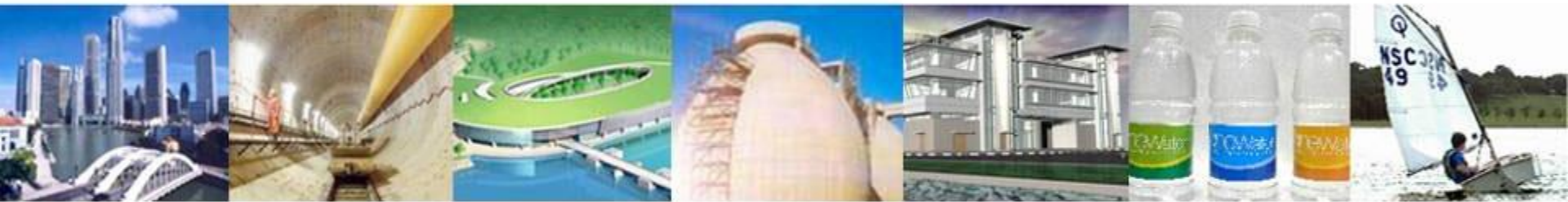
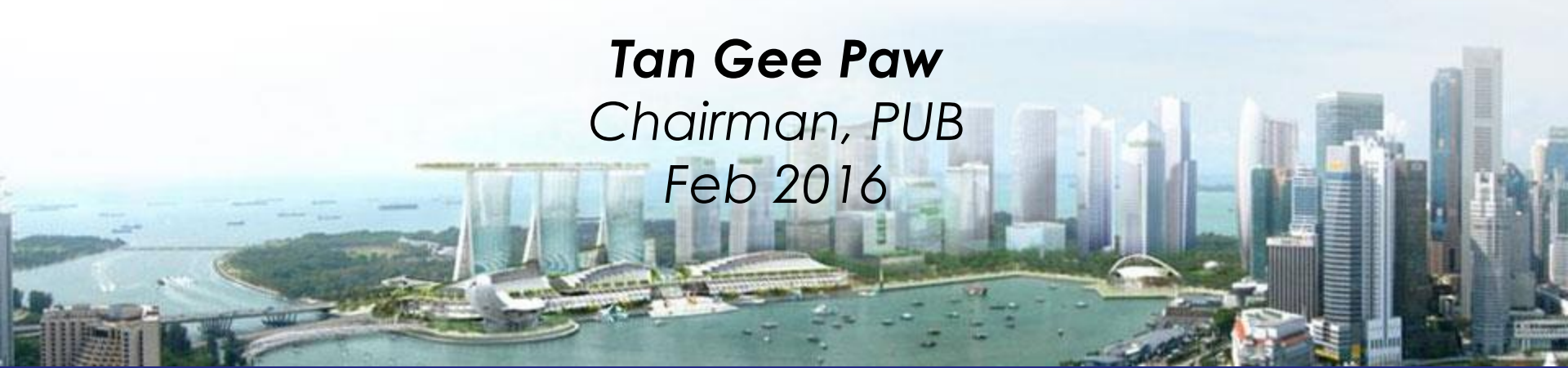


Water for All
Conserve, Value, Enjoy



***Systems Engineering: A Critical Discipline in
Whole-of-Govt Approach to Urban Water Development***

Tan Gee Paw
Chairman, PUB
Feb 2016



The City State of Singapore

A City of Gardens and Waters forged by turning our vulnerabilities into strengths

Our Demographics

Land Area	~700 km ²
Population	5.5 mil
Average Annual Rainfall	2,400 mm
Average Water Demand	1.93 mil m ³ /day



Systems Approach to Water Management

Urban water development is a nested system:

- 1. Overall whole-of-government system**
- 2. Water loop system**
- 3. Four water sub-systems**

Overall whole-of-government system

Singapore's All-Round Development

- ✓ Economic development in order to fund the building of water infrastructure

Economic Development

- ✓ Increasing understanding of water conservation messages and acceptance of technology

Education

- ✓ Increasing willingness to accept social responsibility for keeping waters clean

Social Development

Sustainable Water Resources

Effective Water Specific Strategies

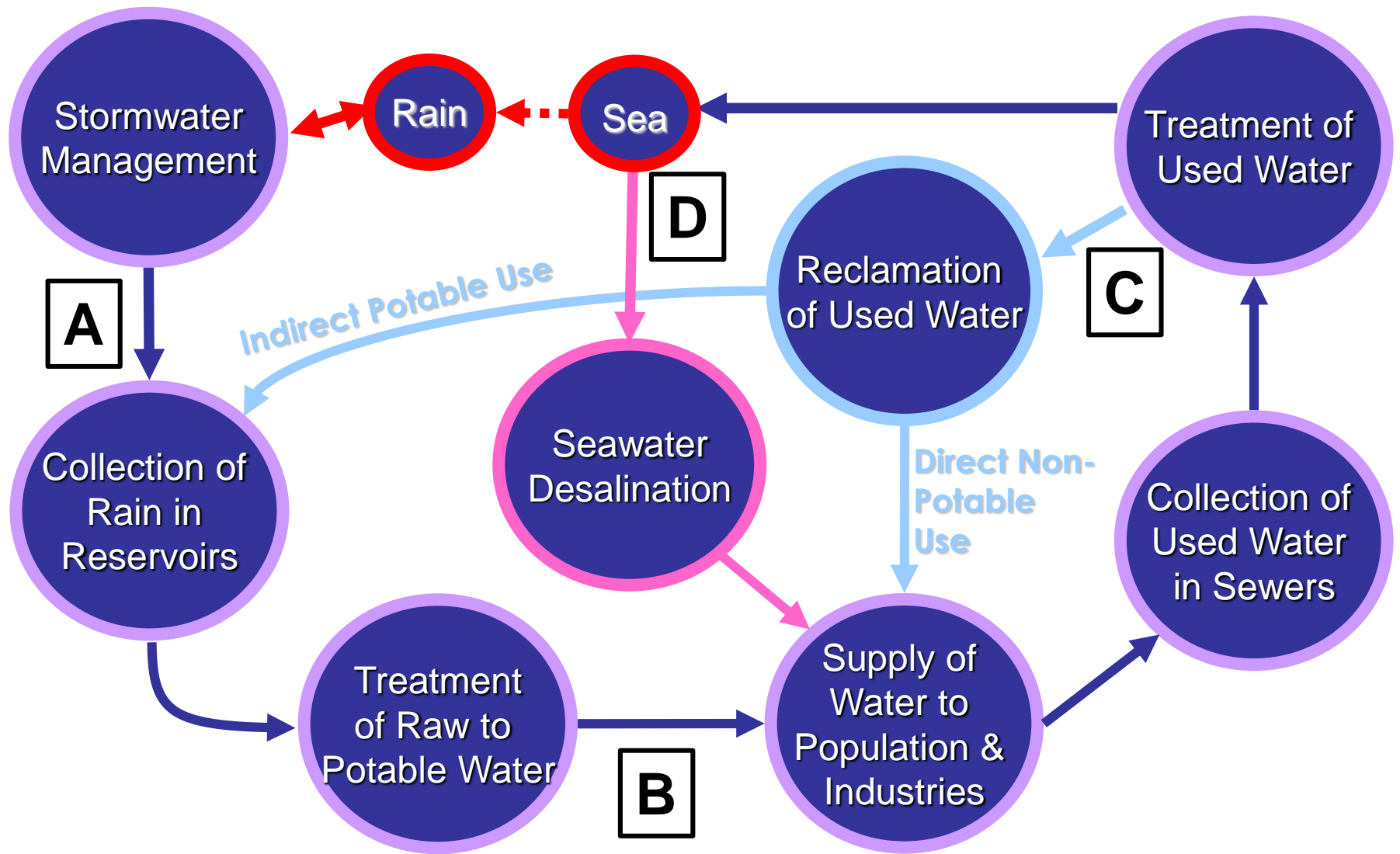
Water Pollution Control

- ✓ Protection of water sources making them suitable for potable use

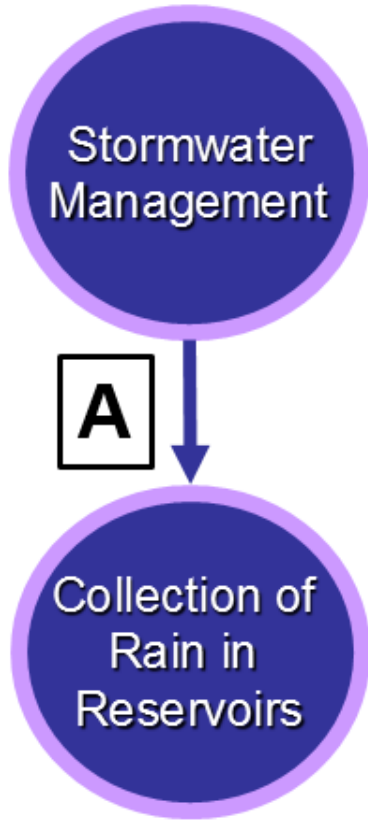
Water Pricing

- ✓ Reflect the scarcity value of water

Water Loop System in Singapore



Sub-system A



Development of sub-system A:

- i. Catchment expansion
- ii. Separation of used water from storm water (Sewerage programme)
- iii. Refuse collection and disposal programme
- iv. Active Beautiful Clean Waters Programme (ABC Waters Programme)

Sub-system A

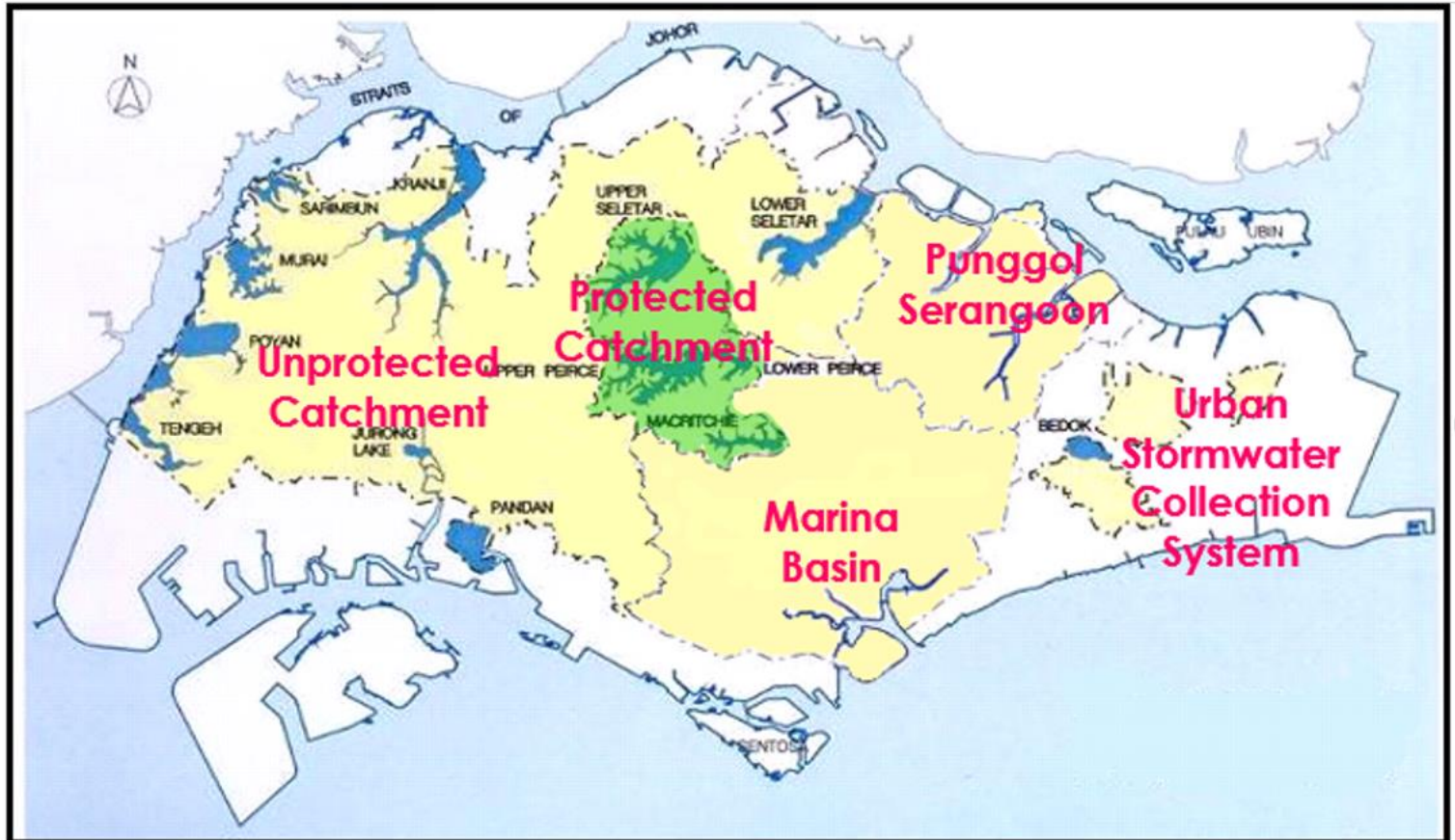
Stormwater Management

A

Collection of Rain in Reservoirs

Development of sub-system A:

i. Catchment expansion



Sub-system A

Stormwater
Management

A

Collection of
Rain in
Reservoirs

Development of sub-system A:

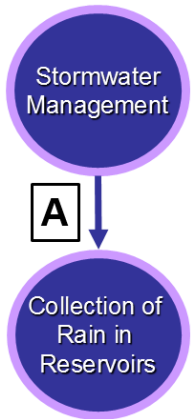
- ii. Separation of used water from storm water
(Sewerage programme)



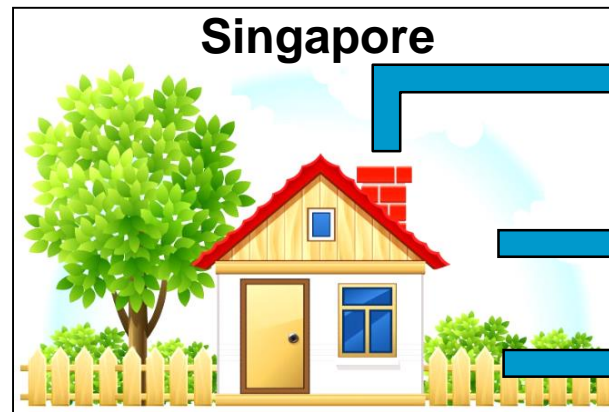
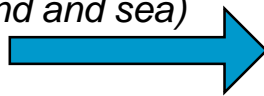
Sub-system A

Development of sub-system A:

iii. Refuse collection and disposal programme



Goods + Material
(by air, land and sea)



Waste gases discharged into atmosphere
(from incinerated waste)

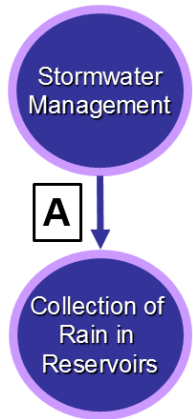
Exports
(by air, land and sea)

Landfill
Ash (incinerated waste)
+ Non-incinerable waste



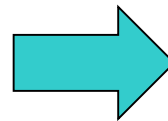
Discharge into sea
(treated used water)

Sub-system A

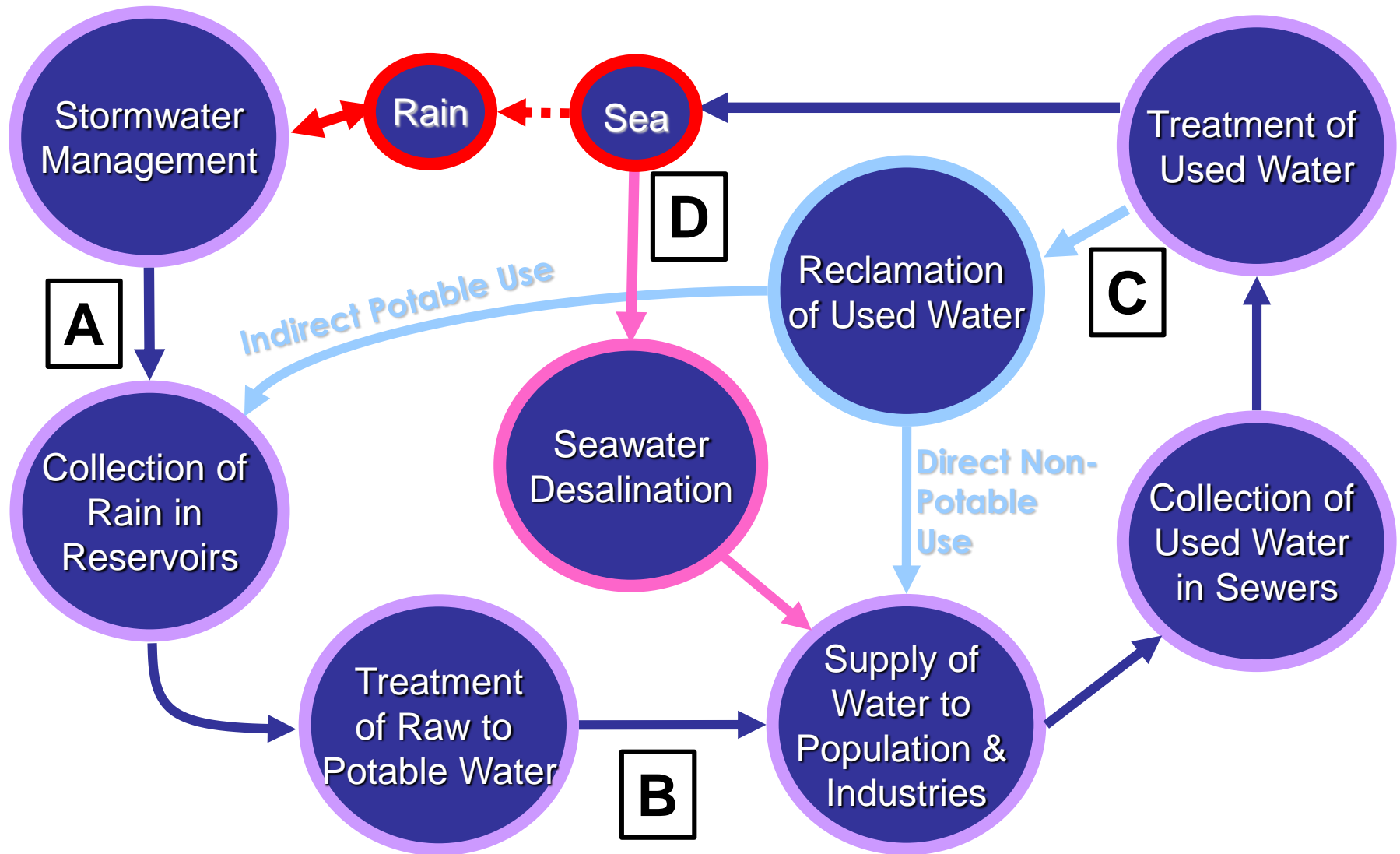


Development of sub-system A:

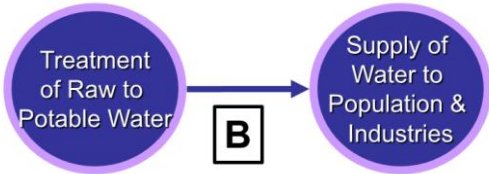
iv. Active Beautiful Clean Waters Programme (ABC Waters Programme)



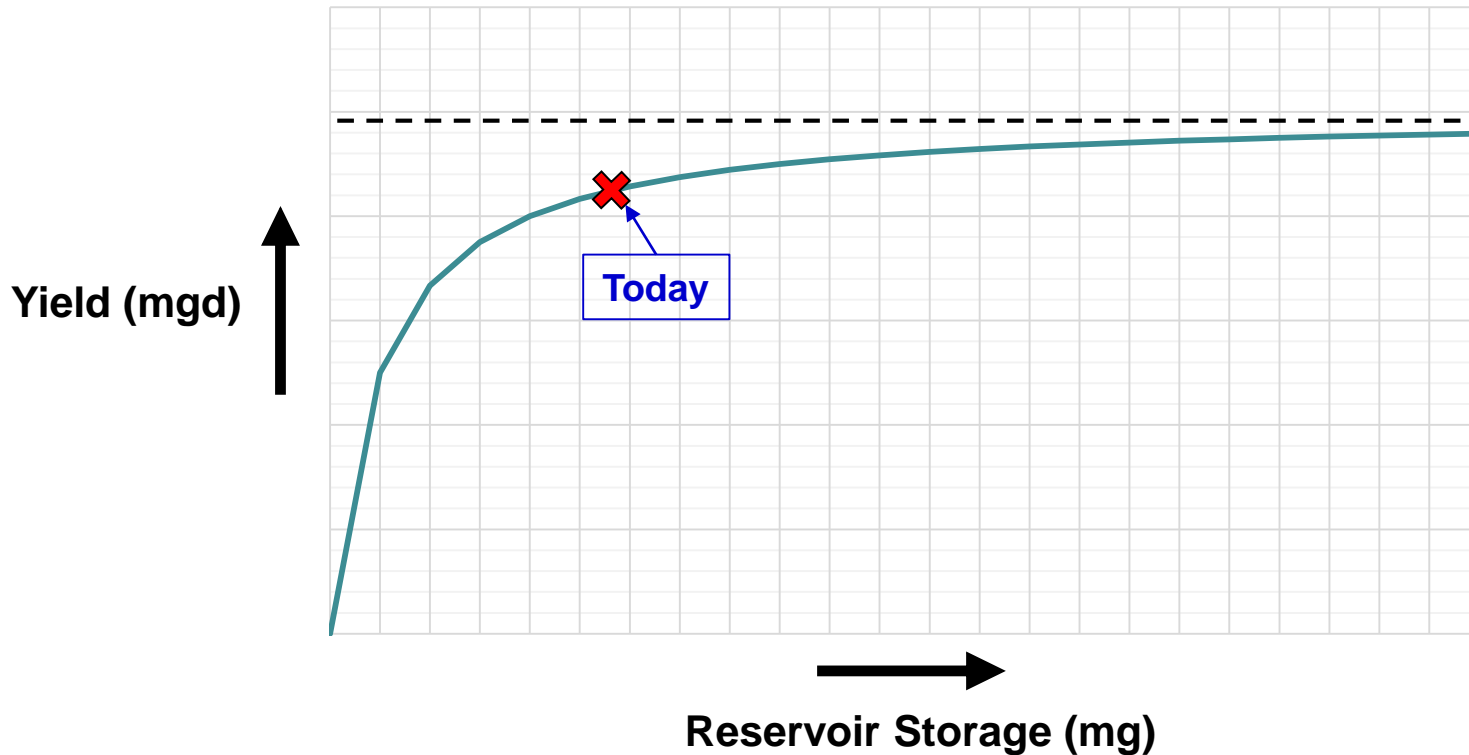
Water Loop System in Singapore



Sub-system B

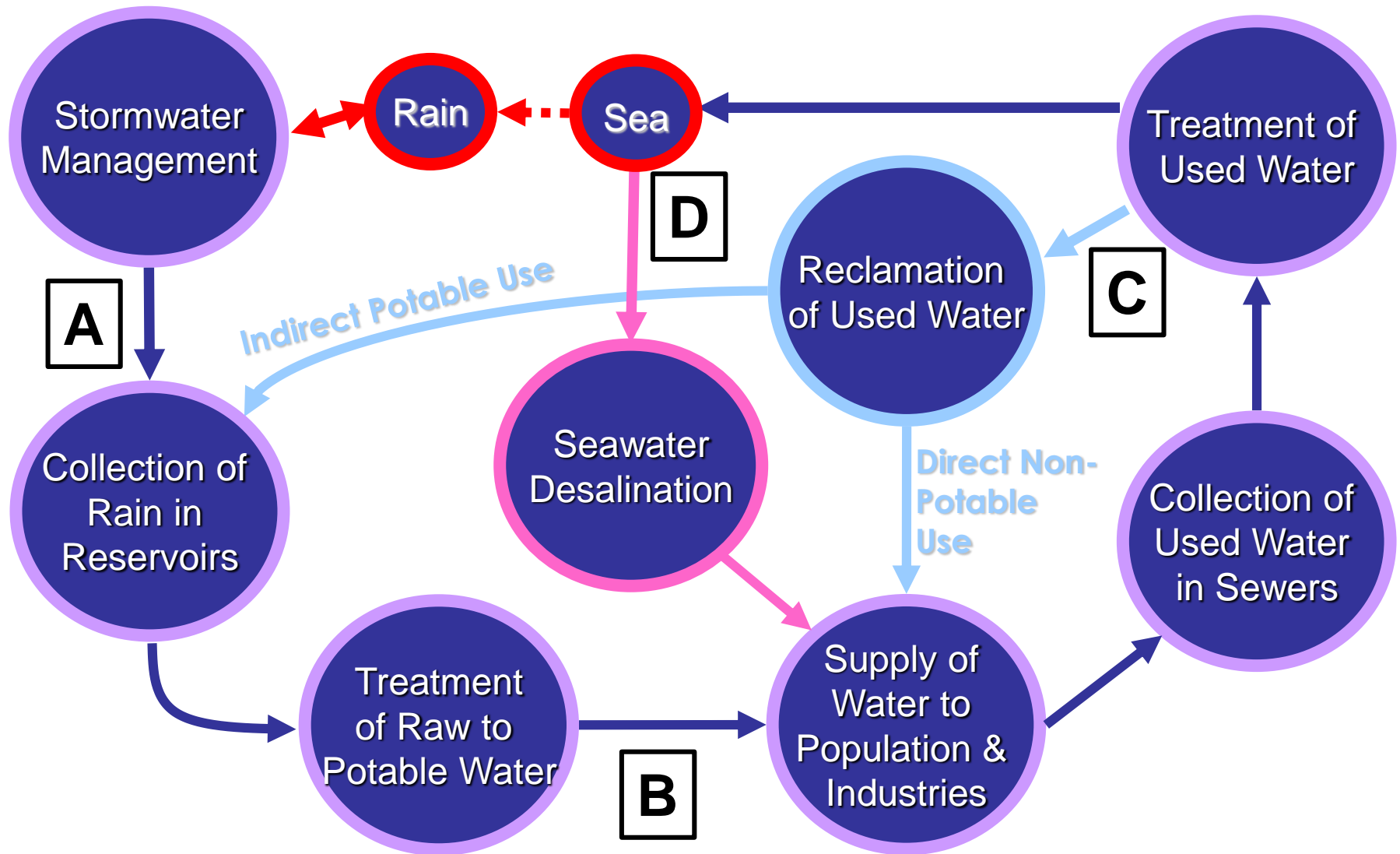


Yield-Storage Graph

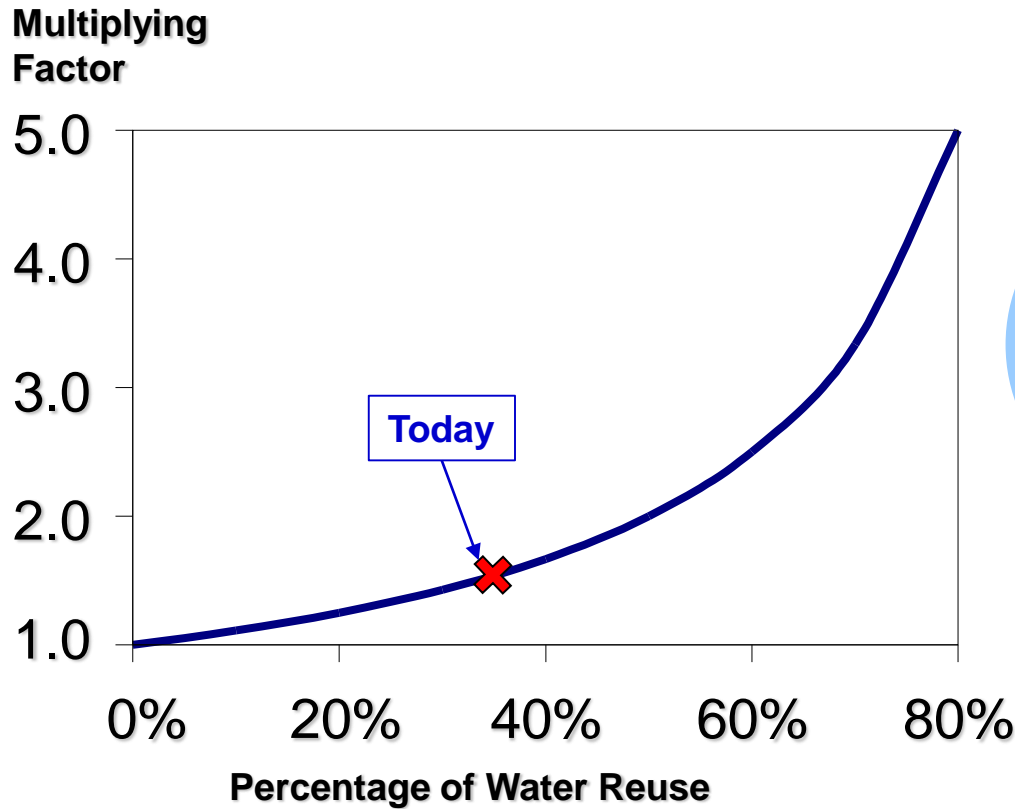


- Continued expansion in reservoir storage leads to diminishing yield

Water Loop System in Singapore

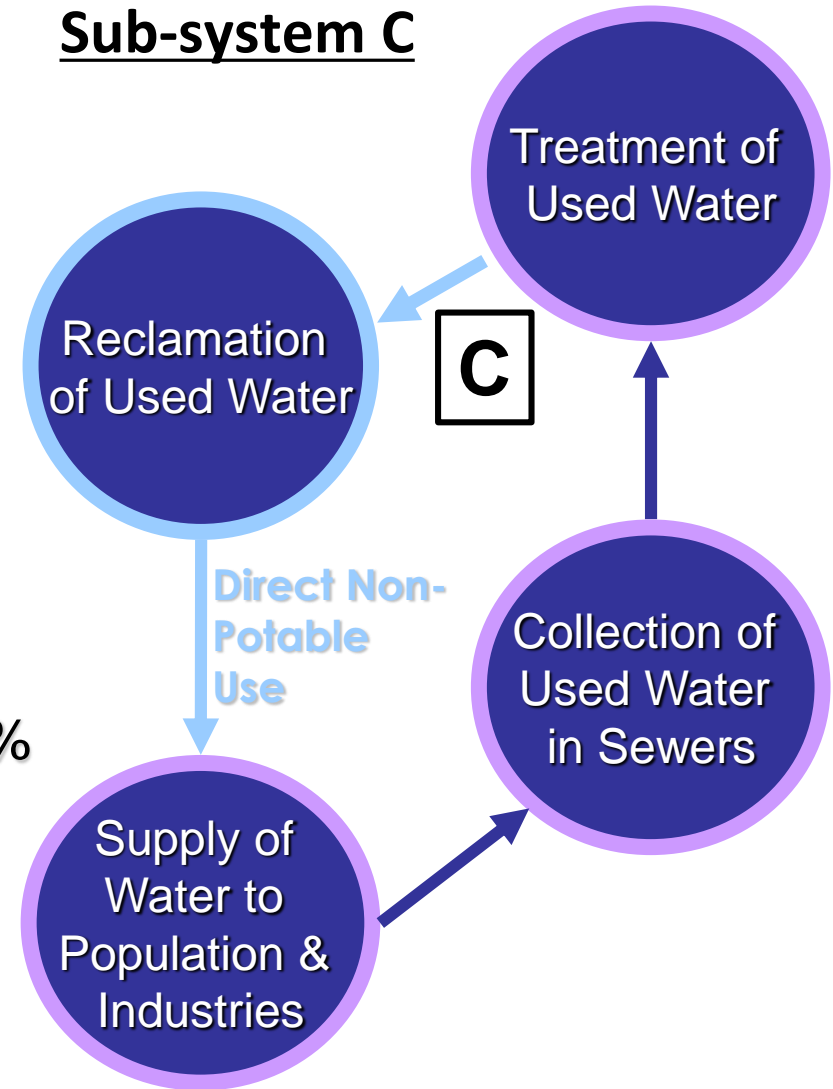


Multiplying Effect of Water Reuse: NEWater

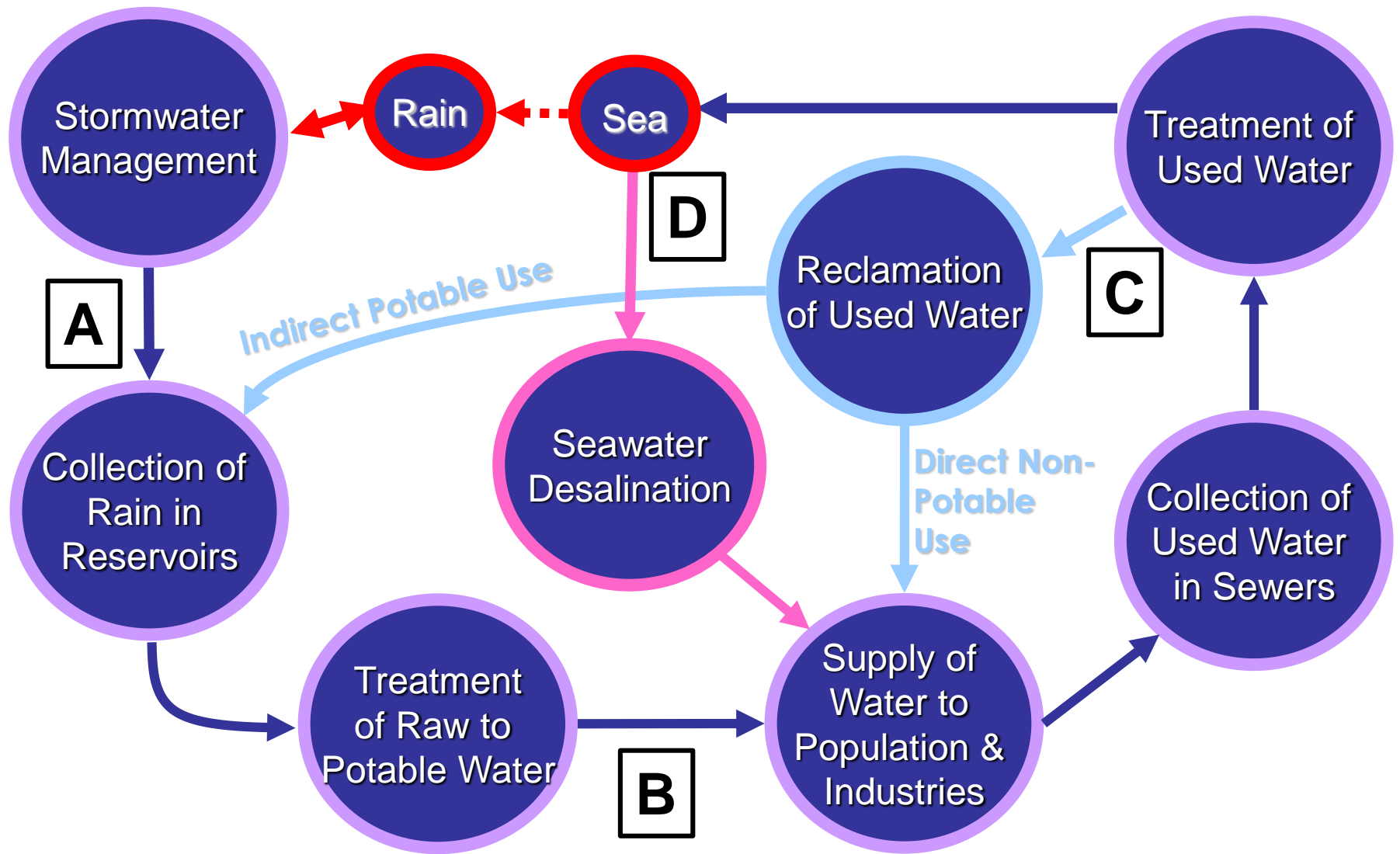


✓ Reusing 50% of water can double the total amount of available water resources.

Sub-system C



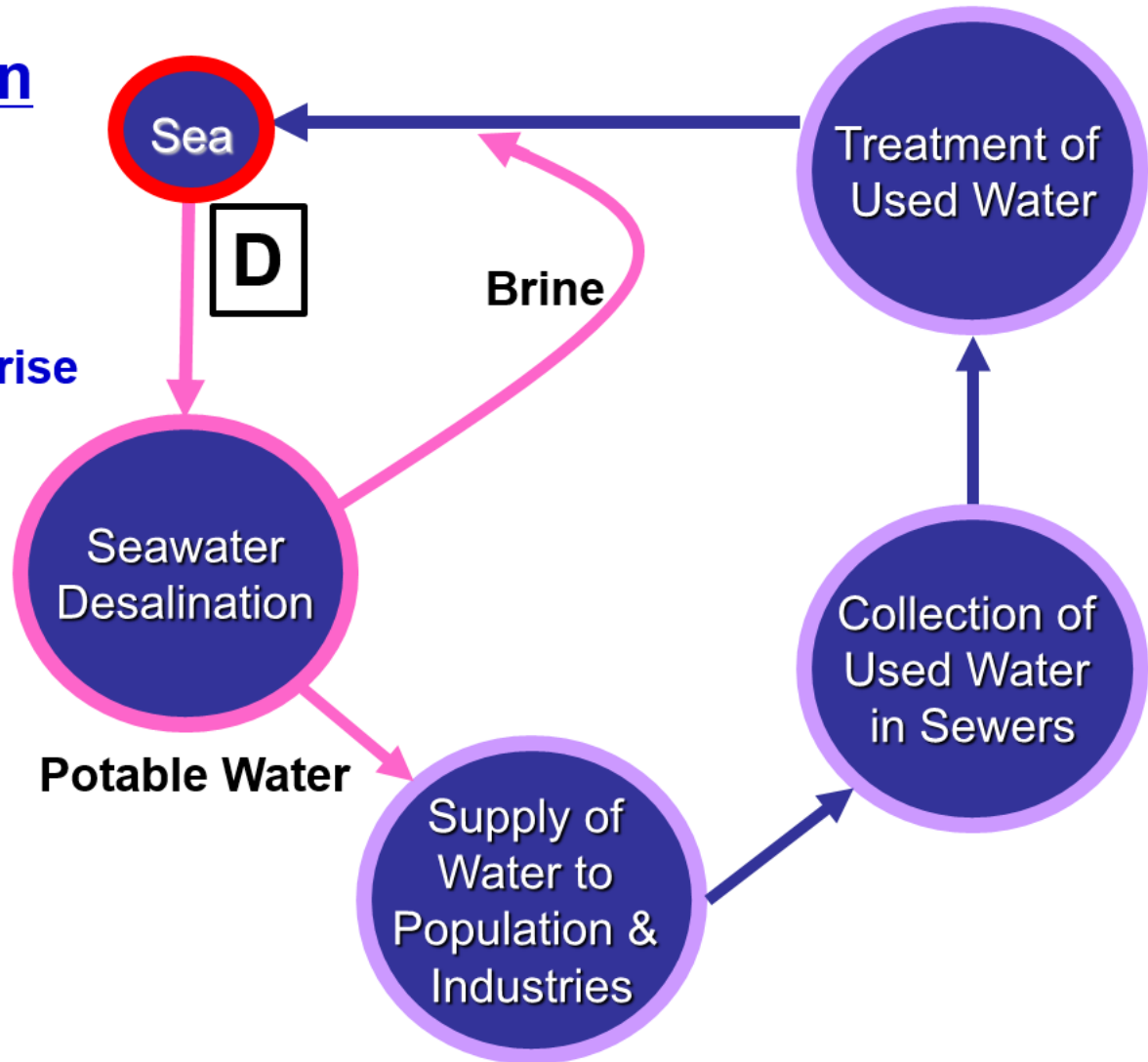
Water Loop System in Singapore



Sub-system D

Seawater desalination

- Closed loop system
- Limitation caused by the brine problem does not arise



Overall whole-of-government system

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Economic Development

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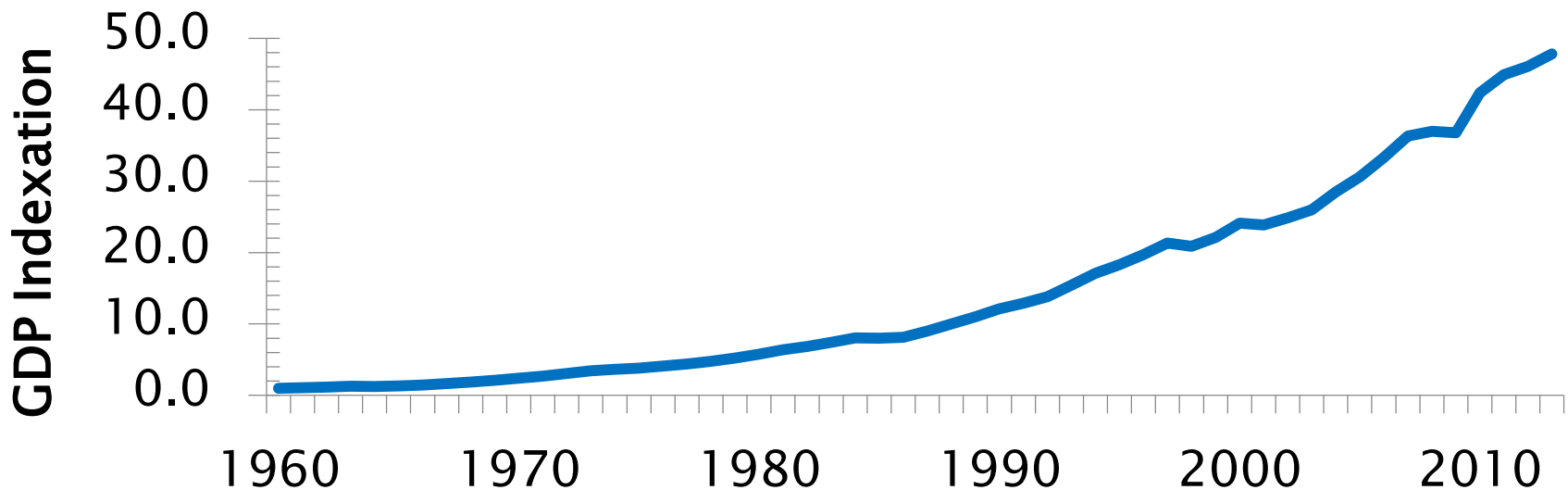
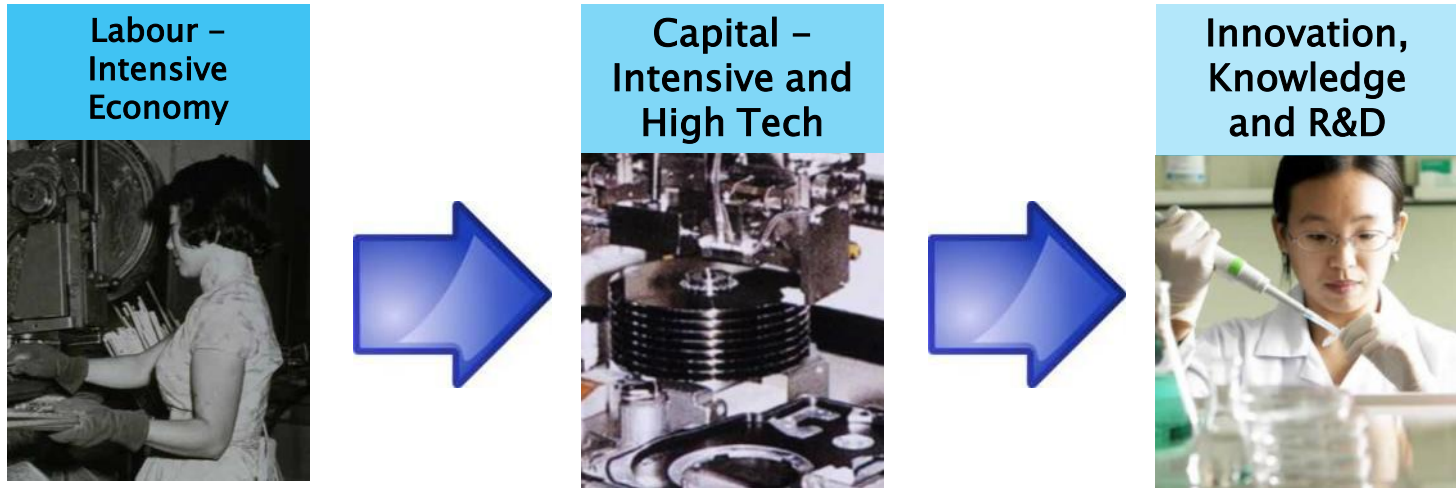
- ✓ Protection of water sources making them suitable for potable use

Water Pricing

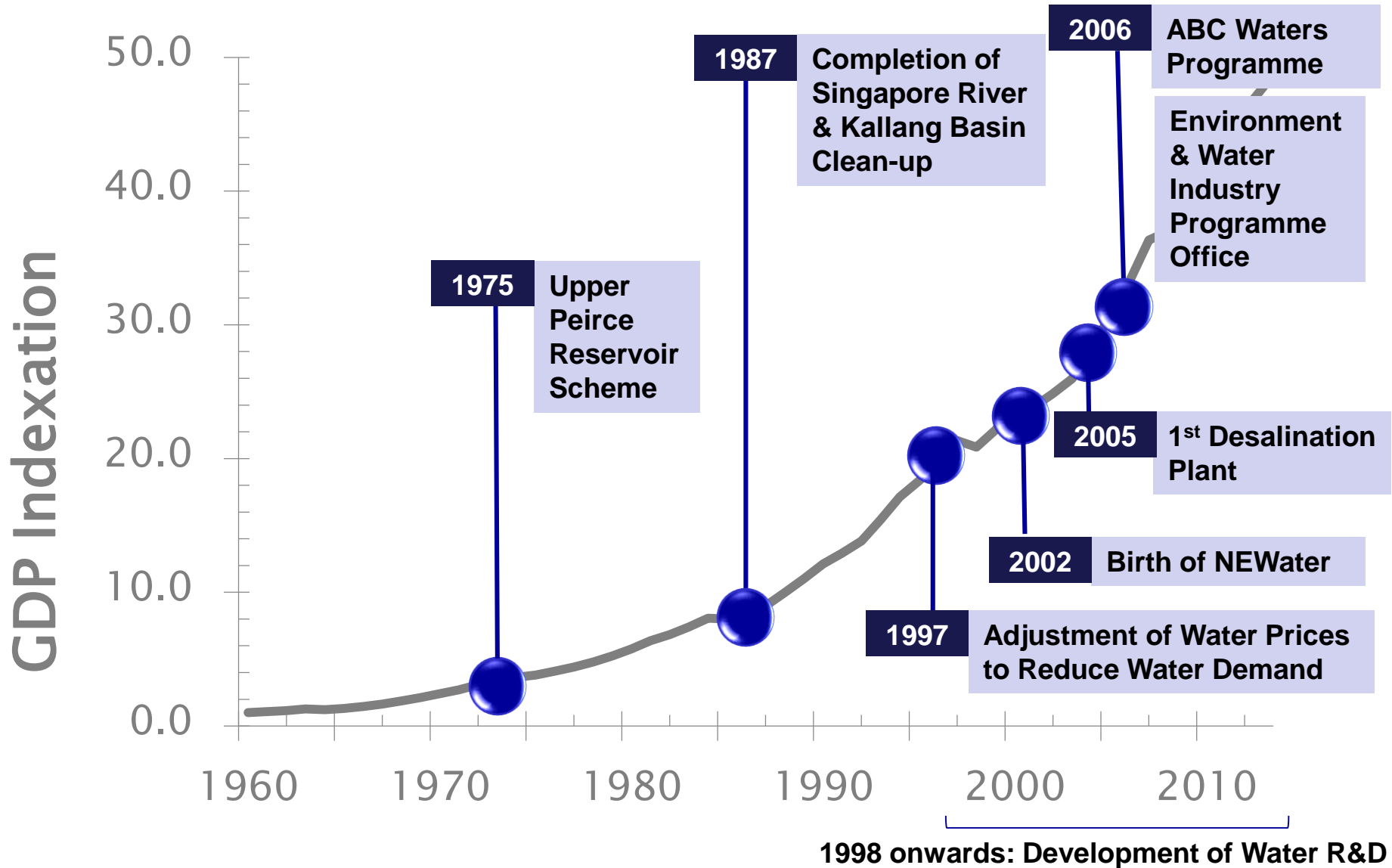
- ✓ Reflect the scarcity value of water

Influence of Economic Development

Key factors necessary for successful water management



Key Milestones with Economic Development





Thank you

