National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Exemplar for Internal Achievement Standard

Earth and Space Science Level 2

This exemplar supports assessment against:

Achievement Standard 91187

Carry out a practical Earth and Space Science investigation

An annotated exemplar is an extract of student evidence, with a commentary, to explain key aspects of the standard. It assists teachers to make assessment judgements at the grade boundaries.

New Zealand Qualifications Authority

To support internal assessment

	Grade Boundary: Low Excellence
1.	For Excellence, the student needs to carry out a comprehensive practical Earth and Space Science investigation. This involves: • carrying out a valid investigation to collect reliable data • explaining how the method allowed for reliable data to be collected • explaining in detail the Earth and Space Science related to the investigation by linking the results, interpretation and conclusion to the relevant science. The student has used a valid investigation and collected reliable data on clay deposition in sea water (1), explained how the method collected reliable data and used this to draw a valid conclusion (2). The Earth and Space science behind the results obtained from the investigation have been explained in detail. Both water density and flocculation were comprehensively explained (3). For a more secure Excellence, the student could explain in more detail how the method is valid, and provide reliable supporting data. A better graph could also have been used. The axis should be labelled and a title given.

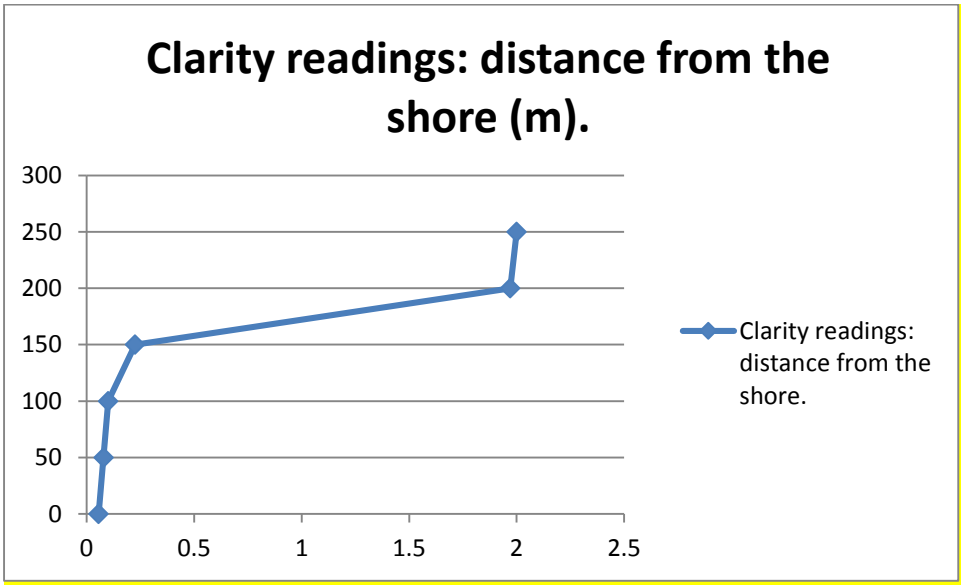
Note: This student also described a valid method, correctly identified key variables and processed raw data.

Purpose: To observe the clarity of sea water off the mouth of the Aparima River following a minor flood that introduced clay into the river and the sea. Clarity will be recorded using a secchi disc on the end of a two metre pole. Readings will be taken on each side of a boat.

Hypothesis: The further the river water travels into Foveaux Strait the clearer the water readings will be. (1)

Results:

Straight line distance from the shore.	0m River mouth	50m	100m	150m	200m	250m
Secchi Reading 1 Right side	0.06m	0.075m	0.095m	0.20m	1.95m	>2.0m
Secchi Reading 2 Left side	0.05m	0.081m	0.096m	0.25m	1.99m	>2.0m
Average	0.055m	0.078m	0.0955	0.225m	1.97m	>2.0m



Interpretation of the data:

The investigation carried out was to establish a pattern of how clay released during a minor flood affected sea water and to find out how far the clay went into the sea water before it had no effect on water clarity. The investigation is a pattern-seeking investigation.

The results show that, where the river water met the sea water, initially the clay stayed suspended in the water. As the river water mixed with the sea water there was a drop off in the concentration of clay particles and water clarity started to increase. The drop off was not

uniform and there was only a minor difference between the river mouth and 150m off shore. After this there was a significant increase in clarity between 150m and 200m from shore and by 200m typical water clarity of Foveaux Strait had been achieved. Between 150m and 200m the change was strongly significant. At 150m the clarity was clay-obscured and yet by 200m the water was quite clear. Something happened between these two points to remove the clay particles from the water. One possible reason is that before 100m the seawater and the river water did not mix together and the fresh river water floated upon the sea water. Between 150m and 200m from the shore the waters mixed and the clay disappeared from the field of view.

Earth and Space science behind the investigation:

a/ Water Densities:

When river water and sea water meet there is a vertical layering between the two water bodies. The fresh water rides over the sea water due to differences in density in the water bodies. Fresh water tends to ride over the sea water because it has a lower density. This separation lasts for quite some time or until the waters get mixed due to wave action, ocean currents or ocean bottom irregularities. A future investigation could be to measure salt water concentrations of the surface waters 250m from the shore. This would require collecting surface water samples and testing for salt concentrations.

b/ Flocculation:

Clay particles are suspended in moving water due to their small size and repulsion by water molecules. Clay can stay suspended in water for very long periods of time. However, when clay particles meet calcium ions they tend to clump together in a process called flocculation. Sea water has a large number of calcium ions (Ca^{2+}) and as river water and sea water mix these calcium ions cause the clay particle to clump (flocculate) and drop to the sea floor. This process could be measured by taking sea floor examples out to 250m from the shore and measuring the amount of clay in the samples. (3)

Conclusion:

The change in water clarity as a river in minor flood flowed out into Foveaux Strait showed a pattern of a sudden clearing between 100m and 150m off shore. This was due to the waters overcoming density differences and the clay particles being flocculated due to the high level of calcium ions in the sea water.

The experiment was valid and showed an expected trend in the data. Our hypothesis was correct; however we expected a gradual change not the abrupt change we got from our readings. This shows that river waters and their suspended sediments stay separate until the waters are mixed and the calcium ions in the sea water can flocculate the lumps of clay. The data was reliable as we took our reading accurately and had a group consensus of the readings. Our readings mirrored what the Southland Environment Council has recorded in the past and this gives validity to our investigation. (2)

	Grade Boundary: High Merit

2.	For Merit, the student needs to carry out an in-depth practical Earth and Space Science investigation.
	
	This involves:
	
	• confirming the original method or refining the method to increase the validity and reliability of collected data by:
	  • development of valid ranges for the key variables
	  • valid measurement of key variables
	  • valid management of other variables
	  • reliable collection of raw data
	• interpreting the processed data to draw a valid conclusion related to the purpose of the investigation
	• explaining the Earth and Space Science related to the investigation.
	
	The student has confirmed the original method and commented on the reliability of the data on clay deposition in sea water. A valid conclusion has been drawn related to the data (1). There are comments in depth on the Earth and Space science related to water densities (2) and there is an explanation of flocculation (3).
	
	To reach Excellence, the student could explain in depth the role of the calcium ions in flocculation rather than just calcium. Reasons why the conclusion is valid could also be provided.

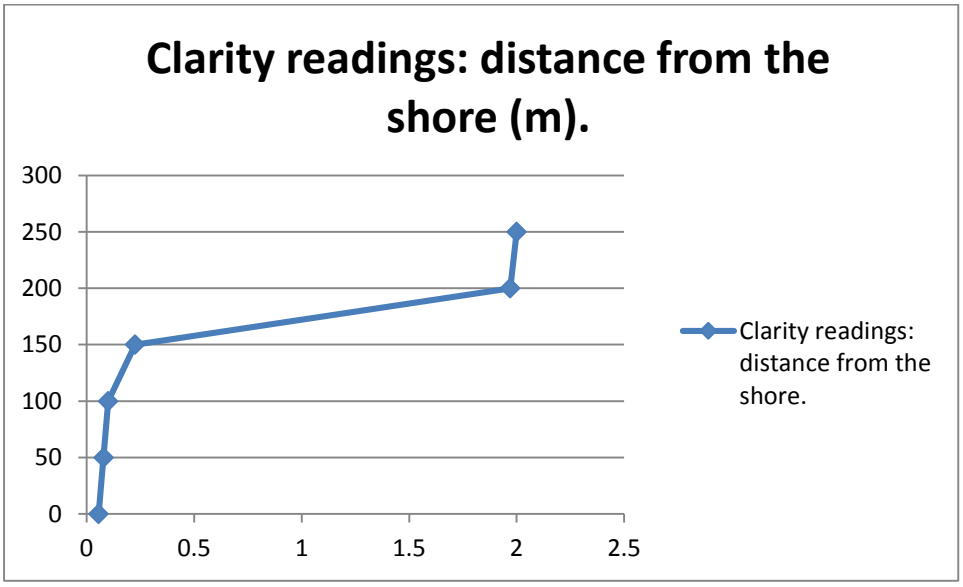
Note: This student also described a valid method, correctly identified key variables and processed raw data.

Purpose: To observe the clarity of sea water off the mouth of the Aparima River following a minor flood that introduced clay into the river and the sea. Clarity will be recorded using a secchi disc on the end of a two metre pole. Readings will be taken on each side of a boat.

Hypothesis: The further the river water travels into Foveaux Strait the clearer the water readings will be.

Results:

Straight line distance from the shore.	0m River mouth	50m	100m	150m	200m	250m
Secchi Reading 1 Right side	0.06m	0.075m	0.095m	0.20m	1.95m	>2.0m
Secchi Reading 2 Left side	0.05m	0.081m	0.096m	0.25m	1.99m	>2.0m
Average	0.055m	0.078m	0.0955	0.225m	1.97m	>2.0m



Interpretation of the data:

The investigation carried out was to establish a pattern of how clay released during a minor flood affected sea water and to find out how far the clay went into the sea water before it had no effect on water clarity. The investigation is a pattern seeking investigation.

The results show that, where the river water met the sea water, initially the clay stayed suspended in the water. As the river water mixed with the sea water there was a drop off in the concentration of clay particles and water clarity started to increase. The drop off was not

uniform and there was only a minor difference between the river mouth and 150m off shore. After this there was a significant increase in clarity between 150m and 200m from shore and by 200m typical water clarity of Foveaux Strait had been achieved. Between 150m and 200m the change was strongly significant. At 150m the clarity was clay-obscured and yet by 200m the water was quite clear. Something happened between these two points to remove the clay particles from the water. One possible reason is that before 100m the seawater and the river water did not mix together and the fresh river water floated upon the sea water. Between 150m and 200m from the shore the waters mixed and the clay disappeared from the field of view. (1)

Earth and Space science behind the investigation:

a/ Water Densities:

When river water and sea water meet there is a vertical layering between the two water bodies. The fresh water rides over the sea water due to differences in density in the water bodies. Fresh water tends to ride over the sea water because it has a lower density. This separation lasts for quite some time or until the waters get mixed due to wave action, ocean currents or ocean bottom irregularities. A future investigation could be to measure salt water concentrations of the surface waters 250m from the shore. This would require collecting surface water samples and testing for salt concentrations. (2)

b/ Flocculation:

Clay particles are suspended in moving water due to their small size and repulsion by water molecules. Clay can stay suspended in water for very long periods of time. However, when clay particles meet calcium they tend to clump together in a process called flocculation. Sea water has a large amount of calcium and as river water and sea water mixes with the calcium causes the clay particles to clump (flocculation) and drop to the sea floor. (3)

Conclusion:

The change in water clarity as a river in minor flood flowed out into Foveaux Strait showed a pattern of a sudden clearing between 100m and 150m off shore. This was due to the waters overcoming density differences and the clay particles being flocculated due to the high level of calcium in the sea water.

The experiment was valid and showed an expected trend in the data. Our hypothesis was correct; however we expected a gradual change not the abrupt change we got from our readings. This shows that river waters and their suspended sediments stay separate until the waters are mixed and the calcium in the sea can flocculate the lumps of clay. The data was reliable as we took our reading accurately and had a group consensus of the readings. (1)

	Grade Boundary: Low Merit

3.	For Merit, the student needs to carry out an in-depth practical Earth and Space Science investigation.
	
	This involves:
	
	• confirming the original method or refining the method to increase the validity and reliability of collected data by:
	  • development of valid ranges for the key variables
	  • valid measurement of key variables
	  • valid management of other variables
	  • reliable collection of raw data
	• interpreting the processed data to draw a valid conclusion related to the purpose of the investigation
	• explaining the Earth and Space Science related to the investigation.
	
	The student has confirmed the original method and commented on the reliability of the data on clay deposition in sea water. A conclusion has been drawn related to the data (1). There is explanation of the Earth and Space science related to water densities (2) and a low-level explanation of flocculation (3).
	
	For a more secure Merit, the student could explain in depth the role of both water densities and, especially, flocculation. A valid conclusion linking to how the water samples cleared needs to be provided and linked to the purpose of the investigation.

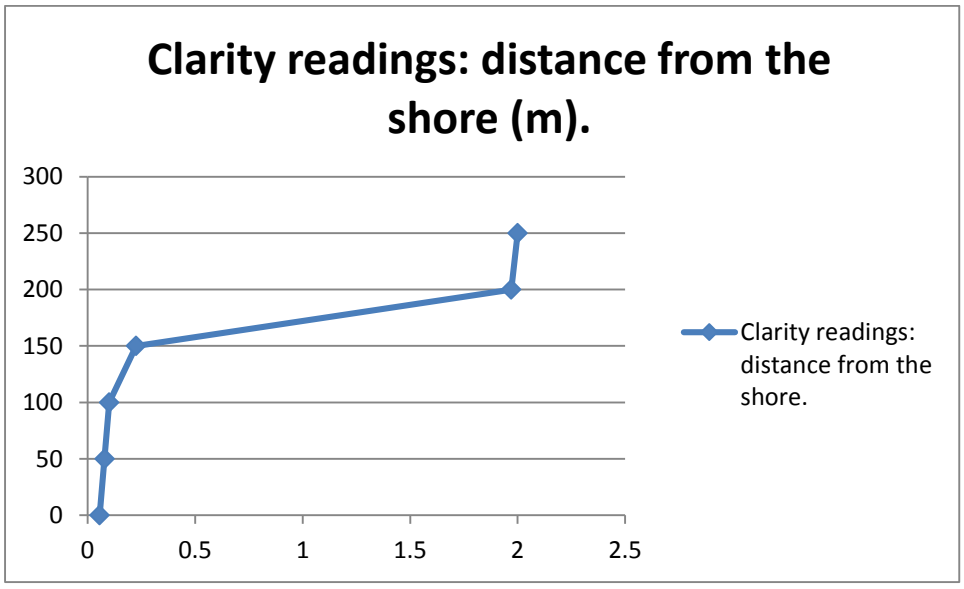
Note: This student produced a valid method, correctly identified key variables and processed raw data.

Purpose: To observe the clarity of sea water off the mouth of the Aparima River following a minor flood that introduced clay into the river and sea water. Clarity will be recorded using a secchi disc on the end of a two metre pole. Readings will be taken on each side of the fishing boat.

Hypothesis: The further the river water travels into Foveaux Strait the clear the water readings will be.

Results:

Straight line distance from the shore.	0m River mouth	50m	100m	150m	200m	250m
Secchi Reading 1 Right side	0.06m	0.075m	0.095m	0.20m	1.95m	>2.0m
Secchi Reading 2 Left side	0.05m	0.081m	0.096m	0.25m	1.99m	>2.0m
Average	0.055m	0.078m	0.0955	0.225m	1.97m	>2.0m



Interpretation of the data:

The investigation carried out was to establish a pattern of how clay released during a minor flood affected sea water and to find out how far the clay went into the sea water before it had no effect on water clarity. The investigation is a pattern seeking investigation.

The results show that where the river water met the sea water initially the clay stayed suspended in the water. As the river water mixed with the sea water there was a drop off in the concentration of clay particles and water clarity started to increase. The drop off was not uniform and there was only a minor difference between the river mouth and 150m off shore. After this there was a significant increase in clarity between 150m and 200m from shore and by 200m typical water clarity of Foveaux strait had been achieved. Between 150m and 200m the change was strongly significant. At 150m the clarity was clay obscured and yet by 200m the water was quite clear. Something happened between these two points to remove the clay particles from the water. One possible reason is that before 100m the seawater and the river water did not mix together and the fresh river water floated upon the sea water. Between 150m and 200m from the shore the waters mixed and the clay disappeared from the field of view. (1)

Earth and Space science behind the investigation:

a/ Water Densities:

When river water and sea water meet there is a vertical layering between the two water bodies. The fresh water rides over the sea water due to differences in density in the water bodies. Fresh water tends to ride over the sea water because it has a lower density. Eventually the densities mix and are not important any more. (2)

b/ Flocculation:

Clay particle are suspended in moving water due to their small size and repulsion by water molecules. Clay can stay suspended in water for very long periods of time. However, when clay particles meet calcium they tend to clump together in a process called flocculation. Sea water has a large amount of calcium and as river water and sea water mixes with the calcium causes the clay particles to clump (flocculation) and drop to the sea floor. (3)

Conclusion:

The change in water clarity as a river in a minor flood flowed out into Foveaux Strait showed a pattern of a sudden clearing between 100m and 150m off shore. This was due to the river and sea waters mixing and the clay dropped to the bottom of the sea bed.

The experiment was valid and showed an expected trend in the data. Our hypothesis was correct however we expected a gradual change not the abrupt change we got from our readings. The data was reliable as we took our reading accurately and had a group consensus of the readings. (1)

	Grade Boundary: High Achieved

4.	For Achieved, the student needs to Carry out a practical Earth and Space Science investigation.
	
	This involves:
	
	• giving a statement of purpose arising from an Earth and space scientific context
	• developing a method that describes:
	  • ranges for key variables
	  • how key variables are measured
	  • the management of some other variables
	  • the collection of raw data
	• collecting raw data consistent with the method
	• recording and processing raw data relevant to the purpose
	• interpreting the processed data to draw a conclusion related to the purpose of the investigation
	• describing the Earth and Space Science related to the investigation
	• reporting on the investigation.
	
	The student has described a purpose (1), collected raw data and interpreted the data on clay deposition in sea water. (2), drawn a valid conclusion related to the investigation (4), given a simple description of the Earth and Space science (density differences and flocculation) (3) and reported on the investigation.
	
	To reach Merit, the student could explain how the investigation relates to key Earth and Space science ideas. For example, the roles of water density differences and the role of flocculation could be linked to the investigation to explain how and why the water cleared from the river mouth.

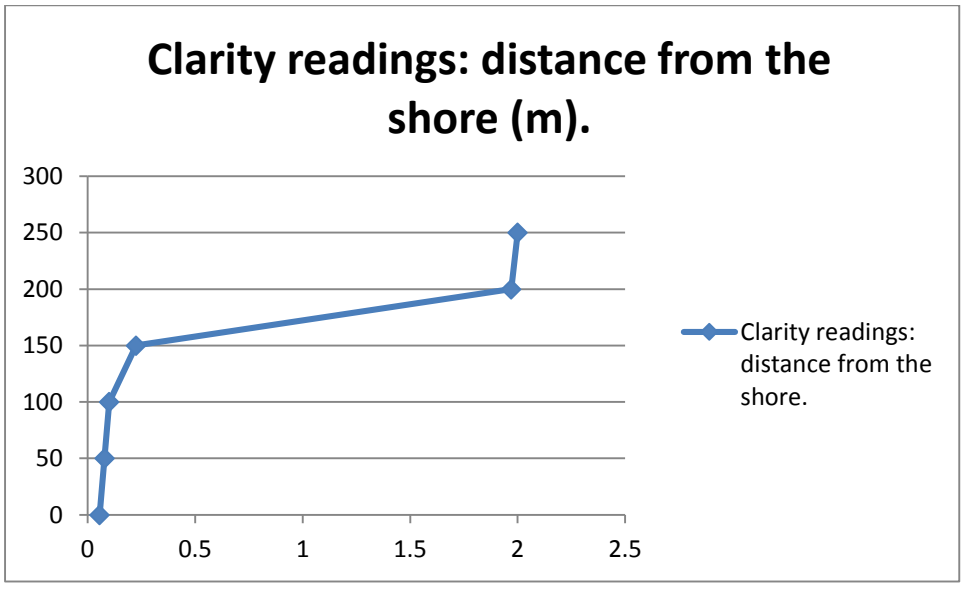
Note: This student also described a valid method, correctly identified key variables and processed raw data.

Purpose: To observe the clarity of sea water off the mouth of the Aparima River following a minor flood that introduced clay into the river and the sea. Clarity will be recorded using a secchi disc on the end of a two metre pole. Readings will be taken on each side of a boat. (1)

Hypothesis: The further the river water travels into Foveaux Strait the clearer the water readings will be.

Results:

Straight line distance from the shore.	0m River mouth	50m	100m	150m	200m	250m
Secchi Reading	0.06m	0.075m	0.095m	0.20m	1.95m	>2.0m



Interpretation of the data:

The investigation carried out was to establish a pattern of how clay released during a minor flood affected sea water and to find out how far the clay went into the sea water before it had no effect on water clarity. The investigation is a pattern seeking investigation.

The results show that where the river water met the sea water the water was very dirty. This stayed the same until 150m from shore then suddenly cleared. This was because the river and sea waters mixed and clay dropped to the bottom of the sea bed. (2)

Earth and Space science behind the investigation:

a/ Water Density:

When river water and sea water meet there is no mixing between the two water bodies because the river water and the sea water have different densities. The river water with the low density sits on the sea water. They will eventually mix because of the tides but that takes time and the water can travel 150m before this happens.

b/ Flocculation:

When clay particles hit sea water they are flocculated. This means they form clumps and sink to the bottom of the sea bed. This is controlled by mixing and calcium metal. Calcium is in sea water because of calcium carbonate. (3)

Conclusion:

The change in water clarity as a river in a minor flood flowed out into Foveaux Strait showed a pattern of a sudden clearing between 100m and 150m off shore. This was due to the river and sea waters mixing and the clay dropped to the bottom of the sea bed.

The change in water clarity was due to the river waters dropping their clay particles and the clean sea water being observed after 150m. (4)

The experiment was valid and showed an expected trend in the data. Dirty water exists in Foveaux Strait until it gets mixed with sea water

	Grade Boundary: Low Achieved

5.	For Achieved, the student needs to carry out a practical Earth and Space Science investigation.
	
	This involves:
	
	• giving a statement of purpose arising from an Earth and space scientific context
	• developing a method that describes:
	  • ranges for key variables
	  • how key variables are measured
	  • the management of some other variables
	  • the collection of raw data
	• collecting raw data consistent with the method
	• recording and processing raw data relevant to the purpose
	• interpreting the processed data to draw a conclusion related to the purpose of the investigation
	• describing the Earth and Space Science related to the investigation
	• reporting on the investigation.
	
	The student has described a purpose (1), collected raw data and interpreted the data on clay deposition in sea water. (2), drawn a conclusion (4), given a simple description of the Earth and Space science (density differences) (3) and reported on the investigation.
	
	For a more secure Achieved, the student could further describe significant Earth and Space science factors that affect the changes in clarity. For example, the role of flocculation could be described.

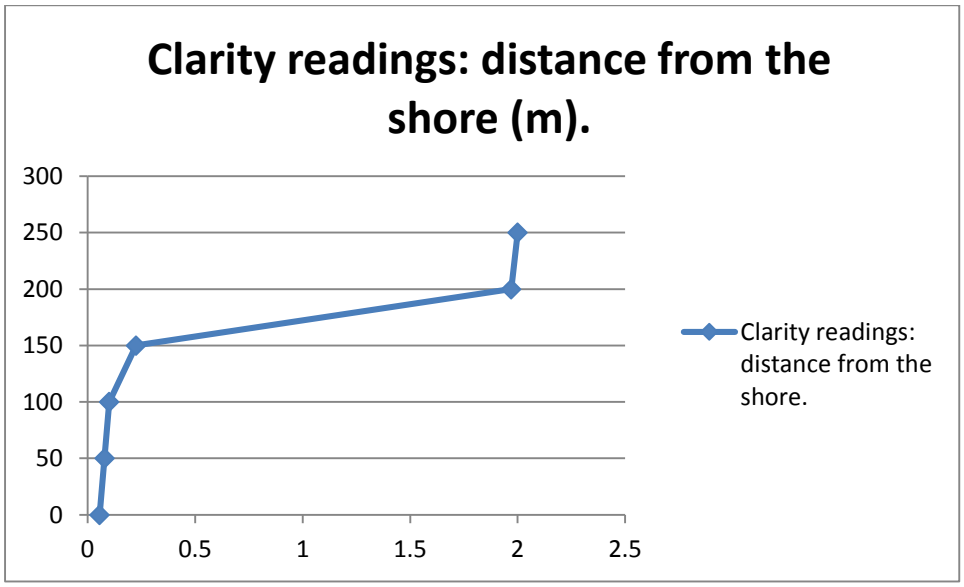
Note: This student also described a valid method, correctly identified key variables and processed raw data.

Purpose: To observe changes in the clarity of sea water off the mouth of the Aparima River for 200m from shore. (1)

Hypothesis: The further the river water travels into Foveaux Strait the clearer the water readings will be.

Results:

Straight line distance from the shore.	0m River mouth	50m	100m	150m	200m	250m
Secchi Reading	0.06m	0.075m	0.095m	0.20m	1.95m	>2.0m



Interpretation of the data:

The results show that where the river water met the sea water the water carried clay particles suspended in it. As the river water mixed with the sea water there was a drop off in clay and water clarity started to increase. There was a significant increase between 150m and 200m from shore and by 200m water was pure sea water. At 150m the water had clay and yet by 200m the water was quite clear. Something happened between these two points to remove the clay from the water. The key thing was different water densities and clay flocculation. (2)

Earth and Space science behind the investigation:

a/ Water Density:

When river water and sea water meet there is no mixing between the two water bodies because the river water and the sea water have different densities. The river water with the

low density sits on the sea water. They will eventually mix because of the tides but that takes time and the water can travel 150m before this happens.

b/ Flocculation:

When clay particles hit sea water they are flocculated. This means they form clumps and sink to the bottom of the sea bed. (3)

Conclusion:

The change in water clarity as a river in minor flood flowed out into Foveaux Strait showed a pattern of a sudden clearing between 100m and 150m off shore.

The change in water clarity was due to the river waters dropping their clay particles and the clean sea water being observed after 150m. (4)

The experiment was valid and showed an expected trend in the data. Dirty water exists in Foveaux Strait until it gets mixed with sea water

	Grade Boundary: High Not Achieved

6.	For Achieved, the student needs to carry out a practical Earth and Space Science investigation.
	
	This involves:
	
	• giving a statement of purpose arising from an Earth and space scientific context
	• developing a method that describes:
	  • ranges for key variables
	  • how key variables are measured
	  • the management of some other variables
	  • the collection of raw data
	• collecting raw data consistent with the method
	• recording and processing raw data relevant to the purpose
	• interpreting the processed data to draw a conclusion related to the purpose of the investigation
	• describing the Earth and Space Science related to the investigation
	• reporting on the investigation.
	
	The student has described a purpose in a simple way (1), collected raw data and interpreted the data on clay deposition in sea water. (2), drawn an incorrect conclusion related to the purpose (4), attempted to describe the Earth and Space science (3) and reported on the investigation.
	
	To reach Achieved, the student could describe how the known Earth and Space Science relates to the investigation. For example, there could be a description of how density affects the water mixing and/or how flocculation reduces clay particles suspended in the water. A valid conclusion should also be provided.

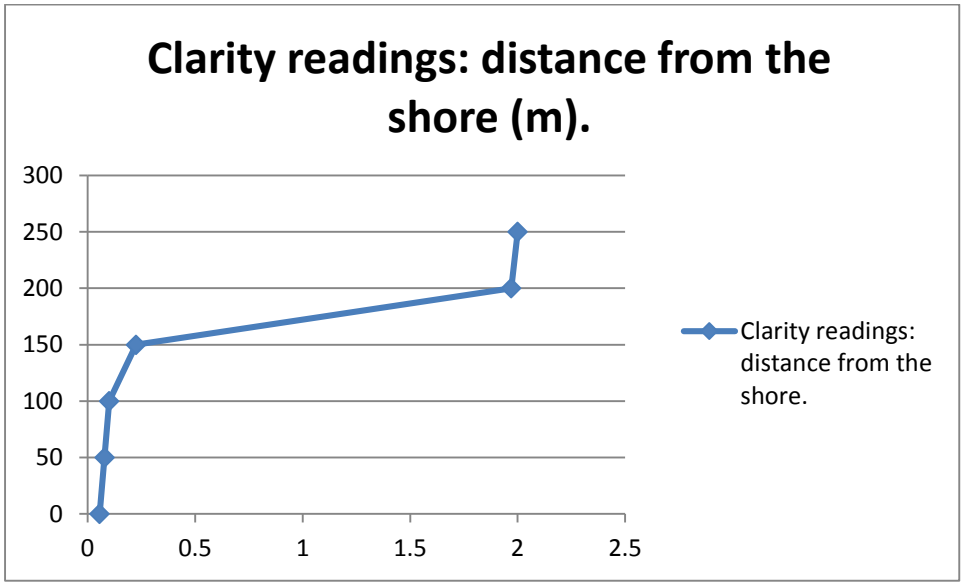
Note: This student also described a valid method, correctly identified key variables and processed raw data.

Purpose: To observe the clarity of sea water off the mouth of the Aparima River. (1)

Hypothesis: The further the river water travels into Foveaux Strait the deeper the water readings will be.

Results:

Straight line distance from the shore.	0m River mouth	50m	100m	150m	200m	250m
Secchi Reading	0.06m	0.075m	0.095m	0.20m	1.95m	>2.0m



Interpretation of the data:

The results show that where the river water met the sea water the water was dirty. As the river water mixed with the sea water there was a drop off in dirt and water clarity started to increase. There was a significant increase between 150m and 200m from shore and by 200m water was pure sea water. At 150m the water was dirty and yet by 200m the water was quite clear. Something happened between these two points to remove the dirt from the water. (2)

Earth and Space science behind the investigation:

a/ Water Mixing:

When river water and sea water meet there is no mixing between the two water bodies so the water remains dirty. When the sea water takes over the river water disappears. Dirty water becomes clean. (3)

Conclusion:

The change in water clarity was due to the waters dropping their dirty particles and the clean sea water being observed.(4)