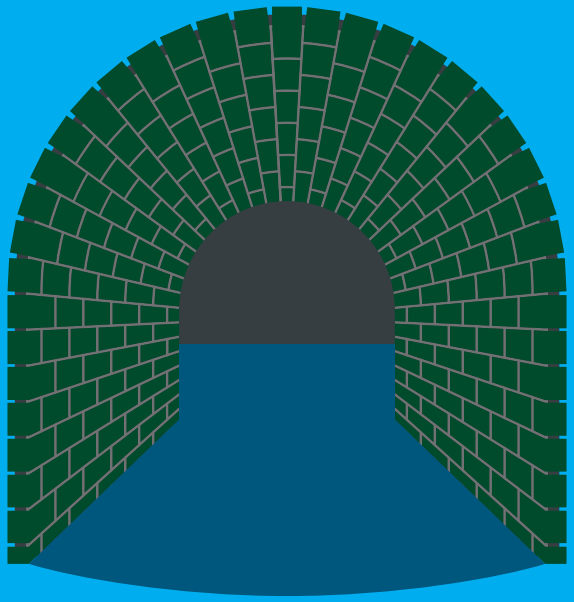
MAYOR OF LONDON

THE LONDON CURRICULUM

CHEMISTRY KEY STAGE 3

HEALTHY LONDON WATER



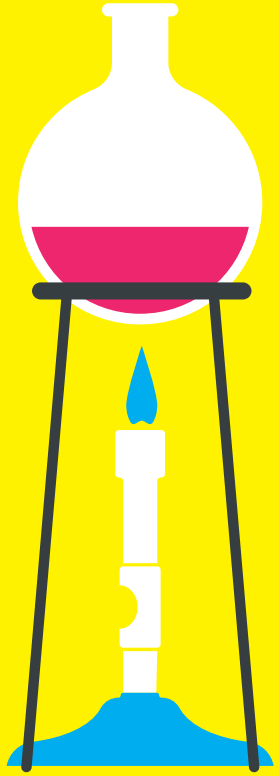
UCL
Institute of Education

THE LONDON CURRICULUM

PLACING LONDON AT THE HEART OF LEARNING

The capital is the home of innovations, events, institutions and great works that have extended the scope of every subject on the school curriculum. London lends itself to learning unlike anywhere else in the world. The London Curriculum aims to bring the national curriculum to life inspired by the city, its people, places and heritage.

To find out about the full range of free resources and events available to London secondary schools at key stage 3 please go to www.london.gov.uk/london-curriculum.



STEM in the London Curriculum

London provides numerous historical and contemporary cutting edge examples of scientists, engineers and mathematicians who have worked in their fields to create innovative solutions to problems throughout the world. Population growth, trade, communication, transport, health, food, water supply and many other aspects of life in London have driven technology-based innovations. London Curriculum science, maths, design & technology teaching resources aim to support teachers in helping their students to:

- **DISCOVER** the application of their subject knowledge to the life of the city.
- **EXPLORE** their neighbourhood and key sites around London, learning outside the classroom to see and understand how STEM subjects have shaped many aspects of the city.
- **CONNECT** their learning inside and outside the classroom, analysing situations and using their subject knowledge to create and present solutions.

CONTENTS

CONDUCTING A RISK ASSESSMENT

For learning outside the classroom

It is the responsibility of each institution, delegated to the class teacher, to make risk assessments for a given class and a given location. Guidance can be found through the membership organisation CLEAPSS for all school science.
www.cleapss.org.uk

More general guidance on risk assessment for school trips can be found here:
www.atl.org.uk/health-and-safety/off-site-trips/risk-assessment-school-trips.asp

For practical work

A general guide for health and safety guidance and risk assessment of practical work can be found here:
www.nuffieldfoundation.org/standard-health-safety-guidance

If any additional specific guidance is necessary for particular practicals, this will be found within the instructions for each practical.

KEEPING LONDONERS HEALTHY OVERVIEW

UNIT AIMS AND OBJECTIVES

London's population is now around 9 million, the biggest ever. One of the major challenges in protecting the health of people in the city is to be able to provide water that is fit to drink. With an increasing London population we are faced with difficult questions:

- Would Londoners be happy to drink water that has been recovered from sewage directly?
- Do we know or care what effect our waste has on the sewers and water treatment plants?
- What causes 'fatbergs'?
- Can we help to prevent blockages in the sewers?

This unit relates to the pure and impure substances section of the science (chemistry) national curriculum. Students will consider what we mean by pure substances and how polluted water can be cleaned and stored. They will consider contemporary technological developments that are aiming to resolve issues related to the Victorian system that is still largely in use, as well as celebrating the history of technology that has supported the population of London over the centuries. Students can explore their own locality and become involved in local citizen science projects measuring the quality of local water in ponds and lakes. They may also visit water works, both those that are still working and those that relate to the history of water and the processing of waste in London.

THE RIVER THAMES

KEY STAGE 3 NATIONAL CURRICULUM

This unit covers some of the subject content of the new key stage 3 science national curriculum. Students will learn about:

Pure and impure substances

- the concept of a pure substance
- mixtures, including dissolving
- simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography
- the identification of pure substances

Chemical reactions

- the pH scale for measuring acidity/alkalinity; and indicators

In addition students will work scientifically and be taught to:

Scientific attitudes

- pay attention to objectivity and concern for accuracy, precision, repeatability and reproducibility
- understand that scientific methods and theories develop as earlier explanations are modified to take account of new evidence and ideas, together with the importance of publishing results and peer review
- evaluate risks

Experimental skills and investigations

- ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience
- make predictions using scientific knowledge and understanding
- select, plan and carry out the most appropriate types of scientific enquiries to test predictions, including identifying independent, dependent and control variables, where appropriate
- use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety
- make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements
- apply sampling techniques

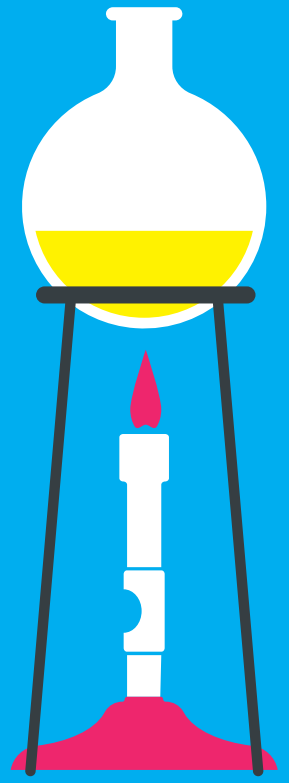
Analysis and evaluation

- apply mathematical concepts and calculate results
- present observations and data using appropriate methods, including tables and graphs
- interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions
- present reasoned explanations, including explaining data in relation to predictions and hypotheses
- evaluate data, showing awareness of potential sources of random and systematic error
- identify further questions arising from their results.

DISCOVER

Students will be encouraged to consider the issues that are involved in maintaining health through having access to clean water. Having recapped the water cycle from the primary national curriculum the discover lessons extend learning to an understanding of the human impacts on the water cycle i.e. water use and disposal of waste.

Students will be engaged in a mixture of practical inquiry and the use of evidence about current technological developments to assess possible solutions for the London of the future.



LESSON 1
PRESSURE ON WATER SUPPLIES FOR LONDON

THE BIG IDEA

As the London population has grown over time, pressure on water supplies has increased. This lesson, which sets the scene for the unit, considers changing sources of drinking water and the relationship that our domestic use of water has to the water cycle that students will have learned about in primary school. Scientific attitudes, such as developing theories over time, and managing risk, are introduced here.

LEARNING OUTCOMES

Could evaluate different news items to judge their reliability and objectivity.

Should be able to explain how our use of water has expanded as London has grown bigger and that this has led to the need for recycling water from waste water.

Should be able to recall the water cycle and apply the idea to recycling water for domestic use.

Must understand that we all need clean water to drink in order to stay healthy.

RESOURCES

Resource 1.1: Where does our water come from and go to?

Resource 1.2: Where does our water come from – prompt sheet

Resource 1.3: Summary of suggested news items with links

Resource 1.4: London over time maps

Resource 1.5: Card sort for maps activity

LESSON 1
PRESSURE ON WATER SUPPLIES FOR LONDON

YOU WILL ALSO NEED

- Facility to show short film

  www.thameswater.co.uk/help-and-advice/18055.htm

KEYWORDS

- Reservoir
- Water treatment works
- Londinium
- Sewage
- Potable
- Hydration
- Evaporation
- Condensation
- Aquifer
- Recycle
- Water cycle

LESSON 1: PRESSURE ON WATER SUPPLIES FOR LONDON

SETTING THE SCENE

London (Londinium) was established by the Romans and has grown massively over time. Since 1700, London has been Europe's largest city and today it has a population of almost 9 million people. The infrastructure to support so many people with clean water for drinking and other purposes, and the effective removal of wastewater, is imperative to keeping such a large population healthy. London is now considered to be a water-stressed city with respect to the availability of water and hence better water management is important. Connecting the idea of the water cycle to water treatment in a real way involves considering water's journey and how we clean it for re-use. The history of London's development makes an interesting story which shows how engineering solutions have developed in response to the challenges of life in a growing and highly populated city.

STANDPIPE TOWER AT LONDON MUSEUM OF WATER & STEAM

Ed Stannard © Wikimedia Commons

The Romans developed a system of transferring water to the city from surrounding areas via channels. In the middle ages water was largely drawn from wells and conduits were also used. Water taken from the Thames had two main problems; it was tidal at the centre of London and was also sometimes foul with waste. The conduits consisted of towers to raise water and channels to deliver this water to the surrounding areas. The Great Conduit ran from Tyburn to Cheapside and there were around 12 other conduits delivering water from further afield to the centre of the city. Water carriers (known as Cobs) with horses and carts delivered water to houses but soon wealthy people started to join their houses to the conduits. The Great Fire of London of 1666 destroyed much of this infrastructure and also the sewerage system as existed.

The cholera outbreak in 1832 and subsequent understanding of how disease spreads in water led to the development of reservoirs and water supply from further afield. Thames water was now only taken from above Teddington, beyond tidal reaches, and a new sewage system was developed to deal with waste. Today a new ‘super sewer’ is planned to deliver waste to Beckton from across London. This will include a new system to cope with overflowing sewers, caused by population density, a reduction in the number of soakaways and heavy rainfall. In addition, we now have a desalination plant at Beckton, which can produce potable water from seawater in times of drought. Public campaigns showing how we can best make use of the systems we have are important to maintain the flow of water within the city e.g. how to conserve as much water as possible and how to prevent blockages in the sewers.

en.wikipedia.org/wiki/London_water_supply_infrastructure

WATER-CARRIER, PLATE IV, THE CRIES OF LONDON: EXHIBITING SEVERAL OF THE ITINERANT TRADERS OF ANCIENT AND MODERN TIMES, 1839

John Thomas Smith

LESSON 1: PRESSURE ON WATER SUPPLIES FOR LONDON

ACTIVITIES

STARTER

Project or print out one copy per group Resource 1.1: Where does our water come from and go to? (page 12).

Students can discuss in pairs or threes then share ideas in larger groups or with the whole class. This will allow you to assess students' existing understanding about the water cycle.

Differentiation

Some students may need some support to consider what happens beyond their experience of water usage, for this you can use Resource 1.2: Where does our water come from – prompt sheet (page 13).

MAIN 1

Hand out selected news items about water usage, health and technological developments to support the London population, or show selected videos, from the list in Resource 1.3: Summary of suggested news items and links (page 14). These articles will serve as introduction to much of the unit and also allow you to find out more about students' prior knowledge.

Give each group of students a different item to look at. Other items may be topical at the point of teaching but those chosen here show a range of ideas.

Students should consider questions as follows:

1. List three main ideas from your news item.
2. Where does your news item come from and what is the date?
3. What evidence does the news item present that convinces you?
4. Is it a balanced piece of writing i.e. does it give more than one point of view? Is there a convincing argument presented?
5. Prepare a two minute summary of your piece for the rest of the class stating your point of view having listened to any argument presented.

If access to the internet is straight forward, students could research other articles on the same topic and compare those found to their own in terms of objectivity, quality of evidence, reliability etc.

Differentiation

Articles in Resource 1.3: Summary of suggested news items and links (page 14) are listed in order of increasing difficulty so can be allocated according to ability. Videos are also provided.

MAIN ACTIVITY 2

Ask students in groups look at Resource 1.4: London over time maps (page 15) and associated text and think about what has changed as London has developed.

Hand out Resource 1.5: Card sort of maps through time activity (page 20) and ask students to match the ideas to the maps.

Plenary

Show the short Thames Water film about the main sources of water:

www.thameswater.co.uk/help-and-advice/18055.htm

Ask students:

- How does the water cycle generate clean water for us?
- Draw a flow chart to describe how this works.
- Use at least 5 keywords from this lesson to write a paragraph.

Homework ideas

- Make an estimate of how much water you use in a day.
- What does the inside of your kettle look like? Find out if your family have a water softener or if you use any special chemicals in your washing machine as well as washing powder.
- Students could be challenged to find as many local place names that refer to rivers, water, mills etc. e.g. Fleet street, Mill lane, Kidbrooke (see London's lost rivers in Further Reading for ideas).
- Choose one of the following people and find out how they help us to have a constant supply of potable water: environmental health officer, chemical engineer, water treatment engineer, waste water technician, structural engineer: **www.stemnet.org.uk/wp-content/uploads/Stemnet-case-study-01-Roma-Agrawal.pdf**
- How does your water get to you – Future Morph for a list of related careers: **www.futuremorph.org/my-future-finder/water/how-does-your-water-get-to-you**

Further reading

en.wikipedia.org/wiki/London_water_supply_infrastructure

www.thameswater.co.uk/cycles

London's lost rivers – a lovely website with lots of images of the routes of London's rivers that have mostly been covered over for many years:
www.londonslostrivers.com

LESSON 1: PRESSURE ON WATER SUPPLIES FOR LONDON

RESOURCE 1.1: WHERE DOES OUR WATER COME FROM AND GO TO?

This morning you turned on the tap in your house or flat and received a stream of fresh drinking water.

- Where does your water come from?
- Where does it go after you have used it?

WHERE WAS THE WATER...		
500 years ago	10 years ago	1 month ago

WHERE WILL THE WATER BE IN...	
1 month	10 years

LESSON 1: PRESSURE ON WATER SUPPLIES FOR LONDON

RESOURCE 1.2: WHERE DOES OUR WATER COME FROM AND GO TO? – PROMPT SHEET

Use the words and pictures below as clues to help you answer the question.

LONSDALE ROAD RESERVOIR
Dudley Miles © Wikimedia Commons

A THAMES VIEW OF LONDON
Berit Watkin © Wikimedia Commons

ICEBERGS IN THE HIGH ARCTIC
Brocken Inaglory © Wikimedia Commons

- Reservoir
- Lake
- Plants
- Animals (including humans)

- Rivers e.g. Thames
- Clouds
- Rain
- Water vapour

- Iceberg
- Snow
- Sea water
- Underground

LESSON 1: PRESSURE ON WATER SUPPLIES FOR LONDON

RESOURCE 1.3: SUMMARY OF SUGGESTED NEWS ITEMS WITH LINKS

1. "Fit to drink" video from Thames water

Andy Triggs Hodge, Olympic gold medallist, talks about why clean water is so important to health and his ability to train. Aimed at primary schools but may be of use to recap ideas or for the lower ability. Students could be asked to make a more suitable video for children their age e.g. as a homework activity.

www.thameswater.co.uk/about-us/17418.htm

2. Machine turns poo into drinking water and electricity

A video from CBBC Newsround showing a machine called the Omniprocessor which extracts drinking quality water straight from sewage.

www.bbc.co.uk/newsround/30711293

3. Can we drink water that had sewage in it?

A short article from the BBC about Thames Water consultation to put treated water straight back into the water treatment plants rather than out to sea where the natural water cycle is needed to recycle the water.

www.bbc.co.uk/news/uk-england-london-22479216

4. London's super sewer gets the go ahead

An announcement that funding has been found to build a 15 mile tunnel to deal with the volume of waste water in London's sewers. The article presents the case for the tunnel with lots of images but also some controversy over the issue that students can be encouraged to evaluate.

www.bbc.co.uk/news/uk-england-london-29175607

5. Science Museum blog

Curator at the Science museum Sarah Harvey talks to Nick Mills from Thames Water about what happens to our sewage and what the future holds for wastewater. This introduces the 'Bin it don't block it' campaign and has gross pictures of 'fatbergs'!

http://blog.sciencemuseum.org.uk/going-down-the-drain/

6. Reclaiming drinking water from seawater

A short article from the Guardian introducing the water desalination plant at Beckton where sea water can be converted into drinking water.

www.theguardian.com/environment/2011/jun/28/water-desalination-plant-beckton-london

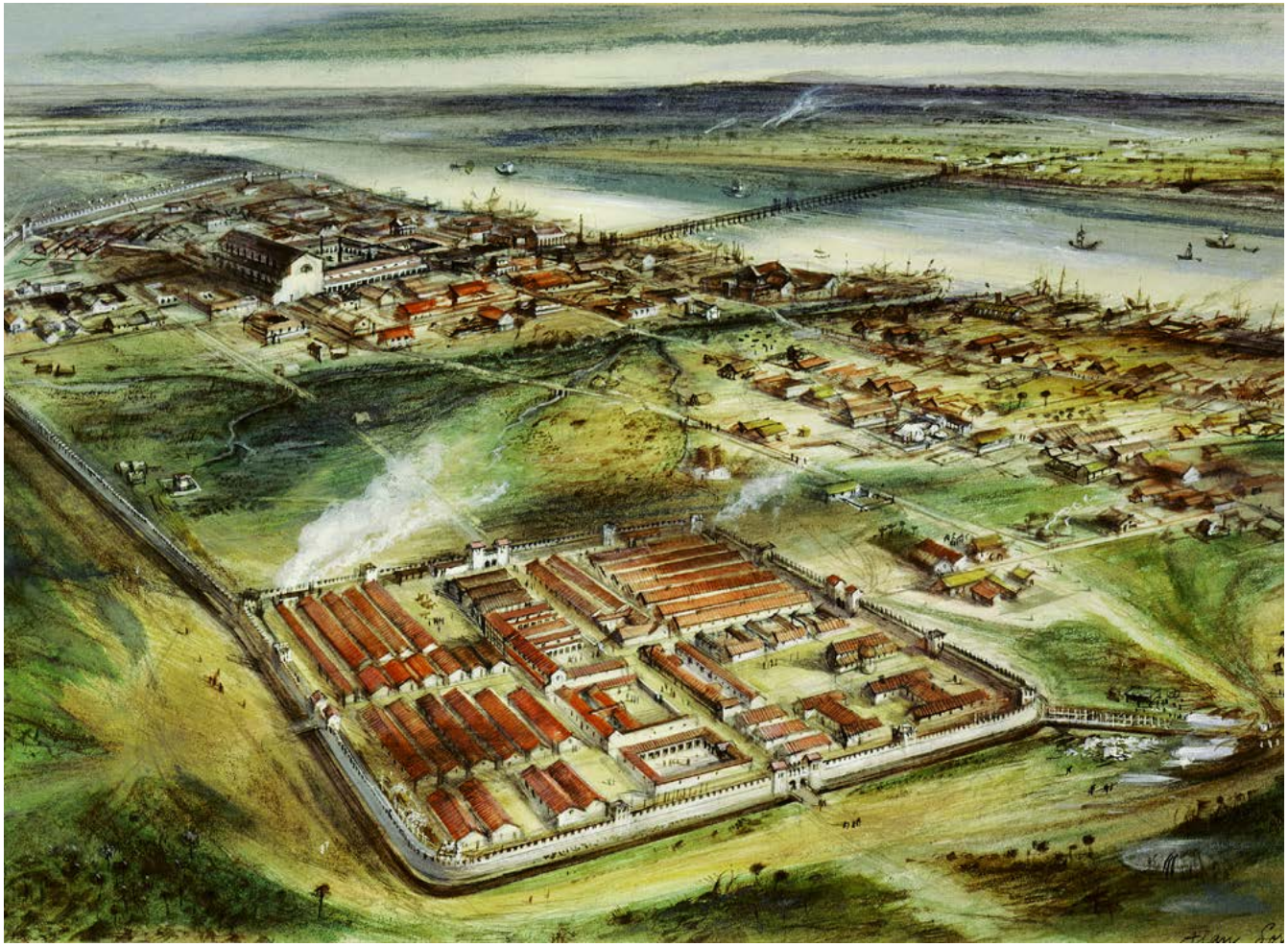
7. Do you really need to drink 8 glasses of water a day

A slightly longer article from BBC presenting evidence for and against the idea that we need to drink so much water every day.
A good piece to allow students to assess the evidence as presented but also to evaluate the way the ideas are presented.

www.bbc.co.uk/news/magazine-24464774

LESSON 1: PRESSURE ON WATER SUPPLIES FOR LONDON

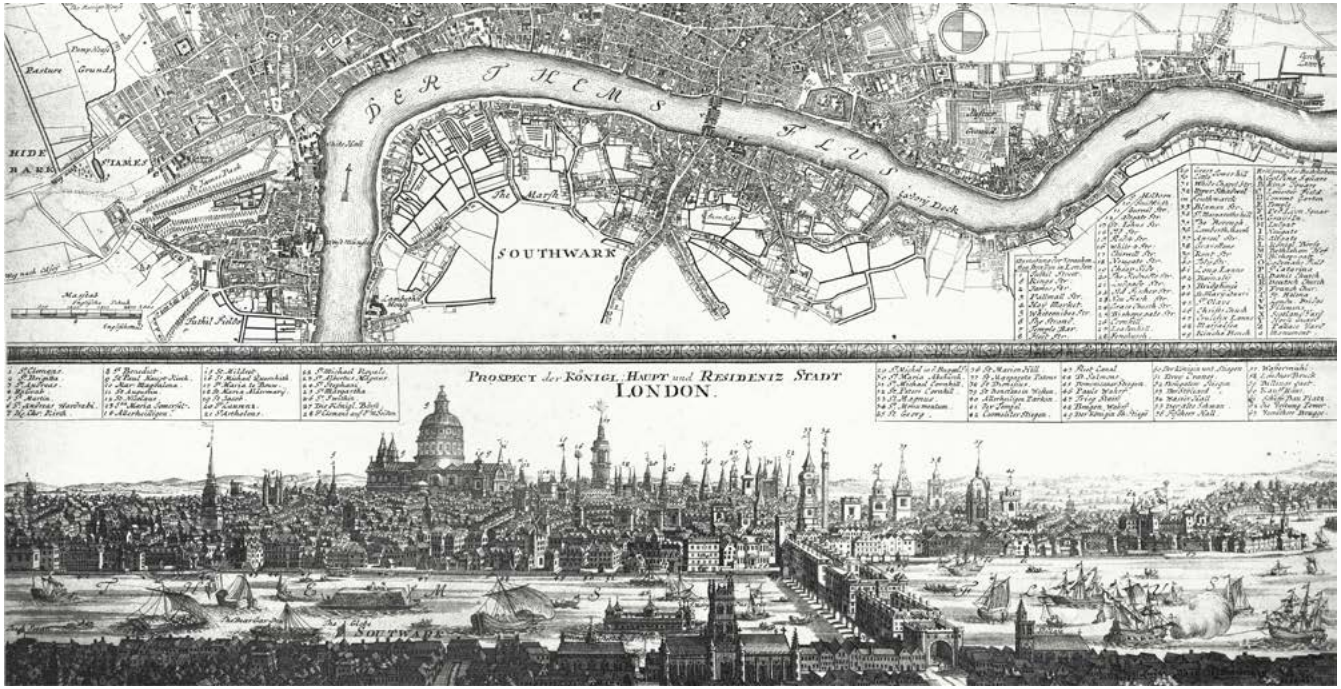
RESOURCE 1.4: LONDON OVER TIME MAPS



RECONSTRUCTION DRAWING OF LONDINIUM LOOKING EAST, C 200AD

LESSON 1: PRESSURE ON WATER SUPPLIES FOR LONDON

RESOURCE 1.4: LONDON OVER TIME MAPS CONTINUED



PROSPECT AND MAP OF LONDON, 1710
Unknown © Museum of London

LESSON 1: PRESSURE ON WATER SUPPLIES FOR LONDON

RESOURCE 1.4: LONDON OVER TIME MAPS CONTINUED

MAP OF LONDON, 1676
Robert Walton © Museum of London

LESSON 1: PRESSURE ON WATER SUPPLIES FOR LONDON

RESOURCE 1.4: LONDON OVER TIME MAPS CONTINUED

This plan of London was based on the map made by the London Huguenot, John Rocque. It was printed in 1766, four years after his death and titled ‘A plan of London with all the new streets, lanes, roads &c to this present year by John Rocque topographer to his Majesty’. Mary Ann Rocque continued her husband’s map selling and making business. The new developments and planned roads have been coloured yellow on the map.

A PLAN OF LONDON WITH ALL THE NEW STREETS, 1766

John Rocque © Museum of London

LESSON 1: PRESSURE ON WATER SUPPLIES FOR LONDON

RESOURCE 1.4: LONDON OVER TIME MAPS CONTINUED

A colour map of London at a scale of 3 3/16 inches : 1 mile, by John Bartholomew, mounted on linen.

NEW PLAN OF LONDON, 1901 – 1902
John George Bartholomew © Museum of London

LESSON 1: PRESSURE ON WATER SUPPLIES FOR LONDON

RESOURCE 1.5: CARD SORT OF MAPS THROUGH TIME ACTIVITY

1 The city is very small. Water is supplied to houses via channels.	2 Human waste is put straight into rivers.	3 Our understanding of disease after the cholera outbreak led to the development of sewers to remove waste.	4 Second World War led to the destruction of many sewers so the Thames became more foul.
5 Water is mainly used directly from the river with no treatment.	6 Horses and carts are mainly used to deliver water to houses of the rich.	7 Our understanding of disease after the cholera outbreak led to the development of reservoirs away from central London to store water.	8 The sewers are no longer big enough to deal with the amount of waste especially as they also have to deal with rain water.
9 The Thames is tidal at many points in London so contains salty water.	10 Channels called conduits were built to deliver water from outside London.	11 Water treatment is introduced to treat any bacterial contamination of water.	12 The Thames tideway tunnel is being developed to deal with waste overflow from sewers.

LESSON 2
GOOD ENOUGH TO DRINK – WHAT IS IN OUR WATER?

THE BIG IDEA

In this lesson students will answer questions about dissolved substances in water from London's water supply and other sources using a problem solving/ inquiry approach. In answering these questions students will be using ideas about pure and impure substances as described in the national curriculum chemistry as well as considering wider implications, including financial.

Whilst much of this lesson may contain ideas fully described at GCSE in terms of the chemistry, the treatment here is within the bounds of the key stage 3 curriculum. You may choose to go more deeply into the chemistry with more able students.

LEARNING OUTCOMES

Could compare the risks and benefits of hard water supplies and/or fluoridation of water.

Should devise a method to discover which water has dissolved solids in it.

Should be able to describe why water is described as hard or soft.

Must describe how to recover a dissolved solid or gas from a solution.

RESOURCES

Resource 2.1: Limescale pictures

Resource 2.2: Fake mineral water discovered on sale!

Resource 2.3: Analysis of powdered residue

LESSON 2
GOOD ENOUGH TO DRINK – WHAT IS IN OUR WATER?

MATHEMATICAL SKILLS

Calculating percentage of dissolved solids in water.

KEYWORDS

- Dissolve
- Pure
- Solution
- Solubility
- Evaporation
- Lime scale
- Limestone
- Hard water
- Soft water
- Fluoride

LESSON 2: GOOD ENOUGH TO DRINK – WHAT IS IN OUR WATER?

SETTING THE SCENE

TEA BREAK DURING VOCATIONAL TRAINING AT A CENTRE IN NEW CROSS, 1962

Many people think London water makes the best cup of tea although others around the country may disagree. London water comes from an area of the country which has a lot of calcium carbonate rocks e.g. chalk and limestone. When rain collects in underground aquifers much of our water passes through the rock and collects underground and in our rivers. As the rain water is slightly acidic it slowly dissolves the rocks adding dissolved minerals to our water supply making the water what we call hard. Hard water makes great tea and supplies our bodies with calcium. Some people believe that water rich in calcium may supplement dietary calcium and protect against heart disease. However, it also leaves deposits in our kettles, washing machines and other water heaters when we use them.

Students will be encouraged to consider the following questions:

- What is dissolved in our drinking water?
- What does this mean for us in terms of health?
- Should we have fluoride added to our drinking water?
- Why is London water so hard?
- What is lime-scale?
- What effects does lime-scale have on us economically?

Fluoride is also added naturally to rain water from the rocks and is believed to protect children's teeth from decay. However adding fluoride to drinking water is controversial and is not actually done in London. Some believe fluoride can cause other health issues if the level is too high. Does this mean young people in London are at greater risk of decaying teeth or can the positive effects of fluoride be gained from toothpaste and mouth washes?

LESSON 2: GOOD ENOUGH TO DRINK – WHAT IS IN OUR WATER?

ACTIVITIES

STARTER

Show students Resource 2.1: Limescale pictures (page 27) – images of kettles and heating elements that have been coated with lime-scale and also pipes that have been blocked. Ask students: What do you think happened to these?

MAIN 1: WHAT IS DISSOLVED IN MY DRINKING WATER? IS IT PURE?

Ask students to brainstorm a method to investigate the differences between tap water, distilled water and sea water; they could also include bottled water. Students should be able to recall from primary school how to recover dissolved solids from solutions; they could then be shown the method.

Using Resource 2.2 Fake mineral water on sale! (page 28) – What is dissolved in the water samples? Students devise a test to identify different water samples. Show them how to heat the watch glasses safely over a beaker of boiling water once they have decided on a plan to identify the different water samples.

Differentiation

More able students could devise a way to calculate the percentage of dissolved solids in a given volume of water.

Equipment needed:

- Water samples labelled A B C D containing tap water, distilled water, sodium chloride solution and mineral water (commercial or made from a weak solution of suitable minerals)
- Bunsen burner, Tripod, gauze and bench mat
- 250cm^3 beaker
- Watch glass
- Safety goggles

For further support see:
www.rsc.org/learn-chemistry/resource/res00001783/to-find-out-if-tap-water-and-sea-water-contain-dissolved-solids

(Alternatively you could set up watch glasses at the end of last lesson and allow the water to evaporate slowly, though this would miss the chance for students to devise their own method.)

The teacher demonstration in the above reference shows that there are also gases dissolved in the water and makes a good link to biology, and the reliance of fish and other life forms on dissolved oxygen. (Students may be interested to know that there is more oxygen in the dissolved gases in water then normal air due to differences in solubility of gases.)

MAIN 2

(Optional if there is time available – it could be a short teacher demonstration)

Once the samples are collected ask students to try to analyse the solids using the instructions in Resource 2.3: Analysis of powdered residue (page 29).

Students can do further tests to help prove the existence of calcium carbonate using hydrochloric acid on the residue of sample they believe to be tap water.

As a teacher demonstration, dissolve some residue from the tests in methanol and set fire to it to see the colour of the flame. You may need to have a sample ready for the demonstration if students have tested all of theirs with acid.

Differentiation

Students can be given a table to record results from given tests, see Resource 2.3: Analysis of powdered residue (page 29).

MAIN 3

Discuss with students: How is London tap water different to rain water? What do we mean by hard water?

Ask students to measure out 10cm^3 tap water in a stoppered boiling tube and add soap solution 1cm^3 at a time with shaking until they get a lasting lather. If time permits they can compare this to distilled water which has the hardness removed i.e. is soft water. Discussion can include why we might prefer not to have hard water.

For reference see:
www.rsc.org/learn-chemistry/resource/res00000426/testing-the-hardness-of-water

This is a long practical more aimed at key stage 4 but may suitable for some key stage 3 groups.

Plenary : Is it better to have hard water or soft water?

How hard is the water in your area?

Visit this website to put in postcode and get a measure for water hardness in your area:

my.thameswater.co.uk/dynamic/cps/rde/xchg/corp/hs.xsl/899.htm

Look back to the starter pictures in Resource 2.1: Limescale pictures (page 27).

Why do humans need calcium in their diet?

Ask students to write a couple of sentences to describe the pros and cons of hard water like we have in London.

Is London tap water pure?

Differentiation

Provide sentence starters for students that require some support.

Homework ideas

- Collect and test lime-scale from the kettle at home with vinegar. Record where lime-scale can be found in the home and investigate cleaning products which suggest they remove lime-scale by looking at the labels to see what chemicals they have in common.
- Undertake a project to consider whether London should add fluoride to drinking water. They would need to conduct an internet search and be encouraged to consider the evidence for and against and to write a short piece to reflect their own point of view.
- Use a table of data on dental decay as a starting point to explore the state of children's teeth in different London boroughs.

Further reading

What's in your water? How is hard water created?
www.thameswater.co.uk/help-and-advice/18136.htm

Sources of hardness – minerals in drinking water US water research:
www.water-research.net/index.php/water-treatment/tools/hard-water-hardness

Hard water stops heart attacks:
news.bbc.co.uk/1/hi/health/3396141.stm

LESSON 2: GOOD ENOUGH TO DRINK – WHAT IS IN OUR WATER?

RESOURCE 2.1: LIMESCALE PICTURES

INSIDE A LONDON KETTLE
Image by Henna

AN INDUSTRIAL PIPE THAT CARRIES WATER
Image by Aleksandr Lebedev

LESSON 2: GOOD ENOUGH TO DRINK – WHAT IS IN OUR WATER?

RESOURCE 2.2: FAKE MINERAL WATER DISCOVERED ON SALE!

Your group has been employed as local environmental health officers working for Trading Standards. You have been asked to identify some samples of water being sold as mineral water. They are thought to be:

- Tap water
- Rainwater
- Bottled mineral water
- Sea water

You have only the following apparatus to hand:

- Bunsen burner, tripod, gauze and bench mat
- 250cm^3 beaker
- Watch glass
- Safety goggles

You have limited time so you need to collaborate with other officers to get the answer as quickly as possible.

Devise a test that could be used to decide which water is which. Your teacher will need to conduct a safety check before you start.

Caution.

Trading Standards needs you to work accurately and efficiently. Tests must be reliable and repeatable otherwise the wrong people may be prosecuted.

Please write a brief summary of your findings including a table of results.

You should include in your report the following keywords:

- Evaporate
- Dissolve
- Solution
- Soluble
- Pure water

Extra challenge

To determine the concentration – calculate what percentage of the sample is dissolved solids.

LESSON 2: GOOD ENOUGH TO DRINK – WHAT IS IN OUR WATER?

RESOURCE 2.3: ANALYSIS OF POWDERED RESIDUE

To be absolutely sure your answer in the last test is correct, you can conduct further tests on the powders left at the end.

1. **Test for calcium carbonate**
   Add one or two drops of dilute hydrochloric acid and look for fizzing. This will prove you have a carbonate like calcium carbonate. Calcium carbonate is left when tap water from London is evaporated.

2. **Test for sodium chloride or calcium carbonate using a flame test**
   Your teacher will demonstrate this with a sample to show that sodium is present. Sodium makes a flame turn bright yellow. Calcium makes a flame turn orangey red. Sodium chloride is ordinary salt left when sea water is evaporated. Calcium carbonate is left when tap water from London is evaporated.

SAMPLE	OBSERVATIONS WHEN DILUTED WITH HYDROCHLORIC ACID	OBSERVATIONS WHEN A FLAME TEST IS CARRIED OUT
A		
B		
C		
D		

LESSON 3
WHAT SHALL DO WITH ALL THE WASTE?

THE BIG IDEA

London sewage treatment was developed to protect Londoners from water borne disease. Now the Thames Tideway tunnel is being built to help the sewage system cope with the rising London population. This lesson will allow students to conduct experimental work to model water treatment and have a chance to consider the importance of water analysis. An understanding of separation techniques in a real context will be developed.

The role of environmental health and water borne disease will also be considered.

LEARNING OUTCOMES

Could describe the use of separating techniques, filtration and distillation in the context of water purification.

Should devise a simple method to filter dirty water and evaluate the result in terms of how good a model they have produced to producing drinking water.

Must describe how filtration works to remove solid waste and why this cannot work for dissolved particles.

Must describe the role scientists can take in maintaining water quality.

RESOURCES

Resource 3.1: Investigating how we can clean up water

Resource 3.2: Watching a video LSS activity

Resource 3.3: Sentence starters

Resource 3.4: A day in the life

LESSON 3
HOW IS LONDON TAP WATER DIFFERENT TO RAIN WATER? WHAT DO WE MEAN BY HARD WATER?

YOU WILL ALSO NEED

A film about desalination from the list below:

youtube.com/watch?v=aysj7696b0A

youtube.com/watch?v=gA_XVxhBmTQ

youtube.com/watch?v=mZ7bgkFgqJQ

Information about fatbergs:

binit.thameswater.co.uk/#http://embed.buto.tv/LLqkg

bbc.co.uk/newsbeat/article/23586290/britains-biggest-fatberg-removed-from-london-sewer

Information about the Thames Tideway project:

www.tideway.london/the-tunnel/

History of Joseph Bazalgette:

www.tideway.london/the-tunnel/history/

Job description of a water quality scientist:

prospects.ac.uk/job-profiles/water-quality-scientist

Information about the water treatment process:

thameswater.co.uk/cycles/accessible/water_treatment.html

youtube.com/watch?v=9z14l51lSwg

KEYWORDS

- Filter
- Distillation
- Water treatment
- Sewage
- Bacteria
- Biodegradable
- Soluble
- Fatberg

MATHEMATICAL SKILLS

Using testing scales for water test strips

LESSON 3: HOW IS LONDON TAP WATER DIFFERENT TO RAIN WATER? WHAT DO WE MEAN BY HARD WATER?

SETTING THE SCENE

As London approaches 9 million people we not only have to consider where we get enough clean water to drink but also how we get rid of the waste, and recycle water for drinking and other uses. London is described as a water-stressed city and scientists and technologists need to be very creative to overcome issues as they arise. Throughout history, technological development and a greater understanding of related science has enabled ever more complex solutions. Water companies in the London area have to take into consideration the fact that London uses more water and produces more waste than any other city. Much of the infrastructure (e.g. sewers) was built to support a much smaller population which adds pressure to the situation. As consumers, we have better understanding and higher expectations about the use of our environment but still we are reticent to believe that water fit for drinking can be directly recovered from heavily polluted water such as sewage.

A big campaign from Thames Water at the present time is the “Bin it don’t Block it” campaign. This is to get local people to understand how to prevent blockages in the pipes and sewers leading from their houses caused by cooking fat and non-biodegradable waste such as baby wipes being flushed down the toilet.

DISCHARGE POINT AT VAUXHALL

LESSON 3: HOW IS LONDON TAP WATER DIFFERENT TO RAIN WATER? WHAT DO WE MEAN BY HARD WATER?

ACTIVITIES

STARTER

Students can discuss what happens at each stage of the treatment process in small groups then as a whole class. The links below can help you explain the treatment process:

www.youtube.com/watch?v=9z14l51ISwg

www.thameswater.co.uk/cycles/accessible/water_treatment.html

MAIN 1

Hand out Resource Resource 3.1: How can we clean dirty water? (page 35). Ask students to devise a water cleaning filter using a variety of materials to model water filter beds. Images can be shown of water treatment works and of slow sand filter systems as inspiration for their plans.

Discuss with students what else needs to be done to water once it has been filtered.

Desalination could be discussed here as well as an extreme form of filtration, with reference to one the following short films:

www.youtube.com/watch?v=aysj7696b0A

www.youtube.com/watch?v=gA_XVxhBmTQ

www.youtube.com/watch?v=mZ7bgkFgqJQ

Differentiation

Some further guidance for how to set up the method might be required.

MAIN 2

Why shouldn't we put fat down the drain?

What happens to baby wipes in the sewers?

This can be a quick demonstration to show the insoluble nature of fats and baby wipes compared to say toilet paper. Pictures of fat bergs can be displayed to impress the point. This could be set up as an alternative investigation to main activity 1.

The videos below show graphic images of fatbergs:
binit.thameswater.co.uk/

www.bbc.co.uk/newsbeat/article/23586290/britains-biggest-fatberg-removed-from-london-sewer

This video shows how baby wipes don't disintegrate in water.
embed.buto.tv/LLqkg

MAIN 3

What do we need to do for the future?

Resource 3.2 Watching a video (adapted from LSS resources) (page 37).

Show the Thames Tideway tunnel project video: *You Poo Too*
vimeo.com/143760244

Students watch the video once then write down any questions they have before watching the video for a second time see Resource 3.2 Watching a video (adapted from LSS resources) (page 37).

Extra information see:
www.tideway.london/the-tunnel/history/

Plenary

Ask students to write a paragraph to explain whether they think the Thames Tideway tunnel is a good idea or not. Ask them to use a persuasive style of writing in the form of an advert for the tunnel or as a campaigning leaflet against the idea.

Differentiation

Provide students needing extra support with Resource 3.3: sentence starters (page 39).

Homework ideas

Read about the work of a water quality scientist. Using Resource 3.4: A day in the life (page 40) write about a day at work in their diary. Imagine what they might encounter during a day.

www.prospects.ac.uk/water_quality_scientist_job_description.htm

Produce a google map to show where the London water treatment works are.

Find out and write down five interesting facts about your local water treatment works. Students can do an internet survey to find out where their water comes from.

The water treatment works on the Thames Water Ring Main are:

- Ashford Common
- Kempton Park
- Hanworth
- Walton
- Hampton
- Coppermills Water Treatment Works
- Beddington Sewage Treatment Works

Further reading

en.wikipedia.org/wiki/Water_treatment

BBC news item about desalination with some opposing arguments:
www.bbc.co.uk/news/10213835

LESSON 3

RESOURCE 3.1: HOW CAN WE CLEAN DIRTY WATER?

Your task is to set up a model of a water treatment filtration plant using only the apparatus given – you do not need to use it all. Once you have completed building and using your model you will compare your model to another group to decide how effective the models are.

Before you start you should watch the video of the water treatment plant and look carefully at the diagram provided.

- Apparatus available
- Large filter funnel
- Beakers
- Filter paper
- Cotton wool
- Gravel
- Sand
- Limestone pieces
- Dirty water
- pH paper

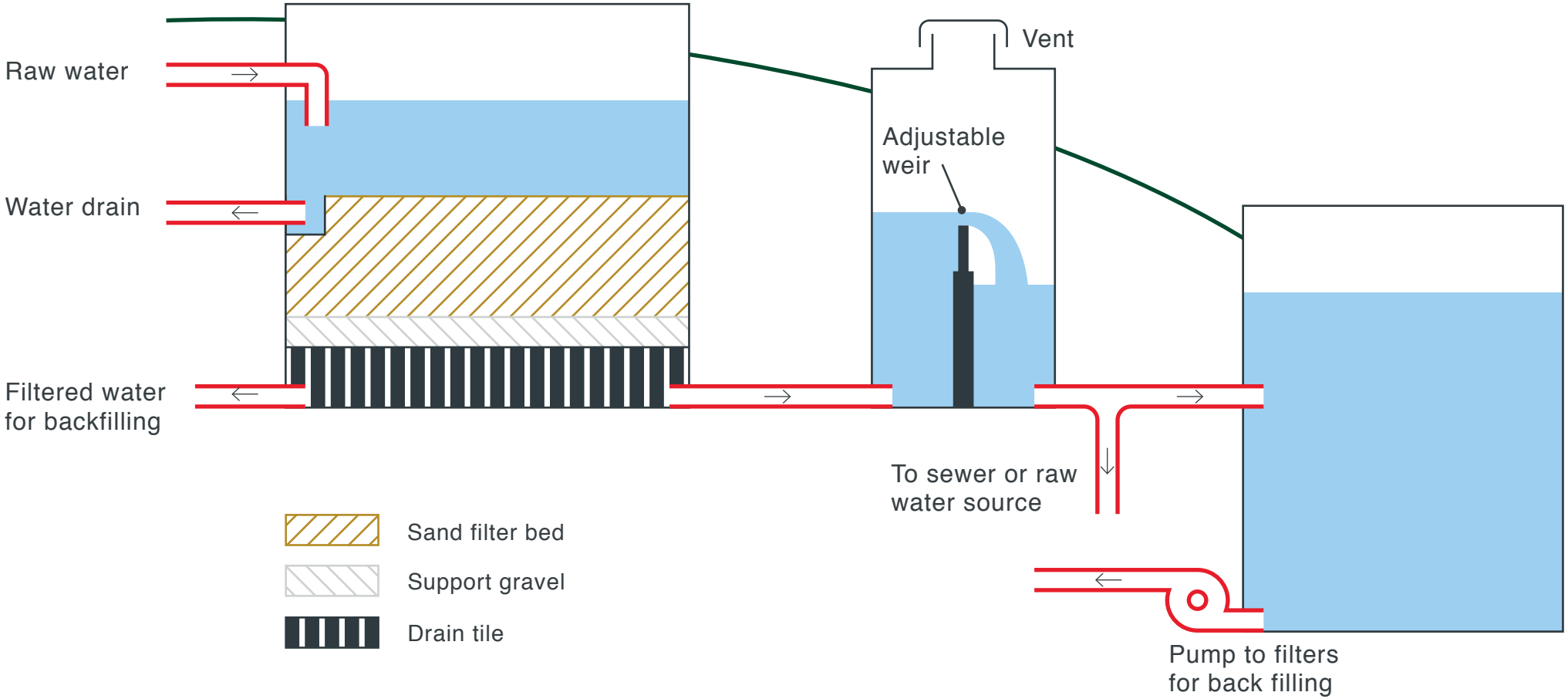
Make a list of the impurities that you might need to remove. In what ways is your model similar to a real water treatment plant?

What might be in the water that you cannot remove with this model? How might you deal with this?

Decide as a group how to set up your filter and collect clean water. Set up the filter and put the water through to clean it. Whilst you are waiting draw and label a picture of your model, explaining what each part of the model is intended to do. When you have finished compare your result to another group and decide on improvements you could make.

LESSON 3

RESOURCE 3.1: HOW CAN WE CLEAN DIRTY WATER? CONTINUED



LESSON 3

RESOURCE 3.2: WATCHING A VIDEO (ADAPTED FROM LSS RESOURCES)

Watch the film once and write your responses in the table below.

QUESTIONS?	THOUGHTS	SOMETHING NEW
Your questions should be about any of the science that you did not understand or that you want to learn more about.	Your thoughts could be about the information in the video, the characters, the scenarios, the music.	This refers to any information, concepts or events that you learned about for the first time.
1.	1.	1.
2.	2.	2.
3.	3.	3.
4.	4	4

LESSON 3

RESOURCE 3.2: WATCHING A FILM LSS ACTIVITY CONTINUED

Report to the class on what you wrote. With your teacher, classify the questions into categories, such as:

- questions dealing with concepts
- questions dealing with people
- questions about processes

Write down some questions of different kinds below. Don't worry too much about the answers yet.

Next to each question, write the category to which it belongs (using the classification that the class developed together).

Concentrate on the questions you've written below while watching the video again, and see if you can answer them now.

- Mark any questions which you have not yet answered.
- In the classroom discussion, you will find out whether other students know the answers. Write the answer down next to the question.

If any question is unanswered, suggest sources of information where you can look for answers.

QUESTION:

CATEGORY:

ANSWER:

QUESTION:

CATEGORY:

ANSWER:

QUESTION:

CATEGORY:

ANSWER:

QUESTION:

CATEGORY:

ANSWER:

LESSON 3

RESOURCE 3.3: SENTENCE STARTERS

To keep healthy, we need water that...

The population of London is getting much bigger, this means...

At the moment we have a problem when it rains because...

Without the Tunnel, London will...

If the Thames is polluted with raw sewage...

The Tunnel is a good idea because...

I am worried about the Tunnel being built because...

Instead of building the Tunnel we should...

LESSON 3

RESOURCE 3.4: A DAY IN THE LIFE

Job overview

A water quality scientist is responsible for safeguarding all aspects of water quality through scientific analysis and the setting of targets and standards in response to specific legislation. They compare test results with these standards, investigate shortfalls and take action to remedy problems.

Depending on the employer, they may be involved in providing solutions to water quality problems and water quality regulation.

Water quality scientists usually specialise in one of three areas:

- drinking water
- surface water (rivers, lakes, estuaries)
- groundwater

More senior roles may involve significant liaison with businesses, the public and other water industry professionals.

Typical work activities

Tasks differ according to the specialist area, particularly with regard to the degree of contact with the public, businesses and regulatory authorities, but all roles are likely to involve some or all of the following:

- taking and testing water samples
- visiting sites of concern, for example, potential sources of pollution or contamination, and sources of complaints about drinking water quality
- contributing to projects concerning water quality improvement
- providing advice on avoiding problems, for example, to businesses discharging effluence
- negotiating charges for effluent discharges
- checking customers' premises and the construction of drains
- investigating pollution incidents and arranging for emergency action in response
- conducting research related to water quality and setting up field surveys

SCIENTIST CHECKING THE WATER QUALITY IN A RIVER

LESSON 4
TODAY'S WATER SOLUTIONS FOR THE CITY

THE BIG IDEA

Students will problem solve by looking into the ways to conserve water using sustainable buildings and water recycling, the use of grey water, maintaining infrastructure and desalination. This lesson provides an opportunity to conduct some formal assessment on the topic so far drawing together student ideas as well as giving an opportunity to make some links to the multitude of careers available in this area and to prepare students for the explore session.

LEARNING OUTCOMES

Could use mathematical skills to estimate total water use by London.

Should explain how a life cycle analysis can apply to water use i.e. ask questions about the way in which water is used.

Should describe the role played by a range of people involved in water treatment.

Must describe a method to collect first hand data in order to calculate personal water use.

YOU WILL ALSO NEED

- Access to computers, laptops or tablets

KEYWORDS

- Life cycle analysis
- Grey water
- Sustainable
- Engineering
- Environmental health

MATHEMATICAL SKILLS

Calculating volume of water used

LESSON 4: TODAY'S WATER SOLUTIONS FOR THE CITY

SETTING THE SCENE

There are many technological solutions being developed to support London's access to clean water and ability to deal with waste products. There are many different scientists, technologists and engineers as well as communication officers and liaison officers working with local communities. Teams are multi disciplinary involving both scientists and non-scientists all working creatively to solve problems encountered in such complex systems as the human water cycle.

LEE TUNNEL

LESSON 4: TODAY'S WATER SOLUTIONS FOR THE CITY

ACTIVITIES

STARTER

If students can get access to a computer they can use the water calculator to work out how much water they use at home, otherwise it could be done as a whole class.

news.bbc.co.uk/1/hi/in_depth/629/629/5086298.stm

Differentiation

Ask students to estimate how much water all of London would use over a given period e.g. one week.

MAIN 1: REDUCE! REUSE! RECYCLE!

List ways that we can:

- reduce the amount of water we use
- reuse more water
- recycle waste water

Differentiation

By outcome

MAIN 2: SUMMARISING THE TOPIC SO FAR

This is a good summative assessment opportunity.

Ask students to revisit the flow chart from lesson one and add ideas that have learned from the topic overall so far about:

- what our water is like
- how we treat waste water
- how we need to protect the human water cycle in order to protect the health of Londoners.

MAIN 3: WHO KEEPS OUR HUMAN WATER CYCLE GOING?

As students to choose one of the following people and find out how they help us to have a constant supply of potable (drinking) water:

- environmental health officer
- chemical engineer
- water treatment engineer
- waste water technician
- structural engineers

The websites below provide a list of related careers:

www.futuremorph.org/my-future-finder/water/how-does-your-water-get-to-you/

www.stemnet.org.uk/wp-content/uploads/Stemnet-case-study-01-Roma-Agrawal.pdf

If there is no access to computers, download and print relevant information in advance and distribute to different groups.

Plenary

Introduce the Explore visit and prepare students (details will depend on location). You may want to introduce the class to the debate that they will be holding in the Connect section of this unit and allocate roles (See Resource 5.1: Role Cards, page 56) This will mean students can look for information and images while on the visit to support them in the end of unit debate.

Homework ideas

Research for their expert group for the debate.

EXPLORE

Students will explore a site of relevance to the topic water quality. This may be to conduct some individual inquiry work on the quality of a local water source, such as a pond, lake or river. Alternatively the visit could be to a site involved in the water industry, such as a water treatment plant or a museum. Teachers should choose which lesson to follow accordingly.

EXPLORE
EXPLORING LONDON'S WATER QUALITY

THE BIG IDEA

Students explore a site of interest to further investigate the water quality issue. This may be to conduct some individual inquiry work on the quality of a local body of water such as a pond or river or to visit a site involved in the water industry. Teachers should choose which lesson to follow accordingly.

LEARNING OBJECTIVES

Could devise their own questions to answer at the given water site.

Should collect and record first hand data at the given site.

Should compare their findings to other data from national data.

Must describe the local site to be investigated using words and images.

RESOURCES

Many of the projects listed below give suggestions for what to look for and have other surveys that students may conduct related to their ideas about water quality.

YOU WILL ALSO NEED

- Test strips to test some or all of the following:
  - pH
  - Nitrate concentration
  - Phosphate concentration
- Oxygen probe
- Thermometer
- Cameras
- Clipboards and pencils

EXPLORE: EXPLORING LONDON'S WATER QUALITY

OPTION 1: TESTING WATER QUALITY IN THE SCHOOLS LOCALLITY

There are many citizen science projects looking at both the quality of local water sources and also at the conservation of water locally and globally. Students have a chance to participate in national or even global research with real live data from their locality which gives them a chance to experience real scientific activity at an appropriate level to their age.

This will probably be a short visit to survey the local water source and may be in the school playground. Alternatively this may be combined with other London Curriculum units e.g. *The Living River* explore lesson would fit well here as well.

If a site is very local this could make the basis of a longer term project where students monitor the water site throughout the year and revisit the data at a later date to make a longer term analysis. It may also be possible to conduct some water quality tests on a trip to a water treatment area.

EXPLORE: EXPLORING LONDON'S WATER QUALITY

ACTIVITIES

MAIN 1

Use water testing kits to see what is in local bodies of water e.g. ponds, rivers or canals using one of the following "citizen science" project guides. At the time of writing schools would be expected to supply their own test kits but it may be worth asking the project teams if any kits are available free for schools.

MAIN 2

Students should consider in groups any ideas/evidence at the water source to support their role for the connect lesson.

Some of the following sources could provide students with additional information or activities to support their research:

Fresh Water Watch is a global citizen science project looking at testing water around the world.

https://freshwaterwatch.thewaterhub.org/content/becoming-a-citizen-scientist

freshwaterwatch.thewaterhub.org/content/get-involved

Water Explorer is an educational programme that has lots of different challenges that students can get involved with.

www.waterexplorer.org

OPAL – The water challenge shows how you can get involved by taking local readings and uploading them to their national survey as well as seeing all the other data supplied by others.

www.opalexplorenature.org/watersurvey

EXPLORE: EXPLORING LONDON'S WATER QUALITY

OPTION 2: VISIT A SITE RELATING TO THE WATER INDUSTRY OR WETLAND SITE

Many of the following visits have bookable workshops many of which are free. These can be normally be followed by some self guided time to consider the student roles for the connect lesson i.e. in role.

Whilst at the visit site they can observe, take photos or research a given aspect and then present ideas found when they return to school.

For example, students could take six photos to tell a story about human impact on the water cycle which can be worked into a cartoon strip or power-point presentation. Alternatively, teachers can set up a 'treasure hunt' type trail at the museum/water works etc with key questions.

WWT London Wetland Centre

Queen Elizabeth's Walk, SW13 9WT

020 8409 4400

One hour workshops are available and are run free for eligible schools i.e. those with 20% or more free school meals.

The workshop *What happens to my water?* offers students an opportunity to work scientifically outdoors with water and launch their own enquiry into the water cycle. Exploring wetland habitats first-hand, students can gather evidence to help identify the role that wetlands play within the water cycle as wetland habitats store, clean and slow our water down. This session offers learners the chance to study this natural system, its impact and potential at varying scales and question how human activities can influence and change the system for better or worse.

Other relevant workshops could be:

What effects a wetland? A fresh water survey using indicator species – could be an overlap with a biology visit.

Or a self guided water trail which allows students to consider the effect of water quality on the environment.

wwt.org.uk/learn/learn-at-wwt-london

WWT THE LONDON WETLANDS CENTRE, 2009
Torla Evans © Museum of London

Creekside Discovery Centre

14 Creekside, SE8 4SA

020 8692 9922
info@creeksidecentre.org.uk

Currently only advertising key stage 2 but Creekside Discovery Centre would make a good joint visit to look at biology topics and to combine with some water testing/filtering at the site.

www.creeksidecentre.org.uk/education

Crossness Pumping Station

The Old Works, Belvedere Road
Abbey Wood, SE2 9AQ

0208 311 3711

Open on Tuesdays, the sewage pumping station built in 1865 by Joseph Bazalgette can arrange a free two hour visit, probably most suited to year 7 for up to 30 students at a time. The visit would mostly be a socio-historical look at the development of sewage works and pumping equipment including the story of Bazalguette and the cholera epidemic. Working at its peak the pumps could pump 500 tons of sewage per minute. An impressive amount of London poo!

www.crossness.org.uk

The Crystal

One Siemens Brothers Way, E16 1GB

0207 055 6400
education@thecrystal.org

Water is Life focuses on the importance of water as a precious and finite resource. The exhibition explores solutions that provide access to drinkable water including rainwater harvesting, waste water recycling, desalination, reducing water use and improved water management

www.thecrystal.org/visit-the-exhibition/exhibition-zones

Hampstead Heath ponds – Water Watch

Hampstead Heath, N6 4JH

020 7482 7073
heath.education@cityoflondon.gov.uk

How do we define and measure water quality? What affects it? Why does it matter? These questions and many more will be answered in this fieldwork based session at the ponds on Hampstead Heath.

www.cityoflondon.gov.uk/things-to-do/green-spaces/hampstead-heath/learning/Pages/Ponds-Project-Education-Programme.aspx

Hogsmill Sewage Treatment Works

Lower Marsh Lane, KT1 3BW

07747 645090
school.bookings@thameswater.co.uk

School tours of Hogsmill, an operational sewage treatment site can help students understand how waste is treated, and there are areas of nature reserve to be explored.

www.thameswater.co.uk/about-us/17727.htm

Kempton Steam Museum

Snakey Lane, TW13 7ND

0156 872 0571
kemptonsteam@gmail.com

The site houses the largest working triple expansion steam engine. They can accommodate a class group visit on Tuesdays or Thursdays when the museum is not open to the general public. The museum is on the site of the Kempton Waterworks.

www.kemptonsteam.org/history/the-site/

Kew Bridge Museum of Water and Steam

Green Dragon Lane, TW8 0EN

0208 568 4757
learning@waterandsteam.org.uk

This new gallery tells the story of London's water supply as the vital lifeblood of our city. Exciting new interactive exhibits, artefacts from the capital's watery past and more bring this little known story to life for visitors of all ages.

From Roman terracotta water pipes to future technology, this gallery explores each exciting chapter of London lives through the ages, sustained by the Thames and the technologies developed to make its water reach the city's growing population.

www.waterandsteam.org.uk

MIDDLESEX FILTER BEDS
Image by Kevin B. Thompson

Lea Valley Waterworks and Middlesex Filter Beds

Whilst there are no specific activities at this site for water processing, this is the site of an original Victorian Middlesex water filter beds and part of the Lea Valley Park. Students could explore the aspects of the filter beds here and combine this with some wildlife watching.

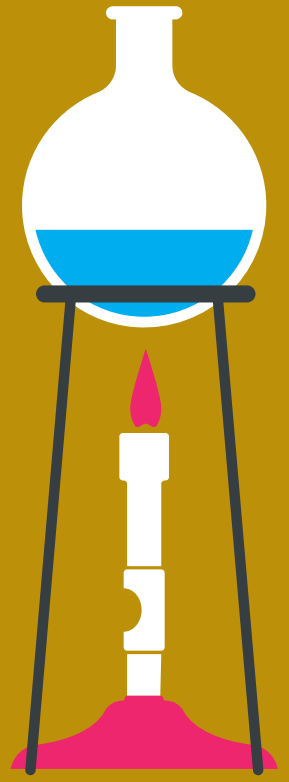
www.visitleevalley.org.uk/en/content/cms/nature/nature-reserve/waterworks-nature-reserve-midd

See also Thames21 who have developed activities within Lea River area.

www.thames21.org.uk/thames-river-watch-water-quality

CONNECT

Having studied water supplies, waste disposal and water conservation in an expanding city and the various ways in which this can be conserved, students are challenged to take on relevant roles and to debate the solutions to improved conservation. This lesson allows students to draw together ideas from across the topic and to improve their argumentation skills as well as focussing on key areas of scientific attitudes.



LESSON 5
THE FUTURE OF LONDON'S WATER

BIG IDEA

Having studied water supplies, waste disposal and water conservation in an expanding city, students are challenged to take on relevant roles and to debate the solutions to improved conservation.

This lesson allows students to draw together ideas from across the topic and to improve their argumentation skills as well as focussing on key areas of scientific attitudes.

LEARNING OBJECTIVES

Could be able to discuss and evaluate risks to support group decision making in the ranking activity.

Should present decision making based on scientific ideas developed throughout the unit.

Must participate in group discussion to develop expert ideas on one area.

Must participate in group presentation on final decisions.

RESOURCES

Resource 5.1: Role cards

Resource 5.2: Decision table

LESSON 5: THE FUTURE OF LONDON'S WATER

ACTIVITIES

STARTER

A useful summary on the human effect on the water cycle can be found at:

www.wwt.org.uk/learn/wwt-learning-resources/the-water-cycle/

MAIN ACTIVITY

Using the information gathered on the trip and through the lessons leading up to its students will debate the various solutions to London's potential water shortages and the challenge of maintaining the system as a whole. They will take on roles of various engineers and scientists as well as local members of the community to conduct a debate on possible solutions i.e.

- Water conservation in houses and industry i.e. use less
- Improve infrastructure – reduce leaks and prevent run off
- Use of grey water
- Water desalination – make use of salt water from tidal region of rivers
- Import water from further afield
- Bin it don't block it

Success criteria can be developed by the class for a successful conclusion to the debate and their ideas presented to the class either verbally or via a summary poster. Success criteria might include:

- Everyone is involved in the group discussion and group presentation
- It is clear who (from role cards) might support or be opposed to the solution
- Science ideas are included in the table for each solution, for example:
  1. How does the solution conserve natural water supplies?
  2. How might this solution reduce human impact on the water cycle or environment in general?
  3. What chemical processes might be involved? e.g. filtering, separating etc.
  4. What energy savings might be involved in this solution?
- What risks might be involved with this solution?
- What are the benefits of this solution?
- Ideas are ranked and reasons clearly given in group presentation

Small groups (of four or five) prepare as experts i.e. according to Resource 5.1: Role cards (page 56).

Divide students into mixed groups to debate the issue.

Each group should decide on their order of priority for the six ideas, and any others they think of, with a rationale for the order. They should complete Resource 5.2: Decision table (page 57) on A3 paper for each group by the end of the discussion and use this to present back to the class either verbally or via a quick poster.

LESSON 5: THE FUTURE OF LONDON'S WATER

RESOURCE 5.1: ROLE CARDS

STRUCTURAL WATER ENGINEER

You are involved day to day in assessing the state of materials eg the structure of sewers and other water bearing pipes. You are involved designing schemes, such as sewer improvement schemes or flood defence programmes, and associated structures, such as pumping stations and pipework. You believe that London is at risk of flooding and that without the new technology that lives will be a risk.

MEMBER OF THE LOCAL COMMUNITY AND ENVIRONMENTAL ACTIVIST

You are concerned that so much land in London has been built over that water has nowhere to go except down the sewers and out to sea. You are wary of building developments eg Thames Tideway Tunnel believing that we should not meddle with nature. You cannot understand why it rains so much in the UK and therefore believe that we should consider importing water to London from other parts of the country where it rains a lot.

THAMES WATER EDUCATION OFFICER

You are very keen to get people better informed about the problems facing the sewer system. One of which is the blockages that are caused by fatbergs and babywipe/nappy blockages. You are developing a community information campaign to help people understand and want to develop easy systems for people to deal with the waste that they currently dispose of down the toilet.

WATER CONSERVATION ENGINEER

You are concerned that London loses so much water from leaking pipes and dripping taps and are keen to educate people to conserve more water. Hence you are marketing a programme of free rain water butts to people who have gardens or flat roof and believe that we should use grey water for many more uses at home and in industry e.g. for flushing toilets, watering gardens, washing cars etc. You believe that industry and home owners should be held responsible for mending leaks and if they don't do this that they should be prosecuted.

A SCIENTIST

You are involved in development of the desalination plant to make drinking water from sea water. You are very excited that the plant at Beckton East London has recently opened and that London will now have a reliable supply of water even in periods of low rain. You realise that this may cost more and uses energy but believe it is worthwhile. Your next project is to develop drinking water straight from sewage and you are keen to convince people that this will be safe.

A LOCAL RESIDENT

You have high expectations that the water delivered to your home will be of very high quality but you feel that you are being charged too much for water via the water meter installed in your flat. You are cross that there is another hosepipe ban and that you are not allowed to water your garden even though you have seen the local Wimbledon tennis courts being watered daily to keep the grass green. You have recently had a sewage overflow in your street and believe that the water company are not doing their job properly.

LESSON 5: THE FUTURE OF LONDON'S WATER

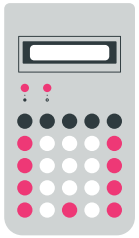
RESOURCE 5.2: DECISION TABLE

IDEA	SCIENCE INVOLVED	RISKS	BENEFITS	RANKING (1 = BEST)
Use less water				
Reduce leaks and prevent run off				
Use more grey water				
Desalinisation				
Bring water from the countryside				
Prevent blockages				

LINKS TO OTHER LONDON CURRICULUM SUBJECTS

The health STEM theme

This unit is part of a set of three exploring the issues that impact on the health of Londoners



SCIENCE – BIOLOGY

Healthy London Living
Drawing on a number of leading London medical and science centres, sporting events and venues, this unit introduces the topics of nutrition and digestion, health and the skeletal and muscular systems.

MATHS

Healthy London Air
demonstrates how statistics are applied to the real 59 life problem of securing good air quality in the city.

CREDITS

The GLA would like to thank the following organisations for their contribution:

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the London Curriculum

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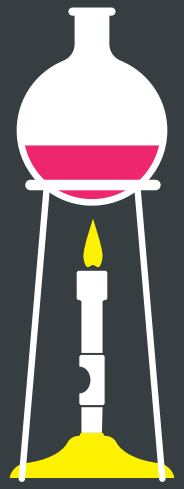

‘The idea of using London as a teaching resource has never been explored much before, so both students and teachers are excited about it’

Key stage 3 teacher

‘It makes me feel proud to be a Londoner’

Key stage 3 student