Lesson 2: Managing waste and polluting the land and water through reducing bathing water quality

Introduction:
This lesson tool can be adapted to your own style of teaching. The activities are designed to be flexible, allowing a teaching mix of demonstration, videos and experiments, so all students can understand the theory in the context of bathing water pollution; something relevant for beachgoers of all ages.

Curriculum links:

Curriculum link:	Students should understand:	Students should be able to:
B3 4.1b	Waste may pollute water with sewage, fertilisers or toxic chemicals. Waste may pollute land with toxic chemicals such as pesticides and herbicides, which may be washed from the land into the waterways	Describe how water can be polluted with sewage, fertiliser or toxic chemicals. Analyse and interpret data about water pollution.

Part 1: Who measures bathing water quality? How do they do it? Why do they do it?
5 min Environment Agency video on bathing water quality: http://www.youtube.com/watch?v=7UL4MoMjQUU.
The video shows the following:

- Who measures bathing water quality
- How they do it
- Why they do it

The DVD also provides an insight into a variety of scientific jobs and careers, plus a valuable background for the other activities in this section of the toolkit.

Suggested activity:
Follow-up class discussion

- What are intestinal enterococci and faecal coliforms? Why might it be a good idea to test for them?
  - Harmless 'indicator' bacteria found in human and animal digestive systems naturally. Prefer the same conditions as more harmful bacteria. Easy to test for, so are used in the screening process to check for water quality. If these 'indicators' are present, more harmful species may also be present, so additional treatment may be required.
  - Harmful species usually come from faecal contamination (human or animal), but can sometimes come from soil.
  - Are present in high numbers in raw (untreated) sewage and water contaminated by raw sewage.
- What do you think are the sources of the pollutants being tested for?
  - Run off from farms
  - dog poo
  - waste water runoff and sewage
  - seagull and pigeon poo
- Do you ever check the bathing water quality before you go in the sea? Why/why not? How might you check the water quality is safe for bathing?
  - Signs and flags (Blue Flag award) at the beach (N.B. bathing water quality is just one criterion for a Blue Flag award- absence of a flag does not necessarily indicate poor bathing water quality)
  - Coastwatch www.wessexwater.co.uk/coastwatch
  - Environment Agency website's 'bathing water explorer' http://environment.data.gov.uk/bwq/profiles/

Part 2: Interpreting bathing water quality data

Coastwatch: www.wessexwater.co.uk/coastwatch
Environment Agency: http://environment.data.gov.uk/bwq/profiles/

Suggested activity:

Data analysis from websites:

- How many beaches have testing stations?
- What percentage of beaches in Dorset have 'good' water quality?
- Based on the previous activities, what factors might influence bathing water quality?
    - High rainfall events
    - Nutrient runoff from farms further up the catchment
    - Dog, seagull and pigeon poo
    - Combined Sewer Overflow events
- The EA data interpretation mentions variations in water quality after high rainfall events. Why might this happen?
- What could be done to improve bathing water quality
    - At home
    - At the beach
    - By water companies
    - By businesses on the seafront and in other areas of coastal towns

Part 3: Surface water soup:

This activity helps students understand the sewage network system and why it is important that contaminants do not get into our drains. Newer sewage systems separate out 'surface water' (i.e. rain from guttering, washing down road drains etc), which then drains directly to the river or sea without treatment. This activity links directly with the Bournemouth Borough Council "Only Rain Down the Drain" project.

Resources:

- Large clear container with a fake drain cover on top
- Car wash soap
- Cigarette butts and litter
- Cleaning fluid from mop bucket
- Rain water – (in a beaker/jug)
- Soil
- Fertilizer
- Motor oil – dripping petrol or diesel

Suggested activity:

Half fill the large clear container in a visible position. Add in the surface water contaminants as students call them out. This 'surface water soup' symbolises what leaves our houses and flows into the nearest river or sea (because this surface water does not get treated.

Class discussion:

What could be done to make sure the surface water reaching the sea is as clean as possible?

- Revert to Combined system (problems with capacity; increased CSOs would result in more pollution reaching water courses, not less).
- Reduce pollutants going in at source- link to Only Rain Down the Drain campaign by Bournemouth Borough Council. E.g. surface drain markers around the town, encouraging businesses to dispose of liquid waste properly(e.g. training cleaners to empty buckets into sink (foul drain) not down surface drains), fixing misconnections, emptying car washing buckets down the loo.

Part 4: Contamination campaigning

Following on from class discussion, divide students into groups of 4-5, with each group choosing a particular liquid contaminant affecting surface water drainage (some ideas above in Part 3). Each group of students should work together to create a campaign poster, leaflet or letter to householders in their street explaining how the contaminant they have chosen directly affect the bathing water at our beaches if it's disposed of (or leaks, spills or runs) into surface water drains. Students will need to

research the impacts of the chemicals involved on river and sea life and on water quality, including how that affects people using the beach and water, and discover how best to dispose of these chemicals. These campaigns should offer positive solutions rather than a 'wagging finger'. Resulting campaign materials could be displayed in school or shared with the wider community.

Encourage students to consider:

- Where does the water from the school's surface drains go on its journey to the sea?
- Which beach does this journey end at?
- What happens to the water quality there if this contaminant reaches the sea?
- How does that affect me as a beach/water user?
- What happens to the plant/animal life in the rivers between the drain and the sea if it comes into contact with this contaminant?
- Are there any other effects on the local area if bathing water quality decreases?

Useful places to start research include:

- Visit www.bournemouth.gov.uk to find contact details to request sewer maps.
- Product labels- warning symbols give clues to how a product's ingredients react with the environment and people.
- www.wessexwater.co.uk provide information on the impacts and potential sources of surface water contamination
- http://environment.data.gov.uk/bwq/profiles/ provides details of how surface water can impact bathing water quality
- www.bournemouth.gov.uk and www.dorsetforyou.com provide useful guides on how to dispose of various household and garden chemicals which may be on the students' lists of potential surface water contaminants.
- Gather other behaviour change leaflets, posters, campaign materials (e.g. stop smoking, drive safe, Change4Life) for students to discuss in their groups which aspects they like about the campaign approaches.

Part 5: Sewage Soup:

Sewage is everything we flush down the loo, and wash down the sink bath and shower. This memorable activity involves making 'sewage' from toolkit components.

Resources:

- Large clear container
- Bath/shower/bathroom sink waste analogue- shampoo and conditioner, facewash, body wash, toothpaste
- Kitchen sink analogue – tea, cooking fat
- Toilet waste analogue– 'faeces' (weetabix mixed with cocoa and enough water to mould, prepared in advance), 'urine' (apple juice or food colouring added to water), toilet paper, wet wipes, cotton buds, sanitary towels, tampons, nappies

Suggested activity:

Half fill the large clear container with tap water in a visible position. Add in sewage components as students call them out until the kit is empty. This 'sewage soup' symbolises what leaves our houses and flows to the sewage treatment works. **Normally**, sewage gets treated before it is discharged into the sea. Most of our sewer system is combined- i.e. foul drains and surface water drains link together and all the water is treated together at the treatment works.

Class discussion:

These 3 'sewage soup' ingredients can cause problems for our beaches and bathing water.

- Rain water
  Rain water is clean! Why/how can it cause water quality issues?
  - Large influxes of rainwater into the combined system cause problems with capacity. Treatment works can only deal with a certain flow-rate of incoming water. What happens when that flow rate is exceeded? Can't deal with it- major problem!

    To solve this, a few treatment works have large storage tanks to absorb the short term problem- when it stops raining and the treatment works can cope with it, the stored excess water is pumped through the treatment works and cleaned as normal before being discharged. In exceptional circumstances even this extra storage might not be enough!

Most treatment works don't have this extra capacity, so what happens when they can't cope with the inflow rate? They are allowed, under carefully controlled conditions, to release untreated sewage directly into rivers and the sea: Combined Sewer Overflow (CSO). As part of the CSO mechanism, the raw sewage is screened with a mesh screen to remove physical contaminants known as Sewage Related Debris (this SRD is then passed on to the treatment works for full treatment), before the dilute sewage is released without treatment into the river or sea.

Note: As CSOs should only operate during periods of unusually intense rainfall, any foul water released from them will be very dilute because of the large volumes of rainwater within the system.

Note: newer sewage systems separate out surface water (e.g. rain from guttering, road drains etc), which is not treated. This means less pressure is added to existing treatment works when new developments are built, but is surface water always clean? (See part 5)

- How can we help stop this?
    1. Collecting rainwater (e.g. water butts) can help reduce the flow into the system at peak times, reducing the need for CSOs. Helps if the water butts are empty before high rainfall events!
    2. Only flush what is appropriate- "unflushables" can clog CSO screens causing further problems, or are too small to be caught, and go on to pollute rivers and seas.

- "Unflushables" – Wet wipes, sanitary items, nappies and cotton buds – Take the "Take the shake challenge" – some things contain plastics, so don't break down in water.
    - Cooking Fat – Clogs up the drains and causes fatbergs – Think about your Christmas turkey! 'Gunk pots' are available to buy from https://www.savewatersavemoney.co.uk/products/view/124/gunk-pot-pink.html

Extension:

- Write a mock newspaper article based on the following scenario: "Overnight rain in Bournemouth causes a CSO to occur. Wessex Water have investigated and found a 15 metre long 'fatberg' in the main sewer pipe."
    - What impacts have occurred at the beach?
    - How can local residents and businesses stop this happening again?

Part 6: Wet wipes vs. toilet paper (take the shake challenge)

What happens when you flush wet wipes down the toilet? This is a simple experiment but a great opportunity for data analysis.

Resources:

- 3 clear plastic bottles with large necks
- Wet wipes
- "Flushable" wet wipes
- Toilet paper

Suggested activity:

Half fill all three bottles with water, and add one of the paper types to each so they can be compared. Put the lids on tightly and shake vigorously to mimic flushing. Pass the shaken bottles round so students can see what has happened to each one.

Data analysis options:

- Report style: What happened to the wet wipes and toilet paper when they were 'flushed'? Why did this happen?
- Journal style: Write up the experiment in full with aims, method, results and analysis.