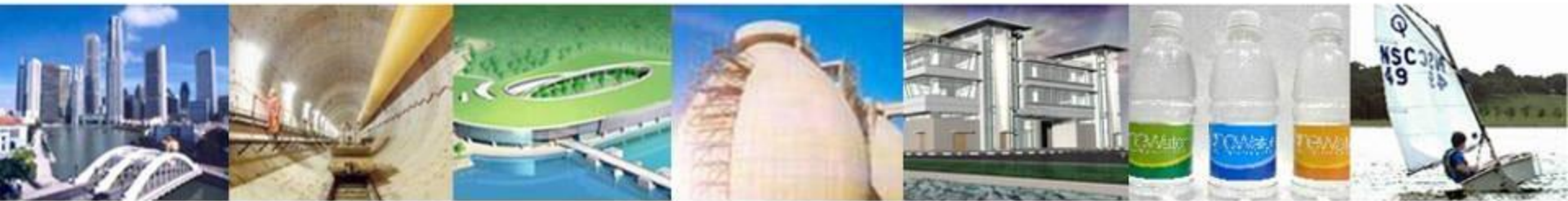


Water for All
Conserve, Value, Enjoy



Used Water Management in Singapore

***Wah Yuen Long
Director, PUB Singapore***

Expert Consultation on Wastewater Management in the Arab World

22 – 24 May 2011

Dubai, UAE



Country Information



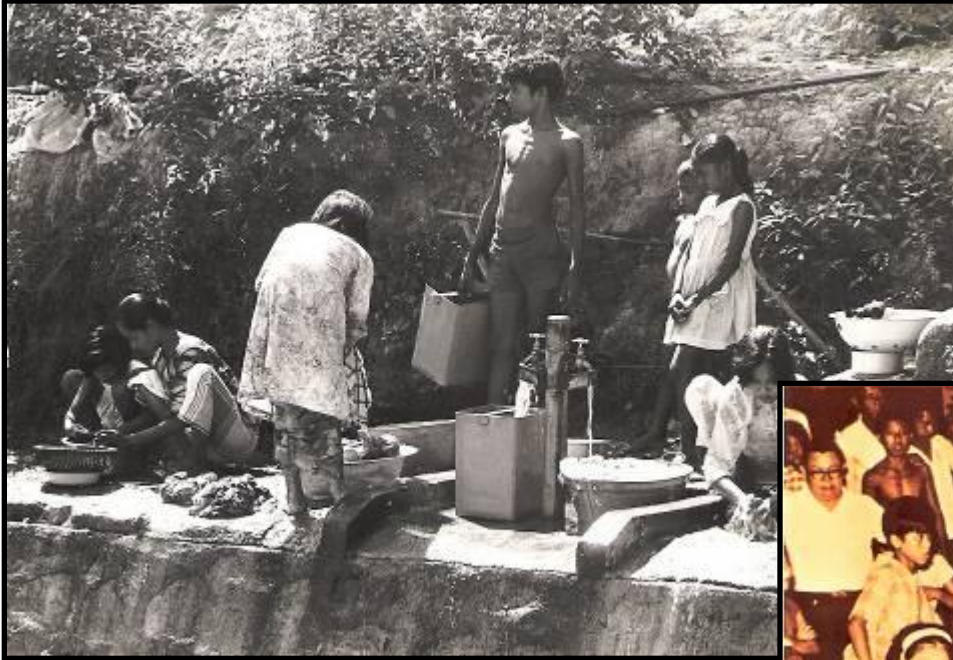
About Singapore

Land Area	710 km ²
Population	5.08 mil
Average Annual Rainfall	2,400 mm
Average Water Demand	1.73 mil m ³ /day

Singapore today...



Singapore Water 1960's



***Water resources
were scarce...***

***Last water
rationing in 1963***





Floods were common occurrences...



Singapore Water **1960's**



Squatters

Public Health Concerns

- *Proper sanitary facilities were lacking...*
- *Public Health Conditions were poor...*



Street hawkers



Outdoor Latrines



Night soil buckets

Singapore Water
1960's

***Our rivers were
polluted...***



Structure of MEWR



Ministry of the Environment
and Water Resources

***“To deliver and sustain a clean
and healthy environment and
water resources for all in
Singapore.”***



***“To ensure a
sustainable quality
environment in
Singapore”***

- ❖ Clean Land
- ❖ Clean Air
- ❖ Public Health



Water for All: Conserve, Value, Enjoy

***“To ensure an efficient,
adequate & sustainable
supply of water”***

❖ Clean Water

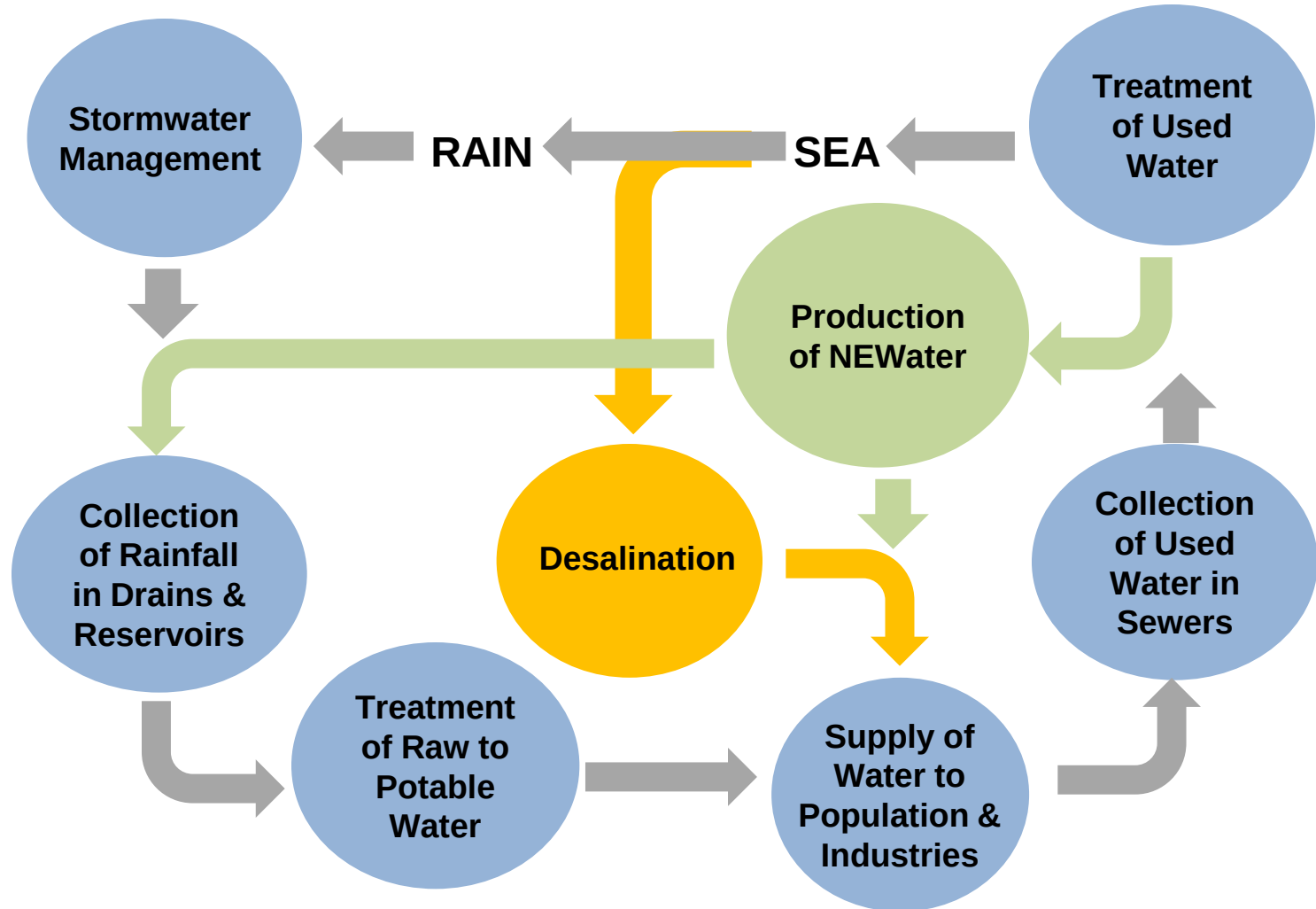
**A Statutory Board constituted
under the Public Utilities Act
2001 to provide integrated water
supply, sewerage and drainage
services**

Water for All: Conserve, Value, Enjoy



Closing the Water Loop

From sourcing, collection, purification and supply of drinking water, to treatment of used water and turning it into NEWater, drainage of storm water



Sustainable Water Resource Management

4 National Taps



Local catchment
Imported water
NEWater
Desalinated water
“Water for All”



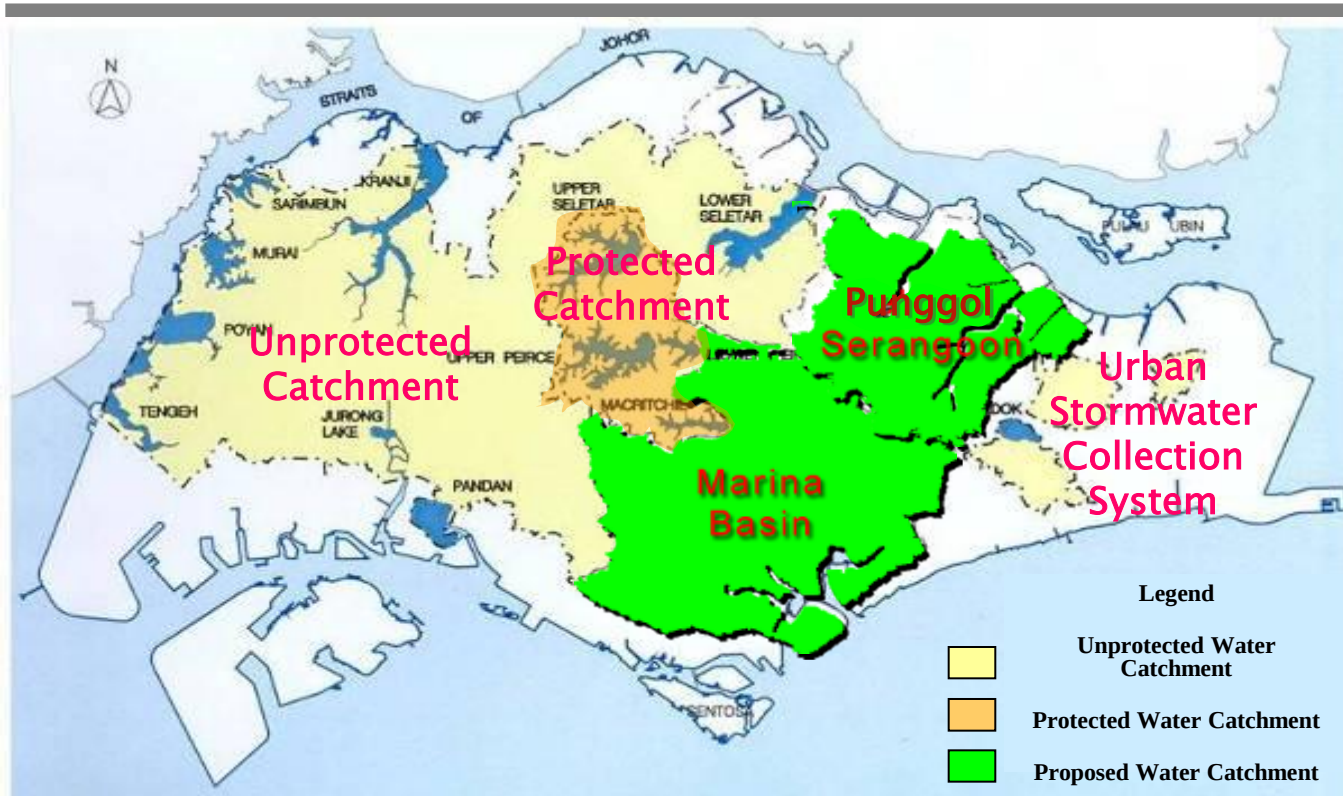
3P Approach



“Conserve Water”
“Value Our Water”
“Enjoy Our Waters”
“Conserve, Value, Enjoy”



Harvesting Every Drop



- 0 Two-thirds of Singapore will become catchment area by end-2011



Two water agreements with Johor, Malaysia

- 1961 to 2011
- 1962 to 2061

State of Johor, Malaysia



**PUB pipelines
carrying water
from Johor**



Treated Used Water



Microfiltration /
Ultrafiltration



Reverse
Osmosis



Ultraviolet
Disinfection



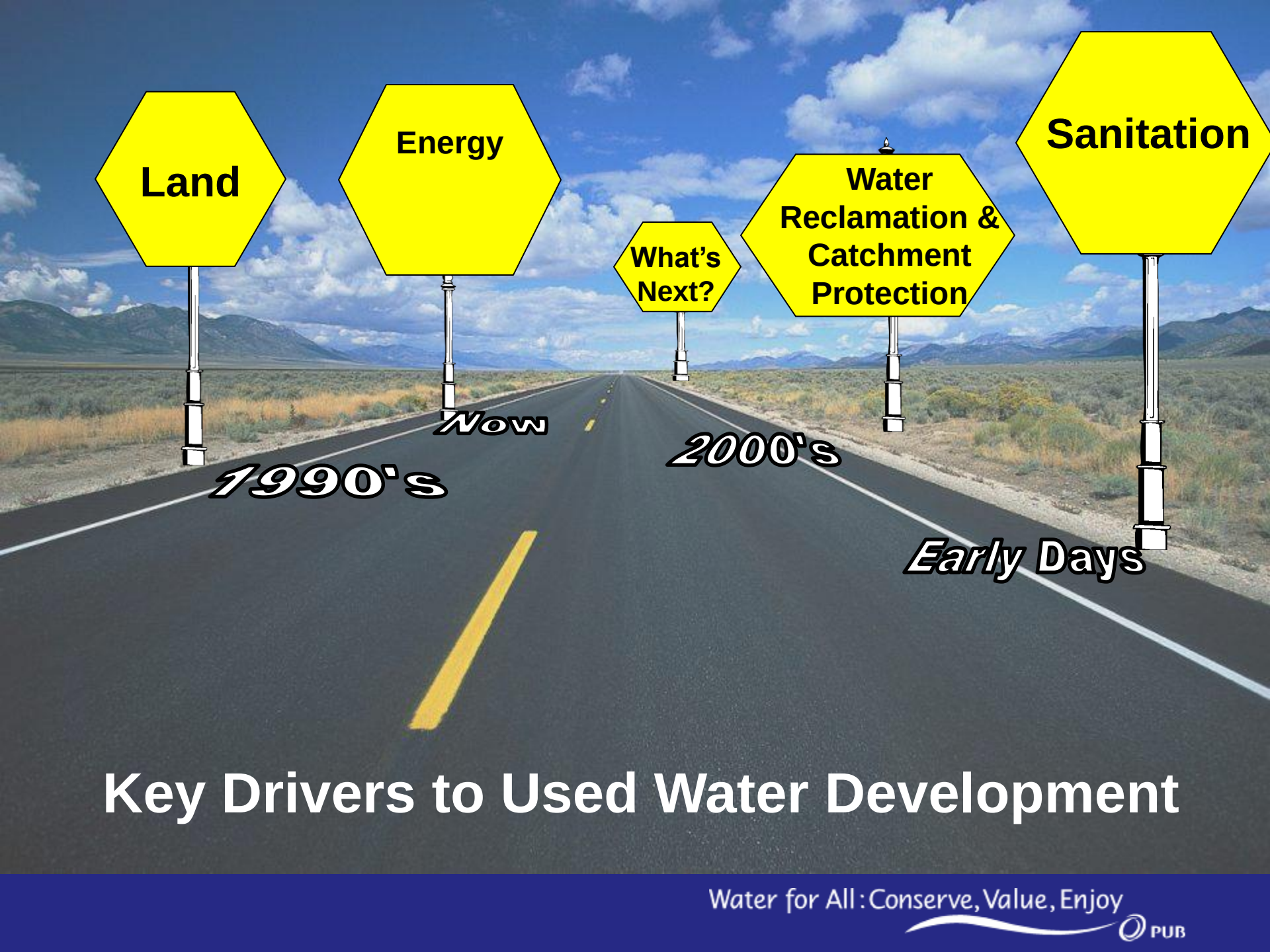
NEWater





- To augment and diversify our water resources
- SingSpring Pte Ltd, under a 20-year DBOO arrangement with PUB opened in Sep 2005
- One of the largest seawater RO plants
- Supply of 136,500 m³/d for 20 years
- 2nd Desalination plant to supply 318,500 m³/d by 2013





Land

Energy

**What's
Next?**

**Water
Reclamation &
Catchment
Protection**

Sanitation

1990's

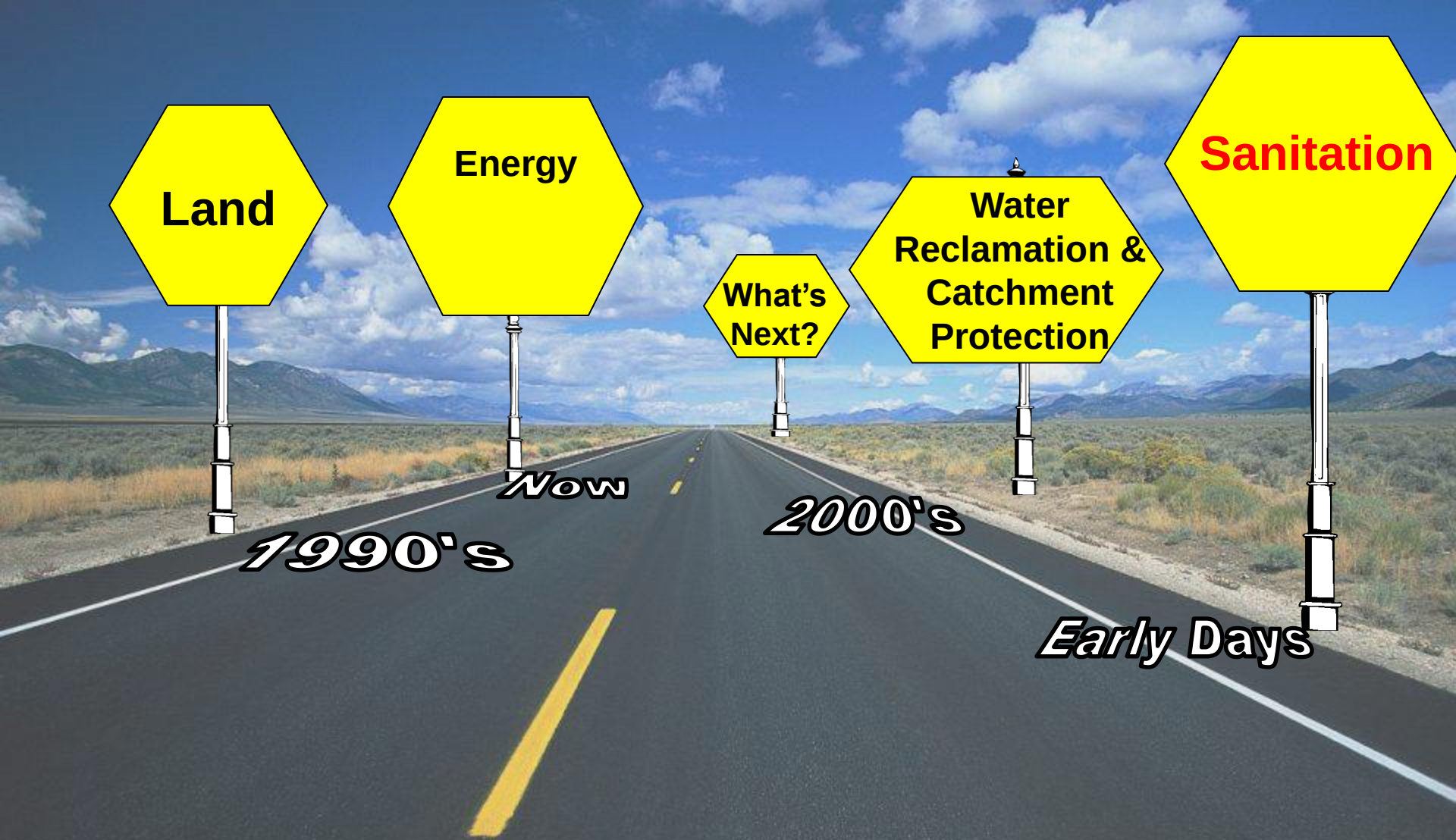
Now

2000's

Early Days

Key Drivers to Used Water Development

Water for All: Conserve, Value, Enjoy

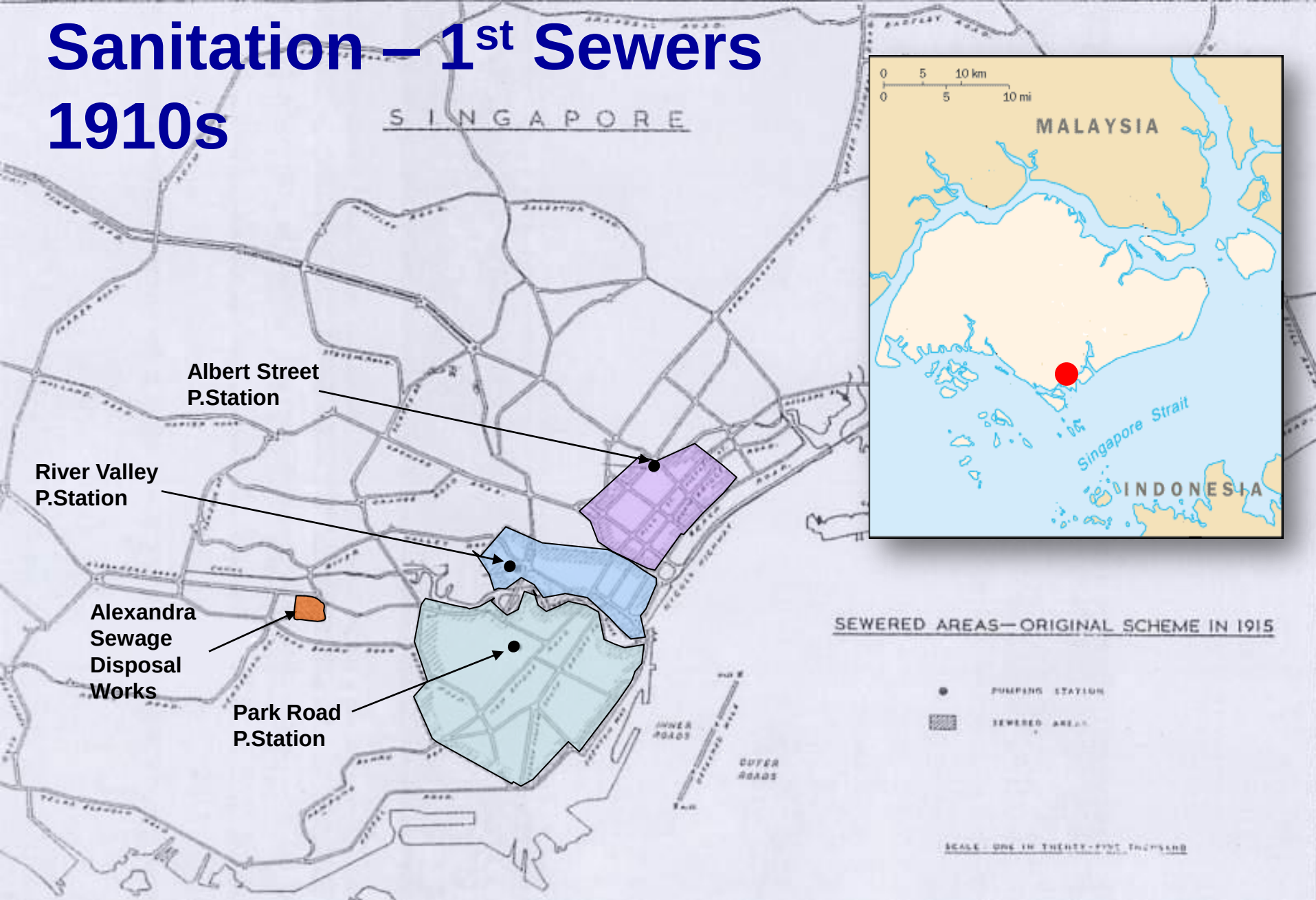


Key Drivers in Used Water Development

Sanitation – Night Soil System



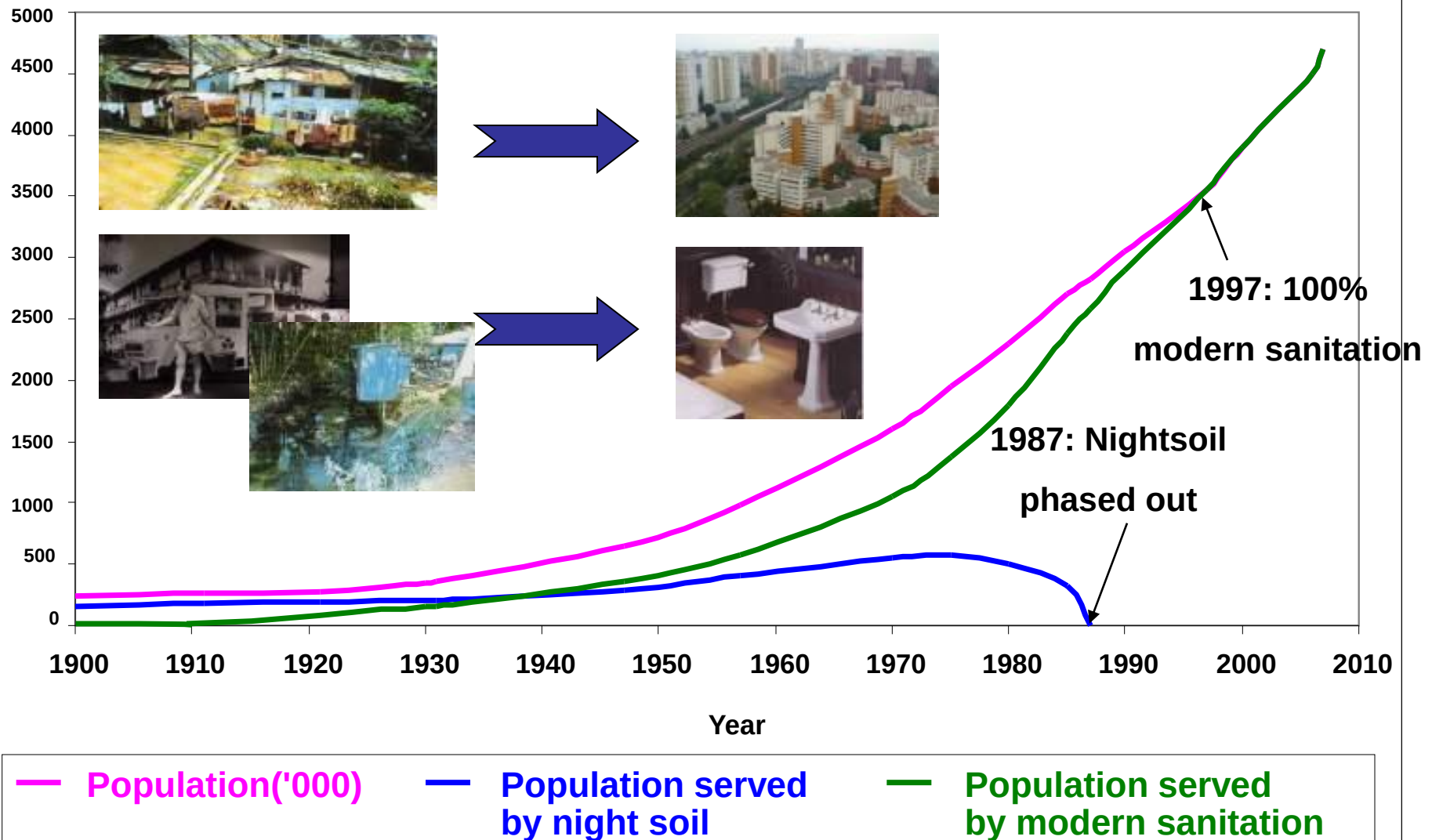
Sanitation – 1st Sewers 1910s



Water for All: Conserve, Value, Enjoy

Population
(^{'000})

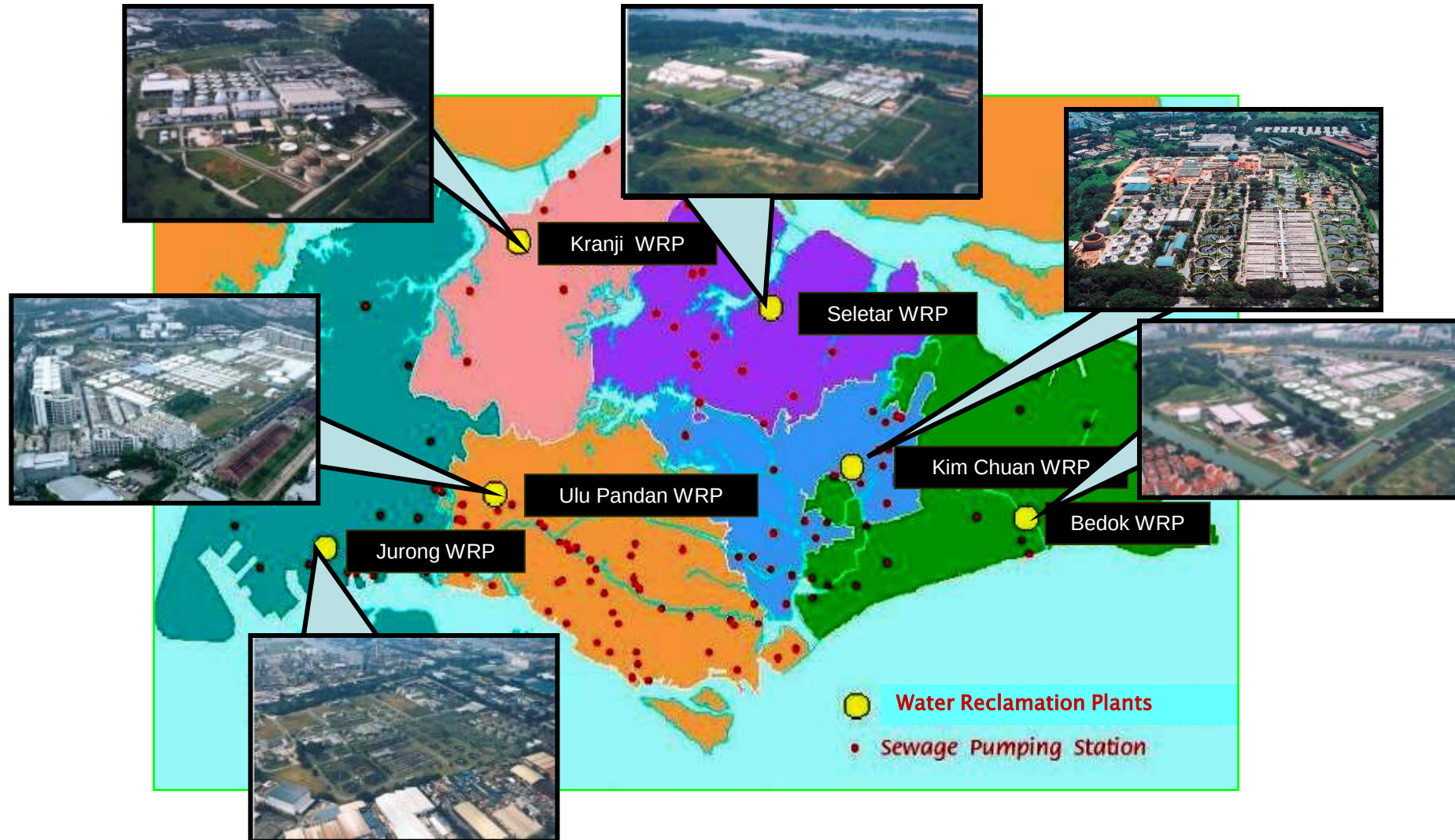
Sanitation

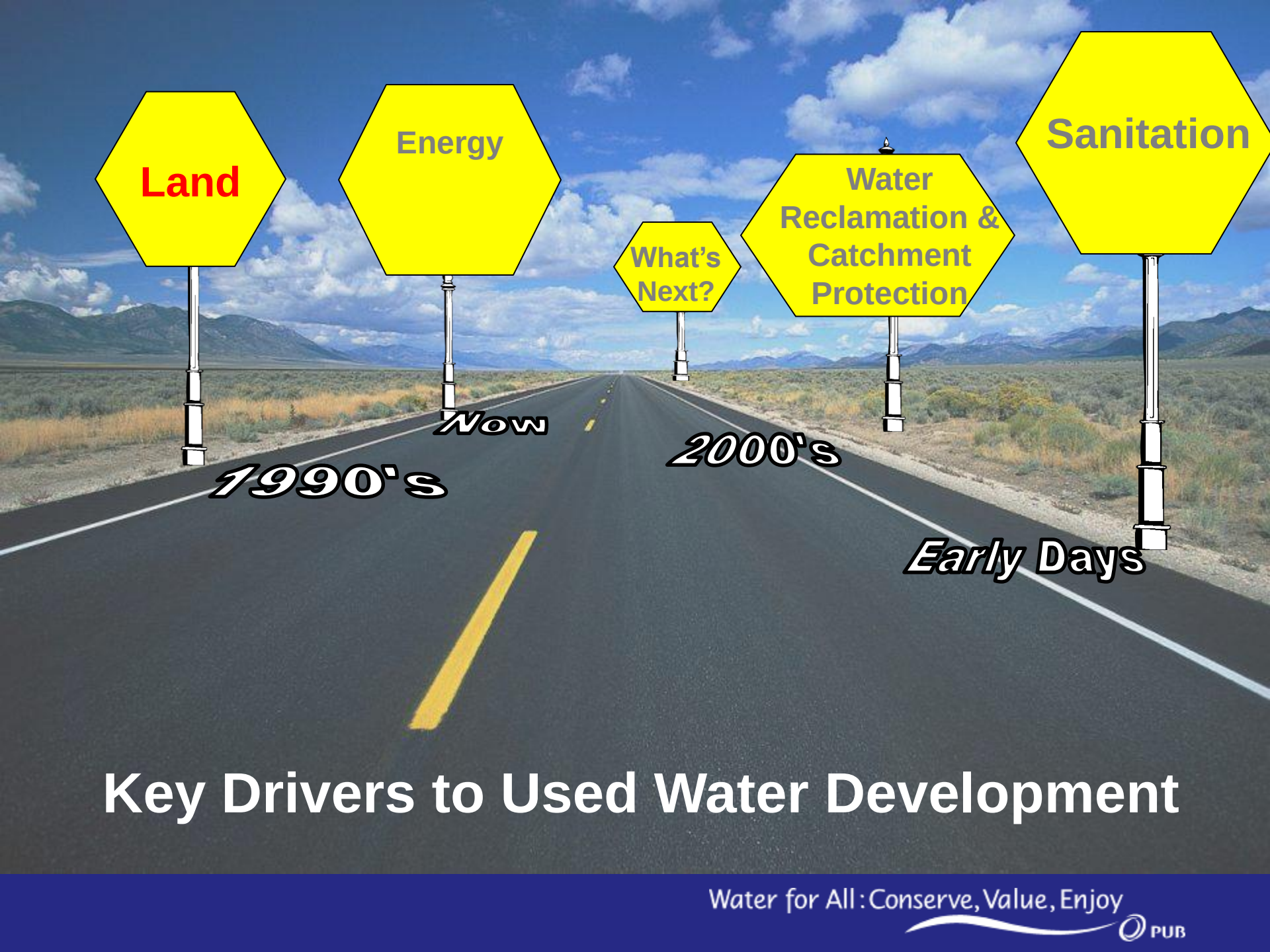


Used Water Collection and Treatment System (before DTSS)

Sewers – 3100km ; Pumping Stations – 131 nos.

Pumping Mains – 210 km ; Water Reclamation Plants (WRPs) – 6 nos.





Land

Energy

**What's
Next?**

**Water
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Catchment
Protection**

Sanitation

1990's

Now

2000's

Early Days

Key Drivers to Used Water Development

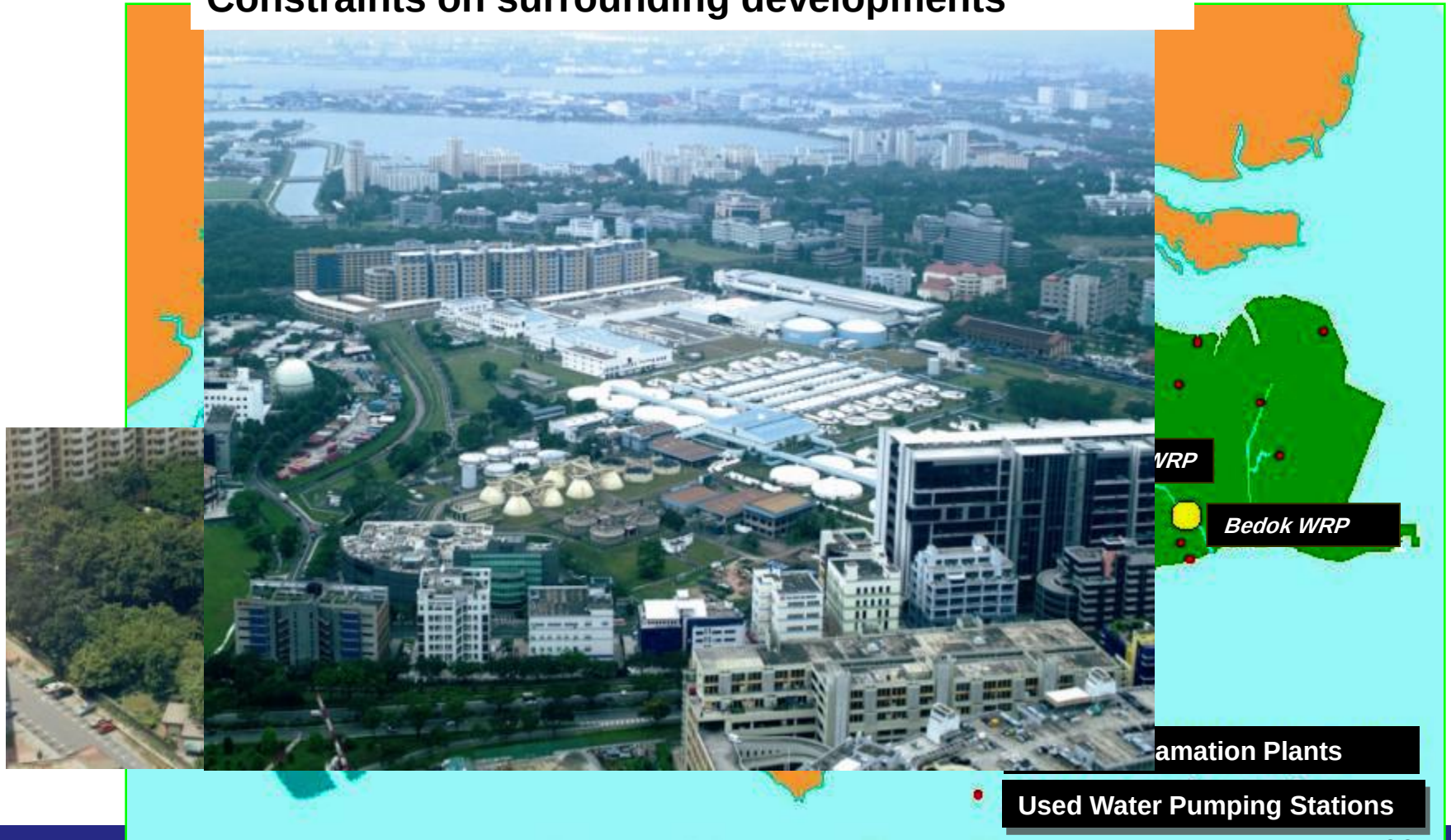
Water for All: Conserve, Value, Enjoy

Limitations

Dispersed & less reliable operation

Require large areas

Constraints on surrounding developments



Land Use



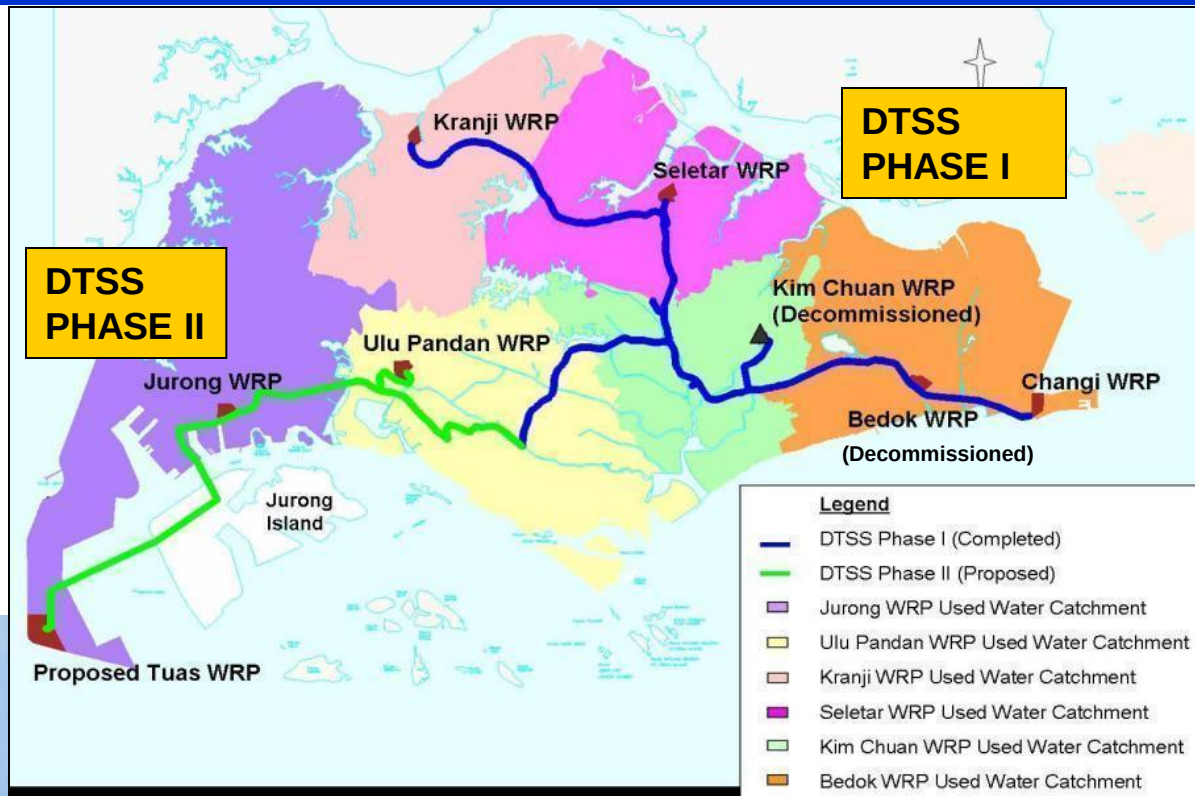
Ulu Pandan Water Reclamation Plant

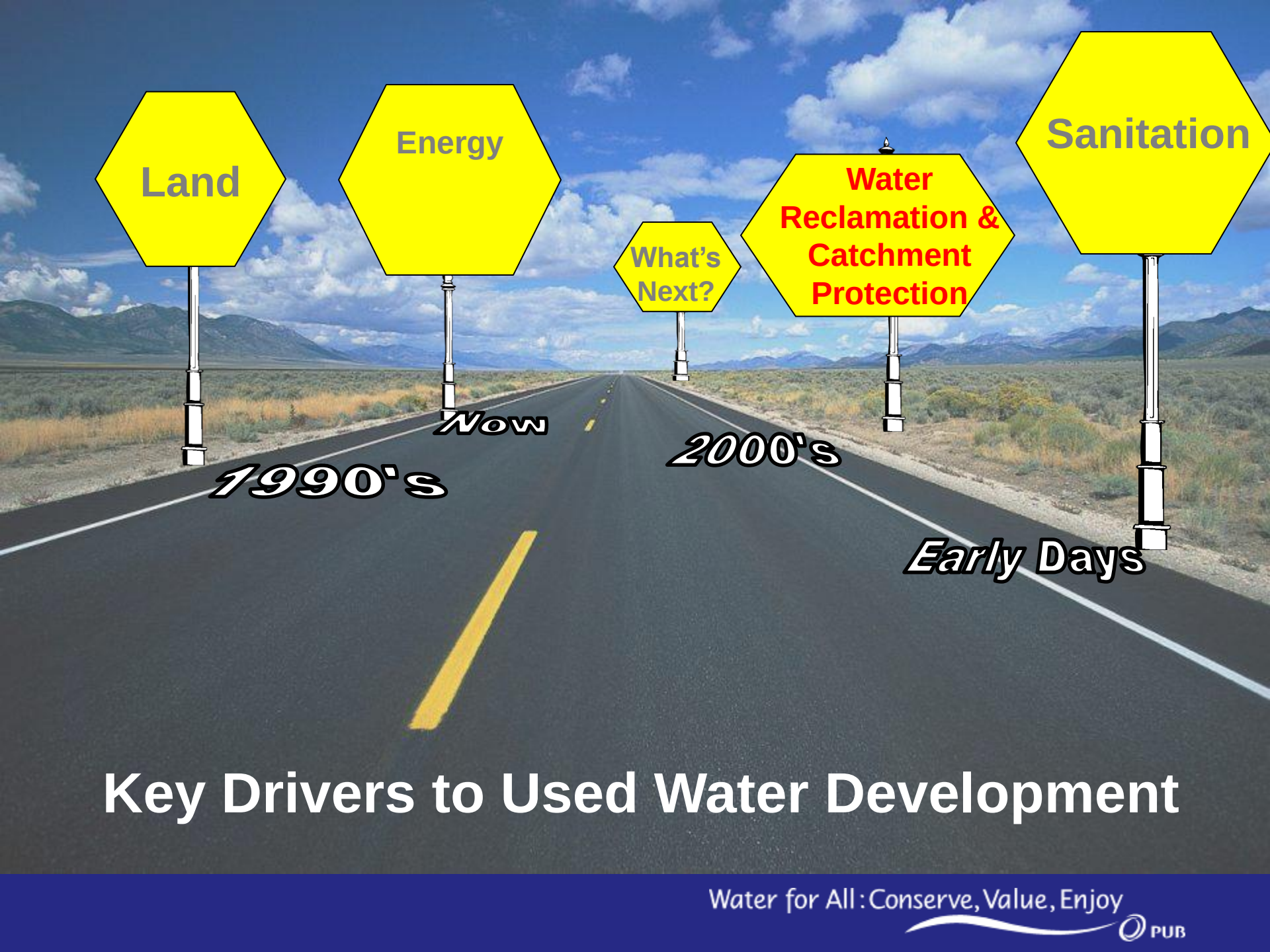
Covered Tanks and Odour Control



Odour Scrubbers

DEEP TUNNEL SEWERAGE SYSTEM





Land

Energy

What's
Next?

Water
Reclamation &
Catchment
Protection

Sanitation

1990's

Now

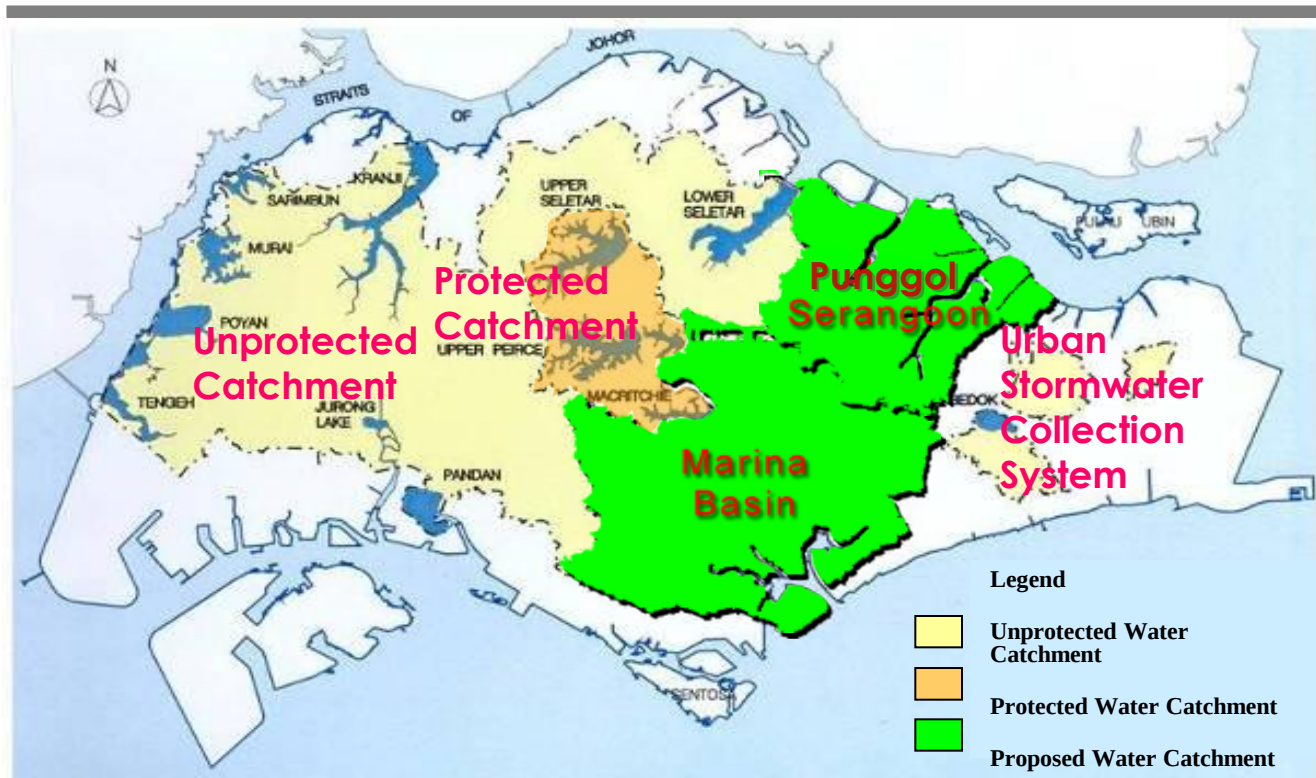
2000's

Early Days

Key Drivers to Used Water Development

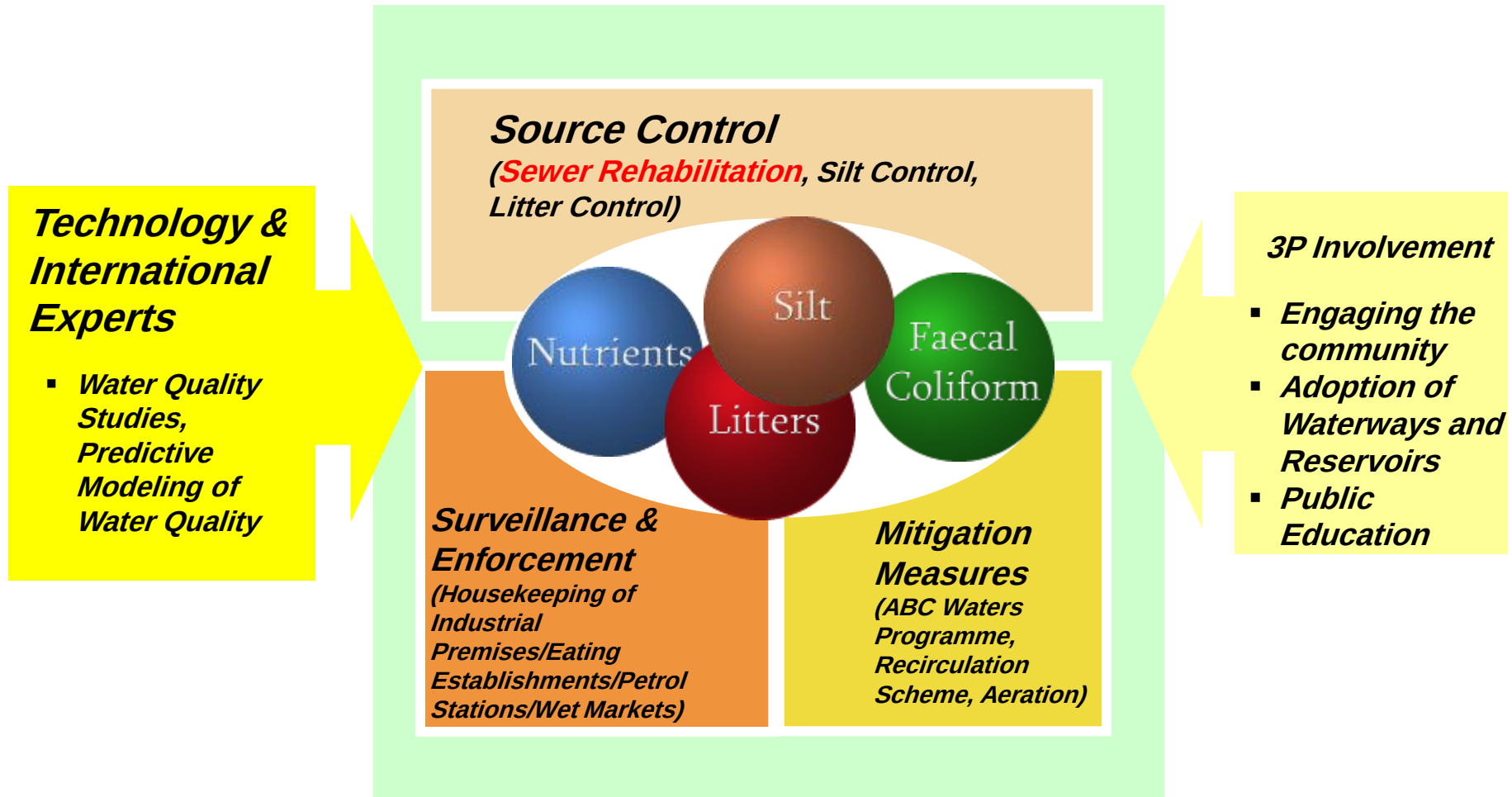
Water for All: Conserve, Value, Enjoy

Water Catchment Protection



- Half of Singapore is already water catchment
- Catchment area will be increased from half to two-thirds by 2011

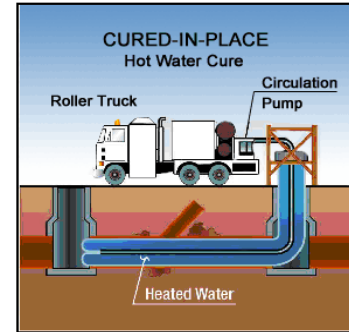
Integrated Catchment Water Quality Management Programme



Sewer Rehabilitation Programme

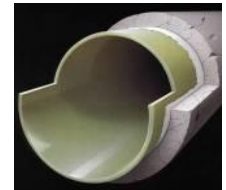
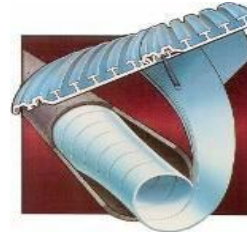
Sewer rehabilitation will :

- Restore structural integrity of the sewers
- Extend the lifespan
- Reduce infiltration and exfiltration



Sewer Rehabilitation Programme

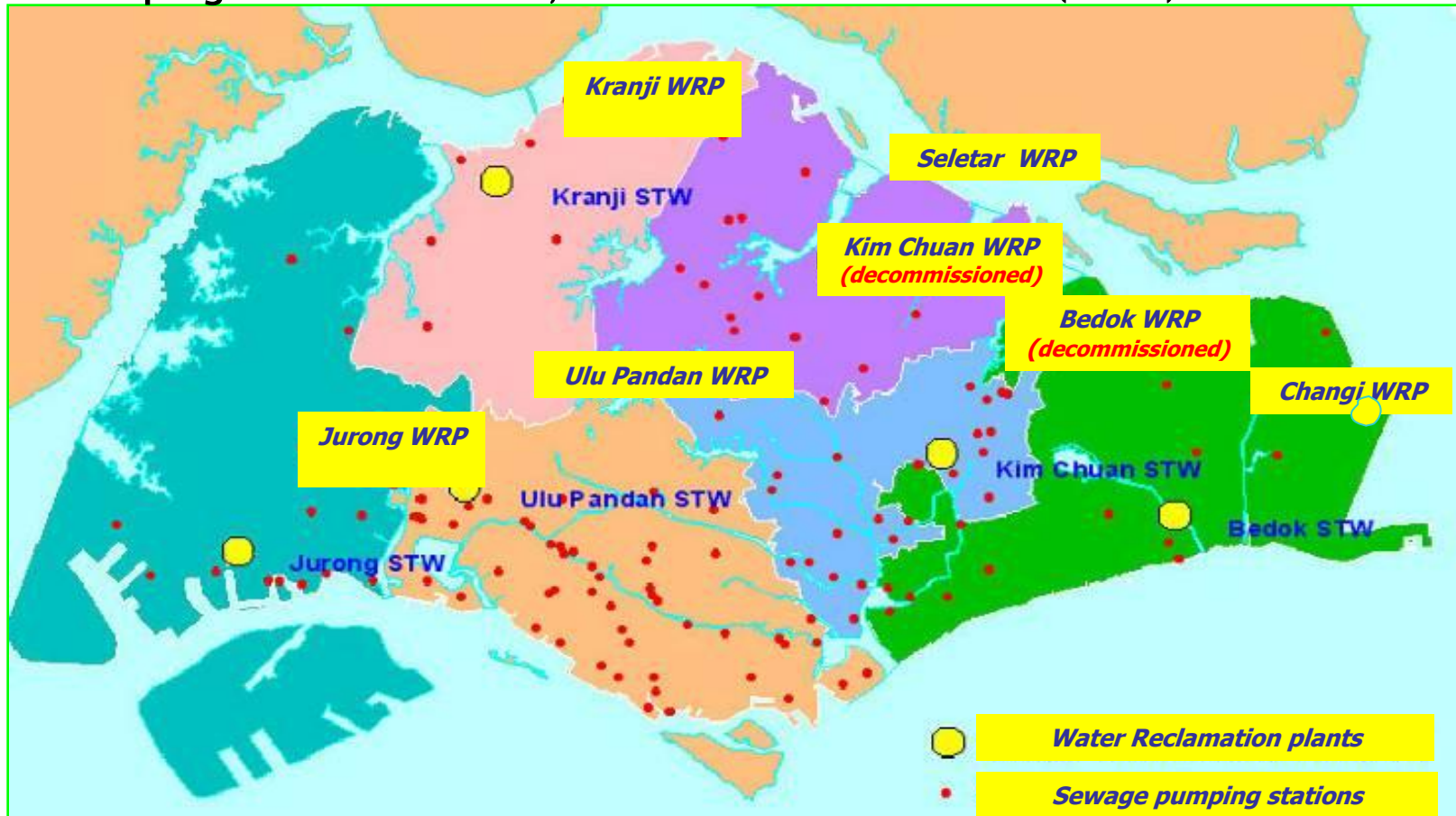
- Started in 1996
- Phase 1 - 3 : 1,100 km of sewers rehabilitated (Completed)
- Phase 4 : 1,000 km of sewers within Punggol & Serangoon Reservoir Catchment and the rest of Singapore will be rehabilitated (Ongoing)



Comprehensive Used Water Infrastructure

Sewers – 3339km ; Pumping Stations – 78 nos.

Pumping Mains – 115 km ; Water Reclamation Plants (WRPs) – 5 nos.



Singapore was historically divided into 6 catchments

Water for All: Conserve, Value, Enjoy

Development of Reclaimed Water

- In 1996 Jurong IWW (125,000 m³/d) was built to produce low quality water for industries from treated effluent
- In 1974 various technologies including reverse osmosis was tested for higher grade water reclamation
 - High quality water could be produced but membranes not reliable and costly
- In the 1990s, water reclamation becomes plausible:
 - improvement in membrane technology & reliability
 - cost of membranes significantly lower



Development of NEWater

A two-year NEWater Study:

- Initiated in 1998 and conducted 2000-2002
- To ascertain the suitability of using NEWater as a source of raw water

NEWater Demo Plant

- i. Capacity - 10,000 m³/d
- ii. Test quality of reclaimed water
- iii. Test capability and reliability of membranes



NEWater Process



**Treated
Used Water**



**Microfiltration /
Ultrafiltration**

Reverse Osmosis



NEWater



Ultraviolet Disinfection

Sampling and Monitoring Programme (SAMP)

- Total of 205,000 analysis to date
- 295 parameters tested, more than the 96 parameters stipulated by USEPA and 113 specified by WHO.



Health Effect Testing Programme (HETP)

- Complements SAMP
- Assessment of NEWater against reservoir water
- Short and long term health effects on two animal species
 - ✓ *Mice Toxicological & carcinogenicity assessment*
 - ✓ *Fish Toxicological, carcinogenicity and estrogenic potential (reproductive and development) assessment*



International Experts Panel

- Comprises both local and foreign experts
- Involved in audit and set up of the study protocol and adoption of latest methodologies, analytical tools and best international practices
- Expert Panel concluded that
 - **NEWater quality is well within international drinking water standards**
 - **NEWater is suitable as raw reservoir water**
 - **No adverse health concerns**
- Endorsement by water experts lend credibility



Water for All: Conserve, Value, Enjoy



Securing Community Acceptance

Multi-pronged approach:

- **Extensive public education**
 - **Public communications**
 - **Bottling NEWater**
 - **NEWater Visitor Centre**
- **Acceptance by the industries**
- **Media / Roadshows**
- **Political Endorsement**

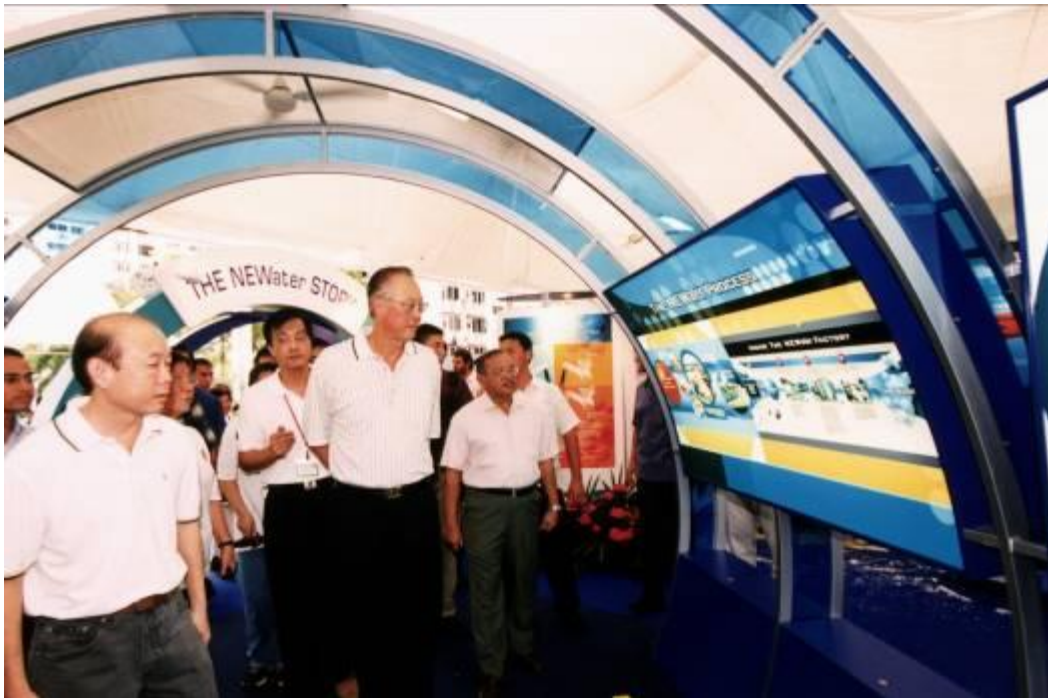
Public Communications

- Water reclamation is not new - in practice in USA for more than 2 decades
- NEWater is “PUB+” and “WHO+”, cost-effective option, safe and valuable
- Choice of words
 - “Used Water” vs “Wastewater”;
 - “NEWater” vs “Reclaimed Water”
 - “Water Reclamation” vs “Sewage Treatment”
- Right Emphasis
 - Concept is not new
 - RO technology
 - Indirect Potable Use



Public communications

- Briefings for Members of Parliament, grassroots leaders and business groups to garner feedback
- Exhibitions held at community and school levels



Bottling of NEWater

- Done as part of public education effort to help the public overcome the psychological barrier associated with water reuse
- Since Aug 2002, about 10 million bottles of NEWater have been distributed



Toasting with NEWater



**10 millionth NEWater
bottle**



- **NEWater Visitor Centre is the focal point of our public education on:**
 - ✓ **Role of NEWater as one of the 4 national taps**
 - ✓ **The importance of water**
 - ✓ **The technology behind NEWater**
- **Targets mainly our younger generation (eg students)**
- **Opened in Feb 2003; 400,000 visitors to-date**



Engaging the Industry

Wafer Fab Industry

- an important one in Singapore's economy
- known to use a lot of water
- critical to push NEWater to replace potable water usage

Reluctance to use NEWater

- sensitive processes
- pretreatment plant to produce ultra pure water
- No wafer fab in the world uses reclaimed water

Overcoming Wafer Fabs Concerns

- a pilot plant was built
 - to simulate real conditions at wafer fabs
 - allows different configurations of ultra pure water systems
 - various wafer fabs could experiment with their own processes
- pilot plant ran for 12 months
- product testings for 6 months
- wafer fabs were fully convinced of reliability, security and quality of NEWater

Engaging the Media

- conducting roadshows and dialogue sessions with key stakeholders and the public
- Briefings and visits to NEWater demo plant
- Media familiarisation trip to USA (eg Orange County, California and Scottsdale, Arizona)



**NEWater
Roadshow**



Water for All: Conserve, Value, Enjoy

Endorsement by Leaders

- Top government officials including the then Prime Minister of Singapore showed their support by drinking NEWater publicly



Public Support for NEWater

- Strong acceptance of NEWater by the public
- 60,000 Singaporeans toasted to NEWater at 2002 National Day Parade.
- Independent survey by Forbes Research at the end of 2002 confirmed the success of the programme.
 - 98 per cent acceptance rate, with 82 per cent of respondents indicating that they would drink NEWater directly and another 16 per cent would drink it mixed with reservoir water.



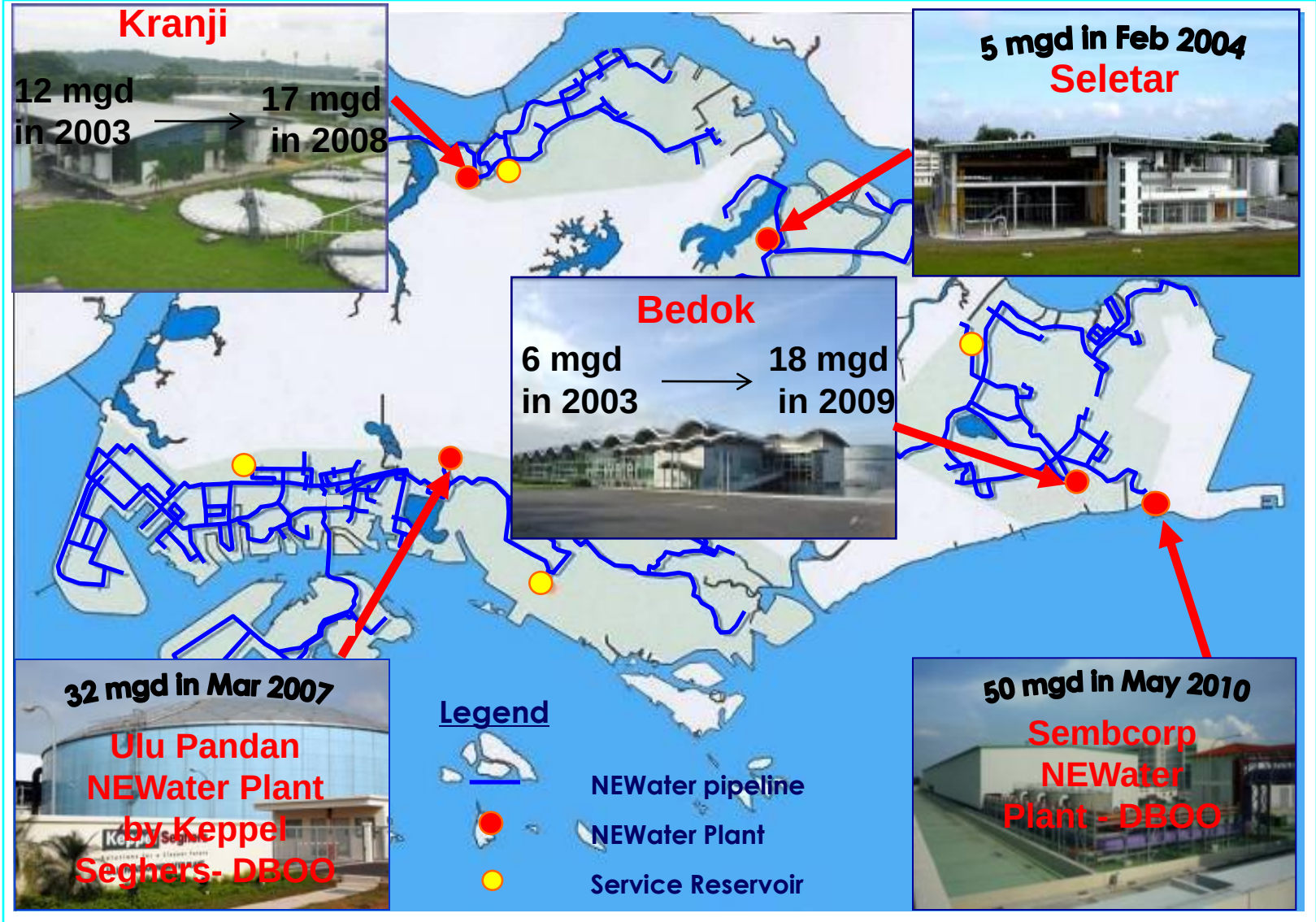
Implementation

With successes in technical studies and public acceptance

- NEWater became Singapore's third source of water
- Industries needing high purity water switch to NEWater
- Economic gains were reported
- NEWater demand is likely to increase as it replaces the need for traditional potable water
- NEWater is a sustainable water source

Third National Tap

NEWater

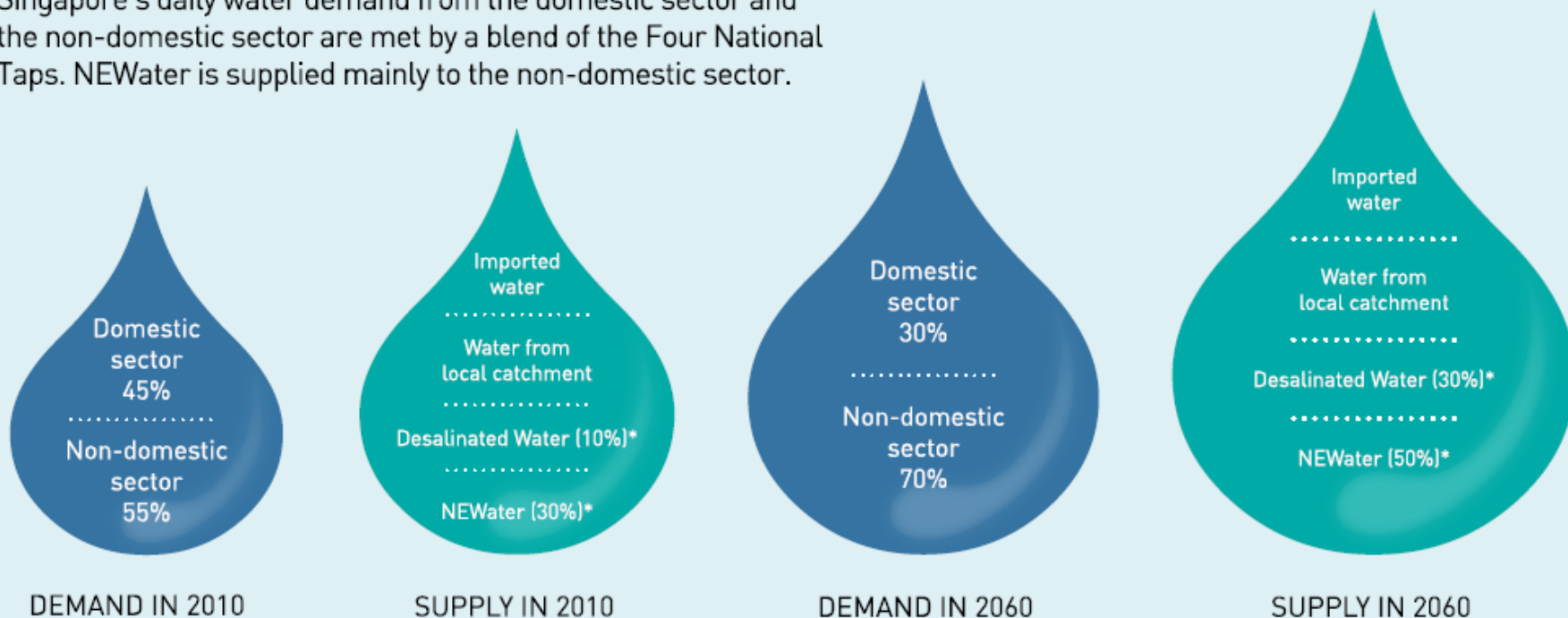


NEWater capacity to meet 30% of Singapore's water needs by 2011

Ensuring Water Sustainability for Singapore

DEMAND AND SUPPLY 2010 & 2060

Singapore's daily water demand from the domestic sector and the non-domestic sector are met by a blend of the Four National Taps. NEWater is supplied mainly to the non-domestic sector.



* % of demand

Conclusion

Key Factors to successful water re-use:

- Effective collection and treatment of used water
- Comprehensive scientific and technological studies and best engineering treatment processes
- A proactive and robust public education programme involving media and all stakeholders

Large scale water reuse in Singapore:

- Pillar in water sustainability strategy
- Closing the water loop



Sustainable Water Solutions for a Changing Urban Environment

- **The global platform for water solutions**
 - **Brings together policymakers, industry leaders, experts and practitioners**
 - **Address challenges, showcase technologies, discover opportunities & celebrate achievements**
- **Key highlights include Lee Kuan Yew Water Prize, Water Leaders Summit (by invitation only), Water Convention, Water Expo & Business Forums**



Year	No. of attendees	No. of countries participated	Value of deals, tenders & investments announced	No. of co-located events	No. of participating companies in Water Expo
2008	8,500	79	S\$380m	42	350
2009	10,000	82	S\$2.2b	76	420
2010	14,000	112	S\$2.8b	120	514

Thank You

