

Waitaki District Council
Contract No. 500
Economic Assessment
of a Coastal Roads Strategy

Oamaru to Waianakarua



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1 Executive Summary

This report assesses the economics of protecting the coastal road in the Waitaki District. Land erosion caused by the sea is occurring along the coastline such that the road will, at some time, become unsafe for use. To prevent erosion, protection measures are required.

The area of land East of State Highway 1, between Oamaru in the North and the Waianakarua River in the South, is predominantly pastoral farming land. The farming community is well served by a network of sealed and unsealed local roads and no farming property is more than 10km from the State Highway. Roading access for farmers and farm service providers to and from the nearby service town of Oamaru, via the State Highway, is very good. The coastal route is not essential to the farming community.

These Waitaki District coastal roads (Beach Road and Waianakarua Road) are quite unique in the South Island, being a road system constructed close to the coastline. The Kaikoura Coast road is another example, but there the Seaward Kaikoura Range prevented any other choice. The Kaikoura Coast Road has required extensive coastal erosion protection works to remain open.

The coastal route's primary function has evolved to service tourism. It is recognised that the extensive coastal protection works that would be required to keep it functional would downgrade the scenic value of this road. There is an interrelationship between the high cost of maintaining the coastal route, versus the benefits that tourists using the route bring to the District and the methods used to protect the route versus the need to preserve the route's natural beauty.

For the purposes of this assessment, the route has been divided into seven Coastal Road Sites located between Oamaru and the Waianakarua River, as used in previous reports/studies for this location. These are as follows:

Site 1	Beach Road	Oamaru to Awamoa Central Road
Site 2	Beach Road	Awamoa Central Road to Gardiners Road
Site 3	Beach Road	Gardiners Rd to Thousand Acre Road
Site 4	Beach Road	Thousand Acre Road to Kakanui
Site 5	Waianakarua Road	Kakanui to Maclean Road
Site 6	Waianakarua Road	Maclean Road to Bowalley Road
Site 7	Waianakarua Road	Bowalley Road to State Highway 1



Figure 1: Map Showing the Seven Coastal Road Investigation Sites

This report looks at each site individually, identifying the cost of works required to protect the coastline from erosion, and the possible alternative routes available should the site be unprotected and abandoned when the road is unsafe for traffic to use.

The report then assesses options in economic terms through dividing the route into two sections, one each to the north and south of Kakanui, and assessing a number of scenarios of protection and/or abandoning of the sites.

For the northern section between Oamaru and Kakanui, the following options have been assessed:

- **North Do-Minimum:** Abandon Sites 1 and 2 when each becomes unsafe. Traffic travelling between Oamaru and Kakanui will be diverted onto Awamoa Central Road from year 2020 when Site 1 becomes unsafe, and then onto Thousand Acre Road from year 2035 onwards when Site 2 becomes unsafe.
- **North Option 1:** Protect Sites 1 and 2. Traffic travelling between Kakanui and Oamaru will continue to use the Beach Road route for the duration of the economic analysis period.
- **North Option 2:** Protect Site 2; abandon Site 1 when it becomes unsafe. Traffic travelling between Oamaru and Kakanui will utilise Beach Road until year 2020 when Site 1 becomes unsafe, at which time traffic will be diverted onto Awamoa Central Road.

For the southern section of the coastal route between Kakanui and State Highway 1, the following options have been assessed:

- **South Do Minimum:** Abandon Sites 5, 6 and 7 when each becomes unsafe. Once the first section of coastal road is abandoned (Site 5 in year 2015), traffic travelling between Kakanui and the state highway will be diverted onto Happy Valley Road.
- **South Option 1:** Protect Sites 5, 6 and 7. Traffic travelling between Kakanui and State Highway 1 will continue to use the Waianakarua Road route for the duration of the economic analysis period.
- **South Option 2:** Protect Sites 5 and 6; abandon Site 7 when it becomes unsafe. Traffic travelling between Kakanui and State Highway 1 will be diverted onto Happy Valley Road from year 2020 when Site 7 is abandoned.
- **South Option 3:** Protect Site 5; abandon Sites 6 and 7 when each becomes unsafe. Traffic travelling between Kakanui and State Highway 1 will be diverted onto Happy Valley Road from year 2020 when Sites 6 and 7 are abandoned.

A summary of the economic analysis is shown in **Table 1**.

Option	PV Nett Costs (\$)	PV Nett Benefits (\$)	Benefit Cost Ratio
Northern Section (Oamaru to Kakanui)			
Option 1 – Protect Sites 1 and 2	6,988,000	1,980,000	0.3
Option 2 – Protect Site 2, abandon Site 1	491,000	182,000	0.4
Southern Section (Kakanui to State Highway 1)			
Option 1 – Protect Sites 5, 6 and 7	5,929,000	2,877,000	0.5
Option 2 – Protect Sites 5 and 6, abandon Site 7	2,501,000	1,393,000	0.6
Option 3 – Protect Site 5, abandon Sites 6 and 7	212,000	1,059,000	5.0

Table 1: Benefit Cost Ratios

Economic analysis of protection options for the seven coastal road sites results in a BCR of less than 1.0 for all sites except for Site 5 which has a BCR of 5.0. With the exception of site 5, it is considered that protection of the Beach Road and Waianakarua Road route cannot be justified based upon the economic analysis. The typically low BCR is due to the high cost of the protection works and readily available alternative routes from Kakanui to Oamaru and State Highway 1. The economic analysis does not include for the additional travel distances which will be necessary to access properties located along the coastal route, for which abandonment of the coastal road sections will result in significant detours to reach Oamaru and Kakanui. However, as there are a very low number of properties, there will be negligible impact on the assessed BCR.

Protection of Site 5 is at a relatively low cost compared to the other sites and will enable the southern section of the coastal route to remain open for an additional 5 years compared to the Do-Minimum, with resulting economic benefits. It is therefore recommended that these protection works are progressed.

It must be emphasised that the average erosion rate of 0.5m per year quoted in this report can be misleading. This is a rate which is averaged over a very long time span and over a long length of coastline. In reality erosion could occur rapidly in localised areas, will occur at any time, could be severe enough to close sections of the coastal road and will cost significant sums to repair.

When dealing with coastal erosion the thirty year timeframe dealt with by this report is a short time. It is impossible to predict the actual extent of coastal erosion that will occur during that time. The Strategy for the Coastal Road must have overarching goals but must remain flexible on how and when these can be achieved.

2 Introduction

2.1 Location and existing condition

The Waitaki District Council route of Beach Road then Waianakarua Road is the coastal route south of Oamaru. It runs adjacent to the coastline for the majority of its length, and passes through the town of Kakanui.

SH1 is almost parallel to this route but, at between 4 to 5.5km inland, does not afford a view of the ocean.

From the intersection of Thames Street and Severn Street in Oamaru, to the intersection of SH1 and Waianakarua Road to the south, the travel distance is:

- 26km – travelling on SH1; and
- 27.2km – travelling along the coastal route.



Figure 2: SH1 Route



Figure 3: Coastal Route

Between SH1 and the coastal road is a network of local roads as shown in **Figure 4**. These vary in lane width (some are single lane), and seal type (unsealed, chip seal, asphaltic concrete).

The roads are used by residents, the local community and tourists. There are a number of farms, which results in farm vehicles and milk tankers using the roads between SH1 and the coastal road.

Businesses with direct access off the coastal road include the Old Bones Backpackers (just north of Gardiners Road), and Seaview Restaurant and Café (just north of Kakanui). These are identified in **Figure 4**.

The coastal route is not signed as a Tourist Route. A rival coastal location is 40km south of Oamaru at the Moeraki Boulders. This is a widely advertised tourist attraction site accessed via a short road directly off the State Highway, adjacent to the coast, and with a café and gift shop.

Photographs are included within the main body of this report, with additional photographs included as **Appendix A**.

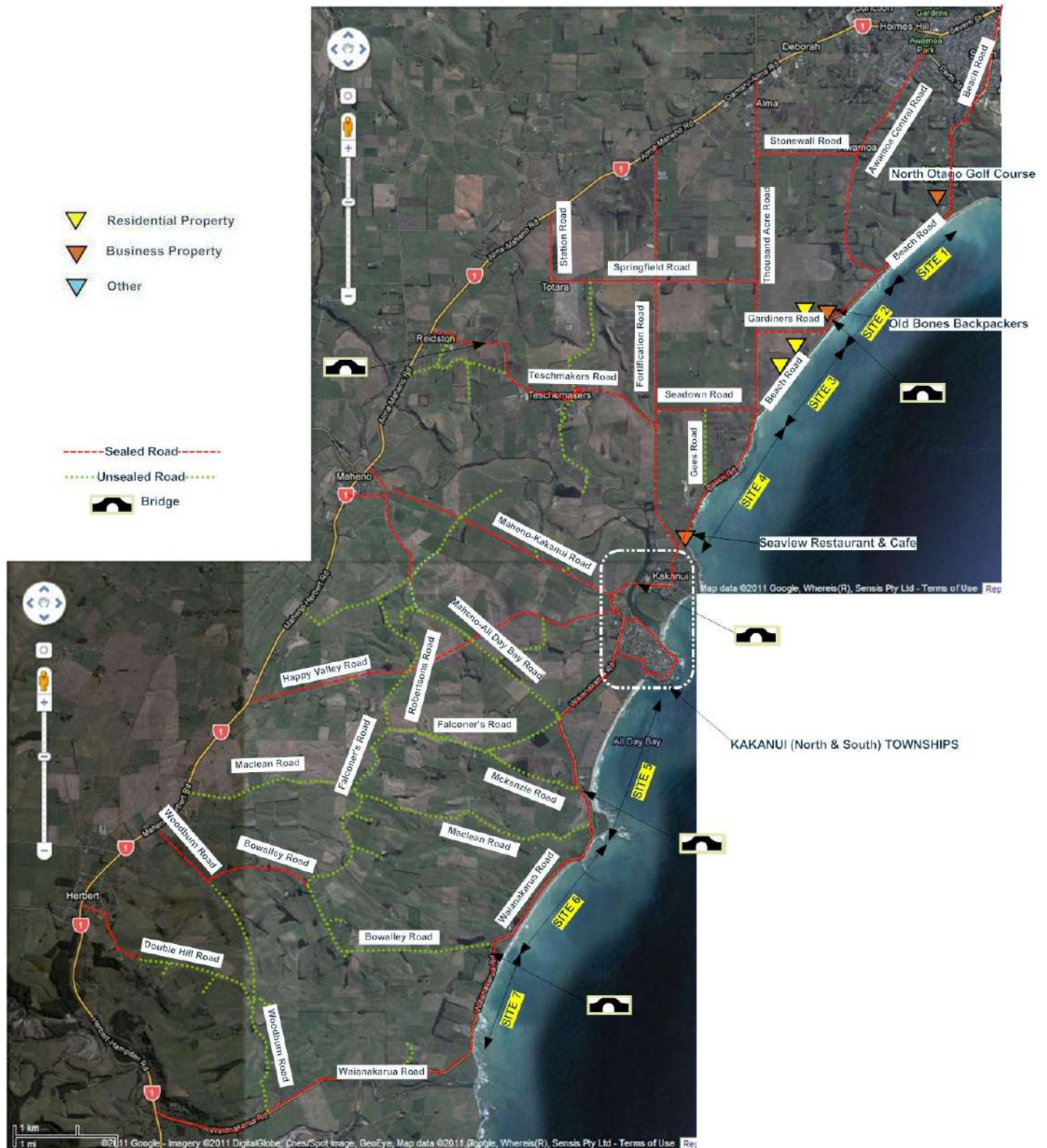


Figure 4: Aerial of Road Layout between SH1 and the Coast, with Businesses and Properties identified along the coastal route

2.2 Local Places of Interest

The Beach Road/Waianakarua Road coastline gives drivers an extensive and unobstructed view of the South Pacific Ocean along most of its length.

There have been a number of sightings of dolphins and seals. Penguins are not seen in this area, but are seen in large quantities nearer (and in) Oamaru.

At various locations, there is an interpretive panel regarding the “Vanished World”. The Vanished World Trail introduces some key geological localities in North Otago, both near the Centre and beyond. The Vanished World Centre is in Duntroon. Together, the Centre and Trail ‘gives you a feeling of “deep time,” so that you can better understand the origins of our land and its living creatures’¹. The trail complements Waitaki’s other well-known tourist attractions including the Moeraki Boulders, the Oamaru Blue Penguin colony and the Clay Cliffs at Omarama. Sites have been selected for their accessibility and their intrinsic value to assist in the telling of our unique Vanished World story. The interpretive panel at the sites gives historical information for the location.

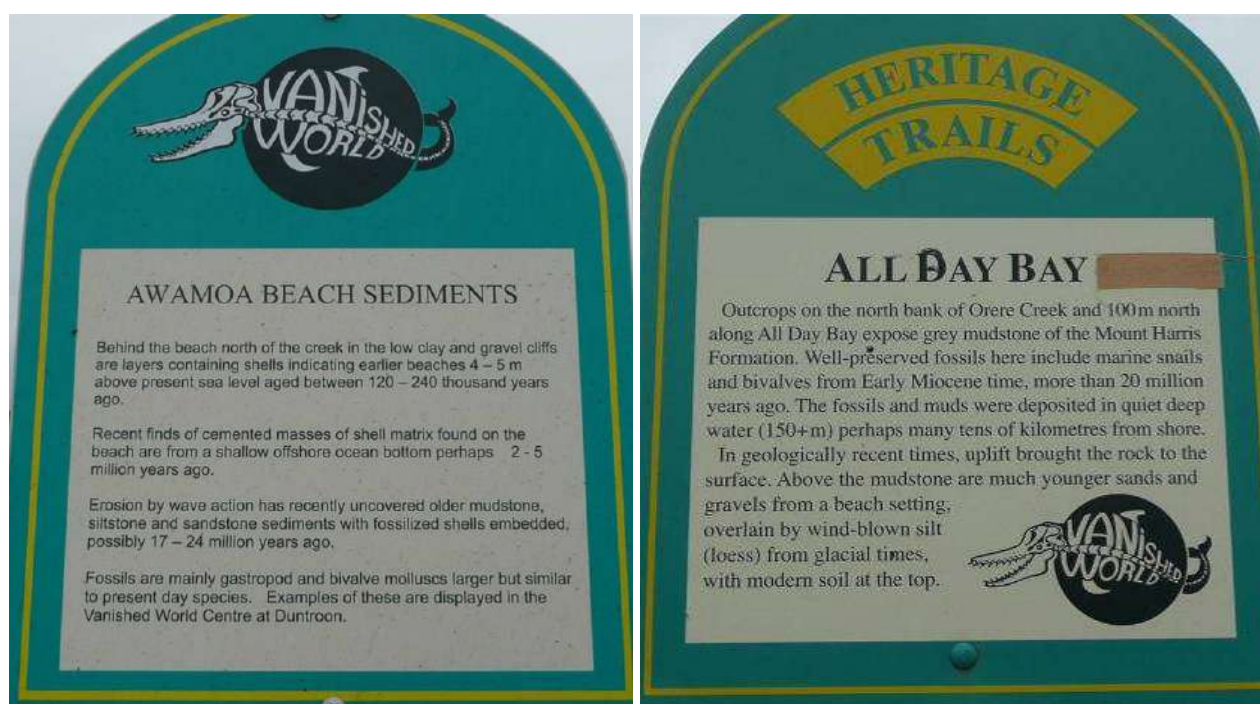


Figure 5 & Figure 6: Vanished World signage at Awamoa Beach (within Site 1) and All Day Bay (within Site 5)

2.3 Coastal Erosion – Previous Studies

Land erosion caused by the sea is occurring along the coastline of the Waitaki District.

Over the last ten years various studies have been carried out on coastal erosion in the Waitaki District. These include:

1. Report on Engineering Issues of a Coastal Roads Strategy (Oamaru to Waianakarua), November 2009, Opus International Consultants
2. Coastal Road Protection Options Report for Beach Road and Waianakarua Rd, May 2009, OCEL Consultants NZ Ltd., Christchurch
3. Preliminary Report on Coastal Erosion Waianakarua Rd and Beach Rd, November 2007. GHD

¹ Taken from www.vanishedworld.co.nz/centre.htm

4. Beach Road Coastal Protection, October 2002, David Hamilton & Associates Ltd. Dunedin
5. Beach Road Investigations and Options Report – Project Feasibility Report, November 2000. Montgomery Watson NZ Ltd. Dunedin
6. Climate Change Leadership Forum, report No.7 June 2008, www.climatechange.govt.nz

Information from old maps indicates that the coastline has been migrating landward continuously during the period of European settlement².

The average long-term rate of erosion on the Waitaki District coastline has been determined at between 0.25m and 0.6m per year depending on location¹. The average long term rate of erosion for this section of coastline is estimated at 0.5m per year¹.

The Intergovernmental Panel on Climate Change (IPCC)³ estimates that the sea level will continue to rise and therefore erosion of the Waitaki coastline can be expected to continue for the foreseeable future.

2.4 Assessments

As indicated in **Figure 4**, for the purposes of this assessment the route has been divided into seven Coastal Road Sites located between Oamaru and the Waianakarua River. This Sites layout was used in previous reports/studies for this location, and are as follows:

Site 1	Beach Road	Oamaru to Awamoa Central Road
Site 2	Beach Road	Awamoa Central Road to Gardiners Road
Site 3	Beach Road	Gardiners Rd to Thousand Acre Road
Site 4	Beach Road	Thousand Acre Road to Kakanui
Site 5	Waianakarua Road	Kakanui to Maclean Road
Site 6	Waianakarua Road	Maclean Road to Bowalley Road
Site 7	Waianakarua Road	Bowalley Road to State Highway 1

This report looks at each of these sites individually. This includes a description of the route; comments on the coastal erosion issues; and identifying the cost of works required to protect the coastline from erosion, and the costs associated with abandoning a site if protection works are not provided. For the 'abandoning' option, a possible alternative route has also been identified.

The results are shown in **Section 4**.

The following sections include the background into the costing philosophies used:

- **Section 3.1** Costing of Coastal Protection Works
- **Section 3.3** Costing of works associated with Site Abandonment
- **Section 3.4** Costing of Roding Upgrades (for the alternative routes).

For the economic assessment/analysis, this report also looks at the coastline being divided into two sections:

1. **North** – this is the section north of Kakanui (Sites 1 to 4); and

² Coastal Road Protection Options Report for Beach Road and Waianakarua Rd, May 2009, OCEL Consultants NZ Ltd., Christchurch

³ Climate Change Leadership Forum, report No.7 June 2008, www.climatechange.govt.nz

2. **South** – this is the section south of Kakanui (Sites 5 to 7).

These look at a number of options of protection and abandonment, considering each section as a whole (rather than as the individual sites).

This split is based on the location of Kakanui, the traffic counts at the north end being much greater than the south, and the alternative adjacent roads at the north end being sealed and more commonly used than the unsealed alternative adjacent routes at the south end of the coastline.

Three options have been analysed for each section. These are detailed in **Section 5**.

It should be noted that:

- No topographical survey work has been undertaken to determine cross-sections (including cliff heights, beach profile); and
- No traffic survey to confirm traffic counts has been carried out.

2.5 Estimated Dates for Site Abandonment

The estimated dates for when each Site will be unsafe for use has been provided in previous reports. These are identified in **Figure 7**. These dates have been taken into consideration in this assessment.

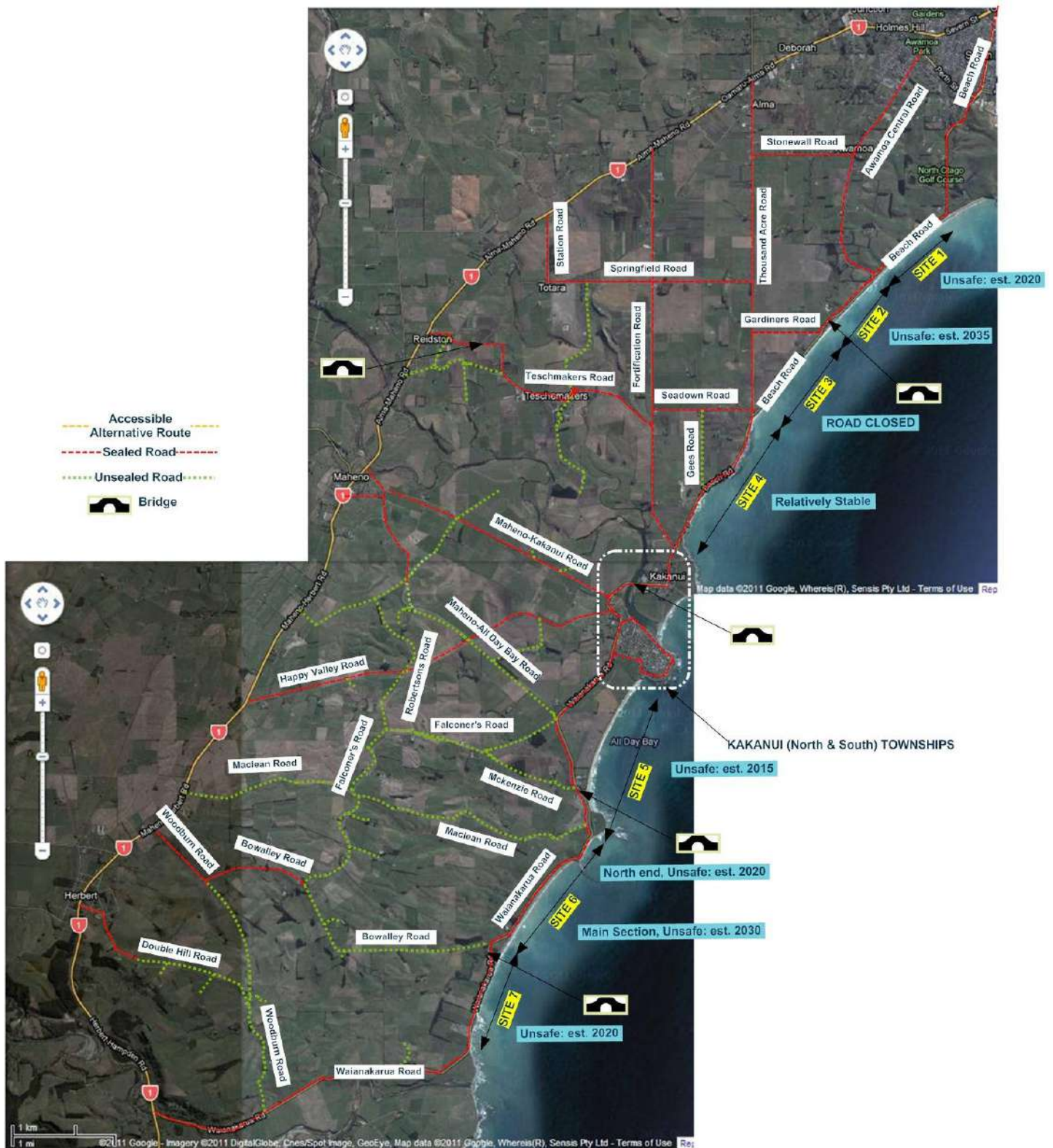


Figure 7: Coastal route with estimated dates for when erosion is likely to result in each site becoming unsafe

2.6 Traffic Counts

This section of Waitaki District Council's roading network is used by residents, the local community and tourists. There are a number of farms which result in farm vehicles and milk tankers using the roads between SH1 and the coastal road.

The traffic counts used in the economic analysis are shown in **Figure 8**. These have been taken from the Waitaki District Council's RAMM Information. The background behind the counts, to indicate the direction of travel, is not known. From the traffic counts it is evident that the coastal routes are used as the primary link between Oamaru and Kakanui, for the case of Beach Road, and Kakanui and the state highway, for the case of Waianakarua Road.

It is expected that the majority of traffic on these routes is local traffic accessing properties in Kakanui with a smaller proportion of tourist traffic and day trippers travelling from Oamaru to the recreational attractions in Kakanui and All Day Bay.

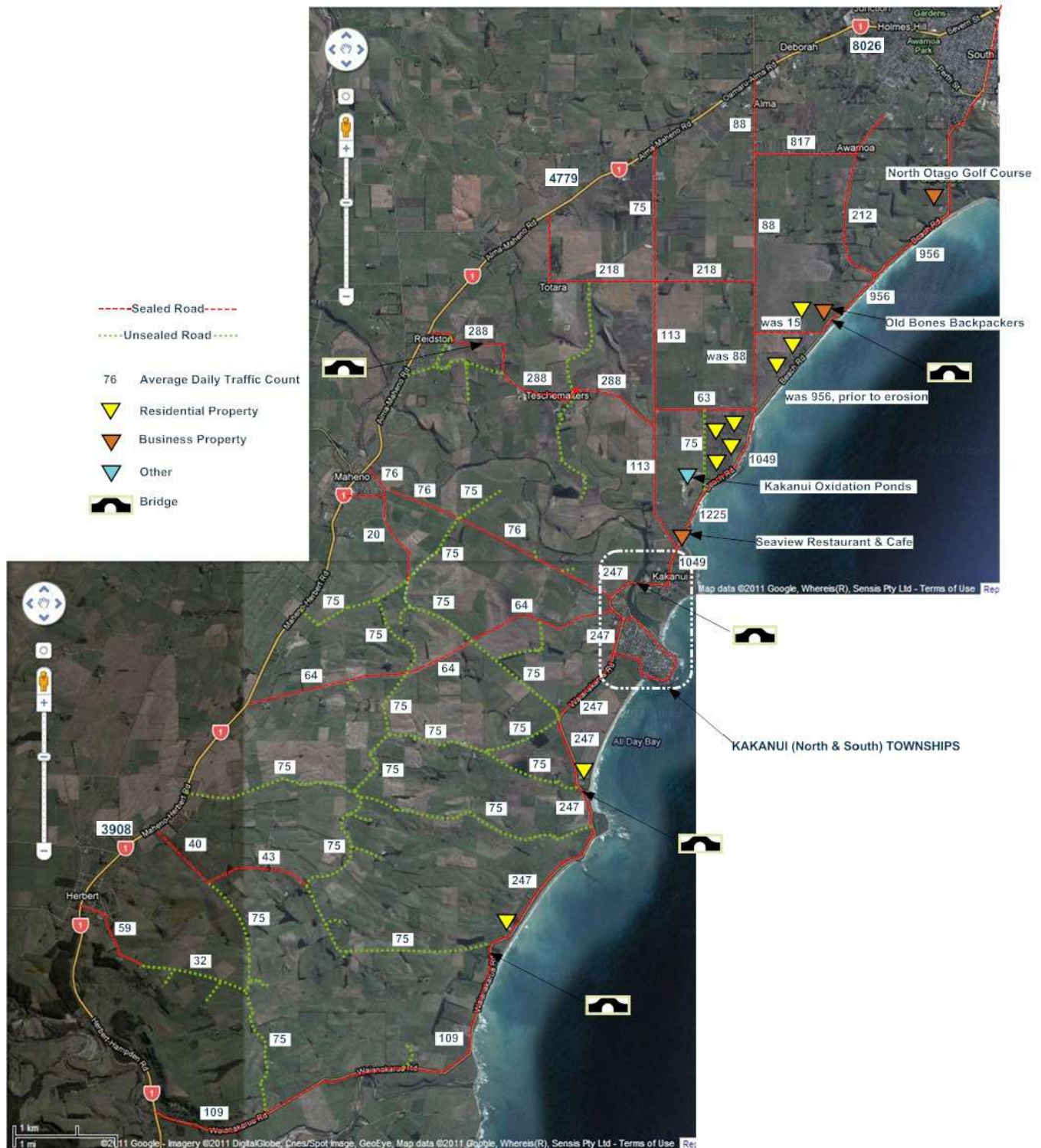


Figure 8: Average Annual Daily Traffic counts for the surrounding road network extracted from the RAMM database. SH 1 traffic counts have been taken from the NZTA traffic data booklet for year 2009

3 Cost Estimates

3.1 Costing of Coastal Protection Works

Although there are a myriad of coastal protection methods available, this economic assessment has been based on the construction of a seawall (with a random rock protection structure) as has been installed previously at the southernmost end of Waianakarua Road.

The 100m section of seawall was constructed in 2007 and cost approximately \$3,000 per lineal metre. This structure consists of an armour rock apron, extending down the beach, upon which a three tier gabion wall was constructed.

The cliff face at this location is higher than normal along this section of coastline due to its proximity to the promontory where the ground levels are somewhat higher. For future seawall construction a seawall of a lesser height may be able to be used which would reduce the cost of construction.



Figure 9: Seawall construction, southern end of Waianakarua Road

A David Hamilton & Assoc, report dated 2000⁴ suggests a seawall construction rate of \$520/lm.

A GHD report dated 2007⁵ suggests a seawall construction rate of \$2,300/lm.

An OCEL Consultants report dated 2009⁶ suggests a seawall construction rate of \$3,000/lm.

The size and type of construction for each section of future seawall needs to be decided to suit the local circumstances. For the purpose of this report a seawall construction rate up to \$6,000/lm has been adopted depending on the local site conditions, with a higher rate used where the road is positioned at a higher level above the beach.

Random-rock protection structures function by absorbing wave energy as the waves swirl around and between the rocks. When these structures are first constructed this wave action flushes the sand and shingle out from under the rocks causing them to settle into the beach. These rocks may be thought of as 'lost' but are, in fact, forming a solid foundation for the structure. An alternative method of construction is to dig a trench along the alignment of the seawall and fill this with rock to form a foundation from the outset. In addition, the force of water moving between the rocks can be sufficiently forceful to pluck rocks out of the structure, causing them to be dragged back down the beach as the wave retreats.

When constructing random-rock protection structures sufficient rock must be placed to:

- Allow for a rock foundation under the beach level
- Allow for the loss of rocks lost down the beach

⁴ Beach Road Coastal Protection, October 2002, David Hamilton & Associates Ltd. Dunedin

⁵ Preliminary Report on Coastal Erosion Waianakarua Rd and Beach Rd, November 2007. GHD

⁶ Coastal Road Protection Options Report for Beach Road and Waianakarua Rd, May 2009, OCEL Consultants NZ Ltd., Christchurch

- Be sufficiently substantial to absorb the wave energy within the structure

In addition, the sea water swirling around and between the rocks will contain beach sand and stones in suspension; this has a sand blasting effect on the rocks, and will slowly erode them away. Occasional top-ups of new rock will be required to replace this loss.

Random-rock structures must be substantial and occasional replacement of rock must be expected.

3.2 Maintenance Costs

Both the OCEL Consultants report and David Hamilton & Assoc reports recommend that 5% of the construction cost of seawalls should be budgeted annually for ongoing maintenance and repairs. This has been included in the cost estimates.

3.3 Costing of works associated with Site Abandonment

For the option of abandoning a site once the erosion is at a level that the carriageway is unsafe to use, alternative routes have been identified. The costs associated with this option include:

- The reconfiguration of the roading layout at the end of the site to provide suitable continuous trafficable lanes (which was previously likely to have been an intersection layout); and
- The upgrading of the alternative route (refer to **Section 3.4**) as appropriate.

For the reconfiguration works, an estimated cost of \$30,000 has been allowed per location. This is to include the necessary minor superelevation works and boundary fencing, barriers for the road closure, and signage.

Where the site does not end at an intersection, an estimated cost of \$40,000 has been allowed per location, for the formation of a turning bay.

No allowance has been considered for any land purchase, or for the removal of the abandoned carriageway materials.

3.4 Costing of Roading Upgrades

For the individual sites, an alternative route has been identified which utilises adjacent existing roads. For these routes, where the existing road does not meet current Policy requirements for Local Roads, an estimated cost has been calculated for widening, reshaping and sealing works.

In accordance with the Waitaki District Council's Roading Policy (2008), for Local Roads:

"Seal Width (where sealed) 5.5m on straights, 6.5m length with poor visibility, low traffic rural standard for structures, pavement marking only where there is poor visibility."

For the purposes of this assessment, where existing unsealed roads are the suggested alternative route (should the existing coastal road be abandoned), costings have been estimated which include widening the carriageway to 5.5m and sealing the carriageway.

It should be noted that this cost of upgrade has been included for each identified site, but may not be a preferred solution due to current/likely low traffic volumes. For the economic analysis these upgrades have not been deemed an economical solution as other alternative routes are available, and are therefore not included. The upgrade costs have been identified for information purposes.

4 Sites 1 to 7

4.1 Site 1 – Beach Road (Golf Club Bend) to Awamoa Central Road

4.1.1 Description of Site 1

Site 1 commences where Beach Road meets the coastline at Golf Club bend, and heads south to the intersection with Awamoa Central Road.

Coastal cliffs are 14m high as they abut the Cape Wanbrow peninsula, and decrease in height as the coastline heads south.

The coast road is located at the top of the cliff. The line of the cliff is irregular and in several places the top edge is in close proximity to the road edge.

At the north end, the beach is wide and marram grass has established along the landward area. Heading south, the beach narrows progressively, and the wave run-up reaches the base of the cliff.

There are no properties/dwellings using this section of Beach Road for access. (Refer to **Appendix B** for Landownership and access information.)

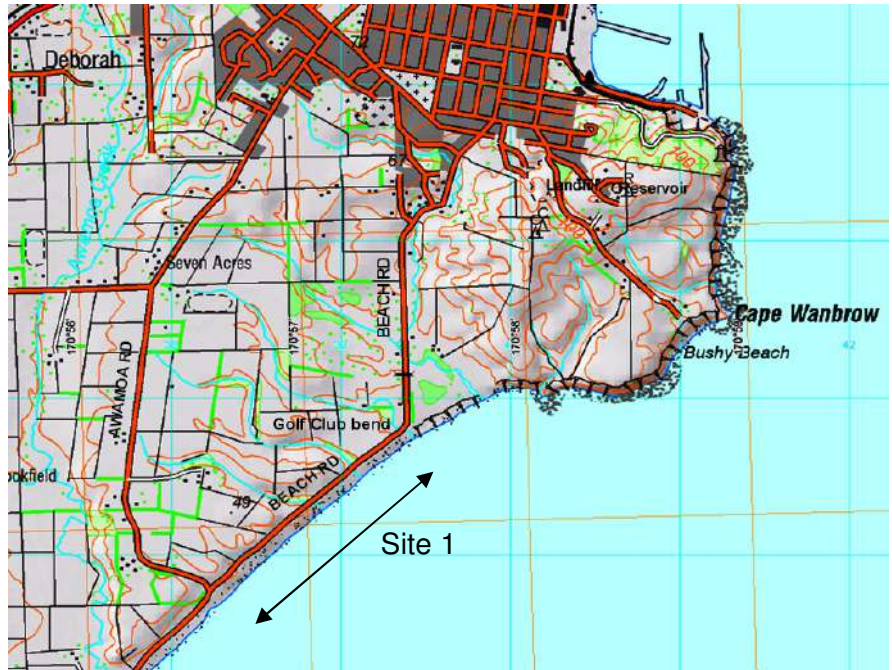


Figure 10: Site Map – Site 1



Figure 11: Aerial Photograph of Site 1



Figure 12: Site 1 – Southern end, looking north

4.1.2 Coastal Erosion Issues

Site 1 is directly south of Cape Wanbrow. Beach sand and shingle carried north by littoral drift will have its passage blocked by the Cape and will accumulate at this site. The gradual widening of the beach from south to north tends to confirm this. The establishment of marram grass along the rear of the beach at the northern half of this site indicates that it is not often inundated by wave run-up. However, no significant sand dune ridges have formed and the beach generally has a low profile.

The coastal cliff is about 50% covered by vegetation. Again the presence of the vegetation would appear to indicate that the cliff is stable.

However, this site has a long term rate of erosion of 0.5m per year and Beach Road has been moved inland on two previous occasions. Therefore from a historical perspective, there are erosion vulnerability concerns about this site. The existing road is again very close to the cliff edge.

This site gives the impression of having been subject to severe erosion in the past but is currently going through a period of calm. A severe sea storm could do considerable damage at this site.

The cliff edge is nearest to the road at locations where there are gullies/culverts. Should protection works be staggered over a number of years, these three locations should be investigated further, as being the first areas of work.

Previous reports estimate that the road will become unsafe due to erosion in 2020.



Figure 13 Site 1 – Irregular cliff face close to road edge

4.1.3 Coastal erosion protection of the existing road

Wave run-up reaches the base of the coastal cliff along the southern portion of this site. It is certain that erosion is occurring to some degree. Further north the beach is wider and wave run-up does not reach the cliff base, however this section of cliff is still considered vulnerable to erosion.

The length of coast requiring protection is 1.6km.

The summary of estimated costs is as follows:

SITE 1: Protection Works	\$ 9,600,000
Associated Maintenance*	\$ 8,640,000
Total Cost	\$ 18,240,000
Total Present Value (PV)*	\$ 6,534,000

** This is based on a 30 year assessment period, with protection works being carried out from year 2-24.*

Further breakdown is included as **Appendix C**.

4.1.4 Utilising other roads in the vicinity

There is no convenient route to circumvent Site 1 on its own. If the road is eroded beyond safe use, Awamoa Central Road and the inland section of Beach Road can be used for access to Oamaru, without the need for any upgrade works. Both roads are sealed. There is therefore no cost associated with upgrading these existing alternative routes.

Abandonment of the coastal section of Beach Road however, will have costs associated with signage and barriers to prevent vehicles from using the road. For the economic assessment, the estimated cost for this is \$70,000. This includes installation of a turning head south of the North Otago Golf Course, and a configuration change at the current intersection of Awamoa Central Road and Beach Road.

The summary of estimated costs is as follows:

SITE 1: Capital Works	\$ 70,000
Total PV*	\$ 37,800

** This is based on a 30 year assessment period, with the works being carried out in year 8.*



Figure 14: Alternative route – Site 1

4.2 Site 2 – Awamoa Central Road to Gardiners Road

4.2.1 Description of Site 2

The high coastal cliffs continue south from the Beach Road/Awamoa Central Road intersection, with the carriageway positioned along the cliff top and about 15m from its edge. The cliff consists of loess clay and is eroding to varying degrees along its length. Limestone boulders have been placed along the foot of the cliff but are too few to be effective.

Approximately 800m south, the road veers inland about 80m to cross a bridge over the Awamoa Creek. On the north side of the bridge a length of limestone random-rock seawall has been constructed to protect the road adjacent to the bridge approach.

Between the road and the ocean is the Kakanui Beach Road Reserve. The Reserve is used as a rest area and picnic spot. The coastal bank around the Reserve is very low. Note: The 'coastal bank' is defined as the sandstone, clay or gravel cliff or embankment at the landward edge of the beach and which defines the boundary between terrestrial and marine erosion processes.



Figure 15: Site Map – Site 2

The intersection of Beach Road and Gardiners Road, where the inland section returns to the coast, designates the southern boundary of Site 2.

There are two properties/dwellings which are accessed from this section of Beach Road. Both are part of the Old Bones Backpackers which is situated to the south of the Awamoa Creek Bridge. (Refer to **Appendix B** for Landownership and access information.)



Figure 16: Aerial Photograph of Site 2

4.2.2 Coastal Erosion Issues

The lack of a coastal bank at Awamoa Creek makes the area vulnerable to coastal erosion, but more probably in the short term, to inundation during sea storm events. The elevation of the bridge across Awamoa Creek seems to be particularly low compared to the adjacent beach crest and the bridge could also be threatened.

The random-rock seawall near the northern Awamoa Creek bridge approach is quite substantially built compared to others. This wall has been topped-up with additional rock at least once.

Erosion of the loess cliff north of the seawall is actively occurring.

Previous reports estimate that the road will become unsafe due to erosion in 2035.



Figure 17: Site 2 – Mouth of Awamoa Creek



Figure 18: Site 2 – Active erosion of cliff face

4.2.3 Coastal erosion protection of the existing road

The high historical rate of erosion at this site and the highly erodible clay composition of the coast cliff make this a very vulnerable site.

Active erosion of the coastal cliff is occurring along virtually the full 0.9km length of coastline along this site. The remaining 300m is the frontage of Kakanui Beach Road Reserve where the road is behind the Reserve. The cost of protection works for Site 2 is therefore \$2,700,000.

The distance from the cliff face to the road verge is typically 15m, with a long term erosion rate of 0.5 m/yr the road will theoretically be threatened in 30 years. It is therefore not considered necessary to protect this site immediately; however lateral instability of the cliff face could reduce this timeframe considerably.

It is recommended that, subject to no identification of earlier erosion to that predicted, protection measures are installed in 300m sections every two years, commencing in year 20.

The summary of estimated costs is as follows:

SITE 2: Protection Works	\$ 2,700,000
Associated Maintenance*	\$ 675,000
Total Cost	\$ 3,375,000
Total PV*	\$ 505,000

**This is based on a 30 year assessment period, with protection works being carried out from year 20 to 30.*

Further breakdown is included as **Appendix C**.

4.2.4 Utilising other roads in the vicinity

There is no convenient route to circumvent Site 2 on its own. If the road is eroded beyond safe use however, other existing roads give direct access to Oamaru, without the need for any upgrade works. These include Awamoa Central Road, Gardiners Road and Thousand Acre



Figure 20: Site Map– Site 3



Figure 21: Aerial Photograph



Figure 22: Site 3 - Corner of Beach Road & Gardiners Road, with the newly configured roading layout



Figure 23: Site 3 – Significant damage to Beach Road



Figure 24: Site 3 - Beach Road closure at the southern end

4.4 Site 4 – Thousand Acre Road to Kakanui

4.4.1 Description of Site 4

From its intersection with Thousand Acre Road, Beach Road continues to the northern fringe of Kakanui to its intersection with High Street and Tyson Street. This section is a distance of 2.8km.

For the majority of Site 4, the road follows the cliff edge. At a point approximately 460m north of Tyson Road, the road is situated atop a 20m high cliff with the sea beneath. From here the road heads inland to Kakanui.

The cliffs consist of a sandstone strata overtopped by loess clay deposits. Along the coastline the sandstone strata extends to about 5m above the mean water level. Kelp beds observed on aerial photographs indicate that this strata extends offshore as submerged platforms, particularly off the headlands at each end of the Site.

The cliff line along the coast consists of a series of scallops each containing a small sand and shingle beach.

There are two properties using this section of Beach Road for access and there is an accessway to the Oxidation Ponds. (Refer to **Appendix B** for Landownership and access information.)

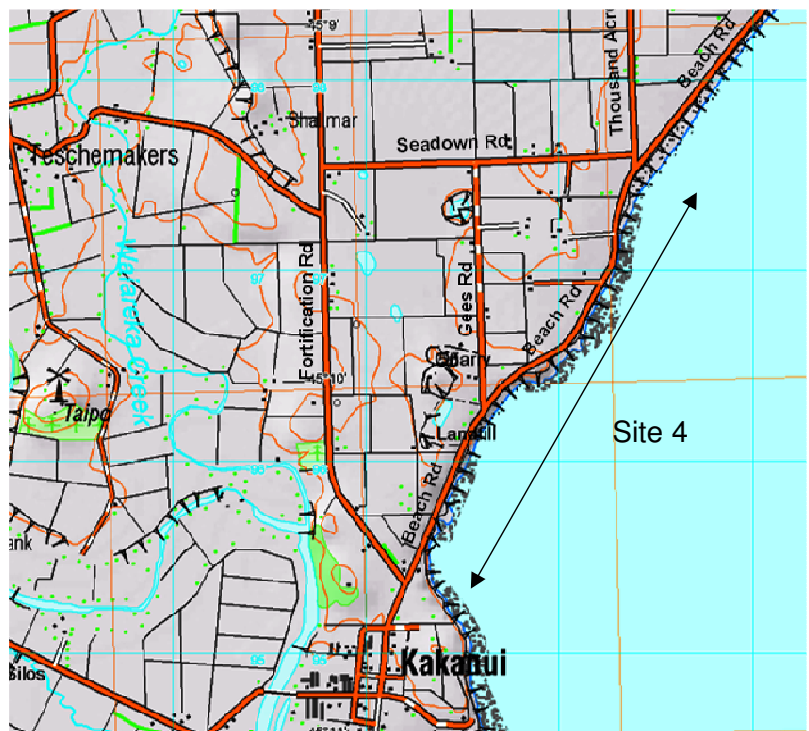


Figure 25: Site Map – Site 4



Figure 26: Aerial Photograph of Site 4

4.4.2 Coastal Erosion Issues

This section of coast fortunately has a sandstone strata located at the correct elevation to resist wave attack of the shoreline. Minor variations in the hardness of the sandstone has caused differential erosion resulting in a series of miniature bays and headlands. In several locations the upper edge of the cliff is in close proximity to the edge of Beach Road. This is particularly evident on the section of coastline adjacent to Kakanui's oxidation ponds.

Submerged reefs are able to 'trip-up' waves causing them to break and in so doing dissipate much of their energy. This section of coast is also orientated directly transverse to storm waves approaching from the South-East.

The existence of mature native vegetation over the upper cliff faces suggests that no subsidence of the cliff has occurred in the recent past. However there are several locations where past erosion of the sandstone strata or steep gully erosion of the clay face of the cliff has caused the cliff edge to approach near to the road verge.

Previous reports do not give an estimate for when the road will become unsafe due to erosion. The reports however, do recommend that the cliff erosion be monitored.



Figure 27: Site 4 - View looking South toward Kakanui

4.4.3 Coastal erosion protection of the existing road

No active coastal erosion was observed at this Site and Beach Road is not considered to be under threat. Future coastal erosion is likely to take the form of erosion of the sandstone strata at the base of the cliff or slumping of the clay cliffs themselves. Long term monitoring of coastline should be carried out to identify the extent of these events and to give warning of any impending threat to Beach Road. The comparison of photographs taken from fixed positions and orientations at, say 6 monthly intervals, will after a few years, provide useful information on the long term stability of the coastal cliffs and may establish long term trends.

4.4.4 Utilising other roads in the vicinity

NOTE: Site 4 is not expected to erode to such a level as to make the road unsafe during the period of time for which this assessment is being carried out. The following information has been provided as an indication of what could be provided in the future.

Should Site 4 need to be abandoned, Fortification Road and Seadown Road provide an alternative sealed road route to this section of Beach Road. Both are single coat sealed roads. If a second coat seal is deemed necessary, then the estimate of cost is \$155,000. Traffic heading to Oamaru can, alternatively, continue along Fortification Road to State Highway 1 and hence to Oamaru.

In order to prevent use of the abandoned section of Beach Road, the intersection with Seadown Road/Thousand Acre Road and the intersection with Fortification Road would require reconfiguration. For the economic assessment, the estimated cost for this is \$60,000.

The summary of estimated costs is as follows:

SITE 4: Capital Works	\$ 215,000
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No PV has been provided as the timing of these works is beyond the period of this assessment.



Figure 28: Alternative route – Site 4

4.5 Site 5 – Kakanui to Maclean Road

4.5.1 Description of Site 5

From Kakanui, Waianakarua Road remains inland until just after the bridge which passes over the Ore Creek lagoon. Here it descends onto a narrow strip of land between the Ore Creek lagoon and the end of the All Day Bay coastline, known as the Ore Creek Causeway. There is a rest area at this location.

At the end of the causeway, the road becomes further from the coastline as it travels along Ore Point.



Figure 29: Site 5

There are no properties/dwelling with access from this section of the coastal road. (Refer to **Appendix B** for Landownership and access information.)



Figure 30: Aerial photograph of the southern portion of Site 5

4.5.2 Coastal Erosion Issues

The causeway adjacent to the Orore Creek lagoon will be partially protected from wave action by Orore Point and its offshore reef. However, this causeway must still be considered vulnerable to erosion from both coastal erosion and by flood flows in the Orore Creek. Loss of the causeway would cause significant problems as the only alternative route would be a new road around the inland side of the lagoon.

The resistance of the causeway depends significantly on its geological composition. Bars across river and creek mouths on the South Canterbury and North Otago coastlines are formed by the littoral drift of beach shingle. The mouth of the Kakanui River is a good example. These bars can be easily eroded and overtopped in storm events. Inspection of the causeway indicates that it consists only of loose sand and shingle rather than the much more resistant volcanic rock or sandstone that forms Orore Point nearby.

The southern end of the causeway appears to be particularly prone to breach due to the marram grass covered sand dunes, present at the northern end, being absent. The wave run-up height on the beach at the southern end is higher than the height of the adjacent road.

Previous reports estimate that the road will become unsafe due to erosion in 2015.



Figure 31: Site 5 - Causeway at the mouth of Orove Creek - Looking South. This shows the seaweed and debris washed up to underneath the trees during rough seas. Waianakarua Road is behind the trees and at a slightly lower level.

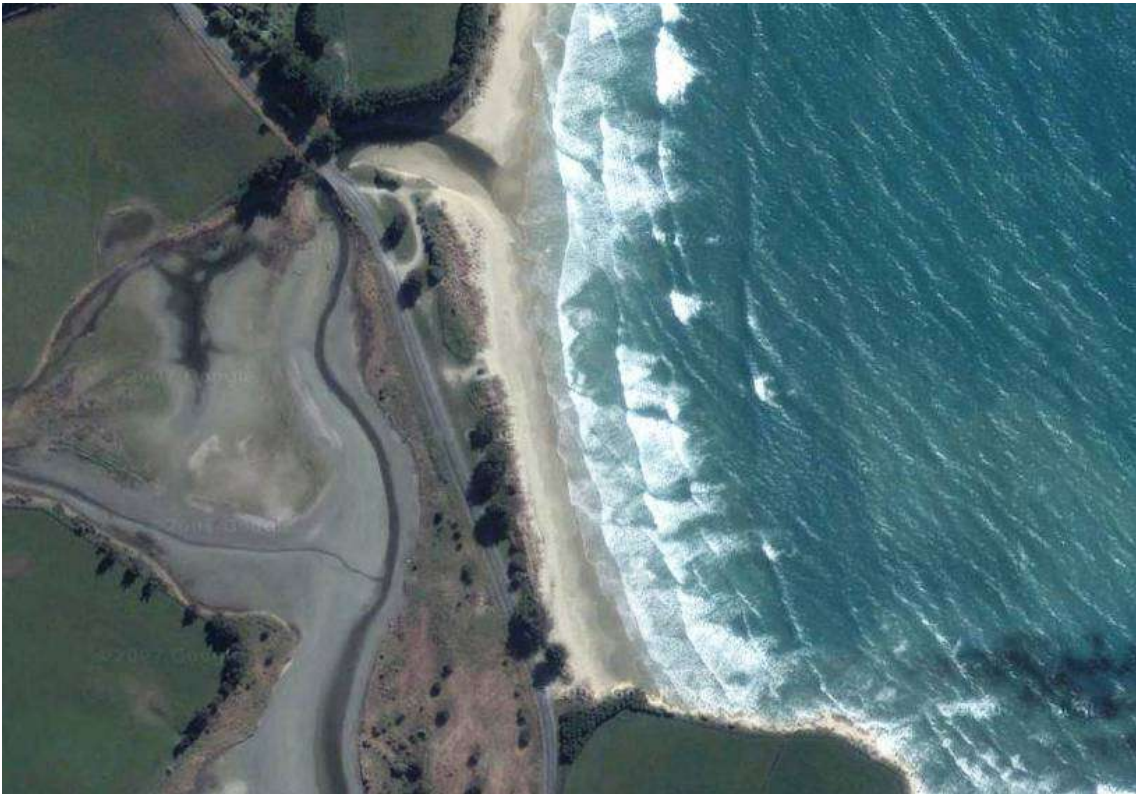


Figure 32: Aerial Photograph of Orove Creek Causeway at the southern end of All Day Bay

4.5.3 Coastal erosion protection of the existing road

The length of beach fronting the causeway from the northern flank of the Orere Point to the Orere Creek mouth is 350m. Assuming some protection is also required on the north side of the creek mouth then the total length of protection works is say 400m. This section does not have cliffs, such that protection measures will not be as extensive as in other locations. Therefore an estimate cost of \$1,000/m has been used.

It is also recommended that the sand dunes on the causeway are preserved and that gaps in them are filled with beach sand and planted with marram grass, particularly at the southern end.

It is recommended that protection measures are installed in 100m sections along this section at, say 10 year intervals.

The summary of estimated costs is as follows:

SITE 5: Protection Works	\$ 400,000
Associated Maintenance*	\$ 290,000
Total Cost	\$ 690,000
Total PV*	\$ 240,800

**This is based on a 30 year assessment period, with protection works being carried out from year 2 to 30.*

Further breakdown is included as **Appendix C**.

4.5.4 Utilising other roads in the vicinity

The nearest alternative route is a circuitous one extending about 4km inland. It follows Maclean Road, Falconers Rd and McKenzie Road, a total distance of 8km. This alternative bypasses 750m of abandoned road.

It is likely that much of the traffic heading south, does so from Kakanui. For this assessment, it is assumed this traffic would use the sealed Happy Valley Road if Waianakarua Road was abandoned.

Traffic from the south could head along Maclean Road to SH1, and then continue north. However, Maclean Road is unsealed, and the estimated cost to upgrade it is \$1,500,000. This cost is significant and is not considered to be warranted given the low traffic volumes and readily available alternative sealed routes.

Abandonment of this coastal section of Waianakarua Road will have associated costs to prevent vehicles from using the road. For the economic assessment, the estimated cost for this is \$60,000. This is for a configuration change at the two current intersections with McKenzie Road and Maclean Road.

The summary of estimated costs is as follows:

SITE 5: Capital Works	\$ 60,000
Total PV*	\$ 47,630

** This is based on a 30 year assessment period, with the works being carried out in 2014, 1 year ahead of when Site 5 is predicted to be unsafe to use.*



Figure 33: Alternative route – Site 5

4.6 Site 6 – Maclean Road to Bowalley Road

4.6.1 Description of Site 6



Figure 34: Site Map – Site 6

At the intersection of Waianakarua Road and Maclean Road, the road is inland due to the large headland called Ore Point. From here, Waianakarua Road heads to the coastline, and runs adjacent to it for 400m around a bay.

The road then travels over another headland called Bridge Point which is protected by an offshore reef. Returning back to the coast, the road runs parallel to the coastal bank for 1.6km, before heading inland for 370m to its intersection with Bowalley Road.

There are no properties/dwelling with access from this section of the coastal road. (Refer to **Appendix B** for Landownership and access information.)



Figure 35: Aerial Photograph of Site 6

4.6.2 Coastal Erosion Issues

The 300m section of road adjacent to the beach at the north end of this Site, north of Bridge Point, is under immediate threat of erosion damage. The coastal cliff face is located directly adjacent to the road shoulder. The photograph below shows Bridge Point in the background, created by the sandstone reef extending out to sea (also visible on the aerial photograph of this Site). Recent slumping of the clay bank in the middle-ground of the photograph indicates active erosion in this area, contributed to by the absence of the sandstone strata at this location. Some minor protection works are shown in the foreground which does appear to be having some effect.



Figure 36: Site 6 Northern Beach – Looking South, Active bank erosion

The long beach (Te Hakapureirei) that takes up most of Site 6 has a buffer of at least 10m between the road edge and coastal bank. There is vegetation growing down the bank which indicates that it is not being actively eroded. The photograph below shows a stratum of sandstone exposed at the base of the bank and this will be providing protection against wave action. Some rock protection work to check an isolated pocket of erosion is shown in the foreground.

Earlier coastal erosion reports do not mention issues at this beach so the overall impression is that it is relatively stable. There are four minor gullies in the coastal bank where natural land stormwater run-off discharges onto the beach. Protection works may be necessary at these gullies in the future, due to either run-off flood damage or storm sea surges being channelled up these gullies and putting the road at risk.

Previous reports estimate that the road will become unsafe due to erosion in 2020 for the northern section, and in 2030 for the southern section.



Figure 37: Site 6 Southern Beach – Looking North, Sandstone strata present at base of coastal bank

4.6.3 Coastal erosion protection of the existing road

The existing rock placement work in the bays does appear to be providing some protection to the toe of the clay bank and could be an economic method to slow down erosion at this location. The placing rock along the toe of the coastal bank at other locations could extend the life of the cliffs, but this is considered a short term measure (and has not been included in the costings).

The coastal bank along the beach south of Bridge Point appears to be stable and no action is required at this location.

The first 300m of the 400m bay at the north end of the Site is under immediate threat of erosion damage. This could be protected in the first year, with the remainder completed at a later time.

It is recommended that protection measures are provided at the 4 minor gully locations along the 1.6km section parallel to the coastline.

The summary of estimated costs is as follows:

SITE 6: Protection Works	\$ 2,400,000
Associated Maintenance*	\$ 2,745,000
Total Cost	\$ 5,145,000
Total PV*	\$ 2,342,300

**This is based on a 30 year assessment period, with protection works being carried out from year 1 to 20.*

Further breakdown is included as **Appendix C**.

4.6.4 Utilising other roads in the vicinity

The northern section of this site is predicted to be unsafe to use 10 years in advance of the southern section. A two stage approach to closure is therefore proposed for this assessment.

There is no short detour route available once the first (and both) sections are abandoned. The alternative route is to use Maclean Road at the north end, and Bowalley Road at the south end. Maclean Road is unsealed for its full length, and Bowalley Road is unsealed for approximately two thirds of its length, after which it is sealed, and leads on to Woodburn Road (also sealed). Clareview Road could be utilised if a shorter detour is preferred, but this is also unsealed.

The estimated cost to upgrade and seal these roads is \$1,600,000 for Maclean Road and \$750,000 for Bowalley Road. Even if the widening component of these upgrades was not to be carried out, the cost is significant and is not considered to be warranted given the low traffic volumes and readily available alternative sealed routes.

Abandonment of the coastal section of Waianakarua Road will have associated costs to prevent vehicles from using the road. For the economic assessment, the estimated cost for this is \$80,000 for Stage 1, and \$40,000 for Stage 2. This includes the installation of turning heads at each end of the closed section for Stage 1, and one turning head at the southern end of the closed section for Stage 2.

The summary of estimated costs is as follows:

SITE 6: Capital Works	\$ 120,000
Total PV*	\$ 53,200

** This is based on a 30 year assessment period, with Stage 1 of the works being carried out in 2019, and Stage 2 in 2029 (each 1 year ahead of when that section of Site 6 is predicted to be unsafe to use).*



Figure 38: Alternative route – Site 6

4.7 Site 7 – Bowalley Rd to State Highway 1

4.7.1 Description of Site 7

At the northern end of Site 7, Waianakarua Road is approximately 360m inland from the coastline at its intersection with Bowalley Road. The road crosses the Bow Alley Creek via a single lane timber bridge just south of this intersection. The bridge is weight restricted.

Waianakarua Road then heads towards the coastline over the next 400m, and runs parallel to it for the next 600m. Just as the road meets a promontory, it is located immediately adjacent to the coastal bank. Here, a 100m long section of seawall was required to be urgently constructed in 2007 following a storm event.

The road heads inland along the promontory for 250m, reaching a distance of 75m from the coastline. This coastline is partially protected from erosion by an offshore reef. Beyond the promontory, it runs adjacent to the coastal bank for 300m before veering inland.

Waianakarua Road heads west and meets State highway 1 about 4km south of Herbert.

There are no properties/dwelling with access from this section of the coastal road. (Refer to **Appendix B** for Landownership and access information.)



Figure 39: Site Map – Site 7



Figure 40: Aerial Photograph – Site 7



Figure 41: Site 7: Bridge over Bow Alley Creek just south of the intersection with Bowalley Road



Figure 42: Site 7 - The Section of Seawall built in 2007

4.7.2 Coastal Erosion Issues

The seaward shoulder of the road is currently within 8m of the adjacent coastal bank along two sections totalling 400m in length. This length of road is under immediate threat of damage from storm events.

A further 600m of road shoulder is currently in the 8m to 16m distance range from the adjacent coastal bank, this length of road will probably come under threat within the next decade.

Previous reports estimate that the road will become unsafe due to erosion in 2020.

4.7.3 Coastal erosion protection of the existing road

The two sections totalling 400m in length need protection measures installed as soon as possible. Previous consenting conditions have only allowed for a maximum of 295m of retaining measures to be installed each year. Therefore, unless changes to the consenting conditions is granted, work at this location would need to be carried out over a two year period.

It is recommended that the remaining 600m be protected at a construction rate of 100m of seawall every two years. This will protect the sections of road where the road shoulder is currently in the 8m to 16m distance range from the coastal bank.

The total construction period for the seawall is therefore fourteen years and the total construction cost is \$3,000,000.

The Bow Alley Creek bridge is weight restricted due to the poor condition of the existing piles and abutments. The Waitaki District Council has estimated the cost to replace the bridge at \$450,000.

The summary of estimated costs is as follows:

SITE 7: Protection Works	\$ 3,450,000
Associated Maintenance*	\$ 3,712,500
Total Cost	\$ 7,165,500
Total PV*	\$ 3,470,700

**This is based on a 30 year assessment period, with protection works being carried out from year 1 to 14.*

Further breakdown is included as Appendix C.

4.7.4 Utilising other roads in the vicinity

Waianakarua Road forms the southern leg of the coastal scenic route starting at Oamaru. Woodburn Road and Bowalley Road could be upgraded to cater for this through traffic. The section of Bowalley Road between Clareview Road and Waianakarua Road, 3.5km long, is currently unsealed.

The full upgrade of these roads will cost approximately \$876,000. Even if the widening component of these upgrades was not to be carried out, the cost is significant and is not considered to be warranted given the low traffic volumes and readily available alternative sealed routes.

The inland section of Waianakarua Road will not require upgrade works, and is currently sealed.

Abandonment of the coastal section of Waianakarua Road, however, will have associated costs to prevent vehicles from using the road. For the economic assessment, the estimated cost for this is \$80,000. This includes installation of a two turning heads: one south of the bridge just before the road meets the coastline; and one at the end of the east-west section of Waianakarua Road just before it meets the coast.

The summary of estimated costs is as follows:

SITE 7: Capital Works	\$ 80,000
Total PV*	\$ 43,222

** This is based on a 30 year assessment period, with the works being carried out in 2019, 1 year ahead of when Site 7 is predicted to be unsafe to use.*

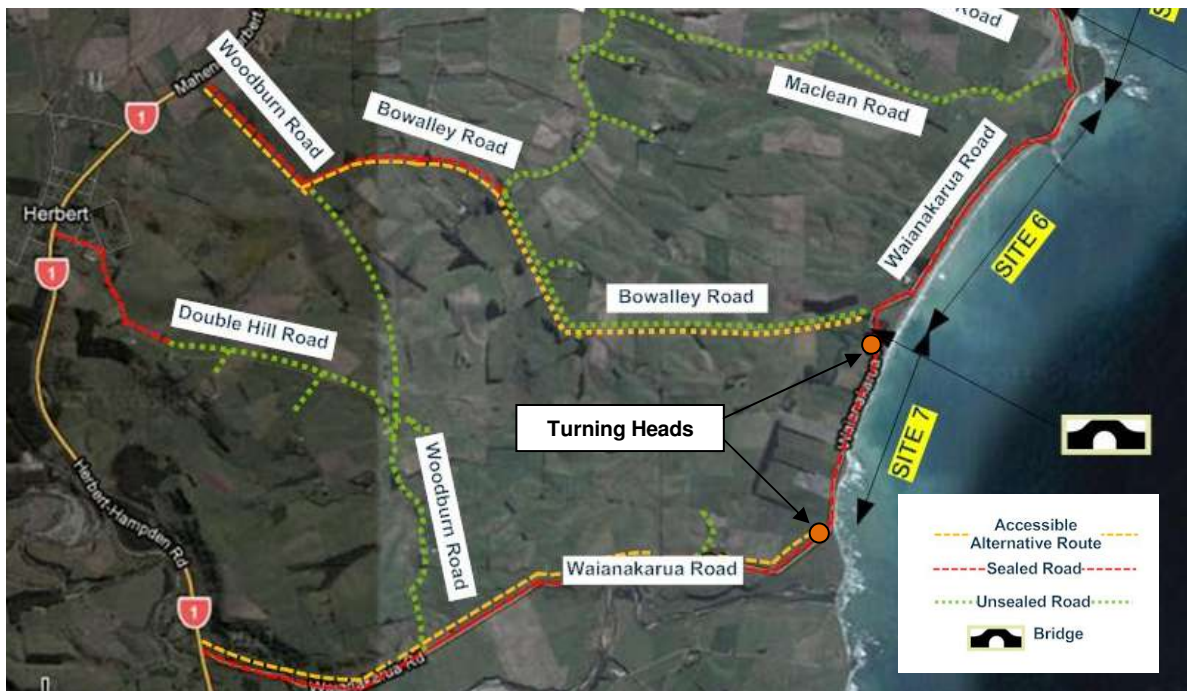


Figure 43: Alternative route – Site 7

4.8 Summary of Costs

A summary of the cost estimates is given in **Table 2**:

	Protect			
	Capital Cost	Maintenance Cost	Total	Discounted Total
Site 1	\$9,600,000	\$8,640,000	\$18,240,000	\$6,534,000
Site 2	\$2,700,000	\$675,000	\$3,375,000	\$505,000
Site 3	\$0	\$0	\$0	\$0
Site 4	\$0	\$0	\$0	\$0
Site 5	\$400,000	\$290,000	\$690,000	\$240,800
Site 6	\$2,400,000	\$2,745,000	\$5,145,000	\$2,342,300
Site 7	\$3,450,000	\$3,712,500	\$7,162,500	\$3,470,700

	Abandon			
	Capital Cost	Maintenance Cost	Total	Discounted Total
Site 1	\$70,000	\$0	\$70,000	\$35,000
Site 2	\$70,000	\$0	\$70,000	\$11,900
Site 3	\$0	\$0	\$0	\$0
Site 4	\$0	\$0	\$0	\$0
Site 5	\$60,000	\$0	\$60,000	\$44,100
Site 6	\$120,000	\$0	\$120,000	\$49,300
Site 7	\$80,000	\$0	\$80,000	\$40,000

Table 2: Summary of costs for coastal protection works and abandonment works

Note these are the costs associated with each site in isolation to the others. These ‘abandon’ costs do not allow for the upgrade of alternative routes.

5 Economic Analysis

5.1 Basis of Analysis

The northern section of the coastal road (Sites 1 to 4) currently forms the primary route between Oamaru and the township of Kakanui (via Beach Road) with approximately 1,225 vehicles/day on this route (refer **Figure 8**). Likewise, the coastal road south of Kakanui (Sites 5 to 7) forms the most direct link between the Kakanui township and the state highway for vehicles travelling to/from the south. Approximately 250 vehicles/day use this route. It is expected that this is primarily traffic travelling to/from Kakanui with only a small volume of traffic travelling the full length of the coastal road between Oamaru and the state highway.

Given the distinct change in traffic volumes north and south of Kakanui, the coastal route has been separated into two sections for the purposes of the economic analysis:

- I) Northern Section (Sites 1 to 4)
- II) Southern Section (Sites 5 to 7)

For each section above, travel time costs, vehicle operating costs and accident costs have been calculated in accordance with the NZ Transport Agency's Economic Evaluation Manual. This has been undertaken for travel between Oamaru and Kakanui, for the case of the northern section, and between Kakanui and State Highway 1, for the case of the southern section. For each section, the coastal road routes (Beach Road or Waianakarua Road) and alternative inland routes have been assessed.

Travel time costs have been based upon an assumed average speed of 0.885 of the posted speed limit and have not included for delays at intersections. Accident costs have been based upon a midblock analysis of the road sections using the General Urban Midblock 50-70 km/hr, or the Rural Two Lane Road ≥ 80 km/hr accident prediction model, as appropriate. The accident history of the site has not been incorporated in the accident costs for the purposes of the economic analysis.

Key analysis parameters are detailed below:

- Time zero: 01/07/2011
- Discount rate: 8%
- Traffic growth: 2%

Full details of the economic analysis are provided in **Appendix D**.

5.2 Routes Assessed

The routes assessed are detailed in **Figure 44** and **Figure 45** with a summary of the assessed travel time, vehicle operating costs and accident costs for each route provided in **Table 3**. The total route costs (sum of travel time, vehicle operating and accident costs) have been used to determine the most attractive alternative route for use in the option evaluation. For the northern section, Awamoa Central Road is the most attractive route after Beach Road. For the southern section, Happy Valley Road is the most attractive route should any section of Waianakarua Road be closed.

Note that the assessment of travel time costs, vehicle operating costs and accident costs for the southern section inland routes assumes that these roads are sealed (only Happy Valley Road is currently sealed). However, as Happy Valley Road is the most attractive alternative route, the other routes have not been carried forward to the Benefit Cost Ratio analysis and sealing of these routes will have no impact on the assessment.

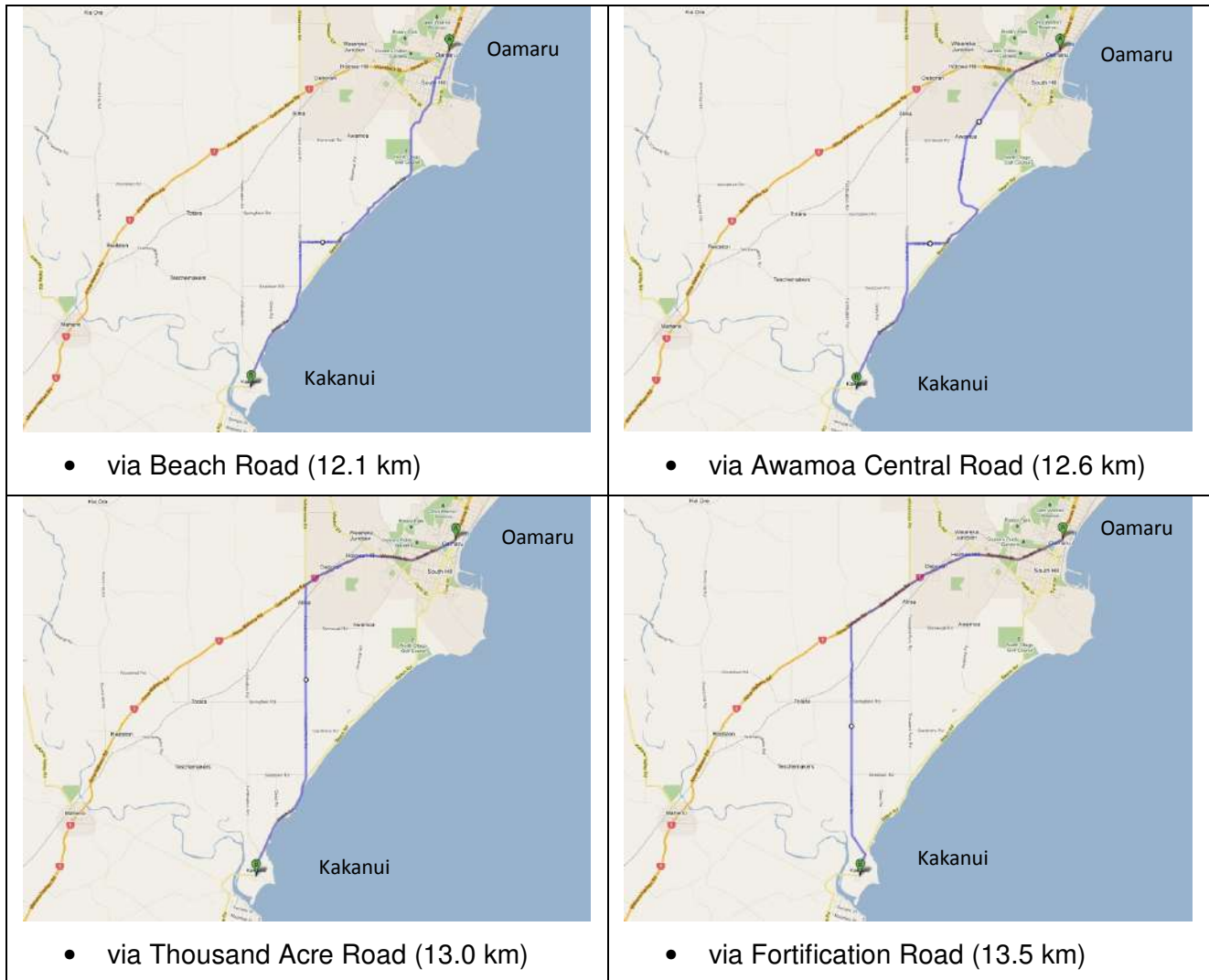


Figure 44: Northern Section routes – all routes have been assessed between the Severn Street (SH1)/Thames Street intersection in central Oamaru and the High street/Kakanui Road intersection in Kakanui.

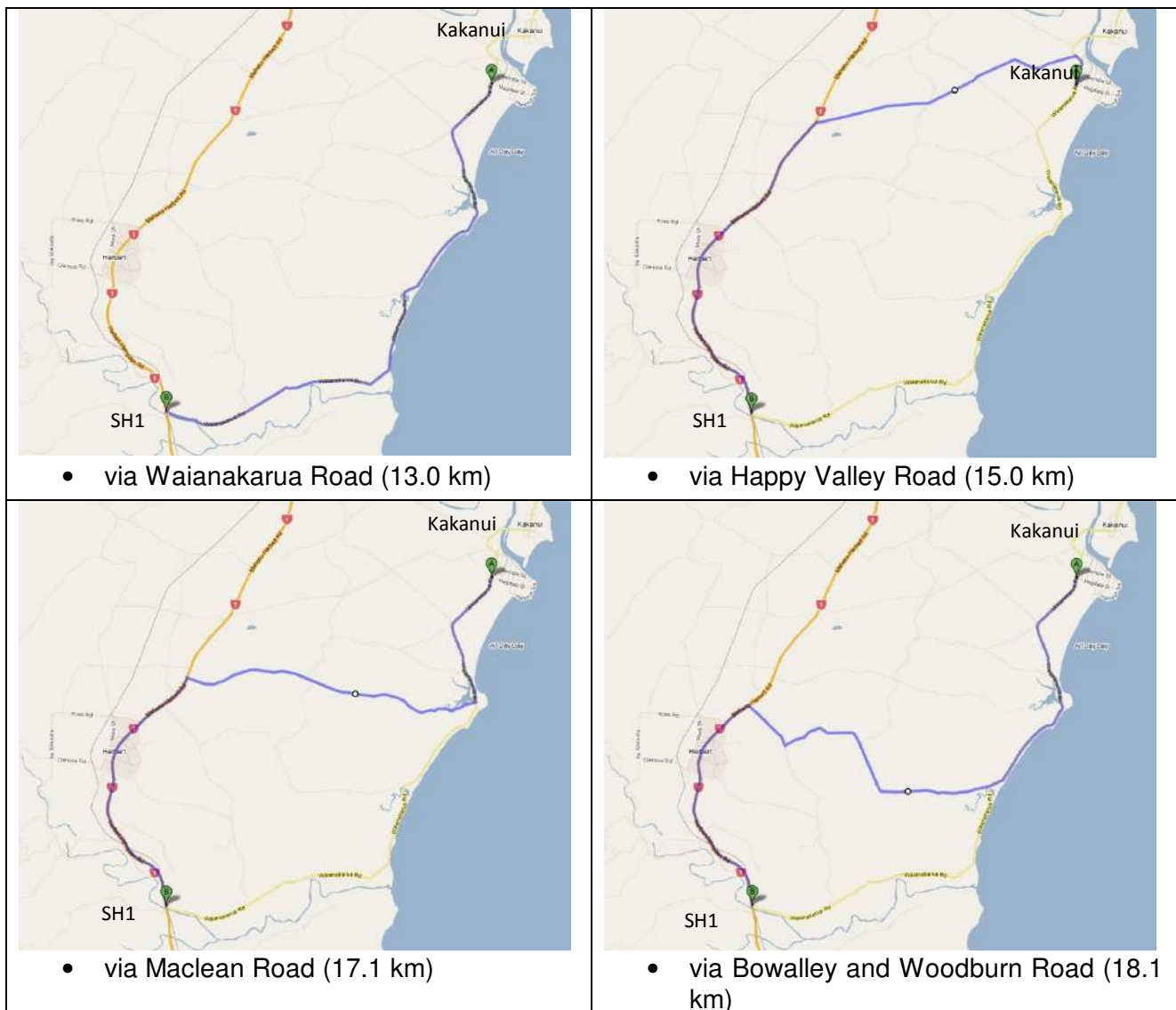


Figure 45: Southern Section routes – all routes have been assessed between the Magdala Street/ Waianakarua Road intersection in Kakanui and the Herbert-Hampden Road (SH1)/Waianakarua Road intersection.

Route	Annual Costs (\$)			
	Travel Time Costs	Vehicle Operating Costs	Accident Costs	Total
Northern Section (Oamaru to Kakanui)				
via Beach Road (12.1 km)	1,522,300	1,846,100	479,100	3,847,500
via Awamoa Central Road (12.6 km)	1,589,400	1,921,100	515,500	4,025,900
via Thousand Acre Road (13.0 km)	1,632,400	1,996,100	469,700	4,098,200
via Fortification Road (13.5 km)	1,694,900	2,073,900	506,100	4,274,900
Southern Section (Kakanui to State Highway 1)				
via Waianakarua Road (13.0 km)	304,500	412,800	96,100	813,400
via Happy Valley Road (15.0 km)	360,300	469,800	122,500	952,500
via Maclean Road (17.1 km)	403,100	539,900	125,000	1,068,000
via Bowalley Road & Woodburn Road (18.1 km)	426,500	571,700	131,100	1,129,300

Table 3: Summary of annual costs assessed for the coastal route and alternative inland routes

5.3 Options Assessed

For the northern section between Oamaru and Kakanui, the following options have been assessed:

- **North Do-Minimum:** Abandon Sites 1 and 2 when each becomes unsafe. Traffic travelling between Oamaru and Kakanui will be diverted onto Awamoa Central Road from year 2020 when Site 1 becomes unsafe, and then onto Thousand Acre Road from year 2035 onwards when Site 2 becomes unsafe.
- **North Option 1:** Protect Sites 1 and 2. Traffic travelling between Kakanui and Oamaru will continue to use the Beach Road route for the duration of the economic analysis period.
- **North Option 2:** Protect Site 2; abandon Site 1 when it becomes unsafe. Traffic travelling between Oamaru and Kakanui will utilise Beach Road until year 2020 when Site 1 becomes unsafe, at which time traffic will be diverted onto Awamoa Central Road.

Note that Site 3 has already been abandoned and an alternative route provided. The protection of this site has therefore not been considered as an option. Similarly, Site 4 is considered relatively stable and unlikely to need substantial capital works within the 30 year analysis period. Therefore protection of this section of the coastal route has not been included in the potential options.

As Site 1 is predicted to become unsafe earlier than Site 2 and also has a significantly higher capital cost to protect, it is not considered sensible to protect Site 1 at significant cost, only to subsequently abandon Site 2. Therefore, this combination of protection works has not been assessed.

For the southern section of the coastal route between Kakanui and State Highway 1, the following options have been assessed:

- **South Do Minimum:** Abandon Sites 5, 6 and 7 when each becomes unsafe. Once the first section of coastal road is abandoned (Site 5 in year 2015), traffic travelling between Kakanui and the state highway will be diverted onto Happy Valley Road.
- **South Option 1:** Protect Sites 5, 6 and 7. Traffic travelling between Kakanui and State Highway 1 will continue to use the Waianakarua Road route for the duration of the economic analysis period.
- **South Option 2:** Protect Sites 5 and 6; abandon Site 7 when it becomes unsafe. Traffic travelling between Kakanui and State Highway 1 will be diverted onto Happy Valley Road from year 2020 when Site 7 is abandoned.
- **South Option 3:** Protect Site 5; abandon Sites 6 and 7 when each becomes unsafe. Traffic travelling between Kakanui and State Highway 1 will be diverted onto Happy Valley Road from year 2020 when Sites 6 and 7 are abandoned.

Note that as Happy Valley Road has the lowest annual costs (sum of travel time costs, vehicle operating costs and accident costs) of the inland routes, it is assumed that traffic will divert onto this route when any of the southern coastal sites are abandoned.

5.4 Scenic Value

Beach Road and Waianakarua Road form a unique scenic route along this section of the coastline and will attract a portion of tourist traffic off of State Highway 1. For the purposes of the economic analysis, it is assumed that 25 tourist vehicles per day use the coastal route. This equates to approximately 10% of the daily traffic on the southern section of the route (between Kakanui and State Highway 1).

A nominal figure of \$20 per tourist vehicle has been applied in the economic analysis to quantify the value of the coastal route to these vehicles (for the coastal route between Oamaru and the

State Highway 1/Waianakarua Road intersection). Where a section of the route is abandoned, and traffic diverted to an alternative inland route, the scenic value benefits will be reduced accordingly. This amounts to an annual value of \$182,500 which equates to a present value of \$2.237 million over the 30 year analysis period.

Table 4 details how the scenic value benefits have been assigned to each of the Options in the economic analysis.

Option	Reduction to scenic value benefits	PV of scenic benefits (\$)
Northern Section (Oamaru to Kakanui)		
Do-Minimum – Abandon Sites 1 and 2	25% for years 2020 to 2034 (Site 1 abandoned) and 50% for year 2035 onwards (Site 1 and 2 abandoned).	2,259,000
Option 1 – Protect Sites 1 and 2	No impact	2,656,000
Option 2 – Protect Site 2, abandon Site 1	25% for year 2020 onwards (Site 1 abandoned)	2,321,000
Southern Section (Kakanui to State Highway 1)		
Do-Minimum – Abandon Sites 5, 6 and 7	25% for year 2015 to 2019 (Site 5 abandoned) and 75% for year 2020 onwards (Sites 5, 6 and 7 abandoned).	1,490,000
Option 1 – Protect Sites 5, 6 and 7	No impact	2,656,000
Option 2 – Protect Sites 5 and 6, abandon Site 7	25% for years 2020 onwards (Site 7 abandoned)	2,321,000
Option 3 – Protect Site 5, abandon Sites 6 and 7	50% for year 2020 onwards (Sites 6 and 7 abandoned)	1,986,000

Table 4: Summary of the scenic value of the coastal route applied in the economic analysis

5.5 Benefit Cost Ratio

The assessed benefit cost ratio (BCR) for each of the options is shown in **Table 5**. Only Option 3 for the southern section has a Benefit cost ratio greater than 1.0. This suggests that protection of the coastal sites is not justified on the basis of the economic analysis with the exception of Site 5 (Southern Section Option 3). Protection of this site is at a relatively low cost compared to the other sites and will result in the southern section of the coastal route remaining open for an additional 5 years compared to the Do-Minimum, with resulting economic benefits.

The low BCR of all other options is to be expected given the readily available alternative routes between Oamaru and Kakanui, and between Kakanui and the state highway for travel to/from the south.

Option	PV Nett Costs (\$)	PV Nett Benefits (\$)	Benefit Cost Ratio
Northern Section (Oamaru to Kakanui)			
Option 1 – Protect Sites 1 and 2	6,988,000	1,980,000	0.3
Option 2 – Protect Site 2, abandon Site 1	491,000	182,000	0.4
Southern Section (Kakanui to State Highway 1)			
Option 1 – Protect Sites 5, 6 and 7	5,929,000	2,877,000	0.5
Option 2 – Protect Sites 5 and 6, abandon Site 7	2,501,000	1,393,000	0.6
Option 3 – Protect Site 5, abandon Sites 6 and 7	212,000	1,059,000	5.0

Table 5: Benefit Cost Ratios

5.6 Sensitivity Analysis

Table 6 details the effect on the BCR of changes to key parameters in the economic analysis. Changes to the key analysis parameters results in minimal change with the BCR for all options varying between 0.2 and 1.1. The exception to this is the Southern Section Option 3 which varies from a BCR of 2.6 to 10.0.

Parameter	Benefit Cost Ratio				
	Northern Section		Southern Section		
	Option 1	Option 2	Option 1	Option 2	Option 3
Base Scenario	0.3	0.4	0.5	0.6	5.0
6% Discount Rate	0.3	0.4	0.5	0.6	4.8
10% Discount Rate	0.3	0.4	0.4	0.5	5.1
6% Traffic Growth	0.4	0.6	0.7	0.8	6.5
Excluding Scenic Value Benefits	0.2	0.2	0.3	0.2	2.6
Scenic value Benefits at \$50/tourist vehicle	0.4	0.6	0.8	1.1	8.5
50% increase in protection and abandonment costs	0.2	0.2	0.3	0.4	3.3
50% reduction in protection and abandonment costs	0.6	0.7	1.0	1.1	10.0

Table 6: Sensitivity Analysis

6 Conclusion

Economic analysis of protection options for the seven coastal road sites results in a BCR of less than 1.0 for all sites except for Site 5 which has a BCR of 5.0. With the exception of Site 5, it is considered that protection of the Beach Road and Waianakarua Road route cannot be justified based upon the economic analysis. The typically low BCR is due to the high cost of the protection works and readily available alternative routes from Kakanui to Oamaru and State Highway 1. The economic analysis does not include for the additional travel distances which will be necessary to access properties located along the coastal route, for which abandonment of the coastal road sections will result in significant detours to reach Oamaru and Kakanui. However, as there are a very low number of properties, there will be negligible impact on the assessed BCR.

Protection of Site 5 is at a relatively low cost compared to the other sites and will enable the southern section of the coastal route to remain open for an additional 5 years compared to the Do-Minimum, with resulting economic benefits. It is therefore recommended that these protection works are progressed.

It must be emphasised that the average erosion rate of 0.5m per year quoted in this report can be misleading. This is a rate which is averaged over a very long time span and over a long length of coastline. In reality erosion could occur rapidly in localised areas, will occur at any time, could be severe enough to close sections of the coastal road and will cost significant sums to repair.

When dealing with coastal erosion the thirty year timeframe dealt with by this report is a short time. It is impossible to predict the actual extent of coastal erosion that will occur during that time. The Strategy for the Coastal Road must have overarching goals but must remain flexible on how and when these can be achieved.

APPENDIX A

Additional Photographs

Site 1 – Beach Road (Golf Club Bend) to Awamoa Central Road



Site 1 – Northern end, looking north



Northern End, looking south



Example 1 - Gully, and edge of carriageway at this location

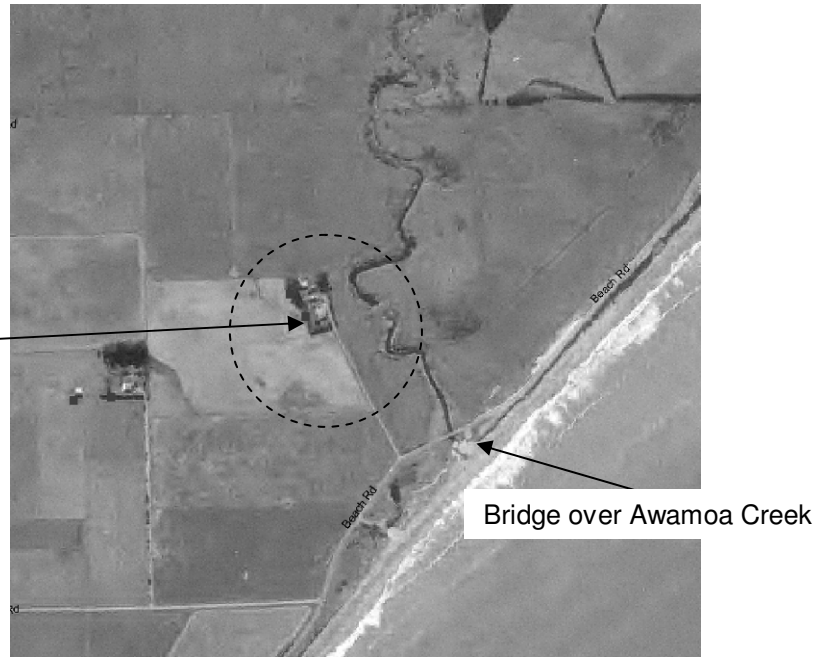


Example 2 - General view of carriageway, and shoulder protection works at a gully location



Example 3 – Shoulder protection works at gully location and general view of carriageway

Site 2 – Awamoa Central Road to Gardiners Road



Old Bones Backpackers is located away from the carriageway with access off Beach Road south of the bridge, adjacent to the Reserve



Road north and south of Awamoa Creek Bridge (both looking towards bridge)



Kakanui Beach Road Reserve, between carriageway and coastline



Views looking north and south on the beach by Kakanui Beach Road Reserve



Random-rock Seawall north of Awamoa Creek

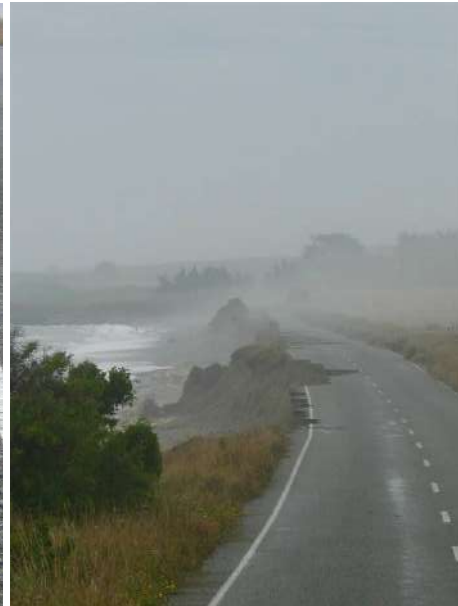


Previous realignment of the road due to erosion, and edge of cliff at this location

Site 3 - Gardiners Road to Thousand Acre Road



Barrier on the redundant Beach Road, just beyond property access; and View of the beach at this location



The abandoned section of Beach Road



Photographs of the new route provided

Site 4 - Thousand Acre Road to Kakanui



View along road looking south toward Kakanui



Looking south by the start of Site 4; and looking south from one of the promontories



Looking north from various locations along the coastline, showing the road further from the cliffs

Site 5 - Kakanui to Maclean Road



Bridge over Orore Creek; and Mouth of Orore Creek (at the coastline)



Looking north and south at the end of All Day Bay



The Causeway and the Orore Creek Lagoon

Site 6 - Maclean Road to Bowalley Road



Site 6 – general views of the (400m long) northern bay



View of the road and coastline at the southern end of the northern bay



General views looking south from Bridge Point

Site 7 - Bowalley Road to State Highway 1



General views looking north and south at the end of Site 7

APPENDIX B

Land Ownership and Access

Land Ownership and Access

Introduction

Previous studies have looked in more detail at the issues associated with access for property owners along the coastal route. The following information is taken from:

Report on Engineering Issues of a Coastal Roads Strategy (Oamaru to Waianakarua), November 2009, Opus International Consultants

This information shows that there are no major concerns expected regarding land access should the sites be abandoned.

Legal Access

The following information is for informative purposes only and specific legal advice should be sought when appropriate.

Roads can be stopped under Section 116 of the Public Works Act or Section 342 of the Local Government Act 1974. When closing a road under Section 116 2 (b) of the Public Works Act the Council has to either provide adequate alternative road access to adjoining land or get consent from the land owner to close the road without providing access. Where there are several parcels of land with separate titles but owned by one entity it is considered that access to one of the parcels is sufficient.

Under the Local Government Act road stopping requires public notification. The Act requires an explanation as to why the road needs to be stopped and coastal erosion that compromised the safety of road users should be more than adequate reason. There is no requirement to provide alternative access. It is recommended that the provisions of the Local Government Act are used when erosion has progressed to the point where the safety of the road is compromised and road closures are required.

Should any land become landlocked then under section 129B of the Property Law Act 1952 there is power for the Court to grant reasonable access via an easement through or transfer of adjacent land. The Council should ensure that the PIM/LIM file notes of properties neighbouring threatened roads include the existence of the erosion hazard to the roading land. The Council cannot put anything on the existing titles directly.

Site 1 – Awamoa Road to Golf Club Bend – Current Land Ownership

Site 1 does not have any dwellings that use Beach Road for access. The property owned by BW Rae and LM Rae, that currently accesses the middle portion of this section of Beach Road, will lose this access, however alternative access is available via another property with the same owners onto Awamoa Road.



Site 2 – Awamoa Central Road to Gardiners Road - Current Land Ownership



Land Ownership at Site 2

There are two dwellings associated with the Backpackers facility that have access off Beach Road as shown diagrammatically in the map above. They appear to use a legal but unformed section of Springfield Road. For future access to the backpacker's facilities, it may be necessary to form a trafficable access along the other unformed section of Springfield Road, out to Thousand Acre Road. The properties owned by BW Rae and LM Rae will, jointly, continue to have legal access onto the unformed section of Springfield Road or alternatively onto Gardiners Road.

Site 3 – Gardiners Road to Thousand Acre Road - Current Land Ownership



Land Ownership at Site 3

At Site 3 all land parcels that have frontages to Beach Road also have alternative access onto either Thousand Acre Road or Gardiners Road. The dwelling shown diagrammatically on the land ownership map is currently using the closed section of Beach Road for access.

Site 4 – Thousand Acre Road to Kakanui - Current Land Ownership



There are two dwellings with accessways onto Beach Road along Site 4. Access to the land containing the dwelling labelled 1 and access to the dwelling itself may become a problem if ever the adjacent Section of Beach Road is closed.

Site 5 – Kakanui to Maclean Road - Current Land Ownership



The land under the lagoon is owned by Central South Island Fish and Game. No other properties would have their access affected.

Site 6 – Maclean Road to Bowalley Road - Current Land Ownership



Land Ownership at Site 6

All the land fronting the coastline along this site has the same owner. Safe access is available to the combined properties from both Bowalley Road and Maclean Road.

Site 7 – Bowalley Road to State Highway 1 - Current Land Ownership

At Site 7 all of the land adjacent to the coastal road is owned by two owners, with the 'Brown' properties having the bulk of the affected road frontage. These parcels of land, combined, have safe access, either directly off Bowalley Road (although crossing Bowalley Creek may be an

issue) or from the northern most section of Waianakarua Road that can remain for public access to the beach, south of the Bow Alley Creek.



APPENDIX C

Cost Estimates

NORTH SECTION

DO MINIMUM OPTION Abandon Site 1 and 2

OPTION 1 Protect Site 1, then protect Site 2

OPTION 2 Abandon Site 1, and protect Site 2

		Abandon		Yearly total
		Site 1	Site 2	
0	2011			\$0
1	2012	\$0	\$0	\$0
2	2013	\$0	\$0	\$0
3	2014	\$0	\$0	\$0
4	2015	\$0	\$0	\$0
5	2016	\$0	\$0	\$0
6	2017	\$0	\$0	\$0
7	2018	\$0	\$0	\$0
8	2019	\$70,000	\$0	\$70,000
9	2020	unsafe	\$0	\$0
10	2021	\$0	\$0	\$0
11	2022	\$0	\$0	\$0
12	2023	\$0	\$0	\$0
13	2024	\$0	\$0	\$0
14	2025	\$0	\$0	\$0
15	2026	\$0	\$0	\$0
16	2027	\$0	\$0	\$0
17	2028	\$0	\$0	\$0
18	2029	\$0	\$0	\$0
19	2030	\$0	\$0	\$0
20	2031	\$0	\$0	\$0
21	2032	\$0	\$0	\$0
22	2033	\$0	\$0	\$0
23	2034	\$0	\$80,000	\$80,000
24	2035	\$0	unsafe	\$0
25	2036	\$0	\$0	\$0
26	2037	\$0	\$0	\$0
27	2038	\$0	\$0	\$0
28	2039	\$0	\$0	\$0
29	2040	\$0	\$0	\$0
30	2041	\$0	\$0	\$0
Site total		\$70,000	\$80,000	\$150,000

NORTH SECTION

DO MINIMUM OPTION

Abandon Site 1 and 2

OPTION 1**Protect Site 1, then protect Site 2**

OPTION 2

Abandon Site 1, and protect Site 2

		Protection		Yearly total
		Site 1	Site 2	
0	2011			
1	2012	\$0	\$0	\$0
2	2013	\$1,800,000	\$0	\$1,800,000
3	2014	\$90,000	\$0	\$90,000
4	2015	\$90,000	\$0	\$90,000
5	2016	\$90,000	\$0	\$90,000
6	2017	\$1,290,000	\$0	\$1,290,000
7	2018	\$150,000	\$0	\$150,000
8	2019	\$150,000	\$0	\$150,000
9	2020	\$1,350,000	\$0	\$1,350,000
10	2021	\$210,000	\$0	\$210,000
11	2022	\$210,000	\$0	\$210,000
12	2023	\$1,410,000	\$0	\$1,410,000
13	2024	\$270,000	\$0	\$270,000
14	2025	\$270,000	\$0	\$270,000
15	2026	\$1,470,000	\$0	\$1,470,000
16	2027	\$330,000	\$0	\$330,000
17	2028	\$330,000	\$0	\$330,000
18	2029	\$1,530,000	\$0	\$1,530,000
19	2030	\$390,000	\$0	\$390,000
20	2031	\$390,000	\$900,000	\$1,290,000
21	2032	\$1,590,000	\$45,000	\$1,635,000
22	2033	\$450,000	\$45,000	\$495,000
23	2034	\$450,000	\$45,000	\$495,000
24	2035	\$1,050,000	\$45,000	\$1,095,000
25	2036	\$480,000	\$945,000	\$1,425,000
26	2037	\$480,000	\$90,000	\$570,000
27	2038	\$480,000	\$90,000	\$570,000
28	2039	\$480,000	\$90,000	\$570,000
29	2040	\$480,000	\$90,000	\$570,000
30	2041	\$480,000	\$990,000	\$1,470,000
Site total		\$18,240,000	\$3,375,000	\$21,615,000

NORTH SECTION

DO MINIMUM OPTION

Abandon Site 1 and 2

OPTION 1

Protect Site 1, then protect Site 2

OPTION 2**Abandon Site 1, and protect Site 2**

		Protection		Abandon		Yearly total
		Site 1	Site 2	Site 1	Site 2	
0	2011					
1	2012		\$0	\$0		\$0
2	2013		\$0	\$0		\$0
3	2014		\$0	\$0		\$0
4	2015		\$0	\$0		\$0
5	2016		\$0	\$0		\$0
6	2017		\$0	\$0		\$0
7	2018		\$0	\$0		\$0
8	2019		\$0	\$70,000		\$70,000
9	2020		\$0	unsafe		\$0
10	2021		\$0	\$0		\$0
11	2022		\$0	\$0		\$0
12	2023		\$0	\$0		\$0
13	2024		\$0	\$0		\$0
14	2025		\$0	\$0		\$0
15	2026		\$0	\$0		\$0
16	2027		\$0	\$0		\$0
17	2028		\$0	\$0		\$0
18	2029		\$0	\$0		\$0
19	2030		\$0	\$0		\$0
20	2031		\$900,000	\$0		\$900,000
21	2032		\$45,000	\$0		\$45,000
22	2033		\$45,000	\$0		\$45,000
23	2034		\$45,000	\$0		\$45,000
24	2035		\$45,000	\$0		\$45,000
25	2036		\$945,000	\$0		\$945,000
26	2037		\$90,000	\$0		\$90,000
27	2038		\$90,000	\$0		\$90,000
28	2039		\$90,000	\$0		\$90,000
29	2040		\$90,000	\$0		\$90,000
30	2041		\$990,000	\$0		\$990,000
Site total		\$0	\$3,375,000	\$70,000	\$0	\$3,445,000

SOUTH SECTION

DO MINIMUM OPTION Abandon all sites

OPTION 1 Protect all sites
 OPTION 2 Protect Sites 5 & 6, Abandon Site 7
 OPTION 3 Protect Site 5, Abandon Sites 6 & 7

		Abandon			Yearly total
		Site 5	Site 6	Site 7	
0	2011	\$0	\$0	\$0	\$0
1	2012	\$0	\$0	\$0	\$0
2	2013	\$0	\$0	\$0	\$0
3	2014	\$60,000	\$0	\$0	\$60,000
4	2015	unsafe	\$0	\$0	\$0
5	2016	\$0	\$0	\$0	\$0
6	2017	\$0	\$0	\$0	\$0
7	2018	\$0	\$0	\$0	\$0
8	2019	\$0	\$80,000	\$80,000	\$160,000
9	2020	\$0	unsafe	unsafe	\$0
10	2021	\$0	\$0	\$0	\$0
11	2022	\$0	\$0	\$0	\$0
12	2023	\$0	\$0	\$0	\$0
13	2024	\$0	\$0	\$0	\$0
14	2025	\$0	\$0	\$0	\$0
15	2026	\$0	\$0	\$0	\$0
16	2027	\$0	\$0	\$0	\$0
17	2028	\$0	\$0	\$0	\$0
18	2029	\$0	\$40,000	\$0	\$40,000
19	2030	\$0	unsafe	\$0	\$0
20	2031	\$0	\$0	\$0	\$0
21	2032	\$0	\$0	\$0	\$0
22	2033	\$0	\$0	\$0	\$0
23	2034	\$0	\$0	\$0	\$0
24	2035	\$0	\$0	\$0	\$0
25	2036	\$0	\$0	\$0	\$0
26	2037	\$0	\$0	\$0	\$0
27	2038	\$0	\$0	\$0	\$0
28	2039	\$0	\$0	\$0	\$0
29	2040	\$0	\$0	\$0	\$0
30	2041	\$0	\$0	\$0	\$0
Site total		\$60,000	\$120,000	\$80,000	\$260,000

SOUTH SECTION

DO MINIMUM OPTION

Abandon all sites

OPTION 1

Protect all sites

OPTION 2

Protect Sites 5 & 6, Abandon Site 7

OPTION 3

Protect Site 5, Abandon Sites 6 & 7

		Protection			Yearly total
		Site 5	Site 6	Site 7	
0	2011				
1	2012	\$100,000	\$900,000	\$600,000	\$1,600,000
2	2013	\$5,000	\$45,000	\$855,000	\$905,000
3	2014	\$5,000	\$45,000	\$285,000	\$335,000
4	2015	\$5,000	\$45,000	\$360,000	\$410,000
5	2016	\$5,000	\$45,000	\$75,000	\$125,000
6	2017	\$5,000	\$645,000	\$375,000	\$1,025,000
7	2018	\$5,000	\$75,000	\$90,000	\$170,000
8	2019	\$5,000	\$75,000	\$412,500	\$492,500
9	2020	\$105,000	\$75,000	\$105,000	\$285,000
10	2021	\$10,000	\$75,000	\$405,000	\$490,000
11	2022	\$10,000	\$675,000	\$120,000	\$805,000
12	2023	\$10,000	\$105,000	\$420,000	\$535,000
13	2024	\$10,000	\$105,000	\$157,500	\$272,500
14	2025	\$10,000	\$105,000	\$435,000	\$550,000
15	2026	\$10,000	\$105,000	\$150,000	\$265,000
16	2027	\$10,000	\$105,000	\$150,000	\$265,000
17	2028	\$10,000	\$105,000	\$150,000	\$265,000
18	2029	\$10,000	\$105,000	\$172,500	\$287,500
19	2030	\$110,000	\$105,000	\$150,000	\$365,000
20	2031	\$15,000	\$405,000	\$150,000	\$570,000
21	2032	\$15,000	\$120,000	\$150,000	\$285,000
22	2033	\$15,000	\$120,000	\$150,000	\$285,000
23	2034	\$15,000	\$120,000	\$172,500	\$307,500
24	2035	\$15,000	\$120,000	\$150,000	\$285,000
25	2036	\$15,000	\$120,000	\$150,000	\$285,000
26	2037	\$15,000	\$120,000	\$150,000	\$285,000
27	2038	\$15,000	\$120,000	\$150,000	\$285,000
28	2039	\$15,000	\$120,000	\$172,500	\$307,500
29	2040	\$115,000	\$120,000	\$150,000	\$385,000
30	2041	\$0	\$120,000	\$150,000	\$270,000

Site total

\$690,000 \$5,145,000 \$7,162,500

\$12,997,500

SOUTH SECTION

DO MINIMUM OPTION

Abandon all sites

OPTION 1

Protect all sites

OPTION 2

Protect Sites 5 & 6, Abandon Site 7

OPTION 3

Protect Site 5, Abandon Sites 6 & 7

		Protection		Abandon	Yearly total
		Site 5	Site 6	Site 7	
0	2011	\$0	\$0	\$0	\$0
1	2012	\$100,000	\$900,000	\$0	\$1,000,000
2	2013	\$5,000	\$45,000	\$0	\$50,000
3	2014	\$5,000	\$45,000	\$0	\$50,000
4	2015	\$5,000	\$45,000	\$0	\$50,000
5	2016	\$5,000	\$45,000	\$0	\$50,000
6	2017	\$5,000	\$645,000	\$0	\$650,000
7	2018	\$5,000	\$75,000	\$0	\$80,000
8	2019	\$5,000	\$75,000	\$80,000	\$160,000
9	2020	\$105,000	\$75,000	unsafe	\$180,000
10	2021	\$10,000	\$75,000	\$0	\$85,000
11	2022	\$10,000	\$675,000	\$0	\$685,000
12	2023	\$10,000	\$105,000	\$0	\$115,000
13	2024	\$10,000	\$105,000	\$0	\$115,000
14	2025	\$10,000	\$105,000	\$0	\$115,000
15	2026	\$10,000	\$105,000	\$0	\$115,000
16	2027	\$10,000	\$105,000	\$0	\$115,000
17	2028	\$10,000	\$105,000	\$0	\$115,000
18	2029	\$10,000	\$105,000	\$0	\$115,000
19	2030	\$110,000	\$105,000	\$0	\$215,000
20	2031	\$15,000	\$405,000	\$0	\$420,000
21	2032	\$15,000	\$120,000	\$0	\$135,000
22	2033	\$15,000	\$120,000	\$0	\$135,000
23	2034	\$15,000	\$120,000	\$0	\$135,000
24	2035	\$15,000	\$120,000	\$0	\$135,000
25	2036	\$15,000	\$120,000	\$0	\$135,000
26	2037	\$15,000	\$120,000	\$0	\$135,000
27	2038	\$15,000	\$120,000	\$0	\$135,000
28	2039	\$15,000	\$120,000	\$0	\$135,000
29	2040	\$115,000	\$120,000	\$0	\$235,000
30	2041	\$0	\$120,000	\$0	\$120,000
Site total		\$690,000	\$5,145,000	\$80,000	\$5,915,000

SOUTH SECTION

DO MINIMUM OPTION

Abandon all sites

OPTION 1

Protect all sites

OPTION 2

Protect Sites 5 & 6, Abandon Site 7

OPTION 3

Protect Site 5, Abandon Sites 6 & 7

		Protection Site 5	Abandon Site 6	Site 7	Yearly total
0	2011	\$0	\$0	\$0	\$0
1	2012	\$100,000	\$0	\$0	\$100,000
2	2013	\$5,000	\$0	\$0	\$5,000
3	2014	\$5,000	\$0	\$0	\$5,000
4	2015	\$5,000	\$0	\$0	\$5,000
5	2016	\$5,000	\$0	\$0	\$5,000
6	2017	\$5,000	\$0	\$0	\$5,000
7	2018	\$5,000	\$0	\$0	\$5,000
8	2019	\$5,000	\$80,000	\$80,000	\$165,000
9	2020	\$105,000	unsafe	unsafe	\$105,000
10	2021	\$10,000	\$0	\$0	\$10,000
11	2022	\$10,000	\$0	\$0	\$10,000
12	2023	\$10,000	\$0	\$0	\$10,000
13	2024	\$10,000	\$0	\$0	\$10,000
14	2025	\$10,000	\$0	\$0	\$10,000
15	2026	\$10,000	\$0	\$0	\$10,000
16	2027	\$10,000	\$0	\$0	\$10,000
17	2028	\$10,000	\$0	\$0	\$10,000
18	2029	\$10,000	\$40,000	\$0	\$50,000
19	2030	\$110,000	unsafe	\$0	\$110,000
20	2031	\$15,000	\$0	\$0	\$15,000
21	2032	\$15,000	\$0	\$0	\$15,000
22	2033	\$15,000	\$0	\$0	\$15,000
23	2034	\$15,000	\$0	\$0	\$15,000
24	2035	\$15,000	\$0	\$0	\$15,000
25	2036	\$15,000	\$0	\$0	\$15,000
26	2037	\$15,000	\$0	\$0	\$15,000
27	2038	\$15,000	\$0	\$0	\$15,000
28	2039	\$15,000	\$0	\$0	\$15,000
29	2040	\$115,000	\$0	\$0	\$115,000
30	2041	\$0	\$0	\$0	\$0
Site total		\$690,000	\$120,000	\$80,000	\$890,000

Waitaki Coastal Roads NPV Calculations

			Site 1		Site 2		Site 5		Site 6		Site 7	
			CAPITAL & MAINTENANCE COSTS		CAPITAL & MAINTENANCE COSTS		CAPITAL & MAINTENANCE COSTS		CAPITAL & MAINTENANCE COSTS		CAPITAL & MAINTENANCE COSTS	
Calendar Year	Time Stream Year	Discount Factor (@8%)	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount
2011	0	1.0000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2012	1	0.9259	\$0	\$0	\$0	\$0	\$0	\$0	\$900,000	\$833,333	\$600,000	\$555,556
2013	2	0.8573	\$1,800,000	\$1,543,210	\$0	\$0	\$100,000	\$85,734	\$45,000	\$38,580	\$855,000	\$733,025
2014	3	0.7938	\$90,000	\$71,445	\$0	\$0	\$5,000	\$3,969	\$45,000	\$35,722	\$285,000	\$226,242
2015	4	0.7350	\$90,000	\$66,153	\$0	\$0	\$5,000	\$3,675	\$45,000	\$33,076	\$360,000	\$264,611
2016	5	0.6806	\$90,000	\$61,252	\$0	\$0	\$5,000	\$3,403	\$45,000	\$30,626	\$75,000	\$51,044
2017	6	0.6302	\$1,290,000	\$812,919	\$0	\$0	\$5,000	\$3,151	\$645,000	\$406,459	\$375,000	\$236,314
2018	7	0.5835	\$150,000	\$87,524	\$0	\$0	\$5,000	\$2,917	\$75,000	\$43,762	\$90,000	\$52,514
2019	8	0.5403	\$150,000	\$81,040	\$0	\$0	\$5,000	\$2,701	\$75,000	\$40,520	\$412,500	\$222,861
2020	9	0.5002	\$1,350,000	\$675,336	\$0	\$0	\$5,000	\$2,501	\$75,000	\$37,519	\$105,000	\$52,526
2021	10	0.4632	\$210,000	\$97,271	\$0	\$0	\$105,000	\$48,635	\$75,000	\$34,740	\$405,000	\$187,593
2022	11	0.4289	\$210,000	\$90,065	\$0	\$0	\$10,000	\$4,289	\$675,000	\$289,496	\$120,000	\$51,466
2023	12	0.3971	\$1,410,000	\$559,930	\$0	\$0	\$10,000	\$3,971	\$105,000	\$41,697	\$420,000	\$166,788
2024	13	0.3677	\$270,000	\$99,278	\$0	\$0	\$10,000	\$3,677	\$105,000	\$38,608	\$157,500	\$57,912
2025	14	0.3405	\$270,000	\$91,924	\$0	\$0	\$10,000	\$3,405	\$105,000	\$35,748	\$435,000	\$148,101
2026	15	0.3152	\$1,470,000	\$463,405	\$0	\$0	\$10,000	\$3,152	\$105,000	\$33,100	\$150,000	\$47,286
2027	16	0.2919	\$330,000	\$96,324	\$0	\$0	\$10,000	\$2,919	\$105,000	\$30,648	\$150,000	\$43,784
2028	17	0.2703	\$330,000	\$89,189	\$0	\$0	\$10,000	\$2,703	\$105,000	\$28,378	\$150,000	\$40,540
2029	18	0.2502	\$1,530,000	\$382,881	\$0	\$0	\$10,000	\$2,502	\$105,000	\$26,276	\$172,500	\$43,168
2030	19	0.2317	\$390,000	\$90,368	\$0	\$0	\$10,000	\$2,317	\$105,000	\$24,330	\$150,000	\$34,757
2031	20	0.2145	\$390,000	\$83,674	\$900,000	\$193,093	\$110,000	\$23,600	\$405,000	\$86,892	\$150,000	\$32,182
2032	21	0.1987	\$1,590,000	\$315,863	\$45,000	\$8,940	\$15,000	\$2,980	\$120,000	\$23,839	\$150,000	\$29,798
2033	22	0.1839	\$450,000	\$82,773	\$45,000	\$8,277	\$15,000	\$2,759	\$120,000	\$22,073	\$150,000	\$27,591
2034	23	0.1703	\$450,000	\$76,642	\$45,000	\$7,664	\$15,000	\$2,555	\$120,000	\$20,438	\$172,500	\$29,379
2035	24	0.1577	\$1,050,000	\$165,584	\$45,000	\$7,096	\$15,000	\$2,365	\$120,000	\$18,924	\$150,000	\$23,655
2036	25	0.1460	\$480,000	\$70,089	\$945,000	\$137,987	\$15,000	\$2,190	\$120,000	\$17,522	\$150,000	\$21,903
2037	26	0.1352	\$480,000	\$64,897	\$90,000	\$12,168	\$15,000	\$2,028	\$120,000	\$16,224	\$150,000	\$20,280
2038	27	0.1252	\$480,000	\$60,090	\$90,000	\$11,267	\$15,000	\$1,878	\$120,000	\$15,022	\$150,000	\$18,778
2039	28	0.1159	\$480,000	\$55,639	\$90,000	\$10,432	\$15,000	\$1,739	\$120,000	\$13,910	\$172,500	\$19,995
2040	29	0.1073	\$480,000	\$51,517	\$90,000	\$9,659	\$15,000	\$1,610	\$120,000	\$12,879	\$150,000	\$16,099
2041	30	0.0994	\$480,000	\$47,701	\$990,000	\$98,384	\$115,000	\$11,428	\$120,000	\$11,925	\$150,000	\$14,907
			\$18,240,000	\$6,534,000	\$3,375,000	\$505,000	\$690,000	\$240,800	\$5,145,000	\$2,342,300	\$7,162,500	\$3,470,700

Waitaki Coastal Roads NPV Calculations

			Site 1		Site 2		Site 5		Site 6		Site 7	
			CAPITAL COSTS		CAPITAL COSTS		CAPITAL COSTS		CAPITAL COSTS		CAPITAL COSTS	
Calendar Year	Time Stream Year	Discount Factor (@8%)	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount
2011	0	1.0000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2012	1	0.9259	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2013	2	0.8573	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2014	3	0.7938	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2015	4	0.7350	\$0	\$0	\$0	\$0	\$60,000	\$44,102	\$0	\$0	\$0	\$0
2016	5	0.6806	\$0	\$0	\$0	\$0		\$0	\$0	\$0	\$0	\$0
2017	6	0.6302	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2018	7	0.5835	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2019	8	0.5403	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2020	9	0.5002	\$70,000	\$35,017	\$0	\$0	\$0	\$0	\$80,000	\$40,020	\$80,000	\$40,020
2021	10	0.4632		\$0	\$0	\$0	\$0	\$0		\$0		\$0
2022	11	0.4289	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2023	12	0.3971	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2024	13	0.3677	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2025	14	0.3405	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2026	15	0.3152	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2027	16	0.2919	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2028	17	0.2703	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2029	18	0.2502	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2030	19	0.2317	\$0	\$0	\$0	\$0	\$0	\$0	\$40,000	\$9,268	\$0	\$0
2031	20	0.2145	\$0	\$0	\$0	\$0	\$0	\$0		\$0	\$0	\$0
2032	21	0.1987	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2033	22	0.1839	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2034	23	0.1703	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2035	24	0.1577	\$0	\$0	\$70,000	\$11,039	\$0	\$0	\$0	\$0	\$0	\$0
2036	25	0.1460	\$0	\$0		\$0	\$0	\$0	\$0	\$0	\$0	\$0
2037	26	0.1352	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2038	27	0.1252	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2039	28	0.1159	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2040	29	0.1073	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2041	30	0.0994	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
			\$70,000	\$35,000	\$70,000	\$11,000	\$60,000	\$44,100	\$120,000	\$49,300	\$80,000	\$40,000

Site 1: Beach Road from Oamaru to Awamoa Central Road

This section is 1.6km and runs parallel with the coastline with the high coast cliff reaching 14m in height. Beach Road has been moved inland on two previous occasions, and is again close to the cliff edge.

There are 3 "gully" locations, and these sections are recommended for earliest protection, with an assumed 100m requirement at each.

The cost rate of \$3,000 has been used throughout this economic analysis, but with the cliff height reaching 14m along this section, \$6,000 per m length has been assumed.

To retain existing route

	Seawall					Maintenance		Yearly Total
	Length	Unit	Rate	Price		5%		
Year 1								
Year 2	300	m	\$6,000	\$1,800,000				\$1,800,000
Year 3						\$90,000		\$90,000
Year 4						\$90,000		\$90,000
Year 5						\$90,000		\$90,000
Year 6	200	m	\$6,000	\$1,200,000		\$90,000		\$1,290,000
Year 7						\$150,000		\$150,000
Year 8						\$150,000		\$150,000
Year 9	200	m	\$6,000	\$1,200,000		\$150,000		\$1,350,000
Year 10						\$210,000		\$210,000
Year 11						\$210,000		\$210,000
Year 12	200	m	\$6,000	\$1,200,000		\$210,000		\$1,410,000
Year 13						\$270,000		\$270,000
Year 14						\$270,000		\$270,000
Year 15	200	m	\$6,000	\$1,200,000		\$270,000		\$1,470,000
Year 16						\$330,000		\$330,000
Year 17						\$330,000		\$330,000
Year 18	200	m	\$6,000	\$1,200,000		\$330,000		\$1,530,000
Year 19						\$390,000		\$390,000
Year 20						\$390,000		\$390,000
Year 21	200	m	\$6,000	\$1,200,000		\$390,000		\$1,590,000
Year 22						\$450,000		\$450,000
Year 23						\$450,000		\$450,000
Year 24	100	m	\$6,000	\$600,000		\$450,000		\$1,050,000
Year 25						\$480,000		\$480,000
Year 26						\$480,000		\$480,000
Year 27						\$480,000		\$480,000
Year 28						\$480,000		\$480,000
Year 29						\$480,000		\$480,000
Year 30						\$480,000		\$480,000
				\$9,600,000			\$8,640,000	\$18,240,000

Site 2: Beach Road between Awamoa Central Road and Gardiners Road

Previous report states that 1.2km (virtually full length of this section) requires protection. For this report, it is considered that this length should be 900m, such that the Kakanui Road Reserve remains unprotected until a time beyond this assessment period, as the road is further from the coastline.

To retain existing route

	Seawall				Maintenance		Yearly Total
	Length	Unit	Rate	Price		5%	
Year 1							\$0
Year 2							\$0
Year 3							\$0
Year 4							\$0
Year 5							\$0
Year 6							\$0
Year 7							\$0
Year 8							\$0
Year 9							\$0
Year 10							\$0
Year 11							\$0
Year 12							\$0
Year 13							\$0
Year 14							\$0
Year 15							\$0
Year 16							\$0
Year 17							\$0
Year 18							\$0
Year 19							\$0
Year 20	300	m	\$3,000	\$900,000			\$900,000
Year 21						\$45,000	\$45,000
Year 22						\$45,000	\$45,000
Year 23						\$45,000	\$45,000
Year 24						\$45,000	\$45,000
Year 25	300	m	\$3,000	\$900,000		\$45,000	\$945,000
Year 26						\$90,000	\$90,000
Year 27						\$90,000	\$90,000
Year 28						\$90,000	\$90,000
Year 29						\$90,000	\$90,000
Year 30	300	m	\$3,000	\$900,000		\$90,000	\$990,000

\$2,700,000

\$675,000

\$3,375,000

Site 3: Beach Road between Gardiners Road and Thousand Acre Road

To retain existing route

This section of coastline has been abandoned due to previous erosion removing the existing road. Upgrade works have been carried out for the alternative route.

There are no costs to be considered for this economic analysis. **\$0.00**

Site 4: Beach Road between Thousand Acre and Kakanui

This section follows the coastline but is well protected from erosion by the sandstone strata. Minor protection works could be carried out in isolated locations, but these would be difficult due to inaccessibility of the cliff base.

To retain existing route

For this economic analysis, no protection works are recommended. This location is to be monitored at least every 6 months to check for any change in the existing conditions.

There are no costs to be considered for this economic analysis. **\$0.00**

Site 5: Waianakarua Road between the mouth of Orore Creek and Maclean Road

To retain existing route

The length of beach fronting the causeway within this section is 350m, with an additional length of 50m requiring protection north of the Creek Mouth.

Provide protection in 100m lengths. Most of the fronting is low, so a \$1000/m cost has been applied.

	Seawall				Maintenance		Yearly Total
	Length	Unit	Rate	Price		5%	
Year 1							
Year 2	100	m	\$1,000	\$100,000			\$100,000
Year 3						\$5,000	\$5,000
Year 4						\$5,000	\$5,000
Year 5						\$5,000	\$5,000
Year 6						\$5,000	\$5,000
Year 7						\$5,000	\$5,000
Year 8						\$5,000	\$5,000
Year 9						\$5,000	\$5,000
Year 10	100	m	\$1,000	\$100,000		\$5,000	\$105,000
Year 11						\$10,000	\$10,000
Year 12						\$10,000	\$10,000
Year 13						\$10,000	\$10,000
Year 14						\$10,000	\$10,000
Year 15						\$10,000	\$10,000
Year 16						\$10,000	\$10,000
Year 17						\$10,000	\$10,000
Year 18						\$10,000	\$10,000
Year 19						\$10,000	\$10,000
Year 20	100	m	\$1,000	\$100,000		\$10,000	\$110,000
Year 21						\$15,000	\$15,000
Year 22						\$15,000	\$15,000
Year 23						\$15,000	\$15,000
Year 24						\$15,000	\$15,000
Year 25						\$15,000	\$15,000
Year 26						\$15,000	\$15,000
Year 27						\$15,000	\$15,000
Year 28						\$15,000	\$15,000
Year 29						\$15,000	\$15,000
Year 30	100	m	\$1,000	\$100,000		\$15,000	\$115,000

\$400,000

\$290,000

\$690,000

Site 6: Waianakarua Road between Maclean Road and Bowalley Road

To retain existing route

The 1600m section is considered relatively stable, however there are 4 minor gullies which should be protected in the future.

The first 300m of the 400m section is under immediate threat of erosion damage, allow this to be protected immediately, with the remainder in year 6.

	Seawall					Maintenance		Yearly Total
	Length	Unit	Rate	Price				
Year 1	300	m	\$3,000	\$900,000				\$900,000
Year 2						\$45,000		\$45,000
Year 3						\$45,000		\$45,000
Year 4						\$45,000		\$45,000
Year 5						\$45,000		\$45,000
Year 6	200	m	\$3,000	\$600,000		\$45,000		\$645,000
Year 7						\$75,000		\$75,000
Year 8						\$75,000		\$75,000
Year 9						\$75,000		\$75,000
Year 10						\$75,000		\$75,000
Year 11	200	m	\$3,000	\$600,000		\$75,000		\$675,000
Year 12						\$105,000		\$105,000
Year 13						\$105,000		\$105,000
Year 14						\$105,000		\$105,000
Year 15						\$105,000		\$105,000
Year 16						\$105,000		\$105,000
Year 17						\$105,000		\$105,000
Year 18						\$105,000		\$105,000
Year 19						\$105,000		\$105,000
Year 20	100	m	\$3,000	\$300,000		\$105,000		\$405,000
Year 21						\$120,000		\$120,000
Year 22						\$120,000		\$120,000
Year 23						\$120,000		\$120,000
Year 24						\$120,000		\$120,000
Year 25						\$120,000		\$120,000
Year 26						\$120,000		\$120,000
Year 27						\$120,000		\$120,000
Year 28						\$120,000		\$120,000
Year 29						\$120,000		\$120,000
Year 30						\$120,000		\$120,000
				\$2,400,000			\$2,745,000	\$5,145,000

Site 7: Waianakarua Road between Bowally Road and the inland prtion of Waianakarua Road

To retain existing route

Immediate works required to the first 400m beyond the previously constructed gabion wall, with a further 600m protected at a construction rate of 100m of seawall every 2 years.

The bridge will need upgrading due to its current weight restrictions resulting from the poor condition of the existing piles and abutments.

The price of this upgrade has been estimated by the WDC as being \$450,000. This has been spread over 2 years for construction, commencing in year 2 to allow for design.

The first section of protection measures is required near the Waianakarua River mouth, at the south end of this site.

	Seawall		Rate	Price		Bridge		Maint	Maint	Yearly Total
	Length	Unit						(Seawall)	(Bridge) 1%	
Year 1	200	m	\$3,000	\$600,000						\$600,000
Year 2	200	m	\$3,000	\$600,000		\$225,000		\$30,000		\$855,000
Year 3						\$225,000		\$60,000		\$285,000
Year 4	100	m	\$3,000	\$300,000				\$60,000		\$360,000
Year 5								\$75,000		\$75,000
Year 6	100	m	\$3,000	\$300,000				\$75,000		\$375,000
Year 7								\$90,000		\$90,000
Year 8	100	m	\$3,000	\$300,000				\$90,000	\$22,500	\$412,500
Year 9								\$105,000		\$105,000
Year 10	100	m	\$3,000	\$300,000				\$105,000		\$405,000
Year 11								\$120,000		\$120,000
Year 12	100	m	\$3,000	\$300,000				\$120,000		\$420,000
Year 13								\$135,000	\$22,500	\$157,500
Year 14	100	m	\$3,000	\$300,000				\$135,000		\$435,000
Year 15								\$150,000		\$150,000
Year 16								\$150,000		\$150,000
Year 17								\$150,000		\$150,000
Year 18								\$150,000	\$22,500	\$172,500
Year 19								\$150,000		\$150,000
Year 20								\$150,000		\$150,000
Year 21								\$150,000		\$150,000
Year 22								\$150,000		\$150,000
Year 23								\$150,000	\$22,500	\$172,500
Year 24								\$150,000		\$150,000
Year 25								\$150,000		\$150,000
Year 26								\$150,000		\$150,000
Year 27								\$150,000		\$150,000
Year 28								\$150,000	\$22,500	\$172,500
Year 29								\$150,000		\$150,000
Year 30								\$150,000		\$150,000
				\$3,000,000		\$450,000		\$3,600,000	\$112,500	\$7,162,500

Summary of Cost Estimates

		Protection								Abandon						
		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
0	2011															
1	2012	\$0	\$0	\$0	\$0	\$100,000	\$900,000	\$600,000								
2	2013	\$1,800,000	\$0	\$0	\$0	\$5,000	\$45,000	\$855,000								
3	2014	\$90,000	\$0	\$0	\$0	\$5,000	\$45,000	\$285,000						\$60,000		
4	2015	\$90,000	\$0	\$0	\$0	\$5,000	\$45,000	\$360,000						unsafe		
5	2016	\$90,000	\$0	\$0	\$0	\$5,000	\$45,000	\$75,000								
6	2017	\$1,290,000	\$0	\$0	\$0	\$5,000	\$645,000	\$375,000								
7	2018	\$150,000	\$0	\$0	\$0	\$5,000	\$75,000	\$90,000								
8	2019	\$150,000	\$0	\$0	\$0	\$5,000	\$75,000	\$412,500	\$70,000						\$80,000	\$80,000
9	2020	\$1,350,000	\$0	\$0	\$0	\$105,000	\$75,000	\$105,000	unsafe						unsafe	unsafe
10	2021	\$210,000	\$0	\$0	\$0	\$10,000	\$75,000	\$405,000								
11	2022	\$210,000	\$0	\$0	\$0	\$10,000	\$675,000	\$120,000								
12	2023	\$1,410,000	\$0	\$0	\$0	\$10,000	\$105,000	\$420,000								
13	2024	\$270,000	\$0	\$0	\$0	\$10,000	\$105,000	\$157,500								
14	2025	\$270,000	\$0	\$0	\$0	\$10,000	\$105,000	\$435,000								
15	2026	\$1,470,000	\$0	\$0	\$0	\$10,000	\$105,000	\$150,000								
16	2027	\$330,000	\$0	\$0	\$0	\$10,000	\$105,000	\$150,000								
17	2028	\$330,000	\$0	\$0	\$0	\$10,000	\$105,000	\$150,000								
18	2029	\$1,530,000	\$0	\$0	\$0	\$10,000	\$105,000	\$172,500							\$40,000	
19	2030	\$390,000	\$0	\$0	\$0	\$110,000	\$105,000	\$150,000							unsafe	
20	2031	\$390,000	\$900,000	\$0	\$0	\$15,000	\$405,000	\$150,000								
21	2032	\$1,590,000	\$45,000	\$0	\$0	\$15,000	\$120,000	\$150,000								
22	2033	\$450,000	\$45,000	\$0	\$0	\$15,000	\$120,000	\$150,000								
23	2034	\$450,000	\$45,000	\$0	\$0	\$15,000	\$120,000	\$172,500			\$70,000					
24	2035	\$1,050,000	\$45,000	\$0	\$0	\$15,000	\$120,000	\$150,000			unsafe					
25	2036	\$480,000	\$945,000	\$0	\$0	\$15,000	\$120,000	\$150,000								
26	2037	\$480,000	\$90,000	\$0	\$0	\$15,000	\$120,000	\$150,000								
27	2038	\$480,000	\$90,000	\$0	\$0	\$15,000	\$120,000	\$150,000								
28	2039	\$480,000	\$90,000	\$0	\$0	\$15,000	\$120,000	\$172,500								
29	2040	\$480,000	\$90,000	\$0	\$0	\$115,000	\$120,000	\$150,000								
30	2041	\$480,000	\$990,000	\$0	\$0	\$0	\$120,000	\$150,000								
		\$18,240,000	\$3,375,000	\$0	\$0	\$690,000	\$5,145,000	\$7,162,500		\$70,000	\$70,000	\$0	\$0	\$60,000	\$120,000	\$80,000

APPENDIX D

Economic Analysis

Waitaki Coastal Roads Economics

Benefit Cost Ratios

Northern Coastal Route (Sections 1-4)

	PV of Costs / Benefits (\$)		
	Do Min	Option 1	Option 2
Travel Time Costs	29,741,210	29,019,897	29,664,595
VOC	27,516,635	26,864,548	27,414,626
Accident Costs	7,595,327	7,385,641	7,654,498
Scenic Value Benefits	-2,259,064	-2,655,750	-2,321,120
Total	62,594,108	60,614,337	62,412,598
Capital + Maintenance Costs	51,444	7,038,951	542,787
Total	51,444	7,038,951	542,787
Net Benefits			1,979,771
Net Costs			181,510
BCR			0.3

Do-Minimum:	Abandon Site 1 and 2 - traffic diverted via Awamoa Central Road Year 2020-2034 and via Thousand Acre Road Year 2035 onwards
Option 1:	Protect Site 1 and 2 - travel via Beach Road
Option 2:	Abandon Site 1, Protect Site 2 - traffic diverted via Awamoa Central Road Year 2020 onwards

Southern Coastal Route (Sections 5-7)

	PV of Costs / Benefits (\$)			
	Do Min	Option 1	Option 2	Option 3
Travel Time Costs	6,599,647	5,804,742	6,340,869	6,340,869
VOC	6,626,936	6,007,088	6,425,147	6,425,147
Accident Costs	1,778,293	1,481,445	1,676,439	1,676,439
Scenic Value Benefits	-1,490,340	-2,655,750	-2,321,120	-1,986,490
Total	13,514,536	10,637,525	12,121,336	12,455,966
Capital + Maintenance Costs	144,083	6,072,939	2,645,506	356,468
Total	144,083	6,072,939	2,645,506	356,468
Net Benefits			2,877,011	1,058,570
Net Costs			1,393,200	212,386
BCR			0.5	5.0

Do-Minimum:	Abandon Site 5, 6 and 7 - traffic diverted via Happy Valley Road Year 2015 onwards
Option 1:	Protect Sites 5, 6 and 7 - travel via Waianakarua Road
Option 2:	Abandon Site 7, Protect Sites 5 and 6 - traffic diverted via Happy Valley Road Year 2020 onwards
Option 3:	Abandon Site 6 and 7, Protect Site 5 - traffic diverted via Happy Valley Road Year 2016 onwards

Waitaki Coastal Roads Economics

Discounting

Time Zero Base Date	2011 Jul-11	Update Factor TT Update Factor VOC Update Factor Acc	1.31 1.00 1.15	Scenic Value Benefits:	= 25 veh/day x \$20 per vehicle x 365 days/year = \$182,500 /year
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NORTHERN SECTION DO-MINIMUM: Abandon Site 1 and 2 - traffic diverted via Awamoa Central Road Year 2020-2034 and via Thousand Acre Road Year 2035 onwards																
Calendar Year	Time Stream Year	Discount Factor (@8%)	TRAVEL TIME COSTS		VEHICLE OPERATING COSTS		ACCIDENT COSTS		CAPITAL COSTS		SCENIC VALUE BENEFITS					
			Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	% Reduction	Discounted Annual Amount			
2011	0	1.0000	\$1,522,300	\$1,522,300	\$1,846,100	\$1,846,100	\$479,100	\$479,100	\$0	\$0	\$182,500	0%	\$182,500	\$182,500	0%	\$182,500
2012	1	0.9259	\$1,552,746	\$1,437,728	\$1,883,022	\$1,743,539	\$483,891	\$448,047	\$0	\$0	\$186,150	0%	\$186,150	\$172,361	0%	\$172,361
2013	2	0.8573	\$1,583,192	\$1,357,332	\$1,919,944	\$1,646,043	\$488,682	\$418,966	\$0	\$0	\$189,800	0%	\$189,800	\$162,723	0%	\$162,723
2014	3	0.7938	\$1,613,638	\$1,280,958	\$1,956,866	\$1,553,423	\$493,473	\$391,735	\$0	\$0	\$193,450	0%	\$193,450	\$153,567	0%	\$153,567
2015	4	0.7350	\$1,644,084	\$1,208,451	\$1,993,788	\$1,465,494	\$498,264	\$366,239	\$0	\$0	\$197,100	0%	\$197,100	\$144,874	0%	\$144,874
2016	5	0.6806	\$1,674,530	\$1,139,657	\$2,030,710	\$1,382,067	\$503,055	\$342,371	\$0	\$0	\$200,750	0%	\$200,750	\$136,627	0%	\$136,627
2017	6	0.6302	\$1,704,976	\$1,074,424	\$2,067,632	\$1,302,959	\$507,846	\$320,029	\$0	\$0	\$204,400	0%	\$204,400	\$128,807	0%	\$128,807
2018	7	0.5835	\$1,735,422	\$1,012,602	\$2,104,554	\$1,227,987	\$512,637	\$299,119	\$0	\$0	\$208,050	0%	\$208,050	\$121,395	0%	\$121,395
2019	8	0.5403	\$1,765,868	\$954,044	\$2,141,476	\$1,156,973	\$517,428	\$279,550	\$70,000	\$37,819	\$211,700	0%	\$211,700	\$114,375	0%	\$114,375
2020	9	0.5002	\$1,875,492	\$938,213	\$2,266,898	\$1,134,013	\$561,895	\$281,087	\$0	\$0	\$215,350	25%	\$215,350	\$80,796	25%	\$80,796
2021	10	0.4632	\$1,907,280	\$883,440	\$2,305,320	\$1,067,809	\$567,050	\$262,654	\$0	\$0	\$219,000	25%	\$219,000	\$76,080	25%	\$76,080
2022	11	0.4289	\$1,939,068	\$831,633	\$2,343,742	\$1,005,191	\$572,205	\$245,409	\$0	\$0	\$222,650	25%	\$222,650	\$71,618	25%	\$71,618
2023	12	0.3971	\$1,970,856	\$782,654	\$2,382,164	\$945,990	\$577,360	\$229,278	\$0	\$0	\$226,300	25%	\$226,300	\$67,400	25%	\$67,400
2024	13	0.3677	\$2,002,644	\$736,368	\$2,420,586	\$890,044	\$582,515	\$214,190	\$0	\$0	\$229,950	25%	\$229,950	\$63,414	25%	\$63,414
2025	14	0.3405	\$2,034,432	\$692,645	\$2,459,008	\$837,196	\$587,670	\$200,079	\$0	\$0	\$233,600	25%	\$233,600	\$59,649	25%	\$59,649
2026	15	0.3152	\$2,066,220	\$651,359	\$2,497,430	\$787,294	\$592,825	\$186,883	\$0	\$0	\$237,250	25%	\$237,250	\$56,093	25%	\$56,093
2027	16	0.2919	\$2,098,008	\$612,389	\$2,535,852	\$740,191	\$597,980	\$174,545	\$0	\$0	\$240,900	25%	\$240,900	\$52,737	25%	\$52,737
2028	17	0.2703	\$2,129,796	\$575,618	\$2,574,274	\$695,746	\$603,135	\$163,009	\$0	\$0	\$244,550	25%	\$244,550	\$49,571	25%	\$49,571
2029	18	0.2502	\$2,161,584	\$540,934	\$2,612,696	\$653,825	\$608,290	\$152,224	\$0	\$0	\$248,200	25%	\$248,200	\$46,584	25%	\$46,584
2030	19	0.2317	\$2,193,372	\$508,231	\$2,651,118	\$614,296	\$613,445	\$142,143	\$0	\$0	\$251,850	25%	\$251,850	\$43,768	25%	\$43,768
2031	20	0.2145	\$2,225,160	\$477,404	\$2,689,540	\$577,036	\$618,600	\$132,720	\$0	\$0	\$255,500	25%	\$255,500	\$41,113	25%	\$41,113
2032	21	0.1987	\$2,256,948	\$448,356	\$2,727,962	\$541,925	\$623,755	\$123,913	\$0	\$0	\$259,150	25%	\$259,150	\$38,611	25%	\$38,611
2033	22	0.1839	\$2,288,736	\$420,991	\$2,766,384	\$508,850	\$628,910	\$115,682	\$0	\$0	\$262,800	25%	\$262,800	\$36,255	25%	\$36,255
2034	23	0.1703	\$2,320,524	\$395,221	\$2,804,806	\$477,701	\$634,065	\$107,991	\$80,000	\$13,625	\$266,450	25%	\$266,450	\$34,035	25%	\$34,035
2035	24	0.1577	\$2,415,952	\$380,994	\$2,954,228	\$465,880	\$582,428	\$91,849	\$0	\$0	\$270,100	50%	\$270,100	\$21,297	50%	\$21,297
2036	25	0.1460	\$2,448,600	\$357,539	\$2,994,150	\$437,200	\$587,125	\$85,731	\$0	\$0	\$273,750	50%	\$273,750	\$19,986	50%	\$19,986
2037	26	0.1352	\$2,481,248	\$335,469	\$3,034,072	\$410,212	\$591,822	\$80,015	\$0	\$0	\$277,400	50%	\$277,400	\$18,752	50%	\$18,752
2038	27	0.1252	\$2,513,896	\$314,707	\$3,073,994	\$384,824	\$596,519	\$74,676	\$0	\$0	\$281,050	50%	\$281,050	\$17,592	50%	\$17,592
2039	28	0.1159	\$2,546,544	\$295,179	\$3,113,916	\$360,946	\$601,216	\$69,689	\$0	\$0	\$284,700	50%	\$284,700	\$16,500	50%	\$16,500
2040	29	0.1073	\$2,579,192	\$276,818	\$3,153,838	\$338,494	\$605,913	\$65,031	\$0	\$0	\$288,350	50%	\$288,350	\$15,474	50%	\$15,474
2041	30	0.0994	\$2,611,840	\$259,558	\$3,193,760	\$317,387	\$610,610	\$60,681	\$0	\$0	\$292,000	50%	\$292,000	\$14,509	50%	\$14,509
Sub-Total			\$22,703,214	\$11,311,210	\$27,516,635	\$14,156,635	\$6,604,632	\$3,595,327	Total	\$51,444						
Update factor			1.31			1.00			Update factor			1.15				
Total			\$29,741,210			\$27,516,635			\$7,595,327							

NORTHERN SECTION OPTION 1: Protect Site 1 and 2 - Travel Via Beach Road																
Calendar Year	Time Stream Year	Discount Factor (@8%)	TRAVEL TIME COSTS		VEHICLE OPERATING COSTS		ACCIDENT COSTS		CAPITAL COSTS		SCENIC VALUE BENEFITS					
			Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	% Reduction	Discounted Annual Amount		
2011	0	1.0000	\$1,522,300	\$1,522,300	\$1,846,100	\$1,846,100	\$479,100	\$479,100	\$0	\$0	\$182,500	0%	\$182,500			
2012	1	0.9259	\$1,552,746	\$1,437,728	\$1,883,022	\$1,743,539	\$483,891	\$448,047	\$0	\$0	\$186,150	0%	\$172,361			
2013	2	0.8573	\$1,583,192	\$1,357,332	\$1,919,944	\$1,646,043	\$488,682	\$418,966	\$1,800,000	\$1,543,210	\$189,800	0%	\$162,723			
2014	3	0.7938	\$1,613,638	\$1,280,958	\$1,956,866	\$1,553,423	\$493,473	\$391,735	\$90,000	\$71,445	\$193,450	0%	\$153,567			
2015	4	0.7350	\$1,644,084	\$1,208,451	\$1,993,788	\$1,465,494	\$498,264	\$366,239	\$90,000	\$66,153	\$197,100	0%	\$144,874			
2016	5	0.6806	\$1,674,530	\$1,139,657	\$2,030,710	\$1,382,067	\$503,055	\$342,371	\$90,000	\$61,252	\$200,750	0%	\$136,627			
2017	6	0.6302	\$1,704,976	\$1,074,424	\$2,067,632	\$1,302,959	\$507,846	\$320,029	\$1,290,000	\$812,919	\$204,400	0%	\$128,807			
2018	7	0.5835	\$1,735,422	\$1,012,602	\$2,104,554	\$1,227,987	\$512,637	\$299,119	\$150,000	\$87,524	\$208,050	0%	\$121,395			
2019	8	0.5403	\$1,765,868	\$954,044	\$2,141,476	\$1,156,973	\$517,428	\$279,550	\$150,000	\$81,040	\$211,700	0%	\$114,375			
2020	9	0.5002	\$1,796,314	\$898,604	\$2,178,398	\$1,089,741	\$522,219	\$261,240	\$1,350,000	\$675,336	\$215,350	0%	\$107,729			
2021	10	0.4632	\$1,826,760	\$846,143	\$2,215,320	\$1,026,122	\$527,010	\$244,108	\$210,000	\$97,271	\$219,000	0%	\$101,439			
2022	11	0.4289	\$1,857,206	\$796,524	\$2,252,242	\$965,948	\$531,801	\$228,080	\$210,000	\$90,065	\$222,650	0%	\$95,491			
2023	12	0.3971	\$1,887,652	\$749,613	\$2,289,164	\$909,059	\$536,592	\$213,088	\$1,410,000	\$559,930	\$226,300	0%	\$89,867			
2024	13	0.3677	\$1,918,098	\$705,281	\$2,326,086	\$855,297	\$541,383	\$199,065	\$99,278	\$91,924	\$229,950	0%	\$84,552			
2025	14	0.3405	\$1,948,544	\$663,403	\$2,363,008	\$804,512	\$546,174	\$185,951	\$270,000	\$91,924	\$233,600	0%	\$79,532			
2026	15	0.3152	\$1,978,990	\$623,860	\$2,399,930	\$756,558	\$550,965	\$173,687	\$1,470,000	\$463,405	\$237,250	0%	\$74,791			
2027	16	0.2919	\$2,009,436	\$586,535	\$2,436,852	\$711,294	\$555,756	\$162,220	\$330,000	\$96,324	\$240,900	0%	\$70,316			
2028	17	0.2703	\$2,039,882	\$551,317	\$2,473,774	\$668,584	\$560,547	\$151,498	\$330,000	\$89,189	\$244,550	0%	\$66,094			
2029	18	0.2502	\$2,070,328	\$518,098	\$2,510,696	\$628,299	\$565,338	\$141,475	\$1,530,000	\$382,881	\$248,200	0%	\$62,112			
2030	19	0.2317	\$2,100,774	\$486,775	\$2,547,618	\$590,314	\$570,129	\$132,106	\$390,000	\$90,368	\$251,850	0%	\$58,357			
2031	20	0.2145	\$2,131,220	\$457,249	\$2,584,540	\$554,508	\$574,920	\$123,348	\$1,290,000	\$276,767	\$255,500	0%	\$54,817			
2032	21	0.1987	\$2,161,666	\$429,427	\$2,621,462	\$520,768	\$579,711	\$115,163	\$1,635,000	\$324,802	\$259,150	0%	\$51,482			
2033	22	0.1839	\$2,192,112	\$403,218	\$2,658,384	\$488,985	\$584,502	\$107,514	\$495,000	\$91,051	\$262,800	0%	\$48,340			
2034	23	0.1703	\$2,222,558	\$378,536	\$2,695,306	\$459,052	\$589,293	\$100,366	\$495,000	\$84,306	\$266,450	0%	\$45,381			
2035	24	0.1577	\$2,253,004	\$355,297	\$2,732,228	\$430,871	\$594,084	\$93,687	\$1,095,000	\$172,681	\$270,100	0%	\$42,595			
2036	25	0.1460	\$2,283,450	\$333,425	\$2,769,150	\$404,345	\$598,875	\$87,446	\$1,425,000	\$208,076	\$273,750	0%	\$39,972			
2037	26	0.1352	\$2,313,896	\$312,843	\$2,806,072	\$379,386	\$603,666	\$81,617	\$570,000	\$77,065	\$277,400	0%	\$37,505			
2038	27	0.1252	\$2,344,342	\$293,481	\$2,842,994	\$355,905	\$608,457	\$76,171	\$570,000	\$71,356	\$281,050	0%	\$35,184			
2039	28	0.1159	\$2,374,788	\$275,271	\$2,879,916	\$333,822	\$613,248	\$71,084	\$570,000	\$66,071	\$284,700	0%	\$33,001			
2040	29	0.1073	\$2,405,234	\$258,148	\$2,916,838	\$313,057	\$618,039	\$66,333	\$570,000	\$61,177	\$288,350	0%	\$30,948			
2041	30	0.0994	\$2,435,680	\$242,051	\$2,953,760	\$293,537	\$622,830	\$61,895	\$1,470,000	\$146,085	\$292,000	0%	\$29,018			
Sub-Total			\$22,152,593	\$22,152,593	Sub-Total	\$26,864,548	Sub-Total	\$6,422,297	Total	\$7,038,951						
Update factor				1.31	Update factor		1.00	Update factor		1.15						
Total			\$29,019,897	\$29,019,897	Total	\$26,864,548	Total	\$7,385,641								

NORTHERN SECTION OPTION 2: Abandon Site 1, Protect Site 2 - traffic diverted via Awamoa Central Road Year 2020 onwards																
Calendar Year	Time Stream Year	Discount Factor (@8%)	TRAVEL TIME COSTS		VEHICLE OPERATING COSTS		ACCIDENT COSTS		CAPITAL COSTS		SCENIC VALUE BENEFITS					
			Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	% Reduction	Calculated Annual Amount	Discounted Annual Amount			
2011	0	1.0000	\$1,522,300	\$1,522,300	\$1,846,100	\$1,846,100	\$479,100	\$479,100	\$0	\$0	\$182,500	0%	\$182,500	\$172,361		
2012	1	0.9259	\$1,552,746	\$1,437,728	\$1,883,022	\$1,743,539	\$483,891	\$448,047	\$0	\$0	\$186,150	0%	\$172,361	\$162,723		
2013	2	0.8573	\$1,583,192	\$1,357,332	\$1,919,944	\$1,646,043	\$488,682	\$418,966	\$0	\$0	\$189,800	0%	\$162,723	\$153,567		
2014	3	0.7938	\$1,613,638	\$1,280,958	\$1,956,866	\$1,553,423	\$493,473	\$391,735	\$0	\$0	\$193,450	0%	\$153,567	\$144,874		
2015	4	0.7350	\$1,644,084	\$1,208,451	\$1,993,788	\$1,465,494	\$498,264	\$366,239	\$0	\$0	\$197,100	0%	\$144,874	\$136,627		
2016	5	0.6806	\$1,674,530	\$1,139,657	\$2,030,710	\$1,382,067	\$503,055	\$342,371	\$0	\$0	\$200,750	0%	\$136,627	\$128,807		
2017	6	0.6302	\$1,704,976	\$1,074,424	\$2,067,632	\$1,302,959	\$507,846	\$320,029	\$0	\$0	\$204,400	0%	\$128,807	\$121,395		
2018	7	0.5835	\$1,735,422	\$1,012,602	\$2,104,554	\$1,227,987	\$512,637	\$299,119	\$0	\$0	\$208,050	0%	\$121,395	\$114,375		
2019	8	0.5403	\$1,765,868	\$954,044	\$2,141,476	\$1,156,973	\$517,428	\$279,550	\$70,000	\$37,819	\$211,700	0%	\$114,375	\$80,796		
2020	9	0.5002	\$1,875,492	\$938,213	\$2,266,898	\$1,134,013	\$561,895	\$281,087	\$0	\$0	\$215,350	25%	\$80,796	\$76,080		
2021	10	0.4632	\$1,907,280	\$883,440	\$2,305,320	\$1,067,809	\$567,050	\$262,654	\$0	\$0	\$219,000	25%	\$76,080	\$71,618		
2022	11	0.4289	\$1,939,068	\$831,633	\$2,343,742	\$1,005,191	\$572,205	\$245,409	\$0	\$0	\$222,650	25%	\$71,618	\$67,400		
2023	12	0.3971	\$1,970,856	\$782,654	\$2,382,164	\$945,990	\$577,360	\$229,278	\$0	\$0	\$226,300	25%	\$67,400	\$63,414		
2024	13	0.3677	\$2,002,644	\$736,368	\$2,420,586	\$890,044	\$582,515	\$214,190	\$0	\$0	\$229,950	25%	\$63,414	\$59,649		
2025	14	0.3405	\$2,034,432	\$692,645	\$2,459,008	\$837,196	\$587,670	\$200,079	\$0	\$0	\$233,600	25%	\$59,649	\$56,093		
2026	15	0.3152	\$2,066,220	\$651,359	\$2,497,430	\$787,294	\$592,825	\$186,883	\$0	\$0	\$237,250	25%	\$56,093	\$52,737		
2027	16	0.2919	\$2,098,008	\$612,389	\$2,535,852	\$740,191	\$597,980	\$174,545	\$0	\$0	\$240,900	25%	\$52,737	\$49,571		
2028	17	0.2703	\$2,129,796	\$575,618	\$2,574,274	\$695,746	\$603,135	\$163,009	\$0	\$0	\$244,550	25%	\$49,571	\$46,584		
2029	18	0.2502	\$2,161,584	\$540,934	\$2,612,696	\$653,825	\$608,290	\$152,224	\$0	\$0	\$248,200	25%	\$46,584	\$43,768		
2030	19	0.2317	\$2,193,372	\$508,231	\$2,651,118	\$614,296	\$613,445	\$142,143	\$0	\$0	\$251,850	25%	\$43,768	\$41,113		
2031	20	0.2145	\$2,225,160	\$477,404	\$2,689,540	\$577,036	\$618,600	\$132,720	\$900,000	\$193,093	\$255,500	25%	\$41,113	\$38,611		
2032	21	0.1987	\$2,256,948	\$448,356	\$2,727,962	\$541,925	\$623,755	\$123,913	\$45,000	\$8,940	\$259,150	25%	\$38,611	\$36,255		
2033	22	0.1839	\$2,288,736	\$420,991	\$2,766,384	\$508,850	\$628,910	\$115,682	\$45,000	\$8,277	\$262,800	25%	\$36,255	\$34,035		
2034	23	0.1703	\$2,320,524	\$395,221	\$2,804,806	\$477,701	\$634,065	\$107,991	\$45,000	\$7,664	\$266,450	25%	\$34,035	\$31,946		
2035	24	0.1577	\$2,352,312	\$370,958	\$2,843,228	\$448,375	\$639,220	\$100,805	\$45,000	\$7,096	\$270,100	25%	\$31,946	\$29,979		
2036	25	0.1460	\$2,384,100	\$348,121	\$2,881,650	\$420,772	\$644,375	\$94,090	\$945,000	\$137,987	\$273,750	25%	\$29,979	\$28,129		
2037	26	0.1352	\$2,415,888	\$326,632	\$2,920,072	\$394,799	\$649,530	\$87,818	\$90,000	\$12,168	\$277,400	25%	\$28,129	\$26,388		
2038	27	0.1252	\$2,447,676	\$306,417	\$2,958,494	\$370,364	\$654,685	\$81,958	\$90,000	\$11,267	\$281,050	25%	\$26,388	\$24,750		
2039	28	0.1159	\$2,479,464	\$287,404	\$2,996,916	\$347,384	\$659,840	\$76,485	\$90,000	\$10,432	\$284,700	25%	\$24,750	\$23,211		
2040	29	0.1073	\$2,511,252	\$269,526	\$3,035,338	\$325,775	\$664,995	\$71,372	\$90,000	\$9,659	\$288,350	25%	\$23,211	\$21,764		
2041	30	0.0994	\$2,543,040	\$252,721	\$3,073,760	\$305,462	\$670,150	\$66,598	\$990,000	\$98,384	\$292,000	25%	\$21,764	\$2,321,120		
Sub-Total			\$22,644,729		Sub-Total	\$27,414,626	Sub-T total	\$6,656,085	Total	\$542,787	Total		Total			
Update factor			1.31		Update factor	1.00	Update factor	1.15								
Total			\$29,664,595		Total	\$27,414,626	Total	\$7,654,498								

SOUTHERN SECTION OPTION 1: Protect Sites 5, 6 and 7 - Travel via Waiānākarua Road																
Calendar Year	Time Stream Year	Discount Factor (@8%)	TRAVEL TIME COSTS		VEHICLE OPERATING COSTS		ACCIDENT COSTS		CAPITAL COSTS		SCENIC VALUE BENEFITS					
			Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	% Reduction	Discounted Annual Amount		
2011	0	1.0000	\$304,500	\$304,500	\$412,800	\$412,800	\$96,100	\$96,100	\$0	\$0	\$182,500	0%	\$182,500			
2012	1	0.9259	\$310,590	\$287,583	\$421,056	\$389,867	\$97,061	\$89,871	\$1,600,000	\$1,481,481	\$186,150	0%	\$172,361			
2013	2	0.8573	\$316,680	\$271,502	\$429,312	\$368,066	\$98,022	\$84,038	\$905,000	\$775,892	\$189,800	0%	\$162,723			
2014	3	0.7938	\$322,770	\$256,225	\$437,568	\$347,356	\$98,983	\$78,576	\$935,000	\$765,934	\$193,450	0%	\$153,567			
2015	4	0.7350	\$328,860	\$241,722	\$445,824	\$327,694	\$99,944	\$73,462	\$410,000	\$301,362	\$197,100	0%	\$144,874			
2016	5	0.6806	\$334,950	\$227,961	\$454,080	\$309,039	\$100,905	\$68,674	\$125,000	\$85,073	\$200,750	0%	\$136,627			
2017	6	0.6302	\$341,040	\$214,913	\$462,336	\$291,350	\$101,866	\$64,193	\$1,025,000	\$645,924	\$204,400	0%	\$128,807			
2018	7	0.5835	\$347,130	\$202,547	\$470,592	\$274,586	\$102,827	\$59,999	\$170,000	\$99,193	\$208,050	0%	\$121,395			
2019	8	0.5403	\$353,220	\$190,834	\$478,848	\$258,707	\$103,788	\$56,073	\$492,500	\$266,082	\$211,700	0%	\$114,375			
2020	9	0.5002	\$359,310	\$179,744	\$487,104	\$243,673	\$104,749	\$52,401	\$285,000	\$142,571	\$215,350	0%	\$107,729			
2021	10	0.4632	\$365,400	\$169,251	\$495,360	\$229,448	\$105,710	\$48,964	\$490,000	\$226,965	\$219,000	0%	\$101,439			
2022	11	0.4289	\$371,490	\$159,326	\$503,616	\$215,992	\$106,671	\$45,749	\$805,000	\$345,251	\$222,650	0%	\$95,491			
2023	12	0.3971	\$377,580	\$149,942	\$511,872	\$203,271	\$107,632	\$42,742	\$535,000	\$212,456	\$226,300	0%	\$89,867			
2024	13	0.3677	\$383,670	\$141,075	\$520,128	\$191,250	\$108,593	\$39,929	\$272,500	\$100,198	\$229,950	0%	\$84,552			
2025	14	0.3405	\$389,760	\$132,698	\$528,384	\$179,894	\$109,554	\$37,299	\$550,000	\$187,254	\$233,600	0%	\$79,532			
2026	15	0.3152	\$395,850	\$124,788	\$536,640	\$169,171	\$110,515	\$34,839	\$265,000	\$83,539	\$237,250	0%	\$74,791			
2027	16	0.2919	\$401,940	\$117,322	\$544,896	\$159,050	\$111,476	\$32,539	\$265,000	\$77,351	\$240,900	0%	\$70,316			
2028	17	0.2703	\$408,030	\$110,278	\$553,152	\$149,500	\$112,437	\$30,388	\$265,000	\$71,621	\$244,550	0%	\$66,094			
2029	18	0.2502	\$414,120	\$103,633	\$561,408	\$140,492	\$113,398	\$28,378	\$287,500	\$71,947	\$248,200	0%	\$62,112			
2030	19	0.2317	\$420,210	\$97,368	\$569,664	\$131,998	\$114,359	\$26,498	\$365,000	\$84,575	\$251,850	0%	\$58,357			
2031	20	0.2145	\$426,300	\$91,462	\$577,920	\$123,992	\$115,320	\$24,742	\$570,000	\$122,292	\$255,500	0%	\$54,817			
2032	21	0.1987	\$432,390	\$85,897	\$586,176	\$116,447	\$116,281	\$23,100	\$285,000	\$56,617	\$259,150	0%	\$51,482			
2033	22	0.1839	\$438,480	\$80,654	\$594,432	\$109,340	\$117,242	\$21,566	\$285,000	\$52,423	\$262,800	0%	\$48,340			
2034	23	0.1703	\$444,570	\$75,717	\$602,688	\$102,647	\$118,203	\$20,132	\$307,500	\$52,372	\$266,450	0%	\$45,381			
2035	24	0.1577	\$450,660	\$71,069	\$610,944	\$96,345	\$119,164	\$18,792	\$285,000	\$44,944	\$270,100	0%	\$42,595			
2036	25	0.1460	\$456,750	\$66,694	\$619,200	\$90,414	\$120,125	\$17,540	\$285,000	\$41,615	\$273,750	0%	\$39,972			
2037	26	0.1352	\$462,840	\$62,577	\$627,456	\$84,833	\$121,086	\$16,371	\$285,000	\$38,533	\$277,400	0%	\$37,505			
2038	27	0.1252	\$468,930	\$58,704	\$635,712	\$79,583	\$122,047	\$15,279	\$285,000	\$35,678	\$281,050	0%	\$35,184			
2039	28	0.1159	\$475,020	\$55,061	\$643,968	\$74,645	\$123,008	\$14,258	\$307,500	\$35,643	\$284,700	0%	\$33,001			
2040	29	0.1073	\$481,110	\$51,636	\$652,224	\$70,002	\$123,969	\$13,305	\$385,000	\$41,321	\$288,350	0%	\$30,948			
2041	30	0.0994	\$487,200	\$48,417	\$660,480	\$65,637	\$124,930	\$12,415	\$270,000	\$26,832	\$292,000	0%	\$29,018			
Sub-Total			\$4,431,101		Sub-Total	\$6,007,088		Sub-T total	Total	\$6,072,939		Total	\$2,655,750			
Update factor				1.31	Update factor		1.00	Update factor		1.15						
Total			\$5,804,742		Total	\$6,007,088		Total		\$1,481,445						

SOUTHERN SECTION OPTION 2: Abandon Site 7, Protect Sites 5 and 6 - traffic diverted via Happy Valley Road Year 2020 onwards																	
Calendar Year	Time Stream Year	Discount Factor (@8%)	TRAVEL TIME COSTS		VEHICLE OPERATING COSTS		ACCIDENT COSTS		CAPITAL COSTS		SCENIC VALUE BENEFITS						
			Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	% Reduction	Discounted Annual Amount			
2011	0	1.0000	\$304,500	\$304,500	\$412,800	\$412,800	\$96,100	\$96,100	\$0	\$0	\$182,500	0%	\$182,500				
2012	1	0.9259	\$310,590	\$287,583	\$421,056	\$389,867	\$97,061	\$89,871	\$1,000,000	\$925,926	\$186,150	0%	\$172,361				
2013	2	0.8573	\$316,680	\$271,502	\$429,312	\$368,066	\$98,022	\$84,038	\$50,000	\$42,867	\$189,800	0%	\$162,723				
2014	3	0.7938	\$322,770	\$256,225	\$437,568	\$347,356	\$98,983	\$78,576	\$50,000	\$39,692	\$193,450	0%	\$153,567				
2015	4	0.7350	\$328,860	\$241,722	\$445,824	\$327,694	\$99,944	\$73,462	\$50,000	\$36,751	\$197,100	0%	\$144,874				
2016	5	0.6806	\$334,950	\$227,961	\$454,080	\$309,039	\$100,905	\$68,674	\$50,000	\$34,029	\$200,750	0%	\$136,627				
2017	6	0.6302	\$341,040	\$214,913	\$462,336	\$291,350	\$101,866	\$64,193	\$650,000	\$409,610	\$204,400	0%	\$128,807				
2018	7	0.5835	\$347,130	\$202,547	\$470,592	\$274,586	\$102,827	\$59,999	\$80,000	\$46,679	\$208,050	0%	\$121,395				
2019	8	0.5403	\$353,220	\$190,834	\$478,848	\$258,707	\$103,788	\$56,073	\$160,000	\$86,443	\$211,700	0%	\$114,375				
2020	9	0.5002	\$425,154	\$212,683	\$554,364	\$277,320	\$133,525	\$66,796	\$180,000	\$90,045	\$215,350	25%	\$80,796				
2021	10	0.4632	\$432,360	\$200,266	\$563,760	\$261,130	\$134,750	\$62,415	\$85,000	\$39,371	\$219,000	25%	\$76,080				
2022	11	0.4289	\$439,566	\$188,522	\$573,156	\$245,817	\$135,975	\$58,317	\$85,000	\$29,378	\$222,650	25%	\$71,618				
2023	12	0.3971	\$446,772	\$177,419	\$582,552	\$231,339	\$137,200	\$54,484	\$115,000	\$45,668	\$226,300	25%	\$67,400				
2024	13	0.3677	\$453,978	\$166,927	\$591,948	\$217,658	\$138,425	\$50,899	\$115,000	\$42,285	\$229,950	25%	\$63,414				
2025	14	0.3405	\$461,184	\$157,015	\$601,344	\$204,734	\$139,650	\$47,545	\$115,000	\$39,153	\$233,600	25%	\$59,649				
2026	15	0.3152	\$468,390	\$147,656	\$610,740	\$192,531	\$140,875	\$44,410	\$115,000	\$36,253	\$237,250	25%	\$56,093				
2027	16	0.2919	\$475,596	\$138,822	\$620,136	\$181,012	\$142,100	\$41,478	\$115,000	\$33,567	\$240,900	25%	\$52,737				
2028	17	0.2703	\$482,802	\$130,486	\$629,532	\$170,143	\$143,325	\$38,736	\$115,000	\$31,081	\$244,550	25%	\$49,571				
2029	18	0.2502	\$490,008	\$122,624	\$638,928	\$159,891	\$144,550	\$36,173	\$115,000	\$28,779	\$248,200	25%	\$46,584				
2030	19	0.2317	\$497,214	\$115,210	\$648,324	\$150,224	\$145,775	\$33,778	\$125,000	\$29,818	\$251,850	25%	\$43,768				
2031	20	0.2145	\$504,420	\$108,222	\$657,720	\$141,113	\$147,000	\$31,539	\$420,000	\$90,110	\$255,500	25%	\$41,113				
2032	21	0.1987	\$511,626	\$101,637	\$667,116	\$132,526	\$148,225	\$29,446	\$135,000	\$26,819	\$259,150	25%	\$38,611				
2033	22	0.1839	\$518,832	\$95,434	\$676,512	\$124,438	\$149,450	\$27,490	\$135,000	\$24,832	\$262,800	25%	\$36,255				
2034	23	0.1703	\$526,038	\$89,592	\$685,908	\$116,821	\$150,675	\$25,662	\$135,000	\$22,993	\$266,450	25%	\$34,035				
2035	24	0.1577	\$533,244	\$84,092	\$695,304	\$109,649	\$151,900	\$23,955	\$135,000	\$21,289	\$270,100	25%	\$31,946				
2036	25	0.1460	\$540,450	\$78,915	\$704,700	\$102,899	\$153,125	\$22,359	\$135,000	\$19,712	\$273,750	25%	\$29,979				
2037	26	0.1352	\$547,656	\$74,044	\$714,096	\$96,547	\$154,350	\$20,868	\$135,000	\$18,252	\$277,400	25%	\$28,129				
2038	27	0.1252	\$554,862	\$69,461	\$723,492	\$90,572	\$155,575	\$19,476	\$135,000	\$16,900	\$281,050	25%	\$26,388				
2039	28	0.1159	\$562,068	\$65,151	\$732,888	\$84,952	\$156,800	\$18,175	\$135,000	\$15,648	\$284,700	25%	\$24,750				
2040	29	0.1073	\$569,274	\$61,099	\$742,284	\$79,668	\$158,025	\$16,960	\$235,000	\$25,222	\$288,350	25%	\$23,211				
2041	30	0.0994	\$576,480	\$57,289	\$751,680	\$74,700	\$159,250	\$15,826	\$120,000	\$11,925	\$292,000	25%	\$21,764				
Sub-Total			\$4,840,358	Sub-Total	\$6,425,147	Sub-Total	\$1,457,773	Sub-Total	Total	\$2,645,506	Total			\$2,321,120			
Update factor				1.31	Update factor		1.00	Update factor		1.15							
Total			\$6,340,869	Total	\$6,425,147	Total	\$1,676,439	Total									

SOUTHERN SECTION OPTION 3: Abandon Sites 6 and 7, Protect Site 5 - traffic diverted via Happy Valley Road Year 2016 onwards																
Calendar Year	Time Stream Year	Discount Factor (@8%)	TRAVEL TIME COSTS		VEHICLE OPERATING COSTS		ACCIDENT COSTS		CAPITAL COSTS		SCENIC VALUE BENEFITS					
			Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	Calculated Annual Amount	Discounted Annual Amount	% Reduction	Calculated Annual Amount	Discounted Annual Amount			
2011	0	1.0000	\$304,500	\$304,500	\$412,800	\$412,800	\$96,100	\$96,100	\$0	\$0		\$182,500	0%	\$182,500		
2012	1	0.9259	\$310,590	\$287,583	\$421,056	\$389,867	\$97,061	\$89,871	\$100,000	\$92,593		\$186,150	0%	\$172,361		
2013	2	0.8573	\$316,680	\$271,502	\$429,312	\$368,066	\$98,022	\$84,038	\$5,000	\$4,287		\$189,800	0%	\$162,723		
2014	3	0.7938	\$322,770	\$256,225	\$437,568	\$347,356	\$98,983	\$78,576	\$5,000	\$3,969		\$193,450	0%	\$153,567		
2015	4	0.7350	\$328,860	\$241,722	\$445,824	\$327,694	\$99,944	\$73,462	\$5,000	\$3,675		\$197,100	0%	\$144,874		
2016	5	0.6806	\$334,950	\$227,961	\$454,080	\$309,039	\$100,905	\$68,674	\$5,000	\$3,403		\$200,750	0%	\$136,627		
2017	6	0.6302	\$341,040	\$214,913	\$462,336	\$291,350	\$101,866	\$64,193	\$5,000	\$3,151		\$204,400	0%	\$128,807		
2018	7	0.5835	\$347,130	\$202,547	\$470,592	\$274,586	\$102,827	\$59,999	\$5,000	\$2,917		\$208,050	0%	\$121,395		
2019	8	0.5403	\$353,220	\$190,834	\$478,848	\$258,707	\$103,788	\$56,073	\$165,000	\$89,144		\$211,700	0%	\$114,375		
2020	9	0.5002	\$425,154	\$212,683	\$554,364	\$277,320	\$133,525	\$66,796	\$105,000	\$52,526		\$215,350	50%	\$53,864		
2021	10	0.4632	\$432,360	\$200,266	\$563,760	\$261,130	\$134,750	\$62,415	\$10,000	\$4,632		\$219,000	50%	\$50,720		
2022	11	0.4289	\$439,566	\$188,522	\$573,156	\$245,817	\$135,975	\$58,317	\$10,000	\$4,289		\$222,650	50%	\$47,745		
2023	12	0.3971	\$446,772	\$177,419	\$582,552	\$231,339	\$137,200	\$54,484	\$10,000	\$3,971		\$226,300	50%	\$44,933		
2024	13	0.3677	\$453,978	\$166,927	\$591,948	\$217,658	\$138,425	\$50,899	\$10,000	\$3,677		\$229,950	50%	\$42,276		
2025	14	0.3405	\$461,184	\$157,015	\$601,344	\$204,734	\$139,650	\$47,545	\$10,000	\$3,405		\$233,600	50%	\$39,766		
2026	15	0.3152	\$468,390	\$147,656	\$610,740	\$192,531	\$140,875	\$44,410	\$10,000	\$3,152		\$237,250	50%	\$37,396		
2027	16	0.2919	\$475,596	\$138,822	\$620,136	\$181,012	\$142,100	\$41,478	\$10,000	\$2,919		\$240,900	50%	\$35,158		
2028	17	0.2703	\$482,802	\$130,486	\$629,532	\$170,143	\$143,325	\$38,736	\$10,000	\$2,703		\$244,550	50%	\$33,047		
2029	18	0.2502	\$490,008	\$122,624	\$638,928	\$159,891	\$144,550	\$36,173	\$50,000	\$12,512		\$248,200	50%	\$31,056		
2030	19	0.2317	\$497,214	\$115,210	\$648,324	\$150,224	\$145,775	\$33,778	\$110,000	\$25,488		\$251,850	50%	\$29,178		
2031	20	0.2145	\$504,420	\$108,222	\$657,720	\$141,113	\$147,000	\$31,539	\$15,000	\$3,218		\$255,500	50%	\$27,409		
2032	21	0.1987	\$511,626	\$101,637	\$667,116	\$132,526	\$148,225	\$29,446	\$15,000	\$2,980		\$259,150	50%	\$25,741		
2033	22	0.1839	\$518,832	\$95,434	\$676,512	\$124,438	\$149,450	\$27,490	\$15,000	\$2,759		\$262,800	50%	\$24,170		
2034	23	0.1703	\$526,038	\$89,592	\$685,908	\$116,821	\$150,675	\$25,662	\$15,000	\$2,555		\$266,450	50%	\$22,690		
2035	24	0.1577	\$533,244	\$84,092	\$695,304	\$109,649	\$151,900	\$23,955	\$15,000	\$2,365		\$270,100	50%	\$21,297		
2036	25	0.1460	\$540,450	\$78,915	\$704,700	\$102,899	\$153,125	\$22,359	\$15,000	\$2,190		\$273,750	50%	\$19,986		
2037	26	0.1352	\$547,656	\$74,044	\$714,096	\$96,547	\$154,350	\$20,868	\$15,000	\$2,028		\$277,400	50%	\$18,752		
2038	27	0.1252	\$554,862	\$69,461	\$723,492	\$90,572	\$155,575	\$19,476	\$15,000	\$1,878		\$281,050	50%	\$17,592		
2039	28	0.1159	\$562,068	\$65,151	\$732,888	\$84,952	\$156,800	\$18,175	\$15,000	\$1,739		\$284,700	50%	\$16,500		
2040	29	0.1073	\$569,274	\$61,099	\$742,284	\$79,668	\$158,025	\$16,960	\$115,000	\$12,343		\$288,350	50%	\$15,474		
2041	30	0.0994	\$576,480	\$57,289	\$751,680	\$74,700	\$159,250	\$15,826	\$0	\$0		\$292,000	50%	\$14,509		
Sub-Total			\$4,840,358	Sub-Total	\$6,425,147	Sub-Total	\$1,457,773	Sub-Total	Total	\$356,468		Total		\$1,986,490		
Update factor				1.31	Update factor		1.00	Update factor		1.15						
Total			\$6,340,869	Total	\$6,425,147	Total	\$1,676,439	Total								

Waitaki Coastal Roads Economics

Adjustment for Traffic Growth

Traffic Growth:
Growth Rate Adjustment Factor for Accident Costs:

2%
-1% (Table A6.1(b))

Scenic Value Benefits:

= 25 veh/day x \$20 per vehicle x 365 days/year
= \$182,500 /year

Calendar Year	Time Stream Year	Northern Coastal Route - Oamaru to Kakanui										Southern Coastal Route - Kakanui to SH1										Scenic Value Benefits
		Oamaru to Kakanui via Beach Road					Oamaru to Kakanui via Awamoa Central Road					Kakanui to SH1 via Waianakarua Road					Kakanui to SH1 via Happy Valley Road					
		TT Costs (\$)	VOC Costs (\$)	Acc Costs (\$)	TT Costs (\$)	VOC Costs (\$)	Acc Costs (\$)	TT Costs (\$)	VOC Costs (\$)	Acc Costs (\$)	TT Costs (\$)	VOC Costs (\$)	Acc Costs (\$)	TT Costs (\$)	VOC Costs (\$)	Acc Costs (\$)	TT Costs (\$)	VOC Costs (\$)	Acc Costs (\$)			
2011	0	1,522,300	1,846,100	479,100	1,589,400	1,921,100	515,500	1,632,400	1,996,100	469,700	96,100	304,500	412,800	360,300	469,800	122,500	182,500					
2012	1	1,552,746	1,883,022	483,891	1,621,188	1,959,522	520,655	1,665,048	2,036,022	474,397	97,061	310,590	421,056	367,506	479,196	123,725	186,150					
2013	2	1,583,192	1,919,944	488,682	1,652,976	1,997,944	525,810	1,697,696	2,075,944	479,094	98,022	316,680	429,312	374,712	489,592	124,950	189,800					
2014	3	1,613,638	1,956,866	493,473	1,684,764	2,036,366	530,965	1,730,344	2,115,866	483,791	98,983	322,770	437,568	381,918	497,988	126,175	193,450					
2015	4	1,644,084	1,993,788	498,264	1,716,552	2,074,788	536,120	1,762,992	2,155,788	488,488	99,944	328,860	445,824	389,124	507,384	127,400	197,100					
2016	5	1,674,530	2,030,710	503,055	1,748,340	2,113,210	541,275	1,795,640	2,195,710	493,185	100,905	334,950	454,080	396,330	516,780	128,625	200,750					
2017	6	1,704,976	2,067,632	507,846	1,780,128	2,151,632	546,430	1,828,288	2,235,632	497,882	101,866	341,040	462,336	403,536	526,176	129,850	204,400					
2018	7	1,735,422	2,104,554	512,637	1,811,916	2,190,054	551,585	1,860,936	2,275,554	502,579	102,827	347,130	470,592	410,742	535,572	131,075	208,050					
2019	8	1,765,868	2,141,476	517,428	1,843,704	2,228,476	556,740	1,893,584	2,315,476	507,276	103,788	353,220	478,848	417,948	544,968	132,300	211,700					
2020	9	1,796,314	2,178,398	522,219	1,875,492	2,266,898	561,895	1,926,232	2,355,398	511,973	104,749	359,310	487,104	425,154	554,364	133,525	215,350					
2021	10	1,826,760	2,215,320	527,010	1,907,280	2,305,320	567,050	1,958,880	2,395,320	516,670	105,710	365,400	495,360	432,360	563,760	134,750	219,000					
2022	11	1,857,206	2,252,242	531,801	1,939,068	2,343,742	572,205	1,991,528	2,435,242	521,367	106,671	371,490	503,616	439,566	573,156	135,975	222,650					
2023	12	1,887,652	2,289,164	536,592	1,970,856	2,382,164	577,360	2,024,176	2,475,164	526,064	107,632	377,580	511,872	446,772	582,552	137,200	226,300					
2024	13	1,918,098	2,326,086	541,383	2,002,644	2,420,586	582,515	2,056,824	2,515,086	530,761	108,593	383,670	520,128	453,978	591,948	138,425	229,950					
2025	14	1,948,544	2,363,008	546,174	2,034,432	2,459,008	587,670	2,089,472	2,555,008	535,458	109,554	389,760	528,384	461,184	601,344	139,650	233,600					
2026	15	1,978,990	2,399,930	550,965	2,066,220	2,497,430	590,155	2,122,120	2,594,930	540,155	110,515	395,850	536,640	468,390	610,740	140,875	237,250					
2027	16	2,009,436	2,436,852	555,756	2,098,008	2,535,852	597,980	2,154,768	2,634,852	544,852	111,476	401,940	544,896	475,596	620,136	142,100	240,900					
2028	17	2,039,882	2,473,774	560,547	2,129,796	2,574,274	603,135	2,187,416	2,674,774	549,549	112,437	408,030	553,152	482,802	629,532	143,325	244,550					
2029	18	2,070,328	2,510,696	565,338	2,161,584	2,612,696	608,290	2,220,064	2,714,696	554,246	113,398	414,120	561,408	490,008	638,928	144,550	248,200					
2030	19	2,100,774	2,547,618	570,129	2,193,372	2,651,118	613,445	2,252,712	2,754,618	558,943	114,359	420,210	569,664	497,214	648,324	145,775	251,850					
2031	20	2,131,220	2,584,540	574,920	2,225,160	2,689,540	618,600	2,285,360	2,794,540	563,640	115,320	426,300	577,920	504,420	657,720	147,000	255,500					
2032	21	2,161,666	2,621,462	579,711	2,256,948	2,727,962	623,755	2,318,008	2,834,462	568,337	116,281	432,390	586,176	511,626	667,116	148,225	259,150					
2033	22	2,192,112	2,658,384	584,502	2,288,736	2,766,384	628,910	2,350,656	2,874,384	573,034	117,242	438,480	594,432	518,832	676,512	149,450	262,800					
2034	23	2,222,558	2,695,306	589,293	2,320,524	2,804,806	634,065	2,383,304	2,914,306	577,731	118,203	444,570	602,688	526,038	685,908	150,675	266,450					
2035	24	2,253,004	2,732,228	594,084	2,352,312	2,843,228	639,220	2,415,952	2,954,228	582,428	119,164	450,660	610,944	533,244	695,304	151,900	270,100					
2036	25	2,283,450	2,769,150	598,875	2,384,100	2,881,650	644,375	2,448,600	2,994,150	587,125	120,125	456,750	619,200	540,450	704,700	153,125	273,750					
2037	26	2,313,896	2,806,072	603,666	2,415,888	2,920,072	649,530	2,481,248	3,034,072	591,822	121,086	462,840	627,456	547,656	714,096	154,350	277,400					
2038	27	2,344,342	2,842,994	608,457	2,447,676	2,958,494	654,685	2,513,896	3,073,994	596,519	122,047	468,930	635,712	554,862	723,492	155,575	281,050					
2039	28	2,374,788	2,879,916	613,248	2,479,464	2,996,916	659,840	2,546,544	3,113,916	601,216	123,008	475,020	643,968	562,068	732,888	156,800	284,700					
2040	29	2,405,234	2,916,838	618,039	2,511,252	3,035,338	664,995	2,579,192	3,153,838	605,913	123,969	481,110	652,224	569,274	742,284	158,025	288,350					
2041	30	2,435,680	2,953,760	622,830	2,543,040	3,073,760	670,150	2,611,840	3,193,760	610,610	124,930	487,200	660,480	576,480	751,680	159,250	292,000					

Waitaki Coastal Roads Economics

Waitaki Coastal Roads Economics

Road Section Costs/Benefits

Option	Section	Section Length (km)	Average Speed ² (km/h)	Route AADT	Travel Time Costs			Vehicle Operating Costs			Model Parameters					AADT for accident analysis (veh/day)					Annual Accident Rate A _r (acc/yr)		Total Costs (\$/year)									
					Travel Time (hr)	Base TT Cost ³ (\$/hr)	TT Cost (\$/year)	Assumed Gradient (%)	Base VOC ⁴ (\$/km)	VOC Cost (\$/vehicle)	VOC Cost (\$/year)	Prediction Model	Speed Limit Area	Cost per Injury Accident ⁵ (\$)	ft	Terrain Type	Lane Width (m)	Seal Shoulder Width (m)	b ⁶	S _{adj} ⁷	Exposure X (10 ³ veh.km)	b ^a		b ^a	Road type	Land Use						
Oamaru to Kakanui via Beach Road	Thames Street, Wharfe Street, Beach Road (Severn Street to Jessop Street)	2.5	50	44	1225	0.056	16.23	409,991	2	0.328	0.82	366,643	(5)	50km/h	225,000	-0.03			3.50	0.25	16	1.12	0.0036	1.08	0.195	2000 Collector	Other	0.165	37,225	813,859		
	Beach Road (Jessop Street to 80/100 speed change)	0.8	80	71	1225	0.011	16.23	81,998	2	0.328	0.26	116,253	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	1.12	0.0098		0.064			0.061	33,797	232,047		
	Beach Road (80/100 speed change to Awamoa Road)	2.0	100	89	1225	0.023	22.72	259,575	2	0.348	0.70	311,199	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	1.12	0.0089		0.160			0.152	84,493	625,265		
	Beach Road (Awamoa Road to Gardiners Road)	1.3	100	89	1225	0.015	22.72	149,224	2	0.348	0.45	202,279	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	1.21	0.0058		0.113			0.107	59,333	410,836		
	Gardiners Road (Beach Road to Thousand Acre Road)	1.1	100	89	1225	0.012	22.72	126,266	2	0.348	0.38	171,159	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	1.17	0.0049		0.092			0.087	48,545	345,970		
	Thousand Acre Road (Gardiners Road to Beach Road)	1.3	100	89	1225	0.015	22.72	149,224	2	0.348	0.45	202,279	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	1.21	0.0058		0.113			0.107	59,333	410,836		
	Beach Road (Thousand Acre Road to Fortification Road)	2.5	100	89	1225	0.023	22.72	286,968	2	0.348	0.87	388,999	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	1.21	0.0112		0.216			0.206	114,101	790,068		
	Beach Road (Fortification Road to Tyson Street)	0.2	70	62	1225	0.003	16.23	23,428	2	0.328	0.06	28,616	(5)	70km/h	425,000	-0.01	Level		3.50	0.00	16	1.21	0.0112		0.054	1225 Local Street	Other	0.051	21,709	73,753		
	High Street (Fortification Road to Kakanui Road)	0.4	50	44	1225	0.009	16.23	65,599	2	0.328	0.13	58,663	(5)	50km/h	225,000	-0.03								0.98	0.108	1225 Local Street	Other	0.091	20,566	144,828		
	High Street (Fortification Road to Kakanui Road)	0.4	50	44	1225	0.009	16.23	65,599	2	0.328	0.13	58,663	(5)	50km/h	225,000	-0.03								0.98	0.108	1225 Local Street	Other	0.091	20,566	144,828		
Oamaru to Kakanui via Awamoa Central Road	Severn Street, Awamoa Road (Thames Street to 50/80 speed change)	2.7	50	44	1225	0.061	16.27	443,881	2	0.328	0.89	395,974	(5)	50km/h	225,000	-0.03			3.50	0.00	16	1.21	0.0040	0.88	0.151	8026 Arterial	Other	0.151	0.128	28,818	868,674	
	Awamoa Central Road (50/80 speed change to Stonewall Road)	0.9	80	71	1225	0.013	16.23	92,248	2	0.325	0.29	130,784	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	1.21	0.0098		0.078			0.074	41,076	264,109		
	Beach Road (Stonewall Road to Beach Road)	2.2	100	89	1225	0.025	22.72	252,532	2	0.348	0.77	342,319	(11)	100km/h near rural	555,000	-0.01	Level		2.75	0.00	16	1.47	0.0098		0.231			0.220	121,985	716,836		
	Beach Road (Awamoa Road to Gardiners Road)	1.3	100	89	1225	0.015	22.72	149,224	2	0.348	0.45	202,279	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	1.21	0.0058		0.113			0.107	59,333	410,836		
	Gardiners Road (Beach Road to Thousand Acre Road)	1.1	100	89	1225	0.012	22.72	126,266	2	0.348	0.38	171,159	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	1.21	0.0049		0.092			0.087	48,545	345,970		
	Thousand Acre Road (Gardiners Road to Beach Road)	1.3	100	89	1225	0.015	22.72	149,224	2	0.348	0.45	202,279	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	1.21	0.0058		0.113			0.107	59,333	410,836		
	Beach Road (Thousand Acre Road to Fortification Road)	2.5	100	89	1225	0.023	22.72	286,968	2	0.348	0.87	388,999	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	1.21	0.0112		0.216			0.206	114,101	790,068		
	Beach Road (Fortification Road to Tyson Street)	0.2	70	62	1225	0.003	16.23	23,428	2	0.32	0.06	28,616	(5)	70km/h	425,000	-0.01	Level		3.50	0.00	16	1.21	0.0112		0.054	1225 Local Street	Other	0.051	21,709	73,753		
	High Street (Fortification Road to Kakanui Road)	0.4	50	44	1225	0.009	16.23	65,599	2	0.328	0.13	58,663	(5)	50km/h	225,000	-0.03								0.98	0.108	1225 Local Street	Other	0.091	20,566	144,828		
	High Street (Fortification Road to Kakanui Road)	0.4	50	44	1225	0.009	16.23	65,599	2	0.328	0.13	58,663	(5)	50km/h	225,000	-0.03								0.98	0.108	1225 Local Street	Other	0.091	20,566	144,828		
Oamaru to Kakanui via Thousand Acre Road	SH1 - Severn Street, Wandbeck Street (Thames Street to Weston Road)	2.3	50	44	1225	0.052	16.27	378,121	2	0.328	0.75	337,311	(5)	50km/h	225,000	-0.03			3.50	1.50	16	0.51	0.0098	0.88	0.128	8026 Arterial	Other	0.109	24,549	739,981		
	SH1 - Wandbeck Street, Oamaru-Alma Road (Weston Road to Thousand Acre Road)	2.2	100	89	1225	0.025	23.25	258,423	2	0.348	0.77	342,319	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	1.21	0.0241		0.080			0.076	42,321	643,063		
	Thousand Acre Road (SH1 to Beach Road)	5.4	100	89	1225	0.061	22.72	619,852	2	0.348	1.88	840,237	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	1.21	0.0241		0.467			0.444	246,459	1,706,548		
	Beach Road (Thousand Acre Road to Fortification Road)	2.5	100	89	1225	0.028	22.72	286,968	2	0.348	0.87	388,999	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	1.21	0.0112		0.216			0.206	114,101	790,068		
	Beach Road (Fortification Road to Tyson Street)	0.2	70	62	1225	0.003	16.23	23,428	2	0.32	0.06	28,616	(5)	70km/h	425,000	-0.01	Level							0.98	0.054	1225 Local Street	Other	0.051	21,709	73,753		
	Beach Road (Fortification Road to Kakanui Road)	0.4	50	44	1225	0.009	16.23	65,599	2	0.328	0.13	58,663	(5)	50km/h	225,000	-0.03								0.98	0.108	1225 Local Street	Other	0.091	20,566	144,828		
	High Street (Fortification Road to Kakanui Road)	0.4	50	44	1225	0.009	16.23	65,599	2	0.328	0.13	58,663	(5)	50km/h	225,000	-0.03								0.98	0.108	1225 Local Street	Other	0.091	20,566	144,828		
	SH1 - Severn Street, Wandbeck Street (Thames Street to Weston Road)	2.3	50	44	1225	0.052	16.27	378,121	2	0.328	0.75	337,311	(5)	50km/h	225,000	-0.03			3.50	1.50	16	0.51	0.0183	0.88	0.128	8026 Arterial	Other	0.109	24,549	739,981		
	SH1 - Wandbeck Street, Oamaru-Alma Road (Weston Road to Fortification Road)	4.1	100	89	1225	0.046	23.25	481,607	2	0.348	1.43	637,958	(11)	100km/h near rural	555,000	-0.01	Level		2.75	0.00	16	1.47	0.0291		0.150			0.142	78,871	1,198,436		
	Fortification Road (SH1 to Beach Road)	6.5	100	89	1225	0.073	22.72	746,118	2	0.348	2.26	1,011,397	(11)	100km/h near rural	555,000	-0.01	Level		2.75	0.00	16	1.17	0.0062		0.684			0.649	360,409	2,117,924		
Oamaru to Kakanui via Beach Road	Beach Road (Fortification Road to Tyson Street)	0.2	70	62	1225	0.003	16.23	23,428	2	0.32	0.06	28,616	(5)	70km/h	425,000	-0.01	Level							0.98	0.054	1225 Local Street	Other	0.051	21,709	73,753		
	High Street (Fortification Road to Kakanui Road)	0.4	50	44	1225	0.009	16.23	65,599	2	0.328	0.13	58,663	(5)	50km/h	225,000	-0.03								0.98	0.108	1225 Local Street	Other	0.091	20,566	144,828		
	Oamaru to Kakanui via Beach Road	12.1				0.173		1,522,300	2																						479,100	3,847,500
	Oamaru to Kakanui via Awamoa Central Road	12.6				0.181		1,589,400	2																						515,500	4,025,900
	Oamaru to Kakanui via Thousand Acre Road	13.0				0.178		1,632,400	2																						469,700	4,098,200
	Oamaru to Kakanui via Fortification Road	13.5				0.184		1,684,900	2																						506,100	4,274,900
	Waiānakerua Road (Magdala Street to SH1)	13.0	100	89	250	0.147	22.72	304,538	2	0.348	4.52	412,815	(11)	100km/h near rural	555,000	-0.01	Level		3.50	0.00	16	0.96	0.0119		0.182			0.173	96,069	813,422		
	Waiānakerua Road (Magdala Street to Happy Valley Road)	0.8	70	62	250	0.012	22.72	35,095	2	0.32	0.24	2																				