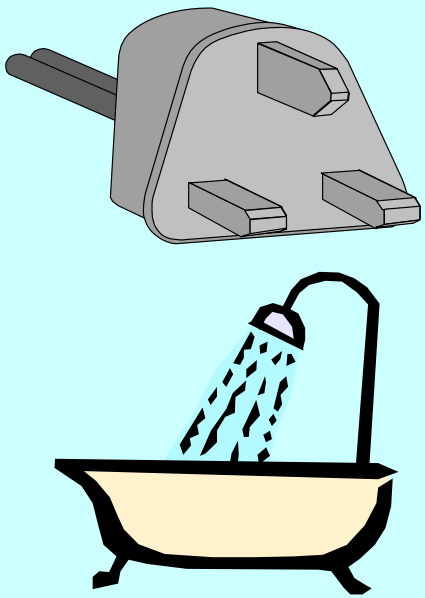
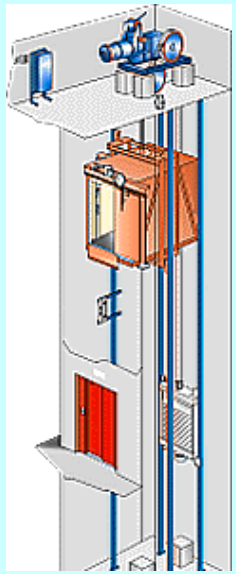
MEBS6000 Utility Services

http://www.hku.hk/mech/msc-courses/MEBS6000/index.html





Course Overview

Dr. Sam C M Hui

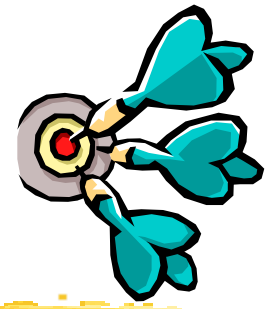
Department of Mechanical Engineering

The University of Hong Kong

E-mail: cmhui@hku.hk

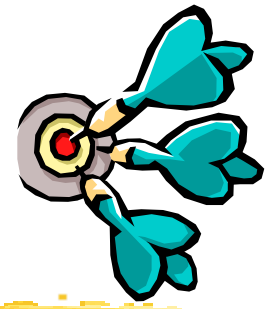
Feb 2009

Course Overview



- Utility Services (公共設備)
  - “Utility” = a service used by the public
  - For example, electricity, water, gas, telephone
- Educational Objectives:
  - To introduce students to various utility services installations in modern buildings
  - To enable students to design appropriate utility services systems aiming at achieving integration and co-ordination between disciplines

Course Overview



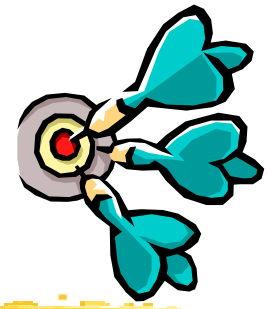
- Study Topics:
  - 1) Lifts & escalators
  - 2) L.V. electrical installation
  - 3) Communication systems
  - 4) Security and alarm systems

Mr. W K Lee

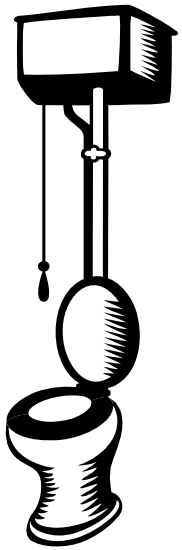
  - 5) Cold and hot water systems
  - 6) Steam systems
  - 7) Sanitary & stormwater drainage
  - 8) Sewage disposal

Dr. Sam Hui

Course Overview



- Teaching content (by Dr. Sam Hui)
  - Cold water supply
  - Hot water supply
  - Steam systems
  - Stormwater & sanitary drainage
  - Sewage disposal



給水排水

MEBS6000 Utility Services

http://www.hku.hk/mech/msc-courses/MEBS6000/index.html

Cold Water Supply

Dr. Sam C M Hui

Department of Mechanical Engineering

The University of Hong Kong

E-mail: cmhui@hku.hk

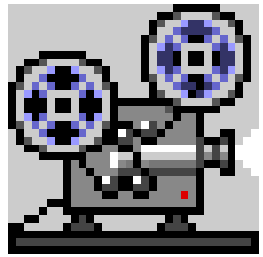
Feb 2009

Contents

- History of water supply in Hong Kong
- Water sources
- Water supply distribution
- Water tanks & pumps
- Water quality & management

History of water supply in HK

- Video presentation: "樓下閂水喉" (Restriction of Water Supply) [25 min.]
  - 1851: sinking of 5 wells in the “City of Victoria”
  - 1860: tanks constructed at Bonham Road
  - 1863: Pok Fu Lam reservoir ……
- Web links
  - History and Future of Water Supply in Hong Kong www.wsd.gov.hk/en/html/water/hkwidx.htm
  - 150 Years of Water Supply in Hong Kong www.info.gov.hk/water150/



History of water supply in Hong Kong (1946-2007)

1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974

1957
Use of seawater for toilet flushing in Shek Kip Mei and Lei Cheng Uk Estate

1960
Water Supply Agreement with Guangdong Supply from Shenzhen Reservoir

1963
Completion of Shek Pik Reservoir
24.5 mcm capacity

1968
Completion of Plover Cove Scheme and Extension in 1973
230 mcm capacity

1959
Completion of Tai Lam Chung Reservoir
20.5 mcm capacity

June 1963 - May 1964
Severe Water Rationing
4 hours of supply every 4 days

1965
Completion of Lower Shing Mun Reservoir
4.3 mcm capacity

1965
Water Supply Agreement with Guangdong
68.2 mcm/year of Dongjiang water supply

(Source: Water Supplies Department, www.wsd.gov.hk)

History of water supply in Hong Kong (1946-2007) (cont'd)

1978
Completion of High Island Scheme
281 mcm capacity

1989
Water Supply Agreement
with Guangdong
Maximum 1,100 mcm/year
of Dongjiang water supply

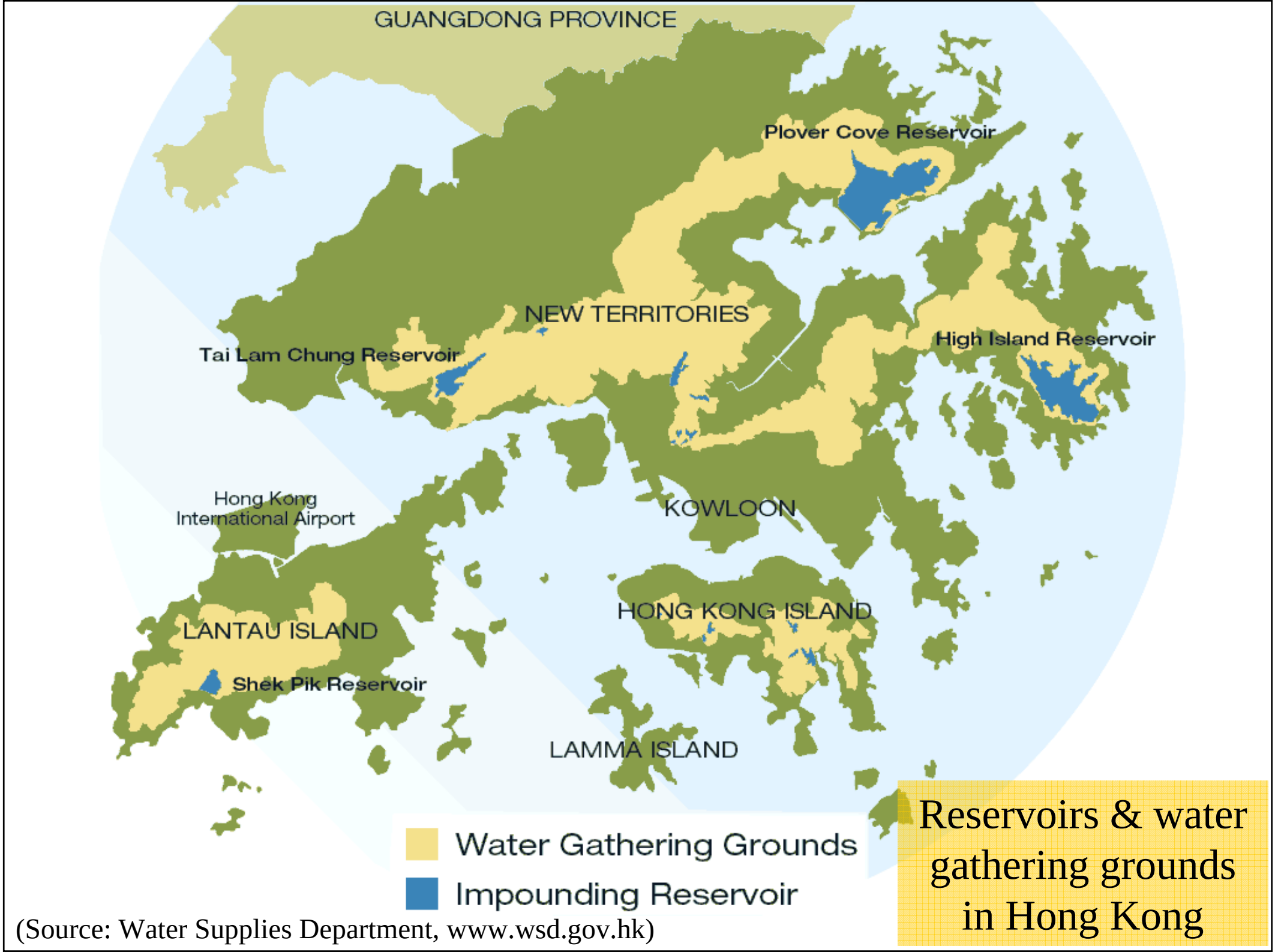
2006
Water Supply Agreement
with Guangdong
Flexible supply of Dongjiang water

1981-1982
Last water rationing
in Hong Kong

2003
Commissioning of 83km dedicated
aqueduct for delivery of Dongjiang water

1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007

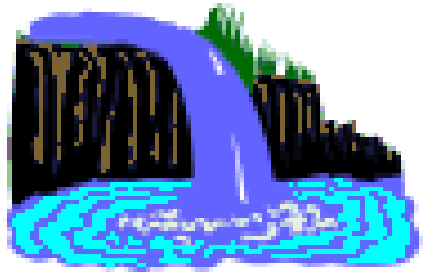
(Source: Water Supplies Department, www.wsd.gov.hk)



Reservoirs & water gathering grounds in Hong Kong

(Source: Water Supplies Department, www.wsd.gov.hk)

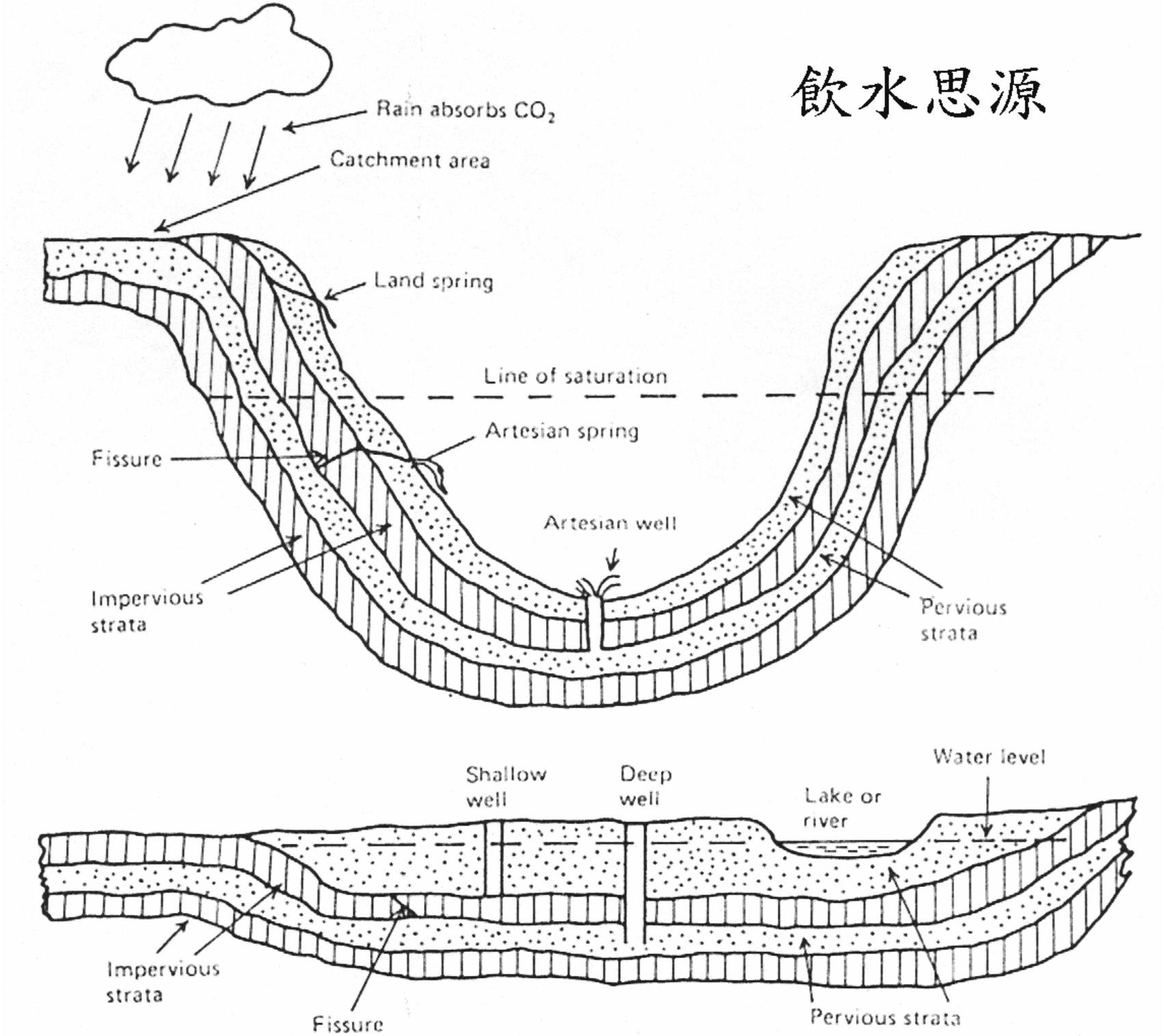
Water sources



- Surface & underground water sources:
  - Shallow wells
    - Sinkings in top water-bearing strata
  - Intermittent or land springs
    - From top water-bearing strata
  - Deep wells
    - Sinkings below the first impervious strata
  - Artesian wells and springs
    - The same source as deep wells
  - Lakes & rivers
    - Catchment of surface and subsoil water

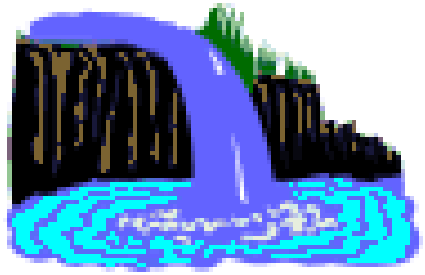
飲水思源

飲水思源

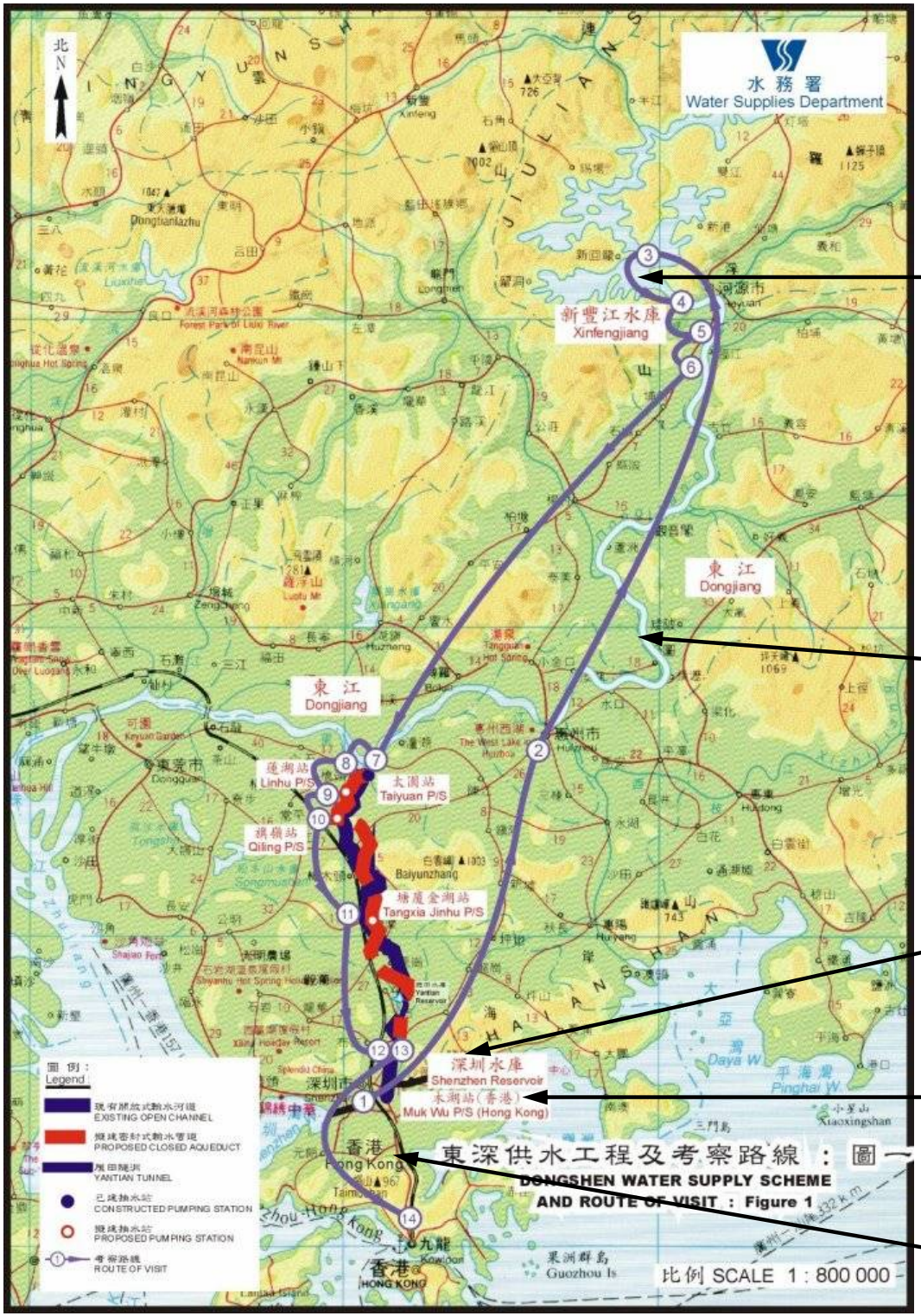


(Source: Hall, F. and Greeno, R., 2007. *Building Services Handbook*)

Water sources



- Water Supplies Department (WSD)
  - To plan & manage water resources & water supply systems
  - To design & construct waterworks projects
  - To operate & maintain water supply & distribution systems
  - To control the quality of water supply to customers
  - To enforce the Waterworks Ordinance & Regulations
    - Include vetting plumbing proposals for buildings (from ‘Licensed Plumbers’)
- Water resources in HK
  - Rainfall from natural catchment + supply from Guangdong
    - 70% of water demand is now met by water from Dongjiang River
  - Sea water for flushing toilets (for over 80% population)



Xinfengjiang Reservoir
新豐江水庫

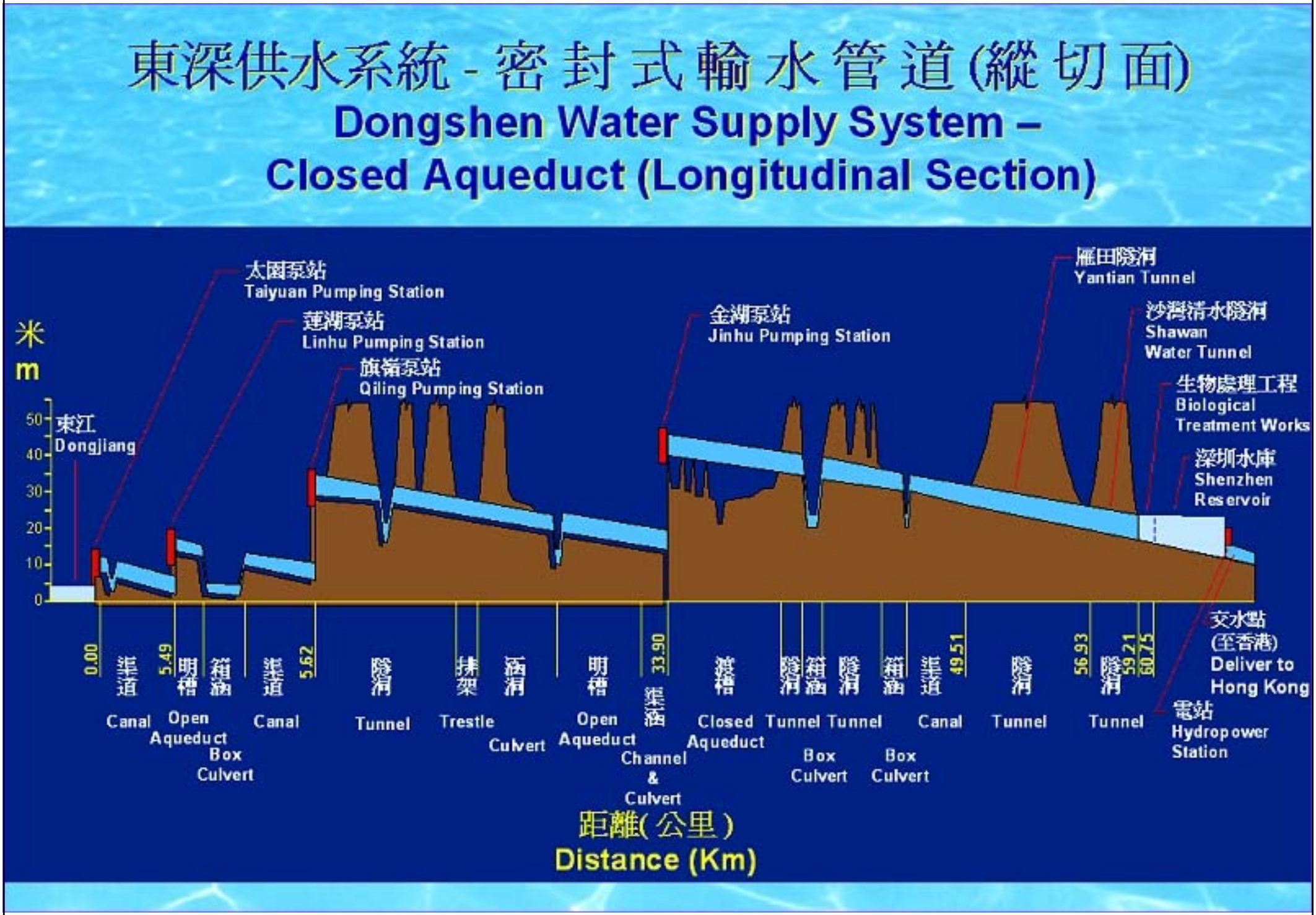
Dongjiang 東江

Shenzhen Reservoir
深圳水庫

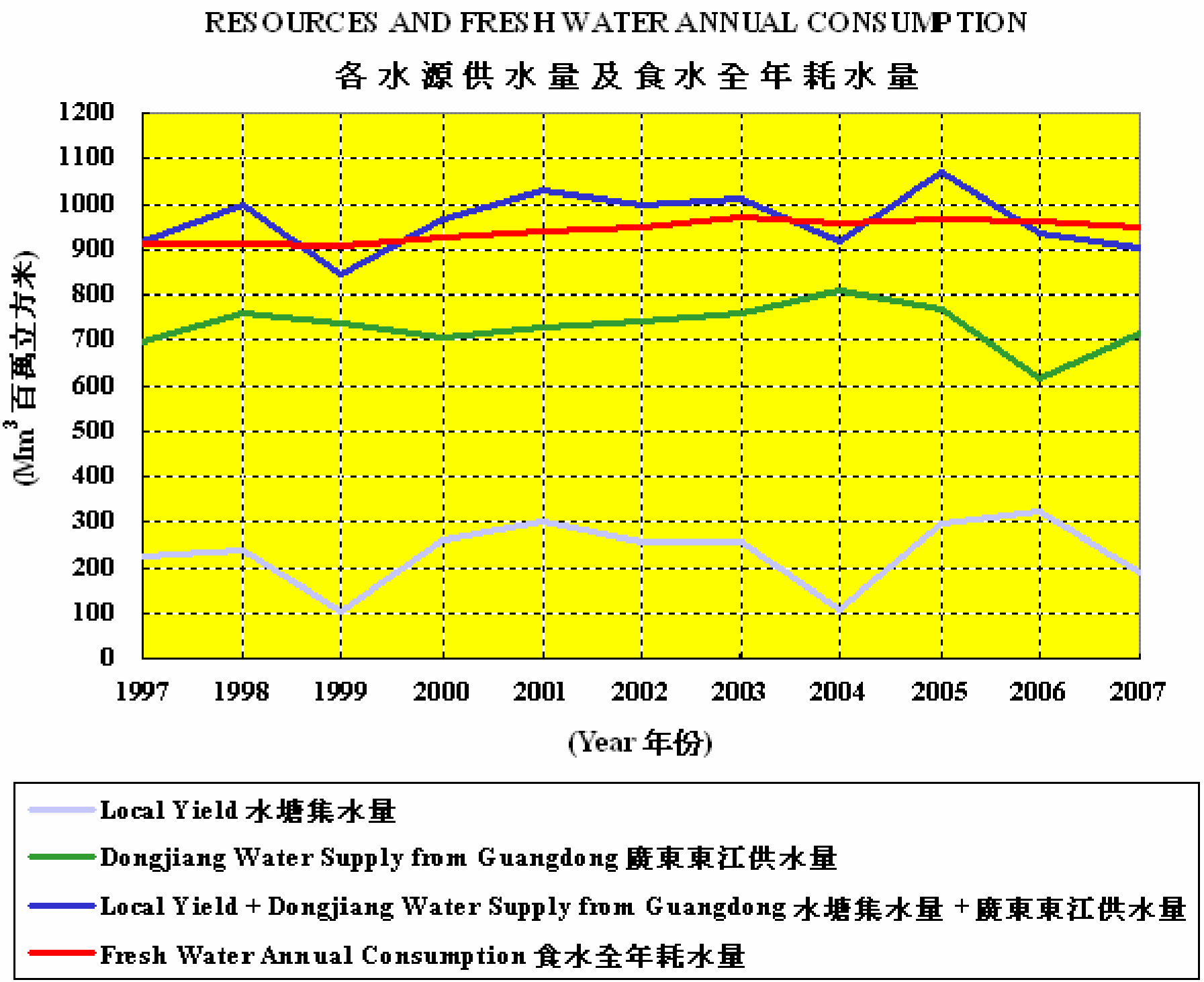
Muk Wu Pump Station (HK)
木湖泵站(香港)

Water pipes along the railway line

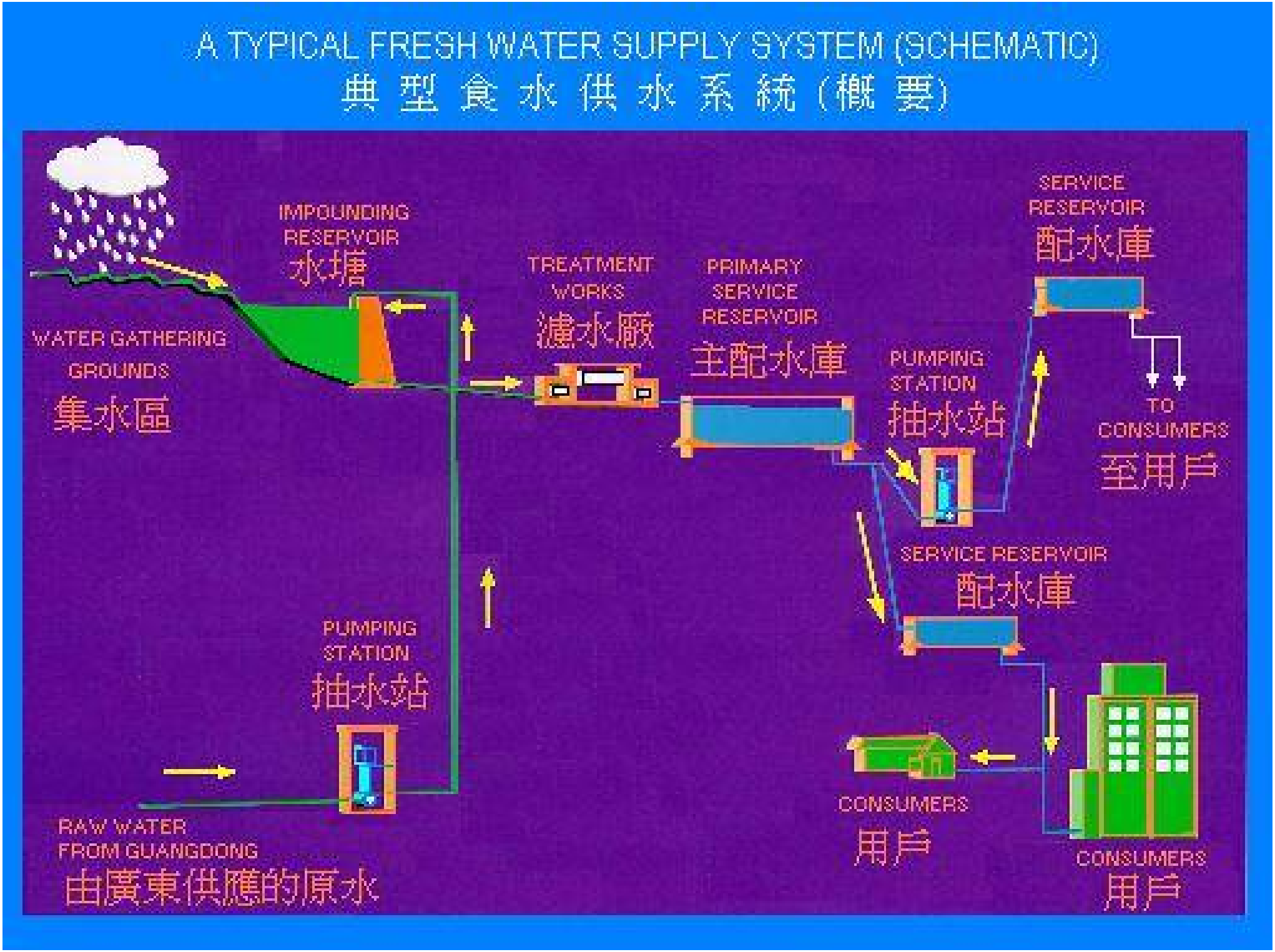
(Source: Water Supplies Department, www.wsd.gov.hk)



(Source: Water Supplies Department, www.wsd.gov.hk)



(Source: Water Supplies Department, www.wsd.gov.hk)



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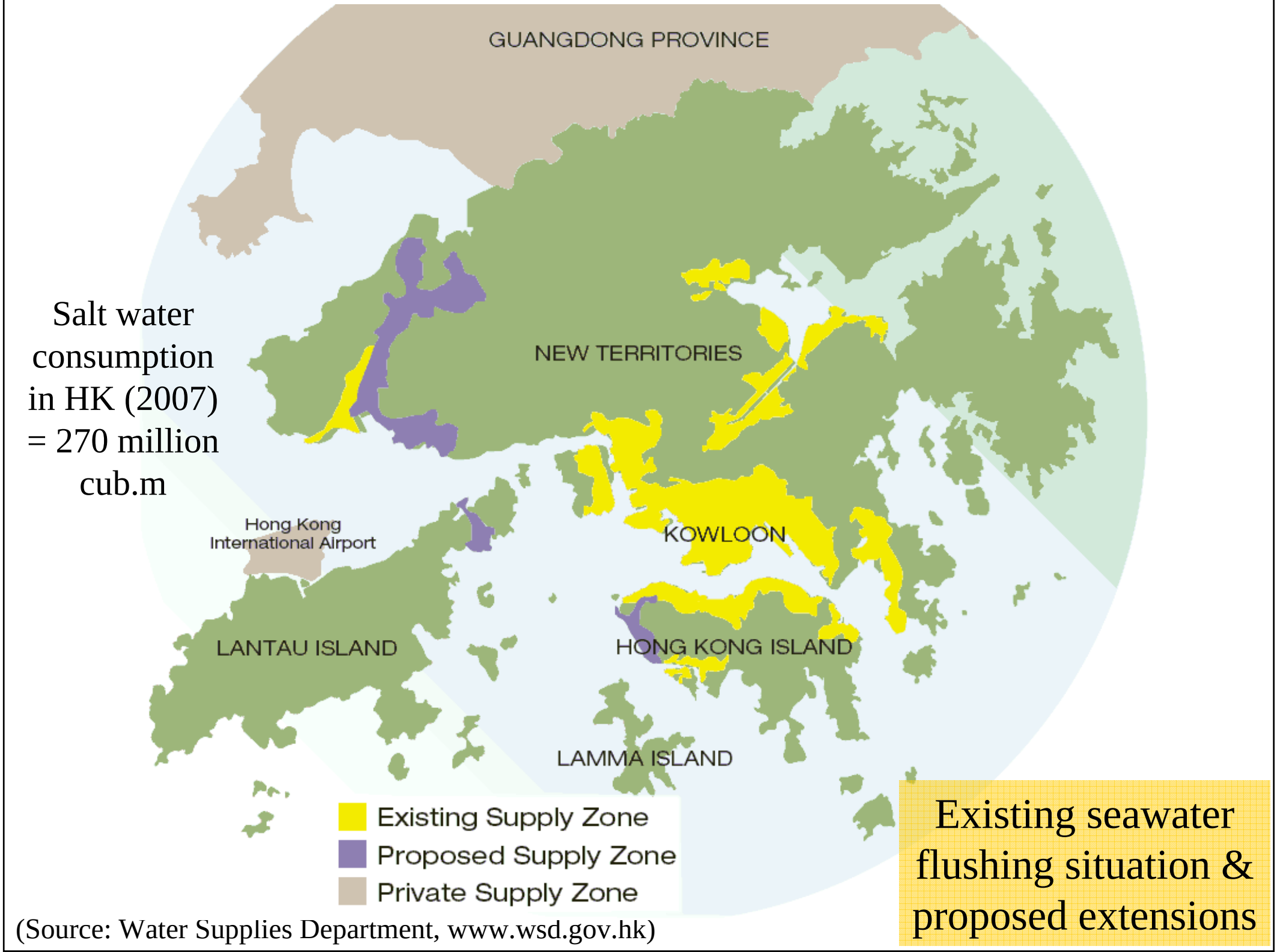
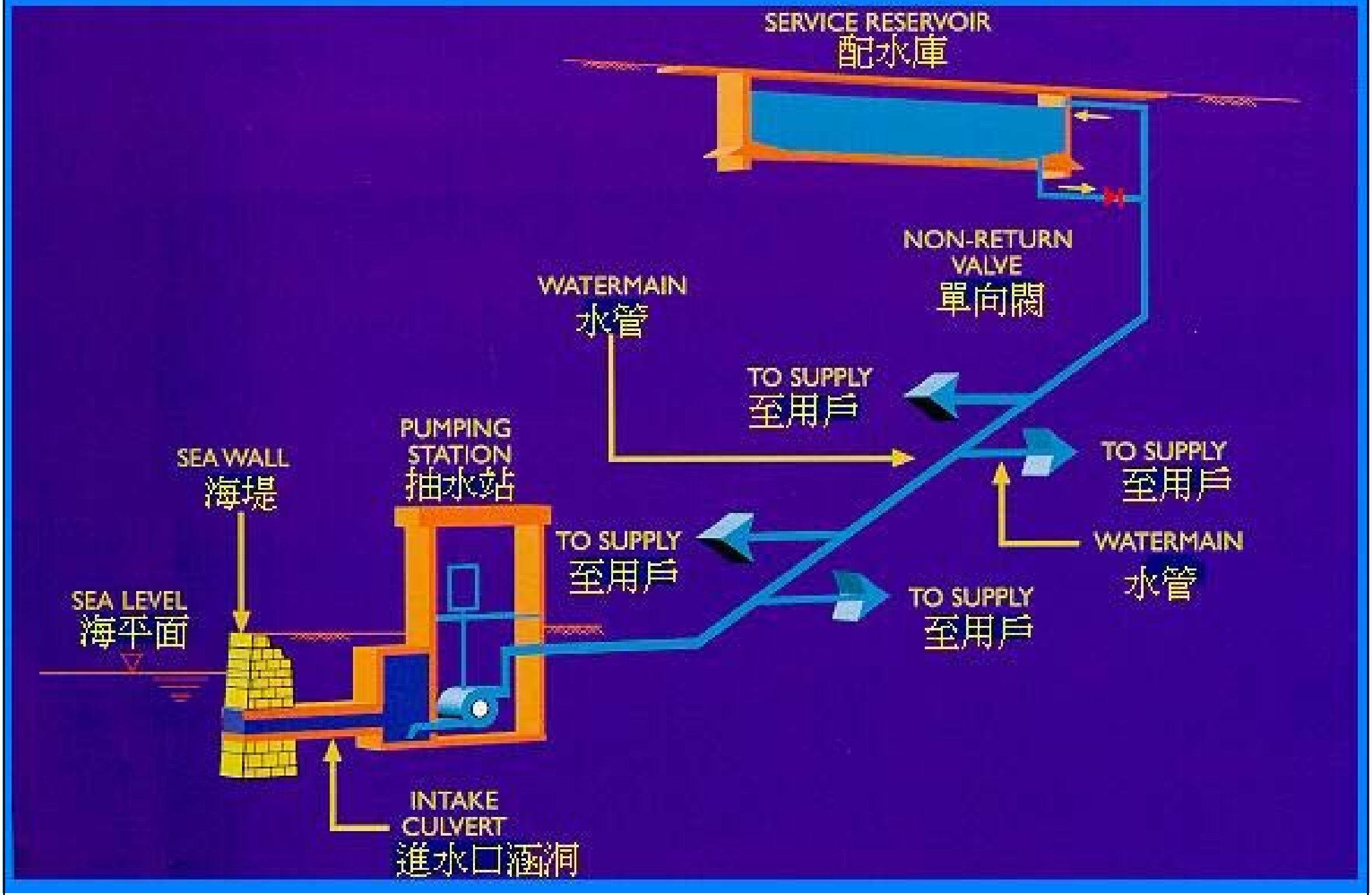


Salt water consumption in HK (2007) = 270 million cub.m

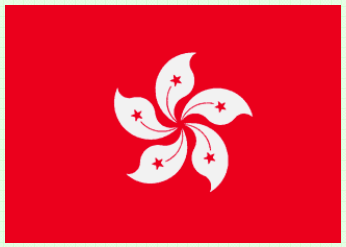
(Source: Water Supplies Department, www.wsd.gov.hk)

Existing seawater flushing situation & proposed extensions

A TYPICAL SEA WATER SUPPLY SYSTEM (SCHEMATIC) 典型海水供水系統（概要）



(Source: Water Supplies Department, www.wsd.gov.hk)

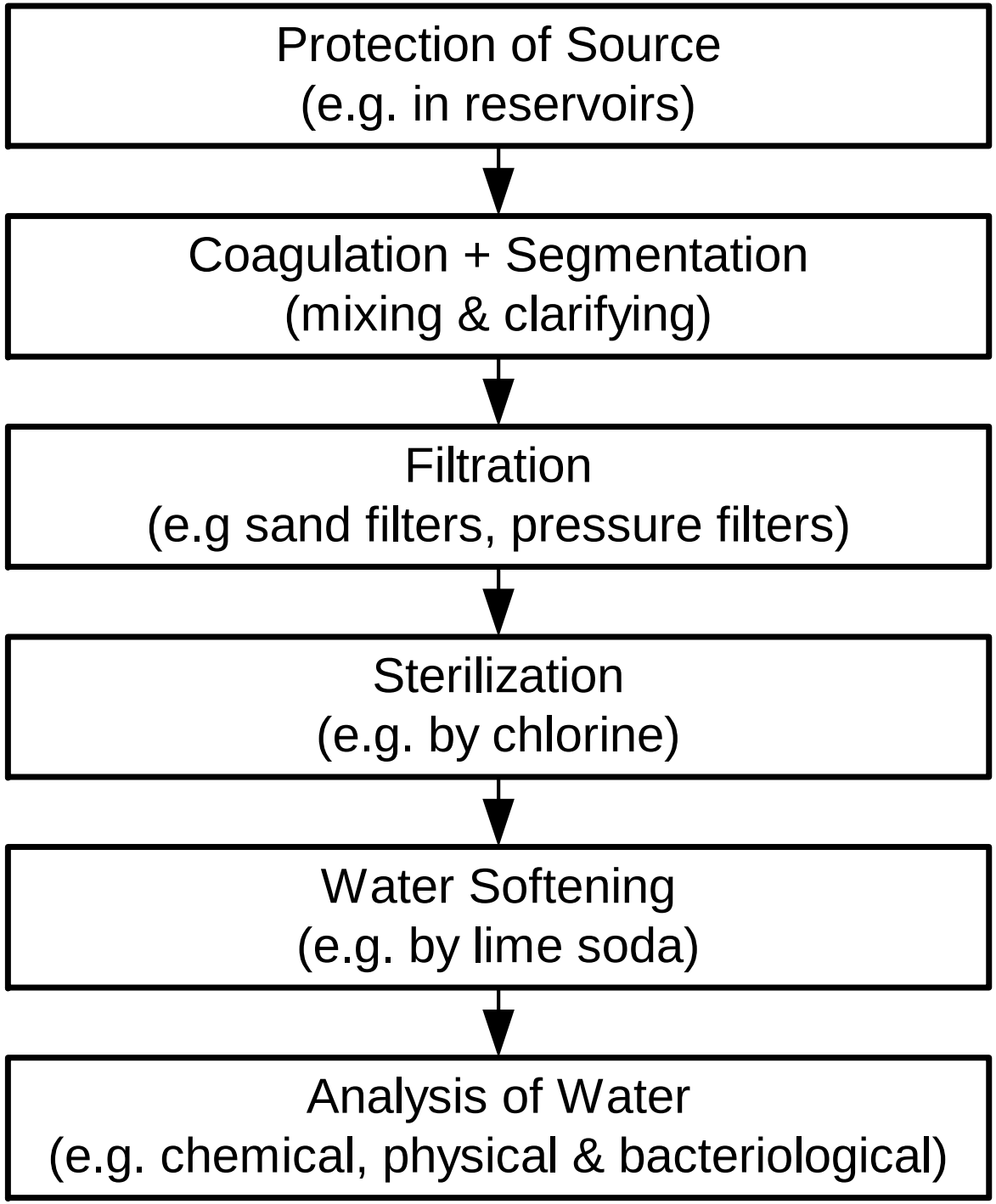


The average fresh water consumption in one day in Hong Kong is (data based on year 2007):

A. 1,310 litre/person	B. 852 litre/person
C. 374 litre/person	D. 244 litre/person

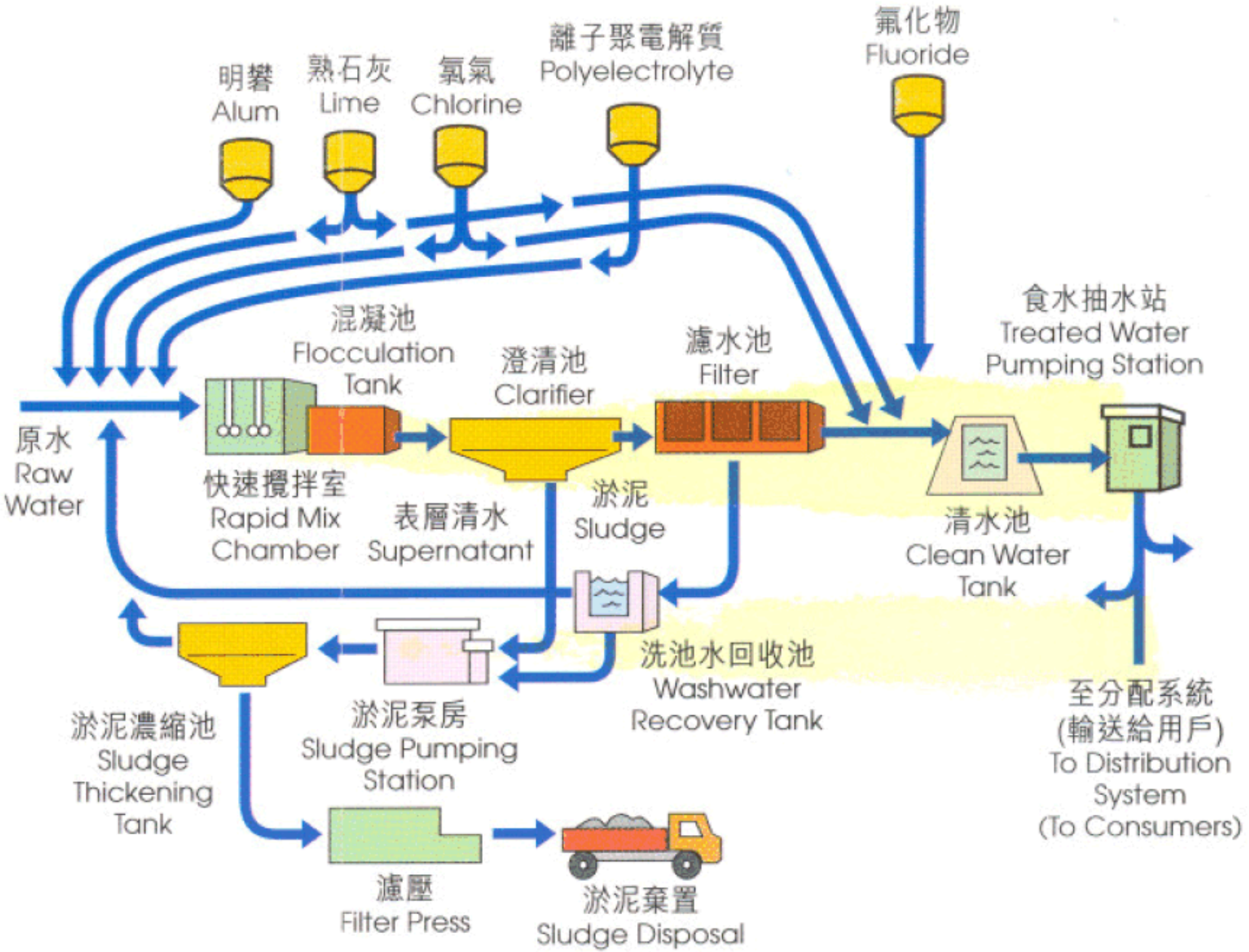
Water sources

- Water for human consumption must be:
  - Free from harmful bacteria & suspended matter
  - Colourless
  - Pleasant to taste
  - For health reasons, moderately ‘hard’ ($CaCO_3$)
- Water storage & treatment process to ensure good water quality
  - Complies with World Health Organization (WHO) guidelines for drinking water



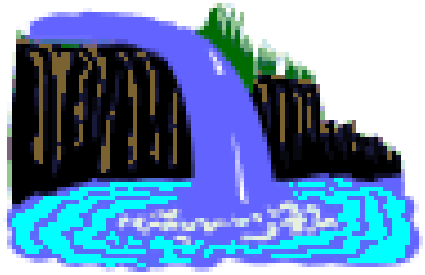
Typical water treatment process

The water treatment process



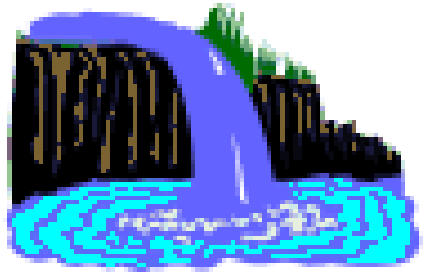
(Source: Water Supplies Department, www.wsd.gov.hk)

Water sources



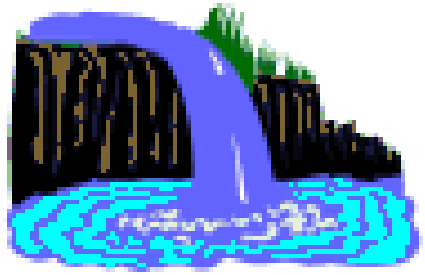
- Typical water treatment process in HK
  - 1. Raw water
    - Comes from different sources, including reservoir(s) and Dongjiang water of Guangdong
  - 2. Mixing
    - Raw water is dosed at the mixing chamber with
      - Hydrated lime to precondition the raw water
      - Chlorine to control algae
      - Alum to coagulate impurities
      - Polyelectrolyte to improve the coagulation and flocculation of impurities

Water sources



- Typical water treatment process in HK (cont'd)
  - 3. Flocculation and Sedimentation
    - After mixing, water is passed to the clarifiers where coagulation and flocculation of the impurities in the water will occur
    - The dissolved alum coagulate impurities in the water into large particles where settle as sludge
    - The sludge is collected and conveyed to sludge thickening tanks for further treatment before disposal

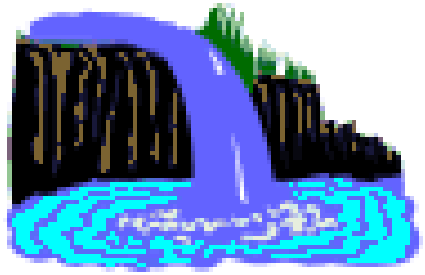
Water sources



- Typical water treatment process in HK (cont'd)
  - 4. Rapid Gravity Filtration

    - Settled water from the clarifiers flows to the constant rate sand filters for removal of more finely divided suspensions
    - Periodically the filter beds are cleaned by backwashing with air and then water
  - 5. Clear Water Tanks
    - Chorine, fluoride and lime are dosed into the filtered water in the contact tanks and disinfect, fluoridate and control the alkalinity of the final treated water
    - The treated water is stored in the clear water tank before conveying to service reservoirs for distribution to people

Water sources

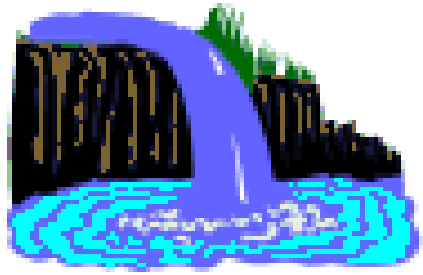


- Typical water treatment process in HK (cont'd)
  - 6. Pumping Facilities

    - Pumping station in the treatment to pump the water to the distribution
  - 7. Environmental Friendly Facilities

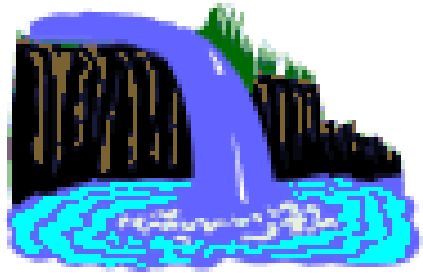
    - The washwater is collected in the recovery tanks for repumping to the inlet for recycling
    - Sludge produced is thickened by three circular sludge thickening tank using electrolyte as coagulant
    - Thickened sludge is compressed by membrane type filter presses into cakes for disposal at landlfill sites

Water sources



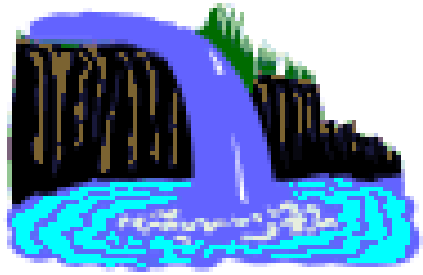
- Typical water treatment process in HK (cont'd)
  - 8. Water Quality Control
    - The quality of water is closely monitored by means of chemical, bacteriological and biological examinations of water samples taken
    - To comply with the Guidelines for Drinking Water Quality recommended by WHO, to ensure a safe and wholesome potable supply

Water sources



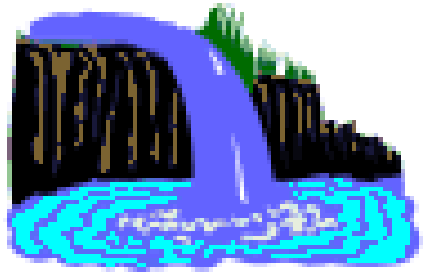
- Water charges in Hong Kong
  - Domestic consumers
    - Billed at 4-monthly intervals (121.64 days)
    - 4 tiers with progressively increasing prices
    - To discourage excessive and unnecessary use of water
    - First tier: 12 cubic metres: free of charge
    - Second tier: 31 cubic metres: $4.16 per cubic metre
    - Third tier: 19 cubic metres: $6.45 per cubic metre
    - Fourth tier: > 62 cubic metres: $9.05 per cubic metre

Water sources



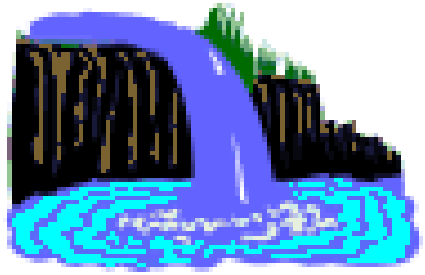
- Water charges in Hong Kong (cont'd)
  - Non-domestic consumers
    - Billed at 4-monthly intervals (for large consumption consumers, billed at monthly intervals)
    - At a flat rate dependent on the purpose of the supply
    - For trade: $4.58 per cubic metre
    - For construction: $7.11 per cubic metre
    - For non ocean-going shipping: $4.58 per cubic metre
    - For ocean-going shipping: $10.93 per cubic metre

Water sources



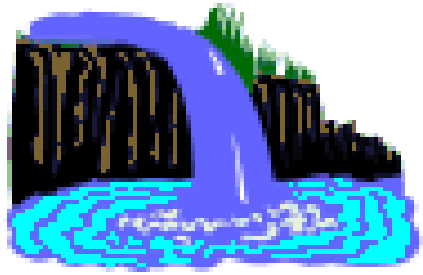
- Water charges in Hong Kong (cont'd)
  - Flushing supplies
    - Sea water supply for flushing is free of charge
    - Fresh water supply for flushing is usually billed at 4-monthly intervals
      - First tier: 30 cubic metres per flat: free of charge
      - Second tier: > 30 cubic metres per flat: $4.58 per cubic metre
    - Only one meter installed in each building to record the total consumption of all flats in the same building
      - Billed separately to the management office, agent, incorporated owner or development company

Water sources



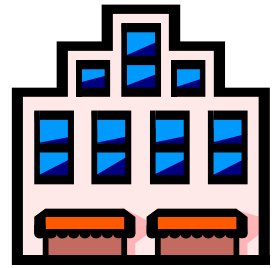
- Water charges in Hong Kong (cont'd)
  - Sewage charges
    - For domestic consumers: at a 4-month interval: $1.31 per cubic metre, with an exemption for the first 12 cubic metres
    - For trade, business and manufacture consumers: $1.31 per cubic metre. Some trades are eligible for 30% discount (e.g. bleaching & dyeing, restaurants, softdrinks & ice-making industries)
    - For 30 types of trade/business/manufacture which discharge trade effluent, the consumer shall also pay a Trade Effluent Surcharge

Water sources



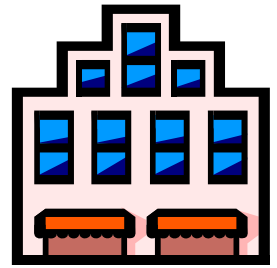
- Licensed Plumbers (持牌水喉匠)
  - A person licensed under the Waterworks Ordinance to construct, install, maintain, alter, repair or remove water supply plumbing
    - Grade I – for construction, installation, maintenance, alteration, repair or removal of a fire service or inside service of any type
    - Grade II – for maintenance and repair of a fire service or inside service; and for installation, maintenance, repair or removal of water appliances

Water supply distribution

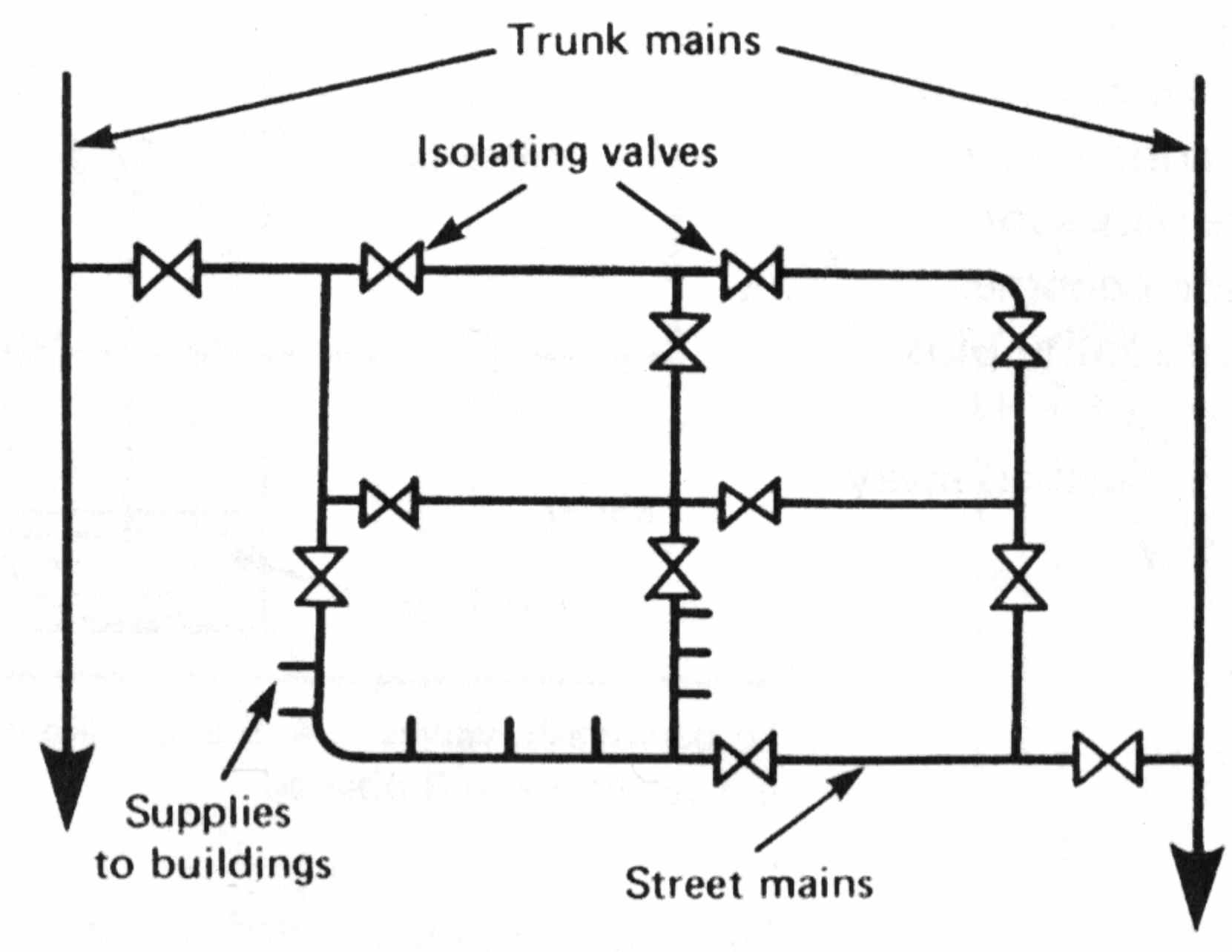


- Distribution network of water supply
  - Main reservoir
  - Pumping stations
  - Water treatment plants
  - Pumping substations
  - Service reservoirs
  - Trunk mains or service trunks
  - Street mains or water mains (into buildings)

Water supply distribution



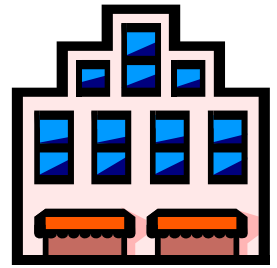
- Mains water supply
  - Size of the water mains
  - Pressure (or head) of water (20 or 30m head)
  - Such as a 75 mm diameter pipe fed from both ends or a 100 mm diameter pipe fed from one end
  - Min. head of 30 m for firefighting purposes
  - Max. head of 70 m to limit wastage and pipe noise
- A ring circuit & a grid of pipes
  - To increase reliability & facilitate maintenance



Ring main distribution

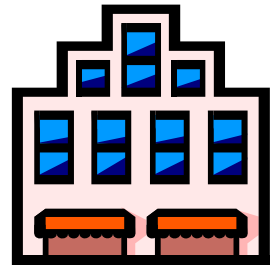
(Source: Hall, F. and Greeno, R., 2007. *Building Services Handbook*)

Water supply distribution

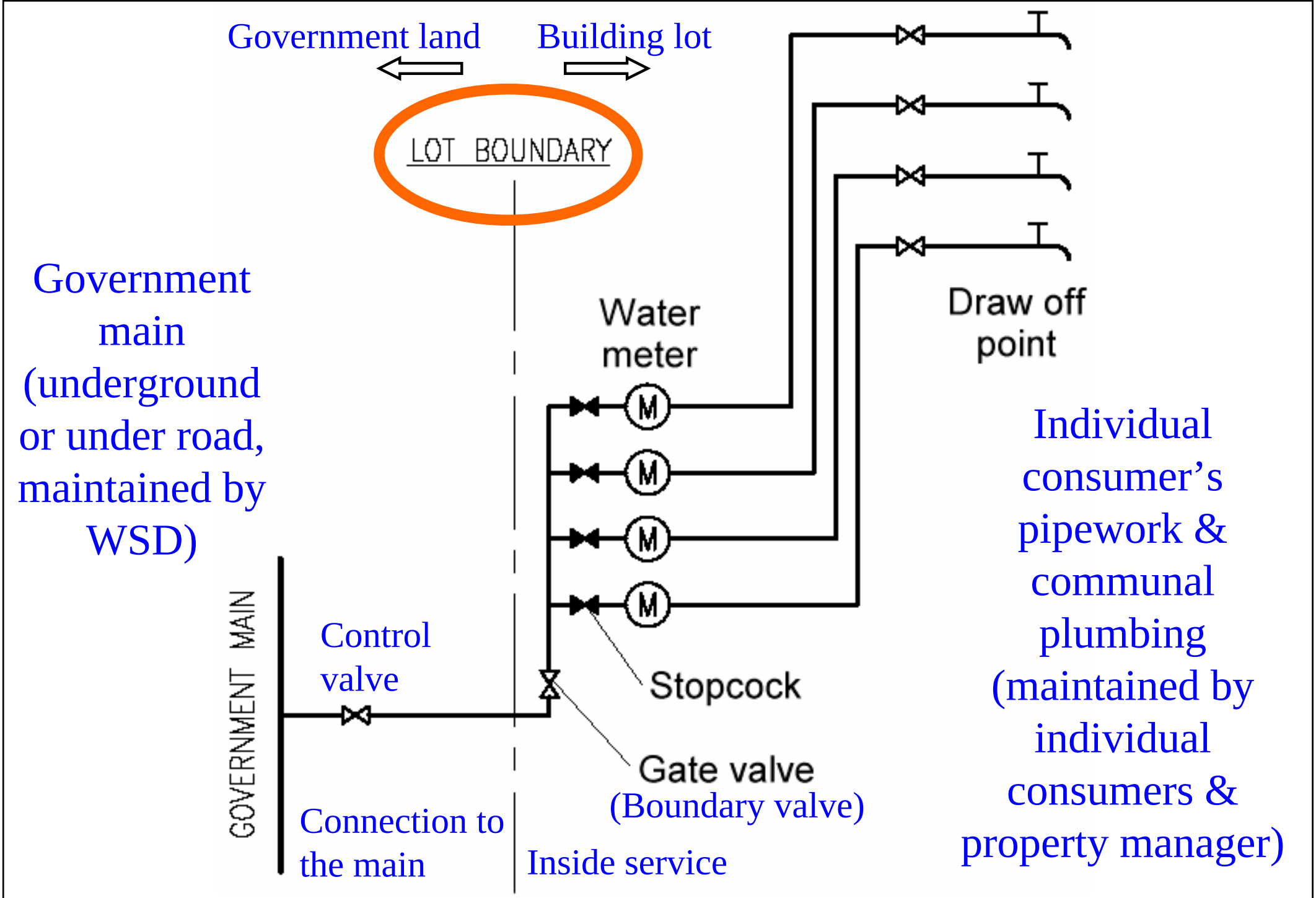


- Pressure of water supplies in HK
  - Fresh water supply: 15-30 metres head
  - Salt water supply: 15 metres head
- They are maintained in the distribution systems except at their extremities
- Reduction of the minimum residual pressure (since 2007): lower from 30- to 20-metre head

Water supply distribution

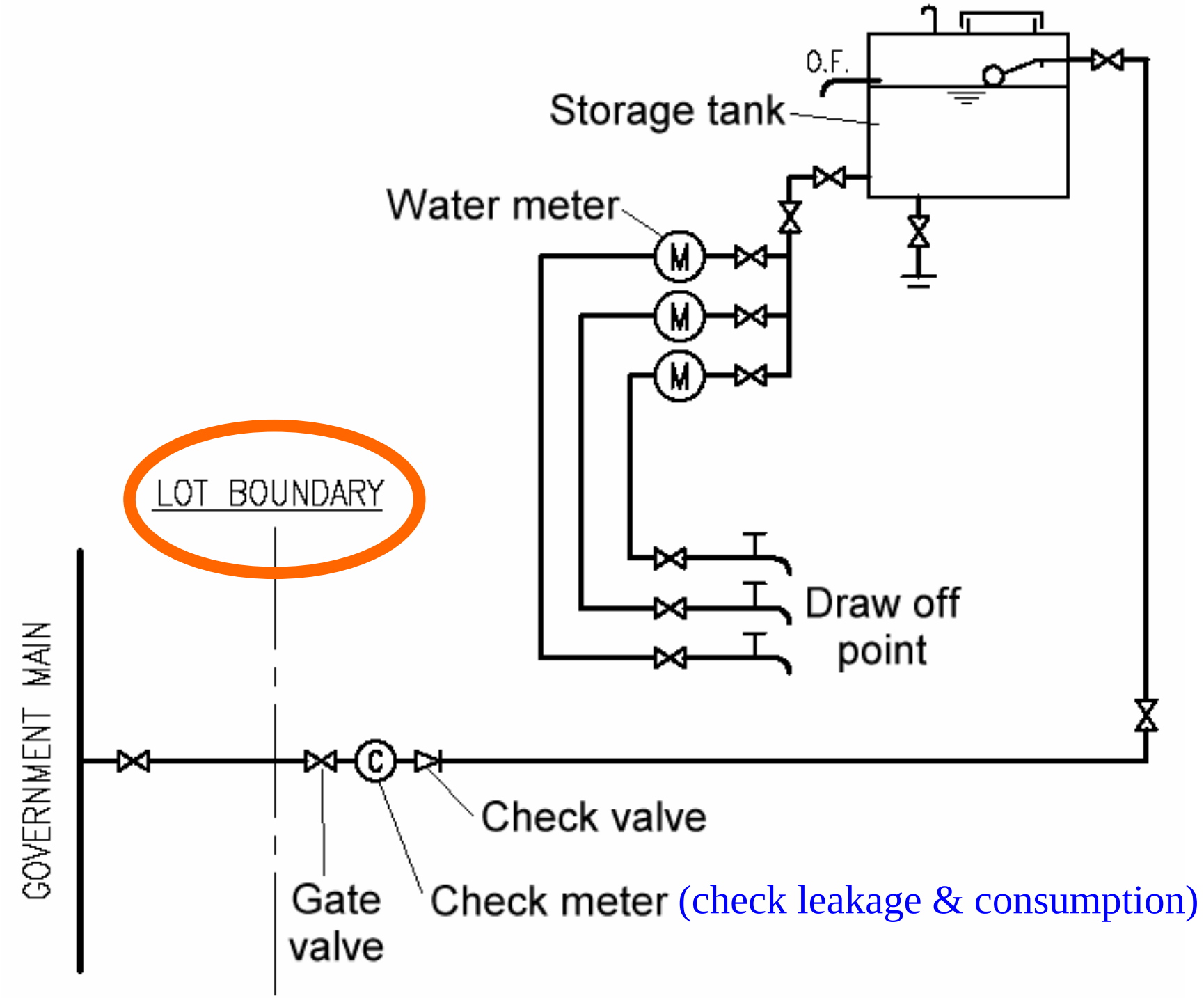


- Water supply systems in buildings
  - *Direct supply system*: conveys water directly from water mains to the point of usage without any transit water storage tanks
  - *Indirect supply system*: conveys water from water mains to the point of usage through a transit water storage tank (usually a sump water tank and a roof water tank)
- Potable/fresh water, flushing/salt water and water for fire services (e.g. FH/HR, sprinkler)



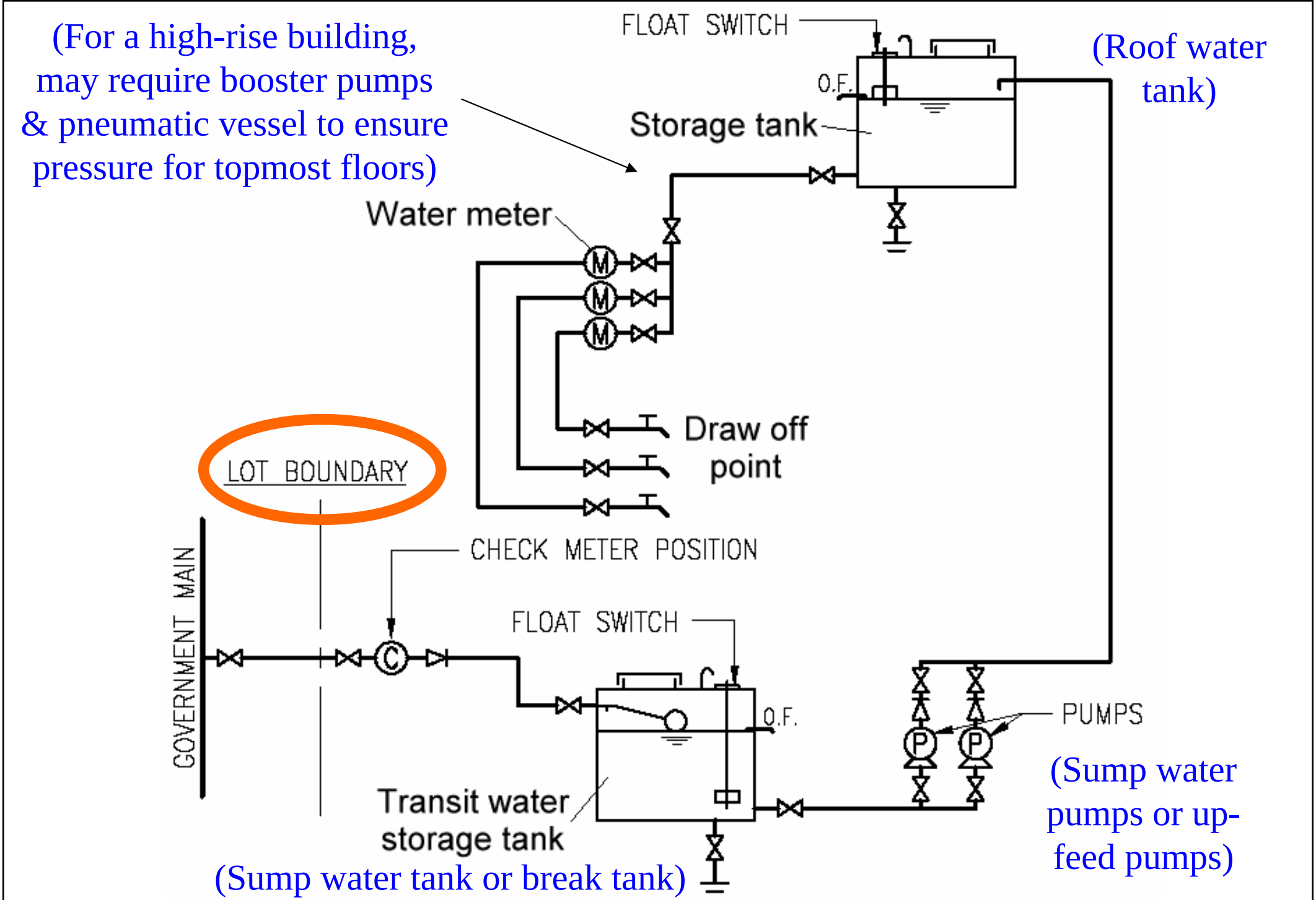
Direct supply system (without storage tank)

(Source: Water Supplies Department, www.wsd.gov.hk)



Direct supply system (with storage tank)

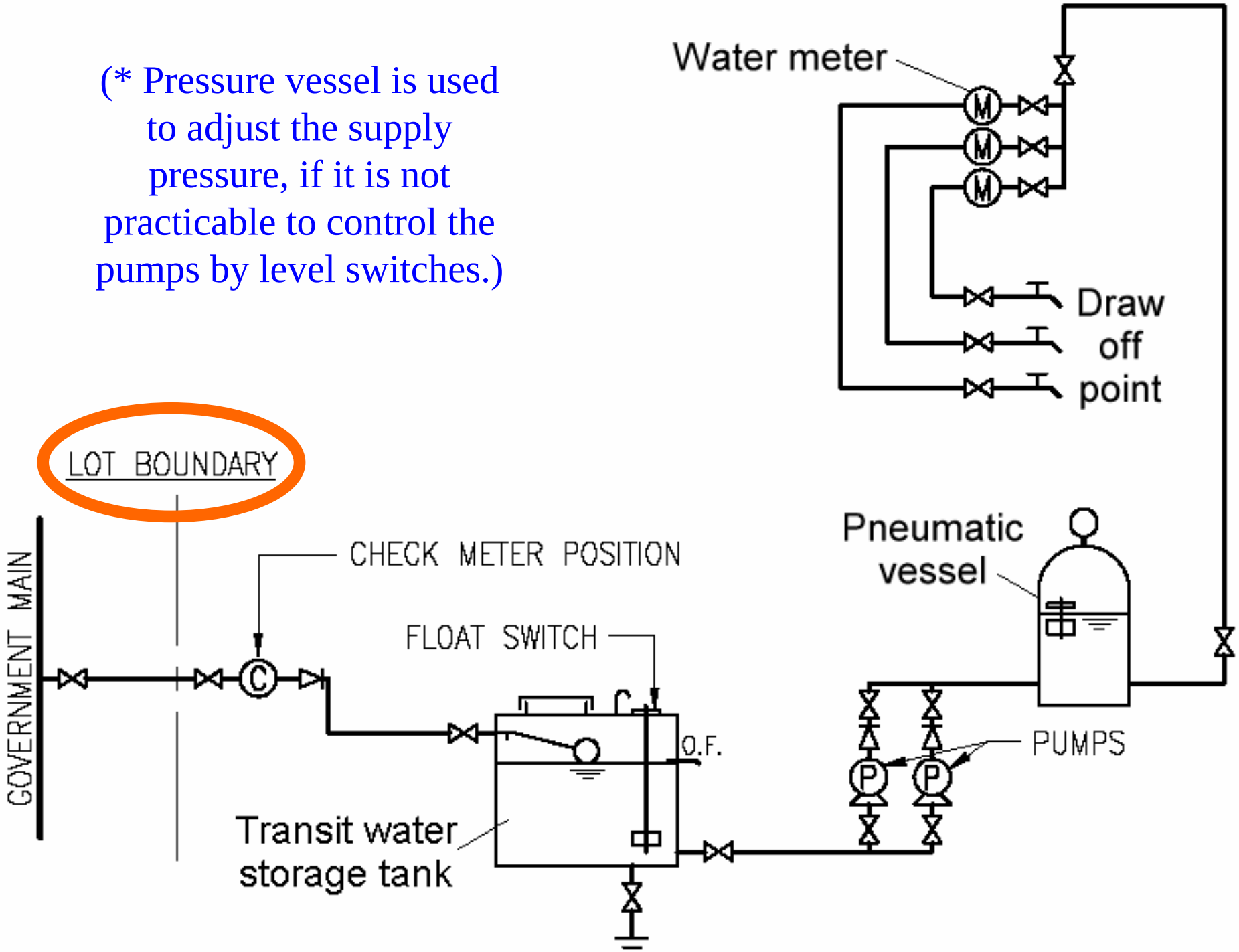
(Source: Water Supplies Department, www.wsd.gov.hk)



Indirect supply system (with sump and pump)

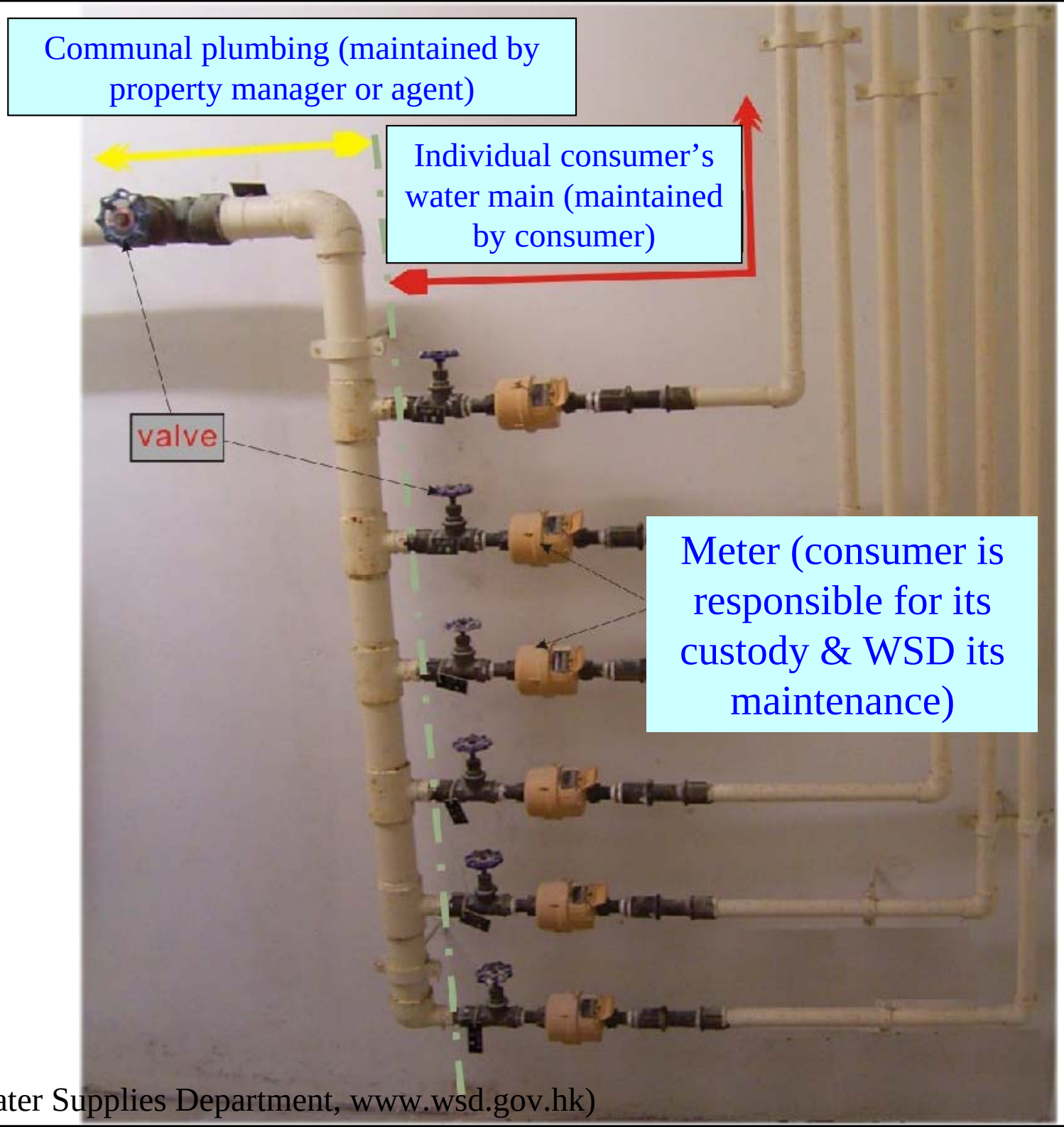
(Source: Water Supplies Department, www.wsd.gov.hk)

(* Pressure vessel is used to adjust the supply pressure, if it is not practicable to control the pumps by level switches.)



Indirect supply system (with pneumatic vessel)

(Source: Water Supplies Department, www.wsd.gov.hk)



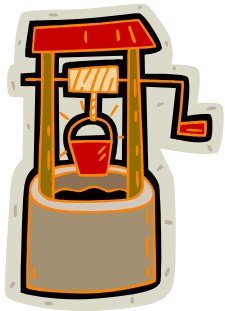
(Source: Water Supplies Department, www.wsd.gov.hk)

(Source: Water Supplies Department, www.wsd.gov.hk)

Comparison of direct and indirect water supply systems

Direct supply	Indirect supply
- Less pipework, smaller or no water tank	- More pipework, large water storage tank
- No storage to satisfy peak demand period	- Water storage to meet peak demand
- Risk of contamination and pressure fluctuation of mains	- Less risk of adverse effects by water mains
- Not feasible for high-rise buildings due to main pressure	- Can be used in high-rise buildings

Water tanks & pumps

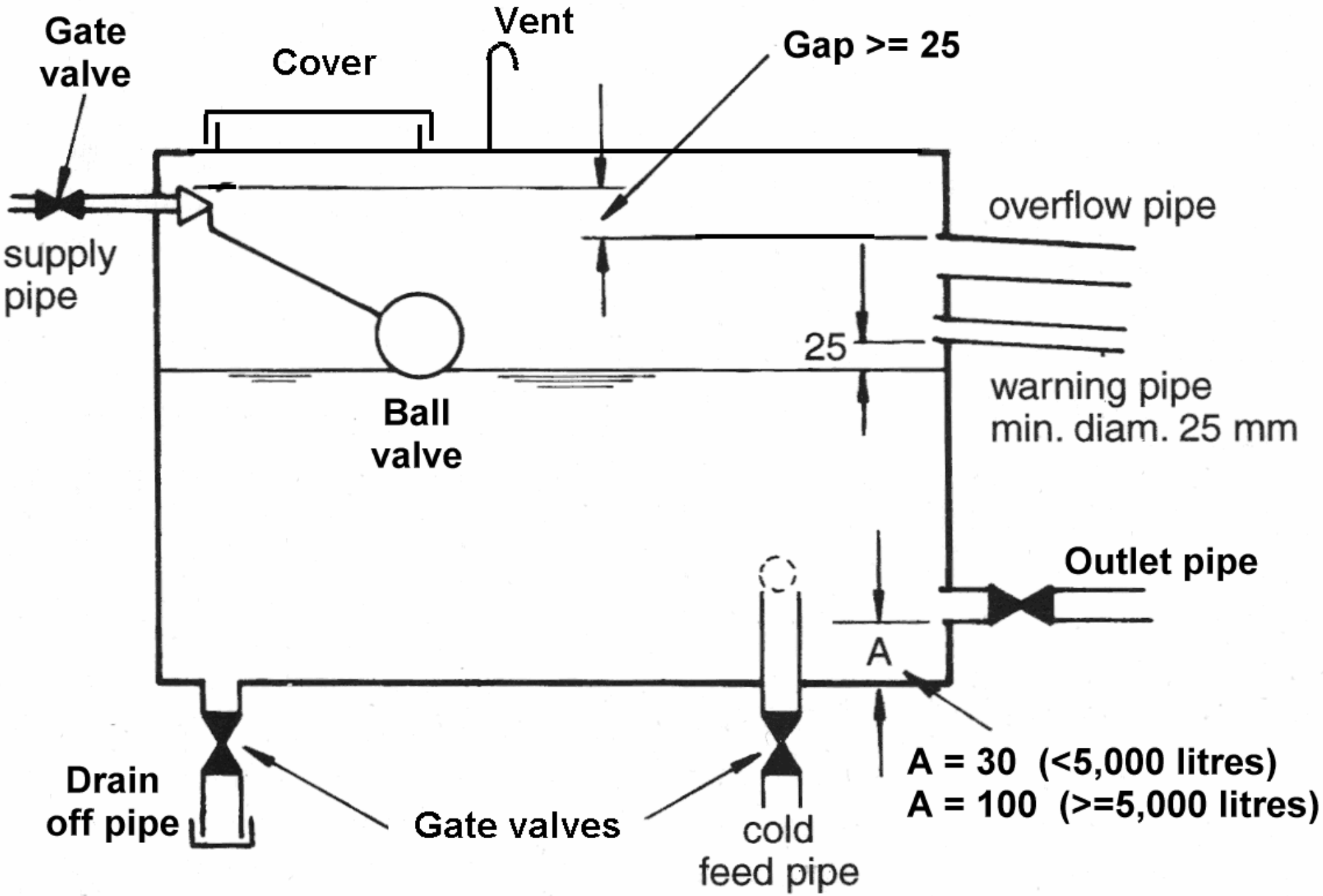


- Water tanks
  - Materials: reinforced concrete, fibre glass, etc.
    - Reinforced concrete is the most common material used
    - Fibreglass storage cistern for potable water shall be of an approved type or certified, with no toxic materials and suitable for storage of potable water
  - Storage capacities:
    - Assessment of water consumption & demand
    - Proportion:- Sump tank : Roof tank = 1 : 3
    - Recommend to meet one-day (24 hours) demand
    - Domestic supply – follows WSD recommendations

Recommended storage capacities in water supply systems

Domestic water supply with sump and pump		**Flushing supply using salt water**	**Temporary mains fresh water for flushing (TMF)**
Up to 10 flats	> 10 flats		
135 litres/flat (total storage including sump tank)	90 litres for each additional flat	Minimum 1/2 day consumption	45 litres per flushing apparatus, minimum 250 litres

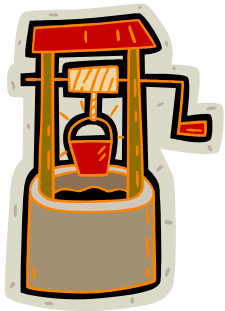
* For industrial use, recommended storage capacity is one-day demand.



Water tank basic requirements (for a gravity supply)

(Source: Garrett, R. H., 2008. *Hot and Cold Water Supply*)

Water tanks & pumps



- Cleansing of water storage tanks
  - Such as sump tank and roof tank
  - They should be cleansed once every three months
- Maintenance of internal plumbing
  - WSD maintains the water supply distribution system up to the building lot boundaries
  - Internal & communal plumbing are maintained by the consumers

Double sealed tank cover with lock

Damaged water tank cover

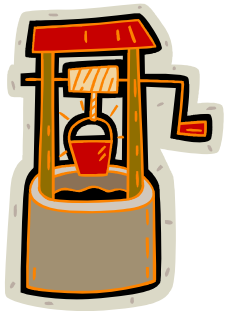
Water tank not cleaned

Rusty water tank cover

Storage tank without proper maintenance & management

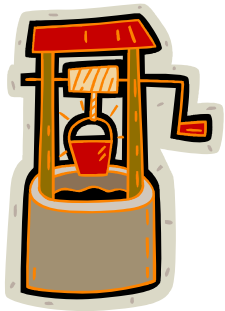
(Source: Water Supplies Department, www.wsd.gov.hk)

Water tanks & pumps

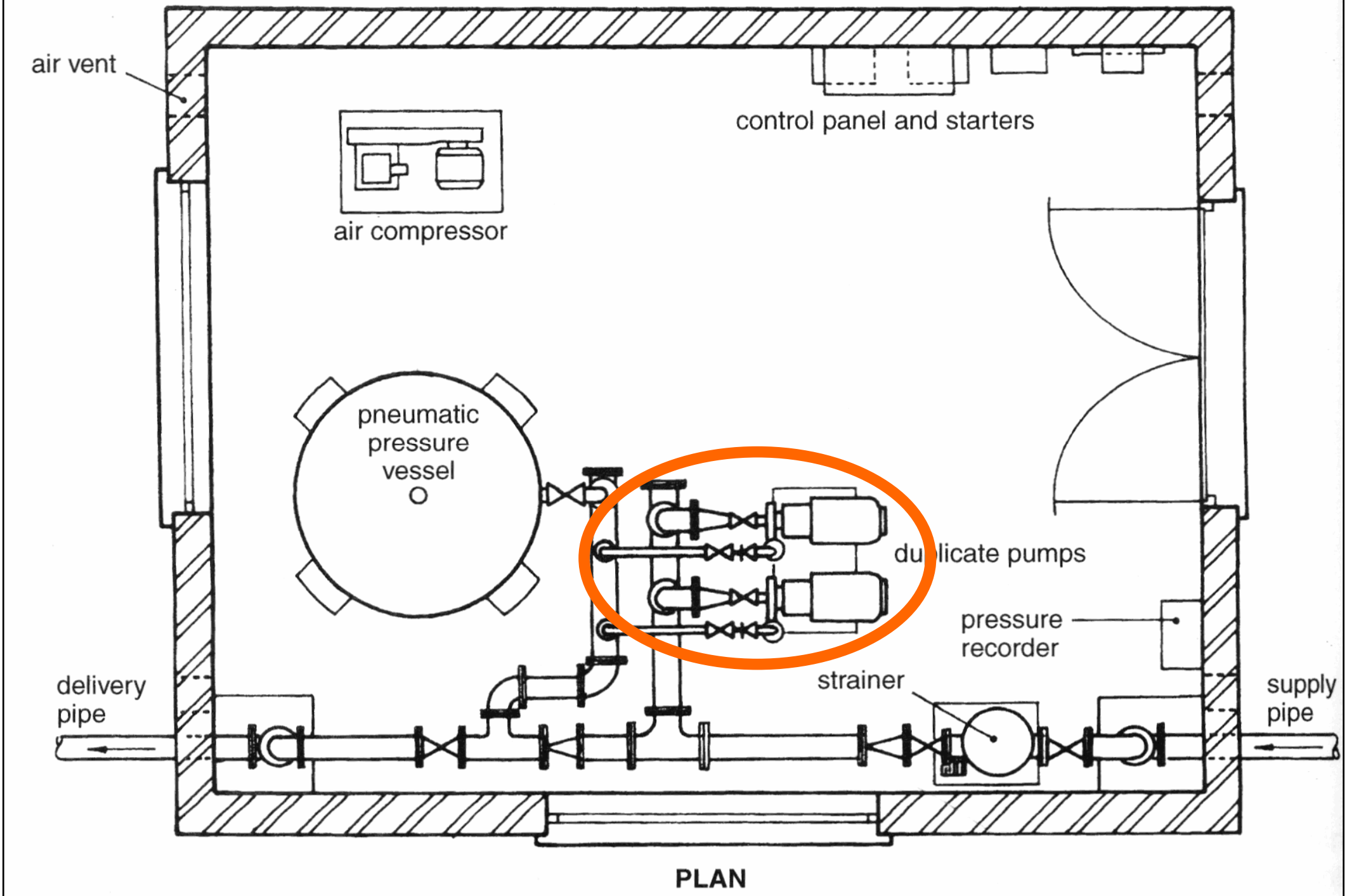


- Water pumps
  - Provide a duplicate set (duty + standby)
  - Pumping capacity >= designed out-flow of tank
  - Minimise vibration and noise problems
    - Adequate pipework support & anchor
    - Solid foundation
- Common pump types
  - Horizontal end suction centrifugal
  - Vertical multistage centrifugal

Water tanks & pumps

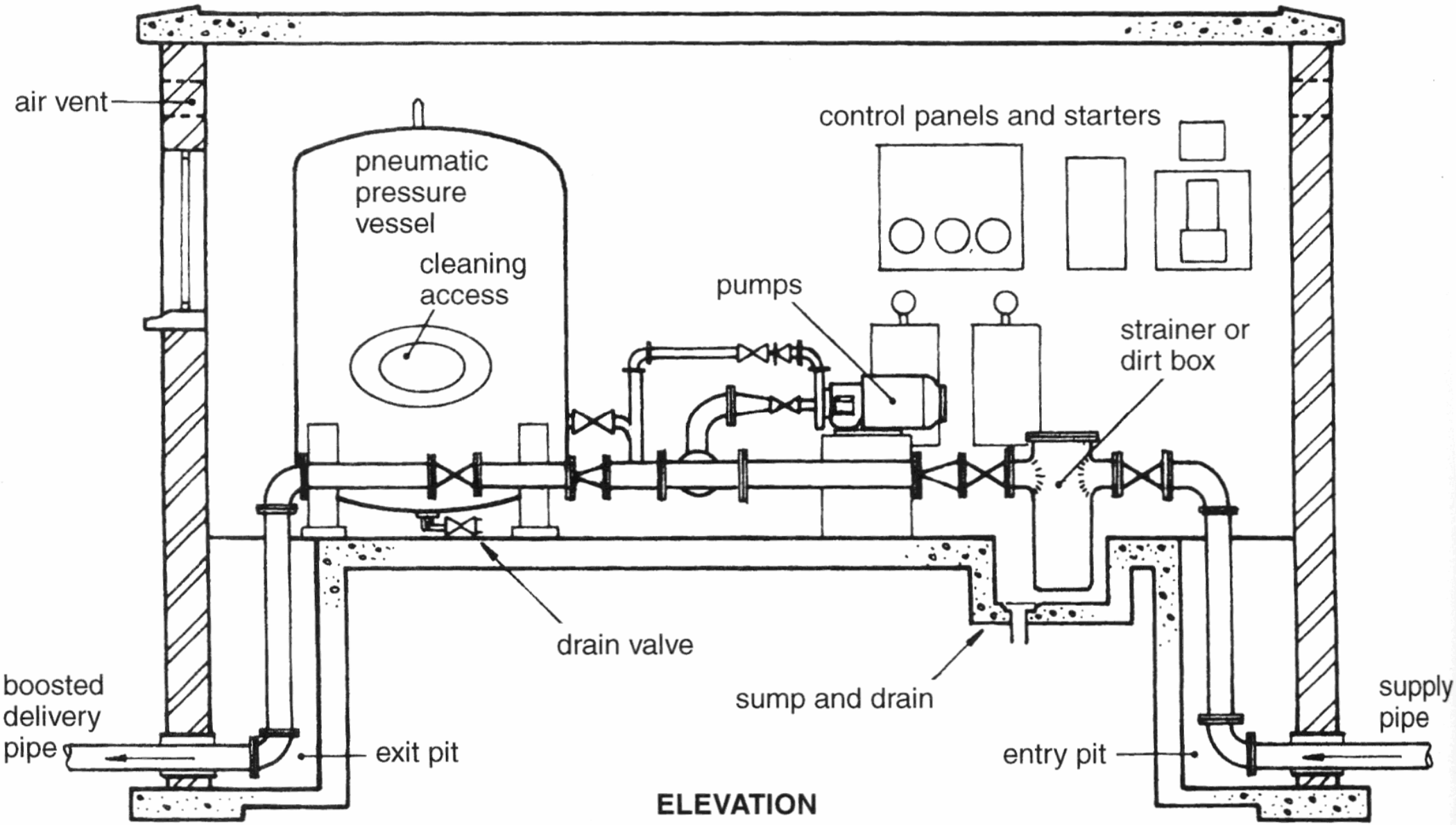


- Pump control
  - Automatic control using pressure switches, level switches, high-level & low-level electrodes
  - Pump selector switch & ON/OFF/AUTO
  - Low-speed preferred (longer life & quiet)
- Pump motor
  - Such as squirrel cage induction type
  - Overload protection (electrical)



Typical pump room

(Source: Garrett, R. H., 2008. *Hot and Cold Water Supply*)



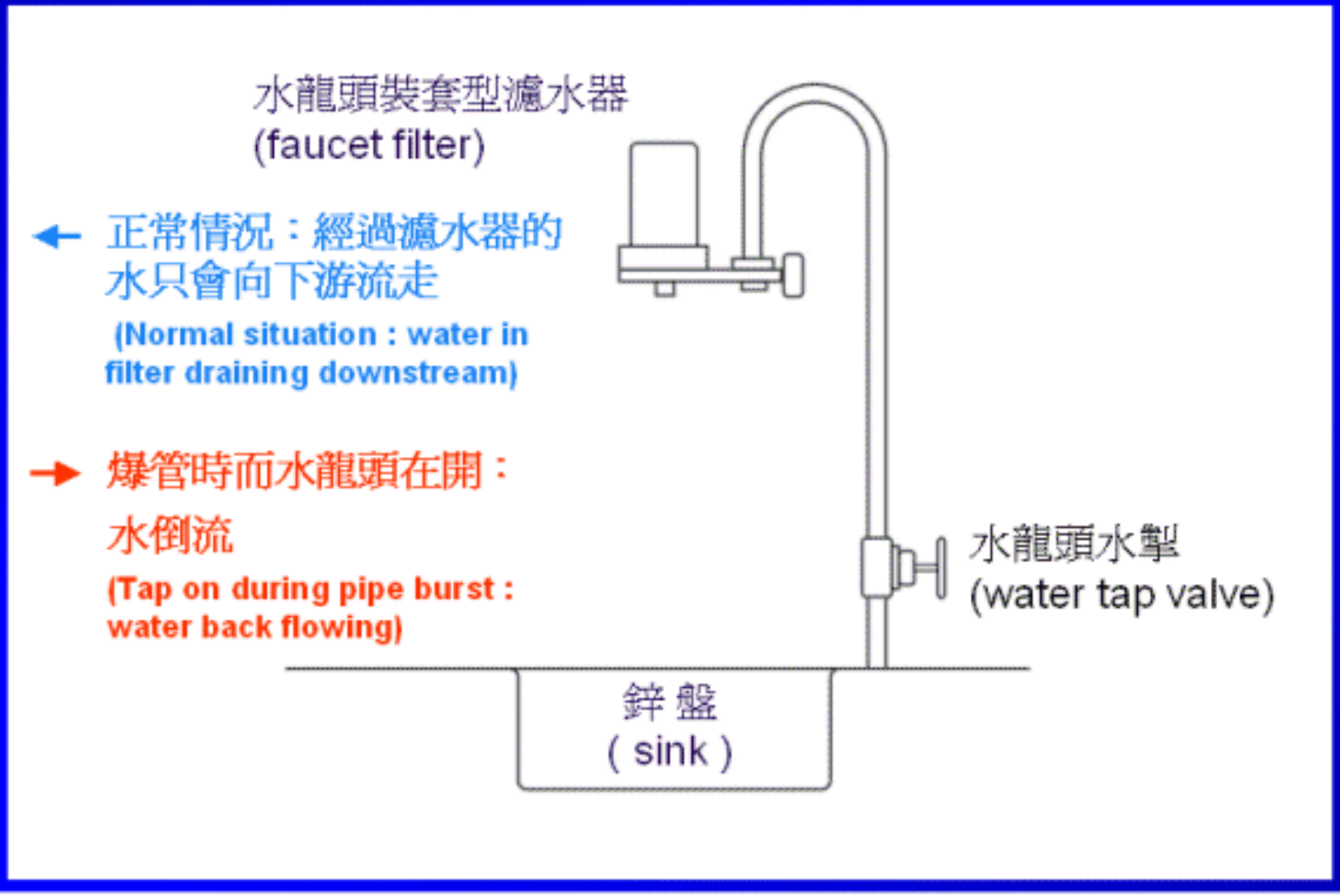
Typical pump room

(Source: Garrett, R. H., 2008. *Hot and Cold Water Supply*)

Water quality & management

- Treated water supplied by WSD at the connection points fully complies with the WHO guidelines for drinking water
- If the water is free from contamination within the plumbing system in a building, it is not necessary to use filter or purifier
- If a filter or purifier is used, it should be properly cleaned & maintained. Non-return valve may be needed to prevent back-flowing

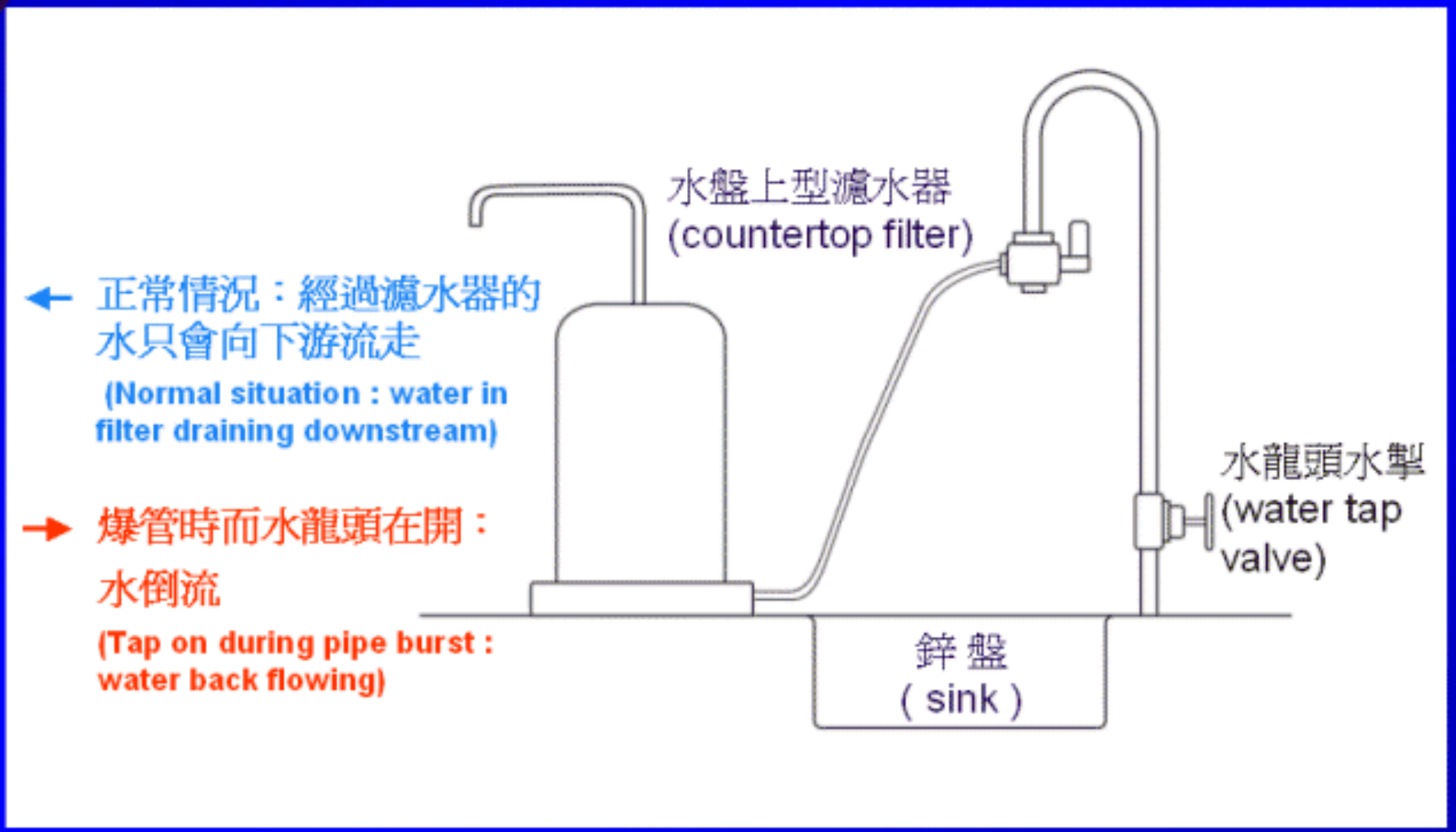
圖二：水龍頭裝套型濾水器
(Fig 2 : Faucet filter)



香港水務署

(Source: Water Supplies Department, www.wsd.gov.hk)

圖三：水盤上型濾水器
(Fig 3 : Countertop filter)



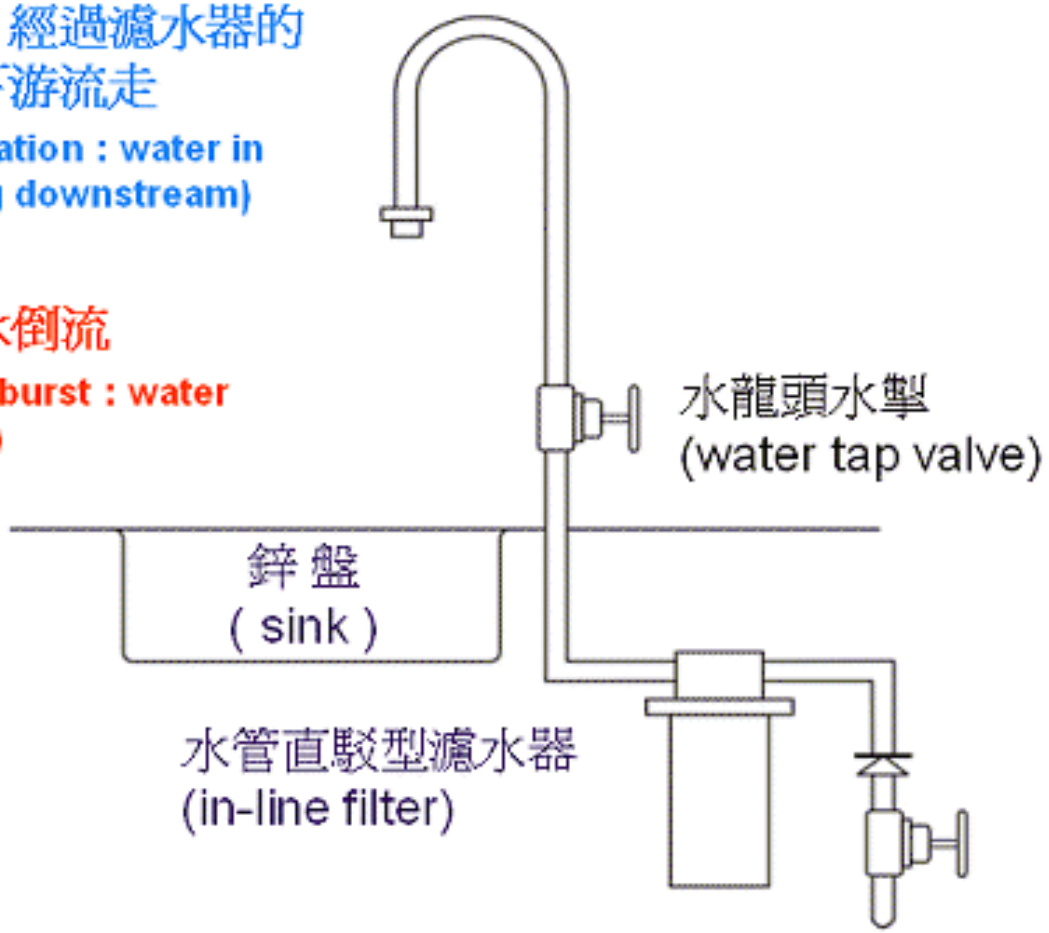
香港水務署

(Source: Water Supplies Department, www.wsd.gov.hk)

圖六：水管直駁型濾水器
(Fig 6 : In-line filter)

← 正常情況：經過濾水器的水只會向下游流走
(Normal situation : water in filter draining downstream)

→ 爆管時：水倒流
(During pipe burst : water back flowing)



香港水務署

(Source: Water Supplies Department, www.wsd.gov.hk)

Water quality & management

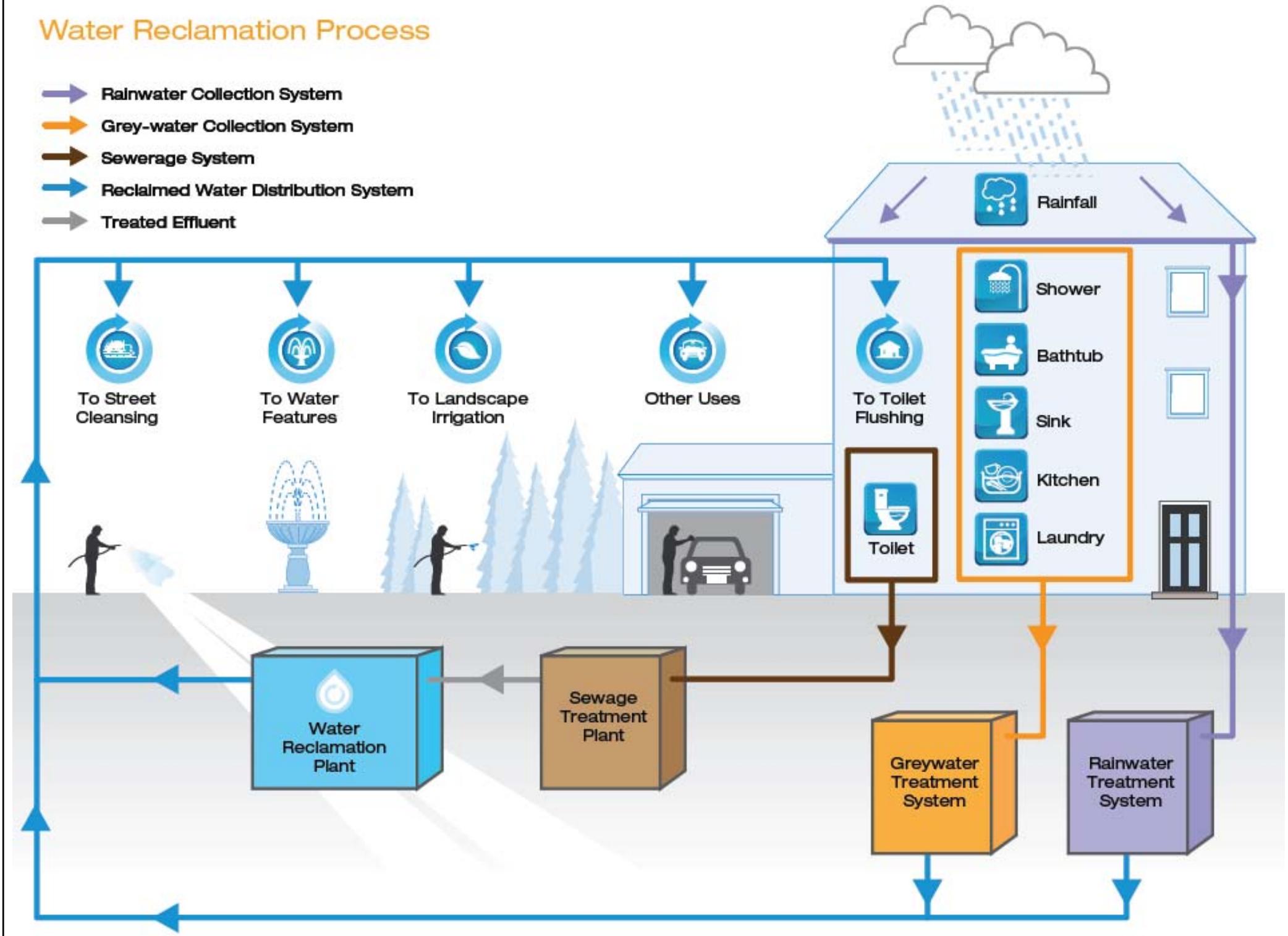
- Quality Water Recognition Scheme for Buildings (by WSD)
  - To encourage building owners to maintain their plumbing systems properly
  - www.wsd.gov.hk/en/html/promote/video8.htm
  - There are 3 grades of certificates:
    - Blue Certificates: New participation or continuous participation with less than 3 years
    - Silver Certificates: Continuous participation 3-5 years
    - Gold Certificates: Continuous participation >= 5 years

Water quality & management

- Since 2000, WSD has launched a programme to replace or rehabilitate the aged water mains
  - For both fresh water and salt water supplies
  - About 3,000 km of water mains (in a network of 7,600 km) to be completed in 15 years
  - Works are carried out in 4 stages
    www.wsd.gov.hk/en/html/edu/rehab/index.htm
    - Video aout the programme
      www.wsd.gov.hk/tc/html/edu/rehab/video9.htm

Water quality & management

- Total Water Management (TWM) strategy
  - Water demand management
    - To enhance public education on water conservation
    - To promote use of water saving devices
    - To enhance water leakage control
    - To extend use of seawater for toilet flushing
  - Water supply management
    - To strengthen protection of water resources
    - To actively consider water reclamation (reuse of greywater & rainwater harvesting)
    - To develop the option of seawater desalination



(Source: Water Supplies Department, www.wsd.gov.hk)

Water quality & management

- Inspect and maintain plumbing to prevent water leaks
  - www.wsd.gov.hk/en/html/promote/video7.htm
- Checking of water leakage: simple method
  - Turn off all water taps
  - Compare the water meter reading over a 30-minutes period
  - If the water meter registers flow when all water taps are turned off, it implies leaking
- However, this method cannot detect very small leakage (seepage)