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# Position Paper on an Improved Planning Process for Water Resources Infrastructure

## Comprehensive Vision Based Planning (CVBP)

International Commission on Large Dams
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# Abstract

The purpose of this paper is to summarize the existing planning process for water resources projects and to highlight the areas that need improvement for the future. It addresses the value of integrated water resources management in the planning for water resources projects. Finally, it recommends a new planning process as the best way forward for new and future water resources projects

Water is a vital resource to sustain civilization and other forms of life on earth. It is the essential element for growth and development as well as the basic requirement for the health of the world's environment. Unfortunately, water is not evenly distributed by season and location.

Today there are many demands for the world's water resources. The demand for domestic water supply will increase significantly between 2009 and 2025 when the population is projected to grow by an additional 3 billion people. The worldwide demands for irrigation, hydropower, flood control and navigation will also increase during this same period. As a consequence, water resources projects will be most critical to both human survival and development. We must remember that our water is a shared resource with shared responsibility. To meet the anticipated need for water, the goal is to provide dependable, reliable and sustainable infrastructure. Sustainable development is a fundamental component of social responsibility, sound business practice and natural resource management and implies economic growth together with protection of environmental quality.

Planning for these new water resources projects will be on the critical path for future worldwide development. To be more effective, the planning process for water resources development must offer a creative, structured and rational approach that addresses and solves the water resource needs. In meeting the challenges for water in the 21$^{st}$ century, ICOLD first reviewed the existing six step planning process which is currently being used throughout the world and subsequently developed a more systematic and holistic approach by applying more comprehensive planning in the watershed and by taking advantage of integrated water resources management.

This paper presents a new and improved planning process for water resources projects that is more comprehensive, transparent and is based on a vision for future sustainable water resources development. This new eight step approach known as "Comprehensive Vision Based Planning" (CVBP) has been established to set the stage for and drive implementation of sustainable water resources projects. It is based on the strategic plan for water resources, regional visions and the watershed goals. To ensure transparency, it includes stakeholder participation and public involvement. It also incorporates both demand-side planning and the traditional supply-side planning. It also integrates a significantly greater level of engineering and cost estimating to ensure that realistic alternatives are developed with accurate and reliable cost estimates. This paper includes input from the World Wide Fund for Nature (WWF), The Nature Conservancy (TNC) and the International Hydropower Association (IHA).

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# Executive Summary

The purpose of this paper is to address several points in the planning process for water resources projects. It summarizes the existing planning process for water resources projects, highlights areas that need to be improved relative to the overall strategy, recommends improvements and enhancements and finally presents a new eight step planning process.

Unquestionably, water is a vital resource to sustain civilization and other forms of life on earth. It is the essential element for growth and development as well as the basic requirement for the health of the world's environment. Unfortunately, water is not evenly distributed by season and location. Moreover, recent impacts of climate change have added to the uneven distribution of water. Adding to this imbalance between water and availability and its needs is careless use and contamination of what water that is available. Tragically, in some regions of the world, life is threatened by the imbalance between the demands and available supplies of water and food. At the same time, history shows us that dams and reservoirs have been used successfully in collecting, storing and managing water needed to sustain civilization for five centuries. As we look to the future, we must be wise to learn and benefit from the past experiences.

The demand for water and therefore more sustainable water resources projects will increase dramatically between 2009 and 2025 in response to a projected worldwide increase of 3 billion more people. Worldwide demand for irrigation, energy, flood control and navigation will also increase during this same period. Most of the predicted growth in population will occur in the developing countries – where the need for water is the greatest and the current supply is limited.

Currently much of the world's planning for water resources projects is being accomplished by a six step process that is conducted on a project by project basis or for several projects in a limited geographic area. The primary focus is on the traditional project purposes of water supply, irrigation, navigation, flood control, hydropower and recreation and the benefit determinations have typically been made on a limited geographical area. In general, the public is briefed at the beginning of the study and then again once the results of the study have been completed. Since water supply is a major issue, focus has only been on the traditional supply-side planning, in other words providing an adequate supply to meet the rising or projected demand and demand side evaluations have not been included.

In the past, mitigation of environmental impacts was not always included and when it was, the costs were usually not very accurate. In addition, during the development of the alternatives, the cost estimates for each alternative were not sufficiently detailed to represent their realistic and accurate costs. As a consequence, the benefit cost analysis of the selected alternative was not accurate. Together, all of this has lead to significant cost increases for the selected alternative during the final design, construction and operation.

In looking to the future, it is clear that the world will need more sustainable water resources projects in order to meet the water needs of an ever expanding population. With respect to nation building, dams and reservoirs are the realistic alternative for providing dependable and reliable sources of water. Based on lessons learned in the past, the International Commission on Large Dams (ICOLD) therefore seeks to advance and significantly improve the traditional planning process for water resources projects. A more comprehensive approach to the planning process that incorporates significantly more interdisciplinary engineering, cost estimating, stakeholder and public involvement, the regional visions and the watershed goals will produce more realistic, cost effective and sustainable projects. Moreover, if the planning process that is based on the concept of integrated water resources management (IWRM), it will produce more comprehensive and realistic solutions.

This new and recommended eight step planning process "Comprehensive Vision Based Planning" (CVBP) for water resources projects presented in this paper is the best road forward. It consists of an interdisciplinary team of experienced professionals from natural, social, economic and engineering disciplines. It is based on a holistic watershed approach and begins with the national economic development plan. It subsequently is refined by taking into consideration the regional visions and respective watershed goals. It also includes stakeholder and public participation. CVBP includes consideration of both demand side and supply side planning. In addition to traditional purposes for projects, CVBP addresses water quality, sedimentation, groundwater management, zoning and land use, critical habitat, maintaining the environment and climate assessments. It incorporates a team of experiences engineers to ensure that all alternatives are evaluated and that they are technically sound, efficient and economical. Because project costs are critical, the cost estimates for the alternatives should be prepared by experienced cost estimators on the engineering team. The cost estimates should be based on life cycle costs which include costs of operation and maintenance as well as monitoring project to ensure structural performance, efficiency and to ensure that the designated benefits are maintained in the future. The risk and uncertainty associated with the respective alternatives is considered and addressed in this process. CVBP's eight step process also addresses socio-economic issues such as resettlement and environmental health of the region. The end result is a more comprehensive, collaborative, realistic and wise planning process.

As we look to the future, it is essential that we must learn and benefit from the past experiences. ICOLD's intent is to ensure that all future water resources projects constructed around the world are adequate, economical, environmentally responsible and socially acceptable and that they are operated and maintained for sustained efficiency and reliability. This paper includes input from the World Wide Fund for Nature (WWF), The Nature Conservancy (TNC) and the International Hydropower Association (IHA). ICOLD encourages governments at all levels and private organizations responsible for water projects to rethink their approach to planning along the lines of CVBP for their future water resources development.

## 1. Background and Introduction

Water is a vital resource to sustain civilization and other forms of life on earth. It is the essential element for growth and development as well as the basic requirement for the health of the world's environment. Unfortunately, water is not evenly distributed by season and location. Moreover, recent impacts of climate change have added to the uneven distribution of water. Adding to this imbalance between water, its availability and the needs is careless use and contamination of what water is available. Tragically, in some regions of the world, life is threatened by the imbalance between the demands and available supplies of water and food.

Only a fixed amount of water exists on the earth. Of this fixed amount, only a small portion consists of fresh water and is available for domestic water supply, irrigation and industrial use. We receive new fresh water from precipitation or rainfall and only a small portion falls on our landmass. As a consequence, the need for careful management of our limited groundwater and the need to collect, store and manage water in reservoirs is of great importance.

There is no doubt that the availability of water in sufficient quantities and of adequate quality in the regions throughout the world continues to be a basic challenge for the future. Today, multipurpose dams and reservoirs that include all of the project purposes continue to be critical, essential infrastructure to provide the dependable and reliable sources of water in order to meet social, economic and environmental needs throughout the world. Fresh water for healthy ecosystems provides vital services to our society. Needless to say, water resources are a shared responsibility starting with communities, counties, states, provinces and in some cases countries. This highlights the need for a new and comprehensive planning process for sustainable water resources projects in the watershed.

The demand for water and therefore more sustainable water resources projects will increase dramatically between 2009 and 2025 as a result of the projected population growth of 3 billion more people. Most of this predicted growth in population will occur in the developing countries where the need for water is the greatest and the current supply is limited. There will also be a significant increase in the need for irrigation, energy, flood control and navigation. Therefore, the planning process for must ensure that these new projects must meet the requirements of sustainable development. Sustainable development is defined as "development that meets today's water needs without compromising the ability of future generations to meet their own needs". It requires the integration of three components – economic development, social development and environmental protection. The essence of this form of development is a stable relationship between human activities and the natural world; that allows future generations to enjoy a quality of life on a level at least as good as our own.

The planning process for this new water infrastructure will be on the critical path for future worldwide development and must be accomplished in a more comprehensive, efficient and transparent manner. Traditionally, the planning

process has been conducted on a project by project basis with the benefit determinations being made on a limited geographical area. Since water supply is the current international issue, the focus has been on the traditional supply-side planning, in other words providing an adequate supply to meet the rising or projected demand. However, in some cases it has been shown that it is possible to match supply and demand by managing the demand side of the equation. This has demonstrated by implementing initiatives such as water efficiency, land use and limiting groundwater withdrawals, a reduction in demand can be achieved. For this reason, it is important that any water resource planning take into account demand side management, as part of the overall solution. While meeting the worldwide need for water is critical, the development of other major purposes of projects such as flood control, hydropower, navigation, irrigation and recreation are very important for the future. For example, the potential for more frequent flooding and drought as a result of climate change must be given careful consideration.

In the past, mitigation of environmental impacts was not always included and when it was the costs were not accurate. Also, during the evaluation of developed alternatives, the cost estimates for each alternative were not sufficiently detailed to represent their costs realistically. This, in turn, has significantly impacted the benefit cost analysis of the selected alternative. Together, all of this has lead to significant cost increases for the selected alternative during the final design, construction and operation. Needless to say, in many cases the outcome was less than optimal.

In looking to the future, it is clear that the world will need the full range of sustainable water resources projects in order to meet the water needs of an ever expanding world population. Especially for nation building, dams and reservoirs are the most realistic alternative for providing the dependable and reliable sources of water. Based on lessons learned in the past, the International Commission on Large Dams (ICOLD) seeks to advance and significantly improve the traditional planning process for water resources projects. Undoubtedly, a more comprehensive approach to the planning process is needed. It should incorporate significantly more interdisciplinary engineering, cost estimating, stakeholder and public involvement and be based on a regional vision and the watershed goals and therefore will produce more realistic, cost effective and sustainable projects. Also, this new and recommended planning process should be take into account the principles and concept of integrated water resources management (IWRM).

The challenge of the future is to meet changing conditions and develop sustainable water resources projects to provide dependable and reliable water to meet the UN Millennium Development Goals and to support nation building in both rural and urban areas. The planning process for water resources projects is the initial and critical step for meeting this goal. To ensure sustainable water resources development in the future, all levels of government and the private water organizations should rethink their planning process and adopt the concept, principles and steps of CVBP.

## 2. Purpose

The purpose of this ICOLD position paper is as follows. First, to address the development and management of water resources using integrated water resources management (IWRM) in the watershed. Secondly, to highlight the need to improve the current process that will produce realistic and sustainable water resources projects with accurate cost estimates. Third, to summarize the current basic planning process that is being used on a worldwide basis for water resources projects. In recent years advances have been made in the technology for the design, construction, operation and maintenance of dams. In addition, suggestions have been made to improve the strategy for planning major water resources projects. It has become obvious that the planning process can be done better. Fourth, to discusses and presents improvements and enhancements that are needed to ensure that only realistic and more cost effective alternatives are evaluated. And finally, to present what ICOLD's recommended new strategy and process that includes initial guidance from and to the decision makers, input from all social, environmental and technical disciplines, collaboration with stakeholders and the public and an external review.

## 3. Integrated Water Resources Management in the Watershed (IWRM)

To fully understand the recommended planning process in this position paper, it is essential to have an understanding of the process and implementation of this integrated approach. IWRM is defined as a systematic process for the sustainable development, allocation, managing and monitoring of water resource use in the context of social, economic and environmental objectives.

The demand for water resources is under increasing pressure as a result of population growth, economic activity and intensified competition for the water among users. Water withdrawals have increased more than twice as fast as population growth and currently one third of the world's population lives in countries that experience medium to high water stress. The world pollution is contributing to water scarcity by reducing water usability downstream. There are shortcomings in the management of water in our watersheds. In some cases, the focus is only on developing new sources; rather than managing existing ones better. A top-down approach to water management results in uncoordinated development and management of the resource. More and more development means greater impacts on the environment. Current concerns about climate variability add to the demand improved management of water resources to ensure adequate storage capacity as well as other sources such as desalination and recycling cope with more intense floods and droughts.

To summarize, IWRM is the practice of making decisions and taking actions while considering multiple points of view on how to manage water. These decisions and actions include management of all of the purposes (water supply, irrigation, hydropower, navigation, flood control and recreation) in the water shed. It also

encompass river basin planning, planning of new growth and development, monitoring groundwater and soil moisture, monitoring environmental conditions, forecasting hydro-meteorological conditions, sediment management and the management of reservoir storage and releases. This approach produces dependable and reliable river flows in the watershed. The planning process for water resources projects should integrate new projects with the existing water resources network. Consideration should be given to the option of restoration and improvements to the existing projects as one of the alternatives.

In many developing countries, the governments consider water resources planning and management to be a central part of the government's responsibility. This view is consistent with the international consensus that promotes the concept of government as a facilitator and regulator, rather than an implementer of projects. The concept of IWRM has been accompanied by promotion of the river basin as the logical geographical unit and a River Basin Commission for its practical realization.

## 4. Fundamentals of the Planning Process for Water Resources Projects

The "planning process" is the creative, rational, deliberate and structured approach used to assist in the decision process for the evaluation of alternatives and the selection of o project to move forward with. Water resources planning helps decision-makers identify water resources problems, conceive solutions to them, and then evaluate and compare the alternatives. This includes the inevitable conflicting values inherent in any and all alternative. Planning is intrinsically an interdisciplinary process. Good planning involves the knowledge, skills and insights of professionals from many of the social, scientific, economic and engineering sciences.

In the past, planning was primarily accomplished by a team of planners and economists with limited input from engineering, current and future stakeholders and the public. The cost of the alternatives was not always accurate and realistic. The public was informed and became involved once an alternative was selected.

## 5. The Current Planning Process

Currently much of the world's planning for water resources projects is being accomplished on a project by project basis or among several projects in a limited geographic area. In general, the focus is on the traditional project purposes of water supply, irrigation, navigation, flood control, hydropower and recreation. The following six-step planning process that is now commonly used around the world for water resources development studies:

Step 1. Identify water resources problems and opportunities in the study area.
Step 2. Inventorying, collecting and forecasting conditions.
Step 3. Develop alternatives to solve the problems.

Step 4. Evaluate the effects of the alternatives.
Step 5. Compare alternatives.
Step 6. Select a plan for recommendation or decide to take no action at the present time. The alternative with the greatest net economic benefits consistent with the water shed goals and national environmental policy is normally selected.

Because this process can begin anywhere, it is an iterative process. That means some steps will be repeated several times. This assures that each step is completed at least once. More importantly, repeating steps is an effective way to expand on what has already been developed. In doing so, the problems and opportunities become well understood. Additional information may become available at any time in the process. Likewise, new ideas can arise at any time.

## 6. Needed Improvements Recognized by ICOLD

Following World War II, economic development throughout the world was accompanied by phenomenal construction of all types of infrastructure. The most significant period for dam construction in the developed countries of the world occurred between 1950 and 1980. Construction continues but on a lesser rate. As this economic development continued, the world population became aware of the price that was being paid for this development.

Today people of the world are looking for a balance between the project benefits and the environment for water resources projects. People are now asking for a holistic approach to watershed management. They are also asking that the environment social impacts be an equal goal with economic purposes. Water resources should be analyzed on a watershed level and that regional visions should be developed along with watershed goals. People understand that we need water projects; however, it must be realistic, reliable, cost effective and sustainable. There is a need for greater level of engineering and cost estimating effort in the planning process to ensure that only technically sound and cost effective alternatives are evaluated. The current planning process has a supply-driven focus. The best results are obtained when both demand-side and supply-side planning need to be considered and incorporated into the process. Improving efficiency of our existing water resources projects must also be addressed in the planning process. In the end, the size and location of new water resources projects should be based on wise and comprehensive planning. All of these highlight the need to improve the existing planning process.

### 6.1. The Need for a Strategic Plan for Water Resources Development

The successful implementation of a nation's water resources program should be based on a national and in some cases multi-national (in shared basins) strategic plans. This result of this approach is developing water resources projects consistent

with the national economic development plan, regional conditions along with the watershed goals and objectives. This approach will facilitate developing coordinated solutions with the potential to achieve sustainability for the economy, the environment and overall quality of life.

## 6.2. The Watershed Approach

The watershed or river basin is defined by hydrology and transcends national, local, political, social and economic boundaries making it the basic element for planning and management of water resources and the ecosystems. Watershed planning must include sound science as well as engineering. Sound scientific data, tools, and techniques are critical to be included in the process. Actions taken include characterizing and prioritizing the watershed problems and solutions, developing action plans and evaluating their effectiveness within the watershed.

## 6.3. A Nation's National Economic Development Plan, Regional Visions and Watershed Goals

To be effective in providing the desired benefits of water resources projects, the starting point for planning new projects needs to be the National Economic Development Plan. A nation's National Economic Development Plan is the strategy or roadmap to the future for sustainable economic growth and balanced regional development. It is also the basis for developing regional visions.

### 6.3.1. Regional Visions

A regional vision is what people want their communities to look like in the future and is therefore critical for planned growth, development and environmental conservation. This vision is developed by a team or group under political leadership with input from communities, businesses, coalitions and the public. Although the management of water and related resources based on a watershed perspective is not new, it has received renewed emphasis in engineering, science and policy. Since the late 1970's, there has been considerable emphasis on environmental quality and the integrated management approaches to watershed resources. This new focus on sustaining economic prosperity while preserving environmental quality requires management approaches that integrate human and natural systems. A watershed approach applies the physical, biological, social and economic sciences in problem solving for multiple needs and opportunities in a region and is essential to achieving this integration. A key to achieving long-lasting benefits in a watershed is the ability to pull together coalitions and councils working toward common aims in developing and implementing effective visions, goals and strategies. A regional vision will typically address population growth, economic development, land use, water and other resources, improved governance and public/private partnerships.

### 6.3.2. Watershed Goals

Watershed goals are developed from the nation's water policy and regional visions. They specify the goals, objectives and strategies to be implemented within the watershed. A strategic environmental assessment is recommended as part of developing the watershed goals. They characterize the current condition of the watershed, set the goals, identify the solutions, design implementation plans, set targets and establish management objectives. Watershed goals are developed by the leadership of River Basin Commissions or Watershed Advisory Groups with input from the public and private sector and include both short-term and long-term goals consistent with the regional vision for growth and development. Examples of watershed goals are:

- Meet domestic, agricultural and industrial water quantity requirements where appropriate
- Meet low flow, average flow and annual flushing flows
- Meet water quality standards
- Reduce flood levels
- Provide adequate fish passage
- Support and restore aquatic habitat
- Improve aesthetics of lakes and reservoirs
- Support recreation at lakes and reservoirs

It is important that adequate monitoring be accomplished to demonstrate and document the successful achievement of these watershed goals. If monitoring proves that these goals are not being achieved then some modification to the operation of the existing water projects or new water resources projects may be required in the future.

The goal is to establish the watershed as the functional planning and management unit for water resources. Therefore, it is important to facilitate collaboration between counties, states and sometimes different countries, especially when the river basin is located between two neighbor countries and a change derived from a new water resources projects proposed by one country can significantly affect the other one.

### 6.4. Expanding Water Resources Project Purposes and Mitigation of Impacts

Traditionally, the six step planning process, described in paragraph 6, has been performed on a project by project basis with benefit determinations made on a limited geographical area. The primary focus was on the basic purposes of large water resources projects:

- water supply
- irrigation
- navigation
- flood control
- hydropower
- recreation

To support watershed goals and to ensure maximum benefits and sustainability, the following additional factors and requirements must be added in the planning process:

- Water quality
- Sedimentation
- Groundwater management
- Land use
- Maintaining critical habitat and species
- Maintaining ecosystem health
- Climate assessment
- Sustaining river-dependent communities
- Alternative sources of water (desalination, recycled.etc.)

While dams provide significant benefits to our society, they can have impacts on the surrounding environment. Their performance can potentially cause serious environmental and social disruption if these are not accurately planned. This can have serious implications for downstream plant and animal communities, as well as human communities dependent upon the goods and services provided by properly functioning river ecosystems. The value of ecosystem services has also to be taken into consideration when estimating the costs. The mitigation of environmental and other impacts was not always included in the planning process and when they were, their costs were generally not accurate. These impacts, both upstream and downstream of the project, include:

- Resettlement and relocation
- Socioeconomic impacts
- Environmental impacts

### 6.5. The Appropriate Level of Engineering Effort and Cost Estimates for Identifying and Developing the Alternatives

Experienced engineers and cost estimators are key members of the planning team. These engineers and estimators must participate in assessing the potential alternatives to determine whether they will function safely, reliably, efficiently, and economically. Technical details and costs should be applied only to alternatives considered to have potential. In addition, team members should jointly assess whether potential alternatives adequately address environmental and social issues to determine whether the alternatives are practical. The engineering assessment shall be based on knowledge of standard analyses and operating experience, and on sound engineering judgment. Senior engineers should be involved to provide experienced judgment in the selection of alternatives. For very complex alternatives, appropriate outside specialists may be consulted for input and recommendations. Engineering members of the team must have input in the decision process for the final recommendation.

## 6.6. Risk and Uncertainty

The planner's primary role in dealing with risk and uncertainty is to identify the areas of uncertainty and their sensitivity and then describe them as clearly as possible. This will allow decisions to be made for the respective alternatives with the knowledge of the degree of reliability of the information. For example, many shortcomings in the planning for water projects in developing countries result from the planning being based on inadequate hydrological information and data. Areas of uncertainty that need to be addressed in the planning process are:

- Reliability of the hydrological records and data
- Natural variability of the precipitation
- Uncertainty associated with climate change
- Uncertainty in the projected demand
- Uncertainty in projected growth by rate and geographic area
- Uncertainty in the environmental impacts and the cost of mitigation
- Uncertainties in the geological conditions and the sites of the alternatives
- Uncertainty of the factors in developing accurate cost estimates.

## 7. The Recommended Approach - "Comprehensive Vision Based Planning" (CVBP)

In meeting the challenges for water in the 21$^{st}$ century, ICOLD's scientific and engineering efforts have been directed towards a systematic and holistic or watershed approach to both comprehensive planning and incorporation of integrated water resources management. It is essential that a strategic plan for water resources be established by the government. It integrates a significantly greater level of engineering and cost estimating to ensure that realistic alternatives are developed with accurate and reliable cost estimates. It incorporates input from regional visions and the watershed goals. It includes stakeholder participation and public involvement. This new approach known as "Comprehensive Vision Based Planning" (CVBP) will set the stage for and drive implementation and the design, construction and operation of sustainable water resources projects.

It is very important to ensure the thorough consideration of the users' or stakeholders' needs in the design and construction process, because an alternative that benefits a group could be significantly harmful for others. Therefore the co-operation of the people who are benefiting from the project as well as other nearby residents is a key element in the planning process.

Partnerships, stakeholder and public involvement is essential to facilitate management and optimize benefits. Watersheds transcend political, social, and economic boundaries. Therefore, it is important to involve all the affected interests in designing and selecting the goals for the watershed. Watershed teams may include representatives from all levels of government, public interest groups, industry, academic institutions, private landowners, concerned citizens and others.

Other stakeholders, as appropriate, who should be included in the decision-making process, are: investors; manufacturers of products; city planners, flood plain managers, developers and designers; nearby local residents who receive the benefits of the water resources projects and local citizens who do not receive direct benefits of these projects. It is important to differentiate between the citizens who receive direct benefits from the project and those citizens that could also be concerned without being affected.

CVBP is accomplished on a watershed basis that addresses the domestic, agricultural, industrial and environmental needs in the watershed. To produce sustainable water resources projects, the process needs to also address water quality and quantity, groundwater management, sedimentation, land use, and maintaining the natural habitat and the environment by ensuring adequate downstream discharges. It needs to include a wide range of engineering experts to ensure realistic alternatives are developed with reliable cost estimates. This is essential in an accurate benefit/cost analysis developed by the economists on the team. This new planning process will feed into good and transparent decision making and result in cost effective and sustainable water resources projects.

### 7.1. The Strategic Plan for Water Resources

In the past, there have been many cases where there has not been a coordinated plan for a nation's water resources. This has resulted in a piece meal approach to developing projects. The implementation of an integrated water resources planning and management approach is a key component of the strategic planning. This approach involves applying integrated tools and perspectives for defining problems and developing solutions with the potential to achieve sustainability for the economy, the environment and overall quality of life. A "Strategic Plan" is the essential starting point and should establish the following goals as a minimum:

**Goal 1.** Provide sustainable development and integrated management and dependable distribution of the nation's water.

**Goal 2.** Mitigate past environmental damage and prevent future environmental losses while protecting the livelihoods of the downstream communities.

**Goal 3.** Ensure that water resources projects perform to meet authorized purposes and evolving conditions in the future.

### 7.2. National Economic Development Plan, Regional Visions and Watershed Goals

CVBP builds on the national economic development plan, regional visions and watershed goals. A typical **National Goal for Water Resources** from the nation's economic development plan is:

"Development of water resources that provides and improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends."

And a typical **Regional Vision** for water resources is:

"*To obtain sustainability of water resources projects that ensure sufficient water quantity of acceptable quality that meets the needs of the people of the region in terms of health, food security, economy, and environment.*

- *Access to safe, adequate and affordable water supply, hygiene, and sanitation.*
- *Provision of sufficient water that will ensure food security for the region.*
- *Provision of sufficient water to spur and sustain the economies and cultural heritage of the region.*
- *Protection of the water environment to preserve flow regimes, biodiversity the livelihood of downstream communities as well as the mitigation of water related hazards".*

Each goal should have accompanying objectives and indicators. The objectives state in specific and measurable terms what must be accomplished in order to reach the larger goal. The indicators are tools that will help us to know how far we are from achieving our objectives and if we are going in the right direction. Progress on the indicators will be shown through periodic summaries displayed in a user-friendly way.

### 7.3. Project Purposes and Mitigation Issues that are Addressed in CVBP

To ensure maximum benefits and sustainability the focus of CVBP is to integrate the traditional purposes outlines in paragraph 7.4 with the requirements for water quality, sedimentation, groundwater, land use, critical habitat, environmental conservation and the climate. A summary of these purposes and other factors critical to long range planning are as follows:

- Water supply and quality
- Irrigation
- Navigation
- Flood control
- Hydropower
- Recreation
- Sedimentation
- Groundwater management
- Land use
- Maintaining critical habitat and species
- Maintaining ecosystem health

- Climate assessment
- Sustaining river-dependent communities
- Alternative sources of water (desalination, recycled...Etc.)

Typical issues that require mitigation and impact the project costs in CVBP are resettlement and socioeconomic impacts.

### 7.4. Engineering Details and Level of Effort in CVBP

The engineering activities associated with the planning process are part of the iterative process and should be performed at the feasibility level. The engineering activities should be performed at all steps in the planning process, with a greater level as the alternatives are narrowed. The data collection, field investigations, design details, and screening level cost estimates should be in sufficient detail to substantiate comparison of alternatives and to select the recommended plan. The level of engineering must also be adequate to develop the baseline cost estimate. For the alternatives studies the engineering team should develop the following:

- Present the basis and results of hydrologic and hydraulic studies required for determining the functional design requirements of the alternative. Explain the methods used, why the methods were selected, and the basic assumptions on which these studies are based. Provide basic data as appropriate and discuss the limitations of the collected data.

- Develop sufficient surveying, mapping, and other geospatial data information to support preparation of the design and cost estimate.

- Develop, describe, and present sufficient geotechnical information to verify the project plan, site selection, foundation design, selection of all structures, and cost estimates.

- Discuss the selection of the project site and evaluation of alternative layouts, alignments, components, aesthetics, relocation of facilities, etc., and describe components and features, including the improvements required on lands to enable the proper disposal of excavated material. Also consider reservoir clearing, archeological and heritage sites. The location of an alternative can have effects on the area and endangered species, as well as emissions and energy consumption. (If a dam is located far away from the communities to which it is supplying water, this implies the construction of larger pipelines over long distances, resulting in more use of resources, more emissions and effluents and a greater number of affected hectares due to the whole supply system network)

- Identify all functional design requirements and technical design criteria for the structural elements of the project. Include references, loads, load combinations, load factors, safety factors, and assumed or calculated uplift pressures.

- Identify all functional design requirements and technical design criteria for the electrical and mechanical systems and equipment of the project. Provide the technical basis for selection of type and configuration of electrical and mechanical equipment and outlet works capable of passing adequate water quality for environmental regimes.

- Identify the potential for the existence of hazardous and toxic materials exists, perform and report upon sufficient investigations and testing to identify the nature and extent of such materials. Include the estimated cost for remediation design and/or treatment and/or removal/disposal of these materials in the cost estimate.

- Briefly describe the construction procedure and water control plan for each construction stage of the proposed plan. Sufficient hydraulic and hydrologic data, hydrographic and topographic information, structural information, geologic and soils information, and environmental information shall be included to support the general features of the water control plan. The plan should also discuss erosion and sedimentation control for the life of the alternative.

- Develop sufficient environmental information to support preparation of the mitigation for the alternative. A brief outline of additional environmental objectives and requirements for design, plans and specifications, construction, and operations shall also be developed

- Describe the plan proposed for operation, maintenance, repair and rehabilitation of all features, including detailed operational cost estimates and potential to accommodate future changes such as climate change and changes in demography.

- Develop sufficient information and data to evaluate and develop the cost to mitigate social impacts such as resettlement, relocation of cemeteries archeological sites and mitigate impacts to downstream communities.

### 7.5. Development of Accurate Cost Estimates for all Aspects of the Alternatives in CVBP

The cost estimate is a critical and essential element of the planning process that serves as the foundation in accomplishing the economic (cost/benefit) analyses associated with the evaluation of alternatives. When analyzing an alternative, it is essential to include the life cycle or full costs of the alternative, considering all of the external costs, operation and maintenance costs and the cost of impacts on others. Preparation of the cost estimates is the responsibility of an experienced cost estimator. In the planning process, these cost estimates are based on the probable type, size and details of each alternative. It should include costs for the design and construction of features, lands, relocations, resettlement, environmental compliance

and mitigation and the appropriate contingencies. The contingencies are important and necessary to assure that unforeseen items of work or level of detail found later in the design are accounted for and do not jeopardize the recommended alternative. It must be recognized that design detail will be limited at this stage. When the cost of an impact cannot be assigned by the team, an independent evaluation by an external expert(s) may be required to develop an accurate cost.

Good judgment and experience of the estimator is essential developing and comparing the various alternatives being studied. When the details of each alternative are given to the cost estimator it is important to have an accurate definition and scope of the project. The three major areas that result in significant cost variations between the initial estimate and the design level estimate are:

- Poor definition in the alternative and unclear scope of work
- Selection of the contingency
- Accurate quantities

Also it is important to understand that the greatest risks of cost increases are in the planning stage of a project.

Since water resources projects are critical and essential infrastructure, they must perform efficiently over their project life. The life cycle cost estimate includes the costs of planning, design, construction, operations, maintenance, rehabilitation and administrative costs during the duration of its functionality or useful life. Therefore, the cost estimates for planning water resources project should include all life cycle costs. It is important to note that the costs of operation and maintenance are included in the life cycle costs.

### 7.5.1. Project Operations, Maintenance, Monitoring and Repair Activities.

The project operations and maintenance (O&M) plan is the detailed written description of the systematic procedures for the day to day operation and maintenance to ensure continued productivity of the project. The plan also summarizes the basic elements of how and when monitoring, inspection, evaluation are to be accomplished. This includes:

- Establishing a program of periodic inspections and evaluation of dams.
- Monitoring and evaluating the performance of the project and its features and components and providing repair and/or remedial construction as necessary.

Comparative cost estimates for the various alternatives used in the screening process to select a recommended plan should all use the same format and level of effort. The cost estimate for each alternative should include a narrative and comments describing the assumptions, technical and design data available, method of construction and sources for the lands, relocations, resettlement and environmental mitigation.

### 7.5.2 Program for Monitoring and Evaluations for Improving Component and Project Efficiency

It is essential to maintain the efficiency of the original design and look to the future to improve efficiency of the project. The owners and sponsors of water resources projects should have a program of periodic monitoring and evaluation of their project as well as developments in technology and the industry for new and improved technology as well as new products and equipment. Maintaining and improving efficiency of projects is essential. Examples of improving efficiency are a) adding storage to an existing dam for water supply and b) improving the efficiency of a hydropower plant to increase output.

### 7.5.3. Monitoring Benefits in the Future

Once a water resources project is placed into operation, it is essential that it continues to provide the appropriate level of benefits over the life cycle. Changes in growth and economic development in a region may require changes or additional benefits from existing projects. Examples are changing the operation of the project to improve overall discharges and providing additional storage for water supply and/or irrigation at an existing dam. Therefore, it is essential that the projects in a region be monitored and evaluated as necessary. To assist in the planning to meet future needs the following should be accomplished to assess current conditions in the watershed:

- Periodic review of national, regional and local needs in the watershed.
- Periodic review of authorized project purposes and benefits of the existing dam projects.
- Optimize the purposes at existing projects. This may include additional purposes as needed.
- Periodic review of the population growth or migration, urban and agricultural growth, changes in zoning, land use and changes in environmental conditions.

## 8. Steps in Comprehensive Vision Based Planning (CVBP)

**"CVBP"** is a more comprehensive and effective approach to planning is presented below, and employs a specific method for building a team and creating collaborative discussions as the process proceeds. The key ingredients of this process are knowledge, accuracy and quality of data and addressing risk. In the planning process is important to consider a broad system level approach, both in time and space. The long-term implications of the alternatives must also be considered in the decision-making process. A peer review is recommended for

complex projects and may be included for a normal project if the decision makers deem it necessary.

One of the goals of CVBP is to optimize the project purposes and benefits as well as improving the economic, social and environmental outcome of water resources planning. It facilitates a common understanding of the needs, regional vision and watershed goals. It also provides a consensus based forum for stakeholders and the public to identify trade-offs and new alternatives.

The first step (step 1) involves organization of the effort and the last step (step 8) consists of documentation of the selected alternative. Steps 2 through 7 are performed iteratively; that is, the sequence of steps is repeated as more information becomes available for evaluation. Public and stakeholder involvement is an integral part of this planning process.

**Step 1** – **Organizing the planning effort.** Build a multi disciplinary team consisting of decision-makers, stakeholders, economists, planners, environmental scientists, and experienced engineers to identify the issues, problems, needs and opportunities. Recognize that in complex alternatives external technical experts may need to be involved.

**Step 2** - Using the regional visions, watershed goals and strategy, and projected new requirements; develop the **study objectives and criteria** for evaluation. Since large multipurpose water resources projects are complex, a **multi-criteria assessment** is advisable.

**Step 3** - **Inventory and analyze the current situation** with respect to needs, opportunities as well as social and environmental issues. Look at demand side planning as well as supply side planning. Identify existing water projects that can be upgraded and/or have the efficiency improved. Document the status quo option.

**Step 4** – The entire team should **"collaboratively formulate"** the full range of alternatives with input from stakeholders and solicit public involvement and input. It is important to hold public meetings and workshops. This ensures that all stakeholder groups are given the opportunity to participate in developing the alternatives.

**Step 5** - The entire team should collaboratively **"evaluate and screen"** the alternatives and develop a team recommended list of alternatives for further study. The team then studies the listed alternatives and establishes the economic and technical feasibility plus the preliminary benefit and cost estimates. Hold public meetings to involve and update the public on study progress.

**Step 6** – Review the screened list to ensure that adequate costs and benefits are associated with each alternative. Then **"compare the**

**alternatives** with respect to benefits and costs along with the regional vision and watershed goals. The comparison is based on the criterion established in step 2 should conclude with some type of ranking.

**Step 7** – The entire team reviews the ranked alternatives along with the study objectives and criteria for evaluation. The team then **"selects the alternative"** which has the greatest net economic, environment and social benefits. This process may require reiteration to get to a selected alternative for implementation.

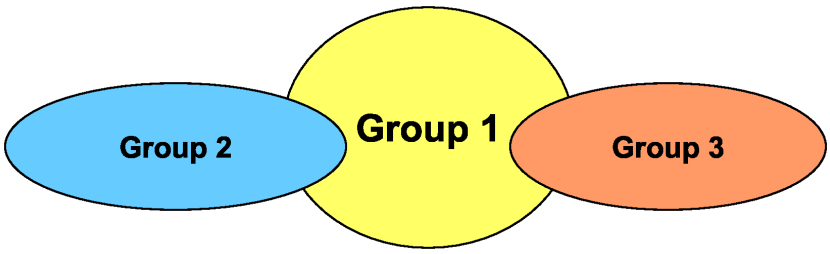
**Step 8** - Once the recommended **plan is accepted** update the engineering and cost estimate for budgetary programming and scheduling of the project. The project is now ready for implementation - final engineering and design, construction and operation.

The flow diagram for CVBP process is shown in Appendix A.

## 8.1. Details of the Steps in CVBP for Water Resources Projects.

### Step 1 – Organize the Planning Effort. Build a Team and Identify Problems with Stakeholders, Decision-Makers and Experts

CVBP utilizes the concept of integrating the interest groups when building the team. The idea is that all members that have an interest in the process belong to one of three groups.




Those in Group 1 belong to the organization responsible for the planning study and as such are most involved in the study and carry out critical tasks, such as organizing meetings, conducting research, developing economic and technical details of the alternatives and preparing the associated costs. Those in group 2 include representatives from key stakeholder groups, but have a somewhat less direct involvement than individuals in Group 1. Group 3 includes representatives from the public and other stakeholder groups, management organizations, and advocacy groups. This group comprises a larger number of people who have less direct involvement in the project than those in Group 2. This approach ensures participation at manageable levels by a large number of stakeholders.

**Step 2 - Using the Regional Vision and Watershed Goals, Develop the Study Objectives and Criteria for Evaluation**

A planning objective is a concise, formally structured statement that explains how and when a study will try to affect a specific resource in a specific place. These objectives should be as clear as possible. The study group should also develop statistical measurements of the performance of the resource system, such as the frequency and duration of supply failures. CVBP puts emphasis on identifying objectives and decision criteria consistent with national objectives, the regional vision and watershed goals. Since large multipurpose water resources projects are complex, a multi-criteria assessment will be necessary. This involves agreement on the criterion to evaluate and screen the alternatives and deciding on the weight of each criterion. The tolerability for financial and other risks is established. The details of this process are described in step 5.

**Step 3 - Inventory and Analyze the Current Situation with respect to the Needs, Opportunities as well as Social and Environmental Issues. Document the status quo option.**

Describe the current conditions and review the projected growth. Document the current water projects and their capacity. Using guidance from the government economic development plans and regional visions document forecasted growth, development and water needs. Review both the demand side as well as supply side to identify potential initiatives to reduce the demand. Identify those existing water projects that can be upgraded (adding storage) and those where the efficiency can be improved (upgrading generators, lining irrigation canals). Evaluate a range of sizes and locations of new water resources projects.

The sources of risk and uncertainties are identified for use in developing the alternatives. They include:

- Reliability of the hydrological records and data
- Natural variability of the precipitation
- Uncertainty associated with climate change
- Uncertainty in the projected demand
- Uncertainty in projected growth by rate and geographic area
- Uncertainty in the environmental impacts and the cost of mitigation
- Uncertainties in the geological conditions and the sites of the alternatives
- Uncertainty of the factors in developing accurate cost estimates.

The status quo alternative shows what the outcome will be without any improvements. This is an important baseline against which alternative outcomes are judged. The description of the status quo is based on collaboration and is tied to study objectives and evaluation criteria.

**Step 4 – The entire team should collaboratively "formulate" the full range of alternatives and solicit public involvement and input.**

This is a very important step in the CVBP process. When formulating the alternatives, all those that provide the same functions need to be included. The size and location of each alternative should be included. The alternatives should be formulated in sufficient technical and economic detail to facilitate a realistic evaluation. This section provides a framework for classifying and understanding alternatives. It is important to hold public meetings and workshops. This ensures that all stakeholder groups are given the opportunity to participate in developing the alternatives. Identify how the identified risks and uncertainties are addressed.

There are three types or categories of alternatives: strategic, operational and emergency. Integration of upgraded and efficiency improved projects should be included in these categories. **Strategic measures** are long-term responses to the national economic development plans and regional visions, such as provision of water supply storage to meet an 8% annual growth rate in population and a 12% annual growth rate in economic development. **Operational measures** are near-term and deal with problems within the framework set by strategic measures. **Emergency measures** are responses to circumstances that exceeded expectations (such as floods, droughts that are more intense or prolonged than any on record , pollution of water supply or disruption of water delivery by floods, earthquakes.

Brainstorming is a crucial process in developing alternatives. Brainstorming is a process which has been used extensively in value engineering and other areas where innovative alternatives must be found. It is best done in small groups led by a recorder who simply lists every idea that is offered by any member of the group.

The key to successful brainstorming is to withhold criticism until the group has exhausted its creativity. This can be very difficult, especially when water experts brainstorm with stakeholders, because many of the ideas will have technical flaws or will be unresponsive to the planning objectives. Encouraging all participants to freely offer solutions achieves many ends: it can allay fears that possible solutions have been overlooked; provide the insight of a fresh perspective to an expert; force the examination of good ideas that experts know have powerful foes; or allow interesting, but ultimately unsuitable ideas to be raised and rejected in an equitable and public manner.

Some alternatives will be on the border of two categories. While it is not important for a study team to label an alternative as being exclusively in one of these three categories, it is necessary for a team to consciously consider the relationships between the three types of measures.

An initial list of alternatives should be developed by brainstorming early in this step. This is apt to include a number of preconceived alternatives to the status quo, some advanced by the stakeholders it will benefit. The teams should focus on the ends, not the means. The next step on evaluating and screening of the alternatives (step 5), describes how these initial ideas can be evaluated quickly so that only the most promising alternatives are developed in detail.

During this step in the CVBP process, stakeholders should be encouraged to express their ideas for alternatives, but the preliminary screening process should allow experts to use their knowledge to explain why some ideas should not be studied further.

**Step 5 – "Evaluation and Screening of the Alternatives". Collaboratively evaluate and screen the alternatives to develop a recommended team list for further study. From this list, establish the economic and technical feasibility and preliminary benefit and cost estimates. Hold public meetings to update the public on study progress.**

The purpose of this step is to determine whether or not an alternative that has been formulated is worthy of further consideration and to develop a prioritized list for further study. Each alternative is reviewed with respect to the study objectives and criteria for evaluation. The effectiveness, efficiency and acceptability of the alternative to the study objective are also important. The initial screening of alternatives should emphasize effectiveness and acceptability. The goal of the initial screening is to eliminate some alternatives and develop a ranking of the remaining alternatives. Some common evaluation criteria include:

- Eliminate those that are not technically feasible
- Economic benefits
- Estimated cost
- Environmental assessment and impacts
- Social assessment and impacts

The process of ranking may help in the continuing effort to communicate and clarify objectives and criteria. Characteristics to measure an alternative are:

- **Completeness: -** all the elements required to make the plan work are included in the plan.

- **Effectiveness: -** the alternative addresses the planning objectives.
- **Efficiency: -** the ratio of plan outputs to inputs is satisfactory.
- **Acceptability: -** the plan satisfies decision criteria and does not violate planning constraints.

The initial screening of alternatives should emphasize effectiveness and acceptability. The goal of the initial screening is to eliminate some alternatives and develop a ranking of the remaining alternatives. The process of ranking may help in the continuing effort to communicate and clarify objectives and criteria. The initial screening permits the focusing of study resources on the detailed evaluation of the most promising alternatives. Hold public meetings as appropriate to update the general public on progress.

**Step 6 – "Comparison of Alternatives". From the screened list, develop the economic and technical details along with associated costs for each of the alternatives as needed. Then the alternatives are compared with respect to benefits, costs and the regional vision, watershed goals and the criterion established in step 2.**

In this step, the screened list is reviewed to ensure that adequate economic and technical details along with associated plans and costs are developed for each of the alternatives. It is important to have feasibility level of engineering effort consisting of field investigations, design and screening level cost estimates to document the aspects of the alternative. Once this is complete the team then compares alternatives with respect to the regional vision and watershed goals and strategy.

The process of evaluation with respect to each of the criterion is as follows:

- Score each of the alternatives against the criteria
- Obtain a weighted score by multiplying the criteria score by the weight (established in step 2)
- Obtain a total score for each alternative
- Rank the alternatives based on total score

A useful tool that can be incorporated into the comparison of the different alternatives is the use of sustainability indicators, which should be capable of measuring the relative performance of one alternative against another and the performance of the alternative in an "absolute" scale. These indicators should include all life stages of the water project and ideally reflect multiple categories of importance, such as ecological, economical, and social aspects.

This step should end with some type of prioritized ranking.

**Step 7 - Select an alternative as the recommended plan for implementation**

This is an important step since a recommended plan should be compared to the "No Action Option". The team reviews the ranked list and the engineering details and cost estimate should be reviewed to ensure that they are adequate to present to the decision makers and the public and selects an alternative as the recommended plan. This recommended plan should be consistent with the national "Strategic Plan for Water Resources" and satisfy the regional vision and watershed goals.

**Step 8 – Acceptance of the Recommended Plan**

The list of prioritized alternatives along with the recommended plan is presented to the decision makers. Once the recommended plan is accepted by the decision makers, the project plan, details and cost estimate is finalized for budgetary programming. The project is now ready for implementation - final engineering and design, construction and operation.

## 8.2. Are There Other Alternatives

Sometimes the team or the decision makers will find it in the best interest of the region, watershed and nation to consider a plan that sacrifices some economic benefits of one alternative for other additional contributions to meet the criteria and objective. This conflict can be resolved in a number of ways ranging from discarding this plan to incorporating some of the benefits into the favored plan. In either case, input from the stakeholders and public is needed to build a consensus before implementation.

## 9. Conclusion

We must be mindful that there is a fixed amount of water on the earth and of this, only a small amount is available for domestic, agricultural, industrial and environmental needs. The availability of water in sufficient quantities and of adequate quality where and when it is needed is one of the greatest challenges for the future. Most of the predicted growth in population will occur in the developing countries – where the need for water is the greatest and the current supply is limited. This highlights a worldwide need for a new and more integrated planning process for the development of sustainable water resources projects to ensure human survival and meet the national economic development needs.

History shows us that dams and reservoirs have been used successfully in collecting, storing and managing water needed to sustain civilization for five

centuries. As we look to the future, we must learn and benefit from the past experiences. ICOLD's intent is to ensure that all future dams and reservoirs constructed around the world are adequate, economical, environmentally responsible and socially acceptable and that they are operated and maintained for sustained efficiency and reliability.

The planning process for water resources projects is the critical starting point and must carefully document the proposed benefits and costs. Stakeholder concerns and the environmental and social impacts must be mitigated. This is the part of careful planning and design that incorporates public involvement and input. When the appropriate mitigation measures are identified early in the planning and design process for a dam and reservoir, they can be efficiently and effectively incorporated into the design, construction and operation of the project.

The Comprehensive Vision Based Planning for water resources recommended in this position paper is the best road forward. It consists of an interdisciplinary team of experienced professionals from natural, social, economic and engineering disciplines. It is based on a holistic watershed approach and starts with the national economic development plan. It is then refined using the regional vision and watershed goals. It includes consideration of both demand side and supply side planning. In addition to traditional purposes for projects, it addresses water quality, sedimentation, groundwater management, zoning and land use, critical habitat, maintaining the environment and climate assessments. It incorporates a team of experienced engineers to ensure that the all of alternatives that are evaluated are technically sound, efficient and economical. Since the cost estimate of all alternatives is a critical element they must be prepared by experienced cost estimators on the engineering team. This process also addresses socio-economic issues such as resettlement and environmental health of the region.

The end result is a more comprehensive, collaborative, realistic and wise planning process that recommends innovative and technically sound water projects.

## 10. Acknowledgements

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# Appendix A

## Basic Steps in the Process of Comprehensive Vision Based Planning (CVBP)