Environmental Guidelines for Dam Construction Projects

February, 1990

Japan International Cooperation Agency (JICA)

Environmental Guidelines for Dam Construction Projects

February, 1990

Japan International Cooperation Agency (JICA)

Definition of Terms

Environmental Consideration

Although environmental consideration is a wide-ranging concept, in these guidelines it refers to "environmental consideration in development projects."

In this context, environmental consideration is defined as follows:

- to study the environmental impact of a development project
- to assess the results of the study
- to formulate measures to prevent or alleviate that impact if necessary

Screening

Screening is a process of judgment on whether or not a development project requires an environmental impact study.

Scoping

Scoping is a process of identification of the critical environmental impacts out of the possible environmental impacts of a development project. Through the scoping process, the priority fields or important items of an environmental impact study are also identified.

Preliminary Environmental Study

The performance of screening, scoping, etc. on the basis of available information, interviews, and site observations in order to collect and analyze data needed to carry out Initial Environmental Examination and Environmental Impact Studies.

Initial Environmental Examination (IEE)

IEE is the first appraisal for identifying the possibility of environmental impacts by the project carried out on the basis of readily available but limited information. IEE is the initial step of the Environmental Impact Study and is carried out with accuracy sufficient to determine whether or not subsequent steps of the EIS will be required.

Environmental Impact Study (EIS)

An equivalent term to Environmental Assessment or Environmental Impact Assessment (EIA). This is a study carried out beforehand to predict and assess the degree and extent of the impact of development activities on environmental elements such as air, water, land, flora and fauna, peoples' lives, etc. It also covers formulation of preventive measures including comparative study of alternatives.

Environmental Impact

Exerting an unfavorable effect on the land, water, atmosphere, flora and fauna, properties, social information, communication, etc., and the present state of the composite contributed by the interaction of these elements.

Environment Management Plan

The environment management plan in these guidelines means formulating the system or method of monitoring, etc., based on the environmental protection standard, in order to monitor the impacts exerted on the environment concerned so that appropriate environmental protection may be achieved during construction and operation of the project.

Master Plan Study (M/P)

A study performed to set up the basic plan for any development project. It is usually carried out at the national or regional level, by sector or at each stage of a development project.

An M/P is required at the initial stage when the various projects are inter-related, showing a regional development character, or when the project is of a multipurpose nature.

Feasibility Study (F/S)

The F/S can be broadly divided into a pre-F/S and the F/S proper, the difference being the scope of subjects and the accuracy of the study.

The F/S is a study which examines the feasibility, priority, and the investment effectiveness of a project, and normally attempts to verify objectively the feasibility of a project socially, technically, economically, and financially. It has become pivotal to JICA's development study operations.

Moreover, the F/S is used by governments in their decisions on whether to proceed with a project or not. Should funds be necessary, the F/S is also used by international funding organizations in their judgment on the appropriateness of loans.

Table of Contents

i. Background

Various efforts are being made at both national and international levels to cope with such global environmental problems as global warming, depletion of the ozone layer, destruction of tropical forests, expansion of deserts, and acid rain. Meanwhile, cooperation against environmental problems of developing countries is being reinforced by both bilateral and multilateral aid agencies.

In view of the above, in 1988, the Japan International Cooperation Agency (JICA) set up the Aid Study Group on Environment in order to strengthen and expand international cooperation in the field of the environment through official development assistance. The Aid Study Group prepared a report, entitled "Sectoral Study for Development Assistance—'Environment,'" dealing with the basic concept for the implementation and organization of international cooperation in this field. The Aid Study Group recommended in its report that further study be conducted on such subjects as (l) investigation and formulation of the scoping procedure and the matters on which to confer with the government of a recipient country, and (2) investigation and formulation of guidelines on environmental considerations.

In pursuance of the recommendations made by the Aid Study Group, this set of guidelines was prepared to suit the development study of the Japan International Cooperation Agency.

ii. Objective

The objective of this work is to provide guidelines to be utilized by JICA in making plans for the study of dam construction projects. The guidelines are to be used for screening and scoping at the stages prior to and during the preliminary study, so that the environmental problems which may occur as a consequence of the development could be foreseen and sufficient consideration to the environment could be paid.

iii. Definition of Dam

The term "dam" in these guidelines is meant to include structures constructed across the river for the purpose of retaining the running water, and the resulting manmade reservoirs.

iv. Use of Guidelines

In order to ensure adequate environmental consideration concerning the dam construction plan, it is indispensable to understand the objectives of these guidelines and to use them effectively. The way to use the guidelines is described below.

(l) Commence the screening process described in these guidelines at the stages of project identification and formulation or request examination by examining, through a theoretical review of the terms of reference and other related materials, whether or not an environmental impact study should be carried out.

(2) By means of a preliminary on-site study, using the screening format in these guidelines, ascertain the decision reached in the theoretical screening process on whether the project in question will exert impacts on the environment. If the preliminary study indicates that there is no threat that the project in question will impact on the environment, it should be concluded that an environmental impact study is not necessary.

(3) If an environmental impact study was judged necessary, the checklists in these guidelines should be used to assess the degree of impact and carry out scoping with the view to indicating the necessity of EIS at the stage of full-fledged study together with indication of the viewpoint and content of the study. At that time, make every effort to define the presumed environmental impact accurately and realistically, making full use of the "Explanation of Items" (Table 3 - 3) of these guidelines. It should be noted that the scoping process will have to be continued over the subsequent stages of study for the environmental elements on which definite scoping has not been made during the preliminary study.

(4) The results of the above examination should be reflected in preparation of the terms of reference for further study so that the preparation of an appropriate environmental impact study and its implementation may be possible.

v. Stipulations for Application

It should be noted that these Guidelines are intended for use by staff members of JICA and other personnel, who are not necessarily experts in the environmental impact study, as reference material for preparing survey reports and the terms of reference for further study on the basis of field surveys, hearings, and meetings with officials of the recipient government and others concerned.

Chapter 1
Outline of Environmental Considerations in Dam Construction Projects

1.1 Basic Concept

The 1988 JICA Report of the Aid Study Group on Environment, entitled "Sectoral Study for Development Assistance--'Environment,'" defines environmental considerations as follows: "to study the environmental impact of a development project; to assess the results of the study; and to adopt measures to prevent or alleviate that impact if necessary." On the premise of this definition, in carrying out environmental considerations with development projects to which Japan is to cooperate on request from a developing country, it should be a prerequisite that the development assistance be provided for sustainable development. To that end environmental considerations should be exercised with a view to promoting environmentally sound development from the earlier stage of development planning based on a long-term perspective.

Because development projects in developing countries are implemented on the decision of the recipient government and within the recipient country's territory, it is necessary to follow the country's laws, regulations, guidelines, etc. pertaining to environmental considerations. On the one hand, there are some countries which have no such regulations. On the other hand, there are countries which have regulations, but they are not always enforced adequately. It is a fact that policies and systems for environmental considerations differ from country to country. The policies and administrative system in the developing country must also be respected in making environmental considerations. And it is necessary to rightly understand the ideas of the recipient country and hold close consultations with a flexible attitude. The fundamental concept behind the environmental considerations by JICA is to promote sustainable development for upgrading the living standard of the people and to contribute to harmonizing development with the environment.

If environmental considerations are not sufficiently made (for example, when attention is not properly paid to natural resource management in the environs of the project) it may happen that the base of development itself will be damaged and development be disrupted. The base of life and subsistence of the people may also be affected unfavorably. Therefore it is necessary to ensure sustainable development by harmonizing a development project with natural resources and livelihoods and subsistence of the residents in its environs.

Since the scale of dam projects is usually large in comparison with that of projects of other types, and the environmental impact due to its implementation may often spread over a wide area and in various features, environmental considerations should be made with utmost care. If the environmental consideration is made after project implementation has been started, serious alteration of the project site, design of structures, etc. may be caused, resulting in waste of labor, materials, and money. For this reason it is necessary to initiate environmental considerations in the planning stage of a development project as early as possible. In other words, environmental consideration is deemed an indispensable element of development planning, and should be made at the stage of alternatives study respecting project site, design, etc.

In line with the above idea, the environmental consideration in the guidelines does not merely mean prediction and evaluation of detrimental impacts and environmental protection measures, but also positive appraisal of the regional and national benefits of development,

improvement of the regional environment and monitoring of the environmental impact by the development project. Further, monitoring can be divided into two stages, one for observing significant changes of the environment during the construction stage of the project and the other after completion of the project.

Figure 1 - 1, based on Development Assistance Committee (DAC) data, shows assignment of environmental assessment and monitoring in the flow of the project cycle. A project begins with establishment of the concept of the basic plan of the project, then undergoes a feasibility study including environmental assessment, and detailed design including environmental protection measures. Then the cycle continues into project implementation and, simultaneously, implementation of environmental protection and monitoring. Thus sustainable development is achieved.

The environment management plan mentioned here is narrowly defined as a monitoring plan and related activities for watching the change in environmental parameters of the project.

Table 1 - 1 and Figure 1 - 2 illustrate the steps in environmental consideration corresponding to those in project implementation so that a sequential relation between the project and environmental consideration can be understood. The project procedure starts with the environmental survey, followed by environmental impact study, and proceeds to environmental protection measures, then to environmental monitoring.

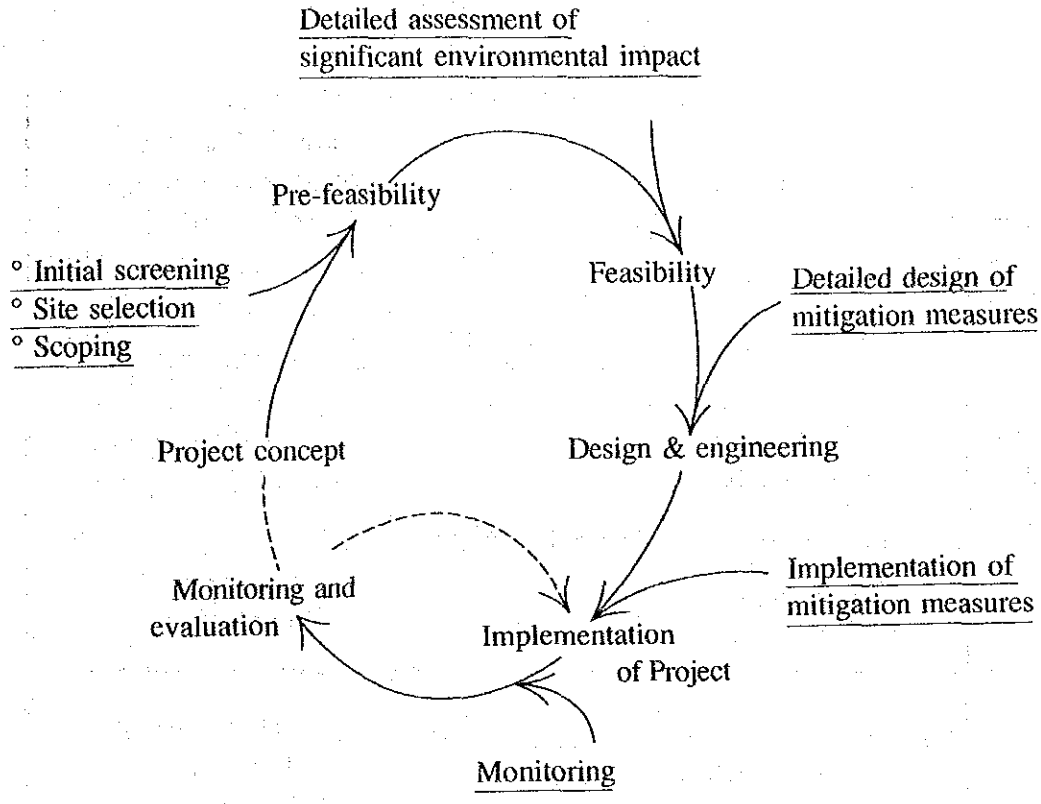


Figure 1 - 1 Flow of Environmental Assessment In Project Cycle
(from DAC/ENV (89) with parts amended)

Table 1 - 1 Comparison Between Stages in Project and Environmental Considerations

<table>
<tr><td colspan="3">Stages in project implementation</td><td>Stages in implementation of environmental considerations</td></tr>
<tr><td rowspan="3">Executed by JICA</td><td>Preliminary Study</td><td>Preliminary Study</td><td>Preliminary Environmental Study</td></tr>
<tr><td>Master Plan Study</td><td rowspan="2">Feasibility Study</td><td>Initial Environmental Examination (IEE)</td></tr>
<tr><td>Feasibility Study</td><td>Environmental Impact Study</td></tr>
<tr><td rowspan="3">Executed by project implementing agency</td><td colspan="2">Preparation of project implementation plan (including detailed design)</td><td>Check of environment conservation measures</td></tr>
<tr><td colspan="2">Execution</td><td>Implementation of environment conservation measures</td></tr>
<tr><td colspan="2">Operation</td><td>Environment monitoring</td></tr>
</table>

Notes:
1. Table does not indicate strict correspondence.
2. For some projects IEE or Environmental Impact Study may not be required.
3. Preparation of implementation plan includes facilities for environmental protection measures and detailed design for the work.

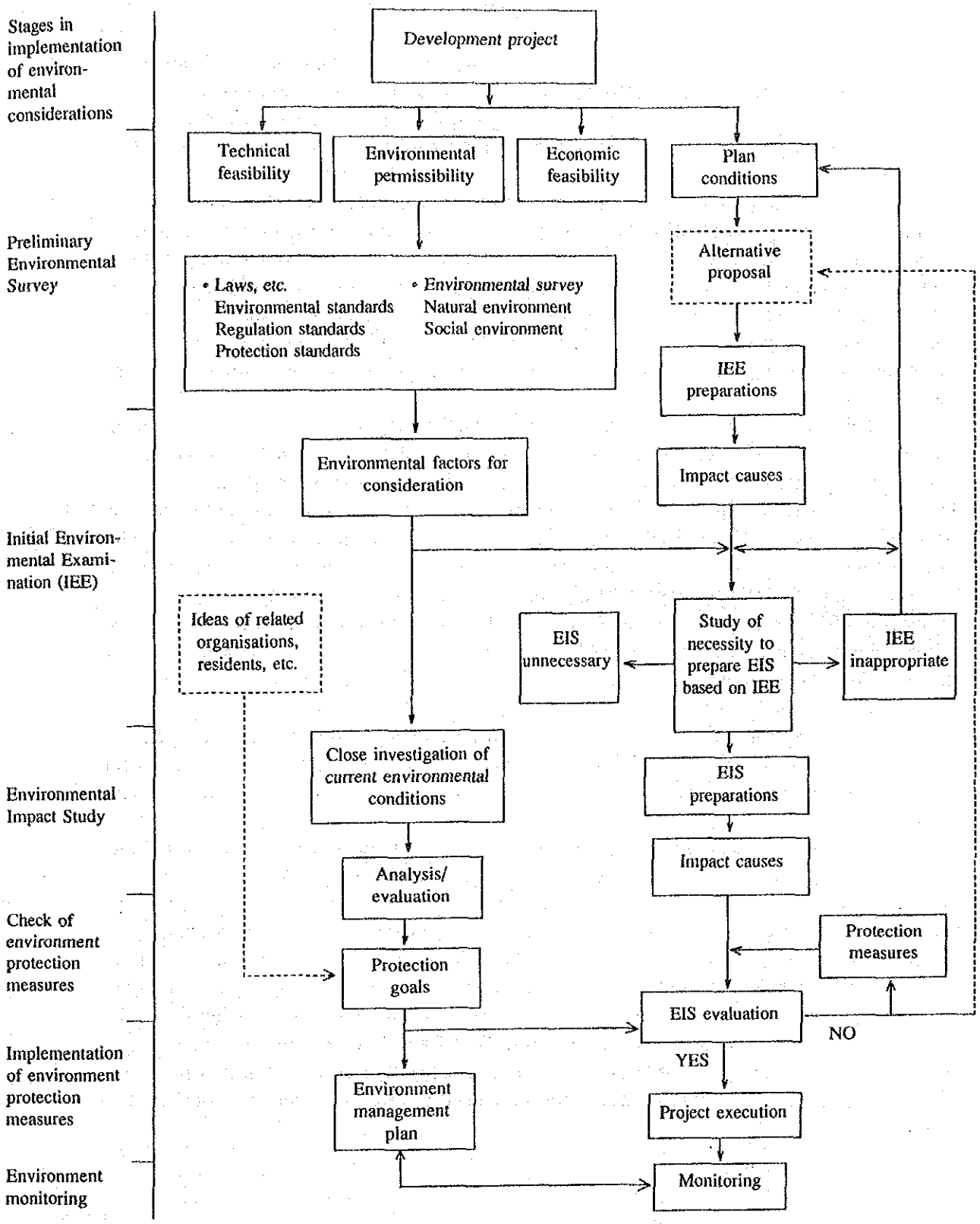


Figure 1 - 2 Environmental Considerations Program

1.2 Current State of Environmental Consideration

At the core of the official development assistance (ODA) of Japan are the Japan International Cooperation Agency (JICA) and the Overseas Economic Cooperation Fund (OECF). Both agencies have been striving to carry out their development assistance in an environmentally sound manner in cooperation with the ministries and other agencies concerned.

JICA has been endeavoring to incorporate environmental considerations in project planning through development studies. It has also been providing assistance related to environmental problems such as environmental pollution, nature conservation and adequate utilization of natural resources etc. through project-type technical cooperation, receiving trainees, and dispatching experts. The environment-related cooperation in various forms of JICA's technical assistance (receiving trainees, dispatching individual experts, project-type technical cooperation, and development studies) has continued to increase during the last ten years or so.

In 1988, JICA prepared a report entitled "Sectoral Study for Development Assistance—'Environment,'" which describes JICA's general guideline of environmental consideration. And in August 1989, the Environmental Affairs Division was set up in the Planning Department and an officer in charge of environmental affairs was assigned to each concerned department. Thus JICA's organizational structure for integrating environmental consideration in the project cycle (from project finding/formation to ex-post evaluation) is being bolstered. The Environmental Affairs Division is now actively involved in integrating environmental considerations in environment projects by undertaking investigation of environmental aspects at the preparatory and planning stages of a development project, coordination at the stage of project implementation, and compilation of environmental information on the recipient country, etc.

On the other hand, OECF, in order to ensure effective and efficient environmental considerations, issued "OECF Environmental Guidelines" on the selected sixteen sectors for ODA loan. The guidelines consist mainly of the checklists of items for which environmental consideration is needed, and their explanation.

JICA's environmental consideration in the development study has been performed on the basis of past experience, taking into full account the laws and regulations as well as natural and social environment, etc. of a recipient country. Environmental consideration has been very carefully made especially in the case of dam construction since it may exert significant impacts on the environment due to the scale of the project. (The incorporation of environmental considerations into JICA's development study, from project finding through full-fledged study, is shown in Figure 1 - 2.) Nevertheless, further effort is needed for implementation of environmental considerations. Therefore, these guidelines, covering mainly the introduction of procedures for screening and scoping of environmental impacts related to the dam construction project, were formulated in order to ensure environmental considerations.

Table 1 - 2 Incorporation of Environmental Considerations in JICA's Survey Operations

Flow of survey operations		Study details and period	Study items
Pick out items	Demand survey/ project finding ↓ Terms of reference accepted ↓ Terms of reference study	(Screening) Judgement of whether Environmental Impact Study is required or not (Scoping) • Decision on main aspect s for Environmental Impact Study • Decision on allotment of work	
Preliminary study	Site survey ↓ Discussion and agreement on scope of work ↓ Preliminary Survey report preparation		(Scope of work; Man-months statement) Study of method for stating agreed items for Screening and Scoping (Preliminary Survey reporting) Clarification of details and agreed items up to the Preoiminary Survey stage
Selection of consultant	Preparation of operations instructions ↓ Consultant selection		(Operations Instructions) Establishment of goals for work quantity and scope for Environmental Impact Study which consultant is in charge of (Consultant Selection) Evaluation of propriety of proposal for operations instructions
Full-fledged study	Inception report—preparation and discussion ↓ Implementation of Environmental Impact Study ↓ Draft final report—explanation and discussion ↓ Preparation of final report ↓		(Design of Environmental Impact Study) Discussion and decision making for Environmental Impact Study items and method based on Scoping results
			(Monitoring) Check on propriety of Environmental Impact Study being carried out (Final Reporting) Clarification of Environmental Impact Study results as well as recommendations, etc.

Source: Report of "Sectoral Study for Development Assistance—'Environment,' 1988," JICA

Chapter 2
Screening

2.1 Basic Idea

JICA's 1988 report, "Sectoral Study for Development Assistance--'Environment,'" defines screening as "a process of judgement on whether a development project requires an environmental impact study or not." That is to say, screening is the first judgement in the process of environmental consideration and should be commenced at an initial stage of the project, such as project finding. If screening is not performed adequately and the project proceeds to its implementation stage, there may be serious environmental problems or substantial alteration in important elements such as the site or design of the project.

Such a definition underlies the screening of dam projects in these guidelines too; nevertheless the decision of whether or not an environmental impact study is necessary is based not on the standard set out quantitatively but rather on ideas and viewpoints for harmonizing sustainable development with the lives of the residents and the environment of the project area.

2.2 Screening Procedure

As mentioned in Section 2.1, JICA's 1988 report, "Sectoral Study for Development Assistance--'Environment,'" defines screening as "a process of judgment on whether a development project requires an environmental impact study or not." As for the procedures for screening, in addition to the provisions detailed in the annex to the 1985 OECD Council Recommendations, screening can be carried out from the following cross-sectional viewpoints.

- Can the project adversely affect the sustainability of production which depends mainly on natural resources?
- Will the project significantly affect people's health?
- Will the project lead to a deterioration or loss of valuable living resources and their habitats?
- Will the project have an unreasonable impact on the livelihoods and subsistence of the people concerned?

When actual procedures for screening a dam construction project are formulated according to the above provisions, it is considered necessary to have a thorough conference with the recipient country in order to achieve better environmental consideration in light of these guidelines, in addition to observing the laws and regulations pertaining to environmental impact studies for dam construction projects already provided by the recipient country.

On the other hand, where no legislation is provided, it may be possible to stipulate a standard with respect to the dimension of the dam construction project (e.g., reservoir area, storage capacity, height of the dam) or region (e.g., national park area) for the purpose of judging whether the development project requires an environmental impact study or not. However, setting up a quantitative standard for judgement is not only difficult but its effectiveness is also doubtful when diverse countries are to receive the development assistance and a variety of environmental characteristics in the recipient countries are to be taken into consideration.

Moreover, dam projects in many cases have environmental impacts over a wide area in various forms such as modification of the topography in a wide area, alteration of the land use pattern, change of the river regime in the upper and lower reaches and sequential effects on the natural environment including biological changes, and induced influence on the social environment. Therefore, it is feared that problems may remain if screening is carried out from a single viewpoint.

As already mentioned, it is difficult to establish a quantitative standard for making screening judgements, and it is more effective to provide a concept or viewpoint with qualitative expressions. (For reference, the standard in Japan stipulates that an environmental impact assessment is necessary for a project covering a reservoir area exceeding 200 hectares.)

On the basis of the above consideration, JICA stipulates that in these guidelines for the environmental impact study on dam construction, the concepts to be adopted in making screening judgement are as follows.

- Bring about ample social benefits from the dam construction project while avoiding harmful effects on the existences and lives of the inhabitants of the dam area and ensuring sustainable development and growth of the region.

- Maintain harmony with the environment for the future, avoiding significant damage from the dam construction project to the existing environment, and preserve valuable environmental assets.

Further, more practical viewpoints based on the above concepts are indicated as follows.

- Will there be an effect on health conservation for the inhabitants of the area, and is there the possibility of an outbreak of a water-born disease?
- Will the project bring about nuisances such as devastation of the land, contamination of the soil, air pollution, and water pollution?
- Will it exert an unfavorable influence on the existing social lives of the inhabitants of the area, such as industry, traffic, and community life?
- Does the region possess any indigenous value (historical, archaeological, cultural, aesthetic, or scientific) or specific social value?
- Is the region valuable for protection and preservation of terrestrial flora and fauna and aquatic organism resources or for their permanent exploitation? Does the region have a vulnerable ecological system?

Screening is carried out from the above viewpoints and the results are summarized in the format shown in Table 2 - 1 and included in the report of the preliminary study. In using the format, the results of screening from each viewpoint are indicated in the column headed "Result of study." Further, the conclusion specifying whether an environmental impact study will be needed and the reason for that decision are briefly described in the column "Overall evaluation."

In these guidelines, the scope for study of environmental impact is not limited to the areas near the reservoir and dam embankment but is taken to mean the area comprising the whole basin—including upstream and downstream areas—and parts which could be directly or indirectly subjected to the impact. It also allows for any environmental problem which could arise during the construction of the dam or its operation.

Table 2 - 1 Screening Format in Preliminary Survey Report

Viewpoint	Result of study
Will there be an effect on health conservation for the inhabitants of the area, and is there the possibility of an outbreak of a water-born disease?	
Will the project bring about nuisances such as devastation of the land, contamination of the soil, air pollution, and water pollution?	
Will it exert an unfavorable influence on the existing social lives of the inhabitants of the area, such as industry, traffic, and community life?	
Does the region possess any indigenous value (historical, archaeological, cultural, aesthetic, or scientific) or specific social value?	
Is the region valuable for protection and preservation of terrestrial flora and fauna and aquatic organism resources or for their permanent exploitation? Does the region have a vulnerable ecological system?	
Overall evaluation: Does the development project require an environmental impact study?	

Chapter 3
Scoping

3.1 Basic Idea

In JICA's 1988 report, "Sectoral Study for Development Assistance—'Environment,'" scoping is defined as "a process of identification of the critical environmental impacts out of the possible environmental impacts of a development project. Through the scoping process, the priority fields or items of an environmental impact study are also identified." Further, it recommends that scoping be carried out through discussions with the government of the recipient country, and these discussions are to be based on discussion items prepared in advance, taking into account the aforementioned cross-sectional judgement provisions.

Based on the above criteria and referring to the methods being used by the various agencies, a procedure is introduced in these guidelines to facilitate adequate screening, within the short period of the preliminary study, with understanding of the entire features of the construction project, and with adequately selected items, even by persons who are not experts in environmental impact assessment of a dam construction project.

3.2 Scoping Procedure

There are several technical methods for environmental impact assessment or scoping, and their application depends on the type of project, maturity of the plan, and characteristics of the environment. The commonly used methods are checklists, matrices, overlays, and networks. The characteristics of each method are comparatively described in Section 3 of the Reference.

Various methods of environmental impact assessment have been proposed; however, the checklist and matrix methods are employed in most cases, as seen in the procedures of various agencies shown in Section 2.2 of the Reference.

For "identification of the critical environmental impacts out of the possible environmental impacts of a development project," as required by the definition of scoping in the "Sectoral Study for Development Assistance—'Environment,'" it is necessary to include all environmental factors that can be predicted to arise along with implementation of the project. To accomplish this, the checklist method seems to be the easiest to understand and the most effective. In view of the above, the checklist method is introduced in these guidelines.

Furthermore, in order to indicate the important sectors and items among those which are included in the checklists, it is considered necessary to understand the cause-and-effect relationship between the actions pertaining to dam construction and the environmental factors. Therefore, to facilitate easy understanding even by people who are not dam engineers, the cause-and-effect relationship is shown as a matrix, which partially includes a network.

Table 3 - 1 shows the checklist to be used for scoping during the preliminary study and Table 3 - 2, the matrix by which the cause-and-effect relationships among environmental factors can be understood.

The following conditions and procedures are relevant in using the checklists for scoping.

(1) Period of application

During construction and operation.

(2) Spatial extent of application

The whole drainage area, not limited to the vicinity of the dam and reservoir but including the upstream and downstream areas and those areas to which direct or indirect impact may reach.

(3) Type of environmental impact

Basically, the detrimental influences on the existing environment.

(4) Rating standard for important fields or important items of the environmental impact study

Each item of environmental impact included in the checklist is classified into five degrees of importance, namely A (grave impact), B (moderate impact), C (little impact), D (unidentified but study is needed, and it may become evident as the study progresses), and X (excluded from environmental impact study). Rating of importance is carried out in reference to the respective description on "Determinant(s)," "Possible Environmental Impact," "Factors for Use in Evaluation," "Countermeasures," and "Related Studies" provided in Table 3 - 3. Special attention should be paid to whether or not the project is directly linked with the regional market and economy and exerts influence on the regional society or daily life of the people. The actual environmental problems described as "precedents of environmental problems on the dam construction" under Section 4.2 of the Reference may be utilized in identifying the important environmental fields.

Further, it is desirable to take into full account of the opinions and ideas of the recipient country in making the above evaluation.

(5) Overall evaluation

The checklist is filled in with the results of rating of each item together with the basis of judgement. For items rated A - C, referring to the concept and viewpoint of screening, make overall evaluation of whether an environmental impact study is necessary or not and describe briefly the direction of subsequent study. If the environmental impact can be averted by appropriate countermeasures, describe them in detail. It should be noted that an environmental study is necessary if not all the items are marked X (e.g., even if there is only one C).

Furthermore, for the overall evaluation, too, it is desirable to pay ample attention to the opinions and ideas of the government of the recipient country.

The format for the overall evaluation is shown in Table 3 - 4.

Table 3-1 Checklist for Preliminary Survey

Environmental Factor					Evaluation	Basis
Social Environment	Population		1	Change of population in the region (including racial minority problems)		
			2	Resettlement (including racial minority problems)		
	Industry		3	Agriculture and forestry		
			4	Fisheries		
			5	Secondary industry (including mining, mineral resources)		
			6	Tertiary industry (including tourism, recreation)		
	Communications		7	Regional disruption (including racial minority problems)		
	Transportation		8	Impact on land transportation		
			9	Impact on water transportation		
	Water areas and their utilization		10	Impact on water and fishing rights		
	Sanitation		11	Water-born diseases and their spread		
			12	Deterioration of sanitation during work		
	Landscape		13	Deterioration of landscape		
	Cultural assets, etc.		14	Impact on cultural assets		
Natural Environment	Lithosphere	Geological phenomena	15	Induction of earthquakes		
		Topography	16	Slope collapse		
			17	Sedimentation in the backwater section		
			18	Impact on downstream waterways		
			19	Impact on coastal areas		
		Soil Condition	20	Soil erosion		
			21	Soil contamination		

Table 3-1 Checklist for Preliminary Survey (cont'd)

Environmental Factor					Evaluation	Basis
Natural Environment	Hydrosphere	Water phenomena	22	Inter-basin diversion		
			23	Impact on the groundwater		
			24	Change of flow regime		
		Water condition	25	Change in water temperature		
			26	Eutrophication		
			27	Turbidity		
		Bottom condition	28	Change in composition of bottom		
	Biosphere	Flora	29	Impact on flora		
		Fauna	30	Impact on fauna		
		Aquatic organisms	31	Impact on aquatic organisms		
		Ecosystem	32	Disruption of ecosystem		
	Atmosphere	Air	33	Air pollution		
			34	Changes in micro-climate		
		Offensive odors	35	Offensive odors		
		Noise, vibration	36	Noise and vibration		

Note 1: Evaluation Codes
- A: Great impact
- B: Moderate impact
- C: Little impact
- D: Unclear (Need for further study. It may so happen that the impact becomes clear as the survey progresses.)
- X: No impact and negligible impact

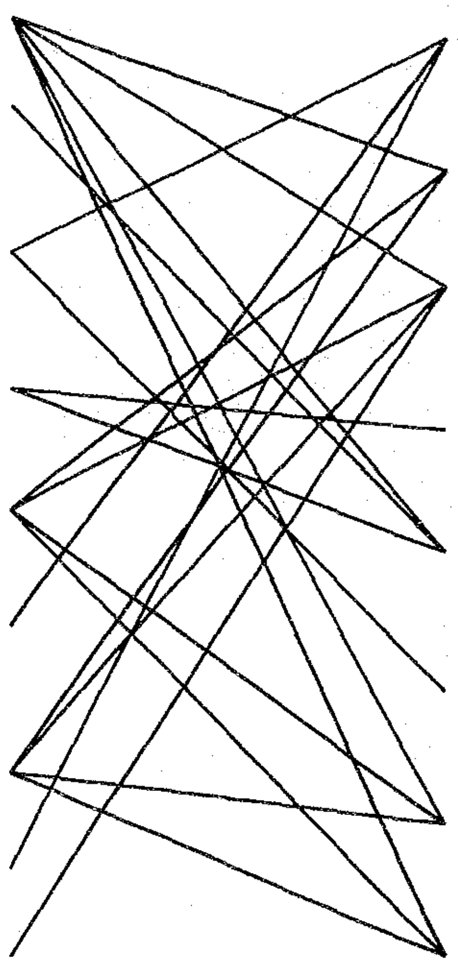
Note 2: When evaluating items, refer to the corresponding sheet of the explanatory notes (pp 22 - 57).

Note 3: Except in very large-scale dam projects, the induction of earthquakes is extremely rare. Furthermore, this evaluation is difficult in a feasibility study, so judgement should be made as carefully as possible.

Table 3 - 2 Matrix for Preliminary Survey (Scoping)

Main activities in dam construction project		
Dam and reservoir	During the work	(1) Dam construction (2) Diversion of existing river
	During operation	(1) Existence of dam and reservoir (2) Regulation of water volume
Borrow pit, Spoil heap	During the work	(1) Collection and disposal of soil
	During operation	(1) Existence of borrow pit, spoil heap
Work roads	During the work	(1) Road construction
	During operation	(1) Existence of road (2) Operation of vehicles

Cause and effect relationship



Social environment

Activities which are considered to have an impact on the environment	Change in population distribution	Resettlement	Agriculture and forestry	Fisheries	Secondary industry	Tertiary industry	Regional disruption	Impact on land transportation	Impact on water transportation	Water rights, fishing rights	Water-born diseases	Sanitation during the work	Deterioration of landscape	Effect on cultural assets
Space occupancy	○	●	○	○	○	○	○	○	○	○	○		○	●
Alteration of topography			○		○	○	○	○					○	●
Operation of construction machines and vehicles								○						
Change in flow regime			○	○					○	○	○			
Change of water condition			○	○						○	○		○	
Sedimentation														
Assembly of workforce	○										○	○		
Accumulation of materials												○		

Natural environment

Activities which are considered to have an impact on the environment	Induction of earthquakes	Slope collapse	Sedimentation in back-water section	Impact on downstream waterways	Impact on coastal areas	Soil erosion	Soil contamination	Change in basin area	Impact on ground-water	Change in flow regime	Change in water temperature	Eutrophication	Turbidity	Change in bottom composition	Impact on flora	Impact on fauna	Impact on aquatic organisms	Ecology	Air pollution	Change in micro-climate	Offensive odors	Noise, vibration
Space occupancy	○		○			○			○	○	○	○	○		●	●	●	●		○		
Alteration of topography		○				○	○		○				○		●	●		●				
Operation of construction machines and vehicles							○									○		○	○		○	○
Change in flow regime				○	○	○		○	○	○	○	○	○	○			○	○				
Change of water condition				○	○	○		○	○			○	○	○			○	○				
Sedimentation			○	○	○	○				○			○									
Assembly of workforce												○										
Accumulation of materials												○										

Note:

● : Extent of impact and availability of countermeasures for these items determines whether dam is feasible or not.

Table 3-4 Overall Evaluation

Environmental factor	Evaluation	Follow-up Survey Plan	Remarks

Table 3 - 3 Explanation of Items - 1

Major heading	Social environment	Secondary heading	Population	Minor heading	
Item	Change of population distribution in the region (including racial minorities problems)				
Determinant(s)	The existing population is forced to move by the acquisition of land for a reservoir or construction site. Also, the population distribution in the region can be changed by people coming in to the site area to provide commercial services to working personnel who have come to live in the area temporarily. Further, when the dam is being operated, population movements may cause depopulation of the region or conversely, there may be an influx of people owing to the start of commercial activities (fisheries, commercial districts), increased employment, tourism and the availability of recreational facilities.				
Possible Environmental Impact	A change in the population distribution due to construction work will have a bad effect on the regional economy and cause problems with distribution, necessitating revision of the regional plan and provision of new infrastructure. This type of social impact can also affect the existing base of government, cause confrontation between the government and the people in the region and create public order problems—especially if there are racial minorities.				
Factors for Use in Evaluation	1. The population distribution in a project area suggests that a high resettlement ratio will cause great problems. 2. Impact will be large where the local population plays a significant role in the regional economy. 3. A region has special racial characteristics or minority groups which have caused disputes or confrontation in the past, suggesting that opposition is likely. In such cases, the impact will be great.				
Counter-measures	1. Selection of suitable project area 2. Study of resettlement plan 3. Release of adequate information beforehand, dialogue, maintenance of public order, economic assistance, etc.				
Related Studies	1. Movement plan. Relocation measures 2. Regional economy 3. NGO recommendations, trends, etc.				

Table 3 - 3 Explanation of Items - 2

Major heading	*Social* environment	*Secondary* heading	*Population*	*Minor* heading	
Item	Resettlement (including racial minority problems)				
Determi-nant(s)	The existing population is moved due to the acquisition of land for the reservoir and construction site				
Possible Environ-mental Impact	The loss of the basis for living of the resettled people and their anxiety about adaptability to their new surroundings in the social and cultural senses can create opposition to the dam project, give rise to conflicts of interest and to internal political problems and intensify racial confrontation. On the other hand, resettlement can also improve the living environment and benefit the economy. Resettlement is a fundamental issue which determines the success or failure of a dam project. Resettlement problems occur easily where there are racial minorities.				
Factors for Use in Evaluation	1. Resettlement is difficult when the particular environment supports the livelihood of the local people. 2. The more economically affluent the inhabitants in the region are, the more difficult it is to resettle them. 3. When there are racial problems among the resettled people a cautious approach is required. 4. Having no attractive resettlement area in the environs of the dam causes great problems.				
Counter-measures	1. Reconsideration of resettlement plan 2. Study of adequate compensation in economic and cultural terms 3. Release of information beforehand, communication, dialogue, etc. 4. Making provisions for the peoples' livelihoods and economic well-being in the resettlement area. 5. Giving assistance for change of occupation				
Related Studies	1. High-ranklng policies 2. Racial distribution, regional economy 3. Suitable resettlement locations				

Table 3 - 3 Explanation of Items - 3

Major heading	Social environment	Secondary heading	Industry	Minor heading	
Item	Agriculture and forestry				
Determinant(s)	The existence of the reservoir, road works, borrow pit, construction site, etc., causes the disappearance of agricultural land and forest areas. In addition, there can be changes in hydraulic conditions in land adjoining the reservoir and in areas downstream, as well as in soil constituents.				
Possible Environmental Impact	Damage to or disappearance of agricultural land and forest areas will reduce agriculture and forestry production and have a negative impact on the regional economy. Other effects are the deterioration of agricultural drainage and the inability to have logs transported. A reservoir often hinders access to working areas for people engaged in agriculture and forestry, but in some cases, the advent of new water transportation and roads makes access to outlying areas easier and stimulates the regional economy, in particular, forestry. A reservoir can provide favorable hydraulic and climatic conditions for agriculture and forestry in the surrounding area.				
Factors for Use in Evaluation	1. Impact from reservoir, road works, borrow pit, etc. is large when agriculture and forestry are very active industries. 2. The problem becomes serious when agriculture and forestry play a significant role in the regional economy and employ a large number of people. 3. Transportation systems after appearance of reservoir				
Countermeasures	1. Sufficient compensation for loss of agricultural land and forest areas 2. Secure alternative areas for agriculture and forestry 3. Provide alternative means of transportation				
Related Studies	1. Flora 2. Regional economy 3. Form of agriculture and forestry management				

Table 3 - 3 Explanation of Items - 4

Major heading	Social environment	Secondary heading	Industry	Minor heading	
Item	Fisheries				
Determinant(s)	The reservoir and the dam will both change the fisheries environment. Turbidity during the work, change in flow regime during operation of the dam, eutrophication caused by the reservoir and change in water temperature will all have a negative impact on fish habitats.				
Possible Environmental Impact	There will be a change in the appearance of fish species currently being caught, reduction in spawning and breeding grounds and fish movements will be affected. This will affect the quantity and quality of fish caught. However, there is the possibility that fish breeding in the reservoir area will create opportunities for employment and production.				
Factors for Use in Evaluation	1. There will be a serious problem if the local people gain their livelihood from fishing. 2. There are many species of freshwater fish that are sensitive to turbidity and changes in current velocity and are likely to migrate. 3. The problem will be serious if fisheries plays a significant role in the regional economy.				
Countermeasures	1. Adequate compensation for people engaged in fishing 2. Maintain flow volume, preserve spawning grounds and habitats, provide fish ladders 3. Limit range of fluctuation of water level in reservoir 4. Promote new fisheries in reservoir area (fish breeding, etc.)				
Related Studies	1. Ecology and habitats of aquatic organisms 2. Lakes and marshes, water quality, bottom quality 3. Water areas and their utilization, regional economy (including markets)				

Table 3 - 3 Explanation of Items - 5

Major heading	Social environment	Secondary heading	Industry	Minor heading	
Item	Secondary industry (including mining, mineral resources)				
Determi-nant(s)	Secondary industry will be affected by loss of land caused by construction work (flooding, land acquisition, etc.). Also, utilization of mineral resources will be hampered and the possibility of developing them lost.				
Possible Environ-mental Impact	This effect on the secondary industries has a negative impact on the regional economy, employment opportunities are reduced and valuable mineral resources can no longer be exploited. Mines often cause an increase in acidity and other forms of deterioration in water quality, which should be taken into account.				
Factors for Use in Evaluation	1. Special consideration is required when a region has important secondary industries. 2. The submerging of valuable mineral deposits (oil, coal. uranium, etc.) is a huge loss for a country both regionally and nationally.				
Counter-measures	1. Adequate compensation for workers or development of alternative industries 2. Reassessment of economy based on dam construction				
Related Studies	1. Mineral resources, water quality 2. Regional economy, urban planning 3. Future plans for the region (regional promotion, etc.)				

Table 3 - 3 Explanation of Items - 6

Major heading	Social environment	Secondary heading	Industry	Minor heading	
Item	Tertiary Industry (including tourism, recreation)				
Determinant(s)	Loss of land through submersion or acquisition for construction purposes and topographical changes have a negative effect on the surroundings where tertiary industries are based.				
Possible Environmental Impact	In addition to being hampered by such loss of land, the existing tertiary industries could suffer from the change in population distribution accompanying the construction work, the negative effect on commercial activities of resettlement, change in regional economic structure and employment opportunities. Also, restriction of the use of leisure facilities can have a negative effect on the economy. On the other hand, the advent of a reservoir can create opportunities for new leisure-related industries.				
Factors for Use in Evaluation	1. Impact is great where tertiary industries play a significant role in the regional economy and many people are employed by them. 2. Where a region is close to a large urban area its utilization value is very high. 3. Tertiary industries require special attention when they are founded on scenic views, waterfalls, mountain streams and other aspects of the natural environment.				
Countermeasures	1. Guarantee minimum discharge, or provide workers with adequate compensation 2. Develop alternative industries 3. Use the reservoir and borrow pit as park facilities, etc.				
Related Studies	1. Regional economy, urban planning 2. Future plans for region (regional promotion, etc.)				

Table. 3 - 3 Explanation of Items - 7

Major heading	Social environment	Secondary heading	Communications	Minor heading	
Item	Regional disruption (including racial minorities problems)				
Determinant(s)	Acquisition of land for the reservoir and dam embankment will harm existing transportation and impede peoples' movements and the distribution of goods, causing disruption of communications in the region.				
Possible Environmental Impact	Disruption of regional communications causes inconvenience to the local people, and may adversely affect economic activities and the political base of regional governments. It can also cause regional isolation, create opposition from the local population and generate demand for the provision of new infrastructure. A discrepancy in benefits between the areas above and below a dam generally gives rise to conflict. This happens easily when there are racial minorities present.				
Factors for Use in Evaluation	1. Impact will be great if the region has good transportation and communications systems. 2. Caution is especially required when racial problems exist within the project area or its environs. 3. Measures need to be taken when regional isolation occurs.				
Countermeasures	1. Adequate compensation 2. Provide new transportation system 3. Provide telecommunications system				
Related Studies	1. Structure of society in region 2. Transportation system, distribution of goods, regional economy 3. High priority regional development plans				

Table 3 - 3 Explanation of Items - 8

Major heading	Social environment	Secondary heading	Transportation	Minor heading	
Item	Impact on land transportation				
Determinant(s)	Human movements and the existing surface transportation system are restricted because land is submerged by the reservoir and land is acquired for various facilities and the construction of work roads. The existing transportation system will be affected in particular by the operation of work vehicles, which add to traffic volume.				
Possible Environmental Impact	Restriction of the surface transportation system and human movements will cause disruption of goods distribution and communications, have a negative effect on the regional economy and cause inconvenience in peoples' lives. The increase in traffic volume due to work vehicles, traffic jams, noise, vibration and dust, as well as reduced traffic safety, are all possible effects. In addition, the replacement of roads and the construction of work roads can produce noise and exhaust gas pollution, which have an adverse effect on plant and animal life. However, in many cases, the existing transportation system is greatly improved, which has an excellent effect on the region's social environment.				
Factors for Use in Evaluation	1. If existing roads and railways are submerged, it is necessary to replace them or provide alternative transportation. 2. Traffic pollution will increase where existing roads are used for the transportation of materials. 3. After completion of the work, work roads are often used for dam operation or general purposes.				
Countermeasures	1. Replacement of routes 2. Provision of new transportation system (in the case of the Wonogiri dam in Indonesia, a submerged railway was replaced by a road and the means of transport changed from train to bus) 3. Installation of traffic safety facilities 4. Installation of noise barriers				
Related Studies	1. Current conditions of regional transportation 2. Replacement of transportation routes 3. Alternative transportation plans 4. Traffic safety plans				

Table 3 - 3 Explanation of Items - 9

Major heading	Social environment	Secondary heading	Transportation	Minor heading	
Item	Impact on water transportation				
Determinant(s)	River channel is blocked by dam embankment. The use of boats is hampered by the temporary and permanent works. The flow regime in the downstream channel is changed by the reservoir. Owing to decreased river flow at flood times, natural maintenance of the river channel is reduced.				
Possible Environmental Impact	Shipping which passes the dam location will be disrupted. However, the reservoir will facilitate water transport above the dam. When a dam is used to increase river flow when the river is low, this helps river transportation below it, but use of the dam to store water in the reservoir or diversion of the river can seriously affect shipping. Shipping below the dam will be endangered by sudden water discharge. Tourism and leisure can be affected when river transport is disrupted. Shipping at the river mouth will be hampered by sandbanks which are not washed away.				
Factors for Use in Evaluation	Impact will be large where a lot of shipping passes the dam location or plies the part of the river where flow will be reduced.				
Countermeasures	1. Installation of lock gates, inclines, etc. 2. Provision of alternative means of transport 3. Application of operation rules with consideration of water transportation 4. Compensation				
Related Studies	1. Current condition of water transportation 2. Proposed alternative transportation plans				

Table 3 - 3 Explanation of Items - 10

Major heading	Social environment	Secondary heading	Water areas and their utilization	Minor heading	
Item	Impact on water and fisheries rights				
Determinant(s)	The advent of the reservoir, dam and other facilities and the turbidity during work will change the conditions for river utilization.				
Possible Environmental Impact	Disappearance of existing fishing and water rights will cause confusion in the utilization of the river for fishing, drinking water, agriculture and industry, with possible disputes and antagonism among the local residents. In general, conflicts can easily occur when there is a difference in benefits between the areas above and below a dam. Water intake facilities are submerged. Alteration of water utilization downstream due to changes in flow regime and water quality. Loss of opportunities for existing fishing, leisure and other industries.				
Factors for Use in Evaluation	1. There will be a great impact where utilization of the river is very important to the local population and industry. 2. In many cases rights to utilization of river water are not established legally, but by tradition. 3. Where there are facilities for water intake or shipping, rights exist since it is considered that water rights have been established, in a practical sense. 4. Where a river flows through different countries, it is necessary to gain the understanding of the individual countries.				
Countermeasures	1. Installation of alternative facilities 2. Operation rules in consideration of existing water utilization 3. Prudent work planning and implementation 4. Compensation				
Related Studies	1. Regional economy 2. River hydraulics				

Table 3 - 3 Explanation of Items - 11

Major heading	Social environment	Secondary heading	Sanitation	Minor heading	
Item	Spread of water-born diseases				
Determi-nant(s)	The reservoir provides a breeding ground for pathogenic organisms, which further spread to the area downstream of the dam. A change in flow regime can also cause the appearance and propagation of disease-causing organisms downstream of the dam.				
Possible Environ-mental Impact	The spread of water-born diseases will have a serious effect on the health of the people living below the dam. Examples are such parasite diseases as snail fever, malaria, filariasis and various contagious diseases				
Factors for Use in Evaluation	1. Care is needed where there have been outbreaks of disease in the past in the area. 2. Note should be taken whenever conditions such as stagnation of the river water, elimination of turbidity, or other changes in water quality have been created.				
Counter-measures	1. Spreading of chemicals 2. Provision of medical facilities, periodic health examination 3. Disrupt breeding grounds of pathogenic organisms (e.g. design for an increase in flow in a water-way preventing the intermediate host stage of blood flukes or impeding the propagation of the malarial mosquito by adjusting the water level in the reservoir) 4. Educate local residents about sanitation and hygiene				
Related Studies	1. Condition of sanitation in the region 2. Aquatic organisms				

Table 3 - 3 Explanation of Items - 12

Major heading	Social environment	Secondary heading	Sanitation	Minor heading	
Item	*Deterioration of sanitation during work*				
Determinant(s)	With an increase in the local population due to an influx of personnel for the construction work and the accumulation of commercial services people accompanying them, there is a risk of contagious disease carriers coming into the area. Also, garbage and human waste can cause deterioration of sanitation in the area surrounding the construction site and the area along the river downstream of the dam.				
Possible Environmental Impact	*Site personnel and people living in the neighboring area become sick due to deterioration in sanitation around the construction site. Putting garbage and human waste into the river can spread disease and have a serious effect on sanitation and peoples' health in areas below the dam.*				
Factors for Use in Evaluation	1. Impact will be greater where the influx of people into the area is greater. 2. Impact will be more pronounced if a greater number of people live in the local site and dowstream areas.				
Countermeasures	1. Provide sanitary and health facilities (water supply and drainage, medical facilities, thorough treatment of garbage and human waste, periodic medical examinations) in the site area. 2. Ensure site personnel are aware of hygiene requirements.				
Related Studies	1. Conditions of utilization of river water 2. Population distribution				

Table 3 - 3 Explanation of Items - 13

Major heading	Social environment	Secondary heading	Landscape	Minor heading	
Item	Deterioration of landscape				
Determi-nant(s)	After construction of the dam, reservoir, work roads and borrow pit fine landscape may be spoiled. The existing landscape downstream will be harmed by the disappearance of water or reduced flow in downstream channels on account of diversion.				
Possible Environ-mental Impact	Destroying a fine landscape by changing the flow regime, topography and flora will cause discontent among people who come to appreciate it, and opportunities for tourism and other tertiary industries will be lost.				
Factors for Use in Evaluation	1. Landscape features closer to the reservoir, work roads, borrow pit, construction site, etc. suffer greater impact. 2. The greater the value of the landscape to the tourism and leisure industries, the larger the impact. Demands may be made to preserve a landscape if it is a special one.				
Counter-measures	1. Re-examine bases for planning, change dam site 2. Consideration of landscape in design of facilities 3. Planting shrubs and trees on borrow pit and road slopes,rapid restoration of environment, setting up parks, etc. 4. Business compensation				
Related Studies	1. Distribution of flora 2. National parks, designation of areas for conservation of natural environment 3. Tourism value survey				

Table 3 - 3 Explanation of Items - 14

Major heading	*Social* environment	Secondary heading	*Cultural* assets	Minor heading	
Item	Impact on cultural assets				
Determinant(s)	The work for reservoir, road or railway replacement, work roads, borrow pits, etc. could cause damage to or disappearance of cultural assets at the site and disrupt traffic to the site. If transport made access too easy and the number of visitors increased, cultural assets could lose their value and the danger of their being removed would increase.				
Possible Environmental Impact	The disappearance of cultural assets or damage to them would mean lost opportunities for academic research and for the tourist and other tertiary industries which accompany them. Their loss could also have an emotional impact on the local residents. There are cases when dam construction becomes unfeasible if there is no possibility of preserving the cultural assets.				
Factors for Use in Evaluation	1. Cultural assets in close proximity to reservoir, replacement roads, work roads, borrow pit and construction site are easily affected. 2. Impact is great if the cultural assets are very important to the world culturally and historically. The more special the cultural asset to a place, the more likely will be calls for its preservation. Relocation can be considered as a possible countermeasure. 3. The older a country's history, the greater the number of cultural assets which should be preserved. 4. It is necessary to exercise special caution in handling cultural properties stipulated in treaties and laws. 5. The evaluation of the recipient country should be used as a reference.				
Countermeasures	1. Re-examination of dimensional plan, change of dam site 2. Protection of cultural assets, relocation 3. Dialogue with local residents, release of information 4. Business compensation				
Related Studies	1. Paleontology, archaeology 2. Regional history, ethnology 3. Plans for protection or relocation work				

Table 3 - 3 Explanation of Items - 15

Major heading	Natural environment	Secondary heading	Lithosphere	Minor heading	Geological phenomena
Item	Induction of earthquakes				
Determinant(s)	Earthquakes can be caused by rupture of the earth's crust owing to an increase in load on it from the reservoir water or an increase in internal pressure from water infiltration.				
Possible Environmental Impact	Seismic activity may increase after the construction of a dam. However, it is believed that the magnitude of induced earthquakes would not exceed that of those naturally occurring in the region before the construction. Induced earthquakes often take place in the course of ponding the reservoir, and may accelerate slope failure due to ponding. It is thought that a reservoir can also dampen seismic activity since its water mass suppresses the rupture of bedrock.				
Factors for Use in Evaluation	1. Earthquakes often occur where there are many faults. 2. Induced earthquakes are common in earthquake-prone regions. 3. The likelihood of induction is great for very deep reservoirs (e.g. over 100 m. deep). 4. There have been no cases of significant damage from induced earthquakes up to now.				
Countermeasures	1. Avoid rapid increases in water depth 2. Provide earthquake monitoring systems				
Related Studies	1. Collection and analysis of earthquake records 2. Geological surveys				

Table 3 - 3 Explanation of Items - 16

Major heading	*Natural environment*	Secondary heading	*Lithosphere*	Minor heading	*Topography*
Item	*Slope collapse*				
Determi-nant(s)	Slopes in the neighborhood of a reservoir can slip due to a loss of stability caused by the increase in water volume as the reservoir gets deeper, or slippage can result from pore pressure remaining in sloping ground if there is a sudden drop in the reservoir water level. In addition, there can be slope collapse in man-made slopes resulting from embankment, borrow pit, spoil heap and road work.				
Possible Environ-mental Impact	The following can result from slope collapse: land devastation; traffic disasters; turbidity in rivers and reservoirs; flooding due to blockage of rivers; disasters caused by avalanches of earth and rocks; deterioration of landscape and scenery. In addition, a landslide into a reservoir can cause a solitary wave which may breach or break the dam, causing great damage in the areas downstream. Slope collapse harms the landscape and scenery.				
Factors for Use in Evaluation	1. Slope collapse is likely to occur in areas where the topography and geology are conducive to it. 2. Rainfall and earthquakes are likely to intensify slope collapse.				
Counter-measures	1. Drainage 2. Soil removal (to reduce load) 3. Slope protection work 4. Planting slopes, landscaping				
Related Studies	Topography, geology, soil				

Table 3 - 3 Explanation of Items - 17

Major heading	Natural environment	Secondary heading	Lithosphere	Minor heading	Topography
Item	Sedimentation in the backwater section				
Determinant(s)	The flow at the top end of the reservoir and at the entry point of branch streams suddenly spreads, resulting in a drop in current velocity and in ability to carry soil, which causes sedimentation in these areas.				
Possible Environmental Impact	Areas above the dam suffer from increased flooding due to an increase in the flood water level caused by sedimentation. Sedimentation occurs at high points in the reservoir water level, reducing effective reservoir volume. Sediment accumulates on land at the upper end of the reservoir.				
Factors for Use in Evaluation	1. Can happen easily if river carries a lot of bed load. 2. Suspended loads of large grain diameter may also deposit in this section. 3. The problem of flooding is apt to occur where there is land vulnerable to inundation or immediately upstream of the backwater section.				
Countermeasures	1. Restrict flow of sediment in upper basin 2. Excavation 3. Adequate purchase of land for site				
Related Studies	1. Suspended sediment 2. Backwater analysis				

Table 3 - 3 Explanation of Items - 18

Major heading	Natural environment	Secondary heading	Lithosphere	Minor heading	Topography
Item	Impact on downstream waterways				
Determinant(s)	Because sediment is selectively trapped by the reservoir and water discharge is controlled by the dam, downstream channels will receive less sediment than before and their composition will be different. The flow regime will change greatly too. Further, bringing in water from neighboring basins and the discharge of water outside the basin will change the dam's basin and the flow regime, altering the form and capacity of sediment transport in the downstream channels.				
Possible Environmental Impact	The undermining of foundations for levees, bridges and water intake facilities by lowering the river bed; reduced function of water intake facilities or their loss; erosion of river bank; local accumulation of sediment due to change in flow regime; silting up of river mouth, which causes flooding and hampering of shipping.				
Factors for Use in Evaluation	1. The more sediment a river carries, the greater the impact 2. The bigger the reservoir, the greater the impact 3. The greater the number of bridges, flood control and irrigation facilities below the dam, the larger the impact 4. Clearing by natural means of river mouths which silt up easily may become difficult due to a decrease in flood water discharge.				
Countermeasures	1. Installation of revetments and groynes, bed protection 2. Training dikes, spur dikes 3. Channel excavation				
Related Studies	1. Sediment transport 2. Existing facilities (bridges, flood control, irrigation, etc.) 3. Littoral sand drift, morphological changes at river mouth				

Table 3 - 3 Explanation of Items - 19

Major heading	Natural environment	Secondary heading	Lithosphere	Minor heading	Topography
Item	Impact on coastal areas				
Determinant(s)	Coastal erosion can occur when the supply of sediment brought down by a river maintaining coastal landforms in the vicinity ofthe river mouth is reduced due to dam construction. Sediment supply is reduced by sedimentation in the reservoir, and it may also be caused by a reduction in the amount of sediment supply from accumulations in river channels when a change in flow regime reduces the sediment transport capacity.				
Possible Environmental Impact	The loss of sand beaches can reduce an area's tourism and recreational value and inconvenience in the fishing industry. Land can be lost through a receding coastline. The ability of the sea bed to absorb wave energy would be reduced by changes in the seabed topography, which in turn would increase the damage caused by waves. With the disappearance of gently sloping beaches, it would become impossible to pull fishing boats ashore.				
Factors for Use in Evaluation	1. Impact will be significant where the coastline is fed by a river carrying a large amount of sediment. 2. The greater the utilization value of the beach, the greater the problem. 3. Special attention is required when an area already has problems with coastal erosion and damage by waves. 4. It takes a long time for the impact to become apparent (more than 10 years).				
Countermeasures	1. Wave dissipation work, offshore breakwaters and other measures against coastal erosion 2. Beach protection 3. Breakwaters 4. Rampways for ships 5. Provision of long-term monitoring system				
Related Studies	1. Sediment transport 2. Drifting sand along coast 3. Records of changes in beachline				

Table 3 - 3 Explanation of Items - 20

Major heading	Natural environment	Secondary heading	Lithosphere	Minor heading	Soil condition
Item	Soil erosion				
Determinant(s)	Erosion occurs naturally as a result of erosion-prone topography, soil conditions, and rainfall. Impact is caused or aggravated by artificial phenomena such as deforestation, pasturing, or cultivation of slopes. Soil erosion on the land in the area surrounding the dam is sometimes aggravated by the construction of the dam itself, by construction of roads or other ancillary facilities, or by compensatory work. The cultivation of slopes or the shifting of cultivation by farmers who lose their land due to inundation may aggravate soil erosion.				
Possible Environmental Impact	There may be loss or reduction of the productivity of the land, or increase in the risk of disaster. There may be contamination of the water supply to downstream areas, as well as, decreased fertility of the soil due to reduction in the supply of sedimentation, reduction of the storage capacity in the reservoir, and perhaps total burying of the dam. When a dam is completely buried, soil and rocks are washed over the dam, causing excessive abrasion on the foot of the downstream side of the dam. This could lead to breakage of the dam and ensuing disaster.				
Factors for Use in Evaluation	1. Special attention must be paid to evidence of soil erosion in upstream locations. 2. Where there is, or is likely to be, pasturing or cultivation of steep slopes in the basin, there is a likelihood of extreme erosion in the future. 3. Cultivation of flatlands, particularly paddy farming, is effective in preventing soil erosion. 4. Basins which are subject to heavy rainstorms are prone to erosion. 5. The more steep slopes there are upstream, the more likely erosion is to occur.				
Countermeasures	1. Protective reinforcement of banks; afforestation 2. Sediment arrestation dams; ravine consolidation dams; etc. 3. Land-use regulations				
Related Studies	1. Landslides 2. Geology, vegetation, and land-use 3. Sediment load				

Table 3 - 3 Explanation of Items - 21

Major heading	Natural environment	Secondary heading	Lithosphere	Minor heading	Soil condition
Item	Soil contamination				
Determinant(s)	There is a danger of pollution from waste oil and other harmful substances, which are discarded during and after construction. There is a danger of the polluting substances being washed to downstream areas and, as a result of mining excavation, of the scattering of harmful minerals.				
Possible Environmental Impact	Harmful substances may be washed down the river, causing problems for downstream water- and land-use and for fisheries, as well as bringing about a reduction in land values.				
Factors for Use in Evaluation	1. Damage occurs readily when there are mines or abandoned mines and mining equipment, discarded industrial waste, or an accumulation of toxic minerals. 2. Damage can easily escalate when there is a lot of water use downstream.				
Countermeasures	1. Waste treatment 2. Moving flora and fauna 3. Ensuring alternative water sources				
Related Studies	1. Geology 2. Downstream water use conditions 3. The ecology of the flora and fauna				

Table 3 - 3 Explanation of Items - 22

Major heading	Natural environment	Secondary heading	Lithosphere	Minor heading	Water phenomena
Item	Inter-basin diversion				
Determinant(s)	In order to improve the effectiveness of the dam, water from an adjoining basin is sometimes introduced into the basin of the dam, or water from the dam is diverted to another basin. In some cases complete flow is introduced or released; and in other cases the introduction or release is carried out when the amount of flow goes below or above a certain level. In still other cases, the water in the reservoir is totally diverted to (an)other basin(s).				
Possible Environmental Impact	After the diversion, only water below the point of diversion is left in the river basin, so the flow may become extremely scant or dry up completely, causing water use problems. There is also a danger of the groundwater along the river drying up. Due to a decrease in the tractive force, there is a possibility of the riverbed rising. Also, there are sometimes bad effects, due to the rise of the water level, or changes in the flow regime or in the water quality in the river that receives the diversion.				
Factors for Use in Evaluation	1. The more water use from the diversion, the bigger the problems. 2. Diversion of the flood flow causes reduction of the tractive force, whereas diversion of the normal or low water discharge has a great impact on the water use downstream.				
Countermeasures	1. Providing water from alternative sources 2. Assuring river maintenance flow				
Related Studies	1. Water use conditions downstream from the diversion				

Table 3 - 3 Explanation of Items - 23

Major heading	Natural environment	Secondary heading	Lithosphere	Minor heading	Water phenomena
Item	Impact on the groundwater				
Determinant(s)	Changing the natural topography by excavation, filling the ground for dam construction, or creating underground impermeable areas by making foundation or grouting, may alter the availability and flow pattern of the ground water. Creation of the reservoir raises the ground water level in the environs, or causes leakages. Due to decreases in the discharge, the condition of the groundwater in the land adjoining the river may change.				
Possible Environmental Impact	There is a danger of wells drying up in the dam environs and in land adjoining the river in downstream areas. Changes in the volume or temperature of water from existing springs around the dam may affect water use in the area. Leakage from the reservoir may cause hazards in the downstream or adjacent areas. Leakage may cause destruction (by dissolution or erosion) of underground geostructure, causing a disaster or destruction of the dam.				
Factors for Use in Evaluation	1. Impact occurs easily in land consisting of highly permeable soil. 2. Negative impact is likely when there is extensive use of underground water (from wells, artesian wells, etc.).				
Countermeasures	1. Design based on adequate survey 2. Cutoff works (grout, blankets, trenches, cutoff walls, etc.) 3. Alternative water sources 4. Drainage equipment and facilities				
Related Studies	1. Topography, geology 2. Irrigation conditions in the dam environs and downstream areas				

Table 3 - 3 Explanation of Items - 24

Major heading	Natural environment	Secondary heading	Hydrosphere	Minor heading	Water phenomena
Item	Change of flow regime				
Determinant(s)	Due to the regulating effects of the reservoir, the downstream flow regime may differ from natural conditions. Generally, the flood discharge decreases and the low water discharge increases. The total volume of runoff in the downstream channel may be reduced due to diversion.				
Possible Environmental Impact	When water is diverted for water use, the amount of water flowing into the downstream channel decreases, possibly having a harmful impact on water use, water transportation, aquatic organisms, scenery, etc. The soil along the channel may lose moisture, which is said to endanger the development of river-side flora and the quality of agricultural products. Due to the averaging effect of the flow, the peak discharge as well as frequency of the flood is reduced, resulting in sedimentation in the river channel, clogging of the estuaries, etc.				
Factors for Use in Evaluation	1. The greater the downstream use of the river, the greater the impact. 2. Special care is needed in cases where the estuary is easily clogged. 3. In cases where the river is shared by more than one country, consultation and mutual agreement are essential.				
Countermeasures	1. Rationalization of dam operation; assurance of river maintenance flow. (In order to ensure unhindered passage of sightseeing boats on one river, guidelines were established for the release of water from an upstream dam so as to maintain a minimum depth of 50 cm.) 2. Construction of after-bay reservoir 3. Issuance of discharge warnings				
Related Studies	1. Studies of actual downstream river use				

Table 3 - 3 Explanation of Items - 25

Major heading	Natural environment	Secondary heading	Hydrosphere	Minor heading	Water condition
Item	Cold water hazard				
Determinant(s)	Problems arise when the water temperature in the river downstream from the dam changes, generally becoming colder, after the construction of the dam's reservoir. The river temperature drops because the water released from the reservoir is colder than the water feeding into the reservoir.				
Possible Environmental Impact	In subtropical and warm regions, from early spring toward summer, the water temperature drops in large, deep reservoirs, manifesting undesirable effects such as retarding the growth of agricultural products and the development of fish species. Manmade lakes in the tropics, on the other hand, maintain a warm temperature year round and there are few problems from changes in water temperature.				
Factors for Use in Evaluation	1. In small reservoirs with great and rapid inflow and outflow, wide-ranging water circulation and active mixing of upper and lower water by convection currents take place, and water quality is nearly uniform: the temperature of the water at the bottom of the reservoir is not much different from that of the inflow, throughout the year. 2. From spring to summer, in large reservoirs where water stands for a long time, the warm water and the stagnant cold water separate into an upper warm layer and a lower cold layer, causing water temperature problems. 3. When the yearly total inflow volume is divided by the total capacity of the reservoir, a ratio of above 20 corresponds to the first case (l above) and a ratio of below 10 to the second case (2). 4. In tropical regions, water temperature changes have virtually no effect on agriculture.				
Countermeasures	1. Selective water intake, i.e., instead of taking water from the deep cold portion of the reservoir, take it from the warmer portion near the surface 2. Facilitate circulation of the water within the reservoir 3. Supply irrigation water through a warming reservoir				
Related Studies	1. Discharge surveys 2. Water temperature surveys (inflow, outflow, reservoir) 3. Evaporation observation				

Table 3 - 3 Explanation of Items - 26

Major heading	Natural environment	Secondary heading	Hydrosphere	Minor heading	Water condition
Item	Eutrophication				
Determinant(s)	Nitrogen and phosphorus brought into the reservoir by the inflowing water are the source of nutrients which encourage the propagation of algae, which, when they die, accumulate on the bottom of the lake. In this way, the organic matter in the lake increases, so the chemical oxygen demand (COD) increases. Besides the flora found in the running water, the flora that grew at the site before creation of the lake also serve as a source of organic material.				
Possible Environmental Impact	Lack of oxygen in the lake may hinder the growth of fish. It may present an obstacle to use of the lake water. Contamination or odor may destroy the area's recreation value. The quality of water downstream may deteriorate. Abundant growth of aquatic plant life may cause increased water loss by evaporation and inconveniences for fisheries, operation of watergates, etc.				
Factors for Use in Evaluation	1. The main sources for nitrogen and phosphorus are residential areas, breeding areas for domestic animals, and general farmland. Eutrophication is likely in the catchment areas where many of these sources exist. 2. Occurrence is likely where water stands for a long time in a big reservoir. 3. The warmer the area, the more likely is eutrophication: in tropical regions, abundant algae and aquatic plant life occur even under natural conditions. 4. When there is already downstream water use, special care is called for.				
Countermeasures	1. Treatment of waste water at the pollution sources in the catchment area 2. Forced circulation of standing water 3. Cleaning of the bottom of the reservoir				
Related Studies	1. Surveys on sources of pollution 2. Estimation of possibility of pollution 3. Downstream water use surveys				

Table 3 - 3 Explanation of Items - 27

Major heading	Natural environment	Secondary heading	Hydrosphere	Minor heading	Water condition
Item	Turbidity				
Determinant(s)	Turbidity of the river increases during floods and usually returns to normal within a few days after a flood. When the reservoir is created, the flood water is stored and released gradually; therefore, the water downstream continues to be turbid over a long period of time.				
Possible Environmental Impact	If the turbidity in the reservoir persists over a long period, there may be significant impact on everyday water use, fisheries, scenery, and recreation activities in downstream areas. Turbid water, which can hinder the propagation of algae and the growth of fish, may have grave effects. For example, there may be propagation of fish which can tolerate turbid water instead of fish, such as *ayu* (sweet smelt), which need clear water.				
Factors for Use in Evaluation	1. Care is needed when water temperature stratification is likely in a large-scale (capacity) reservoir. 2. Turbidity is not problematic in tropical zones where natural water is usually turbid.				
Countermeasures	1. Soil conservation work in the catchment area to reduce water turbidity 2. Install drainage pipes in the lower section of the dam to discharge turbid water soon after the flood 3. Install a stilling basin to settle down suspended particles before supplying water				
Related Studies	1. Study of flood runoff 2. Measurement of turbidity (suspended sediment)				

Table 3 - 3 Explanation of Items - 28

Major heading	Natural environment	Secondary heading	Hydrosphere	Minor heading	Bottom condition
Item	Changes in composition of bottom				
Determinant(s)	Bottom conditions of the reservoir change due to deposition of soil and accumulation of dead bodies and excreta from aquatic flora and fauna. The bottom of the downstream channel changes due to trapping of coarse particles in the reservoir. The bottom changes on account of deposition of waste from upstream agricultural areas, cities, factories, etc.				
Possible Environmental Impact	Impact may include: degeneration of water quality within the reservoir; damage to aquatic organisms; generation of foul odors; changes in the environment of downstream aquatic organisms; deterioration of downstream water quality; difficulty in mining gravel from the downstream channel.				
Factors for Use in Evaluation	1. Where there is a great danger of eutrophication, there is also a danger of changes in the composition of the bottom. 2. Special care should be taken when there might be an inflow of heavy metals from upstream. 3. If fishing will be encouraged in the reservoir, extra care is needed.				
Countermeasures	1. Dredging the bottom 2. Prevention of eutrophication 3. Water treatment 4. Business compensation				
Related Studies	1. Industry in the catchment area 2. Riverbed materials and sediment load 3. Water quality 4. Water use				

Table 3 - 3 Explanation of Items - 29

Major heading	Natural environment	Secondary heading	Hydrosphere	Minor heading	Flora
Item	Impact on flora				
Determinant(s)	The flora on the land for the dam and related facilities, and on the land for the reservoir, is either removed or submerged. Construction of work roads and relocated roads may also have a direct or indirect impact. Environment for plant growth in the downstream area sometimes changes due to change of hydraulic conditions.				
Possible Environmental Impact	There is a danger of extinguishing rare species as well as decreasing animal habitats. Reduction of harvests of forest products such as edible wild plants can have an economic impact on the residents of the area. Threatening survival of the animals which have a food chain with the plant to be extinguished.				
Factors for Use in Evaluation	1. Care should be taken when there are virgin forests in the area for dam construction. 2. Provisions must be made for the preservation of any species which are unique to the area proposed for dam construction. 3. If there are species that are unique to the region in question, cautious consideration must be taken. 4. When the existences of a large number of residents of the area depend on the useful plants, serious problems may arise. 5. Care must be taken when there are multilateral or bilateral treaties on the wildlife.				
Countermeasures	1. Transplanting rare species 2. Lowering the water level of the submerged area 3. Careful planning of routes				
Related Studies	1. Plant life survey 2. Plant and animal ecology survey 3. Resident lifestyle survey				

Table 3 - 3 Explanation of Items - 30

Major heading	Natural environment	Secondary heading	Hydrosphere	Minor heading	Fauna
Item	Impact on fauna				
Determinant(s)	The habitats for the fauna that live on the land to be used for the dam and related facilities, and on the land for the reservoir, are lost. Life and reproduction of fauna may be hampered by exhaust gas or noise emitted during construction work for the dam and roads, etc. Fauna are threatened by the loss of plants on which their sustenance depends, and their movements are obstructed by the reservoir.				
Possible Environmental Impact	There is a possibility of extinction of rare species. The livelihood of inhabitants whose vocation is to catch animals may be threatened, and recreational value may be lost.				
Factors for Use in Evaluation	1. When there are virgin forests or similar wooded lands, care is called for. 2. Provisions must be made for the survival of any species which are unique to the site of the proposed dam. 3. If there are species which are unique to the region in question, cautious consideration must be taken. 4. When a large number of inhabitants of the area live by catching animals, this item is a serious factor. 5. Care must be taken if there are species in the region that are listed as endangered or rare in the *Red Data Book* of the International Union for Conservation of Nature and Natural Resources (IUCN). 6. Care must be taken when there are multilateral or bilateral wildlife treaties.				
Countermeasures	1. Resettlement of rare species 2. Careful route planning 3. Careful construction planning				
Related Studies	1. Animal ecology survey 2. Resident lifestyle survey				

Table 3 - 3 Explanation of Items - 31

Major heading	Natural environment	Secondary heading	Biosphere	Minor heading	Aquatic organisms
Item	Impact on aquatic organisms				
Determinant(s)	Water storage and changes in the flow regime cause changes in water depth, current velocity, water clarity, and water temperature, changing the physical environment for subsistence and reproduction of aquatic organisms. When there is inter-basin diversion of the river, the ecosystem sometimes changes. Water quality degenerates due to eutrophication, and the environment for aquatic organisms changes.				
Possible Environmental Impact	There may be ill effects such as the extinction of rare species or an evolution or increase in the population of an undesirable species. Reduction or change of fishery resources may have a bad effect on industry or recreation. There may be outbreaks of diseases attributable to aquatic organisms, and the lives of creatures whose food chain includes aquatic organisms may be threatened.				
Factors for Use in Evaluation	1. Living conditions for many creatures are affected by the swiftness of the current. 2. There are creatures whose propagation is impeded by very muddy water. 3. Care is needed when aquatic organisms are connected with the spread of endemic diseases. 4. "Fisheries," "Outbreak and Spread of Water-born Diseases,"and "Impact on Fauna" are treated as separate items.				
Countermeasures	1. Reservoir operation 2. Measures to prevent eutrophication 3. Bottom-cleaning work				
Related Studies	1. Aquatic organism ecology 2. Endemic disease survey				

Table 3 - 3 Explanation of Items - 32

Major heading	Natural environment	Secondary heading	Biosphere	Minor heading	Ecosystem
Item	Disruption of ecosystem				
Determinant(s)	Due to the introduction of the dam and the reservoir, and to the inter-basin diversion, there are changes in the factors affecting the existence and reproduction of flora and fauna, such as topography, vegetation, flow regime, water quality, bottom conditions, etc. If some creatures are affected by those changes, they in turn affect other creatures that are linked through living environment and food chain.				
Possible Environmental Impact	Disruption of ecological linkage may cause extinction or reduction of rare or useful living things. There is also the possibility of outbreaks of harmful organisms due to establishment of a new ecosystem. There are cases where disease-carrying agents flourish due to extinction of their natural enemies.				
Factors for Use in Evaluation	1. If there are species or ecosystems unique to only the dam site, or only to the regions that are affected by it, they must be preserved--for example, swampland or mangrove forests, when considered valuable ground of the ecosystem. 2. If there are species that are unique to the region in question, cautious consideration must be taken. 3. This item is a serious problem when the inhabitants live by using useful creatures. 4. See other items for factors concerning "Impact on flora" (Item 29), "Impact on fauna" (Item 30), and "Impact on aquatic organisms" (Item 31).				
Countermeasures	1. Transplanting plants or relocating animals 2. Business reparations				
Related Studies	1. Flora and fauna ecosystem 2. Food chain survey				

Table 3 - 3 Explanation of Items - 33

Major heading	Natural environment	Secondary heading	Atmosphere	Minor heading	Air
Item	Air pollution				
Determinant(s)	Air pollutants are generally said to be the gases produced by burning fuels, work generated smoke, dust, etc. and, in Japan, nitrous oxides, sulfur oxides and minute dust particles. Operation of construction machinery and vehicles generates air pollutants during dam construction work.				
Possible Environmental Impact	It is conceivable that, when the environs of the construction site and the work roads are inhabited, or when there are valuable plants and animals living in the area that might predictably be affected by the generation of air pollutants, they might be affected adversely.				
Factors for Use in Evaluation	1. Institutions which require clean air, such as hospitals and sanatoriums, will be affected. 2. If the environs of the construction site and the work roads are inhabited, the inhabitants will be affected. 3. If there are valuable virgin forests or rare plant or animal species in the environs of the construction site and the work roads, they will be affected.				
Countermeasures	1. Selection of reasonable sites 2. Use of efficient construction methods that generate as few pollutants as possible				
Related Studies	1. Distribution of houses in the environs of the construction site and the work roads; in-depth study of the populace's living situation (including population) 2. Distribution of valuable plants and animals in the environs of the construction site and the work roads				

Table 3 - 3 Explanation of Items - 34

Major heading	Natural environment	Secondary heading	Atmosphere	Minor heading	Air
Item	Changes in microclimate				
Determinant(s)	When a reservoir is created, it is accompanied by microclimatic changes that include increased precipitation, wind, fog and thunderstorms in some cases, and of course, evaporation from the surface of the lake. Japan's reservoirs are relatively small in both area and capacity on a world scale, and the degree of change to the local microclimate is not significant.				
Possible Environmental Impact	The difference between the rate of change of the reservoir's surface water temperature and that of the atmospheric temperature sets up a pattern of convection currents peculiar to the reservoir and the area surrounding it. From spring to summer, the air rises above the warm ground in the evening and falls to the reservoir, generating a lake breeze. In the winter it is just the opposite. As the area surrounding the lake cools down, a warm upward current over the warmer reservoir and the falling air over the land generate a land breeze. In this way, the air temperature and humidity in the region around the reservoir, particularly on the banks, are affected by the breezes, and the temperature falls. In tropical zones, there is considerable evaporation from the surface of the reservoir during the daytime; and, as the evening temperature drops in dry and windless areas, the moisture above the lake cools, sometimes creating fog. The rise in humidity is caused by evaporation from the reservoir. There have been cases of lung disorders and outbreaks of plague in such areas. Rainfall around the lake may increase, causing damage to the region's agriculture; or on the other hand, production sometimes may increase.				
Factors for Use in Evaluation	1. Particularly in arid or semi-arid zones, the larger the scale of the reservoir, the greater the possibility of problems occurring. 2. Care should be taken of changes in wind direction and wind speed due to changes in the topography in the construction site. 3. If the area of the reservoir is not large (say less than 100 m), changes in microclimate are not likely to occur.				
Countermeasures	1. Taking disaster prevention measures against heavy rainfall 2. Making ample reparations if a disaster occurs 3. Agricultural guidance and assistance				
Related Studies	1. Meteorological survey (climate, precipitation, temperature, evaporation, wind force) 2. Simulation study				

Table 3 - 3 Explanation of Items - 35

Major heading	Narural environment	Secondary heading	Atmosphere	Minor heading	Offensive odors
Item	Production of offensive odors				
Determi-nant(s)	Offensive odors are generally defined as gases that give off smells which are unpleasant to humans. Japanese government ordinances list eight substances, which include methyl-mercaptan, hydrogen sulfide, and ammonia, etc. During the work, construction equipment, vehicles, etc. give off various exhaust gases and offensive-odor producing substances. When the dam is put into service, submerged trees decay and produce offensive odors; and water-weed that has propagated in the reservoir decomposes, also producing offensive smells.				
Possible Environ-mental Impact	Inhabitants of the environs of the construction site, the work roads, and the reservoir may be affected. There may be a detrimental effect on the tourism industry.				
Factors for Use in Evaluation	1. If there is no one living in the environs of the construction site, work roads, and reservoir, there is no impact. 2. In regions, particularly tropical regions, where floating waterweeds (water hyacinth. etc.) are evident, care is needed. 3. If the reservoir area (stagnant area) of the dam is large and aquatic plants luxuriate, impact will be great.				
Counter-measures	1. Examination and improvement of construction methods that do not produce offensive odors 2. Removal of waterweeds as appropriate 3. Dredging of the lake bottom 4. Anti-eutrophication measures such as forced circulation 5. Reparations to tourism businesses				
Related Studies	1. The living conditions and population distribution in and around the construction site, work roads, and reservoir and environs 2. Aquatic organisms (floating waterweeds, water hyacinth, etc.) survey, to include distribution and examples of occurrence in the waters of the environs				

Table 3 - 3 Explanation of Items - 36

Major heading	Natural environment	Secondary heading	Atmosphere	Minor heading	Noise, vibration
Item	Production of noise and vibration				
Determinant(s)	During work, noise and vibration are produced by the operation of construction machinery and vehicles, blasting, and the like. Passing of vehicles on relocated roads produces noise and vibration.				
Possible Environmental Impact	Noise and vibration may exert an impact on residents of the environs of the construction site and work roads. Wild animals may flee; and there may also be a negative impact on breeding of domestic animals as well.				
Factors for Use in Evaluation	1. Prudent consideration is called for when there are facilities that need tranquillity, such as hospitals and sanatoriums in the vicinity. 2. If people are living in the environs of the construction site and work roads, the impact is great. 3. When rare wild animals inhabit the environs around the construction site and work roads, and when there is breeding of domestic animals, deliberate countermeasures are called for.				
Countermeasures	1. Working with low-noise, low-vibration machinery; installation of noise-reducing barriers 2. Adjustment of working hours (including blasting)				
Related Studies	1. The living conditions and population distribution of the people living around the construction site and work roads 2. Distribution of the rare animals around the construction site and work roads				

Chapter 4
Basic Matters Concerning Environmental Impact

4.1 Items for Consultation with the Government of the Recipient Country at the Implementation of Screening and Scoping

The matters to be consulted about by those who are engaged in the preliminary study with the government of the recipient country at the implementation of screening and scoping, are the items included in the checklists in Chapter 3 Scoping. It is desirable to have a full discussion on the relevant environmental elements among those included in the checklist; however, in some cases, the expected result might not be achieved because of the limited time available during the preliminary study.

In view of the above, it is efficient for facilitating smooth proceeding of discussion to make a prior request to the officer in charge of the recipient government to collect and collate necessary information about the items relevant to the preliminary study. In order to perform the work effectively, it is useful to concentrate the discussion on the items that may cause serious environmental problems as shown by experience (for example, items related to human life, relocation, safety, sanitation, economy, and culture). It should be noted that relocation is a serious issue that may determine the success of the dam project and as such, it should be examined carefully.

Table 4 - 1 lists the environmental items which should be discussed fully with the government of the recipient country, and examples of the content of the study proposed.

Table 4 - 1 Items Which Should Be Given Priority in Discussion with Foreign Governments and Survey Details

Environmental factor		Survey details
Laws relating to environment		Included in scope of national parks, etc.?
Population	Changes in population distribution in the region	Have there been inter-racial disputes or problems arising from cultural differences in the project area?
	Resettlement	How should compensation problems be dealt with?
Industry	Agriculture and forestry, fisheries, secondary and tertiary industry	Will construction or operation of the dam cause economic hardship?
Sanitation, etc.	Water-born diseases and their spread	Any cases of epidemics in the project area?
Cultural assets, etc.	Impact on cultural assets, etc.	Is there a valuable cultural asset in the region?
Biology	Flora, fauna, aquatic organisms	Is there a valuable species in the region?

4 - 2 Dealing with Laws and Regulations Pertaining to Environmental Assessment

In some countries there are laws and regulations for carrying out environmental assessment, but in other countries no such provisions are made. As to the basic method for dealing with cases where there are legal provisions in the recipient country and the procedures stipulated therein are considered appropriate to the project in question, it is necessary to have a thorough conference with the recipient country with a view to achieving better environmental consideration while observing those provisions. Where there are no such provisions or existing provisions are not adequately enforced, it is necessary to carry out the environmental assessment with a view to performing adequate study of the environmental impacts resulting from implementation of the dam construction plan and to providing appropriate countermeasures while holding consultations based on understanding the consciousness of the people of the recipient country, and taking into account the present state and policy of conservation of the natural environment and improvement of the social environment, and the stages of cultural and economic development of the recipient country.

Table 4 - 2 shows the applicable laws and regulations in the region of the Economic and Social Commission for Asia and the Pacific (ESCAP).

Table 4 - 2 Laws And Ordinances Concerning Execution of Environmental Assessments

Country	Grounds		
	Assessment Laws	General Laws	Administrative Measures
Bangladesh			*
China	*		
Hong Kong			*
India			*
Indonesia	*		
Iran		*	
South Korea		*	
Malaysia		*	
Nepal			*
Pakistan		*	
Papua New Guinea	*		
Philippines	*	*	
Sri Lanka			*
Thailand	*	*	

Adapted from *Environment & Development Series: Environmental Impact Assessment Guidelines for Planners & Decision Makers*, published by the Economic and Social Commission for Asia and the Pacific (ESCAP); and *Development Assistance Environment Preservation Investigation Survey*, March 1988, commissioned by the Environment Agency and prepared by Nomura Research Institute.

4.3 Type and Accuracy of Environmental Data Required at Preliminary Study and Study Method

The types of data required at the Preliminary Study are shown as items in the checklist of Chapter 3 Scoping. As mentioned previously, these items are broadly classified into social environment and natural environment, and cover all the elements that may be influenced by dam construction.

The person in charge of the study will carry out collection, sorting, and examination of the data for these environmental items. Since accurate data and information will be needed only at the stage of full-fledged study, care should be taken not to miss items for study. It is not possible to carry out an actual survey to increase the accuracy of information at the preliminary study stage. Therefore, the source of information is generally existing data, from which information that is deemed highly reliable should be selected. If no such data are available, they will be collected at the time of the full-fledged studies.

The minimum required information that should be obtained by the persons engaged in the preliminary study is listed below.

a) Signatory to treaties related to the environment (Washington Treaty and other bilateral or multilateral treaties), existence of laws, and extent of regulations (laws concerning environmental assessment, such as designation of national parks)
b) Availability of topographic maps, and surveying maps
c) River system conditions
d) Urban districts and population distribution in the region

Table 4 - 3 shows the study method for each environmental item of the checklist to be used in the Preliminary Study. The study method is divided into three forms, namely, field survey, examination of documents and data, and gathering of information from concerned government officials and people in the area concerned. The degree of fitness of each form of study with each environmental item is denoted by " ◎," which is higher than " ○," which is higher than " + ."

Table 4 - 3 Survey Methods for Environmental Data Required in Preliminary Survey

Environmental factor				Site observation	Literature, data	Discussion, etc.
Social environment	Population		Changes of population distribution in region	+	◎	○
			Resettlement	+	◎	○
	Industry		Agriculture and forestry	○	◎	+
			Fisheries	○	◎	+
			Secondary industry (including mining, mineral resources)	+	◎	○
			Tertiary industry (including tourism, leisure)	+	◎	○
	Communications		Regional disruption	+	○	◎
	Transportation		Impact on land transportation	+	◎	○
			Impact on water transportation	+	◎	○
	Water areas and their utilization		Impact on water and fishing rights	+	◎	○
	Sanitation		Spread of water-born diseases	+	◎	○
			Deterioration of sanitation during work	+	◎	○
	Landscape		Deterioration of landscape	+	◎	○
	Cultural assets		Impact on cultural assets	+	◎	○
Natural environment	Geosphere	Geological phenomena	Impact on induction of earthquakes	+	◎	○
		Topography	Slope collapse	○	◎	+
			Sedimentation in backwater section	○	◎	+
			Impact on downstream waterways	+	◎	○
			Impact on coastal areas	+	◎	○
		Soil quality	Soil erosion	+	◎	○
			Soil contamination	+	◎	○

Table 4 - 3 Survey Methods For Environmental Data Required In Preliminary Survey (cont.)

Environmental factor				Site observation	Literature, data	Discussion, etc.
Natural environment	Aquasphere	Water phenomena	Change in water system	+	◎	○
			Impact on ground water	+	◎	○
			Change of flow regime	+	◎	○
		Water quality	Change in water temperature	+	◎	○
			Eutrophication	+	◎	○
			Turbidity	○	◎	+
		Bottom quality	Change in bottom composition	○	◎	+
	Biosphere	Flora	Impact on flora	+	◎	○
		Fauna	Impact on fauna	+	◎	○
		Aquatic organisms	Impact on aquatic organisms	+	◎	○
		Ecology	Disruption of ecology	+	◎	○
	Atmosphere	Air	Air pollution	○	◎	+
			Variation in micro-climate	+	◎	○
		Offensive odors	Production of offensive odors	○	◎	+
		Noise, vibration	Production of noise and vibration	○	◎	+

Legend: Ranking of survey method ◎ → ○ → +

4.4 Method Of Utilizing Local Knowledge

While information related to the project area is obtained mainly from existing documents and data and site observation, there are cases in which the information collected by such methods is not sufficient.

Although accurate data can be collected at the Feasibility Study and subsequent stages, the knowledge gained from the local people (e.g., university personnel, local learned people, local consultants, and residents of the area) can be fully utilized as outline information. Such information is not always quantitatively expressed but it may contain accumulated knowledge of great value.

As to utilization of local knowledge, efforts should be made to collect as much information as possible at the Preliminary Study. It is possible to use such information for screening and scoping. Further, at the stage of full-fledged study, local people can be actively engaged in collecting information to provide materials for analysis.

Table 4 - 4 shows the environmental items for which information from local people can be used. Information relating to the social environment (e.g., racial problems, communications, sanitation, and landscape) and to fauna and flora in the natural environment is particularly worthwhile. However, it is necessary to examine carefully the content, accuracy and reliability of information from local people before using it.

Table 4 - 4 Environmental Factors for Which Information from Local People Can Be Used and Study Details

Social environment

Environmental factor		Study details
Population	Changes in population distribution in region	Distribution of racial minorities in project area, cultural differences
Communications	Regional analysis	Movements of local people in project area, modes of transport
Transportation	Impact on land transportation	Utilization of land transportation in daily life
	Impact on water transportation	Utilization of water transportation in daily life
Sanitation	Spread of water-born diseases	Cases of epidemics in project area
Landscape	Deterioration of landscape	Places with good landscapes

Natural environment

Environmental factor		Study details
Flora	Impact on flora	Distribution of flora, valuable plant species in the project area
Fauna	Impact on fauna	Distribution of fauna, valuable animal species in the project area
Aquatic organisms	Impact on aquatic organisms	Distribution of aquatic organisms and valuable species in the project area

Chapter 5 Preparation of Reports

5 - 1 Makeup of Preliminary Survey reports and details to be recorded in them

Table 5 - 1 below shows the makeup of a normal Preliminary Survey report and its environmental considerations based on Screening and Scoping for a dam construction project.

Table 5 - 1 Table of Contents for Preliminary Survey Report

Item of contents	Details
Photographs, location drawings	· Representative photographs of project site · Location drawings based on suitable topographic maps
1. Introduction	· Objective of survey · Background of requirements · Outline of project plan · Survey team · Contacts in project area
2. Discussion of S/W and details of agreement	· S/W discussion · Details of agreed S/W · Details of agreed M/M
3. Objective of dam (power generation, irrigation, flood control, etc.) in relation to conditions in the project country	· General background · Development of project conditions in relation to objective · Organization and systems in the project country relating to the objective
4. Development plan of target river	· Position in overall development plan · Development project conditions
5. Outline of target river basin	· Location and basin · Climate · Topography, geology · Earthquakes

Table 5 - 1 Table of Contents for Preliminary Survey Report (cont.)

Item of contents	Details
6. Outline of survey in project area	· Conditions of access · Condition of topographical surveys · Condition of geological surveys · Data on hydrology and weather · Consideration of principal structures · Dam construction materials · Property for compensation · Others
7. Preliminary Environmental Survey	On following page
8. Details of full-fledged survey	· Preliminary survey · Supplementary detailed survey
9. List of data collected in project area	
10. List of questions and answers	

Table 5 - 2 Details of Environmental Considerations in Preliminary Survey Report

7. Preliminary Environmental Survey

Item	Details
(1) Outline	
1) Background	· Preferentially discussed items with foreign government and their details · Desired facts, etc.
2) Outline of region	· Problem areas of region's natural and social environment
3) Laws relating to environment	· Existence of laws, standards, etc. pertaining to environmental considerations in client's country. · Check whether applicable to target region.
(2) Screening	· Study based on idea and viewpoint of screening. · Special matters, topics, etc.
(3) Scoping	· Study of Environmental Impact items by checklist · Special matters, topics, etc.
(4) Others	Description of data obtained on the following additional items · Cases of occurrence of environmental problems in the project locality · Special mention of the possibility of the project having a negative impact on the existence and living basis of the local residents as well as the possibility of it causing great losses in the natural environment

5.2 Direction of Summarizing Environmental Impact Study Report in Master Plan Study and Feasibility Study

The main work of the master plan is to optimize the combination of various alternatives and to determine the order of priority among the components of the optimized plan, such as a water resources development or comprehensive flood control, in a certain region. For this purpose, it is more important to make a relative evaluation of all the alternatives proposed in light of the environmental characteristics of the target area than to make a detailed examination of environmental impacts of each individual alternative. Therefore, the study should proceed with enough accuracy for the Initial Environmental Examination (IEE), indicate clearly the possible impacts of significant magnitude and their provisional impact assessment, and propose the direction and components of the environmental impact study at the subsequent feasibility study stage.

At the feasibility study stage, the project site has already been selected, and for the area concerned, study with a higher degree of accuracy should be carried out on the individual environmental items selected through scoping. Evaluation of the alternatives should also be included.

Examples of tables of contents of Environmental Impact Study for the master plan as well as for feasibility studies are shown below.

Table 5 - 3 Table of Contents For Environmental Impact Study of Master Plan Study

1. Outline of dam construction project
   - 1.1 Name of project
   - 1.2 Location of project
   - 1.3 Objective of project
   - 1.4 Necessity of project
   - 1.5 Details of alternative proposals
2. Environmental conditions
   - 2.1 Social environment
   - 2.2 Natural environment
3. Initial Environmental Examination (IEE)
   - 3.1 Prediction and assessment methods
   - 3.2 IEE
   - 3.3 Examination of optimum proposal from environmental viewpoint
4. Necessity and concrete details of Environmental Impact Study to be carried out at the Feasibility Study stage
   - 4.1 Necessity of Environmental Impact Study and reason for it
   - 4.2 Suggested details and implementation procedure for Environmental Impact Study

Table 5 - 4 Table of Contents for Environmental Impact Study of Feasibility Study

1. Outline of dam construction project
   - 1.1 Project name
   - 1.2 Location of project
   - 1.3 Objective of project
   - 1.4 Necessity of project
   - 1.5 Reason for selection of project site
2. Details of project
   - 2.1 Utilization plan
   - 2.2 Work plan
3. Conditions in region
   - 3.1 Social environment
     - (1) Population
     - (2) Customs, culture
     - (3) Industry
     - (4) Transportation
     - (5) Land utilization
     - (6) Water area and its utilization
     - (7) Sanitation
     - (8) Specific regulations of related laws
     - (9) Landscape
     - (10) Cultural properties, etc.
   - 3.2 Natural environment
     - (1) Geosphere (topography, geology, soil, sedimentation)
     - (2) Aquasphere (flow regime, water quality, bottom condition)
     - (3) Atmosphere (weather, air, offensive odors, noise, vibration)
     - (4) Biology (flora, fauna, aquatic organisms, ecology)

Table 5 - 4 Table of Contents for Environmental Impact Study of Feasibility Study (cont.)

4. Establishment of operational factors and environmental factors
   - 4.1 Establishment of operational factors
   - 4.2 Establishment of environmental factors
5. Current environmental conditions
   - 5.1 Population (distribution, composition, races, etc.)
   - 5.2 Customs, culture (communities, languages)
   - 5.3 Topography, soil
   - 5.4 Flow regime, water quality, bottom quality
   - 5.5 Biology (flora, fauna, aquatic organisms, ecology)
   - 5.6 Landscape
6. Prediction and evaluation of environmental impact
   - 6.1 Process of prediction and evaluation and environmental conservation goals
   - 6.2 Prediction and evaluation for time of operation
     - (1) Topography, soil
     - (2) Flow regime, water quality, bottom quality
     - (3) Biology (flora, fauna, aquatic organisms, ecology)
     - (4) Landscape
   - 6.3 Prediction and evaluation during work
     - (1) Resettlement of residents, etc.
     - (2) Customs, culture (communities, languages)
     - (3) Water quality, bottom quality
     - (4) Biology (flora, fauna, aquatic organisms, ecology)
7. Environment conservation measures, monitoring plan and environment control plan
8. Comparison of alternative proposals
9. Overall evaluation

JICA