



# Social Organization Standard

T/CAOE 21.1-2020

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## Technical guideline on coastal ecological rehabilitation for hazard mitigation —

### Part 1:

### General

海岸带生态减灾修复技术导则 第1部分：总则

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## Foreword

The T/CAOE 21 *Technical guideline on coastal ecological rehabilitation for hazard mitigation* consists of the following eleven parts:

- Part 1: *General*;
- Part 2: *Mangroves*;
- Part 3: *Salt marshes*;
- Part 4: *Coral reefs*;
- Part 5: *Seagrass bed*;
- Part 6: *Oyster reef*;
- Part 7: *Sandy coast*;
- Part 8: *Technical guide for the ecological construction of sea walls (trial)*;
- Part 9: *Renovation of island-connecting sea wall and coastal engineering*;
- Part 10: *Directives for sea dike ecological construction of sea reclamation and enclosure project*;
- Part 11: *Supervising and monitoring*.

This is part 1 of the T/CAOE 21.

This part is drafted in accordance with the rules given in the GB/T 1.1-2009.

This part was proposed by the *Marine Early Warning and Monitoring Division, Ministry of Natural Resources*.

This standard was prepared by *China Association of Oceanic Engineering*.

This part was drafted by *National Marine Hazard Mitigation Service; Zhejiang Institute of Hydraulics & Estuary; Third Institute of Oceanography, Ministry of Natural Resources; North China Sea Environmental Monitoring Center of State Oceanic Administration; South China Sea Institute of Planning and Environmental Research, State Oceanic Administration; National Marine Data and Information Service; Hohai University*.

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## Introduction

To implement the spirit of the Third Meeting of the CPC Central Committee of Finance and Economics convened by General Secretary Xi Jinping on October 10th, 2018, *Technical guideline on coastal ecological rehabilitation for hazard mitigation* is formulated for providing scientific guidance to the implementation of coastal protection and rehabilitation projects, building ecological seawalls, improving the ability to withstand typhoons, storm surges and other marine disasters, and promoting the coordinating effects of ecology rehabilitation and disaster mitigation in coastal areas.

# Technical guideline on coastal ecological rehabilitation for hazard mitigation —

## Part 1: General

### 1 Scope

This part of T/CAOE 21 defines the objectives and principles, construction contents, procedures, technical requirements, quality control, achievements and archiving of coastal ecological rehabilitation for hazard mitigation.

This part is applicable to coastal ecological rehabilitation for hazard mitigation in coastal protection and rehabilitation projects, as well as other related works.

### 2 Normative references

The following documents are essential to the application of this document. If the reference document marked is with specific date, only this version is applicable to this document. If not, the latest version (including all amendments) is applicable to this document.

GB/T 12763 (All parts), Specifications for oceanographic survey

GB/T 15776, Afforestation technical regulations

GB/T 17378.1, The specification for marine monitoring – Part 1: General

GB/T 18337.3, Non-commercial forest construction-Technical regulation

GB/T 51015, Code for design of sea dike project

LY/T 1763, Technical regulation for system construction of coastal protective forest

LY/T 2093, Regulations on ecological benefits evaluation of protective forest system

LY/T 2497, Technical regulation for ecological benefits monitoring of protective forest system

T/CAOE 1, Directives for sea dike ecological construction of sea reclamation and enclosure project

T/CAOE 20, Technical guideline for investigation and assessment of coastal ecosystem

### 3 Terms and definitions

The following terminologies and definitions are applicable to this document.

#### 3.1

##### **coastal zone**

transition zone where the sea and land interact

**NOTE** The coastal zone ranges from the farthest boundary of the land that modern seawater can influence on, to the deepest boundary of the seabed affected by wave action, or the farthest boundary of the seabed that can be reached by modern coastal deposits

[GB/T 18190, Definition 2.1.3]

### 3.2

#### **coastal ecological rehabilitation for hazard mitigation**

by protecting and restoring the ecosystem of the coastal zone, functions of preventing tides & waves and fixing the banks & revetments can be consolidated and enhanced. Besides, carrying out ecological construction of coastal protection engineering facilities, and promoting the coordinating effects of ecological protection and hazard prevention and mitigation

**NOTE** It includes restoration of typical ecosystems in coastal zones such as mangroves, salt marshes, coral reefs, seagrass beds, oyster reefs and sandy coasts, restoration of coastal shelterbelt, ecological sea dike reforming, renovation of island-connecting sea wall and coastal engineering, etc.

### 3.3

#### **ecological sea dike reforming**

in order to maintain the ability of the sea wall to prevent tides and disasters and restore the coastal ecological function, the existing sea wall could be maintained, updated and strengthened by optimizing the structure type of the sea wall, using ecological building materials, as well as planting vegetation, etc.

### 3.4

#### **island-connecting sea wall**

the sea wall that connects land or other islands

### 3.5

#### **coastal engineering**

existing projects that locate on or connect to the sea or coast, with the main body locating on the seacoast or landward side of the shoreline

### 3.6

#### **seashore zone**

the seaside area of coastal ecological rehabilitation for hazard mitigation scope generally refers to the area between the seaside boundary of seawall protection areas (with seawall) or the average high tide line (without seawall) and the outer boundary of coral reef and seagrass bed growth

### 3.7

#### **sea dike zone**

the intermediate area of coastal ecological rehabilitation for hazard mitigation, where generally refers to the area between the seaside and landward boundaries of seawall protection

### 3.8

#### **continental zone**

the landward area of coastal ecological rehabilitation for hazard mitigation, which generally refers to the area between the landward boundary of seawall protection areas (with seawall) and the boundary of suitable coastal shelterbelt planting

### 3.9

#### **suitability assessment**

based on historical and on-site investigation data, considering the local current situation, ecological endowment, marine disaster and other natural conditions as well as the impacts on ecological environment by proposed engineering measures, aiming to promoting the coordinating effects of ecological rehabilitation and disaster mitigation, an integrated assessment will be employed to analyze whether the area is appropriate to implement costal ecological rehabilitation project for hazard mitigation

## **4 Purpose and principle**

### 4.1 Construction purpose

Adhere to the people-oriented and ecology first philosophy, creating the coastal ecological hazard mitigation system with "safe and reliable, eco-friendly and natural harmony" on the basis of local adaptation and multi-measures through coastal ecological restorations, so as to enhance the marine disaster prevention abilities in coastal areas, ensure the safety of people's lives and property, and promote the harmonious coexistence between human and nature.

### 4.2 Construction principle

#### 4.2.1 Safety first

Fully implement the requirements for disaster prevention and mitigation in the new era of "two commitments and three transformations" proposed in the 17<sup>th</sup> CPC national congress and give top priority to the improvement of our ability to hazard & storm-surge mitigation and the protection of people's lives and property during the coastal ecological rehabilitation for hazard mitigation.

#### 4.2.2 Ecology first

Firmly uphold the concept of ecological civilization and strengthen ecological protection and restoration. Improve the integrity and the structural stability of coastal ecosystems comprehensively by dominated natural restoration and supplemented artificial restoration.

#### 4.2.3 Local adaptation

Take fully consideration to local conditions, ecological endowments, marine disasters and other natural situations, deeply analyze the issues and needs, draft the construction plan of coastal ecological rehabilitation for hazard mitigation adapting to the local conditions, and ensure the sustaining effectiveness of ecological construction.

#### 4.2.4 Multiple-measures enforcement

Construct a comprehensive spatial hazard mitigation system in a relative large scale by multiple measures, with the main objective of realizing the function of coastal ecological hazard mitigation, considering of the structural characteristics of different spatial zones, and optimizing the design of various construction types.

## **5 Construction content**

### 5.1 General requirement

It is required to give priority to choose the severely damaged ecological open coastal areas with higher marine hazard risks (e.g., frequently suffered from storm surges) as the rehabilitation area. Compile an implementation plan that includes one construction type or



a combination of multiple construction types on the basis of investigation results, spatial characteristics of seashore zone, sea dike zone & continental zone and suitability assessment, carry out an engineering project and build a coastal ecological system for hazard mitigation based on local conditions.

## 5.2 Construction scope

The construction scope of coastal ecological rehabilitation for hazard mitigation refers to the major spatial implementation scope of various construction types of ecological disaster mitigation and restoration in coastal zones, specifically, the outer boundary of the seaward side that can extend to the growth of coral reefs and seagrass beds (water depth of 15m to 20m), and the boundary of the landside that is suitable for coastal shelterbelt cultivation. The construction scope of a specific project may be determined comprehensively according to the appropriate environmental conditions of the construction type involved. The construction scope can usually be divided into seashore zone, sea dike zone and continental zone. See Annex A is the typical section diagrams of different types of coasts.

## 5.3 Construction type

### 5.3.1 Mangrove ecological rehabilitation for hazard mitigation

In seashore or sea dike zones, with the important consideration of improving its disaster mitigation function of reducing the power of sea waves and currents, the mangrove ecosystem can be restored by means of water environment restoration, microgeomorphic modification, sediment environment improvement, as well as vegetation planting and restoration, etc., in the light of local condition adaptation, and the coastal ecological disaster mitigation function can be improved as well. See Annex B for the key points and main measures of mangrove ecological restoration.

### 5.3.2 Salt marsh ecological rehabilitation for hazard mitigation

In seashore or sea dike zones, based on the functional requirements of regional ecological disaster mitigation and the mitigation capacity of different salt marsh vegetation, salt marsh ecosystem can be restored and ecological and disaster mitigation functions can be improved through measures such as removal of threat factors, restoration of water environment, microgeomorphic transformation and improvement of sediment environment. See Annex B for the key points and main measures of salt marsh ecological disaster mitigation and ecosystem restoration.

### 5.3.3 Coral reef ecological rehabilitation for hazard mitigation

In seashore zone, targeting damaged coral reef ecosystems, with the principle of natural recovery firstly and artificial intervention secondly, according to the different substrate and regional ecological characteristics, the project shall promote the coral reef ecosystem restoration by human activities control and coral cultivation and transplantation, enhance coral reef ecosystem stability and promote ecological and disaster mitigation function. See Annex B for the key points and main measures of coral reef disaster mitigation and ecosystem restoration.

### 5.3.4 Seagrass bed ecological rehabilitation for hazard mitigation

In seashore zone, measures such as controlling pollution sources, improving sediment conditions, cultivating seagrass seedlings and transplanting seagrass can be applied to improve the ecological disaster mitigation functions of seagrass bed ecosystems with significant degradation. See Annex B for the key points and main measures of disaster mitigation

and ecosystem restoration.

#### 5.3.5 Oyster reef ecological rehabilitation for hazard mitigation

In the seashore zone or sea dike zone, the damaged oyster reef ecosystem or the sea area with the needs of oyster reef's ecological disaster mitigation function shall be restored by constructing artificial oyster reef or replenishment of oyster reef, so as to improve the ecological disaster mitigation function. See Annex B for the key points and main measures for the restoration of oyster reefs.

#### 5.3.6 Sandy coast ecological rehabilitation for hazard mitigation

In seashore or sea dike zones, restoration measures such as vegetation restoration of backshore sand fixation, sand dune restoration, artificial sand restoration and construction of underwater sand dams shall be implemented according to local conditions in combination with the hydrodynamic conditions of restoration zones, so as to enhance ecological and disaster mitigation functions. See Annex B for the key points and main measures of ecological disaster mitigation and rehabilitation of sandy coasts.

#### 5.3.7 Ecological sea dike reforming

In the seawall zone area, on the premise of not reducing the seawall's defense capability, the ecological friendliness of the seawall itself can be improved through measures such as shoreline protection, embankment structure type optimization, embankment protection, and application of ecological building materials. See Annex B for the emphases and main measures of the ecological construction of seawall.

#### 5.3.8 Renovation of island-connecting sea wall and coastal engineering

In the sea dike zone, on the premise of not reducing the marine hazard precaution capabilities, aiming at the historically constructed island-connecting sea wall and coastal engineering, measures such as sea wall opening, permeable reconstruction, and demolition were taken to restore the marine ecosystem integrity. Refer to Annex B for the key and main measures for the renovation and reconstruction of island-connecting sea wall and coastal engineering.

#### 5.3.9 Others

It mainly includes the ecological sea dike reforming of sea reclamation & enclosure project, and the restoration of coastal protective forest. The ecological sea dike reforming of sea reclamation and enclosure project shall be implemented in accordance with the relevant regulations of T/CAOE 1. The coastal shelterbelts restoration requires the selection of typical afforestation models based on the climatic zones, natural hazard characteristics and site conditions in different types of areas, and construction work of green disaster mitigation barriers shall be based on local conditions. The technique for afforestation shall be implemented in accordance with the relevant regulations of GB/T 15776, non-commercial forest construction technology is in accordance with the relevant regulations of GB/T 18337.3, and the technical for system construction of coastal protective forest is in accordance with the relevant regulations of LY/T 1763.

### 5.4 Division and classification

See Table 1 for coastal ecological rehabilitation for hazard mitigation division and classification.

Table 1 — Division and Classification for Coastal Ecological Rehabilitation for Hazard Mitigation

Geographical division	Construction zone		Construction type								
			Mangrove ecological rehabilitation for hazard mitigation	Salt marsh ecological rehabilitation for hazard mitigation	Coral reef ecological rehabilitation for hazard mitigation	Seagrass bed ecological rehabilitation for hazard mitigation	Oyster reef ecological rehabilitation for hazard mitigation	Sandy coast ecological rehabilitation for hazard mitigation	Ecological sea dike reforming	Island-connecting sea wall and coastal engineering renovation	Coastal shelterbelt restoration
Temperate zone	Seashore zone	Bedrock Coast	—	—	—	—	★	—	—	—	—
		Sandy coast	—	—	—	—	—	★	—	—	—
		Silty coast	—	★	—	★	★	—	—	—	—
	Sea dike zone			—	—	—	—	—	★	★	—
	Continental zone			—	—	—	—	—	—	—	★
Subtropics	Seashore zone	Bedrock Coast	—	—	—	—	★	—	—	—	—
		Sandy coast	—	—	—	—	—	★	—	—	—
		Silty coast	★	★	—	★	★	—	—	—	—

Table 1 (*continued*)

Subtropics	Sea dike zone			-	-	-	-	-	★	★	-
	Continental zone			-	-	-	-	-	-	-	★
Tropics	Seashore zone	Bedrock Coast	-	-	-	-	★	-	-	-	-
		Sandy coast	-	-	★	-	-	★	-	-	-
		Silty coast	★	★	-	★	★	-	-	-	-
	Sea dike zone			-	-	-	-	-	★	★	-
	Continental zone			-	-	-	-	-	-	-	★

Note 1: ★ means that this construction type is recommended for this division; - means that this construction type is not recommended for this division.

Note 2: The applicable area of construction type that can be carried out in the seashore zone can be extended to the sea dike zone.

Note 3: The applicable area of island-connecting sea wall renovation can be extended to the seashore zone.

## 6 Work procedure

Before the implementation of coastal ecological rehabilitation for hazard mitigation, data shall be fully collected and sorted out, and field investigation shall be supplemented to fully grasp the project site situations, and on this basis, and to carry out the suitability assessment to providing the basis for compilation of the implementation plan. Field tracking and monitoring shall be strengthened during project implementation, and effect assessment shall be carried out after official completion and acceptance. Project implementation shall also accept the supervision and regulatory of relevant authorities. Figure 1 shows the work procedures of coastal ecological rehabilitation for hazard mitigation.

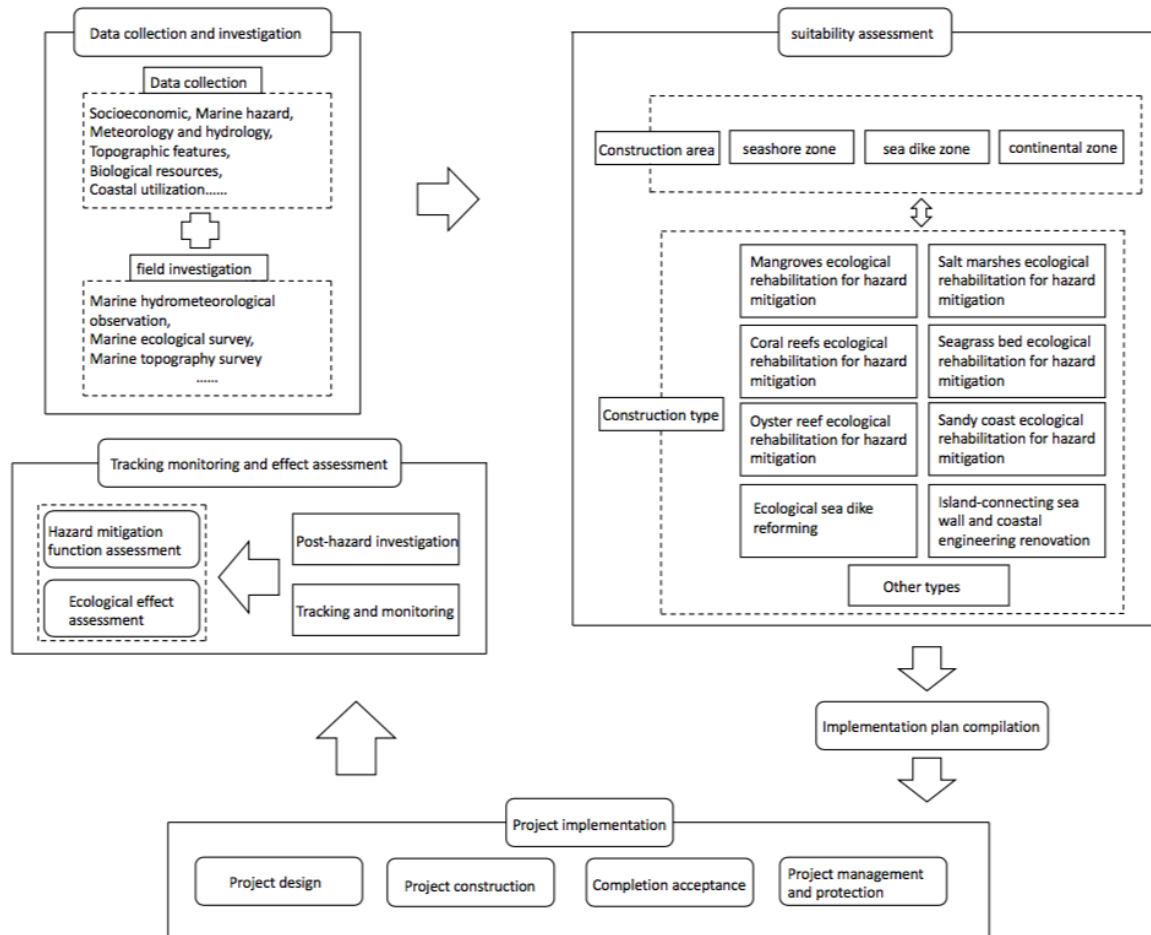


Figure 1 — Coastal zone ecological rehabilitation for hazard mitigation flow chart

## 7 Technical requirements

### 7.1 Data collection and investigation

#### 7.1.1 Data collection

The contents of data collection include social economic situation, marine hazard, meteorological and hydrological conditions, topography and geomorphology, ecological environment, biological resources, coastal engineering construction, regional sea land use, etc. If ecological sea dike reforming is involved, the seawall design, monitoring, current status and operation management data shall also be collected. Specific data collection shall be carried out for each construction type according to the characteristics of the repaired

objects.

#### 7.1.2 On-site investigation

The on-site investigation includes marine hydrological observation, marine meteorological observation, marine chemical element investigation, marine biology investigation, marine geology investigation, marine ecology investigation, marine topography and geomorphology investigation, marine engineering geology investigation, etc. Specific requirements shall be implemented in accordance with GB / T 12763 (all parts). Each type of construction shall carry out specific site investigation according to the characteristics of the repaired objects.

#### 7.2 Suitability assessment

Through data collection and investigation, the current situation and historical situation of the implementation area are comprehensively grasped, and the engineering suitability assessment shall be carried out. The specific requirements are as follows——

- a) assessment of ecological status. The assessment method of coastal ecosystem status is implemented according to the relevant provisions of T / CAO 20.
- b) assessment of hazard mitigation function. By means of physical model test, numerical simulation and disaster field observation, the ecological hazard mitigation functions of coastal ecosystem, such as wave cutting and weak current, promoting silting and consolidating bank, are evaluated.
- c) assessment of rehabilitation suitability. Scientific methods such as numerical simulation and physical model test are used to analyze and access the scientificity and feasibility of habitat rehabilitation, hydrodynamic improvement, biological rehabilitation, seawall green plants and facilities renovation. Taking the coastal zone, seawall zone and land zone of the project area as the construction objects, and taking the seashore zone, sea dike zone and continental zone of the project area as the construction objects, the suitability of the combined design of multi-regional and multiple construction types (Table 1) is studied and judged, and the optimization suggestions of the spatial layout and main measures for the ecological hazard mitigation and rehabilitation of the coastal zone are put forward.

#### 7.3 Implementation plan compilation

According to the results of suitability assessment, the implementation plan of coastal zone ecological hazard mitigation and rehabilitation shall be prepared in the implementation area, and the scheme design of various construction types in the region shall be prepared according to each part. The specific requirements are as follows——

- a) The implementation plan shall follow the regional spatial planning, coastal zone protection and utilization planning, river basin comprehensive planning, storm-surge (flood) professional planning and other relevant planning, and meet the requirements of ecological red line protection and coastline control;
- b) The implementation plan shall fully consider the connectivity, integrity and ecological buffering effect of marine and terrestrial ecosystems. According to the spatial division and different coastal types, combined with the suitability assessment results, one or more types of spatial layout of coastal ecological rehabilitation for hazard mitigation shall be proposed according to local conditions;
- c) The implementation scheme design shall pay attention to giving full play to the comprehensive

benefits of ecology and hazard mitigation, avoid the consumption of space resources and new ecological environment problems caused by engineering construction, and it shall not build a pure landscape project;

- d) The implementation scheme design shall detail the technical requirements, construction methods, scope and scale of specific measures;
- e) The implementation scheme shall be comprehensively analyzed and demonstrated from the aspects of economy, society and environment. As the main content of the project construction, its depth can meet the requirements of the project feasibility study report;
- f) For projects involving sea use and environmental impact assessment, relevant regulations project feasibility study report shall be prepared in accordance with water conservancy construction procedures, but ecological and hazard mitigation functions shall be highlighted.

#### 7.4 Project implementation

##### 7.4.1 Engineering design

The specific requirements of engineering design are as follows:

- a) According to the construction characteristics, the construction scheme shall be refined to meet the construction requirements;
- b) The preliminary design and construction drawing design shall be carried out in accordance with the construction procedures of water conservancy projects, and the relevant provisions of GB / T 51015 shall be met in case of ecological sea dike reforming, island-connecting sea wall and coastal engineering renovation;
- c) The design unit shall have the corresponding design qualification, and the engineering design shall conform to the relevant engineering construction planning;
- d) Engineering design shall have technical demonstration, scientific analysis, economic comparison and qualitative and quantitative conclusions;
- e) The design documents shall meet the relevant compilation requirements, with concise words, clear and complete charts and reasonable investment budget (budget estimate).

##### 7.4.2 Engineering construction

The specific requirements for engineering construction are as follows:

- a) Before construction, hydrological, meteorological, geological and other site conditions shall be investigated, and main influencing factors such as wind, wave, tide and fog shall be analyzed;
- b) According to the approved implementation plan or design documents, the construction personnel shall deeply understand and study the difficulty degree of each project, and clarify the design intent, construction difficulties, quality and schedule requirements;
- c) The project shall be constructed in strict accordance with the design drawing or implementation plan;
- d) According to the site conditions and construction capacity, the construction section,

construction sequence and process lap length shall be reasonably determined;

- e) The construction progress in the construction process shall be carried out according to the design progress, and the scientific and reasonable arrangement of each section and type of work shall be carried out;
- f) During the construction process, the observation shall be strengthened. In case of emergency, the construction shall be stopped immediately, the construction unit and the design unit shall be reported to analyze the cause of the accident, and the corresponding measures shall be taken in time;
- g) In the process of construction, ecological environment protection shall be strengthened to avoid new environmental damage caused by engineering construction;
- h) The specific construction of each construction type shall be carried out according to the construction requirements of corresponding types.

#### 7.4.3 Official completion acceptance of the project

After the official completion of the project, the official completion acceptance shall be carried out in strict accordance with the acceptance procedures, methods and standards, and in accordance with the construction objectives, construction contents and assessment indicators.

#### 7.4.4 Engineering management and maintenance

Project management and maintenance shall take the sustainability of project benefits as the goal, and implement the responsibility subject and management as well as maintenance funds. For qualified projects, special management and protection organizations and full-time management and protection personnel shall be set up for biological measures, engineering facilities and human activities in the area. The management and protection of each construction type shall be carried out according to each part.

### 7.5 Tracking, monitoring and effect assessment

#### 7.5.1 Tracking, monitoring and investigation

##### 7.5.1.1 Tracking and monitoring

In the process of construction and after the completion of the project, the community structure, growth status and productivity characteristics of the coastal ecosystem and the stability changes of the coastal zone shall be focused on according to the types of the coastal ecological rehabilitation for hazard mitigation, combined with the ecological rehabilitation as well as hazard mitigation objectives. And it also shall determine the monitoring scope and monitoring elements, formulate the monitoring scheme, and implement the project tracking monitoring. Implementation for monitoring the storm surge, wave and other marine disasters is carried out. The tracking and monitoring of each construction type shall be carried out in accordance with each part, and the tracking and monitoring of coastal shelter forest rehabilitation shall be carried out in accordance with the relevant provisions of LY/T 2497.

##### 7.5.1.2 Post hazard investigation

Focus on the impact of marine dynamic disasters on coastal ecological rehabilitation for hazard mitigation objects, and investigate the specific situation of typical coastal ecosystem such as mangroves, salt marshes, coral reefs, seagrass bed, oyster reef, sandy coast, coastal shelterbelts and ecological sea dike reforming after the occurrence of marine dynamic disasters



such as typhoon and storm surge.

### 7.5.2 Effect assessment

#### 7.5.2.1 Ecological effect assessment

According to the follow-up monitoring results and the basic data collected by the survey, the improvement of ecological environment before and after the implementation of the coastal ecological rehabilitation for hazard mitigation shall be focused on. Through the assessment of key indicators such as coastal environmental quality, biodiversity, biological habitat status, ecological space scale, beach stability, beach vegetation plant cover rate, coastal landscape value and other key indicators, the ecological benefits of project implementation are well known. The ecological effect evaluation of each construction type is carried out according to each part, and the ecological rehabilitation effect evaluation of coastal shelterbelts rehabilitation is carried out according to the relevant provisions of LY/T 2093.

#### 7.5.2.2 Hazard mitigation function assessment

According to the tracking and monitoring results, and the basic data collected by the survey, the paper shall focus on the functions of wave dissipation and weak current, promoting siltation and consolidating banks, reducing wind speed of typical ecosystems such as mangroves, salt marshes, coral reefs, oyster reef, sandy coast, coastal protection forest, etc., strengthen the safety assessment after the ecological construction of seawall, and study the hazard mitigation effect after the renovation of the island-connecting sea wall and coastal engineering. The change of hazard mitigation function before and after the implementation of coastal ecological rehabilitation for hazard mitigation was compared and analyzed to provide data support for realizing the goal of coastal ecological rehabilitation for hazard mitigation. The hazard mitigation function assessment of each construction type shall be carried out according to each part, and the hazard mitigation function assessment of coastal shelter forest rehabilitation shall be carried out in accordance with the relevant provisions of LY/T 2093.

## 8 Quality control

### 8.1 Quality control system establishment

Each undertaking unit of coastal ecological rehabilitation for hazard mitigation shall accept the supervision of the project entrusting unit and technical supervision organization, incorporate the quality control of the work procedure undertaken by the unit into the operation of its own quality control system, and formulate a quality plan according to the quality system of the unit and the requirements of ecological hazard mitigation and rehabilitation. The person in charge of the project shall appoint the quality director to be responsible for establishing the quality management system of each procedure.

### 8.2 Whole process quality control

The specific requirements for the whole process quality control are as follows:

- a) Each undertaking unit of coastal ecological rehabilitation for hazard mitigation shall fully understand the quality objectives of the entrusted project;
- b) For the existing data and materials used, there shall be clear quality requirements on legality, unit system, traceability, accuracy, timeliness, reliability, etc., and specific quality analysis and assessment shall be carried out;
- c) Use the instruments, equipment, tools and materials that meet the quality requirements

according to the specified procedures, methods and standards within the specified validity period;

- d) The quality control of on-site investigation shall be carried out in accordance with the relevant provisions of T/CAOE 20;
- e) The quality inspection of work contents shall be carried out in time for suitability assessment, implementation scheme compilation and effect evaluation;
- f) The quality control of field investigation, station layout, sample collection, laboratory analysis, data processing and comprehensive evaluation shall be strengthened in the tracking and monitoring, and the relevant provisions of GB/T 17378.1 shall be followed;
- g) Strengthen the quality control before, during and after the project;
- h) The results and filing shall meet the requirements of achievements compilation and archiving.

## **9 Results and archiving**

### **9.1 Results**

#### **9.1.1 Result contents**

##### **9.1.1.1 Result reports**

The results report formed in the process of coastal ecological rehabilitation for hazard mitigation mainly includes suitability assessment report, implementation scheme, effect evaluation report and summary report. The format and outline of each report shall refer to Annex C to Annex F.

##### **9.1.1.2 Drawings and data**

The main drawing and data formed in the process of coastal ecological rehabilitation for hazard mitigation include engineering construction plan sketch drawing, typical cross-section drawing and design and construction drawing. Data mainly include on-site investigation and collection, on-site photos and videos.

#### **9.1.2 Result requirements**

The results shall meet the following requirements:

- a) The report shall be compiled on the basis of in-depth analysis and research on the collected data and on-site investigation data and materials;
- b) The source description of the data quoted in the report shall be complete, clear and accurate;
- c) The report shall be comprehensive in content, prominent in key points, sufficient in argument, clear in conclusion and concise in words;
- d) The report shall have necessary figures and illustrations;
- e) All kinds of drawing materials shall be correctly and fully used in drawing making;
- f) The data of marine environment ecology, hydrology and topography shall be provided by the unit that has obtained the inspection and testing qualification certificate according to

law;

- g) The data of on-site investigation shall comply with the relevant provisions of T/CAOE 20;
- h) The on-site photo and image data shall be obtained and verified through on-site investigation and investigation, and the formation time shall be indicated;
- i) The contents of the achievements shall be fully connected and there shall be no conflict between the contents and conclusions;
- j) Results shall be formed within the specified time limit in accordance with the requirements of the project implementation plan.

## 9.2 Archiving

### 9.2.1 Archiving scope

The archiving materials of achievements mainly include:

- a) Contract, relevant instruction report, approvals, report and important letter, etc.;
- b) Original data collected, original records of investigation and analysis, laboratory test and analysis report;
- c) Suitability assessment report, implementation plan, effect assessment report, summary report, etc.;
- d) Thematic maps and data sets;
- e) Official completion acceptance, quality assessment and other related materials.

### 9.2.2 Archiving requirements

Results archiving shall meet the following requirements:

- a) The filing materials shall be complete, complete, accurate and systematic;
- b) The data shall be classified according to the confidentiality regulations and kept properly;
- c) The relevant documents and materials filed and transferred shall be originals;
- d) The archived materials need to be kept under antimagnetic, moisture-proof and suitable temperature conditions;
- e) The filing of electronic documents shall note technical environment conditions, relevant software version, data type format, operation data, test data and backup requirements.

**Annex A**  
**(annex informative)**

**Schematic diagram of the section of coastal ecological rehabilitation for hazard mitigation scope**

Figure A.1 shows a schematic diagram of a typical cross-section (bedrock coast) of coastal ecological rehabilitation for hazard mitigation scope.

Figure A.2 shows a schematic diagram of a typical cross-section (sandy coast with seawall) of coastal ecological rehabilitation for hazard mitigation scope.

Figure A.3 shows a schematic diagram of a typical cross-section (sandy coast without seawall) of coastal ecological rehabilitation for hazard mitigation scope.

Figure A.4 shows a schematic diagram of a typical cross-section (silty coast with seawall) of coastal ecological rehabilitation for hazard mitigation scope.

Figure A.5 shows a schematic diagram of a typical cross-section (silty coast without seawall) of coastal ecological rehabilitation for hazard mitigation scope.

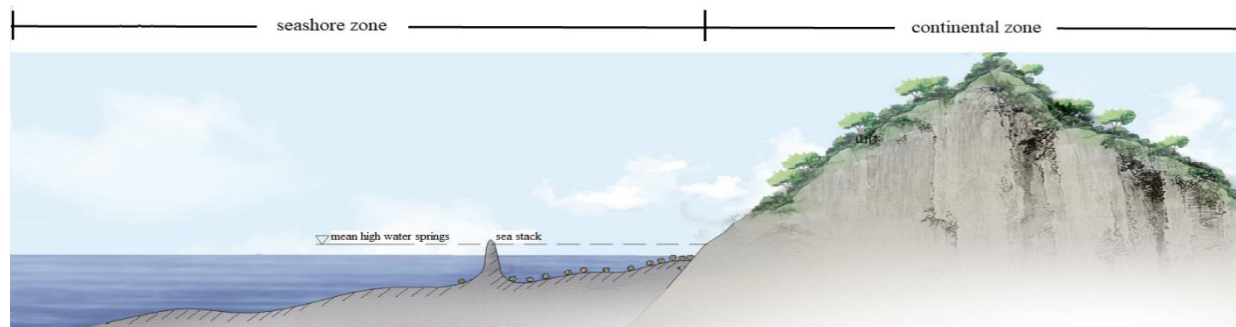


Figure A.1 — Schematic diagram of a typical cross-section of coastal ecological rehabilitation for hazard mitigation scope (bedrock coast)

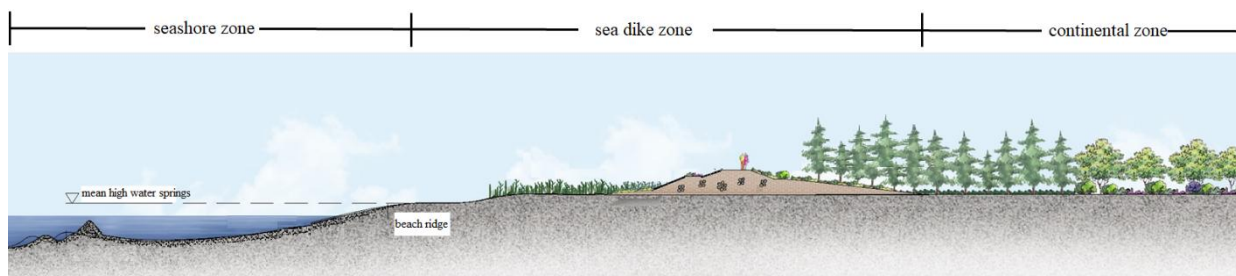


Figure A.2 — Schematic diagram of typical cross-section of coastal ecological rehabilitation for hazard mitigation scope (sandy coast with seawall)

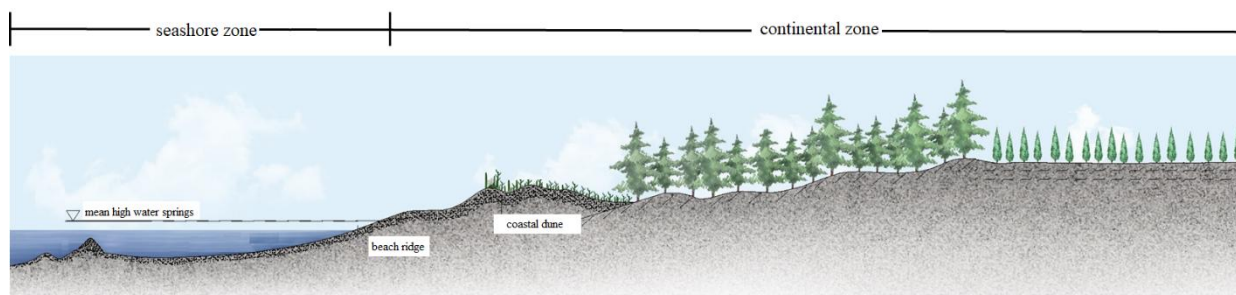


Figure A.3 — Schematic diagram of typical cross-section of coastal ecological rehabilitation for hazard mitigation scope (sandy coast without seawall)

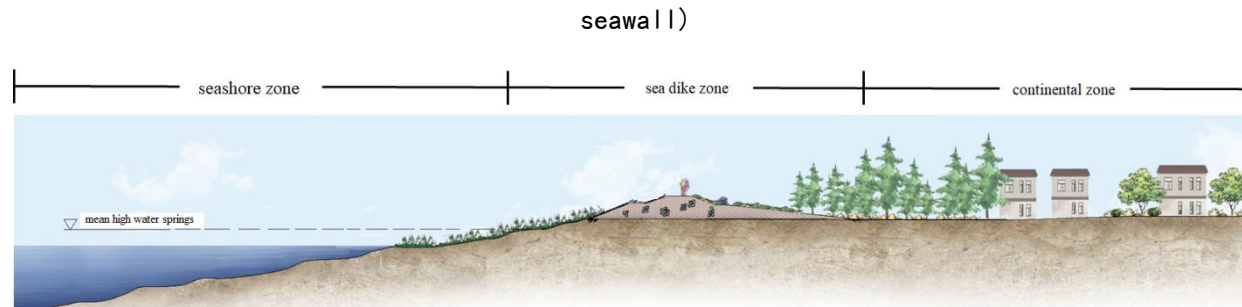


Figure A. 4 — Schematic diagram of typical cross-section of coastal ecological rehabilitation for hazard mitigation scope (silty coast with seawall)

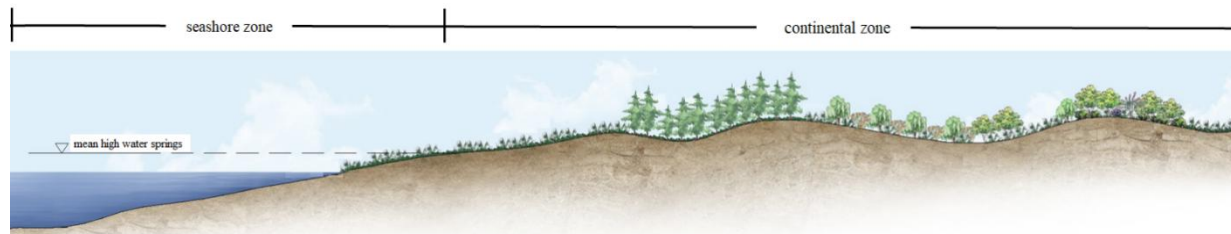


Figure A. 5 — Schematic diagram of typical cross-section of coastal ecological rehabilitation for hazard mitigation scope (silty coast without seawall)

**Annex B**  
**(annex informative)**

**Main construction types of coastal ecological rehabilitation for hazard mitigation**

Table B.1 shows the main construction types of coastal ecological rehabilitation for hazard mitigation.

Table B.1 — Main construction types of coastal ecological rehabilitation for hazard mitigation

No.	Type of construction	Construction area	Key points of construction	Main measures
1	Restoration of mangrove forest ecology by disaster mitigation	Seashore zone/sea dike zone	Focus on the damaged mangrove ecosystems and restoration conditions, habitat restoration and vegetation restoration, and enhance the mangrove's multiple ecological functions and mitigation capabilities.	Create mangrove habitat is by water environment restoration, microgeomorphologic reconstruction, sediment environment improvement and returning ponds to forests, as well as vegetation planting.
2	Ecological mitigation and restoration of salt marshes	Seashore zone/sea dike zone	Focus on salt marsh ecosystem damage and restoration conditions, focus on habitat restoration and vegetation restoration, increase salt marsh area, improve coastal biological disaster prevention capacity.	Water environmental remediation, microgeomorphologic reconstruction, sediment environment improvement, and vegetation disaster mitigation function optimization, etc.
3	Restoration of coral reef ecological disaster mitigation	Seashore zone	Focus on the sediment and ecological conditions of damaged coral reefs, and take economic considerations into account to promote the restoration of coral reef ecosystems through multiple measures.	Ecological matrix application, coral transplantation, human activity control, etc.

Table B.1 (*continued*)

No.	Type of construction	Construction area	Key points of construction	Main measures
4	Disaster mitigation and restoration of seagrass bed ecology	Seashore zone	Focus on the degradation of seagrass bed ecosystem, pay attention to the improvement of bottom quality and plant cultivation, by restoring seagrass bed area to play its function of reducing waves and weak flow.	Control pollution sources, improve sediment conditions, cultivate seagrass seedlings, transplant seagrass plants, etc.
5	Restoration of oyster Reef by disaster mitigation	Seashore zone/seawall zone	Focus on the damage status of oyster reef ecosystem and the suitable conditions of oyster reef habitat, and pay attention to the self-repair ability of oyster reef. By increasing the area and height of oyster reef, we can enhance the coastal biological protection ability and achieve the goal of wave mitigation and disaster mitigation.	Constructing artificial oyster reef and replenishing oyster, etc.
6	Ecological mitigation and restoration of sandy coasts	Seashore zone/sea dike zone	Focus on the damage condition of the sandy coast and choose the restoration measures according to the dynamic conditions and local conditions, in order to improve the stability of the beach geomorphologic system and the ecological environment of the sandy coast and enhance the disaster mitigation capability of the sandy coast.	Restoration of backshore sand fixation vegetation, sand dune restoration, intertidal sand restoration, underwater bar restoration, etc.



Table B.1 (*continued*)

No.	Type of construction	Construction area	Key points of construction	Main measures
7	Ecological sea dike reforming	Sea dike zone	Focus on the connectivity of Marine and land ecosystems, restoring the structure and function of coastal ecosystems without reducing the ability of levees to protect against tides and disasters.	Beach protection, embankment structure optimization, ecological material application, vegetation planting, shrinking dam, adding tidal channel, etc.
8	Renovation of island-connecting sea wall and coastal engineering	Sea dike zone	Focus on whether the current ecological function of the sea area is damaged or not and the project's disaster prevention ability. On the premise of not reducing the Marine disaster risk prevention ability, it chooses the appropriate renovation plan to restore the integrity of the Marine ecosystem.	Seawall opening, pervious transformation, demolition, etc.
9	Restoration of coastal shelter forests	Continental zone	Focus on the characteristics of climatic zones, natural disasters and site conditions, implement typical afforestation models in different types of areas according to local conditions, build coastal shelterbelts, and improve ecological protection capabilities.	Artificial afforestation is arranged for the existing suitable forestlands in the base forest belt. Forestation is carried out to widen the forest belt whose width is not up to the standard and optimize the structure of the base forest belt. Repair the damaged base forest belt and carry out renovation and renovation step by step; The construction of the deep shelterbelt was reconstructed by adjusting the structure, replacing the tree species, replanting afforestation, closing the mountain and cultivating the forest.

**Annex C**  
**(annex informative)**  
**Suitability assessment report format and compilation outline**

**C.1 Text format**

**C.1.1 Text specification**

The report text size is A4 (210mm×297mm).

**C.1.2 Cover format**

The first line of writing: ×× Coastal Ecological Rehabilitation for Hazard Mitigation (No. 1 Song, bold, centered);

The second line of writing: suitability assessment report (No. 1 Song, bold, centered);

The third line of writing: the full name of the organization (No. 3 Song, bold, centered);

The fourth line of writing: ××××year××month (Song Type 3, bold, centered);

The spacing between the above rows shall be appropriate to beautify the entire cover.

**C.1.3 Inside front cover contents**

The inside front cover shall be written in the branch: the full name of the organization that prepared the suitability assessment report (stamped with the official seal); the name of the preparer and reviewer, etc.

**C.2 Outline of suitability assessment report compilation**

Compile the suitability assessment report for ×× coastal ecological rehabilitation for hazard mitigation according to Table C.1. The relevant clauses are allowed to be appropriately added or deleted according to regional characteristics, environmental conditions, construction types and assessment contents.

Table C.1 — Outline of suitability Assessment Report for ×× Coastal Ecological Rehabilitation for Hazard Mitigation compilation

1 Regional overview
1.1 Location
1.2 Natural environment
1.3 Social environment
1.4 Coastal zone development and utilization

Table C.1 (*continued*)

2 Marine hazard situations
3 Ecological damage
4 Suitability analysis of construction types
According to the actual situation, select the construction types separately and sequentially.
4.1 Ecological current situation assessment
4.2 Hazard mitigation function assessment
4.3 Rehabilitation suitability assessment
5 proposal design
5.1 Space layout
5.1.1 Seashore zone
5.1.2 Sea dike zone
5.1.3 Continental zone
5.2 Main measures
According to different construction types, propose the specific optimization measures.
6 Conclusion
Attached drawings
Attached tables

**Annex D**  
**(annex informative)**  
**Implementation plan format and compilation outline**

**D.1 Text format**

**D.1.1 Text specification**

The text size is A4 (210mm×297mm).

**D.1.2 Cover format**

The first line of writing: ×× Coastal Ecological Rehabilitation for Hazard Mitigation (No. 1 Song, bold, centered);

The second line of writing: Implementation plan (No. 1 Song, bold, centered);

The third line of writing: the full name of the organization (No. 3 Song, bold, centered);

The fourth line of writing: ××××year××month (Song Type 3, bold, centered);

The spacing between the above rows shall be appropriate to beautify the entire cover.

**D.1.3 Inside front cover contents**

The inside front cover shall be written in the branch: the full name of the organization that prepared the implementation plan (stamped with the official seal); the name of the preparer and reviewer, etc.

**D.2 Outline of implementation plan compilation**

Compile the implementation plan for ×× coastal ecological rehabilitation for hazard mitigation according to Table D.1. The relevant clauses are allowed to be appropriately added or deleted according to regional characteristics, environmental conditions, construction types, and project contents, etc.

Table D.1 — Outline of implementation plan for ×× coastal ecological rehabilitation for hazard mitigation compilation

1 General description
2 Project overviews
2.1 Location
2.2 The content and approval status of the projects built
2.3 Regional hazard prevention capabilities overview
2.4 Regional ecological environment overview
2.5 Existing problems and necessity analysis

Table D.1 (*continued*)

3 Project construction conditions
3.1 Natural conditions
Including hydrometeorology, topography, geology, ecology, etc.
3.2 Social conditions
Including population economy, land use, planning (compliance), etc.
4 Implementation plans
4.1 Engineering task
4.2 Compilation basis
4.3 General ideas and principles
4.4 Suitability assessment
Introduce the main conclusions of the suitability assessment report.
4.5 Overall layout
The overall layout plan is proposed from the spatial scale of seashore zone, sea dike zone, and continental zone.
4.6 Scheme design
List the plan design of each specific construction type in the coastal zone, seawall zone, and continental zone.
4.7 Environmental impact assessment
5 Implementation plans
6 Investment estimation
6.1 Fund estimation
6.2 Fund raising
6.3 Fund utilizing plan
7 Benefit analysis
8 Safeguard measures
Including organization and implementation, supervision and management, etc.
Attached drawings
Attached tables

**Annex E**  
**(annex informative)**  
**Effect assessment report format and compilation outline**

**E.1 Text format**

**E.1.1 Text specification**

The text size is A4 (210mm×297mm).

**E.1.2 Cover format**

The first line of writing: ×× Coastal Ecological Rehabilitation for Hazard Mitigation (No. 1 Song, bold, centered);

The second line of writing: Effect assessment report (No. 1 Song, bold, centered);

The third line of writing: the full name of the organization unit (No. 3 Song, bold, centered);

The fourth line of writing: ××××year××month (Song Type 3, bold, centered);

The spacing between the above rows shall be appropriate to beautify the entire cover.

**E.1.3 Inside front cover content**

The inside front cover shall be written in the branch: the full name of the organization that prepared the effect assessment report (stamped with the official seal); the name of the preparer and reviewer, etc.

**E.2 Effect assessment report compilation outline**

Compile the effect assessment report for ×× coastal ecological rehabilitation for hazard mitigation according to Table E.1. The relevant clauses can be appropriately added or deleted according to the assessment objects, construction types, and project contents, etc.

Table E.1 — Outline of effect report for ×× coastal ecological rehabilitation for hazard mitigation compilation

1 Project overview
1.1 Natural environment
1.2 Social environment
1.3 Regional hazard prevention capabilities
1.4 Regional ecological environment
2 Project construction
2.1 Project construction tasks
2.2 Project construction contents
2.3 Project implementation
3 Effect Assessment
According to the specific construction types, carry out the assessment separately and sequentially.
3.1 Ecological effect assessment
3.2 Hazard mitigation function assessment
4 Conclusions and recommendations

**Annex F**  
**(annex informative)**  
**Summary report format and compilation outline**

**F.1 Text format**

**F.1.1 Text specification**

The text size is A4 (210mm×297mm).

**F.1.2 Cover format**

The first line of writing: ×× Coastal Ecological Rehabilitation for Hazard Mitigation (No. 1 Song, bold, centered);

The second line of writing: Summary report (No. 1 Song, bold, centered);

The third line of writing: the full name of the organization (No. 3 Song, bold, centered);

The fourth line of writing: ××××year××month (Song Type 3, bold, centered);

The spacing between the above rows shall be appropriate to beautify the entire cover.

**F.1.3 Inside front cover content**

The inside front cover shall be written in the branch: the full name of the organization that prepared the summary report (stamped with the official seal); the name of the preparer and reviewer, etc.

**F.2 Compilation outline of summary report**

Compile the summary report for ×× coastal ecological rehabilitation for hazard mitigation according to Table F.1. The relevant clauses can be appropriately added or deleted according to the specific construction contents.

Table F.1 — Compilation outline for summary report of ×× coastal ecological rehabilitation and hazard mitigation

1 Introduction
Introduce the origin of the project, background, implementation process, etc.
2 Regional overviews
Introduce the regional natural environment, social environment, ecological conditions, hazard prevention capabilities, etc.



Table F.1 (*continued*)

3 Construction state
Introduce the main content, organization and management, investment, source of fund, and implementation progress of the construction project.
4 Management
Introduce the project approval, design, implementation process management, file management, completion (official completion) acceptance, capital management, etc.
5 Main measures and implementation effects
Introduce the main construction types, specific measures and implementation effects of engineering project. Focus on the project objectives and completion of the assessment indicators.
6 Conclusions and recommendations
Attached drawings
Attached tables

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