VCE Environmental Science
2022–2026

School-based Assessment report

This report is provided for the first year of implementation of this study and is based on the 2022 School-based Assessment Audit.

All official communications regarding the Victorian Certificate of Education (VCE) Environmental Science Study Design are provided in the *VCAA Bulletin*. It is recommended that teachers individually subscribe to the *VCAA Bulletin* to receive updated information regarding the study. The *VCE and VCAL Administrative Handbook* and *Important* Administrative *Dates* are published on the Administration page of the VCAA website.

General comments

Responses to the School-based Assessment Audit for VCE Environmental Science indicate that many audited schools had either just introduced the study or had a first-time teacher of the study. The audit responses from all other schools showed that they made a successful transition from the previous study design to the reaccredited [VCE Environmental Science Study Design 2022–2026](https://www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/environmentalscience/Pages/Index.aspx)*.* Two schools formed a partnership to enable the study to run at both schools, and some schools reported sharing resources and combining with other schools for fieldwork.

The [VCE Environmental Science Support Materials](https://www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/environmentalscience/Pages/Index.aspx) provide teaching and learning advice for Units 1 to 4 and assessment advice for school-based assessment in Units 3 and 4, including examples of assessment task contexts across Units 3 and 4, VCAA performance descriptors for each assessment task type in Units 3 and 4, and suggestions for the application of performance descriptors to School-assessed Coursework (SAC) tasks.

Several VCAA reports are available to assist in informing teaching and assessment practices. Schools may use Examination Reports, Statistical Moderation Reports, and School-assessed Coursework Reports to improve the learning outcomes of students and to create assessment tasks that meet the [VCE assessment principles](https://www.vcaa.vic.edu.au/curriculum/vce/Pages/VCEPoliciesandGuidelines.aspx). These reports may be used at the individual teacher level as well as at the departmental, faculty and/or school level.

School-based assessment provides opportunities for non-routine and open-ended environmental science contexts and applications to be explored in greater depth and breadth than is possible in an examination. Almost all audited schools used their own school grounds and/or local environments to develop a teaching and learning programme and a set of assessment tasks across Units 3 and 4 that relate directly to students’ everyday experiences and their understanding of local, national and global environmental issues, challenges and possible solutions. All schools were able to link their laboratory activities and/or fieldwork to the new assessments in the revised study design.

The School-based Assessment Audit

The School-based Assessment Audit enables the VCAA to check that School-assessed Coursework (SAC) tasks are compliant with the four VCE assessment principles (validity, equity, efficiency, and balance) and the requirements of the VCE Environmental Science Study Design.

The first stage of the audit requires schools to complete a study-specific audit questionnaire by providing information about assessment planning, timelines, resources, the types of assessment tasks set, and the conditions under which students sit the tasks. Most audited schools designed and used tasks that met the requirements of the reaccredited study design and the VCE assessment principles. Some schools proceeded to the second stage of the audit process due to issues such as providing insufficient information about how SAC tasks were developed. In other cases, it was not clear through the audit response as to whether the task/s met the definition of the task type as specified in the study design.

Most schools reported that the audit was a useful undertaking as it provided an opportunity to consider or review their practice against the new study design and helped ensure there was a good overview of the whole unit in terms of the relationship between key knowledge and key science skills.

Assessment planning

All schools provided an assessment timetable to students at the beginning of the school year, or occasionally during the previous year’s orientation program, to assist them in planning for assessment. In many schools, SAC tasks were used for both formative and summative purposes.

Prior to each SAC task being undertaken, students should be given a clear and accurate statement of:

* the outcome being assessed
* the selected task type
* the requirements and conditions of the task
* the contribution of the task to the final outcome score.

Where schools used assessment rubrics for SAC tasks, these were generally provided to students prior to the task being undertaken; this practice assists in meeting the VCE assessment principle of equity since all students have clarity about what is expected in terms of the quality of task responses.

The assessment of the student-designed investigation for Unit 4 Outcome 3 was commonly completed in stages, with students often being provided with scaffolds or templates for developing and reporting their investigations. This made it clear to students what would be assessed and also provided opportunities for students to be provided with appropriate feedback, after completion and assessment of the SAC task, about the development of their scientific inquiry skills. This approach also assisted teachers with the authentication of student work and time management in assessing this outcome.

Many schools reported using VCAA performance descriptors, or modified VCAA performance descriptors, to assess student work. Teachers are reminded that these are not mandated. In some cases, school-developed marking schemes may be more appropriate, particularly for tasks that are based on a set of scaffolded questions related to a given scenario or case study.

Task development

The audit has shown that most teachers have paid close attention to both the key knowledge and the key science skills in the reaccredited study design and have designed content-aligned assessment tasks. Teachers are advised to refer to the [*General assessment advice*](https://www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/environmentalscience/Pages/Assessment.aspx#Unit3and) that includes information about each of the assessment tasks across Units 3 and 4, suggestions for developing SAC tasks, and VCAA performance descriptors. Teachers are also encouraged to use the ‘Mapping of VCE Environmental Science assessment tasks against key science skills’ grid hyperlinked in this site to ensure that a range of scientific skills is assessed across Units 3 and 4.

Overall, SAC tasks addressed a wide range of key knowledge and required students to demonstrate relevant key science skills. SAC tasks were created with an understanding of the need to differentiate the performance of the student cohort and to provide the opportunity for all students to demonstrate the highest level of performance on each outcome. Prior fieldwork and laboratory activities were generally used as the basis for SAC tasks. Teachers were able to easily allocate different task types to the different outcomes, as required in the new study design (refer to pages 36 and 42 of the study design).

Often, a field trip was used by audited schools to develop an understanding of environmental science concepts and the application of key science skills. Generally, this led to teachers developing a SAC task for a particular area of study as well as forming the basis of the student-designed investigation in Unit 4 Area of Study 3.

Many schools described how assessment tasks were developed to ensure that higher-order/more complex questions were included and weighted appropriately. Reference was made to a range of command terms (from ‘describe’ and ‘list’ to ‘evaluate’ and ‘design’) being used. Teachers are advised to refer to the [Glossary of Command Terms](https://www.vcaa.vic.edu.au/assessment/vce-assessment/Pages/GlossaryofCommandTerms.aspx) on the VCAA website, being mindful of the command terms in the outcome statement and the assessment tasks. Schools that provided performance descriptors or other assessment rubrics commonly discussed these with students prior to conducting the assessment task so that students were clear about what was being assessed.

Teachers are advised to refer to the online [VCE Environmental Science Support Materials](https://www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/environmentalscience/Pages/Index.aspx) for assessment advice. This resource includes advice about allocating tasks across Units 3 and 4, developing School-assessed Coursework tasks, elaborations of assessment tasks, performance descriptors and sample approaches to using them, and a planner for the assessment of key science skills.

A range of methods were used to develop SAC tasks. In most cases, new tasks were developed each year by the individual teacher. Given the location-specific nature of most assessment tasks, many teachers use teacher networks and/or other Environmental Science teachers at other schools to cross-check task validity. While time-consuming to construct unique tasks each year, schools are reminded of the importance of returning SAC tasks to students to enable feedback to be provided.

The decision to return school-based assessments to students rests with the school. Schools should have access to work completed for assessment until the end of the academic year in which the work was undertaken.

Schools should advise students that they need to retain work completed for assessment until the end of the academic year in which the work was undertaken. Schools may wish to supervise the storage of student work for this purpose, but this is not required.

Work assessed as N, or which may for other reasons be the subject of dispute at a later date, should be retained at the school. Such work may be retained in original or photocopied form.

A large number of SAC tasks were based on case studies, for example, the St Kilda Pier redevelopment, the rehabilitation of the Alcoa mine site and the Boundary Road project. These were sometimes supported by a field trip in cases where teachers wanted to create a task related to the generation of primary data. One audited school reported the teacher experience of learning about microbat harp tray surveys as the basis of constructing an assessment task scenario.

Tasks developed collaboratively with other teachers and/or accessed through environmental education support groups must be modified since it is possible that students can access them. A useful strategy for modification of tasks by some schools was to use a common case study or stimulus and then ask questions to compare the case study or stimulus materials with their own local environments/issues. Another useful strategy was to collaboratively develop a set of generic questions related to the area of study’s key knowledge and key science skills and then modify the original case study or stimulus material to suit their own local situation, making the assessment task unique to each school.

Tasks developed individually generally linked with fieldwork and/or laboratory activities. SAC tasks were then developed by referencing this data and/or collating the data as a class data set that was provided for the SAC task and/or adding relevant investigation data (for example, de-identified student-generated data from previous years) to compare with students’ data from their logbooks and to comment on comparisons and conclusions that could be drawn from the data.

All SAC tasks were fully supervised and material requirements were, in general, similar to external examination requirements and included pens, pencils, highlighters, erasers, sharpeners, rulers, a scientific calculator, and a clear water bottle. Sometimes students were also instructed as to what materials could not be used during SAC tasks; usually blank sheet/s of paper and mobile phones were not permitted.

The VCAA performance descriptors, or modified versions thereof, provided the assessment framework for many assessment tasks. Schools are reminded that these performance descriptors are not mandatory. For tasks involving a series of questions, a marking scheme is more appropriate.

Task format

Schools may nominate SAC tasks to be presented by students in a written, multimodal or oral format. While most schools selected written tasks across each unit, almost half of the audited schools selected a combination of written and multimodal tasks within Unit 3 and/or Unit 4, enabling students to show their understanding and skills in different communication modes. The graph below shows the frequency of use of selected task formats for each area of study:

Note: This graph is based on combined data from two separate audits in Unit 3 and Unit 4

Authentication

Schools must be aware of the authentication requirements set out in the *VCE and VCAL Administrative Handbook*. Any work set over an extended period should include a process for the authentication of student work. This applies particularly to Unit 3 work such as background research related to a threatened endemic species or preparation of summaries related to strategies for the management of a specific environmental science case study, and the Unit 4 Area of Study 3 student-designed investigation. Teachers must monitor and record each student’s work through to completion. The teacher may also consider it appropriate to ask the student to demonstrate understanding of the task at the time of submission of the work.

Most audited schools indicated that SAC tasks were largely completed under teacher supervision, making authentication of student work less problematic. Authentication processes also included schools requiring that student logbooks be kept at school for those assessment tasks that involved preparatory laboratory and/or fieldwork. Some schools reported that satisfactory authentication was facilitated by small class sizes and that collecting enough evidence for authentication was not an issue.

In situations where SAC tasks involved reference to complex stimulus materials, particularly for the Unit 3 Area of Study 2 environmental management task, students were given access to the materials prior to the SAC task and the materials were discussed in class. Annotations from class discussions were collected by teachers and re-issued to students at the beginning of the SAC task being undertaken in class.

Schools with multiple classes and more than one teacher indicated marking consistency was achieved by using a prepared answer sheet, discussion, and/or cross-marking. For schools with only one Environmental Science class, marking validation was often achieved by working with another Environmental Science teacher or the Science Coordinator, either within the school or at a different school, to mark a sample of ‘top’, middle’ and ‘low’ student work. These practices are important to ensure an accurate student rank order is attained.

Many schools reported a faculty-based approach to monitoring and authentication of the Unit 4 Area of
Study 3 assessment task by providing students with an experimental investigation booklet that detailed
a common set of stages for the investigation, methods of assessment including rubrics and allocated timeframes, and minor subject-specific modifications.

All audited schools had in place thorough and appropriate processes related to the authentication of student work, and student redemption of an ‘N’ outcome.

Practical work

Practical work is an important part of the *VCE Environmental Science Study Design*. Most schools followed the increased study design recommendations of 10 hours across Areas of Study 1 and 2 in each unit, with most schools exceeding the upper limits. The table below shows audit data related to practical work undertaken in audited schools:

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit** | **Area of Study** | **Range of school practical work time****(hours)** | **Average practical work time** **(hours)** |
| 3 | 1 | 6 − 15 | 9.1 |
| 2 | 1 −12 | 6.0 |
| 4 | 1 | 4.5 − 8 | 4.9 |
| 2 | 3 − 10 | 6.4 |

Schools reporting higher hours of practical work used the activities as a basis for teaching and assessing environmental concepts and key science skills. Schools reporting lower hours of practical work had often allocated greater time to fieldwork and other activities such as incursions involving guest speakers presenting interactive webinars to students.

Practical activities largely involved those published in textbooks. They included laboratory investigations, simulations, modelling, data analysis, design and construction, teacher demonstrations and participation in citizen science projects. Teachers are advised to refer to the ‘Teaching and Learning’ section of the [Support Materials](https://www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/environmentalscience/Pages/Index.aspx) for suggested practical activities.

Frequently reported Unit 3 practical activities included: quadrat sampling (grass diversity); macroinvertebrate biodiversity (laboratory or simulation); owl pellet dissection; quadrat mark-recapture simulation; water quality experiments; purification of polluted water; native seed germination; suburban lawn biodiversity investigation; mould biodiversity; rocky shore ecology transect sampling (virtual lab); Bird Island GIS activity; Australian woodlands (virtual lab); mammalian hair study of population (primary data analysis); control of an introduced weed (secondary data analysis); comparison of photosynthetic rates in different plants; detection of coliform bacteria; water purification; modelling of species richness and species abundance, and application of Simpson’s Index of Diversity, by using jars of randomly mixed different dried beans; Journey 2050 game – modelling the pillars of sustainable development; and Redmap citizen science project (virtual).

Frequently reported Unit 4 practical activities included: classroom ice cores; comparing melting of sea ice and land ice on sea level rise; modelling the albedo effect; modelling the greenhouse effect; plant mass (carbon sequestration); visualising ppm; measuring CO2 in the atmosphere; measuring Australia’s contribution to global CO2 emissions (data analysis); carbon cycle game/modelling; En-ROADS climate interactive; the Very Simple Climate Model (virtual); heat of combustion of candle wax; hydrogen fuel cell (demonstration); modelling of the effect of roof colour choices on temperature (different colored cans + water in sun); sustainable future modifications to a house; choc-chip cookie mining (effects of mining on Earth’s systems); NOVA energy lab (virtual); STELR: Solar energy/ wind turbine; 3M wind energy virtual lab; solar powered oven design; solar hot water heating system design; solar super-heated steam/electricity generation (demonstration); changing heat energy into kinetic energy (demonstration); modelling thermohaline circulation and the effects of ice melt (teacher demonstration); and energy transfer and degradation (demonstration).

Many schools used an extensive range of ecological monitoring equipment including data loggers and relevant probes. Some schools had limited resources and accessed resources from other schools and/or organisations such as Waterwatch Victoria.

Fieldwork

All audited schools undertook fieldwork across both Unit 3 and Unit 4. Many schools reported undertaking fieldwork on their school site or at adjacent/local wetlands, parks, rivers, creeks and dams. A range of sites external to the school, sometimes involving external experts/equipment, were accessed to support learning and the development of SAC tasks including school-based fieldwork, local fieldwork and site visits to consolidate analysis and evaluation of case studies. Both natural and ‘built’ environments are suitable for study.

Unit 3 fieldwork and sites included: Jawbone Marine Sanctuary intertidal rocky shore quadrat sampling; local wetlands water sampling; Mt Rothwell mammal spotlighting and trapping/ assessment of habitat quality; Werribee Open Range Zoo’s management of Eastern Barred Bandicoot populations; water quality analysis field trip at local sites; St Kilda Pier field trip to supplement the redevelopment case study; site visits related to local sustainable development projects; YouTube virtual tour of the Western Treatment plant; site visits to local waste water treatment plants; DECMIL online conference with students re Road Upgrade Projects in terms of being sustainable development; screencasts from a revegetation nursery to look at sustainability undertaken by a council; Earthshack (a fully off-grid sustainable home), and the Sandhill Sustainable House in Ky Valley.

Unit 4 fieldwork and sites included: an Ecolinc program related to conquering climate change; a field trip to Lal Lal wind farm; and a visit to the ALCOA coal mine rehabilitation site in Anglesea.

Many schools reported the use of incursions involving guest speakers, for example, skyping a scientist (ecology of freshwater ponds Nevada desert); guest speaker from Werribee River (via Zoom) about assessing the numbers of platypus in the Werribee River; presentation by a climate change BOM scientist; an environmental systems analyst for a food manufacturer; an engineer for wind turbines and hydroelectric stations, and an education session with a member of the local catchment management water authority.

Specific information

Teachers are required to allocate four nominated SAC tasks to Outcomes 1 and 2 in Units 3 and 4. An additional SAC task, involving a student-designed investigation, is undertaken in Unit 4 Outcome 3. In designing tasks, teachers should ensure that a representative sampling of key knowledge and key science skills are assessed. A [mapping tool](https://www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/environmentalscience/Pages/Assessment.aspx#Unit3and4) for mapping key science skills against each assessment task can assist teachers to achieve assessment balance so that a range of skills are assessed in school-assessed coursework across Units 3 and 4.

Teachers should ensure that the selected assessment task appears on the front page of a written SAC task and/or on information about the SAC task given to students, for example, a SAC task described as ‘A written report on the <specific project> case study’ required a reference to the selected assessment task type, for example, ‘Analysis and evaluation of <specific project> case study with reference to sustainability principles and stakeholder perspectives’.

Assessment task: Presentation of recommendations using evidence-based decision-making, including analysis and evaluation of primary data

This SAC task must be based on primary data generated by the student and must require students to justify a decision about an environmental issue or scenario that involves multiple possible solutions or perspectives.

Audited schools were able to apply this task to all areas of study, as shown in the graph below:

Note: This graph is based on combined data from two separate audits in Unit 3 and Unit 4

A number of audited schools used fieldwork as the basis of this SAC task. The task often involved students defining terms in the study design in addition to analysing and evaluating data in order to make a decision about an issue.

The major issue with this task was that some audited schools did not use primary data as the basis for making recommendations. Such tasks could be re-configured as one of the three alternative tasks specified in the study design on pages 36 and 42.

**Unit 3 Area of Study 1**

* Several audited schools described field trips involving students collecting primary data related to conservation strategies for species such as the Eastern Barred Bandicoot as being the basis for this SAC task; students consolidated field trip notes and data under supervision; these were then returned to students to complete a SAC task under supervision; a set of scaffolded questions led to students using evidence to justify whether maintaining populations of the endangered species was worth a sustained effort, reflecting the area of study title.
* The ‘decisions’ to be made by students should relate to a dilemma related to the scenario, for example, determining whether a strategy is preferred to another, or deciding where a species may be successfully relocated.
* Some audited schools provided a set of structured questions about different scenarios. This is appropriate, if each scenario involves students having generated primary data in addition to making recommendations. Teachers should consider, however, that multiple scenarios may not allow students sufficient time to analyse data and make recommendations based on the data. One scenario should be sufficient in terms of the VCE assessment principles of validity and efficiency.
* One audited school outlined an innovative approach to this task that supported student agency by allowing students to select their own threatened endemic species; students were allocated time, under class supervision, to research the survival requirements for their selected species, and then undertook fieldwork at their school to determine the best location for reintroduction; recommendations were presented in a multimodal format; a marking scheme allocating marks to the stages in the task was provided to the students prior to the SAC task. Authentication of this task from year to year may involve students selecting a species from a given list so that the list varies each year.
* Another innovative approach to this task was coupled to a field trip to Werribee Zoo that focused on the use of quadrats for studying environment suitability and generating primary data; further data was generated in the school grounds so that students responded to the general question: ‘Is an area of your choosing suitable for the reintroduction of <endangered species>?’
* For schools that did not use field trip or laboratory/experimental data, other approaches such as interviewing a zookeeper to obtain qualitative and quantitative data or using an online simulator to generate data on macroinvertebrates before completing a Simpson’s Index of Diversity to measure the ecosystem health of a lake, provided suitable primary data.
* Simpson’s Index of Diversity (SID) was used by many audited schools to analyse data. In some cases, the data was secondary data provided by the teacher; this renders this task invalid. An interesting example of the use of SID was to make recommendations about the management of a local stream where pollution affected an area of the stream; macroinvertebrate counts were taken at various points along the stream, SID was calculated, and students were required to make evidence-based recommendations.
* Common concepts assessed in this task included definitions of conservation categories, threats, conservation strategies, captive breeding programs, legislative statements and plans, methods of estimating populations, and use of biodiversity indices.

**Unit 3 Area of Study 2**

* Practical work and class activities related to water quality formed the basis of the SAC task requiring students to make recommendations about the Warburton Mountain Bike Trail case study in relation to the impact of development on the sensitive and highly restricted Mount Donna Buang Wingless Stonefly that requires pristine waterways to survive. Students were provided with a set of questions to guide them in justifying recommendations using primary data.

**Unit 4 Area of Study 1**

* A submitted audited SAC required students to undertake two practical activities prior to the SAC task (the global warming potential of carbon dioxide and the classroom analysis of ice core samples); the SAC task required students to make links between these two activities and to suggest possible future research based on their data analysis and findings; authentication was achieved by collecting the students’ logbooks after each practical activity, and returning them to use in the SAC task.

**Unit 4 Area of Study 2**

* Experiments completed in class that linked to environmental challenges were used as the basis of this assessment task by a number of audited schools, for example, making recommendations about the best design for a wind turbine in terms of various factors such as the number of blades, blade length, blade width, tall or short turbines, light or heavy blades. The focus of this task is on data analysis; students determine a different factor to investigate, and the class data are collated by the teacher. The SAC task involves students analysing the collated data to determine the design for an ‘ideal wind turbine’.

Assessment task: Designed or practical response to a real or theoretical environmental issue or challenge

This SAC task must be based on a selected environmental challenge. In adhering to the assessment principle of efficiency, only one challenge or issue should be addressed.

* In general, audited schools used real environmental issues as the basis of the SAC task.
* The task may be based on a familiar or unfamiliar scenario for students. Several schools based this on fieldwork, or on a relevant media article or communication. Information presented as a case study was also used for this task.
* Generally, this task was scaffolded for students, leading students to respond to a specific question about whether the practical or real response was environmentally sustainable.
* Primary and/or secondary data may be used in this task.

Audited schools used this task for three of the four areas of study to which the task applies, as shown in the graph below:

Note: This graph is based on combined data from two separate audits in Unit 3 and Unit 4

**Unit 3 Area of Study 1**

* A rigorous SAC task was developed by an audited school in relation to habitat restoration efforts for the Leadbeater’s possum, presented as a case study; such an approach may involve fieldwork where students are presented with the SAC task as a familiar context, or could be presented as an ‘unfamiliar context’ that does not require fieldwork.
* In one audit submission, students were required to undertake prior research related to a designed or practical response to an issue or challenge involving a biodiversity issue of their choice; the topic was approved by the teacher before students proceeded to record research in their logbooks; an assessment marking grid was provided to students prior to the SAC task to scaffold their planning and response; the SAC task then involved students responding to a set of scaffolded questions.A variation of this approach in another audit submission required students to select a threatened species of choice, identify a practical or theoretical response to increase the population of the species, and respond to a set of structured questions to analyse and evaluate the response.
* One audit submission required students to compare and evaluate three different proposals for ensuring the survival of the Swift Parrot; whilst this is a valid task, only one response to an issue or challenge is mandated, so teachers should assess whether it is efficient to evaluate multiple proposals.
* An audit submission included a SAC task based on the evaluation of the Orange-bellied Parrot conservation project in terms of the conservation of biodiversity and ecosystem services.
* Students at one audited school developed their own hypotheses based on a comparison of historical biodiversity data with primary data generated in the field, for example, ‘How does biodiversity bounce back after bushfires?’ where historical biodiversity data were compared with students’ own measurements.
* Fieldwork formed the basis of some audit tasks, for example, ‘Is shading effective as a means of weed control?’
* Some audited schools included detailed discussions of sustainability principles; this is not required in this task since sustainability principles are assessed in a separate SAC task.
* Common concepts assessed in this task included: defining the issue or challenge; the importance of biodiversity; extinction; hotspots; sampling strategies; biodiversity threats; ecosystem services; conservation status; and application of Simpson’s Index.

**Unit 3 Area of Study 2**

* A media item related to a proposed ‘waste to energy’ incinerator was presented to students; the article contained quotes from multiple stakeholders with different views about whether the proposal should be supported, with accessible language, and short enough to read within the allocated reading time. The stakeholder quotes could be directly linked to sustainability principles, and therefore was a good choice of assessment task.
* Teachers are advised that when constructing SAC tasks, unfamiliar scenarios and case studies should be checked for readability; it may be appropriate to produce a simplified case study or media article.

**Unit 4 Area of Study 1**

* An audit response indicated that students combined primary data related to local weather (greenhouse gas measurements; air temperature; local creek temperature; precipitation) collated prior to the SAC task with secondary data related to these parameters (provided as part of the SAC task) to identify an aspect of climate change that could become an issue, and to suggest a justified monitoring program. Supplementary use of secondary data is appropriate for this assessment task since climate change can only be determined over long time periods.
* A case study related to sea level rise in a Pacific island formed the basis of one audited SAC task. Students were required to submit a strategy, in multimodal format, to a group of philanthropists as to how people on the island could adapt to climate change. A scaffold for preparing the response, and an assessment rubric, were provided to students.
* Following a visit to a sustainable house, one audited school used a modelling activity as the basis of a SAC task where students designed and tested how energy loss from a model house could be reduced; baseline energy data was generated and recorded, modifications were made to the house, and further data was generated and collated to evaluate the effectiveness of changes; findings were presented in a multimodal format.

**Unit 4 Area of Study 2**

* One audit response described a SAC task based on a practical investigation that compared the energy output of various biofuels and fossil fuels, combined with research to collate secondary data, to respond to a provided scenario related to determining an ideal, sustainable energy source to heat a bathtub of water in an eco-house.
* A common practical investigation linked to this assessment task type was the design of a wind turbine; this was applied as a ‘coupled’ experiment. Students determined the optimum number of blades on a wind turbine, as a practical response for building a sustainable energy future that produces lower greenhouse gas emissions and supplies reliable and affordable energy services. To introduce the SAC task, students were provided with a scenario where they have been commissioned to design a wind farm. Each student developed a hypothesis and tested their design. Results were collated by the teacher as the background data to be used in the SAC task. The focus of this assessment task is on detailing the environmental challenge and explaining how the increased efficiency of the turbine blades will contribute to resolving this challenge.
* A field trip to the former Alcoa open-cut coal mine in Anglesea preceded a SAC task that required students to design a response to the sustainable rehabilitation of the site. Responses were presented both as a multimodal presentation and orally.

Assessment task: Analysis and evaluation of a case study, secondary data or a media communication, with reference to sustainability principles and stakeholder perspectives

This SAC task should be based on stimulus materials that enable students to analyse and evaluate the six sustainability principles (conservation of biodiversity and ecological integrity; efficiency of resource use; intergenerational equity; intragenerational equity; precautionary principle; and user pays principle) listed on page 18 of the study design, noting that not all these principles may be directly relevant to the SAC task. It is recommended that the knowledge and values of at least three different stakeholders are considered; students may also be required to identify whether each stakeholder has an anthropocentric, biocentric, ecocentric or technocentric view. Tasks were generally based on a set of structured questions and the completion of tables or other graphic organisers.

Most tasks submitted in the audit required students to analyse the case study or media communication in terms of the three dimensions of sustainable development (ecological, economic and socio-cultural) before evaluating them in terms of the six sustainability principles.

While tables were used to evaluate stakeholder perspectives, one school used a Venn diagram to compare similarities and differences between two stakeholders’ views.

Teachers are reminded that commercial and other materials in the public domain must be significantly modified so that the task is unique to the school. A commercially available resource related to level crossing removal projects was used by an audited school without modification, thereby creating potential authentication issues.

Common concepts assessed in this task for all areas of study included: aims of the case study, project or scenario; dimensions of sustainable development; sustainability principles; stakeholder perspectives; values; consideration as to whether the case study or scenario is sustainable; risk assessment/management; government agency; and case study or scenario evaluation.

This task was largely allocated to Unit 3 Area of Study 3 by most audited schools, as shown in the graph below:

Note: This graph is based on combined data from two separate audits in Unit 3 and Unit 4

**Unit 3 Area of Study 1**

* One audited school developed a SAC task based on a case study involving management strategies for the Mountain pygmy possum, with a focus on the sustainability principles of intergenerational equity and intragenerational equity, and then nominating specific stakeholders from which to consider particular management strategies.
* Another audited school required students to use a set of provided articles related to maintaining populations of the Brush-tailed Rock-wallaby in terms of whether the recovery actions are sustainable, and how stakeholder perspectives may influence actions. Students were provided with a set of questions that formed the basis of a multimodal presentation; the presentation had to respond to an overarching question, ‘Why is Earth’s biodiversity important to conserve?’ including reference to the different types of biodiversity (genetic, ecosystem, population and species).
* A case study related to managing and protecting the Semon’s Leaf-nosed Bat population primarily to provide tourists visiting Cape York with opportunities to view these endangered animals in their natural habitat was used to explore sustainability principles and stakeholder perspectives. Teachers are advised that case studies do not need to be limited to Victoria. National and global perspectives can be used as the basis of teaching and learning activities as well as SAC tasks.

**Unit 3 Area of Study 2**

* Audited schools submitted tasks that were either case studies or media communications; secondary data in isolation may be too abstract for students to explore concepts related to sustainability without the related context.
* Tabulation of the ‘for’ and ‘against’ arguments in terms of ecological, economic, and socio-cultural factors relevant to the sustainable development case study/scenario was useful in supporting students to analyse the information, before making an evaluation; an interesting inclusion as an analytical tool in a SAC task was a qualitative risk analysis matrix.
* Case studies included the St Kilda Pier Redevelopment, Boundary Road Project, Werribee River Environmental Water case study, Western Treatment Plant, Sundrop Farms Greenhouse Project, Golden Plains wind farm, Port Phillip Bay Deepening Proposal, Melbourne-Metro Rail Project, Echuca-Moama Bridge, and the Yan Yean Road Upgrade project.
* In cases where students have a choice of project, teachers should ensure that there is sufficient information available for students to equitably respond to the SAC task.
* One audited school required students to choose their own case study, secondary data or media communication; topics were approved prior to students undertaking the SAC; a set of performance descriptors and project scaffolds were provided to assist students in their research prior to undertaking the 50-minute SAC task in class; a set of PowerPoint slides to which students added their own information formed the basis of the SAC task.
* One audited school required students to imagine that they were asked by the Victorian Planning Minister to present information about a recently completed project at a community information session; the presentation was multimodal.
* Some tasks included reference to Earth systems; teachers should consider whether it is necessary to assess this concept in this task since it is the focus of a different assessment task. Reassessing Earth systems in this task compromises the assessment principles of efficiency and validity.
* Some tasks required students to read the stimulus materials and undertake their own research prior to undertaking the SAC task; teachers are reminded that any out-of-class work that is unsupervised should be accompanied by a VCAA ‘School-assessed Coursework Authentication’ form.

**Unit 4 Area of Study 1**

* A case study based on the management of cliff erosion was used as the basis for a SAC task, with different construction options being proposed by different stakeholders. The task required that students identify and explain the sustainability principles associated with each opinion, and to justify a preferred stance as to a ranking of the actions that should be taken to manage future erosion.

**Unit 4 Area of Study 2**

* In one submitted audit task, students were required to summarise a set of three short articles on the use of energy sources (these included renewable and non-renewable energy sources) and to analyse and evaluate each energy source in terms of at least two sustainability principles, identify differences in stakeholder perspectives, and draw conclusions about the use of each energy source over short-term, medium-term and long-term timeframes. Teachers are reminded that for SAC tasks involving a significant reading load, the stimulus materials may be provided to students before the SAC task; the articles may be discussed in class and/or annotated; any work or further research undertaken at home should be recorded in logbooks and accompanied by a VCAA ‘School-assessed Coursework Authentication’ form.

Assessment task: Application of Earth systems thinking in the evaluation of a response to an environmental scenario, case study, issue or challenge

This SAC task must include a significant portion allocated to an evaluation of relevant stimulus material in terms of Earth’s spheres – atmosphere, biosphere, hydrosphere and lithosphere. Tasks that only included a few questions, or a small percentage of marks, allocated to Earth systems thinking were deemed to be invalid; these tasks required re-focusing to meet the requirements of this task, or were re-configured as an alternative assessment task type. Teachers differentiated the quality of student responses by assessing both individual Earth sphere effects (lower order responses), and the interactions and interdependencies of Earth’s spheres (higher order responses). Inclusion of a table or graphic organiser to support students’ thinking was seen in many audit submissions.

This task was largely allocated to Unit 4 Area of Study 3 by most audited schools, as shown in the graph below:

Note: This graph is based on combined data from two separate audits in Unit 3 and Unit 4

**Unit 3 Area of Study 1**

* Two schools in partnership used the Eastern Barred Bandicoot and the Southern Brush Tailed Rock Wallaby (differentiated tasks for the two schools to ensure that the tasks were unique to each school) as contexts for exploring Earth’s systems; students were scaffolded through evaluating three possible sites for the reintroduction of the species by considering the effects on Earth’s four systems.
* Open-ended /essay-type questions asking students to use Earth systems thinking in the context of a given scenario do not necessarily provide all students to understand what is required, thereby compromising the VCE assessment principle of equity. Teachers are advised to scaffold questions and/or include tables or graphic organisers and/or provide prompts when constructing SAC tasks. This also enables more specific questions to be asked that can fairly differentiate student performance.

**Unit 4 Area of Study 1**

* An innovative approach to this SAC task was to ask students to develop a model/ diagrams/ annotations to convey a climate concept (for example, albedo effect, sea level rise, enhanced greenhouse effect, thermohaline circulation, deforestation impacts on greenhouse gases); the student representations had to include references to Earth system effects.
* The creation of a ‘living shoreline’ was used as the stimulus for a SAC task that required students to analyse how Earth systems would be affected by such a construction, as an adaptation strategy in response to climate change effects on shorelines; students were then expected to use their analysis to comment on the advantages and disadvantages of ‘living shorelines’ as a management strategy for adapting to rising sea levels; a second audited school also used ‘living shore lines’ as the basis of the SAC task, using a specific media article that was provided to students as an ‘unfamiliar context, combined with data related to the annual global sea level change from 1880 to 2019.
* A case study related to the effects of climate change (drought, excess water runoff, reduction in crop output data and increase in invasive species) on a local canola farm was examined in terms of effects on Earth’s systems and included management of these effects by considering land use changes, carbon sequestration, water management, nutrient management, atmospheric gas emissions (nitrous oxide from fertilisers) and crop rotation; the task included written materials, visual images and data..

**Unit 4 Area of Study 2**

* An audit response outlined a SAC task based on the analysis and evaluation of five different low-carbon design features of a sustainable house, such as a rooftop garden, tree placement, and bamboo wood alternatives; students were required to evaluate these in terms of energy efficiency, and how Earth’s four systems were impacted by the innovations.
* A media article about the sustainability of the use of electric car batteries formed the basis of a SAC task; tables and Venn diagrams were used to explore concepts and to compare peoples’ viewpoints. Teachers are advised that if stakeholder views are being compared, these should be linked to Earth systems to differentiate this task from the ‘analysis and evaluation of a case study, secondary data or a media communication, with reference to sustainability principles and stakeholder perspectives’ assessment task.

Assessment task: Communication of the design, analysis and findings of a student-designed and student-conducted scientific investigation through a structured scientific poster and logbook entries

Each student should be assessed on their individual capacity to design, undertake and report on an investigation. In cases where schools have multiple classes or large numbers of students in a single class, it may not be practicable for each student to undertake a unique investigation. In these cases, it is acceptable for students to work in groups to generate data after they have been assessed on their capacity to design an investigation. Teachers must approve all student investigations before they are undertaken; not all planned student investigations can proceed due to issues including safety, equipment availability, time constraints and/or management of large student numbers. Investigations may be restricted to a single area of study, or may combine content from different areas of study and/or units, for example, ‘How do increasing CO2 levels in the atmosphere affect the survival of aquatic macroinvertebrates?’.

The Unit 4 Outcome 3 student practical investigation can be undertaken at any time across Units 3 and/or 4. Audit findings showed that 71% of schools ran this assessment task during Unit 4 while 17% of schools ran the task during Term 3. Less commonly, 6% of schools ran the task across Units 3 and 4, and a further 6% ran the task after the completion of Unit 3 but before the start of Unit 4. Schools that undertook this outcome during Unit 3 used it for formative and summative purposes, particularly in developing students’ capacity to design their own investigations and to critique the investigations of others, including published research.

The recommended timeframe for the investigation is at least 10 hours. Most audited schools followed this recommendation, often including half a day for undertaking the associated preparatory fieldwork. In many cases, the investigation followed a common laboratory or fieldwork activity as a ‘coupled investigation’. In some schools, ‘citizen science’ opportunities arose that were suitable as the basis for student investigations and SAC tasks.

The audit findings showed a varied approach as to the content basis of the investigation, as shown in the graph below:

Note: This graph is based on combined data from two separate audits in Unit 3 and Unit 4

This was often dependent on student interest and determined through student voting on general areas of interest. In other cases, the content basis was limited by school resources and/or faculty planning for all VCE science investigations.

For the 37% of schools where students were given a choice of topic, time was generally allocated to a brainstorming session to explore different options, and subsequently to plan and refine investigations. Students were required to check that resources would be available. Teachers are reminded that where students undertake investigations in different areas of study, the scope of the investigation should be comparable in terms of time and cognitive demand. The use of a common rubric or the VCAA performance descriptors (as published or modified) can be used to ensure that students undertaking different investigations are assessed against the same criteria.

An ‘investigation’ can take many forms, as outlined in the list of investigation methodologies on page 11 of the *VCE Environmental Science Study Design*. The focus of this task is on developing questions leading to the generation of primary data and its subsequent analysis and evaluation. Construction-type investigations, such as building and testing the effectiveness of bird boxes (relevant to Unit 3 content) or developing a climate monitoring system (relevant to Unit 4 content), would be appropriate for this area of study. Any time spent working on the constructions out of class time should be recorded in students’ logbooks and may include photographs as a record of progress.

Audit findings showed that a number of different investigation methodologies were used as the basis of the student-designed investigation. Some investigations involved fieldwork, both hands-on inquiries, for example, ‘How do levels of pollution differ between Moonee Ponds Creek and Merri Creek?’ as well as surveys, for example, ‘How do factors such as age/gender impact on attitudes towards climate change?’. Many investigations were based on controlled experiments that were meaningful for students, for example, ‘Which horse manure – fresh or aged – better assists plant growth?’ Some students developed a product, process or system, for example, ‘Can recycled clothing be used as filtration for stormwater?’. Other investigations were based on modelling, for example, ‘How does a pond of water inside the home affect the heating and cooling efficiency of the home?’ and ‘Will covering a house in mulch keep it warm in winter and cool in summer?’.

While most student investigations extended scientific understanding (for example, ‘How is species diversity affected by organic methods of weed control?), others were based on applying scientific skills (for example, the question ‘How do the opinions on climate change differ between those in <local town> and those in the the rest of the state?’ focused on the analysis of primary compared with secondary data).

Schools are advised to assist students in narrowing the topic of investigation so that it is manageable within allocated timeframes. Often this requires greater specificity with topic definition. For example, a question such as ‘What factors affect the species diversity of soil?’ could be narrowed to ‘How is the species diversity of soil affected by <factor>?’ following preliminary tests on soil for factors such as light, moisture, pH and nutrient concentration.

All schools outlined a process for management of the task which generally involved breaking the task into sections: designing and planning of the investigation; discussion and finalisation of the investigation, including modifications of planned student investigations in cases where investigations were impractical, unsafe, or unable to be resourced; undertaking of the investigation; preliminary analysis of results in class using logbooks and/or provided templates; and production of a scientific poster. Most schools have developed templates for scaffolding the undertaking of scientific investigations, including science-faculty general templates that can be used for all VCE science studies. Specific dates for monitoring of stages should be provided to the students before the start of the task.

Successful approaches to developing the SAC task included:

* providing the same overarching question to the class (for example, ‘How does the distance from a river affect biodiversity?’), with students then working to develop an individual question for investigation by specifying the specific variables related to biodiversity that will be measured and controlled.
* using a coupled inquiry with an initial question (for example, ‘What is the effect of salinity on the survival rate of seed shrimps?’ may be followed by investigations of the effect of salinity on different macroinvertebrates or investigations of different factors, such as detergents or temperature, on selected macroinvertebrates, thereby requiring students to modify a previously completed investigation.
* providing students with a general topic related to an area of study, such as biodiversity, and allowing students to choose their own sub-topic, for example, ‘How has ‘picnic pollution’ affected the biodiversity in park lakes?’, ‘Is the biologically tolerable water temperature for seed shrimp higher than the average biologically tolerable water temperature of other aquatic macroinvertebrates?’ and ‘How have invading deer affected the species richness of plants near the north edge of <river>?’.
* combining fieldwork sampling and laboratory work: for example, ‘How is the population density of <species> related to the concentration of suspended and dissolved solids along a creek?’

Some issues identified in previous audits were not seen in the 2021 audit. All audited schools ensured that investigation titles were phrased as questions, all students were required to design their own investigation, and all investigations were built on class fieldwork and/or investigations so that extra preparation and background reading was not required by students. The time in producing posters was not onerous, possibly assisted by the VCAA template on page 12 of the study design that specifies that the scientific poster word count should not exceed 600 words. There was no evidence that any audited schools accepted drafts of the posters.

2021 audit concerns for Unit 4 Outcome 3 included:

* investigation questions that did not involve the generation of primary data, and could be answered through a literature review, for example, ‘Do lighter (methane) or heavier (carbon dioxide) greenhouse gases trap more heat?’
* investigation questions that were not aligned to a standard expected for Units 3 and 4, for example, the question ‘How does salt affect plant growth?’ could be an experiment that is undertaken in upper primary /lower secondary school levels. In this case, the question could be adapted so that concepts related to Unit 3 were referred to, such as provisioning services (with salt levels affecting the quality of potable water supplies) or supporting services (with salt levels affecting the nutrient content of soils) and/or Unit 4, such as linking salinity to the effects of climate change on increased ocean salinity and the consequences for plant growth.
* investigation questions where valid data may not be feasible to generate due to sample size issues, for example, ‘Do Australians think they are sustainable enough?’; the question could be modified to select a specified sample of the population who could be surveyed.
* investigation questions that were too broad, for example, ‘Is climate change affecting different generations differently?’
* students who were provided with a topic and possible variables, and therefore did not have an authentic opportunity to work independently to design their own investigations
* investigation questions that did not relate directly to the study design, for example, ‘Can we reduce the environmental impact of noisy minors by using scarecrows?’ was nominated as a Unit 3 Area of Study 1 investigation, but the specific concepts in the key knowledge could not be identified; the question requires modification to link directly to the key knowledge and/or key science skills, such as investigating the impacts of the noisy minor becoming an overabundant species (due to logging and clearing of land) on population numbers of other bird species endemic to an area
* investigations that were difficult to complete successfully or required careful advice to ensure that the investigation could be completed within a reasonable timeframe, for example, ‘Is species diversity affected by organic methods of weed control?’
* investigations that were either unsafe, too expensive or did not meet ethical guidelines, for example, questions related to testing pollution effects on vertebrates.

All audited schools reported appropriate management (including authentication) strategies for the student investigation. Successful strategies included: appropriate lead-in class investigations; activities and secondary research prior to beginning the investigation; class discussion of scientific measurement and the assessment rubric prior to undertaking the task; use of half-day or full-day field trips to enable students to generate primary data; teachers signing off on logbooks after each lesson; progressive marking of logbook and/or scientific poster sections; writing up poster sections under test conditions; and a summary 5-minute oral presentation to the class.

Schools may provide data to students in situations where, after designing and running their own investigation, students do not generate a viable set of data that can be analysed. For example, a student investigation related to the effects of different salt concentrations on the growth of native plant seedlings yielded no growth for all salt concentrations tested. In this case, time factors mitigated against the student repeating the experiment using lower concentrations of salt, so the student was provided with secondary data on which to base data analysis and subsequent production of a scientific poster. Assessment of the student’s capacity to design an experiment was based on the student’s original work whereas all other aspects of assessment were based on analysis and evaluation of the secondary data.

Teachers are advised to check the [*VCE Environmental Science Support Materials*](https://www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/environmentalscience/Pages/Index.aspx)*,* which has an extensive list of possible topics. However, teachers are reminded that since these resources are available in the public domain, they must be modified prior to use as an assessment task.