Redoubt Road - Mill Road
Corridor Study

Final Project Feasibility Report

CER: 09/269

Redoubt Road - Mill Road Corridor Study

Project Feasibility Report
FINAL

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Te Kaunihera o
MANUKAU
City Council

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1 Executive Summary

1.1 Background

1.1.1 Background

Mill Road provides an arterial road connection east of State Highway 1 (SH1) between Papakura District and Manukau City. This route is coming under increasing pressure at present and analysis shows that it will be placed under greater pressure as the Flat Bush and Takanini growth areas develop. This route has also created significant community concern in recent years due to its safety record. Manukau City Council considers that the standard of the route at present does not align with its regional arterial function. In addition the development currently under way and proposed in the Flat Bush area, Takanini and Papakura will place increased pressure on the connection between Murphys Road and Redoubt Road.

1.1.2 The Southern Sector Strategic Transport Study (SSST)

This study, carried out in 2004 jointly by Manukau City Council, Papakura District Council, Franklin District Council, The Auckland Regional Council and Transit New Zealand had an objective to review the long term transportation strategy for the southern part of the Auckland Region in the context of the anticipated future land use. One of the recommendations of the study was that:

"Manukau City Council and Papakura District Council undertake a corridor study for a route from Flat Bush to Papakura and possibly to Drury (the "Mill Road Route"). This corridor study should acknowledge the advantages of a multi modal corridor which integrates well with land use."

As a result two separate but linked investigation and reporting studies have been commissioned by Papakura District Council and Manukau City council. This report relates to the section of the route within Manukau City Council's boundary.

1.2 Preliminary Route Options

At the option development stage a number of possibilities were considered and evaluated. A total of ten options were considered for the Redoubt Road / Mill Road Corridor and four options were considered for Murphys Road. A summary of the route options is shown in Figure 1-1 and detailed descriptions of each option are provided in Section 6.3 of this report.

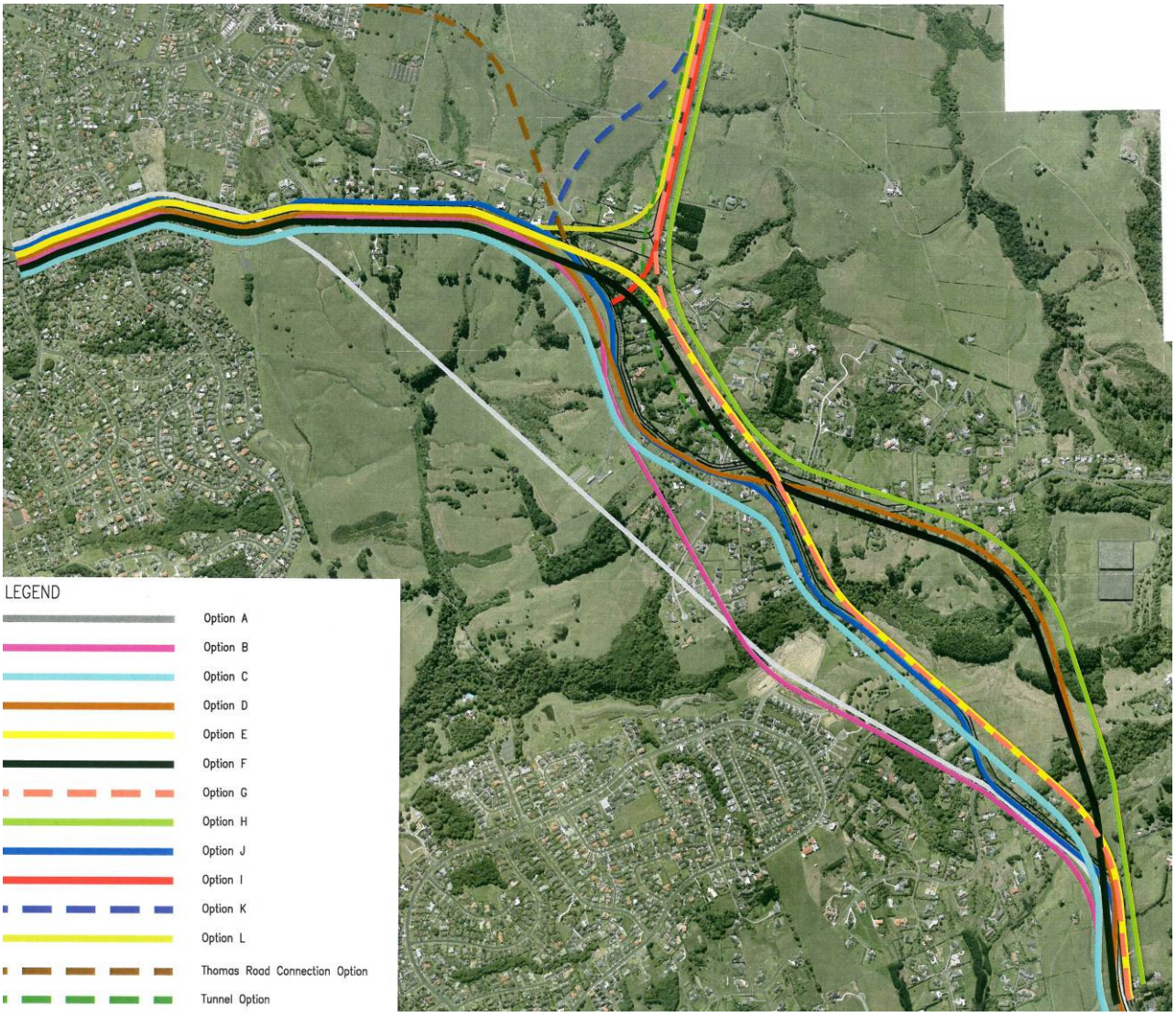

Figure 1-1: Preliminary Route Options

During the route selection process the options were narrowed down to three preferred options for the Redoubt Road / Mill Road Corridor (C, D and J) and two preferred options for Murphys Road (I & K). These five options were further refined at a subsequent workshop attended by Philip Ingram Garth Vipond, Grant Gordon and Rob Wilson.

Given the required combinations of route options being considered, each combination of options was given a scheme number and these are summarised in Section 14.

1.3 Economics

An economic evaluation has been carried out on the proposed upgrading options of the existing Redoubt Road - Mill Road Corridor, on the basis of the Land Transport New Zealand Economic Evaluation Manual (EEM). Values of travel time, congestion relief, carbon dioxide and vehicles operating costs have been derived from the EEM.

The analysis has evaluated 12 upgrade schemes which have benefit cost ratios ranging between 2.4 and 4.8 indicating medium to high economic efficiency.

Based on the current estimates and economic analysis scheme number 9 (Option I plus J at grade) presents the best BCR of 4.8 for the high growth scenario and a BCR of 3.1 for the low growth scenario. However the design team considered that the recommended scheme should be scheme 1 (Option C plus J at grade) which has a BCR of 4.6 for the high growth scenario and a BCR of 3.0 for the low growth scenario.

1.4 Additional Route Options

Preliminary consultation took place from mid August to early October 2008. Consultation was later extended to December 2008 due to the high number of responses received and a public meeting being held. A number of further options were suggested by community. These were reported to Council in February 2009, where it was resolved that two of those options (Option X1 and Option D Alternative) be the subject of further study by Opus.

An Option Evaluation Workshop was held resulting in Option X1 being discarded as it did not meet the transport objectives of this study. Option D Alternative was taken back to the community for another round of targeted consultation.

Option D Alternative is a similar route to the original Option D. The main difference is that the eastern section of the route connects 250m west of the Redoubt Road / Mill Road intersection rather than 900m east of the Mill Road / Redoubt Road intersection. This alteration results in less dwellings being directly affected by the alignment. It also allows for the existing Redoubt Road to remain as an access road to the properties it currently serves.

1.5 Preferred Option

A final workshop was held with Council and Opus staff to identify which option or options would proceed to more details analysis in the Scheme Assessment Phase. The refined options considered are shown in Table 1-1.

Table 1-1: Options Considered

Scheme Number	Redoubt Road / Mill Road Alignment	Murphys Road Alignment	Intersection Treatment
1	Option C	Option I	At grade
2			Grade Separated
3		Option K	At grade

4			Grade Separated
5	Option D	Option I	At grade
6			Grade Separated
7		Option K	At grade
8			Grade Separated
9	Option J	Option I	At grade
10			Grade Separated
11		Option K	At grade
12			Grade Separated
13	Option D Alternative	Option I	At grade
14			Grade Separated
15		Option K	At grade
16			Grade Separated

Option D Alternative was agreed as the preferred option for the Redoubt Road / Mill Road alignment to be considered in the Scheme Assessment phase. The key advantages this alignment has over the other options are that it can be built with minimum interference to existing traffic and enables Redoubt Road and Mill Road to be retained as local service roads. Connecting Redoubt Road and Mill Road to the new corridor through signalised intersections has the potential to allow for a narrower cross-section through a reduced need to provide property access and the possibility of restricting cyclists to using the local service roads.

Option K is the preferred option for the Murphys Road corridor as this enables the new arterial to be built with a minimum of interference to existing traffic. This option can be implemented either before or as part of the Stage 3 Flat Bush development.

A signalised **at-grade intersection** is the preferred arrangement at the major intersection of Redoubt Road and Murphys Road. The grade separated scenario would have required a substantial bridge and traffic signals to control the right turn movements into and out of Murphys Road, and would have also required traffic signals.

1.6 Conclusion

A thorough process of investigation has assessed the feasibility of various options for the Mill Road Corridor. Option evaluation workshops attended by specialists and robust public consultation refined the preferred options to four Redoubt Road / Mill Road alignments, two Murphys Road options and two Murphys Road / Redoubt Road intersection arrangements. Benefit cost ratios for each of these options range between 2.4 and 4.8 indicating the proposed schemes have medium to high economic efficiency.

From these schemes the joint Council and Opus recommended options to proceed to the Scheme Assessment Phase are:

- Option D Alternative be the basis for the main Redoubt Road / Mill Road route,
- Option K be the basis for the new Murphy's Road alignment, and
- Murphys Road / Redoubt Road intersection be at grade.

As Option D Alternative and Option K can be build largely off line and consequently allow Redoubt Road and Mill Road to be retained as local service roads, these options provide the key benefit of being able to be constructed without unduly affecting future traffic flows. The use of Redoubt Road and Mill Road as local service roads with signalised connections to the arterial road will provide residents with safer access to those roads than exists at present.

Opportunities can be created for cyclists to use the service roads rather than the arterial road and as the corridor will have a reduce property access function there is potential for a narrower cross section than initially planned.

2 Introduction

Opus International Consultants have been commissioned by Manukau City Council to investigate potential upgrading options of the existing Redoubt Road / Mill Road corridor. The section of Murphys Road approaching the corridor will also be reviewed for potential improvement options.

A locality diagram for the study is provided in Figure 2-1.

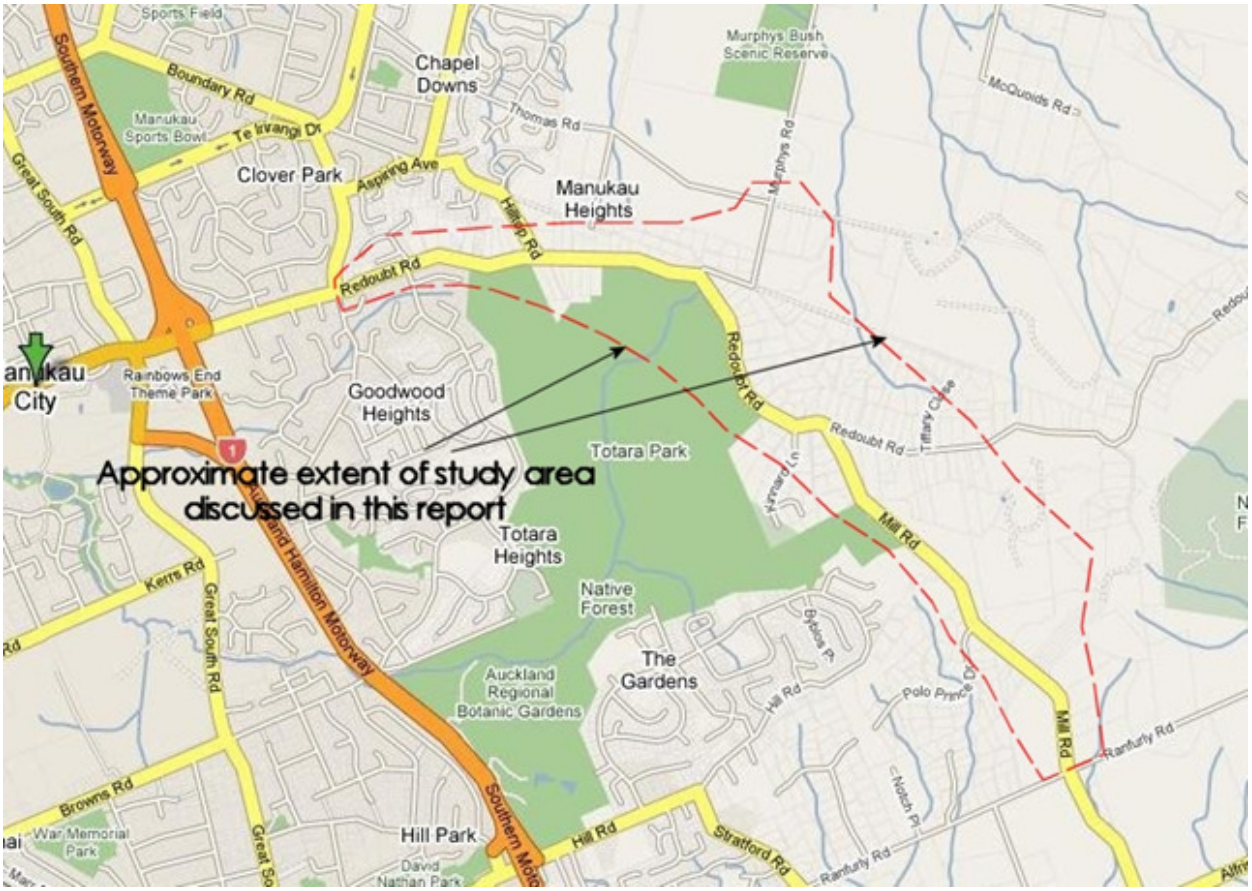

Figure 2-1: Locality Diagram

This report is structured as follows:

- Sections 3-5 describe the problem, project objectives and existing situation.
- Section 6 discusses the design criteria and constraints before introducing the preliminary options which are further refined in Section 7.
- Sections 8-13 summarise the findings of discipline specialists including traffic modelling, geotechnical and geology, stormwater management, utilities, property and environmental issues.
- Section 14 details the initial cost estimates and Section 15 provides economic analysis of the options.
- Risk and the consultation process are covered in Sections 16 and 17 respectively before Section 18 discusses additional options identified and assessed as a result of consultation.

- The options recommended for further development in the Scheme Assessment phase are set out in Section 19.

- Section 20 details RMA issues before Conclusions and Recommendation in Section 21.

3 Description of the Problem

The Mill Road Corridor between Redoubt Road and Manukau City's southern boundary has District Arterial status in the Manukau Operative District Plan. It is also classed as a future regional arterial route in ARTA's Regional Arterial Roads Plan and the Draft Regional Land Transport Strategy. The following are the significant issues that will be addressed as a part of this study:

- The geometry of the route is substandard for the existing alignment and the intended regional arterial function.

- Significant growth in the Flat Bush area at the northern end of the study area has occurred and will continue in the future. Significant growth is also expected in the Takanini and Papakura areas at the southern extent. The existing route is incapable of handling these additional traffic volumes. Further growth in Takanini / Papakura between 2021 and 2041 is expected to almost double the anticipated demand for travel through this corridor.

- The Southern Sector Strategic Transport Study indicates that in the medium to long term, demand will increase beyond the capacity of the Redoubt Road / Mill Road Corridor.

- The study area has a disproportionately high crash rate. The route experienced 2.1 fatal/serious crashes and 8.9 injury crashes per kilometre between 2004 and 2008. This is double the frequency required for a "high" rating according to the Land Transport New Zealand's (LTNZ's) criteria.

- The current carriageway construction is not physically capable of handling the increased traffic loadings expected.

4 Project Objectives

The Mill Road Corridor study involves the investigation of Redoubt Road, Murphys Road and Mill Road in order to determine a preferred route and alignment for an upgraded connection between Manukau City and Papakura District.

The desired outcome of the study is the identification of a viable multi-modal road scheme for improved network connectivity, safety and capacity between Takanini, Papakura, Flat Bush and Wiri (Manukau Central) within a 30 year planning horizon.

The Mill Road Corridor was first identified in the Southern Sector Strategic Transportation Study, carried out in 2004 by Manukau City Council, Papakura and Franklin District Councils, ARC and Transit New Zealand. The study recommended that:

> *"Manukau City and Papakura District undertake a corridor study for a route from Flat Bush to Papakura and possibly Drury (the "Mill Road Route"). This corridor study should acknowledge the advantages of a multi-modal corridor which integrates well with land use".*

The Southern Sector Strategic Transportation Study was consistent with regional and national level policies. At a national level, the study was guided by and consistent with the New Zealand Transport Strategy (2002) and the Land Transport Management Act (2003). At a regional and local level the study was consistent with:

- Auckland Regional Growth Strategy (1999);
- Regional Land Transport Strategy (2003);
- Auckland Regional Growth Strategy, 1999 / Southern Sector Agreement (2001);
- Other relevant local strategy documents, e.g. Manukau Cycling and Walking Strategy; and
- All appropriate District Plans.

As a recommendation of the Southern Sector Strategic Transportation Study, the Mill Road Corridor study will remain consistent with these regional and national level policies.

4.1 Legislation

Other legislation the Mill Road Corridor study will be consistent with include the Local Government Act 2002 (LGA) and the Resource Management Act 1991 (RMA).

4.1.1 Local Government Act 2002 (LGA)

The LGA defines the purpose of local government to:

- Enable democratic local decision making and action by, and on behalf of communities; and,

- Promote the social, economic, environmental and cultural well being (4 wellbeing's) of communities in the present and for the future.

The Mill Road Corridor study is consistent with the principles of the LGA as the project's objectives include consideration of safety, connectivity, economics and transport provision.

4.1.2 Resource Management Act 1991 (RMA)

The RMA is the key legislation in terms of assessing and managing the effects of the project on the environment and communities. In particular, the project will be consistent with the Act's Purpose and Principles, as well as matters of national importance and the principles of the Treaty of Waitangi. The Act's Purpose is summarised as:

> *The purpose of the RMA is to promote the sustainable management of New Zealand's resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety.*

4.2 Strategic Documents

Other Strategic Documents the Mill Road Corridor study will be aligned with include the revised New Zealand Transport Strategy, the Passenger Transport Network Plan and Plan Changes 13 and 20 under Manukau City Council's District Plan.

4.2.1 The New Zealand Transport Strategy, 2008 (NZTS)

The New Zealand Transport Strategy was first published in December 2002. Since the Southern Sector Strategic Transportation Study was undertaken, the NZTS has been reviewed and new targets and direction are included. The government's overall vision for the transport direction for 2040 is that:

> *"People and freight in New Zealand have access to an affordable, integrated, safe, responsive and sustainable transportation system".*

The vision is supported by five transportation objectives including:

- Ensuring environmental sustainability;
- Assisting economic development;
- Assisting safety and personal security;
- Improving access and mobility; and,
- Protecting and promoting public health;

These supporting objectives are retained from the NZTS, 2002. As the options in the Southern Sector Strategic Transportation Study were evaluated using the NZTS, 2002 objectives the Mill Road Corridor study will be consistent with the NZTS, 2008.

4.2.2 Auckland Regional Land Transport Strategy 2005 (ARLTS)

The vision for the RLTS is

> *"An integrated, safe and effective transport system that meets the transport needs of our community and enables the sustainable development of the social, economic and environmental well-being of the Auckland Region."*

The vision is supported by five objectives:

- To ensure the transport system supports regional and local land use projects strategies;
- To provide access opportunities that meets the needs of the people, business and communities;
- To maximise the efficiency of the transport system;
- To avoid, remedy or mitigate the adverse effects of transport on the environment and on the health and well-being of communities; and
- To maximise safety of the transport system.

Mill Road Corridor study is consistent with the strategies, objectives, and the vision of the ARLTS. In summary, the project will provide increased access opportunities that meet the needs of residents, businesses and communities.

4.2.3 Auckland Transport Plan (ATP)

The Auckland Transport Plan (ATP) is the region's ten-year transport planning document. The Plan unites the region's long-term transport programmes and forms a single transport view for the region and the best use of available funding for transport.

The Plan provides a reference for national and regional authorities and organisations in preparing their plans to develop the state highways, rail network, and roading and transport projects that are brought forward to funding.

Five regional Strategic Focus Areas were identified in the ATP and endorsed by the Regional Transport Committee. They are:

1. Greater focus on the regional arterials;
2. Greater focus on safety engineering for streets and roads;
3. Optimise the use of the existing transport system to move people and freight;
4. Strong focus on transport investments that are supportive of the Regional Growth Strategy; and
5. Completion of key links in the region's strategic roading passenger transport and cycling networks.

The Plan includes the development of the region's arterial roads to give priority to moving people and goods as well as better integration with surrounding and rapidly growing town centres and commercial

areas. This outcome includes improving the Mill Road corridor serving the Takanini growth area and providing an alternative route to the Southern Motorway between Papakura and East Tamaki.

The route protection of the Mill Road corridor is a key project within the 10-year Plan.

4.2.4 Regional Land Transport Programme, 2009/10 – 2011/12

This Regional Land Transport Programme (RLTP) prioritises planned transport activities for the following three years which qualify for government funding through the New Zealand Transport Agency. These planned transport activities are consistent with the Strategic Focus Areas within the ATP.

The RLTP is consistent with the 2009 Government Policy Statement (GPS) and gives effect to the Regional Land Transport Strategy (RLTS). The current Auckland RLTP details the funding applications for the 2009/10, 2010/11 and 2011/12 years.

The Mill Road route protection is identified as a key planned project and funding is allocated to the Mill Rd/Redoubt Rd Stage 2 – Investigation and Reporting project within the RLTP.

4.2.5 Passenger Transport Network Plan, 2006 – 2016 (PTNP)

The 10-year Passenger Transport Network Plan recognises the way Auckland is growing and is the plan for how ARTA will deliver the passenger transport outcomes sought by the ARLTS.

It sets out detailed plans for a Rapid Transit Network, a Quality Transit Network, and local and targeted transport services to support the development of Auckland.

The Mill Road Corridor study will take into account the objectives of the Passenger Transport Network Plan, which guides the delivery of improved passenger transport services and infrastructure in the Auckland region and prioritises the implementation of passenger transport infrastructure, services and systems.

4.2.6 Draft Auckland Regional Public Transport Plan

The Draft Regional Public Transport Plan presents ARTA's public transport policies and proposals for service improvements.

The purpose of the Plan is to specify how ARTA will give effect to the public transport components of the ARLTS, and contribute to achieving an affordable, integrated, safe, responsive and sustainable land transport system in an efficient and effective manner.

Within the Plan ARTA has identified the following developments that need to happen within the next 10 years to achieve the required public transport performance:

- Further development of the RTN;
- Establishing the Quality Transit Network;
- Reconfiguring the Local Connector Network;
- Integrated services across the above network layers;

- Serving new and developing areas;
- Improving public transport infrastructure;
- Marketing;
- Integrated ticketing and fares;
- Providing targeted services; and
- Planning for the future.

The current plan does not identify any major impacts for the Mill Road Corridor Study; however the outcomes of this study may be incorporated into future regional planning documents.

4.2.7 Regional Arterial Road Plan

The Regional Arterial Road Plan recognises the important role that regional arterial roads play in Auckland's transport network and outlines standards and levels of service for arterial roads throughout the region and identifies the projects needed to achieve them. Mill Road as a proposed arterial road connection is included within the Plan, as an important passenger transport route to Flatbush. Short-term actions listed for Mill Road include the completion of investigation into concept and alignment and route protection.

4.2.8 Sustainable Transport Plan 2006-2016

The Sustainable Transport Plan sets out a 10 year programme for improving walking and cycling, and for developing Travel Plans with schools, workplaces and neighbourhoods. The Plan includes the future Auckland Regional Cycle Network.

The Mill Road Corridor study will take into account provision for walking and cycling.

4.2.9 Manukau City Council's District Plan

The Mill Road Corridor study will be consistent with the Manukau City Council District Plan including Plan Change 13 - Flat Bush Structure Plan and Plan Change 20 - Takanini Structure Plan.

4.3 Papakura District Council's Mill Road Study

As Mill Road extends to Papakura District Council's jurisdiction, another Corridor study is being undertaken to develop options for the corridor within Papakura. The Manukau Mill Road Study will be cognisant of the Papakura Mill Road study and have a consistent interface.

5 Existing Situation

5.1 Site Description

The Redoubt Road / Mill Road study corridor is approximately six kilometres long. The section of Redoubt Road considered in this study extends southeast from Hollyford Drive / Everglade Drive to the intersection with Mill Road. The study corridor then follows Mill Road in a southeast direction to the intersection with Ranfurly Road.

Due to the existing topography, both Redoubt Road and Mill Road follow rolling terrain. Many of the existing horizontal and vertical curves are substandard based on design standards.

Currently, Redoubt Road is a two-lane undivided roadway between Hollyford Drive and Mill Road. Between Hollyford Drive and Hilltop Road the posted speed limit is 50km/h while east of Hilltop Road this is increased to 60km/h. West of Mill Road, Redoubt Road is a residential access road, and adjacent land use is predominantly residential. The density of development ranges from urban at the western limits of the study corridor to rural residential in the east. Murphys Road has been identified as the boundary between urban and rural land uses. To the south of Redoubt Road between Hollyford Drive and Murphys Road lies Totara Park.

The Mill Road corridor being considered in this study extends from Redoubt Road to the intersection with Ranfurly Road. Mill Road is a two-lane undivided roadway with a posted speed limit of 80 km/h. Land use adjacent to Mill Road is primarily rural residential. The future alignment of Mill Road south of Ranfurly Road is being developed by Papakura District Council.

Within the Redoubt Road / Mill Road corridor there are numerous residential driveways (some serving up to 15 properties) with direct access to the corridor. Several cross streets also intersect with the corridor including (from north to south) Goodwood Drive, Hilltop Road, Murphys Road, Kinnard Lane, and Polo Prince Drive.

Murphys Road will also be realigned as a part of this study. Murphys Road is currently a two-lane undivided roadway that extends north from Redoubt Road. The posted speed limit on Murphys Road ranges from 80 km/h. to 70km/h. Murphys Road currently has a very steep vertical alignment and sharp horizontal curves due to the existing topography.

5.2 Traffic Statistics

The existing traffic conditions were established using existing Flat Bush and Papakura traffic models supplemented with traffic counts and journey time surveys conducted by Opus. The traffic counts and journey times enabled existing validated and peer reviewed models to be extended for the purpose of modelling the base and future conditions. A summary of the traffic counts and journey time surveys conducted by Opus is provided in the following sub-sections.

5.2.1 Traffic Counts

The existing traffic volumes and movements within the study area were reviewed by Opus. Traffic counts were conducted at the following three intersections on April 10, 2008:

- Redoubt Road and Hilltop Road;
- Redoubt Road and Murphys Road; and,
- Redoubt Road and Mill Road.

The morning and afternoon peak hour traffic volumes are summarized in Figure 5-1 to Figure 5-3.

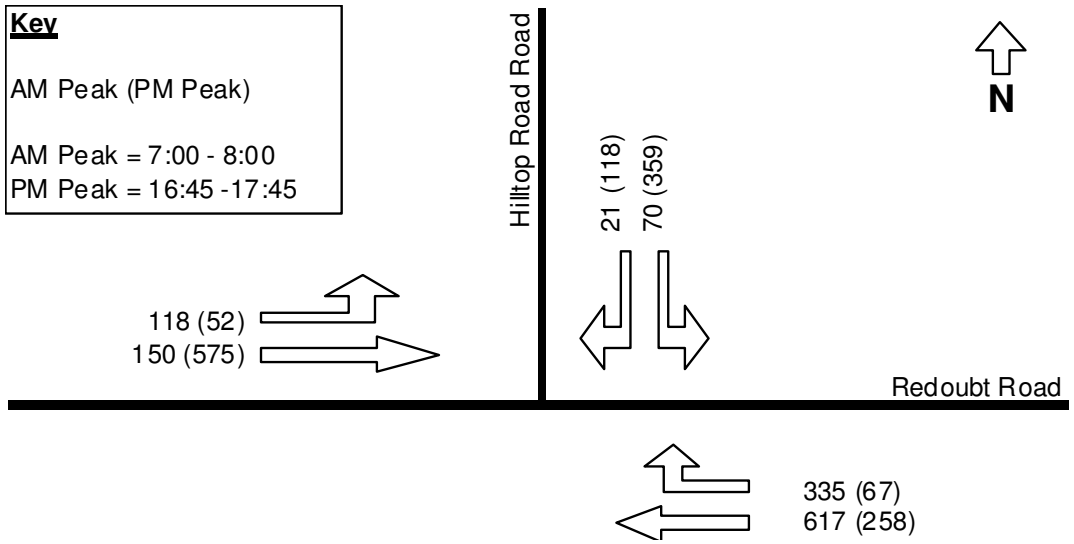

Figure 5-1: Redoubt Road / Hilltop Road Intersection Turning Movement Volumes

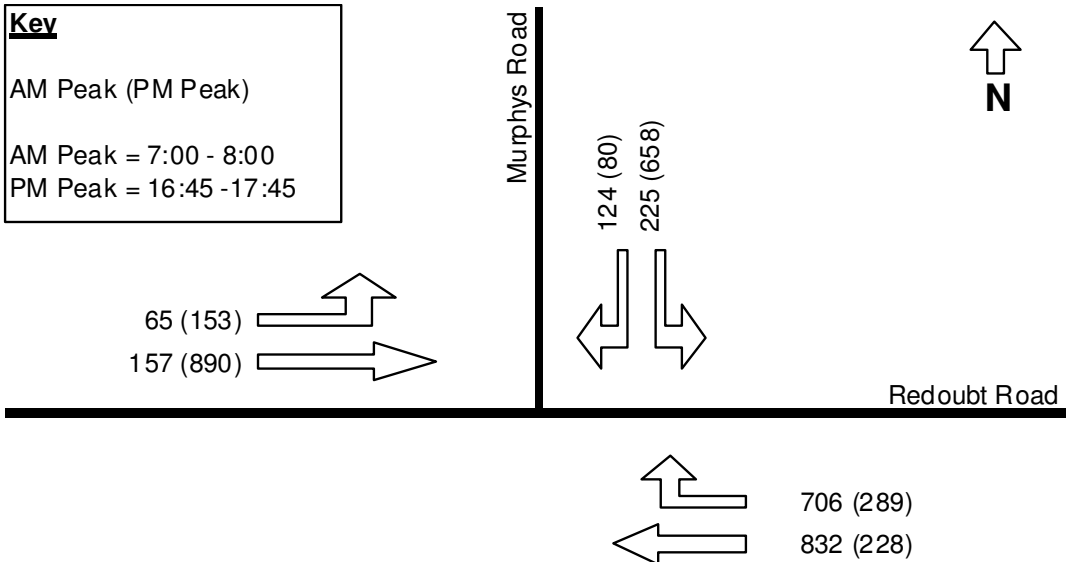

Figure 5-2: Redoubt Road / Murphys Road Intersection Turning Movement Volumes

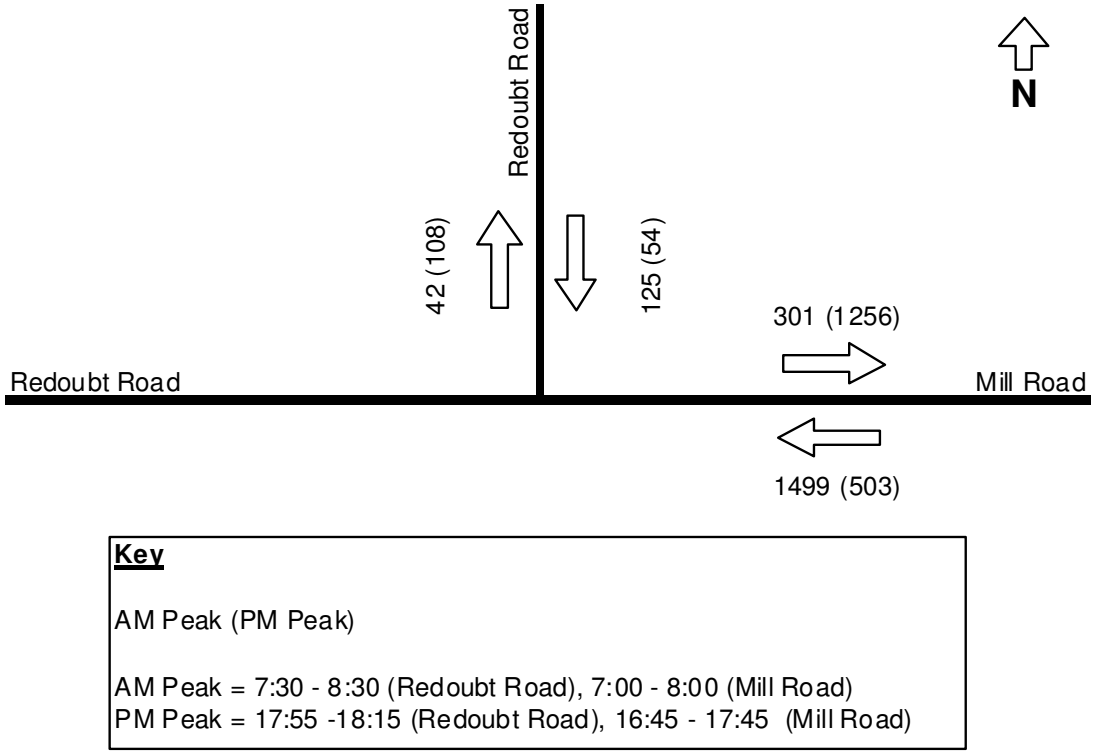

Figure 5-3: Redoubt Road / Mill Road Intersection Volumes

5.2.2 Journey Time Surveys

Journey time surveys were conducted on Redoubt Road / Mill Road between Hilltop Road and Ranfurly Road, in both the northbound and southbound directions, on April 10, 2008. The survey findings are included in Appendix 1. The surveys were conducted during the morning, mid-day and afternoon peak periods. The journey time surveys were used to help calibrate the network model.

5.2.3 On-Site Observations

A CCTV survey was also conducted at the intersection of Redoubt Road and Mill Road on March 28, 2008 between 07:00 and 08:00 to record intersection operations.

5.3 Crash History

Information regarding crashes occurring within the Mill Road and Murphys Road study area between 2004 and 2008 were obtained from the Land Transport Safety Authority's Crash Analysis Software (CAS). The detailed crash data is provided in Appendix 2[1] and a summary is provided in the following subsections.

[1] The crash data provided in Appendix 2 is presented as GIS maps which were produced for the draft issue of this report. The figures have since been updated. However, these updates have not been reflected in the GIS maps due to the cost of updating. It is anticipated that these maps will be updated as part of the scheme assessment phase where further CAS analysis will be undertaken.

5.3.1 Crash Severity

A total of 205 crashes were identified within the study area. A summary of the crash severity is provided in Figure 5-4. A crash diagram indicating the location and severity of crashes within the study area is provided in Appendix 2.

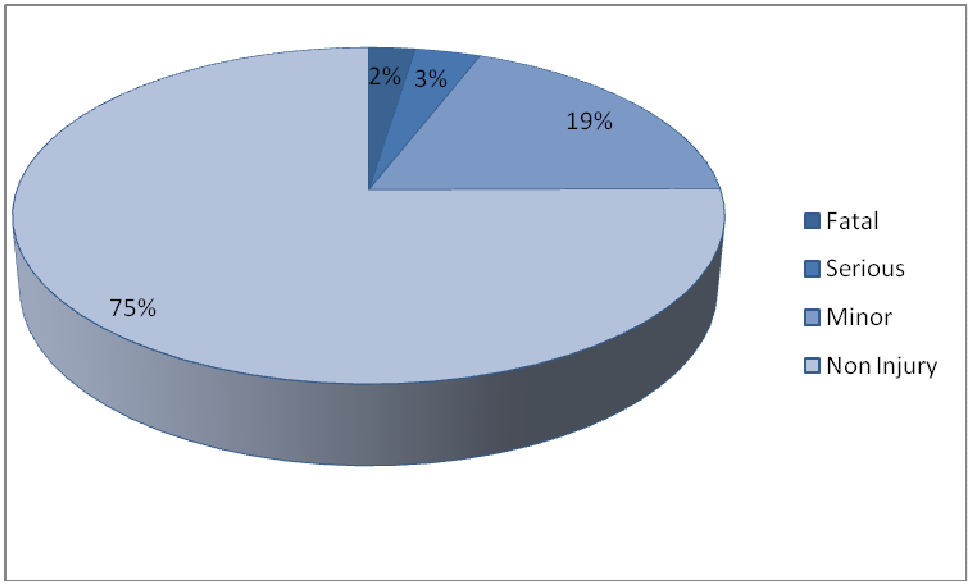

Figure 5-4: Crash Severity

The majority of crashes (75%) were non-injury crashes. Of the 205 crashes within the study area, 51 resulted in injury and five resulted in a fatality.

The five fatal accidents occurred at:

- Mill Road, 200m north of Ranfurly Road (loss of control on straight, head on collision)
- Mill Road, 700m north of Ranfurly Road (motorcycle, loss of control on curve)
- Mill Road, 230m north of Polo Prince Drive (cutting corner, head on collision)
- Redoubt Road, 50m west of Murphys Road (loss of control turning right; hit post, pole or traffic sign)
- Redoubt Road, 320m west of Murphys Road (loss of control turning left; hit fence, tree or ditch)

5.3.2 Crash Type

A summary of the crash type distribution is summarized in Figure 5-5.

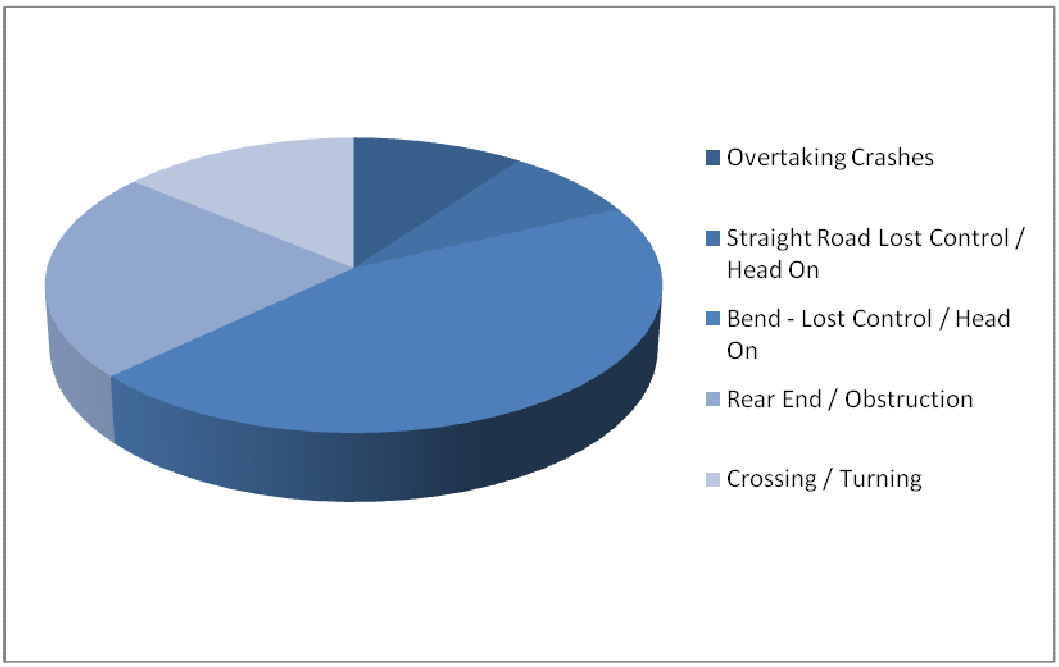

Figure 5-5: Crash Type Distribution

The majority of crashes within the study area (54 percent) are lost control / head-on crashes. Of the 108 lost control /head-on crashes, 85% occurred on a bend. The frequency of lost control / head-on crashes is a concern given the high severity typically associated with head-on crashes.

5.3.3 Spatial Distribution

The spatial distribution of crashes is detailed in the crash diagrams provided in Appendix 2. Between 2004 and 2008, crashes were fairly evenly distributed throughout the study area. A high concentration of crashes (48%) occurred at intersections. The intersection of Mill Road and Redoubt Road had the highest frequency of crashes with 32.

There was also a high concentration of crashes occurring on bends. This is likely due to a number of substandard bends that currently exist within the study area.

5.3.4 Temporal Distribution

The majority of crashes within the study area occurred during the weekday morning and afternoon peak periods. 24% of crashes occurred between 3:00pm and 6:00pm and 22% of crashes occurred between 06:00am and 09:00am.

6 Options Considered

6.1 Identified Constraints

A preliminary review of the site area identified several constraints that would need to be considered during the route identification. A summary of these constraints is provided below and illustrated in Figure 6-1.

Two Water Care water reservoirs were identified adjacent to Mill Road. The first tank is located approximately 150m west of Mill Road and 400m north of Polo Prince Drive. Two water mains, 300mm and 450mm in diameter, extend from the tank and cross Mill Road in an east-west direction.

The second complex of water tanks is located approximately 500m east of Mill Road and 600m north of Polo Prince Drive. A 1200mm diameter water main runs south from the tank running parallel to Mill Road (east side) south from Polo Prince Drive for approximately 450m.

Four overhead power lines were identified within the study area. Three of the lines run in an east-west direction crossing Murphys Road approximately 750m, 950m, and 1,050m north of Redoubt Road. The fourth overhead power line crosses Redoubt Road in a north-south direction approximately 100m east of Hilltop Road.

The geotechnical assessment identified an unstable area east of Mill Road and approximately 550m south of Redoubt Road. Two deep seated instability zones were identified east of Redoubt Road between Murphys Road and Mill Road.

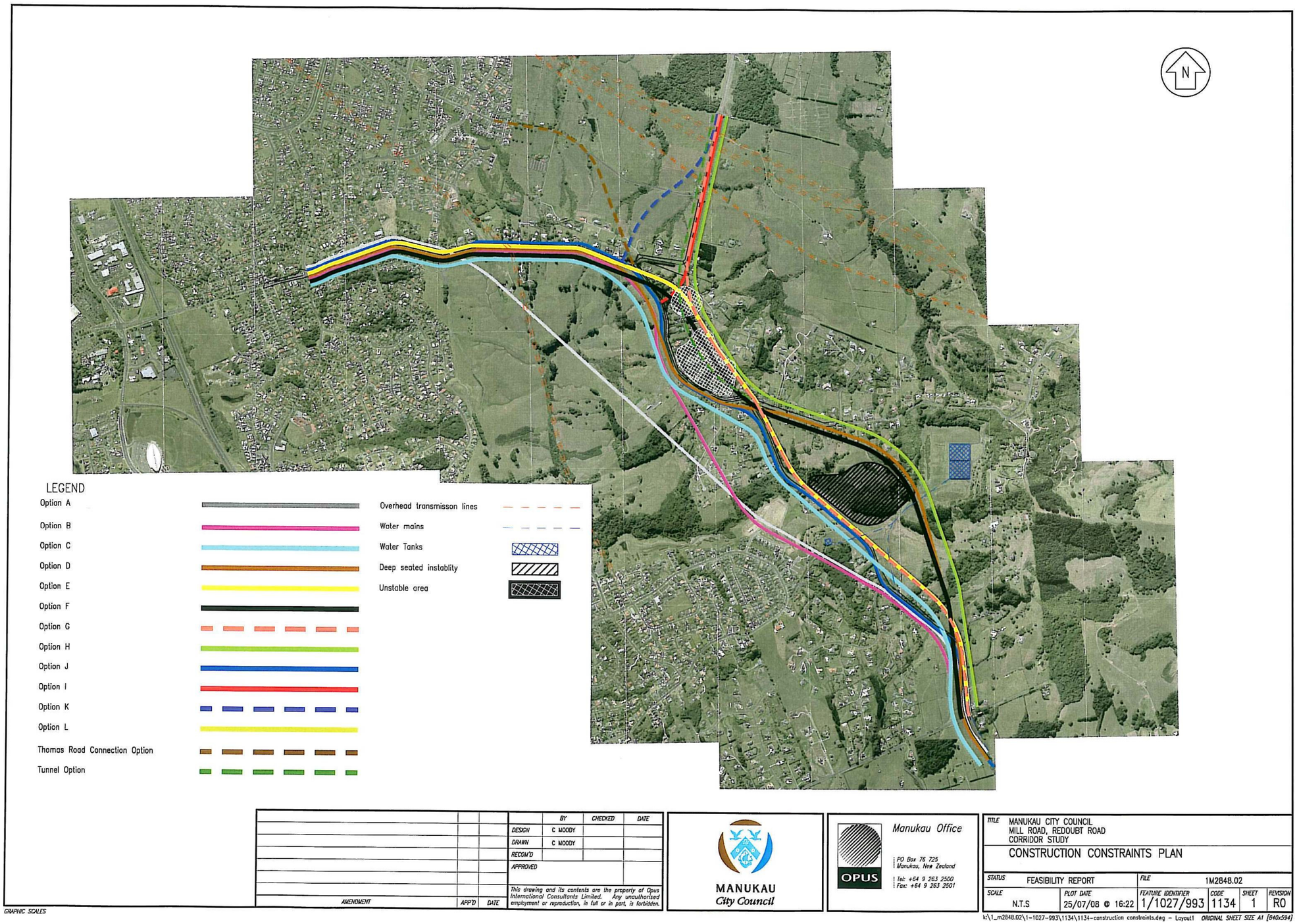

Figure 6-1: Identified Constraints

6.2 Design Criteria

Manukau City's Engineering Quality Standards (EQS) sections 6.B.1 and 6.B.2 specify that maximum grades and carriageway width shall be in accordance with the District Plan, and geometric design is to be governed by Transit New Zealand Standards.

The District Plan specifies maximum grades and carriageway widths for secondary roads, but does not address these issues for district and regional arterials, which the Redoubt Road / Mill Road corridor is assumed to be.

For geometric design, Transit's GDM criteria are very similar to Austroads, but Transit has a more conservative and complex approach to horizontal curve design. The geometric design of the corridor options has been based on Austroads in order to simplify design and to adopt a tighter standard in view of the topographical constraints. This represents a minor relaxation from the EQS criteria.

The key design criteria determining the shape of the road are the choice of design speed, driver reaction time, and cross section. The first two determine how tightly the road can curve to follow the topography, and the latter how broad the ribbon of road will be across the landscape.

Other design criteria such as drivers eye height, object height, and the braking distance component of stopping sight distances are fixed by physical characteristics such as vehicle dimensions. It is not appropriate to vary from established values for those elements, as described in the following guides:

- Transit New Zealand State Highway Geometric Design Manual (GDM);
- Austroads Guide to Traffic Engineering Practice Part 5 Intersections at Grade (GTEP5);
- Austroads Guide to Traffic Engineering Practice Part 14 Bicycles (GTEP14);
- Austroads Rural Road Design (RRD); and,
- Austroads Urban Road Design (URD).

The following sections outline the decisions adopted on choice of the key design criteria.

6.2.1 Cross Sections

Ideally, lane widths of 3.5m are used in New Zealand, with widening on tighter (less than 100m radius) curves (URD notes that this can be reduced in some circumstances). Only one of the listed criteria for reducing lane width may apply to this project, being where finance is limited. Thus as the project develops, the choice of lane width may be reconsidered to minimise cost and footprint.

In view of the frequency of driveways and the speed environment, it is assumed that a flush median will be employed to avoid concentrating turning manoeuvres. A 3.5m flush median has been assumed. This provides space to shelter a turning vehicle clear of the traffic lanes. A kerbed median requires additional width at intersections to accommodate sheltered right turn bays.

Cyclists are provided for with 1.5m shoulders on both sides of the road, consistent with GTEP14, for speeds up to 60km/h. Strictly speaking it is desirable to widen the cycle shoulders to 2m in higher speed areas, but this has not been adopted in view of the topographical constraints in these areas.

6.2.2 Design Speed

The choice of design speed is influenced by capacity and safety considerations. On higher capacity roads the design speed needs to be higher to cater for operating speeds being greater than local roads. Similarly, the design speed is also influenced by the posted speed limit.

Ideally, on a high capacity road the design speed will be greater than the posted speed limit, often rounded to 10km/h higher. However, on high capacity routes, such as four lane and/or dual carriageway, this can extend to as much as 20km/h over the posted limit.

Use of design speeds below the posted speed limit is not appropriate for high capacity routes, but historically has occurred at constrained locations, such as where extreme terrain issues have prevented the development of a higher standard of alignment. In that instance special care needs to be taken to ensure that speeds are correctly transitioned down, or safety problems will result. Even with correct speed transitions, substandard curvature will generate higher crash rates than compliant alignments.

The consequence on road form from choosing a higher design speed is that the road curvature must be more gradual, and longer sight distances are required to hazards on the road or at intersections. The resultant lower grades and larger radius curves flatten and straighten the alignment. This makes it much more difficult to fit the road to the terrain, and increases the earthworks footprint.

The existing road alignment fits the often steep terrain reasonably closely, resulting in standards of curvature and sight distance that are well below that required for a higher capacity route, with speeds posted up to 80km/h. The design speed was selected at the low end of the acceptable range to minimise the environmental impact and the scale of land purchase.

6.2.3 Driver Reaction Time

The standard value of driver reaction time used for design is 2.5 seconds, although a reduction to a minimum of 2.0 seconds can be accommodated for urban or alerted conditions.

The proposed design criteria are summarised in Table 6-1.

Table 6-1: Proposed Design Criteria

Road Section	Speed Limit (km/h) Current / Proposed	Design Criteria: Design Speed (V_d) and Reaction Time (R_T)		
		Ideal	Desirable Minimum	Absolute Minimum
Redoubt Rd (Hollyford Dr to Hilltop Rd)	50 / 50	V_d=70km/h R_T= 2.5sec	V_d=60km/h R_T= 2.5sec	V_d=60km/h R_T= 2.0sec
Redoubt Rd (Hilltop Rd to Mill Rd)	70 / 50	V_d=70km/h R_T= 2.5sec	V_d=60km/h R_T= 2.5sec	V_d=60km/h R_T= 2.0sec
Mill Rd (Redoubt Rd to Ranfurly Rd)	100 / 80	V_d=90km/h R_T= 2.5sec	V_d=80km/h R_T= 2.5sec	V_d=80km/h R_T= 2.0sec
Murphy Road	100 / 50	V_d=70km/h R_T= 2.5sec	V_d=60km/h R_T= 2.5sec	V_d=60km/h R_T= 2.0sec

The application of these criteria to the geometric design is summarised in Table 6-2 to Table 6-5.

Table 6-2: Cross Section Design Criteria

Criteria	Posted Speed Limit	Ideal	Desirable Minimum	Absolute Minimum
Number of lanes		4	4	3 (2+1)
Median		5m	3.5m	3m
Lane width		3.5m	3.5m	3.2m
Shoulder width	<=60km/h	1.5m	1.5m	1.2m
	60 - 80km/h	2m	1.8m	1.5m
	> 80km/h	2.5m	2m	1.8m
Clear zone	<=60km/h	5.5m	4.5m	
	61 - 80km/h	7m	6m	
	> 80km/h	11m	9m	8m
Berm	<=60km/h	5m	4m	3m
	61 - 80km/h	5m	5m	5m
	> 80km/h	9m	7m	5m

Table 6-3: Horizontal Curvature Design Criteria

Criteria	Posted Speed Limit	Ideal	Desirable Limit	Absolute Limit
Design speed	<=60km/h	70km/h	60km/h	60km/h
	70km/h	80km/h	70km/h	70km/h
	80km/h	90km/h	80km/h	80km/h
	> 80km/h	110km/h	100km/h	100km/h
Maximum super elevation	<=70km/h	3%	5%	5%
	>= 80km/h	6%	7%	10%
Minimum radius	<=60km/h	300m	115m	90m
	70km/h	460m	185m	125m
	80km/h	330m	220m	160m

	100km/h	550m	400m	350m

Table 6-4: Vertical Alignment Criteria

Criteria	Posted Speed Limit	Ideal	Desirable Limit	Absolute Limit
Maximum grade		**7%**	**10%**	**12%**
Reaction time		**2.5s**	**2.5s**	**2s**
Design speed	<=60km/h	70km/h	60km/h	60km/h
	70km/h	80km/h	70km/h	70km/h
	80km/h	90km/h	80km/h	80km/h
	> 80km/h	110km/h	100km/h	100km/h
SSD (ASD) level grade	<=60km/h	95m	75m	65m
	70km/h	115m	95m	85m
	80km/h	140m	115m	105m
	100km/h	210m	170m	160m
Crest K-value based on midblock SSD criteria 0.2m object height	<=60km/h	21	13	10
	70km/h	31	21	17
	80km/h	45	31	25
	100km/h	102	67	59
Crest K-value based on ASD criteria 0m object height	<=60km/h	40	25	19
	70km/h	63	40	32
	80km/h	94	63	51
	100km/h	200	139	117
Sag K-value based on comfort (headlight) criteria	<=60km/h	8 (60)	6 (38)	6 (38)
	70km/h	10 (88)	8 (60)	8 (60)
	80km/h	13 (131)	10 (88)	10 (88)
	100km/h	19 (150)	16 (150)	17 (150)

Table 6-5: Intersection Design Criteria

Criteria	Posted Speed Limit	Ideal	Desirable Limit	Absolute Limit
SISD	<=60km/h	149m	121m	113m
	70km/h	181m	149m	140m
	80km/h	215m	181m	170m
	100km/h	297m	253m	240m

6.3 Identified Route Descriptions

Brief descriptions of the options carried forward from the route identification workshop are provided in the following subsections. All of the options have the same typical cross-sections as illustrated in Figure 6-2 and Figure 6-3. Redoubt Road will have an urban cross-section west of Murphys Road and a rural cross-section to the east. Murphys Road will have an urban cross-section.

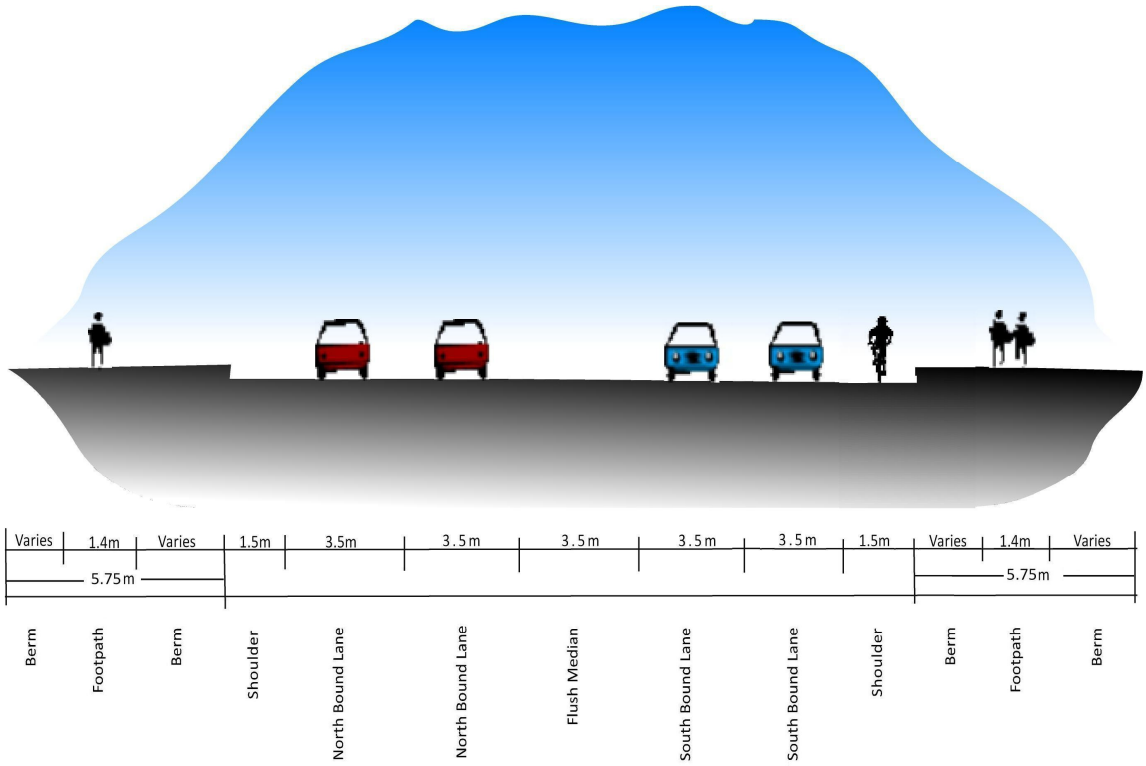

Figure 6-2: Urban Cross-Section

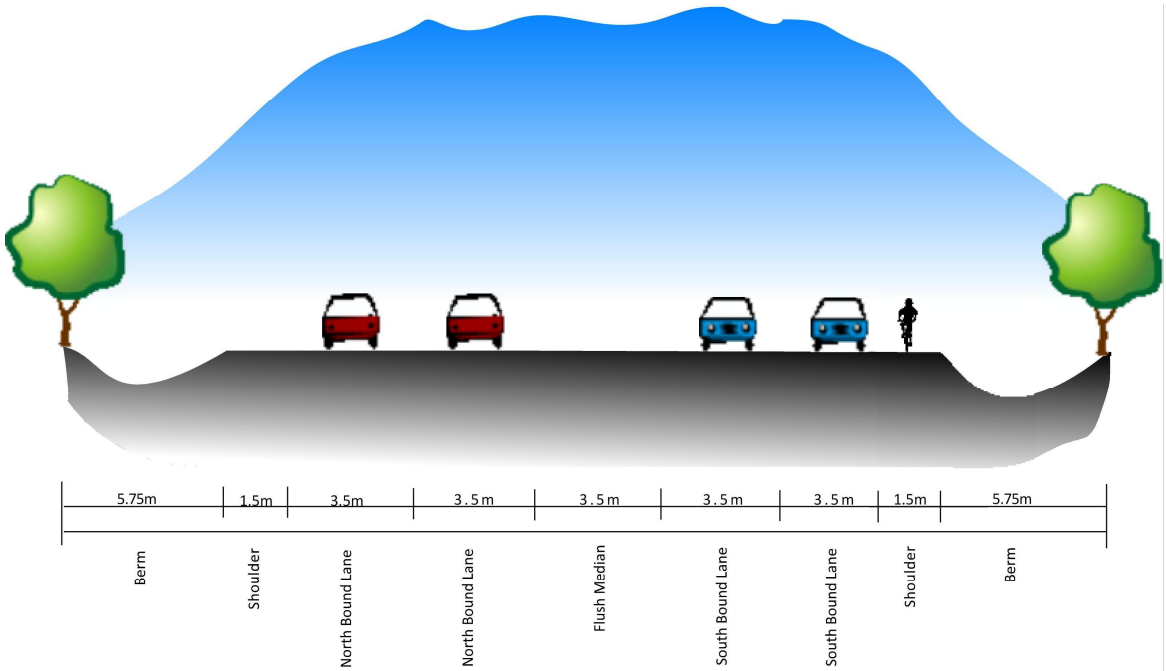

Figure 6-3: Rural Cross-Section

The typical cut/fill cross-sections are illustrated in Figure 6-4.

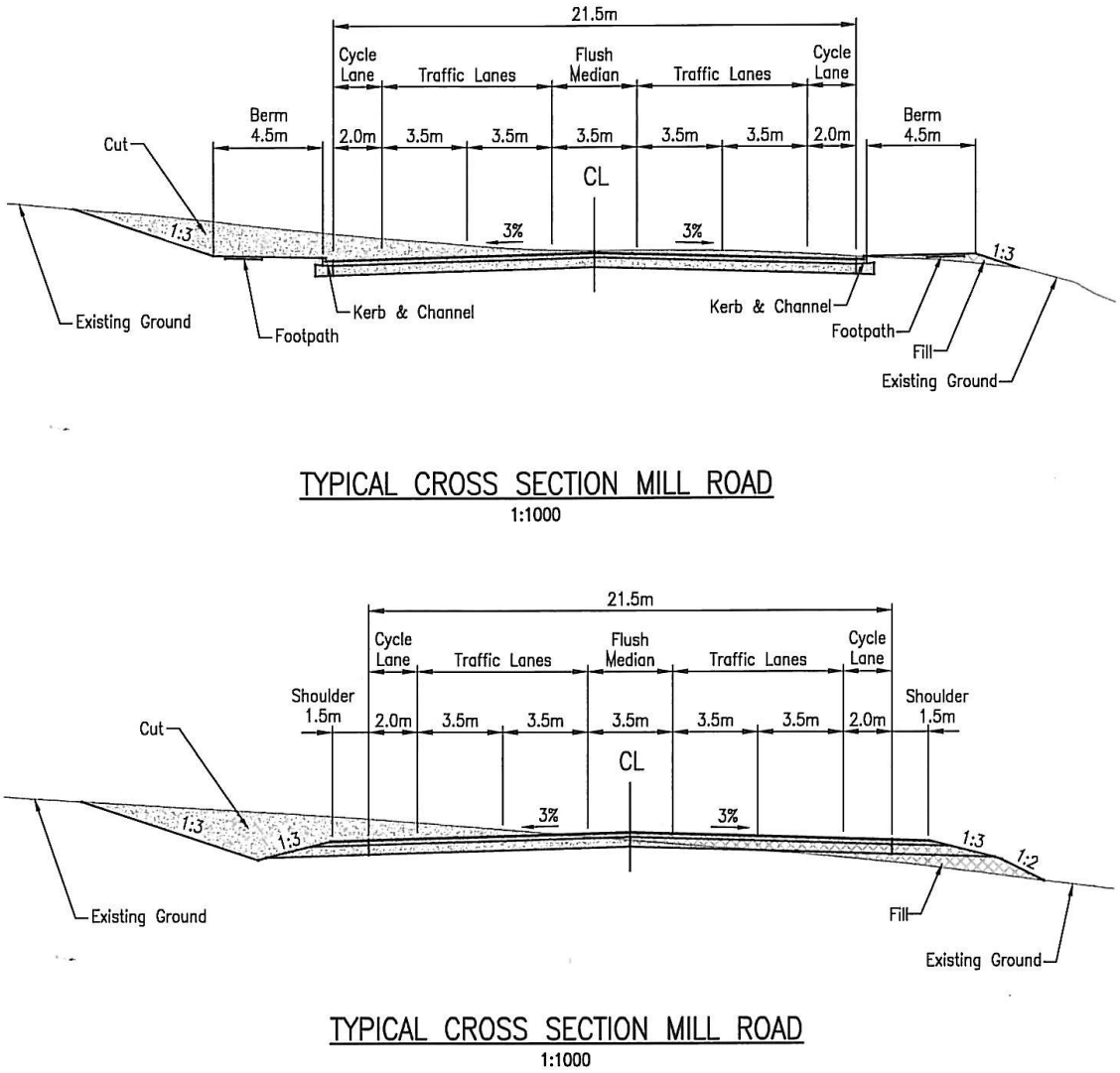

Figure 6-4: Typical Cut / Fill Cross-Section

6.3.1 Redoubt Road / Mill Road Corridor Options

A total of 10 alignment options were identified for the Redoubt Road / Mill Road corridor. The route options are shown in Figure 6-5 and descriptions of each option are provided in the following subsections.

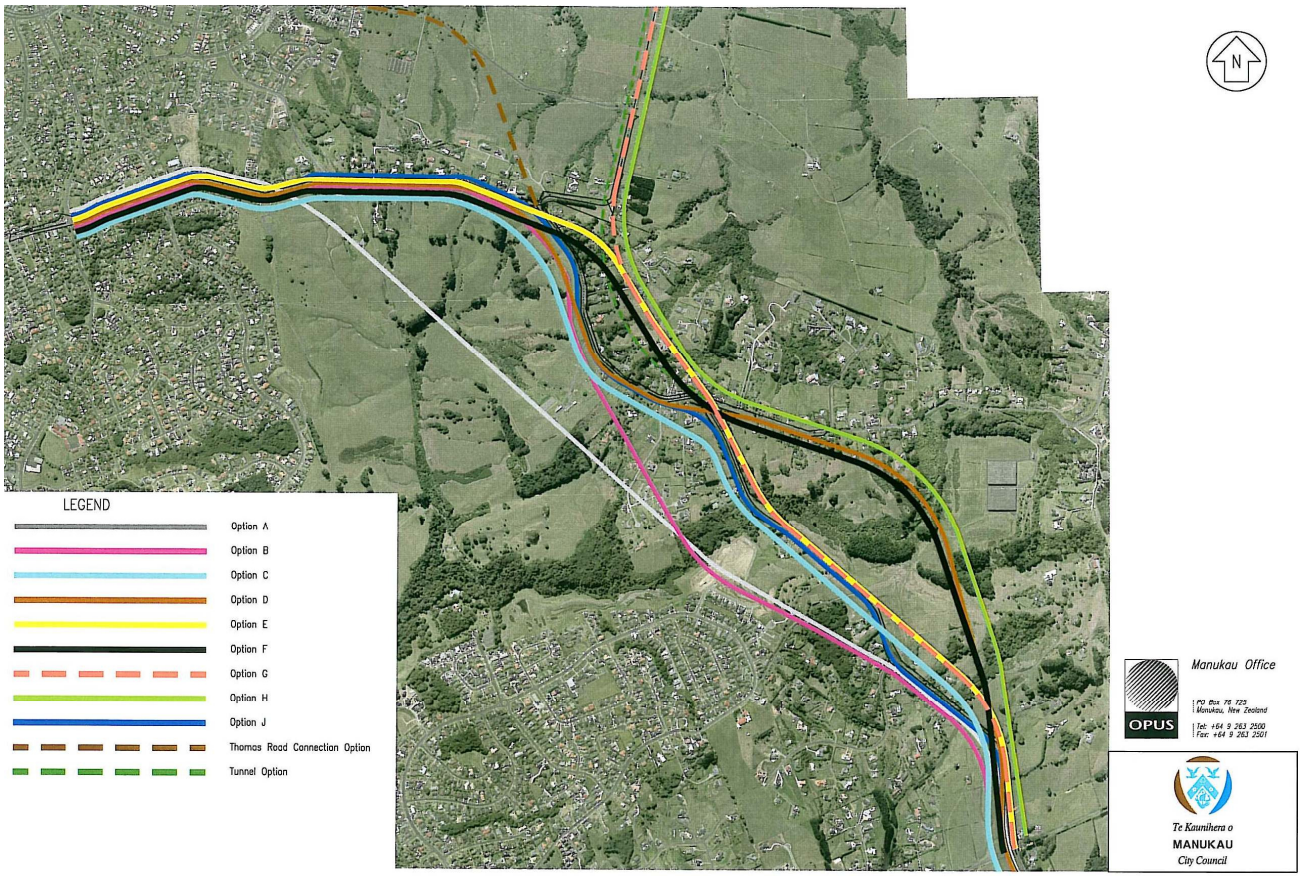

Figure 6-5: Preliminary Redoubt Road / Mill Road Route Options

Figure 6-6: Preliminary Murphys Road Route Options

The constraints identified in Section 6.1 may or may not apply to each of the identified options. Constraints associated with a specific option are discussed in the corresponding option description below.

Option A

From Hollyford Drive, Option A heads east broadly following the existing Redoubt Road corridor to a location west of the Hilltop Road intersection. The option then bears south across Totara Park following an off-line route to the west of the existing road corridor before rejoining the existing Mill Road alignment at the southern end of the study area.

Option A is highly intrusive on Totara Park, and crosses an old area of instability, as well as some subdivisions. These issues led to the option being excluded in the initial review of options.

Option B

From Hollyford Drive, Option B heads east broadly following the existing Redoubt Road corridor to a location west of the Mill Road / Redoubt Road intersection. The option then heads south to follow an off-line route to the west of the existing road corridor before rejoining the existing Mill Road alignment at the southern end of the study area.

The option is intrusive on the east margins of Totara Park, where it follows the alignment common to Options C, and D. At the south end of Totara Park it diverges to the west and passes through some subdivisions. These issues led to the option being excluded in the initial review of options.

Option C

From Hollyford Drive, Option C heads east broadly following the existing Redoubt Road and Mill Road corridor with slight deviations to the west in the vicinity of the Murphys Road and Redoubt Road / Mill Road intersections and to the northeast towards the southern end of the study area.

Option C is intrusive on the east margins of Totara Park, as a consequence of creating a wider route with improved alignment. South of the park the route descends steeply with some alignment improvements that result in route shortening. This steepens the route at the intersections with Kennard Lane and Mill Road, to 9.5%. This grade is too steep for safe turning or stopping, and extends the time taken for turns out from the eastern end of Redoubt Road.

Option D

From Hollyford Drive, Option D heads east broadly following the existing Redoubt Road corridor to a location east of the Redoubt Road / Mill Road intersection where the option heads south to follow a sweeping off-line route to the east of the existing road corridor before rejoining the existing Mill Road alignment at the southern end of the study area.

Like Option C, this option is intrusive on the east margins of Totara Park, as a consequence of creating a wider route with improved alignment. The intersection of Kinnard Lane coincides with a steep grade. Opportunities to reduce the 9.5% grade should be investigated during the scheme design stage.

Option E

From Hollyford Drive, Option E heads east broadly following the existing Redoubt Road corridor to the Murphys Road intersection where the option continues east and south to follow an off-line route to the east of the existing road corridor. The option rejoins the Mill Road corridor in the vicinity of the Redoubt Road / Mill Road intersection and heads south along the existing Mill Road corridor with a slight deviation to the northeast towards the southern end of the study area.

This option traverses steep and unstable areas below the ridge, with major visual intrusion and impacts on adjacent residential properties. Noise would be difficult to screen in places. These issues led to the option being excluded in the initial review of options.

Option F

From Hollyford Drive, Option F heads east broadly following the existing Redoubt Road corridor to the Murphys Road intersection where the option continues east and south to follow an off-line route to the east of the existing road corridor. The option then crosses Redoubt Road and continues south to follow a sweeping off-line route to the east of the existing road corridor before rejoining the existing Mill Road alignment at the southern end of the study area.

Like Option E, this option traverses steep and instable areas below the ridge, with major visual intrusion and impacts on adjacent residential properties. Noise would be difficult to screen in places. These issues led to the option being excluded in the initial review of options.

Option G

From the southern end of Murphys Reserve, Option G heads south following the existing Murphys Road corridor to the sharp bend where the option bears east and south to follow an off-line route to the east of the existing road corridor. The option then rejoins the Mill Road corridor in the vicinity of the Redoubt Road / Mill Road intersection and heads south along the existing Mill Road corridor with a slight deviation to the northeast towards the southern end of the study area. This option also includes upgrading the existing Redoubt Road corridor between Murphys Road and Hollyford Drive.

Like Option E, this option traverses steep and instable areas below the ridge, with major visual intrusion and impacts on adjacent residential properties. Noise would be difficult to screen in places. These issues led to the option being excluded in the initial review of options.

The geometry includes a very steep (over 10%) climb up from Murphys Road, with a sharp crest and deep embankments across highly incised gullies.

Option H

From the southern end of Murphys Reserve, Option H heads south following the existing Murphys Road corridor to the sharp bend where the option bears east and south to follow an off-line route to the east of the existing road corridor. The option then crosses Redoubt Road and continues south to follow a sweeping off-line route to the east of the existing road corridor before rejoining the existing Mill Road alignment at the southern end of the study area. This option also includes upgrading the existing Redoubt Road corridor between Murphys Road and Hollyford Drive.

Like options E and G, this option traverses steep and instable areas below the ridge, with major visual intrusion and impacts on adjacent residential properties. Noise would be difficult to screen in places. These issues led to the option being excluded in the initial review of options.

The geometry includes a very steep (over 10%) climb up from Murphy Road, with a sharp crest and deep embankments across highly incised gullies.

Option J

Option J follows the existing Redoubt Road and Mill Road corridors with a slight deviation to the west in the vicinity of the Redoubt Road / Mill Road intersection.

The alignment has been produced using the absolute minimum standards to try and keep as closely as practical to the existing alignment. This has produced a series of curves separated by short straights south of Murphy Road, which gives a broken back appearance, and produces complications with super elevation development. Several reverse curves may have excessive warp rates. The intersections of Kinnard lane, Redoubt Road and Polo Prince Drive all coincide with grades steeper than 8%, which creates risks of turning vehicles overturning or losing their load.

Tunnel Option

In addition to the options reviewed at the workshop, Opus was asked to consider a Tunnel option. The most appropriate route for the tunnel (as shown on the route options plan) was considered to be from the area to the south east of the Redoubt Road/ Mill Road intersection to Murphys Road just south of Thomas Road.

This option was not progressed any further as it did not fulfil all of the linkage requirements of the scheme and would have a very high cost together with a similar level of property purchase requirements as the above ground schemes

6.3.2 Murphys Road Alignment Options

A total of four alignment options were identified for Murphys Road. The route options are shown in Figure 6-6 and descriptions of each option are provided in the following subsections.

Option I

From the southern end of Murphys Reserve, Option I heads south following the existing Murphys Road alignment before bearing southwest to form a new intersection with Redoubt Road, about 150m south of the existing junction.

The option features a steep (12%) climb up to the ridge, although a grade separated intersection may reduce this slightly. The sharp crest at the ridge limits ASD to absolute minimum values. There are also difficulties with achieving property accesses in the area. Also, with a grade separated option there are potentially weaving issues created with downstream accesses or intersection development on Murphy Road.

Option K

From the southern end of Murphys Reserve, Option K heads south for a short distance following the existing Murphys Road corridor before bearing southwest to follow an off-line route up a spur to the west of the existing road corridor before bearing south to form an intersection with Redoubt Road.

The option features a steep (12%) climb up to the ridge, although a grade separated intersection may reduce this slightly. The sharp crest at the ridge limits ASD to absolute minimum values, and results in a large fill below the ridge on an already steep slope. There are difficulties with achieving property accesses in the area. Further, with a grade separated option there are potentially weaving issues created with downstream accesses or intersection development on Murphy Road.

Option L

Option L follows the existing Murphys Road corridor between the southern end of Murphys Reserve and Redoubt Road with a minor deviation to increase the radius of the sharp right angle bend from about 36m to 148m. The resulting route shortening steepens the grade slightly to 11%.

Thomas Road Connection Option

An additional route for Murphys Road was considered which would link Redoubt Road through to Thomas Road and on to Te Irirangi Drive. This route could potentially serve as a link to east Tamaki; however, it would run through a relatively narrow residential road network, including Dawson Road, before connecting to Te Irirangi Drive. This option does not address the main desire lines as predicted by the traffic model (see Section 8.0) and does not address the growth in traffic anticipated from the new Flat Bush Town Centre.

6.4 Route Identification (Workshop 1)

A route selection workshop was held at Opus International Consultants' Westhaven office on 18th April 2008. Participants at the workshop included representatives from Manukau City Council, Papakura District Council, GHD (consultant to Papakura District Council), Kessels and Associates and various specialists from within Opus.

During the workshop, the various route options were presented and the constraints were then highlighted by the various specialist teams.

The matrix shown Table 6-6 was used during the workshop to evaluate and rank the twelve options. Based on this evaluation, Options C, D, and J were selected as the preferred options for the Redoubt Road / Mill Road Corridor and Options I and K were selected for Murphys Road.

Table 6-6: Original Route Selection Matrix

Option	Geotechnical	Archaeology	Ecology	Adequate Transp. Los	Landscape Visual	Stormwater	Property	Constructability	Overall Score
A	X	X	X	X			X		Options
B	X		X						Ruled out
C	✓	-	-	✓	-	-	-		2
D	-	-	X	✓	X	✓	X		-1
E	-	-	X	✓		X	X		-2
F	X	-	X	✓	X	X	X		-4
G	X	-	X	✓	✓	✓	X		0
H	X	-	X	✓	X	✓	X		-2
I	-	-	-	✓		✓	X		1
J	✓	-	✓	X	✓	✓	-		3
K	-	-	-	✓	X	✓	X		0
L	-	-	-	X	✓	✓	X		0

Scoring

✓ = 1

X = -1

\- = 0

= Redoubt Road / Mill Road Preferred Options

= Murphys Road Preferred Options

Table 6-7: Updated Route Selection Matrix

Option	Geotechnical	Archaeology	Ecology	Adequate Transp. Los	Landscape Visual	Stormwater	Property	Overall Score
C	-1	-1	-3	-1	-2	-3	-1	-12
D	-2	-1	-3	-1	-3	-2	-2	-14
J	-1	-1	-1	-1	-1	-2	-1	-8
X1	-4	0	-3	-3	-3	-1	-1	-15
D Alternative	-2	0	-3*	0	-3	-1	-2**	-11

Notes:

*** Identified as slightly worse than existing D**
****Identified as slightly better than existing D**

7 Option Refinement

Based on the route identification workshop, three preferred options for the Redoubt Road / Mill Road corridor were selected for further refinement. These options include Options C, D and J. Two options, Options I and K, were selected as preferred options for Murphys Road. The preferred options are illustrated in Figure 7-1.

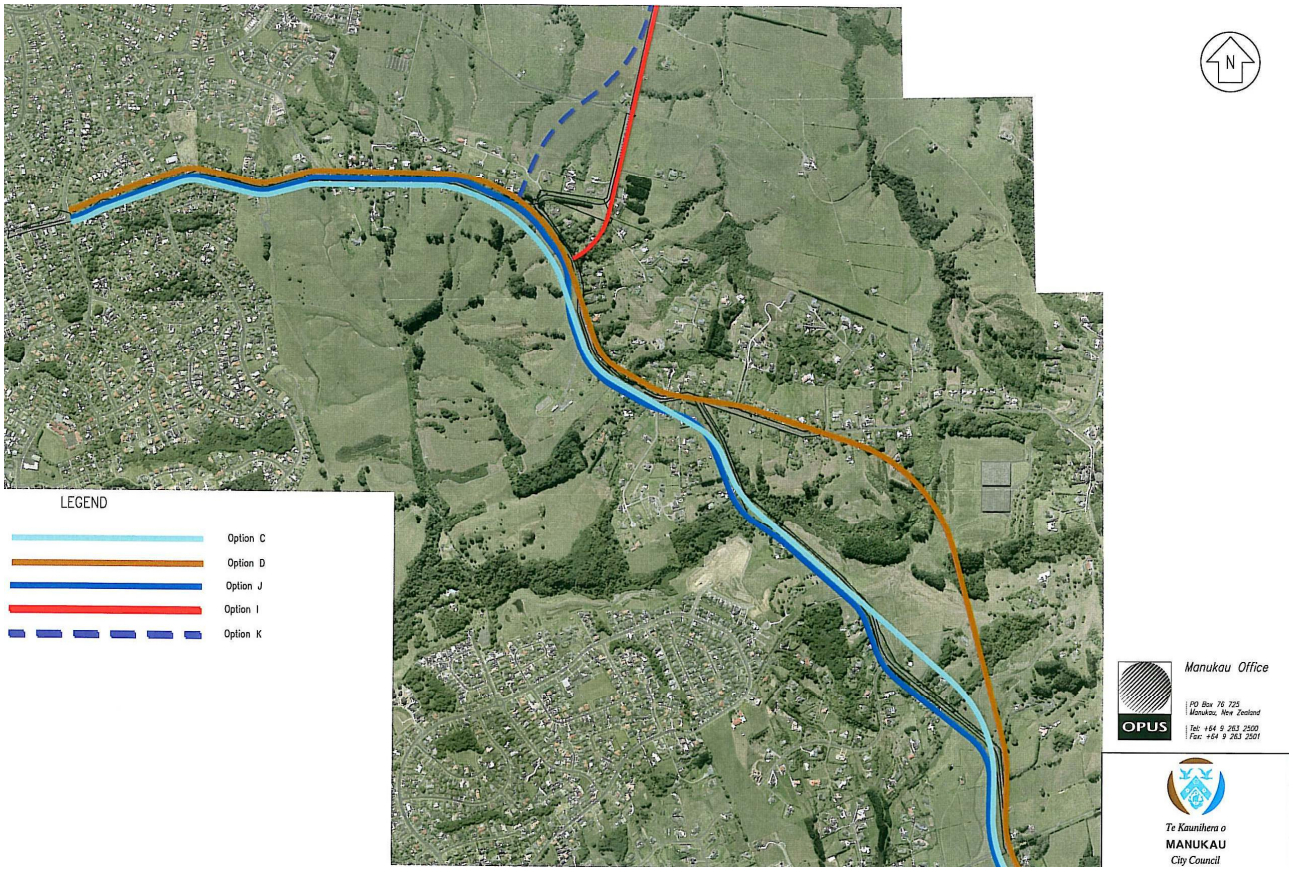

Figure 7-1: Preferred Route Options

7.1 Design Criteria Review (Workshop 2)

Rob Wilson, Philip Ingram, Grant Gordon (Opus) and Garth Vipond (MCC) attended a workshop to refine the selected options. The process carried out at this workshop was to review the options selected at the main workshop and make any refinements in respect of design / posted speed and to review the intersection requirements for Redoubt Road / Murphys Road.

The workshop confirmed that the posted speed limit on Redoubt Road / Mill Road would be 80 km/h from Ranfurly Road to Murphys Road and a 60 km/h posted speed through to the end of the route. The posted speed limit on Murphys Road will be 60 km/h.

7.2 Redoubt Road / Mill Road Corridor

During the route identification workshop (workshop 1), Options C, D and J were selected as preferred options for the Redoubt Road / Mill Road Corridor. Concept plans and longitudinal sections for all three options are found in the Route Options Plans binder.

A summary of the revisions made to the three options during the option refinement process is provided in the following subsections.

7.2.1 Option C

The Option C alignment was derived from a concept of best follows the existing alignment with a standard of geometric design consistent with the development of a four lane arterial. This generally followed the existing route through the 50km/h posted speed limit, but diverges from the route beyond it, where improvements are needed for tight curves and sharp crests west of Murphys Road. The most significant deviations from the current route are:

- The series of short curves with interspersed short straights from 150m west of Murphys Road to 700m east of Murphys Road. In this area the route adopts a single curve to avoid having compound curves with inappropriate camber between. This also increases separation from residential properties north of the route, and enables their access to be developed off short lanes. It also allows easing of the sharp crest at the eastern end of Totara Park.

- A set of reverse curves from Kinnard Lane past Redoubt Road's eastern extension to 200m into Mill Road. The curves have radii down to about 60m, which is well below the standard required for a four lane rural arterial. Straightening the route makes it shorter, increasing the gradient. This is countered by moving the Redoubt Road / Mill Road intersection up the hill to opposite Kinnard Lane. At this location the eased crest starts to reduce the grade below 7%. If the intersection were further down the hill, the steeper grade would create a risk of vehicles overturning.

- The reverse curves, steep grade and sharp crests west of Polo Prince Drive. The geometry over the crest west of Polo Prince is well below that suitable for a four lane rural arterial. This is a consequence of the steep grades on either side of the crest. The proposed solution is to raise Mill Road's embankment over the Puhinui Stream (below the Redoubt Road intersection) and to realign the road to the north opposite Polo Prince Drive so that a more gradual climb and longer crest can be achieved. The realignment would tie into the existing route near the AOG church entrance.

- The sharp curve and limited intersection sight lines at the Ranfurly Road intersection. This would be addressed by realigning Mill Road west of its current alignment between the AOG church entrance and the next curve south of Ranfurly Road, within Papakura District. The Mill Road / Ranfurly Road intersection would be moved about 30m west and the curve radius considerably eased.

7.2.2 Option D

The Option D alignment was derived from a concept of best following the existing alignment west of Mill Road, then realigning the route to follow a greenfield route to avoid the difficult alignment and terrain east of Redoubt Road. This enabled a standard of geometric design consistent with the development of a rural four lane arterial. Option D is the same as Option C up to the crest at the east end of Totara Park. This follows the existing route through the 50km/h posted speed limit, but diverges from the route beyond it;

where improvements are needed to tight curves and sharp crests west of Murphy Road. The most significant deviations from the current route are:

- The series of short curves with interspersed short straights from 150m west of Murphys Road to 700m east of Murphys Road. In this area the route adopts a single curve to avoid having compound curves with inappropriate camber between. This also increases separation from residential properties north of the route, and enables their access to be developed off short lanes. It also allows easing of the sharp crest at the eastern end of Totara Park.

- A set of reverse curves from Kinnard Lane past Redoubt Road's eastern extension to 200m into Mill Road. The curves have radii down to about 60m, which is well below the standard required for a four lane rural arterial. The option adopts a straighter line into the Redoubt Road extension; avoiding the sharp curve into Mill Road. The gradient reaches 9.5%, but at Kinnard Lane and Mill Road intersections the grade eases to under 7%.

- The route turns and heads south approximately 400m east of Mill Road and follows a new alignment through to Mill Road at the curve adjacent to the AOG church entrance, 400 to 500m east of Polo Prince Drive. This new alignment avoids sub standard geometry over the crest west of Polo Prince.

- The sharp curve and limited intersection sight lines at the Ranfurly Road intersection. This would be addressed by realigning Mill Road west of its current alignment between the AOG church entrance and the next curve south of Ranfurly Road, within Papakura District. The Ranfurly Road / Mill Road intersection would be moved about 30m west and the curve radius considerably eased.

7.2.3 Option J

The Option J alignment was derived from a concept of best following the entire length of the existing route, with absolute minimum standards of alignment. This minimises deviations from the existing route, and hence minimises the earthworks footprint, and the amount of land acquisition. Of all the selected options it is the least favoured in terms of the Geometric properties as it just meets the absolute minimum requirements rather that achieving the desirable standards.

Even with this approach, Option J features some deviations from the current route where improvements are needed to tight curves and sharp crests west of Murphy Road. The most significant deviations from the current route are:

- The series of short curves with interspersed short straights from 150m west of Murphys Road to 700m east of Murphys Road. These curves will be eased slightly, increasing their length. The broken back series of curves will be maintained with shortened straights between. The greatest deviation in this section will be the curve through Murphys Road intersection, needed to eliminate the reverse curve west of Murphys Road.

- A sharp crest and set of reverse curves from the east end of Totara Park, descending steeply past the Redoubt Road / Mill road intersection by approximately 200m. The curves have radii down to about 60m, which is well below the standard required for a four lane rural arterial. Straightening the route makes it shorter, increasing the gradient. The 9% grade through the Kinnard Lane and Redoubt Road / Mill Road intersections is steeper than desirable and creates a risk that turning vehicles may overturn.

- The reverse curves, steep grade and sharp crests west of Polo Prince Drive. The geometry over the crest west of Polo Prince is well below that suitable for a four lane rural arterial. This is a consequence of the steep grades on either side of the crest. Option J lowers the crest by up to 4m, and eases the reverse curves, causing the route to move east through the curve opposite Polo Prince Drive. The curve 400m further east at the AOG entrance is similarly eased.

- The sharp curve and limited intersection sight lines at the Ranfurly Road intersection. This would be addressed by realigning Mill Road west of its current alignment between the AOG church entrance and the curve south of Ranfurly Road, within Papakura District. The Ranfurly Road / Mill Road intersection would be moved about 30m west, and the curve radius considerably eased.

- Property access in the areas around the intersection with Murphy's Road are not ideal for an arterial road and the resultant large number of individual accesses could likely have a detrimental effect on safety.

7.3 Murphys Road

During the route identification workshop, Options I and K were selected as the preferred options for Murphys Road. Concept plans and longitudinal sections for these options are provided in the Route Options Plans binder.

A summary of the revisions made to Options I and K during the option refinement process is provided in the following subsections.

7.3.1 Option I

Option I follows the current alignment of Murphys Road up to the first right angled bend where a larger curve radii is followed, such that the route deviates from the current line, passing through the ridge in a cutting to a new intersection with Redoubt Road approximately 150m east of the current junction. Two intersection forms have been considered; a signalized at-grade intersection and a grade separated interchange (see Section 7.4).

The at-grade intersection requires a long crest to provide sufficient forward sight distance to the traffic signals. This raises the profile of Murphys Road from the bottom of the hill up to 4m at the point where it deviates from the current alignment. The route would then cut up to 6m through the ridge as it crests before the signals. The alternative of maintaining the grade of Murphy Road would produce substandard forward sight distance to the signals, and increase the depth of cut through the ridge

A grade separated interchange allows the current level of Murphys Road to be maintained until it diverges to cut through the ridge. The new road would cut more than 15m into the ridge, and pass under Murphys Road to a set of signals controlling the point where the westbound (right turn) ramps cross, immediately south of the overbridge. The eastbound traffic ramps for the left turns into and out of Murphys Road would need to climb up to Redoubt Road. The alignment of these left turn slip roads could follow the terrain more closely than for the traffic signal option. The left turn onto Murphys Road would turn into its own lane, with the right turn ramp developing two lanes at the signals, and then merging back to a single lane before the left turn slip joins.

Both the at-grade and grade separated options will have difficulty providing property access in the area. Further, with a grade separated option there are potentially weaving issues created with downstream accesses or intersection development on Murphys Road.

7.3.2 Option K

Option K deviates from the current alignment of Murphy Road to follow a spur to the west, up to a new intersection with Redoubt Road about 50m west of the current junction. Two intersection forms have been considered; a signalized at-grade intersection and a grade separated interchange (see Section 7.4).

An at-grade intersection requires a long crest to provide sufficient forward sight distance to the traffic signals that are close to the apex of the ridge. This raises the profile of the new route above that of the spur, creating an embankment starting from the bottom of the hill, rising on a 12% grade up to 10m above the surrounding spur 100 to 150m below the ridge. The route would create a small 1 to 2m cut through the ridge as it crests before the signals. The alternative of more closely following the level of the terrain is impractical on the steep slope immediately below the ridge, which would produce extremely substandard forward sight distance to the signals, and increase the depth of cut through the ridge.

A grade separated interchange allows the route to more closely follow the terrain until it cuts through the ridge. The new road would cut up to 10m into the ridge, and pass under Murphys Road to a set of signals controlling the point where the westbound (right turn) ramps cross, immediately south of the overbridge. The eastbound traffic ramps for the left turns into and out of Murphys Road would need to climb up to Redoubt Road. The alignment of these left turn slip roads could follow the terrain more closely than for the traffic signal option. The left turn onto Murphys Road would turn into its own lane, with the right turn ramp developing two lanes at the signals, and then merging back to a single lane before the left turn slip joins.

As previously noted, both intersection options have difficulties with providing property access in the area. Further, with a grade separated option there are potentially weaving issues created with downstream accesses or intersection development on Murphys Road.

7.4 Redoubt Road / Mill Road Intersection

Both at-grade and grade separated intersection concepts were considered for the intersection of Redoubt Road and Murphys Road. Given that there are two different alignment options for both Redoubt Road (Options C and D have a similar alignment at Murphys Road) and Murphys Road, there are potentially eight different intersection scenarios as summarized in Table 7-1.

Table 7-1: Redoubt Road / Murphys Road Intersection Scenarios

Redoubt Road Alignment	Murphys Road Alignment	Intersection Treatment
Option C/D	I	At grade
		Grade Separated
	K	At grade
		Grade Separated
Option J	I	At grade
		Grade Separated
	K	At grade
		Grade Separated

The alignment of Option C/D and Option J vary slightly at the intersection. However, the options are similar enough that the intersection concepts for each option will be similar. Therefore, intersection concept drawings were only prepared for Option C/D at this stage with the assumption that the intersection concepts for Option J would be similar. The four intersection concept drawings are provided in the Route Options Plans binder.

The construction costs and intersection configurations will be similar regardless of the alignment options selected for Redoubt Road and Murphys Road. However, the intersection footprint should be taken into consideration during the selection process as it will have an impact on the property and Totara Park land that is required

For all of the intersection scenarios, the at-grade options feature a steeper Murphy Road approach than is required for grade separated options, where Murphy Road passes underneath Redoubt Road. With at-grade junctions it is easier to develop access to surrounding properties, as there are no ramps cutting them off from Redoubt or Murphy Roads. The at-grade solution also features a significantly reduced footprint, less cut through the ridge, and much smaller earthworks.

With the at-grade options, cycle routes have to cross long left turn slips, which is not ideal. This is proposed to be addressed by treating the left turns as ramps, and having cyclists cross them at near right angles close to the intersection, per AUSTROADS GTEP 14 figure 4-28. The same situation arises for the grade separated options, for both the left and right turns (which connect to the south side of Redoubt Road). This affects cyclists in both directions for the grade separated options, and with possibly higher speeds.

The at-grade options also provide better pedestrian connectivity, as pedestrians cross slower vehicles making the left turns than with grade separation.

The Redoubt Road / Murphys Road intersection will be reviewed in further detail once the route alignments for Redoubt Road and Murphys road are selected.

8 Traffic Modelling

Traffic models were prepared to assist in the evaluation and design of the Mill Road Corridor. The detailed traffic modelling analysis is provided in Opus' Traffic Modelling Report, which is contained in Appendix 3 (Traffic Modelling Report to be included in Final PFR Report). A summary of the traffic modelling is provided in the following subsections.

8.1 Background

Network traffic models were used that preserved consistency of outputs between the Manukau City Council (MCC) Mill Road PFR and the Papakura District Council (PDC) Mill Road PFR. This will ensure that future projected traffic volumes for Mill Road are consistent between the studies and that economic analysis of each scheme is compatible with the other.

The existing Opus traffic models which cover the Mill Road corridor are:

1. Papakura District Model (PDM).
2. Flat Bush Model (FBM).
3. Southern Sector Model (SSM).

All three models were developed using the SATURN suite of transportation modelling software. The Papakura and Flat Bush models were developed to a high level of detail to assess the impacts of developments and the need for network improvements in their respective study areas.

The Southern Sector model was developed at a more strategic level covering a larger area and in less detail than the other two models. As a consequence it does not contain enough detail in the representation of intersections or in the granularity of the zone system to enable it to be used for the Mill Road studies.

The areas covered by the PDM and FBM are shown in Figure 8-1 below. Both models are validated to a 2004 base year and have been accepted by peer review. The parent model for the PDM is the Papakura TRACKS model and the parent model for the FBM is ART/2 (via the Beca AMETI sub-regional model). Future modelled years are:

- PDM: 2011, 2021, 2031
- FBM: 2016, 2021

Opus intends to combine the FBM with the PDM once the updated Auckland Regional Transport model (ART/3) is available to provide updated (2006) base year traffic demands. Given the need to develop new matrices and revalidate the model when it is extended, it is considered prudent to wait until the updated ART/3 is available rather than attempt to combine the existing base year matrices from each model or use traversal matrices from the existing ART/2 model to cover the extended area. This approach is considered reasonable for this PFR stage of assessment.

It is anticipated that ART/3 will be available in time for scheme assessment of proposed Mill Road options and that the PDM and FBM networks are joined together to form an extended Mill Road Model at this point.

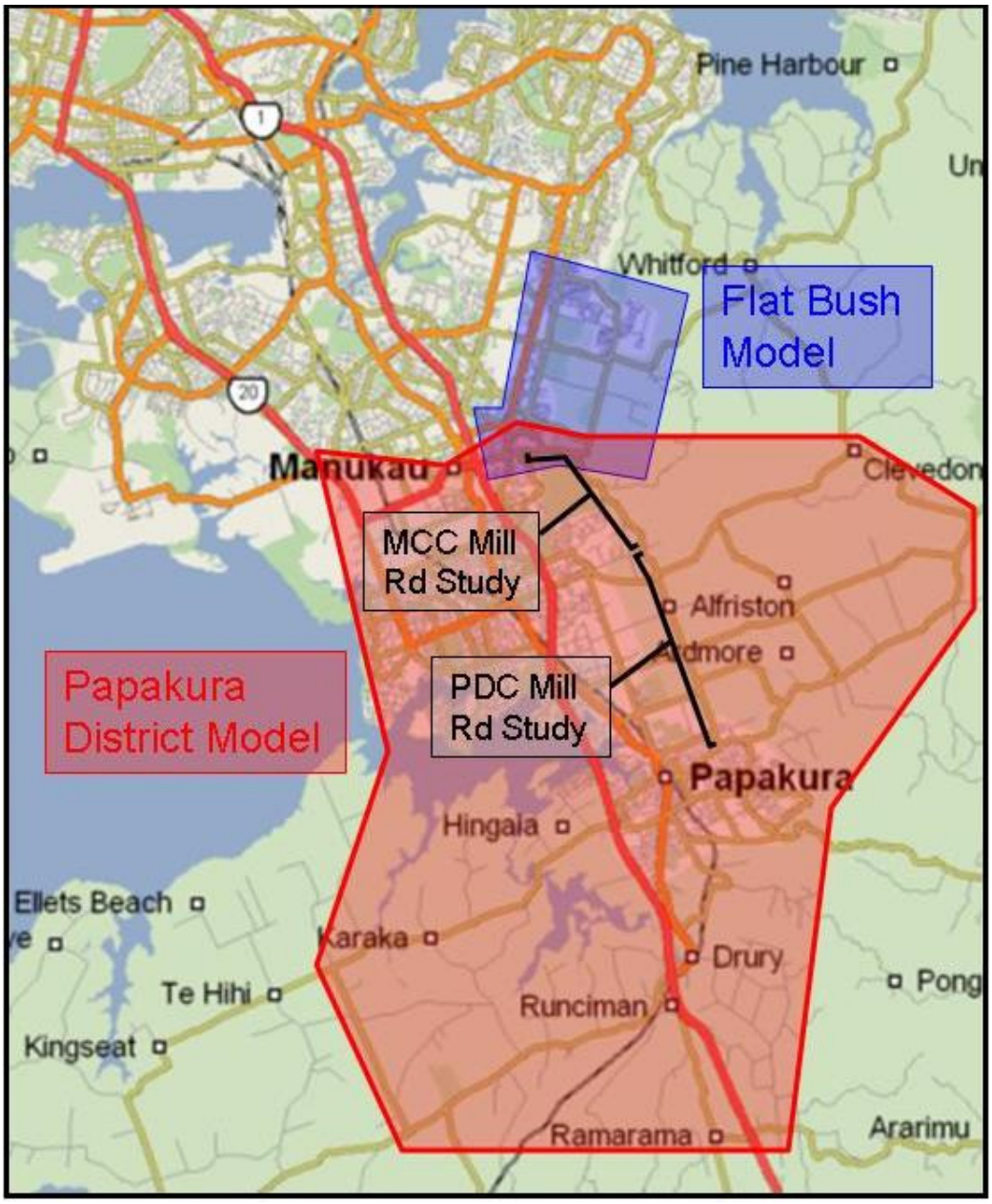

Figure 8-1: Extent of Papakura District Model and Flat Bush Model

Some of the length of Mill Road contained in the MCC Mill Road study area falls outside the bounds of the FBM network. However, the FBM network contains important route choices for traffic heading between Mill Road and Flat Bush in both directions that is not available in the PDM. Select link plots for Mill Road (north of Ranfurly Road) from the existing ART/2 model illustrate this (Figure 8-2).

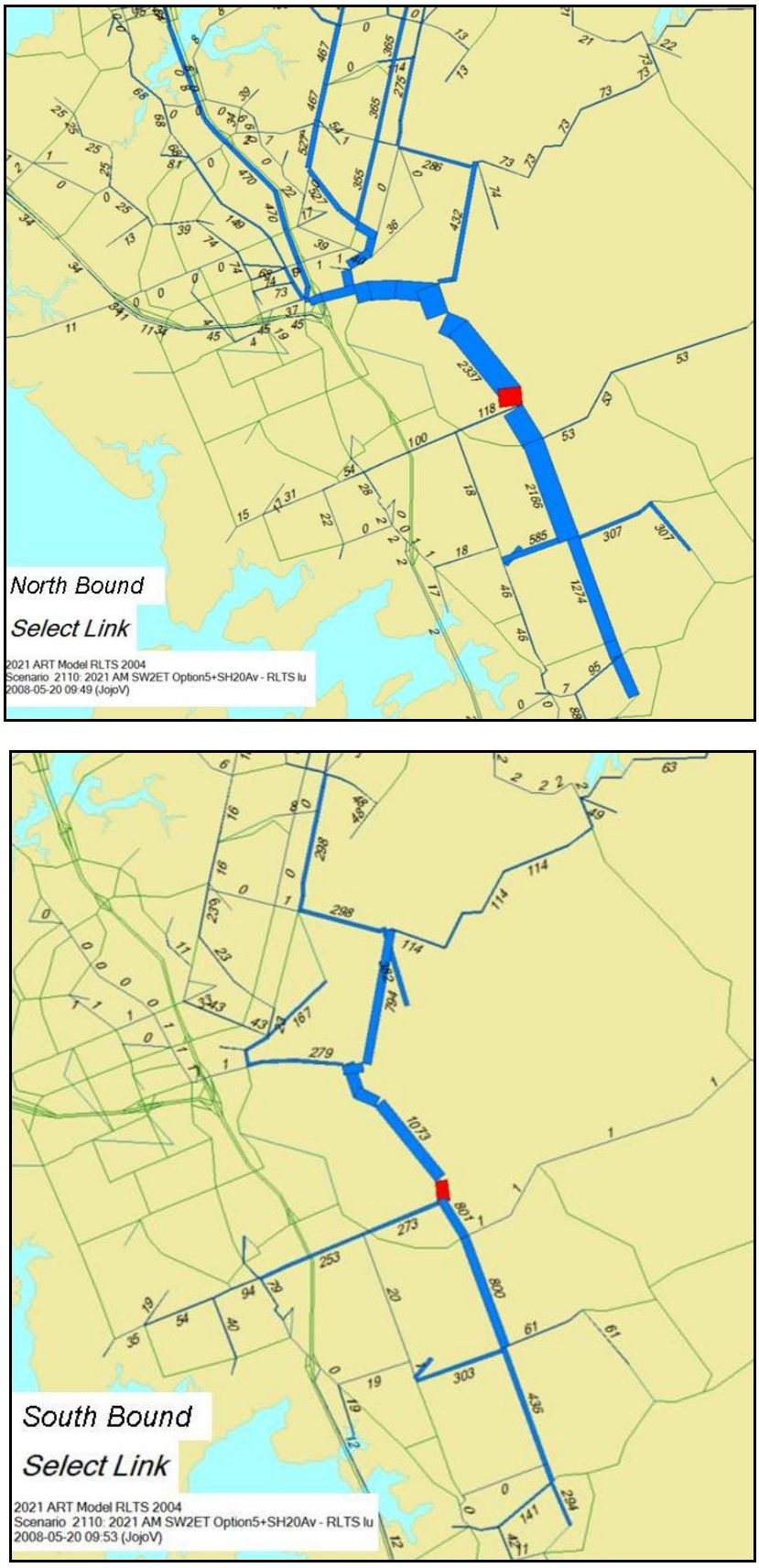

Figure 8-2: Mill Road (North of Ranfurly Road) Select Link Analyses from ART model (2021)

Following discussion with all relevant parties (MCC, the peer reviewer, ARC, and PDC's Mill Road scheme consultant), it was agreed that testing of options at PFR stage for the MCC Mill Road Study will be carried out in accordance with the following philosophy:

- The FBM (base year 2004) will form the main basis for option testing and determination of economic benefits.
- The PDM (base year 2004) will provide information to be incorporated in sensitivity tests to be carried out with the FBM.

Details of the FBM and PDM future year models can be found in the Traffic Modelling Report. An overview of the FBM network is shown in Figure 8-3 below:

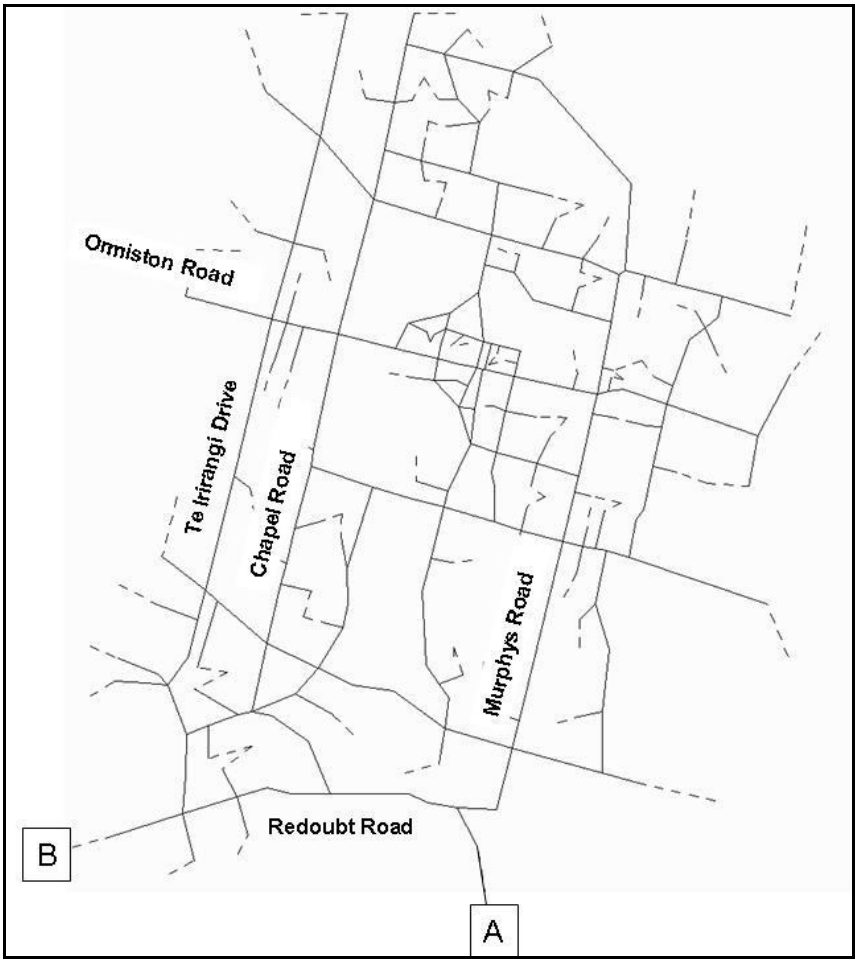

Figure 8-3: Flat Bush Model Network

Scenarios tested with the PDM allowed an estimate of the attractiveness of Mill Road / Redoubt Road north of Ranfurly Road as a route for traffic heading north-south between Papakura / Takanini in the south to Flatbush or beyond in the north. Based on the results of these tests the PDM external zone loads in the FBM were manually modified at the Mill Road / Redoubt Road "gateway" into the network (zone A in Figure 8-3). The external zone load at Redoubt Rd immediately west of Hollyford Drive (zone B in Figure 8-3) was modified in a corresponding way.

8.2 Future Year Traffic Demands

To enable 25-year economic analysis, future modelled years of 2016, 2021 and 2031 were required. However, examination of the existing 2021 FBM (using future demands derived from the ART/2 model) indicated substantial queuing and delays in the PM peak throughout much of the southern end of the network. For this reason, the network was considered saturated at the 2021 demand level and demands were not increased further to model 2031. However, this assumption was subjected to sensitivity testing for the purposes of economic analysis.

Additional high and low scenarios were tested by factoring the 2021 matrix up by 15% (to test additional traffic growth between 2021 and 2031 at an average rate of 1.5% p.a.) and down by 15% (to test network saturation at delay levels lower than those predicted with 2021 demands).

8.3 Future Year Networks

The Do-Minimum network was taken as the full Flat Bush Scheme model including numerous upgrades planned throughout the network (these are detailed in the Traffic Modelling Report). In addition, the Redoubt Road / Hollyford Drive intersection was upgraded as per plans provided by MCC.

Numerous options for the Mill Road / Redoubt Road upgrade have been considered in this study. All options include upgrading to 4 lanes, plus a flush median, along the full length of the scheme with varying geometric alignment improvements. However, in terms of the upgrade proposed for the Murphys Road intersection, the options fall into 2 categories:

- At-grade signalisation.
- Grade separation (partial diamond interchange).

The full range of options was consolidated to a reduced number of options for the SATURN modelling, as many of the alternative alignments will have little difference in terms of SATURN coding for link capacity, length and speed. Two option models were developed, one with an at-grade signalised intersection at Murphys Road and one with grade separation.

8.4 Modelling Results

A brief overview of the modelling results is presented in this section. A detailed assessment of model outputs is provided in the Traffic Modelling Report.

The at grade and grade separated option variations for the Murphys Road / Redoubt Road intersection are both predicted to result in substantial reassignment of traffic. A high degree of rerouting is predicted away from Te Irirangi Drive and Chapel Road towards Murphys Road to take advantage of the significantly reduced delays accessing Redoubt Road as a result of the scheme. This rerouting is particularly noticeable in the southbound direction. As a result of this re-assignment much of the congestion predicted in the 2021 Do Minimum models is relieved as a result of either scheme, particularly in the problematic PM Peak.

In addition to the network SATURN modelling, the proposed at-grade option for the Murphys Road / Redoubt Road intersection was modelled in SIDRA to assist in geometric design (whilst reflecting geometric design constraints) and to confirm signal settings used in the network model. Summaries for AM and PM peaks based on 2021 / 2031 capped flows are provided in Figure 8-4 and Figure 8-5

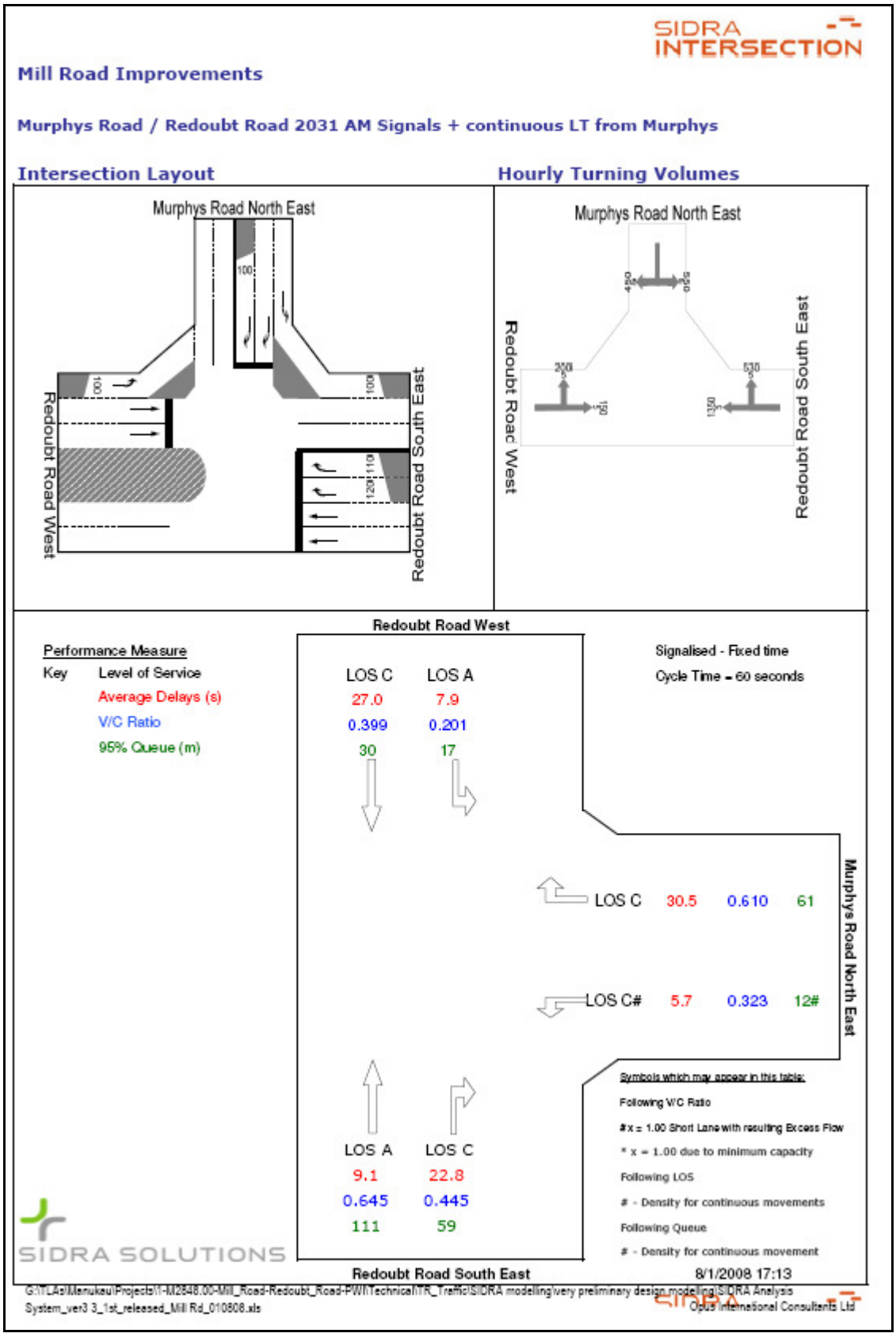

Figure 8-4: Proposed At-Grade Variant for Murphys Road / Redoubt Road Intersection: SIDRA Summary for 2031 AM Peak (Volumes Capped at 2021)

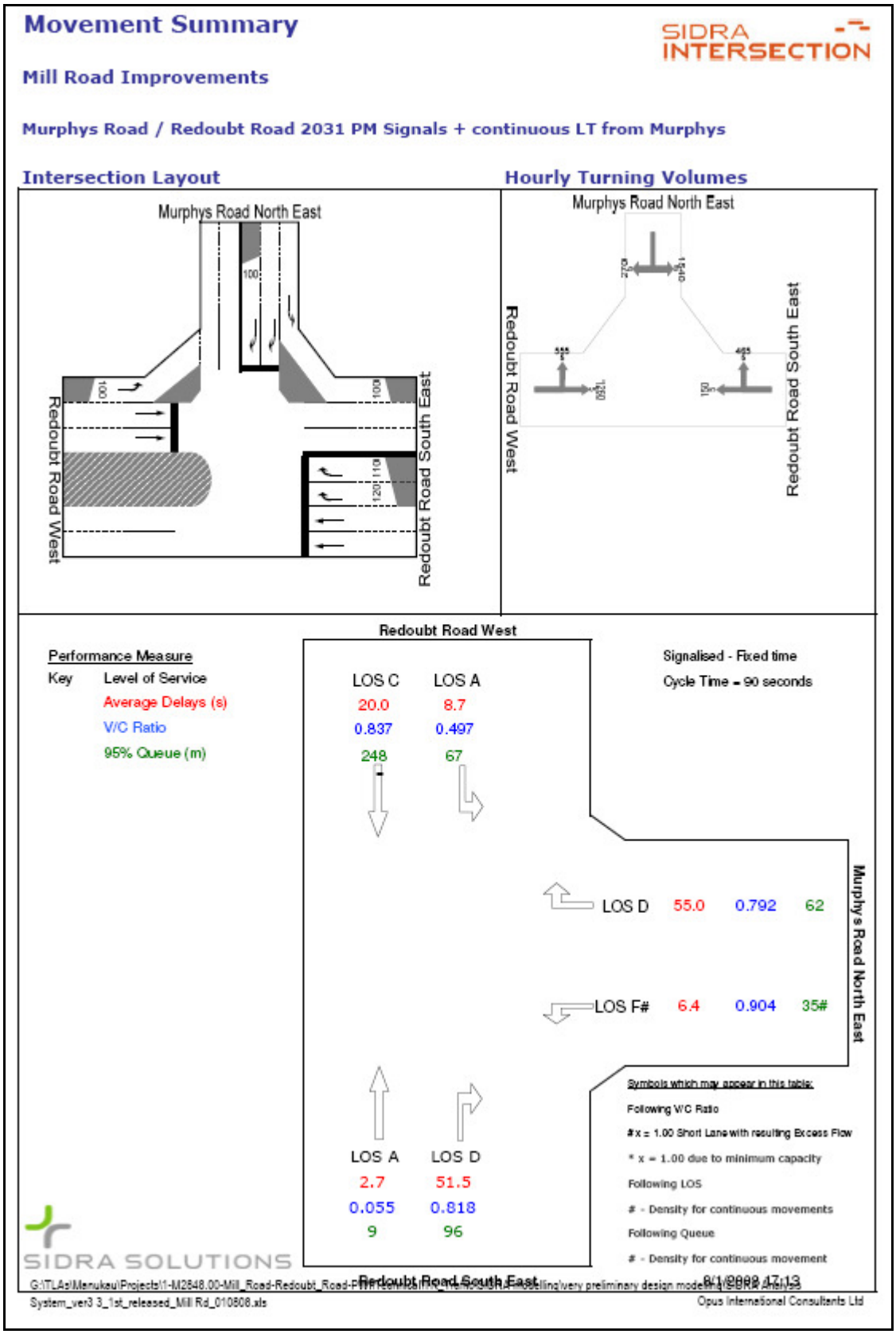

Figure 8-5: Proposed At-Grade Variant for Murphys Road / Redoubt Road Intersection: SIDRA Summary for 2031 PM Peak (Volumes Capped at 2021)

The attraction of the upgraded Murphys Road route to Mill Road via this intersection in the PM peak results in the free left turn lane from Murphys Road to Redoubt road reaching saturation level by 2021 (Volume/Capacity = 0.9). In addition the right turn into Murphys Road and through movement southbound on Redoubt Road come close to capacity (Volume/ Capacity of 0.82 and 0.84, respectively). Geometric constraints through this section of Redoubt Road and the Murphys Road connection to it prevent further capacity being provided easily for these movements. For this reason, higher capacity options including additional through lanes on Redoubt Road and an additional left turn lane from Murphys Road were not investigated.

Further details of the modelling undertaken and results obtained are presented in the Traffic Modelling Report.

9 Geotechnical and Geology

Opus International Consultants previously prepared and submitted a preliminary geotechnical appraisal (PGA) report. A copy of the final report is included in Appendix 4. The report discusses the geological hazards and geotechnical constraints associated with a broad corridor along which numerous options were being considered. Geotechnical testing will be scoped and programmed at Scheme Assessment stage. The PGA report was used to assist in developing geotechnical risk profiles for each of the options at the preliminary stage and will also be used to develop detailed constraints for the preferred option at a later stage once investigations have been undertaken.

The Redoubt Road to Mill Road Corridor traverses moderate rolling Waitemata Group terrain that has been identified on published geological maps as forming the western extent of the "southern landslide zone". This is an area of Waitemata Group terrain that has undergone historic deep-seated slope movement, characterised by deep seated composite block slides with the underlying rock mass and large scale historic debris slides in overlying weathered regolith. This type of terrain will often have complex hydrogeological regimes resulting in isolated shallow seeps and springs associated with gully formation. At the base of gullies soft to firm alluvial soils are common, while at the southern end of the project the alignment corridor begins to traverse the northern extent of the Manukau lowlands that are comprised of Pleistocene aged alluvium.

The main geotechnical risks associated with the project are from deep and shallow slope instability features associated with areas of historic instability and the affect on each alignment option; particularly in relation to cut batter design (see Figure 9-1) and the foundation stability of sidling fills and embankment fills.

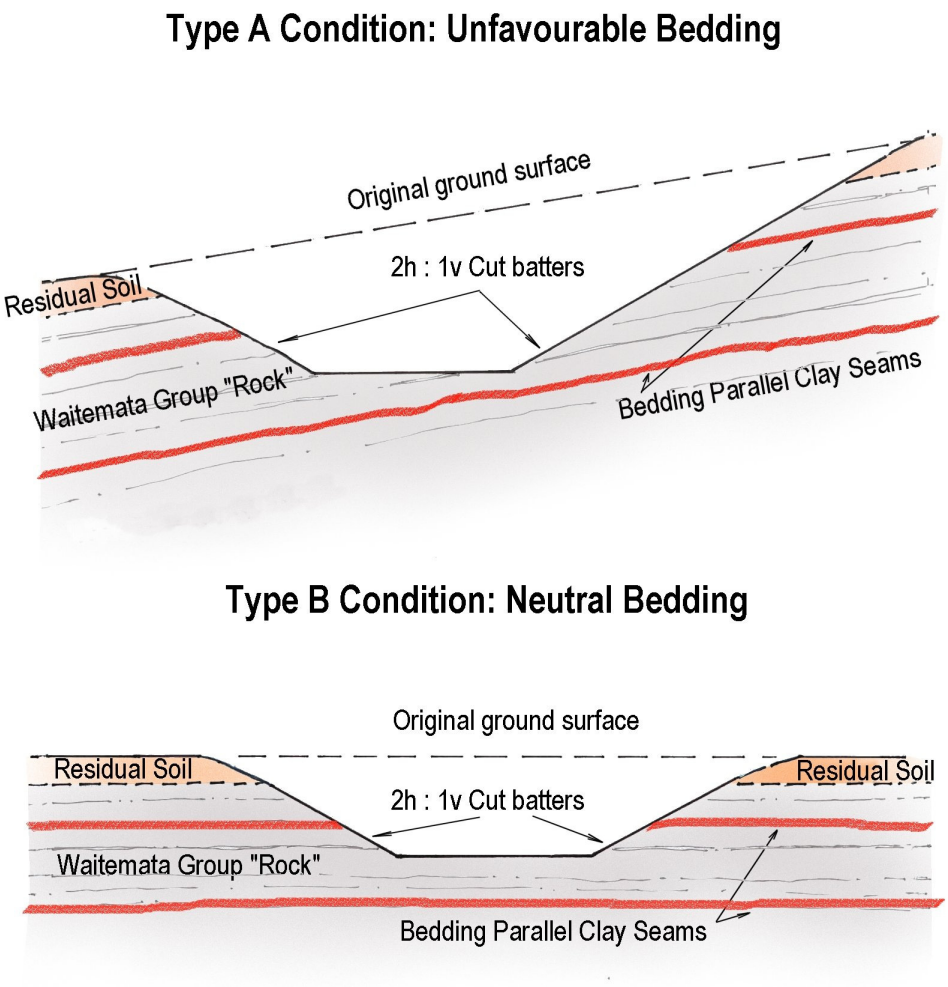

Figure 9-1: Bedding Parallel Clay Seems

Where possible the alignment options should avoid areas of instability. However, if needed, mitigation measures such as drainage, undercutting and retaining walls can be utilised subject to investigation and design.

From a qualitative geotechnical risk assessment, Options C, D, E and J appear to be the preferred options to take forward for the main alignment and as such would be the alignments that would require geotechnical investigations.

All options for Murphys Road are suitable from a geotechnical perspective. Geotechnical investigations will be carried out on the selected options during the Scheme Assessment.

A testing schedule will also be prepared once the favoured options are identified.

10 Stormwater Management

Opus International Consultants has prepared a Stormwater Management Report to evaluate the impact of the preferred options. The final report is provided in Appendix 5 and a summary is provided below.

The upgrade of the Redoubt Road / Mill Road Corridor will involve extensive geometric and alignment variations including widening what is currently a two-lane road with narrow shoulders to a four-lane carriageway with sealed shoulders and flush medians. This carriageway widening and route upgrade will significantly increase both the traffic volumes and the impervious area of the roadway. As such, the volume and peak flow rates of potentially contaminated stormwater runoff will also be increased. Adequate stormwater management techniques will need to be implemented as part of the roading project to avoid or mitigate any adverse effects on the environment caused by this increase in stormwater runoff.

10.1 Stormwater Management Concepts

For the purpose of this assessment the route has been broken into two distinct sections: the main alignment (essentially following the existing Redoubt Road / Mill Road Corridor), and the Murphys Road link section from Redoubt Road to Flat Bush. Three alignment options have been assessed for the main alignment section (Options C, D and J) with two alternative alignment options assessed for the Murphys Rodd link (Options I and K). For each of these options the measures required to avoid or mitigate the adverse environmental effects caused by the stormwater discharges from the newly created impervious areas have been assessed.

Ponds or wetland systems have been determined to be the most practicable stormwater management technique where topography and potential locations are available. The ponds have been sized to allow for water quality treatment, extended detention and flood mitigation for the 50% and 10% AEP rainfall events (and the 1% AEP event in the case of the Murphys Road link options within the Flat Bush Catchment) as per ARC TP10 methodology.

In areas where ponds or wetlands are not deemed suitable, low footprint proprietary filtration devices (or vegetated filter strips where suitable) have been proposed to provide water quality treatment to the relevant subcatchment. Offset mitigation of the extended detention and flood attenuation requirements of these particular subcatchments have been allowed for in the pond/wetland devices of the adjacent subcatchment(s).

In the rare situation where, due to topography or other site constraints, neither water quality treatment or quantity control can be provided for a section of road, both objectives have been offset in the adjacent subcatchment devices to achieve an equivalent level of stormwater management on a project wide basis. In these situations the length of road for which offset mitigation is required has been kept as short as is practical to minimise the volume of runoff that reaches the receiving environment untreated.

Each of the main alignment options has very similar stormwater management requirements, with a single filtration-only device at the northern end, a filter strip/buffer system at the Puhinui Stream crossing and 4-5 pond/wetland devices located along the route (depending on the selected option). The approximate estimated capital costs of the stormwater management systems for the main alignment are: $1.19m (Option J), $1.38m (Option C), and $1.47m (Option D) excluding land costs.

The Murphys Road link options (I and K) each require a single pond/wetland of a similar size located at or near the northern end (depending on the selected option). The estimated capital cost for the Murphys Road pond is between $340,000 (Option I) and $400,000 (Option K), plus land costs.

While all the stormwater management options described are generally feasible, it must be noted that they will involve works outside the road reserve. Should the required land be unavailable for any reason, any alternative solution will be substantially more expensive and may in fact compromise the entire project.

11 Utilities

From the assessment of the utility services carried out previously, it is apparent that all the major utilities running along the corridor will require significant alteration. At this stage, it has not been possible to discuss all of the route options with the utility operators. However, the likely impact of each route option is expected to be broadly similar; the major differences being the potential need to phase the works for Option J, whereas Options C and D are predominantly off line which would make the installation and phasing of new services much more straightforward.

A rough order cost estimate for the utility services alterations is $3,500,000 for Options C and D and $4,000,000 for Option J. The additional cost for Option J is due to the more complex phasing required as noted above.

12 Property Requirements

The properties affected by the route options have been identified as part of a comprehensive property report. Many of the smaller sections east of the Redoubt Road and Hollyford Drive intersection require a substantial proportion of the land to be taken for the scheme. The report and drawings detail the areas of land required for the scheme only. However, it is clear that some of the effects will require entire properties to be purchased. The area of land remaining after taking the land required for the road construction will, in some instances, be too small to accommodate a residential unit and it may be necessary to combine a number of such sections and then sell them on the open market.

In the rural area, many of the sections of land require only a small percentage of their land to be taken for the road construction. However, in some instances the area includes or is very close to the house. In these instances substantial costs will be likely.

The property schedule and drawings have been passed on to Manukau City Council's Property Specialist Allan Walton in order to establish a realistic value for the property requirement for each route option. Current estimates suggest that the property requirements could be in the order of $30,000.000.

Drawings showing the property requirements are shown in the Route Options Plan binder.

13 Preliminary Assessment of Environmental Effects

To determine the impacts of the various routes on the existing environment a number of key specialists have been engaged to assess the options. Reports have been prepared by a consulting archaeologist, a team of environmental specialists with terrestrial and freshwater expertise and a landscape team experienced in landscape and visual assessment.

Below are summaries of their findings with full reports contained in the appendices.

13.1 Archaeology

The archaeological assessment of the routes has been carried out by Clough & Associates. A full copy of the draft Archaeological Assessment Report is contained in Appendix 6 of this report.

There are no previously recorded archaeological or other cultural heritage sites within any of the preferred corridor options as this area of Manukau City generally has few recorded archaeological sites. Archaeological site survey of the corridor options has not included detailed inspection of private property at this stage, but has included public lands and Water Care owned land.

A search of Land Information New Zealand (LINZ) early plans showed old hedge rows, ditch and banks, and post and wire fences once existed on Redoubt Road around its intersection with Mill Road, and potentially within corridor Options C, D and J. No visible evidence of these early farming features was identified during survey along Redoubt Road.

The dates recorded on the early plans suggest that these early farming features may predate 1900 and therefore, may be considered 'an archaeological site' as defined in section 2 of the Historic Places Act 1993 (HPA). However, if any remains survive they are unlikely to contribute greatly to the history of New Zealand, as also required by the HPA, beyond recording their location and dimensions.

It is recommended that further detailed site inspection is undertaken on private property to confirm the presence of any surviving remains of early farming fences, hedges, or ditch and banks in the vicinity of the Redoubt Road and Mill Road intersection, and whether any surviving remains of these features will be directly affected by corridor Options C, D and J. The New Zealand Historic Places Trust (NZHPT) should be consulted if any remains of these early farming features are identified and will be affected.

Based on general background information, current site inspection and study of LINZ maps and plans, the likelihood of previously undetected archaeological sites being discovered within any of the five preferred corridor options is low. However, once a corridor option or options is identified for project planning, private property within this corridor(s) should be surveyed for this purpose.

Also, since archaeological surveys cannot always detect sites of traditional significance to Maori, or wahi tapu, the tangata whenua should be consulted regarding the possible existence of such sites and the recommendations in this report.

13.2 Ecology

13.2.1 Background

An Assessment of Ecological Effects (AEE) report was prepared by Kessels and Associates Ltd. and draft copy of the report is provided in Appendix 7. This ecological assessment constitutes the results of a detailed investigation of the ecological values of the proposed corridor area and the ecological constraints of the overall project, including an evaluation of:

- The location, extent, type and significance of terrestrial and aquatic indigenous vegetation communities, existing protected natural areas and fauna habitats supported within the project area.
- Results of botanical, avifauna and aquatic biota surveys carried out between March and July 2008.
- The nature and magnitude of any potential adverse ecological effects arising from each proposed road alignment option on key ecological features.
- A broad outline of suitable avoidance, remediation and mitigation measures required to address any potential adverse ecological effects.
- An outline of the requirements of further ecological investigations and monitoring requirements.

13.2.2 Description of Existing Vegetation

All options traverse a pastoral and urban landscape with no remaining indigenous plant or animal habitats remaining. However, within stream gullies, patches of native bush and small wetland seepage zones still persist. Some of these are modified and subject to weed intrusion, but others, largely due to the efforts of private landowners, contain intact indigenous vegetation communities. These, stands contain mature taraire and puriri forest with kahikatea and wetland grasses dominating the wet gully floors. Several seepage zones remain in the otherwise almost completely cleared gullies within Totara Park in the northwest of the subject area.

13.2.3 Avi-Fauna

Subject area birds consist of common exotic and native species, with reasonably abundant populations of tui and kereru evident within the bush remnants. North Island kaka visit the area occasionally.

13.2.4 Bats

New Zealand long-tailed bats have previously been found within the Hunua Ecological District, where the proposed corridor area is situated. Though no surveys have been conducted in the corridor area, long-tailed bats may likely be present at this locality.

13.2.5 Aquatic Biota

Fish and aquatic macroinvertebrate habitats consist of species reflecting a reasonably modified semi-urban environment; with pollution tolerant species dominating the silty and mobile substrates.

13.2.6 Ecological Sensitivity Assessment

According to the threatened environments classification described by Walker *et al.* (2007) the main proportion of the proposed corridor area is situated within "Category 3 - At risk". The proposed alignment options C and D would directly affect indigenous vegetation within an area classed as "Category 1 - Acutely threatened" (refer to the map in Appendix IV). The potentially affected indigenous vegetation remnants were also assessed against the Auckland Regional Council Regional Policy Statement criteria and two bush remnants are considered to be of regional significance.

13.2.7 Effects on Indigenous Ecosystems

Options J, I and K are situated within an ideal location from an ecological perspective. These options are largely situated within pasture/urban landscape and largely follow existing roads. Consequently, they do not dissect any significant natural features.

Options C and D require comprise the crossing and clearance of indigenous bush (yet to be quantified, but likely to be less than 1 ha) as well as significant tree trimming; causing habitat loss and disturbance to indigenous wildlife. The dissection of these forest remnants will also result in fragmentation and disruption of ecological corridor values. Substantial mitigation will be required should these options be pursued.

No endangered, rare, threatened or vulnerable plant species or plant communities would be directly affected by any of the proposed alignment options. However, kereru and North Island kaka are present in the area and longfin eel and koura are reported in the Freshwater Fish Database for both Puhinui Creek and Papakura Stream. Further surveys for NZ long-tailed bats and lizards are proposed to confirm with greater certainty that these threatened species do not utilise the site should either Option C or D become the preferred options.

No fish or aquatic macroinvertebrate habitats would be adversely affected provided appropriate sediment control measures are adopted. As all perennial stream crossings are proposed to be bridges, no specific fish passage provisions are required. At this stage water abstraction requirements are unknown. Provided that suitable storage and/or non-fully allocated water sources can be devised and found, water abstraction during construction should result in no more than minor adverse effects on in-stream biota.

The key aspects, which require further investigation, are:

- Assessment of the potential effects of the water abstraction requirements once exact hydrological needs are known.
- Further wildlife surveys should Option C or D be pursued.
- Development of a detailed Ecological Restoration & Monitoring Plan should Option C or D be pursued.

13.3 Landscape and Visual

Opus International Consultants conducted an assessment of landscape and visual amenity. The full draft report is provided in Appendix 8 and a summary of the findings is provided below.

The decision on which routes to take forward to this stage, Stage 2, took account of the levels of impact described below. The report summarises the level of effect of each route, taking account of possible mitigation which can be achieved.

Option C - there is more potential for mitigation in this option as some sections of the proposed alignment are through greenfields and the areas for land take are likely to be extensive. Examples of areas like this are the corner that cuts through Totara Park and the area opposite Polo Prince Drive. Option C also bridges the vegetated gullies which is a positive. Option C will have a significant effect on the area of land around the reformed Redoubt Road. This section of the road will become highly visible. There is however potential for extensive plantings to mitigate the effects and provide a feature on the ridgeline. Although a section of Totara Park is lost, there is potential for reinforcement of the park edge and gully systems. Although the overall area of works is greater than in Option D, there is a greater scope for mitigation measures. But to do this, it is extremely important to purchase a wide enough corridor to mitigate the alignment.

Option D - this option has a section of the alignment through an existing area of greenfields. Therefore, this has no effect for the smaller scale residential environment in this section but will require significant earthworks. The proposed bridges that span the vegetated gullies are positive and essential. There is potential for mitigation and reinforcing the vegetated ridge at the Murphys Road intersection. The bridge sections of the proposed alignment will provide views out into the surrounding greenfield/vegetated gully landscape. This is positive in the sense that it allows people to gain an appreciation and connection with the landscape, and in some ways creates a new landscape experience.

Option I - this option follows the existing alignment for a longer area than Option K does. Therefore there will be less disruption to the existing landscape and less changes to the views into the works from the surrounding areas. This option does not fragment the surrounding landscape than Options C and D. The new section of the alignment that joins up with Redoubt Road may be partially screened from view by the existing vegetation. However, working within the existing alignments does require land take and possible housing loss, altering the local landscape, with limitations on potential for moderating these effects, unless more housing is taken.

Option J - this Option mainly follows the existing alignment. Although this Option has minimal effect on changing the existing visual character of the landscape, it will adversely affect the quality of the existing residential properties by putting the road (which will be noticeably busier that the existing road) closer to the houses. While modifications to an existing route is generally visually less invasive than a new road cutting through the landscape, because this Option is working within the existing corridor, there are fewer options, and less room, for mitigation.

Option K - this Option cuts a new alignment up to the Redoubt Road ridgeline. This will be a change in land use and will alter the views into the area. This option will have an effect on the access to surrounding residential properties. This option will have a moderate to significant effect on the existing landscape form, depending on the design of the intersection, with the large amounts of cut and fill that will be required. Care will need to be taken to integrate the various levels and batter slopes of the intersection, with mass planting as a backdrop to reinforce the ridgeline to mitigate the effects.

In summary, the preferred route for the entire Redoubt / Mill Road proposal, taking account of impacts and the level of mitigation which can be achieved, is Route C.

13.3.1 Level of Significance

The preliminary study identified effects on the landscape under the following categories.

- Local impact – where these were highly localised, in the immediate vicinity of adjacent properties and residents.
- Broad local impact – where the effect was experienced by a wider community or affecting those within a particular suburb.
- Regional impact – experienced by those passing through the area or living in the wider Auckland community or affecting areas of regional landscape significance.
- National impact – impact on feature or aspect that would be recognised as being of significant value by people living outside the Auckland region, or where landscape features are of greater than regional significance.

13.3.2 Means of Mitigation

These include:

- Avoidance of change/loss of existing landform and vegetation – through route alignment and grading.
- Integration of earthworks forms into the surrounding open land or matching slopes, to achieve the grassy rolling land form of the ridge slopes.
- Retention or replacement and reinforcement of the forested gully patterns.
- Bridging over gullies to retain vegetation patterns and trees close to the carriageway
- Extension of existing forest stands, especially where these can provide screening or a backdrop when viewed from the urban areas to the north.
- Location of the road alignment, or levels including bunding or backdrop plantings to avoid the road being skylined.
- Integration of stormwater treatment ponds with the edge of existing forested areas.
- Reinstatement of local treatments to residential boundaries, particularly entryways, fencing and plantings.
- Use of a native plant palette, complemented by exotic plantings in proximity to housing.

14 Cost Estimates

Cost estimates were derived by measuring quantities based on the plans and using July 2008 rates.

No risk workshop was conducted as part of the feasibility stage. Therefore, a 30% contingency was applied to the Construction, Investigating and Reporting and the Design and Project Documentation base estimates. Property costs are only included in the total costs, which are summarized in Section 14.4.

The estimates further include preliminary and general allowance of 17% of the construction work as well as design development, MSQA and consenting fees that amount to 7.0% of the physical works.

As this is a preliminary estimate, a percentage of each option's base estimate was applied as a contingency to get the expected estimate values. For future estimates, a detailed risk assessment would quantify the percentage increase from the base to the expected and 95th percentile estimates.

14.1 Redoubt Road / Mill Road Corridor

The cost estimates for Options C, D, and J are provided in Appendix 9. A summary of the expected cost estimates are provided in Table 14-1.

Table 14-1: Expected Cost Estimates – Redoubt Road / Mill Road Corridor

Redoubt Road / Mill Road Alignment	Estimated Capital Cost*
Option C	$ 49,300,000
Option D	$60,100,000
Option J	$46,300,000

* Property costs not included

14.2 Redoubt Road / Murphys Road Intersection

The cost estimates for the Redoubt Road / Murphys Road intersection, including at-grade and grade separated options, are provided in Appendix 9 and are discussed briefly as follows.

At this stage, it was assumed that the cost of the intersection would be similar regardless of the route options selected for Redoubt Road / Mill Road and Murphys Road. Based on this assumption the expected intersection cost estimates are summarized in Table 14-2.

Table 14-2: Expected Cost Estimates – Redoubt Road / Murphys Road Intersection

Redoubt Road / Murphys Road Intersection	Estimated Capital Cost*
At grade	$ 1,300,000
Grade separated	$10,600,000

* Property costs not included

A more detailed cost estimate will be conducted for the intersection once the final route alignments are selected.

14.3 Murphys Road

The costs associated with Murphys Road will vary depending on the selected alignment for Redoubt Road as well as the selected Redoubt Road / Murphys Road intersection treatment type (at-grade or grade separated). The costs vary due to the different amount of earthworks required for each scenario.

For the purpose of the PFR, it is assumed that the alignment of Redoubt Road will have a negligible impact on the cost. Therefore, there are four different cost scenarios as summarized in Table 14-3. These costs are for the road alignment only and do not include the intersection costs which are detailed above in Table 14-2. The detailed cost estimates for Options I and K are provided in Appendix 9.

The Option K costs presented in Table 14.3 show that the At Grade option has been estimated as more expensive than the Grade Separated option. This is due to the increased earthworks required for the At Grade options. Whilst the Grade Separated Option requires more structures it can more closely follow the terrain than the At Grade Option which will require substantial earthworks to achieve required forward sight distances. Further differences between the At Grade and Grade Separated options are provided in Section 7.3.2.

Table 14-3: Expected Cost Estimates – Murphys Road

Murphys Road Alignment	Intersection Treatment	Estimated Capital Cost*
Option I	At grade	$8,900,000
	Grade Separated	$12,800,000
Option K	At grade	$19,800,000
	Grade Separated	$9,500,000

* Property costs not included

14.4 Total Cost Estimates

As discussed in Section 14.3, the cost of Murphys Road varies depending on the alignment of Redoubt Road / Mill Road and the selected intersection treatment. This results in twelve different combinations or schemes. The cost for each scheme, including property costs ($30M), is summarized in Table 14-4.

Table 14-4: Expected Scheme Cost Estimates

Scheme Number	Redoubt Road / Mill Road Alignment	Murphys Road Alignment	Intersection Treatment	Estimated Capital Cost (including property costs)
1	Option C	Option I	At grade	$89,500,000
2			Grade Separated	$102,700,000
3		Option K	At grade	$100,400,000
4			Grade Separated	$99,400,000
5	Option D	Option I	At grade	$100,300,000
6			Grade Separated	$113,500,000
7		Option K	At grade	$111,200,000
8			Grade Separated	$110,200,000
9	Option J	Option I	At grade	$86,500,000
10			Grade Separated	$99,700,000
11		Option K	At grade	$97,400,000
12			Grade Separated	$96,400,000

15 Economic Analysis

An economic evaluation has been carried out on the proposed upgrading options of the existing Redoubt Road / Mill Road Corridor, on the basis of the Land Transport New Zealand Economic Evaluation Manual (EEM). Values of travel time, congestion relief, carbon dioxide and vehicles operating costs were derived from the EEM.

The analysis has evaluated the twelve upgrade schemes identified in Section 14.4.

Three traffic growth scenarios have been considered for this project. The analysis result for the medium scenario we will be presented in this report and the low and high growth scenarios are provided in Appendix 10. The details of each growth scenario are discussed in Section 8.

15.1 Basis of Analysis

The SATURN model results have been used to derive predictions of travel time and vehicle operating cost savings for the economic evaluation.

A 25-year analysis period has been used as recommended in the EEM, with time zero as 1 July 2014. The construction is assumed to commence as of 1 January 2016, and finish on 1 January 2018.

15.2 Annualisation Factor

Traffic models have been set up related to weekday AM, Inter peak and PM peak periods, and it is necessary to derive estimates of the hours per year which relate to each of these periods.

It is common practice to use the off peak to derive predictions of benefits during the evening and at weekends. Even with future models, severe congestion is not predicted during the Inter peak, hence benefits for the evenings and weekends are assumed to be proportional to the Inter peak flow.

Travel time, congestion relief, carbon dioxide and vehicle operating costs are based on extrapolation of the AM, Inter Peak and PM Peak traffic models, using the following annualisation factors:

- AM Peak: 245 days, at 2 hours per day (07:00-09:00).
- Inter Peak: 245 days, at 8 hours per day (09:00-16:00 and 18:00-19:00).
- PM Peak: 245 days, at 2 hours per day (16:00-18:00).
- Off Peak: 245 days, at 6 hours per day (19:00-24:00 and 06:00-07:00) at 0.26 x Inter peak volumes, based on flows along the Redoubt Road.
- Weekends and Public Holidays: 120 days at approx. at 10 hours per day (1000-2000), at 0.98 x Inter peak volumes, based on flows along Redoubt Road.

The night time (generally 00:00-06:00) is not included in the above, implying that no economic benefits will occur during these hours. This gives a slightly conservative estimate of the likely benefits of the schemes.

15.3 Cost Estimation

The construction and maintenance cost estimates for each scheme are listed in Table 15-1.

Table 15-1: Construction and Maintenance Cost Estimates

Scheme Number	Redoubt Road / Mill Road Option	Murphys Road Option	Intersection Treatment	Discounted Construction Cost	Discounted Maintenance Cost
1	Option C	I	At grade	$66,022,138	$1,835,949
2			Grade Separated	$75,488,705	$1,835,949
3		K	At grade	$73,833,850	$1,830,572
4			Grade Separated	$73,116,686	$1,830,572
5	Option D	I	At grade	$73,982,700	$2,051,138
6			Grade Separated	$83,449,267	$2,051,138
7		K	At grade	$81,794,412	$2,045,761
8			Grade Separated	$81,077,248	$2,045,761
9	Option J	I	At grade	$64,049,550	$2,014,853
10			Grade Separated	$73,516,117	$2,014,853
11		K	At grade	$71,861,262	$2,009,476
12			Grade Separated	$71,144,098	$2,009,476

15.3.1 Construction Costs

It has been assumed to take 2 years (24 months) to complete the construction phase of the project, starting in January 2016. Construction costs are considered to occur at the midpoint of construction, the first half of the payment being in December 2017, and the remaining being in December 2018.

15.3.2 Maintenance Costs

Rough order maintenance costs have been calculated for both annual maintenance and periodic maintenance for the Redoubt Road section of the Mill Road Corridor.

The annual maintenance cost and periodic maintenance cost has been included in the analysis for the scheme. This is expected to cover any additional signal, markings and pavement maintenance costs as a result of the corridor upgrade.

15.4 Tangible Benefits

The benefit stream starts immediately after construction, being January 2018. With the construction phase being 2 years, the benefits of 24 years have been assessed. Road user benefits have been capped at 2021 levels to limit excessive benefits associated with the PM Peak. Opus assume the benefits will be similar between each alignment option and the only difference in benefits is between the two intersection treatments.

The total discounted benefits for each intersection treatment is provided in Table 15-2:

Table 15-2: Total Discounted Benefits

Intersection Treatment	Total Discounted Benefits
At grade	$294,175,588
Grade Separated	$298,764,286

It is noted that majority of the discounted benefits are derived from travel time savings.

15.4.1 Travel Time Savings

The travel time savings have been derived on a link by link basis for each of the time periods. They are calculated by multiplying actual flow on each link by the link travel time. The same method is applied on turning movements. The total network travel time is obtained by summing each link and turn in the entire network.

Trip reliability benefits have not been included in this economic assessment.

15.4.2 Congestion Savings

Congestion and reliability values (CRV's) have been assumed to apply on all turns and on links predicted to be running at greater than 70% capacity, as specified in the EEM.

15.4.3 Vehicle Operating Cost Savings (VOC)

VOC are calculated on the total distances travelled and the number of vehicle stops. The number of stops will decrease, as a result of the options, reducing the idling cost.

The travel time and congestion values are calculated using link by link data. It was decided to do the same with VOC's, therefore making the results more compatible.

Vehicle kilometres per hour (Veh.km/hr) are calculated by multiplying actual flow on each link by the link length and then summing each link in the entire network to obtain the total distance travelled. The same calculation is done for Vehicle hours per hour, (Veh.hrs/hr), where the actual flow on each link is multiplied

by the time spent on each link and then summed for the entire network. Dividing Veh.km/hr with Veh.hrs/hr gives the speed in Veh.kms/hr. This then allows the calculation of VOC.

15.4.4 Vehicle Emission (Carbon Dioxide) Reduction Savings

Benefits to the environment and public health result from the reduction of vehicle emissions. Carbon dioxide (CO_2) emissions are linked to fuel consumption through vehicle operating costs. The benefits have been estimated at 5% of VOC.

15.4.5 Crash Savings

No accident assessment has been undertaken. It is unlikely the accident savings would significantly affect the Benefit Cost Ratio (BCR) of this proposal.

15.5 Benefit / Cost Ratio and First Year Rate of Return

The Benefit Cost Ratio and the First Year Rate of Return (FYRR) are set out in Table 15-3 below.

Table 15-3: Benefit Cost Ratios and First Year Rate of Return

Scheme Number	Redoubt Road / Mill Road Option	Murphys Road Option	Intersection Treatment	BCR	FYRR
1	Option C	I	At grade	4.5	65%
2			Grade Separated	4.0	58%
3		K	At grade	4.0	58%
4			Grade Separated	4.1	60%
5	Option D	I	At grade	4.0	58%
6			Grade Separated	3.6	53%
7		K	At grade	3.6	53%
8			Grade Separated	3.7	54%
9	Option J	I	At grade	4.6	67%
10			Grade Separated	4.1	60%
11		K	At grade	4.1	60%
12			Grade Separated	4.2	62%

The combination of Option J, Option I and at grade intersection of Redoubt Rd and Mill Road provides the highest BCR of 4.6.

FYRR is used to indicate the best start date of the projects. The results show that most schemes provide positive FYRR and are worth starting construction in 2016.

The detailed benefit cost estimates are provided in Appendix 10.

15.5.1 Sensitivity Test

Sensitivity tests were carried out to investigate a range of future traffic growth scenarios. A low growth scenario was tested which capped traffic demands between 2016 and 2021 (by limiting them to 85% of 2021 demand in the base scenario). A high growth scenario applied a factor of 1.15 to 2021 demands, approximating continued traffic growth between 2021 and 2031 of 1.5% p.a (uniformly across the network). A comparison of the BCR's is provided in Table 15-4.

Table 15-4: Low and High Growth Scenarios Benefit Cost Ratios

Scheme Number	Redoubt Road / Mill Road Option	Murphys Road Option	Intersection Treatment	BCR (Low Growth Scenario)	BCR (High Growth Scenario)
1	Option C	I	At grade	3.0	4.6
2			Grade Separated	2.6	4.1
3		K	At grade	2.7	4.1
4			Grade Separated	2.7	4.2
5	Option D	I	At grade	2.7	4.1
6			Grade Separated	2.4	3.7
7		K	At grade	2.4	3.7
8			Grade Separated	2.5	3.8
9	Option J	I	At grade	3.1	4.8
10			Grade Separated	2.7	4.2
11		K	At grade	2.7	4.2
12			Grade Separated	2.8	4.4

15.5.2 Intangible Benefits

Intangible benefits are considered to be a minor part of the overall benefits associated with the proposed corridor upgrade. The EEM does not account for intangible benefits in the economic analysis of projects.

16 Risk Assessment

16.1 Draft Preliminary Risk Assessment Report

The Draft Preliminary Risk Assessment Report, prepared by Opus, is provided in Appendix 11. A structured assessment process has been followed for the preparation of this report for the Mill Road options. The report describes the methodology followed to complete the preliminary assessment to prepare the initial risk register. The risk register is included in Appendix 11.

The requirement was to perform a project risk assessment (qualitative and quantitative) and risk profile in accordance with LTNZ's Programme and Funding Manual.

The methodology used broadly follows the procedures detailed in Transit New Zealand's (Transit) Risk Management Process Manual (AC/Man/1), AS/NZS 4360:2004 Risk Management and SAA/SNZ HB 436:2004 Risk Management Guidelines. These procedures comply with the broadly stated intent of LTNZ. AC/Man/1 replaces Transit's former Minimum Standard Z/10 process.

Z/10 and AC/Man/1 are very project orientated and provide a set of tools to minimise project threats and maximise opportunities by identifying project uncertainties to enable planning for unintended events that may occur.

The Mill Road options are still at a very preliminary planning phase. Thus it is not possible to provide a detailed quantitative risk assessment. In providing this preliminary risk register for the project feasibility report, due recognition has been taken of the preliminary stages of this proposed transport corridor. Quantitative assessments of a very broad nature have been made in the cost estimates in accordance with SM014, with appropriate contingency provision.

Below, the term 'risk' is generically used with respect to both threats and opportunities.

The process sets out to raise awareness within the project team and the client's advisers, to address identified and unknown risks in the area of:

- Issues of community concern
- Environmental effects
- Potential for Scheme delay
- Consenting issues and compliance with the LTMA, RMA and other legislation

Scheme cost and duration has not been specifically addressed at this time.

The outcome of a risk management process will be delivery of best value through minimisation of any significant threat to Manukau City Council's project at Mill Road corridor and the realisation of opportunities. This requires:

- Effective and continuous management of all risks
- Reporting and elevation of all significant risks

- A risk-adjusted programme, and
- A risk-adjusted cost estimate

From the outcomes of the options workshop and the expert reports provided by the project team (archaeological report, geotechnical report, traffic modelling studies, and environmental report) a preliminary risk review has identified 58 strategic risks to the project.

As mentioned above, the risk assessment is only at a preliminary stage and can't be finished until more detailed planning and design work has been completed. At that time, a further workshop should be convened and it is expected that some of the more generic risks identified with planning and consents will be replaced with specific issues.

Similarly, detailed scoring and ranking of the identified risks has not been done by a project team at this stage.

Many of the identified risks detailed in the preliminary register have moderate to high risk rating, and have low resultant likelihood or consequence of occurrence during this preliminary assessment phase.

By identifying risks at an early phase, they can be actively managed out or mitigated before the project moves to construction phase. Some do have, however, the potential to adversely affect the overall project cost.

16.2 Recommendations

The following recommendations are made based on the preliminary risk assessment:

- The risk register should be circulated now to the wider (internal and external) team, to be updated once the Preliminary Design Report has been circulated.
- Mitigation plans for all risks identified within this report should be prepared by identified Risk Owners. The Project Manager would undertake this activity as part of the work required at the next phase of this project – Detailed Design.
- A process of regular review and updating of the risk assessment process be implemented during detailed design.
- The Project Manager should include a Risk item within all project meetings, with the objective of instilling a regular feedback.

17 Consultation

A Community Engagement Plan has been prepared for the project with the main community involvement being the open days in late August 2008 and early September 2008. Feedback was sought on the options from those potentially impacted and from the general public. The feedback resulted in two further options being tested as discussed in chapter 18, with one of these being the subject of further consultation in September 2009.

The project team is working closely with Papakura District Council and attended workshops with PDC. A meeting has been held with ARTA at the project scoping stage and dialogue is continuing. ARC officers have been briefed on the project. A meeting has been held with Water Care. Other key stakeholder consultation is on-going.

18 Additional Options (X and D Alternative)

The first stage of this study commenced in January 2008. By April 2008, Opus had identified 14 different options covering the three main routes (Redoubt Road, Mill Road and Murphys Road) in the study area. Three options for the Redoubt Road / Mill Road Corridor and two options for the Murphys Road Corridor were taken forward for preliminary public consultation.

Preliminary consultation took place from mid August to early October 2008. Consultation was later extended to December 2008 due to the high number of responses received and a public meeting being held. A number of further options were suggested by community, these were reported to Council in February 2009, where it was resolved that two of those options (Option X1 and Option D Alternative) be the subject of further study by Opus. This section describes these two options and summarises the findings from an Option Evaluation Workshop held in June 2009.

18.1 Option X1

This is a new option that proposes to connect Brookby Road to Ormiston Road from approximately the Brookby/Richardson intersection to the Ormiston/Shephards Lane intersection. The proposed route is a greenfield route which crosses the proposed Redoubt Road extension and passes south of the proposed Transpower substation.

This option crossed rural farmland over a mix of flat pasture and steep hill country covered in native and exotic trees. There are significant challenges presented by the steep hill country section along the northern half of the route to achieve the 80kph design speed for the geometric design without significant earthworks and bridging.

A benefit of this route is that there are few dwellings affected by the proposed alignment and so traffic management and accessibility will not be a factor.

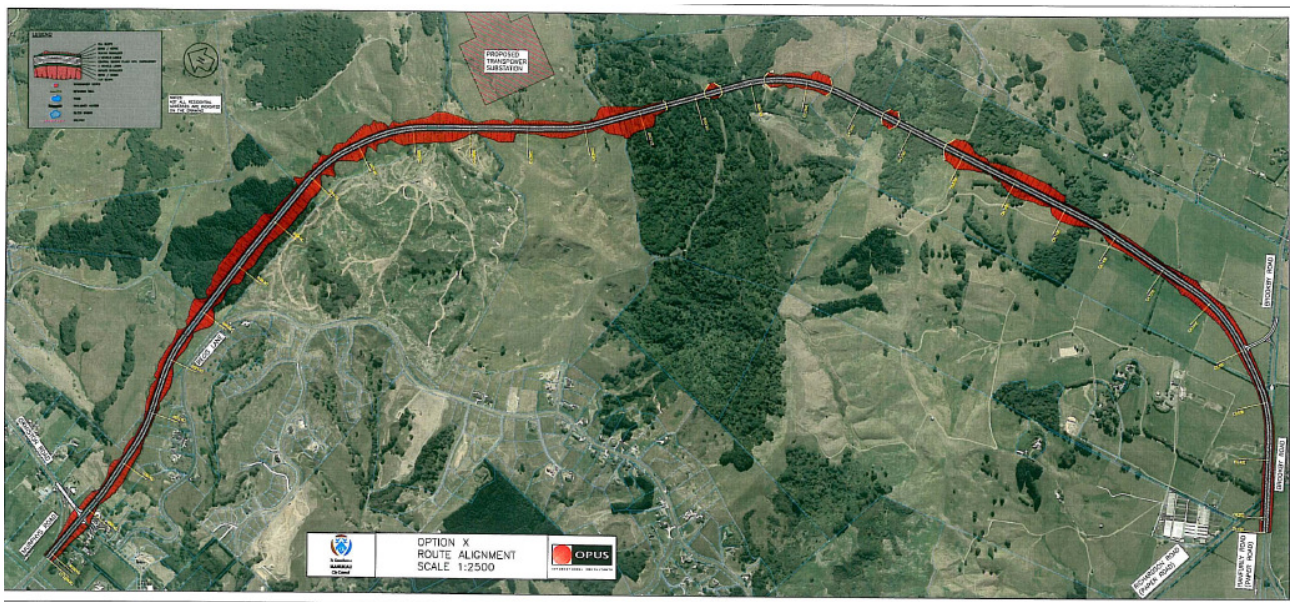

Figure 18-1: Option X1: proposed route

18.2 Option D Alternative

Option D Alternative is a similar route to the original Option D. The main difference is that the eastern section of the route connects 250m west of the Redoubt Road / Mill Road intersection rather than 900m east of the Mill Road / Redoubt Road intersection. This alteration results in less dwellings being directly affected by the alignment. It also allows for the existing Redoubt Road to remain as an access road to the properties it currently serves.

As this option introduces more greenfield elements than the original option D the result is a road with the following positive elements:

- Less side friction due to fewer accesses directly on to the new road. This results in higher operating speeds;
- Improved safety, as fewer accesses mean fewer turning movements at uncontrolled intersections along the route
- Provisions for local road traffic to access at only three controlled intersection locations:
    - Murphys Road (signalised seagull layout)
    - Bridge over Mill Road – potential limited grade separation
    - Mill Road eastern tie in (signalisation)
- Traffic management during construction will be simpler due to the larger amount of greenfield road.

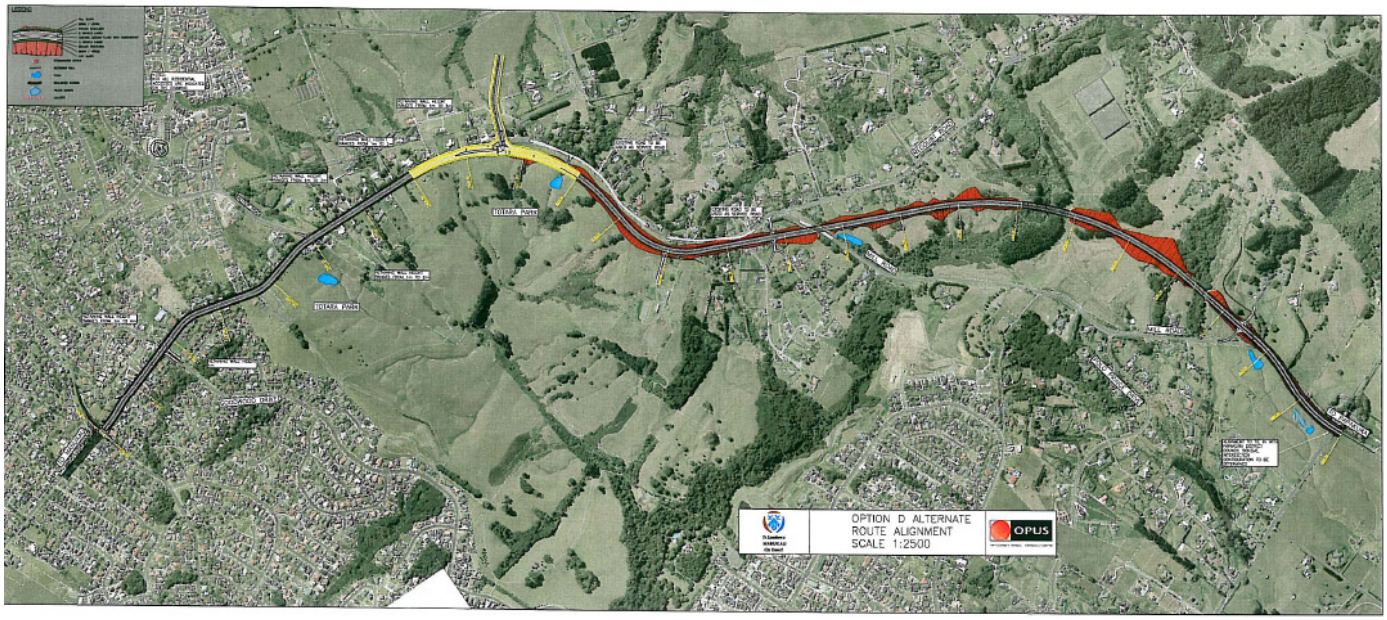

Figure 18-2: Option D Alternative: proposed route

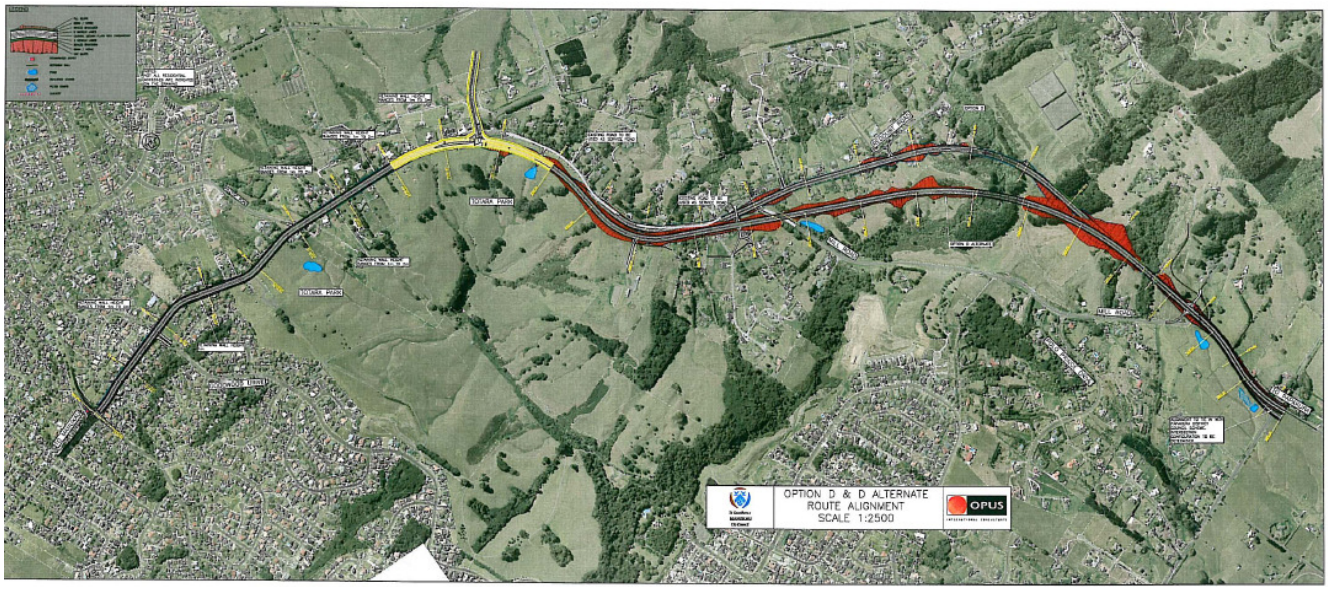

Figure 18-3: Option D and Option D Alternative Routes

18.3 Option Evaluation Workshop

An Option Evaluation Workshop was held on the 11 of June 2009, where Option X1 and Option D Alternative were examined in the same manner as earlier options considered in the April 2008 workshop.

The following subsections outline the key findings from the workshop. Table 18-1 presents rankings for Options X1 and D Alternative as evaluated at the second workshop.

18.3.1 Transportation

The Option X1 route was tested via the Auckland Region Transport model to assess the likely attraction and to quantify any diversion from the Redoubt Road / Mill Road route. The results show that little relief is forecast for the Redoubt Road / Mill Road corridor through Option X1, with only a 7% predicted diversion along this key route, and as such over 40,000 vehicles per day are still expected to use the corridor.

The Option D Alternative would provide the same transport benefits as the original options considered; this includes substantial reassignments of traffic to alternative routes. Much of the reassignment is as a result of vehicles switching from Te Irirangi Drive and Chapel Road, to the upgraded Murphys Road route. This reassignment relieves much of the congestion seen in the 2021 Do-Minimum option.

18.3.2 Geotechnical

A preliminary geotechnical appraisal has been conducted to identify the geological hazards and constraints associated with Options X1 and D Alternative.

Option X1 is identified as appearing to have considerable more risk than other options, some of which can be attributed to the increased length in comparison to other options. As such, Option X1 would require intensive investigation to confirm ground conditions and would likely include high to extensive construction costs.

For Option D Alternative, it is identified that as well as the issues identified for Route D, this route additionally crosses a number of historic slip features and as such increases the geotechnical risk that will need to be mitigated. Within the main preliminary geotechnical appraisal, Option D is assessed as requiring

moderate investigations to confirm ground conditions and would likely include moderate to extensive construction costs.

18.3.3 Ecological

The broad-level ecological assessment undertaken for Option X1, shows that the proposed corridor area contains indigenous vegetation remnants of high ecological significance in terms of primary semi-coastal forest, habitat for threatened terrestrial fauna (kereru and possibly kaka, long tailed bats and lizards), as well as wetlands and streams containing habitat for threatened fish species. With the comparatively large size of some blocks of vegetative areas affected, there is an increased likelihood of threatening species especially considering the presence of a Turanga Creek tributary where threatened native fish are likely to be present.

From an ecological assessment point of view, Option D Alternative is little different to Option D and as such the assessment of directly affecting indigenous vegetation with an area classed as "Category 1 – acutely threatened" remains valid.

18.3.4 Landscape

As a result of the increased route length in comparison to any of the other route conditions, Option X1 has a greater impact for a number of issues including: open space, visual impacts, noise and earthworks; however mitigation of these impacts is also possible.

For Option D Alternative, the impacts on Totara Park, Redoubt Road and Reservoir Basin-Mill Road are the same as Option D and therefore the original assessment stands. The deviation from Redoubt Road as part of Option D Alternative will require two structures (to cross Mill Road) and to span a gully). However, depending on the elevation of these the visual impacts may be limited through alignment and/or screening with mature vegetation.

18.3.5 Alternative Option Assessment

Table 18-1: Option X1 and D Alternative Evaluation

Criteria	Option X1	Option D Alt
Geotechnical	-4	-2*
Archaeology	0	0
Ecology	-3	-3*
Landscape	-3	-3
Stormwater	-1	-1
Property	-1	-2**
Transport	-3	0
Scoring	**-15**	**-11**

Notes:
* Identified as slightly worse than existing Option D
** Identified as slightly better than existing Option D
Scoring method: 1 for low impact, -2 for medium impact, -3 for high impact

Based on the preceding evaluation Option X1 was discarded as it failed to meet the transport requirements of this study.

No further economic analysis was undertaken at this stage. Option D Alternative is largely a refinement of the original Option D and hence the BCR for this option is expected to be similar or better due to the:

- general similarity to Option D;
- benefits listed in Section 18.2 including safety improvements through fewer accesses;
- potential for a narrower corridor through the retention of Redoubt Road as a service road; and
- potential for lower private property purchase requirements.

Further detailed economic analysis will be completed on the preferred option in the Scheme Assessment phase of this study.

Option D Alternative was taken back to the community for another round of focussed consultation and was included with the other Redoubt Road / Mill Road options; C, D and J as preferred options.

19 Recommended Options

A final workshop was held with Council and Opus staff to identify which option or options would proceed to more detailed analysis in the Scheme Assessment Phase. Table 19-1 illustrates the option arrangements that were considered at this workshop.

Table 19-1: Options Considered at Workshop

Scheme Number	Redoubt Road / Mill Road Alignment	Murphys Road Alignment	Intersection Treatment
1	Option C	Option I	At grade
2			Grade Separated
3		Option K	At grade
4			Grade Separated
5	Option D	Option I	At grade
6			Grade Separated
7		Option K	At grade
8			Grade Separated
9	Option J	Option I	At grade
10			Grade Separated
11		Option K	At grade
12			Grade Separated
13	Option D Alternative	Option I	At grade
14			Grade Separated
15		Option K	At grade
16			Grade Separated

Option D Alternative was agreed as the preferred option for the Redoubt Road / Mill Road alignment. The key advantages this alignment has over the other options are that it can be built with minimum interference to existing traffic and enables Redoubt Road and Mill Road to be retained as local service roads. Connecting Redoubt Road and Mill Road to the new corridor through signalised intersections has the potential to allow for a narrower cross-section through a reduced need to provide property access and the possibility of restricting cyclists to using the local service roads.

This narrower corridor may allow the flush median (because there will be no direct property access) and cycle lanes (potentially provided for on the service road sections of Redoubt Road and Mill Road) to be discarded resulting in significant cost savings to the project.

Option K is the preferred option for the Murphys Road corridor as this enables the new arterial to be built with a minimum of interference to existing traffic. The new location of the arterial route (Option D Alternative) may mean that the gradient of the new Murphys Road may be substantially less than 12%. This will be addresses in the SAR.

This option can be implemented either before or as part of the Stage 3 Flat Bush development.

A signalised **at-grade intersection** is the preferred arrangement at the major intersection of Redoubt Road and Murphys Road. The grade separated scenario would have required a substantial bridge and traffic signals to control the right turn movements into and out of Murphys Road.

20 Resource Management Issues

The project is in a pre-statutory phase and as such no consents are being sought. As work is progressed towards a preferred option the project will need to be considered in more detail against the Resource Management Act (RMA) and any other relevant legislation. The RMA governs the use and development of New Zealand's natural and physical. Any Notice of Requirement and applications for Resource Consent are subject to Part II of the RMA. The purpose of the RMA is to promote the sustainable management of natural and physical resources. Sustainable management is defined in Section 5(2) as:

> *"... managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while:*
> *(a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
> *(a) Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and*
> *(b) Avoiding, remedying, or mitigating any adverse effects of activities on the environment*.

20.1 Historic Places Act 1993

Sections 9 to 21 of the Historic Places Act 1993 (HPA) apply to archaeological sites. All archaeological sites are afforded protection under Sections 9 and 10 of the HPA (whether they are formally recorded and/or registered or not), whereby it is unlawful for any person to modify, damage or destroy the whole or any part of an archaeological site without the prior authority of the Historic Places Trust (the Trust). The project will need to consider any requirements of this Act as it progresses.

20.2 Other Relevant Planning Documents

Section 171 of the RMA requires that regard be given to the relevant provisions of any national policy statement, the New Zealand Coastal Policy Statement, and regional and district planning documents. The following policy statements and plans are relevant to the project:

- Auckland Regional Policy Statement
- Auckland Regional Plan: Sediment Control
- Proposed Auckland Regional Plan: Air, Land and Water
- Manukau District Plan

The following non-statutory documents are also considered relevant:

- Auckland Regional Growth Strategy
- Auckland Regional Land Transport Strategy
- Draft Auckland Regional Land Transport Strategy

- ARTA Regional Arterial Road Plan
- ARTA Passenger Transport Network Plan
- ARTA Auckland Transport Plan
- ARTA Regional Road Safety Plan
- ARTA Sustainable Transport Plan
- ARTA Rail Development Plan

21 Conclusions and Recommendations

A through process of investigation has assessed the feasibility of various options for the Mill Road Corridor. Option evaluation workshops attended by specialists and robust public consultation refined the preferred options to four Redoubt Road / Mill Road alignments, two Murphys Road options and two Murphys Road / Redoubt Road intersection arrangements. Benefit cost ratios for each of these options range between 2.4 and 4.6 indicating the proposed schemes have medium to high economic efficiency.

From these schemes the joint Council and Opus recommended options to proceed to the Scheme Assessment Phase are:

- Option D Alternative be the basis for the main Redoubt Road / Mill Road route,
- Option K be the basis for the new Murphy's Road alignment, and
- Murphys Road / Redoubt Road intersection be at grade.

As Option D Alternative and Option K can be build largely off line and consequently allow Redoubt Road and Mill Road to be retained as local service roads, these options provide the key benefit of being able to be constructed without unduly affecting future traffic flows. The use of Redoubt Road and Mill Road as local service roads with signalised connections to the arterial road will provide residents with safer access to those roads than exists at present.

Opportunities can be created for cyclists to use the service roads rather than the arterial road and as the corridor will have a reduce property access function there is potential for a narrower cross section than initially planned.

22 Appendices

The appendices for this report are included in a separate binder titled “Project Feasibility report – Appendices _ Final Issue”. A separate binder is also provided containing all drawings related to this study.