



The **Australian Marine Environment Protection Association (AUSMEPA)** has written a Curriculum Unit of Work for high school teachers, designed around STEM with a focus on 'Engineering'. No need to reinvent the wheel, it's all written for you! All in line with the Australian National Curriculum. Teacher's notes, student's worksheets, links to videos and photos. Easy to use and innovative, your students will love the 'hands on' experience.

SPILLCON is proudly organised by Australia's key government and industry agencies responsible for Australia's marine environmental protection arrangements, the **Australian Marine Oil Spill Centre Pty Ltd (AMOSC)**, the **Australian Institute of Petroleum** and the **Australian Maritime Safety Authority**. This is being held in May in Perth.

The Australian Marine Oil Spill Centre Pty Ltd (AMOSC) operates the Australian oil industry's major oil spill response facility. AMOSC's stockpile of oil spill response equipment includes oil spill dispersant and containment, recovery, cleaning, absorbent and communications equipment. Equally important is AMOSC's role in training and coordinating industry personnel ready to provide immediate emergency oil spill response.

Coinciding with SPILLCON, we are running a competition, for students to design their own 'Oil Spill Clean Up Tool', using engineering elements. Prizes to be won! Teachers and students will be also invited to come along to witness the on-water display of a 'mock' oil spill and attend a special session, with expert maritime speakers, uniquely for students. There is also an exhibition of the latest oil spill equipment, with the opportunity to discuss with the companies



Engineering Pollution Solutions

Teacher & Student material

Introduction to Engineering Pollution Solution investigation

Students will be:

1. Experimenting with the chemical properties of oil
2. Identifying the ways oil spills can be cleaned up
3. Exploring how this equipment is designed and used
4. Exploring the properties of the cleaning equipment and materials used to improve the removal of oil pollution.
5. Designing a project that applies your new knowledge providing engineering designs, new solutions or experiments comparing the properties of materials that could be used to clean up oil spills.

MUST READ - Teachers

How to use these materials:

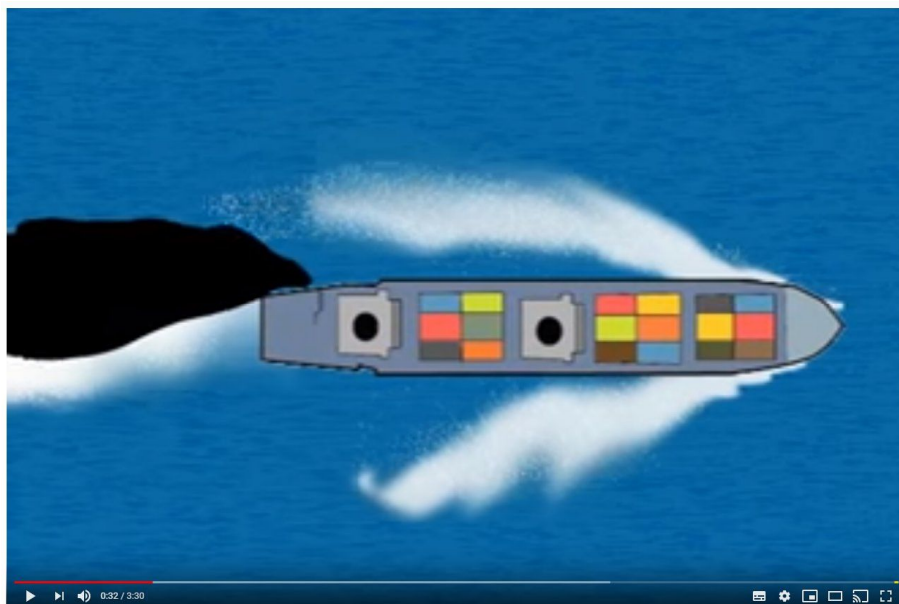
1. Read the introduction and play the video in the introduction (page 3)
2. Read 'Engineering Solutions' (page 6)
3. Experiments are optional depending on the room and equipment available and the time you have. However, you do need to discuss the properties of oil.
4. View the three videos after the experiments. (page 13)
5. Go through each of the methods for responding to oil spills. The coloured text boxes are later reference. (page 14)
6. Research the methods you are interested in. Examine these methods further by clicking on the links in the pink box and doing your own search.
7. Think about what you could do as a project for the method you are interested in.

Examples of the kinds of projects students can submit:

- Design a new tool that will effectively deals with one oil spill issue.
- Using a diagram, label and explain how a complicated machine enhances its ability to collect oil from water.
- Experiment comparing different materials effective ways of removing oil.
- Produce a communication product (e.g. video, powerpoint, labelled diagrams etc) for ways volunteers can help with an oil spill.
- Produce a communication product (e.g. video, powerpoint, labelled diagrams etc) that informs people ways they can prevent oil getting into the environment.
- Produce a working model of machine that cleans oil from water.
- Design a compact kit that fits into the back of a dual cab ute. The kit is used as a first response to a small oil spill in a creek.
- Collect or describe a kit of materials for cleaning and holding onto a dozen birds covered in oil for a week. Write a short manual to go with the kit.

Introduction to oil pollution

There are not many oil spills in Australia. But even a small oil spill has the potential of being catastrophic to the immediate environment. By quickly responding to contain and clean up the oil will minimise the effect of this pollution.



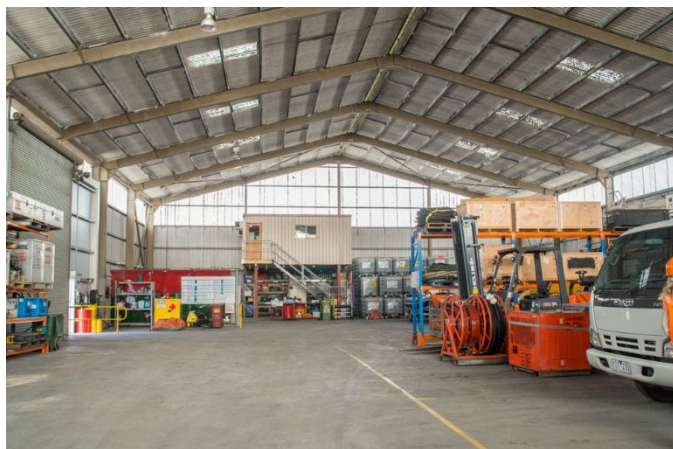
Video https://www.youtube.com/watch?v=APk_65bdhCM

Text <https://www.itopf.org/knowledge-resources/documents-guides/environmental-effects/>

There are many Australian and International regulations that reduce the risk of oil spills. Most oil spills are accidental, but sometimes waste oil is dumped at sea or in rivers.

Australia responds to oil spills by:

1. Having two facilities, one near Geelong in Victoria and the other near Perth, both run by AMOSC – Australian Marine Oil Spill Centre. They have facilities that store a vast array of equipment to contain and clean up oil spills.

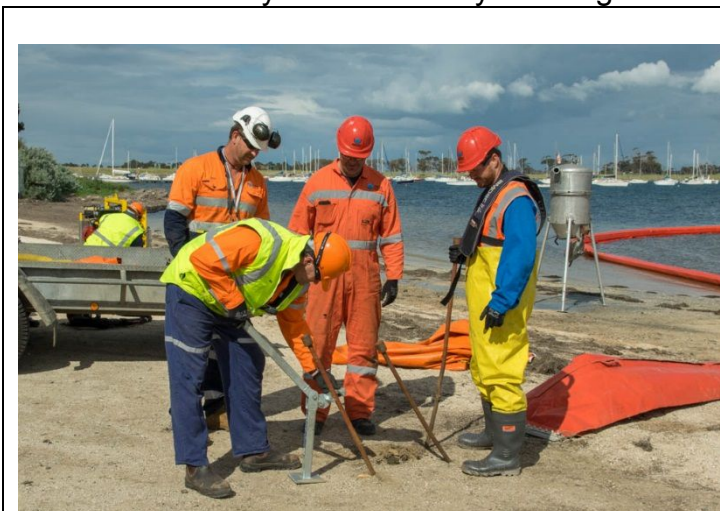




2. The equipment is designed to be carried by standard trucks and transported in cargo aircraft.
3. The equipment is ready to leave the facilities at very short notice.



4. People employed in Maritime Industries are trained to use the equipment so they can safely and effectively use the gear when it arrives.



AMOSC – Australian Marine Oil Spill Centre has a list of its available equipment on its website AMOSC <https://amosc.com.au/equipment/>



LANCER BARGE
AMOSC EQUIPMENT, TEMPORARY STORAGE, VESSELS



DECK BLADDER
AMOSC EQUIPMENT, TEMPORARY STORAGE



SPEED SWEEP
ADVANCED BOOMING SYSTEM, AMOSC EQUIPMENT



BIRD HAZING BUOY
AMOSC EQUIPMENT, WILDLIFE
The Breco Bird Hazer is a compact, light, waterproof system used for hazing of birds within a 500 yard radius.



EQUIPMENT WASHDOWN TRAILER
AMOSC EQUIPMENT, DECONTAMINATION
The Vehicle Washdown Trailer is a semi self-contained trailer designed to prevent secondary contamination from the spill site into the cold zone.



SHORELINE RESPONSE KIT
AMOSC EQUIPMENT, DECONTAMINATION
This kit has been assembled to aid in the response to an oiled shoreline.



HYDRAULIC AIR BLOWER
AMOSC EQUIPMENT, BOOM
The HAB 200 is used for in?ating booms. The air blower consists of a hydraulic motor and air blower installed in a portable aluminium frame.



SHORELINE FLUSHING KIT
AMOSC EQUIPMENT
The shoreline flushing kit is a self-contained, versatile low pressure flushing system for oiled rocky shorelines.



Engineering solutions

The engineer's role is to continually improve the equipment and designing new equipment and the best strategies to contain and clean up oil spills.

- Develop new technologies and use new materials to more efficiently mop up oil in various weather conditions.
- Constantly review how their technology works under different conditions.
- Improve technologies so they are safer, more reliable, easier to use, maintain and transport.

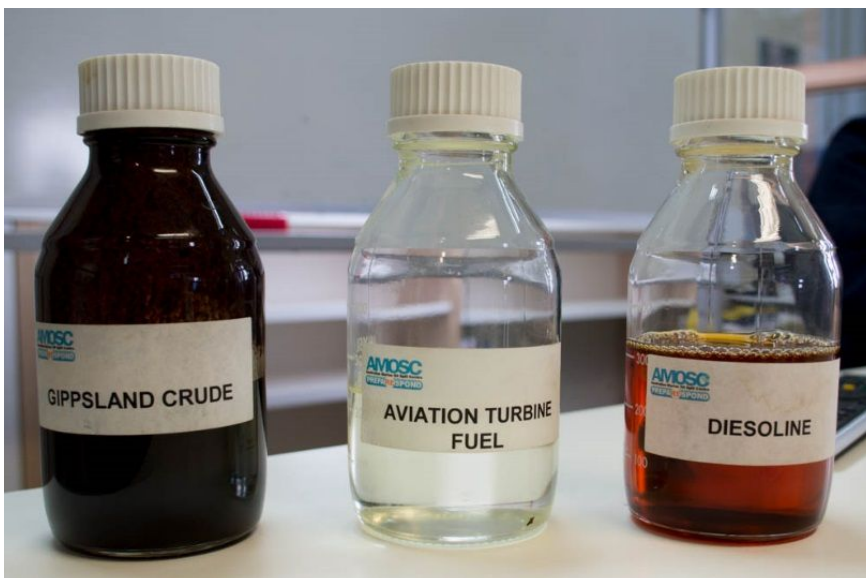


Video <https://youtu.be/s3wsCyo5Q10>

Oils may not be what you think its is.

There are many oils that come out of the ground. It's easiest to think about the difference as:

1. A runny liquid like liquid like the Gippsland crude below.
2. Difficult to stir the thick oil
3. Like thick tar. Thick oil would stick to a spoon.



In the photo above, the Gippsland oil has been refined into aviation fuel and dieseline.

Cleaning up oil spills will depend on the properties of the oil that has escaped into the sea or waterway,

The Science of oil in water experiments

Personal safety

- Experimental setups must be assessed by an adult for any safety issues.
- Avoid using glass in experiments
- Do not use petroleum oils, use as a substitute cooking oil

Removal of waste


- Use cooking oil as a substitute for petroleum oil.
- After the experiments, all liquids containing oil must go into a waste rubbish bin. You will need to store it in a sealed vessel, plastic bag or absorbed by paper towel.



Video <https://www.youtube.com/watch?v=xi-HuV4Yi5A>

Experiment 1. Oil and water

The properties of oil in water. Explain how it could be a problem when released in the environment?


<p>Materials</p> <ul style="list-style-type: none">• Small plastic jar with lid• Water• Cooking oil	<p>Method</p> <ol style="list-style-type: none">1. Half fill plastic jar with water.2. Add oil - about 10% of the water used. Place lid on jar.3. Observe and record what the oil does.4. Shake the jar5. Observe if what happens as the fluid settles.6. Keep materials for next experiment	
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Prediction

Observation

Explanation

Experiment 2. Detergent

Materials <ul style="list-style-type: none">• Small plastic jar with lid• Water• Cooking oil• Liquid detergent• Pipette	Method <ol style="list-style-type: none">1. Use the setup in the first experiment.2. Remove lid and add one drop of detergent to the oil.3. Observe if the detergent produces a change.4. Replace the lid and shake.5. Observe any changes.6. Dispose of the oil and water into a bin.	
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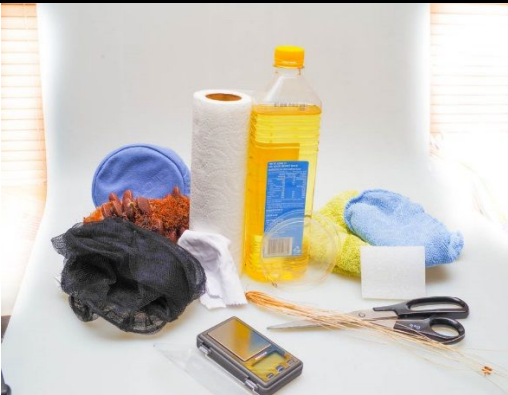
Prediction

Observation

Explanation

Experiment 3. Material that soaks up cooking oil

Scientists and engineers continually research and experiment with materials, to find better ways of cleaning up oil slicks.

<p>Materials</p> <ul style="list-style-type: none">• Equipment (scales) that can measure small difference in weight.• Cooking oil• tweezers• 2 petri dishes• Paper towel for cleaning petri dish• Variety of materials that could absorb cooking oil <p>Examples of material</p> <ul style="list-style-type: none">• Paper towel• Sponge• Cotton• Wool• Steel wool• Toilet paper• Plastic	<p>Method</p> <ol style="list-style-type: none">1. Cut materials into roughly the same size or weight e.g. 2cm by 2cm2. Setup second petri dish half filled with cooking oil3. Setup scales with a petri dish on top4. Record weight of petri dish5. Place material onto the scales and record total weight.6. Minus the weight of the petri dish to work out the weight of the material.7. Using tweezers, place material into oil for 10 seconds.8. When material is removed, hold it over the petri dish for ten seconds to allow drips to fall off and weight again.9. Record the total weight. Calculate how much oil was recovered.10. To work out how effective the material is at absorbing oil, take the weight of the oil and divide it into the weight of11. Clean the petri dish with paper cloth.12. Repeat for each material	
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Record sheet

Materials						
Grams						
Weight of Petri						
Weight of dish plus material						
Weight of material						
Weight of dish, material and oil						
Weight of oil						
Weight of oil divided by material						

Prediction

Observation

Explanation

Experiment 4. Compare oil and treacle

Viscosity is the measurement of how thick a fluid is or how easily it runs. Runny oils with very low viscosities might be able to evaporate. Thick oils with high viscosities will not evaporate. Which one might be stickier?

Materials <ul style="list-style-type: none">• Cooking oil• Treacle or golden syrup• 2 small beakers• 2 stirring rods	Method <ol style="list-style-type: none">1. $\frac{3}{4}$ fill beaker with cooking oil and the same in the second jar with treacle.2. Stir oil with rod. Note how much force is needed.3. Lift the rod out and observe how the oil drips off and how much oil is left after 30 seconds.4. Repeat for the treacle.5. Compare the properties of the cooking oil and treacle	
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Prediction

Observation

Explanation of how thicker oil could have a greater environmental impact.

Causes of oil pollution along our coasts and oceans

Big oil spills from ships and oil rigs will be reported over the world. Oil also enters the sea from rivers, which also impacts on beaches from the land. The source of the oil in rivers, can also be oil spills from truck oil tankers, refineries, illegal dumping of oil waste, from cars and people flushing oily liquids into the stormwater system.



Video <https://www.youtube.com/watch?v=6oYNfvKeznM>

What engineers are doing to provide new solutions?

These two videos show how a variety of equipment designed by engineers and research is helping to contain and clean-up oil spills at sea. This equipment can also be used in our waterways to clean up oil.



Video <https://www.youtube.com/watch?v=3DbSIAg3F3A>



Video <https://hub.jhu.edu/2014/04/15/oil-spill-research-engineering/>

What happens to the collected oil and contaminated material?

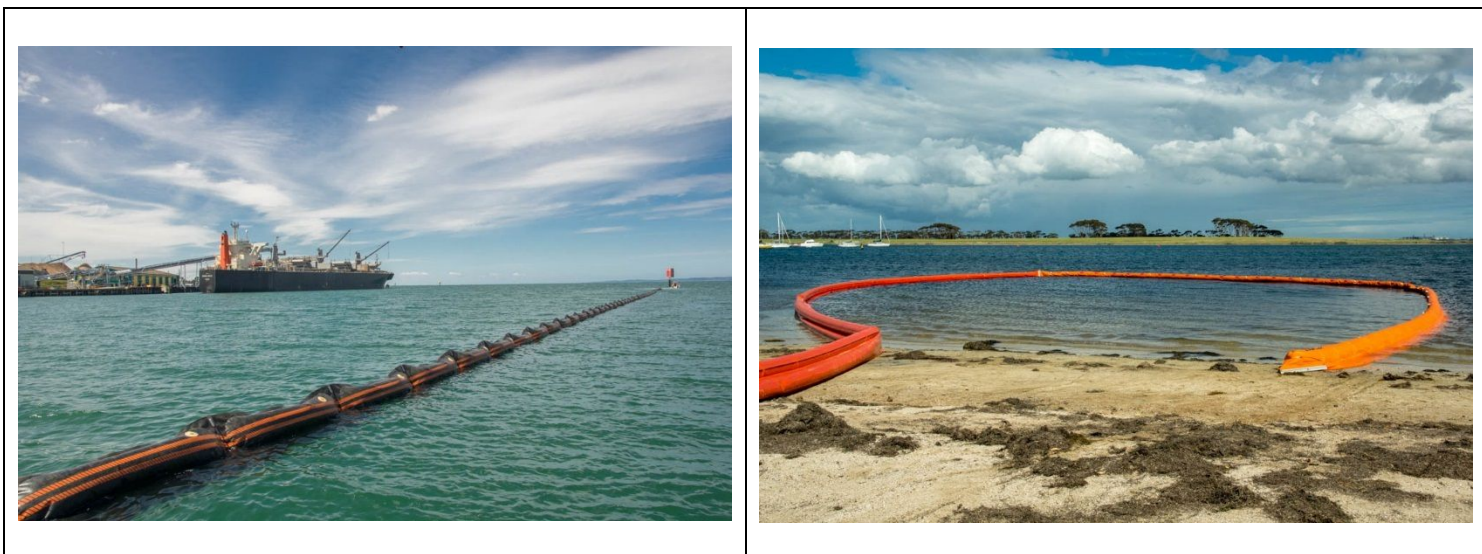
The oil and materials contaminated by oil are removed from the sea and shoreline.

1. At first, the storage of oil and contaminated materials, is stored temporary near to the site of collection. The temporary storage must prevent any of the oil escaping back into the environment.
2. This stored material must be collected. Liquid materials will be pumped into tanks. Solid materials will be transported in trucks.
3. All materials collected will be treated so they no longer cause a threat to the environment. Liquid materials are processed at special waste facilities. Some solid materials could be stored in a toxic waste site.

Containment

[Video www.oilspillprevention.org/oil-spill-cleanup/oil-spill-cleanup-toolkit/booms](http://www.oilspillprevention.org/oil-spill-cleanup/oil-spill-cleanup-toolkit/booms)

Booms are spread around an oil spill. When it's contained it can't move away to impact on a larger area. It's much easier to clean up the oil in a smaller area and it's easier to extract because it is thicker. Big waves can splash water over the booms



On the left is a massive boom brought in by heavy trucks, unloaded using cranes and require a powerful motor boat to pull it from shore. The boom on the right arrived on a ute, requiring a few men to unload, an air pump to blow it up and a tinny to stretch it out.



Booms can also be deployed from boats

Text and images. Find different kinds of booms on this website. <https://spillpro.com.au/spill-equipment>

Video https://www.youtube.com/watch?v=ADLNafH_6XY

Video <http://www.oilspillprevention.org/oil-spill-cleanup/oil-spill-cleanup-toolkit/skimmers>

Video <https://www.youtube.com/watch?v=a3FY7YMj3XA>

Video <https://www.youtube.com/watch?v=RwahKWIZQ-I>

Removal of oil at sea

Skimmers are small and large machines, designed to separate oil from water. Smaller skimmers can be taken to water ways and clean up around ports. The larger vessel will be taken to open water where it can clean up a much larger amount of oil.

<http://www.oilspillprevention.org/oil-spill-cleanup/oil-spill-cleanup-toolkit/skimmers>

<https://www.ultraspin.com.au/products/skimmers/>



Examples of oil skimmers

Video <https://www.youtube.com/watch?v=eO-0aWdXweU>

Video <https://www.youtube.com/watch?v=uXJA82tkaiG>

Video <https://www.youtube.com/watch?v=tX4IQk9txQk>

<https://www.youtube.com/watch?v=eO-0aWdXweU>
<https://www.elastec.com/products/oil-spill-skimmers/>
<https://www.youtube.com/watch?v=g4Pku98QBOA>
https://www.youtube.com/watch?v=Th-n8d2_PL4
<https://www.youtube.com/watch?v=JOEXYMQ1ooM>
<https://www.youtube.com/watch?v=Erl9I4bHbyo>
<https://www.youtube.com/watch?v=RPJ5WjH-wmA>
<https://vimeo.com/72901941>

Video <https://www.youtube.com/watch?v=rVhMxsqV3BU>

Find different kinds of skimmers on this website. <https://spillpro.com.au/spill-equipment>

Removal of oil on the shore

Oil that reaches the shore must also be removed. It will mix with sand and stick to rocks. The oil is toxic and will kill seashore creatures for decades if it is left. Small oil spills may require a few small teams to remove the oil. Mayor spills have used thousands of people and taken months or years.

<http://www.oilspillprevention.org/oil-spill-cleanup/oil-spill-cleanup-toolkit/manual-recovery>
<https://abc7.com/news/gov-brown-declares-state-of-emergency-over-oil-spill/732157/>



When oil reaches the shore, it is mixed and binds to sand, seaweed, shells, rocks and all other surfaces including piers and small craft. Most of it is removed by hand tools such as special rakes, forks and shovels. Large suction cleaners can suck up and separate the oil from water being washed in. In some cases, heavy machinery must be used to remove contaminated sand.

<https://www.sajakorpi.fi/en/manual-oil-recovery/>
<https://www.youtube.com/watch?v=A9ZinAlifFQ>
http://www2.nzherald.co.nz/tcn-environment/news/article.cfm?c_id=1504247&objectid=12068045
<https://spillpro.com.au/information-and-news/oil-spill-vacuum-systems>
https://www.vikoma.com/Oil_Spill_Solutions/Beach_Land_Cleaning/Mini_Vac.html

Dispersion

In some situations, the oil needs to be broken up with chemicals called dispersants. These chemicals are like detergents. They bind with both water and oil and form tiny droplets that will be broken down much faster by bacteria.

<http://www.oilspillprevention.org/oil-spill-cleanup/ocean-oil-spill-cleanup>
<https://www.itopf.org/knowledge-resources/documents-guides/response-techniques/dispersants/>



https://www.youtube.com/watch?v=qb_s8tk4ODU
<https://www.youtube.com/watch?v=WswMtD13bOY>
<https://www.youtube.com/watch?v=r49JpvPoh8k>
<https://www.youtube.com/watch?v=kQI5YFDteE1>
<https://science360.gov/obj/video/f8fa2173-ff69-4183-9b60-3ee87f775a49/wash-ocean-testing-chemical-dispersants-oil-spill-cleanup>
https://www.youtube.com/watch?v=nu_S5wz3Ft8
<https://www.youtube.com/watch?v=kQI5YFDteE1>
<https://www.youtube.com/watch?v=cJgzGLz6-cg>
https://www.youtube.com/watch?v=qb_s8tk4ODU

Sorbents

Materials are constantly being developed to more efficiently attract and hold onto oil. The properties required are:

1. Attract oil and repels water

2. Floats
3. Can absorb 100s time more oil than the weight of the material
4. Is cheap to produce
5. Can be easily removed from the water without oil dripping off.

Once the material has absorbed the oil, it must then be extracted from the water. They can be used quickly for small spills in water and on land.

<http://www.oilspillprevention.org/oil-spill-cleanup/oil-spill-cleanup-toolkit/sorbents>

<https://www.youtube.com/watch?v=KVwJWgnZiIM>



<https://www.youtube.com/watch?v=IUdevBQEbR0>

<https://www.ecospill.com.au/ecosweep-best-absorbent-for-oil-fuel-spills/>

<https://www.globalspill.com.au/product/oil-absorbing-pads-standard-duty/> - click on video

<https://www.grainger.com/content/supplylink-sorbent-types-guide>

<https://www.abc.net.au/news/science/2018-04-19/oil-spill-cleanup-research-waste/9223338>

Protecting and saving wildlife

All sea life is vulnerable to oil spills. Coral reefs are extremely sensitive to the toxic oil. Birds, sea mammals, turtles all breath air and will be covered by oil when on the surface. They will try to clean themselves and will inject the toxic oil. Birds with oily feathers won't be able fly or swim properly. Animal rescuers, which are mostly volunteers, will rescue and remove the oil.

Text <http://datazone.birdlife.org/sowb/casestudy/oil-spills-significantly-reduce-populations-of-seabirds-and-are-costly-to-clean-up->



Video <https://www.youtube.com/watch?v=hyKnDMIZZ14>

Video <https://www.youtube.com/watch?v=JPD6wizyMrE>

Video <https://www.youtube.com/watch?v=ydqZJPJ3pWw>

<https://www.oilspillresponse.com/services/preparedness-services/consultancy/oiled-wildlife-services/>

Text <https://www.racv.com.au/royalauto/living/community/oil-spill-wand-helps-clean-wildlife.html>

Text <https://penguinfoundation.org.au/about-us/research-2/>

Text <http://www.abc.net.au/local/stories/2014/08/08/4063779.htm>

text <https://www.nature.com/news/2004/040322/full/news040322-2.html>

AUSMEPA kindly thanks the following sponsors, who have made this Unit of Work come to life;

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20 – 24 May 2019
Perth, Australia

