VCE Environmental Science

Implementation of VCE Study Design 2022-2026

Unit 1 and Unit 2 knowledge, skills and assessment

VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

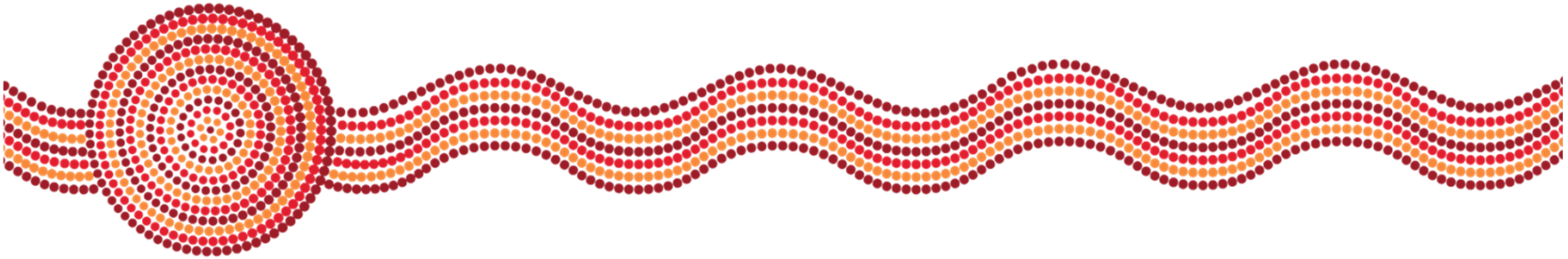
VICTORIA State Government

Acknowledgment of Country

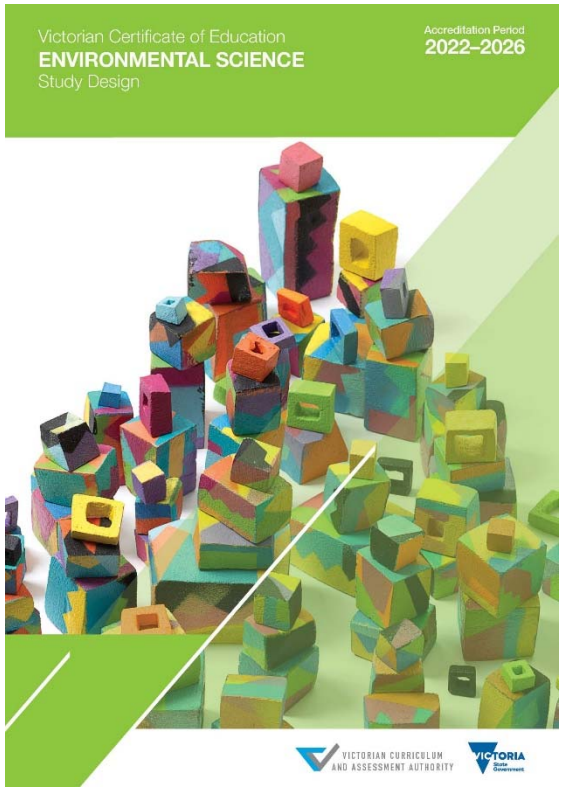
I would like to acknowledge the traditional custodians of the many lands across Victoria on which we are all living, learning and working from today.

Working from Fairhaven, I acknowledge the Eastern Maar Peoples as the traditional custodians of the land.

I would like to pay my respects to Elders past, present and emerging, for they hold the memories, traditions, culture and hopes of all Aboriginal and Torres Strait Islander peoples across the nation, and hope they will walk with us on our journey.



Purpose



- **Support VCE Units 1 and 2 teachers in delivering the newly accredited Environmental Science Study Design 2022-2026**
  - outline the main components of the study design
  - explore content for Units 1 and 2
  - provide ideas for implementation of the study design
  - discuss how assessment tasks for Units 1 and 2 can be developed to align with VCE assessment principles

Units 1 and 2 Structure and Content

Unit titles	Area of Study titles
Unit 1: How are Earth's dynamic systems interconnected to support life?	**Area of Study 1:** How are Earth's systems organised and connected? **Area of Study 2:** How do Earth's systems change over time? **Area of Study 3:** How do scientific investigations develop understanding of how Earth's systems support life?
Unit 2: What affects Earth's capacity to sustain life?	**Area of Study 1:** How can we manage pollution to sustain Earth's systems? **Area of Study 2:** How can we manage food and water security to sustain Earth's systems? **Area of Study 3:** How do scientific endeavours contribute to minimising human impacts on Earth's systems?

Developing a Units 1 and 2 curriculum and assessment program

- **Each school is different:**
  - different contexts in which students operate
  - different resources
  - different circumstances in which schools are situated
- **Students will have different:**
  - strengths, talents and access to resources
  - background experiences
- **Schools have flexibility in:**
  - designing curriculum programs that meet the needs of their cohort and the context in which they are learning
  - developing assessment programs that are aligned to the *VCE Environmental Science Study Design* and comply with VCE assessment principles.

Factors to consider in developing teaching and assessment programs

- **Extent of student agency and choice** – Will all students work on same environmental issues/ case studies? Groups on different issues?
- **Integration of key science skills**
- **Use of 8 scientific methodologies in teaching:** case studies? classification and identification? controlled experiments? correlational studies? fieldwork? literature review? modelling? product, process or system development?
- **Working with other teachers locally (or online)**
- **Local/ regional/ national/ international contexts?**

Components of the study design

Key Science Skills (pp 7-9)

VCE Enviro Study Design 2022–2026
Develop aim and questions, formulate hypotheses and make predictions
Plan and conduct investigations
Comply with safety and ethical guidelines
Generate, collate and record data
Analyse and evaluate data and investigation methods
Construct evidence-based arguments and draw conclusions
Analyse, evaluate and communicate scientific ideas

Integration of key knowledge and key science skills

Key science skills:

- **are not an 'add on' to the key knowledge**
- **may be explicit in key knowledge**
- **may be implicit, allowing flexibility for teachers to choose when/how to include in teaching and learning programs**

Key science skill	Key knowledge examples of the inclusion of key science skills
• select appropriate sampling techniques in fieldwork (including grids, quadrats, transects and mark-recapture)	***Unit 1 Area of Study 1*** • interrelationships within ecological communities as represented by food chains, food webs, energy and biomass pyramids ***Unit 1 Area of Study 3*** and ***Unit 4 Area of Study 3*** • techniques of primary qualitative and quantitative data generation relevant to the investigation

Scientific Investigation (p 9-12):

asking questions; testing ideas; using evidence

- Opportunities for teacher-facilitated, student-adapted and student-designed investigations across Units 1 – 4
- Scientific investigation methodologies for 2022-2026 Study Design:
  - Case study
  - Classification and identification
  - Controlled experiment
  - Correlational study
  - Literature review
  - Fieldwork
  - Modelling
  - Product, process or system development
  - Simulation

Scientific investigation methodologies (pp 9-10)

Methodology	Example
Case study	https://envirobites.org/2020/05/29/uncool-beans-the-future-of-coffee-under-climate-change/
Classification and identification	Use identification keys for aquatic macroinvertebrates as indicators of the health of a river
Controlled experiment	What is the minimum concentration of salt that will inhibit 50% of the growth of alfalfa seeds?
Correlational study	Does the use of indoor plants change air quality?
Fieldwork	How does skiing affect the biodiversity of an area after the snow is gone?
Literature review	Is overfishing a problem in Australia?
Modelling	Construct a scaled model of Earth's layers
Product, process or system development	Design, construct, evaluate and improve a system to filter water
Simulation	View ecological or environmental processes over time, e.g., symbiosis

Practical work

- Central component of learning and assessment
- Includes activities related to the 8 scientific investigation methodologies, for example, work undertaken on a field trip
- Simulations, remote experiments and virtual experiments may be used as the basis for practical work
- A minimum of 10 hours of class time should be devoted to student practical activities and scientific investigations across Areas of Study 1 and 2 for each of Units 3 and 4
- A minimum of 10 hours should be devoted to the student-designed investigation in Unit 4, Area of Study 3
- The support resources on the website provide suggestions for practical work

Fieldwork

A variety of techniques may be used for fieldwork, as decided by schools:

Technique	Examples
Counting	Unit 1: counts associated with citizen science projects such as birds/frogs/bats Unit 2: macroinvertebrate counts to assess water quality
Measuring	Unit 1: soil moisture content – weigh different soil samples before and after slowly drying them out in an oven Unit 2: water quality - salinity, pH, dissolved oxygen, temperature
Environmental quality surveying	Unit 1: use of a class-developed sliding scale from 1 to 5 to assess river quality: clear water with visibility to the bottom = 5 through to muddy water with no visibility beyond 1 cm depth = 0 Unit 2: use of a class-developed sliding scale to assess noise pollution: no appreciable noise = 5 through to intolerable noise = 0
Sketching and photography	Unit 1: comparison of older photographs of a location with current sketches or photographs to determine how the location has changed over time Unit 2: photographs of air pollution strips in different locations
Questionnaires and interviews	Unit 1: recycling practices in the home Unit 2: attitudes to locally grown and imported raw food and/or food products

Contexts for teaching Units 1 and 2

Unit 1 Area of Study 1 Outcome 1

…describe the movement of energy and nutrients across Earth's four interrelated systems, and analyse how dynamic interactions among biotic and abiotic components of selected local and regional ecosystems contribute to their capacity to support life and sustain ecological integrity

Unit 1 Area of Study 1: How are Earth's systems organised and connected?

Investigation of local ecosystems (1 of 2 subsections)

- the range of biotic and abiotic components that determine the environmental conditions of varied habitats within aquatic and terrestrial ecosystems
- interrelationships within ecological communities as represented by food chains, food webs, energy and biomass pyramids.

Possible contexts: ***biotic components:*** the variety, relative abundance and functional roles (ecological niches) of species, particularly keystone species and top-order predators; ***abiotic components***: water availability; light intensity; nutrients; ***environmental monitoring***: temperature; pH; salinity; turbidity; dissolved oxygen*;* ***land****:* rock, soil and sand substrates ***natural forces:*** wind; waves; tides; currents; rain; ***interrelationships***: symbiosis; mutualism; commensalism; amensalism; competition; predation; parasitism; herbivory

Unit 1 Area of Study 1: How are Earth's systems organised and connected?

Earth systems thinking (2 of 2 subsections)

- natural interactions between Earth's four systems – the atmosphere, biosphere, hydrosphere and lithosphere – that support and are affected by the movement of energy and matter within and between local and global ecosystems
- systems thinking as a way of exploring relationships in environmental systems by identifying inputs, outputs, components and processes that may be visible or invisible to the human eye, including representation of a local and regional environmental system.
- **Possible contexts**: ***cycles***: biogeochemical; hydrological; ***processes***: photosynthesis; chemosynthesis; aerobic respiration; anaerobic respiration; ***local systems***: home, school or community garden; fish tank/ aquarium/ fishpond/ lake/ reach of a stream; ***regional systems***: National Park; coastal environment; river; mountains; ***approaches***: systems thinking compared with Traditional Ecological Knowledge; **system *boundaries***: open and closed systems

Unit 1 Area of Study 2 Outcome 2

…analyse how changes occurring at various time and spatial scales influence Earth's characteristics and interrelated systems, and assess the impact of diverse stakeholder values, knowledge and priorities in the solutions-focused management of a selected regional environmental challenge

Unit 1 Area of Study 2: How do Earth's systems change over time?

Earth's dynamic systems (1 of 3 subsections)

- transformative processes occurring during Earth's deep history that shaped the formation of Earth's four interrelated systems
- changes and disruptions to landscapes, ecosystems and biomes that influence their distribution and ecological characteristics
- **Possible contexts**: ***transformative processes***: Milankovitch cycles; geomagnetic reversals; plate tectonics; the Great Oxidation Event; mass extinction of species; ***change and disruption***: daily, diurnal, nocturnal, circadian, seasonal and tidal rhythms; ***natural events***: volcanic activity; earthquakes; glacial melting; El Niño Southern Oscillation; ***climate effects***: fire; drought; flood; desertification; ***species interactions***: invasive species; migration/dispersal; disease; the loss or reduction in numbers of keystone species; urbanisation; farming; erosion

Unit 1 Area of Study 2: How do Earth's systems change over time?

Data and modelling (2 of 3 subsections)

- ways of using data and models to study Earth's systems and changes in Earth over time.
- **Possible contexts**: evidence of Earth's age as 4.5 billion years; Earth's layered structure; existence of a geomagnetic field; thermohaline circulation; the decay of radioisotopes in rocks and minerals; the study of seismic waves, meteorites and deep sediment cores; Milankovitch cycles; natural greenhouse effect; satellite measurement techniques

Unit 1 Area of Study 2: How do Earth's systems change over time?

Managing environmental challenges (3 of 3 subsections)

- the role of innovation and science in responding to challenges as a result of environmental change and disruption
- the contribution of scientific data, new technologies, regulatory frameworks and diverse stakeholder values, knowledge and priorities in managing environmental challenges of regional relevance.
- **Possible contexts**: design and construction of earthquake-resistant buildings; technological developments: site-specific weed management; recording animal movements using sensors; making improvements to tsunami warning systems; application of Aboriginal and Torres Strait Islander ecological knowledge; clear cutting; mining; ***citizen science projects***: mapping migratory pathways of birds; frog calls; butterflies; monitoring of waterways; monitoring of air quality

Unit 1 Area of Study 2

Beach erosion: STEM solutions

- Can humans stop erosion on the shoreline? Should we? Is it cost effective?

Resources

- Sandy coastlines under threat of erosion https://www.nature.com/articles/s41558-020-0697-0
- STEM projects that tackle real-world problems https://resilienteducator.com/classroom-resources/real-world-stem-projects/

Unit 1 Area of Study 3: How do scientific investigations develop understanding of how Earth's systems support life?

Three sections: Investigation design; Scientific evidence; Science communication.

Possible contexts: Area of Study 1 and/or Area of Study 2

Mandated assessment: **(p. 23 of the study design)**:

…a report of a **student-adapted** or **student-designed** scientific investigation using an appropriate format such as a scientific poster, an article for a scientific publication, a practical report, an oral presentation, a multimedia presentation or a visual representation.

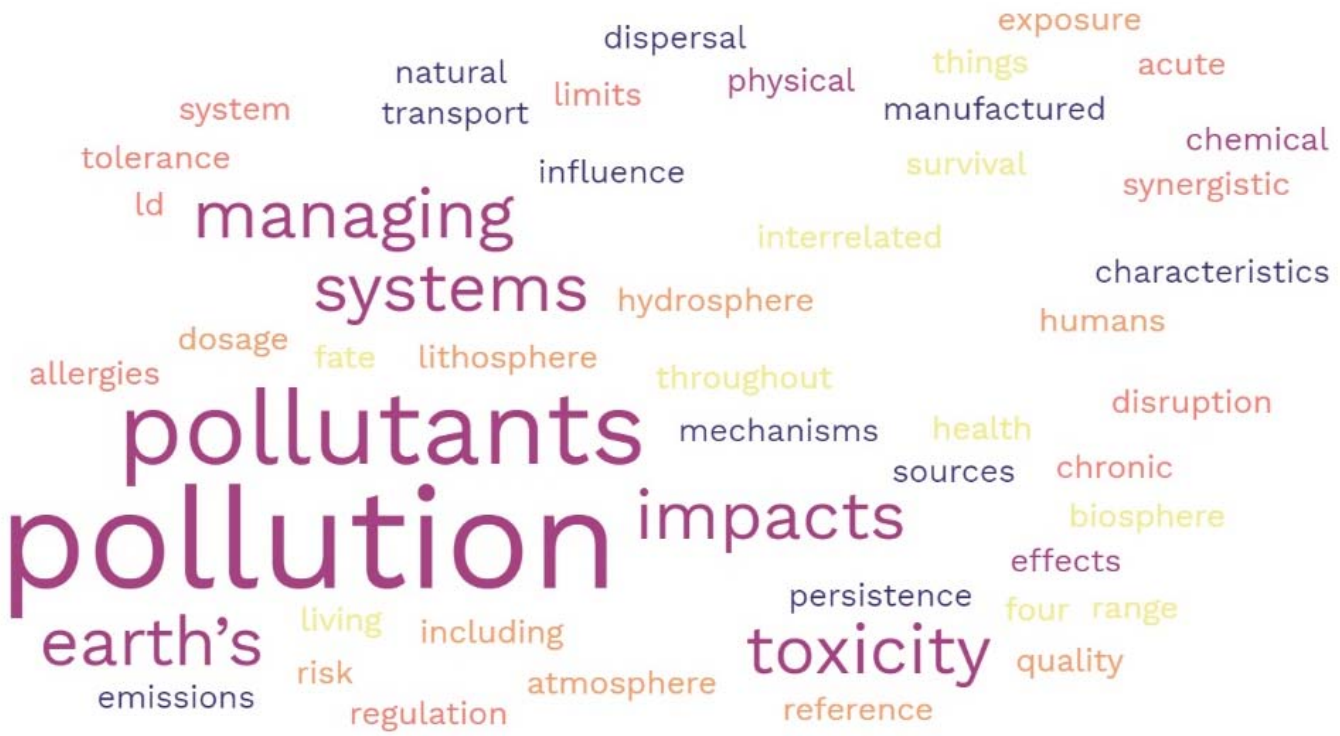
VCE Environmental Science scientific poster example: Fieldwork: Unit 1 Area of study 1

Which bait attracts the most number of bugs? Stu Dent		
Introduction Methodology and methods Results	Old fruit attracts the most number of bugs, and honey attracts the least number of bugs	Discussion Conclusion
References and acknowledgments		

VCE Environmental Science scientific poster example:
Controlled experiment related to Unit 1 Area of study 2

Which types of seeds are more resistant to fire? Stu Dent		
Introduction Methodology and methods Results	Native seeds are better able to germinate after exposure to fire than introduced plant seeds	Discussion Conclusion
References and acknowledgments		

Unit 2 Area of Study 1 Outcome 1



…explain how the chemical and physical characteristics of pollutants impact on Earth's four systems, and recommend and justify a range of options for managing the local and global impacts of pollution

Unit 2 Area of Study 1: How can we manage pollution to sustain Earth's systems?

Pollution effects on Earth's systems (1 of 2 subsections)

- chemical and physical characteristics of pollutants that influence dispersal of emissions from natural and manufactured sources
- the transport mechanisms, persistence, fate and toxicity of pollutants throughout Earth's four interrelated systems
- the impacts of a range of pollutants on the health and survival of living things in the biosphere, including humans, and on the quality of the atmosphere, hydrosphere and lithosphere with reference to risk, exposure, dosage, tolerance limits, LD50, chronic and acute toxicity, allergies, disruption of system regulation and synergistic action.

Possible contexts: ***properties***: state; solubility; density; chemical reactivity; radioactivity; ***health impacts***: risk; exposure; dosage; tolerance limits; LD50; toxicity; ***human effects***: allergies; disruption of system regulation; cancer; ***environmental effects***: bioaccumulation; smog; pollutants: chemicals; noise; heat; odours; radiation; endocrine disruptors

Unit 2 Area of Study 1: How can we manage pollution to sustain Earth's systems?

Managing pollution (2 of 2 subsections)

- the contributions of scientific data, new technologies, regulatory frameworks and diverse stakeholder values and priorities when managing pollution
- options for control and treatment of pollution to reduce local and global impacts.

Possible contexts: ***urbanisation***: urban sprawl and urban infill; ***human activities***: noise from industry and recreational pursuits; emissions from agriculture and transportation; solid waste and landfill; ***emissions monitoring***: legislated incentives and/or penalties; ***innovation and environmental solutions***: remediation and restoration of affected sites; new technologies; education; personal and/or institutional behavioural modification/change

Unit 2 Area of Study 1: context example

Case study: The Montara blowout oil spill disaster

The Montara blowout is thought to be one of Australia's worst environmental disasters. In 2009, 220 km off the coast of WA an oil rig caught fire and leaked crude oil into the Timor Sea for 74 days causing a 90,000 square kilometre oil slick that reached as far as Indonesia.

More than 15,400 Indonesian seaweed farmers have been devastated by the effects of the spill, which killed their crops and left their economy an estimated $1.5 billion worse off, every year since the disaster.

The effects of an oil spill can go beyond the deaths of cute marine life. Seabirds and whales are not only victims, but their suffering is perhaps the most visible of many impacted groups. The impact on other living and non-living things is also significant.

Problem-based learning: start simple

- Ask students what they already know about oil spills
- Set a scenario/ show students a YouTube clip about an oil disaster
- Ask each group of students to mix oil and water in a large container and add a few feathers to the mix; then pass out materials like sponges, paper towels, cotton balls, straws or small spoons and instruct the groups to try to remove the oil from the water and feathers.

How can the oil and water be separated? Is it easy to remove oil from feathers?

References:

- **Using cotton to clean up oil spills:**
  https://www.sciencenewsforstudents.org/article/soaking-oil-spills-with-cotton#:~:text=Just%20throwing%20a%20huge%20wad,bringing%20it%20inside%20the%20fibers
- **10 methods to clean up marine oil spills:**
  https://www.marineinsight.com/environment/10-methods-for-oil-spill-cleanup-at-sea/

Unit 2 Area of Study 2 Outcome 2

…compare the advantages and limitations of different agricultural systems for achieving regional and global food security, evaluate the use of ecological footprint analysis for assessing future food and/or water security, and recommend and justify a range of options for improving food and/or water security for a nominated region

Unit 2 Area of Study 2: How can we manage food and water security to sustain Earth's systems?

Sustainable food systems (1 of 2 subsections)

- challenges to supplying adequate and affordable food in regional and global locations that achieve regional and global food security
- qualitative differences between food produced by conventional monoculture and organic monoculture agricultural systems
- **Possible contexts**: populations; transportation of agricultural food; growing wealth; changing food habits; food loss and food waste practices; land use competition between food and biofuel crops; land degradation; pollution including chemicals used in or produced as by-products of industrial activities, domestic, livestock and municipal wastes, agrochemicals, and petroleum-derived products; water scarcity; food quality; crop yield; land area requirements; ethical treatment of animals

Unit 2 Area of Study 2: How can we manage food and water security to sustain Earth's systems?

Maintaining food and water security (2 of 2 subsections)

- options for improving food security that consider organisational, political and structural enablers and barriers to change
- the use and limitations of ecological footprint analysis, in terms of the sustainability principles of intragenerational equity and the efficient use of resources
- the ecological footprint of either an individual, local and/or international community or business, or a local or imported raw food and/or food product
- options for decreasing water demand and improving water-use efficiency

Possible contexts: government subsidies and incentives; health and food system education; advocacy by individuals, communities and organisations; integration of agro-ecological farming practices ecological; footprint analysis; water restrictions; installation of water-efficient devices;

Using ‘special days’ to develop learning and assessment activities

- **Sustainability seafood week**
  21-27 March 2022
- **World Oceans Day**
- **8 June 2022**

https://www.msc.org/en-au/what-we-are-doing/our-approach/what-is-sustainable-seafood

“Sustainable seafood has been caught in a way that means there’s plenty more fish in the sea now and in the future.
We believe we should have fish forever, so we use science to end overfishing. As scientists who care about people and planet, we maintain the world leading **MSC Fisheries Standard** for sustainable fishing.
Sustainable fishing means:

- Maintaining healthy populations of fish;
- Minimising impact on the marine environment;
- Fished in an area with effective, responsive, and responsible management.”

Note: Stimulus material be modified/expanded to develop an assessment task

Which fish are sustainable to eat in Australia?

https://www.australiangeographic.com.au/topics/science-environment/2018/01/a-guide-to-sustainable-seafood/

Examples include:

- **Australian salmon**
- **Crabs**
- **Flathead**
- **Bay prawns**
- **Whiting**
- **Barramundi**
- **Blue mussel**
- **Southern calamari**

Assessment task examples:

- **Data analysis**: Comparison of sustainable versus non-sustainable fish populations over time
- **Photojournalism**: 'What factors affect the sustainability of fish populations?'
- **Designed response/s** to improving stocks of sustainable fish
- **Stakeholder perspectives**: Does it matter if barramundi become extinct?

Unit 2 Area of Study 3: How do scientific endeavours contribute to minimising human impacts on Earth's systems?

Two sections: Scientific evidence; Science communication.

Possible contexts: Area of study 1 and/or Area of Study 2

Mandated assessment (p. 29 of the study design):

A response as to how science can be applied in the management of a selected pollutant or in securing food and/or water, communicated in an appropriate format for a specified audience.

Many ways to organise assessment for example:

- Students may all respond to the same issue/ scenario
- Students may individually research their own pollutant of interest/ food or water security issue – notes/ideas in logbooks – set of questions to respond to.

Planning template – putting it all together

Provide details of the outcome, time period (Term/Week–Term/Week), key knowledge and key science skills *(from the study design)*		List and describe the learning activities that will be used to provide appropriate opportunity for students to demonstrate satisfactory achievement of the outcome (this includes practical activities, demonstrations and excursions/field work)	List and describe the assessment tasks that will be used to assess students level of achievement. Include an estimate of when each task will occur
Unit 1, Outcome 1: <insert outcome statement – see page 14 of VCE study design>			
Anticipated teaching time allocation: <insert as appropriate; e.g. Term 1 Week 1 – Term 1 Week 6>			
Key knowledge:	**Env. Science Units 1–4 Key science skills:**	<Consider a range of resources when developing appropriate learning activities; e.g. VCE Advice for Teachers located on the VCAA website: www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/environmentalscience/advice-for-teachers/Pages/Index.aspx – ensure that any activities directly sourced from a public resource are contextualised to your school/provider's approach>	<Select and describe as appropriate. See page 17 of the VCE study design. Include an estimate of when the task will occur>
• <Select as appropriate. See pages 14–15 of VCE study design>	• <Select as appropriate. See pages 11–12 of VCE study design>		

Whilst designed specifically for schools seeking to deliver a VCE study for the first time, the VCE Curriculum and Assessment Plans are a useful tool for all teachers in planning assessment.

Assessment

VCE assessment principles

The VCE Assessment Principles state that assessment will be:

- ***valid and reasonable -*** **should not assess learning that is outside the scope of a study design**
- ***equitable -*** **should neither privilege nor disadvantage certain groups of students**
- ***balanced -*** **a variety of task types should be used**
- ***efficient -*** ***only need to assess enough to rank students.***

Units 1 and 2 Assessment

- **All assessments at Units 1 and 2 are school-based, including procedures for assessment of levels of achievement**
- **Underpinned by VCE Assessment Principles**
- **S or N for each Unit is reported to the VCAA**
- **List of selected tasks to choose from for Outcomes 1 and 2 in Unit 1 (p 23)**
- **List of selected tasks to choose from for Outcomes 1 and 2 in Unit 2 (p 28)**
- **May choose your own tasks for Outcome 1 and 2 in Units 1 and 2**
- **If multiple tasks are used for Outcome 1 and/or 2, they must be different**
- **Same task cannot be selected more than once across Outcomes 1 and 2**
- **Unit 1 Outcome 3:** Report of a student-adapted or student-designed investigation
- **Unit 2 Outcome 3**: A response to an investigation into a pollutant or food/water security issue.

Assessment validity: assessment of Outcomes

VCE Environmental Science Unit 2 Outcome 2

…compare the advantages and limitations of different agricultural systems for achieving regional and global food security, evaluate the use of ecological footprint analysis for assessing future food and/or water security, and recommend and justify a range of options for improving food and/or water security for a nominated region

Notes:

- All of the Outcome should be assessed to determine an 'S' or an 'N', noting the 'level' of command terms
- Tasks to determine and report levels of performance are school-determined

New Unit 4 Outcome 3 Scientific poster format

Maximum: 600 words

20 – 25% of space allocated to communicating main finding

<table>
<tr><td colspan="3">Title as an investigation question
Student name</td></tr>
<tr><td>Introduction

Methodology and methods

Results</td><td>Communication statement reporting the key finding of the investigation in response to the investigation question as a one-sentence summary</td><td>Discussion

Conclusion</td></tr>
<tr><td colspan="3">References and acknowledgments</td></tr>
</table>

VCE Environmental Science scientific poster example:
fieldwork for Unit 1 Area of Study 1

How does phosphate content along a river change? Stu Dent		
Introduction Methodology and methods Results	Mid-stream phosphate content was higher than upstream or down stream, possibly because of local farm soil fertiliser application	Discussion Conclusion
References and acknowledgments		

VCE Environmental Science scientific poster example: modelling for Unit 1 Area of Study 2

How can erosion be controlled? Stu Dent		
Introduction Methodology and methods Results	Construction of foundational pier systems are effective in managing erosion	Discussion Conclusion
References and acknowledgments		

VCE Environmental Science scientific poster example:
a correlational study for Unit 2 Area of study 1

Is air quality at my school affected by the highway? Stu Dent		
Introduction Methodology and methods Results	There is a weak correlation with distance from the highway and air quality at my school	Discussion Conclusion
References and acknowledgments		

VCE Environmental Science scientific poster example: fieldwork for Unit 2 Area of Study 1

How much plastic is on Elwood beach? Stu Dent		
Introduction Methodology and methods Results	Elwood beach has an average of 19.93 g of plastics – including microplastics – per square metre	Discussion Conclusion
References and acknowledgments		