APPENDIX 6

SAMPLE TERMS OF REFERENCE INDEPENDENT SAFETY ASSESSMENT FOR EXISTING DAMS

MARCH 2021

GOOD PRACTICE NOTE ON DAM SAFETY
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Appendix 6
Sample Terms of Reference Independent Safety Assessment for Existing Dams

Background

1. An independent safety review of an existing dam is required by the World Bank Environmental and Social Framework (ESF)/Environmental and Social Standard 4 (ESS4) and Annex 1 on Dam Safety if such a dam would be rehabilitated by World Bank-funded projects or on which the World Bank-funded downstream project relies or may rely for water supply, irrigation, hydropower generation, and so on.

2. In addition to ESF/ESS4/Annex 1, the ESF Good Practice Note (GPN) should be referred to, which is designed to enhance the quality of practice without creating new requirements for the application of the ESF.

3. In most cases, an individual dam safety expert (hereafter referred to as expert) may be adequate to undertake the safety inspection and assessment of the dam, associated facilities, and their operational status or procedure.

4. The expert is supposed to submit a report on the dam safety conditions and operational status and, if necessary, make recommendations on required measures for rehabilitating and improving the structural and/or nonstructural elements of the dam.

5. If the result of the safety assessment of the expert raises serious dam safety issues, more detailed assessment may be warranted by the expert or a group of experts, including required technical expertise with due consideration to the potential risk of the dam.

6. These terms of reference (TORs) provide key characteristics of the existing dam to be covered by, or related to, World Bank projects, including owner or operator of the dam; dam purpose, type, location, and other salient features of the dam and surrounding areas (catchment, reservoir, and downstream areas); access routes; and so on.

Objectives

7. The objectives of this assignment are to
   a. Assess the safety condition of the dam and associated structures, its operational status or procedure, and its performance history, in accordance with the national standards and international guidelines and practices;
b. Assess the overall risk of the dam and any required works or safety-related measures necessary to upgrade the dam to an acceptable standard of safety, considering the potential risk of the dam and urgency of interventions; and

c. Prepare a dam safety assessment report, including any safety issues, potential risks, and recommendations of remedial works and safety improvement measures, covering both structural and nonstructural elements along with their conceptual design and preliminary cost estimates.

**Scope of the Assignment**

8. The main tasks of the expert are described in two tiers. If the Tier I dam safety inspection or assessment raises serious dam safety issues and warrants the Tier II examination, the tasks under Tier II would be requested to the expert or team of experts based on consultations between the client and the World Bank. The potential risk of the dam may also warrant Tier II examination.

**Tier I: Dam Safety Inspection and Assessment**

9. The tasks of Tier I dam safety inspection and assessment include the following:

   a. Meet with the representatives and technical staff of the dam owner or operator to discuss the safety condition and the operation and maintenance (O&M) status or plan, including surveillance, monitoring, and contingency procedures.

   b. Review the dam safety inspection and periodic safety review reports performed by the dam owner or other entities, if any, and check the quality of the reports based on the expert’s own site visit and field inspection.

   c. Review available design reports, design or as-built drawings, and, if available, construction records, including geological reports, foundation investigations, materials testing, materials strength parameters, and stability analysis.

   d. Review recent O&M records and instrumentation monitoring records, such as reservoir level, inflow and outflow volume, spillway discharge volume, seepage volume, settlement, and so on.

   e. Review available data and records of surveillance and monitoring instruments and analytical results of monitoring data, if any, and check their quality, trends, and anomalies.

   f. If major deficiencies arise regarding basic surveillance measures, issue an interim report to highlight the issues and indicate urgent remedial actions. This should be done on priority basis, before undertaking further assessments or in parallel with those, depending on the expert’s judgment.

   g. Review the criteria, methodology, and determination of the design flood, flood routing studies, and spillway sizing; check the spillway operation records; and evaluate the adequacy of the spillway capacity considering current and future conditions.

   h. Conduct field inspection of the dam and associated structures, such as spillway, outlet structures, and gates or valves; water intake; saddle dam; control and monitoring instruments; and so on.

   i. Apply checklists to appraise the safety condition of the dam and associated structures. Annexes A and B provide examples of check lists that can be used as a broad guidance which should be
adapted to the specific case with due consideration to proportionality principles. The condition of each element on the checklist should be noted and categorized according to one of the following: satisfactory, fair, poor, or unsatisfactory. Additional explanations should be provided for categories that are poor or unsatisfactory, including general recommendations of required remedial and upgrading measures with preliminary cost estimates.

j. Assess the current operational procedures and conditions, including the Operation and Maintenance Plan (O&M Plan) or O&M Manual (including regular surveillance, instrumentation monitoring and data analysis, periodic inspection, flood forecasting, reservoir operation, sediment management, downstream warning, and so on) and Emergency Preparedness Plan, if available.

k. Assess the number, types, and functionality of monitoring equipment and needs for replacement and upgrading, including data acquisition, storage system, and procedures.

l. Assess the capacity of the dam owners and operators in terms of organizational structure, staffing, skills, budget, equipment, and facilities needed to operate and maintain the dam in a safe and sustainable manner.

m. Assess conditions of the catchment area, reservoir rim slope, and downstream areas, and provide expert opinion on potential effects on safety of dam and downstream communities.

n. Provide key findings of the overall safety condition of the dam and recommendations of required structural and nonstructural remedial measures based on the potential risk of the dam.

**Tier II: Detailed Dam Safety Examination**

10. If the client, dam owner, and/or the World Bank confirms that further and more detailed analysis is required to ensure dam safety based on the Tier I assessment results and due consideration of potential consequence, Tier II dam safety examination is to be undertaken, covering the following tasks along with suitable expertise to be determined based on the Tier I assessment.

   a. Review engineering analyses as required (hydrological, geotechnical, seismic, structural, hydraulic, and so on) to fill any uncertainties or gaps identified by the Tier I assessment.

   b. Undertake detailed analyses of dam safety monitoring data since the beginning of the dam operation and check trends and anomalies, if any.

   c. Review the stability analysis of the dam and associated structures under various loading conditions based on the specific site condition, national regulations, and/or international standards and practices. If necessary, perform independent stability analysis.

   d. Review the safety condition of the dam foundation and abutments, as well as the effectiveness of foundation treatment works for seepage control and slope stabilization based on monitoring records and seepage analysis. Additional survey or investigation may be requested if needed.

   e. Review the seismic hazard of the dam area, including any seismic records during operation, any damages or repair works during operation, and adequacy of loading criteria and conditions used for design of the dam and its seismic stability if the dam is located in a high-seismic area.
f. Undertake flood hydrology assessment, adding inflow and outflow data during the operational period and assessing the adequacy of the design, and check flood and spillway capacity considering the current and future conditions of the catchment and reservoir silting.

g. Check the condition and any damages (such as scouring and cavitation) in the spillway weir or chute, energy dissipating arrangements, and downstream river conditions, as well as any design issues.

h. Review the upstream catchment and reservoir rim conditions with regard to potential landslides and required measures for instrumentation and monitoring, as well as physical interventions, if any.

i. Review the silting level of the reservoir and sedimentation trends, condition of check dams, intakes, bottom outlets, including sediment flushing and sluicing facilities, if any, along with suitable sediment management measures.

j. Check the conditions of the intake and outlet works, including the capacity for emergency reservoir drawdown, and any damages and design issues.

k. Check the design and condition of electromechanical facilities and equipment, including spillway gates, hoisting mechanism, backup generators, and so on, and their quality and sufficiency—with due consideration to potential failure scenarios (severe flood, loss of power, loss of communications, and so on).

l. In case of high-risk dams, undertake potential failure mode analysis, including potential failure mode analysis and brainstorm sessions as per the methodology under the Technical Note for potential failure mode analysis (PFMA).

m. Provide key findings of the overall dam safety conditions and recommendations of required structural and nonstructural remedial measures based on these examination results and the potential risk of the dam.

**Reporting of Key Findings and Recommendation**

11. Based on the dam safety inspection and assessment and dam examination results under Tier I or II, respectively, in consultation with the client and relevant authorities, the expert should prepare and submit a report summarizing key findings and recommendations on any required remedial or safety improvement measures covering both structural and nonstructural aspects in the following manner:

   a. Summarize the expert’s key findings on the dam safety conditions, main issues, and potential risks of the dam considering the likelihood of failure and downstream consequence potential based on the inspection, assessment, or examination results with reference to the sample sheet in Annex A or a similar one.

   b. Recommend a set of remedial measures, possibly including civil works, installation of dam safety monitoring instruments, upgrade of the procedure and capacity of the O&M and emergency preparedness, and so on.
c. Categorize the recommended actions with due consideration to the urgency of interventions, potential failure modes, and risks.

d. Recommend additional survey and investigations, such as core drilling, sampling, laboratory testing or installation of monitoring instruments, or other field exploration, if needed.

e. Provide a preliminary cost estimate of the aforementioned recommended field survey, investigation, monitoring, and remedial works.

f. Recommend additionally required technical expertise for detailed assessment for Tier II detailed dam safety examination, if any, in the areas of hydrology, seismology, geology, geotechnical engineering, hydromechanical equipment, design of concrete dams and embankment dams, and so on; and assist in preparing the TORs along with indicative effort level and budget.

g. Recommend capacity enhancement and training programs for the dam owners or operators, if needed.

**Expert's Qualification**

12. The expert should possess sound knowledge in the fields of dam engineering and dam safety and at least 15 years of experience, including (to be adjusted depending on actual site conditions)

   a. A degree in civil engineering, preferably with additional training in geotechnical and hydraulic engineering;

   b. Proven capacity of dam safety inspection and review;

   c. Extensive experience in dam design, construction, operation, and safety management;

   d. Computer skills, including Microsoft Office and other commonly used office software and web-based applications;

   e. Strong communication, interpersonal, analytical, and problem-solving skills;

   f. Familiarity with internationally accepted dam safety guidelines, such as the International Commission on Large Dams (ICOLD) and so on; and

   g. Ability to sift through a large amount of data, draw conclusions, and write clear and concise reports.

**Deliverables**

13. The expert is required to submit a draft report at the end of the assignment at the client’s office or in the field before departing the country or region. The expert will submit a final report within two weeks upon the receipt of comments from the client and the World Bank.

14. The submitted report will be either Tier I or II, depending on the assignment, as follows:

   I. **Tier I: Dam Safety Inspection and Assessment Report:** Summarizing the expert’s findings and recommendations on dam safety, along with urgency and priority levels based on the aforementioned tasks with all supporting documentation.

   II. **Tier II: Detailed Dam Safety Evaluation Report:** Summarizing the expert team’s findings and recommendations on dam safety, along with urgency and priority levels based on the aforementioned tasks with all supporting documentation.
Duration of Dam Safety Inspection and Assessment

15. In the case of Tier I dam safety inspection and assessment, in general, about 5 to 10 days per dam, including site visits and report preparation, may be sufficient, depending on dam safety conditions, distance and time to dam sites, and so on.

16. The required duration, expertise, and input level for Tier II examination, if necessary, will be assessed based on the review of Tier I report.
Annex A: Sample Sheet for Dam Safety Data and Items

I. Dam Basic Data
   A. General Information
      1. Name of the dam - project
      2. Location - river, basin, subbasin, and village or province
      3. Type of dam
      4. Year of completion
      5. Height of dam (elevations: deepest foundation, riverbed, FRL (Full Reservoir Level), MWL (Maximum Water Level), crest of dam)
      6. Impounding capacity at FRL and at MWL
      7. Index map showing location of dam, catchment area, indication of other existing or planned reservoirs upstream, and downstream area subject to potential damage as a result of failure of dam or failure of operating equipment
      8. Nearest downstream city, town, village, or critical infrastructure that can be located on the map, as well as its distances from the dam and the population
      9. Description of economic and social development in downstream areas

   B. Detailed Dam Information
      10. Design report, including detailed features of the dam and associated structures
      11. Construction drawings indicating plans, elevation, and sections of the dam and appurtenant structures, including the details of the discharge facilities, such as outlet works, spillways, and operating equipment
      12. Emergency preparedness or contingency plan, including communications and downstream warning systems, auxiliary power, access roads, remote operation, security of the site, and so on

   C. Hydrology
      13. Description of drainage basin - drainage area and basin runoff characteristics
      14. Design flood - design assumptions and analysis; storage of flood control zone
15. Spillway capacity and flood routing criteria

16. Reservoir elevation-area-capacity curves

17. Elevation of crest; type; width; crest length; location of spillway; and number, size, and type of gates

18. Type, location, capacity entrance, and exit levels of other outlet works

19. Emergency drawdown capacity and drawdown operation curves

20. Type, location, observations, and records of hydrometeorological monitoring data

D. Geology and Foundation

21. Geological description of the dam site, reservoir, and surrounding areas and any issues (faults, shear zones, karstic zones, and so on), along with geological maps

22. Adequacy of geological or geotechnical investigation

23. Foundation treatment, such as cutoff wall, grouting, drainage, and so on

24. Slope stabilization works, such as abutments, reservoir rim, and so on

E. Others

25. Construction history, including diversion scheme, construction sequence, construction problems, alterations, and repairs

26. Operation and regulation plans under normal conditions and during floods and other emergency conditions, as well as Emergency Preparedness Plan and downstream flood warning system, if any

27. Operation record – experiences during past major floods

28. Stability and stress analysis of the dam, spillway, and appurtenant structures and features, including the assumed properties of materials and all pertinent applied loads

29. Instrumentations and records of performance observations

30. Any known deficiency that may pose a threat to the safety of the dam or to human life and property

II. Inspection Items

This list provides guidance for performing field inspections and may serve as the basis for developing a detailed checklist for each dam.
A. Concrete Structures

1. Concrete surfaces
   The condition of the concrete surfaces should be examined to evaluate the deterioration and continuing serviceability of the concrete.

2. Structural cracking
   Concrete structures should be examined for structural cracking resulting from overstress as a result of applied loads, shrinkage, and temperature effects or differential movements.

3. Movement - horizontal and vertical alignment
   Concrete structures should be examined for evidence of any abnormal settlements, heaving, deflections, or lateral movements.

4. Junctions
   The condition at the junction of the structure with abutments or embankments should be determined.

5. Drains - foundation, joint, face
   All drains should be examined to determine whether they are capable of performing their design function.

6. Water passages
   All water passages and other concrete surfaces subject to running water should be examined for erosion, cavitation, obstructions, leakage, or significant structural cracks.

7. Seepage or leakage
   The faces, abutments, and toes of the concrete structures should be examined for evidence of seepage or abnormal leakage, and records of flow of downstream springs should be reviewed for variation with reservoir pool level. The sources of seepage should be determined, if possible.

8. Joints
   All monolith and construction joints should be examined to determine the condition of the joint and filler material, any movement of joints, or any indication of distress or leakage.

9. Foundation
   The foundation should be examined for damage or possible undermining of the downstream toe.

10. Abutments
    The abutments should be examined for signs of instability or excessive weathering.

B. Embankment Structures

1. Settlement
   The embankments and downstream toe areas should be examined for any evidence of localized or overall settlement, depressions, or sinkholes.
2. **Slope stability**
   Embankment slopes should be examined for irregularities in alignment and variances from smooth, uniform slopes; unusual changes from original crest alignment and elevation; evidence of movement at or beyond the toe; and surface cracks, which indicate movement.

3. **Seepage**
   The downstream face of abutments, embankment slopes and toes, embankment-structure contacts, and the downstream valley areas should be examined for evidence of existing or past seepage. The sources of seepage should be investigated to determine cause and potential severity to dam safety under all operating conditions. The presence of animal burrows, colonies, and tree growth on slopes that might cause detrimental seepage should be examined.

4. **Drainage systems**
   The drainage systems should be examined to determine whether the systems can freely pass discharge, that the discharge water is not carrying embankment or foundation material with sufficient filters, and so on. Systems used to monitor drainage should be examined to ensure they are operational and functioning properly.

5. **Slope protection**
   The slope protection should be examined for erosion-formed gullies and wave-formed notches and benches that have reduced the embankment cross-section or exposed less wave-resistant materials. The adequacy of slope protection against waves, currents, and surface runoff that may occur at the site should be evaluated. The condition of vegetative cover should be evaluated, if pertinent.

**C. Spillway Structures**

Examination should be made of the structures and features, including spillway weirs, chutes, side walls, energy dissipators, and electromechanical operational system of all service and auxiliary spillways that serve as principal or emergency spillways for any condition, which may impose operational constraints on the functioning of the spillway.

1. **Control gates and operating machinery**
   The structural members, connections, hoists, cables, and operating machinery and the adequacy of normal and emergency power supplies should be examined and tested to determine the structural integrity and verify the operational adequacy of the equipment where cranes are intended to be used for handling gates and bulkheads; the availability, capacity, and condition of the cranes and lifting beams should be investigated. Operation of control systems and protective and alarm devices, such as limit switches, sump high water alarms, and drainage pumps, should be investigated. Maintenance systems, including upstream maintenance gates, stoplogs, and so on, should be examined.

2. **Spillway weirs and chutes**
   All main and auxiliary spillway weirs and chutes (both lined and unlined) should be examined for evidence of erosion, cracks, and any conditions that may impose constraints on the functioning of the spillway. The ability of the spillway to resist erosion because of operation, including its foundation
conditions and drainage system, and the potential hazard to the safety of the dam from such operation should be examined.

3. Approach and outlet channels
The approach and outlet channels should be examined for any conditions that may impose constraints on the functioning of the spillway and present a potential hazard to the safety of the dam.

4. Stilling basin (energy dissipators)
Stilling basins, including baffles, flip buckets, or other energy dissipators, should be examined for any conditions that may pose constraints on the ability of the stilling basin to prevent downstream scour or erosion, which may create or present a potential hazard to the safety of the dam. The existing condition of the channel downstream of the stilling basin should be determined, including riverbed and slope protection works.

D. Outlet Works
The outlet works examination should include all structures and features designed to release reservoir water below the spillway crest through or around the dam.

1. Intake structure
The structure and all features should be examined for any condition that may impose operational constraints on the outlet works. Entrances to intake structure should be examined for conditions, such as silt or debris accumulation, which may reduce the discharge capabilities of the outlet works.

2. Operating and emergency control gates
The structural members, connections, guides, hoists, cables, and operating machinery, including the adequacy of normal and emergency power supplies, should be examined and tested to determine the structural integrity. The operational adequacy of the operating and emergency gates, valves, bulkheads, and other equipment should be verified.

3. Conduits, sluices, water passages, and so on
The interior surfaces of conduits should be examined for erosion, corrosion, cavitation, cracks, joint separation, and leakage at cracks or joints.

4. Stilling basin (energy dissipators)
The stilling basin or other energy dissipator should be examined for conditions that may impose any constraints on the ability of the stilling basin to prevent downstream scour or erosion, which may create or present a potential hazard to the safety of the dam. The existing condition of the channel downstream of the stilling basin should be determined by soundings.

5. Approach and outlet channels
The approach and outlet channels should be examined for any conditions that may impose constraints on the functioning of the discharge facilities of the outlet works or present a hazard to the safety of the dam.
6. Drawdown facilities
Facilities provided for drawdown of the reservoir to avert impending failure of the dam or to facilitate repairs in the event of stability or foundation problems should be examined for any conditions that may impose constraints on their functioning as planned.

E. Monitoring Instruments
Instruments that have been installed to measure behavior of the structures should be examined for proper functioning. The available records and readings of the installed instruments should be reviewed to detect any unusual performance of the instruments or evidence of unusual performance or distress of the structure. The adequacy of the installed instrumentation to measure the performance and safety of the dam should be determined.

1. Headwater and tailwater gauges
The existing records of the headwater and tailwater gauges should be examined to determine the relationship between other instrumentation measurements, such as stream flow, uplift pressures, alignment, and drainage system discharge with the upper and lower water surface elevations.

2. Horizontal and vertical alignment instrumentation (concrete structures)
The existing records of alignment and elevation surveys and measurements from inclinometers, inverted plumb bobs, gauge points across cracks and joints, or other devices should be examined to determine any change from the original position of the structure.

3. Horizontal and vertical movement, settlement, and pore-water pressure instrumentation (embankment structures)
The existing records of measurements from settlement plates or gauges’ surfaces should be examined to determine the movement history of the embankment. Existing piezometer measurements should be examined to determine whether the pore-water pressures in the embankment and foundation would, under given conditions, impair the safety of the dam.

4. Uplift instrumentation
The existing records of uplift measurements should be examined to determine whether the uplift pressures for the maximum pool would impair the safety of the dam.

5. Drainage system – instrumentation
The existing records of measurements of the drainage system flow should be examined to establish the normal relationship between pool elevations and discharge quantities and any changes that have occurred in this relationship during the history of the project.

6. Seismic instrumentation
The existing records of seismic activity and site instrumentation should be examined, if any, to determine the seismic activity in the area and evaluate the response of the structures to past earthquakes.

F. Reservoir and Watershed
The following features of the reservoir, upstream rivers, and watersheds should be examined to assess the potential hazards to the safety of the dam and associated structures, such as potential landslide and other geological features.
1. Shoreline
   The landforms around the reservoir should be examined for indications of major active or inactive
   landslide areas and to determine susceptibility of bedrock stratigraphy to massive landslides of
   sufficient magnitude to significantly reduce reservoir capacity or create waves that might overtop
   the dam.

2. Sedimentation
   The reservoir and drainage area should be examined for excessive sedimentation of recent deve-
  lopments in the drainage basin that could cause a sudden increase in sediment load, thereby
   reducing the reservoir capacity with attendant increase in maximum outflow and maximum pool
   elevation.

3. Potential upstream hazards
   The reservoir and upstream river area should be examined for potential hazards, such as landslide,
   debris flow, avalanche, glacier lake outburst flow, etc. which could affect the safety of the dam and
   associated structures and other geological features subject to potential backwater flooding.

4. Watershed
   The watershed and catchment basin should be examined for any extensive alterations to the sur-
   face of the drainage basin, such as changed agriculture practices, timber clearing, railroad, or
   highway construction or real estate developments that might extensively affect the runoff charac-
   teristics. Upstream projects and dams that could have effects on the safety of the dam should be
   identified.

G. Downstream River Channel
   The river channel immediately downstream of the dam should be examined for conditions (for exam-
   ple, scouring, erosion, landslides, slope failure, and so on) that might impose any constraints on the
   operation of the dam or present any hazards to the safety of the dam. The potential flooded area down-
   stream of the dam should also be assessed for consequence assessment.

H. Operation and Maintenance Features
   1. Overview of the Operation and Maintenance Plan
      The O&MP or O&M Manual should be prepared according to the relevant national and/or international
      guidelines covering the following elements. This may be called the Operation and Maintenance Plan
      or Operation and Maintenance Manual.

   2. Reservoir operation plan
      The actual practices in regulating the reservoir and discharges under normal, flood, and emergency
      conditions should be examined to determine whether they comply with the designed reservoir regu-
      lation plan and to ensure that they do not constitute a danger to the safety of the dam, human life, or
      property. The reservoir operation plan during floods in coordination with the downstream flood
      management plan should be prepared, including spillway gates operation and downstream warning
      when required.
3. Maintenance
   The maintenance of the operating facilities and features that pertain to the safety of the dam should be examined to determine the adequacy and quality of the maintenance procedures followed in maintaining the dam and facilities in safe operating condition.

4. Surveillance, inspection, and dam safety review
   The adequacy of regular surveillance, periodic inspection, and dam safety review should be assessed in comparison with the potential risk of dams.

5. Instrumentation
   The type, number, specification, and reading frequency should be assessed in the instrumentation plan. How the data is collected, analyzed, reported, and stored should be reviewed. The adequacy of the instrumentation system and data management should be assessed.
Annex B: Dam Safety Inspection Form

Name of dam: ____________________________________________

Location: _______________________________________________

River name: ________________

Nearest downstream city, town, or village name: ________________________

Construction start date: ______________ Completion date (actual or planned): ______________

Name of owner: ____________________________________________

Address of owner: __________________________________________

Email: ____________________________________________________

Telephone number: _________________________________________

Name of chief engineer: ____________________________________

Name(s) of main contractor(s): __________________________________

Name of owner’s engineer (if designer and construction supervisor are different, please list both names): __________________________________

Name of contract engineer: __________________________________

Section 1: Available Information

List all plans and reports that are available on the dam and that have been studied for the dam safety inspection. Please enclose copies of plans with typical details. If no such plans exist, sketches can be used.

A copy of a map of suitable size showing the location of the dam and reservoir area must also be attached. Photographs taken during the inspection should also be enclosed and referred to in the report.

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

Section 2: Description of the Dam

Dam type: __________________________ Dam height: __________________________

Dam crest length: ______________ Storage capacity (gross, live, or dead): ________

(In addition to the main dam, the information of the saddle dams, such as dam type, height, and crest length, should be provided.)

Major repair and rehabilitation works done after completion, if any: _______________________________

__________________________________________________________________________________________________________________________________________

Main dam safety issues previously observed, if any: _____________________________________________________________________

__________________________________________________________________________________________________________________________________________

Section 3: Geology of Dam Site

General details (rock types, quality, weathering, joint openings and filling, shear zones, faults, and so on):

Please attach a copy of the geological map—plan view and cross-section.

__________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

Geological conditions and actual or potential problems, such as sliding resistance, settlement, seepage, and erodibility.

Left flank: __________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

Right flank: _______________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

River section: _____________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

Spillway channel: _________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

Are the slopes around the reservoir rim stable? ________________________________________________

__________________________________________________________________________________________________________________________________________
Section 4: Description of Main and Saddles Dams Material

__________________________________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________________________________

Section 5: Evaluation of the Downstream Consequence Potential

Estimate of the number of people at risk/potential loss of life: _______________________________________________________

__________________________________________________________________________________________________________________________________________
Estimate of potential economic loss, including major infrastructure and potential environmental and social impacts: ______________________________________________________________________________________________________________________
Consequence potential level: ____________________________________________________________________________________

Section 6: Flood Estimates

Catchment area (square kilometers): __________________________________________________________________________________

Mean annual precipitation (millimeters): __________________________________________________________________________________

Methods used for flood estimates: ____________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

Flood estimates

Return period and inflow for diversion facilities design criteria during construction (1:50 and so on and discharge volume in cubic meters per second): _________________________

__________________________________________________________________________________________________________________________________________
1:100 (cubic meters per second):______________________________

1:200 (cubic meters per second):______________________________

1:1,000 (cubic meters per second):___________________________

1:5,000 (cubic meters per second):___________________________

1:10,000 (cubic meters per second):__________________________

Probable maximum flood (cubic meters per second): _________________________
Inflow design flood (cubic meters per second): ____________________________________________

Safety check flood (cubic meters per second): ____________________________________________

Any explanation for determining the inflow design flood and safety check flood and any historical large flood events:
__________________________________________________________________________________
__________________________________________________________________________________

Section 7: Evaluation of Capacity of Service and Auxiliary Spillways

Spillway type: _______________________________________________________________________________________

Spillway length: ________________ Critical spillway width: ________________

Spillway gates type and number, if any: __________________________

Nonoverspill crest level: _______ Full supply level or spillway sill level (meters): _______

Maximum flood water level (surcharge water level under inflow design flood and safety check flood): __
__________________________________________________________________________________

Spillway design capacity during inflow design flood (cubic meters per second): ___________________

Will the incoming flood be significantly reduced by flood attenuation? ________________________________

Available freeboard during inflow design flood (meters): _______________________________________________________________________________________

Attach graphs for inflow and outflow hydrographs and reservoir water level corresponding to “design flood” and “check flood” as well as the rating curve for spillway discharge capacity vs. reservoir water level.

Any safety concerns related to the spillway capacity and gates operational reliability, if any: ___________
________________________________________________________

Any safety concerns related to the actual freeboard as a result of crest settlements, reservoir silting, and so on:
________________________________________________________

Section 8: Dam Inspection

Date: ___________________ Reservoir water level: __________________

Names of inspection team leader and members: ________________________________________________

Note: For dams under construction, the inspection report should indicate the quality of the construction works and any safety issues related to detailed design and construction methods or procedure.
Crest of Embankment Structure

Crest width (meters): ________________________________

Is the crest still level or has settlement occurred? ________________________________

Are there signs of erosion? ________________________________

Describe: ________________________________

Are there signs of crack? ________________________________

Describe (use separate page, if necessary): ________________________________

Is maintenance necessary on the crest? ________________________________

Are there signs of animal holes (ants, rats, moles, and so on) or vegetation? ________________________________

Describe: ________________________________

Upstream Face of Embankment Structure

Slope (vertical: horizontal): ________________________________

Slope protection measures, if any: ________________________________

Are there signs of erosion? ________________________________ Describe: ________________________________

Are there signs of cracks? ________________________________ Describe: ________________________________

Are there signs of settlement? ________________________________ Describe: ________________________________

Downstream Face of Embankment Structure

Slope (vertical: horizontal): ________________________________

Slope protection measures, if any: ________________________________

Are there signs of erosion? ________________________________ Describe: ________________________________

Are there signs of cracks? ________________________________ Describe: ________________________________
Are there signs of settlement? ____________ Describe: ______________________________________________________
________________________________________________________________________________________________________________________________________
Are there signs of bulging or sliding? _______________________________________________________________________________________
Are there wet patches? _________________ Describe: ______________________________________________________
________________________________________________________________________________________________________________________________________
Are there signs of seepage or leaks? __________  Describe: ______________________________________________________
________________________________________________________________________________________________________________________________________
Amount of leakage? _______________________________________________________________________________________________________________
Is the leaking water clear or turbid? _______________________________________________________________________________________
Are there signs of animal holes (ants, rats, moles, and so on)? _______ Describe: ______________________________

**Vegetation on Embankment Structures**

Are there any trees or shrubs on the structures? __________________________________________________________________________
________________________________________________________________________________________________________________________________________
If so, describe type, size, number, and position: __________________________________________________________________________
________________________________________________________________________________________________________________________________________

**Drainage System in Embankment Structures**

Has a toe drain or internal drainage systems been provided? __________________________________________________________
Describe: _____________________________________________________________________________________________________________
________________________________________________________________________________________________________________________________________
Amount of leakage (cubic meters/s)? ______________________________________________________________________________________
Is the water from the drains clear or turbid? ______________________________________________________________________________

**Concrete Structures**

Any cracks? _________________ Describe position, size, and length (on separate page, if necessary): __
________________________________________________________________________________________________________________________________________
Is there leakage through the cracks? ________________ Describe (flow rate): _______________________________________________________________________________________
________________________________________________________________________________________________________________________________________
Is there leakage at the joints? ________________ Describe: ______________________________________________________________________________
Is there settlement? ________________  Describe: __________________________
________________________________________________________________________

Is there relative movement? ________________  Describe: __________________________
________________________________________________________________________

Describe condition of concrete: __________________________
________________________________________________________________________

Upstream slope (horizontal: vertical): __________________________

Downstream slope (horizontal: vertical): __________________________

Describe pressure relief holes: __________________________
________________________________________________________________________

**Downstream Toe and Flanks of Dam Structures**

Describe wet patches (position, size): __________________________
________________________________________________________________________

Seepage and leaks (position, flow rate): __________________________
________________________________________________________________________

Are there trees within 5 meters of the downstream toe of the dam structures? __________________________
________________________________________________________________________

Describe: __________________________
________________________________________________________________________

**Flood Outlets, Return Channels, and Training Walls**

Condition of structures in spillway channel (sills, retaining walls, and so on): __________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Is the stability of the dam threatened by the spillway channel? __________________________

Is there loose material in the spillway channel? __________________________

Describe: __________________________

Is there any erosion in the spillway channel? __________________________

Describe: __________________________

Is there any erosion in the river? __________________________

Describe: __________________________
Are the spillway length and freeboard still as shown on the drawings?______________________________

**Stilling Basins and Apron**

When was the stilling basin last emptied and inspected for scouring? ______________________________

Observations and evaluation: __________________________________________________________________________________________________
________________________________________________________________________________________________________________________________________

**Outlet Works**

Number of outlet conduits and pipes: _______ Diameter: __________________________________________

Type: ___________ Maximum discharge capacity (cubic meters/s):_______________________________

Condition of outlet works foundation: _______________________________________________________________________________________

Is the control upstream or downstream, and what are their types? ________________________________

Is there provision for an upstream emergency gate or valve, and what are their types? __________
________________________________________________________________________________________________________________________________________

Are the gates or valves used regularly? _______________________________________________________________________________________

Are the gates or valves in working condition? ______________________________________________________________________________

Are there leaks alongside the outlet conduit or pipe? ___________________________________________

Is there any erosion downstream of the outlet works? __________________________________________

Rust protection? __________________________________________________________________________________________________________________________________________

Sediment deposits and any removal facilities or functions? _______________________________________________________________________________________________

Emergency drawdown rate (the number of days lowering from the full level to the half level and to the bottom):
________________________________________________________________________________________________________________________________________

Other observations:
________________________________________________________________________________________________________________________________________

Attach the rating curve of outlet works.

**Section 9: Overall Safety Evaluation of the Dam and Associated Structures**

________________________________________________________________________________________________________________________________________
Section 10: Evaluation of Construction and Quality Control (for Dams under Construction)

Quality of contractor’s quality control plan and actual compliance: _________________________________________________
__________________________________________________________________________________________________________________________________________

Owner’s engineer’s construction supervision and quality assurance plan and quality of control or progress reports:
__________________________________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________________________________

First reservoir impoundment plan and actual filling:
__________________________________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________________________________

Section 11: Evaluation of the Quality of Operation and Maintenance

Names and titles of operation staff:____________________________________________________________________________________________

Have there been any major floods and damages since the beginning of operation or during construction works? ______________________________________________________________________________________________________________________________

Are the Operation and Maintenance Plan and Emergency Preparedness Plan, or similar plans, available? Are they used and up to date?
__________________________________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________________________________

What routine inspection reports, monitoring records, or maintenance records were available for evaluation? ___________________________________________________________________________ _______________________________________________________
__________________________________________________________________________________________________________________________________________

Are relevant stakeholders aware and ready to implement the emergency action plan and any warning system installed?
__________________________________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________________________________

Section 12: Other Findings
__________________________________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________________________________

Section 13: List of Appendixes

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<tr>
<th>Item</th>
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<th>Comments</th>
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<tbody>
<tr>
<td>Site plan</td>
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<td>Geological maps/model</td>
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<td>Selected design/completion drawings</td>
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<td>Spillway discharge curve/table/formula</td>
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Appendix 6: Sample Terms of Reference
Independent Safety Assessment for Existing Dams

Reservoir elevation-area-capacity curves/tables
Inflow/outflow hydrographs
Instrumentation Plan
Operation and Maintenance Plan
Reservoir operation plan, including flood periods
Accidents/damage reports, if applicable
Any relevant photos

Section 14: Recommendations of Previous Dam Safety Inspection, if Any

Date of previous evaluation: ________________________________
Name of inspector: ________________________________________
List of previous recommendations and status of implementation:

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Section 15: Recommendations of This Dam Safety Inspection, Assessment, and Examination

Recommendations for remedial works, safety improvement measures, and maintenance needs, regular routine inspections, monitoring, further investigations, rehabilitation should be included.

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The recommendation should be repeated in the main inspection report.

__________________________________________

Signature (by the expert or team leader and all members of the inspection team): ____________________________

Date: __________________________