

# Flood Proofing

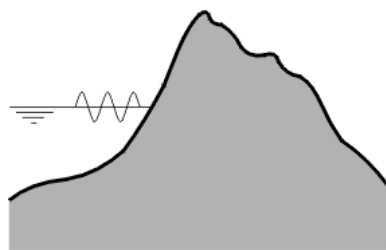


**Integrated Flood Management**  
Hanoi, Vietnam, 5-8 April 2011

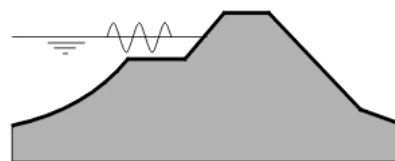
## Outline

- Failure Mechanisms Flood Defence Systems
- Flood Proofing:
  - What, why, where, when and how?
  - Feasibility of Flood Proofing
  - Design Considerations
- Examples and illustrations

## Failure Mechanisms



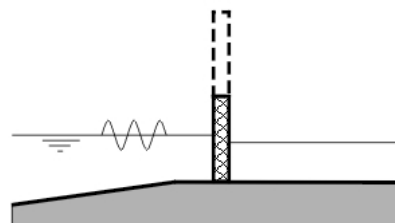
Dune



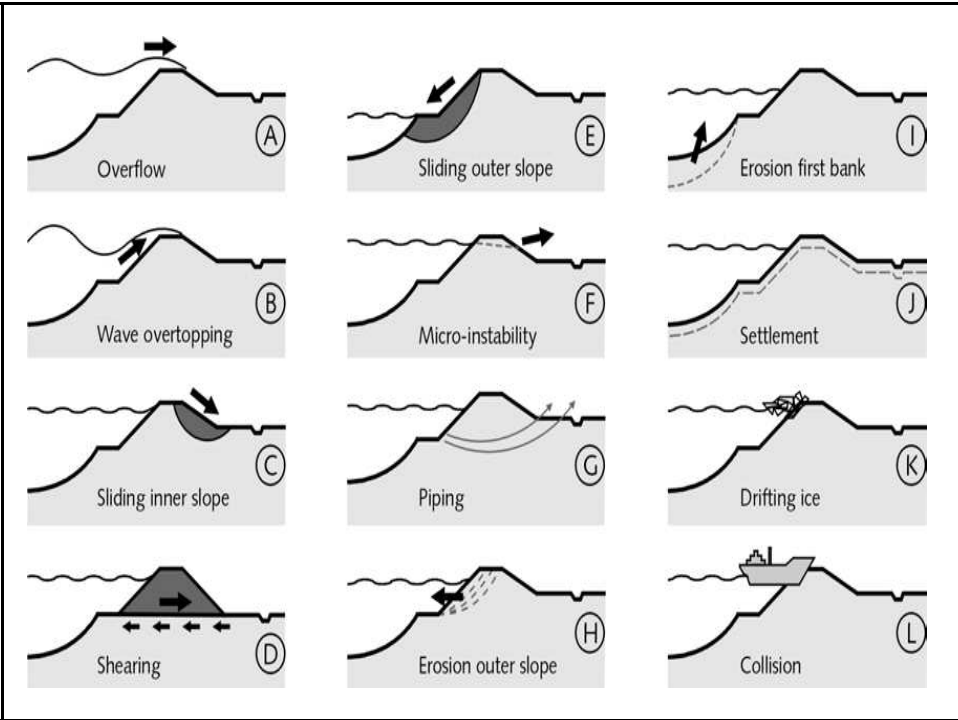
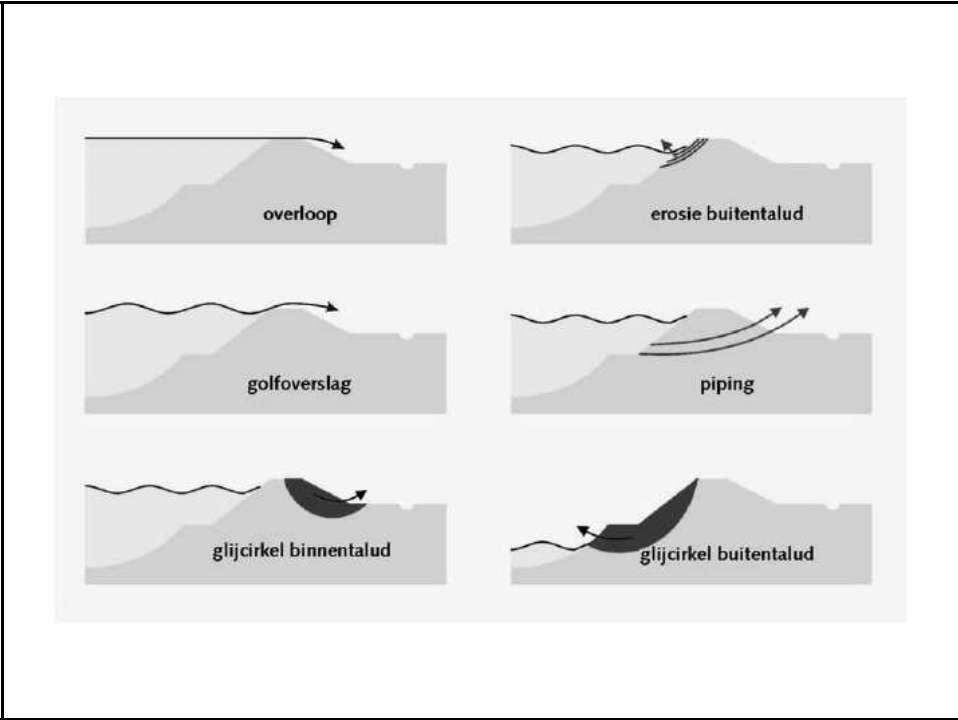
Dike



Embankment  
(special structure)



Sluice (water retaining  
hydraulic structure)



Failed Flood Embankment



Piping through Embankment



## Sand Migration due to Underseepage



## Controlling Under-seepage



## Confined Seepage





## Emergency Intervention - Blow-up



# Flood Proofing

December 2009  
Draft Final Report



THE MEKONG RIVER COMMISSION SECRETARIAT  
**THE MEKONG RIVER COMMISSION SECRETARIAT**



## **Best Practise Guidelines for Structural Measures and Flood Proofing**

The Flood Management and Mitigation Programme,  
Component 2: Structural Measures & Flood Proofing  
in the Lower Mekong Basin

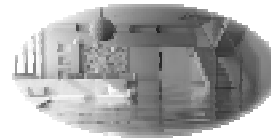
December 2009  
Draft Final Report



## What is Flood Proofing?

... is a combination of adjustments and/or additions of features to individual buildings that are designed to eliminate or reduce the potential for flood damage.

... are considered flood vulnerability reduction measures in the context of IFRM.



*... does not eliminate all flood risks – but it can “buy down” the risk to an acceptable level.*

## Why Flood Proofing?

Floodwater inundation damages infrastructure, roads, bridges, buildings, housing, equipment, and other components/utilities.



Ensuring that losses of life and damage to buildings and structures are reduced.



Flood proofing is an initial step in reducing vulnerability to flooding in unprotected settlements, and urban areas in unprotected floodplains.



## **Where** Flood Proofing?

- Residential areas
- Non-residential areas
  
- Existing buildings, infrastructures
- New buildings, infrastructures



## **Where** Flood Proofing?

### **Residential areas**

- Protect lives, neighbourhood

### **Non-residential areas**

- Protect important and critical services such as water supply, electricity, telephone, airport, key transportation corridors such as roads and bridge, etc.

## **Where Flood Proofing?**

### **Existing buildings & infrastructures**

Flood proofing of existing structures may include

- raising of structures to prevent damages,
- relocation of utilities,
- changed building use,
- installation of protective walls and waterproof closures, and
- use of materials that are not damaged by water and can be easily cleaned after the flood event.

## **Where Flood Proofing?**

### **New buildings, infrastructures**

- Any new construction permitted in the flood plain should be flood proofed to reduce future damages.
- Building codes can be developed that minimize flood damages by ensuring that beneficial uses of buildings are located above the design flood elevation.
- Examples:
  - buildings can be raised above the design flood level by placement of fill, stilts or piles; and
  - building utilities can be located above the design flood level

## When Flood Proofing?

- ***Well before*** the flood event: (Semi-) Permanent measures;
- ***Immediately before*** the flood event: Contingent measures;
- On relative ***short notice before*** the flood: Emergency measures.



## How Flood Proofing?

### **Classification**

- *Permanent measures*
- *Contingent measures*
- *Emergency measures*

### **Other Classification**

- *Dry Flood Proofing*
- *Wet Flood Proofing*

### **Note:**

*In the Guideline part of Contingent Measures, when constructing Flood Barriers.*

## Permanent Measures

- Permanent floodproofing measures are those, once installed, require no further action to be taken when flooding occurs.



- These measures include closures and sealants, watertight cores, floodwalls and levees, and elevation of the structure.

### Permanent Measures

...are most effective

- when used in areas that are subject to frequent flooding, relatively high flood depths, or
- where insufficient flood warning time is available to implement contingent floodproofing measures.

## Permanent Measures

Types:

1. Permanent closures and sealants
2. Watertight cores
3. Floodwalls and levees
4. Elevation

## Permanent Measures

Advantages	Disadvantages
<ul style="list-style-type: none"><li>• Reduce reliance on a sophisticated flood warning and preparedness system</li><li>• Effectiveness not jeopardized on human error in installing any portion of the system</li><li>• Operation and maintenance costs often less compare with permanent measures</li><li>• Often meet the minimum floodplain management requirements of the National Flood Insurance Program</li></ul>	<ul style="list-style-type: none"><li>• Initial construction costs may be relatively high</li><li>• Adjustments made may restrict access to and use of certain parts of the structure</li></ul>

## Examples Permanent Measures

### Elevated Structures



### Flood Proof House



## Contingent Measures

- Those that require some type of installation, activation, or other preparation immediately prior to the occurrence of a flood.
- These measures include flood shields, watertight doors, and moveable floodwalls.

## Contingent Measures

Advantages	Disadvantages
<ul style="list-style-type: none"><li>• Components may be moved aside or stored during non-flood periods allowing full access to the doors, windows, and other openings</li><li>• Very cost effective when protecting against relatively shallow flood depths</li><li>• The most adaptable and feasible techniques for use of existing non-residential structures</li></ul>	<p>Subject to human error associated with applying the system's components</p> <ul style="list-style-type: none"><li>• inadequate recognition of flood hazards,</li><li>• improper installation,</li><li>• failure to install an element of the system due to poor coordination,</li><li>• inability to find elements or installation equipment due to poorly planned or maintained storage areas, or</li><li>• improper training of the installation team</li></ul>

## Type of Contingent Measures

### 1. Flood shields



### 2. Watertight doors

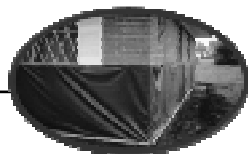


### 3. Movable floodwalls



## Dry Flood Proofing

- Completely sealing the exterior of a building to prevent the entry of flood waters.
- Seals all openings below the flood level and relies on the walls of the house to keep water out.



## Dry Flood Proofing

.....is practical only

- for houses with walls constructed of flood-resistant materials, and
- where flood depths are low (no more than 2 to 3 feet).



## Flood Panels to Reduce Damage



### Flood Panel



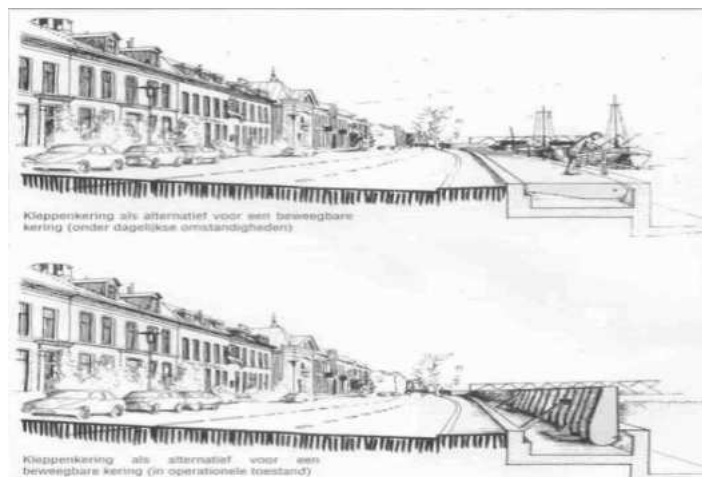
### Flood Panel



## Emergency Flood Wall



## Movable Flood Wall



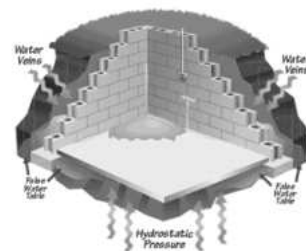
## Wet Flood Proofing

- often used when dry flood proofing is not possible or is too costly.
- modifying a structure to allow floodwaters inside, but ensuring that there is minimal damage to the building's structure and to its contents ;
- Permanent or contingent measures that prevent or provide resistance to flood damage by allowing flood waters to enter the structure .

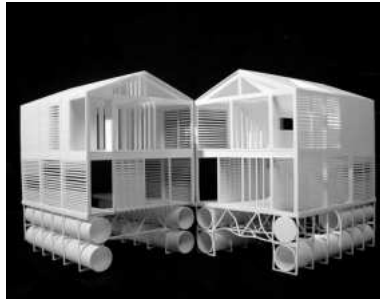
## Wet Flood Proofing



**Hydrostatic Pressure**



## Floating Houses



## Emergency Measures

- Characterized by their ability to be initiated on relatively short notice using previously obtained and stored materials.
- These methods are most effective in flood areas where water velocities are low and depths are shallow, and where floodwaters rises lowly.
- Advantages: low cost
- Disadvantage: substantial advance warning is required to mobilize personnel and install emergency barriers.

## Emergency Measures

1. SANDBAG LEVEES
2. RETAINING WALLS
3. STOP LOG BARRIERS

## Emergency Measures

### STOP LOG BARRIER



## Emergency Measures

### EARTHFILL CRIB RETAINING WALLS



## Feasibility of Floodproofing options

The optimum solution would be one that:

- Provides for reduction in damages for the selected or required design level and does not result in increased damages to other property.
- Is responsive to all applicable floodplain regulations.
- Provides for the safety of persons on and adjacent to the site.
- Is cost effective with regard to installation, maintenance and operation of the system.
- Is acceptable to the property owner, employees and the general public with regard to operational efficiency and impacts on the surrounding environment.

## Design Considerations of Flood Proofing Measures

1. Flood hazard boundaries
2. Flood Depth
3. Flow Velocity
4. Rate of water rise
5. Flood Duration
6. Frequency
7. Freeboard
8. Site specific factor
9. Geology, groundwater, and soils condition
10. Infrastructure
11. Physiographic characteristics of the area

## Examples of Flood Proofing Measures

## Emergency Measures

### SANDBAG LEVEES



## Examples Permanent Measures

### Floodwalls & Levees



## Relocation



## Flood Panels



## Movable Floodwall



Before deployment



After deployment

## Stop Log outside a cafe



### **Flood Proofed Bridge**



### **Flood Shield**



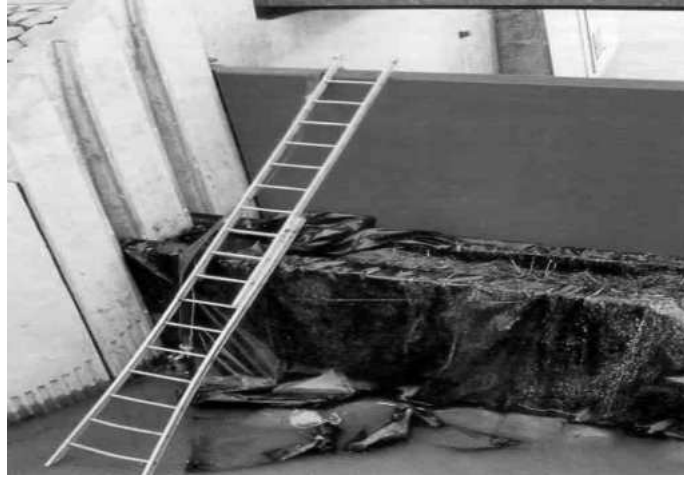
## Watertight Door



## Flood Panels



## Emergency Flood Wall



## Emergency Flood Wall (2)



## Sandbags as Emergency Measure



## Columns for Emergency Flood Panels



## Floating Houses



## Floating Houses (2)





**Floating Buildings  
Adjustable to Any Flow Regime**

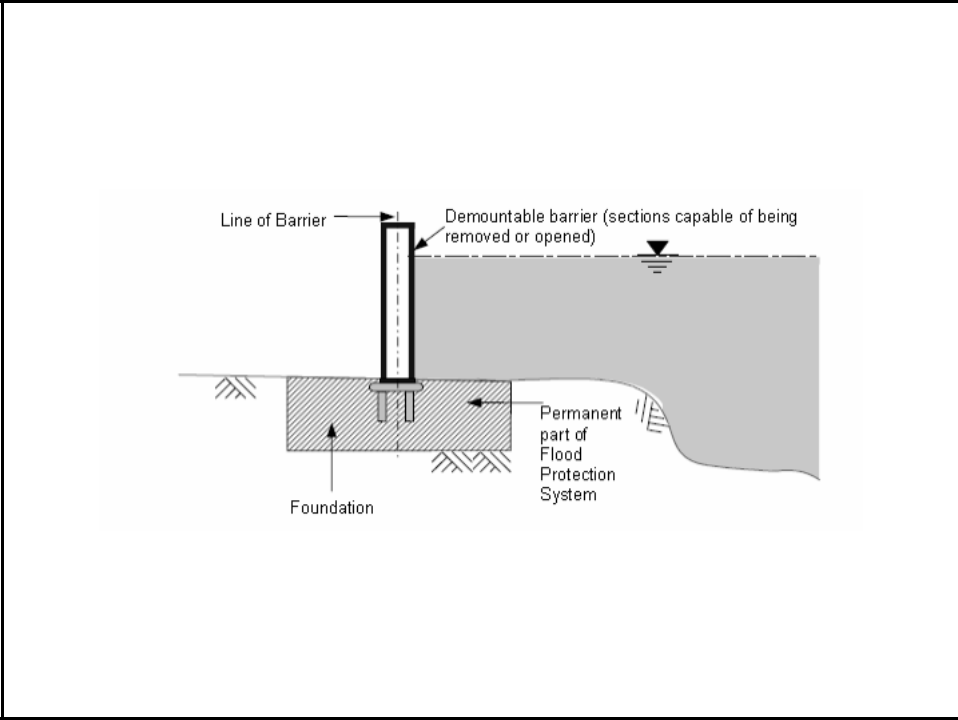
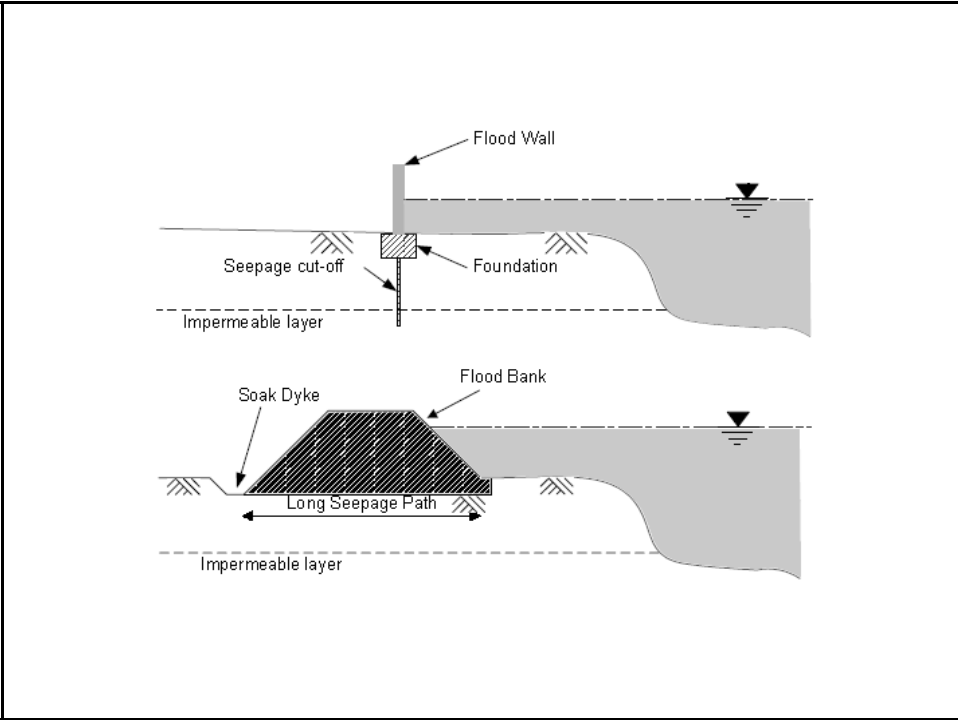


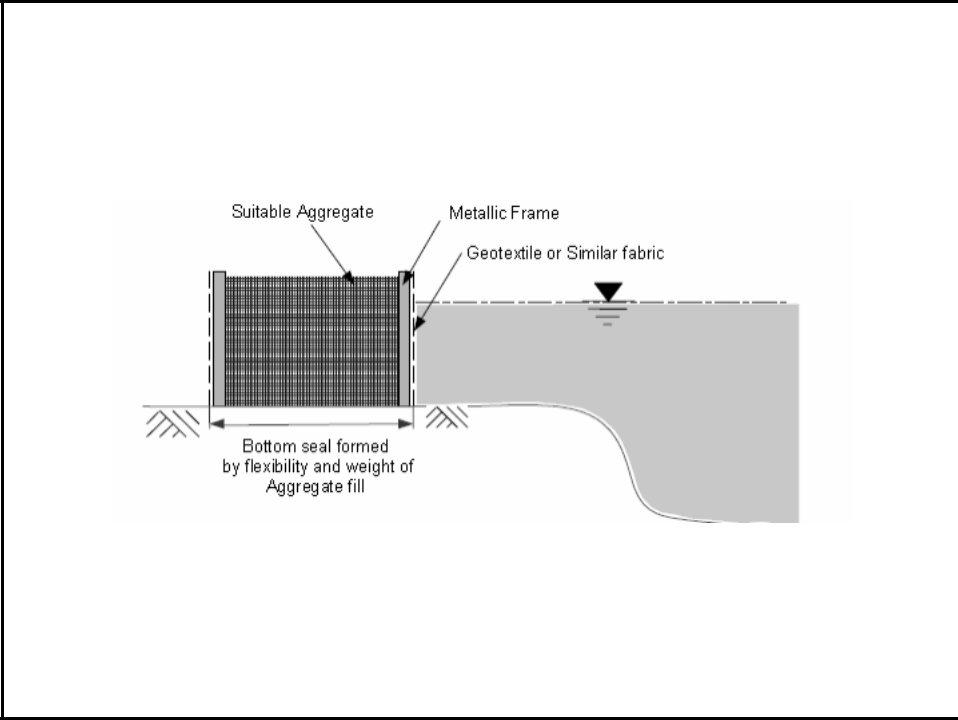
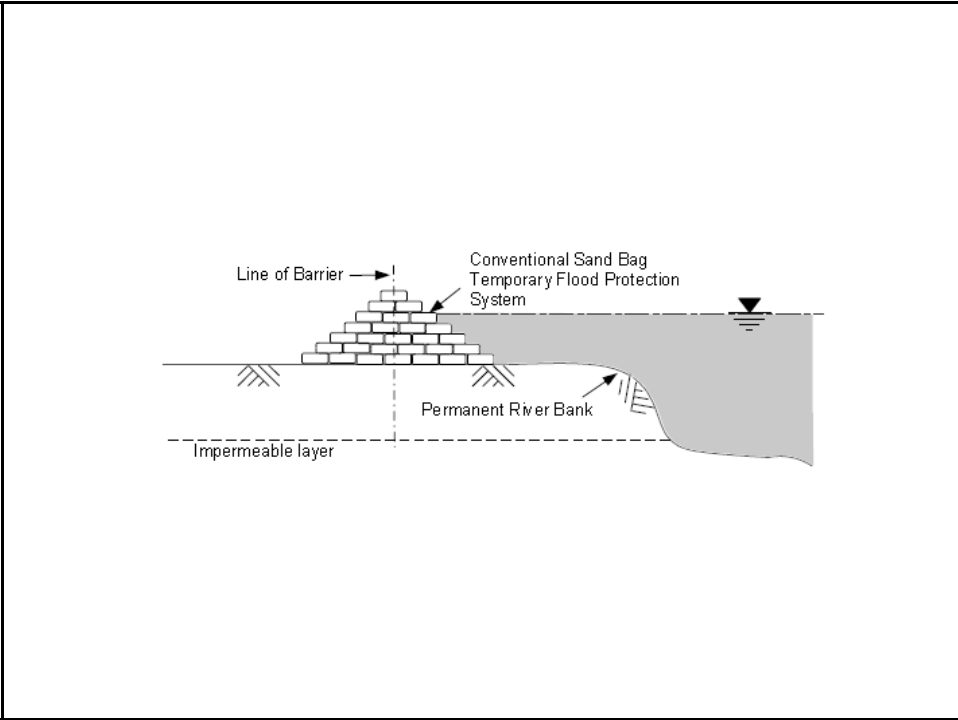
# **Waterscapes**

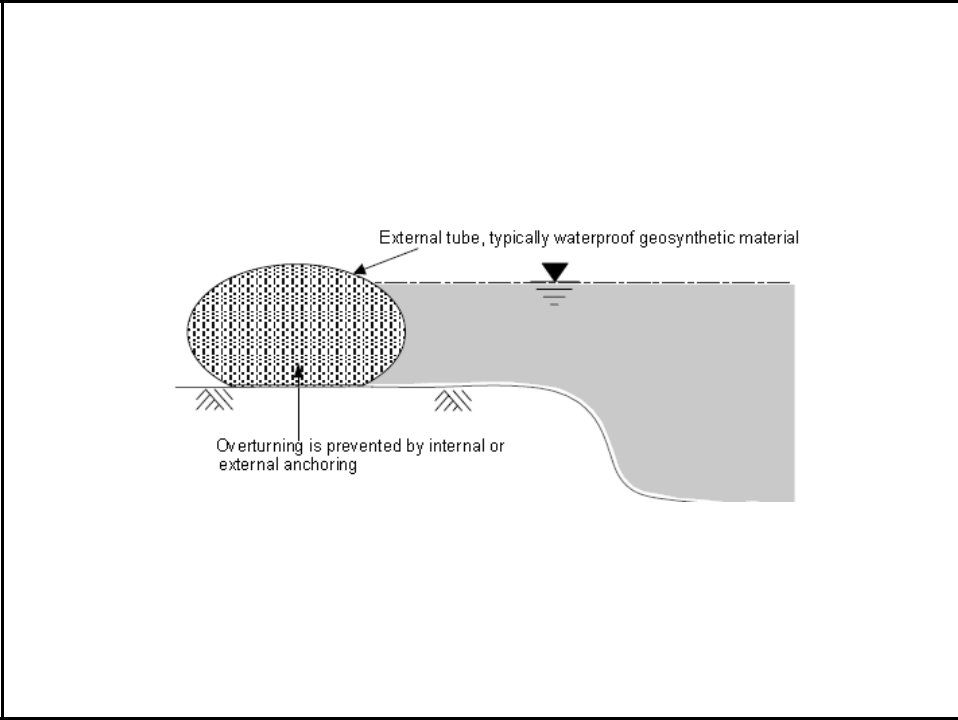
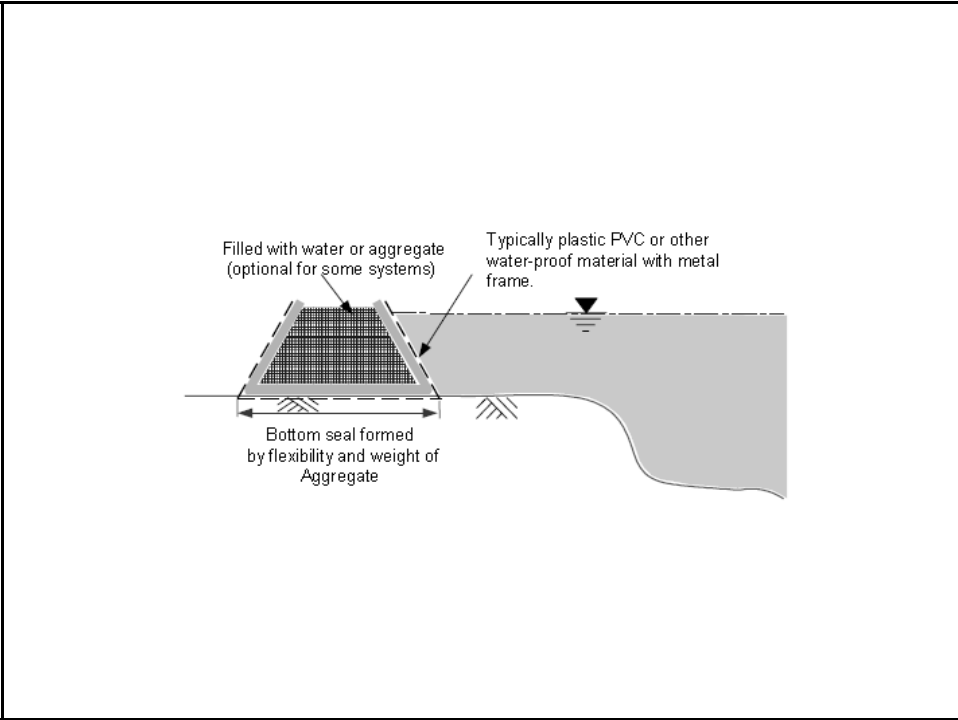
**for Drainage, Retention, Recharge, Esthetics**

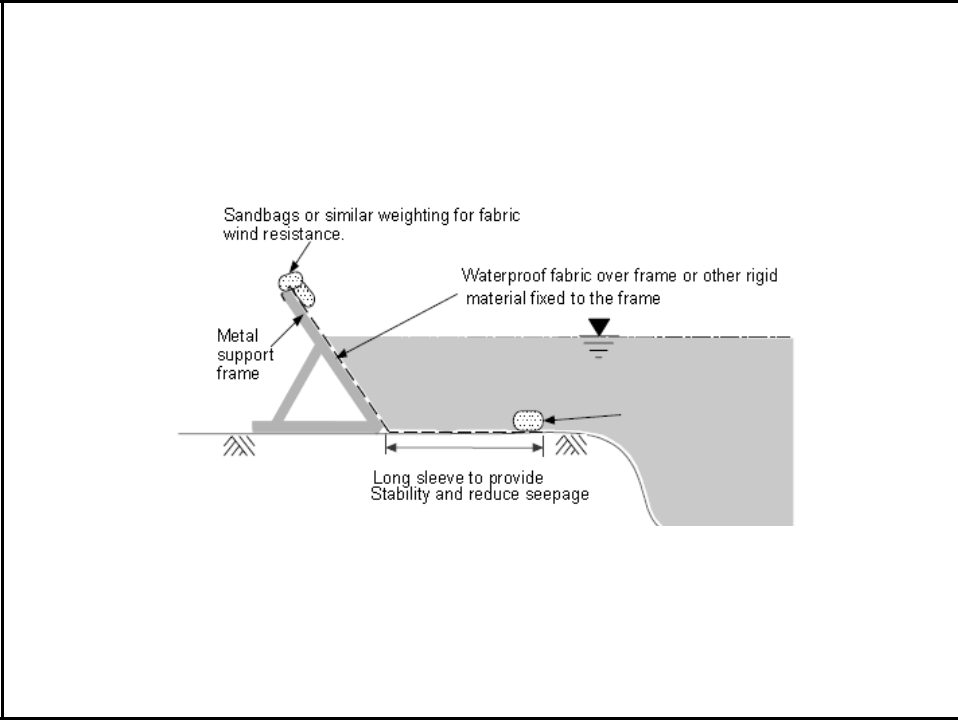
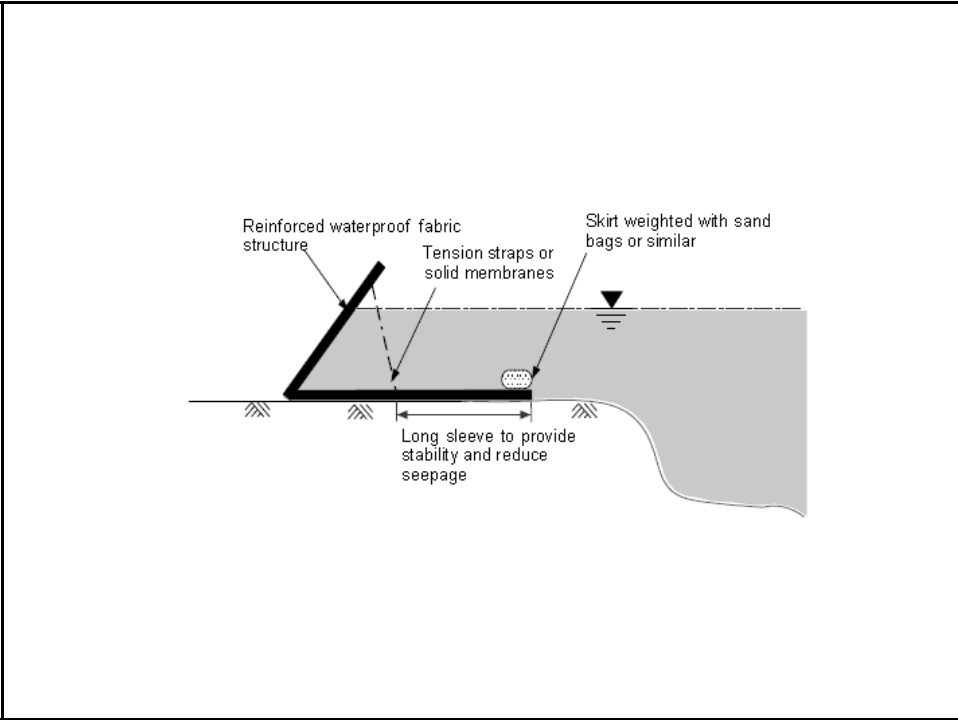


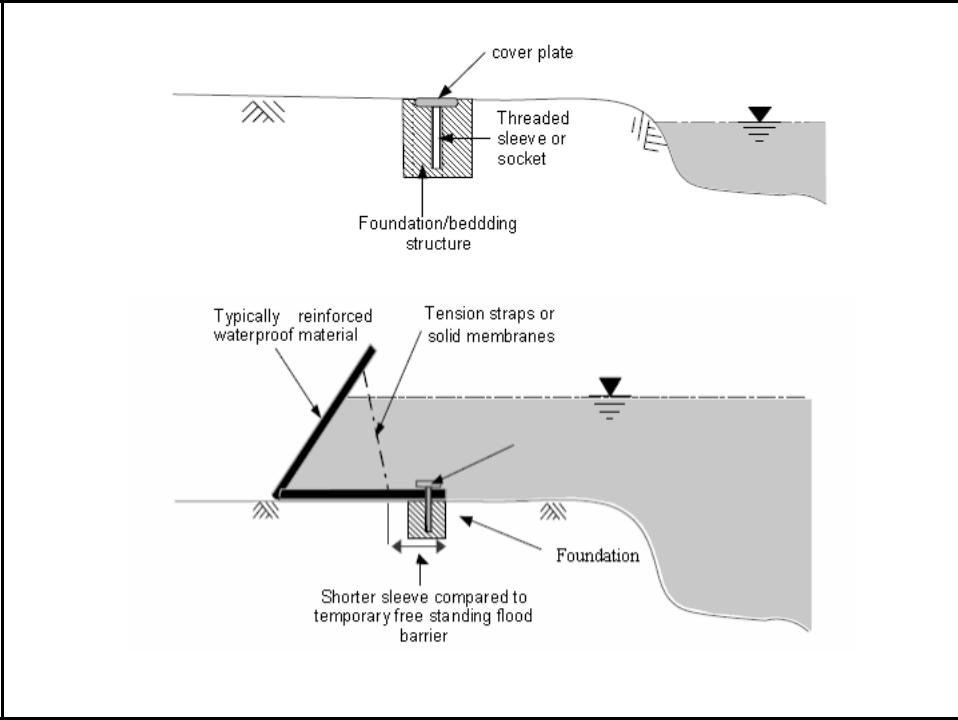
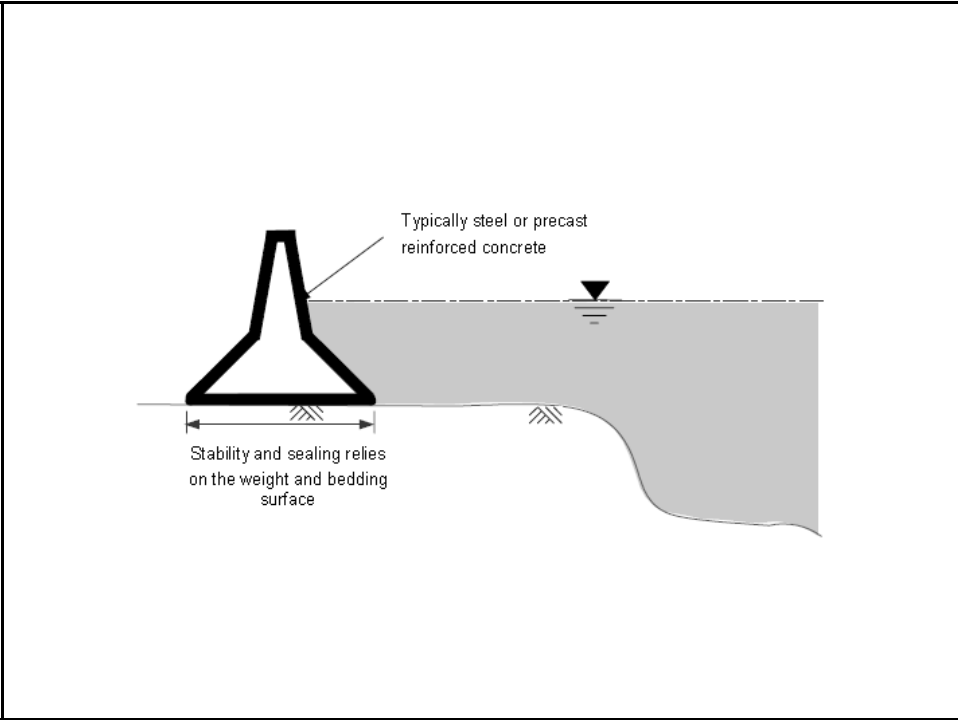
**Temporary and Demountable  
Flood Defence Structures**

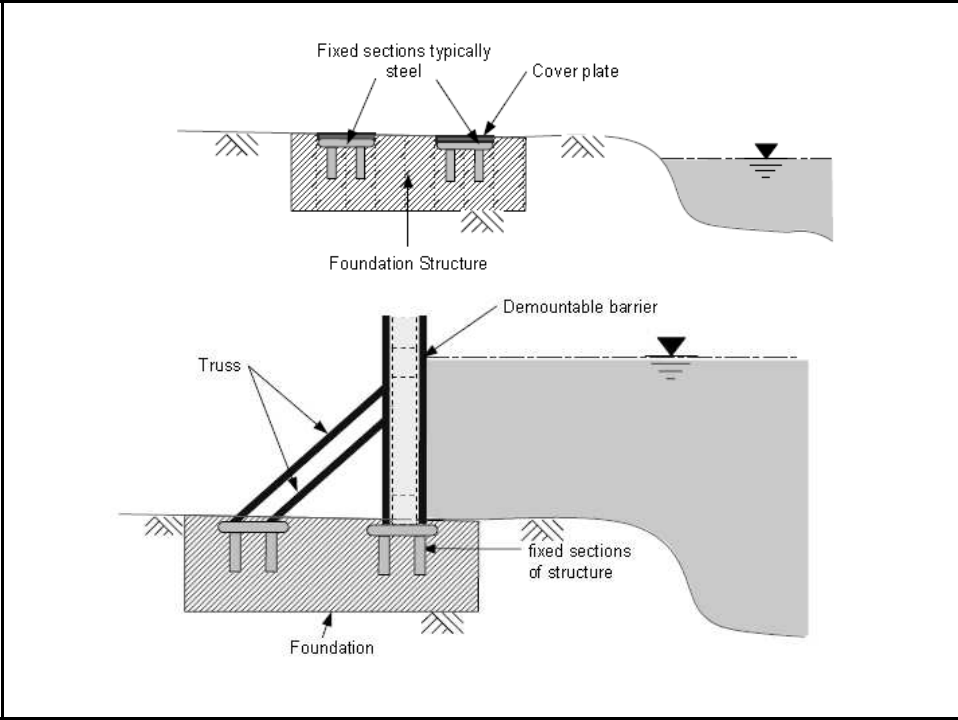
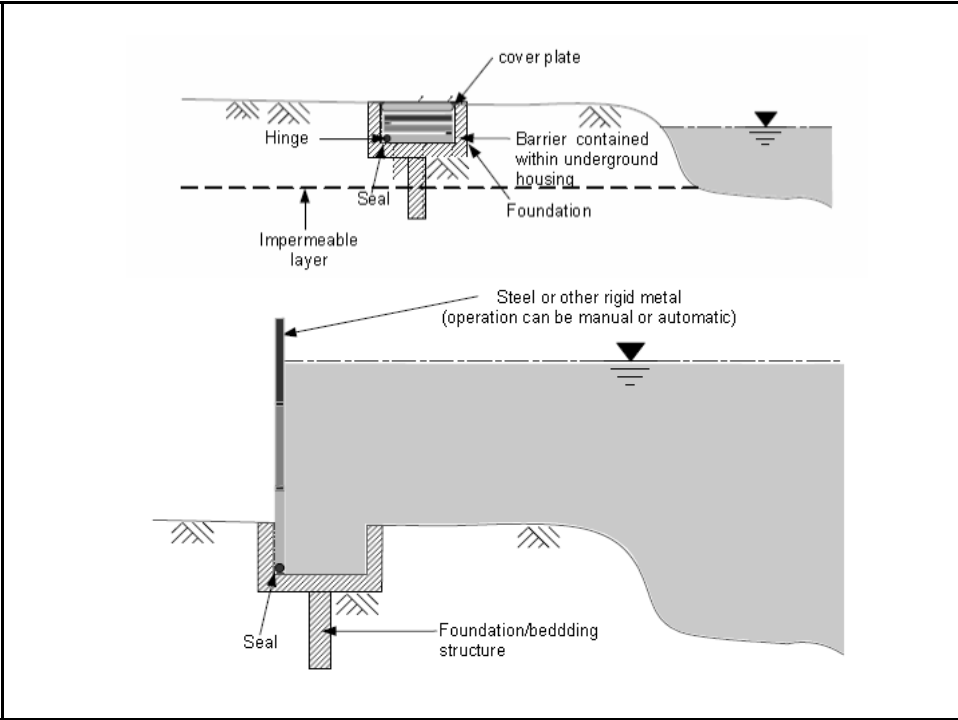


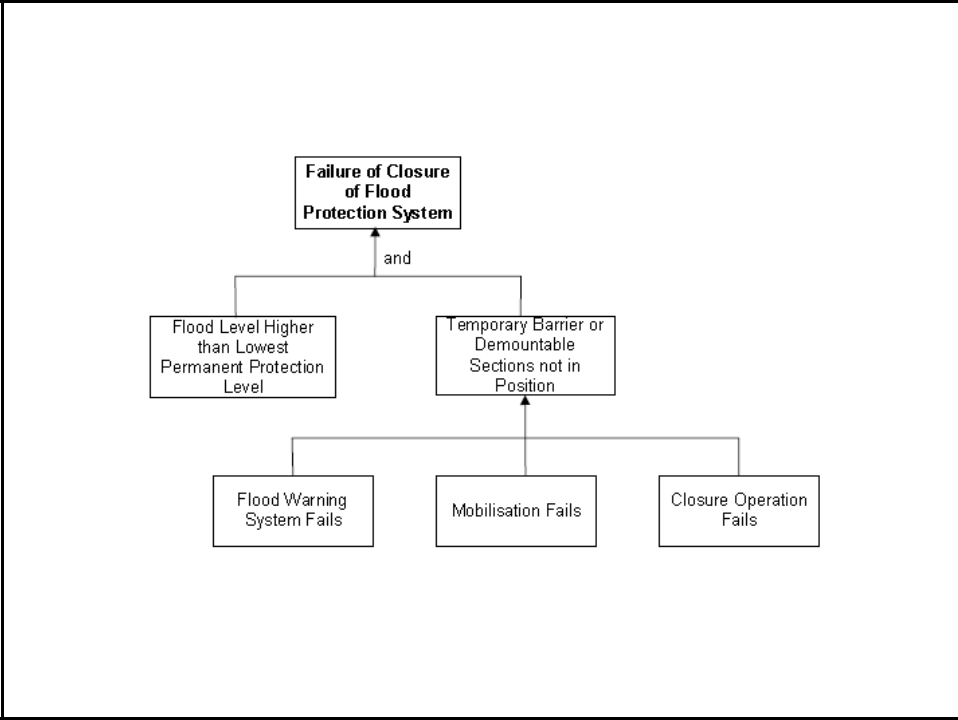
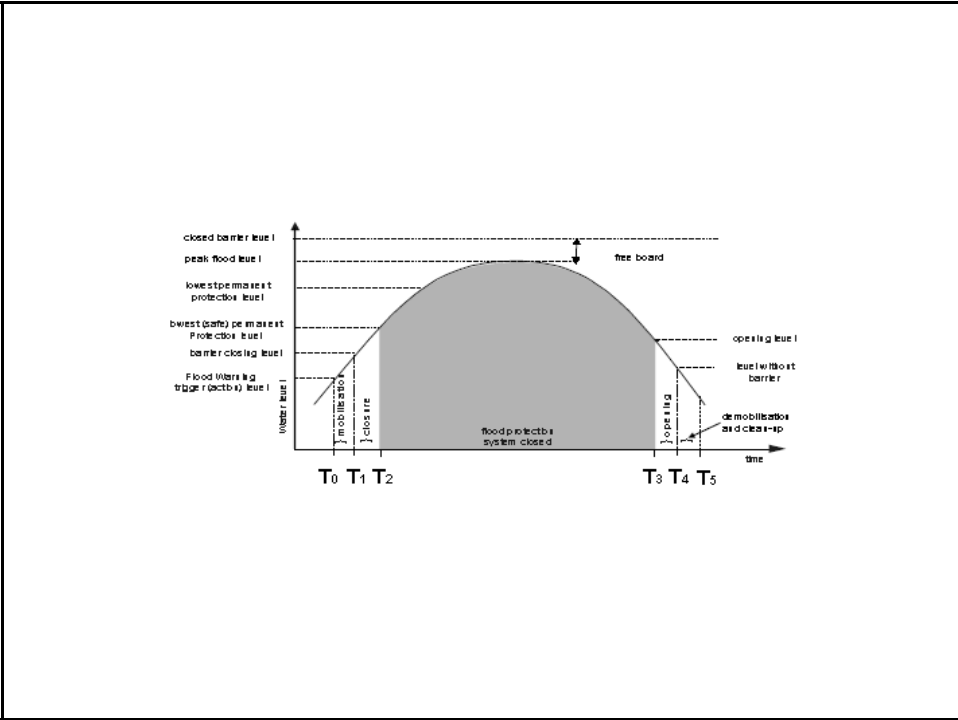


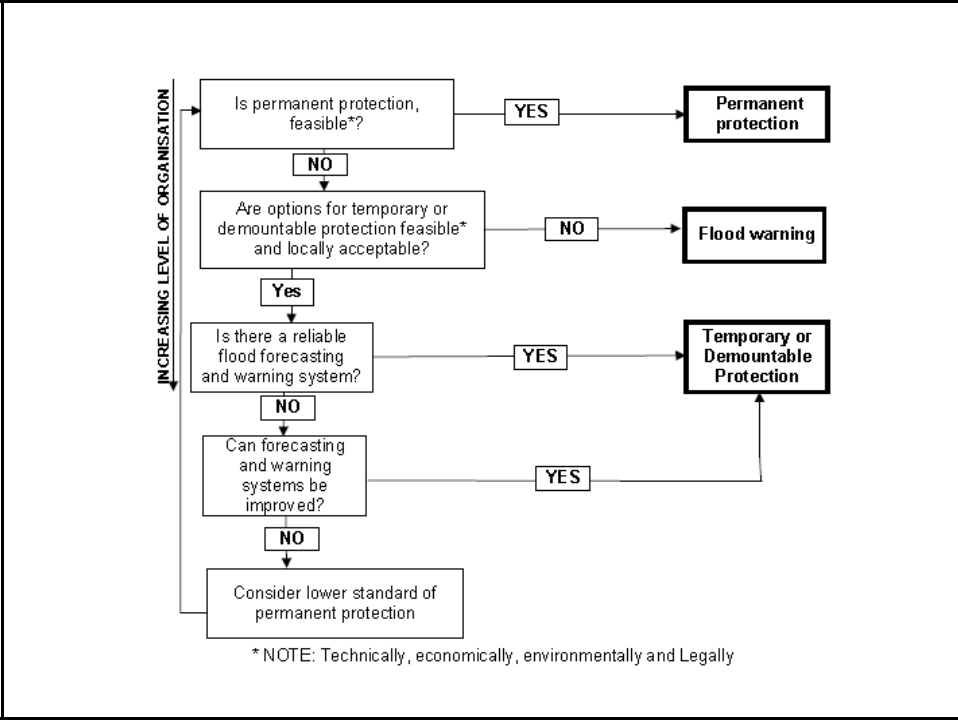
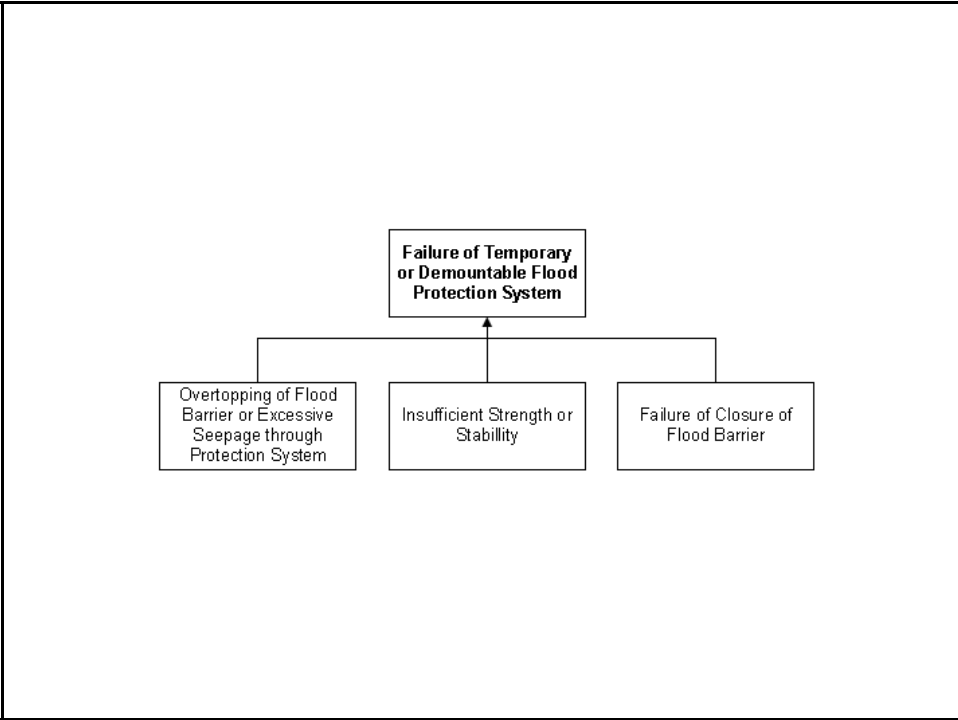


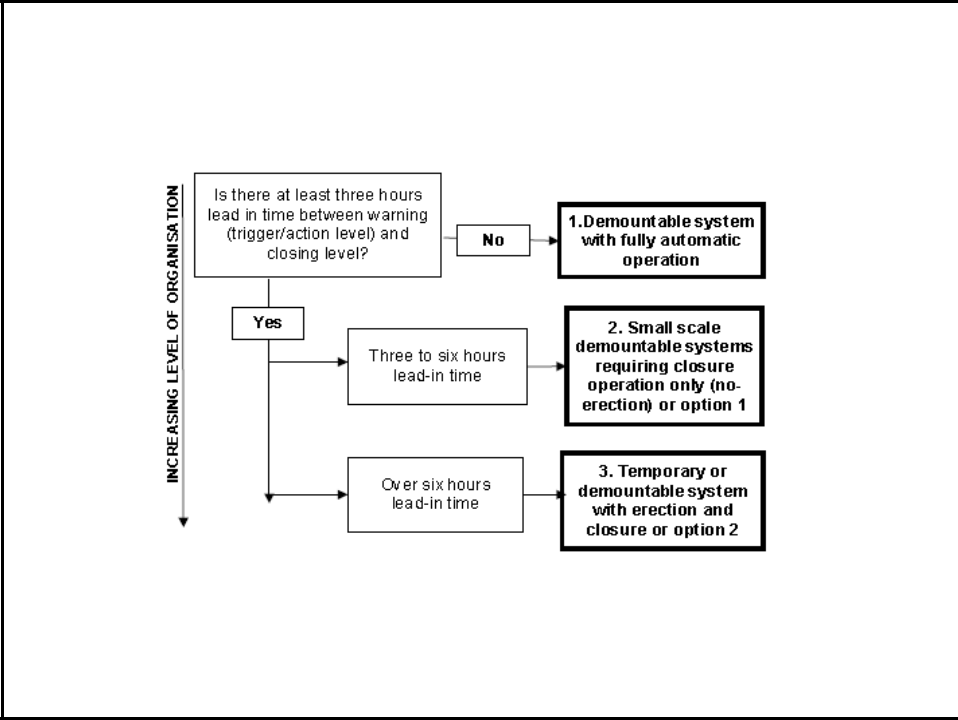
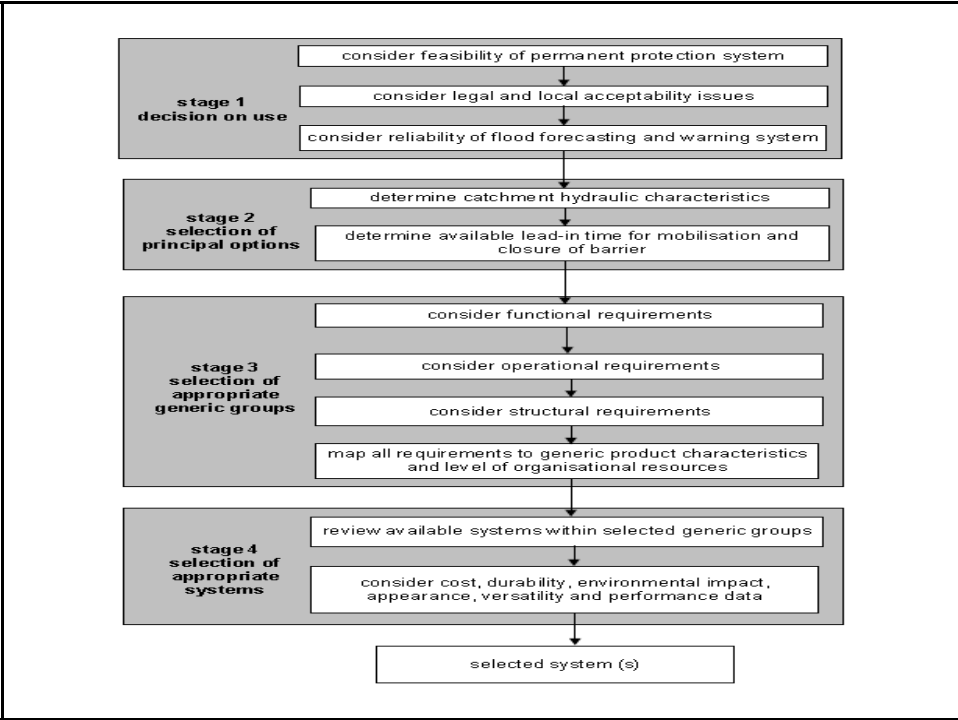












**One of the most advanced concept of  
Elevated House (prototype only)**



Thank you...

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