

## Unit 2 Water

### 2.6 Water conservation and pollution

#### Teaching scheme

Learning element in Science	Framework of National Security Education		Suggested learning activity
<ul style="list-style-type: none"> <li>Recognize that water is a precious natural resource</li> <li>Recognize the importance of water conservation and the ways to conserve water</li> <li>Recognize some causes of water pollution and the harmful effects of water pollution on humans and the environment</li> <li>Be aware of our responsibility to minimize water pollution</li> </ul>	<u>Strand 1</u> The concept and importance of national security	<ul style="list-style-type: none"> <li>Understand the definition of national security and the 13 domains of national security<sup>#</sup> (e.g. resource security)</li> </ul>	<b>Classroom activities:</b> Discuss with students about: <ul style="list-style-type: none"> <li>Sources of fresh water in Hong Kong</li> <li>Importance of water conservation and the ways to conserve water</li> <li>Negative effects of water shortage on the society, economy and environment</li> <li>Importance of water conservation to the sustainable development of the Hong Kong SAR and our country</li> </ul> <b>After-class activities:</b> <ul style="list-style-type: none"> <li>Cross-curricular activity: collaborate with Design and Applied Technology to make a water-saving device using 3D-printing technology (STEM)</li> <li>Site visit: H<sub>2</sub>O Public Education (H<sub>2</sub>OPE) Centre</li> </ul>
	<u>Strand 7</u> Major domains of national security	<ul style="list-style-type: none"> <li>Understand the importance of homeland security, resource security and nuclear security to the social-economic development of the country</li> <li>Explore topics related to ecological security and new security domain (e.g. biodiversity, conservation, and exploration and protection of deep seas and polar regions), understand the impact of human activities on the ecology and environment, and the necessity of safeguarding ecological security and new security domain</li> </ul>	

<sup>#</sup> The 13 domains of national security include: political security, homeland security, military security, economic security, cultural security, social security, technological security, cyber security, ecological security, resource security, nuclear security, overseas interests security and new security domain.

## Teaching notes

### (A) Fresh water supply in early Hong Kong

Hong Kong does not have natural lakes, large rivers or groundwater (地下水) reserves. Before the 1860s, Hong Kong relied only on streams and water wells to supply fresh water. In 1860, to cope with the increasing demand for fresh water, the government started to build impounding reservoirs (水塘) to collect and store rainwater (Fig a). By 1978, 17 reservoirs had been built.



**Fig a** Pok Fu Lam Reservoir (薄扶林水塘), the first impounding reservoir in Hong Kong

### (B) Water shortages in Hong Kong

The water supplies from streams, water wells and reservoirs greatly depend on precipitation (降水), but rainfall in Hong Kong can show huge variations from year to year. When rainfall is low, water shortages may occur and water rationing (制水) may be needed.

There were several rounds of water rationing from 1895 to 1982 in Hong Kong. In the most severe phase of the droughts (乾旱) of 1963 and 1964, water was only supplied to the public for four hours every four days (Fig b).



Learn more about the supply of water in Hong Kong on the Water Supplies Department (WSD) website at:

<https://www.wsd.gov.hk/en/home/>



**Fig b** People queuing for fresh water during water rationing  
(Photo credit: [https://www.wsd.gov.hk/filemanager/en/share/pdf/DJW\\_Leaflet-e.pdf](https://www.wsd.gov.hk/filemanager/en/share/pdf/DJW_Leaflet-e.pdf))

Water shortages can have serious impacts on the society, economy and environment. For example:

- hygienic conditions become worse due to insufficient water for showering and cleaning;
- certain diseases (e.g. cholera 霍亂) may spread more easily as people may drink untreated water from streams;
- conflicts may occur when people use or collect water during water rationing;
- farm production drops because crops cannot grow without water;
- industrial production (e.g. textiles) drops and, hence, income of workers falls.

### (C) Importing fresh water from the Mainland

To ease the problem of water shortages, the government had imported water from the Zhujiang (珠江) since the early 20th century. In 1960, an agreement was reached between the governments of Hong Kong and Guangdong Province (廣東省) to supply water to Hong Kong from Shenzhen Reservoir (深圳水庫). To further secure fresh water supply, the Hong Kong government signed another agreement with the Guangdong government in 1963 to purchase water from the Dongjiang (東江). Today, about 70% of the fresh water consumed in Hong Kong is imported from the Dongjiang, with the rest supplied by local reservoirs.

The Dongjiang originates in Jiangxi Province (江西省). It provides fresh water for more than 40 million people in Guangdong Province and Hong Kong. Dongjiang water is first carried through water pipes to Shenzhen Reservoir. It is then delivered to Muk Wu Raw Water Pumping Station (木湖原水抽水站) in Hong Kong (Fig c). Finally, the water is delivered to water treatment works (濾水廠) for purification, or to local reservoirs for storage.



**Fig c** The supply route of Dongjiang water

To ensure that the quality of Dongjiang water meets the national standard, a number of measures are taken. For example:

- remove polluting factories and farms along the Dongjiang;
- raise water charges to discourage water usage;
- build dedicated (專用) water pipes (Fig d) from the Dongjiang to Shenzhen Reservoir (Fig e);
- install facilities to prevent polluted water from flowing near pumping stations;
- build a biological treatment plant at Shenzhen Reservoir to improve water quality;
- closely monitor the quantity and quality of water in the Dongjiang river basin (流域).

Protecting the water quality of the Dongjiang also helps secure water resources of our country.



**Fig d** Dedicated water pipes for transporting Dongjiang water



**Fig e** Shenzhen Reservoir for storing water from the Dongjiang

## (D) Planning for the future

The average amount of water resources available from the Dongjiang is only 1100 m<sup>3</sup> per person per year. The Dongjiang river basin is classified as an area of water scarcity (稀缺) by international standards and the consumption of Dongjiang water is close to its exploitation limit. Therefore, a scheme was implemented to allocate the amount of water distributed to cities along the Dongjiang. This means the supply of Dongjiang water may not be sufficient for the growing population and economy of Hong Kong in the future.

To ensure water security and support the development of Hong Kong, the government prepared a Total Water Management Strategy (全面水資源管理策略) in 2008. The primary approaches of the strategy are (1) promoting water conservation and (2) finding new water sources.

### (1) Promoting water conservation

Examples:

- educate the public about ways to save water;
- promote the use of water-saving devices;
- reduce leakage rates of government pipes;
- extend sea water supply network for flushing.

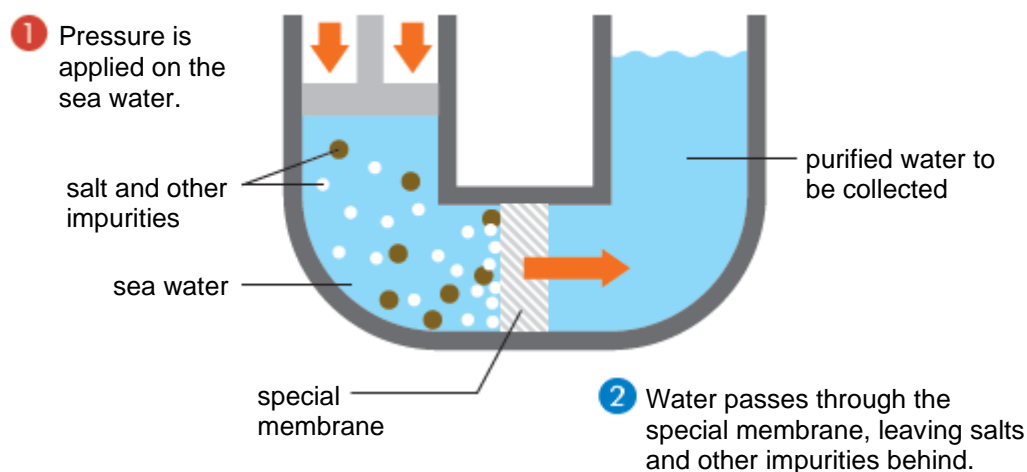


Find out more ways of water conservation at:  
<https://www.waterconservation.gov.hk/en/home/index.html>

## (2) Finding new water sources

### (a) Desalination

Desalination (海水化淡) is the process of removing salt in sea water to produce fresh water. Its conventional approach involves distillation of sea water. However, the cost of heating water is very high. Modern desalination makes use of a technology called reverse osmosis (逆滲透). Its production cost is much lower. Fig f shows how reverse osmosis works.

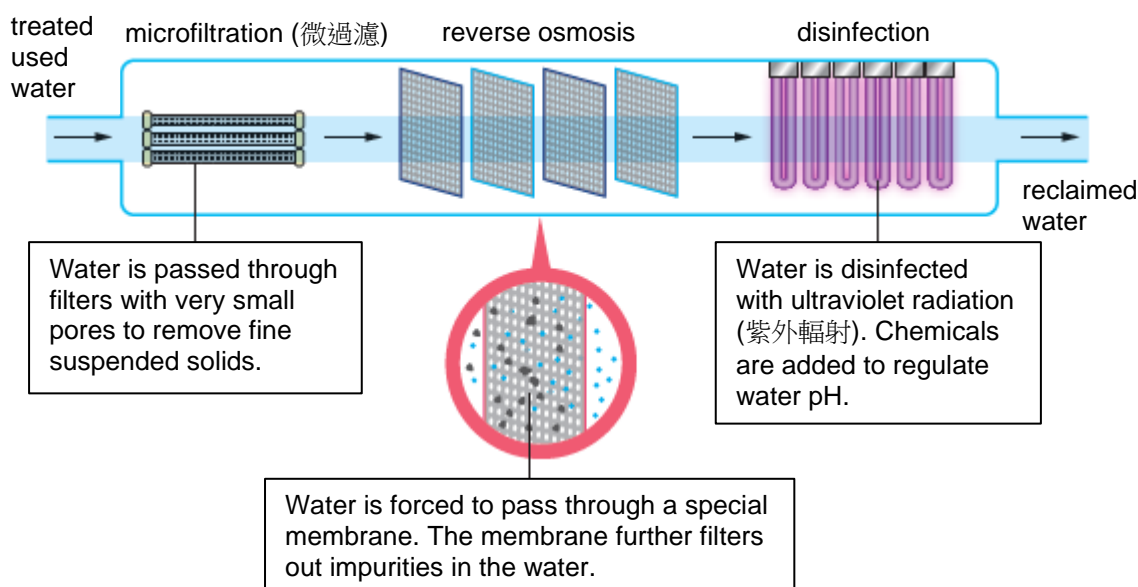


**Fig f** Reverse osmosis

A desalination plant is being built in Tseung Kwan O. It makes use of reverse osmosis to produce fresh water. It is expected to be completed in 2023, and can supply about 5% of the total fresh water consumption of Hong Kong.

### (b) Reclaimed water

Reclaimed water (再造水) is purified waste water. Its production involves reverse osmosis and typical water treatment methods (Fig g).



**Fig g** Process of producing reclaimed water



In Hong Kong, reclaimed water is produced in the following four sewage treatment works at present:

- Ngong Ping Sewage Treatment Works (昂平污水處理廠)
- Sha Tin Sewage Treatment Works (沙田污水處理廠)
- Tai Po Sewage Treatment Works (大埔污水處理廠)
- Sai Kung Sewage Treatment Works (西貢污水處理廠)



In Singapore, reclaimed water provides about 40% of the fresh water consumed. Learn more about this at:

<https://www.pub.gov.sg/watersupply/four-nationaltaps/newwater>

The reclaimed water is only used for non-drinking uses, such as flushing toilets, cleaning roads and vehicles, irrigating parks and sport fields, and industrial production.

## Discussion guidelines for teachers

- 1 Explore the main sources of fresh water in Hong Kong.
- 2 Discuss the possible causes of water shortages.
- 3 Outline the effects of water shortages on the society, economy and environment.
- 4 Describe the measures taken to secure the quality of fresh water supplied to Hong Kong.
- 5 Discuss ways of conserving water at the personal level.

## Worksheet

- 1 Hong Kong does not have large natural water storages (e.g. **(a)** \_\_\_\_\_ , **(b)** \_\_\_\_\_ and **(c)** \_\_\_\_\_). In the late 19th century, the Hong Kong government started to build **(d)** \_\_\_\_\_ to collect and store rainwater. There are **(e)** \_\_\_\_\_ of them in Hong Kong.
- 2 Water shortages may occur when there is a **(a)** \_\_\_\_\_ (i.e. when rainfall is low). During water shortages, water **(b)** \_\_\_\_\_ may be needed. Impacts of water shortages include worsening **(c)** \_\_\_\_\_ conditions, spreading of **(d)** \_\_\_\_\_ , conflicts between people collecting water, and drop in industrial production.
- 3 The Dongjiang originates in **(a)** \_\_\_\_\_. It supplies water to people in **(b)** \_\_\_\_\_ and Hong Kong. Dongjiang water is first transported to **(c)** \_\_\_\_\_ , then delivered to Hong Kong.
- 4 To secure water resources, we can conserve water. For example, we can install **(a)** \_\_\_\_\_ devices and use **(b)** \_\_\_\_\_ for flushing.
- 5 Another approach of securing water resources is creating new water sources.
  - Fresh water can be produced by **(a)** \_\_\_\_\_. Salts and other impurities are removed from seawater by pushing seawater through a special membrane. This technique is called **(b)** \_\_\_\_\_ .
  - Wastewater can be purified to produce **(c)** \_\_\_\_\_ water.
- 6 **(a)** Explain the working principle of distillation in producing fresh water by desalination.  
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- (b)** With reference to Fig g, state how the special membrane used in reverse osmosis separates salt from water.  
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**Answers**

- |          |          |   |          |                    |          |                    |
|----------|----------|---|----------|--------------------|----------|--------------------|
| <b>1</b> | <b>a</b> | lakes   | <b>b</b> | rivers             | <b>c</b> | groundwater        |
|          | <b>d</b> | impounding reservoirs   | <b>e</b> | 17                 |          |                    |
| <b>2</b> | <b>a</b> | drought   | <b>b</b> | rationing          | <b>c</b> | hygiene            |
|          | <b>d</b> | diseases  |          |                    |          |                    |
| <b>3</b> | <b>a</b> | Jiangxi Province  | <b>b</b> | Guangdong Province | <b>c</b> | Shenzhen Reservoir |
| <b>4</b> | <b>a</b> | water-saving  | <b>b</b> | seawater           |          |                    |
| <b>5</b> | <b>a</b> | desalination  | <b>b</b> | reverse osmosis    | <b>c</b> | reclaimed          |
| <b>6</b> | <b>a</b> | When seawater is heated, only water boils into water vapour. Salt remains in the seawater. The water vapour is then condensed to liquid water in the condenser. |          |                    |          |                    |
|          | <b>b</b> | Salt is larger than the pores on the special membrane. It cannot pass through the membrane.   |          |                    |          |                    |