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ENERGY SECTOR STANDARD
OF THE PEOPLE'S REPUBLIC OF CHINA
中华人民共和国能源行业标准

PNB/T10347-2019

Replaced SDJ 302-88

Code for Environmental Impact Assessment of Hydropower Projects
水电工程环境影响评价规范

Issued on December 30, 2019 Implemented on July 1, 2020

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Chief Development Department: China Renewable Energy Engineering Institute

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Introduction

This English version is one of China's energy sector standard series in English. Its translation was organized by China Renewable Energy Engineering Institute authorized by National Energy Administration of the People's Republic of China in compliance with relevant procedures and stipulations. This English version was issued by National Energy Administration of the People's Republic of China in Announcement [20xx] No. x datedxx, 20xx.

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Many thanks go to the staff from relevant standard development organizations and those who have provided generous assistance in the translation and review process.

For further improvement of the English version, all comments and suggestions are welcome and should be addressed to:

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National Energy Administration has approved 152 energy sector standards (see Attachment 1) including the *Code for Operating and Overhauling of Excitation System of Small Hydropower Units* and the English versions of 39 energy sector standards (see Attachment 2) including the *Code for Safe and Civilized Construction of Onshore Wind Power Projects*, and they are hereby issued.

Attachments: 1. Directory of Sector Standards
2. Directory of English Versions of Sector Standards

National Energy Administration of the People's Republic of China
December 30, 2019

Attachment:

Directory of Sector Standards

Serial Number	Standard No.	Title	Replaced standard No.	Adopted international standard No.	Approval date	Implementation date
…						
24	NB/T 10347-2019	Code for Environmental Impact Assessment of Hydropower Projects	SDJ 302-88		2019-12-30	2020-07-01
…						

Foreword

According to the requirements of Document GNKJ [2012] No. 326 issued by National Energy Administration of the People's Republic of China, "Notice on Releasing the Development and Revision Plan of the Second Batch of Energy Sector Standards in 2012", and in accordance with the requirements of the environmental protection laws and regulations and current technical standards for environmental impact assessment, and after extensive investigation and research, summarization of practical experience, consultation of relevant national and sector standards, and wide solicitation of opinions, the drafting group has prepared this code.

The main technical contents of thiscode include: assessment classification and range, project investigation, engineering analysis and environmental impacts identification, current environmental status investigation and assessment, environmental impact prediction and assessment, environmental protection measures and techno-economic verification, environmental risk assessment and risk management, environmental monitoring plans, environmental management and supervision plans, environmental protection cost estimate and cost-benefit analysis, and comprehensive assessment.

The main technical contents of this code revision are as follows:

——Transformed the mandatory clauses 1.0.1, 1.0.5 and 2.0.5 of the original code into recommended clauses;

——Added terms and assessment classification and Range;

——Added project investigation, engineering analysis, environmental protection measures and techno-economic verification, environmental risk assessment and risk management, environmental monitoring plans, environmental management and supervision plans, environmental protection cost estimate and cost-benefit analysis, etc.

——Added Appendixes B~H and Appendix J.

——Deleted the original Appendix I *Compilation Formats and Requirements for Environmental Impact Assessment Outline for Water Conservancy and Hydropower Projects* and the original Appendix III *Preparation Formats and Filling Instructions for Environmental Impact Assessment Reports for Water Conservancy and Hydropower Projects*.

——Revised the original General Provisions, current environmental status investigation and

assessment, environmental impact prediction and assessment, and comprehensive assessment;

——Revised the original Appendix II into "Appendix A *Contents of Environmental Impact Assessment Report of the Hydropower Project"*.

National Energy Administration of the People's Republic of China is in charge of the administration of this code. China Renewable Energy Engineering Institute has proposed this code and is responsible for its routine management. Energy Sector Standardization Technical Committee on Hydropower Planning, Resettlement and Environmental Protection is responsible for the interpretation of the specific technical contents. Comments and suggestions in the implementation of this code should be addressed to:

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Contents

1General Provisions

1.0.1 The code is formulated in order to standardize the work contents and methods and to unify the technical requirements for environmental impact assessment of hydropower projects.

1.0.2 The code is applicable to the environmental impact assessment of new, re-constructed and expanded hydropower projects.

1.0.3 The environmental impact assessment of small hydropower projects can be simplified according to the code.

1.0.4 The environmental impact assessment of hydropower projects shall carry out the policy of taking all factors into consideration, adjusting measures to local conditions and efficiency, conform to the environmental protection laws, regulations and policies,as well as the overall requirements of environmental impact assessment of river hydropower planning, follow the principles of objectivity, impartiality, scientificity, rationality and emphasis, and fully coordinate the relationship between hydropower development and ecological environmental protection.

1.0.5 The environmental impact assessment of hydropower projects shall focus on the long-term, cumulative and regional impacts of the projects on hydrology, water temperature, surfacewater quality, aquatic ecosystem, terrestrial ecosystem, etc., and the impacts on environmental sensitive targets. Monographic studies shall be conducted on any possible significant environmental impacts, and major environmental constraints.

1.0.6 The environmental impact assessment of hydropower projects shall comply with the current sector standard HJ 2.1,*Technical Guideline for Environmental Impact Assessment of Construction Project—General Programme* and HJ/T 88,*Code for Environmental Impact Assessment of Water Conservancy and Hydropower Project.* Specifically, the contents and requirements of the environmental impact assessment include:

1 Collecting relevant data, and investigating the current environmental status of the possible affected areas of the project.

2 Identifying environmental impact factors, defining environmental protection targets and screening evaluation factors.

3 Defining assessment classification and range.

4 Performing environmental rationality analysis of the projectgineering scheme.

5 Forecasting and assessing the possible environmental impacts of the recommended engineering scheme.

6 Proposing the environmental protection measures and environmental monitoring plans, and performing cost-benefit analysis of environmental impacts.

7 Drawing the environmental impact assessment conclusion, and preparing environmental impact assessment statement. The contents of the environmental impact assessment

statement of hydropower projects shall be in accordance with Appendix A of this code.

1.0.7 The environmental impact assessment of re-constructed and expanded projects shall forecast and assess the possible cumulated impacts of re-construction and expansion on the environment on the basis of the retrospective assessment of the environmental impacts of the original projects, and propose the control measures for the original environmental pollution and ecological damage related to the projects.

In the environmental impact assessment of re-constructed and expanded projects, the possible cumulated impacts of re-construction and expansion on the environment shall be forecasted and evaluated on the basis of the retrospective assessment of the environmental impact of the original projects, and the countermeasures to control the original environmental pollution and ecological damage related to the projects shall be put forward.

1.0.8 The implementation of environmental protection of the projects that have completed such works as "three supplies and one leveling " works shall be investigated. The investigation shall mainly cover: design changes of project schemes and the environmental rationality, the actual environmental impact of project construction, and the implementation and effectiveness of the "Three-Simultaneity" system for environmental protection measures.

1.0.9 In addition to this code, the environmental impact assessment of hydropower projects shall also comply with the current relevant standards of China.

2Terms

2.0.1 environmental impact of hydropower project

environmental impact of construction, operation, and resettlement of hydropower complex, etc., including direct and indirect impacts, positive and negative impacts, as well as reversible and irreversible impacts.

2.0.2 environmental sensitive target

various natural and cultural preservation sites, ecological sensitive areas, areas of social concern, protected species and their important habitats, intakes, central residential areas, etc.

2.0.3 environmental protection objective

environmental quality, ecological functions, protection requirements for environmental sensitive targets and other requirements related to environmental protection that shall be maintained during the construction and operation of hydropower projects.

2.0.4 cumulative impact

cumulationand consequences of temporal and spatial impacts on hydrological regime, water temperature, aquatic ecosystem, etc. of combined operation of a hydropower project with upstream and downstream cascade stations or reservoirs, water diversion projects, etc.

2.0.5 hydrological regime

temporospatial variation and trend of hydrological elements such as river discharge, flow velocity, water level and sediment.

2.0.6 water reduced reach

the reach downstream of the dam site where the discharge reduces due to water diversion and power generation in a hydropower project, usually between the dam site and the tailwater of the hydropower project.

2.0.7local climate

microregional climate in the reservoir area of the hydropower project affected by the underlying surface and the change of water and heat transport conditions, with the characteristic elements mainly including temperature and humidity, etc.

2.0.8 drawdown area

areas along the bank of the reservoir inundation area that is exposed due to periodic fluctuations in the operating water level of the reservoir.

2.0.9 ecological operating scheme

operation modes of hydropower project and reservoir in order to such as discharge regulation and sediment regulation adopted to meet the requirements of ecological water demand, environmental water demand, estuary salinity control, sediment transportation, etc., so as to maintain the ecological environment function, improve the ecological environment quality and exploit the ecological environment benefits.

3Assessment Classification and Range

3.1 General Requirements

3.1.1 In order to make environmental impact assessment of hydropower projects, the assessment shall be classified by environmental elements according to the project characteristics, environmental characteristics of the project area and environmental sensitivity, and the investigation and assessment shall be carried out according to the depth requirements of the corresponding class.

3.1.2 In order to make environmental impact assessment of hydropower projects, the assessment range of each environmental element shall be determined according to the project characteristics, degree of impact, distribution of environmental sensitive targets and the coordination among the impact of each relevant environmental element.The maps of assessment range shall be drawn with the national standard coordinate system.

3.2Hydrological Regime

3.2.1 Hydrological regime assessment class shall be determined as per Table 3.2.1 according to the affected river scale and the reservoir regulation performance.

Table 3.2.1Determination of Hydrological Regime Assessment Class

Affected river scale	Reservoir regulation performance		
	Yearly and above regulation	Seasonal regulation	Weekly and below regulation
Large river	Class I	Class I	Class II
Medium river	Class I	Class II	Class II
Small river	Class I	Class II	Class III

Note: 1 Larger river means the river with the average annual discharge at the dam site more than or equal to 150m^3/s.

2 Medium river means the river with the average annual discharge at the dam site more than 15m^3/s but less than 150m^3/s.

3 Small river means the river with the average annual discharge at the dam site less than or equal to 15m^3/s.

3.2.2 The hydrological regime assessment class shall be increased by one class if the hydropower project is under the following circumstances:

1 Where the water in the river channel is reduced due to diversion type or mixed type development of the hydropower project.

2 Where there are reservoirs of the yearly and above regulation performance upstream of the reservoir with seasonal regulation performance, resulting in cumulated impacts on the hydrological regime.

3 Where the hydropower project affects the tidal reach of a large river, and results in impacts of saltwater intrusion.

4 Where the assessed water area involves environmental sensitive areas.

3.2.3 The hydrological regime assessment range shall include the reaches of the mainstream and tributaries in the reservoir area affected by the project, reaches downstream of the dam, and reaches protected as fish habitats. Among them, the assessment range of the reaches downstream of the dam shall be determinedaccording to the reservoir regulation performance, converging of downstream tributaries, construction and operation of hydropower project, and distribution of environmental sensitive objects.

3.3 Water Temperature

3.3.1 Water temperature assessment class shall be determined as per Table 3.3.1 according to the water temperature sensitivity of the affected river and the reservoir water temperature distribution pattern. The reservoir water temperature distribution pattern shall be determined according to the current sector standard NB/T 35094,*Code for Water Temperature Calculation of Hydropower Projects*.

Table 3.3.1 Determination of Water Temperature Assessment Class

River water temperature sensitivity	Reservoir water temperature distribution pattern		
	Stratified pattern	Transition pattern	Mixed pattern
Sensitive	Class I	Class I	Class II
General	Class I	Class II	Class III

Note: 1 "Sensitive" means that there are aquatic ecological sensitive areas, important wetlands, intakes of medium- and large-scale irrigation areas, and other environmental sensitive objects of special requirements for water temperature.

2 "General" means the situations except those included in the sensitive situations.

3.3.2 Water temperature assessment range shall include the reaches of the mainstream and tributaries in the reservoir area, and the reaches downstream of the dam. Among them, the assessment range of the reaches downstream of the dam shall be determined according to the reservoir water temperature distribution pattern, converging of downstream tributaries, construction and operation of hydropower project, and distribution of water temperature sensitive objects.

3.4 Surface Water Quality

3.4.1 Surfacewater quality assessment class shall be determined as per Table 3.4.1 according to the pollution load level of the reaches and the reservoir regulation performance.

Table 3.4.1 Determination of Surface Water Quality Assessment Class

Pollution load level of assessed reach	Reservoir regulation performance		
	Yearly and above regulation	Seasonal regulation	Weekly and below regulation

High load	Class I	Class I	Class II
Medium load	Class I	Class II	Class III
Low load	Class III	Class III	Class III

Note: 1 "High load" means that the waste water volume discharged directly from the point pollution sources along the assessed reach is more than or equal to 20 000m^3/d, and that the permanganate index, chemical oxygen demand, total phosphorus and ammonia-nitrogen concentration of the water in the assessed reach exceed the standards.

2 "Medium load" means the situations except those included in high load and low load.

3 "Low load" means that the waste water volume discharged directly from the point pollution sources along the assessed reach is less than 200m^3/d, and that the permanganate index, chemical oxygen demand, total phosphorus and ammonia-nitrogen concentration of the water in the assessed reach meet the environmental quality standards of the water area where the reach is located.

3.4.2 The surfacewater quality assessment class shall be increased by one class if the hydropower project is under the following circumstances:

1 Where the assessed reach involves drinking water source protection areas.

2 Where the water in the river channel is reduced due to diversion type or mixed type development of the hydropower project on a river of medium or high load.

3.4.3 The surfacewater quality assessment range should be consistent with the hydrological regime assessment range.

3.5Groundwater Environment

3.5.1 Groundwater environment assessment class shall be determined according to the relevant provisions on Class III construction projects in the current sector standard HJ 610, *Technical Guidelines for Environmental Impact Assessment—Groundwater Environment*.

3.5.2 Groundwater environment assessment range shall include the distribution area of the project-related groundwater environmental sensitive objects, and reflect the regional groundwater environment status and the basic characteristics of flow field.

3.6Aquatic Ecosystem

3.6.1 Aquatic ecosystem assessment class shall be determined as per Table 3.6.1 according to the aquatic ecological sensitivity of the affected river and the scope of the affected water area. Aquatic ecological sensitivity shall be determined by selecting ecological sensitive areas related to aquatic ecosystem protection according to the current sector standard HJ 19, *Technical Guidelines for Environmental Impact Assessment—Ecological Impact*, and the aquatic germplasm resources conservation zones shall be included in the important aquatic ecological sensitive area.

Table 3.6.1Determination of Aquatic Ecosystem Assessment Class

Aquatic	Affected water area

ecological sensitivity of affected river	Reservoir area more than or equal to 20km^2, or affected river length more than or equal to 100km	Reservoir area more than 2km^2 but less than 20km^2, or affected river length more than 50km but less than 100km	Reservoir area less than or equal to 2km^2, affected river length less than or equal to 50km
Special aquatic ecological sensitive area	Class I	Class I	Class I
Important aquatic ecological sensitive area	Class I	Class I	Class II
General area	Class I	Class II	Class II

3.6.2 Aquatic ecosystem assessment range shall be determined according to the impact range of the changes of hydrological regime, water temperature and surfacewater quality, the range necessary for the protected fishes in the basin where the project is located to complete their life cycle, and the impact range of the aquatic ecosystem. The key assessment range shall include the mainstreams and tributaries of the project affected reaches, as well as protected reaches as fish habitats.

3.7 Terrestrial Ecosystem

3.7.1 Terrestrial ecosystem assessment class shall be determined as per Table 3.7.1 according to the terrestrial ecological sensitivity of the affected area, the reservoir inundation area and the project occupied area. Terrestrial ecological sensitivity shall be determined by selecting ecological sensitive areas related to terrestrial ecosystem protection according to the current sector standard HJ 19, *Technical Guidelines for Environmental Impact Assessment—Ecological Impact*.

Table 3.7.1Determination of Terrestrial Ecosystem Assessment Class

Terrestrial ecological sensitivity of affected area	Reservoir inundation area and project occupied area		
	More than or equal to 20km^2	More than 2km^2 but less than 20km^2	Less than or equal to 2km^2
Special terrestrial ecological sensitive area	Class I	Class I	Class I
Important terrestrial ecological sensitive area	Class I	Class II	Class III
General area	Class II	Class III	Class III

3.7.2 Terrestrial ecosystem assessment range shall include reservoir inundation area, affected area around the reservoir, affected area on both banks of the reach downstream of the dam, construction area of the hydropower project, resettlement area, and protected areas round the reservoir as the

habitats of protected species.It can be expanded to include the complete ecological unit as needed by the assessment. If the project involves a terrestrial ecological sensitive area, that sensitive area shall be included in the assessment area as a whole.

3.8 Atmospheric Environment

3.8.1 Atmospheric environmental impact of hydropower project should be assessed according to Class III determined in the current sector standardHJ2.2, *Technical Guidelines for Environmental Impact Assessment—Atmospheric Environment*.

3.8.2 Atmospheric environmental impact range shall include the area directly affected by hydropower complex construction and the distribution area of atmospheric environmental sensitive objects, and should cover 500m outward from the boundary of each construction area and 200m on both sides of the centerline of each construction road.

3.9 Acoustical Environment

3.9.1 Acoustical environment assessment class shall be determined according to the current sector standard HJ 2.4, T*echnical Guidelines for Noise Impact Assessment*.

3.9.2 Acoustical environmental impact range shall include the area directly affected by hydropower complex construction and the distribution area of acoustical environmental sensitive objects, and should cover 200m outward from the boundary of each construction area and 200m on both sides of the centerline of each construction road.

4 Project Investigation

4.1 Planning Overview

4.1.1 During project investigation, physical geographical overviews such as landform, meteorology, river system, runoff, flood and sediment characteristics of the basin and information on economic and social development shall be collected.

4.1.2 During project investigation, it is required to understand the river hydropower planning and approval processes, overview of the recommended planning scheme and planning implementation opinions, and planning implementation, and collect the techno-economic indicator table, map of the river systems in the basin, layout plan, and layout of longitudinal section of the recommended planning scheme.

4.1.3 During project investigation, it is required to understand the environmental impact assessment of river hydropower planning and the retrospective assessment on environmental impact of hydropower development as well as the review processes, collect assessment documents and main conclusion of the review opinions, and investigate the overall layout and implementation of environmental protection measures, andrequirements for environmental protection of the project, etc.

4.2 Project Overview

4.2.1 During project investigation, it is required to collect the latest engineering design achievements, project feasibility study report and other technical documents at the stage of environmental impact assessment, especially the information, data, drawings and other materials related to environmental protection.

4.2.2 During investigation of main works, it is required to investigate basic information of the project such as geographical location, development tasks, construction necessity, comparison and selection of project schemes, project scale, development mode, project composition, project arrangement and main structures of the recommended scheme, and collect or prepare project characteristics list, project compositions list, geographical location map, complex layout, etc. The main characteristics list of a hydropower project shall be in accordance with Appendix B of the code.

4.2.3 During investigation of project construction planning, it is required to investigate construction diversion, overall arrangement of construction, permanent and temporary construction land occupation, construction plant facilities, construction transportation, stockyard planning, waste disposal area planning, construction technics, main quantities, construction master schedule, etc., and collect construction drawings such as external traffic and general layout.

4.2.4 Investigation on the initial impoundment plan of a reservoir shall be conducted on the period of initial impoundment of the reservoir, types of discharge facilities, layout plan, discharge capacity, initial pool level and outflow discharge under the reservoir.

4.2.5 During investigation of the project operation scheme, it is required to investigate the operation modes of the reservoir and the powerhouse, the changes of reservoir water level in typical years and on typical days, the process of reservoir inflow and outflow, and the stage-discharge relation curve of the design section.

4.2.6 During investigation of the resettlement planning, it is required to investigate the scope of resettlement planning survey response to construction land acquisition, the physical indicators of different levels of administrative regions, rural resettlement, urban relocation, treatment of special projects and reservoir basin cleaning, and collect the map of reservoir inundation scope, the resettlement planning map, the general layout for residential construction, the general layout for urban relocation, and the general layout for rehabilitation planning for special projects.

4.2.7 During investigation of environmental protection of the project, it is required to investigate the works in the hydropower complex and the resettlement planning design with environmental protection functions, and the environmental protection measures taken and their effectiveness.

4.2.8 During investigation of re-constructed and expanded projects, it is required to collect the composition, main economic indicators and other engineering characteristics of the original project, and investigate the environmental protection measures taken and their effectiveness, construction contents of the proposed project, and the reliance relation with the original project, etc.

4.2.9 During investigation of such works as the "three supplies and one leveling" works, it is required to understand the composition of such works and the reliance relation with the main works, collect the environmental impact assessment documents and their approval opinions regarding such works, and investigate the project implementation, design changes of the project scheme, environmental protection measures taken and their effectiveness, etc.

5 Engineering Analysis and Environmental Impacts Identification

5.1 General Requirements

5.1.1 On the basis of engineering analysis, environmental impact factor analysis, environmental impact identification and evaluation factor selection should be carried out in the environmental impact assessment of hydropower projects according to the composition of environmental elements in the engineering area and the relationship with engineering functions.

5.1.2 On the basis of analysis of environmental impact factor analysis, environmental impact assessment of hydropower projects shallidentify the characteristics and extent of impact of each environmental element, screen and determine the assessment factors, and define the focuses of environmental impact assessment.

5.2 Engineering Analysis

5.2.1 Engineering analysis shall be conducted on the consistency and coordination between the hydropower project and environmental protection laws, regulations, policies and relevant environmental protection planning, the environmental rationality of the project scheme, and the environmental impact factors of the project.

5.2.2 Consistency analysis shall be in accordance with the requirements of the national hydropower development and sustainable development strategy, combined with the engineering development task and comprehensive benefits, planning for the project with the national and local national economic and social development, principal function zoning plan, ecological function zoning, environmental protection planning, river hydropower planning and its environmental impact assessment, and retrospective assessment on environmental impact of hydropower development shall be analyzed.

5.2.3 Coordination analysis shall be carried out to analyze the coordination between the project and the relevant planning for water conservancy, and navigation, etc. in the basin.

5.2.4 Environmental rationality analysis of hydropower complex scheme shall be carried outfrom such aspects as environmental constraints and extent of environmental impact, the environmental rationality of the dam site, powerhouse site, dam type, arrangement of hydropower complex, normal pool level and reservoir operation shall be analyzed, and the processes of step-in of environmental impact assessment to compare & select and optimize project schemes shall be clarified.

5.2.5 Environmental rationality analysis of construction planning shall cover the environmental rationality of overall arrangement of construction, construction transportation, stockyard planning, waste disposal area planning, initial impoundment plan, etc. from such aspects as comprehensive utilization of construction land and earth-rock, scope and type of construction land, extent of impact on important environmental sensitive objects, technical difficulty in protection, and protection investment, etc.

5.2.6 Environmental suitability analysis of resettlement shall cover the suitability of the environmental constraints in rural resettlement planning, and urban relocation planning,etc., as well as the geological and topographical conditions, water and soil resource conditions, and environmental conditions for production, development and resettlement of the resettled people.

5.3 Analysis of Environmental Impact Factors

5.3.1 Analysis of environmental impact factor shall cover the way, range and characteristics of impacts of the ecological impact factors and pollution impact factors in construction, operation and resettlement of hydropower complex, and calculate the pollution source intensity on the basis of the analysis of relevant measures, technics and effects and mass balance in the engineering design.

5.3.2 Analysis of pollution impact factors shall focus on the generation links, generation time, pollutant type and characteristics, and existing treatment measures of wastewater and sewage, dust and waste gas, noise, solid wastes, etc. generated during construction, operation and resettlement of hydropower complex, and calculate the generated volume, discharge volume and concentration of main pollutants under normal and abnormal conditions.

5.3.3 Analysis of ecological impact factors shall focus on the objects, range, paths, time and characteristics of impact of construction land occupation, initial reservoir impoundment, project operation, dam barrier, and resettlement, etc.

5.3.4 Analysis of environmental impact factors should be performed using such methods as analogy and mechanism analysis，and the calculation of pollution source intensity should be performed using such methods as analogy, field measurement and mass balance. When using analogy, analogic projects shall have similarity and comparable quantitative analysis data. Calculation of pollution source intensity of hydropower projects should conform to Appendix C of the code.

5.4 Environmental Impact Identification and Assessment Factor Screening

5.4.1 Environmental impact identification shall be based on the preliminary analysis of the characteristics and extent of the impact of hydropower complex on environmental elements in the construction, operation and resettlement of hydropower complex. According to the characteristics, the impact can be divided into positive and negative impact, long-term and short-term impact, reversible and irreversible impact, direct and indirect impact, and cumulative impact. According to the extent, the impact can be divided into major impact, medium impact, small impact and no impact.

5.4.2 Assessment factor screening shall screen and determine the environmental factors that can reflect the project features, main features of environmental impact and regional environmental conditions as the assessment factors according to the identified impact characteristics, extent and weight.

5.4.3 Environmental impact identification and assessment factor screening should be performed using such methods as tabulation, matrix, network, map overlap, index and expert grading methods. The matrix table for environmental impact identification and assessment factor screening for hydropower projects should be in accordance with Appendix D of the code.

5.5Comprehensive Analysis

5.5.1 The results of engineering analysis shall define the coordination degree between the project scheme and environmental protection laws, regulations, policies and relevant planning, analyze the contradictions among them and the existing environmental constraints or major ecological impacts, and propose the suggestions on optimization of the project scheme and the contents of the monographic study.

5.5.2 The results of environmental impact identification and assessment factor screening shall determine the key contents and the content that can be simplified of environmental impact assessment of hydropower projects. Long-term and cumulative impact and environmental factors that seriously constrain project construction shall be determined as the key assessment factors of environmental impact.

6Investigation and Assessment of Environmental Status

6.1General Requirements

6.1.1 During investigation of environmental status, it is required to fully collect and utilize the existing information, analyze the validity of information and the reliability and representativeness of the data, and then compile the information and data. If the existing information cannot meet the design requirements of environmental impact forecasting and assessment as well as environmental protection measure plan, field investigation and monitoring shall be conducted.

6.1.2 The range of investigation of environmental status shall not be less than the assessment range. The investigation sections, point positions and line transects shall be set to be representative and controllable.

6.1.3 According to the correlation among environmental elements, the investigation time, range, contents and accuracy of relevant environmental elements shall be arranged in coordination.

6.2 Climateand Meteorology

6.2.1 During investigation of climate and meteorology, it is required to collect the long-term observation data, analysis reports, drawings and other information on weather and climate from the meteorological representative stations in the same region and basin. When using analogic projects for assessment, the meteorological observation data for a relative long time before and after the project construction shall be collected during the investigation of weather and climate.

6.2.2 Investigation of climate and meteorology shall cover:

1 Basic climatic features such as topographic features, atmospheric circulation and regional circulation, main disastrous weather and extreme weather in the project area.

2 Average monthly value for many years of such meteorological elements as temperature, precipitation, evaporation, relative humidity, wind velocity, wind direction and frost-free period, extreme temperatures and extreme precipitations at the meteorological representative stations.

3 Type, distribution, size and seasonal change of the snowbergs and glaciers in the assessment range.

6.2.3 During the investigation of climate and meteorology for the hydropower project where water temperature forecasting is performed, it is required to investigate the corresponding statistical values of such meteorological elements as temperature, relative humidity, wind velocity, sun exposure and cloud cover in the project area according to the calculation requirements for water temperature forecasting.

6.2.4 During assessment of climate and meteorology status, it is required to analyze the basic climatic features, main disastrous weather and evolution trend of weather & climate in the project area

according to the investigation statistics.

6.3 Hydrological Regime

6.3.1 During investigation of hydrological regime, it is required to collect such basic information as runoff, flood, sediment and ice condition adopted for the river hydropower planning and project design, analysis calculation results and main conclusion.

6.3.2 Investigation of hydrological regime status shall cover:

1 Basic hydrological features in the basin, mainly including landform, area, shape ,river system of the basin, river length, gradient, channel roughness, geomorphology, vertical and horizontal sections of river channels; hydrological station network distribution, long-term measured water level, tidal level, discharge and ice condition at design basis stations and main benchmark stations, and investigation and verification data of flood and low flow; hydrological analysis calculation and research results in the basin and the adjacent areas.

2 Water demands of objects sensitive to hydrological regime, mainly including the ecological water demand, industrial and agricultural water demands and navigation water demand on the downstream.

3 Runoff analysis calculation results, mainly including runoff features, impact analysis of human activities on runoff and restoring computation of runoff; runoff analysis calculation results of main tributaries and main engineering design sections at dam site, powerhouse site, etc.

4 Flood analysis calculation results, mainly including flood cause and discharge, flood occurrence time, and duration and features of a single flood.

5 Sediment analysis calculation results, mainly including perennial average suspended sediment concentration at the dam site, annual sediment transport and annual distribution of suspended load and bed load, sediment transport modulus, and sediment concentration during flood season.

6 Ice condition analysis calculation results, mainly including river regime at the time of icing and thawing, ice thickness during icing period, and icing features of the entire river; occurrence time,position and scale of shore ice, ice jam, ice dam and ice run; the earliest, latest and perennial average icing and thawing dates.

6.3.3 The requirements of different assessment classes for runoff analysis calculation results shall comply with the provisions of Table 6.3.3.

Table 6.3.3 Requirements of Different Assessment Classes for Runoff Analysis Calculation Results

Assessment class	Class I	Class II	Class III
Runoff analysis calculation results	Daily discharge in low-flow, normal-flow and high-flow years	Monthly discharge in low-flow, normal-flow and high-flow years, and daily discharge during concentrated spawning periods of key protected fishes	Perennial average monthly discharge

6.3.4 The investigation sections of hydrological regime shall reflect the overall morphological characteristics of the assessed reaches and channels and the controlled environmental sensitive sections, and coordinate with calculation requirements such as surfacewater quality forecasting, water temperature forecasting, ecological discharge calculation, and design for fish habitat protection.

6.3.5 If the underwater topographical information on the reservoir and downstream does not meet the assessment requirements, it is required to conduct additional measurement for representative sections or underwater topography of the controlled reaches, and measure the water level and discharge at the representative sections during the investigation of hydrological regime. When a tidal reach at the estuary is involved, relevant tidal level shall be measured.

6.3.6 During assessment of hydrological regime status, it is required to analyze the basic features and evolution trend of the hydrological regime in the reach where the project is located, and evaluate the satisfaction degree for the target requirements of the current ecological water demand according to the investigation statistics.

6.3.7 Water level and discharge shall be measured in accordance with the current sector standard NB/T 10233,*Code for Hydrologic Design of Hydropower Projects*. The table of runoff analysis calculation results should be in accordance with Appendix E of the code.

6.4Water Temperature

6.4.1 During water temperature investigation, it is required to collect the natural water temperature of the assessment reaches, temperature of discharged water from upstream cascade stations, water temperature of the analogic or verification reservoir and other information.

6.4.2 Water temperature investigation for assessed reaches of different assessment classes shall meet the following requirements:

1 Daily channel water temperature in typical years shall be investigated during Class I and Class II assessment.

2 Monthly channel water temperature in typical years shall be collected during Class III assessment.

6.4.3 If there are no measured water temperature data for the assessed reaches and upstream and

downstream, the water temperature of the assessed reaches can be calculated by analogic analysis of the temperature and water temperature of the similar regions, and the current water temperature observation shall be supplemented when necessary.

6.4.4 During assessment of water temperature status, it is required to analyze distribution features and change law of water temperature of the reaches, and evaluate the satisfaction degree for the water temperature requirements of the objects sensitive to current water temperature according to the water temperature statistics results.

6.4.5 Water temperature observation and calculation shall be performed in accordance with the current sector standard NB/T 35094,*Code for Water Temperature Calculation of Hydropower Projects*.

6.5Surface Water Quality

6.5.1 During investigation of surfacewater quality, it is required to collect the water function regionalization and water environment function zoning of the river where the project is located, water pollution sources of the assessed reaches and the upstream reaches, water quality monitoring results of conventional monitoring sections for the recent three years and runoff information of conventional monitoring sections during the corresponding periods.

6.5.2 Investigation of water pollution sources shall mainly include the types of pollution source, discharge volume of wastewater and sewage, main pollutants and their concentration, and sewage outletposition.

6.5.3 If the current water quality monitoring results do not meet the assessment requirements, it is required to conduct status monitoring and observe relevant hydrological parameters at the same time during investigation of surfacewater quality; if the concentration of heavy metals in the surfacewater exceeds the standards, it is also required to monitor the river substrate. To conduct the investigation of surfacewater quality, it is required to arrange monitoring sections in such water areas as reservoir area, dam site, water-reduced reach, powerhouse site, and junction of main tributaries. Where surfacewater quality sensitive objects such as drinking water source protection areas are involved, monitoring sections shall be increased.

6.5.4 To conduct the investigation of surfacewater quality, it is required to select the seasons and months that can represent the low-flow, normal-flow and high-flow periods of the river, reservoir and estuary. The investigation periods of surfacewater quality of different assessment classes in different water areas shall comply with the provisions of Table 6.5.4.

Table 6.5.4 Investigation Periods of Surface Water Quality of Different Assessment Classes in Different Water Areas

Type of water area	Assessment class		
	Class I	Class II	Class III
River and reservoir	Low-flow, normal-flow and high-flow periods in a hydrological year	Normal-flow and low-flow period. When non-point source pollution is serious and	Low-flow period. When the non-point source pollution is serious and the surfacewater quality

		the surfacewater quality during high-flow period is inferior to that during low-flow period, the water quality during normal-flow and high-flow period shall be investigated.	during high-flow period is inferior to that during low-flow period, the water quality during high-flow period shall be investigated.
Estuary	Low-flow, normal-flow and high-flow periods in a tidal year	Normal-flow and low-flow period. When non-point source pollution is serious and the surfacewater quality during high-flow period is inferior to that during low-flow period, the water quality during normal-flow period and high-flow period shall be investigated.	Low-flow period. When the non-point source pollution is serious and the surfacewater quality during high-flow period is inferior to that during low-flow period, the water quality during high-flow period shall be investigated.

6.5.5 Investigation of surfacewater quality sensitive objects shall focus on the location, range, protection zoning, positional relation with the project, water supply scale and water quality protection requirements of drinking water source protection areas and various intakes.

6.5.6 During assessment of surfacewater quality status, it is required to assess the surfacewater quality by the standard of the water quality targets in the environmental function category of the water area where the assessed reaches are located, and analyze main water environment problems and causes according to the monitoring results, and calculate the water demand of the water environment according to water quality and hydrological features.

6.5.7 Assessment of surfacewater quality status shall be conducted in accordance with Appendix F of the code. Water demand calculation of the water environment shall be performed in accordance with the current sector standard NB/T 35091, *Code for Calculation of Ecological Flow of Hydropower Projects*.

6.6 Groundwater Environment

6.6.1 During investigation of groundwater environment, it is required to collect such information as the regional hydrogeological map (scale: ≥ 1:200 000), hydrogeological results in the engineering geological investigation report, existing hydrogeological investigation results in the assessment range, groundwater level for the recent three years, water quality monitoring results, and groundwater development and utilization status and planning.

6.6.2 Investigation of environmental hydrogeological background shall mainly cover topographical

features of the assessment range; formation lithology, geologic structure, permeability and other features as well as the spatial distribution regularities of aeration zones and aquifers and groundwater type as well as runoff recharge and discharge features of the groundwater.

6.6.3 If there is no monitoring information in the assessment range, it is required to conduct additional field monitoring during the investigation of groundwater environment by making full use of the existing groundwater wells and engineering geological prospecting working wells in the assessment range. Groundwater level and quality monitoring can be performed for one phase in the case of Class III assessment, and the monitoring frequency can be increased properly in the case of Class II assessment.

6.6.4 Investigation of groundwater environmental sensitive objects shall focus on such sensitive objects as centralized water supply sources, spring area and important wetlands for groundwater that have hydraulic relation with the project area, and investigate their location, range, aquifers and water volume with water supply and potential water supply significance, recharge paths and volume, spring discharge and water quality .

6.6.5 During assessment of groundwater environment status, it is required to analyze the existing environmental hydrogeological problems and causes in the assessment range, and assess the groundwater quality according to the collected information and investigation results. When the recharge volume from the groundwater on both sides of the water-reduced reach cannot meet the non-dehydration of the riverbed or the lowest point of the overburden surface, it is also required to calculate the water demand and process of groundwater recharge for the channel.

6.6.6 Assessment of groundwater quality status shall be performed using the single-factor standard index method. Water demand calculation of groundwater recharge for the channel shall be performed in accordance with the current sector standard NB/T 35091, *Code for Calculation of Ecological Flow of Hydropower Projects*.

6.7 Aquatic Ecosystem

6.7.1 Investigation of aquatic ecosystem shall collect the relevant investigation and scientific research results of the existing aquatic ecology and fishery situations in the basin where the project is located, planning results of involved aquatic ecological sensitive areas, etc.

6.7.2 Investigation of aquatic habitats shall cover morphological structure, hydrological regime, physicochemical properties of water bodies, and type and features of substrates of water areas in the assessed reaches.

6.7.3 Aquatic organism investigation shall include the community structure of aquatic organisms, the species composition of phytoplankton, periphytic algae, zooplankton, benthos and aquatic vascular plants, the distribution and biomass of dominant species and their changes.

6.7.4 Fish investigation shall include fish species, catches, biological characteristics, important habitats, early resources and fisheries. Among them, the important habitats of fish shall include spawning grounds, nursery grounds, wintering shelters and migration pathways. The investigation of early fish resources shall include the drifting hatching conditions of drifting ovocytes and the environmental conditions of spawning waters of sunken and viscous ovocytes.

6.7.5 The investigation of aquatic ecological sensitive objects shall focus onaquatic ecological sensitive areas, protected fishes and important economic fishes, and investigate their distribution,

ecological characteristics, protection scope, protection requirements, resource status, protection status and positional relation with the project area.

6.7.6 The investigation of aquatic habitats, aquatic organisms and fish shall be carried out simultaneously. Investigation of aquatic ecological status of different assessment classes shall meet the following requirements:

1 The investigation time for Class I assessment shall cover the sensitive periods such as the peak period of reproduction and incubation period of most fishes in the assessment waters, and also include the major flood processes during such periods. The Class I assessment shall quantify the investigation results of aquatic organisms and fishes, observe the underwater topography and riverbed substrate composition of important habitats such as fish spawning grounds, and investigate the hydrological process and water temperature during fish breeding seasons.

2 During Class II assessment, one-phase field investigation shall be carried out during the concentrated spawning season of key protected fishes in the river reach to be assessed, and focus on the location, quantity and scope of the protected fishes and the important habitats for fishes. For aquatic organisms, qualitative investigation results are enough.

6.7.7 The assessment of aquatic ecosystem status shall include the following contents according to the investigation of the basic characteristics of aquatic ecosystem:

1 Quality status and suitability of aquatic habitats.

2 Distribution and species diversity of aquatic organisms.

3 Evolution trend of fish resources, reproduction status of fishes of different ecological types, dynamic changes and viability of important fish stocks, and habitat suitability of important fish habitat waters.

4 Aquatic ecological water demand, including aquatic ecological basic flow and hydrological process during fish breeding seasons.

5 Connectivity, functionality and changing trend of aquatic ecosystem.

6.7.8 The investigation of aquatic ecosystem status and assessment method shall conform to the current sector standard NB/T 10079, *Technical Specification for Aquatic Ecology Survey and Evaluation of Hydropower Projects*. The aquatic ecological water demand shall be calculated according to the current sector standard NB/T 35091, *Code for Calculation of Ecological Flow of Hydropower Projects*.

6.8 Terrestrial Ecosystem

6.8.1 The investigation of terrestrial ecosystem shall collect the principal function zoning and ecological function zoning of the project area, the existing terrestrial ecological related investigation, scientific research achievements, soil investigation results, and the terrestrial ecological sensitive area planning results, etc.

6.8.2 The investigation of soil environmental characteristics shall include the regional soil type, physicochemical properties, distribution characteristics and the relation with groundwater.

6.8.3 The investigation of terrestrial vegetation shall include vegetation regionalization, vegetation types and their distribution characteristics, plant community species composition and community structure characteristics.

6.8.4 The investigation of terrestrial plants shall include species of wild and cultivated plants, distribution range, growth conditions and habitat conditions. For hydropower projects with low-temperature water discharge, the investigation of terrestrial plants shall also include the demand of main water temperature sensitive crops for the irrigation water temperature.

6.8.5 The investigation of terrestrial animals shall include the species, quantity, distribution, ecological habits and habitat types of wild animals, and the human disturbance.

6.8.6 The investigation of terrestrial ecological sensitive objects shall focus on the sensitive areas of terrestrial ecology, special vegetation, protected animals and plants, endemic species, ancient and famous trees and important animal habitats, and investigate their distribution, ecological characteristics, protection scope, protection requirements, protection status, and positional relation with the project area.

6.8.7 The investigation of terrestrial ecosystem status of different assessment classes shall meet the following requirements:

1 During Class I assessment, two-phase field investigations shall be carried out to obtain quantitative or semi-quantitative investigation results by the combination of sample plot investigation, line transect investigation and remote sensing interpretation.

2 During Class II assessment, one-phase field investigation shall be carried out to obtain semi-quantitative investigation results by means of remote sensing interpretation combined with the typical field investigation.

3 Class III assessment shall give a brief explanation to the investigation results by adopting available data with the necessary typical field investigation.

4 When the protected animals and plants are involved in the assessment range, the field investigation on the quantity and distribution of resources of protected animals and plants shall be carried out for each assessment class to obtain quantitative or semi-quantitative investigation results.

6.8.8 The assessment of terrestrial ecosystem status shall include the following contents based on the investigation of status of terrestrial vegetation and terrestrial animals and plants:

1 Horizontal and vertical distribution and succession of vegetation, distribution of zonal vegetation and special vegetation.

2 2 The population dynamics and survival state of protected plants and animals and endemic species, survival state of ancient and famous trees, quality and distribution of important habitats of animals, and the ecological risks of alien invasive species.

3 Water demand of riverine wetlands including ecological water demand and process of important wetlands under dams that are hydraulically connected with rivers and riparian natural vegetation in arid areas that utilizes the river water as water source.

4 Composition characteristics, structure, pattern and service function of terrestrial ecosystem.

6.8.9 The investigation of terrestrial ecosystem status and assessment method shall conform to the current sector standard NB/T 10080, *Technical Code for Investigation and Assessment of Terrestrial Ecosystem for Hydropower Projects*. The water demand calculation of rivers and wetlands shall be in accordance with the current sector standard NB/T 35091, *Code for Calculation of Ecological Flow of Hydropower Projects*.

6.9 Atmospheric Environment

6.9.1 The atmospheric environment investigation shall collect the information of the landform, atmospheric environmental function zoning, atmospheric diffusion conditions, wind direction, wind speed and wind frequency at the local meteorological station, atmospheric environmental pollution sources, and the routine environmental air quality monitoring results of assessment scope and surrounding areas in the past three years.

6.9.2 The investigation of atmospheric environmental sensitive objects shall focus on cities, towns and residential areas within the assessmentrange, and investigate their distribution, scale, protection requirements and positional relation with the project area.

6.9.3 When there is no monitoring data in and around the assessment scope or the monitoring results do not meet the assessment requirements, the environmental air quality status shall be monitored for the atmospheric environment investigation. The monitoring items should include TSP, PM_{10}, SO_2 and NO_2.

6.9.4 According to the monitoring results, the assessment of the atmospheric environment status shall take the quality objectives of ambient air function zones within the assessment scope as the standard, to assess the ambient air quality status and analyze the existing problems and reasons.

6.9.5 Ambient air monitoring technology shall conform to the current national standard GB 3095, *Ambient Air Quality Standard*. The single-factor standard index method shall be adopted as the assessment method for ambient air quality.

6.10 Acoustical Environment

6.10.1 The acoustical environment investigation shall collect the information of acoustic environmental function regionalization, noise sources and the results of routine acoustical environment quality monitoring of the assessment scope and its surrounding areas in the past three years.

6.10.2 The investigation of current acoustical sources shall include the category, distribution and spreading range of the existing acoustical sources, the affected noise level and its contribution to the acoustical environment quality within the assessment scope.

6.10.3 The investigation of acoustical environmental sensitive objects should focus on cities, towns, residential areas and areas with main functions including medical and health, culture and education, scientific research within the assessment scope, and investigate their distribution, scale, protection requirements and location relation with current noise sources and project areas of.

6.10.4 As for Class I and Class II assessments, the monitoring of the acoustical environment status shall be carried out on representative sensitive objects within the assessment scope. As for Class III assessment, if there is no monitoring data in or around the assessment scope or the monitoring results cannot meet the assessment requirements, the monitoring of acoustical environment status shall be carried out. The monitoring items shall include day-time and night-time equivalent sound pressure level.

6.10.5 According to the monitoring results, the assessment of the acoustical environment status shall take the quality objectives of acoustical environment function zones within the assessment scope as the standard, to assess the day-time and night-time acoustical environment quality status and analyze the existing problems and reasons.

6.10.6 The acoustical environment monitoring technology shall conform to the current national standard GB 3096, *Environmental Quality Standard for Noise*.

6.11 Solid Waste

6.11.1 The investigation of solid waste shall collect the information of the solid waste collection and treatment and disposal status in the project area, and the relevant infrastructure construction planning.

6.11.2 The investigation of solid waste sources shall focus on municipal solid wastes, agricultural wastes and industrial waste residues stacked or buried centrally in reservoir inundation affected area, surrounding area of reservoir, hydropower complex construction area and resettlement area, and investigate the category, volume, leachate generation quantity, and treatment and disposal status, etc.

6.11.3 According to the categories of solid waste and its treatment and disposal status, the assessment of the solid waste status shall analyze and assess its treatment and disposal effect and its impact on the surrounding environment.

6.12 Public Health

6.12.1 The investigation of public health shall collect the information on the types, incidence rates, epidemic intensity of natural epidemic diseases, water-borne infectious diseases, insect-borne infectious diseases, endemic diseases and other diseases, as well as the relevant epidemic prevention measures and plans adopted by the health and epidemic prevention departments in the project area.

6.12.2 The investigation of public health shall include the infection routes and inducing conditions of main epidemics, population quantity and ecological habits of disease vectors in the reservoir inundation affected area, surrounding area of reservoir, hydropower complex construction area and resettlement area, as well as the living and sanitary conditions and health and epidemic prevention conditions of local residents.

6.13 Landscape

6.13.1 The investigation of landscape shall collect the information on the tourism development planning of the project area, the overall planning of important landscape sensitive areas such as scenic and historic area, geoparks and forest parks, the protection level of key landscape resources, and landscape protection planning, etc.

6.13.2 Landscape investigation objects shall include natural landscape and cultural landscape. Landscape investigation shall mainly include the following contents:

1 Important landscape sensitive areas such as scenic and historic area, geoparks and forest parks, and key landscape resources involved in the directly affected areas and surrounding areas of the project.

2 Positional relation between the project and key landscape resources.

3 Waterscape resources associated with rivers and their landscape aesthetic characteristics under different hydrological conditions.

6.13.3 The landscape status assessment shall be conducted with appropriate assessment units and indicators according to the category and value of landscape resources, combination characteristics, degree of importance and requirements of development and utilization; when there are waterscape resources distributed in the downstream reach of the dam, the water demand and process of the landscape shall also be analyzed and calculated.

6.13.4 The investigation of landscape status can be conducted by means of data collection and field investigation etc. The assessment method of landscape status assessment shall conform to the current national standard GB/T 50298, *Standard for Scenic and Historic Area General Planning*. Water demand calculation of landscape shall be in accordance withthe current sector standard NB/T 35091, *Code for Calculation of Ecological Flow of Hydropower Projects*.

6.14 Environmental Status of Resettlement Areas

6.14.1 The investigation on environmental status of resettlement areas shall focus on the resettlement areas of rural immigrants for land development and relocation areas, relocation areas for towns and cities, rehabilitation areas for important special projects such as transportation, hydraulic engineering and industrial and mining enterprises.

6.14.2 The investigation on environmental status of resettlement areas shall be carried out in combination with the status investigation of various environmental elements, mainly including the following contents:

1 Natural environment and ecological status of rural resettlement areas.

2 Environmental quality, ecology, land resources, water resources and other conditions of the urban relocation areas.

3 Environmental quality and ecological status of the specialproject rehabilitation areas.

6.14.3 According to the investigation results and the distribution of environmental sensitive objects, the assessment of the environmental status of resettlement areas shall assess the environmental quality, ecology and resource status of the resettlement areas and analyze the environmental constraints.

6.15 Comprehensive Assessment of Environmental Status

6.15.1 The comprehensive assessment of environmental status shall analyze the regional environmental quality status, historical changing process, main existing environmental issues and their causes based on the status investigation and assessment of various environmental elements, and in combination with historical data and the development and construction activities of river basins.

6.15.2 The comprehensive assessment of environmental status shall determine the environmental protection objectives of the project according to the regional environmental function orientation, ecological function orientation, environmental sensitive object protection requirements and main existing environmental issues.

7 Environmental Impact Forecasting and Assessment

7.1 General Requirements

7.1.1 Environmental impact forecasting and assessment shall forecast the changes of the selected assessment factors after construction of the project based on the engineering analysis, investigation and assessment of environmental status, and assess the impact of the project on the environment and the necessity of taking environmental protection measures according to the requirements for environmental protection objectives.

7.1.2 The forecast period shall include the construction period and operation period. As for the construction period, peak construction year should be taken as the forecasting level year. As for the operation period, 3~5 years after the designed operation conditions are satisfied as the forecasting level year, and the forecasting operation conditions such as isolated operation and joint operation shall be set based the construction of cascade stations in the basin and the possible cumulative impacts. For environmental elements such as hydrological regime, surfacewater quality and aquatic ecosystem, the impact forecast in initial impoundment stage shall also be carried out.

7.1.3 As for the environmental impact forecasting and assessment of re-constructed and expanded projects, the possible cumulative impacts of project re-construction and expansion on the environment shall be forecasted and assessed based on the assessment on existing environmental impacts of the original projects.

7.2 Climate Impacts

7.2.1 Climate impacts shall include local climate impacts and regional climate impacts of the reservoir, and the forecasting and assessment shall be determined according to the reservoir area, reservoir capacity, climate characteristics of the project area and the distribution of climate-sensitive objects.

7.2.2 As for the climate impact forecasting, the horizontal gradient and vertical gradient changes, seasonal changes and extreme changes of temperature, precipitation and other sensitive meteorological elements in the assessment area shall be analyzed and calculated, and the changes of meteorological elements in climate sensitive periods shall be focused on.

7.2.3 As for the climate impact assessment, the basic characteristics and change laws of regional climate such as local climate of reservoirs and river basins, as well as possible major meteorological disasters such as drought, rainstorm, high temperature and low temperature rain and snow shall be analyzed according to the forecasting results of meteorological element changes, and the impact on climate sensitive objects shall be assessed.

7.2.4 For local climate impact forecasting of reservoirs, analogy method should be adopted for quantitative forecasting and qualitative analysis; for regional climate impact forecasting, mathematical model method should be adopted for quantitative forecasting.

7.3 Hydrological Regime Impacts

7.3.1 The hydrological regime impact forecasting and assessment shall be carried out in the initial impoundment stage and operation stage according to the initial impoundment scheme of the project

and the comprehensive scheduling plans for power generation, flood discharge and sand drainage during operation period.

7.3.2 Hydrological regime impact forecasting shall be carried out according to the reservoir area, water reduced reach, river reach below the station tail water. Hydrological regime impact forecasting for each section shall meet the following requirements:

1 As for the hydrological regime impact forecasting of reservoir area, the water form such as reservoir area and water surface width, and the changes of hydrological parameters such as water level, water depth and flow velocity shall be analyzed and calculated based on the investigation of reservoir characteristic parameters.

2 As for the hydrological regime impact forecasting of the water reduced reach, the change process and change of hydrological parameters along the process such as flow, water level, water depth, flow velocity and river width shall be analyzed and calculated according to the operation mode of the reservoir.

3 As for the hydrological regime impact forecasting of the river reach below the station water tail, the change process and change of hydrological parameters along the process such as flow, water level, water depth, flow velocity and river width shall be analyzed and calculated according to the operation mode of the reservoir and station.

7.3.3 The forecasting periods of hydrological elements of different assessment classes in each section shall conform to the provisions in Table 7.3.3.

Table 7.3.3 Forecasting Periods of Hydrological Elements of Different Assessment Classes in Each Section

Section	Assessment class		
	Class I	Class II	Class III
Reservoir area	Monthly in typical year	Monthly in typical year	Monthly in typical year
Water reduced reach	Daily in typical year; hourly on typical day	Monthly in typical year and daily during concentrated spawning period of protected fished; hourly on typical day	—
River reach below station tail water	Daily in typical year; hourly on typical day	Monthly in typical year; hourly on typical day	Multi-year monthly average; hourly on typical day

7.3.4 As for the sand regime impact forecasting, the calculation results of reservoir sedimentation and concentration of sediment passing through the machine should be adopted to forecast and analyze the erosion and deposition changes in the reservoir area and the reach below the dam.

7.3.5 As for the ice regime impact forecasting, the ice thickness of the reservoir, the possibility of ice berg and ice dam formed at the end of the reservoir and its backwater height, the location of the zero water temperature section at the downstream of the reservoir and the unfrozen distance shall be analyzed and calculated.

7.3.6 As for the hydrological regime impact assessment, the impact scope, impact approach and impact degree of the initial impoundment scheme and operation scheduling scheme of the project on the downstream hydrological regime shall be analyzed, and the impact of hydrological regime changes on water consumers shall be assessed.

7.3.7 As for Class I and Class II assessments, the mathematical model method shall be adopted to forecast and calculate the hydrological elements, so as to give the comparison table or diagram of hydrological elements before and after the station operation. The hydrological regime impact forecasting method shall conform to the provisions of Appendix G hereof. As for Class III assessment, the existing design results of the project can be adopted for a brief statistical analysis. Table of Hydrological Regime Forecasting Results should conform to the provisions of Appendix H hereof.

7.4 Water Temperature Impacts

7.4.1 As for the water temperature impact forecasting, the reservoir water temperature and the lower reach water temperature shall be calculated, and the change of water temperature along the process at the lower reach shall be analyzed.

7.4.2 The forecasting periods of water temperature of different assessment classes shall conform to the provisions of Table 7.4.2.

Table 7.4.2 Forecasting Periods of Water Temperature of Different Assessment Classes

Forecasting Item		Assessment class		
		Class I	Class II	Class III
Reservoir water temperature	Water temperature in reservoir area	Monthly in typical year	Monthly in typical year	Unlimited
	Discharge water temperature	Monthly, 10-day, daily in typical year	Monthly, 10-day in typical year	—
Lower reach water temperature		Monthly in typical year	Monthly in typical year	—

7.4.3 As for the water temperature impact assessment, the impact scope, impact period and impact degree of the discharge water temperature of the project on the lower reach water temperature shall be analyzed, and the impact of water temperature change on sensitive objects shall be assessed.

7.4.4 The water temperature impact forecasting method shall be determined according to the current sector standard NB/T 35094, *Code for Water Temperature Calculation of Hydropower Projects*. As for Class I and Class II assessments, the mathematical model method shall be adopted to predict and calculate the water temperature impact, and the measured water temperature of the reservoir with similar geographical location and reservoir characteristics should be selected to calibrate the

parameters of the mathematical model and verify the model. As for Class III assessment, empirical formula method or analogy method can be adopted to forecast, calculate or analyze the impact of water temperature.

7.5 Surface Water Quality Impacts

7.5.1 The surfacewater quality impact forecasting and assessment shall include the impact of initial impoundment of the reservoir and the operation of project on the water quality, the eutrophication trend of the reservoir water, the change of the water pollutant-holding capacity and the impact of total dissolved gas supersaturation.

7.5.2 As for the water quality impact forecasting in the initial impoundment stage, the characteristics of major pollution sources in reservoir inundation area shall be analyzed, and its impact on the water quality of reservoir shall be forecasted based on the reservoir basin cleaning scheme.

7.5.3 The water quality impact forecasting during the operation period shall be carried out according to the reservoir area, water reduced reach, river reach below the station tail water based on the assessment of river reach and upstream pollution source forecasting, in combination with the operation scheme of the project and the following requirements shall be met:

1 As for the reservoir water quality impact forecasting, the distribution and change of major pollutants in the reservoir, especially in the areas such as branch reservoirs and reservoir bays shall be analyzed and calculated based on the hydrodynamic characteristics of reservoir.

2 As for the water quality impact forecasting of water reduced reach, the distribution and changes of major pollutant concentration in such reach along the process shall be analyzed and calculated based on discharge process of dam site and forecasting results of reservoir water quality.

3 As for the water quality impact forecasting of the reach below the station tail water, the distribution and changes of major pollutant concentration along the process shall be analyzed and calculated based on the hydrological regime changes at the downstream of the station tail water and the water quality forecasting results of reservoirs and water reduced reach.

4 The forecasting periods of water quality during operation periods of different assessment classes shall conform to the provisions of Table 7.5.3.

Table 7.5.3 Forecasting Periods of Water Quality during Operation Periods of Different Assessment Classes

Assessment class	Class I	Class II	Class III
Forecasting periods	Abundant water period, level period, drought period in typical year; the freeze-up	Level period, drought period in typical year; the level period and abundant	Unlimited

	period shall also be forecasted for the water area used as domestic drinking water source and food processing water source or having water demand for fisheries with long freeze-up period	water period in typical year shall be forecasted when the water quality in abundant water period is inferior to that in drought period	

7.5.4 As for the reservoir water eutrophication forecasting and assessment, the nutriture and change trend of reservoir water shall be assessed based on the analysis of the source of nutrients in the reservoir, in combination with the reservoir capacity, water exchange, flowrate changes, etc.

7.5.5 When Class I assessment is involved and the pollution load level of the reach to be assessed is high, the water pollutant-holding capacity shall be calculated for the surfacewater quality impact forecasting. The calculation of water pollutant-holding capacity shall be carried out according to the reservoir area and downstream reach of the dam. Meanwhile, the water functional area shall be taken as the calculation unit for the downstream reach of the dam, and the larger tributary confluence and water intakes and other sections with changed hydrological conditions are taken as the calculation nodes.

7.5.6 For hydropower projects with ski-jump energy dissipation, the degree and scope of impact of supersaturation of total dissolved gas in water of the downstream reach of the dam due to flood discharge shall be forecasted and analyzed according to the flood discharge mode and frequency of the station.

7.5.7 The surfacewater quality impact assessment shall assess the surfacewater quality after the completion of the project and analyze the eutrophication trend of reservoir water and the change of the water pollutant-holding capacity etc. based on the water quality forecasting results.

7.5.8 The surfacewater quality impact forecasting methods at different assessment levels should be implemented in accordance with the provisions of Table 7.5.8, and conform to the relevant provisions of the current sector standard HJ 2.3, *Technical Guidelines for Environmental Impact Assessment—Surface Water Environment*. The reservoir water nutriture assessment method shall conform to the relevant provisions of the current sector standard NB/T 10079, *Technical Code for Investigation and Assessment of Aquatic Ecosystem for Hydropower Projects*.The water pollutant-holding capacity calculation method shall conform to the relevant provisions of current national standard GB/T 25173, *Code of Practice for Computation on Allowable Permitted Assimilative Capacity of Water Bodies*.

Table 7.5.8 Surface Water Quality Impact Forecasting Methods at Different Assessment Levels

Reservoir regulation performance	Assessment class		
	Class I	Class II	Class III
Quarterly regulation and above	3D; combination of vertical 2D with plane 2D	Plane 2D	Empirical formula method and analogy method
Daily and weekly regulation and below	Plane 2D	Plane 2D for large rivers; longitudinal 1D for medium and small	

		rivers	

7.6 Groundwater Environmental impacts

7.6.1 As for the groundwater environmental impact forecasting and assessment, the water quality change scope, impact degree and development/change trend of groundwater environmental sensitive objects shall be forecasted and analyzed and the groundwater quality after the completion of the project shall be assessed.

7.6.2 As for Class II assessment, analytical method or analogy method should be adopted for forecasting and analysis; as for Class III assessment, analogy method can be adopted for forecasting and analysis.

7.7 Aquatic Ecosystem Impacts

7.7.1 The aquatic ecosystem impact forecasting and assessment shall include the impact of construction and operation of the project on aquatic habitats, aquatic organism, fishes, aquatic ecological sensitive areas and aquatic ecosystem.

7.7.2 As for the aquatic habitat impact forecasting, the changes of river connectivity, water body morphology and structure, hydrological process, water body physicochemical properties and substrates shall be forecasted and analyzed based on the hydrological regime, water temperature and surfacewater quality impact forecasting results.

7.7.3 As for aquatic organism impact forecasting, the species composition of phytoplankton, periphytic algae, zooplankton, benthonic animals and aquatic vascular plants, the distribution and biomass of dominant species and their changes shall be forecasted and analyzed.

7.7.4 Fish impact forecasting shall include the following contents:

1 Impact of dam barrier on migratory fish completing life cycle and gene exchange between upstream and downstream fish populations.

2 Impact of hydrological process, physicochemical properties of water body and changes of aquatic biological factors on the species composition, resource quantity, reproduction and growth of fishes in the reach to be assessed, especially protected fishes and important economic fishes.

3 Change trend in important habitats of fishes.

7.7.5 For hydropower projects involving aquatic ecological sensitive areas, the sensitive area specific impact assessment should be carried out and the impact of the project on the key protected objects, structures and ecological functions of the sensitive areas shall be analyzed and assessed as priorities.

7.7.6 As for the aquatic ecosystem impact assessment, the impact of the project on the spatial connectivity, structure and service function of the aquatic ecosystem shall be assessed and the possible key aquatic ecological issues and existing aquatic ecological constraints shall be analyzed according to the impact forecasting results of aquatic habitats, aquatic organisms, fishes and their important habitats.

7.7.7 The aquatic ecosystem impact forecasting and assessment method shall be taken from the methods stipulated in current sector standard NB/T 10079, *Technical Code for Investigation and Assessment of Aquatic Ecosystem for Hydropower Projects*.

7.8 Terrestrial Ecosystem Impacts

7.8.1 The terrestrial ecosystem impact forecasting and assessment shall include the impact of construction and operation of the project on soil environment, terrestrial vegetation distribution pattern, animal and plant species and habitats, terrestrial ecological sensitive areas and terrestrial ecosystem.

7.8.2 As for soil environmental impact forecasting and assessment, the impact of the project on soil salt content, pH value and other factors in the assessment areas shall be forecasted and analyzed and its impact on soil structure, physicochemical properties, soil fertility and land productivity shall be assessed.

7.8.3 Terrestrial vegetation impact forecasting shall include the following contents:

1 Vegetation types, distribution areas and proportions affected by the project, and the ways and degrees of impact on special vegetation types and vegetation in water-level-fluctuating zone.

2 Impact of the change of hydrological regime on important wetlands and natural vegetation along the river bank.

3 Impact of the change of water temperature on the growth of crops irrigated by river water.

7.8.4 As for the terrestrial vegetation impact forecasting, the impacts of project land occupation and changes of abiotic factors such as climate and soil on plant species composition and diversity shall be forecasted and analyzed, and the ways and degrees of impact on protected plants, narrow-ranged plant species, ancient and rare trees shall be forecasted as priorities.

7.8.5 As for the terrestrial animal impact forecasting, the impact of changes in habitat conditions of terrestrial vegetation etc. on the composition of animal species in the area, direct and indirect impacts of the construction of the project on animals shall be forecasted and analyzed and the ways and degrees of impact on protected animal populations and important habitats shall be forecasted as priorities.

7.8.6 For hydropower projects involving terrestrial ecological sensitive areas, the sensitive area specific impact assessment should be carried out and the impact of the project on the key protected objects, structures and ecological functions of the sensitive areas shall be analyzed and assessed as priorities.

7.8.7 As for the terrestrial ecological impact assessment, the changes in the types and distribution of terrestrial ecosystem caused by the project shall be forecasted, and its impact on the service function and integrity of terrestrial ecosystem shall be assessed according to the impact forecasting results of terrestrial vegetation, terrestrial animals and plants and important habitats.

7.8.8 The terrestrial ecosystem impact forecasting and assessment method shall be taken from the methods stipulated in current sector standard NB/T 10080, *Technical Code for Investigation and Assessment of Terrestrial Ecosystem for Hydropower Projects*.

7.9 Public Health Impacts

7.9.1 As for the public health impact forecasting and assessment, the epidemic trends and changes of possible natural focus diseases, water-borne infection diseases, insect-borne diseases, endemic diseases and other diseases shall be forecasted and the impact on the health of construction personnel, immigrants and local residents in the surrounding areas of reservoir shall be assessed according to the population changes and environmental changes brought by the construction and operation of the project.

7.9.2 The public health impact forecasting and assessment should adopt analogy method, stocking experimental method, ecological mechanism analytical approach, expert forecasting method etc.

7.10 Landscape Impacts

7.10.1 For hydropower projects involving important landscape sensitive objects, landscape impacts shall be forecasted and assessed.

7.10.2 As for the landscape impact forecasting and assessment, the impact of the construction and operation of the project on the landscape sensitivity, landscape quality and development and utilization value of important landscape resources, impact of new landscape resources of the project, and the compatibility of project landscape such as project layout, reservoir landscape and architectural appearance with regional landscape shall be forecasted and analyzed according to the assessment results of landscape resources.

7.10.3 For hydropower projects with waterscape resources distributed in the downstream reach of the dam, the impact of hydrological regime changes on the waterscape quality shall be analyzed and assessed.

7.10.4 For landscape impact forecasting and assessment, the method stipulated in current sector standard HJ/T 6, *Index System for Evaluating Environmental Effect of Mountainous Type Scenic Resource Development* shall be adopted according to the landscape impact assessment contents.

7.11 Environmental Impacts of Resettlement Activities

7.11.1 The environmental impact forecasting and assessment of resettlement activities shall include the impact of reservoir basin cleaning, rural resettlement, urban relocation, major project rehabilitation on the ecological environment. Meanwhile, special environmental impact assessment shall be carried out for resettlement programs such as centralized resettlement areas, urban relocation, centralized sewage treatment plants, domestic waste sanitary landfill sites or incineration stations, hazardous waste treatment and disposal facilities, major special rehabilitation facilities, etc.

7.11.2 As for the environmental impact forecasting of reservoir basin cleaning, the pollution source characteristics in reservoir inundation area and its impact on the water quality of the reservoir after reservoir cleaning as well as the impact of the disposal scheme outside the reservoir on the surrounding environment shall be forecasted and analyzed based on the reservoir basin cleaning scheme.

7.11.3 As for the environmental impact forecasting of rural resettlement, the impact of land resettlement on terrestrial ecosystem, and the impact of relocation and resettlement on environmental

elements such as surfacewater quality, groundwater environment, terrestrial ecosystem and public health in the resettlement area shall be forecasted and analyzed.

7.11.4 As for the environmental impact forecasting of urban relocation, the impact of environmental elements such as surfacewater quality, groundwater environment, terrestrial ecosystem, atmospheric environment and acoustical environment in resettlement area shall be forecasted and analyzed.

7.11.5 As for the environmental impact forecasting and assessment of major project rehabilitation, assessment factors and assessment priorities shall be determined according to the specific characteristics of major projects and environmental impact characteristics.

7.11.6 As for the environmental impact assessment of resettlement, the environment feasibility of rural resettlement, urban relocation, major project rehabilitation schemes shall be assessed and major environmental constraints shall be identified according to the impact forecasting results.

7.12 Environmental Impacts of Hydropower Complex Construct

I Impact of construction wastewater and sewage

7.12.1 For the impact forecasting and assessment of construction wastewater and sewage, the degradation and diffusion of major pollutants under normal discharge and abnormal discharge conditions shall be forecasted, the scope and degree of impact on the water quality of surrounding waters shall be analyzed, and the water quality shall be assessed according to the accounting results of construction wastewater and sewage source intensity.

7.12.2 When multiple pollution sources are close to each other, the scope and degree of cumulated impact of multiple pollution sources shall be forecasted for the construction wastewater and sewage impact forecasting.

7.12.3 The method for construction wastewater and sewage impact forecasting shall be determined according to the following provisions depending on the water environment function zoning of the water area where the project is located and the distribution of surfacewater quality sensitive objects:

1 When the receiving waters are Grade I and Grade II waters, the instantaneous burst blowdown model shall be adopted to forecast the impact of accident discharge for the construction wastewater and sewage impact forecasting.

2 When the receiving waters are Grade III waters or below, the pollution sources are simplified as continuous and constant discharge point sources on the bank and the zero-dimensional water quality model and the river one-dimensional or two-dimensional water quality model are respectively adopted to forecast the impact of normal discharge and abnormal discharge in the full mixing section and the mixing process section for the construction wastewater and sewage impact forecasting.

3 When surfacewater quality sensitive objects such as drinking water source protection areas are distributed in the assessment reach, the overlay method shall be adopted to assess the

impact on water quality sensitive objects according to the water quality forecasting results for the construction wastewater and sewage impact forecasting.

IIAtmospheric environmental impact

7.12.4 As for the atmospheric environmental impact forecasting and assessment, the contribution values and superposed values of organized and unorganized emissions of air pollutants to the ambient air quality shall be forecasted, and the ambient air quality of sensitive objects shall be assessed according to the accounting results of atmospheric pollution source intensity.

7.12.5 The atmospheric environmental impact of hydropower projects can be forecasted and analyzed in estimation mode.

IIIAcoustical environmental impact

7.12.6 As for the acoustical environmental impact forecasting and assessment, the contribution values and superposed values of daytime and nighttime construction noise to regional noise shall be forecasted, the acoustical environment quality of sensitive objects shall be assessed and the causes of noise exceeding the standard and the main noise sources causing a breach of standard shall be analyzed according to the accounting results of noise source intensity.

7.12.7 Construction machinery and auxiliary enterprise noise should be forecasted according to fixed point sources, traffic noise should be forecasted according to line sources, and equivalent A-weighted sound pressure level should be adopted for quantity assessment. The blasting noise should be forecasted according to the burst noise of fixed point sources and the maximum A-weighted sound pressure level shall be adopted for quantity assessment.

7.12.8 The acoustical environmental impact forecasting of different assessment classes shall meet the following requirements:

1 In Class I assessment, the forecasting value of acoustical environment of each sensitive object and the noise value at the boundary of the construction site shall be calculated, the equivalent sound pressure level diagram of fixed sound sources and moving sound sources of road sections passing through the urban built-up areas or planning areas, and the vertical equivalent sound pressure level diagram of sensitive buildings above or equal to three floors shall be drawn, and the affected population distribution within each noise level range, and the range and degree of noise exceeding the standard shall be analyzed.

2 In Class II assessment, the forecasting value of acoustical environment of each sensitive object and the noise value at the boundary of the construction site shall be calculated, and the equivalent sound pressure level diagram shall be drawn according to the assessment needs, and the affected population distribution within each noise level range, and the range and degree of noise exceeding the standard shall be analyzed.

3 In Class III assessment, the distribution of noise level and the scope and degree of impact on sensitive objects shall be analyzed.

7.12.9 The acoustical environmental impact forecasting method shall conform to the provisions in Appendix J hereof.

7.12.10 For hydropower projects with vibration environmental sensitive objects distributed in the assessment areas, the construction blasting vibration and its impact on sensitive objects shall be forecasted.

IVSolid waste impact

7.12.12 As for the solid waste impact forecasting and assessment, the impact on the surrounding environment shall be analyzed according to types, quantity and disposal of solid waste generated from the project.

7.12.13 Analogy method, empirical formula method and mechanism analysis method etc. can be adopted for solid waste impact forecasting.

7.13 Comprehensive Analysis of Environmental Impacts

7.13.1 For comprehensive analysis of environmental impacts, the environmental quality changes caused by the construction and operation of hydropower projects and the degree, duration and potential consequences of impact on regional environmental functions, ecological functions and environmental sensitive objects shall be analyzed based on the environmental impact forecasting and assessment of sub-factors.

7.13.2 The long-term and cumulative impacts caused by the project as well as the main existing environmental issues shall be clearly identified in the conclusion of comprehensive analysis of environmental impacts, and corresponding environmental protection requirements shall be put forward.

8 Environmental Protection Measures and Techno-Economic Verification

8.1 General Requirements

8.1.1 The environmental protection measures scheme for hydropower projects shall follow the principles of feasible technology, safety and reliability, convenient management and economic rationality to coordinate the relationship between the upstream and downstream, main stream and tributary, and the relationship between environmental protection measures and the main works.

8.1.2 The environmental protection of hydropower projects shall take the control of environmental pollution and ecological damage caused by engineering activities, maintaining the ecological environmental function of the project area and meeting environmental quality requirements as objectives.

8.1.3 The environmental protection measures scheme for hydropower projects shall be systematically planned and prepared item by item. As for the itemized protection scheme, multiple schemes shall compared according to the environmental protection objective requirements based on the overall layout of the measure system to propose the recommended scheme and calculate the quantities item by item.

8.1.4 For the environmental protection of re-constructed and expanded projects, the environmental protection countermeasures that meet the requirements of the current environmental protection shall be put forward based on the assessment of effectiveness of the environmental protection countermeasures that have been implemented,

8.2 Ecological Operating Schemes

8.2.1 Ecological operating schemes shall be adopted preferentially for the operation of hydropower projects to meet the needs of ecological environment for hydrological elements such as water level, flow, sediment and its change process.

8.2.2 The requirements for joint ecological scheduling operation of cascade stations and the ecological operating scheme for an individual works shall be put forward in ecological operating schemes according to the operation characteristics of the project and the upstream and downstream cascade stations and based on the analysis of the conformity of the existing operation modes with the reservoir area and the downstream ecological requirements.

8.3 Ecological Flow Discharging Measures

8.3.1 In the ecological flow discharging measures, the ecological flow discharge shall be calculated according to the ecological water demand target requirements of the downstream reach of the hydropower projects, and the flow discharge of the hydropower projects shall be determined in combination with the water demand requirements of various social service functions such as industry, agriculture and shipping. The ecological flow discharge calculation shall be conducted in accordance with relevant provisions of the current sector standard NB/T 35091, *Code for Calculation of*

Ecological Flow of Hydropower Projects.

8.3.2 Ecological flow discharge measures shall be formulated separately for the initial impoundment stage and operation stage in combination with the initial impoundment and operation dispatching scheme of the main works.

8.3.3 Various measures should be combined for ecological flow discharge, and priority should be given to the use of the existing drainage structures of the hydropower project or the storage capacity of the downstream reservoir, so as to meet the ecological flow discharge demand through optimizing the water storage scheme and operation dispatching scheme. When existing buildings and dispatching cannot meet the demand of ecological flow discharge, special facilities shall be set for it.

8.3.4 Special facilities for ecological flow discharge shall be flexible, and measures such as ecological units and ecological discharge facilities may be adopted. The scheme of special facilities can be determined through comprehensive comparison and selection based on the initial impoundment process and the fluctuation of upstream water level during operation and dispatching, combined with construction diversion and layout of project buildings.

8.4 Water Temperature Recovery

8.4.1 For thewater temperature recovery, engineering measures can be taken such as selective withdrawal intake, water retaining curtain wall, temperature rise of discharged water and so on according to reservoir water temperature stratification, water temperature demand of sensitive objects and actual engineering conditions. The design of water temperature restoration engineering measures shall be coordinated with the main works design, safe and reliable, and flexible to operate.

8.4.2 The hydropower project shall be designed in combination with the water intake, giving priority to selective withdrawal intake, with multilever type, stoplog gate type, flap gate type, muff type, inclined horizontal type, etc. The design of selective withdrawal intake for the hydropower project shall comply with the current industry standardNB/T 35053, *Design Code for Layered Water Intake of Hydropower Project*.

8.4.3 For the hydropower project where the variation of reservoir water level is small and selective withdrawal intake cannot be carried out, it is appropriate to adopt the measure of setting water retaining curtain wall in front of the water intake of the hydropower project.

8.4.4 When measures cannot be taken for the layout of the hydropower project, or the temperature of the discharged water cannot meet the water temperature demand of sensitive objects after measures are taken, measures such as extending the water delivery channel, building a suntan pool, etc. can be taken to increase the temperature of the discharged water.

8.5Reservoir Water Quality Protection

8.5.1 For the reservoir water quality protection, measures of reservoir basin cleaning, pollution source control in and around the reservoir, etc. should be put forward based on the distribution of pollution sources in and around the reservoir and in combination with the development and utilization planning of the reservoir and its surroundings.

8.5.2 When cleaning the basin of the reservoir, all kinds of solid and liquid wastes that may pollute the water body in the flooded impact area of the reservoir shall be cleaned up and harmlessly treated.

When hazardous wastes are involved, the basin cleaning of the reservoir shall specify the destination and disposal scheme of the pollution source and the contaminated soil in the original site after cleaning. When necessary, the requirements for special environmental protection design shall be put forward.

8.5.3 The treatment of reservoir pollution source should reasonably control the development and utilization of the reservoir, and put forward demands of pollution prevention, control and treatment according to the environmental function requirements of the reservoir water body.

8.5.4 The treatment of pollution source around the reservoir should set the target of total amount control of pollutants around the reservoir and entering the river from upstream, and formulate the requirements of new pollution source control, closure or upgrade and reconstruction of existing sewage outlets, etc.

8.5.5 The hydropower project affected by gas supersaturation should put forward optimization or management measures of the project scheme.

8.6 Groundwater Environmental Protection

8.6.1 For groundwater environmental protection, supplementary or perfect countermeasures for sensitive objects should be formulated based on the groundwater protection measures for the main works, such as seepage prevention and blockage removal.

8.6.2 For the hydropower project affected by groundwater sources, the requirements of optimizing the project layout, or reasonable and feasible backup water sources should be proposed first. When necessary, compensation measures for relocation of sensitive objects shall be taken in combination with resettlement planning.

8.7 Aquatic Ecosystem Protection

8.7.1 For aquatic ecosystem protection, a comprehensive measure system shall be formulated according to the affected characteristics, protection value, ecological habits, distribution characteristics of important habitats, artificial breeding characteristics and technical feasibility of fishes, and in combination with river morphology, hydrological characteristics, development of upstream and downstream cascade stations, and types and distribution of suitable habitats for fishes.

8.7.2 The hydropower project shall give priority to habitat protection measures to avoid aquatic ecological sensitive areas. When necessary, habitat protection shall be carried out in the main and tributary reaches with similar habitats to natural river courses, basically the same fish composition, low development level and connectivity with the project affected reaches, and the scope of protection and protection requirements shall be clearly defined.

8.7.3 Special fish passage facilities shall be set up for the hydropower project that obstructs fish migration routes and affect fish to complete their life history. The hydropower project that only affects the exchange of fishes can adopt manual measures such as manual fishing for fishes passing through dams. Measures for fishes passing through should effectively connect the upstream and downstream fish habitats, and define the objects, scale and seasones for fishes passing through. The type selection of fish passage facilities shall comply with the current industry standard NB/T 35054, *Design Code for Fish Passage Facilities in Hydropower Project*.

8.7.4 Measures for fish restocking shall reasonably determine the objects, scale and locations of

restocking according to the overall layout of fish restocking in the basin, and in combination with the availability of fish parents, the technical basis of artificial domestication and breeding and the habitat conditions of the restocking waters. The design of fish restocking station shall conform to the current industry standard NB/T 35037, *Code for the Design of Fish Restocking Station of Hydropower Project*.

8.7.5 Habitat restoration shall take engineering measures to create or repair important habitats of fish such as spawning grounds and feeding grounds according to such habitat requirements as morphological structure of waters, hydrological conditions and substrates of water body for fish growth and propagation in the reaches of the project.

8.8 Terrestrial Ecosystem Protection

8.8.1 For terrestrial ecosystem protection, a comprehensive measure system should be formulated according to the affected characteristics and protection requirements of terrestrial ecosystem sensitive objects, from the perspective of ecosystem protection, animal and plant species protection and ecological restoration of locally damaged areas, and in combination with ecological characteristics of regional and river valley.

8.8.2 The hydropower project should adopt measures such as the construction of protective forest around the reservoir, the management of the reservoir's water-level-fluctuating zone and the construction of ecological corridors to maintain the functions of regional terrestrial ecosystem. For the hydropower project involving special vegetation and other important ecosystems, priority should be given to taking measures such as avoiding and delimiting habitat protection areas to protect special vegetation on site. When it is difficult to protect in situ, measures such as artificial vegetation in different places and ecosystems construction should be taken to compensate in the suitable areas of adjacent habitats.

8.8.3 In order to protect plants, narrow-area species and ancient and famous trees, priority should be given to on-site protection measures such as avoiding, fencing, listing and establishment of plant protection areas. When in-situ protection is difficult, ex-situ protection measures such as transplanting and construction of rare botanical gardens should be taken, and the technical feasibility of ex-situ protection should be analyzed. When the survival rate of transplanting is low, measures such as seed collection and reproduction, seed preservation, etc. should be taken, and the construction scheme and requirements of nursery garden should be put forward when necessary.

8.8.4 Important measures for terrestrial animal protection shall meet the following requirements:

1. When there are many kinds or large quantities of protected animals involved in the hydropower project, animal rescue stations should be built to protect those animals.
2. When there are many important animal habitats involved in the hydropower project, priority should be given to avoidance measures; When it is difficult to avoid, according to the ecological habits, breeding characteristics and suitable habitats of the protected animals, ex-situ protection measures such as building food source and

artificial habitat should be taken after analyzing their technical feasibility.

3. When the hydropower project blocks the migration passage of wild animals, separate animal passage should be built.

8.8.5 For ecological protection of locally damaged areas caused by construction activities, ecological restoration measures such as vegetation restoration shall be taken according to construction planning and in combination with water and soil conservation scheme, and the requirements for plant species selection, allocation, tending and management shall be specified.

8.8.6 For soil environmental protection, measures such as adjustment of land use, construction of drainage works, optimization of farming methods, etc. shall be taken in light of potential soil incubation, salinization and desertification caused by the hydropower project and in combination with agricultural development planning and topographic and geological conditions in the affected areas.

8.9 Public Health Protection

8.9.1 Measures for public health protection should focus on controlling the infection sources and transmission media of natural epidemic diseases and infectious diseases to maintain the health of construction personnel, immigrants and local residents around the reservoir.

8.9.2 Measures such as cleaning and disinfecting the basin of the reservoir, sanitation quarantine, epidemic monitoring and early warning, disease prevention and environmental sanitation management should be taken for public health protection.

8.10 Landscape Planning

8.10.1 The hydropower project shall, according to the composition of regional landscape structure, landscape style and regional tourism landscape planning, take measures such as avoiding important landscape sensitive areas and carrying out engineering landscape planning and design to protect regional landscape.

8.10.2 For the hydropower project involving important landscape sensitive areas, priority should be given to avoiding important landscape sensitive areas according to the assessment results of the impact of project layout on landscape sensitivity and landscape visual effects; When the project involves scenic spots, geological parks, forest parks and other important scenic spots, the project layout should meet the overall planning requirements of the scenic spots.

8.10.3 Landscape shall be planned based on ecological restoration and from the perspective of landscape compatibility. The requirements for landscape planning and design shall be put forward for permanent land requisition areas and resettlement areas of the hydropower project.

8.11 Resettlement Environmental protection Measures

8.11.1 The resettlement of rural migrants shall take environmental protection measures such as ecological protection in land development, and drinking water source protection, domestic sewage treatment, domestic waste disposal and ecological restoration in relocation and resettlement. Rural domestic sewage should be used for farmland irrigation after treatment. Waste collection areas should

be set up in the resettlement sites, and the collected waste should be treated in combination with the waste treatment facilities in cities and towns.

8.11.2 Environmental protection measures for relocation of cities and towns shall meet the following requirements:

1 The measures for treatment of domestic sewage from cities and towns should, in combination with the construction of drainage pipe network and sewage treatment infrastructure in the relocation area, clarify the sewage treatment plant's location, occupied area, layout, treatment level, treatment scale, treatment process and treatment requirements for water quality.

2 The measures for treatment of domestic waste in the cities and towns should, on the basis of the scale of urban construction and long-term development plan, and considering the surrounding rural immigrant population, determine the treatment scale, site, process and layout, etc. Domestic waste disposal facilities can be set up separately or in different areas, and a waste collection and transportation system should be accordingly established.

3 Environmental protection measures should be taken during the relocation and construction of the cities and towns in terms of construction wastewater and sewage treatment, construction noise prevention, construction dust reduction, solid waste treatment and terrestrial ecological protection.

8.11.3 Environmental protection measures should be taken during the reconstruction period of professional items in such aspects as construction wastewater and sewage treatment, construction noise prevention, construction dust reduction, solid waste treatment and terrestrial ecological protection. During the operation period, environmental protection measures should be formulated according to the characteristics of different professional items.

8.11.4 The environmental protection requirements for reservoir basin cleaning shall conform to Articles 8.5.2 and 8.9.2 of this code.

8.12 Construction Environmental protection Measures for Hydropower Project

I Treatment of construction wastewater and sewage

8.12.1 For the treatment of construction wastewater and sewage, protective measures shall be respectively proposed, based on the type, discharge amount and environmental protection requirements of wastewater and sewage, for wastewater of sandstone processing, wastewater of concrete mixing system, repair system wastewater, construction domestic sewage, as well as drainage of foundation pit and cavern.

8.12.2 The treatment of construction wastewater and sewage shall follow the principle of "recycling, reduction and innocuity", and shall be recycled primarily after treatment according to the results of water balance analysis of the utilization of wastewater and sewage.

8.12.3 The treatment measures shall, in combination with the project layout, geology, site conditions and environmental functional requirements of the receiving waters, and through comprehensive comparison and selection in technology, economy and management, define the collection, storage and comprehensive utilization scheme of wastewater and sewage, as well as the treatment process, treatment standards and sewage outlets setting.

IIAtmospheric environmental protection

8.12.4 For atmospheric environmental protection, reduction and control measures shall be proposed respectively, according to the types of pollution sources such as construction dust and construction waste gas, emission characteristics and environmental protection requirements, for excavation blasting dust, construction production dust, traffic dust, construction machinery and vehicle fuel tail gas, and residential area coal-fired waste gas.

8.12.5 Measures for atmospheric environmental protection should give priority to clean construction technology and clean fuel, closed production and transportation, installation of dust removal and purification devices and other reduction measures, supplemented by sprinkling water to reduce dust, enhanced construction management and other impact control measures.

III Acoustic environmental protection

8.12.6 For acoustic environmental protection, priority should be given to adjusting construction layout and avoiding environmental sensitive objects.

8.12.7 For construction noise prevention and control, measures shall be proposed, according to the types of noise sources, emission characteristics and environmental protection requirements, for construction production noise, traffic noise and blasting noise respectively.

8.12.8 For construction noise control, low-noise equipment and process, reasonable arrangement of operation time, strengthening construction management and other measures shall be preferentially adopted to reduce noise sources.

8.12.9 The acoustic environmental protection for environmental sensitive objects can adopt measures such as setting up sound barriers, sound insulation windows and other sound insulation and noise reduction facilities, or relocation, economic compensation and other measures, and schemes of the same nature will be compared for selection.

IV Solid waste disposal

8.12.10 Spoil areas should be set up in the project area for centralized storage of waste slag and soil of the project. Engineering, plant and management measures should be taken for spoil areas to reduce ecological damage and repair damaged ecological environment.

8.12.11 For the treatment of domestic waste, a domestic waste collection and transportation system should be established to classify and post-treat domestic waste. The treatment of domestic waste should give priority to the use of existing waste treatment facilities near the project area; When the existing facilities cannot meet the treatment requirements, incineration, sanitary landfill and other schemes can be adopted. The scheme of domestic waste treatment measures should be formulated after

comprehensive comparation and selection in terms of technology, economy and management, and should specify site selection, treatment process and plane layout, etc.

8.12.12 For waste oil disposal, temporary storage facilities for waste oil collection in the project area should be built, and the oil should be recycled and disposed of harmlessly by professional companies with business license for hazardous waste after outward transportation.

8.13 Environmental Scientific Research Plan for Environmental Protection

8.13.1 The scientific research plan for environmental protection shall be formulated according to the design, implementation and operation needs of environmental protection measures for the hydropower project.

8.13.2 The items of scientific research plan should include basic research, protection effect research, design experiment research, technology and measures research, etc.

8.14 Comprehensive Analysis of Environmental Protection Effects

8.14.1 The plan of environmental protection measures should include the implementation schedule of various measures and rationality analysis according to different execution periods of main works.

8.14.2 For the technical and economic demonstration of environmental protection measures, the technical feasibility, economic rationality, reliability of stable operation and up-to-standard emission, and accessibility of ecological protection and restoration effects of various measures should be analyzed and demonstrated.

8.14.3 For comprehensive analysis of the effects of environmental protection measures, the effectiveness of various environmental protection measures should be analyzed based on the technical and economic demonstration of such measures. And then, make clear whether the quality of regional ecological environment after taking the measures can reach the corresponding environmental protection objectives and meet the protection requirements of environmental sensitive objects. Finally, give a conclusion on whether the project scheme is environmentally feasible.

9 Environmental Risk Assessment and Risk Management

9.1 General Requirements

9.1.1 For environmental risk assessment of the hydropower project, sudden or uncertain environmental events or accidents other than man-made damages and natural disasters that may occur during construction and operation should be the focus, environmental risks should be identified, the possibility and consequences of causing environmental pollution or ecological damage should be specified, and the requirements for environmental risk management should be put forward.

9.1.2 The determination classes of environmental risk assessment for hydropower project shall conform to the current industry standard HJ 169, *Technical Guidelines for Environmental Risk Assessment on Projects*.

9.1.3 The scope of environmental risk assessment for hydropower project shall be determined according to the impact scope of environmental risk sources, the nature of impact and the characteristics and distribution of environmental sensitive objects that may be affected.

9.2 Identification of Environmental Risks

9.2.1 Environmental risk identification of hydropower project should include the following contents:

1 Identification of environmental risk sources, including hazardous substances or production activities that are sudden or uncertain during the construction and operation of the project and may cause environmental pollution or ecological damage.

2 Identification of environmental risk types, including environmental pollution and ecological damage.

3 Identification of environmental factors that may be affected, mainly including surface water quality, groundwater environment, aquatic ecosystem, terrestrial ecosystem, landscape and public health.

9.2.2 Environmental risk identification of hydropower project should be carried out by the checklist method. Environmental risk identification and verification of hydropower project should comply with the provisions of Table 9.2.2.

Table 9.2.2 Environmental Risk Identification and Verification of Hydropower Project

Period	Environmental risk sources		Route of transmission and release	Environmental factors that may be affected
	Hazard materials	Production activities		
Construction period	Oil	Storage and transportation of oil	Leakage	Surface water quality, groundwater environment and soil

				environment
	Explosives	Storage and transportation of explosives	Fire caused by explosion	Terrestrial ecosystem
Operation period	Hazardous waste	Reservoir basin cleaning or stockpiling around reservoir	Leakage and leaching	Surface water quality and aquatic ecosystem
	Biological pollution sources and infectious pollution sources	Reservoir basin cleaning or stockpiling around reservoir	Leakage and leaching	Surface water quality, aquatic ecosystem and public health
	A large number of exogenous or endogenous nutrients	Reservoir impoundment	Bloom outbreak	Surface water quality and aquatic ecosystem
	Alien invasive species	Unreasonable vegetation restoration or release activities	Massive invasion	Terrestrial ecosystem and aquatic ecosystem

9.3 Environmental Risk Analysis and Assessment

9.3.1 Environmental risk analysis and assessment should include accident possibility analysis and risk consequence assessment. Among them, the risk accident possibility analysis should include the conditions and probability of environmental pollution risk and ecological damage accidents.

9.3.2 Environmental pollution risk analysis and assessment shall be carried out according to the characteristics of the hydropower project and the current industry standard HJ 169, *Technical Guidelines for Environmental Risk Assessment on Projects* for the use, storage and transportation of toxic, harmful, flammable and explosive substances.

9.3.3 Ecological damage risk analysis and assessment should combine the integrity of the ecosystem to qualitatively analyze the degree of damage caused by the project to the survival of protected species, the structure and function of the ecosystem. Among them, the analysis and assessment on risk of invasion by alien species shall be carried out in compliance with the current sector standard HJ 624,T*echnical Guidelines for Assessment on Environmental Risk of Alien Species*.

9.4 Environmental Risk Management

9.4.1 For the purpose of planning for environmental risk management, targeted environmental risk prevention measures shall be put forward in such aspects as construction and operation management and engineering measures, and from the perspective of management and control of risk sources, and the requirements on implementation in such aspects as design, construction and resources allocation shall be clarified.

9.4.2 In the emergency plan against environmental risk, principles of and requirements on preparation of such contents as classification of environmental incidents, organizations and duties, prevention and warning, emergency response, emergency guarantee, handling of aftermath and emergency plan management and exercise shall be put forward, aiming at the risk of potential sudden environmental pollution or ecological damage.

10 Planning for Environmental Monitoring

10.1 General Requirements

10.1.1 For the purpose of environmental monitoring in hydropower project, the dynamic change in environmental elements or factors during construction and operation of hydropower project shall be grasped, the implementation of environmental protection measures shall be monitored and the effects of environmental protection measures shall be verified.

10.1.2 For the purpose of planning for environmental monitoring in hydropower project, the currently available basis of monitoring work of relevant disciplines and network of environmental monitoring stations that have been established by national, local and relevant sectoralauthorities shall be made full use, representative, systematic and economic principles shall be followed and monitoring plan shall be formulated in a collaborative manner.

10.1.3 The environmental monitoring plan for hydropower project shall comply with the requirements on monitoring system of ecological environment in the river basin, and shall be coordinated with the planning for environmental monitoring stations in upper and lower cascade stations in accordance with the environmental impact characteristics of the hydropower project. The plan shall be prepared respectively for construction, operation and resettlement for different hydropower projects.

10.2 Environmental Monitoring for Construction of Hydropower Complex

10.2.1 Environmental monitoring for construction of hydropower project shall comply with the requirements on monitoring of pollution control and environmental management effects during construction of hydropower project.

10.2.2 The way of monitoring by manual sampling should be adopted for environmental monitoring for construction of hydropower project, where the monitoring shall be carried out from the period of preparation to the period of completion of hydropower project, and the frequency of monitoring shall depend on the construction planning, construction schedule and construction intensity.

10.2.3 The objects subject to environmental monitoring for construction of hydropower project shall mainly include wastewater and sewage from construction works, surface water quality, ambient air, acoustical environment, terrestrial ecosystem and aquatic ecosystem. In case that there are environmental sensitive objects to groundwater in the area to be assessed, the groundwater environment shall also be monitored. Technical requirements on monitoring of construction environment in hydropower project shall comply with the provisions in Table 10.2.3.

Table 10.2.3 Technical Requirements on Monitoring of Construction Environment in Hydropower Project

Monitoring Object	Monitoring Factor	Monitoring Point	Time and Frequency of Monitoring

Wastewater and sewage from construction works	Wastewater from processing of sand and gravel	SS, wastewater flow	Water inlet and outlet of each wastewater and sewage treatment facility	1 round of monitoring to be conducted during normal works in each quarter during the construction period
	Wastewater from concrete mixing system	pH value, SS and wastewater flow		
	Wastewater from repair and maintenance system	SS, petroleum and wastewater flow		
	Domestic sewage from construction works	pH value, SS, BOD_5, COD, fecal coliform, ammonia nitrogen, total phosphorus and sewage flow		
Surface water quality		Items with background water quality of river out of standard, total volume control items and items of characteristics of wastewater and sewage from construction works	Reference section to be set in upper reaches of construction layout; control section to be set downstream of wastewater and sewage outlet; reducing section to be set in lower reaches of construction layout; monitoring sections to be added for environmental sensitive objects such as water intake.	1 round of monitoring to be conducted in each quarter of construction period
Ambient air		TSP, PM_{10}, SO_2, NO_2	Primary construction areas, construction sites such as stockyard, slag yard and sand and gravel processing system, areas along construction route and sensitive area of atmospheric environment	At least 2 rounds of monitoring to be conducted in each year of construction

Acoustical environment	Equivalent noise level A and maximum noise level A	Primary construction areas, construction sites such as stockyard, slag yard and sand and gravel processing system, areas along construction route and sensitive area of acoustical environment	At least 2 rounds of monitoring to be conducted in each year of construction, respectively in daytime and nighttime

Table 10.2.3 (Continued)

Monitoring Object		Monitoring Factor	Monitoring Point	Time and Frequency of Monitoring
Aquatic ecosystem		Parameters of aquatic habitats, species and reserves of aquatic organisms, species and reserves of fish and important parameters related to habitats	River reaches in construction area of hydropower project and aquatic ecological sensitive area	1 round of monitoring to be conducted before impoundment in reservoir
Terrestrial ecosystem	Terrestrial plants	Recovery and coverage of vegetation, species composition and growth conditions of plants	Permanent sample plot to be set in each temporary construction area and transplanting area for plants, and reference sample plot to be set in the area without being disturbed by construction works	1 round of monitoring to be conducted in peak construction period before impoundment in reservoir, and frequency of monitoring to be appropriately increased for hydropower project with a longer construction period
	Terrestrial animals	Species, habits and activities of wildlife	Construction area of hydropower project, area inundated by reservoir and terrestrial ecological sensitive area that may be affected	
Groundwater environment		pH value, total dissolved solids, ammonia nitrogen, permanganate index, total coliform and water level	Monitoring wells to be laid out around environmental sensitive objects of groundwater	1 round of monitoring to be conducted in each quarter of construction period

10.3 Environmental Monitoring for Operating of Hydropower Complex

10.3.1 Monitoring of operating environment of hydropower project shall comply with the change in environmental factors upon commencement of systematic observation works and effect of the change on the local environment, where the conclusions of environmental impact assessment and the requirements on monitoring of effects of environmental protection measures during operation of hydropower project shall be verified.

10.3.2 For the purpose of monitoring of operating environment for hydropower project, a long-term monitoring is required after trial operation of hydropower project, where the time period of monitoring shall depend on the time when the environmental elements and environmental sensitive objects are being affected.

10.3.3 The currently available monitoring stations should be adopted at the monitoring points, with reference points, control points and reducing points respectively provided. The monitoring points of environmental sensitive objects shall be laid out in the area that may be affected by the hydropower project.

10.3.4 The operating environment monitoring objects for hydropower project shall mainly include hydrological regime, domestic sewage from power plant, surface water quality, terrestrial ecosystem and aquatic ecosystem. Corresponding environmental monitoring shall also be conducted for the hydropower projects subject to influences by water temperature, groundwater environment and climate. Technical requirements on monitoring of operating environment for hydropower project shall comply with the provisions in Table 10.3.4.

Table 10.3.4 Technical Requirements on Monitoring of Operating Environment for Hydropower Project

Monitoring Object	Monitoring Factor	Monitoring Point	Time and Frequency of Monitoring	Way of Monitoring
Hydrological regime	Flow rate and water level	Monitoring points to be set at tail and center of reservoir, upstream side of dam and downstream side of dam in accordance with the planning for automatic measuring and reporting system of water regime in hydropower project	Long-term hourly monitoring	Permanent automatic monitoring
	Ecological flow	Water outlet of ecological flow discharging facility or natural river channel downstream of dam	Monitoring facility shall be completely installed before impoundment for hydropower project, for the purpose of long-term hourly monitoring.	Permanent automatic monitoring

Domestic sewage from power plant	pH value, SS, BOD_5, COD, fecal coliform, ammonia nitrogen, total phosphorus and sewage flow	Water inlet and outlet of domestic sewage treatment facility	Long-term daily monitoring should be conducted.	Permanent automatic monitoring

Table 10.3.4 (Continued)

Monitoring Object		Monitoring Factor	Monitoring Point	Time and Frequency of Monitoring	Way of Monitoring
Surface water quality	Water quality in river reaches in project area	Total phosphorus, ammonia nitrogen, BOD_5, COD, main pollution factors of pollution sources along river, and water quality factors already out of limit in the river before construction of hydropower project	Monitoring points to be set at tail and center of reservoir, upstream side of dam, water reduced reach and lower reaches of tailwater from hydropower project in accordance with distributions of pollution sources, confluences of tributaries and environmental sensitive objects of surface water, as well as the monitoring points for water temperature, hydrological regime and aquatic ecosystem	1 round of monitoring to be conducted in each of wet season, normal season and dry season each year upon operation of hydropower project (long-term daily monitoring to be conducted as allowed by conditions)	Monitoring to be conducted by manual spot check (permanent automatic monitoring to be conducted as allowed by conditions)
	Nutrients of water in reservoir	Total phosphorus, total nitrogen, chlorophyll a, permanganate index and transparency	Mostly set in such areas as branch reservoir and reservoir bay	To be conducted as per monitoring works of water quality in reservoir, where 1 round of monitoring shall be conducted once water in reservoir is out of limits of total phosphorus and total nitrogen.	Monitoring to be conducted by manual spot check

	Reservoir basin sediment	Heavy metal pollution factors in reservoir water out of limit	To be set at the points where reservoir water is out of limit of heavy metal content and at upstream side of dam	To be conducted as per monitoring works of water quality in reservoir, where 1 round of monitoring shall be conducted once water in reservoir is out of limit of heavy metal content.	Monitoring to be conducted by manual spot check
	Saturation of total dissolved gas	Composition and concentration of total dissolved gas	To be set as per distributions of such environmental sensitive objects as confluences of tributaries in lower reaches and fish spawning area	Monitoring to be conducted for 3 years after operation of hydropower project, where the time period of monitoring each year shall start in flood discharge period of hydropower project, until there is no supersaturation in total dissolved gas.	Monitoring to be conducted by manual spot check

Aquatic ecosystem		Parameters of aquatic habitats, species and reserves of aquatic organisms, species and reserves of fish and important parameters related to habitats, effects of protection measures for fish	To cover the entire river reach to be assessed, mostly the trunk and branch streams at reservoir, water reduced reach, lower reaches of tailwater from hydropower project, river reach to be conserved as habitat and aquatic ecological sensitive area	1 round of monitoring to be conducted every 3 to 5 years since operation of hydropower project (as long-term monitoring task), where the time period of monitoring shall cover such sensitive time periods as peak period for reproduction and egg & fry development period for most of fish	Monitoring to be conducted by manual spot check
Terrestrial ecosystem	Terrestrial plants	Vegetation coverage and species composition of plants; survival rate and growth of transplanted plants	Permanent sample plot to be set in temporary construction area, areas around reservoir, water-level-fluctuating zone and transplanting area	1 round of monitoring to be conducted every 3 to 5 years since operation of hydropower project (as long-term monitoring task), where the time period of monitoring should cover peak season of plant growth.	Monitoring to be conducted by manual spot check

	Terrestrial animals	Species, sizes, habits and activities of wildlife, distribution of important habits and human disturbance, and effects of protection measures	To be set in construction area of hydropower project, areas around reservoir, water-level-fluctuating zone and terrestrial ecological sensitive area	1 round of monitoring to be conducted every 3 to 5 years since operation of hydropower project (as long-term monitoring task), where the time period of monitoring shall cover such sensitive time periods as breeding season and migration season of most of the monitoring objects	

Table 10.3.4 (Continued)

Monitoring Object	Monitoring Factor	Monitoring Point	Time and Frequency of Monitoring	Way of Monitoring
Water temperature	Temperature of incoming water into reservoir	To be set in hydrological stations at tail of reservoir or in natural river reaches upstream of such tail	Long-term hourly monitoring	Permanent automatic monitoring
	Reservoir water temperature	Appropriate monitoring sections and monitoring plumbing lines to be set after full consideration of river morphology in reservoir area, confluences of tributaries and layout of headrace structures, where the measuring points of plumbing lines can be laid out as per water depth and water temperature layering in reservoir.	Reservoir area: monitoring to be conducted at least every 1 hydrological year or natural year, where the change in water temperature in each season or month and sensitive period of the year shall be reflected by the monitoring results. Upstream side of dam: long-term hourly monitoring	Reservoir area: monitoring to be conducted by manual spot check Upstream side of dam: permanent automatic monitoring
	Discharge water temperature	To be set at end of tailwater canal of powerhouse	Long-term hourly monitoring	Permanent automatic monitoring
	Water temperature along the river downstream of dam	To be set as per river morphology downstream of dam and distributions of confluences of tributaries and objects sensitive to water temperature	Monitoring to be conducted at least every 1 hydrological year or natural year, where the change in water temperature in each season or month and sensitive period of the year shall be reflected by the monitoring results, and long-term hourly monitoring shall be conducted as allowed by conditions.	Monitoring to be conducted by manual spot check (permanent automatic monitoring to be conducted as allowed by conditions)

Groundwater environment	pH value, total dissolved solids, ammonia nitrogen, permanganate index, total coliform and water level	Monitoring wells to be laid out around environmental sensitive objects of groundwater	1 round of monitoring to be conducted in each of the wet season, normal season and dry season in the first year since operation of hydropower project	Monitoring to be conducted by manual spot check
Climate	Temperature, precipitation, humidity, wind, fog and other sensitive meteorological elements	Currently available meteorological stations to be used, and new observation points to be set if necessary. The observation points can be laid out longitudinally along the reservoir and laid out vertically on a typical cross section.	Long-term daily monitoring	Permanent automatic monitoring

10.4 Environmental Monitoring Plans of Resettlement Activities

10.4.1 Monitoring of resettlement environment shall comply with the requirements of continuously and systematically observing the impact by resettlement environment, and monitoring the effects of the protection measures for the resettlement environment.

10.4.2 The objects subject to monitoring of resettlement environment shall mainly include domestic sewage, water quality of drinking water source and terrestrial ecosystem. The technical requirements on monitoring of resettlement environment shall comply with provisions in Table 10.4.2.

Table 10.4.2 Technical Requirements on Monitoring of Resettlement Environment

Monitoring Object		Monitoring Factor	Monitoring Point	Time and Frequency of Monitoring	Way of Monitoring
Domestic sewage		pH value, SS, BOD_5, COD, fecal coliform, ammonia nitrogen, total phosphorus and sewage flow	To be set at water inlet and outlet of domestic sewage treatment facilities in cities and towns planned for relocation and on centralized resettlement sites	Long-term daily monitoring should be conducted.	Permanent automatic monitoring
Water quality of drinking water source		In compliance with the current national standard GB 3838, *Environmental Quality Standard for Surface Water*	To be set at water point of centralized water source area in resettlement area	Long-term monitoring to be conducted, and 1 round of monitoring to be conducted in each quarter of each year	Monitoring to be conducted by manual spot check
Terrestrial ecosystem	Terrestrial plants	Recovery and coverage of vegetation, species composition and growth conditions of plants, and survival rate and growth of transplanted plants	To be set in resettlement area of development land and centralized resettlement area	1 round of comprehensive monitoring to be conducted after completion of resettlement works	Monitoring to be conducted by manual spot check
	Terrestrial animals	Species, sizes, habits and activities of wildlife, distribution of important habits and human disturbance, and effects of protection measures			

11 Planning for Environmental Management and Supervision

11.1 Planning for Environmental Management

11.1.1 For planning of environmental management, the basic tasks, administrations, duties and systems for environmental management shall be made clear.

11.1.2 Planning for environmental management in hydropower project shall be coordinated with planning, objectives, tasks and standards for environmental management in river basin.

11.1.3 The basic tasks of environmental management shall comprise organizing, implementing, managing and supervising the environmental protection work of hydropower project, and ensuring the implementation of environmental protection measures, environmental monitoring and scientific research plan.

11.1.4 The job content of environmental management shall mainly include management of purchasing by invitation to bid, management of facility operation, emergency management, information management and management of facility acceptance.

11.2 Planning for Environmental Supervision

11.2.1 The environmental supervision shall be carried out throughout the construction of hydropower project, from preparation for construction of hydropower project or commencement of resettlement activities to acceptance of environmental protection works at completion of hydropower project.

11.2.2 For the purpose of planning for environmental supervision, it shall be clarified that the scope of environmental supervision, time period, objectives, organizational structure and personnel allocation, work system and procedures, main job contents, working method and expenditures required, and technical requirements shall comply with the current sector standard NB/T 35063,*Code of Environmental Supervision of Hydropower Project*.

11.3 Planning of "Three-simultaneous (Simultaneous Design, Construction and Operation)" Management for Environmental Protection

11.3.1 Planning of "three-simultaneous" management for environmental protection shall follow the principles of simultaneous design, construction and operation with main works.

11.3.2 For the purpose of planning of "three-simultaneous" management for environmental protection, engineering measures and management measures shall be listed as per the schedules for construction works, operation and resettlement activities of hydropower project; job contents of measures, deadlines for design, construction and operation of each measure and subjects implementing the measures (including their main tasks and requirements on duties) shall be made clear; main job contents and requirements on special acceptance of environmental protection facilities, acceptance of environmental protection during impoundment and acceptance of environmental protection at completion of hydropower project shall be proposed.

12 Environmental Protection Investment Estimate and Cost-benefit Analysis of Environmental Impact

12.1 Composition of Cost

12.1.1 Total investment in environmental protection for hydropower project shall include engineering investment with function of environmental protection and special investment for environmental protection, where the special investment for environmental protection shall consist of special investment for environmental protection in hydropower project, special investment for environmental protection in land acquisition and resettlement for construction, independent expenses and basic reserve funds.

12.1.2 The special investment for environmental protection in hydropower project and special investment for environmental protection in land acquisition and resettlement for construction shall be accounted respectively, and shall both include those expenses related to construction works, equipment and installation works, environmental monitoring works, special study on environmental protection and operation and maintenance of environmental protection facilities during construction.

12.1.3 The independent expenses shall include management expenses for project construction, survey and design expenses for scientific research and other taxes and dues.

12.1.4 The basic reserve funds shall include the cost of environmental protection measures taken to solve change in environmental protection design and to prevent natural disasters, and the cost reserved to compensate for loss caused by natural disasters that are not covered in insurance for hydropower project.

12.1.5 For investment in environmental protection, opinions on investment cost allocation respectively in construction period and operating period shall be put forward on the basis of the time when investment cost incurs, and this kind of investment cost shall be respectively accounted into project estimate and cost for power generation.

12.2 Method of Investment Estimate

12.2.1 The special investment for environmental protection in hydropower project as well as land acquisition for construction and resettlement shall be estimated with the following methods:

1 The expenses for construction works, equipment and installation works should be estimated by multiplying quantities of works by unit prices of works. For the items of which the quantities of works are hard to be detailed in the environmental impact assess stage, the expenses can be estimated on the basis of the design parameters, scales and types of relevant items, and via market research and analysis of unit cost indexes in similar type of works. The price datum year and basic price of unit prices of works shall be consistent with hydropower project, land acquisition for construction and resettlement.

2 Cost for environmental monitoring shall be analyzed and calculated in accordance with environmental monitoring plan as well as standard of charging for local environmental monitoring works.

3 Cost for special study on environmental protection can be estimated as per actual demand or via comparison to cost indexes of similar type of works.

4 Cost for operation and maintenance of environmental protection facilities during construction shall be analyzed and calculated as per operating time of environmental protection facilities as well as actual data including labor, materials, power and management.

12.2.2 Independent expenses shall be calculated in compliance with the current sector standard NB/T 35033,*Preparation Regulation for Special Investment on Environmental Protection Design of Hydropower Project*.

12.2.3 The basic reserve funds shall be calculated as per relevant ratings. The ratings can be determined on the basis of the complexity of environmental issues and via deep analysis of environmental protection design for hydropower project. The base figure for calculation of such ratings shall be the sum of special investment for environmental protection in hydropower project, special investment for environmental protection in land acquisition for construction and resettlement, and independent expenses.

12.2.4 Investment by years shall be calculated as per the progress of implementation of environmental protection measures, with a calculation method in compliance with the current sector standard NB/T 35033, *Preparation Regulation for Special Investment on Environmental Protection Design of Hydropower Project*.

12.3 Cost-benefit Analysis under Environmental Impact

12.3.1 For the cost-benefit analysis under environmental impact in hydropower project, environmental benefits and environmental losses shall be calculated as per the environmental impact assessment results.

12.3.2 The environmental benefits of hydropower project shall include environmental benefits brought by hydropower generation, environmental benefits realized by comprehensive utilization and other environmental benefits with environmental protection measures implemented.

12.3.3 Environmental losses of hydropower project shall include losses in natural resources and values of ecological environment caused by such factors of influence as construction works, reservoir impoundment, project operation, dam barrier and water reducing in river.

12.3.4 Those environmental benefits and environmental losses that are quantifiable and can be monetized should be estimated in a monetized manner for hydropower project. Such methods as market valuation and reference of achievements can be adopted for monetized estimation of environmental benefits. Such methods as reimbursement for expenses, service value and shadowing project can be adopted for monetized estimation of environmental losses.

12.3.5 For the purpose of cost-benefit analysis under environmental impact, index analysis shall be

carried out with such methods as benefit-cost ratio and economic net present value and on the basis of calculation and analysis of environmental benefits and losses in hydropower project.

13 Comprehensive Assessment

13.0.1 For the purpose of comprehensive assessment on environmental impact, environmental reasonability of the project scheme shall be analyzed systematically on the basis of assessment of each environmental element, to make clear the major environmental impacts and potential environmental constraints in hydropower project, to put forward environmental protection measures and to determine the environmental feasibility of hydropower project.

13.0.2 Conclusions of comprehensive assessment on environmental impact shall include the following contents:

1 Project Overview, including overview for river basin planning and planning for environmental impact assessment, objectives of project development, comparison and optimization process for project scheme and environmental protection thereof, and main environmental impact factors and pollution source intensity during construction and operation of hydropower project.

2 Conclusions of assessment of environmental status, including regional environmental quality status and existing major environmental issues, as well as major issues existing in the completed hydropower projects in the reconstruction and expansion works.

3 Conclusions of environmental impact forecasting and assessment, including positive impacts and negative impacts, focusing on the long-term and cumulative impacts, and existing major environmental issues.

4 Environmental protection measures to be taken, investment and techno-economic feasibility.

5 Adoption of public opinions.

6 Conclusions of environmental feasibility for projects.

7 Major issues to be concerned for construction works and operations, and relevant suggestions on scientific research, supervision and environmental impact post-assessment.

Appendix A Contents of Environmental Impact Statement of Hydropower Project

Appendix B Table of Major Characteristics of Hydropower Project

Table B Major Characteristics of Hydropower Project

S/N	Item	Unit	Qty.	Notes
I	Hydrology and sediment			
1	Drainage area			
	Total drainage area	10,000km^2		
	Drainage area upstream of dam site of hydropower project	10,000km^2		
2	Annual average flow rate at dam site	m^3/s		
3	Average annual sediment concentration at dam site	g/m^3		
4	Natural annual average water stage and corresponding flow rate	m,m^3/s		Specify the location
II	Reservoir			
1	Water level in reservoir			
	Normal pool level	m		
	Operating water level in flood season	m		
	Dead water level	m		
2	Area of reservoir in normal pool level	km^2		
3	Backwater length			
	Backwater length in mainstream	km		
	Backwater length in tributary	km		
4	Capacity of reservoir			
	Total capacity of reservoir	100 million m^3		Corresponding check flood level
	Capacity of reservoir below the normal pool level	100 million m^3		
	Regulating storage capacity	100 million m^3		Normal pool level to dead water level
	Dead capacity of reservoir	100 million m^3		Below dead water level
5	Regulating characteristics	—		
III	Discharged flow rate			
1	Rated discharge of hydropower project	m^3/s		
2	Minimum flow rate for power generation	m^3/s		
3	Minimum discharged flow rate at dam site	m^3/s		
IV	Benefit index of hydropower project			
1	Installed capacity	MW		
2	Annual average energy output	100 million kWh		
3	Annual utilization hours of power generation at installed capacity	h		
V	Land acquisition and resettlement for construction			
1	Area of land acquisition and occupation	Mu		

S/N	Item	Unit	Qty.	Notes
2	Population to be resettled	Person		
3	Main special facilities	—		
VI	Major structures and equipment			
1	Water retaining structures			
	Type	—		
	Dam crest elevation	m		
	Maximum dam height	m		

Table B (Continued)

S/N	Item	Unit	Qty.	Notes
2	Water release structures			Each water release structure shall be listed by items, and those with special facilities for ecological flow discharging shall be separately listed.
	Type	—		
	Qty. and dimension	m		
	Weir crest elevation or bottom slab elevation	m		
	Flow rate per unit width	$m^2/(s \cdot m)$		
	Way of energy dissipation	—		
3	Water conveyance structures			In case that layered intake is to be adopted, such parameters as type of layered power intake, height of layer and crest height shall be provided.
	Design flow rate	m^3/s		
	Maximum flow rate	m^3/s		
	Type of power intake	—		
	Power intake center elevation or bottom sill elevation	m		
	Type and Qty. of headrace tunnel	Nr.		
	Type of surge shaft or forebay	—		
	Type and Qty. of penstock	Nr.		
	Type and Qty. of tailrace canal	Nr.		
4	Powerhouse and major M&E equipment			Those with eco-friendly units shall be separately listed.
	Type of powerhouse	—		
	Dimension of main powerhouse	m		
	Number of turbine units	Set		
	Rated head	m		
	Rated flow rate	m^3/s		
5	Type of switchyard	—		
6	Fish pass facilities			
	Type	—		
	Length	m		
	Width	m		
VII	Construction works			
1	Volume of main earthwork			
	Volume of excavation	$10,000m^3$		
	Volume of filling works	$10,000m^3$		
2	Material sources			
	Concrete aggregates	$10,000m^3$		
	Rock materials for filling works	$10,000m^3$		
	Earth	$10,000m^3$		

Table B (Continued)

S/N	Item	Unit	Qty.	Notes
3	Waste slags from construction			
	Qty. and floor area of slag yard	Nr, hm^2		
	Capacity planned	$10,000^3$		
	Volume of recovery	$10,000^3$		
	Final slag quantity	$10,000^3$		
4	Water diversion works for construction			
	Water diversion method and structure	—		
	Diversion flow rate	m^3/s		$P =$ %
5	Labor force needed			
	Total man-days	10,000 man-days		
	Average peak number	Person		
6	Transportation for construction			
	Method and distance of external transportation	km		
	Length of main access roads on site	km		Highway, bridge and tunnel
7	Total construction period	Month		
VIII	Economic indexes			
1	Total investment	RMB 10,000		
2	Static investment	RMB 10,000		
3	Investment in environmental protection	RMB 10,000		

Appendix C Pollution Source Intensity Accounting for Hydropower Project

C.0.1 Accounting for source intensity of wastewater and sewage for hydropower project shall comply with provisions in Table C.0.1.

Table C.0.1 Accounting for Source Intensity of Wastewater and Sewage for Hydropower Project

Source	Production of Wastewater and Sewage			Treatment Process	Recycling		Discharge of Wastewater and Sewage					Object of Impact
	Factor of pollution	Concentration (mg/L)	Water volume (m^3/h)		Qty. of recycling (m^3/h)	Recycled for	Concentration (mg/L)	Water volume (m^3/h)	Time period of discharge	Discharged for	Compliance	
Wastewater from processing of sand and gravel	pH value											
	SS											
Wastewater from concrete mixing system	pH value											
	SS											
Wastewater from repair and maintenance system	SS											
	Petroleum											
Domestic sewage from construction works	COD											
	BOD_5											
Water drained from foundation pit and	SS											
	Petroleum											

chamber												
Domestic sewage from power plant	COD											
	BOD_5											
Domestic sewage from resettlement area	COD											
	BOD_5											

C.0.2 Accounting for source intensity of atmospheric pollution from construction works of hydropower project shall comply with provisions in Table C.0.2.

Table C.0.2 Accounting for Source Intensity of Atmospheric Pollution from Construction Works of Hydropower Project

Source	Production of Pollutants		Treatment Process	Emission of Pollutants					Object of Impact
	Factor of pollution Factor of pollution	Concentration (mg/m^3)		Concentration (mg/m^3)	Rate of emission (kg/h)	Time period of emission	Way of emission	Compliance	
Dust from excavation and blasting works	TSP				—				
Dust from construction and production	TSP				—				
Flying dust from traffic	TSP				—				
Tail gas of fuel oil from construction machinery and vehicles	TSP				—				
	SO_2								
	NO_x								
Coal-fired tail gas from living camp	TSP								
	SO_2								
	NO_x								

C.0.3 Accounting for source intensity of noise pollution from construction works of hydropower project shall comply with provisions in Table C.0.3.

Table C.0.3 Accounting for Source Intensity of Noise Pollution from Construction Works of Hydropower Project

Source	Type of	Intensity of	Treatment	Noise at	Time	Compliance	Object of

	Noise Source	Noise Source (dB(A))	Process	Construction Boundary (dB(A))	Period of Impact		Impact
Noise from construction and production							
Noise from traffic							
Noise from blasting works							

C.0.4 The accounting for source intensity of solid waste of hydropower project shall comply with provisions in Table C.0.4.

Table C.0.4 Accounting for Source Intensity of Solid Waste of Hydropower Project

Source	Unit	Qty. of Production	Way of Disposal	Method of Storage	Stored for	Object of Impact
Waste slag and spoil from construction	m^3					
Domestic waste	t					
Industrial waste	m^3					

Note: The Qty. of production includes the Qty. from construction works, the Qty. from operation of hydropower project and the Qty. from reservoir basin cleaning work.

Appendix D Matrix of Screening for Environmental Impact Identification and Assessment Factors for Hydropower Project

Table D Matrix of Screening for Environmental Impact Identification and Assessment Factors for Hydropower Project

Environmental Elements	Environmental Factors		Construction of Hydropower Project							Operation of Hydropower Project				Resettlement				Screening Result
	Factor of pollution	Weight in regional environment	Water diversion works for construction	Plant of construction	Living area of construction	Traffic and transportation	Land occupancy for construction	Quarry and borrow area for construction	Waste slag from construction	Dam blocking	Reservoir impoundment	Operating schedule	Operation management of hydropower project	Rural resettlement	Urban migration	Handling of project-related items	Reservoir basin cleaning works	
Climate and meteorology	Temperature																	
	Precipitation																	
	Humidity																	
	Wind																	
	Evaporation																	
Hydrological regime	Flow rate																	
	Water level																	
	Water depth																	
	Flow velocity																	
	Suspended sediment																	
	Bed sediment																	
	Sediment Siltation																	
	Tide																	
Water temperature	Water temperature																	
Surface water quality	pH value																	
	SS																	
	COD																	
	BOD_5																	
	DO																	
	Petroleum																	
	Total phosphorus																	
	Ammonia nitrogen																	
	Permanganate index																	
	Water trophic																	

	status																	
	Water pollutant-holding capacity																	
	Saturation of total dissolved gas																	

Table D (Continued)

Environmental Elements	Environmental Factors		Construction of Hydropower Project							Operation of Hydropower Project				Resettlement				Screening Result
	Factor of pollution	Weight in regional environment	Water diversion works for construction	Plant of construction	Living area of construction	Traffic and transportation	Land occupancy for construction	Quarry and borrow area for construction	Waste slag from construction	Dam blocking	Reservoir impoundment	Operating schedule	Operation management of hydropower project	Rural resettlement	Urban migration	Handling of project-related items	Reservoir basin cleaning works	
Groundwater environment	Water level																	
	pH value																	
	Total dissolved solids																	
	Ammonia nitrogen																	
	Permanganate index																	
Aquatic ecosystem	Suitability of aquatic habitat																	
	Diversity of aquatic organisms																	
	Type of fish																	
	Quantity of fish resources																	
	Viability of fish population																	
	Connectivity of aquatic ecosystem																	
	Structure of aquatic ecosystem																	
	Functions of aquatic ecosystem																	
	Conserved fish and important economic fish																	
	Aquatic ecological sensitive area																	

Table D (Continued)

Environmental Elements	Environmental Factors		Construction of Hydropower Project							Operation of Hydropower Project				Resettlement				Screening Result
	Factor of pollution	Weight in regional environment	Water diversion works for construction	Plant of construction	construction	Living area of transportation	Traffic and construction	Land occupancy for construction	Quarry and borrow area construction	Waste slag from	Dam blocking	Reservoir impoundment	Operating schedule	Operation management of hydropower project	Rural resettlement	Urban migration	Handling of project-related items works	Reservoir basin cleaning	
Terrestrial ecosystem	Soil structure																		
	Physicochemical properties of soil																		
	Fertility of soil																		
	Type of vegetation																		
	Distribution of vegetation																		
	Diversity of plants																		
	Diversity of terrestrial animals																		
	Type of terrestrial ecosystem																		
	Functions of terrestrial ecosystem																		
	Integrity of terrestrial ecosystem																		
	Conserved animals, plants, endemic plants of narrow area and ancient and rare trees																		
	Terrestrial ecological sensitive area																		

Table D (Continued)

Environmental Elements	Environmental Factors		Construction of Hydropower Project							Operation of Hydropower Project				Resettlement				Screening Result
	Factor of pollution	Weight in regional environment	Water diversion works for construction	Plant of construction	Living area of construction	Traffic and transportation	Land occupancy for construction	Quarry and borrow area for construction	Waste slag from construction	Dam blocking	Reservoir impoundment	Operating schedule	Operation management of hydropower project	Rural resettlement	Urban migration	Handling of project-related items	Reservoir basin cleaning works	
Atmospheric environment	TSP																	
	NO_x																	
	SO_2																	
Acoustical environment	Noise																	
Public health	Source of infection																	
Landscape	Resource of landscape																	
	Vision of landscape																	

Notes:

1. Properties of impact: Positive impact is marked by +, negative impact is marked by -; long-term impact is marked by L, short-term impact is marked by S; reversible impact is marked by R, non-reversible impact is marked by N; direct impact is marked by D, indirect impact is marked by I; cumulative impact is marked by C.

2. Degree of impact: No impact is marked by 0, slight impact is marked by 1, medium impact is marked by 2 and big impact is marked by 3.

3. Weight: Important impact is marked by III, secondary important impact is marked by II and negligible impact is marked by I.

4 Screening results: Significant assessment is marked by ★, general assessment is marked by ☆ and no assessment is marked by △.

Appendix E Table of Analysis and Calculation Results of Runoff

E.0.1 Table of analysis and calculation results of runoff at dam site and plant site shall comply with provisions in Table E.0.1.

Table E.0.1 Analysis and Calculation Results of Runoff at Dam Site and Plant Site

Item	June	July	August	September	October	November	December	January	February	March	April	May	All Year Round	Wet Season	Normal Season	Dry Season
Annual average runoff (m^3/s)																
Runoff in wet season (m^3/s)																
Runoff in normal season (m^3/s)																
Runoff in dry season (m^3/s)																

E.0.2 Table of analysis and calculation results in assessment of runoff from tributaries shall comply with provisions in Table E.0.2.

Table E.0.2 Analysis and Calculation Results in Assessment of Runoff from Tributaries

Target River	Description of Tributary	Category of Bank	Distance from Confluence to Dam Site (km)	Drainage Area (km^2)	Annual Average Flow Rate (m^3/s)	River Length (km)	Gradient (‰)

Appendix F Method of Assessment for Surface Water Status

F.0.1 Single-factor assessment shall be adopted for assessment of surface water status. In such single-factor assessment, values monitored for many times can be averaged as the value of some item of water quality. In case of a great variation in the values monitored for such item, the mean value affected by higher values can be calculated with Nemerow mean value. The Nemerow mean value shall be calculated with the following formula:

$$c_N = \left(\frac{c_{max}^2 + \overline{c}^2}{2} \right)^{\frac{1}{2}} \tag{F.0.1}$$

Where:

C_N is the Nemerow mean value within characteristic pollutant concentration (mg/L);

C_{max} is the maximum concentration of characteristic pollutant monitored for many times (mg/L);

$\overline{c}$ is the arithmetic mean concentration of characteristic pollutant (mg/L).

F.0.2 Standard index method shall be adopted for single-factor assessment. The standard index method shall comply with the following provisions:

1 The standard index of a water quality item*i* at monitoring point *j* shall be calculated with the following formula:

$$S_{ij} = C_{ij} / C_{si} \tag{F.0.2-1}$$

Where:

S_{ij} is the standard index of water quality item *i* at monitoring point *j*;

C_{ij} is the representative statistic value of measured concentration of water quality item *i* at monitoring point *j* (mg/L);

C_{si} isstandard limit of surface water quality of water quality item *i* (mg/L).

2 The standard index of dissolved oxygen shall be calculated with the following formula:

$$S_{DO,j} = DO_s / DO_j, \quad DO_j \leq DO_f \tag{F.0.2-2}$$

$$S_{DO,j} = \frac{|DO_f - DO_j|}{DO_f - DO_s}, \quad DO_j \rangle DO_f \tag{F.0.2-3}$$

$$DO_f = 468/(31.6 + T) \tag{F.0.2-4}$$

Where:

$S_{DO,j}$ is the standard index of dissolved oxygen at monitoring point *j*;

DO_s is the standard limit of surface water quality of dissolved oxygen (mg/L);

DO_j is the representative statistical value of measured concentration of dissolved oxygen at monitoring point *j* (mg/L);

DO_f is the saturated dissolved oxygen concentration (mg/L);

T is the water temperature (°C).

3 The standard index of *pH* value shall be calculated with the following formula:

$$S_{pH,j} = \frac{7.0 - pH_j}{7.0 - pH_{sd}}, pH_j \leq 7.0 \quad \text{(F.0.2-5)}$$

$$S_{pH,j} = \frac{pH_j - 7.0}{pH_{su} - 7.0}, pH_j > 7.0 \quad \text{(F.0.2-6)}$$

Where:

$S_{pH}j$ is the standard index of *pH* value at monitoring point *j*;

pH_j is the representative statistical value of pH value at monitoring point *j*

pH_{sd} is thelower limit of pH value specified in standard of surface water quality;

pH_{su} is the upper limit of pH value specified in standard of surface water quality.

F.0.3 For the purpose of assessment of surface water quality status, the compliance of the water quality item shall be determined as per the calculation results of standard indexes of such water quality item as follows:

1 The water quality item shall be judged as exceeding the limit if the standard index is greater than 1.

2 The water quality item shall be judged as reaching the standard if the standard index is less than or equal to 1.

Appendix G Method of Hydrological Regime Impact Forecasting

G.0.1 The De Saint-Venant system of equations with unsteady flow shall be adopted as the mathematical model for hydrological regime impact forecasting, and the calculation shall be carried out with the following formula:

$$\frac{\partial Q}{\partial x}+\frac{\partial A}{\partial t}=q \tag{G.0.1-1}$$

$$\frac{\partial Q}{\partial t}+\frac{\partial}{\partial x}\left(\frac{Q^2}{A}\right)+gA\frac{\partial Z}{\partial x}+g\frac{n^2Q|Q|}{AR^{4/3}}=0 \tag{G.0.1-2}$$

Where:

Q is the flow rate on cross section (m^3/s);

x is the longitudinal distance of water flow (m);

A is the effective area of cross section of water (m^2);

t is the time (s);

q is the side inflow per unit river length (m^2/s);

g is the acceleration of gravity (m/s^2);

Z is the water level on cross section (m);

n is the Manning roughness factor;

R is thehydraulic radius (m).

G.0.2 The numerical solution of the De Saint-Venant system of equations shall be obtained with verified calculation software.

G.0.3 For the purpose of calculation with mathematical model, base data shall be collected first or supplementary investigation is needed to determine the boundary conditions and initial conditions, and to carry out parameter calibration and model verification.

Appendix H Table of Hydrological Regime Forecasting Results

H.0.1 The hydrological regime forecasting results in the initial impoundment stage of the reservoir shall comply with provisions in Table H.0.1.

Table H.0.1 Hydrological Regime Forecasting Results in Initial Impoundment Stage of Reservoir

Time (h or d)	Reservoir Inflow (m^3/s)	Flow Rate for Water Impoundment (m^3/s)	Capacity of Reservoir (10,000 m^3)	Water Level in Reservoir (m)	Reservoir Outflow (m^3/s)	Water release facilities and capacity (m^3/s)
1						
2						
3						
4						
…						

H.0.2 The monthly hydrological regime forecasting results on representative cross section in reservoir area in the typical year shall comply with provisions in Table H.0.2.

Table H.0.2 Monthly Hydrological Regime Forecasting Results on Representative Cross Section in Reservoir Area in the Typical Year

Period	Reservoir Inflow (m3/s)	Water Level (m)		Water Depth (m)		Water Surface Width (m)		Flow Velocity (m/s)	
		Natural	Operation period	Natural	Operation period	Natural	Operation period	Natural	Operation period
June									
July									
August									
September									
October									
November									
December									
January									
February									
March									
April									
May									

H.0.3 The monthly hydrological regime forecasting results on representative cross section in water reduced reach and lower tail water reach of hydropower project in the typical year shall comply with provisions in Table H.0.3.

Table H.0.3 Monthly Hydrological Regime Forecasting Results on Representative Cross Section in Water Reduced Reach and Lower Tail Water Reach of Hydropower Project in the Typical Year

Period	Flow Rate (m^3/s)		Water Level (m)		Water Depth (m)		Flow Velocity (m/s)		River Width (m)	
	Natural	Operation period	Natural	Operation period	Natural	Operation period	Natural	Operation period	Natural	Operation period
June										
July										
August										
September										
October										

Table H.0.3 (continued)

Period	Flow Rate (m^3/s)		Water Level (m)		Water Depth (m)		Flow Velocity (m/s)		River Width (m)	
	Natural	Operation period	Natural	Operation period	Natural	Operation period	Natural	Operation period	Natural	Operation period
November										
December										
January										
February										
March										
April										
May										

H.0.4 The hourly hydrological regime forecasting results on representative cross section in water reduced reach and lower tail water reach of hydropower project in the typical day shall comply with provisions in Table H.0.4.

Table H.0.4 Hourly Hydrological Regime Forecasting Results on Representative Cross Section in Water Reduced Reach and Lower Tail Water Reach of Hydropower Project in the Typical Day

Period	Flow rate (m^3/s)		Water Level (m)		Water Depth (m)		Flow Velocity (m)	
	Natural	Operation period	Natural	Operation period	Natural	Operation period	Natural	Operation period
1h								
2h								
3h								
4h								
5h								
6h								
7h								
8h								
9h								
10h								
11h								
12h								
13h								
14h								
15h								
16h								
17h								
18h								
19h								
20h								

21h								
22h								
23h								
24h								

Appendix J Method of Acoustical Environmental impact Forecasting

J.1 Forecasting of Noise from Construction Machinery and Auxiliary Enterprises

J.1.1 Parameters for forecasting of noise from construction machinery and auxiliary enterprises shall include range of construction machinery and auxiliary enterprises, descriptions, models and quantities of main equipment, noise source intensity, operating mode and operating time.

J.1.2 Analysis of transmission route of noise from construction machinery and auxiliary enterprises shall include distance and altitude difference between noise source and forecasting point, transmission route between noise source and forecasting point, and such factors as state of ground, obstacles and forests that may affect the transmission of noise wave.

J.1.3 In view of model for forecasting of noise from construction machinery and auxiliary enterprises, geometrical spreading attenuation formula of non-directional point sound source shall be adopted. The impacts of each noise source on environment shall be calculated with the following formula:

$$L(r) = L(r_0) - 20\lg(r/r_0) \tag{J.1.3}$$

Where:

L(r) is the noise level (dB) at forecasting point *r*;

$L(r_0)$ is the noise level (dB) at measuring point r_0 of noise source;

r is the distance (m) from forecasting point to center of noise source;

r_0 is the distance (m) from measuring point of noise source to center of noise source.

J.1.4 For the purpose of forecasting and assessment of impact by noise from construction machinery and auxiliary enterprises, the calculation results shall be compared with the limit value of quality standard in functional area of acoustical environment, to assess the quality of acoustical environment at the forecasting point.

J.2 Forecasting of Traffic Noise

J.2.1 Parameters of forecasting for traffic noise shall include those parameters related to structures and materials on pavements of each construction section of road, average traffic flow, peak traffic flow and traffic speed in daytime and nighttime at each construction section of road, types, descriptions and scales of sensitive objects along each construction section of road, the road sections where those objects are located as well as relative distances and altitude differences from those objects to subgrade.

J.2.2 Analysis of transmission route of traffic noise shall include distance and altitude difference between noise source and forecasting point, transmission route between noise source and forecasting point and such factors as state of ground, obstacles and wood that may affect the transmission of noise wave.

J.2.3 For the purpose of forecasting of traffic noise, single-vehicle model and parameters of heavy duty truck shall be adopted, and calculation shall be carried out with the following formula:

$$L_{eq}(h) = L_{0E} + 10\lg(N/VT) + K\lg(7.5/r)^{1+a} - 16 \tag{J.2.3}$$

Where:

$L_{eq}(h)$ is the equivalent noise level per hour at the forecasting point (dB(A));

L_{0E} is the average vehicle speed and average level of noise energy A (dB (A)) in an average horizontal distance of 7.5m from the centerline of lane;

N is the average traffic flow per hour at some forecasting point in daytime and nighttime (Nr./h);

V is the average vehicle speed (km/h);

T is the time for calculation of equivalent noise level, taken as 1h;

K is the coefficient of correction of vehicle density, taken as 15;

r is the distance (m) from centerline of lane to forecasting point;

a is the factor of noise absorption and attenuation on ground, taken as 0.

J.2.4 For the purpose of forecasting and assessment of impact by traffic noise, the calculation results shall be compared with the limit value of quality standard in functional area of acoustical environment, to assess the quality of acoustical environment at the forecasting point.

J.3 Forecasting of Impact by Noise Superposition

J.3.1 In case that the impacts by multiple noise sources are superposed at the forecasting point, the impact by noise superposition can be calculated with the following formula:

$$L_{eq} = 10\lg\left(\sum_{1}^{i} 10^{0.1L_{eqi}}\right) \tag{J.3.1}$$

Where:

L_{eq} is the superposed value (dB) of equivalent noise levels of multiple noise sources at the forecasting point;

L_{eqi} is the contribution value (dB) of equivalent noise level of noise source i at the forecasting point;

i is the quantity of noise sources.

J.3.2 For forecasting and assessment of impact by multiple noise sources, the calculation results of impact by noise superposition shall be compared with the limit value of quality standard in functional area of acoustical environment, to assess the quality of acoustical environment at the forecasting point.

Explanation of Wording in This Code

1Words used for different degrees of strictness are explained as follows in order to mark the differences in executing the requirements in this code:

1) Words denoting a very strict or mandatory requirement:

"Must" is used for affirmation; "must not" for negation.

2) Words denoting a strict requirement under normal conditions:

"Shall" is used for affirmation; "shall not" for negation.

3) Words denoting a permission of a slight choice or an indication of the most suitable choicewhen conditions permit:

"Should" is used for affirmation; "should not" for negation.

4) "May" is used to express the option available, sometimes with the conditional permit.

2 "Shall meet the requirements of…" or "shall comply with…" is used in this code to indicate that it is necessary to comply with the requirements stipulated in other relative standards and codes.

List of Quoted Standards

GB 3095, *Ambient Air Quality Standard*

GB 3096, *Environmental Quality Standards for Noise*

GB 3838, *Environmental Quality Standard for Surface Water*

GB/T 25173, *Code of Practice for Computation on Allowable Permitted Assimilative Capacity of Water Bodies*

GB/T 50298, *Standard for Scenic and Historic Area General Planning*

NB/T10079, *Technical Code for Investigation and Assessment of Aquatic Ecosystem for Hydropower Projects*

NB/T 10080, *Technical Code for Investigation and Assessment of Terrestrial Ecosystem for Hydropower Projects*

NB/T 10233, *Code for Hydrologic Design of Hydropower Projects*

NB/T 35033, *Preparation Regulation for Special Investment on Environmental Protection Design of Hydropower Project*

NB/T 35037, *Code for the Design of Fish Restocking Station of Hydropower Project*

NB/T 35053, *Design Code for Layered Water Intake of Hydropower Project*

NB/T 35054, *Design Code for Fish Passage Facilities in Hydropower Project*

NB/T 35063, *Code of Environmental Supervision of Hydropower Project*

NB/T 35091, *Code for Calculation of Ecological Flow of Hydropower Projects*

NB/T 35094, *Code for Water Temperature Calculation of Hydropower Projects*

HJ 2.1, *Technical Guideline for Environmental Impact Assessment of Construction Project —General Programme*

HJ 2.2, *Technical Guidelines for Environmental Impact Assessment—Atmospheric Environment*

HJ 2.3, *Technical Guidelines for Environmental Impact Assessment—Surface Water Environment*

HJ 2.4, *Technical Guidelines for Noise Impact Assessment*

HJ/T 6, *Index System for Evaluating Environmental Effect of Mountainous Type Scenic Resource Development*

HJ 19, Technical Guidelines for Environmental Impact Assessment—Ecological Impact

HJ/T 88， *Code for Environmental Impact Assessment of Water Conservancy and Hydropower Project*

HJ 169, *Technical Guidelines for Environmental Risk Assessment on Projects*

HJ 610, *Technical Guidelines for Environmental Impact Assessment—Groundwater Environment*

HJ 624, *Technical Guidelines for Assessment on Environmental Risk of Alien Species*