressed by developing a conceptual framework for identifying needs followed by more specific technical guidance for implementing inventory procedures. What should be inventoried needs to be identified before detailed implantation guidance can be developed for the inventory.

4. Develop visions of sustainable environments. Without visions of a sustainable state, there is no way to determine the status of sustainability or any practical way to gauge achievement progress. Identifying the desired future condition of the resource is a basic tenet of natural resource management. To assure completeness and acceptability for future collaboration, the Corps needs an internally acceptable vision for a sustainable state that incorporates the views of others and protects the interests of future generations while providing for present needs. Because different distributions of resource conditions can equally achieve environmental sustainability, a single vision of success is more limiting and more costly to implement than selection from diverse scenarios.

5. Organize strategies for objective achievement. Without long-term trend assessment and clearly stated program strategies, the Civil Works Program does not have the institutional sense of direction and approaches needed to achieve environmental sustainability and sustainable development in the Civil Works environmental footprint, or to contribute to environmental sustainability elsewhere through its ecosystem restoration program. Sustainable development and the environmental, social, and economic dimensions of sustainability need to become the framework for organizing and articulating future Civil Works strategic plans. Some of the issues identified here are raised in the Strategic Plan, but, in most cases, strategic management of the issues is described minimally, if at all. The existing strategic plan fails to raise sustainable development to the level of Civil Works Program mission that incorporates all specific missions. It should remain consistent with national policy and the EOP, and feature authorized purposes consistent with maintaining environmental, social and economic sustainability as its main strategies for achievement. The strategic plan also fails to link to the long-range planning required for efficient and effective achievement of program-area objectives. And it continues to embrace the idea that complex environmental problems have permanent “solutions” while incongruously espousing the need for adaptive management.

Secondary Issues Affecting Integration

Left unmanaged, six other issues complicate management of the core issues. Proper management of three of the secondary issues aids integration at and between project and program levels.

6. Unify environmental benefits metrics. Existing metrics inadequately indicate the environmental benefits from ecosystem restoration and protection at project and program levels. Decisions are complicated by the many different metrics used. Issues management starts with clearly stating the objective of environmental sustainability as maintenance of national natural heritage. Heritage protection benefits have nonuse value, which is not acceptably measured in

monetary terms by the Corps. Existing metrics have fallen short of need. Discovering an acceptable measure of natural heritage value would greatly reduce the large number of metrics now being used. A possible candidate, the Biodiversity Security Index, indicates the value of biologically scarce ecological resources based on public desire to maintain our national heritage. This and other metric concepts need to be further investigated.

7. Integrate policy for effective sustainability guidance. Civil Works environmental policy guidance lacks coherence and focus on the achievement of environmental sustainability for sustainable development. Sustainability is now addressed unevenly in separate policies directed at project planning, operations, stewardship, ecosystem restoration, budget planning, regulatory, and other activities. Existing policies are fragmented by program area, without clear integration of intent and language regarding the achievement of environmental sustainability and sustainable development goals. No Civil Works Program policy comprehensively addresses environmental sustainability or its relationship to sustainable development, economic sustainability, and social sustainability. This issue should be managed by updating policy guidance to explicitly show the relevancy of sustainability to all program areas.

8. Improve collaboration and integrated resources management. Collaboration is the integration of specific organization goals and process into an inter-organizational pursuit of common goals. Incomplete and ineffectual collaboration impedes achievement of environmental sustainability and sustainable development. Effective collaboration requires clear and complete communication, close coordination, and full cooperation. For government agencies, sustainable development should be a common pursuit, but past differences in understanding of and commitment to those concepts have hampered collaboration at all levels of agency activity. A good strategic plan is one way to communicate organizational commitment to sustainable development. Improved collaboration should start with adopting a broader perspective than Integrated Water Resources Management implies—one that emphasizes integrated management of all natural and human resources focused on sustainable development.

Secondary Issues Affecting Systems Context Planning

Management of the three other peripheral issues serves systems-context planning needs. The three issue-management actions are best developed in concert.

9. Develop a multi-activity, regional assessment process. There is no Corps conceptual framework for guiding regional assessments of existing and forecast natural and man-modified conditions. The past approach to water resources planning and management failed to assure environmental sustainability, largely because of the project focus. The Corps needs a greater emphasis on continuous assessment of natural and man-modified processes in regions delineated by natural systems boundaries. Continuous assessment allows timely identification of the causes of unsustainable environmental conditions and the ways they might be restored. It also provides the spatial context for adaptive planning and management, and systems-context project planning.

10. Develop a systems-context, project planning process. There is a limited conceptual foundation for guiding adaptive management of projects toward achievement of environmental sustainability over the entire project life-cycle and systems context. Insufficient regard for

system effects contributed to unsustainable environmental states as projects were built without careful regard for cumulative environmental impacts. The issue can be managed by developing a systems-context planning process and appropriate guidance for its implementation. Scenario-based planning is needed to help manage the uncertainty in forecasts of climate, land use, and societal wants. In addition to Corps project operations and regulatory planning, this approach needs to integrate other significant development, protection, and restoration actions anticipated in the systems context, regardless of agent. The framework for a systems-approach needs to be developed and integrated with a regional planning framework.

11. Develop tools and training for a systems approach. The Civil Works program does not have all of the program-level planning and management tools of the appropriate scale and complexity needed to efficiently achieve environmental sustainability. In addition it does not provide the policy and technical training of its entire workforce (including researchers) needed to fully adapt a systems approach to risk assessment and risk management planning. The most basic deficiencies are insufficient scientific understanding of ecological and systems processes and integration of that understanding, once obtained, into models that can be used for systems-wide purposes. The complex processes and topographic features that need to be tracked in detail within systems-context planning cannot be considered adequately without models of appropriate scale. Recent advancements in systems-wide model development should be continued. Corps R & D also needs to be more collaborative, both internally and externally.

Need for a Comprehensive and Systematic Approach

Because the 11 issues are systemically interrelated, the management of any one issue is greatly influenced by the degree other issues have been managed. For that reason, the issues and their management are best developed simultaneously with more early emphasis on the five core issues. But the main intent is provide a coherent structure for organizing management into a more effective process. Practicality typically favors a more opportunistic approach than is ideal as evidenced. Progress is fragmented and has advanced slowly and unevenly across the issues. For example, the basic problem associated with unclear program objectives was identified indirectly by addressing problems associated with restoration benefits measurement. As opportunities arise, the framework should provide more systematic thinking about the issues as they are addressed.

This framework is limited to issues that most complicate achievement of environmental sustainability in environmental footprint of Corps civil works projects, both directly and indirectly. All of the core issues and most of the secondary issues pertain to sustainable development and to the achievement of social and economic sustainability. Many of the issues raised here probably apply to achievement of economic and social sustainability. Securing each of these three pillars of sustainable development is more likely if done in concert. This framework for achieving environmental sustainability is intended to be a start in that direction.

SECTION 1: INTRODUCTION

Report Purpose

The costly impact of recent extreme weather events and growing awareness of global changes in the environment are reminders of the U. S. Army Corps of Engineers (Corps) commitment to achieve environmental sustainability and the challenges that achievement presents. In 2012, the U. S. Army Corps of Engineers (USACE, Corps) revised the Environmental Operating Principles (EOP) announced in 2002 to accommodate contemporary needs and to invigorate existing commitment to sustainability (Bostick 2012, USACE undated). USACE (undated) confirms “the concepts embedded in the original principles remain vital to the success of the Corps and its missions”. EOP revision responded to changing resource challenges, priorities, and need for greater emphasis on translating sustainability “into everyday actions that have an effect on the environmental conditions of today, as well as the uncertainties and risks of the future” (USACE undated). Consistent with the National Environmental Policy Act (NEPA), the revised EOP relate to the human environment and apply to all Corps activities (Bostick 2012).

In its revision of the first principle of the EOP, the Corps broadened the original EOP challenge by replacing a commitment to “strive for achievement of environmental sustainability” (USACE 2003a) with a commitment to “foster sustainability as a way of life” (Bostick 2012). The explanation for the first of the revised principles reveals what sustainability means in the Corps’ ultimate goal, which is “protecting and restoring natural systems while encouraging productive sustainable economic development that improves the quality of life...” (Bostick 2012). This is, in effect, a sustainable development goal. The explanation also states that the Corps “must continue to achieve sustainability”. Full achievement must be broadened beyond the concept of environmental sustainability to include economic and social dimensions of sustainability.

Natural systems and ecological dimensions are clearly environmental and protecting and restoring them clearly contributes to environmental sustainability. There is growing scientific awareness that little in nature is unaffected by humans and the concept of nature without man is becoming increasingly unimaginable. But the concept is well ingrained. By natural is meant here not obviously a creation of man, but of nature mostly independent of man. There would be no human society or economic wellbeing without the support of the material environment created by nature, including the support of its natural systems, which we all interact with ecologically and depend upon for life support. Economic and social dimensions of sustainable development are clearly different aspects of sustainability. They depend on the material environment in part and influence the material environment, but are not in themselves aspects of the material environment.

The primary purpose of this report is to identify strategic issues revealed by the EOP and other sources to be impediments to achieving environmental sustainability in the project footprint of the Civil Works Program and to present a systematic, conceptual framework for managing the risks they pose for achieving environmental sustainability. In the context of this analysis, strategic issues management is a process of identifying and minimizing risks that threaten achievement of organizational goals and objectives (Coates et al. 1986, Bryson 1995, Heath and

Palenchar 2008). Many uncertainties and risks of undesired consequences face the Corps in its pursuit of environmental sustainability, starting with defining what it means through all facets of its achievement. The management of risk and uncertainty is intrinsic to management of all of the issues presented here. It is far too pervasive and fundamentally important to raise it as a separate management issue.

This investigation of issues covers the period since NEPA was signed into law in 1970, but focuses particularly on the decade between the first pronouncement of the EOP in 2002 and their revision in 2012. The primary audience for which this report is written is the body of Corps strategists and program managers most responsible for moving the Corps toward environmental sustainability.

It is not the intent of this framework to address achievement of other economic and social goals, except to differentiate them from environmental sustainability and its achievement. Nor is the purpose to develop Civil Works policy guidance. Guidance development is necessarily a corporate activity, but one that needs more careful conceptual consideration of issue management needs than has been demonstrated so far. The analysis was limited to the needs of Civil Works project planning and management, but also may apply in many respects to other program areas of the Corps.

This report points out many of the significant challenges facing the Corps with respect to its achievement of environmental sustainability in the footprint of water resources projects. Showing progress in issues management concept development is essential if the EOP and subsequent indications of commitment to them are to be perceived as honest and earnest, thus laying a foundation for new budget requests. The framework developed here addresses other critical issues that arise from program management and significantly complicate program achievement of environmental sustainability and sustainable development. Even with well developed issue management concepts, nothing in this framework should suggest that issues management will be easy or quickly accomplished, even with concerted effort.

Sustainability Concepts

Concept Origins

In recognizing a need to achieve environmental sustainability in 2002, and sustainable economic development more recently, the Corps joined many others in similar expressions of need, both locally and globally (WCED 1987, TPCSD 1996, NRC 1999b, Edwards 2005, Cole et al. 2014a). Most international concepts of sustainability are traceable to the United Nations concept of global sustainable development (WCED 1987). It was defined as "...development to meet the needs of the present without compromising the ability of future generations to meet their own needs". In an internal analysis of Corps implications, Martin and Stakhiv (1999) described environmental, social and economic aspects of sustainability that are identifiable in the concept of sustainable development. The Corps referred to and accepted the U. N. concept of sustainable development in the Implementation Guidance that accompanied the original EOP (USACE

2003a). More recently, the Corps supported a historical assessment of the concept's development (Cole et al. 2014b).

Federal government has been considering sustainability issues at least since the turn of the 20th century, when concepts of sustainable renewable resource production evolved during the Administration of Theodore Roosevelt. Some minimum amount of the resource production base had to be sustained to maintain resources and the economy based on those resources. While sustainable use was a major emphasis in what was called for the first time natural resource conservation (e.g., Hays 1959), concern for sustaining a diverse wildlife heritage was also growing. Roosevelt, for example, established the first national wildlife refuge to protect egrets from extinction and was instrumental in preserving the last of the bison.

Nearly two decades before the U. N. concept of sustainable development was first published (WCED 1987), the policy and goals of NEPA mapped out a closely related concept for fostering productive harmony between humans and their environment. NEPA brought together the concepts of sustainable use and heritage preservation in its statement of goals, which also emphasized the ethical obligation of the Nation to “fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.” NEPA goals collectively promoted the widest range of beneficial uses of the environment while assuring safe, healthful, productive, and pleasing environments for all Americans; preserving important cultural and natural aspects of our national heritage; and maintaining an environment that supports diversity and variety of individual choice. NEPA specifically required an environmental impact statement for all federal activities that have potential environmental impact. Implementation guidance emphasized consideration of impact mitigation for any significant adverse effects, whether economic, heritage, or other adverse effect on human welfare.

In the U. N. concept of sustainable development, environmental sustainability pertains to the sustainability of the living and non-living material environment, in all of its diversity. Economic sustainability pertains to the sustainability of material wealth—those aspects of the material world that are valued by people and often bartered privately in the market place. However, the concept also includes wealth that benefits the public as a whole through public access to use of commonly held property. The basic idea of sustainable economic development is to improve welfare by building upon existing wealth. Doing this requires wise investment in exploration, research, and development as well as development of human knowledge, skills, and opportunities. Social sustainability is about maintaining a quality of life that promotes social stability. Essential social attributes for long-term social stability include continuous respect for the basic rights of all members of the society, at least minimum levels of economic welfare for all, and a nurturing and sustainable environment for all.

Defining Environmental Sustainability and Its Status

One of the most fundamental impediments to Corps achievement of environmental sustainability is confusion over its meaning. For that reason, the definition of environmental sustainability used here is clearly stated and separated from economic and social sustainability. Achieving sustainable development as defined by the U. N. (WCED 1987) requires each human generation

to leave future human generations with an economic, social, and environmental heritage that not only passes on the inherited options and opportunities, but enriches them before passing them on. As defined here, environmental sustainability serves humanity through maintenance of natural heritage.

The definition of environmental sustainability used here links natural process to national and international goals. Particularly influential in developing the definition was the goal in NEPA that highlights preservation of historic, cultural and natural aspects of national heritage to sustain diversity and individual choice. The definition adopted here is modification of one suggested for Corps adoption in a report recommending sustainability principles and definitions (Cole et al. 2014a):

“Environmental sustainability is the maintenance of a heritage held in natural resources that sustain options and opportunities for present and future generations of human beings.”

The definition was modified to replace environmental resources with natural resources. The change was made to clearly separate natural heritage from cultural heritage, associated with man-made environments, and economic heritage associated with valued aspects of the environment. Cultural heritage is an aspect of social sustainability. The above definition assumes—as did Goodland (1995, 1996), Goodland and Daley (1996), Martin and Stakhiv (1999), and Cole et al. (2014a, b) — environmental, social, and economic sustainability differ from one another and are interrelated aspects of sustainable development (Figure 1). This is consistent with the concepts of Goodland and Daley (1996), the World Commission on Environment and Development (WCED 1987) and The President’s Council on Sustainable Development (TPCSD 1996).

The definition shows the human-welfare relevance of environmental sustainability and the focus on maintaining options for future use. This does not imply that all further human alteration of natural environments to benefit humanity must be stopped and all past alteration reversed. That proposal is impractical and inconsistent with national and international goals. The intent is to sustain enough of each distinct natural resource in supportive natural systems to maintain options for future resource development and potential use. Natural resources are not necessarily resources with known uses. Most have no known use, but all have potential use, whether direct or indirect (in a support role). The sustainability goal implied in the definition would be challenging enough without continued population growth, but that must be taken into consideration as well. Sustaining a naturally functioning ecosystem context for resource maintenance is essential for goal achievement because of the many services provided by more or less natural ecosystems, including continued replacement of diverse natural resources and generation of new resources through organic evolution.

This definition of environmental sustainability does not include culturally modified material resources or the immaterial aspects of social and economic heritage maintained in legal, educational, and financial institutions. Those are reserved for concepts of social and economic sustainability (Martin and Stakhiv 1999, Cole et al. 2014a). Social-economic institutions sustain information, systems of governance, financial systems, and a legal basis for protecting individual

rights, including cultural preservation, property and opportunity rights (United Nations 1992, Martin and Stakhiv 1999, Cole et al. 2014a).

Environmental sustainability is not about maintaining the environment in a condition suitable only for present-day use. Many natural resources are economically valued for their use and sustainable use is an important aspect of economic sustainability (Cole et al. 2014a).

Environmental sustainability is not, for example, about maintaining production for recreational use, such as wildlife watching, which has value that can be monetized and contributes to the economy. Resource production usually can be adjusted by resource management in response to changes in human demand for it, without risking total loss of irreplaceable natural heritage. Duck hunting is a good example. Sustainability of the duck hunting economy requires waterfowl management that generates a duck “surplus” above that beyond the abundances necessary to sustain a natural heritage. Most duck species are abundant and well-secured from extinction. International goals to meet a certain level of waterfowl abundance, such as the goals in the North American Waterfowl Management Plan, are higher than the numbers just to sustain them for future generations because they are based on the surplus desired for duck-based recreation.

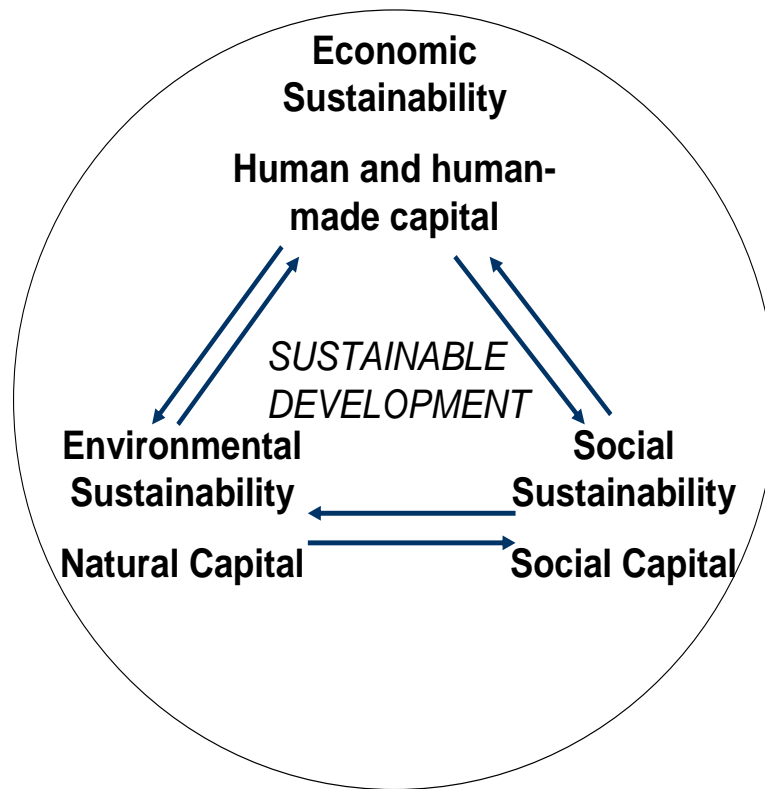


Figure 1. The general relationships among environmental, social, and economic sustainability in a prevalent concept of sustainable development (modified from Goodland and Daly 1996)

Members of this and future generations may have to pay a higher price for more regulated resource use when it is reduced by use, but the resource remains sustainable as long as options for future use remain intact. Declines in economic sustainability sometimes precede declines in environmental sustainability, however, as the recent move to list blue-fin tuna under the protection of the Endangered Species Act (ESA). But, in most cases, recent closures of commercial fisheries responded to an economically unsustainable condition of the fishery resource; not the risk of total extinction. Similarly, maintenance of stocks for cultural reasons (e.g., traditions, spiritual aspects) has to do with social sustainability as long as the stocks are secure from extinction.

Environmental sustainability pertains to the diversity of natural resources with *potential* use value, which can never be realized if options are not left to future generations in natural heritage. Use value may be direct or indirect. Ducks, for example, rely on many natural resources for support, each of which is indirectly used by the people who are willing to pay for the privilege of hunting ducks. These indirect uses of resources are rarely well known, but may become a critical limitation for resources that are used directly. Leaving options for future generations often requires offsetting present resource use through resource protection. This nonuse value is, as expressed in the goals and protections of public law, associated with preservation of potential resources in natural heritage (Cole 2014a, b).

Land and water resources can be developed and managed for increased or decreased resource supply to sustain and develop the economy as long as all of the natural parts and processes that allow for future resource management flexibility and choice are sustainable in renewable inventories. A minimum of natural environment must be sustained to provide the full diversity of options and opportunities that we may now fail to recognize as potentially useful. Doing this well requires maintenance of enough unique parts and processes of all ecosystems to assure biodiversity sustainability. In making that point, Aldo Leopold once wrote: “To keep every cog and wheel is the first precaution of intelligent tinkering” (Leopold 1966). This is the first principle underlying resource management that aims to achieve environmental sustainability. The second is to maintain all of the information needed to reassemble the parts into functional units. Ecosystems maintain that information in species genes.

Goodland and Daley (1996) describe three categories of human action necessary for achieving sustainability of natural resources for human use. The categories of action include: 1) keep wastes within the assimilative capacities of ecosystems, 2) harvest species (or other intentional or incidental take) within the regenerative capacities of renewable resources, and 3) deplete non-renewable resources at no more than the rate that renewable substitutes are generated. The regenerative capacities of naturally diverse ecosystems need to be sustained to maintain “natural capital” (Goodland and Daley 1996). These are basic strategies for managing the risk of option and opportunity loss.

Corps activities routinely alter the natural environment by changing local geophysical and biological conditions and contributing cumulatively to global human effect. Some of that effect has contributed to irreversible environmental losses earlier in its history (Cole 2009). Most Corps activities have not caused irreversible environmental impact in recent decades, however, largely because the Corps has complied with protective laws (Cole 2009). Yet, a large fraction

of the nation's natural heritage remains much less secure from extinction than it was a century ago, as shown in the declines of many species components of ecosystems affected by Corps projects (Cole 2009).

Some argue that the Corps has contributed to the loss of natural rivers and shorelines too, but those "losses" are in general somewhat reversible if desired enough by the public. The extinction of unique species and subspecies is not reversible. Ecosystem function erodes as biodiversity declines, species by species. Some Corps activities affect the environment at global scales, mostly through air quality effects that could also contribute to extinction. But the impact of Civil Works may be comparatively modest because Civil Works authorities happen to support forms of transportation and energy production that are among the least polluting. Improvement has been encouraged by a series of executive orders spanning the last three presidents. That effort, however, is a fraction of what is needed to achieve environmental sustainability in the Corps Civil Works footprint. The larger challenge is associated with alteration of aquatic and riparian habitats by past water resources project development (Cole 2009).

Corps Commitment to Achieving Sustainability

Expressions of Commitment

In the same year that the EOP were announced, a representative of American Rivers, a non-government organization (NGO) pushing for Corps reform, testified to Congress that the Corps' Civil Works Program was among the leading causes for the past disappearance of freshwater biodiversity at a rate equal to that in the world's tropical rainforest, which proved untrue (Cole 2009). More troubling was her claim that the Civil Works Program was a continuing threat to future sustainability of the Nation's freshwater biodiversity. The Civil Works Program continued to be criticized for environmental missteps after the EOP were announced. The NWFTC (2004) claimed that the program's record for mitigating project damage to fish, wildlife and wetlands is "abysmal". Implied in the view of these and other critics (Grunwald 2007, McQuaid 2007), the Civil Works Program has not achieved its proper contribution to sustainability. Because of perceived incompetence, calls continue for the Corps to be dismantled and its purposes redistributed to the private parties and other agencies (e.g., Edwards 2012).

To the skeptical, the EOP may amount to little more than empty rhetoric, ripe for future criticism when the Corps fails to live up to the high standards it has set. Others want to believe the Corps is sincere, but fear that neither the will nor the way is there to deliver as promised. To many Civil Works employees and collaborators, proper application of the principles toward achievement of environmental sustainability remains a mystery awaiting demonstrable solution (some believe the Corps is doing quite well, however). Non-federal partners watch warily for new hurdles between them and the federal funding they want. Most thoughtful stakeholders probably would agree that the goal of achieving sustainability is ambitious at the very least.

No fundamental institutional impediment stands in the way. Four decades have passed since the NEPA was passed followed soon after by the Clean Water Act (CWA) and ESA. These three laws are among the most influential in federal water resources management and have been

incorporated into the planning and implementation practices of the Corps. Environmental protection has had mission status in the Civil Works Program for two decades. Having had an environmental improvement authority for over two decades, the Corps now has a powerful authorization advantage over other agencies in identifying and repairing presently unsustainable environmental conditions associated with its infrastructure and in aquatic ecosystems anywhere in the United States. The Civil Works Strategic Plan is committed to sustainable development and environmental repair. Why then, ask critics and supporters alike, has there been so little indication of progress?

In responses to questions asked of the Deputy Director of the Civil Works Program in May of 2001 about the draft EOP, Mr. Fred Caver stated that:

“The environmental principles are intended to supplement and enforce the direction established within NEPA, the P & G and our planning guidance...The environmental principles and precepts are one way in which the Corps is striving for improvement and avoiding a decline in the relevance of our work to the Nation’s needs.”

He also noted how the purpose statement of the NEPA “could be used as an operating definition of environmentally sustainable development and that federal agencies have focused too much on the NEPA process and not enough on the goal.” He stated emphatically that Corps projects and programs *must* become environmentally sustainable. Thus the most important contribution of the EOP, in this statement at least, has been to explicitly focus, like the agency never had before, on achieving environmental sustainability.

According to Mr. Caver, the EOP were developed to achieve the following objectives: They were intended to address the American public’s environmental values, to respond to recommendations made by public representatives in listening sessions, to encourage more innovative approaches to managing water resource and environmental remediation problems, to make environmental and economic considerations more nearly equal in Civil Works activities, and to more effectively use Corps’ technical capabilities in problem management. While these objectives tell why the EOP were developed, they do not explain what projects and programs would look like once they were environmentally sustainable, or how to make them so.

In 2003, the USACE headquarters produced a plan for integrating the EOP into headquarters operations (USACE 2003b). In its vision statement, the plan recognized a tripartite economic, environmental and social infrastructure. It also recognized that:

“the highest value of the tripartite infrastructure is its ability to sustain and enhance all life....Our vision states that for our projects to be successful, they will have sound economics, solid engineering and be environmentally sustainable, all of which contribute to the well being of our nation’s citizens.”

A number of objectives were stated. In brief, they include 1) ensure policy support, 2) develop and use an Environmental Management System to track progress, 3) engage the public, 4) use a watershed approach, 5) establish sustainability metrics, 6) do supporting research and

development (R & D), 7) educate the Civil Works workforce, 8) encourage integration in field offices, and 9) reward and publish successes and lessons learned. The plan, with its clearly committed vision and objectives to guide its achievement indicate that the Corps leadership was serious and in the process identified preferred means for managing a number of implied issues. However, after early activity, the plan was set aside indefinitely as agency reorganization and other activities usurped priority.

Yet the Corps leadership continued to promote the EOP and a systems approach to issues resolution that effectively pursues corporate goals. In speaking for leadership sentiments about water resources problem management in an issue of Corps *Points* (USACE 2005)—“a weekly compendium of facts and talking points to help leaders tell the Corps story”—the Chief of Engineers, Lt. General Carl A. Strock, stated the following:

“America must invest wisely within economic constraints and prevailing priorities to develop and manage water resources in ways that preserve and protect our National prosperity, competitiveness, quality of life and environmental sustainability...The Corps must work towards providing a greater role as a collaborator or facilitator amongst all interested participants to develop, as a group, water resources solutions that balance economic, environmental and social objectives.”

The commitment to preserving and protecting environmental sustainability clearly stands among other social and economic expectations for the future in General Strock’s vision of what amounts to sustainable development as interpreted by the Corps.

The vision is consistent with the mainstream concept of sustainable development (e.g., Martin and Stakhiv 1999) built on commitments to economic, social, and environmental sustainability that provides for the needs of present generations without compromising the ability of future generations to provide for their needs (WCED 1987). The vision points out the need for clear environmental objectives to guide discovery of water resources “solutions” and to “balance” them against economic and social objectives. It also seems to commit the Corps to protection of environmental essentials underlying national prosperity in a national heritage for future generations. On the other hand, the word “balance” can imply that negotiated trade off of irreplaceable national heritage for present consumptive use and associated economic and social gain is allowed, an interpretation that is inconsistent with the prevalent concept of sustainable development (WCED 1987, Martin and Stakhiv 1999, Cole et al 2014b). This and other ambiguities that arise from unclear meanings and intents contribute significantly to the strategic issues needing better management.

Lt. Gen. Robert L. Van Antwerp, Chief of Engineers, reaffirmed the importance of the EOP and the achievement of sustainable management. In referring to the Corps in an issue of *The Corps Environment*, a Corps newsletter, General Van Antwerp stated:

“Embracing sustainability means living our Environmental Operating Principles... The Environmental Operating Principles provide us direction on how to better achieve stewardship of air, water and land resources, while demonstrating the connection between water resources, protection of environmental health and the Nation’s security.”

Most recently Lt. General Thomas P. Bostick authorized reissuance of revised EOP to accommodate recently recognized rapid change in climate and sea level and expand and intensify the Corps level of environmental commitment (Bostick 2012). The commitment to sustaining environmental heritage is encapsulated in this quote:

“The Army emphasizes sustainability, and the Corps has a major role as stewards of this Nation’s environmental resources. Sustainability is the environmental legacy we pass on to future generations to improve upon and enhance.”

In sum, since before the EOP were first announced, the Corps leadership has consistently supported the principles and sustainability achievement.

While the public commitment of the corporate leadership to sustainable development, including environmental sustainability, has been clear, the standards set for Corps achievement in the EOP are left to corporate interpretation. Progress has been uneven. Achieving the objectives of the Program Management Plan for implementing the EOP (published by Corps headquarters in 2003) and meeting the milestones of Executive Order 13514 has been slower than desired. The reasons for slow progress are many and complex, but among the most fundamental ones argued here are shortcomings in the strategic thinking needed to provide a conceptual foundation for facilitating translation of sustainable development strategy into project planning and management practice. While some advances have occurred in recent years, described later in this report, the environmental sustainability goals of the EOP and the Strategic Plan have yet to be systematically translated into a more coherent approach toward strategic management of troublesome issues.

Substantial distrust of the Corps remains in the environmental community, some of whom suspect duplicity, dysfunction, or both. Some critics in news organizations have high national visibility. The differences between Corps corporate views on sustainability and other perceptions of Corps performance appear to be rooted more in impediments to Corps follow-through than unprincipled corporate values. These impediments are revealed in the absence of clear resource-condition objectives, cost-effective effort to achieve them, and careful monitoring of performance. They are also revealed in Corps policy priorities. Commitment to integrating the EOP into existing program management is limited “to the extent legally and financially practicable.” Corps views of practicality may be seen as insufficient commitment by others.

The extent to which sustainability is achieved depends on perceived priorities and funding, which is especially limited at the program level. Because of its project-based funding, the Corps is substantially a captive of the long-established habits of Congress and the Office of Management and Budget (OMB). Based on past history, Corps Civil Works authority will largely remain project-based and budget limited for the foreseeable future (Cole 2013a). However, the fact that funding has been a limiting factor for decades makes it a convenient scapegoat for weak follow-through. Fostering achievement of environmental sustainability faces numerous resource management obstacles that can be addressed despite funding impediments.

Corps Actions

Before and since 2002, important strategic issues have slowed achievement of environmental sustainability in project planning and management of the Civil Works Program. They typically stem from not fully and clearly answering two fundamental questions: What is sustainability, and what do we have to do to achieve it?

Some progress has been made, however. The Corps reconvened its Environmental Advisory Board in 2003, after a period of dormancy and requested scientific evaluations and recommendations for Civil Works procedures that address the environment (NRC 2004a, b, c; NAPA 2007). In its first Civil Works Strategic Plan, the Corps adopted a mission that was to be pursued "...in an environmentally sustainable, economic, and technically sound manner..." (USACE 2004 pg vii). The commitment remained intact in its second Strategic Plan for 2010-14 (USACE 2009a). Numerous other contributions to managing impediments are described in the report. Yet, many fundamental aspects of the basic questions about sustainability remain incompletely addressed and systematically fragmented. The framework provides a comprehensive conceptual approach to further answering the questions and a basis for future development of detailed guidance.

Most of the issues impeding achievement of environmental sustainability became evident early in the study, but their dimensions, relationships, and integration into a conceptual framework evolved over ensuing years and events. Several events and emerging issues had exceptional influence. The first event was Corps headquarters reorganization in 2004-5. Before reorganization, a detailed plan for achieving environmental sustainability was developed by Headquarters and a taskforce was convened to move environmental sustainability forward in Civil Works. In the process of reorganization, the thrust forward was lost as personnel responsibilities changed significantly.

A year later, the aftermath of Hurricane Katrina stimulated intense introspection about Corps practices. The Chief of Engineers announced 12 "Actions for Change" in late 2006 (USACE 2006) to take place in the Corps, including sustainable management of all problems addressed by the Corps in its civil works and military programs, research and development, and all other activities. Many of the issues identified as impediments to achieving environmental sustainability were addressed more generally in the Actions for Change. Progress made under that program is reported in issue descriptions. Corps campaign plans began to emphasize sustainable solutions for managing water resources problems.

In 2009, President Obama signed Executive Order 13514, which sets sustainability goals for federal agencies to focus more pointedly on increased energy efficiency, reduced greenhouse gas emissions and otherwise improved environmental performance. The executive order directed the Corps toward attainment of specific sustainability targets. It called attention to other issues pertaining to sustainability, such as the looming role of climate change in influencing future project performance. While the Corps had begun to consider the potential consequences of climate change, EO 13514 committed it to more serious integration of the potential into project risk and uncertainty assessment and management. The revised EOP raised risk management to a higher level of prominence and precipitated a reexamination of the issues and integration of consequential changes into the issues assessment.

Avenues for Achieving Sustainability

The Corps goal of encouraging economic sustainable development while protecting and restoring natural ecosystems specifically reflects Corps authorities and program purposes. More generally, the goal also reflects the tensions set up between environmental use and heritage goals in NEPA and the needs of present and future generations in the U. N. concept of sustainable development. Promoting wise husbandry of resources for a sustainable future has had mixed success throughout human history. Providing for the future of one's own child is much less abstract and more emotionally satisfying than providing for strangers who have yet to live. But this obligation to provide for the needs of future generations as living generations provide for themselves is the essence of the U. N. concept that has been endorsed in principle by United States and anticipated in the goals of NEPA.

Difficult challenges are faced while making decisions about what parts of the environment can be used for existing benefit without reducing future options and choices. The concepts of environmental use and nonuse value have particular relevance for decision-support analysis in general and for the Corps Civil Works Program in particular (see NRC 2005 for concept descriptions). In general, use value can be measured in dollars based on estimates of public willingness to pay for protecting existing resource use and improving future resource use. Encouraging beneficial use through project improvements amounts to economic development. All but one of the seven authorized purposes of the Civil Works Program promotes beneficial use of water resources and economic development. In general, the value that accrues largely to this generation from use of the environment can be priced in dollars. Corps project planning regulations require the changes in the use value generated by projects to be measured in dollars.

Sustainable economic development of the environment requires protections of economic and social welfare. Protection of private wealth has been guaranteed as a right since the Nation's early years. The Bill of Rights assures preservation of private property value through fair compensation when government requires the property for some larger public good. NEPA provides for consideration of the equivalent in rights to use publicly owned environments—such as for outdoor recreation, transportation, and commodity production (e.g., food fisheries). It promotes economic sustainability through mitigation of EQ impacts that results in sustainable resource use.

Impact mitigation preserves the existing economic value of environmental use at Corps projects, during development and operations, either by avoiding the impact entirely or by compensating for lost value through creation or restoration of equally valued EQ. NEPA favors conservative use of depletable natural resources and materials recycling. Executive Order 13514 emphasizes the particular need for federal agencies to reduce fossil fuel use directly and indirectly (through electric power use) because of the impact fossil-fuel use is likely to have on climate and associated economic sustainability. Compensatory mitigation is commonly used to sustain the economic value of public environments. Total avoidance is less common because economically valued environmental attributes are rarely irreplaceable at reasonable cost. A future determination that a mitigation site might be more beneficially used will require subsequent consideration of economic impact mitigation to sustain public right to access.

Social sustainability is achieved when cultural heritage is preserved well enough to sustain unique information in material form for the potential use of future generations. While the history recorded in libraries is essential for social sustainability, preserving representative examples of the man-made environment also maintains options for new discovery as science advances and economic resources increase. Social sustainability is achieved when projects establish equal environmental protections for people regardless of economic or minority status. NEPA establishes this principle in its goal to provide safe, healthful, and pleasing environments for *all* Americans. In effect, the goal establishes a human right to be respected by the federal government in all of its activities. Compliance has been boosted by Executive Order 12898 on environmental justice and by EPA emphasis. Environmental justice is based in the intrinsic value of the human right to a clean, safe, and pleasant environment regardless of income level. That right is nonnegotiable and cannot be traded off to maximize economic benefit as long as society stands behind it in its institutions. Compliance with environmental justice directives typically distributes benefits among members of the public differently than the most economically efficient means.

In the Civil Works Program, environmental sustainability is approached through mitigation of environmental quality (EQ) impacts and its ecosystem restoration and protection authority. The two approaches differ in important ways. Mitigation of adverse impacts preserves the value of existing natural heritage during project planning, construction and operations (including Corps lands stewardship) while ecosystem restoration and protection increase the national value of existing EQ. Impact mitigation must be considered in all Corps project activities while ecosystem restoration and protection is limited to projects considered under a specific authority. Impact mitigation addresses potential adverse impacts of local to national significance while ecosystem restoration and protection is limited to impacts of national significance.

The two approaches are similar in some ways. In individual project interactions, environmental protections through mitigation may be traded for exceptional beneficial use value and when alternatives exist for sustaining unsustainable attributes of the environment. In ecosystem restoration and protection considerations, the heritage value of desired ecosystem resources may be traded for greater use value when the total benefit to the Nation is maximized. For restoration and mitigation, the heritage that results must be protected for an indefinitely long time.

The Civil Works Program also may act to preserve natural heritage through compliance with other regulations and directives. The Corps must comply with numerous environmental laws that have direct or indirect effects on heritage preservation. The CWA and ESA are two good examples of strong environmental laws. Executive Order 13514 requires broad program management of potential risks imposed on scarce natural heritage by exceptionally rapid climate change. Executive Order 11990 requires exceptional consideration of federal impacts on wetland functions and values, including effects on the heritage value of threatened and endangered species.

NEPA implementation regulations require federal agencies to consider mitigation of the impact of their activities on EQ that the public values enough to protect through laws, organizational missions, presidential executive orders, protests in public demonstrations, and other means. NEPA regulations require that all significant effects on EQ be considered without regard for whether or not they are monetizable. Once a decision is made to mitigate based on public recognition of significant EQ effect, the cost of mitigation is incorporated into project plan costs. For economic development projects, mitigation costs diminish the estimated monetary benefit of the plan; sometimes enough to reduce the net benefit to zero or lower. Plans with negative net benefit are screened out of further consideration. Public recognition of significant effect does not discriminate between use and nonuse value.

Everyone in the Corps is expected to embrace sustainability in all of its dimensions, but the environmental community has historically acted within the Corps Civil Works Program to assure environmental protection and proper restoration of the environment. The Corps has an environmental mission, established in law in 1990, which commits it to careful consideration of adverse environmental impacts and impact mitigation. That mission complements its ecosystem restoration mission, which is focused on reducing the scarcity of unsustainable ecosystem elements and protecting them for continued contribution to the Nation's diverse ecological heritage. While economic sustainability that results from mitigation of impacts on environmental use is important, the more fundamental concern of the Corps environmental community is preservation of important natural and cultural heritage. The environmental community of practice throughout the Corps needs to lead in the management of the issues raised here.

The ultimate hope for this effort is for framework concepts to contribute to improved Civil Works strategic and project plans, and to improved policy and technical guidance. The primary audience for whom the report is written is the body of Corps strategists and program managers most responsible for moving the Corps toward achievement of environmental sustainability.

SECTION 2: ISSUES RAISED BY THE EOP AND OTHERS SOURCES

Status and Overview

The issues impeding achievement of environmental sustainability in the Corps Civil Works footprint have deep roots, but were raised to a higher level of importance by pronouncement of the original EOP in 2002 and the revised EOP in 2012. The explanations of EOP meaning and implications for the revised EOP (Bostick 2012) and the Implementation Guidance for the original EOP (USACE 2003a) raise these issues to the surface of Corps sustainability policy, either directly or by implication. Other sources of information pertaining to the issues include Corps authorities, policy guidance, and reports; Civil Works strategic plans; National Research Council reports; critical reviews, and other relevant literature. The issues raised by each of the EOP principles are described separately.

The EOP in their revised form are accepted as the corporate foundation for environmental sustainability policy throughout all Corps program areas (Bostick 2012, USACE undated). Implementation of the EOP is required (Regulation No. 200-1-5) and Implementation Guidance (the Guidance) for the original EOP were provided in 2003 (USACE 2003a). The Corps still accepts the original principles (Bostick 2012, USACE undated) and, presumably, those aspects of the Guidance doctrine that clearly pertained to achievement of environmental sustainability. While the revised EOP are briefly explained, Bostick (2012) indicated that the much more detailed 2003 Guidance needs to be replaced with guidance that takes into account the broader goal of the revised EOP and relevant events since 2002. That had yet to take place at this writing.

This report is limited to environmental sustainability achievement in the Civil Works Program and was largely informed by the original Guidance as well as the more recent EOP explanations. The goal of the 2003 Guidance was USACE inclusive and “concrete enough to meaningfully guide the environmental responsibilities of the Corps.” Those responsibilities vary somewhat in the Civil Works and Military Programs of the Corps. Both the Guidance and explanation of the revised EOP elaborate on the meaning of the EOP more than they explicitly inform implementation. The development of specific information for implementation was left to the individual programs. This report includes issues remaining incompletely addressed, progress made, and future issue management needs in the Civil Works Program. Presentation of the framework for issues management presented here is preceded with a review of the issues that emerge out of existing EOP guidance (USACE 2003a), by intent and by implication. They are described here for each of the seven principles.

Principle 1: Foster Sustainability

Foster sustainability as a way of life throughout the organization

Consistent with NEPA, the lead into explanations for each of the revised EOP affirms that the environment of EOP concern is the human environment and the goal is to create and maintain environmental conditions that “can fulfill the social, economic and other requirements of present and future generations” (Bostwick 2012). The original first principle addressed achievement of environmental sustainability. In dropping the environmental adjective in the revised principle,

the concept was opened to all aspects of sustainable development, including economic development, environmental justice (a social concept), and ecological sustainability. The explanation for revised Principle 1 continues to commit the Corps to achieving environmental sustainability (Bostick 2012), but achievement also includes economic and social sustainability. Because social and economic sustainability may be influenced by factors other than the material environment, their sustainability is not solely dependent on Corps environmental impacts. In addition to the economic and social effects of environmental alteration, other social and economic aspects must be considered (these aspects are not addressed in this report—which concentrates on the material environment).

Unlike the original statement of Principle 1, the revision explicitly indicates that sustainability achievement requires behavioral changes throughout the Corps. While the Guidance indicated the importance of adopting the EOP throughout all Corps programs, this and other changes in the EOP reflect dissatisfaction with the pace of sustainability achievement, as well as new planning and management emphases since the original EOP were announced in 2002 (USACE 2003a).

The elaboration of Principle 1 states the general goal introduced in the preamble more explicitly in terms of sustainable development:

“Protecting and restoring natural systems and the environment while encouraging productive sustainable economic development that improves the quality of life is our goal” (Bostick 2012).

This goal raises important issues about the sustainability objectives of the Corps, the measurement of their achievement, and how to proceed toward achievement in Civil Works planning and operations. These and related issues recur in many activities of the Corps and are the most fundamental considerations in the framework presented here. Because of the differences in economic, social and ecological dimensions of sustainable development, no single objective for or measurement of sustainable development is judged to be possible. Each requires separate objectives and measurement to gauge progress in achieving a sustainable development goal. Otherwise goal achievement becomes thwarted by muddled or immeasurable objectives. The process of achievement must be comprehensive, diversified, well integrated, collaborative, and well informed to achieve the objectives.

The prevalent concept of sustainable development identifies interactive but separate economic, social, and environmental aspects of sustainability (Figure 1, Goodman and Daly 1996). The economic and social dimensions of humanity cannot persist without the human environment, but they also depend on the initiative, creativity, and social interactions of humanity. NEPA establishes the environment of national concern as one that is safe, healthful and pleasant for all Americans. The human environment is a collective concept—it is the material surroundings for all of society, both present and future. Human ecosystems cannot exist without the environment. But the environment, including ecosystems, can exist without humans in some alternative expression. Since the human environment seems inseparable from all of the features and processes that humans interact with in the ecosystem they occupy, the concepts of human environment and human ecosystem are close enough to be considered the same.

Adding to the potential for confusion over objectives for achieving the new goal is the implied difference between environment and natural systems. Perhaps developed and undeveloped parts of the human environment are implied here since the qualities of both undeveloped and developed environments are of interest to the federal government. Both undeveloped and developed environments can contribute to economic and social sustainability, as well as to the sustainability of the material environment. Some attributes of undeveloped and developed environment are valued enough to protect them from destructive use and abuse to preserve natural and cultural heritage. While natural heritage flows from the sustainability of natural structure and process, cultural heritage flows from the sustainability of social structure and process. Unlike natural heritage, which is self-regulating, cultural heritage must be maintained by humans. Thus preserving cultural heritage requires a social sustainability objective while preserving natural heritage requires an objective for sustaining the natural environment.

Since it only addresses environmental sustainability, the Guidance will likely require updating to incorporate more information about economic and social sustainability, and how they differ from one another and from environmental sustainability. The Guidance addresses environmental dimensions quite thoroughly and the issues it raises continue to be relevant for this assessment of environmental sustainability.

The Guidance impedes achievement of environmental sustainability by confusing the meaning of environmental sustainability in two different definitions. The definition in the main body of the Guidance has much in common with the U. N. definition of sustainable development. It states: "... the Corps defines environmental sustainability as 'a synergistic process whereby environmental and economic considerations are effectively balanced through the life cycle of project planning, design, construction, operation and maintenance to improve the quality of life for present and future generations'." The Guidance refers to the seminal role of the United Nations report, "*Our Common Future*" (WCED1987), but fails to mention that the report's main topic is sustainable development. Like the United Nations definition of sustainable development, the Guidance definition is anthropocentric and focused on the sustainability of human welfare, including the needs of both present and future generations.

The glossary definition is quite different: "Environmental sustainability is the dynamic under which the Earth's systems function together in a self-regulating and self-generating manner, maintaining its balanced interdependence while providing the essential ingredients for sustaining all life forms." The glossary definition is focused on self-regulation, regeneration, and sustaining biodiversity. It is not linked to the needs of present and future generations, but, if achieved, would sustain all of the diverse options for future potential use by future generations. The glossary definition has more in common with the focus of the environmental sustainability goal of the original EOP on maintaining the health and diversity of the environmental life-support condition, but does not make clear that the keystone life support is that needed to sustain human welfare.

This confusion over definitions is a fundamental issue that needs to be better managed with clearer policy statements of program objectives. The concept of environmental sustainability described later and accepted in this report has elements of both definitions.

The main body of the Guidance also reflects acceptance of the glossary definition of environmental sustainability. It reiterates the focus of the environmental sustainability goal on living organisms by emphasizing that: “the Corps, in executing its authorized programs, must strive to sustain our Nation’s ecology”. As used here, ecology is nearly synonymous with ecosystem, but also includes ecological resources. An extreme interpretation of this statement would have USACE striving to prevent any development that involved modification of natural ecological structure and function. The more likely intent is to strive during development to prevent unnecessary loss of unique attributes of life and their ecological support systems, and to replace any locally lost ecological resources having significant economic value with substitute resources. The statement could imply that the Corps will strive to restore unsustainable ecological resources impacted by its projects to a sustainable state and contribute even further to correcting the negative impacts of others. In being too succinct and broadly stated, the Guidance implies much about the important role of diverse living resources in a program objective, but does not make the environmental sustainability objective transparently clear.

The Guidance for the original Principle 1 also adds little to determine what satisfies achievement of an environmentally sustainable condition or how to sum up the contributions of each Corps activity into measures of program progress achieving environmental sustainability. However, the original principle does provide some indication of a proper objective subject. The first principle indicates that environmental sustainability is achieved when a life support system is maintained in a “healthy, diverse, and sustainable condition”. While the Guidance is clear that environmental sustainability is about life support and viability, implying that some form of biodiversity objective and metric is suitable for objective definition and measurement, it falls far short of specifying an objective and appropriate objective metrics and accomplishments. Managing this issue requires clear definition of the environmental sustainability objective and specification of metric needs.

The explanation for the revised principle notes the importance of protecting and restoring natural systems and the Implementation Guidance emphasizes the importance of diverse life support systems, especially in fresh water ecosystems, but neither one clearly points out that the biggest threat to the Nation’s natural heritage is the erosion of biodiversity through species decline and global extinction, or that environmental sustainability requires maintenance of biodiversity through restoration and protection of those unsustainable species in supporting ecosystems. In addition, neither one mentions that species recovery and maintenance in naturally sustaining ecosystem contexts is a firm basis for indicating achievement of environmental sustainability.

The Guidance for Principle 1 recognizes the need for collaboration: “Achieving environmentally sustainable management requires collaboration among federal, state, and local government agencies, and non-government organizations”. Despite that recognition, it fails to explicitly recognize that collaboration effectiveness suffers from a lack of a collaboration focus provided in clearly stated, quantifiable and acceptable program objectives. Managing this issue also requires development of an integrated resource management (IRM) concept suitable for inter-organizational coordination, cooperation and communication.

Effective collaboration requires trust, which may be influenced by the way the original and revised EOP are stated. The emphases of the EOP in general, and the first principle in particular, is on actions taken much more than on results expected in natural resource condition. Corps critics often accuse it of being more interested in process that perpetuates employment than in achievement of something worthy of public investment. It is easier to provide evidence of “striving” or “fostering” than evidence of actual achievement. The EOP principles appear to focus more on how the Corps will try to achieve environmental sustainability than on what is to be achieved. With some justification, “striving” or “fostering” may be thought a ruse if just trying appears to be the goal; not actual achievement of something tangible. The Corps cautiously recognizes the difficulty of goal achievement and is reluctant to “promise” anything that may not be deliverable given technical and budgetary limitations. Yet the EOP may be more effective if the Guidance pointed out that process should not overshadow achievement. Doing that requires clearly stated objectives and performance indicators to match.

Principle 2: Proactively Consider Environmental Consequences

Proactively consider environmental consequences of all Corps activities and act accordingly.

The explanation for Principle 2 emphasizes leadership on environmental matters and early engagement with others in project and program contexts. That raises the issue of how well the Corps collaborates with others in integrated resource management. The principle also emphasizes the need to mitigate environmental impacts by avoiding adverse effects when possible and mitigating, through repair or replacement, when impact avoidance is impractical. That raises the issue of what impact should be avoided at all cost, if anything. The explanation also implies a need for continuous performance monitoring and performance correction, when needed, by advocating for continuous accounting of changing environmental conditions. The issue raised is the extent an adaptive management process is needed to achieve environmental sustainability. Monitoring and adaptive management are essential for achieving environmental sustainability. National guidance for how to go about it has yet to be released.

“Proactive” achievement of environmental sustainability requires information about the existing condition and the desired future condition of the environment. Without a broad inventory of the existing condition and a broad vision of the future desired condition, the approach to impact minimization and enhancement of positive effects must be limited to the local view of conditions. Proactive achievement requires these two issues to be addressed to improve the adaptive planning and management process. More effective decision support also requires a regional systems approach to assess environment degradation and improvement. If for example, conditions are degrading everywhere rapidly in the region, the emphasis on avoidance over environmental repair or replacement may be justifiably greater to reduce the risk that repair or replacement may not be as effective as once thought possible. On the other hand, if conditions are broadly improving, repair and replacement risks are more acceptable and often less expensive than avoidance, resulting in beneficial development while assuring that the regional environment is sustainable.

Originally, the first part of principle 2 directed recognition of the interdependence of life and the physical environment (USACE 2003a). That need is less generally applicable for a sustainable

development goal with social and economic dimensions, but it continues to pertain to environmental sustainability with a focus on the natural environment. The Guidance makes clear that *any* life, not just human life, could be impacted by the environmental effects of activities in Corps programs (USACE 2003a). The focus on the interdependence of life and physical environment affirms the focus of the original first principle on ecological support systems for all life. Because considerations and actions are to be proactive, Principle 2 stresses the importance of envisioning desirable future conditions for the environment at a program level in order to achieve them, i.e., “to consider what kind of planet we ultimately want for ourselves and future generations.” This implicitly raises an important issue about Corps failure to establish a vision of desired resource condition in its environmental footprint.

The Guidance points out that environmental consideration must extend to national scope and “evaluate the long-term implications of our mission execution”. This raises issues about project and program planning adequacy that are not explicitly addressed in the EOP. The original Principle 2 implies a need for Corps planning at a larger program scope than the project level and across alternative possible futures. The need to plan comprehensively with a vision of desired future condition in mind is addressed in the Framework. It is considered in issues having to do with adaptive management over the entire project-life cycle, inventory of sustainability conditions, envisioning desired future conditions, and program strategic planning directed proactively at achieving environmental sustainability.

The Guidance recognizes that freshwater ecosystems are of particular significance to the Corps and are “among the most fragile and endangered of all major ecosystem types. Therefore, our future treatment of this ecosystem is especially important to achieving environmentally sustainable development”. As significant as this recognition is, the Corps has yet to fully inventory the possible contributions of its past activities to unsustainable environmental conditions in freshwaters or other ecosystems. Managing this issue by implementation of an appropriate inventory is central to any framework for achieving environmental sustainability. Such an inventory is prerequisite both to envisioning more desirable future conditions and to undertaking action to “maintain the viability of natural systems” by identifying unsustainable ecosystems.

The Guidance also states that “the Corps will endeavor to identify and prioritize degraded ecosystems and develop alternatives” for their restoration. This is consistent with evaluating the long-term implications of Corps programs and the need for a project life-cycle perspective, including alternative plans cast against alternative futures. A variety of specific arrangements of project structure and integrations with natural ecosystem functions may satisfy the needs of an environmentally sustainable state for maintaining future options while also contributing to improvements of existing economic and social welfare. Opportunities for increased environmental sustainability may exist in major rehabilitations of projects, project decommissioning, and ecosystem restoration projects.

The Guidance points to emerging conflicts in the United States “between consumptive use and the long-term needs of aquatic ecosystems”. It indicates that members of the public “expect the Federal government to seek solutions that balance economic and environmental needs”, which is “clearly a role for Corps programs and activities”. In that role the Guidance states: “Now and in

the future, Corps water management will seek to optimize the use of existing surface water projects to address multiple objectives of flood control, navigation, agriculture, water supply, and the restoration of aquatic ecosystems.” Yet, this statement and the Corps planning guidance remain, for the most part, project focused. The Corps has yet to develop clear concepts for Civil Works program planning at the regional and national levels. Two important issues are the deficiencies of planning guidance for multi-project, regional planning (e.g., watershed or river basin planning) and single-project planning in a systems context.

Principle 3: Seek Sustainable Development

Create mutually supporting economic and environmentally sustainable solutions.

More succinctly than the original, the revised Principle 3 conveys the interplay between economic sustainability and environmental sustainability that is desired to achieve a sustainable development goal. It clearly distinguishes the two concepts of sustainability and returns to the issue of determining measurable objectives and metrics for achievement, as well as effective achievement process. Objective formulation is necessary to guide planning and management process more effectively toward meeting the sustainable development goal. Reliable metrics are required to gauge progress. And more cost-effective approaches to planning and management are needed to assure program success.

While the entire environmental sustainability objective is linked to the material environment, the economic sustainability objective is only partly linked to the material environment. The environmental contribution to an economic sustainability objective is reasonably clear in the mitigation impact principle of NEPA process—to maintain the existing economic welfare of the public by avoiding impact if possible and replacing economic value when impact is unavoidable. Since the economic value of public resources is rarely irreplaceable, unless the resource is unique and has no use substitute, economic sustainability is often compensated through resource replacement of some nearly equal value, but not necessarily with precisely the same resource. The main difference from NEPA requirements in project planning process is the need to measure the effects in monetary units to better inform tradeoff analysis, proper mitigation choices, and proper resource replacement amounts and costs. The failure to monetize complicates achievement of separate economic and environmental sustainability objectives as well as benefits and cost accounting necessary for the most effective planning process.

The explanation for the revised principle reiterates the need to protect the environment but adds protection of quality of life, apparently including qualities that do not derive from the environment. That is consistent with assuring social sustainability. Two aspects of social sustainability are clearly addressed in NEPA mitigation considerations. One aspect is based in the need to avoid impact on environments with exceptional cultural significance. This includes man-made environments of historic and archeological significance and natural environments of special cultural significance. Impact avoidance is much preferred over moving or replacing objects of cultural heritage, which typically derive much of their value from their origins and environmental context. The second is based in the need to provide environmental justice for all in as uniform a distribution of safe and healthful environments as possible. While NEPA also mentions a right to pleasing environments, aesthetics are not as uniformly recognized as safe and

healthful conditions. Variation in the aesthetic value of the environment is a significant aspect of private property pricing. However, exceptionally pleasing environments are often set aside for public use by anyone who can afford to go there. For the Corps, safety is typically the most significant concern.

The environmental sustainability objective in NEPA mitigation considerations is based in the need to avoid impact on irreplaceable attributes of the environment desired by the public. Attributes are rarely totally irreplaceable, however, they may be so scarce, and the replacement risks, so high that impact avoidance is the prudent choice. The scarcity of ecosystem structures and functions may well be important indicators of high heritage value. While, the revised Principle 3 erases the previous emphasis on natural systems verses development, it preserves that emphasis in the sustainable development goal introduced in the explanation for revised principles 1 and 3.

The revised Principle 3 also links environmental effects on ecosystems to economic effects through service effects that can be beneficial or costly. It emphasizes the land and water resource stewardship role of the Corps and the need to protect resources in a balanced way, which raises the issue about what resources need to be protected as the economy is developed. The explanation mentions the restoration mission of the Corps and making restored ecosystems available for public use, but does not mention the need to protect the project output justifying the investment from consumptive use. This raises the issue about how an environmental sustainability objective applies both to preserving existing conditions and restoring conditions through ecosystem restoration projects.

Principle 3 also points the way towards a process that will achieve balance between human activities and restoration of sustainable natural ecosystems. Two recurrent issues arise here as well. First, clear articulation of environmental and economic sustainability objectives are needed for Corps project planning and management. Second, there is a need to do much more procedurally to achieve sustainability. The explanation also expresses a need to account for benefits and costs in monetary and non-monetary metrics. Once again, this raises the issue of how to measure achievement of environmental sustainability. The Guidance for the original principle also indicates that the process of determining the appropriate “balance between economic and environmental factors” requires “collaboration with other agencies, stakeholders, and citizen groups”.

The introduction to the explanations for the revised EOP reiterates a continued Corps commitment to the NEPA policy of creating “conditions under which man and nature can exist in productive harmony” and fulfilling the needs of present and future generations of Americans. Principle 3 echoes the need to eliminate tension between man and nature by promoting mutually supportive economic and environmentally sustainable solutions. Leaving out social sustainability in Principle 3 reflects Corps authorities, which are presently limited to developing the economy and to restoring and protecting the environment. Assuring social sustainability is a constraint, however, including protection of cultural heritage and a renewed emphasis on environmental justice. Principle 3 does not, however, reiterate the NEPA commitment to present and future Americans, or explain how economic, social and environmental sustainability relate to them.

While economic and social sustainability quite clearly benefit humans, the beneficiaries of environmental sustainability are less clear. Is it nature or man?

In addressing this issue in improved policy guidance, Principle 3 could provide a foundation for a planning framework that addresses management of environmental and economic problems consistent with existing Civil Works project planning policy. The explanation for revised Principle 3 touches on that possibility by directing the accounting of benefits and costs in monetary and nonmonetary units. But it leaves open the issue of what should and should not be monetized. In a more fully developed framework, the relevant tensions that need to be addressed by mutually supportive solutions more properly exists in the sustainable use and economic needs of present generations and the environmental sustainability needs of future generations. Suitable monetary metrics exist for economic needs, but the metrics most appropriate for future needs are much less clear. Optimal integration of economic and environmentally sustainable solutions requires protection and restoration of no more of the unsustainable aspects of the material environment than necessary to sustain a potentially useful heritage for future generations. Preserving more than necessary could unnecessarily limit the existing generation's economic gain from sustainable use of the environment.

The principle of optimal development that preserves heritage applies as well to the federal objective of Civil Works project planning in the Corps, which seeks to maximize net return in human benefit from combinations of national economic development (NED) for resource use and national ecosystem restoration (NER) in Civil Works projects. In this context, the issue is raised about how to measure environmental benefits in ways that will aid 1) the NEPA process, 2) evaluation of ecosystem restoration plans in the Civil Works Program, and 3) summing up project contributions to environmental sustainability at the national program level. As the original EOP Implementation Guidance states about performance measures (benefits): “measures must be understandable and attainable. They should cover both individual projects as well as macro project trends.”

Universally applied environmental metrics are not being used now. A mix of incomparable metrics is being used at project and program levels (Cole 2013c, d). The Guidance recognizes the need for acceptable measurement and implies a need for new metrics that overcome the limitations of existing metrics. However, the Guidance fails to point out that securing and maintaining natural heritage is a firm basis for measuring environmental benefit. Rigorously quantitative indicators of natural heritage improvement are needed.

The Guidance recognizes that Principle 3 is procedural rather than visionary. It does not define what a “balance” of the two would look like in full achievement in the Corps infrastructural footprint. The principle is conceptually incremental, consistent with the project-centered authorities that garner 95 percent of the Civil Works budget. That focus places great demands on estimating the cumulative effects of each project on EQ without knowledge of desired resource conditions at regional and national scales. This issue can be managed by developing visions of environmentally sustainable resource conditions for consideration during project and program planning process and operations.

With respect to integrating concepts of natural-system value and developed-system values, the Guidance indicates that "... models should integrate the value of natural resources development...with environmental enhancements." Neither the Guidance nor explanations for the revised EOP provide information about how to do this and raise the issue about developing "a more realistic picture of the impacts and positive contributions of these activities upon natural systems". But it does emphasize the importance of R & D for managing this and other issues—especially the need for improved models to better analyze the cumulative effects of environmental impacts.

Principle 4: Meet Corporate Responsibility for Environmental Impacts

Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.

The revised Principle 4 confirms the original principle commitment to being a responsible and accountable federal agency, consistent with law. For the first time among the revised principles, the natural environment is mentioned and is separated from the human environment. This follows from the introduction to the explanations, which indicates that the word environment means the total environment, which includes natural and human needs. Presumably, this means that the needs of nature are indirectly important because of the services they provide humans, not that nature has independently recognized needs. Recognizing independent needs of nature would be inconsistent with NEPA policy, which encourages harmony between man and *his* environment. None of the NEPA policy and goals indicates anything about providing for the needs of the natural environment independent of safe and healthful beneficial use and heritage preservation for human needs. Consistent with this limitation to the human environment, the announcement of the revised principles on the Internet (USACE undated) indicates that the EOP relate to the human environment, presumably including the natural environment. If the natural environment has independent needs that need to be considered, the environmental sustainability objective would need to be expressed and measured in those terms. The presumption here is that is not the intent of the revised EOP.

The explanation for the revised Principle 4 emphasizes the importance of considering the environment throughout conceptualization and operational lives of projects as well as the engaging expertise and available tools to avoid environmental conflict. These points raise several specific procedural issues for achieving environmental sustainability. First is the need for a planning process that is flexible enough over decades of project lives to continue to achieve sustainability objectives. This flexibility will require more of a project life-cycle perspective in project planning guidance and process. Project and program conceptualization for environmental sustainability requires a broader regional perspective in planning to account for the interactions of multiple projects and other activities, as well as more complete inventories of existing sustainability conditions and a better vision of the desired future condition. Existing planning tools need improvement to more effectively address the spatial and temporal dimensions needed to plan for environmental sustainability.

The original Principle 4 added more information about the expected condition of environmental sustainability, which clearly includes "the continued viability of natural systems". In the

ecological context used, the term “viable” means long term continuity maintained by life processes independent of human intervention. The Guidance indicates that the viability of natural systems is most frequently indicated by the viability of native species-populations and maintenance of biological diversity. Nonnative species introduced by humans are often considered unnatural and sometimes threaten the sustainability of native species (Cole 2009). However, many are here to stay and are part of the natural process in the sense that they do not depend on humans to sustain them. Continued viability of natural systems is the anticipated outcome from maintaining the essential ingredients of all life. Population viability can be quantified and the number of individuals needed to sustain a population has been estimated for numerous species (Traill et al. 2010). The meaning of systems viability can be better managed by clearer definition of viability and its relationship to environmental sustainability, as well as policy clarification. The emphasis on viability is consistent with the Guidance for the original Principle 1, which emphasized life support.

The original Principle 4 provides direction for the Corps’ environmental improvement authorities. It strongly suggests that restoration projects should contribute to increased viability of natural systems that are eroding away with the decline of species to extinction. In its acceptance of or meeting *corporate* responsibility and accountability (as opposed to project management responsibility), the Corps implicitly reaffirms the program-level application of the principles and implies that it will account for its actions at the program level. However, the type of accounting system to be used is not prescribed in the Guidance. Managing Corps activities to improve and protect system viability requires a systems approach with appropriately expansive spatial and temporal scales. It also requires clarification of the environmental sustainability objective, improved ways to measure its achievement, and clearer policy guidance.

It is important to recognize, however, that ecosystem viability does not mean the same system will continuously regenerate through time. Ecosystems are continuously changing in time and space as climate and other environmental attributes change (e.g. Hobbs et al. 2013). But most of the species and other elements of the Nation’s ecosystems can remain viable in new ecosystem arrangements with a concerted national effort, and the Corps can contribute to that concept of systems viability.

The Guidance emphasizes that the Corps must look first to the law to assure it is in compliance and contributes meaningfully to achievement of national, state and local environmental objectives. It states:

“...the values of environmental sustainability have in large part already been incorporated into the Nation’s laws and mandates to governmental and private actors...We must be responsible for assuring that everything we do is within the law. Failure to abide by the standards established in laws...may result in civil and criminal enforcement actions.”

While compliance with law should go without saying, the Guidance indicates a need to do more than the absolute minimum defined by law. The legal imperatives are followed by an ethical imperative—spelled out in the Army Environmental Strategy—for agency leaders to “expand the scope of their responsibility and incorporate a more comprehensive and coordinated approaches

(sic) to environmental stewardship”. In effect, the strategy asks agency leaders to be more proactive in achieving environmental sustainability. It implies transcendence of project-focused activity to more programmatic attention. Despite the Army Environmental Strategy, the revised EOP had to reemphasize the need for proactive environmental consideration in the Principle 2.

The Guidance reiterates the importance of NEPA in “providing the strongest basis for achieving environmental solutions” and reiterates the general indicators (of environmental sustainability) identified in NEPA policy and goals. Using NEPA as a basis for achievement requires determination of: 1) what is a harmonious state between man and nature, 2) what qualifies as environmental damage, 3) what environmental conditions stimulate human health and welfare, and 4) what the nationally important resources and ecosystems are. These are addressed in several of the issues raised for management attention in the Framework described in the next section.

The Guidance less clearly states that, in addition to minimum requirements, environmental laws often set goals that provide guidance for acting more “responsibly” within valid constraints, especially as they relate to natural system viability. The ESA goal is an excellent example. It goes well beyond the “last resort” protections of species listed as threatened and endangered. Congress more broadly establishes a viability objective for the Nation’s species to maintain a “fish and wildlife heritage” (wildlife includes plants as well as animals). The ESA explicitly enlists all federal agencies to do what they can within their authorities to pursue the goal. Conservation biologists now believe that several times the number of plant and animal species listed under ESA protection is in decline toward possible extinction and a need for listing (Cole 2009). While the viability of natural systems is clearly important to the Corps, neither the Guidance or the explanations for the revised EOP fail to point out that the most insecure parts of systems should gain priority attention based on national objectives. This issue pertains to specification of an environmental sustainability objective, to its measurement, and to the need for improved policy guidance, especially for the ecosystem restoration program.

More explicitly, four avenues could be more aggressively followed to improve natural system viability if certain issues were better managed. First, the Corps could proactively inventory species sustainability within its Civil Works footprint, regardless of ESA listing status. Second, the Corps could act to protect all species technically recognized to be in decline toward a need to list them under ESA protections, even if they are not now protected under existing law. Third, it could more actively solicit non-federal project sponsors to engage in restoration projects focused more on reducing the vulnerability of the threatened components of natural systems. And fourth, it could rank ecosystem restoration projects for funding in the annual budget process based on the most threatened components of ecosystems. Issues pertaining to inventory needs, objective specification, policy updates, and measurement of objective achievement need to be better managed to more effectively foster these actions.

The Guidance makes clear the need to accurately report on activities that contribute to environmental sustainability. The Civil Works Program has thus far shown limited evidence of monitoring its environmental impacts and contributions to environmental improvement so that it can account for progress at a program level. Most typically, it reports process—dollars spent; acres managed; actions taken. However, the Guidance states: “the Corps as a whole must work

to be responsible and account for all of its activities”, both in terms of process and outcomes, relative to environmental sustainability. The deficiency of an inventory of current environmental conditions and visions of desired future conditions (including indicators of success) are particularly relevant issues raised and addressed in subsequent sections of this report. In addition, the Guidance implies the need for a more systematically adaptive management process that learns from the results of its past activities.

Principle 5: Include Environment in a Systems and Risk Management Approach

Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.

The revised Principle 5 places less emphasis on improving assessments of cumulative environmental effects and their mitigation, and more emphasis on risk management as it applies to environmental considerations. Since mitigation of adverse impacts has been an important aspect of previous principles, even though it is not so explicitly mentioned, its elimination from the revised principle is not that significant a change. Much rests on the explanation of how risk management and a systems approach contribute to achieving sustainability.

The explanation’s big emphasis is on using conceptual models to identify sources of risk and adaptive risk management. Presumably the conceptual models are regional systems models developed at temporal and spatial scales adequate for more effective cumulative effects assessment, including climate change. The explanation emphasizes use of adaptive risk management in place of “overdesign”. Presumably, overdesign results from favoring plans that treat worst-case scenarios using expensive management measures that may prove unnecessary. Use of highly vulnerable floodplains and coastal areas is judged to be too risky by fiat and should be avoided (presumably after appropriate risk assessment and management study). Areas that are highly vulnerable to flooding or have high ecological value “should be a focus for restoration or management as natural areas”. The explanation for revised Principle 5 raises many of the fundamental procedural issues pertaining to planning for an adaptive process using project life-cycle analyses informed by regional systems assessments of environmental condition, a national inventory of sustainability problems, and a vision of future desired conditions.

Both the original and the revised versions of Principle 5 imply the need for a much more expansive “systems” approach to environmental considerations than used in the past. In elaborating on this principle, the original Guidance states: “Without incorporating cumulative effects into environmental planning and management, it will be impossible to move towards sustainable development”, as it is defined by the U. N. Commission Report (WRC 1987) and by the Council of Environment Quality in its “*Considering Cumulative Effects Under NEPA*” (CEQ 1997). To achieve sustainable development as envisioned by the U. N., the existing generation is ethically obligated to maintain an intact heritage of options and opportunities for future generations.

But the Guidance tends to gloss over the challenges faced by systematic life-cycle planning. Bringing “full life-cycle” and “systems” approaches to the mitigation process places more emphasis on planning and output measurement over longer time frames and at regional and

national scales. The increased dimension of planning perspective places greater emphasis on forecasting, which can be improved only so much before remaining uncertainty becomes irreducible. The revised EOP emphasizes on conceptual modeling and adaptive management are significant improvements, but require further concept development to adequately inform implementation guidance. The potential effects of climate change have increased the importance of more complete assessments of risk and uncertainty in Corps planning (e.g., Olsen 2013). While collaboration is necessary, it also complicates planning. In large part because of the way the Corps is funded, its activities are focused largely on planning and implementation of individual projects in collaboration with non-federal sponsors who must assume operation responsibilities and have a large say in decisions, especially at the end of the project life-cycle.

Past determination of cumulative effects and mitigation actions has been limited to project planning for the most part and has not considered the full costs, including environmental costs of operations and life-cycle completion. The majority of projects operated by the Corps were authorized and constructed before NEPA. Operations impacts were assessed over several years following passage of the Act when implementation guidance had yet to become federal rules and Corps personnel were inexperienced. The analysis of cumulative effects was often rudimentary. While impact to species listed under the protection of the ESA was generally avoided, there was little consideration for species in decline toward a future need to list them under protection of the ESA. Most of those projects have not been reassessed, despite three decades of elapsed time since environmental impact was last assessed.

A fraction of the completed projects have undergone study for EQ improvement under Section 1135 of the Water Resources Development Act (WRDA) of 1986, mostly to correct for previous impact on fish- and wildlife-based recreational use and commercial use of water resources. Few 1135 projects restore degraded heritage and protect it indefinitely. Section 1135 authorized repair of EQ damage at existing Corps projects as long as a non-federal sponsor shares the cost and takes responsibility for long-term operation and maintenance. The cost sharing requirements of this partnership increases the total funding provided for projects by about 50 percent over what it might be with federal funding alone, but it also can distract from Corps attention to serving the national interest and to national environmental sustainability. Because of the non-federal sponsorship required, repair is not necessarily consistent with national priorities

Section 206 of the 1996 WRDA provides an authority that is limited to heritage restoration and protection at any aquatic ecosystem in the United States, as long as a non-federal sponsor participates and agrees to long term operation and maintenance. Thus the long-term performance of a non-federal sponsor is critical to assure the long-term sustainability of the restored ecological heritage that justifies the project investment. Section 206 projects may have even more potential for national priority inconsistency as Section 1135. Some potential partners more interested in water use improvement, such as recreational use, are attracted to the fiscal advantages and more subjective evaluation of benefits and costs in ecosystem restoration planning. They have in the past taken advantage of an unclear program objective and vary in to restoring those aspects of ecosystems that contribute most to national heritage value and protecting them destructive use. The absence of transparently clear objectives and inventories of national priority need hampers proactive recruitment of more appropriate non-federal sponsors.

For many older projects, operation and maintenance is funded totally from the federal budget. Even so, there has been little or no systemic evaluation of project life-cycle interactions, cumulative effects, and unaccounted intergenerational tradeoffs that have occurred over the 50 to 75 years typical of past Corps constructions. This “project life” often extends well beyond the 35-40 years over which the calculated benefits are expected based on past discount rates. The assumption that longer-lasting projects will benefit future generations is not always justified. A number of projects have had significant adverse impacts while benefitting the nation little for their intended purpose. That seems to be recognized in the EOP aversion to overdesign. But, without more careful analysis of the entire life-cycle during operation and maintenance, the Corps could continue to select and rehabilitate long-lasting engineered structures that are economically difficult to modify or reverse when preferences change or regrettable decisions are uncovered. Adaptive management places more value on those plans that allow greater flexibility in modifying or even removing a project once it is implemented (NRC 2004a).

Principle 5 encourages a systems approach over the entire life cycle, which should encourage more frequent performance evaluation and adaptive management of older projects as new projects are integrated into the Corps resource management systems and as old projects are rehabilitated or decommissioned. Encouragement of a systems approach is consistent with the findings of an NRC (2004b) study of Corps planning, which indicates that past Corps activities have not taken a broad or integrated-enough view:

“Effective water project planning requires an integrated approach that can balance the various benefits and costs of a project, while reducing the possibility that attempts to solve problems in one realm, or subsystem, will cause problems in other parts... An ideal environment for fully integrated water project planning that addresses social, economic, and environmental objectives at all relevant spatial and temporal scales would require a substantial amount of advanced investigation and planning at the scale of river basins and coastal systems... Incorporating a broader view of natural systems in water resources project analysis will increase the nation’s economic productivity and environmental well-being in a sustainable manner by minimizing the potential that project benefits in one location are offset by adverse impacts (costs) on other components of the system.”

The NRC (2004a) hastens to add that the failure to adequately manage adverse cumulative impacts is not of the Corps choosing. It lays the blame on the “limitations of the existing decision making framework” imposed by law. High costs all but guarantee that the ideal assessment is never done at the project planning level and that mitigation of damaging environmental effects is less effective than it might be if assessed primarily at a program level. In keeping with that program view of planning, the NRC (2004b) recommended that:

“The Corps’ planning guidance should be modified to provide Corps planners with contemporary analytical techniques necessary for integrated systems planning on large scales within river basin and coastal systems.”

Several of the issues raised in subsequent sections relate to this recommendation.

The Guidance expresses the need for more expansive planning perspectives at project life-cycle and watershed scales:

“When considering cumulative impact analysis it is important to consider, where appropriate, the entire watershed...during the entire life cycle of Corps activities including design, construction, and operation and maintenance.”

The Guidance also points out that the scope of cumulative environmental effects evaluation is “within the discretion of the implementing agency”. It concludes that this should be done within the Corps on a case by case basis. At least three of the strategies for managing issues described in the next section apply to a systems approach relevant to cumulative effects analysis and adaptive management over the life cycle of projects.

In sum, several procedural issues about planning and management are raised here. To achieve environmental sustainability, there is a need for conceptualizing a more adaptive planning and management process, including a project life-cycle concept that can provide the basis for national project planning guidance. The adaptive planning process also requires conceptualization of a regional systems approach to multi-activity assessment of conditions. This approach is needed to provide input for a more forward looking, scenario-based and adaptive approach to project life-cycle planning and management. Applying a systems approach also requires a more complete conceptualization of integrated resource management and inter-organizational collaboration. Risk assessment and management concepts need to be infused throughout, including the possible risks and definite uncertainties of rapid climate change.

Principle 6: Leverage Knowledge to Understand Corps Environmental Effects

Leverage scientific, economic, and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.

The explanation for revised Principle 6, indicates that leveraging knowledge is an active pursuit of the best available science, wherever it may be found. It also affirms that Corps workforce and laboratories position the Corps for environmental learning from within and outside the agency and laboratories should prioritize research based on need (which implies they are aware of significant knowledge gaps). The research effort should be scaled to match the significance of decisions. Collaboration requires collaborative training with other agencies and use of uniform data standards. The issue that immediately comes to mind from the explanation is the need for tools that help improve integration of water resource management at the appropriate systems scale. Such tools are needed to more effectively adopt a systems approach and to more comprehensively identify the essential sources of risk that threaten the sustainability of Corps environments, including environments that are managed and operated by collaborating agencies and organizations.

The discussions of Principle 6 recognize the need to invest in the education of its existing employees. They also recognize the need for management skills that support team building within and across agencies and also resolve conflict and other counteractive issues. However, the

workforce also needs to understand the limits and constraints of their authorities and the principles behind complete, efficient, acceptable and effective planning and management. Despite the need for tool improvement, tools cannot replace a well educated and thoughtful workforce that is encouraged to thoroughly think through objectives and risks before they choose tools and apply them.

The original guidance also pointed out the need for “an objective and reliable basis for assessing environmental impacts and benefits”, which relate closely to the need for good sustainability metrics. The explanation for the revised Principle does not mention the persistence of inadequacies of benefits metrics despite recent research, which may reflect on the workforce and policy guidance more than R & D. Cost savings need to be balanced properly against cost-effectiveness with a clear eye on the benefits. Achieving a sustainable environment will not be easy, nor will it be done inexpensively. Obviously, the workforce has to be aware of the larger condition of environmental sustainability and desirable future conditions to make the best investment choices in ecosystem restoration and the most cost-effective mitigation decisions. This is impeded however, by inadequate regional and national inventories of the existing state of environmental sustainability and visions of conditions that would achieve sustainability in the water resources development footprint.

Determining the relevant R & D gaps requires in depth understanding of the Corps environmental protection and ecosystem restoration objective and how they relate to a programmatically comprehensive objective for achieving environmental sustainability. While the workforce should have input into determining need, it also may have a tendency to be overly reliant on past approaches to planning, which have fallen short of the needs implied by a systems approach and the most effective risk management assessment and planning. The laboratories should also carefully interact with and consider the views of policy specialists and strategists at the national level, including resources at headquarters, the Institute for Water Resources (IWR), and experts outside the Corps (such as past NRC panel participants). One of the more fundamental deficiencies is a conceptual framework for developing these interactions and setting R & D priorities.

Most models and other tools developed for Civil Works planning by Corps R & D have been project-focused in large part because both Congressional funding and Corps personnel have remained project focused and, until recently, have not shown much interest in alternative perspectives. While some progress has been made, more research is needed to develop integrated systems models useful for evaluating the cumulative environmental effects of project and system interactions and for supporting integrated resource management. The complexity and costs have been daunting, but recent reorientation to this direction in several R & D programs is a start toward ultimate needs. The management of insufficient knowledge and technology is among the issues described in a later section of this report.

Principle 7: Employ a Transparent Process Respectful of All Views

Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.

The revised Principle 7 basically provides Corps behavioral guidance for integrating the NEPA process into planning and management more effectively. NEPA opened up Corps and other federal agency decision process potentially affecting the environment to public input and possible law suit if the NEPA process is not properly followed. The revision of Principle 7 dropped previous reference to win-win solutions to the Nation's problems and the need to protect and enhance the environment. However, these points are either implied or are explicit in other principles and their explanations. Making these revisions focuses single-mindedly on the need for transparency and stakeholder inclusion in planning and management.

The explanation for Principle 7 returns, once again, to recurrent issues about sustainability objectives and achievement measures. We are reminded of those issues when the explanation directs consideration of ethnic, cultural and economic values as factors of the human environment, and natural habitat separate from the human environment. The point has already been made that separation of natural environment from the human environment during project planning and management is inconsistent with NEPA and the fact that natural habitats and systems can have ethnic, cultural and economic values. Natural habitat becomes part of the Corps environment as soon as it is considered for restoration and/or protection. No habitat addressed by the Corps is free of interaction with humans. Virtually all ecosystems interact with humans, if through no other process than global atmospheric effects.

The explanation is clear about the need to give "appropriate" consideration to minority, low income, business and all other groups, which, from the stand point of social sustainability raises the specific issue of environmental justice and its relationship to environmental sustainability, if any. Transparency requires a clear presentation of all of the sustainability objectives and federal obligations for working toward their achievement, or at least not impeding achievement in any way. Without clearly defining the objectives and considering the potential conflicts and tradeoffs that may arise, stakeholders in the planning process are more likely to be confused and less willing to interact positively than when objectives, constraints, and tradeoffs are clear.

Perhaps the writers of Principle 7 were concerned about the Corps' past reputation for an overbearing style, but Principle 7 appears to overstate the need to respect the views of others without also balancing that need with the responsibilities of others to respect each other and the Corps views as well. Listening is important, but too much listening to local concerns can overwhelm proper Corps consideration of the national interests. The Guidance indicates the need for the Corps to respond to numerous national needs, but it is less clear about how it weighs those interests against local interests. The Corps needs to clearly convey the federal objectives it is authorized to serve, the uncertainties and risks entailed in any planning outcome, federal responsibilities to present users and future generations, and the federal vision of an optimum resource condition for long-term benefit maximization. Clarity of purpose and communication is the first rule for effective collaboration. A clearly conceived environmental objective and a vision for success provide a focus for collaboration and other stakeholder contribution.

Understandably, many stakeholders are concerned about their own needs. With respect to environmental sustainability, the Corps has to “listen” to the needs of future generations as well as the living, and act accordingly, regardless of pressures to short-change heritage for more immediate economic gain. In elaboration of the implication that environmental sustainability is not negotiable, the Guidance for the original EOP states that:

“The Corps recognizes its obligation to promote the interests of the Nation—rather than the well being of only those that most directly benefit from either a civil works or military action being taken.”

In some settings this means that projects will not be built where irreplaceable environmental resources would be further degraded. In other settings it means that compensatory mitigation is allowed where the resources are confidently replaceable. The first challenge is determining what is environmentally replaceable and what is not.

Neither the original nor revised principles clearly state that the essential ingredients of an intact environmental heritage cannot be traded off for consumptive use. Too much reliance on the letter of the law over the spirit of the law can defeat the intent of decision making in favor of environmental sustainability. For example, environmental sustainability is not well-served when species populations recognized by the best science available to be in decline, yet are not protected by law, are traded away for development up to the point they become listed. Such actions only contribute to the onerous need to list species under ESA protection. There is too much evidence that past compensatory mitigation has been unsuccessful (e.g., NRC 1999c) and negative effects can accumulate rapidly toward a need to list species for ESA protection. If compensatory mitigation is relied on instead of avoidance, the planning process should assure that it needs to be done in advance of construction to assure success. Failed mitigation for economic sustainability is less likely to result in permanent harm as long as the economically valued resources remain fundamentally sustainable.

Organization of the Principles

A thoughtful reader can deduce that the framers of the EOP recognized the world as composed of natural and humanly developed systems, that there exists some optimum integration of the two, that existing imbalance and trends reflect impediments for sustainability achievement, and that achievement requires a systems approach to risk management, more knowledge, and collaboration. Yet, even though systems thinking is thematic throughout the original and revised EOP, the Guidance and the explanation for EOP revision do not claim the EOP themselves are systematically organized to reflect a logical, cause-and-effect flow from Principle 1 to Principle 7. Making that case would serve as a model for systems thinking, including development of a conceptual model of the interactions among the seven principles.

A case can be made that the order of the principles is a proactive and systematic organization that started before NEPA and evolved quickly once NEPA was passed, and that the EOP are a formal restatement of long-established process. Alternatively, another case can be made that the

sustainability goal came about reactively and incrementally as a consequence of other actions, starting first with the need to comply with law. Which sequence of events actually took place provides insight into how issues impeding sustainability emerged and should be managed.

If the present organization of the EOP implies cause and effect starting with Principle 1, the principles would flow systematically in a sequence with numerous feedback interactions that look something like Figure 2. In that interpretation, The EOP reiterated Corps commitment to fostering sustainable development as indicated by national environmental policy and goals soon after NEPA was signed into law on January 1, 1970. Assuming that scenario, all Civil Works project authorities were interpreted in light of and consistent with NEPA policy, goals and procedural rules soon after the rules were published. As a matter of federal policy for all federal projects, NEPA established national goals to beneficially use the environment while assuring safe, healthful, and pleasing environments for all Americans and preserving important cultural and natural aspects of national heritage. These were, in effect, sustainability goals. With acceptance of those goals, the Corps committed to planning with careful consideration of possible adverse environmental impacts. It sought proper balance between human development and natural systems—what would now be called sustainable development.

This commitment would not only lead the Corps to mitigate for environmental impact at its Civil Works projects consistent with NEPA, it would encourage more enthusiastic compliance with the spirit of all environmental laws and reinforce the will to foster goal achievement in all aspects of Corps endeavors. In following the logic flow in Figure 2, the need to manage risks more effectively stimulated Corps R & D investigation of more cost effective ways to mitigate environmental impact and to restore degraded EQ. In addition, the Corps carefully monitored success to inform its commitment to fostering sustainability. In the process of raising various issues impeding success, this scenario also establishes a basis for a systematic approach to managing the issues, which is the approach taken to the framework described in the next section.

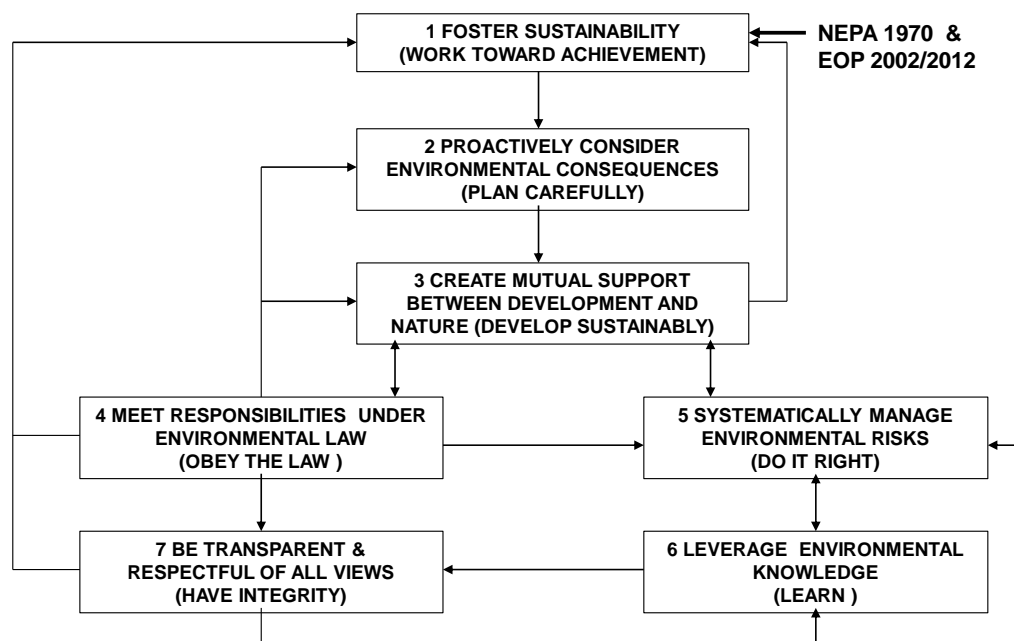


Figure 2. The flow of motivations influencing the Corps as implied by the order of the Environmental Operating Principles, which start with the sustainability goal.

The idealistic view of the organizational history of the principles, shown in Figure 2, may well reflect present Corps values, but is not entirely consistent with Corps history. While there were signs of an earlier awakening, the history of EOP evolution most clearly starts with commitment of the Corps to compliance with NEPA and other strong environmental laws of the 1970s (Principle 4 in Figure 3) and with the national objectives of the Water Resources Planning Act (which were NEPA influenced). During that time a lot of learning occurred in the Corps that resulted in a deeper understanding and ownership of the principles established in NEPA and other national policies. That evolution continues with the most recent articulation of and commitment to achieving sustainability in the revised EOP, including commitment to economic, social and environmental sustainability in Principle 1 (Figure 3). In this view, EOP pronouncement in 2002 was a reaction to criticism of Corps environmental practices after nearly three decades of NEPA and other strong environmental law, and EOP revision in 2012 is a reflection of increased ownership of the principles and recognition of the difficulties.

Like other agencies, the Corps is empowered by its statutory authorities and constrained by its budget and by many regulations. Its history indicates that the Corps did little more than required using a limited budget (critics claim that it failed to meet all requirements, resulting in numerous law suits), but was gradually assimilating the EOP principles. Civil Works ecosystem restoration

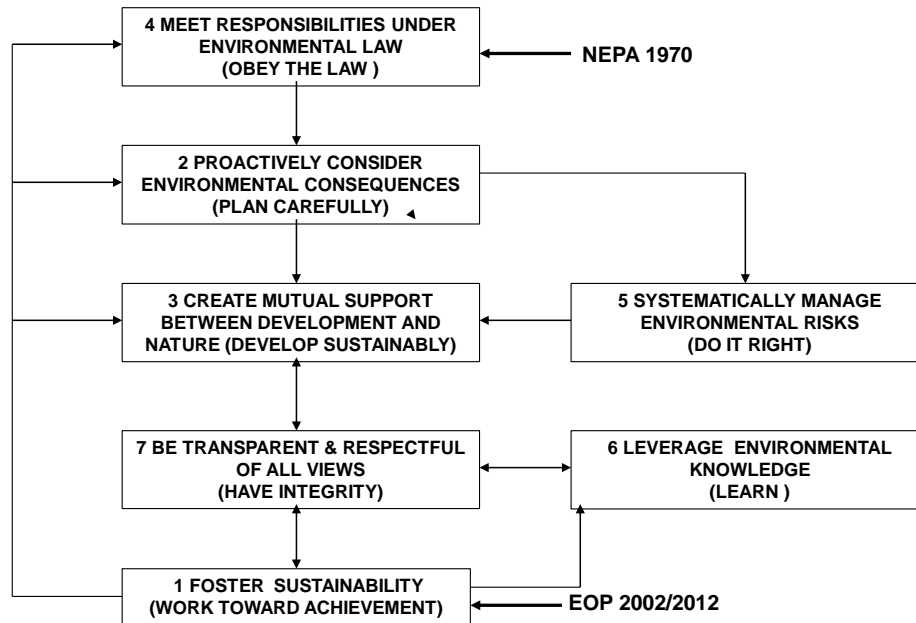


Figure 3. The flow of motivations influencing the Corps that is consistent with the history of increasingly restrictive federal law and policy.

and protection authority passed in 1996 (Section 206, WRDA 1996) may have hastened acceptance of environmental stewardship thinking more as a Corps purpose than a constraint, favoring more complete acceptance of the environmental sustainability goal. During that period of assimilation, however, the issues addressed in this framework have had time to emerge, grow and become more resistant to effective management.

During its long history, the Corps has developed a corporate identity and a culture that greatly influences how it will respond to new directions through legislation and executive directives, its budget constraints, and its respect for civil authority. To the extent statements of commitment by the Corps in the EOP are followed through with effective action, the EOP should reinforce the Corps' respect for the law. But, consistent with past history, it may not do any more "for the environment" than budget authorization allows. Agency budget history and continuous pressure to reduce costs is a potentially serious impediment to sustainability achievement, but one the Corps has minimum power to control. Within those limits, however, much can be done to improve.

The first organization of the EOP (Figure 2) is more optimistic about real Corps change than the second (Figure 3) because it implies a proactive agency bent on achieving environmental sustainability. The second organization is more pessimistic, being a systematic reaction to the

environmental and accountability constraints. The second is indicative of the past, mostly the period of Corps evolution into an “environmental” agency, and the first is, hopefully, more indicative of the future. Sustainability may be achievable by either approach, but if idealism can transcend practicality it is more likely to get the Corps there sooner. Even so, the fiscal constraints and demands placed on the Corps will pressure it to approach environmental sustainability more conservatively than the ideals of the EOP demand.

There are promising indications within the Corps that most employees care about the environmental consequences of their work. Most impediments to realizing the EOP goal stem more from knowledge and financial deficits than from internal intransigence. In addressing the information vacuum, concepts for transition to an environmentally sustainable program need to be clear and guidance clearer still once the concepts are well developed. However, it is hard to resist the imperative of present resource use demands so as to preserve national heritage for future generations. The Corps must be vigilant and apply its authorities wisely to identify damaged environmental essentials, to restore them, and to assure their protection for posterity.

As the last section revealed, the original and revised EOP principles raise management questions about numerous issues impeding sustainability achievement. The Corps now has vague notions about program objectives for environmental sustainability, how to frame program level planning for achievement and monitoring program-level performance, what to inventory for sustainability assessment at the program level, how to envision future conditions of achieved sustainability, and how to assure that some program-level condition of environmental sustainability is realized through strategic-, program-, and project-context levels of planning. These are among the important issues requiring management to realize the EOP goal.

SECTION 3: AN ISSUES MANAGEMENT FRAMEWORK

Review of the 2002 EOP Guidance revealed numerous strategic issues needing management before environment sustainability can be more effectively and efficiently achieved. Strategic issue management is an approach used to manage the risks and uncertainty faced by the Corps strategically as it strives to achieve its sustainability goal (see Coates et al. 1986, Bryson 1995 for more on issues management). Eleven critical strategic issues are identified here. The 11 issues may not be an exhaustive list, but they are among the most important in this assessment. Despite recent progress, they continue to impede objective achievement.

The issues need to be managed first by clearly defining the problems, context, relevant concepts, and challenges associated with them. Once the issues are more clearly understood, a more thorough development of issue management concepts can be outlined. An outline must be completed before guidance is developed and implemented. The conceptual approach to issue management is outlined briefly to provide initial input into more complete development in future analyses. Finally, a framework for identifying and addressing the issues conceptually is described (Figure 4).

Issues Categories and Relationships

The process of identifying critical issues thwarting achievement of environmental sustainability uncovered a snarl of problems that are both individually complex and highly interactive. While the issues impeding achievement of environmental sustainability can be addressed opportunistically, a more efficient approach is more systematic (Figure 4) and closely linked to the Civil Works Strategic Planning process. Each of the issues and its management needs is described in depth, which varies with issue complexity and the extent to which each has already been addressed.

The eleven issues form three groups. Management of the five *core issues* occupies the central column in Figure 4. These are the most essential issue-management elements in the framework for achieving environmental sustainability. These include:

- Specify an achievable environmental sustainability objective
- Develop an adaptive, project life-cycle management process
- Inventory environmental conditions relevant to program objective achievement
- Develop visions of sustainable environments that satisfy objective achievement
- Develop and integrate strategies for realizing visions of objective achievement

The remaining issue-management actions are peripheral aids to development of the framework core. In the column to the right in Figure 4, they include three issue management actions that *support integration* at and between project and program levels. These include:

- Unify environmental benefits metrics
- Integrate policy for more effective sustainability guidance
- Improve integrated water resources management (IWRM) and collaboration

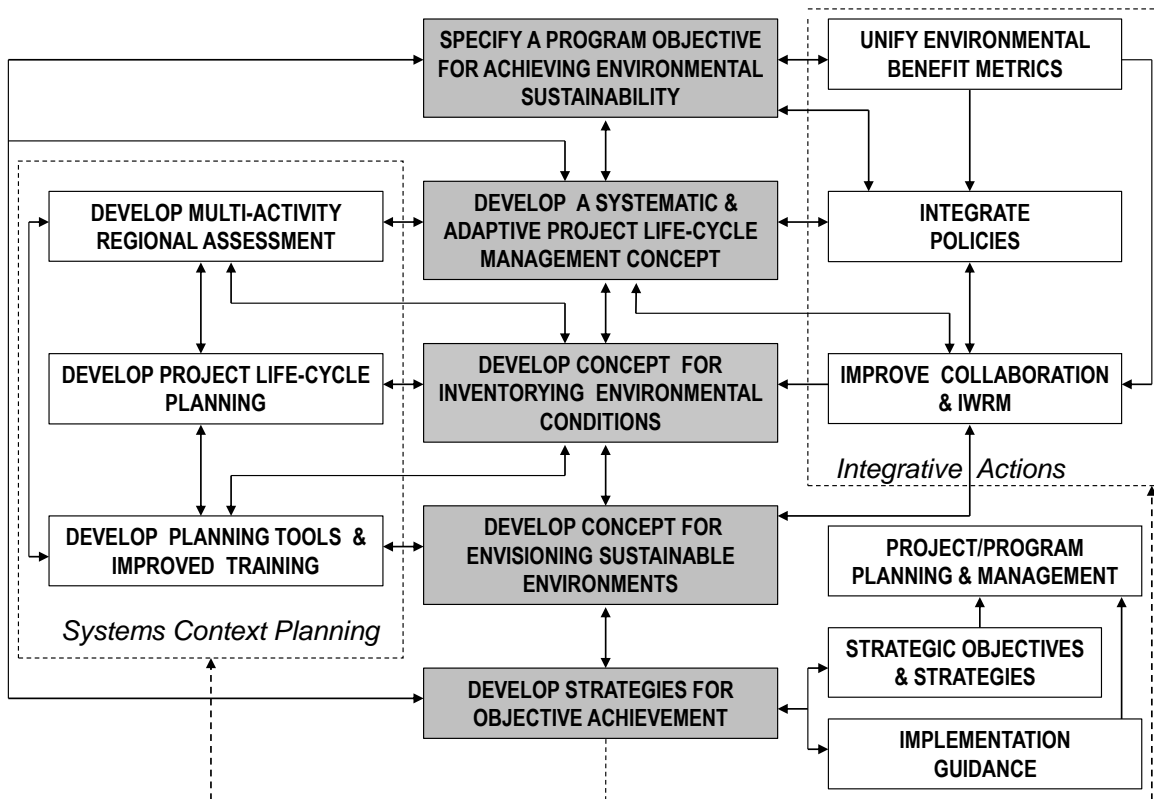


Figure 4. Framework for developing the conceptual basis for managing issues that impede achievement of environmental sustainability.

In the left column are issue-management actions that serve *systems-context planning* needs. These elements are highly interactive and best developed together. They include:

- Develop a multi-activity regional assessment process
- Develop a systems-context project life-cycle planning concept
- Develop new planning tools for systems-context planning

The Five Core Issue Management Actions

The five core elements of this framework are essential for managing the issues that impede achievement of environmental sustainability. That achievement requires clearer program objectives, a coherent system of program management, an inventory of unsustainable condition within the Corps footprint, visions of alternative conditions that would be environmentally sustainable in the Corps footprint, and a less fragmented, more environmentally coherent strategic plan. These are described briefly below.

Action 1: Specify an achievable objective.

Issue: *The Civil Works Program does not have a quantifiable objective that explicitly serves achievement of the environmental sustainability goal.*

The sustainable development goal of the EOP sets general directions for the Civil Works Program. Environmental sustainability is an important aspect of that goal. Having a goal without an achievable program objective leaves the Corps with a compass but no sextant to assess achievement progress. Goals are best pursued through quantifiable achievement of clearly stated objectives organized hierarchically from the program level through individual projects and other activities. Environmental sustainability has been defined in this report for purposes of coherent development, but it has yet to be clearly enough defined by the Corps in policy guidance to differentiate it consistently from sustainable development and from economic and social sustainability. While all essential aspects of sustainability, they require separate consideration as objectives while recognizing how they interact. The aspects of sustainability are described by WCED 1987, Martin and Stakhiv 1999, Cole et al. 2014a, Cole et al. 2014b, and numerous other authors. The Sustainable Solutions Project Development Team of the Corps proposed sustainability definitions and principles for Corps consideration, but no objectives (Cole et al. 2014a).

An unambiguous statement of an environmental sustainability objective is prerequisite to success. Despite strong hints in the 2002 EOP Guidance and 2012 EOP explanations—that environmental sustainability occurs when natural systems are restored and protected, biological systems remain diverse and productive, and life-support systems are maintained in a healthy, diverse, and sustainable condition—no statement of objective determines what aspects and amounts of life and life support are essential to sustain. An objective is needed to 1) guide adaptive management and efficient inventory of project performance indicators, 2) envision alternative desired conditions that would achieve the objective, 3) adaptively manage program resources to become environmentally sustainable, and 4) to focus the inter-organizational collaboration necessary for success. Proceeding otherwise reduces funding effectiveness. The absence of a clear objective statement contributes to existing disconnection between Civil Works project activities and program approaches to strategic planning and performance-based budget planning. In short, it limits EQ protection and restoration effectiveness.

The objective should be clearly linked through the environmental sustainability goal to an agency mission based in the concept of sustainable development and clearly distinguished from the closely related economic and social sustainability goals. Before the EOP were pronounced, Martin and Stakhiv (1999) assessed implications for the Corps of implementing sustainable development concepts expressed in international (WCED 1987) and national (TPCSD 1996) studies and recommendations. They concluded that social, economic, and environmental sustainability contributed separately to a foundation for sustainable development. This “three-legged stool” that underpins sustainable development is recognized in many other works summarized more recently in a recent Corps study (Cole et al. 2014b). The report recommends separation of the concepts and distinct definitions.

As a government agency, the Corps concept of environmental sustainability and objective specification must be consistent with its Congressional authorities, Executive Orders, and other policy. In the realm of environmental law, NEPA stands out for the influence it has had on the Corps' sense of EQ and environmental sustainability, including its influence on the national objectives for water resources planning established by amendment to the Water Resources Planning Act (WRPA). The NEPA concept of EQ is quite broad. It pertains to all aspects of both the natural and humanly influenced environment, to social and economic sustainability, and to environmental sustainability as they have been recognized in sustainability literature (WCED 1987, Martin and Stakhiv 1999, Cole et al. 2014b). EQ is enhanced by increasing the benefits from environmental use while preserving important natural and cultural aspects of our national heritage. Preservation sometimes requires restoration of important but unsustainable heritage to sustainable states. In that broad concept of EQ, Corps development of water resources for beneficial use adds to the NEPA concept of maintaining and improving human welfare by improving the economy and other aspects of social well being. It further coincides with NEPA by prioritizing the relative importance of heritage for the benefit of future generations.

Congress programmatically authorized the Corps Civil Works Program to carry out ecosystem restoration and protection to improve EQ in the public interest in 1996. Congress clearly required protection of the ecological output targeted for restoration from incompatible use. In its federal project planning objective statement, the Corps planning guidance determined that environmental protection is achieved when environmental damage is avoided or eliminated and natural and cultural aspects of national heritage are preserved (USACE 2000). The guidance created a national objective for ecosystem restoration projects, which targets restoration of desired ecosystem resources. Since restored resources must be protected from destructive use and is a natural resource than a cultural resource, it contributes to natural aspects of national heritage. More specifically, it contributes to ecological aspects of natural heritage, leaving out purely physical features, such as river flows and beaches, independent of their inhabitants.

Natural heritage is valued solely for the potential resource utility it holds in its diverse attributes. It has no existing use value, measurable in monetary terms, but it has increasingly high natural heritage value as it grows scarcer and approaches complete loss (Cole 2010, 2014a). The value of heritage for the options it maintains for the present generation may be measured in monetary terms (e.g. NRC 2005), but the willingness of future generations to pay us for its heritage is impossible to determine. The value added by successful investment in restoring environmental heritage to a sustainable state is a form of public bequest value, which the Corps exempts from monetary measurement in its planning policy guidance because the existing methods are unreliable. The potential loss of options can be indicated instead by the forecast sustainability of natural resources.

Living organisms comprise much of our imperiled natural heritage, but imperiled heritage also includes unique aspects of the physical environment important enough to set aside for the benefit of future generations as well as present generations. From a protection standpoint, the living and nonliving heritage vulnerable to total loss needs to be considered for impact mitigation—usually through total avoidance. Most unique aspects of physical natural heritage have been afforded official protection in parks and other means. In contrast, only small fractions of the species that are judged by conservation biologists to be vulnerable to extinction are protected by federal law

(Scott et al. 2006). Corps planning guidance for ecosystem restoration is unclear but indicates a focus on the ecological heritage that needs to be restored to a sustainable state based on solid evidence of public interest, such as laws, executive orders, and technical recognition of an unsustainable state (Cole 2014a, c). Targeting maintenance of ecological heritage is consistent with the emphasis on life support in the EOP Guidance. Present generations can and are gradually trading away these unprotected and unsustainable resources for short-term gain, in direct contradiction to the concepts of sustainable development and environmental sustainability. Adherence to environmental sustainability principles does not permit such tradeoffs.

An objective based on maintenance of natural heritage needs to be carefully considered for its effectiveness in achieving and maintaining environmental sustainability, and providing the basis for determining an environmental sustainability objective. A tentative objective statement for the Civil Works program is proposed as follows:

The objective of environmental sustainability achievement is to leave future generations enough of each element in the natural diversity of the environment to sustain the known and potential resource development and use options inherited by this generation.

This objective requires determination of the minimum amounts of resources and environmental support systems needed to achieve environmental sustainability now and in the future.

In an environmental protection context, the ability to replace the lost resource value is the test for determining whether to avoid damage entirely or to compensate for it by replacement. Avoidance of damage is the safest course for presently unsustainable resources (as determined by credible science), but if replacement is the choice it should always be done in advance of damage to manage significant risks. Achieving the objective requires careful assessment of direction from Congress and the Administration, scientifically defensible appraisal of existing conditions, clear vision of desired conditions, and competent project planning, project implementation and operations, and program planning.

Action 2: Develop a systematic, adaptive-management process.

Issue: *There is no conceptual framework for systematically guiding long-term, adaptive management of the Civil Works Program toward achievement of environmental sustainability.*

Past Corps projects were planned deterministically, with the intent of ascertaining significant risks to project success during planning and implementing projects that managed them at a level acceptable to stakeholders. But it did not emphasize the importance of systems interactions and needs. That approach proved too often to contribute to unsustainable conditions. The Corps has responded by further emphasizing a systems approach and adaptive management in policy guidance, but without sufficient development of technical guidance. In the past, the Corps produced numerous long lasting projects that interacted in unpredicted ways within dynamic ecosystem contexts; sometimes in ways that are not environmentally sustainable. The most obvious evidence of undesirable results is the many imperiled aquatic species that are adversely

influenced by the effects of Corps projects on their life support systems (Cole 2009). A more effective program management framework would provide an adaptive, systems approach to reducing scientific and institutional ignorance and the risks associated with them in project and program activities, through a rigorous commitment to institutional learning, research, and continuous planning and management improvement.

This process is referred to here as systematic adaptive management, which includes planning, implementation, and rehabilitation or deconstruction. It relies on a broader, scenario-based approach to characterizing possible future environmental conditions, project outcomes, and corrective management actions. Systematic adaptive management planning and action requires much more comprehensive systems perspective, proactive planning for an adaptive process, monitoring project performance, R & D activities at the program level, effective coordination between research and management across collaborators, and more reliable adaptive measures when needed to assure environmental sustainability. It must take a long, program-wide view and be consistent with the time scale associated with project life-cycle management.

Numerous factors contribute to the difficulty of managing this issue. Achieving environmental sustainability has global dimensions and is fraught with many risks and the uncertainty that sustainability will never be achieved. Even with clearly stated goals and objectives, achieving environmental sustainability will be hampered by uncertainty about project and program outcomes. Project and program decisions have to be made against a background of changing and incompletely predictable social, economic and environmental systems. Long-term, program-level systems analysis and scenario-based adaptive management planning are needed to increase the likelihood for achievement. This is recognized in the WRDA 2007 requirement to develop a monitoring plan to allow for project adjustment as needed. The necessity of managing risk and uncertainty by building flexibility into infrastructure management and construction is recognized in the preamble to the revised EOP (Bostwick et al. 2012).

Conceptual and technical guidance for Corps application of adaptive management principles has been drafted (Barr et al. 2011, Adaptive Management Product Delivery Team. 2011), but the work remains incomplete, particularly as to how it relates to a systems approach. Further improvement requires technical guidance on the systems approach and more integration of strategic, regional and project life-cycle planning (treated as separate issues, yet integral to an adaptive process). It also requires much more guidance about how to sustain an intact national ecological heritage as exceptionally rapid changes in climate come about and their effects interact with other environmental changes to change habitat suitability for many species (Cole 2014d). A more integrated approach requires planning systemically for adaptive management over the project life, monitoring, and adjusting at the project and program levels as needed.

The past approach to environmental planning has too often been environmentally unsustainable. This is clearly indicated by widespread species decline where the Corps has been active (Cole 2009). Because of rapid environmental changes, technical limitations and human error, no development program can be expected to get environmental management right the first time, much of the time. Program managers need to learn from the past to improve the rate of environmental sustainability achievement. Agencies committed to environmental sustainability

need to leave a program management legacy that provides meaningful management options and a progressive history of improvement. The concept of adaptive management fits that need.

Contemporary concepts of adaptive resource management emphasize the integration of scientific observation and learning into resource management planning and operations (e.g., Holling 1973, Walters 1986, Walters and Holling 1990, NRC 2004a). Adaptive management concepts emphasize objective formulation and revision as needed, planning flexibility, systems models, projections of possible futures, monitoring and evaluating project outcomes, corrective management as needed, incorporating learning into models and management decisions, and collaboration (NRC 2004a). The reversibility of management measures is an important standard for determining if a project can be adaptively managed cost effectively. Adaptive management principles dissuade investment in plans that are prohibitively expensive to modify or reverse once implemented, especially when the benefits of the project are marginal and uncertain.

Adaptive management is applicable at any and all scales. Done systematically, it is the strategic means by which the uncertainty and risk of failure is comprehensively managed. The scope of adaptive management envisioned here for the Corps is hierarchical, ranging from specific measures taken at Corps projects, through project watersheds and coastal zones, to major river basin, national and international scales. These concepts have been reviewed and incorporated by the National Research Council into recommendations for water resources project planning (NRC 2004a,b,c), but are also applicable to Civil Works operations.

The Corps has formally applied adaptive management in the upper Mississippi region and in Florida where it is explicitly required in study authorities. It also has recently required all new project planning studies to create an adaptive management plan. While not required, it is conceptually applicable in the operation and maintenance of projects now managed by the Corps. The USACE has already adopted fragments of an adaptive management program in its project management policy. It has promoted project life-cycle and environmental systems management in its Project Management Business Process (PMBP). Both are basically adaptive approaches. Compliance with the Government Performance and Results Act (GPRA) has much in common with a programmatic adaptive management process.

Since 1986, most new Corps projects have had to be passed on to a non-federal sponsor of the projects once construction is completed. Applicability of adaptive management throughout the project life cycle of new projects has to somehow accommodate this division of authority and responsibility. While these new projects are a small fraction of the total, the challenges they present need to be met to assure achievement of an environmentally sustainable objective. Older projects present a different challenge, since their operation and management is fully federal. While monitoring of infrastructural condition is an essential aspect of operation and maintenance, and major repair is often a consequence, the policy for monitoring and repairing environmental damage is less clear. Many projects completed environmental impact assessments under NEPA for the first and last time in the 1970s. While incorporating adaptive management planning into new and rehabilitated projects is important, similar planning adjustments are needed for operations and maintenance, if environmental sustainability is to be achieved in the Corps footprint. The conceptual basis for this practice needs to be developed first.

National policy guidance does not provide much insight into the development and implementation of a coherent adaptive management process. However, management of this issue has progressed within the last few years. The Adaptive Management Project Delivery Team formed under Actions for Change summarized all authority and policy relevant to adaptive management into guidelines. The Jacksonville District of the Corps recently completed adaptive management planning guidance specific to the needs of The Comprehensive Everglades Restoration Plan. Brekke et al. (2009) established a federal perspective for proceeding with adaptations to climate change—an issue of rapidly growing importance for water resources management. These are likely to contribute to the development of a Corps-wide program management framework focused on achievement of sustainability in the Corps environmental footprint.

Natural resource systems and adaptive management understanding and guidance has improved, but still falls short of need. As currently conceived in Civil Works project planning guidance, some “adaptive management” is more properly called adaptive implementation of projects and some “engineered systems” fall far short of the environmental systems that need to be considered. Strict time limits are placed on monitoring the benefits that flow from projects. This limited perspective does not address the larger issues associated with the uncertainty of estimating benefits for the life cycles of economic development projects that often exceed half a century. Ecosystem restoration projects in effect have open ended life-cycles that are usually intended to last much longer. These issues are raised to a new level of complication and concern by the likely prospect of rapidly changing climate (Parry et al. 2007, Brekke et al. 2009).

Continued uncertainty about environmental sustainability is caused in part by scientific ignorance in general and more specifically in the Corps. It is also caused by the fragmented authorities of the Corps and its non-federal partners, who must assume operations of ecosystem restoration projects and assure that adverse project impacts continue to be mitigated. This fragmented authority requires a thoroughly planned and adaptive systems approach to project and program management that can transcend the limits imposed by project-based authorities through more proactive collaboration reinforced by binding partnership agreements.

A more systematic adaptive-management framework for environmental sustainability needs to be integrative across environmental systems and organizational programs, flexible, and able to generate new knowledge for better informed decisions. It needs to be adaptive enough to assure that unsustainable states can be made sustainable. It must take a longer and wider view programmatically than has been the usual practice and consistent with the temporal scales of project life cycles and the spatial scales needed to sustain ecosystem functions and services in changing environments. Planning for adaptive management also requires management of several peripheral issues that are described in subsequent Issue Management Actions. These include policy guidance that is consistent and integrated across program areas (Action 7), specific guidance for collaboration and integrated resource management (action 8), multi-project assessment in a regional context (Action 9), project life-cycle planning in a systems context (Action 10), and development of tools and training for a systems approach (action 11).

Action 3: Inventory conditions relevant to objective achievement.

Issue: *Because there is no Corps inventory of environmental conditions, there is no way to respond informatively to questions and criticisms about the Corps environmental stewardship or to establish a benchmark for achieving a sustainable state.*

Assuming that the environmental sustainability objective of the Corps is, at least in part, to maintain the nation's heritage in biological diversity; it has a way to go to achieve its objective in the footprint of Civil Works projects. After nearly two centuries of civil works activity, the Corps leaves behind a large footprint in thousands of miles of developed waterways and flood control levees that separate natural floodplain features from rivers; hundreds of square miles of flood control reservoirs, regulated wetlands, and coastal harbors; and many other effects. Some Corps projects undoubtedly contribute to unsustainable conditions in biotic communities of freshwater ecosystems (Cole 2009). As soon as the Corps has completely framed its objective for environmental sustainability, it needs an inventory of the existing state of environmental sustainability in its environmental footprint. This includes the condition of ecological resource sustainability at the national scale and its vulnerability to project effects at different stages of project life cycles.

Claims that the Corps has been and continues to be environmentally destructive (NWFTCS 2004, Cole 2009) cannot be quickly countered with reliable documentation. This deficiency provides a basis for critic claims of Corps hypocrisy. But more importantly, the Corps needs the information to achieve sustainability. Cole (2009) completed a preliminary review of the impacts of water resources projects on the viability of native freshwater biodiversity, but did not go into the project-level detail necessary to assess the conditions of life support systems. Without a complete assessment of sustainability in its project footprint, the Corps has no meaningful way to proactively influence management priorities for environmental sustainability.

Determining the most appropriate indicators of sustainability, and cost effective ways to measure them, should be part of any inventory of needs for achieving environmental sustainability. Many ecological and other indicators of environmental performance are recognized and used for various purposes (e.g., NRC 2000, The Heinz Center 2008). Some are only marginally relevant to Corps needs. Determining the appropriate performance indicators is critical before an inventory starts. There is a need to determine which indicators are essential for monitoring achievement of sustainability objectives and which are useful for diagnosing problems. Satisfying this need depends on how the Corps defines its environmental sustainability objective and the extent to which it adopts a more programmatic and adaptive management approach. Once the indicators are determined, they must be inventoried for present condition and monitored for objective achievement. More is said about performance indicators under Action 6, on environmental benefits metrics.

Present performance monitoring is inadequate. The criteria now used to rank ecosystem restoration projects for GPRA-compliant budget allocation places much more emphasis on habitat condition than on the scarcity of inhabitants (USACE 2010, Cole 2014e, f), which is inconsistent with what is scarcest among ecosystem elements, recognized in law as nationally

significant, and what the PGN states are indicators of objective achievement (USACE 2000, page 3-24). Similarly, the habitat-based indicators used to guide plan formulation to achieve objectives often have not been clearly linked to the least sustainable ecosystem elements that should be the focus of the program. In mitigation considerations, adverse impacts on species listed under the law must be avoided, but the habitat needs of species that are recognized by conservation biologists as equally unsustainable often are not the focus of habitat replacement. Frequently, common and broadly adapted species are selected to indicate habitat needs. These species typically make poor indicators of the more demanding habitat needs of unsustainable species, which are typically narrowly adapted.

Once the Corps establishes clear environmental sustainability objectives and appropriate performance indicators, it needs to establish an inventory plan and a scope of work. The environmental sustainability goal may be best served by collaborating with an independent agency to do the actual inventory. The U. S. Geological Survey is an outstanding possibility. Naturally, the use of an external agency does not release the Corps from assuring that the best possible inventory is complete. Therefore, the Corps needs to have the scientific capability and time available to direct and monitor the process. A significant amount of Corps work is needed to develop the inventory plan and performance indicators before the concept is shared with outside agencies and NGOs for their review and comment.

Action 4: Develop visions of sustainable environments.

Issue: *Without visions of environmentally sustainable resource conditions, there is no way to determine the status of sustainability in the Civil Works program from inventories alone or any practical way to gauge progress toward its achievement.*

Achievement of environmental sustainability cannot be recognized without a preconceived vision of sustainable resource conditions. The vision includes desired resource distributions, abundances, productivities and other ecological indications of desired future condition. Identifying the desired future condition of any given resource is a basic tenet of natural resource management. Any vision of a sustainable state should be accepted by the Corps as its own, as long as it remains consistent with the national interest.

The Corps cannot achieve a sustainable state of any degraded resource on its own; it needs to cooperate with others to assure completeness and acceptability. The Corps also needs to consider the visions of potential collaborators as it develops its own visions of success. An example of one collaborator's general vision of success is found in the watersheds of the United States that The Nature Conservancy considered necessary to protect and restore to sustain freshwater biodiversity (Chaplin et al. 2000). More specific and updated visions of success are needed, however, to indicate the difference between existing and desired conditions of species and their support systems. These visions become the basis for guiding protection and restoration investment portfolios and become an important criterion for determining a Corps interest in partnering with a non-federal sponsor in a project planning study.

The Corps now relies largely on compliance with the NEPA process and with regulations established under other environmental law to indicate achievement of environmental sustainability. Compliance alone is insufficient. The original EOP Implementation Guidance and some laws ask for more than minimum compliance. The ESA, for example, demands protection of listed species and asks all federal agencies to use their authorities to achieve ESA objectives. ESA administrators have indicated that agencies should do what they can to reverse species decline toward a need to list, which is often viewed as a last resort and far from risk free. The Corps has an ecosystem restoration authority that can be used more proactively to recover from the unsustainable ecosystem conditions that result in species decline, whether or not the species is listed under ESA protections (Cole 2009). In numerous ways, the Corps can do more than just comply for little additional cost.

The dimensions of the problems needing to be managed for a sustainable state are based in a measure of differences between forecasts based on current inventoried conditions and the visions of desired resource conditions. Allowances must be made for the most probable expansion of the existing Civil Works footprint into new regions. Because different distributions of resource conditions can equally achieve environmental sustainability, a single vision of success is more limiting and more costly to implement than selecting from a set of vision scenarios cast against possible environmental and social changes.

Certain specified resource conditions need to be satisfied if environmental sustainability is to be achieved. These “maps” of spatial and temporal distributions of water resource conditions establish templates of desired future conditions for objective achievement in the environmental footprint of the Civil Works Program. An array of possible distributions of resource improvements and protections may equally achieve environmental sustainability for any particular region. The NEPA process can be used more proactively and programmatically to forecast cumulative effects of its projects as they interact with the effects of other public and private projects, natural process, and global climate change. This needs to be done for new and existing projects.

Vision needs to be developed at project, regional and national program levels, and integrated across all water resource management purposes and phases of planning, implementation, operation, decommissioning and restoration or other new project implementation. A watershed approach to projects and larger regional definitions are suitable for much of the Corps footprint, but an eco-regional approach is more suitable for marine and some terrestrial settings. This is consistent with informed recommendations for Corps project planning (NRC 2004c), but is equally suited to its operations. Some prospective project cosponsors are not as likely to be as sympathetic with the Corps environmental sustainability goal as others. Carefully developed program visions help to sort the best potential partnerships from less effective ones.

Certain specified resource conditions need to be established if environmental sustainability is to be achieved. For clear communication of the vision, the conditions should be displayed in spatially and temporally explicit “maps” of desired future resource conditions. They should be consistent with objective achievement within the environmental footprint of the Corps Civil Works Program. Desired future conditions can take more than one form depending on the manageability of changes that actually occur within the footprint. An array of possible

distributions of resource improvements and protections that achieve environmental sustainability should be developed. Of these scenarios, only a small subset may be acceptable to collaborators and stakeholders affected by the resulting distribution of improvements and corrections. Because conditions change through time in ways that cannot always be anticipated in planning, the process must be repeated as needed to be useful.

For water resources development by the Corps, the outer boundaries of the program footprint are generally quite well defined by physical and legal limitations to further new development. However, a few possibilities for expansion may remain open and should be included in the visions of alternative future conditions, thereby satisfying a desired condition of ecosystem resources. Numerous possible scenarios for achievement success are likely to exist within that broad footprint.

Recognition of global climate change and probable but uncertain climate change at local scales has profoundly changed past assumptions and perspectives of natural resource managers. Past management assumptions are no longer tenable. Once assumed to be stable and stationary, ecosystems and their components cannot be reliably restored and sustained in place for very long. Planning must engage at much larger landscape and seascape scales and carefully consider the possible habitat changes and connectivity needed between present and future habitats. A useful approach is to join cross-organizational partnerships like the landscape conservation cooperatives set up by the Department of the Interior to address climate and other environmental change at appropriate scale (Cole et al. 2014c).

Action 5: Organize strategies for objective achievement.

Issue: *Civil Works strategic planning does not raise environmental sustainability to the level of a program requirement that is well integrated with economic and social sustainability requirements to serve a sustainable development mission.*

Without long-term trend assessment and clearly stated program strategies, the Civil Works Program does not have the institutional sense of direction and approaches needed to achieve environmental sustainability and sustainable development in the Civil Works environmental footprint, or to contribute to environmental sustainability elsewhere through its ecosystem restoration program. The final core issue that needs to be managed to achieve environmental sustainability is the organization of the agency strategic plan.

The Civil Works Strategic Plan is organized in compliance with the Government Performance and Results Act of 1994. The Act promotes integration of strategic planning, program performance measurement, and annual budget recommendation into a more organized process for government pursuit of national welfare improvement. Agency strategic plans can also provide the link between long range assessments of an agencies planning environment and near-term program planning that is more proactive than it might otherwise be. Good strategic plans are effective ways to communicate among collaborating agencies each agency's mission, goals, objectives, issues management strategies, and collaboration intentions.

All three of the Civil Works strategic plans so far produced (USACE 2004, 2009a, 2014) declared the importance of several of the strategic issues raised here, including adaptive management, IWRM, collaboration, and technology development, to mention a few. IWRM achieved the status of overarching strategy in the most recent plan. But, neither the issues nor the strategies for their management are well enough developed or integrated to provide adequate program direction. Three of the core issues are largely passed over, including 1) clear definition of sustainability achievement, 2) an inventory of the existing state of sustainability in the Corps, and 3) establishing a vision of desired environmental resource condition. Three of the peripheral issues are not addressed either.

The mission statements of the strategic plans summarize the authorized purposes of the Civil Works Program and indicate a need to pursue them in an environmentally sustainable manner. The two earlier statements explicitly mention sustainable development and how it relates to environmental sustainability, but the most recent one does not. Despite the promising titles (*Sustainable Solutions to America's Water Resources Needs*), the most recent plans reflect incomplete agency assimilation of the unifying principles underlying the concept of sustainable development. The fragmentation apparent in the oldest plan is only marginally improved in the newest plan. Mission and goal fragmentation continues to complicate achievement of the EOP environmental sustainability goal in the context of a sustainable development mission or a truly integrated approach to IWRM (which typically has sustainable development as its objective in other nations).

None of the plans recognized the prevalent international concept of sustainable development as development that proceeds on the bases of economic, social and environmental sustainability (e.g., Martin and Stakhiv 1999, Cole et al. 2013a, b). In all plans, the idea of sustainable development as an overarching goal with IWRM as its overarching strategy is lost in fragmented mission statements and goals. The framers did not seem to understand or were unable to communicate that all of the purposes and goals of the Civil Works Program serve sustainable development, which “provides for the needs of the present without compromising the needs of the future” (WCED 1987, Cole et al. 2014b).

The goals, objectives and strategies of the Civil Works Strategic Plan have yet to be sorted into economic, social and environmental sustainability categories to resolve potential confusion. Little attempt has been made to determine what the best balance among the three categories should be to most rapidly reach a condition of sustainable development in Corps practices. If sustainable development is truly the aim of the Civil Works program, the strategic plan should resolve these issues to provide a basis for pursuing new programmatic funding and realigning existing program budgets according to sustainable development needs.

Despite touting “sustainable solutions”, the newer plans are even less explicit than the oldest plan about sustainable development and environmental sustainability in goal and objective statements. The recent plans reflected off of the Corps Campaign Plan (USACE 2009b), which established a sustainable solutions goal for Civil Works planning and implementation. The emphasis on “solutions” is engrained in Corps thinking, as demonstrated throughout the EOP, and may be symptomatic of a tactical view of the Corps relationship to water resources—one that sees the implementation of each project as an end, rather than a work in progress that needs

continuous life-cycle monitoring and adaptive management to achieve welfare improvement objectives. Despite numerous indications of change in corporate attitude, clinging to “solution” thinking reveals lingering adherence to old ways and limited understanding of what adaptive management, life-cycle planning, and strategic planning entail.

With respect to environmental sustainability, none of the strategic plans identifies what is irreplaceable once lost, and what is essential to sustain. Natural heritage maintenance is not mentioned. The plans rely instead on the minimum requirements of environmental law, which is of little help when making decisions about ecosystem restoration for additional environmental benefits and is inconsistent with a policy of doing more than the minimum. Environmental sustainability must be a strategic constraint that is well integrated into each goal. It needs explicit and achievable objectives that serve the Civil Works environmental sustainability objective so that each can be monitored quantitatively.

Various environmental sustainability objectives were incorporated into the oldest Strategic Plan, but were fragmented, incomplete and entirely absent from the environmental repair goal, leaving the reader to wonder what environmental repair is about, if not environmental sustainability. The objectives of the newer plans appear to be even less clearly linked to environmental sustainability. Neither plan is explicit about environmental sustainability being the programmatic objective of ecosystem restoration, remediation, and the Corps regulatory program. All objectives should clearly reflect this national commitment of the Corps to NEPA policy, goals, and implementation regulations, as well as other environmental laws.

Much of what is addressed in this framework should support development of a strategic plan that is more explicit and informed about sustainable development and achievement of environmental sustainability. The Corps needs to move sustainable development up from goal status to a program mission to concentrate agency focus on achievement of environmental sustainability (and economic and social sustainability) as well as beneficial development of human well being. Everything the Corps does should serve the needs of the present without compromising the needs of future generations (WCED 1987, Cole et al. 2014a, c).

Strategic planning requires long-range analysis of environmental resource supply, demand, and management costs that have yet to be seriously considered in scenarios of alternative futures. It is best to look at strategic plan development in the light of long-range forecasts and analyses, including environmental and social change. The bit of long range environmental trend analysis that has been done for the Civil Works program (e.g., Cole 2014c) provides some insight into strategic needs, but greater investment in trend analysis and possible trend-shifting events should improve the strategic planning process.

A comprehensive conceptual analysis of the strategic plan’s environmental protection and restoration effectiveness is needed to inform future strategic process in the Civil Works Program. Because economic and social sustainability interact with environmental sustainability, the Corps needs to develop clear concepts of economic and social sustainability and how they relate to environmental sustainability. Some work by the Sustainable Solutions Project Development Team acting in pursuit of Campaign Plan Goal 2 of USACE has proposed definitions for

economic, social and environmental sustainability (Cole et al. 2014a). These may provide a basis for further consideration.

Many of the issues impeding achievement of environmental sustainability pertain to achievement of social and economic sustainability as well. Future strategic thinking should consider development of frameworks for achievement of economic and social sustainability, and a master framework for sustainable development. Congress may modify authorized purposes of the Civil Works program, but is not likely to diminish the importance of achieving environmentally, socially and economically sustainable development for improved present and future citizen welfare. The concepts, while variously defined, are consistent with American concepts of government purpose and the goals are well established in international agency thinking (Cole et al 2012b). A good strategic plan would express goals that clearly reflect NEPA goals and the strategic nature of authorized Civil Works purposes in clear statements of how each purpose serves the nation through beneficial use of the environment and maintenance of national heritage.

To achieve sustainability, the objectives set for each of the Civil Works purposes should be cast in terms of sustainability. For example, objectives for economic development should indicate they shall proceed only with assurances that the integrity of our cultural and natural heritage will be sustained. For restoration, the objective is to restore the environment to a more sustainable state of the Nation's ecological heritage—the achievement of which can be quantitatively indicated (Cole 2010). Objective by objective, the importance of environmental sustainability should be clearly shown throughout the entire program. In many cases, the objectives will follow existing Corps protocol because of NEPA, but they will more clearly target the outcomes expected from NEPA implementation and encourage improvements.

If the Civil Works Program takes the EOP seriously, the Strategic Plan will develop strategies that inform more optimal investment in development for short term use of water resources and in restoration of degraded natural resources to ensure long-term sustainability of potential resource use options. It will recognize that the challenging issue in achieving optimal investment in present and future benefits is identifying what is essential to pass on in a national natural heritage. The Corps strategic plan also will consider other social needs to achieve maximum public well being over the long run, such as appropriate protection of cultural resources and human health as well as human safety (including environmental justice). It will identify a need to inventory existing conditions for their sustainability and a vision for a sustainable resource condition. It will address the fragmentation that exists in policy regarding sustainability. And it will more clearly define the characteristics of an adaptive systems approach to regional, multi-project management over the full life cycle of each development project and over indefinitely long time frames for ecosystem restoration projects.

Three Integrative Issue Management Actions

The management of six issues addressed in the framework is not central to success, but supports management of the core issues. Three of the six peripheral issues emerge out of incoherent and fragmented environmental benefits analysis, environmental policy, and management activities. Strategic management of these six issues starts with developing a more unified approach to

environmental benefits measurement and focusing the collaboration needed on objective achievement. This includes actions to improve directions for integrated resource management (IRM) and collaboration in policy and technical guidance

Action 6: Unify environmental benefits metrics.

Issue: There is no widely accepted, single metric for the environmental benefits that indicates progress toward the achievement of an environmental sustainability objective in the Civil Works environmental footprint.

Description of the first management issue revealed the confusing murkiness of the Corps environmental sustainability objective. Civil Works project planning guidance (USACE 2000) implies that it has to do with sustaining natural aspects of national heritage and explicit articulation of an ecological heritage maintenance objective is the means for managing the issue. Measurement of ecological heritage maintenance is challenging, however. Its institutionalized maintenance reflects public recognition of its bequest value, a form of nonuse value. No method for measuring nonuse value in monetary terms is widely accepted because too many questions remain about its reliability (NRC 2005, Cole 2014a). The Corps prohibits measurement of bequest value in monetary terms using existing techniques (USACE 2000).

NEPA implementation regulations do not require any uniform measurement of sustainability nor does any other law, even though some resources sustained minimally for future use of the investing public can be priced. Monetary measurement of “environmental” benefits is rarely adopted by agencies, however, even though beneficial uses, including recreational and closely related aesthetic uses (e.g. “sight-seeing”) are acceptably priced in monetary terms (NRC 2005, Cole 2014a). NEPA instead emphasizes avoidance of significant EQ impact when possible and otherwise replacing lost EQ through compensatory mitigation. Generally speaking, compensatory mitigation is negotiated among agencies and other stakeholders based on replacement of the material resources that are expected to be degraded by plan implementation. The assumption is that *all* use and nonuse value will be sustained, whether or not the value can be monetized.

Without quantified measurement, however, it is difficult to monitor the effectiveness of mitigation and cumulative effects on environmental, economic, and social sustainability. Consideration of whether to avoid adverse impacts on irreplaceable natural or cultural heritage, or to mitigate through compensation, suffers from inadequate guidance about replacement risks. Generally, those values that can be replaced through compensatory mitigation are use values measurable in monetary terms (NRC 2005). Their compensatory replacement contributes to economic sustainability by sustaining useful stocks above the level needed to sustain heritage.

Economically sustainable natural resources are more plentiful than the fundamental level of sustainability required for heritage maintenance. There is usually little risk of irreplaceable loss of heritage when mitigation fails to compensate for loss of economically valued resources. Once overexploited resources become quite scarce and unsustainable, the prices for their use usually soar, often cutting the demand for them and allowing them to rebound. In many cases though,

overly exploited resources require restoration and protection from use to recover at least the minimum level of sustainability for heritage maintenance.

While project planning guidance could be much clearer about the heritage objective of the ecosystem restoration and protection program area, it does define environmental protection in heritage terms and definitely emphasizes the long-term sustainability of the desired outputs and output protection from incompatible use (USACE 2000). It also indicates that the nonuse value that derives from protection is not to be measured in monetary terms because the technique for doing so is unreliable. It does not discount output value, indicating that the benefit is to accrue to future generations as well as to the investing generation. The missing element is coherency. The guidance does not clearly tie these points together. But the only logical conclusion is that restoration and protection measures serve an ecological heritage objective.

Compliance with The Government Performance and Results Act requires indicators of relative contribution to achievement of national welfare improvement objectives. How those benefits are measured is left to the executive branch to determine. For many decades, the Office of Management and Budget directs measurement of benefits in monetary units when acceptable methods exist. Otherwise, some nonmonetary measure of expected performance is recommended and used as a basis for seeking cost effective achievement of authorized objectives. Because the metrics used in Corps project planning could not be compared for relative contribution to national welfare improvement, the Corps developed yet another nonmonetary indicator of benefit to rank ecosystem restoration projects for federal budget recommendation.

The metrics now used to indicate environmental benefits at Corps project and program levels are not comparable and do not adequately address the value gained from heritage maintenance (Cole 2014e). This contributes to the incoherency of the environmental sustainability objective. The diversity of metrics now used complicates planning communication and review process as well as the comparison of project outputs for national budget ranking. The issue could be more manageable if an environmental sustainability objective is specified clearly in heritage maintenance terms and a new metric for its measurement is developed for all activities. Ideally, the metric would be consistently useful for project planning and program needs and comparable across projects, much like monetized benefit can be quantitatively compared across economic development projects.

The most common way Corps planners have measured environmental benefits from restoration as well ecosystem restoration is influenced by past compensatory mitigation practices. The U. S. Fish and Wildlife Service developed the Habitat Evaluation Procedure (HEP) primarily to guide compensatory mitigation of damage to fish and wildlife recreation and commercial use (USFWS 1980). The product of HEP is a habitat unit (HU) determined by the product of the number of acres times a habitat suitability index (HSI). When used in ecosystem restoration projects, the HU becomes an index of relative value—a habitat unit index (HUI) (Cole 2014e). HUs were based on the needs of an indicator species—usually one that indicated potential loss in economic sustainability, such as recreationally or commercially important species. Preservation of fish and wildlife heritage through damage avoidance was left largely to compliance with ESA requirements even though many unsustainable species were not listed as threatened and

endangered. Many of those species continued to decline as compensatory mitigation became more routinely applied to federal projects.

HUs rely on HSIs based on the habitat needs of an indicator species. The first set of indicator species selected (USFWS 1981) were typically common and of direct or indirect commercial or recreational value. While the method guides replacement of habitat for the indicator species, the habitat does not indicate use value directly. It is only as good as the fish and wildlife species that inhabit the replacement habitat and the demand for their use. Many factors can interfere with replacement habitat colonization by the desired species. However, many economically valued species broadly tolerate a wide range of environmental conditions and generally find their way into even crudely constructed replacement habitats (Cole 2014e). This is not the case for most species that are in decline toward extinction and some of them may have suffered as a consequence of past mitigation practices. But superficial monitoring has left us uncertain (NRC 1999c).

Finding a single acceptable measure of ecological heritage value would greatly reduce the number of monetary and nonmonetary metrics now used to represent Civil Works project purposes to two. The ecological metric would not be suitable for indicating the value of purely geophysical natural heritage, but geophysical heritage is not the objective of ecosystem restoration and its value does not need to be explicitly estimated for mitigation purposes (although it would be helpful to quantify it in some way).

Heritage value is indicated by the resources that are desired by the public in greater quantity to assure their continued existence (as indicated in explicit laws and other reliable evidence of public desires). The best example of such evidence is the fish and wildlife heritage maintenance goal of the ESA. The Corps ecosystem restoration authority is not limited to geophysical resources. It has the authority to restore them as part of the ecosystem support required for the desired inhabitants. The physical-chemical elements of habitats are environmentally sustainable and not scarce in their own right. They can always be reassembled in support of desired inhabitants. Their scarcity is determined by the needs of species that are not sustainable and their value is tethered to the heritage value of desired species. They have no independent heritage value.

With unsustainable species in mind, Cole (2010 and 2014b, f) developed a benefits metric for Corps use in ecosystem restoration project and program planning. The Biodiversity Security Index (BSI) indicates relative value based on the scarcity of ecological resources desired by the public for the ecological heritage value sustained in native biodiversity. Different forms of the BSI are used for ranking feasibility studies for budget appropriation and for project planning and construction ranking. Each form of the BSI is universally applicable across projects and programs. See Cole (2010 and 2014b, f) for details.

The form used for ranking feasibility studies for annual budget allocation is relatively simple. It indicates the relative vulnerability of unique species attributes to extinction for species in the project vicinity. The highest scores are associated with high numbers of highly unique and greatly imperiled species. The form used for project planning and ranking for construction budget allocation also includes a residual risk term, which requires a careful analysis of the

degree to which alternative plans manage the risks faced by species populations as they attempt to inhabit the supporting ecosystem restored in the project area. The “currency” of value is in units of viable (i.e., sustainable) species populations established in the project area. The index satisfies a need for indicating long-term sustainability of the project output through the estimated viability of the desired populations. Because the number of individuals required for population viability is generally known, the area of habitat required to sustain the population over the long run can be calculated from life history data. Benefit increases as the unique attributes of each species become less vulnerable to extinction threats.

A fundamental flaw of the HUI is its inability to reliably indicate the sustainability of the result and the associated heritage value (Cole 2014e). Because the HUI does not identify the amount of habitat needed to establish sustainable resource populations, they do not reliably indicate sustainability and heritage value. The BSI contends with this by making its unit measurement of value a viable population unit—one that is probabilistically expected to persist well beyond the 50-year period used for population viability analysis. Through that type of analysis, a minimum population size is estimated. Analyses of hundreds of studies indicate that a good initial estimate for most species is about 5000 individuals (Traill et al. 2010). Any less than the required quantity of habitat of a particular quality would be insufficient.

The focus on species and habitats in virtually all metrics used, including the BSI, is consistent with the federal planning objective and the study objective for ecosystem restoration and protection purpose described in project planning policy (USACE 2000). But a careful reading points to species restoration in a supportive habitat setting. The federal planning objective indicates that the quantity and/or quality of the desired ecological resources are functions of habitat improvement. This implies that the inhabitant species are the significant resources, and the habitat improvement costs are justified only by their reestablishment in the improved project area. More explicit still, “biologically desired” species and high plant and animal diversity are the “desired outputs” identified in examples of objective achievement provided in planning guidance. Ecosystem support for the desired outputs is also identified, but it indirectly derives its value from the resources it supports. Species that indicate conditions needed to restore the desired outputs are also mentioned but have no value separate from the desired outputs they are supposed to indicate.

It is unlikely that a single nonmonetary metric for all heritage value will be developed anytime soon. However, cultural heritage fits more properly into the category of social sustainability. Among natural resources, most geophysical resources are environmentally sustainable (but perhaps not economically sustainable). Some, however, are unique and deserve long-term protection based on benefits separate from ecological benefits. For mitigation purposes, simply identifying them as significant is sufficient for now. But, at least for ecosystem restoration projects, ecological resources provide a broad basis for indicating restored and protected contributions to environmental sustainability. Unifying the many metrics now used for the Corps EQ improvement authority into a single monetary metric and a single nonmonetary metric would focus its activity more fruitfully on achievement of environmental sustainability objectives. The BSI and other metric concepts need to be further investigated and developed with management of this issue in mind.

This issue is a priority within the hierarchy of issues managed because of the intense interaction between it and the high-priority need for an improved environmental sustainability objective statement. The two issues are best developed in close association.

Action 7: Integrate policy for effective sustainability guidance

Issue: *Civil Works environmental policy guidance lacks coherency and focus on achievement of environmental sustainability, especially in its most empowering Civil Works authority—aquatic ecosystem restoration and protection of environmental quality.*

All significant programmatic authority was developed before the EOP were pronounced in 2002, including the 1996 authority to improve EQ of interest to the public by carrying out aquatic ecosystem restoration and protection. On close examination, the existing policy guidance appears in many respects to be consistent with achieving environmental sustainability. However, policy guidance is fragmented by program area. It does not clearly integrate intents and language into a focused achievement of the environmental sustainability goal. No Civil Works Program policy comprehensively addresses environmental sustainability. To the extent it is addressed, sustainability is fragmented among separate statements of policy for project planning, operations, stewardship, ecosystem restoration, budget planning, regulatory, and other activities. The one commonality is impact mitigation consideration through the NEPA process. But that is a procedural constraint; not an objective that provides direction for the process.

The policy fragmentation and confusion over the environmental sustainability objective may derive in part from too much programmatic reliance on the implementation rules for interpreting NEPA policy and goals into process. This transformed NEPA from a clear statement of national goals for agencies to pursue to a recipe for strict procedural compliance. NEPA goals clearly separate into economic, social and aspects by promoting beneficial use of the environment; provision of a safe, healthful and pleasing environment for all; and preservation of natural and cultural aspects of national heritage. A sustainability goal is not mentioned explicitly, but is certainly implied by the heritage goal and a goal to “fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.” The NEPA concept of “productive harmony” between man and nature is more like the U. N. concept of sustainable development, which has separate economic, social and environmental aspects (Martin and Stakhiv 1999, Cole et al. 2014b).

The original EOP were explicitly linked to the U. N. concept of sustainable development by the EOP Implementation Guidance (USACE 2003a) and by the explanations that accompany the recently revised EOP (Bostick 2012). In a change from the Implementation Guidance, the explanations for the revised EOP explicitly differentiate among the three forms of sustainability, but refer to environmental sustainability as ecological sustainability. They do not, however, describe their differences and relationships in any depth.

Environmental sustainability is not explicitly mentioned in the Principles and Guidelines (WRC 1983) and when it is implicit, as with EQ maintenance consistent with implementation of NEPA EQ evaluation procedures, it does not differentiate environmental sustainability from economic

and social sustainability. In the Principles and Guidelines, EQ maintenance implies sustainability of all natural and cultural resources valued significantly for use as well as for heritage. As such, all three categories of sustainability are considered for protection based on the significance of the resource. The WRDA of 2007 authorized a rewrite of the Principles and Guidelines, and in that authorization it declared in a policy of Congress to maximize “sustainable economic development”, which is incorporated in the new guidance (CEQ 2014). As a goal of water resources planning and implementation, Congress in effect raised sustainable development to an explicit level of national policy recognition. Consistent with that recognition of importance, the Corps interpretation of that congressional policy in a new version of the PGN should be explicit about sustainable development and its social, economic, and environmental dimensions.

The PGN (USACE 2000) defers to the Principles and Guidelines except for certain aspects of the ecosystem restoration authority and other law passed after 1983. The PGN implies that the program objective of environmental sustainability is to maintain natural heritage through its reference to natural heritage in the definition of environmental protection. But the PGN fails to identify natural heritage maintenance as the NER objective or that the protection of the desired output from ecosystem restoration projects is critical for program success. Because protection is not mentioned, the connection of NER to natural heritage and environmental sustainability is unclear and generally unrecognized by ecosystem restoration planners. Readers have to work harder than necessary to come to that conclusion after integrating all of the fragments into a coherent whole.

Sustainable development is explicitly mentioned once in the Appendix:

“Integrated, the implementing regulations for the WRPA and the NEPA provide an effective framework for the formulation and evaluation of water resources comprehensive plans and implementation projects, which is responsive to the challenge of sustainable development in our Nation and the world.” PGN page C-1.

The PGN also sorts out the economic, social and environmental aspects of resource sustainability, but almost as an afterthought in a brief statement about taking a watershed perspective:

“Specifically, civil works planning should consider the sustainability of future watershed resources, specifically taking into account environmental quality, economic development and social well-being.” PGN page 2-16.

While these are the only explicit references to sustainability and sustainable development in the PGN, they are significant because they confirm that one measure of project planning framework effectiveness is how “responsive” the project is “to the challenge of sustainable development” and that there are clearly three distinctive aspects. But the two statements are far apart in guidance and not linked to each other or more implicit expressions of their meaning in other parts of the PGN. The concepts of sustainability and sustainable development deserve much more than a footnote in planning guidance. They need to be raised to mission status level in the

strategic plan and in all Corps activities, if the Corps is to completely adopt national policy and its own EOP.

In referring to accounting, the PGN implies differences among environmental, social and economic sustainability, but does not indicate how those differences apply to the four objectives and accounts that are so important in the federal planning process. Explicitly connecting the concept of sustainability to maintenance of an ecological heritage in the environmental objective would clarify its meaning in the context of NEPA goals and provide a clearer rationale for what should be displayed in the EQ account.

The Civil Works Ecosystem Restoration Pamphlet (EP 1165-2-502) is more informative than the PGN about the goal of the ecosystem restoration program and what should be protected to sustain the environment (as opposed to the economy and society). It indicates that the goal of an ecosystem restoration approach is to restore and *sustain* ecological resources:

“The goal of the ecosystem approach is to restore and sustain the health, productivity, and biological diversity of ecosystems and the overall quality of life through a natural resources management approach that is fully integrated with social and economic goals....Restoration projects should be conceived in a systems context, considering aquatic (including marine, estuarine and riverine), wetland and terrestrial complexes, as appropriate, in order to improve their potential for long-term survival as self-sustaining, functioning systems.” (EP 1165-2-502, page 13)

The wording clearly indicates the Corps EQ improvement and protection authority refers to the “long-term” sustainability of the desired resources and the supporting ecosystem. But what is often overlooked in the PGN, because it is so unclear, is the importance of biological diversity as an output from ecosystem restoration projects. Health and productivity are processes that sustain output but are not in themselves output. Life in all of its diverse forms is the output from a healthy and productive system.

Even here, however, more information should be conveyed. When the natural resources associated with life become unsustainable, they need to be protected from further loss to preserve the potential for future utility. While protection is implied in the desire for long-term viability of restoration outputs, once again it is not explicitly stated for those readers who require explicit guidance. Unlike the ecosystem restoration objective, consideration of natural resource protection under NEPA also includes geophysical features of the environment considered independently of life forms for their natural resource heritage value. Geophysical features by themselves fall outside the scope of the ecosystem restoration objective.

Project operations policy also could be much more explicit about sustainability. Despite program consistency with environmental sustainability based in avoidance, minimization and compensatory mitigation, the connection to environmental sustainability is only implied. Curiously, the “Procedures for Implementing NEPA” does not mention environmental protection, preservation, conservation, maintenance, or other language that might imply sustainability of the environment, probably because of too much focus on NEPA process over

NEPA goals. Program descriptions of regulatory purpose fail to make the connection as clearly as they could. Making this clear would link the regulatory program into a common sustainability theme with other USACE activities. Connections of the regulatory program to sustainable development also need to be made more explicit.

The natural resource management policy guidance for project lands and waters is referred to as “stewardship” and is as clearly directed at environmental sustainability as any program policy in the USACE. Environmental stewardship is defined in terms of sustainable ecosystems and biodiversity:

“Environmental stewardship shall include both passive and proactive management to sustain healthy ecosystems and biodiversity, and conserve natural resources, such that Corps lands and waters are left in a condition equal to or better than their condition when acquired, and such that those natural and cultural resources are available to serve the needs of present and future generations.” Page 1-1

But the policy does not mention the connection between ecosystem sustainability and environmental sustainability explicitly. Nor does it point out that biodiversity is the collection of desired ecosystem attributes while a healthy ecosystem condition is a characterization of the means for producing and maintaining that diversity.

An appropriate issue management strategy is two pronged: 1) development of improved omnibus environmental policy in EOP implementation guidance and 2) integration of common language and concepts among diverse policy guidance documents. This is best done once the objectives of environmental sustainability are clearly stated, including quantification in a limited number of comparable metrics. Until all program guidance consistently refers to heritage maintenance as the objective of environmental sustainability, it will remain unclear in policy guidance and connection to the EOP, strategic plans, and other official actions of the Corps.

Action 8: Improve collaboration and integrated resource management

Issue: *Collaboration is an oft-used word with limited conceptual basis for informing integration of environmental sustainability into a multi-organizational approach to natural resources management at both project and program levels.*

Organizational collaboration is a widely supported strategy for achieving more cost effective federal service to the Nation. Collaboration is the integration of organizational objectives, actions, language, financing, program planning and implementation methods, and other processes needed for effective natural resource management in pursuit of common goals. It is the means by which comprehensive and fully integrated natural resources management happens. Collaboration can occur among federal, state, and local agencies, and NGOs. Collaborative activities range from program coordination to full partnership in jointly funded projects and other activities. While guidance exists for many particular aspects of collaboration, there is no

comprehensive guidance for penetrating barriers to collaborative integration of resource management

Collaboration barriers occur at all levels of interaction within and among organizations. They may result from profound differences in perceived objectives and performance standards and lack of trust to chronically frustrating differences in budget cycles and methods. Given limited resources, collaborators need to surmount these barriers to marshal the most cost effective management of the Nation's water resources problems. Government barriers to collaboration often originate in different interpretations of authorized purposes, goals, objectives, and policy constraints pertaining to environmental development, restoration, and protection. Effective collaboration across diverse agencies and NGOs requires a shared sense of purpose, shared resources, clear and meaningful communication, and, most fundamentally, trust among all participants in the ability and commitment of all collaborators to follow through on stated intents.

Collaboration is nearly universally promoted by government, including the Corps. This promotion reflects widespread recognition of the numerous barriers to more effective inter-organizational interaction (Wondolleck and Yaffee 2000). The Corps and other organizations often must complement their limited authority with the authorities of other organizations to achieve beneficial program outcomes. Ideally, interactions between environmental protection and environmental development agencies would be more collaborative than antagonistic, but that has not always been the case. Collaboration and related concepts, such as watershed planning and integrated water resources management (IWRM), were to be considered in rewriting of the federal water resources project planning guidance (WRC 1983) required by Congress in Section 2032 of the 2007 WRDA. Explanation of the revised EOP indicates that reinvigorated commitment to the EOP is essential for successful integrated resource management (IRM).

A case can be made that the most fundamental goal of all government project and program investments in the United States is human welfare development that assures environmental, social and economic sustainability—i.e., sustainable development. Sustainable development can be a conceptually strong focus for collaboration when all parties involved accept a common understanding. It has the advantage of international recognition of its world-wide relevance (WCED 1987) and virtually all natural resource management activities, ranging from environmental protection to development, play complementary roles in its pursuit. NEPA policy and goals map out a similar concept of sustainable development. Yet, differences in the understanding of and commitment to sustainability, as well as sustainable development, may have contributed significantly to collaboration barriers. Even when purpose and objectives are clear and shared, insufficient coordination, communication, and cooperation often confound objective achievement.

Collaboration is often encouraged by financial incentives and is commonly imposed by laws, executive orders and regulations. One example is the project cost-sharing requirements for federal water resources development projects. Cost-sharing requirements force “collaboration” before anything can be achieved. But imposition of interagency collaboration does not assure effectiveness, which starts with the behavior of individuals and extends to larger organizational interactions. Critical preconditions for collaboration typically include identification and

acceptance of common purposes among potential collaborators and the resources to pursue them. The clarity of organization mission and objective statements, as well as the metrics used to gauge objective achievement, are central to communication preceding and during collaboration. Previously described issues have established that the environmental sustainability goal of the Civil Works Program is not explicitly defined or objectified. Once clear, the statements can be more explicitly compared across agencies and possibly modified to make them more generally consistent whenever possible.

Required or coerced collaboration can obscure the sense of common purpose, especially when trust is limited. Distrusted organizations must work especially hard to follow through on the policy goals and objectives that introduce many environmental laws. Policy goals and objectives are too often dismissed as political pap, when they can and should provide common ground on which to build more fruitful collaboration. Developing trust requires a consistent and comprehensive approach to program management, including program strategic planning. A good Strategic Plan is an excellent way to communicate organization mission, strategic objectives and strategies for achievement to collaborators. But good enough plans are rare.

Ideally, strategic plans should be among the materials first shared among potential collaborators, instead of shelving them in obscure websites. But federal strategic planning often is too narrowly viewed as an accountability requirement of GPRA or as a public relations vehicle. Few strategic plans are specified clearly enough and in the detail needed to communicate to other agencies possibilities for collaboration. It does limited good at best to declare a dedication to environmental sustainability when too few details are provided to clearly demonstrate sustainability objectives and strategies. Good strategic plans allow organizations to compare general organizational intents when the plans are well developed. The plans need to be written in common language and in sufficient detail to prove truly useful for cross-agency communication as well as internal communication. Working across agencies to develop improved guidance for strategic plans is one way to advance toward improved collaboration.

The adoption of conceptually standard approaches to management is also critical. Adaptive management is increasingly recognized as the basis for a commonly used management framework that links program performance to specific project and activity performance and improvement in pursuit of program objectives under uncertain conditions. Given the rates of environmental change and the uncertainty of their effects, adaptive management is a practical alternative to traditional “command and control” approaches to management. Most resource agencies have also accepted an ecosystem approach to management (Franklin 1997) and signed a Memorandum of Understanding to that effect nearly two decades ago. Collaborative development of a “standard” concept of a systems approach to adaptive resource management is recommended for consistent understanding among all potential collaborators.

Another concept needing collaborative attention is Integrated Water Resources Management (IWRM), which is promoted in the Corps Civil Works Strategic Plan and is a widely used concept in other developed nations (e.g. Cardwell et al. 2006). The meaning of IWRM is far from standardized, however. As the emphasis on collaborative effort has grown, the IWRM concept has become more broadly encompassing, involving an array of facilitative methods and procedures for negotiated settlement and conflict resolution. Work at IWR indicates that IWRM

is most usefully understood as a unifying, collaborative process focused by common purpose—especially a broad purpose, such as sustainable development (Cardwell et al. 2006). Collaboration is essential for concept application. It may be necessary to aggressively reach out to and recruit collaborators who must understand the management framework used by the Corps. But the Corps needs to fully understand its own framework first, including the concepts and roles of environmental sustainability and sustainable development. Congress directed consideration of IWRM in the new federal guidance for water resources planning. The new guidance does not mention it explicitly, but emphasizes the need for an integrated approach, which leaves room for a process broader than IWRM.

The concept of IWRM may be too narrow for the most effective resource integration and collaboration. This seems to be recognized in the preamble for the revised EOP, which dropped water from its reference to integrated resources management (IRM) and meaningful collaboration within the larger environmental community (Bostwick 2012). The Military Program of the Corps is just one example of a Civil Works collaborator that is not water focused in its management, but most collaborators are cognizant of watershed principles and the effects of land management on water quality. Integration is needed across all material, energy, and human resources management, not just water resources management. While the Corps is authorized to enter into IRM through water resources management authorities, it must embrace integration with forest, crop-culture, livestock management, urban development, and other land-based resource management, as well as other water managers, around the common purpose of sustainable development. Informed decisions need to consider the optimum benefit produced across a wide array of management investments—not just water resource investments.

If it does continue to emphasize IWRM, the Civil Works Program needs to very carefully define its meaning as it relates to environmental effects of Corps activities on all resource management. It must also determine what IWRM must become to achieve effective collaboration as an important dimension of sustainable development in pursuit of environmental sustainability. It will most likely need to incorporate the concept of natural or ecosystem services (Daily 1997, Stakhiv et al. 2003, NRC 2005) because that approach is rapidly emerging as the means to pursuing more complete analysis of project and program benefits. The revised federal guidance for water resources planning emphasizes consideration of all ecosystem services in the planning process (CEQ 2014). Application of the federal guidance has been greatly expanded to include all federal programs and projects that could influence water resource quality and quantity. These trends would most likely encourage more complete assessment of ecosystem service effects of Corps projects and the potential need for impact mitigation once appropriate guidance is developed.

In addition to IWRM, the Corps Strategic Plan emphasizes use of watershed and systems approaches to planning and operations. A watershed orientation has a well established history in natural resources management and provides a common geographical basis for planning in many federal agencies (Cole et al. 2005). The physical concept of a watershed is quite clear, but its application in all Civil Works activities is limited geographically and largely to plan formulation. The broader concept of a systems approach to management (often through a watershed portal) may be more useful, but had not been clearly defined by the Corps for its use by 2006 (Cardwell et al. 2006) and policy guidance has not progressed much further. It is critical to discern and

clarify how a systems approach differs from and integrates with adaptive management, IRM and a watershed approach.

At the program level, collaboration can be encouraged by developing a common understanding of the nature of problems facing all collaborative organizations. For natural resources programs with an environmental sustainability objective, three interrelated problems stand out—global climate change, unprecedented loss of biodiversity, and the sustainability of human welfare (Lubchenco et al. 1991). Organizations must share their individual understanding of these issues and how they apply to them before they collaborate to develop joint statements of understanding and strategies for issues management.

Many impediments to collaboration are procedural. Certainly there is a need to improve interpersonal skills pertaining to everyday communication, coordination, and cooperation. An important rule for improved collaboration is to assure that all who need to be involved are involved and understand their role well. Too much can be made of “team” approaches without sufficient indication of the expectations from each team “position”. Disagreement is a common impediment to progress. Development and use of dispute resolution and other techniques to improve collaboration can help to ameliorate some aspects of this issue. A history of such work supported by IWR reveals this has been an issue in Corps project planning for many years. Recent examples of advances supported by IWR emphasize computer-aided dispute resolution in shared vision planning (Cardwell et al. 2009, Creighton and Langsdale 2009, and Creighton 2010).

Insufficient funding may be the greatest single impediment to making fundamental changes needed to encourage more effective collaboration. No agency ever seems to have enough funding. Funding is typically directed at maintaining agency strength sometimes at a cost in funding for collaborative purposes. Effective collaboration often requires difficult funding decisions. Failure to change past patterns of organizational behavior often is rooted in the inability of organizations to overcome this fundamental barrier. The insufficient-funding excuse can become a wall between collaborators. In such situations, agency complaints about not being understood by others can become chronic and self-fulfilling. But collaboration is no excuse for inefficiency. It must be cost effective.

Three Systems-Context Issue Management Actions

Management of three of the issues aids implementation of a systematic adaptive management process that takes into account the entire operational “lives” of projects, including rehabilitation and decommissioning phases. The process also aids inventory of environmental conditions in the Civil Works Program, and the development of alternative future scenarios for achieving environmental sustainability.

Action 9: Develop a multi-activity, regional assessment process.

Issue: *There is no Corps conceptual framework for developing policy guidance for the multi-activity, regional-context assessments of environmental impacts needed to achieve environmental sustainability more efficiently and effectively.*

With some exceptions, the Corps has used an approach to planning that has been too narrowly focused on a project area determined by an authorized project purpose. Except for those projects planned in the context of a regional program, such as the Everglades restoration program, the project area is expected to encompass all of the regional considerations needed to properly assess environmental sustainability. The approach is not programmatically cost effective. A more cost effective process would document and continuously update conditions affecting sustainability in all regions within the Corps environmental footprint. It would be closely linked to needs identified for the adaptive management process (Issue 2) and to the inventory of sustainability in the Corps footprint (Issue 3), but pertain more to the conditions that influence resource sustainability. This is one of the most difficult issues to manage because of existing fragmentation in regional assessment of environmental conditions at the national level and limited agency interest in this period of shrinking federal budgets. However, the Corps can establish a foundation for future improvement when opportunities arise.

This regional assessment of present and future conditions differs from the inventory of existing resource sustainability in the Corps footprint. Its emphasis is on assessment of cumulative environmental impacts from the interactions of all existing projects and activities in the region on conditions where the Corps is already active or anticipates future activity. The assessment needs to include all existing and forecast water development projects and all existing and forecast land use activities having an impact on aquatic and riparian ecosystems, including agricultural, urban development, transportation development, and other land use. It also needs to assess changes that may be linked to past climate change. It should be national in scope and organized by hydrologically defined regions, including river basins and coastal ecosystems. It must be comprehensive enough to provide a broad basis for forecasts of ecosystem conditions throughout the full life cycle of Corps projects as well as other interactive public and private projects (addressed in Issue 10). Assessments would require periodic review and updating as the future unfolds.

The project-focused approach fails to account well enough for all of the interactions that can occur among projects and other activities in the region. Completing a thorough cumulative effects analysis for each project (addressed in Issue 10) requires the same regional, multi-project context promoted here. Non-federal sponsors often are skeptical about the cost of more comprehensive planning. Each time a project is proposed in the region, this inefficient approach requires doing over much of what has been done. A regional system assessment process is likely to be a more cost-effective alternative in the long run. Although it costs more up front, it eliminates duplicative effort over the years.

As indicated in Issues 1, 3 and 6, the most critical aspect of environmental sustainability is the viability of living components now in decline toward extinction. Once the impacts on these

unsustainable species are known and understood, regional assessments can be used to document existing benefits and costs associated with Corps and other public project purposes, potential for decommissioning projects, and prospects for partially to fully removing structures that are no longer beneficial enough to justify continued species impacts. The needs for major rehabilitation also should be evaluated and prioritized for their potential for natural heritage improvements as well as beneficial use.

Ideally programmatic funding would be made available, but it is more realistic to plan for it to come out of existing operations and authorities for new and rehabilitated project planning, wherever possible, using funds from different projects in the region in an integrated assessment. Cross agency collaboration should be pursued, possibly through existing mechanisms, such as Landscape Conservation Cooperatives of the Department of the Interior, existing River Basin Commissions, and state coastal zone management areas. However, regional boundaries of existing approaches differ and are nationally incomplete in the case of River Basin Commissions. The depth of the analysis depends largely on the fiscal resources available and the limits of existing knowledge. Management of this issue requires significant investment in concept development and potential agency interactions at different levels of funding availability. Early development may need to be rudimentary, but provide a firm foundation for more complete assessments as resources become available. Recent initiation of a watershed-based assessment tool by the Corps at the IWR is intended to be applicable for all of the river basins in which the Corps works. This is an important step in a process that should undergo continued refinement.

The assessment process must include all influential land and water use regardless of the source. Land disturbance by agriculture and urban development is most often associated with risk factors facing imperiled species (Cole 2009). Corps projects can interact with land use changes to increase or decrease adverse impacts. Reservoirs, for example, often interrupt material and species movements, but also may trap sediments, nutrients and toxic chemicals, as well as impede movements of invasive species that threaten native species (Cole 2009). Rates of climate change and its secondary effects need to be assessed as well as future demands for transportation, energy, and other goods and services. The intent is to optimally integrate navigation, flood and coastal plain, recreation, hydropower, water supply, agriculture, forest and range management, urban land use and other water and land use into the process. The regional restoration programs can provide useful “lessons learned”.

Ultimately, a nationally comprehensive regional assessment of existing and forecast environmental conditions needs to be funded programmatically. A carefully considered approach needs to be developed before requesting such funding. Great advances have been made in the availability of spatially explicit data relevant to the assessment as well as data on watershed and coastal interactions affecting resource sustainability for heritage maintenance.

Action 10: Develop a systems-context project planning process.

Issue: *A limited conceptual foundation exists for developing guidance to assess contributions of projects and other activities to achievement of environmental sustainability over the entire project life-cycle and systems context.*

For good reasons, the most recent version of the Civil Works planning regulations (USACE 2000) directs project planning to be done in a “systems context”. Business management policy advocates project life-cycle planning. Past planning for project life-cycles within a systems context was incomplete and has since contributed unsustainable environmental conditions at locations within the Corps environmental footprint. The Corps now realizes that projects can have adverse cumulative effects, especially on the sustainability of many freshwater species (Cole 2009). Even so, technical guidance has yet to be developed for multi-project, life-cycle planning in regional systems contexts.

Project planning has focused too much on the near vicinity of the project area and discounting influential trends, cumulative effects from interactions with other projects and, natural processes, and the uncertainty and risk that exists in plan implementation. The Corps has learned that retrofitting fundamental changes in completed projects can be technically challenging and expensive. Many projects have lasted decades without reassessment of the benefits and costs they produce. These costs and benefits need to be considered in the larger context of all of the interactions that are expected to take place over the project life cycle. Many projects continue to be beneficial enough to justify expensive operations and rehabilitation that includes modifications designed to achieve environmental sustainability. Evaluations of less promising projects should consider decommissioning and restoration recommendations.

Concept development is needed to inform implementation guidance, ideally resulting in more complete assessment of the cumulative effects on achievement of environmental sustainability in the Corps footprint. Whether projects are new or rehabilitated, planning should include a thorough life-cycle analysis of benefits and costs, including the costs of removing or significantly modifying the project through adaptive management. Systems-planning can be done more cost effectively in the context of multi-activity regional assessments completed at the program level (see previous issue management action). The management of these interrelated issues depends on integrative tools of the necessary scope (see Issue 11). As each new project is planned, the regional systems context plan is modified to reflect new information, but the planning process can make use of much information that has been incorporated into previous plans.

These regional plans should form the basis for adaptive program management. The ability to plan completely and effectively for each new or rehabilitation project should improve as more information is incorporated into the comprehensive plan. Central to this concept is inclusion of a regional-scale simulation model that enables integration of new information through time and improvements in the model structure. Such models can be used for sensitivity analysis to direct planning inventories and to focus program research on the greatest information deficiencies.

The framework for such planning not only can be developed based on principles used to guide project-focused planning, but must be consistent with the principles established in any new federal guidance for water resources planning. It must expand plan formulation to include the significant effects of all other activities forecast to occur in the region, including all private and public land and water management; population demographics, preferences, and attitudes; and economic conditions. Because of the difficulty inherent in forecasting such complex interactions, the process requires continuous updating of conditions in the regional context (Issue 10) and adaptive management that is responsive to needs revealed by new information.

Climate change is only one of many important trends that need to be carefully considered at the regional level, but its potential for wide ranging effects on the species components of ecosystems is exceptional (e.g. Thomas et al. 2004). Temperature is a fundamental environmental variable affecting species survival. The first recourse that species have in response to changed temperatures is to redistribute to locations without intolerable environmental conditions. Many river systems in the United States are now fragmented by dams for water supply and flood management, hydropower and navigation, and by water quality alteration. As water temperatures increase, many species may be unable to move into cooler waters to survive. As sea levels rise, the habitats of some species will be reduced as a consequence of salinity and other changes. These challenges to sustainability need to be regionally documented (Issue 10) and included in systems-based plan formulation. The Corps has begun to assess the effects of climate change on risk and uncertainty in project planning (Olsen et al. 2012, Cole 2014d) providing some basis for improved concept development and eventual technical guidance.

As with any forecast, precision is always an issue. Uncertainty is great. A scenario-based approach is more suitable for conveying the range of uncertainty than the determination of the most probable scenario. A set of plans needs to be developed based on a manageable number of reasonable scenarios. As assessments and plans are updated, the scenario approach will anticipate alternative planning foci needed for new project, rehabilitation or operations needs. It will also support more rapid adaptation. Sophisticated, regional-systems simulation models may be essential for this task and for systems-based, life-cycle planning in general.

Action 11: Develop tools and training for a systems approach.

Issue: *The Civil Works program does not have plans to develop tools and training of the scale and complexity needed for program-level planning and management that efficiently achieves environmental sustainability.*

Program planning for environmental sustainability is complicated by the scale and complexity of the necessary systems analysis. Planning tools have been improving, but adequate assessment of regional cumulative effects is thwarted in several ways. Training has not been updated as much as needed to accommodate needs. Most basic is the insufficient integration of environmental states and processes into spatially explicit and dynamic models that can be used for assessment and other planning purposes. The Corps needs to develop a comprehensive R & D plan that is coordinated with other issues management described here. While there is a need to continue to respond to existing District needs, the strategic needs addressed here have not been well met.

Most planning methods, models, and other tools have been developed for applications of substantially more modest scale and complexity than needed for sustainability assessment and regional systems-based, multi-project, life-cycle planning.

While major advances have been made, spatially and temporally explicit regional systems models capable of life-cycle planning analysis of ecological effects have yet to be fully developed to the scale and complexity needed for regional water resources planning and operations analysis. Adequate assessment of cumulative effects is thwarted in several ways by existing models. Most basic is the insufficient understanding of environmental processes and integration of what is understood in process simulation models. Improved models would be valuable for adaptive, multi-project program planning analysis; documenting and updating inventories of resource conditions, envisioning future resource conditions, and facilitating integrated resource management. While project planning requires specific applications of systems models, it is both possible and efficient to develop general simulation models that are adaptable to a range of specific project conditions in rivers, riparian zones, lakes, estuaries and coastal areas.

The Corps has developed and improved computer models of the needed scale and complexity through the Systems-Wide Water Resources Program (Ashby Undated) and other programs administered at the Corps Engineer Research and Development Center. The Corps Hydrologic Engineer Center of the IWR has continued to expand and refine a large suite of watershed-based tools for project and regional planning (e.g., IWR-HEC 2008). Efforts may be further enhanced by a more systematic and complete conceptualization of the methods and models needed to manage the issues now complicating the achievement of environmental sustainability. For project planning purposes, these tools need to complement and be integrated with models used in shared vision planning (Cardwell et al. 2009).

The planning tool needs are challenging, and the R & D budget is too limited to address them well. Like the agency as a whole, complex R & D requires collaboration across program areas with different strengths. Limited funding has predictably led to budgetary competition that threatens collaboration and cost effective R & D. Too much of the limited budget may be too closely tied to traditional project-focused needs. These issues may be addressed through two coordinated strategies. The first strategy would focus programmatic R & D funding on model prototype development through strong program leadership at Corps headquarters, which is coordinated with (but independent of) the research arms. The second strategy would develop planning guidance that requires full life-cycle analysis of costs and benefits at the needed system scale and technical guidance for the standards that must be met in planning models up to the task. The development costs for calibrating and refining prototypes for specific regional conditions will be included in project planning costs. Such modeling is expensive but necessary. The program fraction spent on model development will most likely need to increase.

Framework Organization

The issues are organized in Figure 4 to reflect the degree their management is likely to support the management of other issues. A clear statement of Civil Works Program objective for

environmental sustainability is a logical starting point for managing all issues that presently impede the achievement of environmental sustainability in both the Corps water resources management footprint and new activities. Identifying the program objective for achieving environmental sustainability is prerequisite to developing specific program approaches to objective achievement, an inventory of achievement performance indicators, a vision of a desired future condition and inclusion of effective strategies in the Civil Works Strategic Plan. As they are managed, feedbacks from issues lower in the chain not only support a continuous process of refinement and adaptation, but also aid management of difficult issues higher in the framework. For that reason, many of the arrows in Figure 4 point both directions.

The management issues are best approached concurrently, but with more effort placed at the higher levels until they are conceptually well addressed. In general, the core issues require earlier attention than the peripheral issues. However, conceptual development of approaches to managing the five core issues may be helped by concurrent development of management concepts for the six peripheral issues. For example, recent metric development for ecosystem restoration benefits (Cole 2010, 2014c, f) required reassessment of Corps planning objectives for ecosystem restoration projects, which contributed to a proposed environmental sustainability objective for the Civil Works Program. Metric concept improvement could also contribute to a plan for better integrating policy guidance for more effective achievement of environmental sustainability. Those actions in turn contribute to shaping an improved project-life cycle management process from planning to rehabilitation or decommissioning and restoration.

The determination of an environmental sustainability objective is a compass for guiding other issue management activities. The objective is the benchmark for an adaptive management process. Any plans for inventorying environmental conditions and establishing visions for success need to be informed by the clear statement of objectives and the adaptive management process that applies to all stages of each project life cycle. A conceptual basis for collaboration guidance may not be essential for the inventory, but it would most likely increase planning efficiency and effectiveness as well as the development of the management process and visions for success. Collectively all of the issues management actions contribute to the development of strategies for achieving environmental sustainability, which in turn feed back to influence further refinements in the conceptual framework. The process is continuously refined as is the implementation guidance influenced by the framework concepts.

Among the advantages of concurrent development of issues management concepts, regardless of position within the framework, is the capacity to evaluate the issues and their management in the context of the management system. A more concurrent and interactive development of the eleven issues discussed in this framework provides opportunities for testing each for relationships and consistency. For example, specifying a program objective at the same time metrics are developed for objective measurement could reinforce the specification of a clearly stated objective and appropriate metrics.

The framework provides an organized context for the most effective use of opportunities as they arise. While the relative emphasis placed on issues in the framework proposed here is believed to be most efficient, uncontrolled events often favor addressing issues as opportunities arise. This

may result in a less efficient, but ultimately more effective process as long as the entire framework is kept in mind as the management of each issue is considered.

The concepts for each of the issues management actions indicated in the framework need to be thoroughly addressed. In some instances, a single conceptual paper may be sufficient, but most issues are complex enough to benefit from different points of view. Attention to the issues has varied greatly, however. The metric issue for ecosystem restoration, for example, has gained considerable attention in recent years while the objective for environmental sustainability and its measurement has yet to be addressed directly in any published work.

Framework Limits and Assumptions

This framework is limited to the issues that pertain to striving for the achievement of environmental sustainability in the project footprint of the Civil Works Program. While sustainable development and related concepts of sustainability are addressed in the process of defining terms and objectives appropriate for this framework development, the framework itself does not address achievement of economic or social goals. The assumption made here is that environmental sustainability is a condition that is to be fostered regardless of the economic and social welfare that may or may not result from Corps activities.

Many issues must be taken into account in practice. The more important of these, described above, include: defining and objectifying environmental sustainability, measuring objective achievement, characterizing tools that support objective achievement, improving policy to focus more on objective achievement, developing inventories of conditions now inconsistent with objective achievement, developing visions of conditions that would satisfy objective achievement, developing concepts of program planning for objective achievement, integrating objective achievement into adaptive integrated water resources management, and integrating strategies for achievement into the Civil Works strategic planning process.

The fundamental aims of the EOP and the environmentally relevant goals of the Civil Works Strategic Plan are assumed in this analysis to hold well into the future. This does not mean that specific statements of program goals and objectives will not change as public, congressional and administration priorities change, and Corps approaches to program management change. Nor does it mean that the presently authorized functions of water resources management have to remain specifically with the Corps. Worthy goals are likely to outlive specific statements of national objective and agency assignments of authority.

Lastly, although there may be a number of alternative conceptual approaches to managing the issues, some are more organizationally efficient to implement than others. Screened-out alternatives include those that are generally 1) illegal, 2) obviously inconsistent with basic tenets of Civil Works policy, 3) technically infeasible, and 4) economically infeasible. The Corps of course must work within its authority and comply with all laws. Priority is given to policy conservative approaches, which require the least amount of policy modification.

Although investment in promising new techniques is not only justified but imperative, there is little to be gained from approaches that require techniques beyond reach of near-future development or techniques so complicated they are not practical in the Civil Works context. Cost is always an underlying consideration, but stifles problem management if it is allowed to dominate the Corps approach to achieving sustainability. Determining when costs may be excessive is the most subjective consideration. Given recent Corps history, the program budget allocated by Congress in the future is not likely to consistently exceed the annual inflation-adjusted budget of about \$5 to \$5.5 billion experienced in recent years. A practical approach is consistent with funding levels in existing budget categories, at least in the near term.

This framework is one approach to important issues that impede achievement of environmental sustainability in the Civil Works Program of the Corps. These issues and their management are interrelated and can be approached in various ways; not necessarily in the order described here. In fact, flexibility that takes advantage of opportunities as they occur is desirable. No single issue should impede development of management approaches to other issues.

SUMMARY POINTS

1. The Corps of Engineers has declared its commitment to fostering sustainable development, including achievement of environmental sustainability in its EOP. Achieving environmental sustainability within the environmental footprint of the Corps is unlikely without management of numerous issues that impede progress.
2. Whereas some understanding of these issues has come about in recent years, the Corps has yet to examine them with an eye toward systematic management. That must start with extensive development of issue management concepts and strategies, followed by explicit guidance.
3. More complete development of each of the issue management concepts introduced here is a necessary precursor to more effective development of implementation guidance. A systematic approach is promoted, addressing all of the management issues concurrently, while emphasizing management of that one issue which appears to be most limiting the rate of objective achievement.
4. The eleven management issues and their respective conceptual bases for action are broken into two broad groups. The “core” group is composed of five interrelated management issues. The second group is made up of six issues that require management for more effective management of the core issues.
5. Five core actions include development of:
 - An environmental sustainability objective or objectives to guide goal achievement
 - A systematic and adaptive project life-cycle management process
 - A framework for inventorying the status of sustainability in the Corps environmental footprint

- A program-wide vision of success in achieving environmental resource sustainability in the Corps environmental footprint
 - Strategies for objective achievement and for contribution to the Civil Works Strategic Plan and to implementation guidance
6. Three actions that support integration include development of:
 - Metrics for indicating objective achievement at project and program levels
 - An analysis of and recommendations for integrating environmental sustainability consistently throughout Civil Works policy guidance
 - A conceptual framework for organizing more effective collaboration through integrated resource management
 7. Three other actions support systems-context planning through development of:
 - A conceptual approach to multi-activity, regional- scale assessment of conditions influencing environmental sustainability
 - A conceptual approach to systemic and systematic, project life-cycle planning.
 - New models and other planning tools that provide the systems-wide dimensions needed for complex comprehensive planning
 8. The 11 issues management actions are systemically interrelated and optimally developed simultaneously with comprehensive consideration of the total framework, but an opportunistic approach is more realistic and nearly as effective when considered in the framework context.
 9. The framework addresses achievement of environmental sustainability alone. Economic and social sustainability are equally important aspects of sustainable development and many of the issues raised here may apply to them as well.

REFERENCES

- Adaptive Management Product Delivery Team. 2011. *Summary of existing adaptive management authorities, policies and applications*. Draft Report, Civil Works Technical Series, Washington, DC: U. S. Army Corps of Engineers.
- Ashby, S. L. No Date. *Systems-wide water resources program*. Vicksburg, VA: Engineer Research and Development Center. U. S. Army Corps of Engineers.
<http://el.erdc.USACE.army.mil/factsheets/swwrp.pdf>
- Barr, K., T. Barnes, S. Bartell, M. Cook, C. Fischenich, E. Kurzback, A. LoShiavo, R. Thomas, and B. Thompson. 2011. *Adaptive management technical guide*. USACE Campaign Plan Goal 2: Systems Approach (Draft Report). Washington, D. C.: U. S. Army Corps of Engineers.
- Bostick, T. P. 2012. *Reissuance of the U. S. Army Corps of Engineers (Corps) Environmental Operating Principles*. Memorandum CECW-CP. Washington DC: U. S. Army Corps of Engineers
- Brekke, L. D, J. E. Kiang, J. R. Olsen, R. S. Pulwarty, D. A. Raff, D. P. Turnipseed, R. S. Webb, and K. D. White. 2009. *Climate Change and water resources management: A federal perspective*. United States Geological Survey Circular 1331. Reston, VA: U. S. Geological Survey.
- Bryson, J. M. 1995. *Strategic planning for public and nonprofit organizations: A guide to strengthening and sustaining organizational achievement*. Revised Edition. San Francisco, CA: Jossey-Bass Publishers.
- Caldwell, L. K. 1998. *The National Environmental Policy Act: An agenda for the future*. Bloomington, IN: Indiana University Press.
- Cardwell, H., R. Cole, L. Cartwright, and L. Martin. 2006. Integrated Water Resources Management: Definitions and Conceptual Musings. In *Integrated Water Resources Management: New Governance, Tools, and Challenges—Selected International Perspectives*, ed., B. Hooper, 8-17. Issue 135, Journal of Contemporary Water Research & Education.
- Cardwell, H., S. Langsdale, and K. Stephenson. 2009. *The shared vision planning primer: How to incorporate computer aided dispute resolution in water resources planning*. IWR Report 2008-R-02. Alexandria Va: Institute for Water Resources, U. S. Army Corps of Engineers.
- CEQ (Council on Environmental Quality). 1997. *Considering cumulative effects under NEPA*. Washington, DC: Council on Environmental Quality.
- CEQ (Center for Environmental Quality). 2014. *Updated principles and requirements for water and land related resources implementation studies*. Washington DC: White House
<https://www.whitehouse.gov/administration/eop/ceq/initiatives/PandG>
- Chaplin, S. J., R. A. Gerrard, H. M. Watson, L. L. Master, and S. R. Flack. 2000. The geography of imperilment. In *Precious heritage: The status of biodiversity in the United States*, eds. B. A. Stein, L. S. Kutner, and J. S. Adams, 159-199. Washington, DC: The Nature Conservancy and Association for Biodiversity Information.

Coates, J. F., V. T. Coates, J. Jarratt, and L. Heinz. 1986. *Issues management: How you can plan, organize and manage for the future*. Mt. Airy, MD: Lomond Publications, Inc.

Cole, R. A. 2009. *The sustainability of freshwater biodiversity and water resources development policy of the Army Corps of Engineers*. IWR Report 09-12-9. Alexandria, VA: Institute for Water Resources, U. S. Army Corps of Engineers.

Cole, R. A. 2010. *A new nonmonetary metric for indicating environmental benefits from ecosystem restoration projects of the U. S. Army Corps of Engineers*. ERDC/EL TR-10-12. Vicksburg, MS: Engineer Research and Development Center, U. S. Army Corps of Engineers.

Cole, R. A. 2014a. *Measuring environmental value in nonmonetary terms: A review of common practices and elements*. ERDC/EL CR-14-1. Vicksburg, VA: Engineer Research and Development Center, U. S. Army Corps of Engineers.

Cole, R. A. 2014b. *The Biodiversity Security Index: A new metric for benefits from USACE ecosystem restoration projects*. Draft Technical Report. Vicksburg, VA: Engineer Research and Development Center, U. S. Army Corps of Engineers

Cole, R. A. 2014c. *Trends and outlook for the ecosystem restoration purpose of the USACE Civil Works Program*. IWR Report 14-R-03. Washington, DC: Institute for Water Resources, U. S. Army Corps of Engineers.

Cole, R. A. 2014d. *Adapting to climate change: Risk-informed ecosystem restoration planning for decision making in a changing environment*. Draft IWR Report. Alexandria, VA: Institute for Water Resources, U. S. Army Corps of Engineers.

Cole, R. A. 2014e. *Concept acceptability of non-monetary environmental benefits metrics for ecosystem restoration projects planned by the U. S. Army Corps of Engineers*. Draft Technical Report. Vicksburg, MS: Engineer Research and Development Center, U. S. Army Corps of Engineers.

Cole, R. A. 2014f. *Case study application of the Biodiversity Security Index to ranking feasibility studies for ecosystem restoration projects of the U.S. Army Corps of Engineers*. Draft Technical Report. Vicksburg, MS: Engineer Research and Development Center, U. S. Army Corps of Engineers.

Cole, R. A., T. J. Feather and J. D. Muncy 2005. Watershed planning and management in the United States. In *Economics and ecological risk assessment*, eds. R. J. F. Bruins and M. T. Heberling, 11-42. Boca Raton, FL: CRC Press

Cole, R. A., F. A. Appelfeller, K. D. White, D. A. Warnock, S. E. Durden, J. C. Laufle, and S. L. Ferguson. 2014a. *Recommended sustainability definition and principles for the U. S. Army Corps of Engineers*. CP2A10-Draft Report, Washington, DC: U. S. Army Corps of Engineers

Cole, R. A., D. A. Warnock, F. A. Appelfeller, and K. D. White. 2014b. *Evolution of sustainability concepts and definitions*. CP2A10—Draft Report, Washington DC: U. S. Army Corps of Engineers.

Cole, R. A., M. A. Haynes, E. A. Vuxton, P. F. Wagner, and J. A. Cushing. 2014c. *Participation of the U. S. Army Corps of Engineers Civil Works Program in Landscape Conservation Cooperatives*. IWR White Paper (Draft). Alexandria, VA: Institute for Water Resources, U. S. Army Corps of Engineers

- Creighton, J. L. 2010. *How to conduct a shared vision planning process*. IWR Report 10-R-6. Alexandria VA: Institute for Water Resources, U. S. Army Corps of Engineers
- Creighton, J. L., and S. Langsdale. 2009. *Analysis of process issues in shared vision planning cases*. IWR Report 09-R-5. Alexandria VA: Institute for Water Resources, U. S. Army Corps of Engineers
- Daily, G.C. 1997. *Nature's services*. Washington, DC: Island Press.
- Edwards, A. R. 2005. *The sustainability revolution*. Gabriola Island, BC: New Society Publishers.
- Edwards, C. Cutting the Army Corps of Engineers. *In Downsizing the Federal Government*. <http://www.downsizinggovernment.org/usace%20>
- Franklin, J.F. 1997. Ecosystem management: An overview. In *Ecosystem management: Applications for sustainable forest and wildlife resources*, eds. M.S. Boyce and A. Haney, 21-53. New Haven, CT: Yale University Press
- Goodland R. 1995. The Concept of Environmental Sustainability. *Annual Review of Ecology and Systematics* 26: 1-24
- Goodland, R. and H. Daly. 1996. Environmental sustainability: Universal and non-negotiable. *Ecological Applications* 6: 1002-1017.
- Goodland, R. 1996. Environmental sustainability challenge for the hydro industry. *International Journal on Hydropower & Dams* 3: 37-42.
- Grunwald, M. 2007. Reining in the Corps of Engineers. *Time Magazine*: September 20, 2007.
- Hobbs, R.J., E. S. Higgs, and C. M. Hall, eds. 2013. *Novel ecosystems: Intervening in the new ecological world order*. Hoboken, NJ: John Wiley & Sons, Ltd.
- Heath, R. L. and M. J. Palenchar, eds. 2008. *Strategic Issues Management: Organizations and Public Policy Challenges*. Second Edition. Thousand Oaks, CA: Sage Publications, Inc.
- Holling, C. S., ed. 1978. *Adaptive Environmental Assessment and Management*. New York, NY: John Wiley and Sons.
- IWR-HEC (Institute for Water Resources-Hydraulic Engineering Laboratory). 2008. *HEC-WAT: Watershed analysis tool user manual. Beta Version 1.0*. Davis, CA: Hydraulic Engineering Laboratory, Institute for Water Resources, U. S. Army Corps of Engineers
- Leopold, A. 1966. *A Sand County Almanac with Other Essays on Conservation from Round River*. New York: Oxford University Press
- Lubchenco, J., A. M. Olson, L. B. Brubaker, S. R. Carpenter, M. M. Holland, S. P. Hubbell, S. A. Levin, J. A. Macmahon, P. A. Matson, J. M. Melillo, H. A. Mooney, C. H. Peterson, H. R. Pulliam, L. A. Real, P. J. Regal and P. G. Risser. 1991. The sustainable biosphere initiative: an ecological research agenda. *Ecology* 72: 371-412.

- McQuaid, J. 2007. Broken: The Army Corps of Engineers. *Mother Jones*: August 26, 2007
- Martin, L. R. and G. Z. Stakhiv. 1999. *Sustainable development: Concepts, goals and relevance to the Civil Works Program*. IWR Report 99-PS-1. Alexandria, VA: Institute for Water Resources, United States Army Corps of Engineers.
- NAPA (National Academy of Public Administration). 2007. *Prioritizing America's Water Resources Investments: Budget Reform for the Civil Works Construction Projects at the U. S. Army Corps of Engineers*. Washington, DC: National Academy of Public Administration.
- NRC (National Research Council) 1999a. *New Directions in Water Resources Planning for the U. S. Army Corps of Engineers*. Washington, DC: National Academy Press.
- NRC (National Research Council) 1999b. *Our Common Journey: A Transition toward Sustainability*. Washington DC: National Academy Press.
- NRC (National Research Council) 1999c. *Compensation for Wetland Losses under the Clean Water Act*. Washington DC: National Academy Press.
- NRC (National Research Council) 2000. *Ecological Indicators for the Nation*. Washington DC: National Academy Press.
- NRC (National Research Council) 2004a. *Adaptive Management for Water Resources Planning*. Washington DC: National Academy Press.
- NRC (National Research Council) 2004b. *River Basins and Coastal Systems Planning Within the U. S. Army Corps of Engineers*. Washington DC: National Academy Press.
- NRC (National Research Council) 2004c. *U. S. Army Corps of Engineers Resources Planning: A New Opportunity for Service*. Washington DC: National Academy Press.
- NRC (National Research Council) 2005. *Valuing Ecosystem Services: Toward Better Environmental Decision Making*. Washington, DC: National Academy Press.
- NWFTCS (National Wildlife Federation and Taxpayers for Common Sense) 2004. *Crossroads: Congress, the Corps of Engineers and the future of America's water resources*. Washington, DC: National Wildlife Federation.
- Olsen, R. J., E. L. Rooks, B. Harper, M. T. Placht, J. A. Cushing, and D. A. Moser. 2013. *Risk-informed decision making in a changing climate*. Draft IWR Report. Alexandria, VA: Institute for Water Resources, U. S. Army Corps of Engineers.
- Parry, M. L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, eds. 2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK
- Scott, J. M., D. D. Goble, L. K. Svancara, and A. Pidgorna. 2006. By the numbers. Pages 16-35 *In* D. D. Goble, J. M. Scott, and F. W. Davis. Editors. *The Endangered Species Act at thirty: Renewing the conservation promise*. Volume 1. Island Press, Washington, DC

Stakhiv, E., R. Cole, P. Scodari, L. Martin. 2003. *Improvements in environmental benefits analysis*. IWR Report 03-PS-3. Alexandria, VA: Institute for Water Resources, U. S. Army Corps of Engineers

Thomas, C.D., A. Cameron, R. E. Green, M. Bakkenes, L. J. Beaumont, Y. C. Collingham B. F. N, Erasmus, M. F. D. Siqueira, A. Grainger, and L. Hannah. 2004. Extinction risk from climate change. *Nature* 427:145–148.

The Heinz Center. 2008. *The State of the Nation's ecosystems 2008: Measuring the Lands, Waters and Living Resources of the United States*. Washington DC: Island Press.

TPCSD (The President's Council on Sustainable Development). 1996. *Sustainable America: A new consensus*. Superintendent of Documents, Washington DC.

Traill, L.W., B. W. Brook, R. R. Frankham, and C. J. A. Bradshaw. 2010. Pragmatic population viability targets in a rapidly changing world. *Biological Conservation* 143:28-34

United Nations. 1992. Annex 1. *Rio declaration on the environment and development*. Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992

USACE (US Army Corps of Engineers). 2000. *Planning Guidance Notebook*. Regulation No. 1105-2-100GN. <http://140.194.76.129/publications/eng-regs/er1105-2-100/toc.htm>

USACE (US Army Corps of Engineers). 2003a. *EOP regulations: Policy for implementation and integrated application of the U. S. Army Corps of Engineers (USACE) Environmental Operating Principles (EOP) and doctrine*. ER 200-1-5. Washington, DC: U.S. Army Corps of Engineers

USACE (US Army Corps of Engineers). 2003b. *Program management plan for integrating the Environmental Operating Principles within HQUSACE*. FINAL EOP PgMP, Version 4.6. USACE, Washington, DC: U. S. Army Corps of Engineers.
<http://www.hq.USACE.army.mil/CEPA/7%20Environ%20Prin%20web%20site/eoppgmp.pdf>

USACE (U. S. Army Corps of Engineers). 2004. *Department of the Army Corps of Engineers Civil Works Strategic Plan: Fiscal Year 2004 – Fiscal Year 2009*. Washington, DC: U. S. Army Corps of Engineers, http://www.USACE.army.mil/cw/hot_topics/ht_2004/cw_strat.pdf

USACE (US Army Corps of Engineers). 2005. *Weekly focus: USACE Campaign Goal #2- Develop Sound Water Resources Solutions*. Corps Points! 13 July 2005. Washington DC: USACE Public Affairs Office,

USACE (US Army Corps of Engineers). 2006. *U.S. Army Corps of Engineers releases its "12 Actions for Change"*. Press Release. Washington DC: U. S. Army Corps of Engineers.
<http://pnwa.net/new/articles/12%20Actions%20for%20Change.pdf>

USACE (U. S. Army Corps of Engineers). 2009a. *Sustainable solutions to America's water resources needs: Department of the Army Corps of Engineers Civil Works Strategic Plan 2010-2014*. Version 4. Washington, DC: U. S. Army Corps of Engineers.

USACE (U. S. Army Corps of Engineers). 2009b. *Campaign Plan of the US Army Corps of Engineers*. Washington DC: U. S. Army Corps of Engineers.

<http://www.USACE.army.mil/about/Documents/USACE%20Campaign%20Plan%20March%202009.pdf>

USACE (U. S. Army Corps of Engineers). 2010. *Army programs—Corps of Engineers civil works direct program, program development guidance FY 2012*. Engineer Circular 11-2-199. Department of the Army, U. S. Army Corps of Engineers, Washington, DC.

USACE (U. S. Army Corps of Engineers). 2014. *Civil Works Strategic Plan: Sustainable solutions to America's water resources needs: Department of the Army Corps of Engineers Civil Works Strategic Plan 2014-2018*. Version 4. Washington, DC: U. S. Army Corps of Engineers.

USACE (U. S. Army Corps of Engineers). Undated. *Environmental Operating Principles. Headquarters Internet Announcement of re-energized principles*:

<http://www.usace.army.mil/Missions/Environmental/EnvironmentalOperatingPrinciples.aspx>

USFWS (U. S. Fish and Wildlife Service) 1980. *Habitat evaluation procedures (HEP)*. ESM 102. Division of Ecological Sciences. Washington, D.C: Fish and Wildlife Service, U. S. Department of Interior

USFWS (U. S. Fish and Wildlife Service) 1981. *Standards for the development of Habitat Suitability Index models*. ESM103. Division of Ecological Sciences. Washington, D.C: Fish and Wildlife Service, U. S. Department of Interior

Walters, C. 1986. *Adaptive Management of Renewable Resources*. New York, NY: Macmillan.

Walters, C. J., and C.S. Holling. 1990. Large-scale management experiments and learning by doing. *Ecology* 71: 2060-2068.

WCED (World Commission on Environment and Development). 1987. *Our Common Future*. Oxford, England: The Oxford University Press.

Wondolleck, J. M., and S. L. Yaffee. 2000. *Making Collaboration Work: Lessons in Innovation in Natural Resource Management*. Washington DC: Island Press

WRC (Water Resources Council). 1983. *Economic and environmental principles and guidelines for water and related resources implementation studies*. Washington, DC: U. S. Army Corps of Engineers.

http://www.USACE.army.mil/cw/cecw-cp/library/Principles_Guidelines.pdf



Institute for Water Resources

The Institute for Water Resources (IWR) is a U.S. Army Corps of Engineers (USACE) Field Operating Activity located within the Washington DC National Capital Region (NCR), in Alexandria, Virginia and with satellite centers in New Orleans, LA; Davis, CA; Denver, CO; and Pittsburgh, PA. IWR was created in 1969 to analyze and anticipate changing water resources management conditions, and to develop planning methods and analytical tools to address economic, social, institutional, and environmental needs in water resources planning and policy. Since its inception, IWR has been a leader in the development of strategies and tools for planning and executing the USACE water resources planning and water management programs.

IWR strives to improve the performance of the USACE water resources program by examining water resources problems and offering practical solutions through a wide variety of technology transfer mechanisms. In addition to hosting and leading USACE participation in national forums, these include the production of white papers, reports, workshops, training courses, guidance and manuals of practice; the development of new planning, socio-economic, and risk-based decision-support methodologies, improved hydrologic engineering methods and software tools; and the management of national waterborne commerce statistics and other Civil Works information systems. IWR serves as the USACE expertise center for integrated water resources planning and management; hydrologic engineering; collaborative planning and environmental conflict resolution; and waterborne commerce data and marine transportation systems.

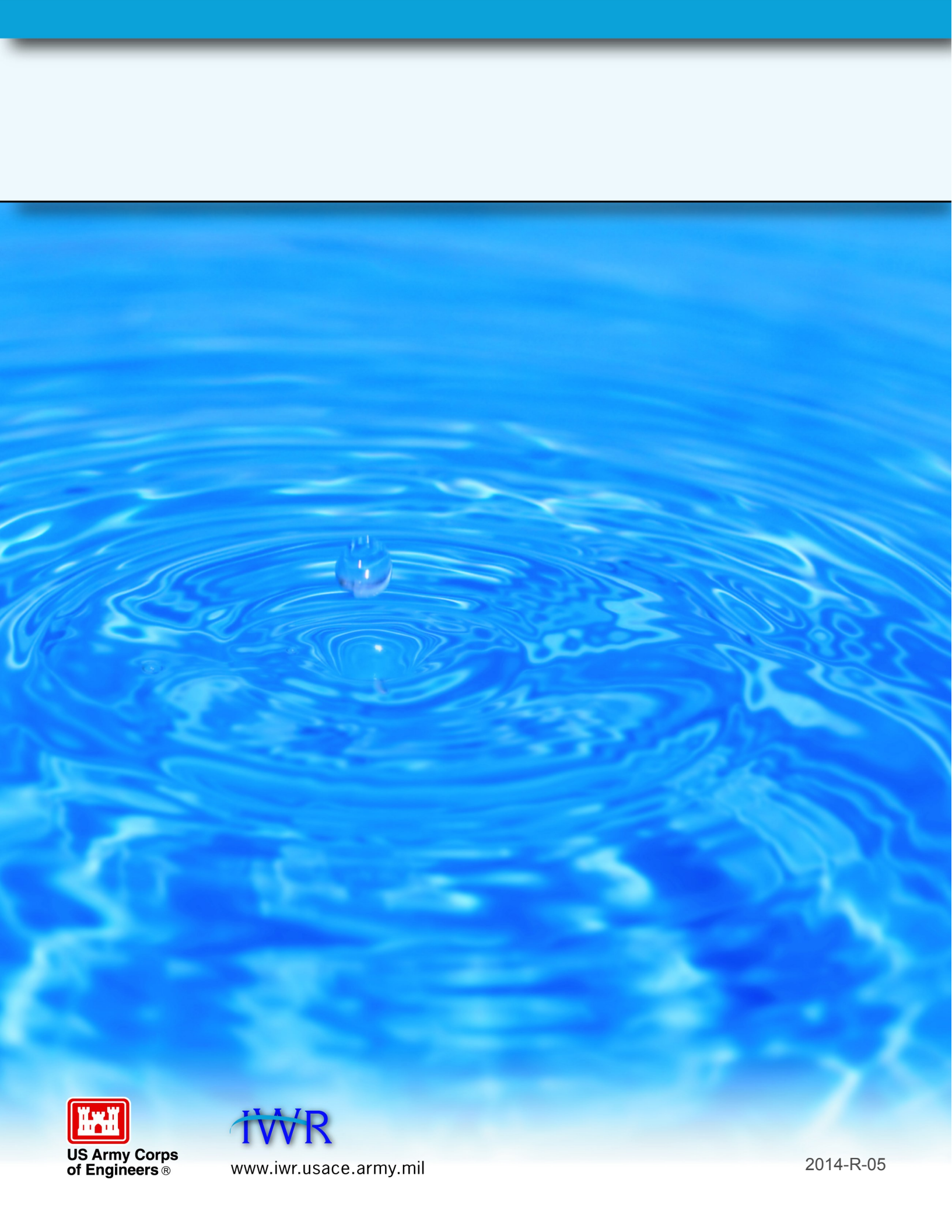
The Institute's Hydrologic Engineering Center (HEC), located in Davis, CA specializes in the development, documentation, training, and application of hydrologic engineering and hydrologic models. IWR's Navigation and Civil Works Decision Support Center (NDC) and its Waterborne Commerce Statistical Center (WCSC) in New Orleans, LA, is the Corps data collection organization for waterborne commerce, vessel characteristics, port facilities, dredging information, and information on navigation locks. IWR's Risk Management center is a center of expertise whose mission is to manage and assess risks for dams and levee systems across USACE, to support dam and levee safety activities throughout USACE, and to develop policies, methods, tools, and systems to enhance those activities.

Other enterprise centers at the Institute's NCR office include the International Center for Integrated Water Resources Management (ICIWaRM), under the auspices of UNESCO, which is a distributed, intergovernmental center established in partnership with various Universities and non-Government organizations; and the Conflict Resolution and Public Participation Center of Expertise, which includes a focus on both the processes associated with conflict resolution and the integration of public participation techniques with decision support and technical modeling. The Institute plays a prominent role within a number of the USACE technical Communities of Practice (CoP), including the Economics CoP. The Corps Chief Economist is resident at the Institute, along with a critical mass of economists, sociologists and geographers specializing in water and natural resources investment decision support analysis and multi-criteria tradeoff techniques.

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