25 June 2020

s 7(2)(f)(ii)

Mauao - Additional Works Optioneering

2-9b463.02

Dear s 7(2)(f)(ii)

1 Introduction

Further to your request we have inspected the land surrounding the Pohutukawa tree identified at the western end of the recently repaired section of the base track located on the southern side of Mauao. This letter presents our observations, risk assessment and recommendations following our site visit on 18 June 2020.

The site location is shown in Figure 1 below.

Figure 1: Location of tree is at the western end of the recently repaired section of the base track on the southern side of Mauao.

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2 Site Observations

2.1 General observations and geomorphology

- The Pohutukawa tree is located approximately 7.5m to the south of the new wooden fence at the western end of the slip repair. At this location there is a promontory/ terraced lobe which extends out in a southerly direction from the track.
- The tree comprises two main trunks which have diameters of approximately 0.8 to 1.0m respectively.
- At about 2.5m from the site fence there is a 1.2m vertical drop down to a flattish terrace which the tree is sitting on. The terrace is bounded to the east by the slip scarp of the original slip which occurred in 2017 and by the original slope to the west.
- The overall slope gradient immediately below the tree is approximately 70 degrees while to the east of the promontory, slope gradients range from 60 to 70 degrees and the slope to the west is 35 to 40 degrees.
- The height of the slope is approximately 10m at the location of the tree (from top of flat terrace to toe of slope).
- We inspected the top of the terrace/ lobe feature in which the tree was founded. There was no tension cracking observed above the tree however we must note that such cracking may have been infilled.
- It also appears that the trees are supported by the slope at the base and there are large roots visible extending above the trees into the soil however on the western side there are many small diameter roots which appear to have little support and are overhanging the slope.

2.2 Geology

- The base of the promontory predominantly comprises a hard-brown ash typical of Te Puna Ignimbrite and below the base of the Pohutukawa tree are interbedded layers of hard volcanic tephra (Matua Subgroup).
- The soil supporting the tree appeared to be hard and weakly welded on the surface where exposed.

3 Slope Stability & Risk Assessment

Based on our site inspection observations, the slope supporting the tree appears to be currently stable under normal conditions, however we believe that failure of the slope could occur under adverse conditions (i.e. it is possible) such as a very high rain event like the event that occurred in 2017 which triggered the original landslide.

That said, if a failure occurred along a tension crack at the top of the lobe where it drops down 1.2m, then the current track would still be approximately 2.5m away from the failure surface, however a larger, deeper failure surface may still be possible which could encroach into the current track alignment. We have sketched these scenarios on the attached annotated drawings C01 and C22. Although it is hard to predict the depth of the failure surface, we believe failure surface B which could affect the track would be much less likely than A.

Therefore, the consequence of a failure would either result in the loss of the tree and the formation of a scarp in front of the track or a deeper failure which would result in the possible encroachment of a slip scarp into the track at its western extent resulting in a reduction of the track width and possible closure of the track while repairs are undertaken.

It is also worth mentioning that the actual stability of the tree is not covered in this assessment as it is outside the scope of our services, however we understand that the original arborist noted that the tree appeared to be currently stable.

4 Options

Based on our site inspection and experience at this site we present the following options for consideration and discussion. We have presented our options in terms of relative cost for comparison purposes.

4.1 Option 1 - Do nothing

There would be no immediate cost associated with this option and the risk would be that a future storm event may trigger a slip which could cause the loss of the tree and in the worst-case scenario potentially affect part of the existing track reducing the width. This may result in a steep scarp adjacent to the track or affect part of the track. This may or may not result in closure of the track depending on how significant the failure was.

We also note that there would be room to widen the track at this location if required but would require closure of the track to undertake repairs.

4.2 Option 2 - Tree removal or weight reduction

This option would involve either removing the tree or significant pruning which would reduce the weight on the edge of the slope. It is understood that total removal of the tree is not a viable option for the trustees of Mauao.

That said, there may be benefits to removing some of the larger limbs or undertaking pruning to reduce the weight. This option is best considered in consultation with an arborist however, it must also be noted that the slope may still be prone to failure following removal or weight reductions and would have resilience similar to other portions of the base track.

We anticipate that this option would be low to medium cost and could also be undertaken in conjunction with regular monitoring.

4.3 Option 3 - Retreating of slope

This option would involve trimming the bank opposite the location of the promontory. This would enable the track to be moved further away from the tree location outside the influence of a future slip. This option would be a medium cost option and would require consultation with stakeholders and the closure of the track while the work is undertaken. Also, consideration of where the soil could be disposed should be given for this option.

4.4 Option 4 - Soil nails and drainage

This option would involve installing soil nails and bored horizontal drains to the west of the current repair to improve the stability of the bank in which the Pohutukawa is situated on. The soil nail pattern, length and spacing would need to be confirmed by modelling the

existing slope. This option assumes that the tree is currently stable and will not prevent failure of the tree due to inadequate structural roots etc. This option would be a high cost option, however would provide the best resilience against future slips and potential closure of the base track. Due to the location, the works may be able to be undertaken with the track open however this would need to be confirmed with a contractor.

5 Adjacent gully drainage

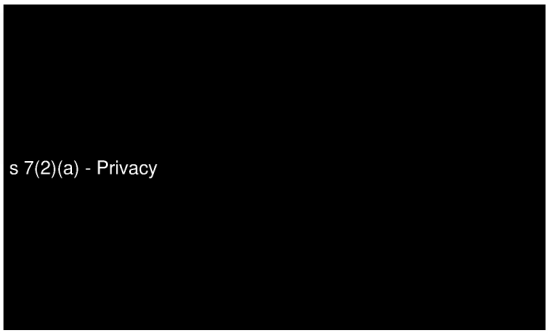
As per our previous memo dated 26 February 2020 regarding the cracking observed on the western side of the slip repair we would recommend the installation of bored drains below the track to mitigate pore pressures building up in the slope. The drainage would need to be designed and the stability of the gully modelled to determine the effectiveness of such drains.

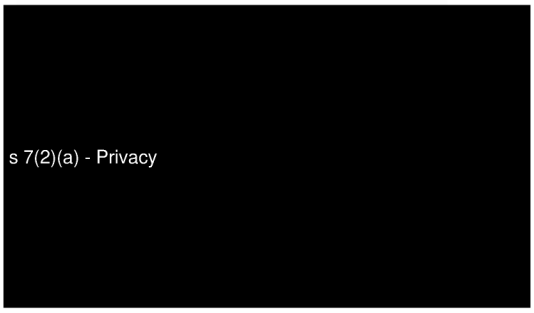
6 Further work recommendations

In addition to this assessment, WSP could undertake slope stability analysis of the promontory at the location of the Pohutukawa tree as a preliminary stage to options 3 or 4 which would aid in understanding of the factor of safety and therefore likelihood of a deeper-seated failure which may inform the decision on whether to pursue soil nails and/ or additional drainage.

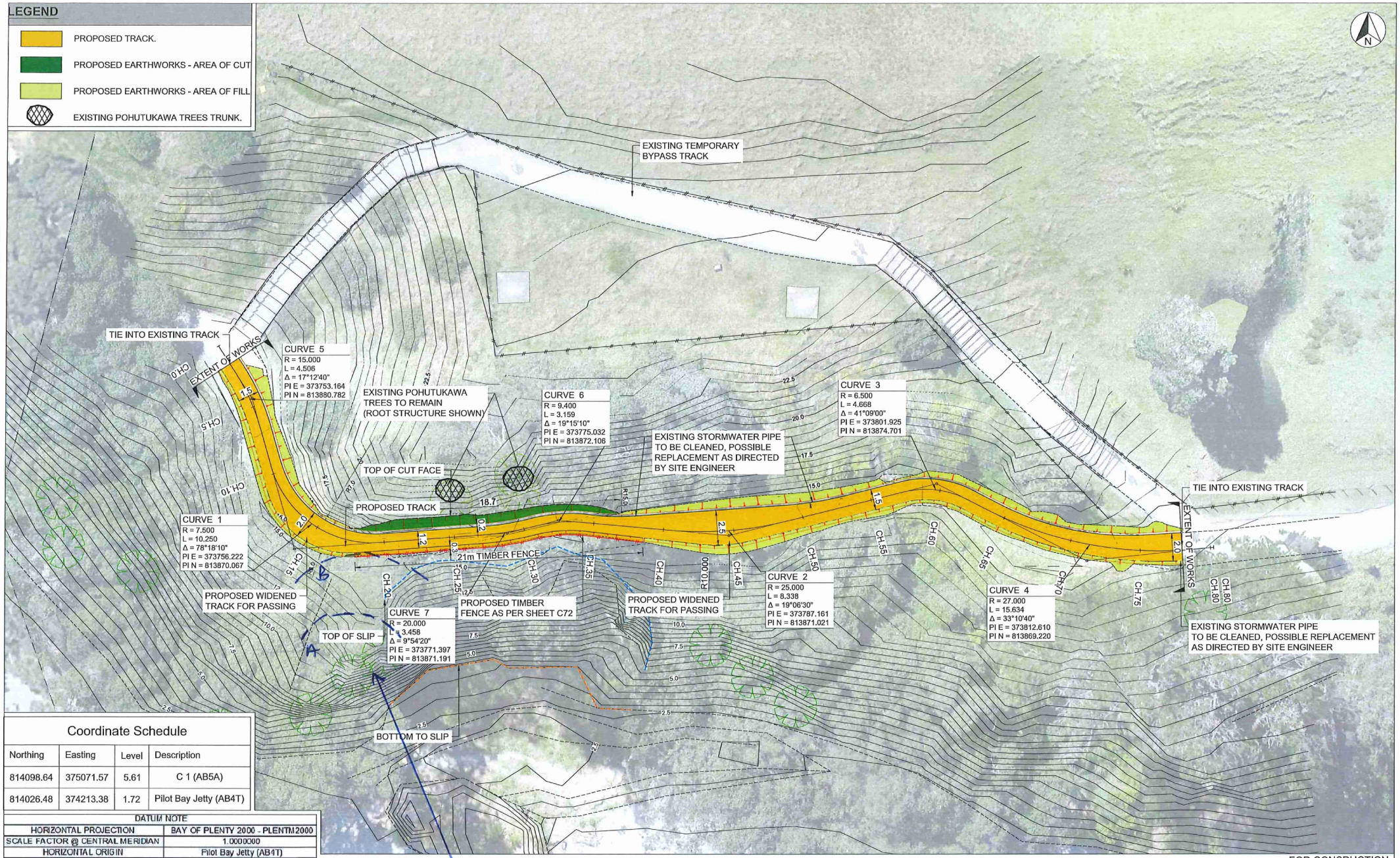
If options 3 & 4 are progressed, detailed design will be required. This would involve creating a ground model from existing borehole investigations and geologic observations in order to design the required cut slope or soil nail pattern & drainage. The modelling would utilise the existing survey and borehole information for the site.

WSP can provide support with finalising the above options or the detailed design of the chosen option if required.





Attachments: Annotated Drawings
Site Photographs



FOR CONSRUCTION

Coordinate Schedule

Northing	Easting	Level	Description
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814026.48	374213.38	1.72	Pilot Bay Jetty (AB4T)

DATUM NOTE	
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SCALE FACTOR @ CENTRAL MERIDIAN	1.0000000
HORIZONTAL ORIGIN	Pilot Bay Jetty (AB4T)
VERTICAL DATUM	MOTURIKI 1953
VERTICAL ORIGIN	Pilot Bay Jetty (AB4T)

COMMENTS.

1:125 @ A1
1:250 @ A3
0 2 4 6 8 10 12 m

Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSRUCTION	s 7(2)(a) -	2019-11-22

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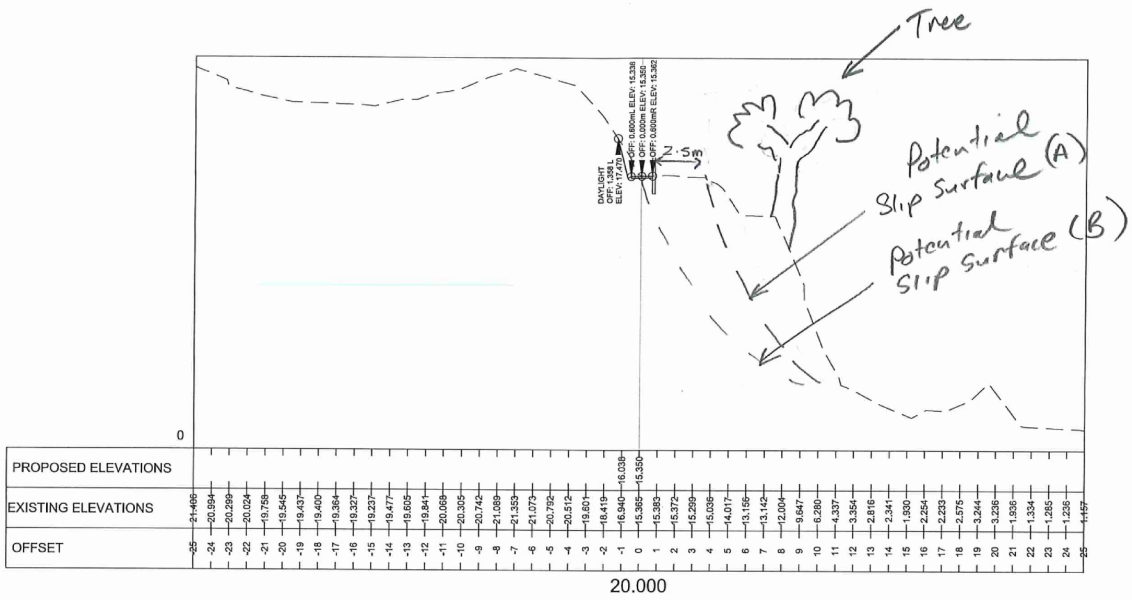
Designed	Approved	Approved Date
s 7(2)(a) - Privacy		2019-11-22
Drawn: s 7(2)(a) - Privacy	Scales: 1:125 (A1) 1:250 (A3)	

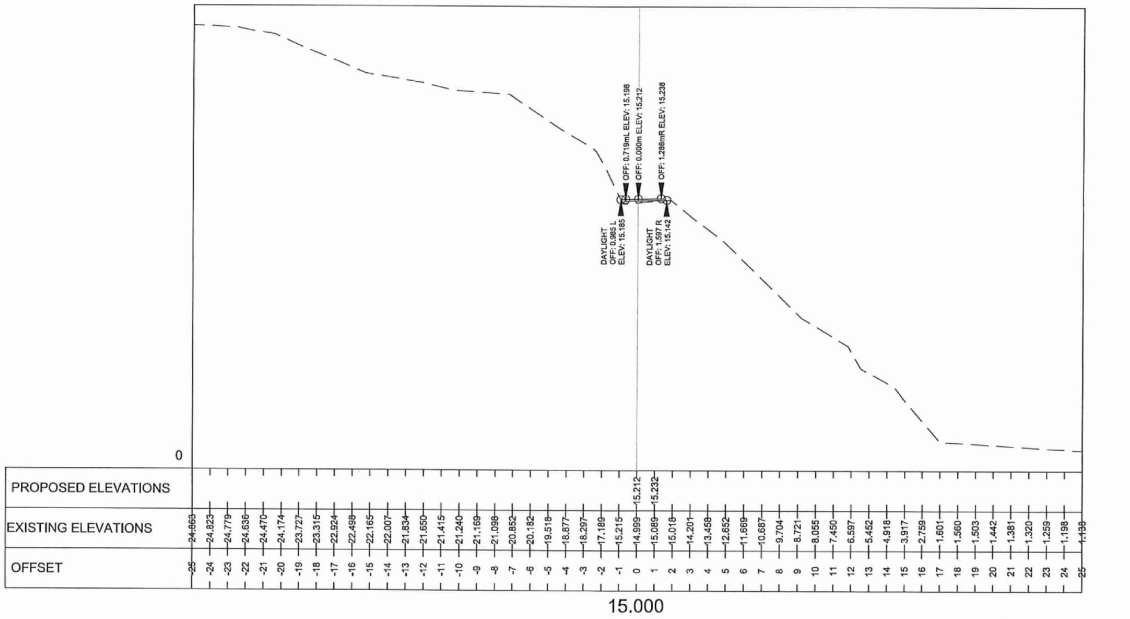
Project
TAURANGA CITY COUNCIL
MAUAO BASE TRACK REINSTATEMENT
MOUNT MAUNGANUI, TAURANGA

Sheet
GENERAL LAYOUT
SHEET 1 OF 1

Project No.	Sheet No.	Revision
2-9B463.00	C01	1

Original Sheet Size A1 [841x594] Plot Date 2019-11-22 at 1:41:02 PM Path U:\Projects\NZ29\2-9B463.00 Mount Base Track Investigations\Home\4. Design\Drawings\(C) Civil+AutoCAD\2-9B463.00_GENERAL LAYOUT - OPTION 1.dwg C01[1]





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1	ISSUED FOR CONSRUCTION	s 7(2)(a) - Pri	2019-11-22

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Designed	Approved	Approved Date
s 7(2)(a) - Privacy		2019-11-22
Drawn: s 7(2)(a) - Privacy	Scales: 1:150 (A1) 1:300 (A3)	

Project
TAURANGA CITY COUNCIL
MAUAO BASE TRACK REINSTATEMENT
MOUNT MAUNGANUI, TAURANGA

Sheet
CROSS SECTIONS - OPTION 1
SHEET 2 OF 8

Project No.	Sheet No.	Revision
2-9B463.00	C22	1

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1:300 @ A3
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Original Sheet Size A1 [841x594] Plot Date 2019-11-22 at 1:41:48 PM Path U:\Projects\NZ\29\2-9B463.00 Mount Base Track Investigations\Home\4. Design\Drawings\(C) Civil+AutoCAD\2-9B463.00_CROSS SECTIONS - OPTION 1.dwg C21[1]

Site Inspection Photos

Photograph 1 – Photo of tree and exposed lower roots

Photograph 3 – As above close up

wsp	Tauranga City Council	Photograph 1 & 2
	Project No: 2-9B463.02	

Mt Base Track Inspections

Photograph 4 – Front of promontory

Photograph 5 – Hard bedded tephra surrounding tree

wsp	Tauranga City Council	Photograph 3 & 4
	Project No: 2-9B463.02	
Mt Base Track Inspections		

Photograph 5 – Close up view of soils supporting tree

Photograph 6 – 1.2m scarp at top of promontory

wsp	Tauranga City Council	Photograph 5 & 6
	Project No: 2-9B463.02	
Mt Base Track Inspections		

Photograph 7

Photograph 8

wsp	Tauranga City Council	Photograph 7 & 8
	Project No: 2-9B463.02	
Mt Base Track Inspections		

Photograph 9

Photograph 10

wsp	Tauranga City Council	Photograph 9 & 10
	Project No: 2-9B463.02	
Mt Base Track Inspections		

Photograph 11 – Bank opposite promontory

Photograph 12 – Gully to the west

wsp	Tauranga City Council	Photograph 11 & 12
	Project No: 2-9B463.02	
Mt Base Track Inspections		

Photograph 13 – Failed Pohutukawa on Foreshore

WSP	Tauranga City Council	Photograph 13
	Project No: 2-9B463.02	
Mt Base Track Inspections		