



# Procedures and Techniques Used to Ensure the Safety of the Dam

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- Since the beginning of civilization, humans have needed to maximize the usefulness of water resources and minimize destruction from floods and drought.
- To this end, dams have been used for millennia, to store water for future use particularly in areas where the rainfall is unreliable. The water stored in the dams may be used for a variety of purposes



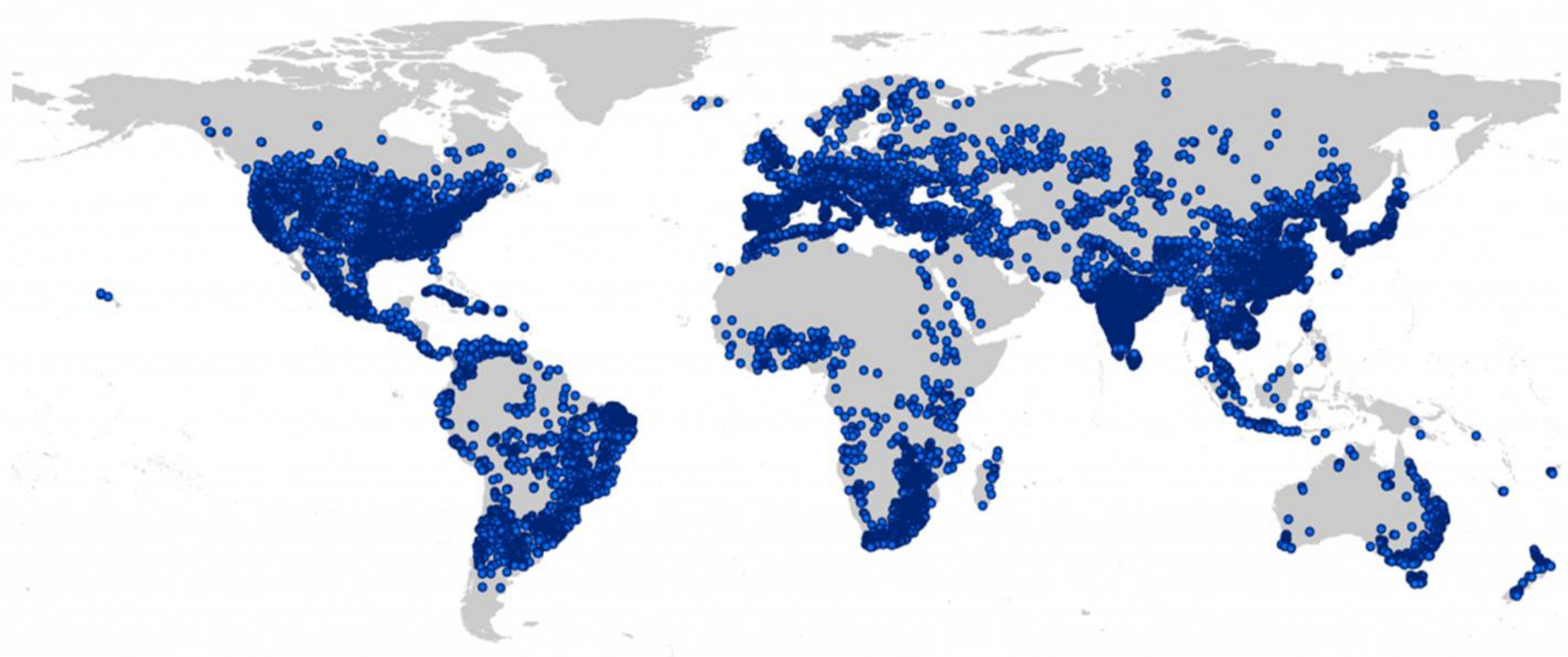


- Dams generally can be classified as concrete dams or embankment dams : fewer than 10% are made of concrete dam
- Embankment (or earthen) dams (made of soil and rock) are Very common type in dam construction.





# Global Dam Watch





**International Commission  
on large dams**

## Number of Dams by Country Members

Country	Number
China	23 841
United States of America	9 263
India	4 407
Japan	3 130
Brazil	1 365
Korea (Rep. of)	1 338
South Africa	1 266
Canada	1 156
Mexico	1 079
Spain	1 064
Turkey	965
France	720
Iran	594
United Kingdom	580
Australia	567
Italy	541
Germany	371
Norway	347
Albania	308
Zimbabwe	256
Romania	241

Activate Windows  
Go to Settings to activate Windows.

- The most recent edition of the World Register of Dams of ICOLD (2019), contains information on **58,000** large dams, defined as dams with a structural height above foundation not less than 15 meters
- More than 50% in excess of 50 years in age
- Properly engineered and maintained useful life of dams exceeds 100 year



The construction of dams is one of the difficult and huge constructions work





## • Dam hazards:

- While dams are essential components of our infrastructure systems, they also present potential hazards.
- The mass and potential energy of the water impounded by a dam can be devastatingly destructive if the dam were to fail and the water were to be released uncontrolled.
- Also there are many risks involved in their operations.
- When a dam fails and there is an uncontrolled release of water, the resultant flood can cause massive destruction by flooding downstream areas ,this will create fatal consequences to the population living close to the dam and to those in the direction of the floodwater wave.



# Living With dam Know Your Risks



Ask  
1

Why should I care about dams?

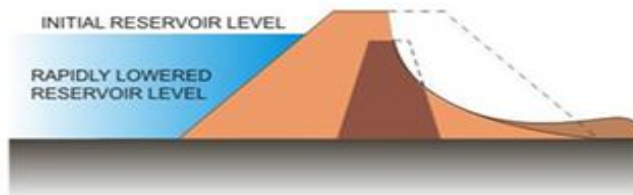
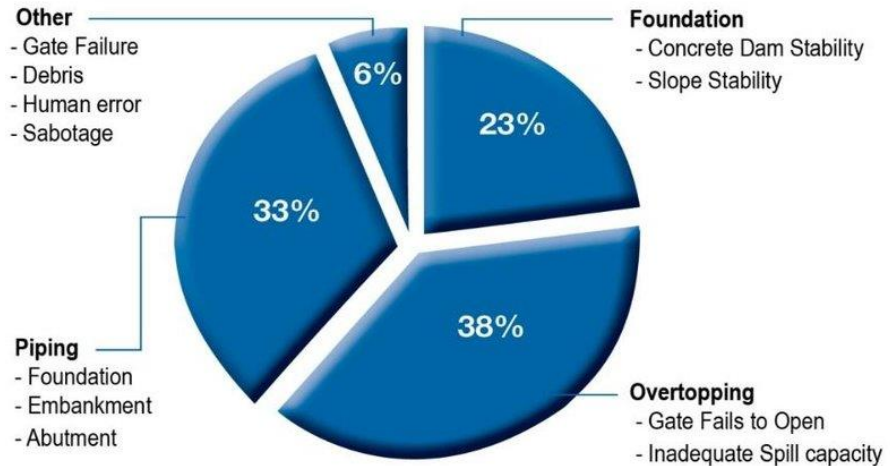
Ask  
2

What are the risks associated with dams?



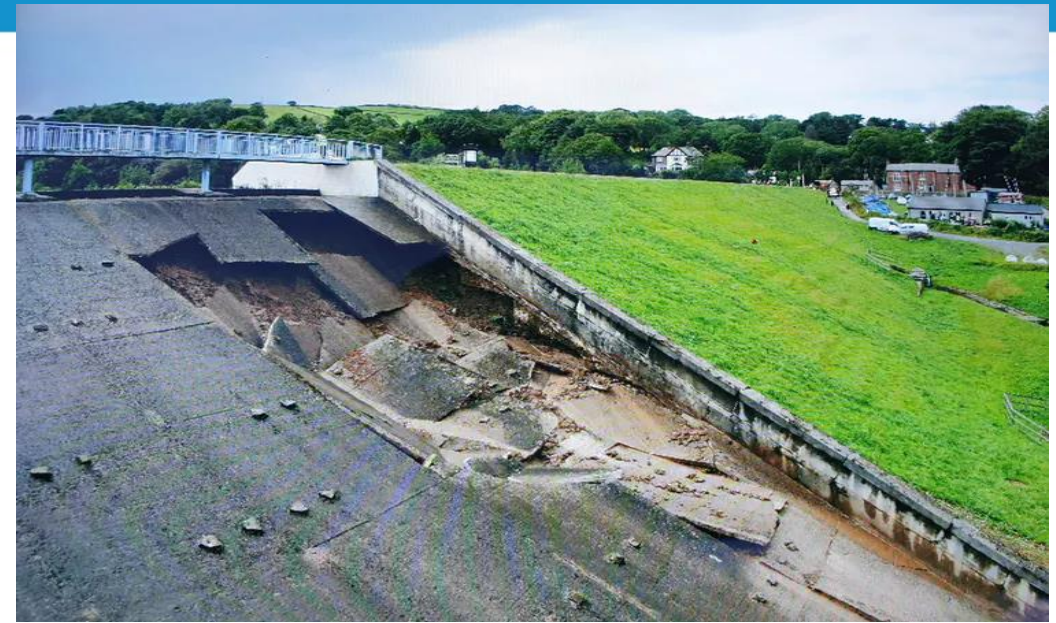


# Causes of Failure of Dam





# Inadequate maintenance





A dam failure is simply an uncontrolled release of water from a reservoir through a dam this will  
Cause significant damage and loss of life.









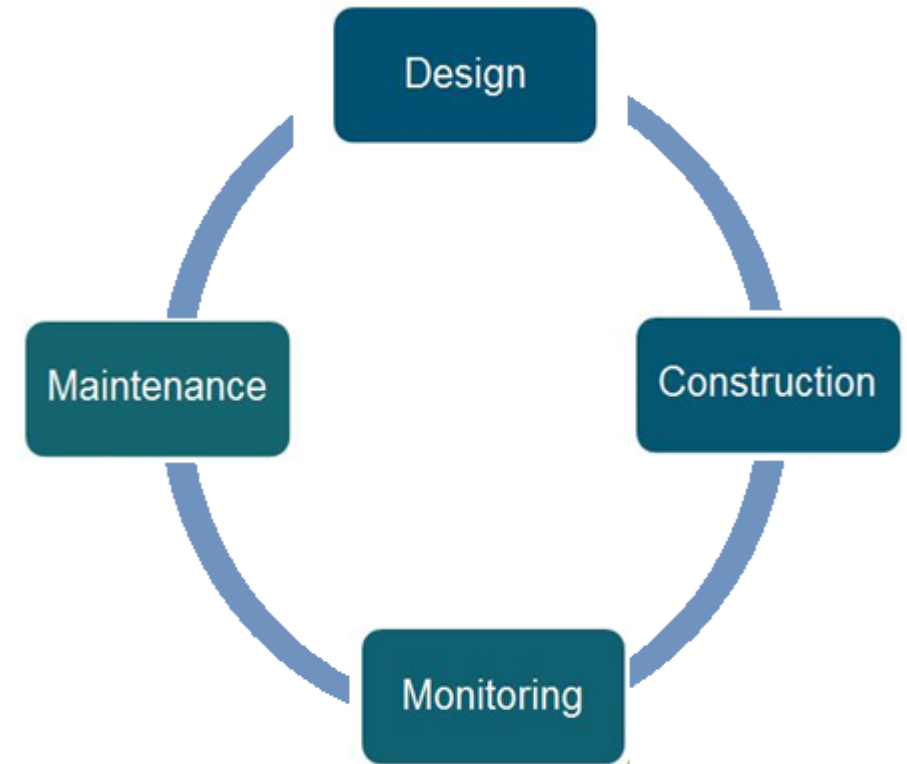


- Dams tend to receive public attention only when a failure appears imminent.





# Concept Dam Of Safety







**MAY 31 is**

# **DAM SAFETY DAY**

[FEMA.gov/dam-safety](https://www.fema.gov/dam-safety)



**FEMA**



# Why dam safety

- Each dam has a different age, size, condition, use, and hazard potential.
- Many dams have varied structural deficiencies and shortcomings in operation and monitoring facilities, while few do not meet the present design standard-both structurally and hydro logically.
- The complexity of each dam's make managing dam infrastructure a difficult task.
- Many dams failed due to lack of proper engineering and maintenance
- Today, as climate change alters rainfall patterns and development of areas downstream from dams leads to hazard creep.
- Safety of the dam is key to the effectiveness of a dam
- Dams with greatest risk: Higher dam safety requirements
- The safe design, construction, operation, and maintenance is the responsibility of the dam owner,



# Dam Safety is important for:

- Safeguarding Water security and huge investments in infrastructure.
- able to recognize problems in their early stages and eliminate them before they become complex and expensive,
- minimizing risks to others and potential liability in case of failure,
- Safeguarding human life, and properties of the people living downstream of the dams.
- To be examined for ensuring public confidence
- Provide sufficient budgets for maintenance and repair of the dam.





# The Dam Owner responsibility :

- Liability Due to Operation of the Dam
- Periodic inspections after construction to verify if the requirements are met
- Maintenance , Repairs
- DOCUMENT your inspections and maintenance
- Prepare Annual Reports -complete review of dam's conditions, operation procedures Information provided by monitoring instruments and maintenance works carried -external factors (weather, reservoir's level, etc
- Know your downstream hazard classification
- Emergency Action ,plan and emergency action plan
- Potential Personal Injury Liability A dam may be visited by employees, contractors, invited visitors or worker's compensation insurance,
- Environmental Concerns (cause water levels to fluctuate .Variations in the impoundment and downstream elevations can also impact)
- Maintaining and operating dams requires Expertise (Dam design , management of dam systems-hydraulic engineer -A hydrologist-geotechnical-Mechanical and electrical engineers





# Monitoring of dams is a key operational component to:

The purpose of a dam inspection program is

- identify problems and/or unsafe conditions.
- maintenance program for a dam and repair items.
- Improve decision making
- Manage risks
- Increase safety
- Increase productivity
- Optimize designs
- Reduce costs



## The steps include :

- Monitoring – Recording - Reviewing - analyzing all existing – Collected data
- Inspecting the dam - Visiting the site
- Assessing significance of observed conditions
- Deciding what to do next.

This will enable a dam owner to secure the information needed to determine the need for subsequent detailed investigation , repairs and maintenance



# Inspection of Dams:

- You should inspect your dam at least three times a year and following any major rainfall:
- **Some of the best times to look at a dam are**
- In the late spring or early summer when the **reservoir is at Full Supply Level (FSL)** (seepage which might occur under, through or around the dam will be most noticeable at FSL),
- In the late summer or early fall when the **reservoir is drawn down** (exposing the upstream face to allow for closer inspection),
- after severe weather events such as **heavy rainfall**, flooding, windstorms, severe icing, **rapid snowmelt**
- After a severe seismic event.



The procedures and things which have:  
Provided , done  
For the safety of large Dams

First The Deficiencies grouped to:

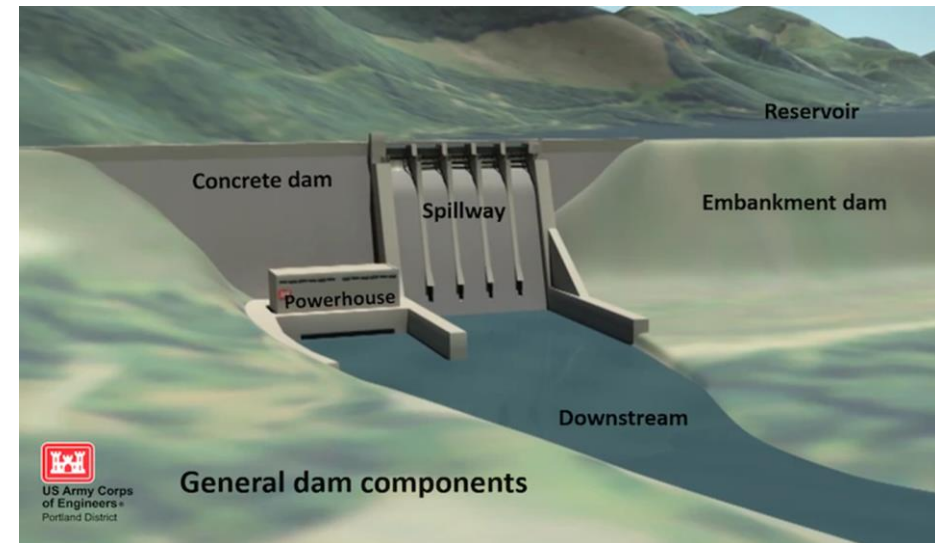
Dam body

Spillway

Outlet Works

Foundation,

Abutment and Reservoir







# The Observation & Monitoring system Inflow to Reservoir





# Reservoir Water level Monitor



*Chain of  
staff gauges*



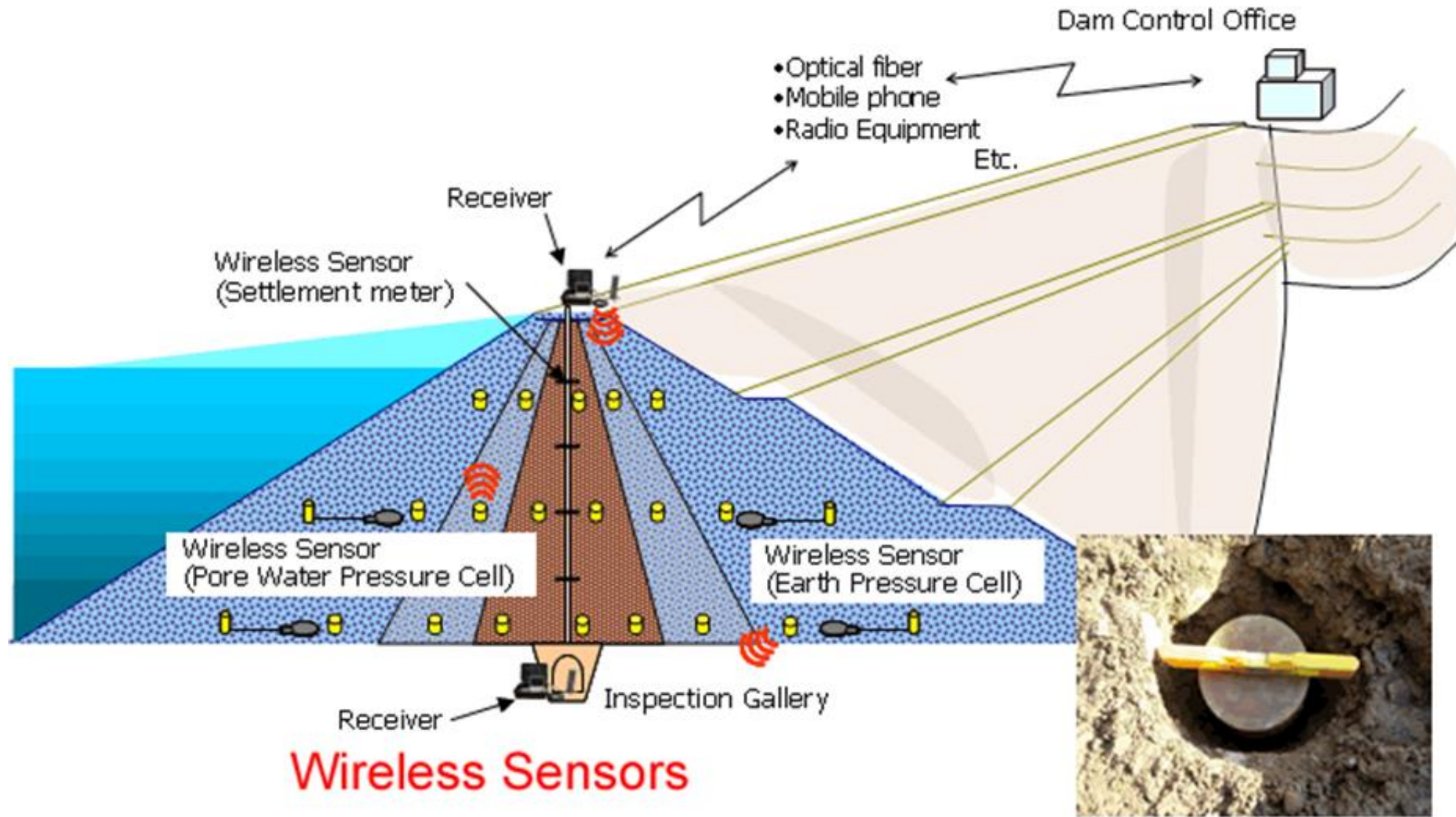


# Weather station



# Seismic station





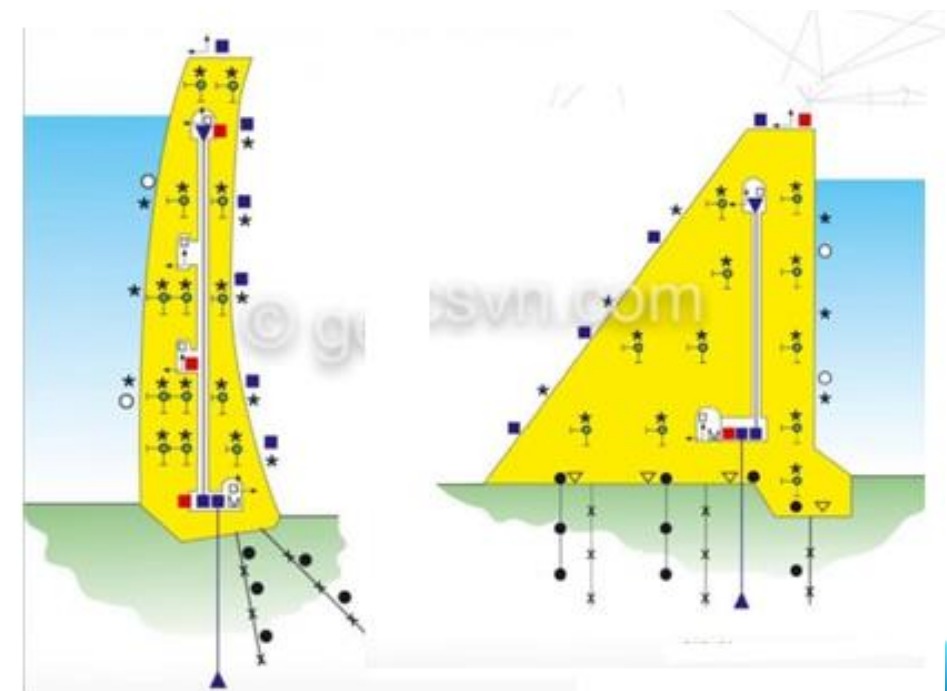
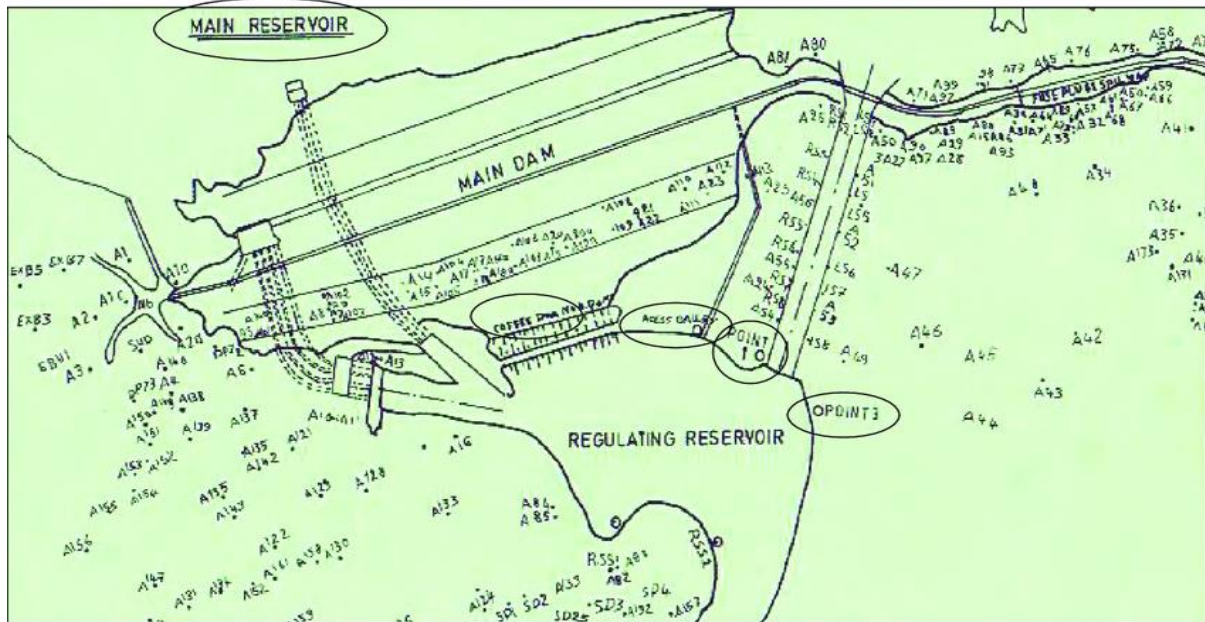
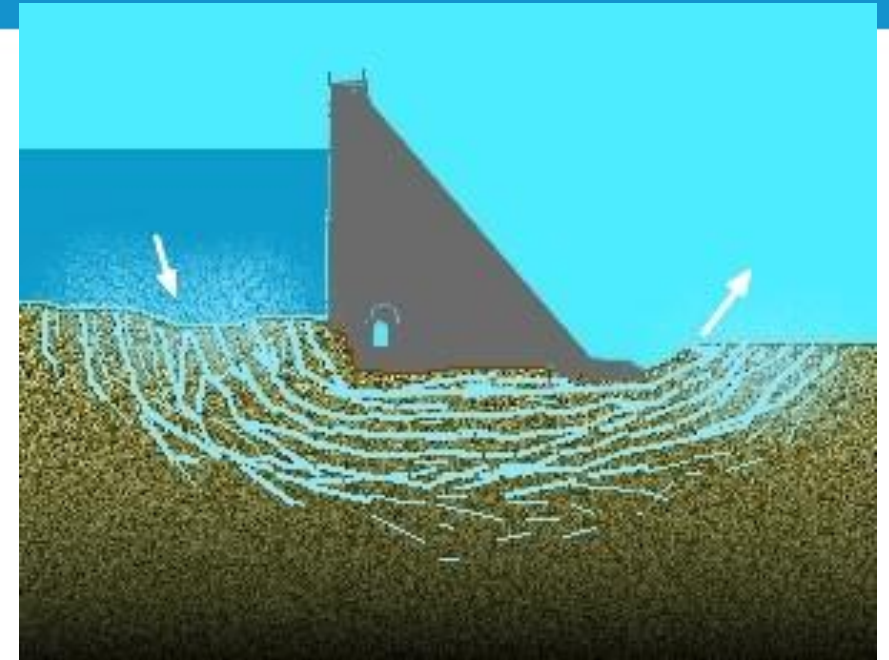
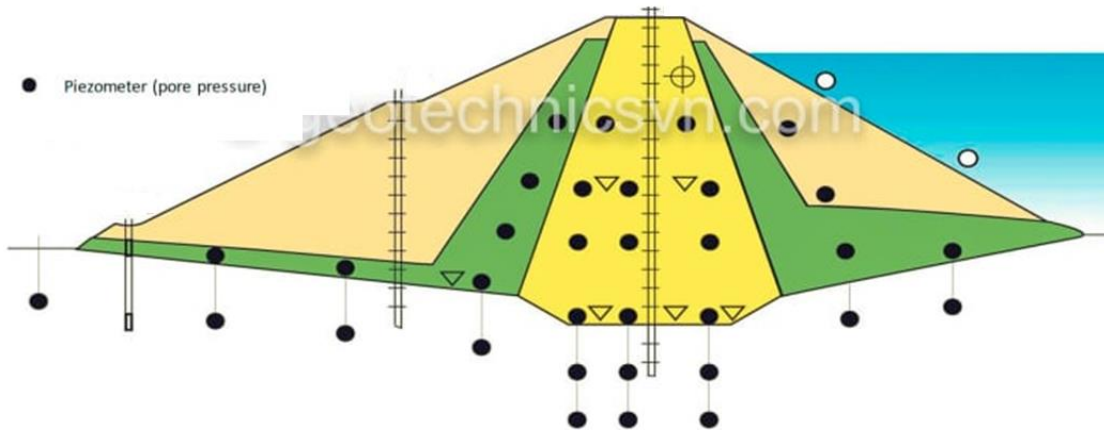
## Wireless Sensors



Photo: Installation of sensor

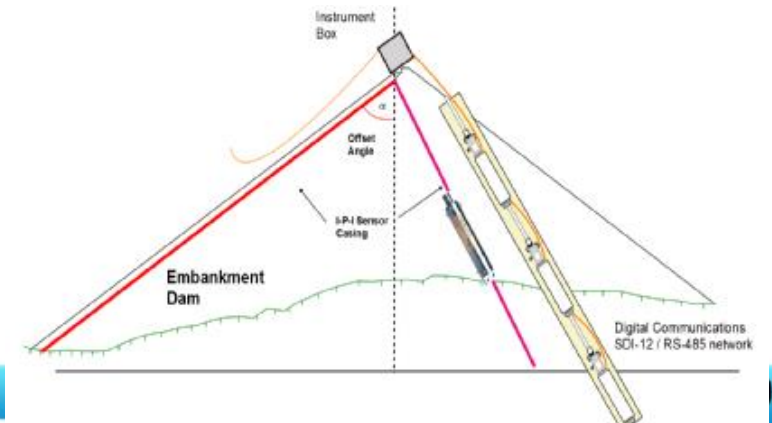
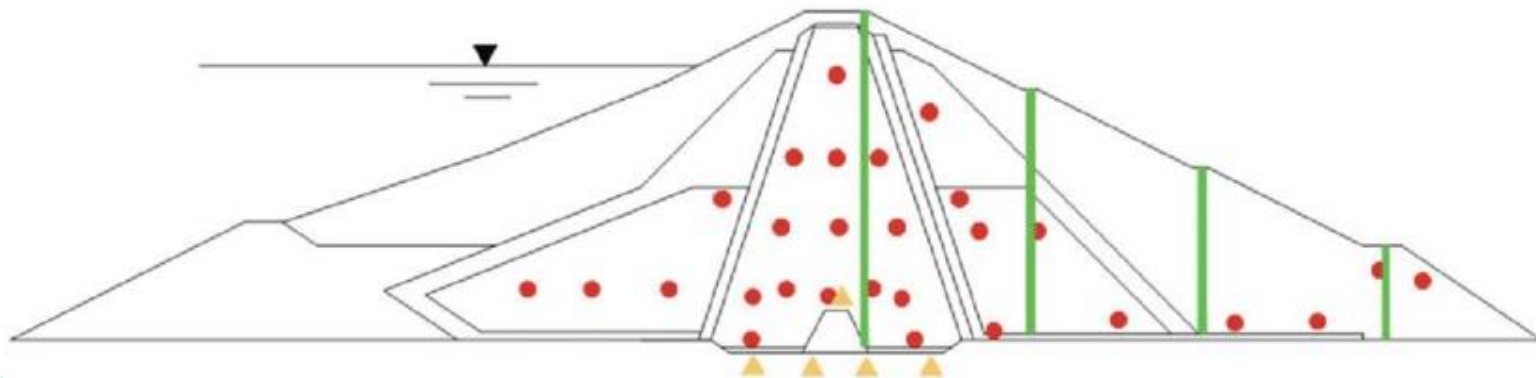
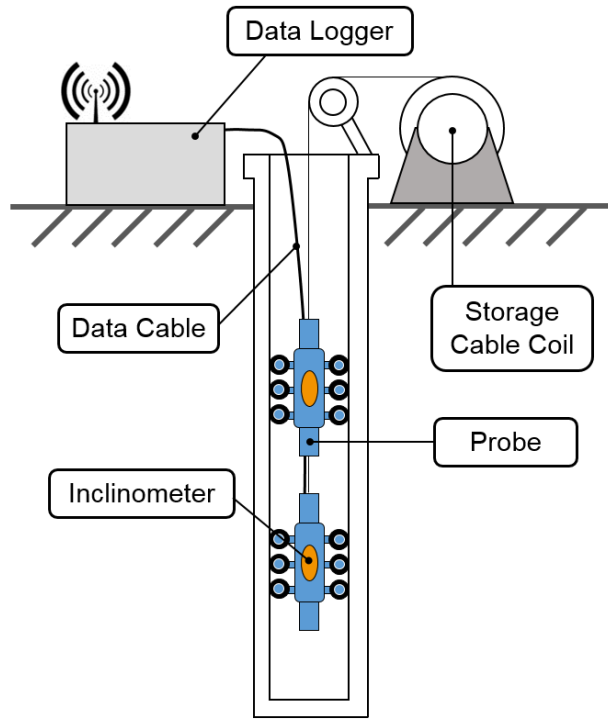


# Seepage Sensors

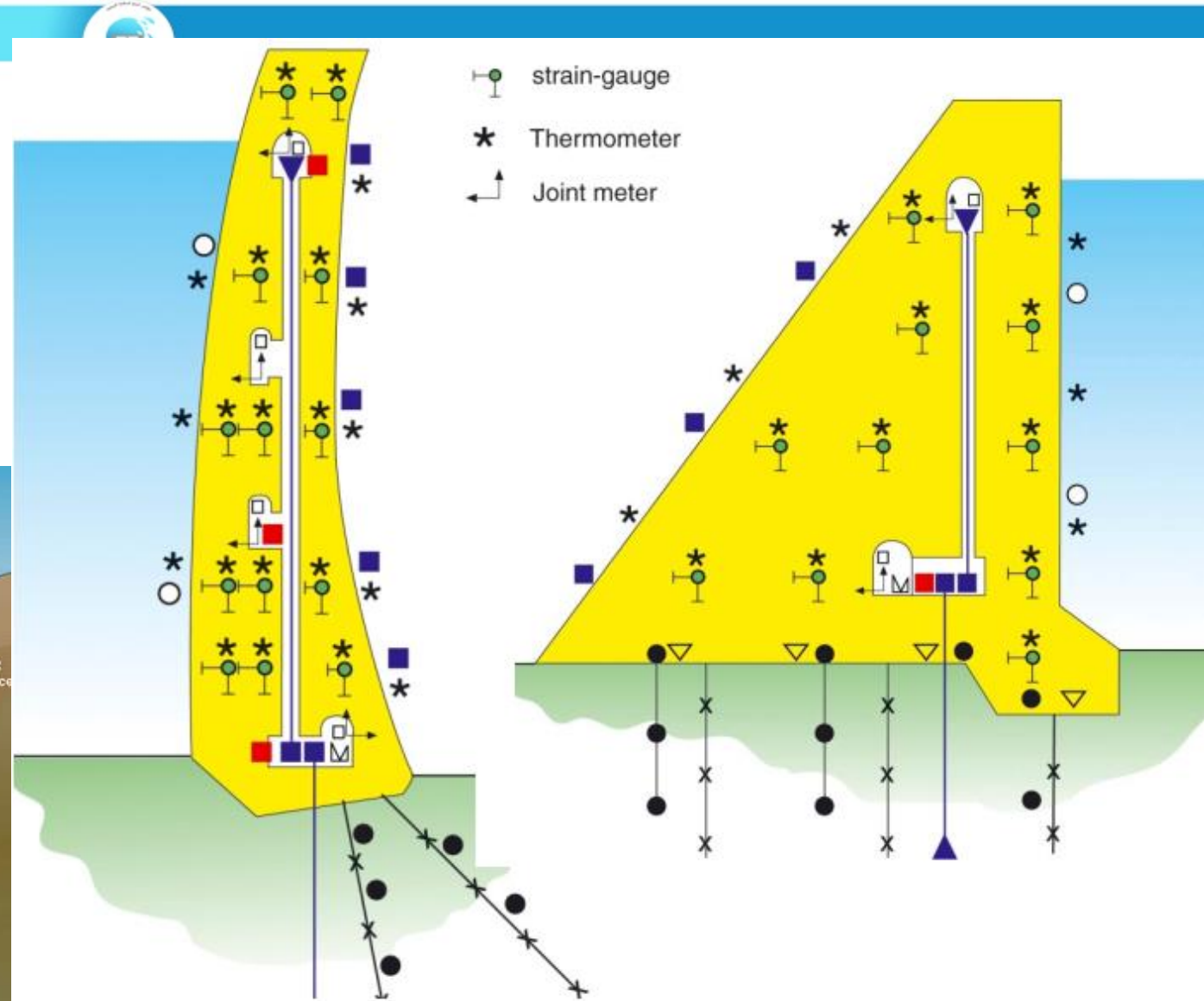
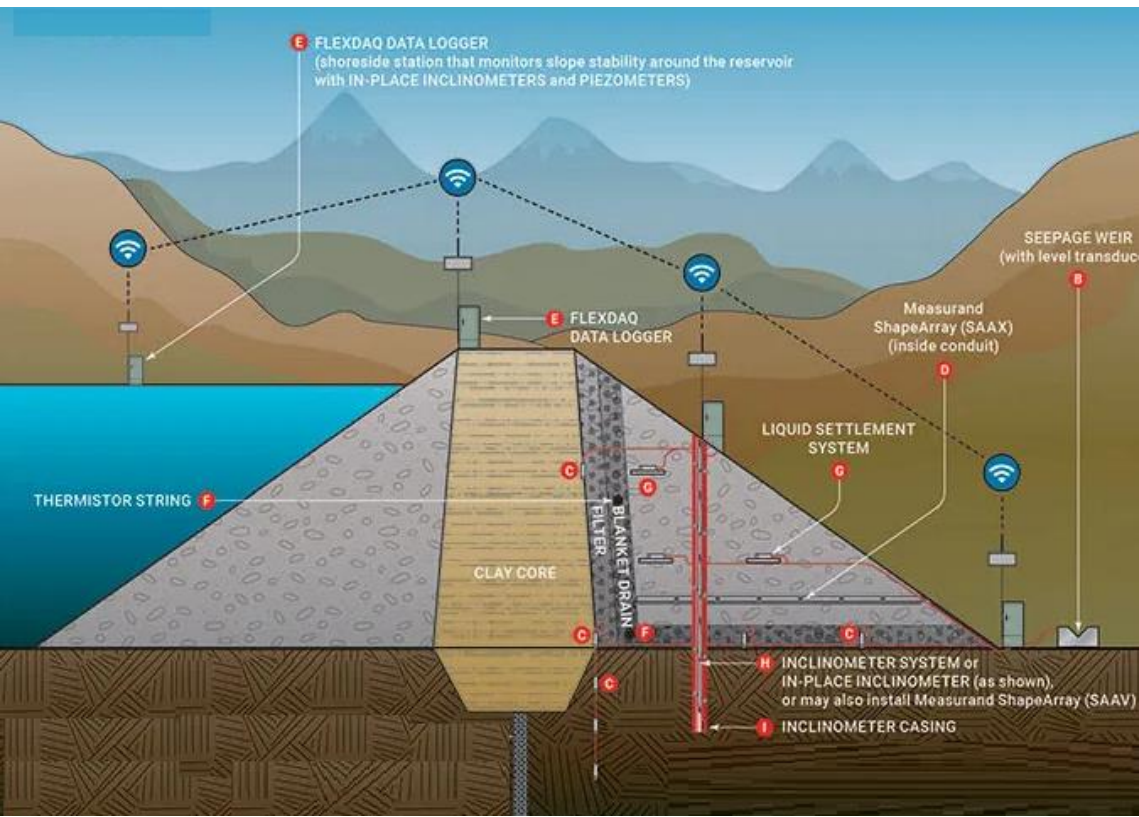


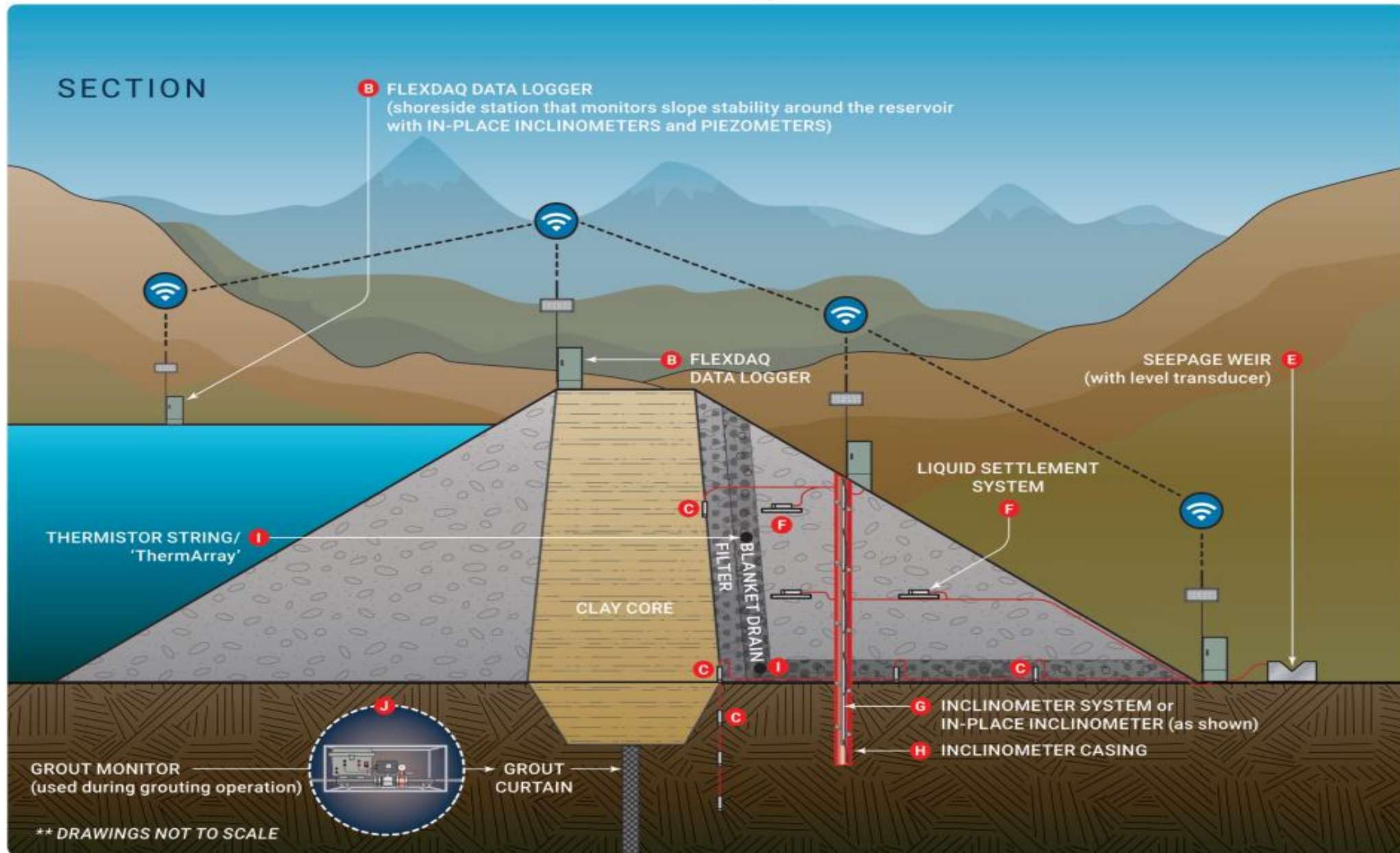


# Digital Inclinometers

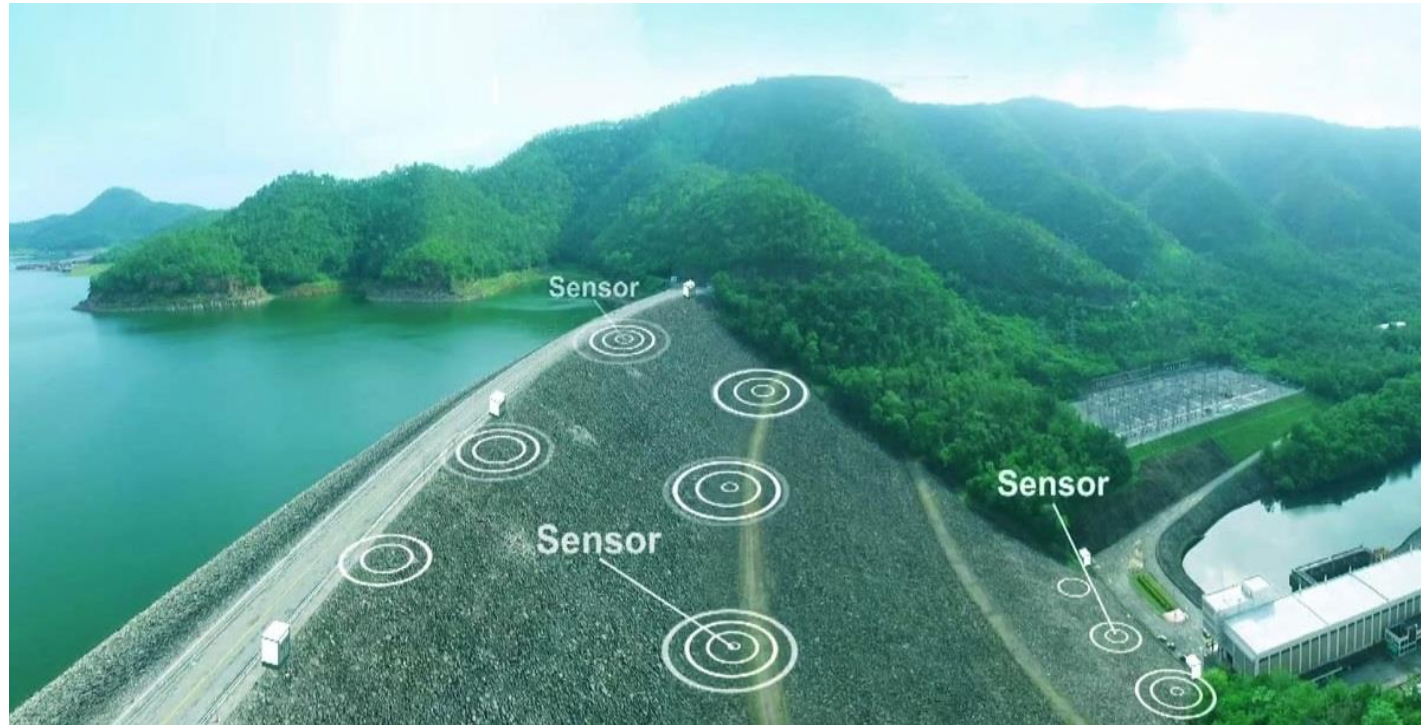


- Thermometers
- Strain gages
- Settlement sensors
- Joint Meter









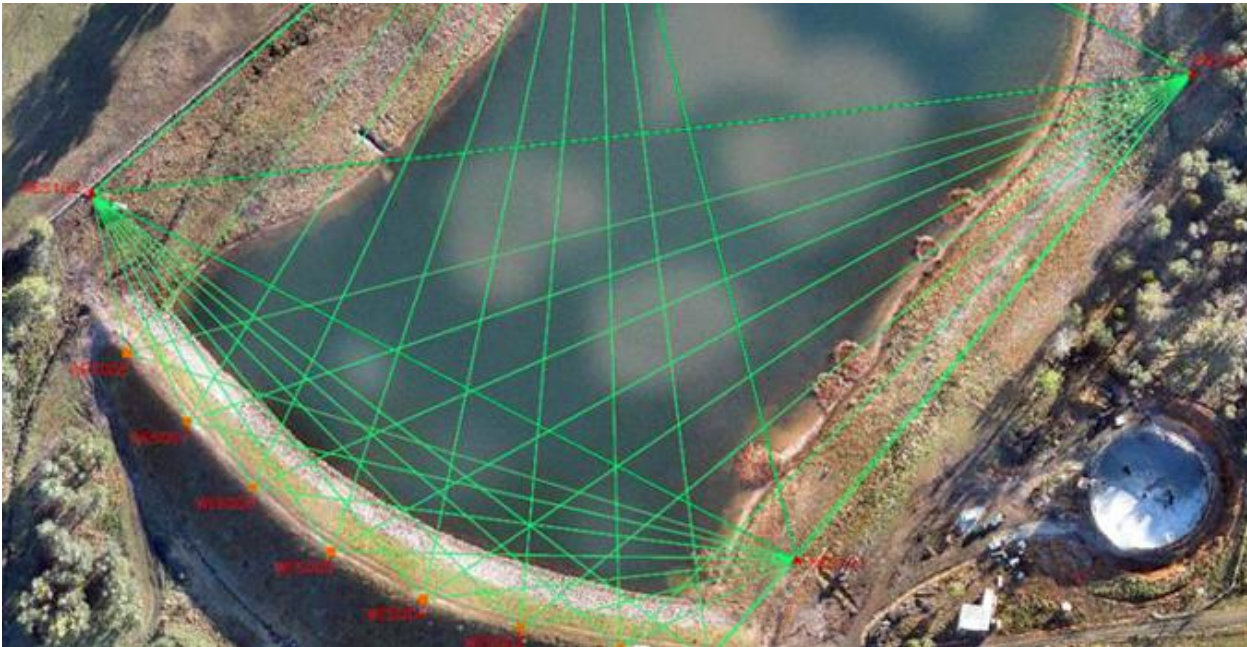
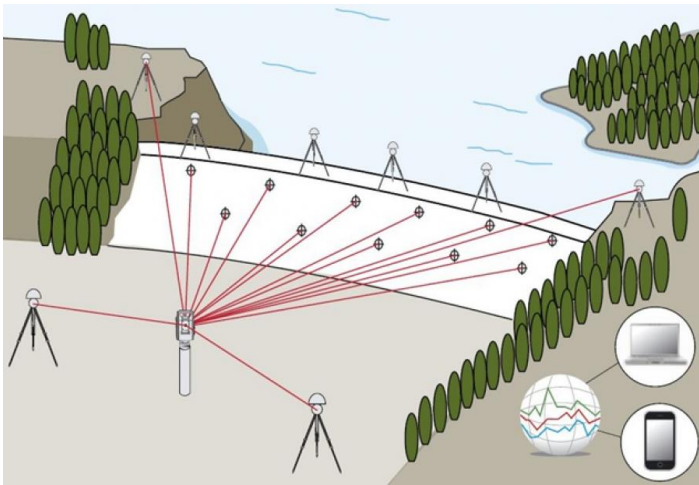


# Control center





# Dam Survey (any Deformation)





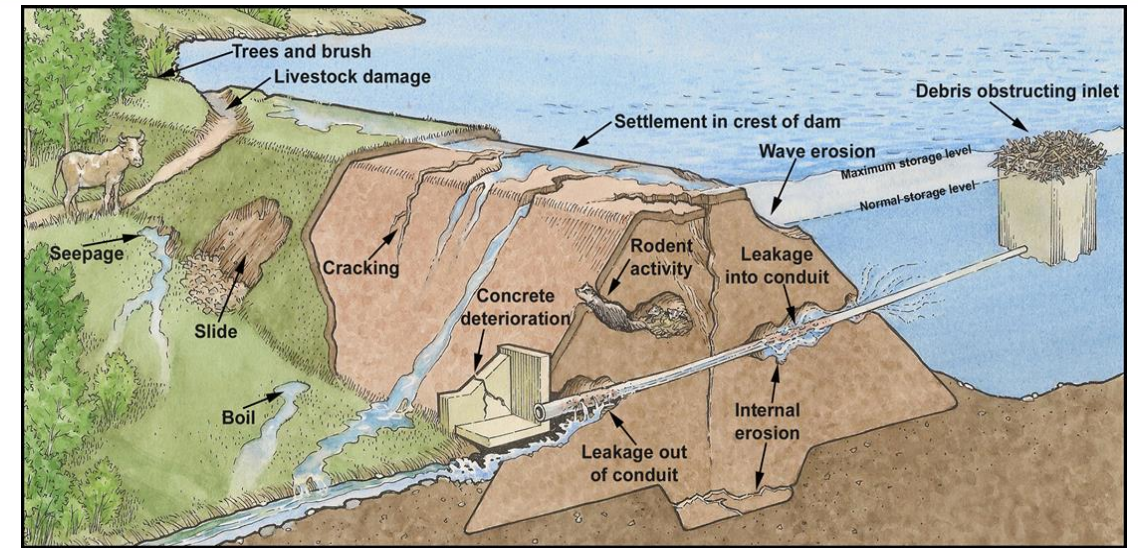
# Inspection



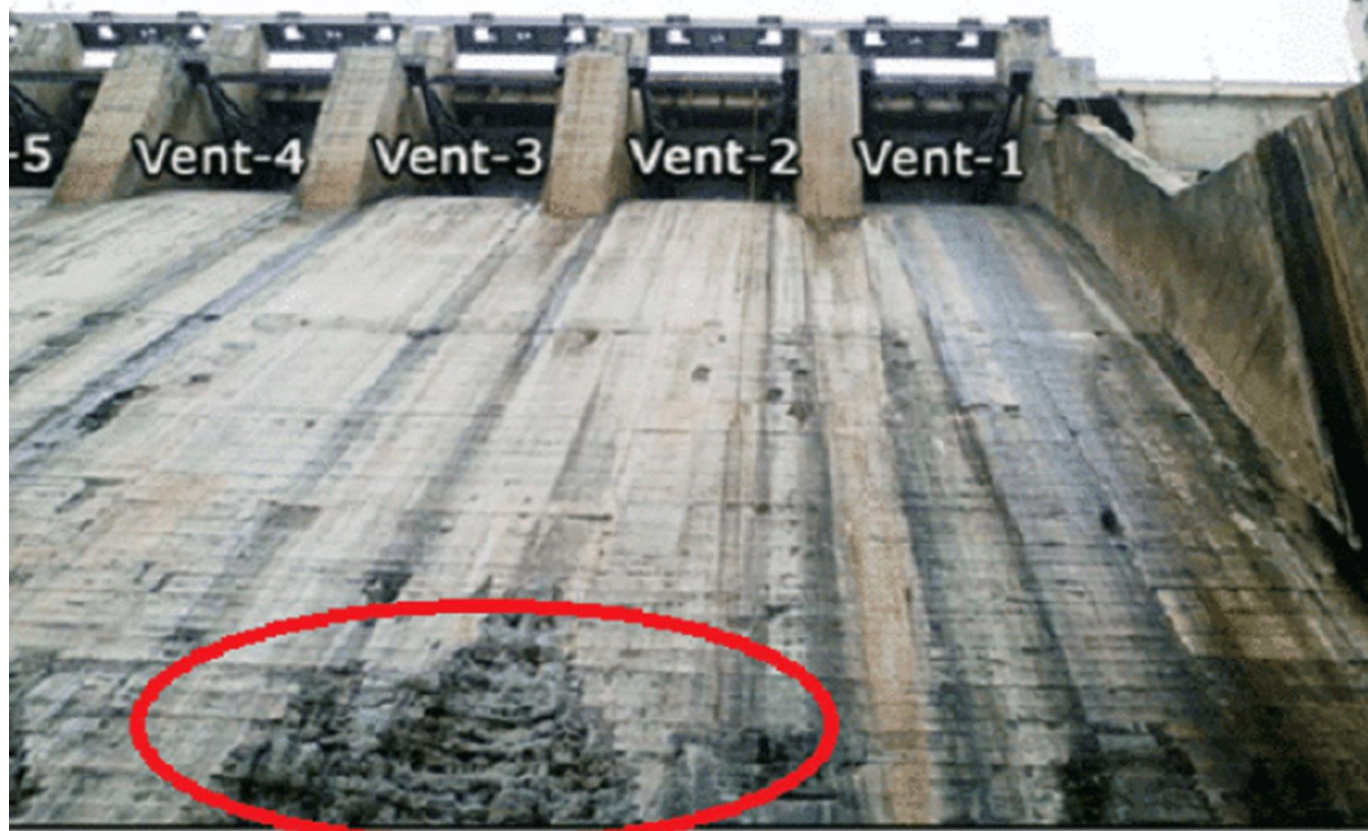


# Inspection of Dam:

- Spillways are not plugged or obstructed
- Seepage from the dam D/s
- Soil erosion has not developed
- Holes or cracks in the dam have not appeared
- Deterioration
- Recent High Water Marks
- Settlements or carks (crest Erosion U/s , D,S Slides )
- spillway ( gate , Leakage, obstruction, scour D/s )
- Concrete or riprap deterioration concrete parts , plunge pool , stilling basin Erosion
- outlet obstructions
- Inadequate vegetation cover
- Any development in upstream (catchment area) which might effect on dam
- Development in downstream Floodplain

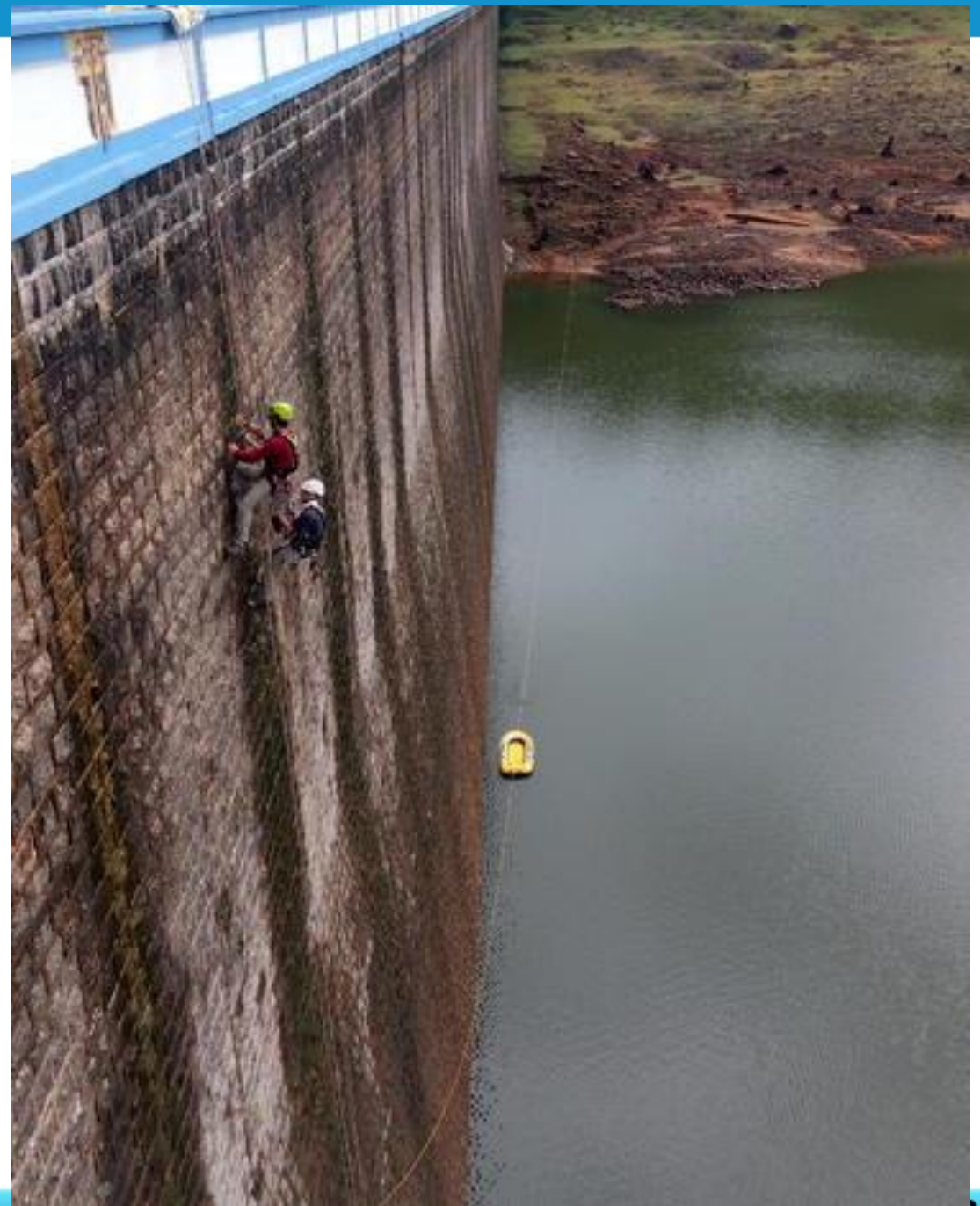


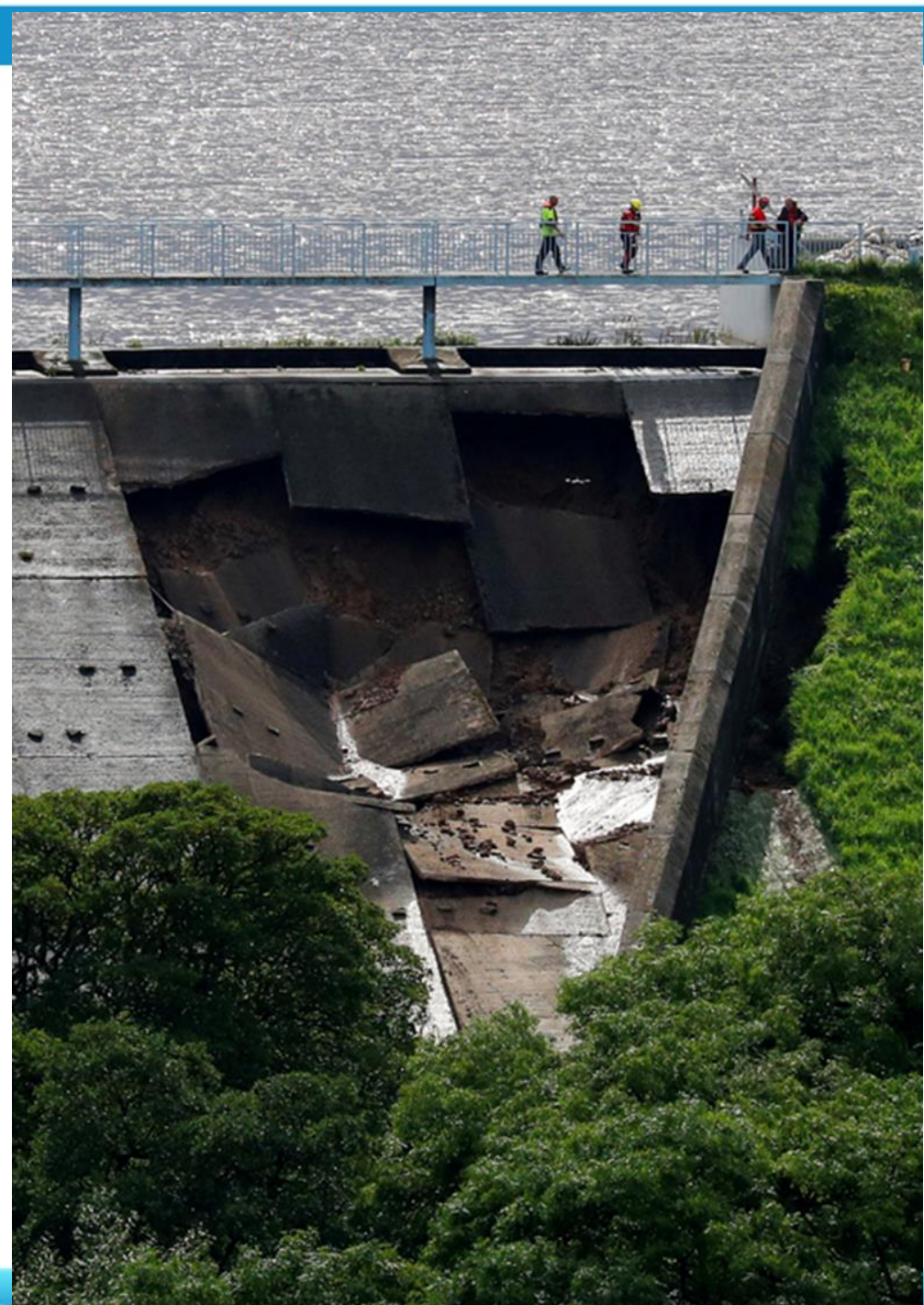


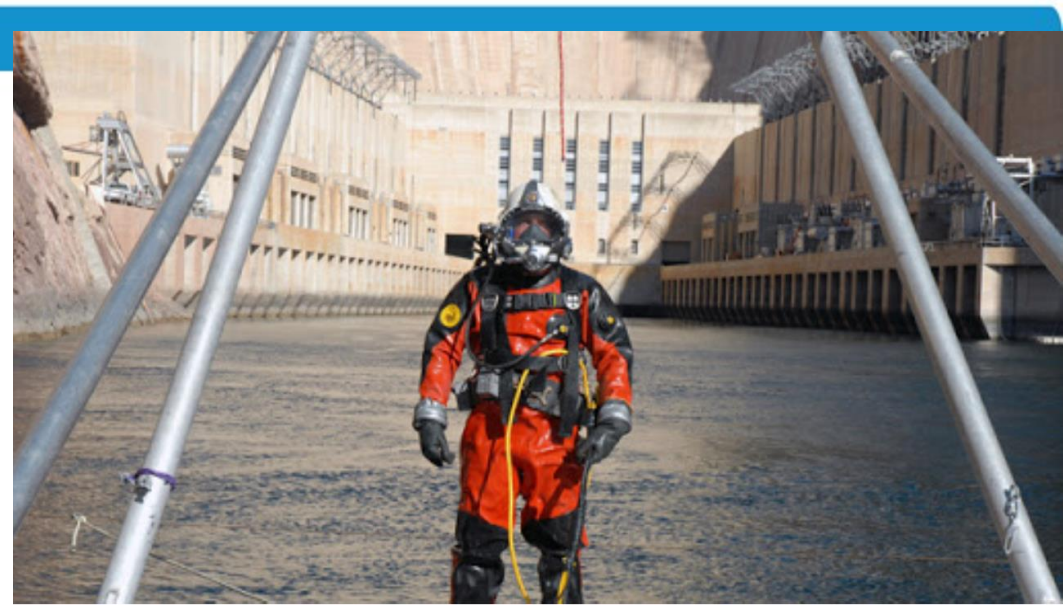
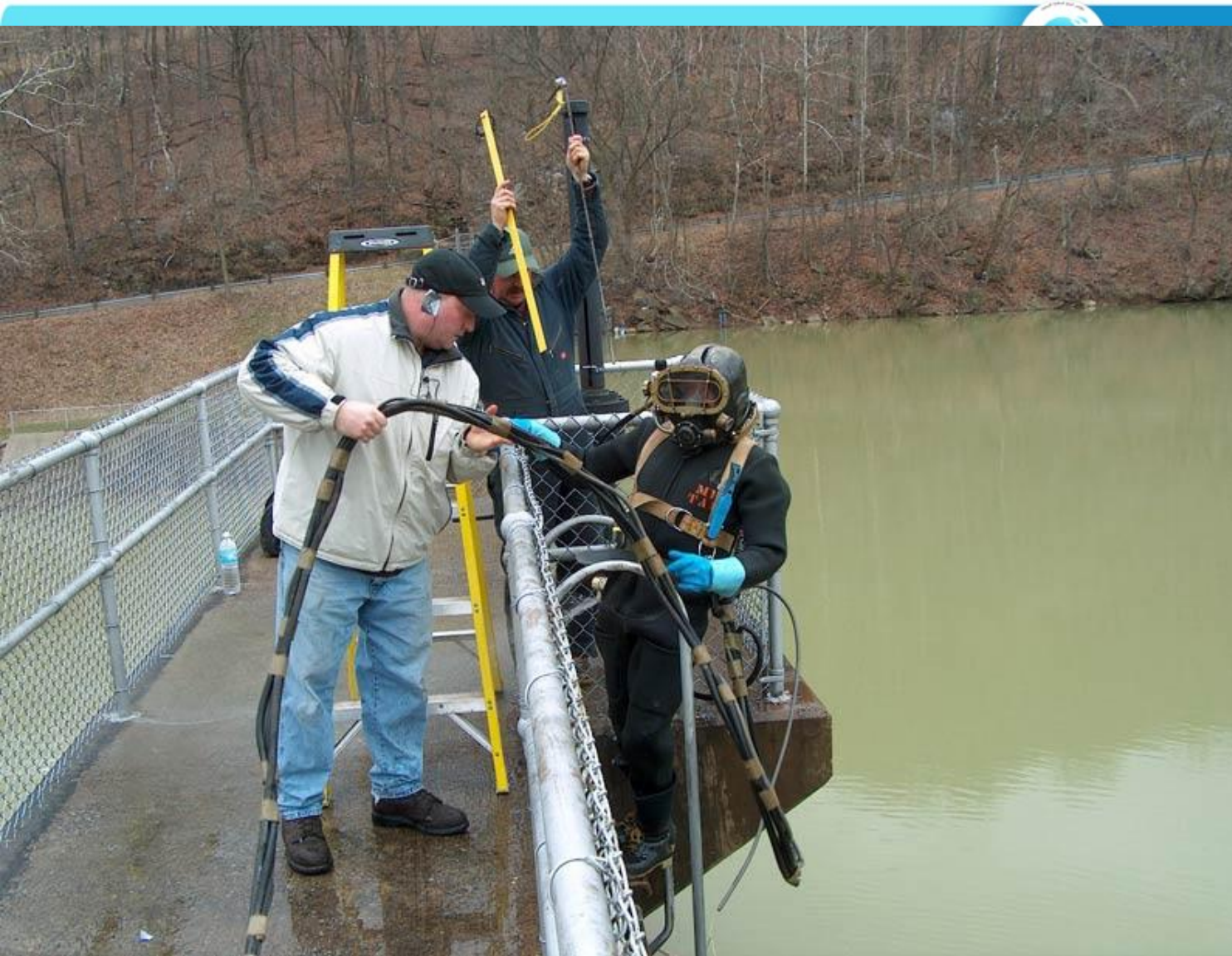








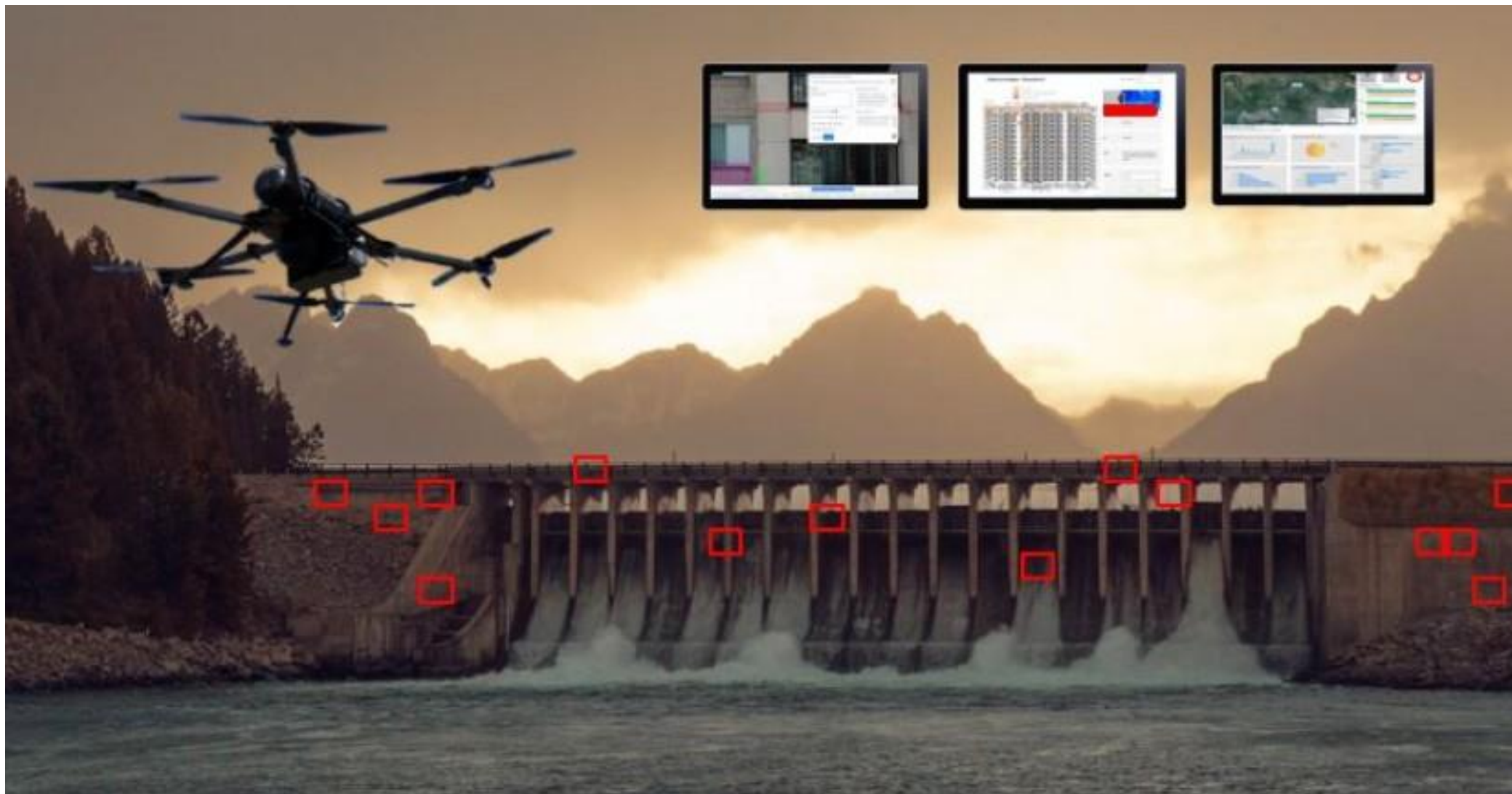






# Drones used for Dam inspection

Drones can making large-scale dam inspections faster to complete.

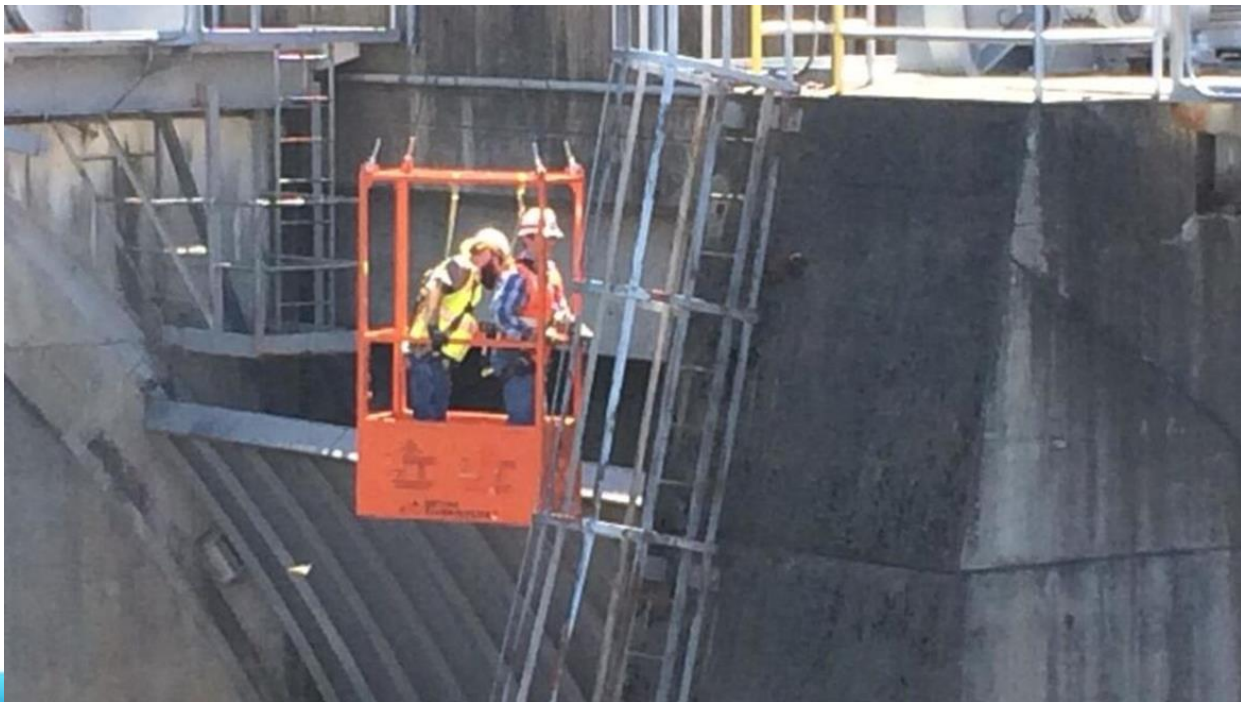




# INSPECTION OF SPILLWAYS - OUTLET WORKSAND

- **Common problems**
- Obstructions
- Differential movement
- Misalignment
- Foundation problems
- Seepage
- Cracking
- Surface defects
- Concrete deterioration: cavitation
- Concrete deterioration
- D/s Scour
- Leaking Joints
- Inadequate or damaged water stops joint problems







# Test Operation for Gates:

The Gates should be operated smoothly and without binding





# Seismic effect







# Protection Work





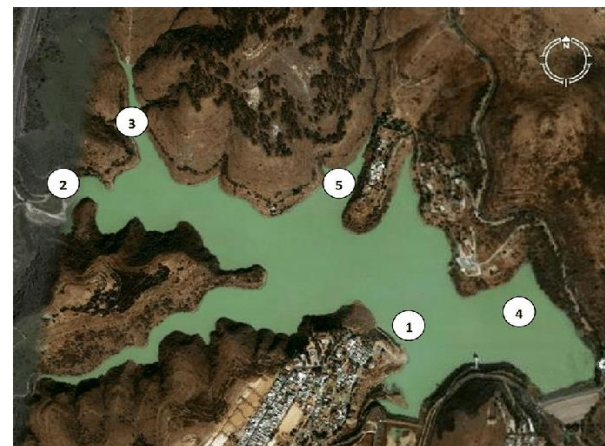
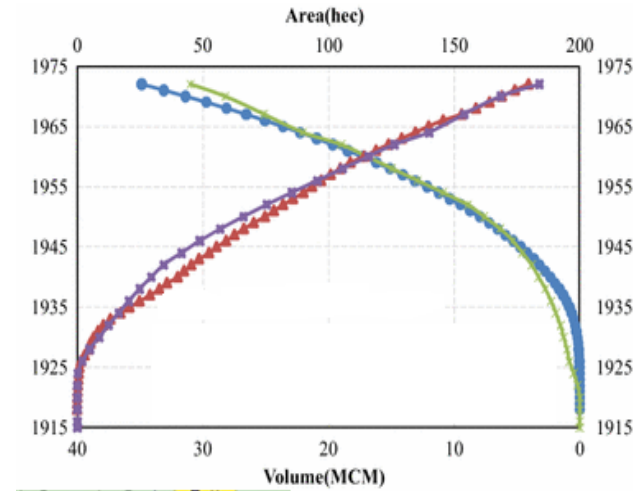
# Maintenance





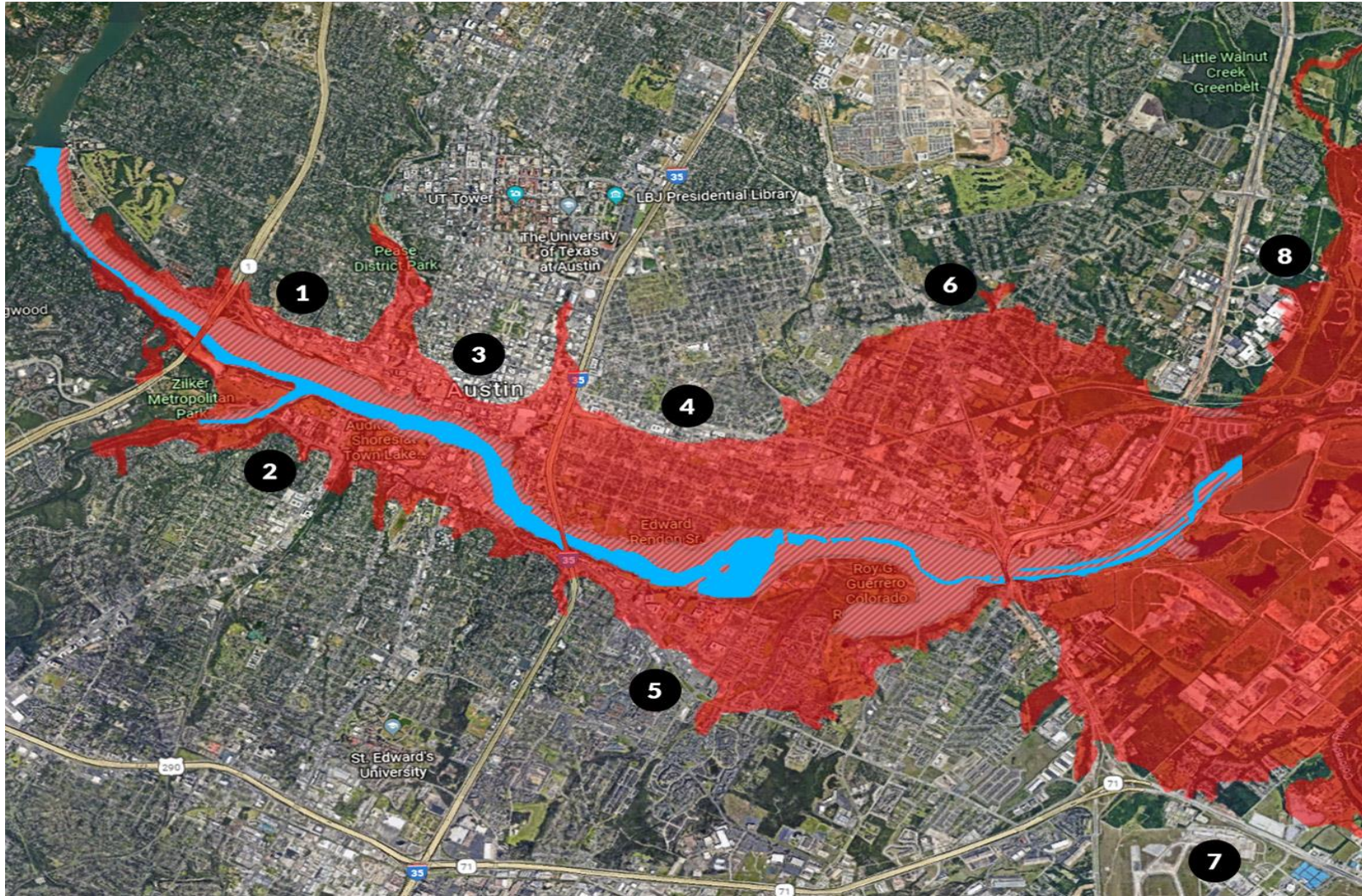
# Annual Reservoir Survey :

changes in Reservoir Area Volume under different stage-Time  
Change Reservoir profile (Sediment sliding)  
Water Quality





# D/S - Inundation map under different condition





# Dam Annual Report



## VISUAL INSPECTION CHECKLIST

NID ID# \_\_\_\_\_  
SHEET \_\_\_ OF \_\_\_

### GENERAL INFORMATION

NAME OF DAM:	POOL ELEVATION:
NATIONAL INVENTORY OF DAMS ID#:	TAILWATER ELEVATION:
OWNER:	CURRENT WEATHER:
HAZARD POTENTIAL CLASSIFICATION:	PREVIOUS WEATHER:
SIZE CLASSIFICATION:	INSPECTED BY:
PURPOSE OF DAM:	INSPECTION FIRM:
O & M MANUAL REVIEWED:	DATE OF INSPECTION:
EMERGENCY ACTION PLAN REVIEWED:	

ITEM	YES	NO	REMARKS
<b>RESERVOIR</b>			
1. Any upstream development?			
2. Any upstream impoundments?			
3. Shoreline slide potential?			
4. Significant sedimentation?			
5. Any trash boom?			
6. Any ice boom?			
7. Operating procedure changes?			

ITEM	YES	NO	REMARKS
<b>DOWNSTREAM CHANNEL</b>			
1. Channel			
a. Eroding or Backcutting			
b. Sloughing?			
c. Obstructions?			
2. Downstream Floodplain			
a. Occupied housing?			
b. Roads or bridges?			
c. Businesses, mining, utilities?			
d. Recreation Area?			
e. Rural land?			
f. New development?			

ITEM	YES	NO	REMARKS
<b>EMERGENCY ACTION PLAN</b>			
1. Class I or Class II Dam?			
2. Emergency Action Plan Available?			
3. Emergency Action Plan current?			
4. Recent emergency action plan exercise?			DATE: _____

ITEM	YES	NO	REMARKS
<b>INSTRUMENTATION</b>			
1. Are there			
a. Piezometers?			
b. Weirs?			
c. Observation wells?			
d. Settlement Monuments?			
e. Horizontal Alignment Monuments?			
f. Thermistors?			
2. Are readings			
a. Available?			
b. Plotted?			
c. Taken periodically?			

## DAM INSPECTION CHECKLIST

DAM NAME:			INSPECTED BY:		
			DATE:		
Yes	No	NA	General Conditions	Remarks	(References to "left" or "right" are made as if facing downstream)
			1. Recent High Water Marks		
			2. Development in Downstream Floodplain		
			3. Inadequate Vegetative Cover		
			4. Alterations to Dam		
Yes	No	NA	Crest		
			5. Settlements or Cracks		
			6. Erosion		
			7. Trees		
			8. Rodent Holes		
Yes	No	NA	Upstream Slope		
			9. Settlements, Slides, or Cracks		
			10. Erosion		
			11. Trees		
			12. Rodent Holes		
			Principal Spillway Inlet	Water Surface EL:	Est. Flow Rate:
Yes	No	NA	Size and Type:	Drawdown:	
			13. Spalling, Cracking, or Scaling		
			14. Leakage		
			15. Inadequate Trash Rack		
			16. Obstructions		
Yes	No	NA	Auxiliary Spillway	Type and Location:	
			17. Obstructions		
			18. Erosion		
			19. Rodent Holes		
			20. Vegetation Condition Inadequate		
Yes	No	NA	Downstream Slope		
			21. Settlements, Slides, or Cracks		
			22. Erosion		
			23. Trees		
			24. Rodent Holes		
			25. Problems at Drain or Well Outlet	Est. Flow Rate:	
			26. Seepage or Boils	Est. Flow Rate:	
Yes	No	NA	Principal Spillway Outlet	Size and Type:	Est. Flow Rate:
			27. Spalling, Cracking, or Scaling		
			28. Leakage		
			29. Obstruction		
			30. Erosion		
Yes	No	NA	Plunge Pool/Stilling Basin		
			31. Concrete or Riprap Deterioration		
			32. Outlet Channel Obstruction		
			33. Erosion		
<b>Condition Assessment:</b>					
<b>Additional Comments:</b>					

# lightning system



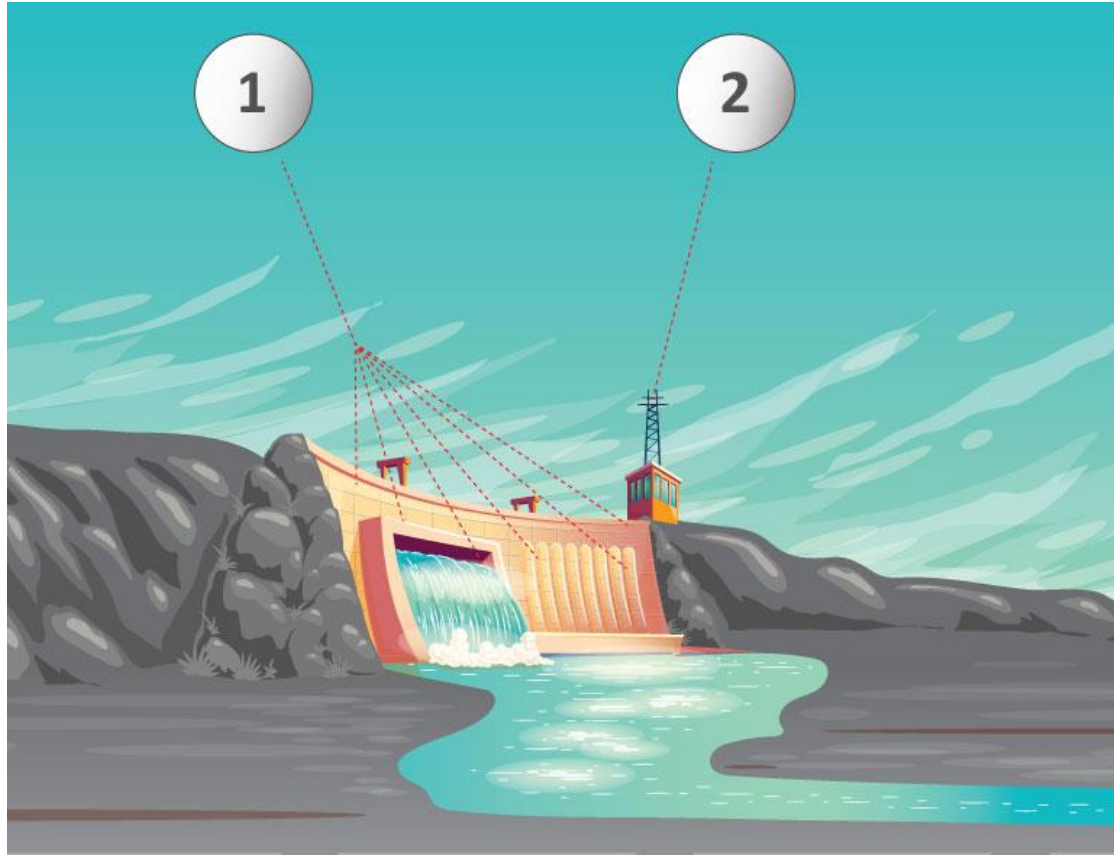


# Surveillance Cameras





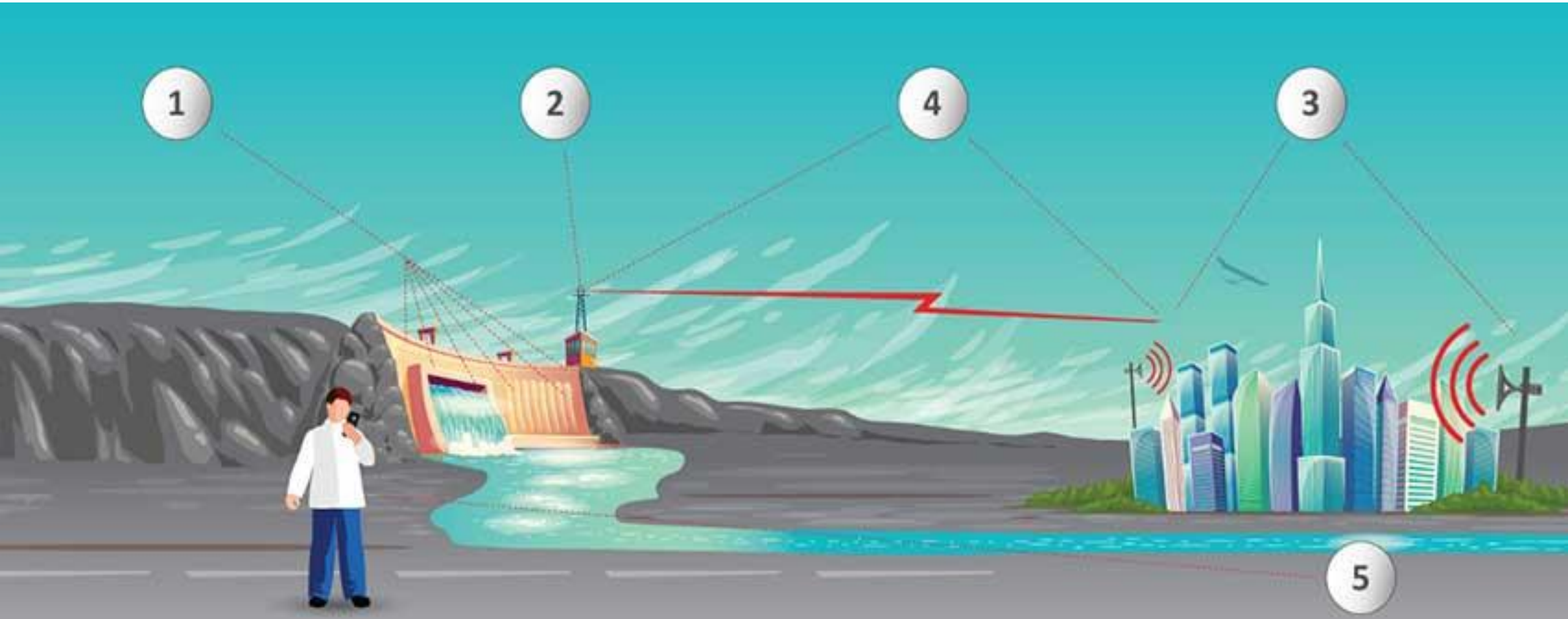
# Warning system







# Dam emergency action plans





# Civil Defense Department:





# Medical Center





# Dam Protection Force





Thank You