ŌTAKI TO NORTH OF LEVIN PFRs

Report No. 9: Whirokino Trestle Project Feasibility Report

Prepared for NZ Transport Agency

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Executive Summary

This Project Feasibility Report (PFR) is one of a number of reports being undertaken to determine the package of improvements that should be implemented to improve the safety and efficiency of the highway between Ōtaki and north of Levin as part of the Wellington Northern Corridor Road of National Significance (RoNS).

The purpose of this report is to determine the feasibility of replacing the existing SH 1 Whirokino Trestle and strengthening or replacing the adjacent Manawatu River. Neither bridge currently allows HPMV loads; also the Whirokino Trestle is fast approaching the end of its structural and economic life.

This Project Feasibility Report builds on work carried out in previous investigations by exploring additional options.

A number of options were investigated for the section of SH1 from south of the Manawatu River Bridge to South of Newth Road with the primary aim of improving freight efficiency by allowing the passage of High Productivity Motor Vehicles (HPMVs) as well as providing a safe and secure route for SH1 over the Moutoa Floodway.

A summary of the economic analysis for the two options which are considered the most viable to take forward into the scheme assessment is shown below.

Table 1-1: Option Summary

Option Description	Capital Costs	NPV Benefits	Benefit Cost Ratio
Option 9-1: Replace and strengthen bridges on the existing alignment	$30.3 M	$7.7M	**0.6**
Option 9-2: Replace both bridges on new alignment	$46.2M	$14.0M	**0.5**

Option 9-1 involving the replacement of the Whirokino Trestle and strengthening of the Manawatu River Bridge has a higher BCR than Option 9-2, which aims to replace both bridges. However, the BCR for both options is less than 1.

None of the other options identified are likely to be feasible due to their adverse impact on the floodway.

This signifies that the Do-Minimum, effectively Option 9-1 constructed in 10 years' time, is likely to be the preferred option, noting that if the Trestle falls into the replace in five year category, the BCR will increase to 99 as an NZTA default.

However, this preference needs to be considered in light of the short, medium and long term strategy for this section of highway which is being developed concurrently with this PFR.

NZ Transport Agency

Report 9: Whirokino Trestle

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1 Introduction and Background

Using the outcomes of the Ōtaki to North of Levin Scoping Report and addendum, the NZTA decided that the most appropriate strategy for the highway between Ōtaki and North of Levin is to upgrade the existing highways as the first stage of a long term strategy. This allows the NZTA to realise important safety benefits in the short to medium term whilst deferring the need to construct four lanes for the time being.

This report is one of a number of reports being undertaken to determine the package of improvements that should be implemented to improve the safety and efficiency of the highway between Ōtaki and north of Levin as part of the Wellington Northern Corridor Road of National Significance (RoNS).

The objectives of the Wellington Northern Corridor RoNS, which runs from Wellington Airport to north of Levin, are:

- To enhance inter regional and national economic growth and productivity;
- To improve access to Wellington's CBD, key industrial and employment centres, port, airport and hospital;
- To provide relief from severe congestion on the state highway and local road networks;
- To improve the journey time reliability of travel on the section of SH1 between Levin and the Wellington Airport; and
- To improve the safety of travel on state highways.

For the Ōtaki to north of Levin section; the objectives are:

- To provide best value solutions which will progressively meet (via a staged approach) the long term RoNS goals for this corridor of achieving a high quality four lane route;
- To provide better Levels of Service, particularly for journey time and safety, between north of Ōtaki and north of Levin;
- To remove or improve at-grade intersections between north of Ōtaki and north of Levin;
- To engage effectively with key stakeholders; and
- To lodge Notices of Requirement and resource consents as appropriate with the relevant consent authorities for the first individual project by the 2013/14 financial year.

The projects that are being developed to help meet these objectives are presented in Section 2.

The purpose of this report is to determine the feasibility of replacing the existing SH 1 Whirokino Trestle and strengthening or replacing the adjacent Manawatu River Bridge. This Project Feasibility Report will build on work carried out in previous PFRs, see Appendix I, by exploring additional options.

The geographical extent of this project is from 1 km south of the Manawatu River Bridge to just south of Newth Road, a length of approximately 3.8 km.

Although the Whirokino Trestle is strictly outside the Ōtaki to Levin study area, it is being considered at this stage due to its proximity to the study area and the impact that is has on the efficiency of the Wellington Northern Corridor RoNS and the local State Highway network regarding both in its current state and if it were to fail.

BBO, NZTA's bridge consultants for this area estimate that the Whirokino Trestle will need to be replaced in 5 – 10 years' time, due to its poor structural integrity as it reaches the end of its economic life. The Manawatu River Bridge requires strengthening to allow use by High Productivity Motor Vehicles (HPMV). As the two bridges are not currently suitable for HPMV traffic, alternative routes via either Foxton, Shannon and Levin or Sanson, Palmerston North and Levin (SH57) are currently required to be used.

Other benefits of replacing both structures include improved level of service, crash reduction, increased and safer use by cyclists and improved route security.

The outcome of this PFR will be considered alongside the outcomes of the other PFRs and used to determine the best package of works to progress as the first stage of the long term strategy.

2 Projects Currently Being Investigated

The projects that are currently being investigated to meet the short to medium term objectives of the Ōtaki to north of Levin RoNS project are presented in the figure below.

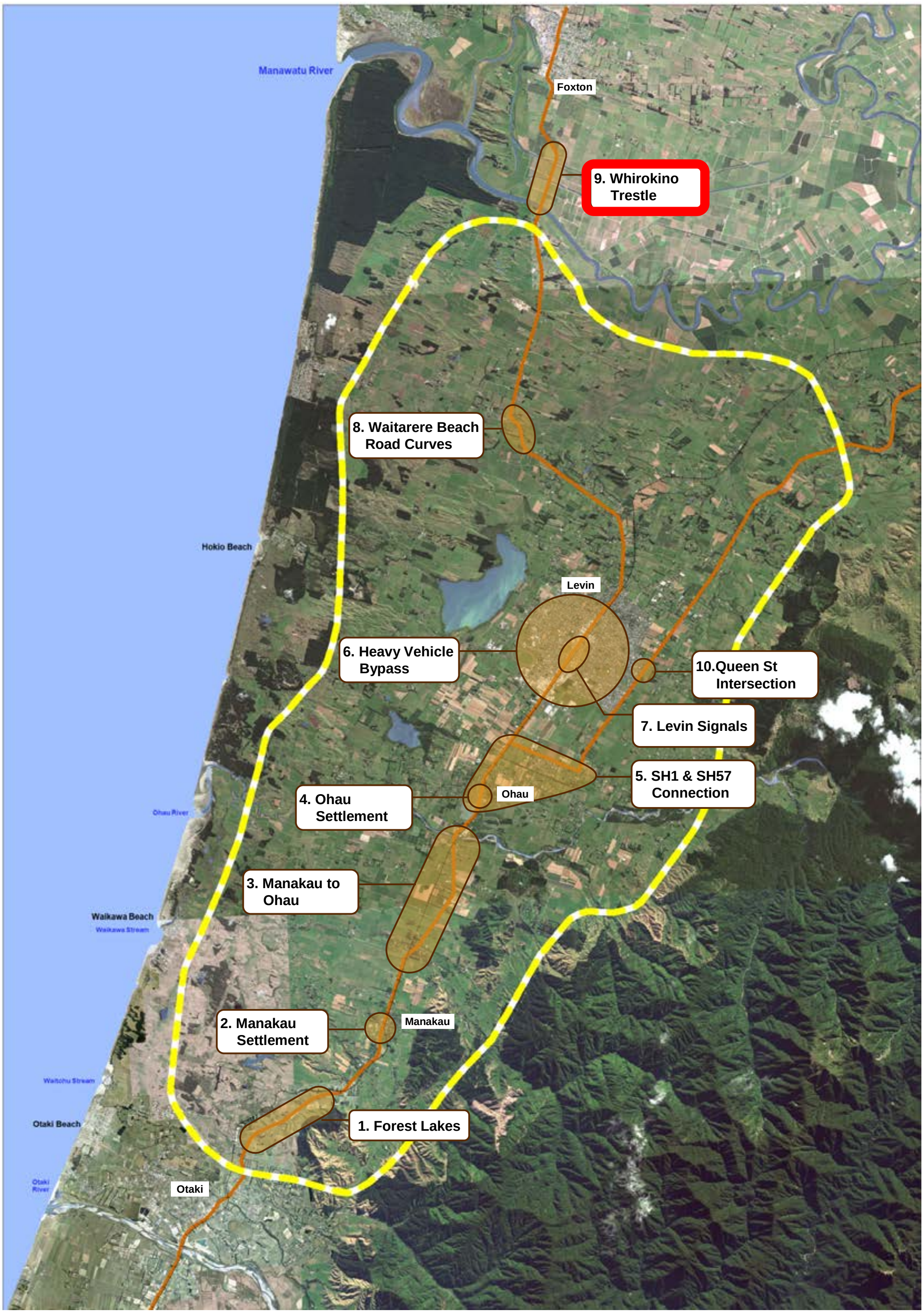


Figure 2-1: Projects Currently Being Investigated

In addition to the above PFRs, reports are also being undertaken on Route Improvements (i.e. edge treatment, passing lanes, walking and cycling, side friction etc.; Report No. 11) and on Four Lane Alignments (Report No.12).

3 Description of Problem

3.1 Ōtaki to North of Levin

State Highway 1 and State Highway 57 through the study area have a number of deficiencies, resulting in a poor crash history and a number of locations where the free flow of vehicles is restricted by the physical characteristics of the highway.

State Highway 1 currently follows the historic route established in the late 19th and early 20th centuries. As a consequence it is constrained by a now substandard alignment, towns and settlements, narrow curved bridges and significant side friction caused by local roads, commercial frontages and property accesses for the entire stretch.

3.2 Whirokino Trestle and Manawatu River Bridge

The Whirokino Trestle Bridge and Manawatu River Bridge have a number of existing issues; mainly relating to freight efficiency, narrow width, poor structural condition and subsequent high on-going reactive maintenance costs.

The key issues are outlined below:

- Both the Whirokino Trestle Bridge and Manawatu River Bridge do not meet High Productivity Motor Vehicle (HPMV) criteria;
- The Whirokino Trestle is coming to the end of its economic/structural life and will need to be replaced in 5 – 10 years' time, strengthening is not economically justified;
- Lack of safe, convenient cycle facilities on the Manawatu River Bridge;
- Insufficient lane and shoulder width on both bridges;
- Route security issues due to the age and condition of the Trestle;
- Delays to traffic when structures are closed to allow overweight/wide vehicles to cross;
- High ongoing structural maintenance cost relating to the Trestle (minimum $100k p.a.)
- Significant traffic delays during maintenance, sealing and minor repair activities.

4 Site Description

The project area (see Figure 4-1) consists of a 3.8 km length of SH1 from 1 km south of the Manawatu River Bridge to 170 m south of Newth Road (RP954/11.66 – RP967/1.00) with approximately 150 m between structures. This stretch is located approximately four kilometres south of Foxton and 14 km north of Levin.

Whirokino Trestle: SH1 RP 954 / 11.66 – 12.76

The Whirokino Trestle Bridge is a 1,100 m long reinforced concrete bridge comprising 90 no. 12.2 m spans, constructed circa 1938. The purpose of the structure is to carry SH1 traffic over the Manawatu flood plain (which now includes the Moutoa Floodway). The bridge has 3.3 m wide lanes and narrow shoulders; provisions for pedestrians and cyclists are therefore provided by a separate pathway across the floodplains at ground level alongside the structure. The narrow width also means that if a breakdown occurs, the bridge is restricted to one lane operation.

Manawatu River Bridge: SH1 RP 954 / 12.91 – 13.09

The Manawatu River Bridge is a 180 m long, 7 span steel plate girder structure. Constructed in circa 1942, the bridge carries SH1 traffic over the Manawatu River with 3.3 m wide lanes and 0.2 m shoulders. There are currently no dedicated facilities for cyclists and pedestrians therefore they use the existing bridge width.

Refer to Site Plans and photos in Appendix A and Appendix B respectively.

Figure 4-1 below shows the study location.

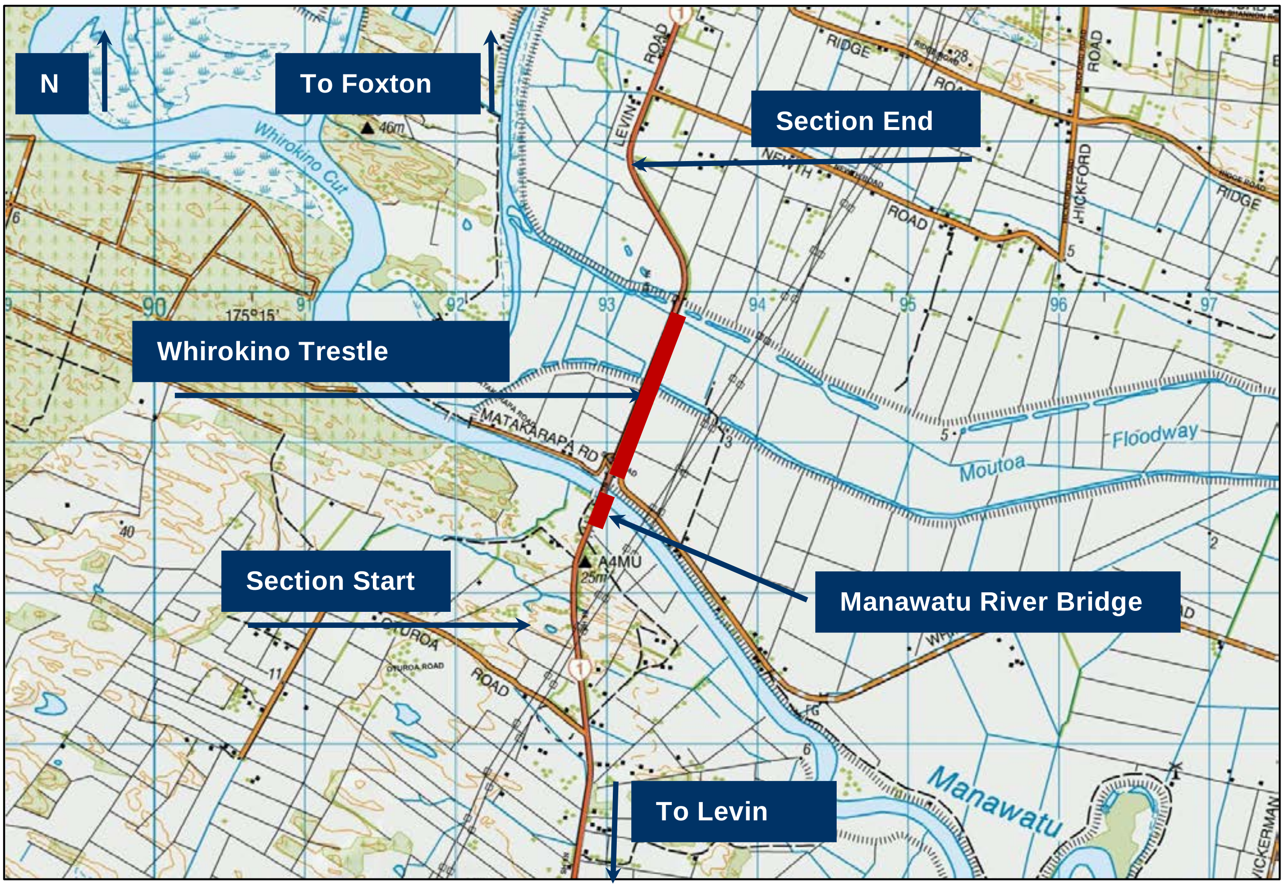


Figure 4-1: Site Location Plan

Other features along the project length include:

- A rest area for northbound traffic south of the bridges at RP 967/0.2;
- A southbound passing lane south of the bridges, from RP 995/0.25 to RP 995/1.25. The passing lane has a length of 750 m (excluding tapers) which, for an operating speed of 100 km/h, is less than the desirable length of 950 m, but greater than the minimum of 550 m[1].
- Three horizontal curves along the project area including;
    - Curve south of the Manawatu River Bridge – 650 m radius
    - Curve just north of the Whirokino Trestle Bridge – 365 m radius (out of context curve)
    - Curve south of Newth Road – 410 m radius
- A crossroads intersection between the two bridges is located at RP 954/12.8 with Matakarapa Road on the west side (river access – no exit) and Whirokino Road on the east side.
- The Moutoa Floodway is part of the Lower Manawatu Scheme (LMS), designed in the 1950s to protect farms and orchards of the Manawatu Plains from flooding. The Whirokino Trestle Bridge was built over the wider Manawatu Floodplain before the LMS was introduced and as a consequence is longer than necessary. Refer to Appendix F for more information on the Moutoa Floodway and the Manawatu Floodplain, including correspondence with Horizons Regional Council engineers.

Other special features identified during the constraint mapping undertaken during the Ōtaki to North of Levin Scoping Report include:

A gas pipeline is in the vicinity, the exact location of this will be determined at a later date.

[1] Austroads Guide to Road Design Part 3 Table 9.2

Threatened flora/fauna at various locations in the vicinity of the project area.

5 Traffic Statistics

The Annual Average Daily Traffic (AADT) flow at the NZTA count site Whirokino (ID: 01N00995) was 7,800 vehicles per day (vpd), 2011, with the proportion of Heavy Vehicles (HCVs) at 14%.

The traffic growth rate at the count site is estimated to be -0.5%, using data from 2002 (when this site was installed) to 2011. However volumes have typically fluctuated around the mean of 7,900 vpd with a standard deviation of 4% and a range of values between 8,500 vpd and 7,300 vpd. It should be noted that this count station is not permanent and therefore there can be variation in the traffic volumes recorded. Whirokino count site was only established in 2001 the table below shows the traffic growth rates for two nearby count sites; Foxton and Levin (Kawiu Road/ Gordon Place), as well as the nearest Telemetry Site, Ohau.

Over the last 20 years the telemetry stations on SH1 either side of the site (at Ohau and Sanson) record 1.3% traffic growth.

The table shows that in the last 10 years traffic growth has been in decline for all three sites, with positive growth in the longer term.

Table 5-1: Comparison of Traffic Growth Rates

Count Site	2011 AADT	Growth Rate 1992-2011	Growth Rate 2001-2011
Foxton	8,000	0.7%	-1.1%
Whirokino	7,800	N/A	-0.5%
Levin (Kawiu Road/Gordon Place)	9,600	0.5%	-0.2%
Ohau Telemetry	14,600	1.3%	0.4%

Due to the HPMV restriction that these bridges create and the long alternative routes, the current numbers of HPMVs are very low. However, it is estimated that if SH1 was to be opened up to HPMVs that a significant number of HPMVs would start to travel on this route.

This project is outside the extent of the Ōtaki to north of Levin SATURN base network model, and accordingly, no Level of Service (LoS) outputs are available.

Further traffic information can be found in Appendix C.

6 Crash History

6.1 Crash Data

A review of NZTA's CAS database over the five-year period from July 2007 to June 2012 revealed a total of 27 crashes along the 3.8 km section of highway from 170 m south of Newth Road to 1 km south of the Manawatu River Bridge (SH1 RP 954/10.3 – RP 967/1.02).

The following tables provide a summary of the CAS output data.

Table 6-1: Annual Distribution of Crashes

Year	Fatal	Serious	Minor	Non-Injury	Total	DSi*
July - Dec 2007	0	0	0	3	**3**	0
2008	0	1	3	9	**13**	1
2009	0	1	0	2	**3**	1
2010	0	0	2	4	**6**	0
2011	0	0	1	1	**2**	0
Jan – June 2012	0	0	0	0	**0**	0
Total	-	2	6	19	**27**	2

* Death and serious injury casualties

Table 6-2: CAS Crash Type

Crash Type	Number of Reported Crashes	Percentage of Reported Crashes
Overtaking Crashes	2	7%
Straight Road Lost Control/Head On	8	30%
Bend – Lost Control/Head On	7	26%
Rear End / Obstruction	8	30%
Miscellaneous Crashes	2	7%
Total	**27**	**100**

Table 6-3: HRRRG[2] Crash Type

Crash Type	Number of Reported Crashes	DSi	Percentage of Reported Crashes
Run off Road	16	2	59%
Other	9	0	33%
Head on	1	0	4%
Intersection Crash	1	0	4%
Total	**27**	**2**	**100**

[2] High-Risk Rural Roads Guide (HRRRG), NZTA, September 2011

Table 6-4: Crash Causation Factors of Reported Injury Crashes

Causation	Number of Reported Injury Crash Causation Factors	Number of Reported Non-Injury Crash Causation Factors
Poor handling	3	5
Poor observation	3	4
Road factors	3	6
Other	2	6
Alcohol	1	-
Too fast	1	4
Overtaking	1	1
Poor judgement	1	3
Weather	1	1
Vehicle factors	-	3
Fatigue	-	2
Incorrect Lanes/Position	-	3
Failure to keep left	-	1

Table 6-5: Environmental Factors

	Wet	Dry		Night	Day		Weekend (Fri 6:00PM to Monday 5:59AM)	Weekday
No.	6	21		13	14		8	19
%	22	78		48	52		30	70

Of the 27 crashes occurring on this 3.8 km section of SH1:

- None were fatal, two were serious, six were minor and 19 were non-injury.
- No severe crashes occurred on either bridge. Both serious injury crashes were curve loss of control crashes. The first on the curve immediately north of the Whirokino Trestle Bridge and the second on the curve 250 m south of Newth Road.
- 16 (59%) involved run-off road movements resulting in two serious and five minor injury crashes (2 DSi).
- Nine (19%) crashes were movement codes classed as ‘Other’. Including one rear end minor injury crash.
- One was a head on non-injury crash, caused by fatigue.
- The single ‘intersection’ movement crash involved a car travelling northbound on SH1 hitting another car reversing along the road.
- A high proportion of night/ dark crashes occurred (48%) compared to the East Wanganui state highway network average of approximately 30%.
- The main injury crash causation factors included poor handling, poor observation.
- Common road factor crash causes included: visibility limited by curve, road surface under construction and slippery roads. Equivalent
- 16 crashes involved objects being struck; with bridges being struck five times (19%), over bank five times (19%) and guard rail/fences struck twice (7%).

The narrow width of the existing Whirokino Trestle and Manawatu River Bridges would normally result in a high number of high severity head on crashes. However, because they are such an obvious out-of-context feature, drivers often increase their alertness and reduce their speed, which results in fewer crashes than expected.

6.2 Crash Risk

The section of SH1 was analysed according to the High-Risk Rural Roads Guide (HRRRG) which identifies that crash risk can be generally defined in two ways:

- Actual Crash Risk; which is based on crashes reported in the last 5 years. This is separated into collective risk, which is also known as crash density, and personal risk, which is also known as crash rate.
- Predicted Crash Risk; which is based on KiwiRAP road protection score (RPS) and the KiwiRAP star rating.

In terms of crash risk this 3.8 km section of SH1 from south of the Manawatu River Bridge to south of Newth Road has:

- A collective risk of 0.11 high-severity (fatal and serious) crashes per km per year;
- A personal risk of 2.07 high-severity crashes per 100 million vehicle km; and
- An average KiwiRAP star rating of 3.2, giving a published KiwiRAP rating of 3 stars.

The personal risk value equates to the highway having a low-medium risk. However, the collective risk was calculated as medium-high and therefore this means this length of SH1 is classified as a high-risk rural road and a 'Safer Corridors' treatment philosophy is suggested (see HRRRG).

Further Crash Data can be found in Appendix D.

7 Alternatives and Options Considered

A number of options were investigated for the section of SH1 from south of the Manawatu River Bridge to South of Newth Road with the primary aim of improving freight efficiency by strengthening the bridges to allow the passage of HPMVs as well as providing a safe and secure route for SH1 over the Moutoa Floodway.

The Do-Minimum has been assumed to include the on-going maintenance costs of the Whirokino Trestle as well as its replacement after 10 years, with concurrent strengthening of the Manawatu River Bridge. This is due to the poor condition of Trestle and the strategic importance of SH1 with regard to freight efficiency and route resilience.

The Do-Minimum for HPMV benefits considered the route advantages of the 21.88 km SH1 route, from SH1/SH57 south of Levin to SH1/Foxton-Shannon Road, compared with the existing SH1 bypass of 35.8 km via SH57 and the Foxton – Shannon Road. The SH1 bypass route is shown in Appendix A.

The two options considered are outlined below:

Option 9-1 Strengthening & Replacement of Bridges on Existing Alignment – This option retains the existing alignment and performs strengthening work on the Manawatu River Bridge, and replacement of the Whirokino Trestle with a similar structure.

Option 9-2 Replacement of Bridges on New Alignment – This option involves the replacement of the existing structures on a new alignment eliminating lower radius and out of context curves.

7.1 Discarded Options

Following consultation with Horizons Regional Council senior engineers the following options were discarded:

7.1.1 Option 9-3: Culverts

This option would involve an elevated roadway above the floodplain supported by embankments with numerous culverts running underneath. However, this would result in a smaller cross section across the floodway than already exists and the Whirokino Trestle is already the most restricted point along the floodway, with the design flood levels over the current soffit of the Trestle. Further, a culvert solution would not only decrease the floodway capacity but cause flood backup and debris related maintenance issues.

7.1.2 Option 9-4: All traffic on floodway

The Horizons engineers agreed that a road across the floodway may be feasible depending on design details. However, when the floodgates do open (currently an average of 11.5 month opening frequency since 1990) the road could have water up to 4.5 m deep for two weeks or more.

Delays of such nature with return periods of 1 year are unacceptable for SH1 and therefore the option for all traffic to be on the floodway was discarded.

7.1.3 Option 9-5: HPMV and Heavies Commercial Vehicles on the floodway

This option explored retaining the existing Whirokino Trestle and Manawatu River Bridges for light vehicle traffic and constructing a new road on the floodway for HPMVs and HCVs.

As discussed above, the floodgates have been opened approximately annually since 1990. While closure periods of two weeks or more due to flooding are unacceptable for all of SH1's traffic, this option aimed to explore the feasibility of providing a floodway route for HPMVs and HCVs only. This route would be rendered impassable due to flooding for two weeks of the year with HPMVs able to use the SH57/Foxton-Shannon bypass route during this time.

The option would involve the construction of a 1.2 km length of highway, half of which will be on the floodway, as the existing cross section of the floodway cannot be reduced further the surface level would need to be at the same level as the bottom of the floodway and will require on-going drainage.

The benefits of this option include increased freight efficiency for up to 50 weeks of the year by allowing the passage of HPMVs and other HCVs alongside SH1 rather than the longer SH57/ Foxton-Shannon Road route.

There would also be travel time benefits to traffic which would otherwise be delayed due to overdimensioned and overweight vehicles travelling down the Trestle Bridge at crawl speed.

Costing Estimates

A rough order costing is provided below for drainage, surfacing and pavements works, no other costs have been taken into account at this stage.

The intention of the drain is to keep the ground immediately adjacent to the highway relatively dry to reduce the impact of ground water on the pavement. It would also help the road to be reopened as quickly as possible after the operation of the floodway.

The drainage system would include swale drains, drainage pipes, a culvert crossing, subsoil drains and a pumping station (SWPS).

The total drainage cost is roughly estimated to be $1.8 M for a 0.6km length of highway.

Operation and maintenance costing for the SWPS has not been considered. Running costs will depend on the amount of time the SWPS is required to operate either after the flood way has operated or potentially on a more regular basis.

Due to the floodplain environment a reinforced concrete pavement design was assumed with an estimate of \$550 /m^2. Based on a 12 m carriageway (3.5 m lanes and 2.5 m shoulders) and a length of 1.2 km, a concrete pavement is roughly estimated to be $7.9M.

The total estimate for drainage and pavement amounts to $9.7M excluding earthworks, ancillary safety works, fees or contingency.

Geometrics

The feasibility of constructing a roadway over the stopbanks and back down to the floodway level was investigated by a CAD vertical profile drawing, attached in Appendix E. The vertical profile showed that based on an operating speed of 90 km/h the required crest and sag curves would reduce the floodway's cross sectional capacity, which due to the Trestle is already below Horizons design standards of the floodway, by approximately 40%. Therefore further reducing the reoccurrence interval of floods this floodway can successfully manage, and so this option was not progressed for further analysis.

Further Manawatu Flood Plain information, including Horizons correspondence can be found in Appendix F.

The remaining two options put forward for further analysis are outlined below.

7.2 Option 9-1: Replace and strengthen bridges on the existing alignment

Structural refurbishment of the bridges was initially explored as an option. However, a recent structural assessment of the Whirokino Bridge recommended that strengthening was not the preferred option due to the short remaining life of the structure and therefore a replacement structure is required.

The Manawatu River Bridge may either be strengthened to accommodate HPMV at a cost of $500,000 or replaced at an estimated cost of $8,500,000[3]. There are other benefits associated with replacement such as reduced maintenance cost, crash reduction and provision for pedestrians and cyclists. However, these are unlikely to be sufficient enough to warrant the increased capital expenditure. Nevertheless, this is considered as part of Option 9-2.

Accordingly, this option involves the construction of a new floodway bridge and strengthening of the Manawatu River Bridge. The form of the structure has not been considered but will need investigating during the next stage of investigation. Details of the option include:

Construction of a new 600 m Floodway Bridge to replace the Whirokino Trestle immediately west of the existing bridge

Strengthening of the existing Manawatu River Bridge (note this option does not include widening).

650 m of new highway (excluding the two bridges) between the two structures to join the new floodway bridge into the strengthened river bridge to the south.

Retain the existing curve south of the Manawatu River Bridge with realignment of the curve north of the Floodway Bridge to 550 m.

Typical bridge and highway cross sections are showing in Figure 7-1 and Figure 7-2 below.

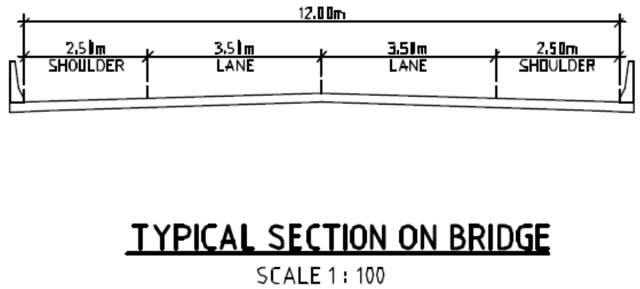
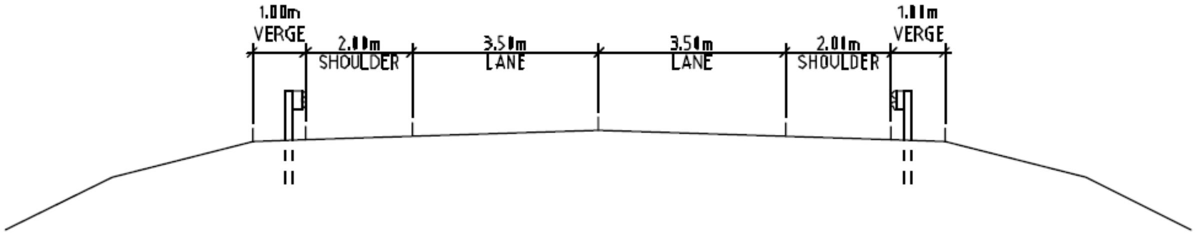


Figure 7-1: Typical New Bridge Section

[3] From BBO (NZTA's Bridge Consultant) correspondence (2011)



TYPICAL SECTION – FILL EMBANKMENT
SCALE 1 : 100

Figure 7-2: Typical Highway Section

7.3 Option 9-2: Replace both bridges on a new alignment

Due to the close proximity of the Manawatu River Bridge and the Whirokino Trestle combined with the age of both structures and the narrow carriageways replacement of both structures on a new alignment is being considered. This option has been designed to address all of the deficiencies on this stretch of highway, such as geometric (design speed), safety and cycling facilities, as well as the route security and HPMV aspects of Option 9-1.

Details of the option include:

- Construction of a new 165 m Manawatu River Bridge
- Construction of a new 770 m Floodway Bridge
- Removal of all the substandard curves along this section of highway:
  - Curve south of the Manawatu River Bridge – 650 m radius
  - Curve just north of the Whirokino Trestle Bridge – 365 m radius (out of context curve)
  - Curve south of Newth Road – 410 m radius

The form of the structures has not been considered but will need investigating during the next stage of investigation.

The length of the realignment as shown in the option drawings is 3.70 km with a single 1100 m radius curve, which replaces 3.81 km of existing highway. It is noted that other alignments to the east or west could also be considered which may have slightly differing lengths and costs which could provide greater compatibility with a far future bypass of Foxton. These variations would need to be further investigated at a later stage if this option was progressed.

7.4 Other Aspects

7.4.1 Passing Lanes

The current options assume that the existing 0.75 km (excluding tapers) southbound passing lane south of the Manawatu River Bridge will be retained. For Option 2 which joins SH1 part way alongside the existing passing lane, this would require local widening at the southern end of the option to achieve the same length or ideally to extend it to the desired length. However, this needs to be confirmed with the passing lane strategy for Ōtaki to Levin which is being undertaken concurrently with this PFR (see Report No. 11 Route Improvements).

7.4.2 Rest Areas

The northbound rest area at Whirokino should be retained and potentially upgraded to serve as a load check facility as per the recommendations of the Wellington Airport to Levin Strategic Study.

For Option 2, which bypasses the existing rest area, a new load check facility will need to be constructed on the northbound approach to the Manawatu River Bridge.

8 Design Statement

This project is at a feasibility stage, and therefore several assumptions have been made in the design.

The design assumptions include the following:

- The cost estimate has been based on the judgement of an engineer who has knowledge of the site.
- The cost estimate has been based on the assumption that the project can be built using proven technology.
- No adverse ground conditions are encountered (e.g. contaminated material).
- Clear zones rather than edge barrier is proposed. However, based on recent NZTA research, this will need to be revisited at the next stage. A rough costing was undertaken on the guardrail option and it was found to be roughly similar.
- Earthwork batter slopes are assumed to be 3H:1V for fills and 2H:1V for cuts. Barrier side protection, rather than clear zones, has been allowed for. Further investigation will be undertaken at Scheme Assessment phase to determine the extent of side protection barriers versus clear zones. Earthwork extents have been estimated as no topographical survey data is available.
- Geotechnical testing has not been undertaken. As such, subgrade strengths and pavement depths have been judged based on local knowledge. Conservative values of 300 mm of M/4 basecourse and 450 mm of GAP65 subbase have been chosen. The next design stage will revisit pavement design, and the depths may be able to be reduced depending on ground conditions encountered.
- A standard pavement design of 350 mm subbase, 170 mm M4 type basecourse and two coat chipseal has been assumed. The bridges would also have a chipseal surface.
- For the structures element, an initial assessment has been undertaken. A full structural assessment should be undertaken at scheme stage, particularly given the lack of topographical and geotechnical information.
- Option 9-2 involves a substantial realignment of the existing highway, and the proposed alignment shifts the highway close to a Natural Gas Corporation pumping station. Allowance has been made in the cost estimate for protection / relocation of existing high pressure gas mains. No allowance has been made for constructing a new pump station as it is assumed the proposed alignment allows adequate clearance (approx. 17 m from proposed centreline to nearest corner of pump station).
- The demolition of the redundant bridges has not been included in the Feasibility Estimate. Option 9-2 would require the existing Manawatu River bridge to remain operational for local access requirements.

9 Cost Estimates

The expected and 95th percentile estimates for the options are detailed in Table 9-1 below.

Table 9-1 : Cost Estimate

Option Description	Expected Estimate	95th Percentile Estimate
Option 1: Replace Whirokino and strengthen Manawatu on the existing alignment	$30.3M	$38.9M
Option 2: Replace both bridges on a new alignment	$46.2M	$59.2M

The cost estimates for the options have been calculated using concept layouts of the options and with no survey data, and are based on the design statement assumptions and judgements as listed above. The cost estimates for the options are given in Appendix F.

The estimates are significantly higher than the estimates presented in previous reports. The main reason for this is due to a detailed Feasibility Estimate (FE) being prepared rather than a lump sum estimate.

The majority of the additional cost is due to:

- relocation of existing utilities outside of the carriageway ;
- an allowance for I & R, D & PD and MSQA fees;
- the flood plain replacement bridge is 100 m longer than that assumed previously (600 m rather than 500 m);
- land acquisition; and
- inclusion of contingency and funding risk.

10 Economic Assessment and Risk Assessment

10.1 Basis of Analysis

An Economic Evaluation has been carried out in accordance with the simplified procedures (SP3, SP6 and SP11) of the Economic Evaluation Manual Volume 1 and 2 (EEM). The options were analysed against the Do Minimum option. The inputs, assumptions, and results are described in the following sections.

The worksheets used for the economic evaluation are included in Appendix G.

The following assumptions have been made in the calculation of the Benefit Cost Ratio:

1. The base year is 2012 and time zero is 2013.
2. Time zero AADT along this section of road is projected to be approximately 7,775 vehicles per day (2013) and annual traffic growth is estimated as 1.0 %. This is different to the historical growth rate for the last 10 years, which is considered to be supressed due to the global financial crisis. Long term growth rates of nearby count stations are higher and these are more appropriate when considering a 30 year analysis period. The traffic growth for HV-II is higher at 2.0%.
3. The 2011 update factors and a discount rate of 8% have been used.
4. Simplified Procedures 6: HPMV
   The assessment included:
   a. Benefits from the reduced number of heavy commercial vehicle (HV-II) trips that result from permitting freight to be carried by HPMVs on the route. These result in vehicle operating costs, CO2 and HCV accidents.
   b. Travel Time Savings from the HCV-II trips saved per year were also considered (Using SP3 methodology).
   c. Costs are the bridge upgrades and maintenance necessary to accommodate HPMVs on the route plus other relevant costs.

   d. All HPMV net benefits (Do-min cost minus Option cost) will end at year 10 when the Do-Minimum (replacement of the Whirokino and strengthening of the Manawatu River Bridge) would be constructed.

5. Simplified Procedures 3: General Road Improvements
   The assessment included:
   a. Travel time savings due to bridge crossing delays of overweight/overdimensional vehicles; this is estimated at two 20 minute delays a week for the Do-Minimum. The net benefits of this delay will end at year 10 as outlined in 4d above.
   b. Vehicle operating costs savings for all vehicles due to speed change cycles due to the above delay have not been assessed.
   c. Travel time savings and Vehicle operating costs savings due to widening and realignment.
   d. Crash benefits from bridge replacement(s), based on Accident Rate Analysis (Method B).
   e. Crash benefits from highway seal widening and/or realignment lengths (excluding bridges) are based on Accident Rate Analysis (Method B).
6. Simplified Procedures 11: Worksheet 5 – Walking and Cycling
   The assessment included:
   a. Health and environmental benefits from improvements at hazardous sites for cyclists based on an estimated 45 new trips per day from the improvement works.
   b. Safety benefits from improvements at hazardous sites for cyclists based on an estimated 45 new trips per day from the improvement works.
   c. Benefits from walking were not assessed (negligible pedestrian demand assumed).
7. The risk of earthquake or loss of structures from a major flood event have not been included as these risks are assumed to be minimal.

A summary of the economic analysis is detailed in the sections below.

10.2 Travel Time Savings

As discussed in Section 10.1 Basis of Analysis, three types of travel time costs have been determined. These include; travel time savings due to overweight vehicle bridge crossings causing delays, travel time savings from HCV-II trips saved and highway realignment travel time savings.

Travel time savings due to road closure/overweight (OW) and over-dimensioned (OD) vehicles closing the Whirokino Bridge for up to 20 minute periods approximately two times a week have been considered. The travel time savings due to this delay were calculated based on the total traffic volumes affected by the delays, using a $23.25 EEM rural strategic hourly travel time uncongested cost. These travel time savings amount to $261,100 per year.

The travel time savings from the approx. 6,500 HCV-II trips saved per year, by the introduction of HPMVs, has also been included in the analysis along with the travel time savings arising from the realignments.

The expected travel time cost savings per year and NPV travel time benefits are shown in the Table 10-1 and Table 10-2 respectively.

Table 10-1: Travel Time Costs per Year

Section	Travel Time Cost / Year		
	Do-Minimum	Option 9-1 Replace and strengthen	Option 9-2 Replace both bridges on a new alignment
OW/OD Delay Costs	$261,000	N/A	N/A
HCV-II Trips Cost	$33,100	N/A	N/A
Route Travel Time Cost	$2,650,000	$2,500,000	$2,440,000
Total	**$2,940,000**	$2,500,000	**$2,440,000**

Table 10-2: NPV Travel Time Benefits

Section	NPV Benefits	
	Option 9-1 : Replace and strengthen	Option 9-2 Replace both bridges on a new alignment
OW/OD Delay Costs	$1,900,000*	$1,900,000*
HCV-II Trips Cost	$240,000*	$241,000*
Route Travel Time Cost	$1,060,000*	$2,630,000
Total	$3,200,000	$4,770,000
Total including 2011 update factors	**$4,260,000**	**$6,350,000**

*Benefits only included up to construction of Do-Minimum.

10.3 Vehicle Operating Cost Savings

As outlined in the basis of analysis, vehicle operating costs have been considered for HPMVs as part of SP6 and in terms of the highway realignment. The speed change cycles resulting from OW and OD vehicles crossing the Whirokino Trestle was not assessed.

Vehicle operating cost (VOC) and CO2 savings have been assessed according to the SP6 method of the EEM. The Do-Minimum route with the length of 35.8 km was assessed against the option length of 21.88 km for HPMVs.

The expected HPMV vehicle operating and CO2 cost savings per year is shown in Table 10-3. The expected vehicle operating and CO2 cost savings per year arising from the realignment is shown in Table 10-4 with the NPV VOC benefits are shown in Table 10-5.

Table 10-3: HPMV Vehicle Operating and CO2 per Year

Section	HPMV VOC / Year		
	Do-Minimum	Option 9-1 Replace and strengthen	Option 9-2 Replace both bridges on a new alignment
State Highway Rural <3% Grade	$235,000	$219,000	$219,000
State Highway Urban <3% Grade	$21,600	$53,600	$53,600
Local Road Rural <3% Grade	$175,000	N/A	N/A
Local Road Urban <3% Grade	$19,800	N/A	N/A
Total	**$451,000**	**$273,000**	**$273,000**

Table 10-4: Realignment Vehicle Operating and CO2 per Year

Section	All Traffic VOC / Year		
	Do-Minimum	Option 9-1 Replace and strengthen	Option 9-2 Replace both bridges on a new alignment
Route VOC & CO_2	$3,950,000	$3,960,000	$3,920,000

Table 10-5: NPV Vehicle Operating and CO2 Benefits

Section	NPV Benefits	
	Option 9-1 : Replace and strengthen	Option 9-2 Replace both bridges on a new alignment
HPMV VOC & CO_2	$1,350,000*	$1,350,000*
Route VOC & CO_2	-$70,900*	$484,000
Total	$1,280,000	$1,840,000
Total including 2011 update factors	**$1,330,000**	**$1,910,000**

*Benefits only included up to construction of Do-Minimum.

Option 9-2 has higher vehicle operating and CO_2 benefits due to a longer benefit stream and a reduced overall alignment compared to the Do-Minimum.

10.4 Crash Benefits

The crash benefits were assessed under the EEM SP6 worksheet 4, using a heavy vehicle exposure based crash model for both the SH1 only route, from the intersection of SH1/SH57 to SH1/Foxton-Shannon Road intersection, compared with the existing SH1 bypass of 35.8 km via SH57 and the Foxton-Shannon Road.

The crash benefits for bridge replacement(s), considering all traffic, was also assessed as a two way two lane rural bridge.

In addition, the route crash benefits from highway seal widening and/or realignment lengths (excluding bridges) was assessed.

The expected accident cost savings per year and Net Present Value (NPV) crash benefits are shown in the Table 10-6 and Table 10-7 respectively.

Table 10-6: Crash Costs per Year

Section	Crash Cost / Year		
	Do-Minimum	Option 9-1 Replace and strengthen	Option 9-2 Replace both bridges on a new alignment
HPMV Accident Costs	$31,200	$19,100	$19,100
Whirokino Bridge Accident Costs	$259,000	$36,300	$46,600
Manawatu Bridge Accident Costs	$90,800	$90,800	$9,690
Route Accident Costs*	$215,000	$197,000	$106,000
New highway length (excluding bridges)	N/A	1.32 km	2.77 km
Total	**$596,000**	**$343,000**	**$182,000**

* excludes all bridge lengths

Table 10-7: NPV Crash Benefits

Section	NPV Benefits	
	Option 9-1 : Replace and strengthen	Option 9-2 Replace both bridges on a new alignment
HPMV Accident Costs	$91,600*	$91,600*
Whirokino Bridge Accident Costs	$1,620,000*	$1,550,000*
Whirokino Bridge Length	0.6 km	0.77 km
Manawatu Bridge Accident Costs	N/A	$1,041,352
Route Accident Costs	$130,000*	$1,390,000
Total	$1,850,000	$4,080,000
Total including 2011 update factors	**$2,160,000**	**$4,770,000**

*Indicates that only partial (10 years) benefits have been considered due to the construction of the Do-Minimum at year 10.

Option 9-1 is effectively the Do-Minimum constructed at year 1; therefore the net benefit stream for this option ends at year 10 when the Do-Minimum would be constructed.

The tables above show that option 9-2 would have an NPV crash saving of 4.8 million compared to the 2.2 million of option 9-1.

10.5 Walking and Cycling Benefits

The Whirokino trestle bridge has a foot/cycleway across the flood plain at ground level which can only be used in dry weather, while the Manawatu bridge has no cycle/pedestrian facility. It is estimated that a new bridge (with 2.5 m shoulders) would increase the number of cyclists from 15 to 60 per day, with the most common trip likely to be a 20 km journey between Levin and Foxton. Any benefits for walking were not assessed as it is considered unlikely that such a facility would generate any new walking trips.

The cycling benefits based on EEM SP11 were assessed as about $71,000 per year for Option 9-2. This included both safety benefits and health and environment benefits. Since Option 9-1 only strengthens the Manawatu River Bridge, no cycling benefits for this option have been considered.

10.6 Costs

The capital costs for each option are outlined in Table 10-8 below. The difference between Option 9-1 and the Do-Minimum is the year of construction. The $30.2 million Do-Minimum when discounted down to year 9, reduces to a Present Value (PV) cost of $15.2M which is approximately half of the original undiscounted cost.

Table 10-8: Capital Costs

Costs	Do-Minimum	Option 9-1	Option 9-2
Replace Whirokino and Upgrade Manawatu Bridges (2011 Costs)	$30.2 M	$30.2M	-
Replace Both Bridges (2011 Costs)	-	-	$46.2M
PV Cost	**$15.2M**	**$29.1M**	**$44.3M**

The bridge and highway maintenance costs for each option are outlined in Table 10-9 below. The Do-Minimum includes the high reactive maintenance for both the Whirokino and Manawatu River Bridge. A 20% maintenance cost reduction for the Whirokino Trestle was assumed after its replacement with no change to the Manawatu River Bridge.

Option 9-2 includes an assumed 20% reduction in the existing maintenance cost for the two new bridges. Option 9-1 includes an assumed 20% reduction in the existing maintenance of the Whirokino with no reduction in the Manawatu River Bridge cost.

Table 10-9: Bridge and Highway Maintenance Costs

Costs	Do-Minimum	Option 9-1	Option 9-2
Maintenance per year (1-10)	$194,000	$90,100	$54,100
Maintenance per year (11+)	$54,100	$90,100	$54,100
PV Cost	**$1.5M**	**$0.9M**	**$0.2M**

The total capital costs, in 2011 prices, the present value costs and the Net Present Value (NPV) costs are outlined in Table 10-10 below for each of the options.

Table 10-10: NPV Costs

Costs	Do-Minimum	Option 9-1	Option 9-2
Capital Costs (2011)	$30.2M	$30.2M	$46.2M
PV Costs	$16.8M	$30.0M	$44.9M
NPV Costs	**-**	**13.2M**	**$28.1M**

10.7 Benefit Cost Ratio Results

Table 10-11: Economic Analysis Summary

Option Description	Net Costs (NPV)	Net Benefits (NPV)	BCR_n
Option 9-1: Replace and strengthen bridges on the existing alignment	$13.2M	$7.7M	**0.6**
Option 9-2: Replace both bridges on new alignment	$28.1M	$14.0M	**0.5**

Option 9-1 involving the replacement of the Whirokino Trestle and strengthening of the Manawatu River Bridge has a higher BCR than Option 9-2, which aims to replace both bridges. However, the BCR for both options is less than 1.

This signifies that the Do-Minimum, effectively Option 9-1 constructed in 10 years' time, is likely to be adopted. The $30 million Do-Minimum when discounted down to year 10, reduces to a NPV cost of $13.8M which is under half of the original undiscounted cost.

10.8 Sensitivity Testing

If the Whirokino Bridge needed replacing in year 5 instead of year 9, the BCR of Option 9-1 and Option 9-2 remain at 0.6 and 0.5 respectively. Although the net costs for both options decrease due to a higher Do-Minimum cost, the benefits also reduce. This supports the notion that funding can be delayed without loss of BCR.

However, if in the future, the Trestle falls into the replace in five year category, the BCR will increase to 99 as an NZTA default.

It is considered that during the scheme design stage a better bridge alignment could eventuate, if one assumed a 20-25% overall reduction in cost the BCR for option 9-2 would increase by approximately 0.1, still however below 1.0.

10.9 Risk Assessment

The risks to the project have been assessed using the General Approach as determined in the NZTA Risk Management Process Manual (AC/Man/1).

The major potential risks associated with the Whirokino Trestle improvement project are considered to be:

- Project unable to get funded due to constrained funding environment.
- Inaccurate cost estimate due to level of available data at this feasibility state, including utility information and assumptions in regards to earthworks required, bridge unit costs etc.
- Undesirable ground conditions.
- Traffic delays during construction.
- Environmental effects during construction.
- Impacts on existing services.
- Land acquisition difficulties.

- Difficulties in obtaining resource consents and/or alteration to designation.
- Opposition from local iwi.
- Additional landowner accommodation works required.
- A stopbank breach resulting in flooding of the State Highway and/or damage to the bridge(s).
- Whirokino Trestle fails prior to a replacement bridge being constructed.

11 Assessment Profile

The Government Policy Statement on Land Transport Funding (GPS) requires the NZTA to consider a number of matters when evaluating projects. To assist in understanding how projects perform against these matters and hence what investment decisions to make, the NZTA utilises an assessment profile process.

The assessment profile is a three-part rating for an activity, rated as high, medium or low e.g. HMM, and representing the assessment for Strategic Fit, Effectiveness and Efficiency respectively.

It is considered that the assessment profile[4] for Whirokino Trestle is **HH_**. The following paragraphs outline how this profile has been created.

11.1 Strategic Fit

The strategic fit factor is a measure of how an identified problem, issue or opportunity that is addressed by a proposed activity or combination of activities, aligns with the NZTA's strategic investment direction.

As this project a key freight link, facilitates HPMVs and is classified as a High Risk Rural Road, the Strategic Fit is **High**.

11.2 Effectiveness

The effectiveness factor considers the contribution that the proposed solution makes to achieving the potential identified in the strategic fit assessment and to the purpose of the Land Transport Management Act (LTMA).

A wide range of assessment factors are available for use in this effectiveness rating and these draw from the five LTMA areas of:

- Economic Development
- Safety and Personal Security
- Access and Mobility
- Public Health
- Environmental Sustainability

A number of other key criteria need to be considered including integration, consideration of options and responsiveness.

As this project is part of the Roads of National Significance programme, it is recommended that the effectiveness factor for RoNS projects of **High** is adopted.

This is considered appropriate as the project will contribute positively to safety and is consistent with NZTA's strategies and plans.

[4] NZTA Planning and Investment Knowledge Base, www.pikb.co.nz/assessment-framework

11.3 Efficiency

The economic efficiency assessment considers how well the proposed solution maximises the value of what is produced from the resources used. This is primarily undertaken by the Benefit Cost Ratio.

As this project has a BCR of less than 1, the efficiency rating is **blank**.

12 Social and Environmental Assessment

While this section of highway is outside the study area of the Ōtaki to Levin RoNS, a limited amount of information was collated during this study which is relevant to the Whirokino Trestle section of the highway. A social and environmental assessment will be required to identify and confirm the constraints that may affect the proposed works. Constraints associated with heritage, tangata whenua and flood hazards (Manawatu Floodplains) are likely to be the main issues to be assessed, and mitigation measures will need to be introduced to address these issues.

Special features identified during the constraint mapping undertaken during the Ōtaki to North of Levin Scoping Report include:

- A gas pipeline is in the vicinity, the exact location of this will be determined at a later date.
- Threatened flora/fauna in the vicinity. The BioWeb database administered by the Department of Conservation holds data on natural and historic heritage. The database contains records of threatened flora/fauna species in the vicinity. Further investigation is required to obtain more details.
- Historic building in the vicinity. The Nye Homestead is a listed historic building (64 Newth Road). The property where the homestead is located is traversed by the state highway.

Consultation has been carried out under the scoping phase of the Ōtaki to north of Levin RoNS and on-going consultation will continue with stakeholders throughout the planning and design process of the other sections of highway being investigated. The Whirokino Trestle area is identified as being of cultural importance to the iwi of Rangitane o te Whanganui a Tara, Ngati Raukawa ki te Tonga and Ngati Toa Rangatira.

A Consultation Plan will be required and consultation will be undertaken in accordance with the plan. The purpose of the plan is to:

- Provide a documented process for intended engagement with the community, including the project context, the parties involved, and desired outcomes;
- Maximise effective and efficient engagement of community within generally tight time constraints;
- Provide the specifics of consultation to be undertaken, including timeframes;
- Help the project team to proactively manage risks to the project/project future from inappropriate or inadequate community engagement; and
- Help the project team to constructively manage community expectations.

13 Geotechnical Requirements

As this section of highway was outside the scope of the original Ōtaki to Levin investigation, the preliminary geotechnical appraisal report did not contain data on this section, with the exception of external data noting that the liquefaction risk is high in the area.

As a result further investigation will need to take place to determine:

- The floodplain and stopbank considerations.
- settlement potential.

- subgrade strength.
- potential maximum batter slopes.

14 Land Requirements

Option 9-1 requires land to be purchased from three separate appellations. In total, Option 9-1 requires approximately 6,300 m2 of land adjacent to the current highway to be purchased.

Option 9-2 requires land to be purchased from ten separate appellations. Option 9-2 requires a total of approximately 195,000 m2 of land to be purchased. The 195,000 m2 includes three areas of severed land. At this stage no consultation has been undertaken to determine if the surplus land could be on sold upon the completion of construction. The Feasibility Estimate has not allowed for on selling the surplus land.

15 Resource Management Issues

The project must meet all statutory requirements. There are a number of documents (both statutory and non-statutory) that must be considered when planning for the state highway improvements. In particular, the requirements of the Resource Management Act, the Horowhenua District Plan and the Horizons Regional Plan (proposed One Plan) will be assessed to ensure that the proposed project meets the plan provisions and follows the statutory process.

15.1 District Plan Provisions

15.1.1 Designations

The section of SH1 is designated under the Horowhenua District Plan (Map 4) for “state highway purposes” (D2). The existing designation is narrow in places and may need to be altered to accommodate bridge widening/replacement and road improvements.

The options require the utilisation of land immediately adjoining the existing designation. Accordingly, it is recommended that the designation boundaries be altered to accommodate these works under s181 RMA. NZTA will be required to give notice to the Council of its requirement to alter the designation (NOR). An outline plan will also be required to indicate the scale of the prosed works within the designation.

Alternatively, NZTA could apply for a resource consent (land use consent) to carry out the proposed works outside the designation.

The highway traverses an area designated as D96 which is for “Soil conservation and River Control purposes” (Map 4) or more specifically the Moutoa Floodway. The designating authority is the Horizons Regional Council (HRC). Approval will be required from HRC for works in this area.

15.1.2 Heritage Issues

Schedule 2 – Heritage Features of the District Plan identifies the Nye Homestead (64 Newth Road) (H3) in the vicinity of the proposed works. The property on which the homestead is located is traversed by the state highway.

15.1.3 Natural Hazards

Inherently, there is the potential for flooding in the vicinity of the proposed works. While this is recognised by the District Council, it is a regional council role to manage flooding (by means of the Moutoa Floodway).

15.2 Regional Plans

The final designs and construction plans will determine what regional consents are required. As the options being investigated involve extensive works within the floodplain of the Manawatu River, the following resource consents are likely to be required under the proposed One Plan administered by the Horizon's Regional Council:

- Land use consents for the placement/extension of structures in the riverbed;
- Temporary diversions of water and takes of water during bridge construction;
- Bore permit for geotechnical investigation;
- Stormwater discharges from bulk earthworks;
- Soil and vegetation disturbance;
- Gravel extraction;
- Discharges of contaminants to land; and
- Discharge of contaminants to air from road construction.

15.3 Other Provisions

Given that the proposed works will involve earthworks on the floodplain and on the river bank, there is the potential to unearth Maori artefacts. Current information does not identify any known sites but an archaeological authority may be required should a site be discovered.

16 Maintenance Issues

The Whirokino Trestle constructed in late 1930s is in very poor condition. The Trestle's age compounded with its 1.1 km length results in high reactive maintenance costs in the region of $112,000 per year. This figure is projected to rise due to accelerated deterioration with the bridge nearing the end of its serviceable life.

The 180 m Manawatu River Bridge has a maintenance cost of $45,000 per year, based on $650,000 painting costs every 15 years and minor maintenance costs of $10,000 every 5 years.

These aspects have been included in the economic evaluation.

17 Conclusions and Recommendations

This report explores the feasibility of replacing the Whirokino Trestle Bridge, which is nearing the end of its serviceable life, and either replacing or strengthening the Manawatu River Bridge. The replacement and strengthening would result in enhanced freight efficiency by allowing the passage of High Productivity Motor Vehicles (HPMVs) as well as providing a safe and secure route for SH1 over the Moutoa Floodway.

Option 9-1, which involves the replacement of the Whirokino Trestle and strengthening of the Manawatu River Bridge, achieves a higher BCR than Option 9-2, which replaced both bridges. However, the BCR for both options is less than 1 and Option 9-2 has higher crash benefits as it facilitates the removal of two substandard curves to the north of the Whirokino Trestle because it allows for complete realignment of the corridor.

None of the other options identified are likely to be feasible due to their adverse impact on the floodway.

Accordingly, the cost of replacing the Whirokino Trestle within the 30 year analysis period is unavoidable. This signifies that the Do-Minimum, effectively Option 9-1 constructed in 10 years' time, is likely to be the preferred option, noting that if the Trestle falls into the replace in five year category, the BCR will increase to 99 as an NZTA default.

However, this preference needs to be considered in light of the short medium and long term strategy for this section of highway which is being developed concurrently with this PFR.

In the short term, until the bridge is replaced, consideration should be given to installing edge barrier on the bridge to improve safety.

Appendix A HPMV Bypass Route

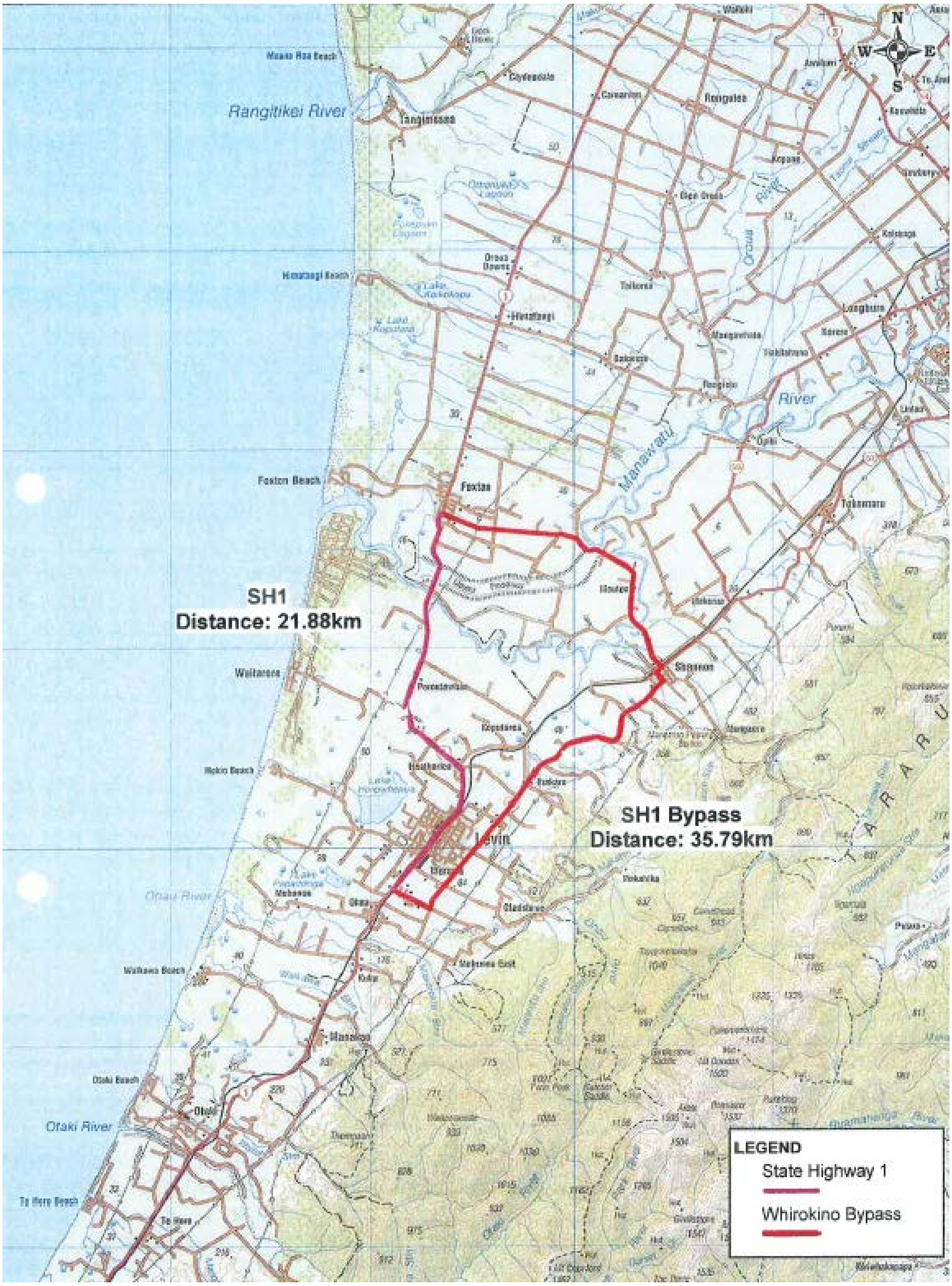


Figure 17-1: SH1 HPMV bypass route

Appendix B Photographs

Figure 17-2: Whirokino Trestle Bridge (nouthbound)

Figure 17-3: Manawatu River Bridge (southbound)

Figure 17-4: View of the Whirokino Trestle from the cycleway (northbound)

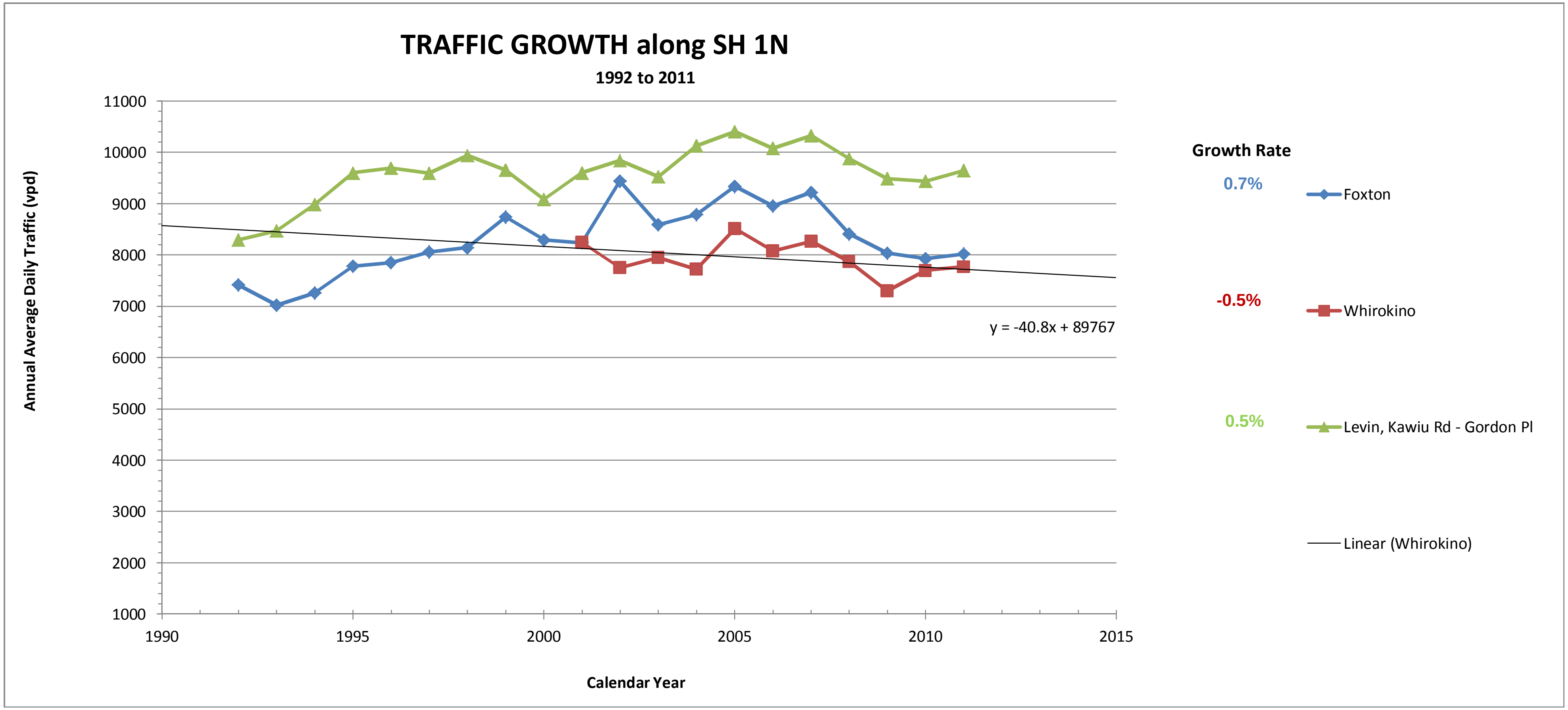
Figure 17-5: Side view of the southern end of the Whirokino Trestle and stopbank

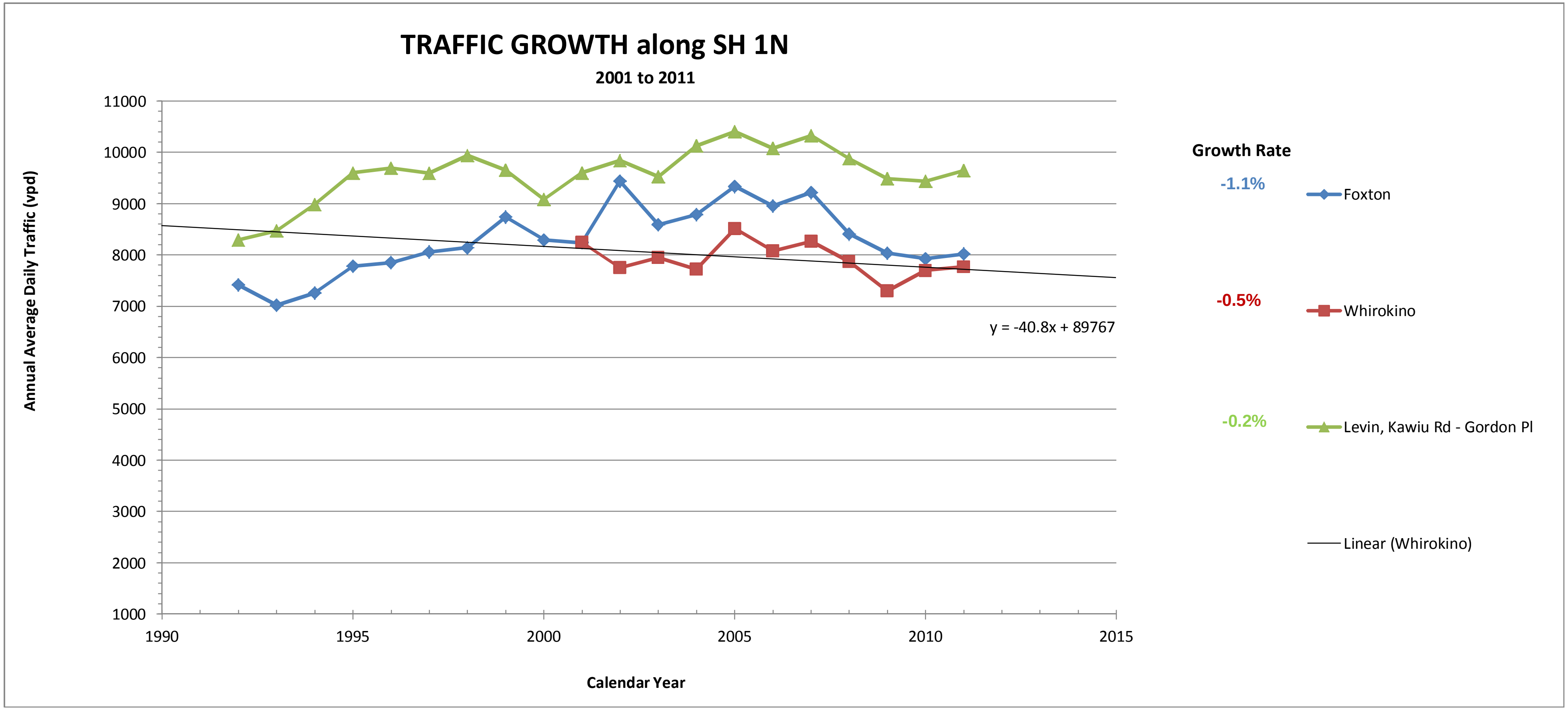
Figure 17-6: Columns of the Whirokino Trestle

Underside

Figure 17-7: View of the Whirokino Trestle and parallel cycleway (southbound)

Appendix C Traffic Data


TRAFFIC GROWTH along SH 1N
1992 to 2011
Annual Average Daily Traffic (vpd)
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
1990
1995
2000
2005
2010
2015
Calendar Year
y = -40.8x + 89767
Growth Rate
0.7%
Foxton
-0.5%
Whirokino
0.5%
Levin, Kawiu Rd - Gordon Pl
Linear (Whirokino)


TRAFFIC GROWTH along SH 1N
2001 to 2011
Annual Average Daily Traffic (vpd)
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
1990
1995
2000
2005
2010
2015
Calendar Year
y = -40.8x + 89767
Growth Rate
-1.1%
Foxton
-0.5%
Whirokino
-0.2%
Levin, Kawiu Rd - Gordon Pl
Linear (Whirokino)

Appendix D Crash Data

CRASH LIST DETAIL REPORT

Run on: 10 Oct 2012

Crash List: Whirokino_250m S Newth to 750m S Manawatu RB (27 crashes)

Total Injury Crashes:	8
Total Non-Injury Crashes:	19
	27

Crash Type	Number	%
Overtaking Crashes:	2	7
Straight Road Lost Control/Head On:	8	30
Bend - Lost Control/Head On:	7	26
Rear End/Obstruction:	8	30
Crossing/Turning:	0	0
Pedestrian Crashes:	0	0
Miscellaneous Crashes:	2	7
TOTAL:	27	100 %

Location	Local road	%	St.Highway	%	Total	%
Urban	0	0	0	0	0	0
Open road	0	0	27	100	27	100
TOTAL:	0	0	27	100	27	100 %

Intersection/Midblock	Number	%
Intersection:	1	4
MidBlock:	26	96
TOTAL:	27	100 %

Environmental Factors	Number	%
Light/Overcast Crashes:	14	52
Dark/Twilight Crashes:	13	48
TOTAL:	27	100 %
Wet/Ice:	6	22
Dry:	21	78
TOTAL:	27	100 %

Day/Period	Number	%
Weekday	19	70
Weekend	8	30
TOTAL:	27	100 %

Vehicles	Number	%
Car	28	74
Van/Ute	5	19
Truck	3	11
Bus	0	0
Motorcycle	0	0
Bicycle	0	0
TOTAL:	36	104 %

Note: Percentages represent the % of crashes in which the vehicle, cause or object appears.

Crash factors (*)	Number	%
Alcohol	1	4
Too fast	5	19
Failed Keep Left	1	4
Overtaking	2	7
Incorrect Lane/posn	3	11
Poor handling	8	30
Poor Observation	7	26
Poor judgement	4	15
Fatigue	2	7
Vehicle factors	3	11
Road factors	9	33
Weather	2	7
Other	4	15
TOTAL:	51	189 %
Crashes with a:		
Driver factor	33	123 %
Environmental factor	11	40 %

(*) factors are counted once against a crash - ie two fatigued drivers count as one fatigue crash factor.

Note: Driver/vehicle factors are not available for non-injury crashes for Northland, Auckland, Waikato and Bay of Plenty before 2007. This will influence numbers and percentages.

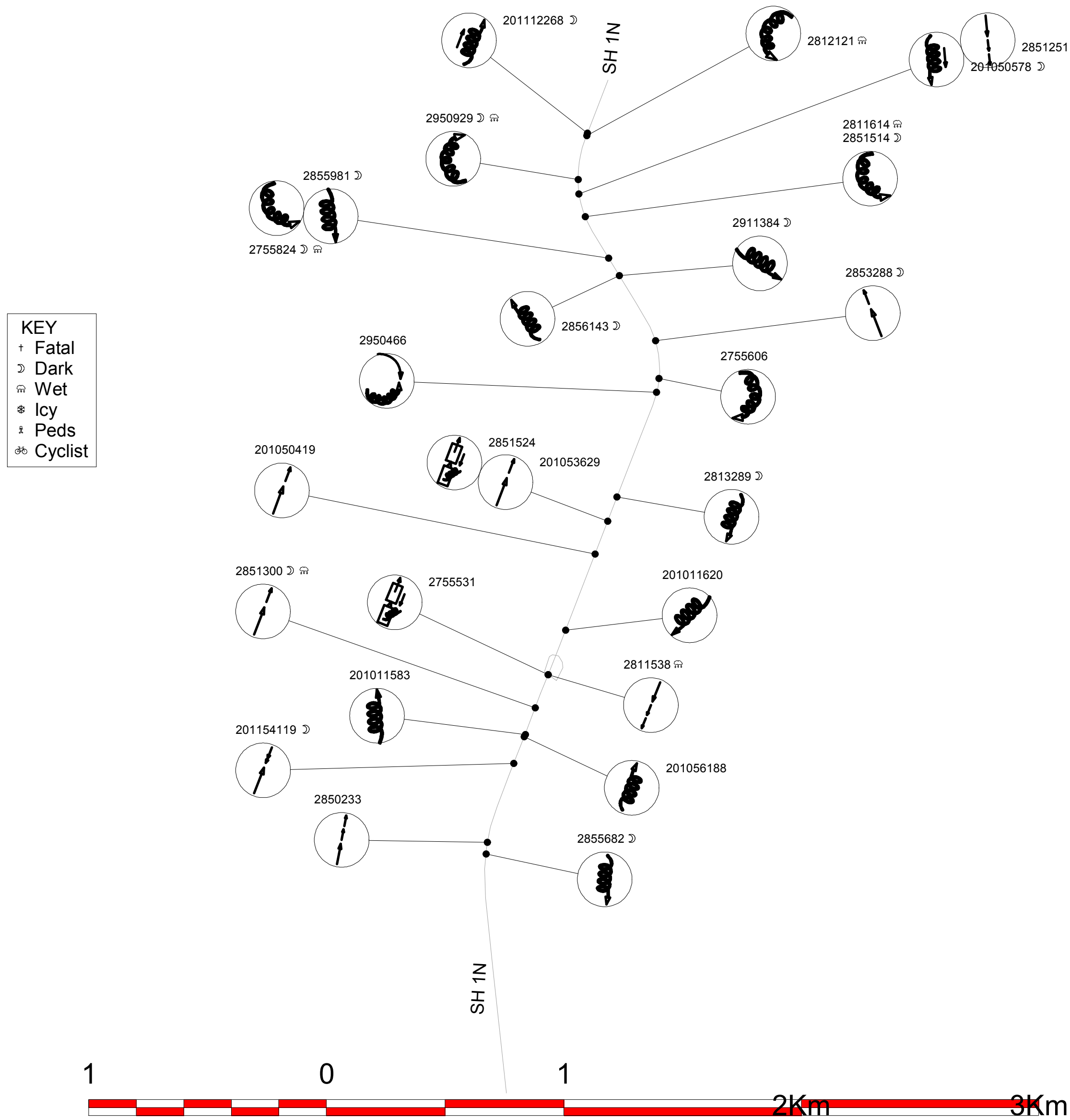
Crashes with objects(s) struck 15 56 %

Object Struck	Number	%
Bridge	5	19
Debris	1	4
Over Bank	5	19
Fence	2	7
Guard Rail	1	4
Tree	1	4
Ditch	1	4
TOTAL:	16	61 %

Crash Numbers

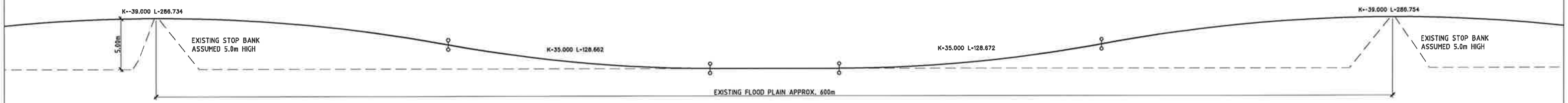
Year	Fatal	Serious	Minor	Non-Inj
2007	0	0	0	3
2008	0	1	3	9
2009	0	1	0	2
2010	0	0	2	4
2011	0	0	1	1
TOTAL:	0	2	6	19

Whirokino Trestle and Manawatu River Bridge Collision Diagram



First Street	DIR Distance	Second street or landmark	Crash Number	Date DD/MM/YYYY	Day DDD	Time HHMM	MVMT	DR VN1 VVV234	Factors and Roles (A is for vehicle 1, B is for veh 2 etc)	OBJECT	CURVE	WET	LIGHT	WTHR	JUNCT	CONTR	MARKS	SPD LMT	Total Inj FAT	SER	MIN	PED age	CYC age	Map Coordinates
1N/954/10.397	240S	NEWTH ROAD	201112268	10/05/2011	Tue	0847	AD	CN1C	155A 156A 830	F	R	D	DO	F		N	L	100			1			1793214 5515095
1N/954/10.407	250S	NEWTH ROAD	2812121	01/03/2008	Sat	1729	DB	4S1E	135A 801	V	M	W	O	L		N	C	100		1				1793211 5515085
1N/954/10.597	440S	NEWTH ROAD	2950929	07/05/2009	Thu	0730	DA	CN1	131A 517A	F	E	W	DN	H		N	C	100						1793175 5514900
1N/954/10.657	500S	NEWTH ROAD	201050578	24/01/2010	Sun	2243	AD	CE1C	152A 199A		E	D	DN	F		N	C	100						1793178 5514840
1N/954/10.657	500S	NEWTH ROAD	2851251	03/04/2008	Thu	1350	FD	CS1V	191A 191B 831		S	D	B	F		N	C	100						1793178 5514840
1N/954/10.757	600S	NEWTH ROAD	2811614	01/03/2008	Sat	1730	DB	CS1	130A 407A	E	M	W	O	L		N	C	100			1			1793205 5514744
1N/954/10.757	600S	NEWTH ROAD	2851514	08/04/2008	Tue	0530	DB	CS1	131A 517A	E	M	D	DN	F		N	C	100						1793205 5514744
1N/954/10.957	800S	NEWTH ROAD	2855981	03/11/2008	Mon	0413	CC	CS1	116A 139A 817	B	E	D	DN	F		N	C	080						1793303 5514570
1N/954/10.957	800S	NEWTH ROAD	2755824	11/10/2007	Thu	2250	DB	CS1	123A 134A 410A	E	S	W	DN	F		N	C	100						1793303 5514570
1N/954/11.043	A	NORTH WHIROKINO BR	2856143	01/11/2008	Sat	0120	CA	CN1	112A 132A 817	B	R	D	DN	F		N	N	100						1793348 5514497
1N/954/11.043	A	NORTH WHIROKINO BR	2911384	23/01/2009	Fri	2146	CB	CS1	103A	G	R	D	DN	F		N	C	100		1				1793348 5514497
1N/954/11.357	1200S	NEWTH ROAD	2853288	30/06/2008	Mon	1547	FA	TN14	181A 350A 817		M	D	TN	F		N	C	100						1793500 5514223
1N/954/11.517	1360S	NEWTH ROAD	2755606	04/10/2007	Thu	1340	DA	CS1	135A 806	ET	M	D	O	F		N	C	100						1793515 5514065
1N/954/11.577	1420S	NEWTH ROAD	2950466	16/02/2009	Mon	1000	BF	CN1C	410A		E	D	B	F		N	C	100						1793505 5514006
1N/954/12.048	800N	WHIROKINO ROAD	2813289	01/11/2008	Sat	0025	CA	CS1	112A 135A 804 817	B	R	D	DN	F		N	C	100			1			1793338 5513566
1N/954/12.157	2000S	NEWTH ROAD	201053629	25/06/2010	Fri	1138	FA	CN1V	110A 181A 407A		R	D	B	F		N	C	100						1793299 5513464
1N/954/12.157	2000S	NEWTH ROAD	2851524	01/04/2008	Tue	1445	QG	VN14	682A	D	E	D	O	F		N	C	100						1793299 5513464
1N/954/12.304	A	WHIROKINO TRESTLE	201050419	01/01/2010	Fri	1350	FA	CN1C	331A		R	D	O	F		N	C	100						1793246 5513327
1N/954/12.648	200N	WHIROKINO ROAD	201011620	24/02/2010	Wed	1340	CC	TS1	132A 331A	B	R	D	B	F		N	C	100			1			1793122 5513006
1N/954/12.848	A	WHIROKINO ROAD	2811538	01/04/2008	Tue	0746	FD	CS1CC	331A 901		R	W	O	H		N	C	100			1			1793049 5512820
1N/954/12.885	I	WHIROKINO ROAD	2755531	27/09/2007	Thu	0745	QG	VN1T	682A		R	D	B	F	X	N	P	100						1793049 5512819
1N/954/13.035	150S	WHIROKINO ROAD	2851300	01/04/2008	Tue	0745	FA	CN1C	331A 901		R	W	DN	H		N	C	100						1792995 5512680
1N/967/0	1540N	OTUROA ROAD	201011583	25/03/2010	Thu	1004	CB	4N1	132A 357A	E	R	D	O	F		N	C	100			2			1792953 5512568
1N/967/0.01	1530N	OTUROA ROAD	201056188	05/12/2010	Sun	1120	CA	4N1	406A 615A		R	D	B	F		N	C	100						1792948 5512559
1N/967/0.131	400S	MATAKARAPA ROAD	201154119	24/09/2011	Sat	2315	MG	CN1C	102B 371B		R	D	DN	F		N	C	100						1792904 5512447
1N/967/0.481	750S	MATAKARAPA ROAD	2850233	02/01/2008	Wed	1224	FD	VN1C	181A 402A		E	D	B	F		N	C	100						1792794 5512115
1N/967/0.531	800S	WHIROKINO ROAD	2855682	02/11/2008	Sun	2240	CA	CS1	112A 817	B	R	D	DN	F		N	C	100						1792788 5512066

Appendix E Outline Plans

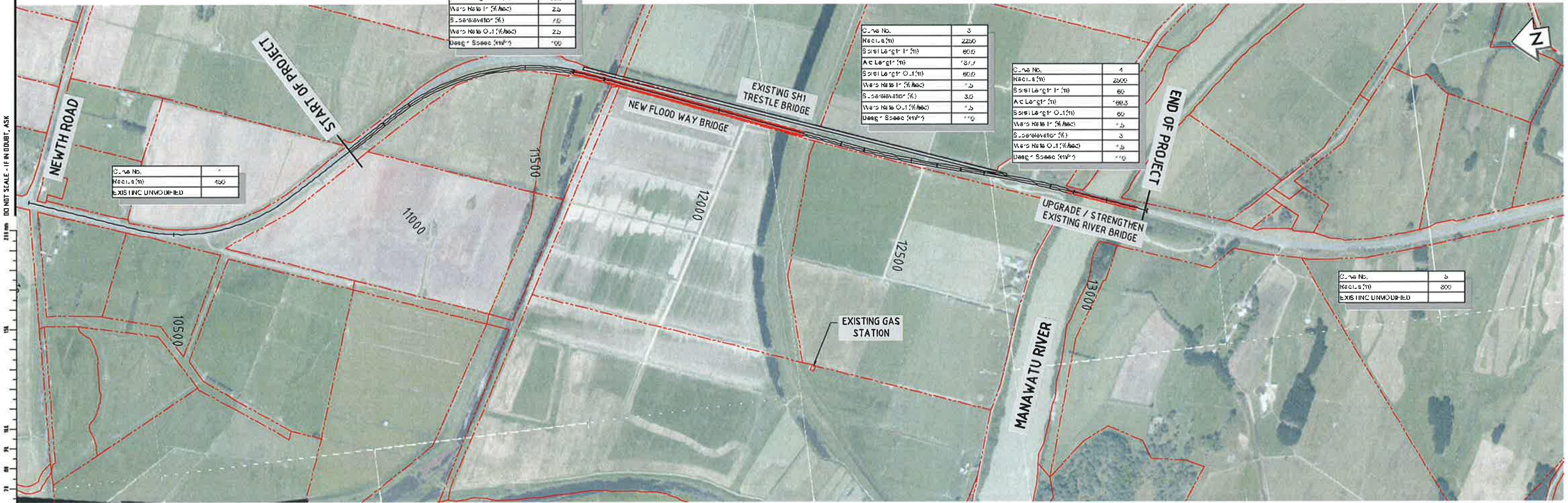


ROAD PROFILE OVER STOP BANKS

SCALES - H 1 : 1000 (A1)
V 1 : 200 (A1)

NOTES

1. VERTICAL PROFILE BASED ON:
- OPERATING SPEED 90 km / h (HPMV's ONLY)
- REACTION TIME 2.50 SEC
- COEFFICIENT OF DECELERATION = 0.29
- SSD = 172m



Curve No.	1
Radius (m)	450
EXISTING UNMODIFIED	

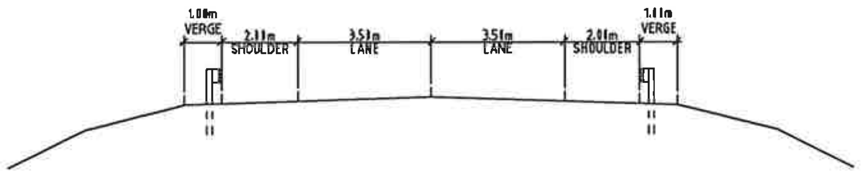
Curve No.	2
Radius (m)	550
Spiral Length In (m)	80.0
Arc Length (m)	432.0
Spiral Length Out (m)	80.0
Warp Rate In (%/sec)	2.5
Superelevation (%)	[illegible]
Warp Rate Out (%/sec)	2.5
Design Speed (km/h)	100

Curve No.	3
Radius (m)	2250
Spiral Length In (m)	60.0
Arc Length (m)	187.7
Spiral Length Out (m)	60.0
Warp Rate In (%/sec)	1.5
Superelevation (%)	3.0
Warp Rate Out (%/sec)	1.5
Design Speed (km/h)	110

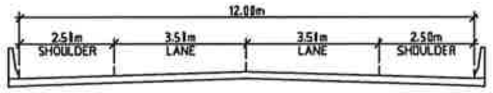
Curve No.	4
Radius (m)	2500
Spiral Length In (m)	60
Arc Length (m)	169.3
Spiral Length Out (m)	60
Warp Rate In (%/sec)	1.5
Superelevation (%)	3
Warp Rate Out (%/sec)	1.5
Design Speed (km/h)	110

Curve No.	5
Radius (m)	800
EXISTING UNMODIFIED	

PLAN – OPTION 9 – 1
SCALE 1:5000



TYPICAL SECTION – FILL EMBANKMENT
SCALE 1:100



TYPICAL SECTION ON BRIDGE
SCALE 1:100

LEGEND
- PROPERTY BOUNDARY
- BRIDGE

NOTES
LENGTH OF PROPOSED HIGHWAY = 2118 m
LENGTH OF EXISTING HIGHWAY REPLACED = 2120 m

DO NOT SCALE - IF IN DOUBT, ASK
ORIGINAL SIZE A1

NOT FOR CONSTRUCTION

REV	REVISIONS	DRAWN	CHECKED	APPROVED	DATE
B	TYPICAL SECTION UPDATED	GC	MO	PP	31.01.13
A	PRELIMINARY	GC	MO	PP	30.10.12

	Name	Date
SURVEYED		
DESIGNED	G. CORIN	10/12
DRAWN	G CORIN	10/12
CHECKED	P. PEET	10/12
REVIEWED	M. OPPENHUIS	10/12
APPROVED	P. PEET	11/12

MWH

NZ TRANSPORT AGENCY
WAKA KOTAHI

NZ TRANSPORT AGENCY
OTAKI TO LEVIN PFRs

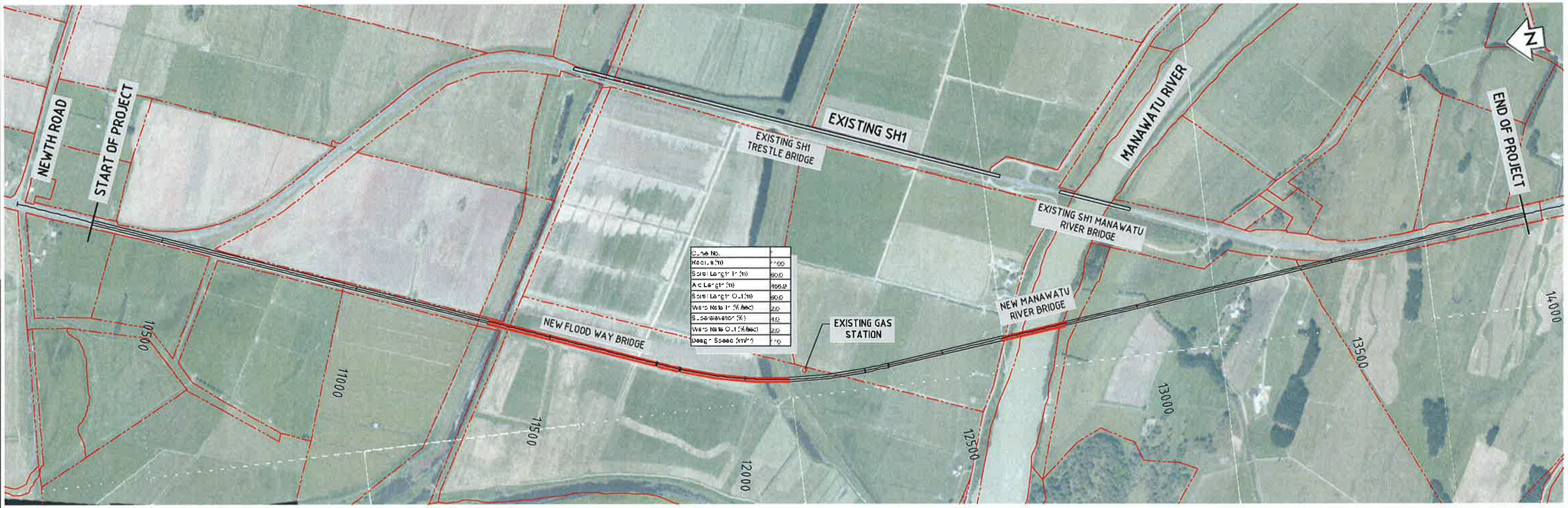
WHIROKINO TRESTLE PFR
PLAN – OPTION 9 – 1 (SHEET 1 OF 1)

Status Stamp: PRELIMINARY
Date Stamp: 31 JAN 2013
SCALES (A1) AS SHOWN (HALF SIZE A3)
Drawing No. 80500902 0108 | Sheet No. C001 | Rev. B

XREFS :

ORIGINAL SIZE A1

DO NOT SCALE - IF IN DOUBT, ASK



PLAN - OPTION 9 - 2

SCALE 1 : 5000

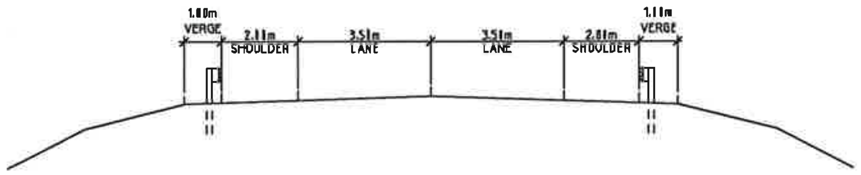
LEGEND

- PROPERTY BOUNDARY
- NEW BRIDGE

NOTES

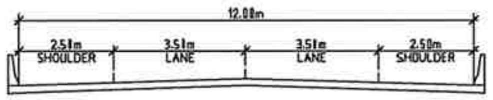
LENGTH OF PROPOSED HIGHWAY = 3781 m

LENGTH OF EXISTING HIGHWAY REPLACED = 3610 m



TYPICAL SECTION - FILL EMBANKMENT

SCALE 1 : 100



TYPICAL SECTION ON BRIDGES

SCALE 1 : 100

NOT FOR CONSTRUCTION

REV	REVISIONS	DRAWN	CHECKED	APPROVED	DATE
B	TYPICAL SECTION UPDATED	GC	MO	PP	31.01.13
A	PRELIMINARY	GC	MO	PP	31.10.12

	Name	Date
SURVEYED		
DESIGNED	G. CORIN	10/12
DRAWN	G CORIN	10/12
CHECKED	P. PEET	10/12
REVIEWED	M. OPPENHUIS	10/12
APPROVED	P. PEET	11/12

MWH

NZ TRANSPORT AGENCY WAKA KOTAHI

NZ TRANSPORT AGENCY
OTAKI TO LEVIN PFRs

WHIROKINO TRESTLE PFR
PLAN - OPTION 9 - 2 (SHEET 1 OF 1)

Status Stamp: PRELIMINARY

Date Stamp: 31 JAN 2013

SCALES (A1) AS SHOWN (HALF SIZE A3)

Drawing No.	Sheet No.	Rev.
80500902 0108	C002	B

XREFS :

Appendix F Cost Estimates

Project Estimate - Form A

Project Name: Whirokino Trestle
Option 9 - 1

FE
Feasibility Estimate

Item	Description		Base Estimate	Contingency	Funding Risk
A	**Nett Project Property Cost**		21,000	4,200	6,900
	Investigation and Reporting				
	- Consultancy Fees		654,000	130,800	215,800
	- NZTA-Managed Costs		55,000	11,000	18,200
B	**Total Investigation and Reporting**		709,000	141,800	234,000
	Design and Project Documentation				
	- Consultancy Fees		1,080,000	216,000	356,400
	- NZTA-Managed Costs		55,000	11,000	18,200
C	**Total Design and Project Documentation**		1,135,000	227,000	374,600
	Construction				
	MSQA				
	- Consultancy Fees		1,295,000	259,000	427,400
	- NZTA-Managed Costs		45,000	9,000	14,850
	- Consent Monitoring Fees		5,000	1,000	1,650
	Sub Total Base MSQA		1,345,000	269,000	443,900
	Physical Works				
D1	*Environmental Compliance*		100,000	20,000	33,000
D2	*Earthworks*		2,059,750	617,900	1,029,900
D3	*Ground Improvements*		0	0	0
D4	*Drainage*		168,000	33,600	55,400
D5	*Pavement and Surfacing*		1,383,750	276,800	456,600
D6	*Bridges / Structures*		15,000,000	3,000,000	4,950,000
D7	*Retaining Walls*		0	0	0
D8	*Traffic Services*		545,000	109,000	179,900
D9	*Service Relocations*		900,000	180,000	297,000
D10	*Landscaping*		70,000	14,000	23,100
D11	*Traffic Management and Temporary Works*		600,000	120,000	198,000
D12	*Preliminary and General*		1,000,000	200,000	330,000
D13	*Extraordinary Construction Costs*		0	0	0
	Sub Total Base Physical Works		21,826,500	4,571,300	7,552,900
D	**Total Construction & MSQA**		23,171,500	4,840,300	7,996,800
E	**Project Base Estimate**	(A+B+C+D)	25,036,500		
F	**Contingency** *(Assessed / Analysed)*	(A+B+C+D)		5,213,300	
G	**Project Expected Estimate**	(E+F)		30,249,800	
	Project Property Cost Expected Estimate			25,200	
	Investigation and Reporting Expected Estimate			850,800	
	Design and Project Documentation Expected Estimate			1,362,000	
	Construction Expected Estimate			28,011,800	
H	**Funding Risk** *(Assessed / Analysed)*	(A+B+C+D)			8,612,300
I	**95th Percentile Project Estimate**	(G+H)			38,862,100
	Project Property Cost 95th Percentile Estimate				32,100
	Investigation and Reporting 95th Percentile Estimate				1,084,800
	Design and Project Documentation 95th Percentile Estimate				1,736,600
	Construction 95th Percentile Estimate				36,008,600

Base Date of Estimate	1 Feb 2013	**Cost Index**
Estimate prepared by:	G. Corin	**Signed**
Estimate internal peer review by:		**Signed**
Estimate external peer review by:		**Signed**
Estimate approved by NZTA Project Manager:		**Signed**

Note: *(1) These estimates are exclusive of escalation and GST.*

Project Estimate - Form A

Project Name: Whirokino Trestle
Option 9 - 2

FE

Feasibility Estimate

Item	Description	Base Estimate	Contingency	Funding Risk
A	**Nett Project Property Cost**	800,000	160,000	264,000
	Investigation and Reporting			
	- Consultancy Fees	1,140,000	228,000	376,200
	- NZTA-Managed Costs	110,000	22,000	36,300
B	**Total Investigation and Reporting**	1,250,000	250,000	412,500
	Design and Project Documentation			
	- Consultancy Fees	1,620,000	324,000	534,600
	- NZTA-Managed Costs	110,000	22,000	36,300
C	**Total Design and Project Documentation**	1,730,000	346,000	570,900
	Construction			
	MSQA			
	- Consultancy Fees	1,946,000	389,200	642,200
	- NZTA-Managed Costs	90,000	18,000	29,700
	- Consent Monitoring Fees	10,000	2,000	3,300
	Sub Total Base MSQA	2,046,000	409,200	675,200
	Physical Works			
D1	*Environmental Compliance*	*100,000*	*20,000*	*33,000*
D2	*Earthworks*	*1,942,575*	*582,800*	*971,300*
D3	*Ground Improvements*	*0*	*0*	*0*
D4	*Drainage*	*186,000*	*37,200*	*61,400*
D5	*Pavement and Surfacing*	*2,989,000*	*597,800*	*986,400*
D6	*Bridges / Structures*	*22,500,000*	*4,500,000*	*7,425,000*
D7	*Retaining Walls*	*0*	*0*	*0*
D8	*Traffic Services*	*980,000*	*196,000*	*323,400*
D9	*Service Relocations*	*1,406,250*	*281,300*	*464,100*
D10	*Landscaping*	*100,000*	*20,000*	*33,000*
D11	*Traffic Management and Temporary Works*	*720,000*	*144,000*	*237,600*
D12	*Preliminary and General*	*1,500,000*	*300,000*	*495,000*
D13	*Extraordinary Construction Costs*	*0*	*0*	*0*
	Sub Total Base Physical Works	32,423,825	6,679,100	11,030,200
D	**Total Construction & MSQA**	34,469,825	7,088,300	11,705,400
E	**Project Base Estimate** (A+B+C+D)	38,249,825		
F	**Contingency** *(Assessed / Analysed)* (A+B+C+D)		7,844,300	
G	**Project Expected Estimate** (E+F)		46,094,125	
	Project Property Cost Expected Estimate		960,000	
	Investigation and Reporting Expected Estimate		1,500,000	
	Design and Project Documentation Expected Estimate		2,076,000	
	Construction Expected Estimate		41,558,125	
H	**Funding Risk** *(Assessed / Analysed)* (A+B+C+D)			12,952,800
I	**95th Percentile Project Estimate** (G+H)			59,046,925
	Project Property Cost 95th Percentile Estimate			1,224,000
	Investigation and Reporting 95th Percentile Estimate			1,912,500
	Design and Project Documentation 95th Percentile Estimate			2,646,900
	Construction 95th Percentile Estimate			53,263,525

Base Date of Estimate	1 Feb 2013	**Cost Index**
Estimate prepared by:	G. Corin	**Signed**
Estimate internal peer review by:		**Signed**
Estimate external peer review by:		**Signed**
Estimate approved by NZTA Project Manager:		**Signed**

Note: *(1) These estimates are exclusive of escalation and GST.*

Appendix G Economic Analysis Worksheets

Summary Worksheet 1 (SP3,6,11)

1	Evaluator(s)	Dhimantha Ranatunga (MWH)
	Reviewer(s)	David Wanty (MWH)
2	**Project/package details**	
	Road controlling authorities	NZTA
	Project/package name	Otaki to Levin PFR: Report 9 - Whirokino Trestle
	Your reference	Z1925700
	Project description	SH1 Whirokino Trestle Bridge and Manawatu River Bridge PFR
3	**Location and route**	
	Brief description of the location	**SH1 Manawatu Bridges: Whirokino and Manawatu River Bridge**
	Full description of the route or routes	SH1 Whirokino Trestle Bridge SH1 RP 954 / 11.72 – 12.82
		SH1 Manawatu River Bridge SH1 RP 954 / 12.97 – 13.16
4	**Options**	
	Summary of the options assessed	**Option 1 :Replacement of the Whirokino Trestle Bridge and Strengthening (no widening) of the Manawatu River Bridge along existing alignment**

5	**Timing**		
	Time zero (assumed construction start date)	1-Jul-13	
	Duration of bridge upgrade works	1	Years from time zero
	Start benefits	100	% of full benefits
	Time until full benefits	1	Years from time zero
6	**Traffic**		
	Route length	21.88	kilometres
	Freight tonnage growth rate (at time zero)	2.0%	% / year
	Affected HCVII (both directions)	578	average / day
	HCVIIs changed to HPMVs	90	average / day
	HCVII trips saved	6570	average per year
7	**Economic efficiency**		
	Date economic evaluation completed (mm/yyyy)	Oct 2012	
	Base date for costs and benefits	1-Jul-12	
8	**PV cost of preferred option** (from worksheet 2)	30,029,023	**A**

9 **Benefit values** (from worksheets 3 and 4)

PV VOC & CO2 savings $	1,281,032	**C** x Update factor VOC	**1.04**	= $	1,332,274	**X**
PV Accident Cost savings $	1,845,537	1 **D** x Update factor AC	**1.17**	= $	2,159,278	**Y**
PV Travel Time Savings	3,200,485	E x Update factor TTS	**1.33**	= $	4,256,645	**Z**
PV Walking and Cycling Savings	0	1 E x Update factor WC	**1.07**	= $	0	**Z**

10 BCR_N = **PV net benefits** / **PV net costs** = **X + Y + Z** / **A** = 7,748,197 / 13,204,254 = **0.6**

Summary Worksheet 1 (SP3,6,11)

1 Evaluator(s): Dhimantha Ranatunga (MWH)

Reviewer(s): David Wanty (MWH)

2 **Project/package details**

Road controlling authorities: NZTA

Project/package name: Otaki to Levin PFR: Report 9 - Whirokino Trestle

Your reference: Z1925700

Project description: SH1 Whirokino Trestle Bridge and Manawatu River Bridge PFR

3 **Location and route**

Brief description of the location: **SH1 Manawatu Bridges: Whirokino and Manawatu River Bridge**

Full description of the route or routes: SH1 Whirokino Trestle Bridge SH1 RP 954 / 11.72 – 12.82

SH1 Manawatu River Bridge SH1 RP 954 / 12.97 – 13.16

4 **Options**

Summary of the options assessed: Option 2: Replacement of both the Whirokino Trestle Bridge and Manawatu River Bridges along a new shorter alignment

5 **Timing**

Time zero (assumed construction start date)	1-Jul-13	
Duration of bridge upgrade works	1	Years from time zero
Start benefits	100	% of full benefits
Time until full benefits	1	Years from time zero

6 **Traffic**

Route length	21.88	kilometres
Freight tonnage growth rate (at time zero)	2.0%	% / year
Affected HCVII (both directions)	578	average / day
HCVIIs changed to HPMVs	90	average / day
HCVII trips saved	6570	average per year

7 **Economic efficiency**

Date economic evaluation completed (mm/yyyy): Oct 2012

Base date for costs and benefits: 1-Jul-12

8 **PV cost of preferred option**

(from worksheet 2) 44,916,823 **A**

9 **Benefit values**

(from worksheets 3 and 4)

	PV		Update Factors (2011)		
PV VOC & CO2 savings $	1,835,742	**C** x Update factor VOC	1.04	= $ 1,909,172	**X**
PV Accident Cost savings $	4,076,676	1 **D** x Update factor AC	1.17	= $ 4,769,711	**Y**
PV Travel Time Savings	4,770,903	E x Update factor TTS	1.33	= $ 6,345,301	**Z**
PV Walking and Cycling Savings	917,080	1 E x Update factor WC	1.07	= $ 981,275	**Z**

10 $BCR_N = \frac{\text{PV net benefits}}{\text{PV net costs}} = \frac{X + Y + Z}{A} = \frac{14,005,460}{28,092,054} = 0.5$

Summary Worksheet 1 (SP3,6,11)

1 Evaluator(s): Dhimantha Ranatunga (MWH)

Reviewer(s): David Wanty (MWH)

2 Project/package details

Road controlling authorities: NZTA

Project/package name: Otaki to Levin PFR: Report 9 - Whirokino Trestle

Your reference: Z1925700

Project description: SH1 Whirokino Trestle Bridge and Manawatu River Bridge PFR

3 Location and route

Brief description of the location: **SH1 Manawatu Bridges: Whirokino and Manawatu River Bridge**

Full description of the route or routes: SH1 Whirokino Trestle Bridge SH1 RP 954 / 11.72 – 12.82

SH1 Manawatu River Bridge SH1 RP 954 / 12.97 – 13.16

4 Options

Summary of the options assessed: **Option 1 :Replacement of the Whirokino Trestle Bridge and Strengthening of the Manawatu River Bridge along existing alignment**

Sensitivity Testing

5 Timing

Time zero (assumed construction start date)	1-Jul-13	
Duration of bridge upgrade works	1	Years from time zero
Start benefits	100	% of full benefits
Time until full benefits	1	Years from time zero

6 Traffic

Route length	21.88	kilometres
Freight tonnage growth rate (at time zero)	2.0%	% / year
Affected HCVII (both directions)	578	average / day
HCVIIs changed to HPMVs	90	average / day
HCVII trips saved	6570	average per year

7 Economic efficiency

Date economic evaluation completed (mm/yyyy): Oct 2012

Base date for costs and benefits: 1-Jul-12

8 PV cost of preferred option (from worksheet 2): 30,029,023 **A**

9 Benefit values (from worksheets 3 and 4)

PV VOC & CO2 savings $	733,111		**C** x Update factor ^{VOC}	1.04	= $	762,436	**X**
PV Accident Cost savings $	1,075,875	1	**D** x Update factor ^{AC}	1.17	= $	1,258,773	**Y**
PV Travel Time Savings	1,811,398		E x Update factor ^{TTS}	1.33	= $	2,409,160	**Z**
PV Walking and Cycling Savings	0	1	E x Update factor ^{WC}	1.07	= $	0	**Z**

10 BCR_N = $\frac{\text{PV net benefits}}{\text{PV net costs}}$ = $\frac{X + Y + Z}{A}$ = $\frac{4{,}430{,}369}{7{,}984{,}254}$ = **0.6**

Summary Worksheet 1 (SP3,6,11)

1 Evaluator(s)	Dhimantha Ranatunga (MWH)	
Reviewer(s)	David Wanty (MWH)	
2 Project/package details		
Road controlling authorities	NZTA	
Project/package name	Otaki to Levin PFR: Report 9 - Whirokino Trestle	
Your reference	Z1925700	
Project description	SH1 Whirokino Trestle Bridge and Manawatu River Bridge PFR	
3 Location and route		
Brief description of the location	**SH1 Manawatu Bridges: Whirokino and Manawatu River Bridge**	
Full description of the route or routes	SH1 Whirokino Trestle Bridge SH1 RP 954 / 11.72 – 12.82	
	SH1 Manawatu River Bridge SH1 RP 954 / 12.97 – 13.16	
4 Options		
Summary of the options assessed	Option 2: Replacement of both the Whirokino Trestle Bridge and Manawatu River Bridges along a new shorter alignment	
	Sensitivity Testing	
5 Timing		
Time zero (assumed construction start date)	1-Jul-13	
Duration of bridge upgrade works	1	Years from time zero
Start benefits	100	% of full benefits
Time until full benefits	1	Years from time zero
6 Traffic		
Route length	21.88	kilometres
Freight tonnage growth rate (at time zero)	2.0%	% / year
Affected HCVII (both directions)	578	average / day
HCVIIs changed to HPMVs	90	average / day
HCVII trips saved	6570	average per year
7 Economic efficiency		
Date economic evaluation completed (mm/yyyy)	Oct 2012	
Base date for costs and benefits	1-Jul-12	
8 PV cost of preferred option		
(from worksheet 2)	44,916,823	**A**

9 Benefit values

(from worksheets 3 and 4)				Update Factors (2011)			
PV VOC & CO2 savings $	1,258,277		**C** x Update factor ^{VOC}	1.04	= $	1,308,608	**X**
PV Accident Cost savings $	3,392,482	1	**D** x Update factor ^{AC}	1.17	= $	3,969,204	**Y**
PV Travel Time Savings	3,878,972		E x Update factor ^{TTS}	1.33	= $	5,159,033	**Z**
PV Walking and Cycling Savings	917,080	1	E x Update factor ^{WC}	1.07	= $	981,275	**Z**

10 BCR_N = **PV net benefits** / **PV net costs** = **X + Y + Z** / **A** = 11,418,119 / 22,872,054 = **0.5**

Appendix H Manawatu Floodplain Information

Dhimantha Ranatunga

From: Peter Blackwood <Peter.Blackwood@horizons.govt.nz>
Sent: Thursday, 25 October 2012 6:30 p.m.
To: Phil Peet; Graham Doull
Cc: Dhimantha Ranatunga; Allan Cook
Subject: RE: Whirokino Trestle

Importance: High

Hi Phil,

I did ask Graham to reply in my absence. Can I please just stress on Questions 2 (a) and also (c). Any new/replacement bridge must have the 1% AEP design capacity plus freeboard. That freeboard would be in terms of the NZTA spec of 0.6m or 1.2m where large trees are carried. We can discus that a bit further, but it would most definitely lie in that range.

The current bridge has negative freeboard, which is most undesirable.

Freeboard is necessary for model imprecision plus phenomenon not explicitly included (waves, aggradation etc) plus for bridges to allow passage of debris.

I have made a diary note to call you tomorrow.

Pete

From: Phil Peet [mailto:Phil.J.Peet@nz.mwhglobal.com]
Sent: Wednesday, 24 October 2012 10:50 p.m.
To: Graham Doull; Peter Blackwood
Cc: Dhimantha Ranatunga
Subject: RE: Whirokino Trestle

Graeme,

Thank you very much for your prompt response. It is very much appreciated.

We will be back in touch if we have further queries.

Thanks again,

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From: Graham Doull [mailto:graham.doull@horizons.govt.nz]
Sent: Wednesday, 24 October 2012 7:12 p.m.
To: Peter Blackwood; Phil Peet
Cc: Dhimantha Ranatunga
Subject: RE: Whirokino Trestle

Hello Phil,
My answers to your questions are as follows:

1. **Moutoa Floodway: Probability/frequency of the gates opening**
   a. *What is the frequency of the Moutoa floodway gates being opened*?

The long term interval between openings of the Moutoa Sluicegates was once every 20.5 months before 1990, and has been once every 11.5 months since 1990. There was a step-change at about that time, with an increase in the number of floods during spring. There is a lot of scatter in the intervals between Gate Operations, with no discernible trend apart from the step-change. The interval can be as much as 4 or 5 years, or as little as one week.

   b. What is the return period of a major flooding event (which is large enough to close SH1 around the Whirokino Trestle)?

The flooding of SH1 near the trestle does not occur by design. A major flooding event has only once closed SH1, and that was in the major February 2004 event. On that occasion a stopbank failed, and it was the only such failure during the 50 years that the Lower Manawatu Scheme (LMS) has been in place. The breached section of stopbank has since been repaired to a very high standard.

   c. *If SH1 by the Whirokino Trestle is closed, how likely is it that the alternative route using the Foxton - Shannon Road also be closed*?

Flooding of the Foxton – Shannon road does not occur by design. It has been subject to major flooding once to my knowledge, again due to a stopbank failure during the February 2004 event.
The LMS design standard is the 100 year or 1% AEP event. The Feb 2004 event was slightly larger than the design event according to our pre 2004 statistics. The statistics had to be revised after the Feb 2004 event, and that flood is now regarded as a 70 year event for the Manawatu River.

   d. Can you confirm our assumption that in the event of a major flooding event that closes SH1, SH56 will also be closed (due to the Opiki floodway?).

SH56 has to be closed frequently, on average about once every eight months. The average interval used to be about 15 months, but substantial silt deposition on riverbanks upstream of the Opiki Bridge forces water out of the channel more frequently than used to be the case.

2. **Moutoa Floodway Capacity:**
   a. *What is the existing capacity of the Moutoa floodway at the Whirokino Trestle and is this the most restricted point on the floodway*?

The design discharge down the floodway is 2270 cumecs. The design flow is about 150mm higher than the trestle bridge beam soffit. The headloss through the structure is about 60mm. It is the most restricted point on the floodway (apart from the sluicegates themselves, which is by deliberate design).

   b. *Is the capacity/throughput reduced by the cycleway*?

The impact of the cycleway on flood carrying capacity is negligibly small

   c. *What is the minimum cross section needed to provide for appropriate long term floodplain operation*?

We could not accept a smaller cross section than already exists at the trestle bridge. We would have a strong preference for a bridge that did not have a submerged soffit, and I am sure you would prefer that. The existing situation is an unavoidable compromise resulting from historical circumstances, in particular that the trestle bridge pre-dated the floodway by 20 or 30 years.

   d. What is the recurrence interval of an event that uses this full capacity (e.g. 100 year?)

The design event is the 1% AEP or 100 year flood. Larger floods are of course possible, but the consequences of such an event are uncertain, in terms of water extra water that might go down the floodway, or might escape somewhere else instead.

3. **The options we are currently investigating on behalf of the NZTA include:**
   1. New bridge(s) (Trestle & Manawatu);
      a. Along existing alignment

b. *Align to Levin Road*

2. *Maintain bridge(s) – Do Minimum (replace Whirokino in 10 years and strengthen the Manawatu River Bridge)*
3. *Replace the Whirokino Trestle with culverts under and then embankments;*

As indicated in 2 c. above, we could not accept a smaller cross section than already exists, so culverts under an embankment are definitely not a viable option.

4. *Retain the existing Whirokino Trestle but as it cannot handle HPMVs, create new road on the floodway for these "overweight" vehicles;*
5. *Remove the Whirokino Trestle Build a new road on the floodway to cater for all traffic.*

In principle, a road across the floodway is probably viable, depending on the details. There would possibly be some geotechnical issues depending on how the road was configured in relation to the stopbanks.
A new road could not be elevated above the adjacent ground if the trestle bridge remained in place. With the trestle bridge removed, the road could be elevated a little, as long as the heading up thus caused did not exceed 60mm.
The road could have water flowing across it for up to 72 hours. Flows would be up to 4.5 metres deep, and move at velocities of up to one metre per second, although it would usually be less than that. The road would then be submerged by stationary water for another week or two, depending on how quickly the last of the water in the floodway took to drain away. That in turn is determined mainly by the recession rate of river flows, but to some extent by tides. Drainage will be faster during spring tides than during neap tides.

Regards,

Graham

From: Peter Blackwood
Sent: Wednesday, 24 October 2012 5:19 p.m.
To: 'Phil Peet'; Graham Doull
Cc: Dhimantha Ranatunga
Subject: RE: Whirokino Trestle

Graham,

I realise there are some pressing priorities. Can you please consider and we can discuss next Monday and reply.

Thanks

Peter

From: Phil Peet [mailto:Phil.J.Peet@nz.mwhglobal.com]
Sent: Tuesday, 23 October 2012 9:59 p.m.
To: Peter Blackwood
Cc: Dhimantha Ranatunga
Subject: Whirokino Trestle

Hi Peter,

Thanks for the discussion today. Below are the questions we are hoping that you or your team will be able to answer over the next couple of days.

1. **Moutoa Floodway: Probability/frequency of the gates opening**
   a. What is the frequency of the Moutoa floodway gates being opened? Note that the Moutoa Sluice Gates & Floodway infosheet (Date unknown- possibly 2009?) by Horizons states "In their first 40 years to 2002 the sluice gates were opened almost 50 times. Since then they have been opened on average every 15 months with the biggest test being the disastrous floods of 2004."

b. What is the return period of a major flooding event (which is large enough to close SH1 around the Whirokino Trestle)?
c. If SH1 by the Whirokino Trestle is closed, how likely is it that the alternative route using the Foxton - Shannon Road also be closed?
d. Can you confirm our assumption that in the event of a major flooding event that closes SH1, SH56 will also be closed (due to the Opiki floodway?).

2. **Moutoa Floodway Capacity:**
   a. What is the existing capacity of the Moutoa floodway at the Whirokino Trestle and is this the most restricted point on the floodway?
   b. Is the capacity/throughput reduced by the cycleway?
   c. What is the minimum cross section needed to provide for appropriate long term floodplain operation?
   d. What is the recurrence interval of an event that uses this full capacity (e.g. 100 year?)

3. **The options we are currently investigating on behalf of the NZTA include:**
   1. New bridge(s) (Trestle & Manawatu);
      a. Along existing alignment
      b. Align to Levin Road
   2. Maintain bridge(s) – Do Minimum (replace Whirokino in 10 years and strengthen the Manawatu River Bridge)
   3. Replace the Whirokino Trestle with culverts under and then embankments;
   4. Retain the existing Whirokino Trestle but as it cannot handle HPMVs, create new road on the floodway for these "overweight" vehicles;
   5. Remove the Whirokino Trestle Build a new road on the floodway to cater for all traffic.

I would really appreciate your comments on the last three options, especially if there are any physical or planning reasons why these cannot be progressed.

Hopefully we can hear back from you in the next few days.

Regards,

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Moutoa Sluice Gates & Floodway

Helping keep our Region safe

Introduction

The Manawatu Plains have developed into a regional and national economic powerhouse thanks to the system of drainage and flood protection that has evolved since the late 19th Century when farmers began digging drains to turn flood-prone swamp country into highly productive pastoral and arable land.

The Moutoa Sluice Gates and floodway, completed in 1962, are recognised as one of New Zealand's outstanding engineering projects of the 20th century. They still serve as a lynchpin of the vast and growing network of drains, stopbanks and floodgates that comprise the Lower Manawatu Scheme and protect the farms, orchards, market gardens and homes between the ranges and the sea.

In their first 40 years to 2002 the sluice gates were opened almost 50 times. Since then they have been opened on average every 15 months with the biggest test being the disastrous floods of 2004. In fact, 2004 was a particularly notable year for floods in the Manawatu River with the gate required to be opened six times.

The sluice gates and floodway played a key role in protecting the lower Manawatu Plain during the huge floods of February 2004.

Each time the gates are opened, they help speed the passage of floodwaters to the sea by releasing them into the 10km floodway that bypasses the 30 km of slow-flowing meandering channel of the lower Manawatu River around Koputaroa and Moutoa.

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While Horizons Regional Council continues to invest many millions of dollars in building new stopbanks and increasing the effectiveness of existing systems, the Moutoa Sluice Gates remain a crucial component of the Lower Manawatu Scheme. Being able to open the gates when significant flooding threatens means many thousands of hectares and hundreds of homes downstream are spared the worst effects of flooding.

Background

The Manawatu River originates north of Norsewood in Tararua District, to the west of the Ruahine Ranges. It drains 6000 square km on its way through the Manawatu Gorge to the sea at Foxton. On this circuitous route it is joined by several major, fast flowing tributaries, both above and below the Gorge, including the Mangatainoka, Tiraumea and Mangahao Rivers and the streams of the South East Ruahines above the Gorge, together with the Oroua, Pohangina and Tokomaru below the Gorge.

During dry periods cattle graze the diversion channel upstream from the sluice gates to the Manawatu River.

On reaching the wide Manawatu Plain the river adjusts to a shallower gradient and meanders over the last 48 km of its journey, with a fall of just 18 cm per km. The Manawatu Plain was formed from silt carried downstream by the river. Much of this flat expanse of land is at sea level or below and consequently the area can flood easily.

Lower Manawatu Scheme

Hand-dug drains were a feature of the low-lying swampy areas since the 1880s and the arrival of mechanical digging equipment in the 1920s enabled large areas of previously boggy land to be drained and successfully farmed. The drains also provided some protection against flooding and prior to the establishment of the Manawatu Catchment Board in 1944, various river and drainage boards installed stopbanks and greatly improved the natural drainage and flood protection on the plain.

But a devastating flood in 1941 confirmed that effective, co-ordinated flood protection was badly needed. The Lower Manawatu Scheme was designed in 1946 by Paul Evans, Chief Engineer of the Catchment Board. His brief was to protect 280 square km of pastoral, horticultural and urban land between Ashhurst and the sea. His design included the Moutoa floodway and the sluice or flood gates.

The design incorporated stopbanking along most of the Manawatu River from the Gorge to the sea, some of which was already in place when the scheme was given its first major test in the

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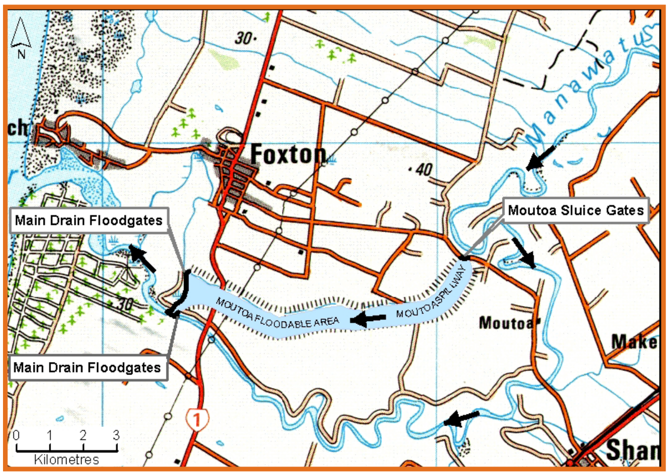
flood of 1953. Only with significant help from the army in laying sand-bags, was the flood water contained. It was obvious that sluice gates were needed and they were built between 1959 and 1962.

The Moutoa Floodway

Located on the Foxton-Shannon Road, south of Opiki and just above Moutoa, the gates are able to divert water from the main river into a specially designed 10 km floodway that rejoins the river at Whirokino.



The 10km Moutoa floodway bypasses 30 km of meandering channel as the Manawatu River makes its way to the sea at the Foxton estuary.

The floodway bypasses the 30 km of slow-flowing, meandering channel that can easily flood and pour water over many hectares of valuable land. It is 600 m wide and is bounded on both sides by stopbanks 5.5 m high.

Several features of the design prevent the floodway from being damaged by flood flows:

- energy dissipation blocks immediately adjacent to the gates reduce the speed of the water as it comes under the gates
- the curved shape of the structure enables the water to fan out and spread evenly across the floodway
- the floodway rises slightly away from the gates so the water has room to pool and does not gouge out a channel.

The Moutoa Sluice Gates

The curving reinforced concrete structure contains nine steel radial gates, each 15 m wide by 4.5 m high and weighing 15 tonnes. They are raised by a pulley system attached to the concrete piers and are operated by a series of electric motors. Each gate can be operated independently and standby power is available in case of electricity failure. The present day replacement value of the gate structure is assessed as $23 million.

The curving reinforced concrete structure that contains the nine gates, each 15 m wide by 4.5 m high, was completed in 1962 and was valued at $23 million in 2009.

To open or not to open?

The gates are ready to be opened at any time should they be needed and Horizons staff are trained in their operation. The skill of controlling the flood water effectively is in judging the correct time to open, and subsequently close, the gates, by how much and how quickly. When fully opened they allow 2450 cumecs of water to pass through.

The nine gates at Moutoa are raised by a pulley system powered by a series of electric motors. Operations are controlled from this nearby building.

The decision to open the gates has to take into account a number of factors. The point at which the gates are raised is timed according to the amount of water flowing, not only down the main Manawatu River, but also in tributaries swollen by local rainfall, such as the Tokomaru River. If the gates are opened too soon or too quickly, the riverbed and banks may scour upstream and water flow in the main river will slow down. This will accelerate silt build-up in the riverbed, further restricting the flow of water along this meandering stretch. The gates are opened alternatively over approximately 40 minutes. Initially, they need to be opened very slowly to prevent a wave surging down the floodway and damaging both land and stopbanks.

Opening the gates in flood conditions has no effect on flood levels in Palmerston North city or on the drainage of water from low-lying land on the Manawatu Plain. By the time conditions have made it necessary to open the gates, natural drainage from lower lying areas will have ceased. The river, contained by stopbanks, will be at a higher level than much of the surrounding land. This means that gate opening can be delayed until the maximum operational level of the gates is reached. It will not disadvantage those with land upstream of the gates, but will avoid the floodway being under water longer than is really necessary.

The gates are not kept open at the maximum operating level for longer than is absolutely necessary. They are shut down slowly as the river falls, to avoid any sudden changes in water level and to ensure the maximum flow possible is retained in the main river channel in order to minimise silt deposition.

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Moutoa Sluice Gates

A feat of river engineering

Introduction

The Moutoa sluice gates are a unique feature of the flood protection scheme for the Lower Manawatu River. Since they were installed more than 35 years ago the gates have been opened 20 times, saving properties and many hectares of land downstream of Opiki from the destructive floods that used to affect residents and landowners alike.

Background

The Manawatu River originates north of Norsewood and drains 6000 square km on its way through the Manawatu Gorge to the sea at Foxton. On this circuitous route it is joined by several major, fast flowing tributaries, both above and below the Gorge, including the Mangatainoka, Tiraumea and Mangahao Rivers and the streams of the South East Ruahines above the Gorge together with the Oroua, Pohangina and to Tokomaru below the Gorge. On reaching the wide Manawatu plain the river adjusts to a shallower gradient and, for the last 48 km of its journey it meanders with a fall of just 18 cm per km.

The Manawatu plain was formed from silt carried downstream by the river. Much of this flat expanse of land is at sea level or below and consequently the area can flood easily.

Photo: **Faces of the River.** David Young, Bruce Foster

The big flood of 1953 at Half Crown Bend.

Lower Manawatu Scheme

Prior to the establishment of the Manawatu Catchment Board in 1944, various river and drainage boards had installed stopbanks and greatly improved the natural drainage on the plain. But the devastating flood in 1941 confirmed that effective, co-ordinated flood protection was badly needed.

The Lower Manawatu Scheme was designed in 1946 by Paul Evans, Chief Engineer of the Catchment Board. His brief was to protect 280 square km of pastoral, horticultural and urban land between Ashhurst and the sea. His design included the Moutoa floodway and the sluice or flood gates - features unique to the Lower Manawatu Flood Protection Scheme and the lynch pin of the flood control system.

The design incorporated stopbanking along most of the Manawatu River from the Gorge to the sea, some of which was already in place when the scheme was given its first major test in the flood of 1953. Only with significant help from the army in laying sand-bags, was the flood water contained. It was patently obvious that the sluice gates were an essential part of the flood control scheme. They were built between 1959 and 1962.

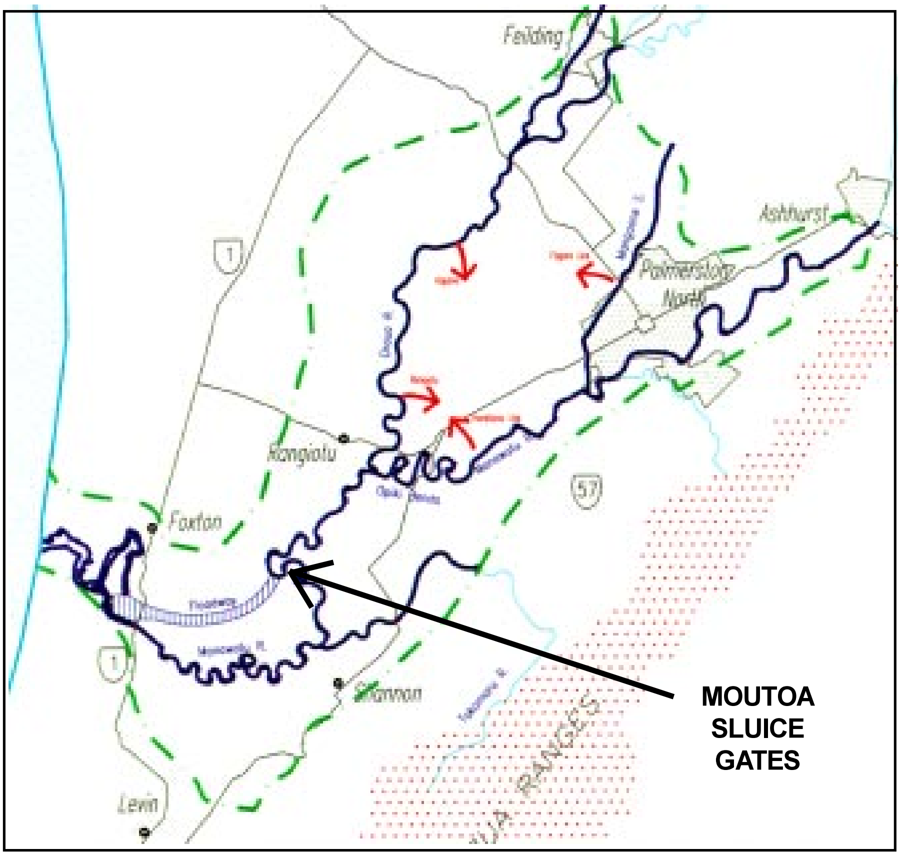
The Moutoa Floodway

Located on the Foxton-Shannon Road, south of Opiki and just above Moutoa, the gates are able to divert water from the main river into a specially designed 10 km floodway that rejoins the river at Whirokino. The Floodway bypasses the 30 km of slow-flowing, meandering channel that can so easily flood, pouring water over many hectares of valuable land.

The Moutoa floodway, an integral part of the system, is 600 m wide and is bounded on both sides by stopbanks 5.5 m high along its length.

Several features of the design prevent the floodway from being damaged by flood flows:

- energy dissipation blocks immediately adjacent to the gates reduce the speed of the water as it comes under the gates
- the curved shape of the structure enables the water to fan out and spread evenly across the floodway
- the floodway rises slightly away from the gates so the water has room to pool and does not gouge out a channel.



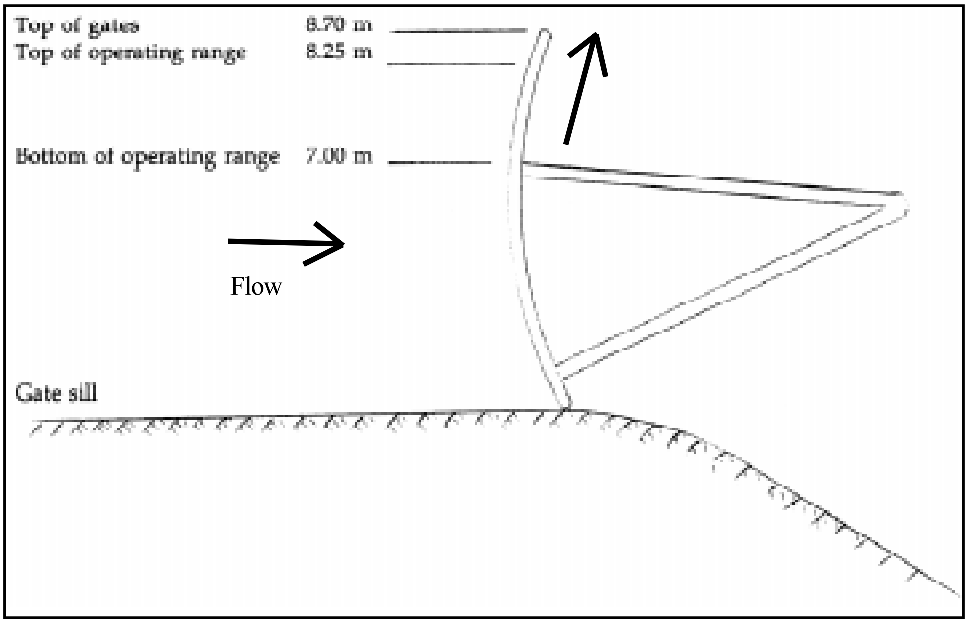
The Manawatu catchment showing the location of the gates and floodway.

Photo: **Faces of the River.** David Young, Bruce Foster

Paul Evans, designer of the Lower Manawatu Scheme, and his pride and joy - the Moutoa sluice gates.

The Moutoa Sluice Gates

The curving reinforced concrete structure contains nine gates. These are steel radial gates, each 15 m wide by 4.5 m high, weighing 15 tonnes. They are raised by a pulley system attached to the concrete piers, operated by a series of electric motors. Each gate can be operated independently and standby power is available in case of electricity failure.



Section through a sluice gate. The gate sill is at ground level of the surrounding land.

To open or not to open?

The gates are ready to be opened at any time should they be needed and **horizons.mw** staff are trained in their operation. The skill of controlling the flood water effectively is in judging the correct time to open, and subsequently close, the gates, by how much and how quickly.

The decision to open the gates has to take into account a number of factors.

The gates are designed to operate within a range of river levels as shown on the diagram above. As the water level in the river begins to rise, the point at which the gates are raised is timed according to the amount of water flowing, not only down the main Manawatu River, but also in tributaries swollen by local rainfall, such as the Tokomaru River. The amount of water in the Manawatu River is determined by weather conditions over the whole of its catchment area. The Tokomaru River is affected by rainfall in the immediate area and adds to the surface flooding on the Manawatu plain.

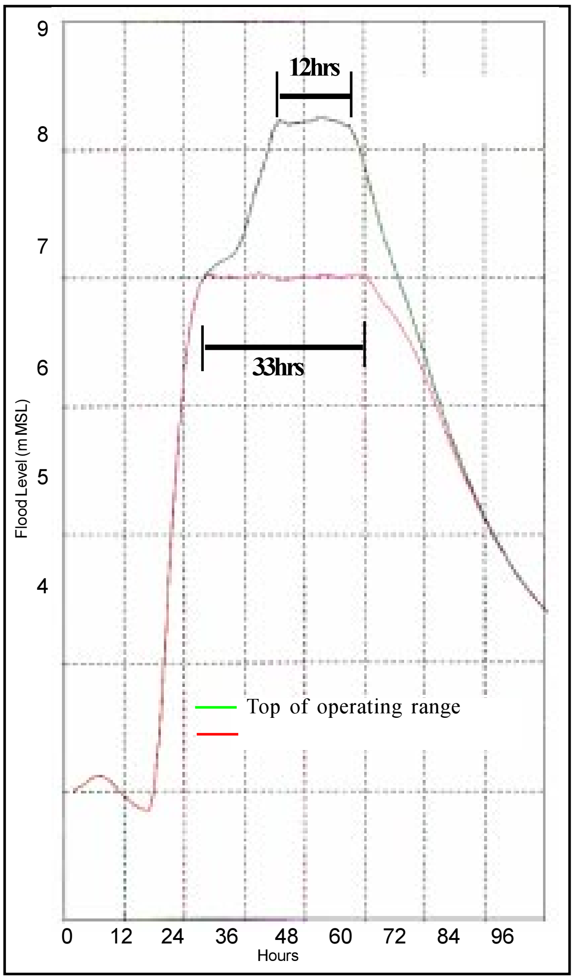
If the gates are opened too soon or too quickly, scouring of the river bed and banks may occur upstream; water flow in the main river will slow down and deposit silt in the already silted river bed. This partially closes the river channel and further restricts the flow of water along this meandering stretch.

The possible rise in water level has to be anticipated to allow gate opening to be very slow at the start. Opening them too quickly could cause a wave to surge down the floodway resulting in damage to both land and stopbanks.

Opening the gates in flood conditions has no effect on flood levels in Palmerston North City or on the drainage of water from low-lying land on the Manawatu plain. By the time conditions have made it necessary to open the gates, natural drainage from lower lying areas will have ceased. The river, contained by stopbanks, will be at a higher level than much of the surrounding land.

This means that gate opening can be delayed until the maximum operational level of the gates is reached. It will not disadvantage those with land upstream of the gates, but will avoid the floodway being under water longer than is really necessary.

Moutoa Sluice Gates



This graph compares the effect of opening the gates at their minimum (7m) and maximum (8.5m) operational water levels. Waiting until the water rises to 8.5m level leaves the floodway under water for only 12 hours compared with 33 hours if the gates are opened at the 7m level.

In practice, the gates would not remain at the maximum operating level for longer than is absolutely necessary. They are shut down slowly as the river falls, to avoid any sudden changes in water level.

The Moutoa flood gates are a remarkable feat of river engineering. The design won an IPENZ award recognising them as one of the key flood control structures of this century. Landowners and residents in the Lower Manawatu Scheme have a unique innovation helping to protect their properties from the devastation of past floods.

Photo: **Faces of the River.** David Young, Bruce Foster

An unwelcome flood in 1914 affects drying flax from the Miranui Flax Mill, Shannon.

The Moutoa sluice gates in operation

For more information contact your nearest office

Offices:
Taumarunui
34 Maata Street
Phone 07-895 5209

Wanganui
6 Bates Street
06-345 0705

Marton
Hammond Street
Phone 06-327 7189

Dannevirke
Weber Road
Phone 06-374 6700

Head Office:
Palmerston North
11-15 Victoria Ave
Phone 06-952 2800

Freephone 0508 446 749

help@horizons.govt.nz

www.horizonsmw.govt.nz

24 Hour Pollution Hotline
Freephone 0508 476 558

Depots:
Levin
11 Bruce Road
Phone 06-367 8259

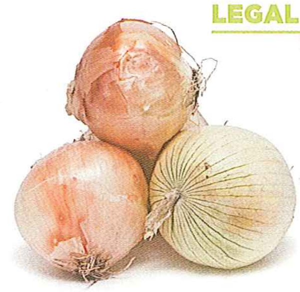
Taihape
Torere Rd, Ohotu
Phone 06-388 0192

Pahiatua
Cnr Huxley & Queen Streets
Phone 06-376 7758

Kairanga
Cnr Rongotea & Kairanga-Bunnythorpe Roads
Phone 06-350 1769

horizons.mw
Your Regional Council

Do onions float?



In *Easton Agriculture & Anor v Manawatu Wanganui Regional Council* (CIV-2008-454-31, 7 September 2011, Palmerston North High Court), we succeeded in defending a claim against the council for $2,540,387 arising from the 2004 Manawatu floods.

BY SARAH MACKY

The massive storm in the Lower North Island was a 1 in 110 year event. It caused the third-largest flood flow in the Manawatu River since records began.

The Manawatu Wanganui Regional Council (Horizons) managed the Lower Manawatu Flood Control Scheme. This scheme protects a land area of 320km^2 from flooding including the city of Palmerston North. It comprises 250km of stopbanks and a floodway called the Moutoa floodway to which flood waters are diverted from the Manawatu River through the Moutoa floodgates in times of peak flow.

The construction of the Lower Manawatu Flood Control Scheme stopbanks, Moutoa floodway and Moutoa floodgates took place between 1959 and 1965. The construction of the Moutoa floodway stopbanks included construction of the south stopbank up under pre-existing structures such as the Whirokino trestle bridge. This construction was undertaken by the council's predecessor.

The maintenance of the Lower Manawatu Flood Control Scheme is funded by the community and more directly by those who gain benefit from the protection offered by the Scheme. During the storm, the council decided the peak flow was likely to be such that the floodwaters should be diverted through the Moutoa floodgates into the floodway. While the floodway was in use, a section of the south stopbank in the Moutoa floodway breached. The breach occurred in the vicinity of the Whirokino trestle bridge which cut through the top of the south stopbank. As a result of the breached stopbank, the plaintiffs' potato and onion farms were flooded. The plaintiffs' crops were lost. The force of the storm resulted in some of the plaintiffs' onions ending up piled one and a half metres against the plaintiffs' fences.

The plaintiffs said a gap existed under the Whirokino trestle bridge and that the gap and the interaction between the stopbank, the floodwaters and the bridge had caused the stopbank to breach. The plaintiffs alleged the council should have addressed these issues and if it had the stopbank breach would not have occurred. They claimed against the council for their losses. The causes of action were in negligence, nuisance, breach of statutory duty and *Rylands v Fletcher*.

When local government reorganisation occurred in 1989, Horizons took over the duties of the catchment board in managing the Lower Manawatu Flood Control Scheme. Section 148 of the Soil Conservation & Rivers Control Act 1941 provides a defence to a claim against a council for breach of a stopbank where the breach of the stopbank was caused without any negligence on the part of the council. The court found this defence applied and so that put an end to the causes of action in nuisance, breach of statutory duty and *Rylands v Fletcher*. This is the first case where this defence has succeeded in New Zealand. That left the claim in negligence to be dealt with.

The evidence established the existence of a gap between the top of the stopbank and the underside of the Whirokino trestle bridge. The council had a system of regular inspections that it undertook of the stopbanks. In addition, the council had engaged experts to inspect the stopbank over the years. The council inspectors did not notice the gap under the bridge. The court concluded that the council ought to have seen the gap and because it did not, that the council had fallen below a reasonable standard of care in not seeing the gap and doing something about it. However, despite finding that the gap existed, the court found that the gap did not in fact cause the stopbank to breach. The part of the stopbank directly under the Whirokino trestle bridge was built up with concrete bags. The experts all agreed that the concrete bags would be the slowest to dislodge compared with the loose material in the stopbanks upstream and downstream of the bridge. The court found that breaches occurred initially in those two areas and because of that, the plaintiffs' properties would have flooded in any event. Therefore, the plaintiffs' claims against the council failed.

In every case you learn something new. The answer to the question in the title "Do onions float?" is a resounding yes.

Appendix I Previous Reports and Correspondence

Whirokino Trestle Bridge – SH1, RS 954/11.72

Deficiencies

Whirokino Trestle is a nominal 1.1km long reinforced concrete t-beam structure comprising 90 no. 12.2m spans, constructed circa 1938. The structure carries SH1 traffic over the Manawatu flood plain.

Our screening process identified the bridge beam and deck elements to be under capacity for HPMV loading.

Figure A1.3: Whirokino Trestle Bridge

The structure is was subject to a detailed condition report in 1997 which identified an ongoing maintenance liability. It is understood that the structure is currently costing in the region of $100,000 a year for reactive maintenance but that this figure is projected to rise due to accelerated deterioration with the bridge rapidly approaching the end of its serviceable life.

Assessment

Initial assessment results indicate that the structure is under capacity for HPMV loading.

Recommendation

It is noted that the Wellington Northern Corridor will terminate just north of Levin. The Whirikino Trestle Bridge will therefore ***not*** be bypassed by this project.

Strengthening is not the preferred option due to the short remaining life of the structure.

The estimated cost for replacement is ***$17m***. A floodway has been constructed to contain the flood flow to a nominal 500m wide channel. It is assumed that the new structure will only need to span between the floodway stopbanks:

- Exclusions
    - Land acquisition, if required
- Inclusions
    - Approach embankments and realignment
    - 5 no. stock underpasses / culverts on approach alignment
    - 12m wide carriageway

Manawatu River (Whirokino) Bridge – SH1, RS 954/12.97

Deficiencies

The Manawatu River (Whirokino) Bridge is a 7 span steel plate girder structure constructed circa 1943.

Our screening process identified the central span bridge beam elements to be under capacity for HPMV loading.

Figure A1.4: Manawatu River (Whirokino) Bridge

Assessment

Assessment results show that the bridge is under capacity for HPMV loading. The bridge beam elements fail at the central piers B, C and D. There are also mid span failures for spans CD and DE.

Recommendation

If the decision is taken to replace Whirokino Trestle, replacing this bridge at the same time may be preferred to achieve both a more favourable alignment and a cost saving, in comparison with two discreet replacement schemes.

Strengthening is also an option and would be cheaper in terms of initial capital investment. Options include retrofit of additional cross bracing and beam strengthening.

Rough Order Cost for Strengthening – $500,000

TO: Tony Manns, BBO

FROM: Philip Gifford, MWH New Zealand Limited

RE: Preparation of Project Feasibility Report (PFR) – SH1, Whiokino Trestle

Date Sept 2011

Dear Tony

Kevin McFarlane has requested that we prepare a PFR in this project in view of the HPMV investigation.

I am just getting underway so any comment, information you could provide would be appreciated.

Capital

(a) Capital Costs

I see that the $17,000,000 capital cost includes realignment. This figure is a rough order costing only – basis was 500m long structure by 12m overall deck width @ $2000/m2. Easy construction, repeatability, easy access thus the low unit rate. We allowed a $5M allowance to cover southern embankment construction and tie ins. Figure is GST exclusive and does not allow for P&G costs.

Do you have an idea of the scope of the realignment? No real work done on this aspect. Alignment will be driven by whether or not the Manawatu River bridge is replaced at the same time and construction sequence.

I note that the Manawatu River bridge is costed at strengthening $ 500,000, would it be viable to reconstruct at the same time. Apprrox how much would that cost? In the ideal world the Manawatu River Bridge would be replaced at the same time. This would assist with alignment, levels of service both carriageway width and load carrying capacity. The current bridge is 180m long and spans between stopbanks so would assume a similar length for any replacement bridge – much more expensive to build with piers likely to be in waterway, tidal effects etc. Our ROC would be 180 x 12 @ somewhere between $3500-4500/m2 plus P&G. So at $4000/m2 comes in at $8.5M +P&G for the bridge itself plus approaches.

Does the cost include alternative road alignment? No Does it include traffic diversion physical works? No What is the anticipated construction sequence?

If the proposed structure is shorter, will there be hydraulic issues with the Regional Authority? Wouldn't think so. The current bridge while being 1 km long crosses the flood channel being approximately 500m. The flood channel stopbank passes under the bridge at the mid point and is designed to take the flood flows within this existing channel. The existing bridge deck level is just above the top level of the stopbank. I would anticipate a new structure would be beneficial to the flood hydraulics as there would be a reduction in the number of piers in the flood channel and the deck level would be such that the soffit of the beams would be above the top of the stop bank. Some provision may have to be made to allow flood water to pass the southern embankment should the stop bank be breeched as occurred in 2004. The stock underpasses could serve this dual purpose.

(b) Maintenance Costs

I see the report nominates an estimated annual cost of $100,000 per year? (For Whirokino trestle) What could I use as an approximate value for the Manawatu river bridge? Painting costs every 15 years is approx $650k plus an minor maintenance say $10k every 5 years say annualised maintenance cost $45k.

(c) Structure Life and Earthquake Risk

I have been told that the whirokino structure is to be replaced in 5-10 years. Is this realistic? Environmental deterioration on this structure is extensive – approximately $100-125k is spent annually patching up the bridge but the deterioration continues. We are basically trying to hold its condition until a replacement can be built. So 5-10 year replacement period is reasonable.

What is the residual life of the manawatu river bridge? Structurally 20+ years

If I was to do some type of earthquake risk analysis, do you have a suggestion for how long it would take to get the road operational again?. Not sure where you are going with this one. Assuming a total loss of the trestle – there is only one main waterway that passes under the Trestle Bridge which could be spanned easily with Bailey stock. The other drains could be piped easily. If a temporary roadway was built on the ground adjacent to the existing bridge under emergency conditions I would expect a period of 4 weeks to get something opened again.