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View the website at
www.sewagesleuths.sa.edu.au
Introduction

This teacher resource has been developed to guide teachers’ classroom use of the Sewage Sleuths website. Sewage Sleuths is a web-based resource aligned with Year 7 Australian Curriculum: Mathematics, Geography and Science. It is designed for use with computers and iPads. The sources have been selected and brought together to support teachers’ discussions with students about issues around living in a sustainable environment and the connections between the health of communities and water management. Sewage Sleuths gives students a good understanding of the workings of a key community utility system.

This resource has been developed by the South Australian Department for Education and Child Development, specialist teacher Simon Langsford and project officer, Kerrie Mackey-Smith. The source material in the website has been developed using the specialist knowledge held at SA Water by engineers and scientists. The developers wish to thank Phillip Jones, Hayley Morton and Nick Swain from SA Water for their contributions to the project.

Curriculum links

This resource has been designed to assist teachers make authentic, inquiry-based connections for their students.

Australian Curriculum: Mathematics

• investigate, interpret and analyse graphs from authentic data

Australian Curriculum: Geography

• the nature of water scarcity and ways of overcoming it
• the forms that water takes as a resource

Australian Curriculum: Science

• water is an important resource that cycles through the environment

The resource is underpinned by the domains of the South Australian Teaching for Effective Learning (TfEL) framework. See the resource's Learning design approach for details.
What will students do?

Students will learn about sewage treatment processes. They will then apply their understanding of the process as water scientists and engineers would, to build a picture of what is not working correctly at the wastewater plant. Students interpret reports containing data sets to find the likely causes of problems for the town, in each of three problem scenarios (tasks). While detecting and solving these problems, students learn about the wastewater cycle and how it impacts on human lives.

Using the website

Teachers should familiarise themselves with the Sewage Sleuths website before using it in the classroom.

Website outline

• Introduction video
  o gives an overview of water management
  o introduces the students to the idea they are to solve a water issue
  o allows student to select one of three tasks

• Task (choice of three scenarios)
  o audio and text outline of the problem to be solved

• Graphic of sewage treatment plant
  o a full screen graphic of a treatment plant
  o a zoom-in function on the graphic to help identify icons that allow further exploration.

Links to further information about the treatment processes
Students can read the text or listen to the audio link.

Links to reports, graphs and information relevant to the task problem
Each report has a second page which contains the data graphs.

Tasks

Suggested engagement strategies:

• Teams of two or three students investigate problem scenarios, or tasks.

• Students may choose their own task, or the teacher may assign tasks.

• One member of the student’s group has the task screen open, while others search the various information screens to collaboratively solve the problem.

• Use an electronic whiteboard to support a whole class discussion.

• Teams of students could compete to find the solution first.

Possible solutions to the three tasks are provided later in this resource.
Background for teachers

Wastewater was once a pollutant, but now it is a resource. This transformation has been made through age-old biological processes being harnessed by modern technologies and research. The process is outlined in this video. Treating wastewater is important for human and environmental health. The importance of treating wastewater can be seen here. And, a short, amusing video that might engage students in the issue of wastewater can be found here.

Extension maths activities for students who need additional challenge can be found here.

Summary of the wastewater treatment process
Screens
Large solid objects that should not be in the sewerage system are removed by screens.

Removing grit
Sand and grit particles are removed by swirling.

Settling tank
Faeces and other soft solid material sink to form sludge. The water is now much cleaner, but still contains urine and other wastes.

Sludge is sent to sludge digesters.

Water is sent to aerobic tanks.

Sludge digester
Microbes eat the waste, turning it into biomass (more microbes) and producing gasses such as methane and carbon dioxide.

Biosolid drying
When all the waste in the sludge digesters is consumed, the dried biomass (microbes) is dried to make a solid fertiliser (biosolid(s)) for use by farmers.

Aeration tank
Here microbes feed on unsettled wastes. When air bubblers aerate the water, microbes that are oxygen-loving (aerobic) feast on some of the dissolved waste. When the bubbles are turned off, oxygen is rapidly used up and oxygen-hating (anaerobic) microbes feast on different compounds in the water.

Clarifiers
After most of the waste in the water has been consumed, the water is sent to clarifiers where the microbes are recovered by letting them sink to the base of a pond. These microbes are either returned to the aeration tanks to eat more waste or sent to the sludge digesters to be turned into biosolid(s).

Lagoons
The treated water can be sent to ‘polishing’ lagoons where sunlight, plants and other living things finish the process of destroying pathogens.

Reuse
Water from the lagoons can be filtered, treated further and reused for irrigation and purposes other than drinking. Or, it can be released into the environment as fresh water.
Scenario solutions

Students may come up with alternative answers that are valid solutions. It is recommended that students draw their own conclusions and discuss them before you share the information below.

### Scenario 1

<table>
<thead>
<tr>
<th>What is the problem?</th>
<th>What is causing the problem?</th>
<th>What is happening?</th>
<th>What tests reveal the problem?</th>
<th>What could be done about this?</th>
</tr>
</thead>
<tbody>
<tr>
<td>The smell from the sewage treatment plant is worse than usual.</td>
<td>The heater in the digester tank is not working and the tank is too cold.</td>
<td>The microbes in the tank are not doing their job because they are too cold. They are not eating waste properly and are producing smelly gasses as well as the usual methane and carbon dioxide.</td>
<td>The digester temperature graph shows a fall in temperature. Less methane is being produced.</td>
<td>Fix the heater.</td>
</tr>
</tbody>
</table>

### Scenario 2

<table>
<thead>
<tr>
<th>What is the problem?</th>
<th>What is causing the problem?</th>
<th>What is happening?</th>
<th>What tests reveal the problem?</th>
<th>What could be done about this?</th>
</tr>
</thead>
<tbody>
<tr>
<td>The biosolids that are used to fertilise plants are killing them instead. (Biosolids are the dead remains of the microbes that have eaten all the waste.)</td>
<td>Industrial waste, in this case dissolved copper, is entering the sewerage system.</td>
<td>The copper is absorbed by the microbes as they eat the waste. The biosolids made from the dead microbes contain enough copper to kill plants.</td>
<td>Heavy metals in the inlet stream. Heavy copper in biosolids.</td>
<td>Find the factory that is leaking copper solution into the sewers. Make factories that poison the sewage pay a fine.</td>
</tr>
</tbody>
</table>

### Scenario 3

<table>
<thead>
<tr>
<th>What is the problem?</th>
<th>What is causing the problem?</th>
<th>What is happening?</th>
<th>What tests reveal the problem?</th>
<th>What could be done about this?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants and animals are dying in cloudy water coming from the sewage treatment plant.</td>
<td>The pump that sends the microbes from the clarifier has broken down. The clarifier is the big, still pond where the microbes sink to the bottom.</td>
<td>The microbes should be pumped back to eat more waste, but they are building up in the clarifier instead. Eventually they overflow with the cleaned water and pollute the lagoons and thus the river.</td>
<td>There is a drop in the amount of microbe-rich water returning to the aeration tank. There is an increase in the numbers of microbes in the cleaned water flowing to the lagoons.</td>
<td>Fix the pump.</td>
</tr>
</tbody>
</table>
Learning design approach

The learning design approach brings together the Domains of the South Australian Teaching for Effective Learning (TfEL) framework with the Australian Curriculum. The Sewage sleuths website supports collaborative approaches to planning. As the teacher you decide:

- the inquiry that you would like students to engage with
- how best to use the sources provided to support students’ investigations
- how to guide student discussion on the key concepts, such as wastewater and sustainability
- the usefulness of the website for supporting the intended learning.

What do we want students to learn?

Read the relevant references in the Australian Curriculum: Mathematics, Geography and Science.

Choose an inquiry question to guide the ‘big ideas’ behind students' learning.

- What are the existing understandings of learners?
- Do the learners bring alternative conceptions?
- What are different ways that enable students to demonstrate their existing understandings, skills and knowledge?
- What dispositions and experiences do they bring?

How will we know students have ‘got it’?

How will students know what comprises high quality learning?

- What opportunities are there for students to express their understanding?
- What does ‘at this level’ mean?
- What distinguishes this learning from the achievement standards which come before and after this level?

What are the multiple ways learners can demonstrate their learning?

- What assessment strategies will best reflect this? (peer/self/teacher)
What will we do to get there?

How can we engage students with the Sewage sleuths website by building on current interests?

- How can I stretch all learners?

What will be needed to ensure all learners achieve the intended learning? For example: time, scaffolds, models, prompts, explicit teaching and ways to demonstrate developing mathematical and scientific understanding and skills.

The Learning design template is a thinking tool for teachers, which brings the Australian Curriculum and the South Australian TfEL together. It is designed to guide planning conversations about what you want students to know, and how you will get them there.

Learning design template
# Glossary

The meanings in this glossary are developed in the context of this inquiry.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>aeration</td>
<td>Adding air for the purpose of oxygenation, often by bubbling air through a liquid</td>
</tr>
<tr>
<td>aerobic</td>
<td>Oxygen-loving. Aerobic microbes will live well if oxygen is dissolved in their water, but do not live well if there is no oxygen. Humans are aerobic. (See anaerobic)</td>
</tr>
<tr>
<td>algae</td>
<td>Plants that grow in water. They can be large like seaweed or tiny like the millions of tiny plants that make up slime.</td>
</tr>
<tr>
<td>anaerobic</td>
<td>Oxygen-hating. Anaerobic microbes do not live well if oxygen is dissolved in their water, but do live well if there is no oxygen. (See aerobic)</td>
</tr>
<tr>
<td>bacteria</td>
<td>Small living things made of only one cell</td>
</tr>
<tr>
<td>biomass</td>
<td>All the living things in a place. The biomass of a football crowd would be how many tonnes of people were in the crowd (plus the weight of any pigeons or seagulls in the crowd.)</td>
</tr>
<tr>
<td>biosolid</td>
<td>The dead, dried remains of the microbes that ate the sewage.</td>
</tr>
<tr>
<td>black water</td>
<td>Wastewater containing bodily or biological wastes, as from toilets, or hospital drains, and kept separate from grey water</td>
</tr>
<tr>
<td>digester</td>
<td>A big tank where microbes eat (and digest) the waste. They eat up all the waste and make many more microbes—and gas.</td>
</tr>
<tr>
<td>engineers</td>
<td>People who design machines and structures to make our life easier</td>
</tr>
<tr>
<td>faeces</td>
<td>Bodily waste matter derived from eating food, commonly referred to as poo</td>
</tr>
<tr>
<td>grey water</td>
<td>The relatively clean wastewater from baths, sinks, washing machines and other kitchen appliances</td>
</tr>
<tr>
<td>grit</td>
<td>Small hard particles, such as sand or iron filings</td>
</tr>
<tr>
<td>lagoons</td>
<td>Large ponds</td>
</tr>
<tr>
<td>methane</td>
<td>A gas. It burns well and is lighter than air. The digestive tract of cows and sheep makes methane and then it is expelled into the atmosphere.</td>
</tr>
<tr>
<td>microbes</td>
<td>Small living things, too small to see. Bacteria and viruses are microbes.</td>
</tr>
<tr>
<td>parts per million</td>
<td>One bit in a million bits (e.g. one drop in a million drops, or a drop in about 5000 litres)</td>
</tr>
<tr>
<td>pathogen</td>
<td>A microbe that caused diseases</td>
</tr>
<tr>
<td>pollutant</td>
<td>Something that damages the environment</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>resource</td>
<td>Something that is useful to make something else. For example, wheat is a raw food resource that can be used to feed animals, or ground and turned into flour, which in turn makes bread, pasta and so on.</td>
</tr>
<tr>
<td>screens</td>
<td>In a wastewater plant the screens filter out rubbish from the sewage.</td>
</tr>
<tr>
<td>sewer</td>
<td>A pipe, or set of pipes, that takes wastewater away from houses and factories.</td>
</tr>
<tr>
<td>sewage</td>
<td>Another name for wastewater. (Not to be confused with the word sewerage)</td>
</tr>
<tr>
<td>sewerage</td>
<td>The pipes and pumps that move sewage (See sewage)</td>
</tr>
<tr>
<td>sludge</td>
<td>A thick mud-like paste that settles out of sewage</td>
</tr>
<tr>
<td>sludge digester</td>
<td>A warm place where anaerobic microbes eat all the sludge that has been removed from the sewage</td>
</tr>
<tr>
<td>urine</td>
<td>It is one of the body’s chief means of eliminating excess water and salt, commonly referred to as wee</td>
</tr>
<tr>
<td>wastewater</td>
<td>The water that has been used for washing, cleaning and flushing away waste</td>
</tr>
<tr>
<td>wastewater</td>
<td>A physical plant/factory where biological and/or chemical processes are used to change the properties of the wastewater, so that the water can be safely reused in the environment (e.g. to water ovals and parks)</td>
</tr>
</tbody>
</table>


Ideas for extending learning

Mathematics

Explain the aeration tanks graph

The graph of oxygen in the aeration tanks goes up and down quite a bit. This is normal. Can you explain what is happening to make the line go up and down?

Calculate the missing data

Here is some more data from the thermometers in Rivertown’s sludge digesters. The data was collected last year when something went wrong with the digesters. Unfortunately, someone spilt their lunch on the report. Draw a graph of the data. (Estimate the missing numbers.) Then try to work out what the digester’s problem might have been.

<table>
<thead>
<tr>
<th>WEEK 1</th>
<th>WEEK 2</th>
<th>Week 3</th>
<th>Week 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon</td>
<td>35</td>
<td>Mon</td>
<td>26</td>
</tr>
<tr>
<td>Tue</td>
<td>36</td>
<td>Tue</td>
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<td>Wed</td>
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<tr>
<td>Sat</td>
<td>29</td>
<td>Sat</td>
<td>20</td>
</tr>
<tr>
<td>Sun</td>
<td>27</td>
<td>Sun</td>
<td>19</td>
</tr>
</tbody>
</table>

How much is made in a year?

The grit and other rubbish removed from the sewerage needs to be sent to a dump. The engineers need to make enough space in the dump. Use the graphs in the Rivertown sewerage plant reports to estimate the following weights.

1. How many kilograms of grit do they need to get rid of each year? How many tonnes is this?

2. How many tonnes of ‘rags’ do they need to get rid of each year?
What would happen?

If a new factory was built to make weed killer and some of it leaked into the sewerage system, it would change the way the sewage treatment plant works. The graphs below show the results of three sewage treatment plant tests before the poison arrives. Draw new graphs showing what shape the lines might look like after the poison arrives. Would all the graphs change?

Science

*Sewage Sleuths* may also support the curriculum strand Science as a Human Endeavour. For example, the historical aspects of sewage and systems could be explored in the light of:

- Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people’s understanding of the world.

- Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations.

- Science understandings influence the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management.

For example, students could explore:

- the history of sewage
- issues of human population
- the role of modern utility companies, such as SA Water
- health issues for communities with poor water sanitation
- sewage requirements of modern cities and towns
- septic vs sewage treatment plants.
Literacy

**Australian Curriculum: Literacy Level 5—Comprehending texts**

- Navigate, read and view learning area texts; navigate, read and view a variety of challenging subject-specific texts with a wide range of graphic representations.

- Listen to extended spoken and audio texts, including audio-visual texts, respond to and interpret stated and implied meanings, and evaluate information and ideas.

- Interpret and analyse learning area texts; interpret and evaluate information, identify main ideas and supporting evidence, and analyse different perspectives using comprehension strategies.

**Grammar knowledge**

- Use wide knowledge of the structure and features of learning area texts to comprehend and compose texts, using creative adaptations of text structures and conventions for citing others.

**Text knowledge**

- Control a range of simple, compound and complex sentence structures to record, explain, question, argue, describe and link ideas, evidence and conclusions.

**Express opinion and point of view**

- Use language to evaluate an object, action or text, and language that is designed to persuade the reader/viewer.

Students could analyse the texts presented to them in *Sewage Sleuths*; for example, to understand how the structure, language features and purpose of the content relates to them as an audience. Students might examine the features of the video content, as opposed to the reports, to gain insights into how the texts are designed to persuade, or inform. Students could design their own texts in response, using those in the website as a model.