2021 VCE Environmental Science external assessment report

General comments

The importance of following the instructions in each question needs to be emphasised with students in preparing for the examination. In cases where students provide more than two examples, only the first two are marked. Another case where the question was not always well read was Question 1d., where students were asked for a management strategy that was not related to habitat restoration – many incorrect responses gave descriptions related to how the habitat could be restored.

Many responses lacked depth and clarity in the explanation of areas of key knowledge and specific key science skills expected from VCE Environmental Science students. Many students seemed to find it difficult to fully develop their responses and include enough clear detail to gain full marks.

Question 3a. was worth six marks and allowed for students to write a longer response. This type of question has occurred on previous papers, but the standard of coherent, logical writing was not high this year. Students need to focus on relating the specific sustainability principles asked for in the question to the case study given and providing some clarity about relevant environmental concerns. A key element is to specifically compare the sustainability of the two proposals, which was not always clearly included in responses.

Some key terms from the study design were not clearly understood by a number of students and therefore questions that relied on these were not well answered. Terms that were not well explained included 'peak demand', 'biocentrism', 'intergenerational equity', 'efficiency of resource use', 'precision', 'accuracy' and 'albedo effect'. All relevant terms and concepts in each of the areas of study could be included in examination questions, and should be a focus of students' studies. It is expected that students should be able to define key terms, and also be able to correctly apply them to different examples.

Specific information

This report provides sample responses or an indication of what responses may have included. Unless otherwise stated, these are not intended to be exemplary or complete responses.

The statistics in this report may be subject to rounding resulting in a total more or less than 100 per cent.

Section A – Multiple-choice questions

Question	Correct answer	% A	% B	% C	% D	Comments
1	D	1	0	7	92	Most students correctly connected the limited distribution of the butterfly to the term 'endemic'.
2	C	2	33	45	19	The stem indicates that the species is critically endangered. Therefore, Option C defines the term as categorised by the International Union for Conservation of Nature.
3	C	18	1	55	25	Option C is a more suitable strategy (rather than just maintaining remnant vegetation) as wildlife corridors allow the movement of butterflies between areas of remnant habitat that are at risk due to habitat fragmentation, thereby increasing the population's chances of successfully breeding.
4	C	3	3	78	16	Most students correctly selected the Convention on International Trade in Endangered Species as the international agreement. While Option D may have been important in the species conservation, it is a piece of federal legislation rather than an international agreement.
5	A	8	76	1	16	The understanding for the correct answer is that if a mass extinction occurred it would wipe out a wide variety of species in a short period, therefore the species remaining would be greatly reduced and therefore show a 'small variety of fossils' over that time period. Most students may have incorrectly chosen Option B as the answer thinking that a mass extinction has occurred and wiped out species, therefore there would be lots of dead animals and plants forming a variety of different fossils from this event. This is not the case – by studying fossil records scientists can show the 'pre-mass extinction' biodiversity, which has a much greater variety of fossil species, and then identify the mass extinction event in the fossil layers above by a large decrease in fossil (species) variety.
6	B	4	87	2	7	
7	C	10	2	88	0	
8	C	2	8	81	9	
9	D	6	14	12	67	
10	C	4	5	88	2	
11	A	91	1	5	3	
12	D	0	3	6	90	
13	B	8	68	16	7	The shift to the right of the graph shows a delay in the peak rate of crude oil production rather than an increased rate of

Question	Correct answer	% A	% B	% C	% D	Comments
						use. The delay in time between the theoretical peak production and observed peak production could be explained by improved technologies over time making less-accessible oil reserves more readily accessed.
14	A	64	8	21	6	This question required students to carefully read the graph line and axis. The two lowest points of the graph, reaching 0.35% lower than long-term mean albedo of the Earth, initially occurred in early 2001 and again in late 2005, which corresponded to Option A.
15	B	17	52	25	6	
16	B	4	81	3	11	
17	B	6	82	2	9	
18	D	4	7	7	82	
19	D	6	3	13	78	A molecule of carbon dioxide has a global warming potential baseline value of 1, as although each molecule doesn't absorb as much infra-red as other greenhouse gases like methane or nitrous oxide, carbon dioxide is relatively abundant and persistent, and can therefore be used as a standard reference.
20	D	20	8	7	65	Some students may have misread the question and incorrectly nominated climate refugees as not being an impact of the enhanced greenhouse effect. Global average sea temperatures will increase as a result of the enhanced greenhouse effect, not reduce or decrease, so Option D was the correct response.
21	B	9	88	2	1	
22	C	1	2	90	7	
23	A	69	5	21	4	Sunlight is needed for nitrogen oxides to be converted to ozone, so this will not take place inside the tunnel. Although tropospheric ozone is a greenhouse gas, it does not move to the stratosphere, repair the hole in the ozone layer or reduce climate change. Option A is a direct consequence of an increase in road traffic through the tunnel and is a better option than C because climate change refers to a change in longer-term average temperatures over a much wider area (global scale), not the local temperatures around the entry and exit points of the tunnel.
24	D	1	29	13	57	
25	C	8	12	47	33	'Sustainability' broadly focuses on meeting human resource needs now and into the future, whereas 'ecologically sustainable development' considers using and maintaining these resources now and into the future but also

Question	Correct answer	% A	% B	% C	% D	Comments
						emphasises the protection and conservation of the ecology of Earth (i.e. environmental concerns). Option D is not correct as sustainability is not confined to considering economic needs, but may also consider social and environmental factors.
26	B	8	69	8	15	Although the key challenges to sustainability include population growth, energy, water and food security, increasing all fossil fuel energy sources is not practical (or prudent given global warming impacts), hence human efforts are currently focused on developing non-fossil energy sources. The best option was B.
27	D	6	6	12	75	Option D is a better description of a controlled variable, because ideally the controlled variable or variables are kept constant to isolate the relationship between the independent and dependent variable.
28	B	3	90	2	5	
29	B	47	22	11	20	Option B is the correct answer, as the management plan includes strategies to reduce the negative impacts of the environmental project. A risk assessment involves identifying possible negative impacts and quantifying their likelihood prior to the project, but does not in itself develop the methods to reduce negative impacts of a project. A management plan should recognise and comply with regulatory frameworks (Option C) but is not a method in itself.
30	A	40	6	19	35	To evaluate the effectiveness of management strategies, collected data needs to be compared against historical or baseline data, hence Option A is correct. Many students incorrectly chose Option D; while it is important to continue to collect biodiversity data, effectiveness of the management strategies requires some analysis and comparison with previous data.

Section B

Question 1a.

Mark	0	1	2	3	Average
%	3	4	21	72	2.6

The majority of students used the data in the table to correctly calculate a Simpson's Index of species diversity figure of 0.858. A few made minor multiplication or addition errors.

Question 1b.

Mark	0	1	2	3	Average
%	5	4	70	21	2.1

Based on the given Simpson's Index figure before restoration and the diversity figure they calculated after restoration, most students were able to identify that these habitat restoration efforts have been successful, as there was an increase in plant diversity. For this question, suitable data needed to be referred to, such as an increase in diversity from 0.674 before restoration to 0.858 after revegetation, or an increase in the total number of species from 7 to 9. A key point that many students failed to identify was that there was a major reduction in exotic weed species from 55 to 15, which was a key element to evaluating the success of the revegetation project.

Question 1c.

Mark	0	1	2	Average
%	12	50	38	1.3

Many students were able to correctly identify one reason for including the weed species in the Simpson's Index calculation, but many found it difficult to clearly identify a second reason. The most common reason given related to the idea that weeds are still part of the total plant species diversity in the area, and as such should still be included. Other common answers included to allow for a comparison and evaluation of the overall effectiveness of the project, or that weeds have an impact on the ecosystem and native species in the area (usually negative) and numbers should be recorded.

Question 1d.

Mark	0	1	2	Average
%	73	6	21	0.5

Some students focused on habitat restoration despite the question stating not to do so. Responses that scored highly explained strategies such as protection of the area by including fencing or limiting human access to prevent disruption, or the development of wildlife corridors to connect habitats and allow for movement of species, which would create greater breeding opportunities.

Question 1e.

Mark	0	1	2	Average
%	21	41	38	1.2

One advantage of quadrat sampling as a method of measuring species diversity needed to be outlined. The most common correct responses explained that quadrats are a simple, time-efficient and cost-effective way of collecting data in the field. They allow samples of diversity to be measured and this data can be used to estimate diversity for the larger site. The idea that quadrats are used because plants don't move is not correct – for example, quadrats can be used to measure insect diversity at a site.

Question 2a.

Mark	0	1	2	Average
%	7	20	73	1.7

Most students were able to identify the two key elements that justified why the possum was classified as 'extinct in the wild', that is because there are no remaining individuals in the wild and the only possums left are found in captivity within the sanctuary.

Question 2b.

Mark	0	1	2	Average
%	13	21	65	1.5

Responses that scored highly were able to identify and describe one possible threat to biodiversity that could have led to the 'extinct in the wild' classification. Many students described the impacts of large-scale clearance or habitat modification of the rainforest that led to habitat loss and a decrease in food or shelter resources. Other correct responses described the negative impacts on biodiversity of invasive species, including introduced predators.

Question 2c.

Mark	0	1	2	Average
%	37	36	27	0.9

Many students had difficulty explaining the concept of captive breeding. Given the only possums left are the 50 in captivity, the importance of mating less closely related individuals using genetic records would be key to this strategy. As identified in the stem of the question the possum species is 'extinct in the wild' and it is not possible, as many students incorrectly suggested, to bring in mates from another population.

Question 2d.

Mark	0	1	Average
%	43	57	0.6

The two key elements that define a biodiversity hotspot are a very high endemic species diversity (over 1500 species of plants) and being under serious threat (having lost at least 70% of their primary vegetation). Not all students were able to identify one of these key factors.

Question 2e.

Mark	0	1	2	Average
%	7	48	45	1.4

Responses that scored highly stated that the strategy of releasing the remaining population into a grassland habitat would not be successful because the possums would be unlikely to adapt to this very different habitat. They highlighted the difficulty in finding food sources and nesting sites in a grassland (compared to a rainforest). A second reason given often focused on the difficulty organisms had in being reintroduced to the wild after being raised in captivity. Responses that did not score well stated that the strategy would succeed and focused on the point made in the stem regarding the lack of natural predators in the grassland habitat.

Question 3a.

Marks	0	1	2	3	4	5	6	Average
%	15	9	19	27	19	8	1	2.6

This question asked for students to write a description and comparison between the two proposals to develop a sustainable water supply for the growing city. The standard of responses varied considerably and few responses scored highly. It is expected that students will be able to write a coherent and logical analysis of the case study and demonstrate an understanding of the specific sustainability principles. Not all students were able to define the principle of 'efficiency of resource use' clearly, instead giving simple comments such as 'use efficiently' and 'maximise outputs versus inputs'. The principle of 'conservation of biodiversity and ecological integrity' was also often very generally described as protecting living things and ecosystems.

Responses that scored highly clearly defined each term and discussed how they applied to the dam and desalination plant proposals, with some specific details and relevant analysis. These responses explained that neither proposal meets the 'efficiency of resource use / conservation of biodiversity and ecological integrity' principle very well because of various environmental concerns, but in terms of sustainability the desalination plant could be argued as a better overall choice.

Question 3b.

Mark	0	1	2	Average
%	17	45	38	1.2

The focus of the question was justifying the claim made that the desalination plant would meet the sustainability principle of 'intergenerational equity' more effectively than the dam. Responses that scored highly argued that the desalination plant could be expanded to cater for increasing growth / water needs of the city into the long-term future, whereas it would be unlikely that enough water could come from the river

system for continued population growth. Therefore, the desalination plant is the only option that could provide for the needs of future generations.

Question 3c.

Mark	0	1	2	Average
%	12	63	24	1.1

Many students had difficulty making the connection between monitoring to collect data around the impact of saline outflows into the marine environment and then using this information to inform management practices and to implement risk reduction. Monitoring is not useful in itself if no actions are taken to interpret and use the results to maintain environmental quality.

Question 3d.

Mark	0	1	2	Average
%	40	27	32	0.9

The question was not well answered in general – it seemed that students had not read the question carefully and incorrectly named a government organisation (e.g. DWELP or a local council) or simply stated a broad term such as the community, residents or population (rather than a non-government organisation). Some responses that did not score well were those that failed to describe how the organisation would be involved in the decision-making process.

Question 4a.

Mark	0	1	2	3	Average
%	33	42	19	5	1.0

There was some confusion by many students about the difference between biodiesel and diesel produced from fossil fuels. High-scoring responses indicated that both fuels undergo combustion to release carbon in the form of CO_2, therefore they both generate this greenhouse gas and contribute to global warming. The point about how this related to the carbon cycle was less successfully explained in many responses. Few students were able to explain that because diesel is releasing 'long-term stored' carbon from fossil fuels and adding it to the atmosphere, it has a much greater impact compared to biodiesel, which is produced by plants taking CO_2 out of the atmosphere during photosynthesis, and then returning it following combustion – it is more carbon neutral/balanced within the carbon cycle in the short term.

Question 4b.

Mark	0	1	Average
%	43	57	0.6

The logic was that 25% of the electrical energy was provided from 12 units, therefore the input energy needed from the biodiesel generator was 48 units.

Question 4c.

Mark	0	1	2	3	Average
%	20	40	38	2	1.2

Very few students scored full marks for this question; many students did not fully explain the term 'peak demand' and did not link the discussion to how the renewable biodiesel would be able to meet the town's needs. 'Peak demand' is the time when demand is at its highest during the day, usually between 4pm and 8pm, because people are returning home and turning on their household appliances such as air-conditioning/heating and lights. Many responses that did not score well simply stated that it was 'the highest point in energy usage', which is far too general.

Question 4d.

Mark	0	1	2	Average
%	33	34	33	1.0

The major environmental reason for locating the biodiesel plant close to town was related to the shorter distance required to transport the electrical energy to the users. Less energy loss through the transmission lines means greater efficiency / less waste from the energy source. Other acceptable responses focused on less habitat disturbance/fragmentation associated with establishing electrical transmission infrastructure and roads over a shorter distance between the generator and town.

Question 5a.

Mark	0	1	2	Average
%	4	22	75	1.7

Most students were able to correctly identify two possible renewable energy sources from tidal, wind, geothermal, wave or solar.

Question 5b.

Mark	0	1	2	3	Average
%	27	30	40	3	1.2

The term 'biocentrism' was generally misunderstood – many students simply stated that it referred to a viewpoint that all living things were important. Few students were able to clearly explain the idea that biocentrism is the belief that the rights and needs of humans are not more important than those of other living things, and that equal priority when making decisions should be given to all organisms. Therefore, the closure of a greenhouse-gas-producing energy industry (the power station) will be better for all living things, and does not just consider the energy needs of humans. The plans for habitat restoration and rehabilitation of the site will improve living conditions for all native plants and animals.

Question 5c.

Mark	0	1	2	Average
%	34	46	20	0.9

Most students were able to identify one disadvantage in replacing a coal power station with batteries as an energy storage source but were less successful in describing this disadvantage clearly. Responses that scored highly focused on the issues related to putting in a renewable energy source to provide energy for a battery storage system, such as lack of reliability of wind and/or sun. A few students successfully described issues related to the high cost of battery technology, the resources required to manufacture them and the limited lifespan of battery storage systems.

Question 5d.

Mark	0	1	2	Average
%	28	24	48	1.2

Students were generally able to explain one reason related to infrastructure for using the existing electricity station site for the battery storage facility. Most students discussed the idea that because the infrastructure already existed it would be cheaper and easier to distribute the electricity through the existing power lines and re-use existing buildings so fewer resources would be required.

Question 6a.

Marks	0	1	2	3	4	5	Average
%	21	15	17	17	18	14	2.4

The ideas that needed to be outlined were generally not completely covered in many responses. Most students attempted to use a labelled diagram with some description. The basic incoming radiation types (ultraviolet light, infra-red radiation and visible light) were identified. What wasn't always shown clearly was the visible light being absorbed by Earth's surface and re-emitted as infra-red, with some reflection. This reradiated infra-red is absorbed by natural greenhouse gases and heats the atmosphere allowing life on Earth to exist. The absorption of much of the incoming ultraviolet and infra-red in the atmosphere before it reaches Earth's surface was not always shown or discussed.

Question 6b.

Mark	0	1	2	Average
%	39	39	22	0.9

Many students found it difficult to clearly state the specific cause of both the natural and enhanced greenhouse effects. The natural greenhouse effect is due to the naturally occurring emissions of greenhouse gases such as those from natural atmospheric cycles and events such as volcanic eruptions or naturally occurring forest fires. The enhanced greenhouse effect is due to greenhouses gases being emitted to the atmosphere as a result of various human activities such as fossil fuel combustion.

Question 6c.

Mark	0	1	2	Average
%	11	25	64	1.5

Most students were able to identify two major greenhouse gases that Sally's farm would be emitting. Most listed carbon dioxide from fossil fuel burning by farm machinery and methane from cattle.

Question 6d.

Mark	0	1	2	Average
%	31	25	44	1.2

Carbon sequestration was not always clearly defined as removing carbon from the atmosphere and storing it. Most students were able to suggest that extensive tree planting or increasing soil organic carbon by increasing biomass production and minimising organic matter loss from soil would be viable sequestration methods for the farm. Geosequestration by collecting, cooling and injecting CO_2 deep into the ground is not a viable suggestion for a small-scale farm**.**

Question 7a.

Mark	0	1	2	3	Average
%	2	11	67	20	2.1

Based on the data shown in the graph there was a clear downward trend in the ice mass in Antarctica, which most students described. Few students were able to use the data to describe a loss of around 2600 Gt over 19 years, or approximately 140 Gt per year. Responses that scored highly then described one reason for this trend based on the continued global warming process (due to increasing greenhouse gas levels) resulting in higher atmospheric temperatures and therefore the melting of ice mass.

Question 7b.

Mark	0	1	2	Average
%	29	44	27	1.0

Some students found it difficult to describe one other global measurement used to monitor the rate of climate change (apart from the amount of global ice and snow coverage). Many incorrectly discussed the use of 'modelling', which in itself is not a measurement, but a tool to enable interpretation of data based on various measurements. Other unsuccessful responses discussed measurements of the level of atmospheric greenhouse gases, which again is not a direct measure of the rate of climate change. Responses that scored highly described the use of global average annual temperature measurements from air monitoring stations, tree ring and ice core estimates or global sea level measurements (or temperatures) from tidal gauges and satellite data.

Question 7c.

Mark	0	1	2	3	Average
%	22	14	32	31	1.7

Most students were able to explain the basic concept of the 'albedo effect' adequately. In simple terms, this is a measure of how much radiation a surface reflects (or absorbs). Responses that scored highly then went on to explain how the melting of ice in Antarctica (reduction in the area of ice), which has a higher reflectivity than seawater, will lead to even greater warming.

Question 8a.

Mark	0	1	2	Average
%	46	33	21	0.8

Some students were unable to demonstrate an understanding that carbon dioxide is found in much higher concentrations in the atmosphere compared to fluorocarbons. Also, they were often confused about the magnitude of the scale of the two units, and didn't understand that parts per million is used to measure much higher concentrations than parts per trillion. Responses that did not score well suggested that because one trillion is a larger number than one million, there was a higher concentration of fluorocarbons in the atmosphere.

Question 8b.

Mark	0	1	2	Average
%	48	23	30	0.8

It is expected that students will have investigated the source and impact of fluorocarbon gases, one of the main gases contributing to the enhanced greenhouse effect, (and not only focus on carbon dioxide and methane). Atmospheric levels of these gases were zero in 1900 because they are synthetic/human-made gases discovered in the 1930s and increasingly used since then. Responses such as 'very low' or 'almost zero' could not be accepted.

Question 8c.

Mark	0	1	2	Average
%	46	28	26	0.8

As shown in the graph, levels of the four fluorocarbon gases are low (and in some cases slowly decreasing since they were banned). They are still of concern because individual molecules of CFCs and HCFCs have a very high global warming potential due to a high persistence in the atmosphere and their strong ability to absorb infra-red energy, thus continuing to contribute to global warming. Not many students were able to explain this connection fully.

Question 9a.

Mark	0	1	Average
%	51	49	0.5

The dependent variable is the temperature inside each shed. Many students gave an incorrect response, such as 'the weather' or simply stated 'temperature', which was not specific enough.

Question 9b.

Marks	0	1	2	3	4	Average
%	31	22	17	16	15	1.6

Many students were not clear on the difference between the terms 'accuracy' and 'precision'. Therefore, the quality of answers varied. Responses that scored highly made it clear that checking and calibration of the data loggers was done to improve accuracy and not precision. Scientific accuracy refers to how close the measured result is to the 'true' value of the quantity being measured, while precision refers to how closely two or more measurement values agree with each other. Therefore, if the data logger is correctly calibrated, the temperatures being recorded will be closer to the actual temperatures and the data will be more accurate.

Question 9c.

Mark	0	1	2	Average
%	16	24	60	1.5

Most students correctly read the graph and indicated that the lower temperature on day three, in both sheds, was due to an environmental factor connected to the weather such as a cloudy, cool or rainy day.

Question 9d.

Mark	0	1	2	3	Average
%	29	14	43	14	1.5

Some students were not able to logically and correctly identify which of the two hypotheses was better supported by the data. Responses that scored highly clearly identified that Group 2's hypothesis was better supported because although both hypotheses suggest that Shed B does not get as hot as Shed A, more specific detail was included in the second hypothesis. The data showed that Shed A lost more heat overnight and there was less fluctuation in Shed B temperatures throughout the whole day.

Question 9e.

Mark	0	1	2	Average
%	52	16	33	0.8

A number of students seemed unfamiliar with the 'hydrosphere' and others gave basic responses, such as 'the roofs will save water'. Responses that scored highly explained the benefits to the local hydrosphere of capturing rainwater and plants using it on the green roofs, which reduces total run-off (including pollutants) and stormwater running into local drains and creeks.

Question 9f.

Mark	0	1	2	Average
%	32	29	39	1.1

Most students understood that, based on the data, using a green roof system would help to keep the building cooler during the day, and then help to retain heat overnight. Some responses that scored highly then went on to make the connection that this would result in a lower overall energy consumption (because of a decreased use of air-conditioners and fans during the day and less heating required overnight).