4 Omokoroa

4.1 Site description

Omokoroa Peninsula is located within the central part of the Tauranga Harbour, just north of Motuhoa Island. The shoreline has approximately 2.5 km of cliffs and approximately 1.5 km of unconsolidated beach shoreline. The site is split into 10 cells based on differences in exposure, morphology, shoreline elevation and long term erosion trends (Figure 4-1).

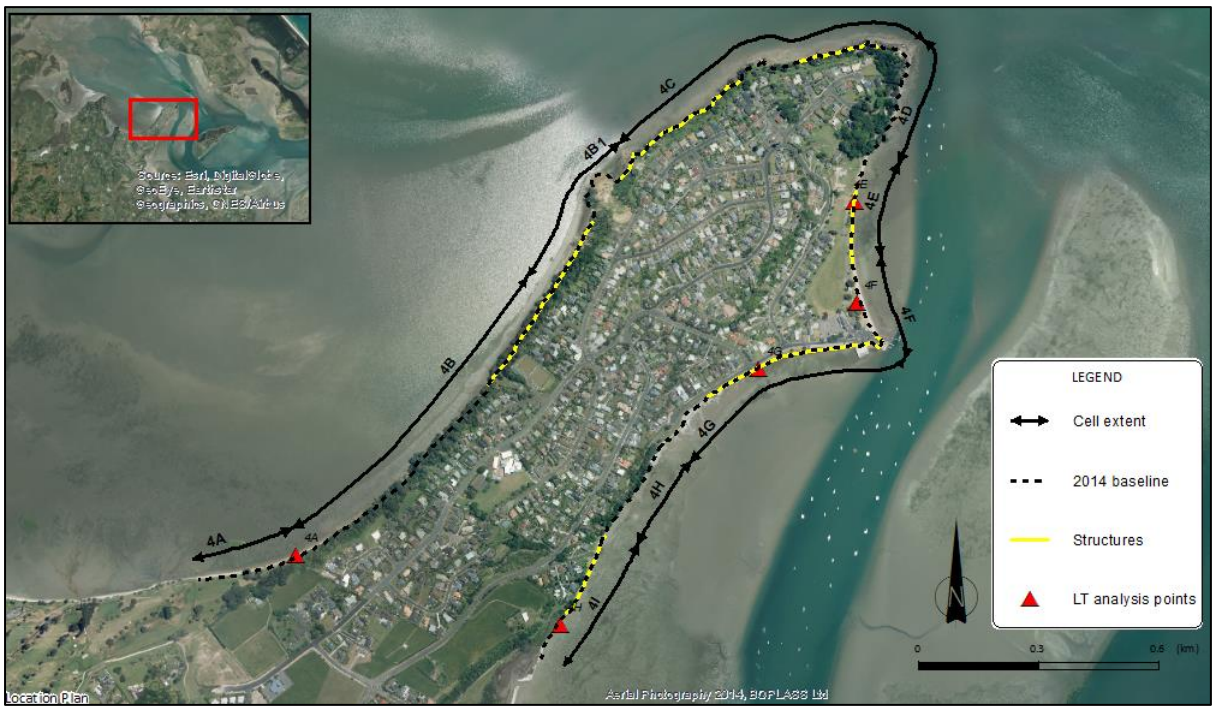

Figure 4-1 Location and cell extent of the Omokoroa shoreline within Tauranga Harbour.

The first section of the northwest-facing Omokoroa shoreline is characterised by an unconsolidated shoreline (Cell 4A). East from Cell 4A the shoreline rises to northwest-facing cliffs which range in elevation from RL 15 m to 30 m (Cell 4B). Cliff elevations continue to rise within Cell 4B1 where it ranges from RL 25 m to 35 m. Cell 4C is characterised by slightly lower cliffs ranging from RL 10 m to 15 m. The cliffs are mostly vegetated with shrubs and larger trees along the base and crest of the slope. However, large slips have occurred leaving a bare cliff face (Figure 4-2A). The northern side of Omokoroa Peninsula is exposed to winds from the west around to the north. There is a maximum fetch of approximately 20 km from Athenree and an average fetch of approximately 14 km from Kauri Point.

At the north-eastern tip of Omokoroa, below the Gerald Crapp Historic Reserve, the cliffs are 10 m to 15 m high with an eastern aspect (Cell 4D) (Figure 4-2B). Around the north-eastern tip there is a shore platform at the base of the cliff which extends approximately 50 metres into Tauranga Harbour and is exposed at low tide. Due to the proximity of the deep channel that runs between Matakana and Omokoroa, the north-eastern tip of the peninsula is exposed to strong tidal currents.

Between Gerald Crapp Historic Reserve and the Omokoroa Ferry Terminal is a section of low unconsolidated shoreline. The northern end of the unconsolidated shoreline has a narrow high tide beach (Cell 4E), while the southern end has a large high-tide beach which is approximately 4 m wide (Cell 4F) (Figure 4-2C). South of the Omokoroa Ferry Terminal the unconsolidated shoreline has a south to south-east aspect, running parallel with The Esplanade (Cell 4G) (Figure 4-2D). The shoreline is mostly protected by a combination of rock and timber seawalls.

Further south is a small section of unprotected, east-facing cliffs that range in elevation from RL 15 m to 20 m. The cliffs are well-vegetated with a small high-tide beach at the base.

Further southwest the shoreline reduces in elevation to a consolidated bank which is partially protected by ad-hoc revetment (Cell 4I).

Figure 4-2 Site photos for Omokoroa. (A) Exposed, northeast-facing cliffs (Cell 4C), (B) east-facing cliffs below Gerald Crapp Historic Reserve (Cell 4D), (c) unconsolidated shoreline north from the ferry terminal (Cell 4F), (D) Omokoroa Ferry Terminal (Cells 4F & 4G).

4.2 Geology

The geological map of the area[4] indicates that the site comprises:

- Matua Subgroup: Poorly to moderately sorted gravel with minor sand and silt underlying terraces; includes minor fan deposits and loess, and
- Holocene river sediments: Alluvial gravel, sand, silt, mud and clay with local peat.

Field observations of cliff exposures include reworked ignimbrites to the base of the cliffs, and interbedded ash layers to the top of the cliffs.

The existing slope angles within this area range from 3° to 18° in the unconsolidated areas, and 20° to 50° in the cliff areas. The range of stable slope angles for Omokoroa are shown in Table 4-1 below.

The failure types observed around Omokoroa Peninsula are typically shallow surface failures on the steep cliff faces. Some of the landslips observed along the western side of the Peninsula are deep-seated, rotational landslips with large debris flow deposits. There have been several studies investigating the landslips and associated geology at Omokoroa[5, 6]. The studies indicate that there is

[4] Leonard, G.S.; Begg, J.G.; Wilson, C.J.N. (compilers) 2010: *Geology of the Rotorua area*. Institute of Geological & Nuclear Sciences 1:250,000 geological map 5. 1 sheet + 102 p. Lower Hutt, New Zealand. GNS Science.

a sensitive silt layer (loosely classified as the Pahoia Tephras[6]) within the Matua Subgroup that is sensitive to water pressure build up. It has been noted that increased pore water pressure, especially after heavy rainfall events, reduces the strength of the sensitive materials, resulting in failure along those beds[5]. For this reason, horizontal drains have been installed in the cliffs around the peninsula to lower the water pressure in some areas.

Based on the presence of the sensitive silt layer which has been identified within the geology, the likelihood of rotational landslips around Omokoroa is reasonable.

4.3 Coastal processes

Regression analysis based on historic shorelines within Cell 4A shows long term erosion rates ranging from -0.06 to -0.19 m/yr. Based on a 5 km fetch from the north, the maximum theoretical significant wave height is estimated to be 1 m. Based on model results the short term storm cut is estimated to range from 5 to 9 m.

Due to tree coverage along the entire cliff edge within Cells 4B, 4B1, 4C and 4D, it is difficult to determine long term erosion rate of the cliff toe. Due to the similar level of exposure, it is assumed that long term erosion rates within Cells 4B, 4B1 and 4C are similar to those measured within Cell 4A. The range of erosion rates for the north-western side of the peninsular is also consistent with the maximum erosion rate estimated by Opus (2015) (-0.2 m/yr) and the average erosion rate measured by Garae (2015) (-0.07 m/yr).

Long term erosion rates for the cliff toe within Cell 4D are estimated to be slightly less than the northwest-facing cells (-0.05 to -0.15 m/yr). Recent field evidence indicates that the cliffs within Cell 4D are well-vegetated and more stable compared to cliffs within Cells 4B and 4C. The lower erosion rate is most likely due to the small fetch exposure. Previous studies also indicate that the erosion rate on the eastern tip is less than the northern side. For example, Opus (2015) estimate the maximum long term erosion rate for the tip to be -0.1 m/yr and Garae (2015) indicate the average long term erosion rate is around -0.04 m/yr.

Previous reports indicate that the net sediment transport is clockwise around the tip of the peninsula, resulting in sediment deposition on the northern side of the ferry terminal. Field observations indicate that there is sediment accretion around the unconsolidated shoreline directly north from the ferry terminal (Cell 4F). However, approximately 0.2 km north from the ferry terminal the shoreline shows erosion (Cell 4E). This eroding site is more exposed to the east (less sheltered by Motuhoa Island). Regression analysis indicates erosion up to -0.04 m/yr within Cell 4E and accretion up to 0.36 m/yr within Cell 4F. Based on a 3 km fetch from the east, the maximum theoretical significant wave height is estimated to be 1 m. Based on model results the short term storm cut is estimated to range from 3 to 8 m.

Field observations indicate sediment accretion on the southern side of the groynes within Cell 4G, which suggests the littoral drift is northward on the southern side of the ferry terminal.

The long term erosion rate of the cliff toe within Cell 4H is estimated to be between -0.03 and -0.1 m/yr. This is based on the more stable appearance and sheltered exposure relative to the cliffs on the north-western side and eastern tip of the peninsular.

4.4 Local considerations

There are sections with rock revetment at the base of the cliff along the northern end of the cliff shoreline (Figure 4-3A). The southeast-facing shoreline has a variety of protection structures. In the

middle of Cell 4E there is a section of old concrete seawall and rip rap, ranging from 0.5 to 1.5 m high. The structures are in poor condition and it is evident that wave overtopping occurs. At the northern end of the seawall there is a stormwater outfall. Within Cell 4F there is approximately 0.4 km of rock seawall followed by a timber wall which ranges from 1.5 to 2 m high (Figure 4-3B & C). The seawall protects a section of carparks, Esplanade Road and grass reserve. In addition to the seawall there are several groynes which contain drainage outfalls. Within Cell 4H there is approximately 0.2 km of ad-hoc revetment, including concrete blocks and builder's rubble which ranges from 0.5 to 1 m high. The revetment protects the footpath along the Omokoroa Beach Grove Reserve and there is some evidence of overtopping in the low sections.

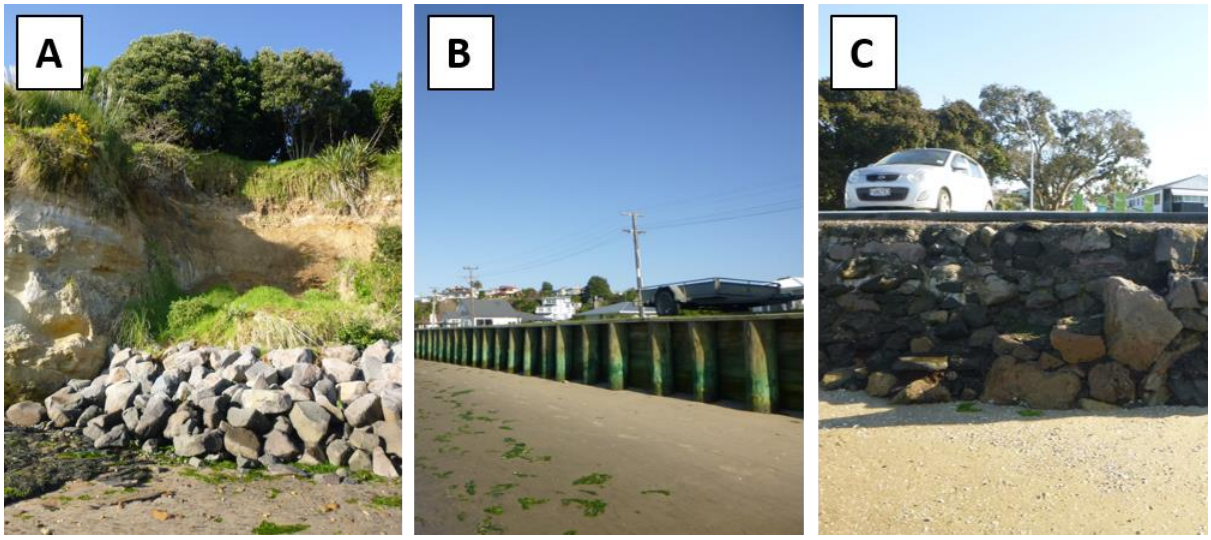

Figure 4-3 Protections structures around Omokoroa. (A) Revetment at the base of cliff (Cell 4C), (B) timber seawall (Cell 4G), (C) rock seawall (Cell 4G).

4.5 Adopted component values

Adopted component values are presented within Table 4-1. The short term values are equal to zero for the consolidated cells as short term erosion is not applicable for consolidated shorelines (see section 4.6.2 in main report).

Table 4-1 Component values for cells around Omokoroa.

Site		4. Omokoroa									
Cell		**4A**	**4B**	**4B1**	**4C**	**4D**	**4E**	**4F**	**4G**	**4H**	**4I**
Cell centre (NZTM)	**E**	1867840	1868449	1868694	1869079	1869468	1869365	1869382	1869110	1868814	1868665
	N	5829945	5830413	5830799	5831183	5831112	5830887	5830628	5830456	5830148	5829877
Morphology		Unconsolidated	Consolidated	Consolidated	Consolidated	Consolidated	Unconsolidated	Unconsolidated	Unconsolidated	Consolidated	Consolidated
Geology		Holocene river deposits	Matua Subgroup	Matua Subgroup	Matua Subgroup	Matua Subgroup	Holocene river deposits	Holocene river deposits	Holocene river deposits	Matua Subgroup	Holocene river deposits
Exposure (average fetch/direction)		7 km (NW)	7 km (NW)	7 km (NW)	7 km (NW)	5 km (SE)	3 km (east)	2 km (NE)	3 km (S)	3 km (SE)	2 km (SE)
State		Natural	Partially protected	Partially protected	Partially Protected	Natural	Partially protected	Partially protected	Partially protected	Natural	Partially protected
Short-term (m)	Min	5	0	0	0	0	3	3	3	0	0
	Mode	7	0	0	0	0	6	6	6	0	0
	Max	9	0	0	0	0	8	8	8	0	0
Dune/Cliff elevation (m above toe or scarp)	Min	1	15	25	11	9	0.5	0.5	1	15	1
	Mode	1.2	20	30	16	16	1	1	1.2	18	1.2
	Max	1.5	30	35	18	18	2	2	1.5	20	1.5
Stable angle (deg)	Min	24	24	24	24	24	30	30	30	24	24
	Mode	26	26	26	26	26	32	32	32	26	26
	Max	50	50	50	50	50	34	34	34	50	50
Long-term (m)	Min	-0.2	-0.2	-0.2	-0.2	-0.15	-0.04	0.07	-0.04	-0.1	-0.27
	Mode	-0.15	-0.15	-0.15	-0.15	-0.1	0.00	0.22	0.03	-0.07	-0.12
	Max	-0.05	-0.05	-0.05	-0.05	-0.05	0.04	0.36	0.08	-0.03	0.02
Closure slope (beaches) /SLR response factor (cliffs)	Min	0.05	0.3	0.3	0.3	0.2	0.05	0.05	0.08	0.1	0.1
	Mode	0.09	0.4	0.4	0.4	0.3	0.15	0.08	0.1	0.2	0.2
	Max	0.1	0.5	0.5	0.5	0.4	0.2	0.1	0.2	0.3	0.3

4.6 Coastal erosion hazard assessment

Coastal erosion hazard distances for Omokoroa are presented within Table 4-2 and an overview map in Figure 4-4. Histograms of individual components and resultant erosion hazard distances using a Monte Carlo technique are shown in Appendix B. For the purpose of this assessment all coastal erosion protection structures have been ignored (refer to main report Section 4.5.4).

Overall, both current and future erosion hazard are greatest along the cliff shorelines, particularly along the northwest-facing cliffs, where cliff heights and fetch exposure are largest.

For the cliffs, the current $P_{66\%}$ is up to -31 m, whereas along the beaches on the eastern side the current $P_{66\%}$ only ranges from -3 m to -10 m.

For the future erosion hazard the values are up to -102 m along the exposed north-west facing cliffs (Cell 4B1). The large values are due to a combination of high cliff heights with the potential for low stable angles of repose and large fetch exposure, resulting in a high SLR response factor.

The methodology used within this assessment is consistent across all sites in that it does not take into account known slips, such as the slip at Bramley Drive, Omokoroa. However, the slip at Bramley Drive does reflect the derived hazard lines (see main report Section 6.3). The erosion scarp of the large deep-seated instability sits in line with the current $P_{5\%}$ (-65 m), which indicates a large scale mass movement such as that at Bramley Drive is possible but extremely unlikely.

Future erosion values for the unconsolidated shoreline within Cell 4F indicate the future shoreline being seaward of the current shoreline. This is due to the historic accretion trend in the lee of the Omokoroa Ferry Terminal. As outlined in the main report (section 6.2), the future erosion area has been mapped at the equivalent location to the current erosion hazard area.

Table 4-2 Coastal erosion hazard widths (m) for current, 2080 and 2130 timeframes.

Site	Cell	Timeframe	SLR (m)	Probability of Exceedance					
				Min	$P_{66\%}$	$P_{50\%}$	$P_{5\%}$	$P_{1\%}$	Max
Omokoroa	4A	Current	0.03	-7	-10	-10	-12	-12	-13
		50yr (2080)	0.12	-10	-16	-17	-20	-21	-22
			0.2	-11	-17	-18	-21	-22	-23
			0.4	-13	-19	-20	-24	-25	-27
			0.6	-16	-22	-23	-26	-28	-30
		100yr (2130)	0.22	-12	-22	-24	-29	-30	-32
			0.6	-17	-27	-28	-34	-35	-38
			0.8	-19	-29	-31	-37	-38	-41
			1.25	-24	-35	-37	-43	-46	-50
			1.6	-28	-39	-41	-48	-52	-57
	4B	Current	0.03	-14	-31	-35	-56	-63	-75
		50yr (2080)	0.12	-18	-37	-42	-62	-71	-83
			0.2	-19	-39	-44	-65	-73	-86
			0.4	-20	-43	-47	-68	-77	-90
			0.6	-22	-45	-50	-71	-79	-93

Site	Cell	Timeframe	SLR (m)	Probability of Exceedance					
				Min	$P_{66\%}$	$P_{50\%}$	$P_{5\%}$	$P_{1\%}$	Max
Omokoroa	4B	100yr (2130)	0.22	-23	-44	-49	-70	-79	-93
			0.6	-26	-52	-56	-78	-88	-103
			0.8	-28	-55	-59	-82	-91	-107
			1.25	-30	-59	-64	-88	-97	-113
			1.6	-31	-63	-68	-92	-102	-117
	4B1	Current	0.03	-24	-41	-46	-65	-70	-78
		50yr (2080)	0.12	-29	-48	-53	-72	-78	-85
			0.2	-29	-49	-55	-74	-80	-88
			0.4	-31	-53	-58	-78	-84	-92
			0.6	-32	-55	-61	-81	-87	-96
		100yr (2130)	0.22	-30	-54	-60	-79	-85	-92
			0.6	-33	-62	-67	-88	-95	-104
			0.8	-34	-65	-70	-92	-98	-108
			1.25	-36	-70	-75	-98	-105	-117
			1.6	-38	-73	-79	-102	-110	-122
	4C	Current	0.03	-12	-21	-24	-34	-37	-40
		50yr (2080)	0.12	-16	-28	-31	-42	-45	-49
			0.2	-16	-30	-33	-44	-47	-52
			0.4	-18	-33	-36	-48	-52	-57
			0.6	-19	-36	-38	-51	-55	-62
		100yr (2130)	0.22	-18	-35	-37	-49	-53	-60
			0.6	-21	-42	-45	-58	-63	-73
			0.8	-22	-45	-48	-62	-67	-78
			1.25	-25	-49	-53	-69	-74	-86
			1.6	-26	-52	-56	-73	-79	-92
	4D	Current	0.03	-10	-20	-23	-33	-36	-40
		50yr (2080)	0.12	-13	-25	-28	-38	-41	-45
			0.2	-13	-26	-29	-39	-43	-47
			0.4	-14	-28	-30	-41	-45	-49
			0.6	-15	-29	-32	-43	-46	-51
		100yr (2130)	0.22	-16	-30	-33	-44	-47	-52
			0.6	-18	-34	-37	-48	-52	-58
			0.8	-18	-35	-38	-50	-54	-60
			1.25	-20	-37	-41	-53	-58	-64
			1.6	-20	-39	-42	-55	-60	-67
	4E	Current	0.03	-3	-6	-7	-8	-9	-10
		50yr (2080)	0.12	-2	-6	-7	-9	-10	-11
			0.2	-2	-7	-7	-10	-11	-12
			0.4	-4	-8	-9	-12	-13	-15
			0.6	-5	-10	-10	-14	-15	-18

Site	Cell	Timeframe	SLR (m)	Probability of Exceedance					
				Min	$P_{66\%}$	$P_{50\%}$	$P_{5\%}$	$P_{1\%}$	Max
Omokoroa	4E	100yr (2130)	0.22	0	-6	-7	-10	-11	-13
			0.6	-3	-9	-10	-13	-15	-19
			0.8	-4	-10	-11	-16	-18	-22
			1.25	-6	-13	-14	-21	-24	-30
			1.6	-8	-16	-17	-25	-30	-36
	4F	Current	0.03	1	-3	-3	-6	-6	-8
		50yr (2080)	0.12	18	9	8	1	-1	-4
			0.2	17	8	7	0	-2	-5
			0.4	15	6	4	-3	-5	-8
			0.6	13	3	1	-6	-8	-11
		100yr (2130)	0.22	37	22	19	7	4	1
			0.6	32	16	13	2	-1	-6
			0.8	30	14	11	-1	-4	-10
			1.25	25	8	5	-7	-11	-18
			1.6	21	3	0	-12	-16	-24
	4G	Current	0.03	-3	-6	-6	-8	-9	-9
		50yr (2080)	0.12	0	-4	-5	-8	-9	-11
			0.2	0	-5	-6	-9	-10	-11
			0.4	-1	-7	-7	-11	-12	-14
			0.6	-2	-8	-9	-12	-14	-16
		100yr (2130)	0.22	5	-3	-4	-9	-11	-13
			0.6	2	-6	-7	-12	-14	-17
			0.8	1	-7	-9	-14	-16	-19
			1.25	-2	-11	-12	-18	-21	-23
			1.6	-4	-14	-15	-22	-24	-27
	4H	Current	0.03	-14	-24	-27	-38	-41	-44
		50yr (2080)	0.12	-16	-27	-30	-42	-45	-48
			0.2	-17	-28	-31	-42	-45	-49
			0.4	-17	-28	-31	-43	-46	-50
			0.6	-18	-29	-32	-44	-46	-51
		100yr (2130)	0.22	-19	-31	-34	-45	-48	-52
			0.6	-20	-32	-36	-47	-50	-55
			0.8	-20	-33	-36	-47	-51	-56
			1.25	-20	-34	-37	-49	-52	-57
			1.6	-20	-34	-38	-49	-53	-58
	4I	Current	0.03	-1	-2	-3	-4	-5	-5
		50yr (2080)	0.12	-1	-7	-9	-15	-17	-19
			0.2	-1	-8	-9	-16	-17	-19
			0.4	-1	-9	-10	-17	-18	-21
			0.6	-2	-10	-11	-18	-20	-23

Site	Cell	Timeframe	SLR (m)	Probability of Exceedance					
				Min	$P_{66\%}$	$P_{50\%}$	$P_{5\%}$	$P_{1\%}$	Max
	4I	100yr (2130)	0.22	-1	-12	-14	-26	-29	-32
			0.6	-1	-14	-17	-28	-31	-35
			0.8	-2	-15	-18	-30	-32	-37
			1.25	-3	-18	-20	-32	-35	-41
			1.6	-5	-19	-22	-34	-37	-44

Notes: Aerial photograph sourced from the LINZ Data Service (dated 2015)

A3 SCALE 1:7,000

0 0.15 0.3 (km)

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ARCFILE	CEHA Overview2.mxd	
SCALE (AT A3 SIZE)	1:7,000	
PROJECT No.	1001628.1000	

Tauranga Harbour Coastal Erosion Assessment

Erosion Hazard Overview

Site 4: Omokoroa

FIGURE No. Figure 4-4

Rev. 0

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