North Harbour No2 Watermain

Greenhithe Bridge Watermain Duplication and Causeway

Technical Report F – Traffic

10 July 2015

Watercare
An Auckland Council Organisation

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EXECUTIVE SUMMARY

Jacobs has been commissioned by Watercare Services Limited (Watercare) to assess the potential traffic effects related to the construction of Watercare's proposed Greenhithe Bridge Watermain Duplication and Causeway project.

A number of options for construction access and egress as part of the Greenhithe Bridge Watermain Duplication and Causeway project have been suggested for the key elements of construction and the transport effects of these have been explored. In conclusion, the following options have the least adverse effect on the transport environment and are preferred from a transport perspective.

Construction elements 2 and 6: A combination of Option 1 for light vehicles (via Station Street) and Option 3B for heavy vehicles – alternative access from the east

Construction elements 1, 6 and 7: Option 1A – access and egress via the private road off Squadron Drive with construction traffic arriving from the east.

Construction elements 3 and 4: Option 1 – divert the shared path into the eastbound crawler lane.

Construction element 5: Option 3A – access from Tauhinu off-ramp with modifications to the existing traffic island to allow the left turn for larger vehicles. Option 3B has a similar impact on the transport environment and may be a more practical option. If sufficient space is available at the construction site, vehicles can turn around which removes the need to reverse to or from the site.

Although these are the options with the least effect on the transport environment, it is recognised that they may not be the preferred options in terms of constructability or the preferred options of all stakeholders. If they are deemed unacceptable from a constructability or stakeholder perspective, an alternative option should be chosen. The potential effects of the alternative options presented in this report can be managed providing the following key outcomes are achieved:

- Shared path connectivity between Squadron Drive and Tauhinu Road must be maintained for the duration of the project. Any temporary closures necessary for construction should be limited to between the hours of 10 pm and 5 am where possible. Auckland Transport and the New Zealand Transport Agency should be consulted to agree an acceptable temporary closure period.
- The clear through width of any temporary shared path must be at least 2.5 m wide
- The successful contractor must complete detailed TMPs for all necessary stages of work in accordance with CoPTTM as per the normal requirements for proposed works within the road reserve.
- The New Zealand Transport Agency, Auckland Motorway Alliance and Auckland Transport are to be consulted on the contractor's TMP prior to construction beginning.
- A 0.9m safety /deflection zone must be provided between any temporary barrier separating motorway traffic from pedestrians and cyclists. This differs to the requirement in CoPPTM and reflects the current performance of temporary barriers available in Auckland.
- Closure of motorway on and off-ramps should be restricted to after 11 pm and before 6 am where possible
- Two traffic lanes must be operational in both directions on SH18 for the duration of the project. If necessary, one traffic lane in either direction may be temporarily closed between 11 pm and 6 am.
- Where possible construction materials and supplies shall arrive to site from the east via SH18

- A dedicated site staff car park should be provided
- Upon completion of the project the existing transport environment shall be restored to the pre-construction condition

If the above outcomes are achieved, the overall effect of the Greenhithe Bridge Watermain Duplication and Causeway Project is considered to have a less than minor effect on the transport environment.

1 INTRODUCTION

Jacobs has been commissioned by Watercare Services Limited (Watercare) to assess the potential transport effects related to the construction of Watercare's proposed Greenhithe Bridge Watermain Duplication (GBWD) and Causeway project.

The proposed GBWD and Causeway project requires various resource consents under the Resource Management Act 1991 ("RMA"). This technical report provides specialist input for the GBWD and Causeway – Assessment of Effects on the Environment report ("the main AEE") report prepared by URS New Zealand and Jacobs New Zealand Limited which supports the resource consent application.

The works described in section 2 and the drawing set provided in Volume 3 of the AEE have been considered in the technical assessment presented in this report.

In summary, the GBWD and Causeway project involves duplication of a section of the existing NH1 watermain, construction of a section of the Northern Interceptor (NI) wastewater project, and widening of the State Highway 18 (SH18) Causeway in order to accommodate these pipelines.

NH1 is located within the southern side of the Greenhithe Bridge. Duplicating this section of the watermain will enable the existing NH1 within the bridge to be shut down for essential maintenance work whilst maintaining water supply to the North Shore. The proposed new watermain will be attached under the north side of the Greenhithe Bridge.

NI is a new wastewater project that will convey wastewater from north-western parts of Auckland to the Rosedale Wastewarer Treatment Plan (WWTP) in Albany. A section of the NI pipeline route, to the west of the Greenhithe Bridge, shares a common corridor with the proposed new watermain. Consequently, Watercare proposes to integrate the development of these projects in this locality.

In order to provide the necessary space for the GBWD and NI projects to the west of the Greenhithe Bridge, Watercare proposes to widen and extend the existing SH18 Causeway.

All dimensions, areas and volumes provided in this report are approximate and it is possible that some details may change as the design and construction methods are finalised.

2 TRANSPORT ASSESSMENT SCOPE

This transport assessment focusses on the construction traffic effects of the project on the existing transport environment. It is assumed that upon completion of the project that the transport environment will be restored to the pre-construction condition i.e. there will be no lasting effect on the transport environment post construction and the effect of maintenance operations will be less than minor.

As outlined in section 2 of the AEE, the proposed construction has seven key elements, described below and shown in Figure 1:

1) Causeway widening and extension and installation of new pipes within the causeway;
2) Connection pipe between NH1 and the new watermain – west end;
3) New watermain connection to the Greenhithe Bridge; and
4) Watermain transition structure at the west end of the Greenhithe Bridge;
5) Valve chamber and connection between NH1 and the new watermain – east end;
6) West end valve chambers; and
7) Scour chamber

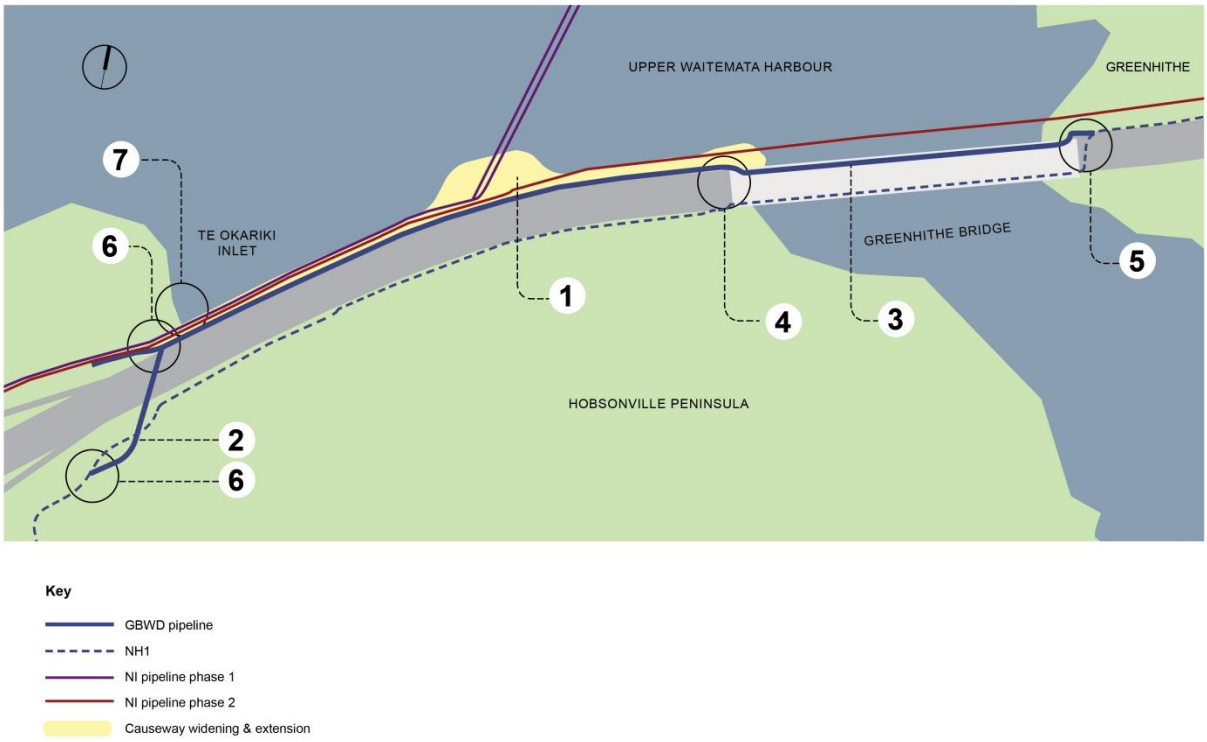


Figure 1 Key elements of construction

This transport assessment has considered a number of access and egress options to allow the construction of the above key elements. These are discussed in:

- Section 4 – construction elements 2 and 6
- Section 5 – construction elements 1, 6 and 7
- Section 6 – construction elements 3 and 4
- Section 7 – construction element 5

These elements have been grouped together as such because they are located in a similar geographical area and will have similar options for access and egress. For each of the options, the effect of the proposed construction works on the various transport system users has been assessed.

Transport system users are defined as pedestrians, cyclists and general vehicles (light and heavy vehicles not associated with the proposed construction works) using the publicly accessible road reserve. Any movement of construction vehicles outside of the publicly accessible road reserve will not affect the transport system users and therefore has not been considered as part of this assessment of effects.

It will be the responsibility of the successful contractor to adopt a construction methodology and staging which allows the outcomes presented in this report to be achieved. To do so is likely to require the contractor to develop a logistics plan for construction vehicle movements on the construction site.

The options presented have been considered at a high level based on the available information; these options may change as further information becomes available. It will be the responsibility of the successful contractor to prepare detailed Traffic Management Plans (TMPs) prior to construction which outline construction access and egress to site. The TMPs shall be in accordance with the New Zealand Transport Agency's Code of Practice for Temporary Traffic Management (CoPTTM).

The following sections of this report provide:

- A description of the existing transport environment
- An assessment of the actual or potential effects on general traffic, pedestrians and cyclists due to the construction works outlined in section 2 of the AEE. This includes the identification of activities that could result in adverse effects and, in turn, identifying design refinements or construction methodologies that could avoid, remedy or mitigate such effects
- Recommended mitigation and management measures

3 EXISTING TRANSPORT ENVIRONMENT

The proposed works will be undertaken adjacent to SH18 (Upper Harbour Motorway) between Squadron Drive and Tauhinu Road. This section of state highway is the main motorway connection between West Auckland and the North Shore and has a speed limit of 100 kph. Currently there is a shared path alongside the motorway on the northern side which connects the shared path on Squadron Drive with Tauhinu Road via the Greenhithe Bridge. The location of the project and the local road network are shown in Figure 2.

The Squadron Drive eastbound on-ramp and westbound off-ramp provide motorway access for the existing and proposed development in Hobsonville Point. The Tauhinu Road eastbound off-ramp and westbound on-ramp provides motorway access for southern Greenhithe.

There is an over-dimension route along Upper Harbour Drive which would require the use of Tauhinu Road off-ramp. However NZTA's current over-dimension vehicle route maps are dated 2004 before the opening of SH18 connecting to Albany Highway. Most over-dimension vehicles are likely to use the new motorway rather than choose to exit at Tauhinu Road.

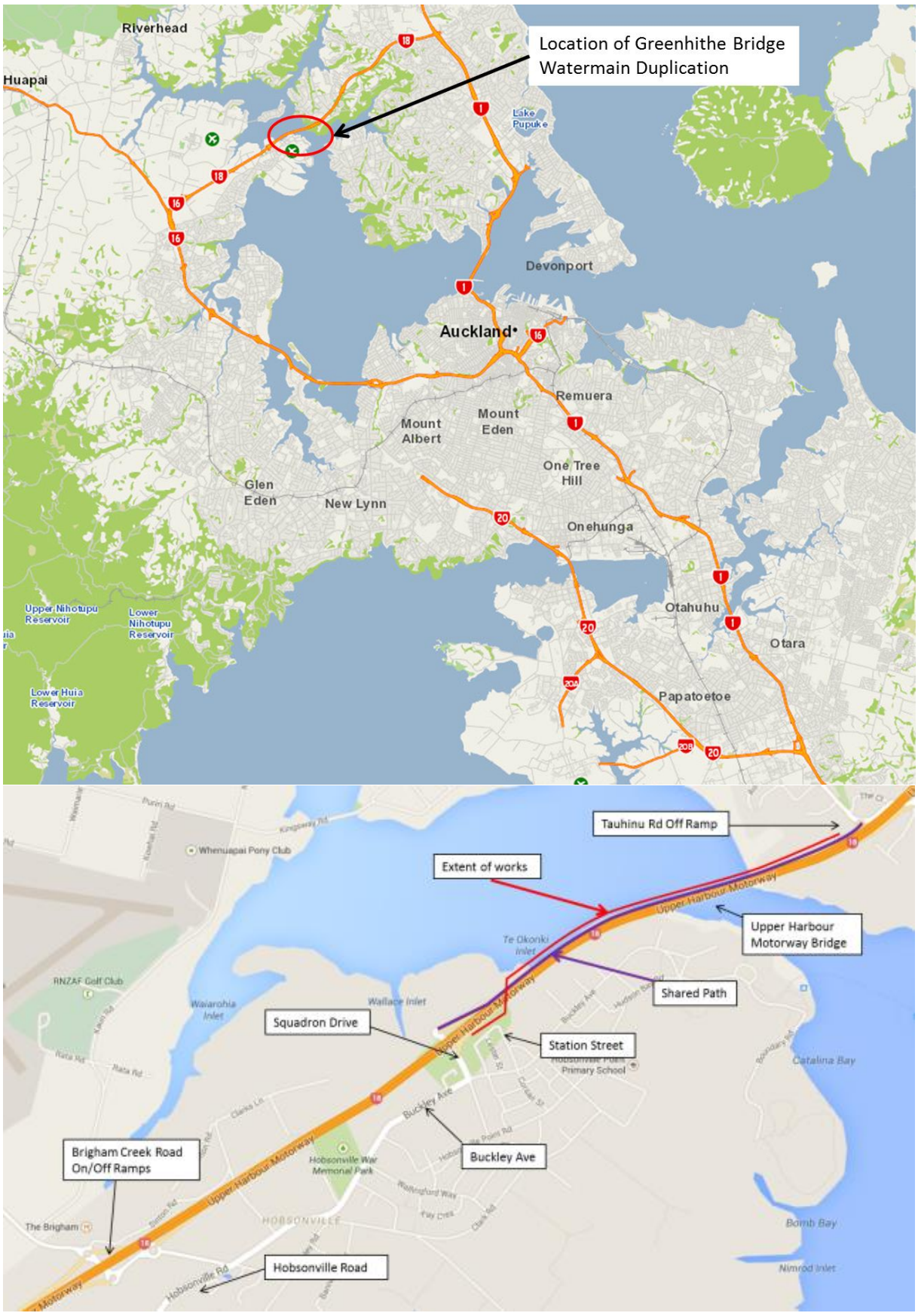


Figure 2 Project Location

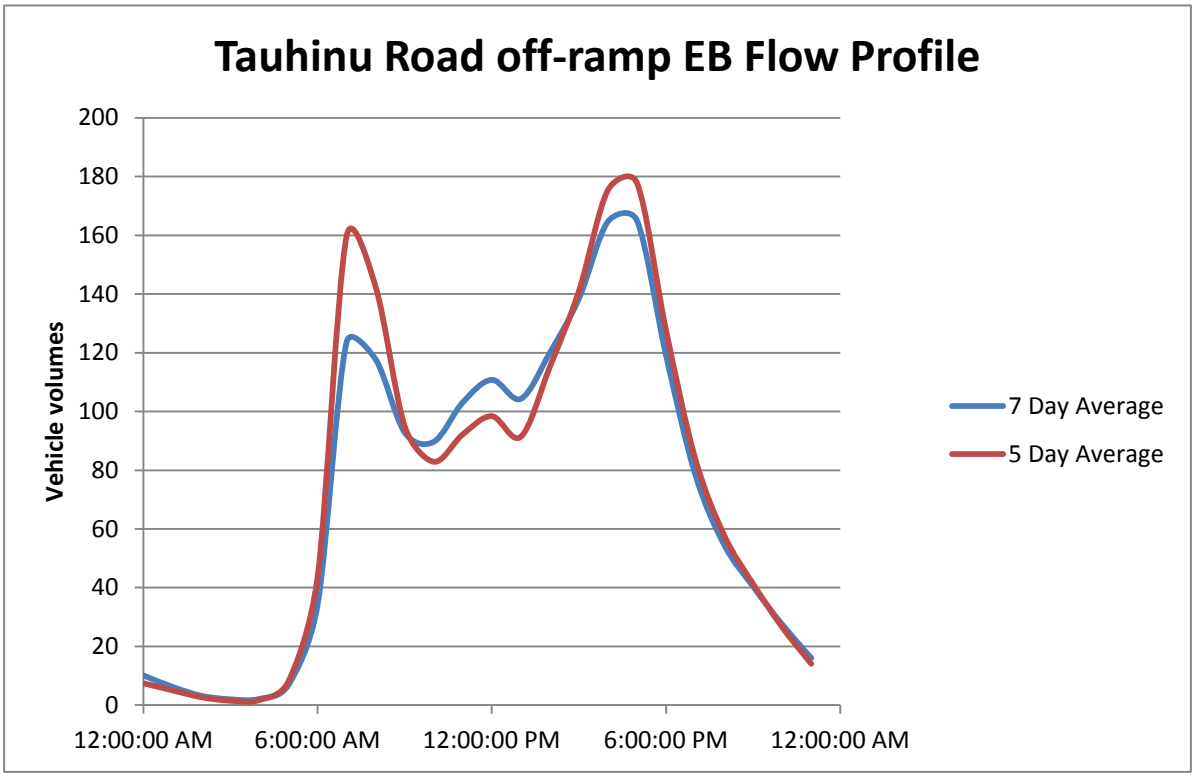
In an eastbound direction SH18 has two lanes between the Squadron Drive on-ramp and the Greenhithe Bridge. At the western bridge abutment an eastbound crawler lane is provided to cater for heavy vehicles and slow vehicles travelling up the steep gradient on the bridge. The three lanes on the bridge continue past the Tauhinu Road off-ramp. In the westbound direction SH18 has two lanes between Tauhinu Road on-ramp and Squadron Drive off-ramp.

The 2013 Annual Average Daily Traffic (AADT) volumes on this section of SH18 and the on and off-ramps are shown in Table 1.

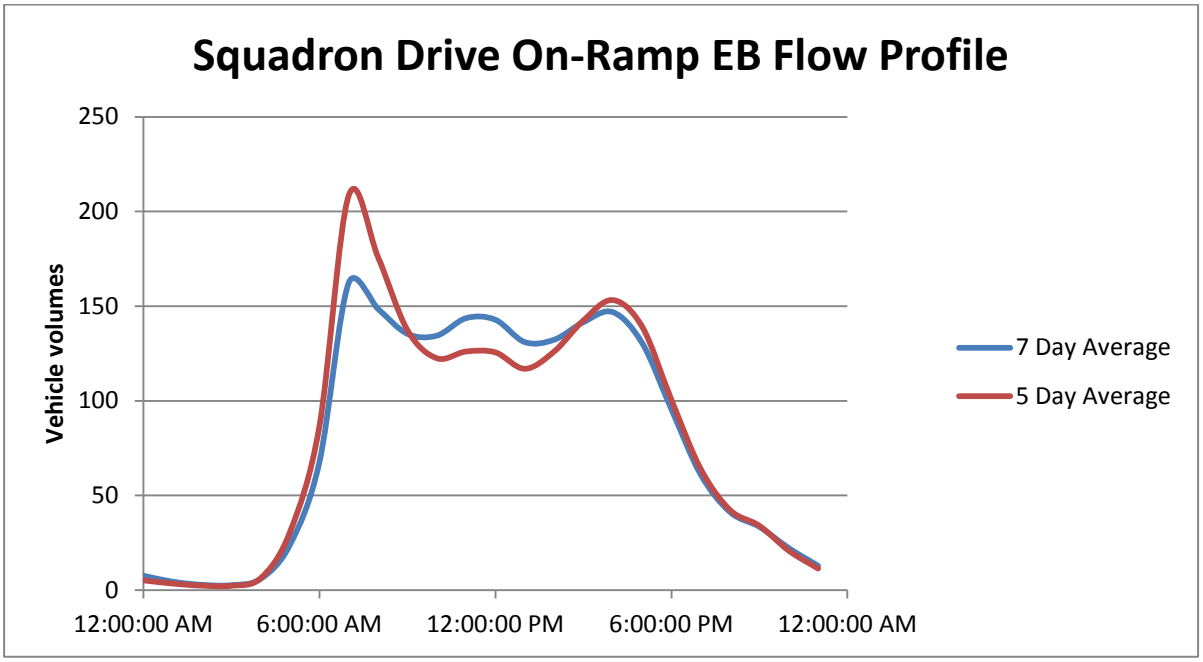
Table 1: 2013 AADT

Location	AADT	% Heavy Commercial Vehicles (HCVs)
SH18 Squadron Dr On-Ramp Eastbound (EB)	1,900	3.5
SH18 Upper Harbour Bridge EB	17,800	3.5
SH18 Tauhinu Rd Off-Ramp EB	1,600	3.6
SH18 Squadron Dr Off-Ramp Westbound (WB)	1,900	2.9

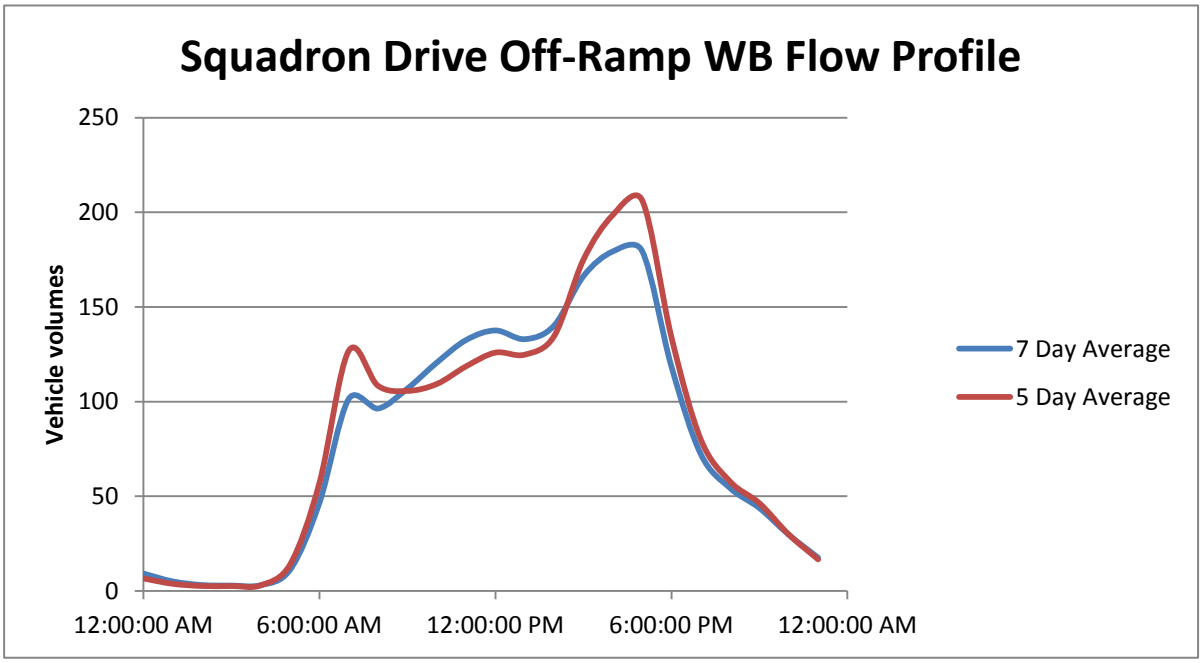
The 2013 daily flow profiles for each of these locations are shown in the graphs below. A five day (weekday) average and a seven day average are shown.



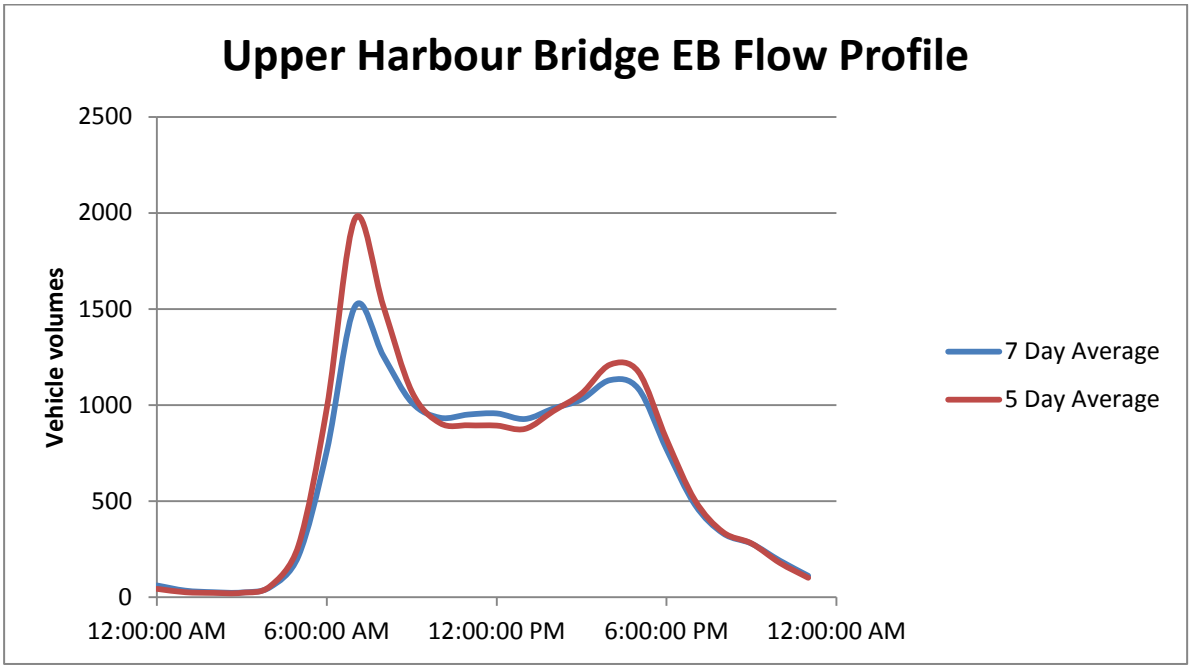
The Tauhinu Road off-ramp has five day average AM and PM peaks of approximately 160 and 180 vehicles per hour respectively.



The Squadron Drive on-ramp has five day average AM and PM peaks of approximately 210 and 150 vehicles per hour respectively.



The Squadron Drive off-ramp has five day average AM and PM peaks of approximately 130 and 210 vehicles per hour respectively.



The Upper Harbour Bridge has five day average AM and PM peaks of approximately 2,000 and 1,200 vehicles per hour respectively. The eastbound traffic volumes vary across the day. The traffic volumes during a number of different off-peak periods are outlined in Table 2.

Table 2 Upper Harbour Bridge2013 five day average traffic volumes by period

Period	General vehicles during period
24 hour	15,100
9 am – 4 pm and 6pm – 7 am (hours outside peak periods)	10,300
8 pm – 6 am	1,300
11 pm – 6 am	550
10 pm – 5 am	450
12:00 am – 5:00 am	170

The 5 day Average Daily Traffic volumes (ADTs) on the surrounding local network are shown in Table 3.

Table 3: Local Road 5 day ADTs

Location	ADT	AM peak	PM peak	Direction	Year
Buckley Ave (west of Squadron Drive)	950	160	80	Eastbound	2011
Buckley Ave (west of Squadron Drive)	930	120	140	Westbound	2011

Hobsonville Road (west of Brigham Creek Road)	7,000	830	780	Both	2014
Tauhinu Road (near The Close)	3,400	340	330	Both	2012

4 CONSTRUCTION OF ELEMENTS 2 AND 6

The 192m pipe connecting the new watermain to NH1 at the western end of the causeway will be pipe-jacked under SH18 between temporary jacking and receiving pits. The jacking and receiving pits will be located north and south of SH18, within the widened causeway and adjacent to Station St respectively (locations shown on Drawing 2010674.005 in **Volume 3**).

To access the western end of the project, construction vehicles coming from the west would exit SH18 at the Brigham Creek off-ramp and use Hobsonville Road and Buckley Ave. Construction vehicles coming from the east would exit SH18 at Squadron Drive.

Options for access to and egress from the receiving pit construction area (adjacent to Station Street on the southern side of SH18) are illustrated in Figure 3 and include:

- **Option 1 – access and egress via Station Road from either east or west –** the existing wastewater pump station access off Station Street could be widened to provide access to the construction site. This could provide a permanent access solution for future operational and maintenance requirements. Station Street is a local road with a carriageway width in the order of 5 m. It currently provides access to the newly developed residential area near the Squadron Drive off-ramp.
- **Option 2 – alternative access and egress from the west –** construction vehicles could use the Squadron Drive roundabout to turn around and drive straight across the off-ramp from the right turn lane on Squadron Drive (see Figure 3). Currently there is a lighting pole that would need to be relocated for this option. Egress could be via the same path with construction vehicles turning left onto Squadron Drive. There may not be sufficient sight distance available for this manoeuvre to be undertaken safely so closure of one off ramp lane may be required.
- **Option 3 – alternative access and egress from the east –** construction vehicles would exit SH18 at Squadron Drive and either:
    - **Option 3A** – Diverge from the motorway off-ramp onto the shoulder and turn left once off the shoulder. The topography of the batter adjacent to the off-ramp and the available space for turning manoeuvres may require some earthworks. Egress would be via Station Street or left onto Squadron Drive
    - **Option 3B** – Use Squadron Drive roundabout to turn around as per Option 2. Egress would be via Station Street or left onto Squadron Drive
- **Option 4 – access from the east prior to Squadron Drive off-ramp –** construction vehicles would diverge from the traffic lane into the shoulder prior to the off-ramp, decelerate in the shoulder and then pull off the motorway into the berm. Temporary barriers and a crash cushion would need to be installed and the existing steel barrier removed. As for option 3 some earthworks to the existing batter may be required.

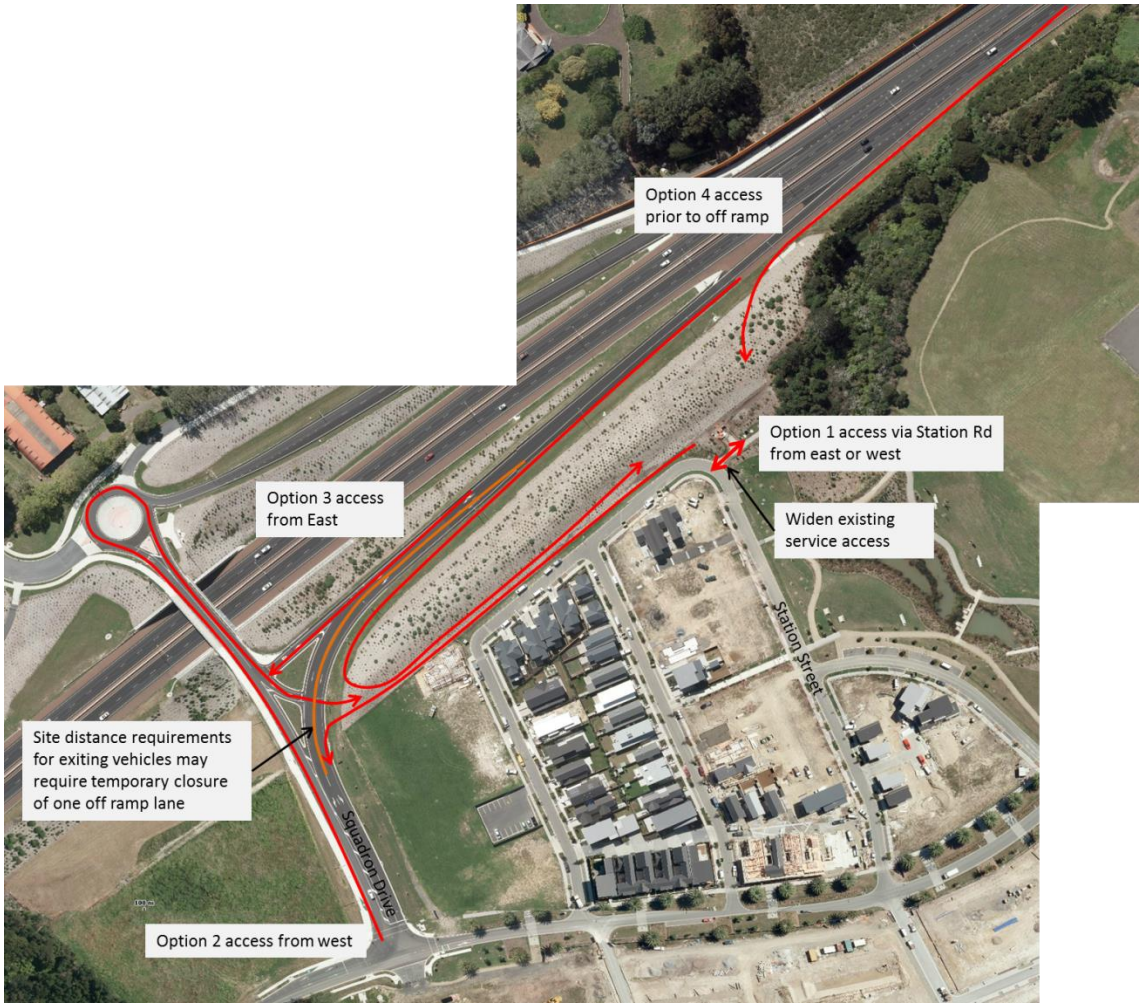


Figure 3 Access to receiving pit

4.1 Construction traffic volumes

The construction of the connection pipe between NH1 and the new watermain – west end and west end valve chambers is estimated to take in the order of 10 months. The traffic associated with the construction of the receiving pit will potentially include the following:

- Daily trips made by site staff
- Daily deliveries of supplies
- One-off deliveries of heavy machinery
- Trucks removing spoil
- Trucks delivering pipes
- Occasional visitor trips

Staff working on the project are likely to drive to site. This may have an adverse effect on the local street network if staff occupy the on street parking intended to serve the residential development. To mitigate the effect of this, a site staff car park should be provided. The location of this car park is subject to further investigation

The daily volume of construction traffic accessing the receiving pit may be in the order of 25 vehicles per day. In the absence of any other information, this has been based on the assumptions presented in Appendix A and discussions with a contractor have suggested that this volume is a conservative

value. This volume is not considered to be of a significant quantum and will have a less than minor effect on the operation of SH18 and the local road network providing that staff car parking arrangements are managed.

4.2 Assessment of effects

Pedestrians and cyclists

None of the four options require alterations to the existing walking and cycling facilities within the project area. The effect of the additional construction traffic on pedestrians crossing the local roads and cyclists travelling on the local roads is considered to be no more than minor.

General vehicles

The carriageways of Station Street and Buckley Ave are narrow (in the order of 5 and 6 m respectively) which may cause conflict between heavy construction vehicles and general traffic in Option 1. The maximum width of a standard-size vehicle permitted on New Zealand roads is 2.5 m excluding collapsible mirrors that may extend to a maximum of 240mm beyond the side of the vehicle. Typical passenger vehicles are in the order of 2 m wide.

In the instance where a passenger vehicle and a heavy vehicle meet, the vehicles would slow and pass each other with limited clearance between them and limited clearance to vehicles parked on-street. If a vehicle is partially parked in the carriageway this will cause a short section of the street to operate as an informal one-way section with one vehicle giving way to the other (informal courtesy give way). A similar scenario occurs often on many local roads in Auckland with vehicles parked on street. Buckley Ave and Station Street are local roads which provide access to the residential development in Hobsonville Point. Both the traffic volumes and speeds on these roads are low and neither is marked with a centreline so this is considered to be no more than a minor effect.

Two heavy vehicles are unlikely to be able to pass each other on Station Street therefore construction vehicles should operate one way on Station Street. It is likely that heavy vehicles will need to turn into Station Street from the opposing side of the carriageway on Buckley Ave to avoid mounting the kerb. This is considered to be a no more than minor effect, as the intersection will operate in an informal courtesy give way manner as discussed above.

Option 2 and 3B will avoid using the narrow local roads however will require construction vehicles to cross the Squadron Drive off-ramp as shown in Figure 3. This is considered to have a less than minor safety impact due to the low volume of general vehicles using the off-ramp, the length and uphill gradient of the off-ramp and the fact that vehicles currently turn right and merge with vehicles on the off-ramp. Construction vehicles will be required to give way to vehicles coming off the motorway therefore delay to general vehicles will be minimal.

If either Option 2 or Option 3B is chosen, a minimum of 20 m should be provided on the other side of the off-ramp such that a truck and trailer can stop without blocking the off-ramp. To allow for the left turn egress onto Squadron Drive to be made safely, stopping sight distance must be provided. If sufficient sight distance is not available, temporary closure of one off ramp lane may be required. The volume of vehicles using the off ramp is low therefore closure of one off ramp lane is considered to be a less than minor effect.

Options 3A and 4 avoid the need for construction vehicles to cross the Squadron Drive off-ramp. In Option 4, construction vehicles will have to diverge from the motorway prior to the off-ramp. To minimise the safety risk, a higher level of Temporary Traffic Management will be required which would

include elements such as a temporary speed limit, temporary barriers and crash cushions. A controlled gate system into the site may also be required to ensure that general vehicles cannot access the site. The effect of Option 3A on the operation and safety of general vehicles is considered to be less than minor. The effect of Option 4 is considered to be marginally greater than Option 3A but still less than minor.

A combination of the above options is also possible. For example, the regular traffic movements of smaller vehicles could access and egress the site via Station Street and the one-off large deliveries could access and egress via Squadron Drive. This would remove the need for large vehicles to use Station Street.

5 CONSTRUCTION ELEMENTS 1, 6 AND 7

The existing causeway will be widened and extended as described in section 2 of the AEE. Drawings 2010673.852 – 855 (**Volume 3**), show typical cross-sections for the causeway widening and extension. Valve chambers will be constructed within the jacking and receiving pits to house the connections to NH1 and the new watermain. The NH1/new watermain scour chamber will be installed along-side the valve chamber to the north of SH18 (refer drawing 2010673.008).

Options for construction access and egress to and from the construction area to the north of SH18 at the west end are shown diagrammatically in Figure 4 and include:

- **Option 1 –** access via the private road off Squadron Drive
  - Option 1A access/egress around trees and the existing stormwater sand filter via private driveway and a temporary construction access road as shown on drawing 2010673.008. This option may require the use of private land and the topography of this land may require earthworks to enable construction vehicle access.
  - Option 1B egress via the motorway
- **Option 2 –** access via the motorway and egress via private road and temporary construction access road (refer drawing 2010673.008)
- **Option 3A, 3B and 3C –** access and egress via motorway

Typically trucks with a drawbar trailer which are in the order of 19 – 20 metres long are used for the transport of construction fill. These vehicles have a similar swept path as an 18 m four-axle semi-trailer. These vehicles require a wall-to-wall turning width in the order of 25 m to turn 180° through a 12.5 m radius on road. As the construction of the causeway will occur off-road, where construction vehicles will be travelling at low speeds, the necessary manoeuvres will be able to be carried out with a tighter steering lock and a reduced swept path.

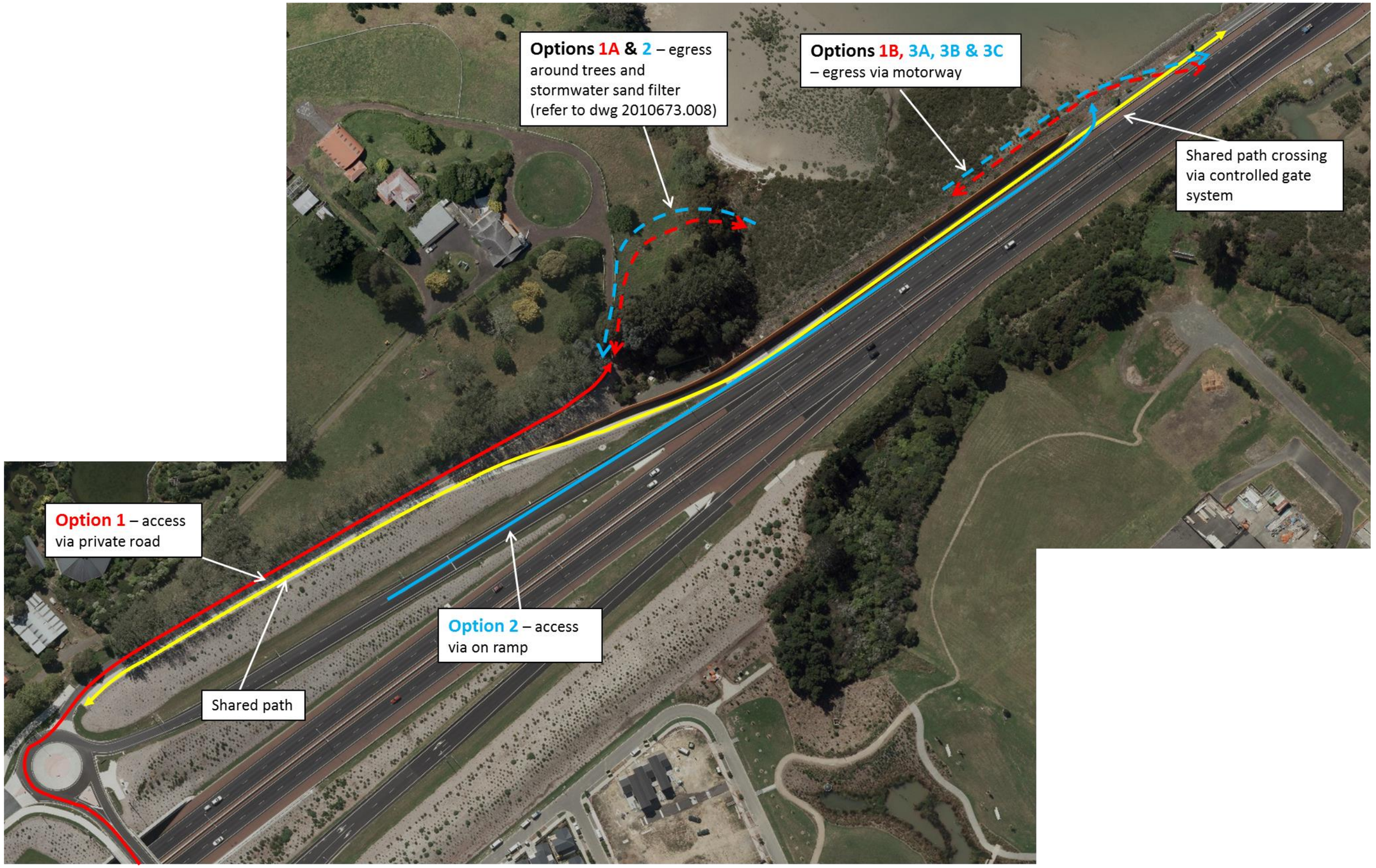


Figure 4 Construction elements 1, 6 and 7 jacking pit and causeway construction access options

The proposed construction methodology for the causeway extension is outlined in section 2 of the AEE. It is likely that this methodology will require the use of the existing shared path in order to operate excavators and trucks. Watercare has made it a priority that cycle and pedestrian connectivity across the bridge must be maintained. Therefore it is proposed to divert the shared path onto the motorway shoulder and install a temporary barrier (concrete or steel) to separate pedestrians and cyclists from motorway traffic.

In order to further maximise space adjacent to SH18 for construction vehicles and equipment to construct the causeway, it may be necessary to narrow the existing traffic lanes on SH18 and implement a temporary speed limit of 80 kph. This will require appropriate level 3 Temporary Traffic Management in accordance with CoPTTM.

The existing typical cross section of the road / causeway (for the eastbound carriageway) is illustrated in Figure 5. A potential cross section which maximises space for construction vehicles and equipment, without closing a traffic lane or the shared path, is shown in Figure 6. This provides a maximum of approximately 4.7 metres of space for construction vehicles and equipment.

It will not be possible for a truck to turn 180° within a width of 4.7 m therefore (without constructing a turning platform or part of the causeway) construction vehicles will need to operate one-way along the length of causeway adjacent to SH18. Potential options for access and egress to and from the motorway under such a system are outlined below in section 5.1. As discussed above, access and egress could also be from the private road off Squadron Drive.

As outlined in section 2 of the AEE, the proposed construction methodology will be finalised once a contractor has been appointed. At that time, a detailed Construction Management Plan (CMP) will be prepared which confirms the detail of the proposed works and management controls. When preparing the CMP, the contractor will need to be aware that the maximum space available for construction vehicles and equipment, without closing a traffic lane or the shared path, is 4.7 m. The construction methodology adopted by the contractor will need to allow for this accordingly.

The effects associated with completely closing a traffic lane and/or the shared path for the duration of the project are likely to be significant; therefore this has not been considered an option. However if required, one traffic lane could be closed between 11 pm and 6 am with a less than minor effect due to the low volume of traffic during this period (550 vehicles).

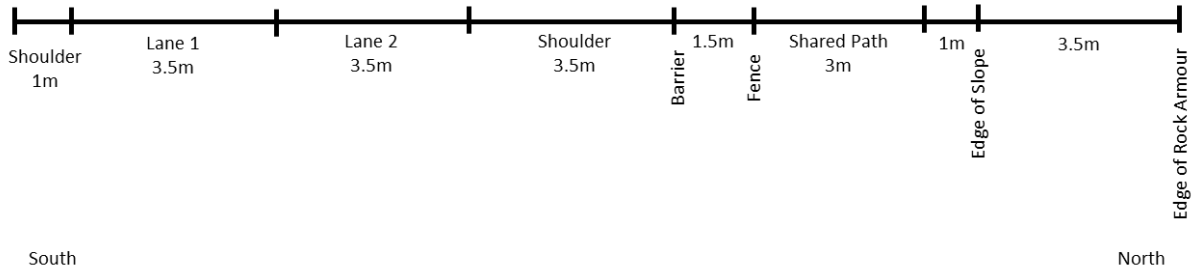


Figure 5 Existing cross section looking west (widths are approximate)

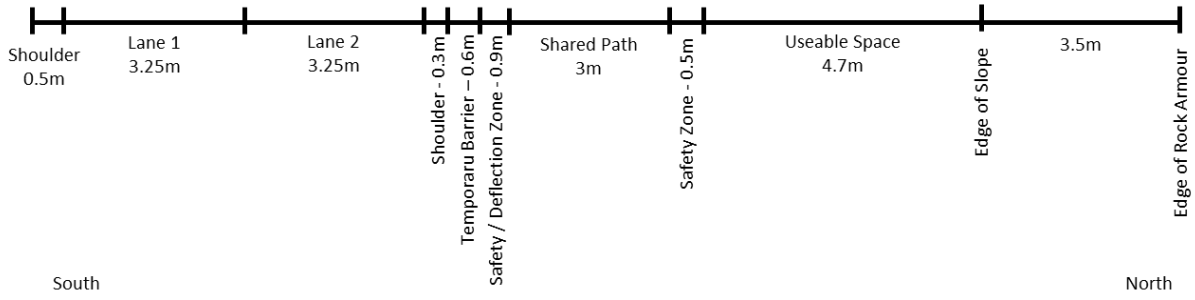


Figure 6 Potential cross section (widths are approximate)

The lane and shoulder widths shown in the cross section in Figure 6 have been taken from CoPTTM with the following exceptions:

- 0.5 m shoulder to the median barrier to allow for existing catchpits
- 0.9m safety /deflection zone to reflect the current performance of temporary barriers available in Auckland. Consideration should be given to increasing the width of safety zone as this section of SH18 is known for excessive speeding.

If the widths of the lanes, shoulders or safety zones are narrowed this will have an effect on safety of general vehicles, pedestrians and cyclists. The width of the shared path could be narrowed to a minimum of 2.5 m but a width below this is likely to have an adverse effect on the level of service for pedestrians and cyclists.

Options 1B, 2 and 3 all require construction vehicles to cross the shared path at least once which creates a potential safety issue for pedestrians and cyclists. As discussed below in section 5.3, a controlled gate system could be used to provide a safe crossing.

5.1 Access and egress via the motorway

The sub options for Option 3 – egress via the motorway are discussed below and shown in Figure 7 and Figure 8:

- **Option 3A –** exiting at the eastern end of the causeway directly into the crawler lane as shown in Figure 7. This would require crossing the shared path again using a controlled gate system as discussed in section 5.3. At the western end of the bridge the shoulder disappears and the crawler lane develops which means the temporary shared path in the crawler lane (west of the bridge) will need to be diverted back onto the existing shared path on the outside of the bridge.
- **Option 3B –** entering and exiting at the same point via a controlled gate system as discussed in section 5.3. Construction vehicles would exit into an acceleration lane (the existing shoulder with a temporary barrier) and then merge with general traffic prior to the bridge or alternatively the acceleration lane could join the crawler lane. If the shoulder is used as an acceleration lane then pedestrians/cyclists must use the existing shared path. This is shown in Figure 8.

  The length available for an acceleration lane is approximately 500 m before the start of the crawler lane. Austroads guidance suggests that the length of acceleration lane should be sufficient to allow the accelerating vehicle to accelerate to a speed no less than 20 kph below the mean free speed. The Austroads guidance states that a 42.5 tonne (fully laden) semi-trailer requires 320 m to accelerate to 60 kph and 550 m to accelerate to 70 kph on a 0% grade. It is

likely that truck and trailer units will be used to deposit fill for the causeway and that these will be empty when leaving the site therefore it is likely that they will be able to accelerate at a greater rate than a fully laden semi-trailer. Figure 8 shows an acceleration lane of 400 m.

- **Option 3C –** exiting under an attenuator (a safety appliance mounted on the rear of a vehicle that dissipates the energy of a rear-end collision caused by a following vehicle, by collapsing when impacted by that vehicle). Instead of providing an acceleration lane, an attenuator could be used to create a gap for trucks to pull into the general traffic stream. This arrangement is currently being used on the SH16 Causeway project and would allow the temporary diversion of the shared path into the existing shoulder.

  At the western end of the bridge where the shoulder disappears and crawler lane develops, the shared path will need to either rejoin the existing shared path on the bridge or continue onto the crawler lane.

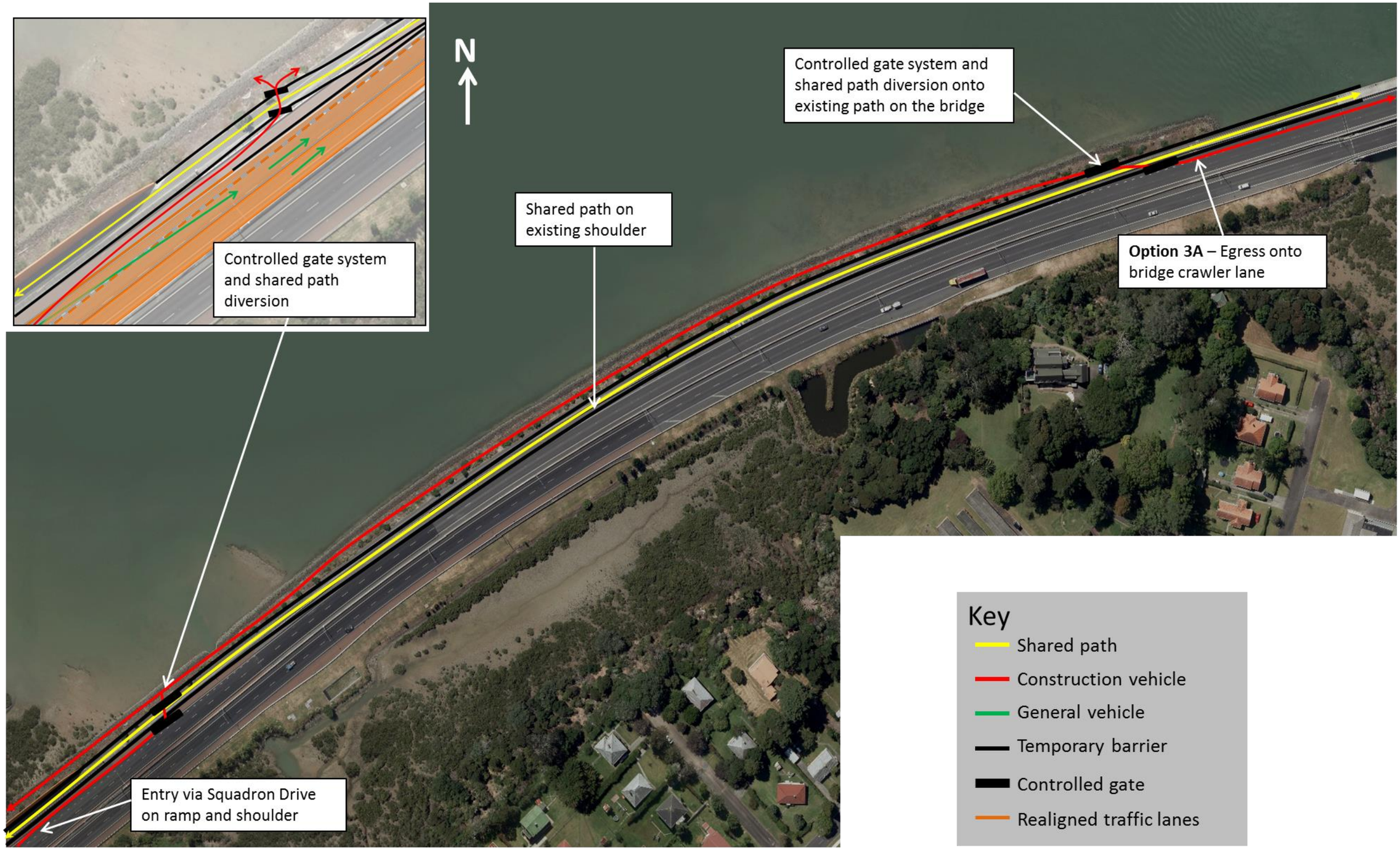


Figure 7 Construction elements 1, 6 and 7 access option 3A - egress onto bridge crawler lane

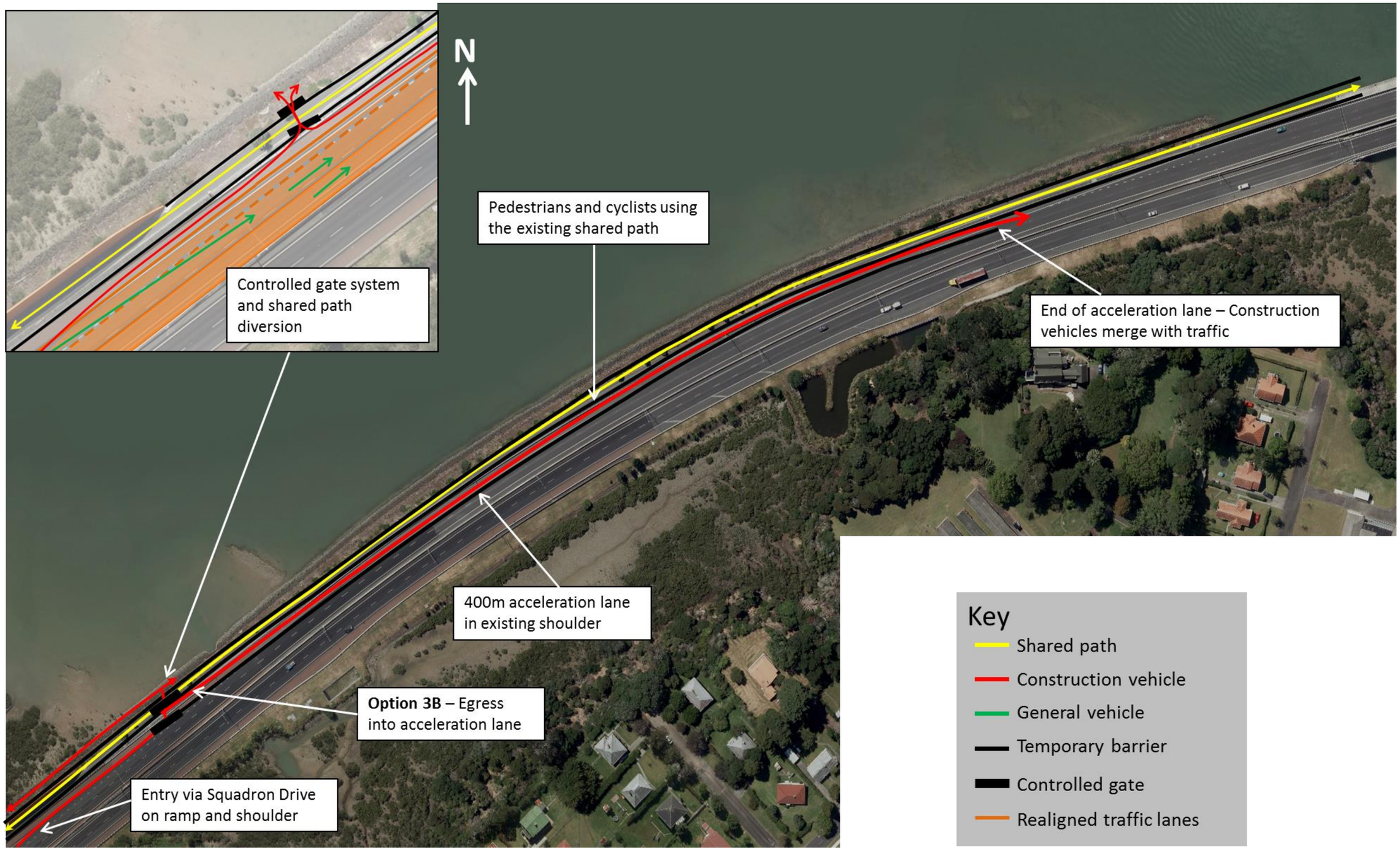


Figure 8 Construction elements 1, 6 and 7 access option 3B - egress into acceleration lane

5.2 Construction traffic volumes

A significant volume of construction traffic will be generated as a result of the significant volume of fill required to create the causeway. The initial estimate fill volume is approximately 96,500 m^3.

This equates to between 30 truck movements a day (assuming all trucks with trailers) and 70 truck movements a day (assuming all trucks without trailers) over a 250 day (12.5 month) construction period. The capacity of the truck and trailer units has been assumed as 14 m^3 (6 m^3 in the truck and 8 m^3 in the trailer). Assuming an 8 hour working day, this equates to a maximum of approximately 1 truck every 7 minutes (or 9 trucks per hour).

In addition to the above construction traffic, and similar to construction elements 2 and 6, the following traffic will be generated:

- Daily trips made by site staff
- Daily deliveries of supplies other than fill material
- One-off deliveries of heavy machinery
- Trucks delivering pipes
- Occasional visitor trips

The daily volume associated with this activity is likely to be in the order of 50 vehicles per day. In the absence of any other information, this has been based on the assumptions presented in Appendix A and discussions with a contractor have suggested that this volume is a conservative value. This volume is not considered to be of a significant quantum and will have a less than minor effect on the operation of SH18 and the local road network, providing that staff car parking arrangements are managed.

5.3 Assessment of effects

Pedestrians and cyclists

Options 1 to 3 maintain a 3 m wide shared path which is consistent with the width of the existing shared path. As discussed above, the shared path width could be reduced to a minimum of 2.5 m however a width below this is likely to have an adverse effect on the level of service for pedestrians and cyclists. Any diversion onto the motorway shoulder will require an appropriate barrier and safety/deflection zone to safely separate motorway traffic from shared path users.

Options 1B, 2 and 3 all require construction vehicles to cross the shared path at least once which creates a potential safety issue for pedestrians and cyclists. Option 3A and potentially 3C require two crossing points. In Option 1A there is also potential conflict between construction vehicles and shared path users however this is an existing crossing point on the Private Road where the shared path begins so is not considered to be a significant or new safety issue.

If one of these options is chosen, a controlled gate system should be implemented to ensure that conflict between construction vehicles and pedestrians and cyclists is avoided. A similar operation is currently being used on the SH16 Causeway project. This concept is illustrated in Figure 9.

As shown in Figure 9, construction vehicles would pull into the shoulder, decelerate behind a temporary barrier and come to a stop in front of a gate. A traffic controller would open the gate, blocking the shared path as a construction vehicle crossed it. The gate would then be reopened for pedestrians and cyclists. This operation would isolate the hazard however may result in some delay

for the shared path users. The maximum delay that could be expected is likely to be in the order of 20 – 40 seconds however the average delay would be less than this. The average delay could be reduced by timing the opening of the gate to be when no pedestrians or cyclists are approaching.

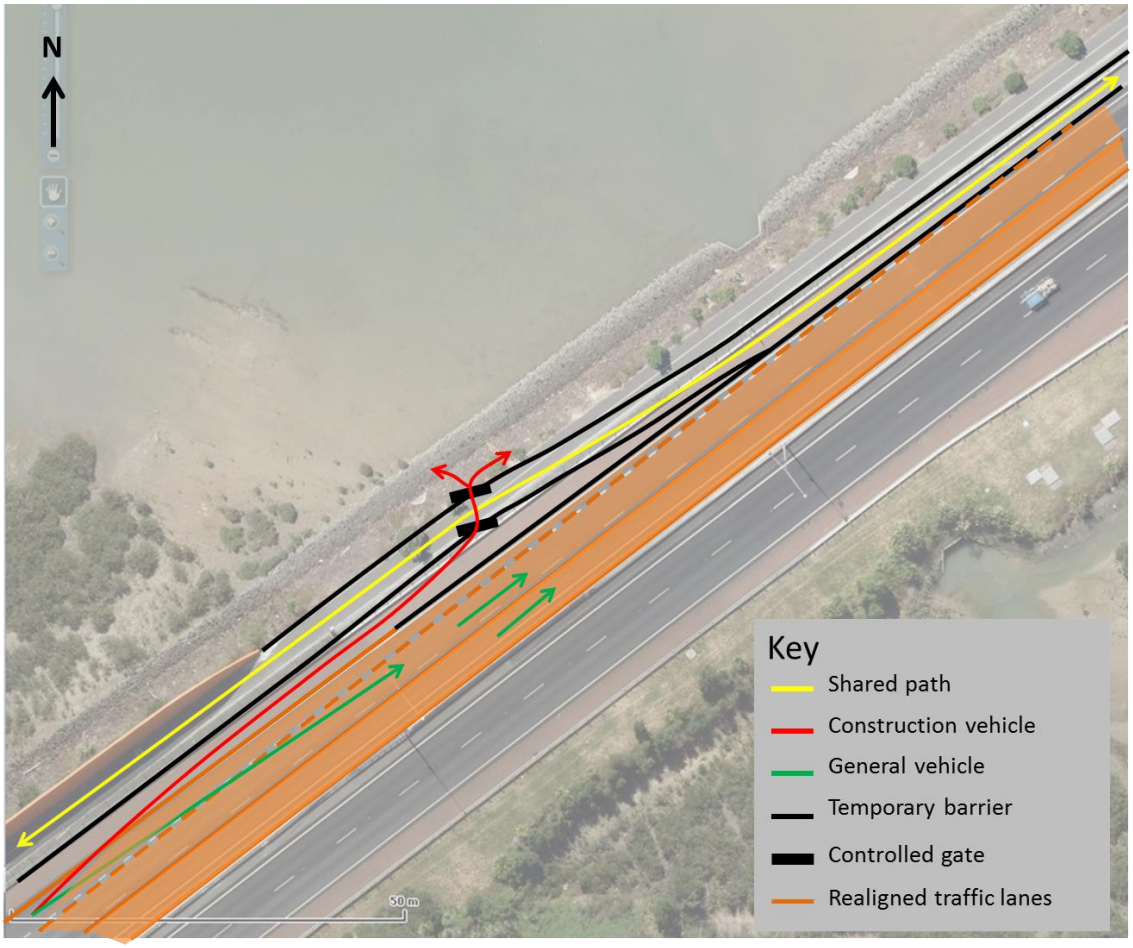


Figure 9 Shared path controlled gate crossing

In Option 3A and 3C the additional crossing point is at the bridge abutment where the gradient of the path steepens in an easterly direction. If a crossing is provided at this point, extra precaution is required as cyclists travelling downhill may be travelling at speeds of up to 60 kph. Additional measures could include “cyclist slow”, and “trucks crossing” signage and ensuring the traffic controller understands the risk of high speed cyclists when opening the gate.

General vehicles

Options 1A will have the least effect on general vehicles as construction vehicles would not use SH18 for access or egress, therefore no TTM would be required on SH18. There would be a minor increase in traffic on the local road network. On Hobsonville Road / Buckley Ave the additional construction traffic is in the order of 5% of the existing traffic in each direction assuming that construction material comes from the west. This increase is considered to have a less than minor effect on the local road network. For this reason Option 1A is considered the preferred option from a traffic perspective.

Options 1B, 2, 3A, 3B, and 3C will all require appropriate TTM including the implementation of a temporary speed limit and narrowing traffic lanes on SH18. This is considered to be a no more than minor adverse effect on general vehicles due to the marginal increase in travel time due to the lower speed along the 3 km stretch between Squadron Drive and Tauhinu Road. The adverse effect of Option 3C is likely to be marginally greater than that of the other four options as some vehicles

travelling in the left lane on SH18 will be required to slow down to less than 80 kph when an attenuator is present. The SH16 Causeway project is currently successfully using attenuators to allow construction vehicles to safely exit onto SH16 with a reduced, 80 kph speed limit. If Option 3B is chosen, it is important that sufficient length of acceleration lane is provided such that construction vehicles can achieve a speed of at least 60 kph, preferably 70 or 80 kph, before merging with traffic. If this is not achieved, there is likely to be a significant safety issue on SH18. If a shorter acceleration lane is provided, a lower temporary speed limit on SH18 may be required to ensure the speed differential is reduced. However this would have a minor adverse effect on general vehicles due to the marginal increase in travel time with the lower speed limit in place.

6 CONSTRUCTION ELEMENTS 3 AND 4

Construction element 3 – a reinforced concrete transition structure will be formed on the causeway beneath the western end of the bridge to support the transition of the new watermain from the causeway to the bridge.

Construction element 4 – the new watermain will be attached to the Greenhithe Bridge from the bridge itself (i.e. no access is required from the harbour). Two options are being considered for constructing the pipe on the bridge; these are described in section 2 of the AEE and will be confirmed by the contractor:

1) Launching the pipe from the eastern end of the bridge. This will require closure of the existing shared path while the pipe brackets are installed using a mobile under-bridge access unit (see section 2 of the AEE). Once the brackets are installed, the pipe will be launched onto the brackets from the eastern end of the bridge. During the pipe launching it may be possible for the shared path to be reopened.
2) Using a moveable scaffolding system to work on the bridge 25 m at a time. Pipe brackets and pipe sections will be lowered from the shared path by a hydraulic arm mounted on a truck. This would require full closure of the existing shared path.

Options to provide access and egress to undertake construction elements 3 and 4 are shown in Figure 10 and Figure 11. These are:

- **Option 1 –** divert the shared path into the eastbound crawler lane separated by a temporary barrier (concrete or steel) from general traffic. A similar cross section as that shown in Figure 6 for the construction elements 1, 6 and 7 could be continued onto the bridge together with a temporary speed limit. Construction vehicles would access the construction area via either the completed sections of the proposed causeway or the motorway. Vehicles would exit either at the eastern end of the bridge (as for Option 3A and 3B discussed in section 7 below) via the existing shared path on the bridge or at the western end of the project if the causeway had been constructed and sufficient manoeuvre space was available to turn around.
- **Option 2 –**close the shared path and undertake installation at night when the demand for the shared path is low. At night the shared path would be fully closed and no connectivity would be provided. Alternatively a shuttle service could be provided during the closure. Construction vehicles would access the construction area via the causeway or the closed shared path and exit as per Option 1.

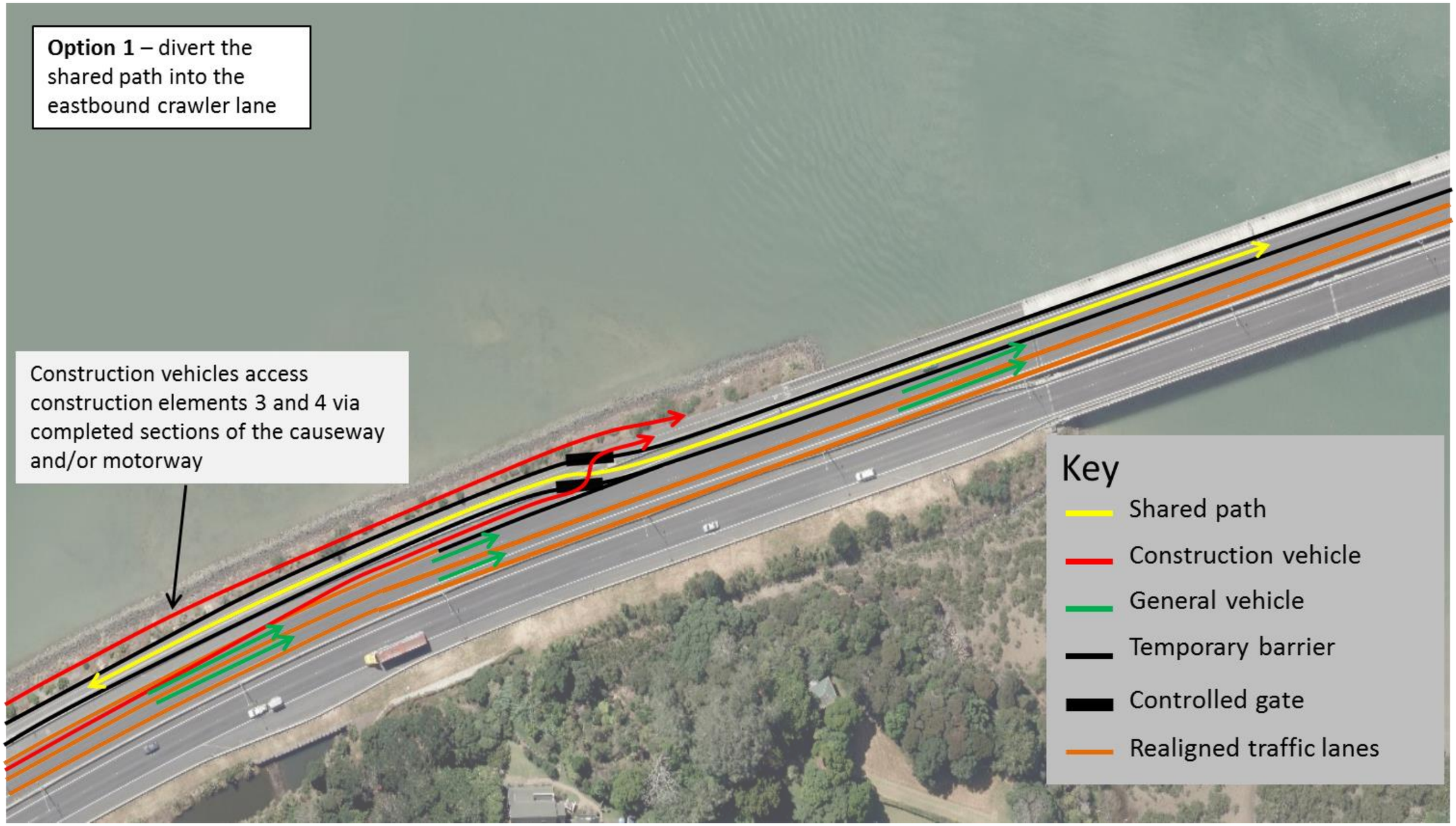


Figure 10 Construction elements 3 and 4 access – Option 1

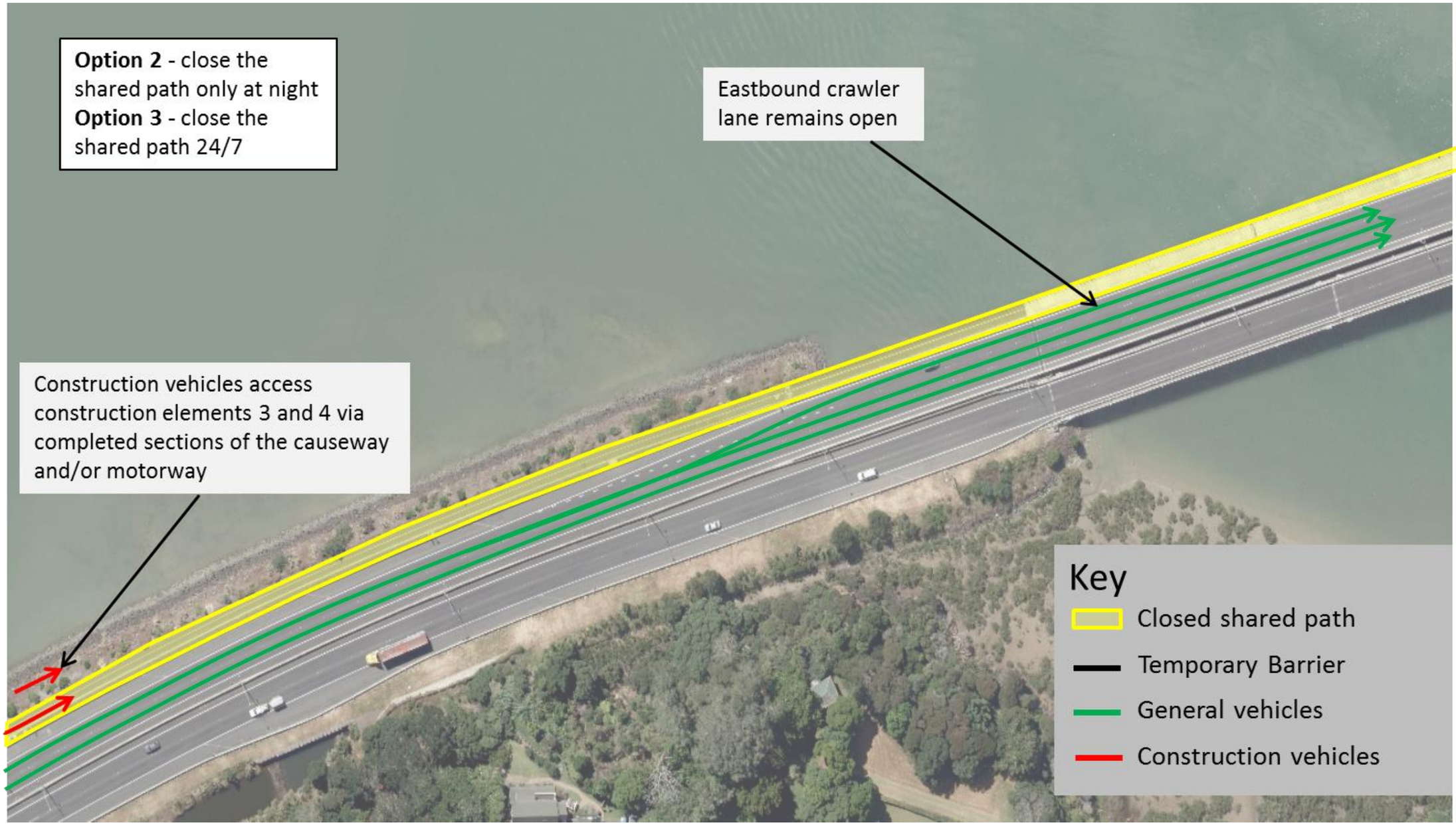


Figure 11 Construction elements 3 and 4 access – Options 2 and 3

6.1 Construction traffic volumes

The construction of elements 3 and 4 are expected to take a total of approximately eight months. The traffic associated with these elements will potentially include the following:

- Daily trips made by site staff
- Daily delivery of supplies
- One-off delivery of proprietary access equipment
- Trucks delivering pipes
- Occasional visitor trips

The daily volume associated with this activity is likely to be in the order of 20 vehicles per day. In the absence of any other information, this has been based on the assumptions presented in Appendix A and discussions with a contractor have suggested that this volume is a conservative value. This volume is not considered to be of a significant quantum and will have a less than minor effect on the operation of SH18 and the local road network providing that staff car parking arrangements are managed.

The majority of vehicles should be able to drive along the existing shared path on the side of the bridge therefore this activity will not impact general vehicle operations on SH18. Heavy vehicles and delivery of the pipe and brackets may require the use of the crawler lane.

6.2 Assessment of effects

Pedestrians and cyclists

Option 1 maintains a 3 m wide shared path which is consistent with the width of the existing shared path. Therefore option 1 is considered to have a less than minor effect on pedestrians and cyclists. As discussed in section 5.3, the shared path could be reduced to a minimum of 2.5 m however a width below this is likely to have an adverse effect on the level of service for pedestrians and cyclists.

The delivery of the pipe and other supplies may require the use of the crawler lane as well as the shared path. This would mean that in Option 1 pedestrian and cycle connectivity would be severed during deliveries. If deliveries were made during the night when demand for the shared path is low this would reduce the effect of the closure.

Option 2 is considered to have a minor adverse effect on pedestrians and cyclists. The magnitude of this effect will be dependent on the extent of the closure. The effect is considered minor if the closure occurs after 10 pm and before 5 am because the demand for the shared path at these times is likely to be very low (this is outside of typical commuting and exercise times).

Auckland Transport has been contacted in regard to available pedestrian and cyclist count information on the shared path and at the time of writing the author was awaiting receipt of this. Auckland Transport and the New Zealand Transport Agency should be consulted to agree an acceptable temporary closure period based on the available count data. The effect of the closure could be mitigated through public notices and signage on the shared path outlining the closures.

A further mitigation measure could include providing a shuttle service during the night closure. This could be targeted for the few hours after the evening closure and a few hours before the morning opening when there may be a small demand for the shared path.

General vehicles

Option 1 would reduce the lanes available to general traffic on the bridge from three to two. Currently the bridge has five day average AM and PM peaks of approximately 2,000 and 1,200 vehicles per hour respectively. This flow is likely to be well below the capacity of the two remaining lanes. The left lane would act as a crawler lane increasing the delay for some vehicles which must now find a gap in the right lane in order to pass a slow vehicle.

Currently the average daily percentage of Heavy Commercial Vehicles (HCVs) travelling eastbound on the bridge is 3.5% which equates to approximately 70 vehicles in the AM peak. Assuming all HCVs use the left lane and that all light vehicles use the right lane, the right lane would have a flow of around 1,900 vehicles per hour. This volume of traffic is approaching the capacity of a single lane, though in uninterrupted stretches, capacities of over 2,000 vehicles per hour can be achieved. This suggests that the closure of the crawler lane is unlikely to have a significant effect on the traffic operation on the bridge.

Option 2 and 3 are considered to have a less than minor effect on general traffic. As discussed above, during the delivery of the pipe and other heavy materials, the crawler lane may need to be closed. The closure could be temporary while the delivery was being made and could occur during off peak hours to mitigate the effect. Table 2 in section 3 shows the volume of traffic on the bridge during several off peak periods.

If the crawler lane is closed and deliveries made between 10 pm and 5 am (as above to minimise the effect on shared path users) the total volume of vehicles crossing the bridge in the seven hour period is in the order of 500 vehicles. This volume is well below the capacity of the remaining two lanes. Therefore the effect of closing one lane during this period is considered less than minor.

7 CONSTRUCTION ELEMENT 5

At the eastern end of the Greenhithe Bridge the new watermain will be constructed adjacent to the NH1 pipeline and connections between the pipes will be made within a valve chamber at the east end.

The valve chamber will be constructed around the existing NH1 pipe on the northern side of SH18 (Refer to drawing 2010674.006). The grassed area to the north of the shared path will provide a laydown and works area for construction of the chamber.

To gain access to the northern side motorway road reserve east of the bridge, the following options, shown in Figure 12 to Figure 14, have been developed:

- **Option 1 access from crawler lane –** pedestrians and cyclists would be required to use the existing shared path. This may be possible if the installation of brackets and the pipe on the bridge has been completed. The existing concrete barrier, just east of the bridge abutment, would need to be broken out to allow construction vehicles to cross over the existing shared path and into the motorway designation. A similar gated system as at the western end would be required to cross the shared path. To the east of the access, the shared path could be diverted into the motorway shoulder if required.
- **Option 2 access with attenuator –** if the installation of brackets and the pipe on the bridge has not been completed, pedestrians and cyclists may need to use the crawler lane. Therefore a similar arrangement as that shown in Figure 13 could be implemented. An attenuator would follow construction vehicles in the middle lane allowing them to pull into the crawler lane and cross the shared path. This option will require adjustments to the existing traffic lanes at the beginning of the Tauhinu Road off-ramp. The design for these adjustments should be undertaken as part of the contractor's TMP. The Tauhinu Road off ramp may need to be closed if there is insufficient room to provide a safe design.
- **Option 3A access from Tauhinu off-ramp –** access could be further east along the off-ramp as shown Figure 14. This would require the closure of the left turn onto Tauhinu Road from the motorway off-ramp. This would require construction vehicles to reverse down the shared path for approximately 350 m to the construction area. Whilst this is a potential option, it is up to the contractor to consider the practicality of this option. .

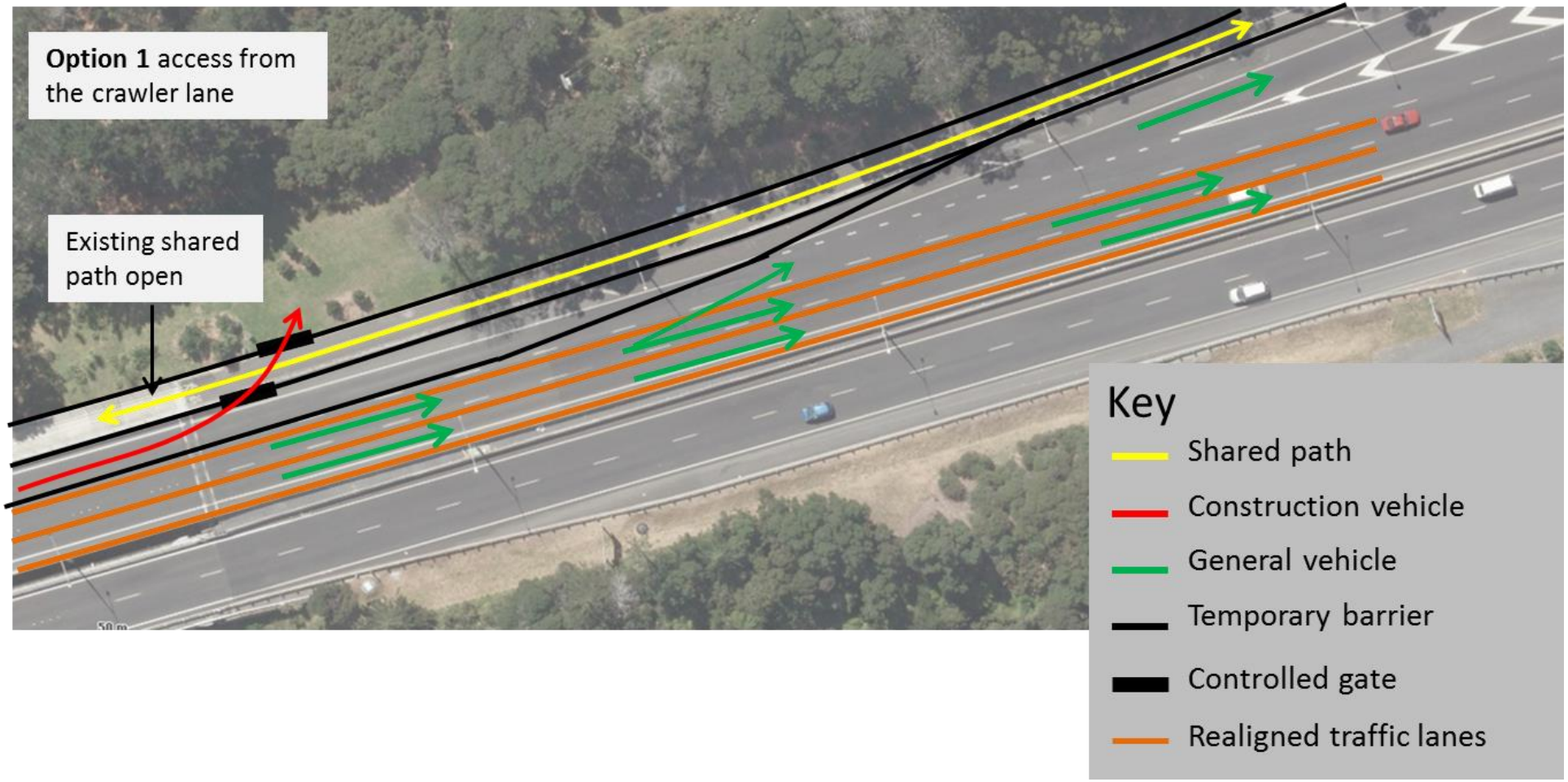


Figure 12 Option 1 access from crawler lane

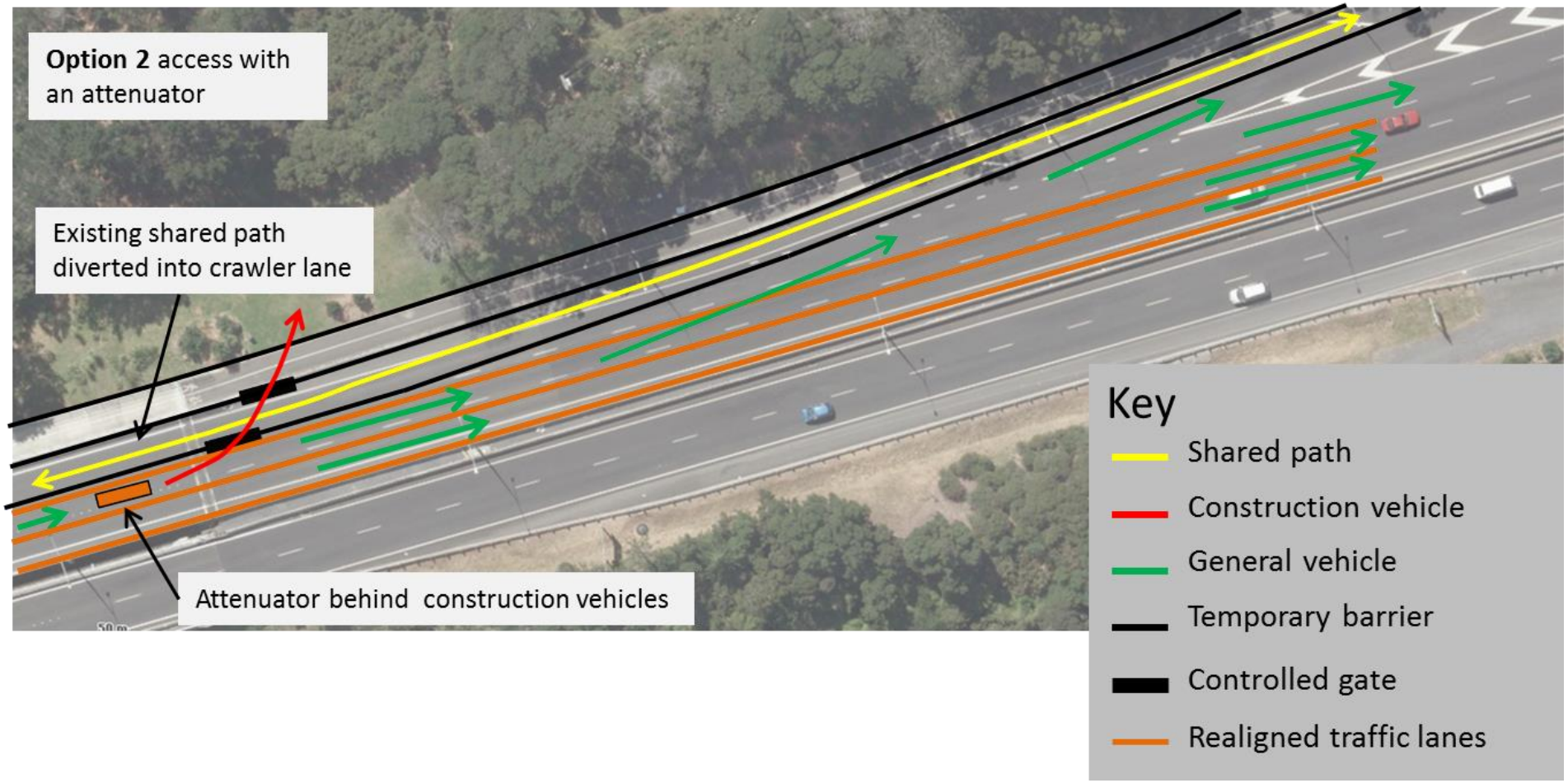


Figure 13 Option 2 access with an attenuator

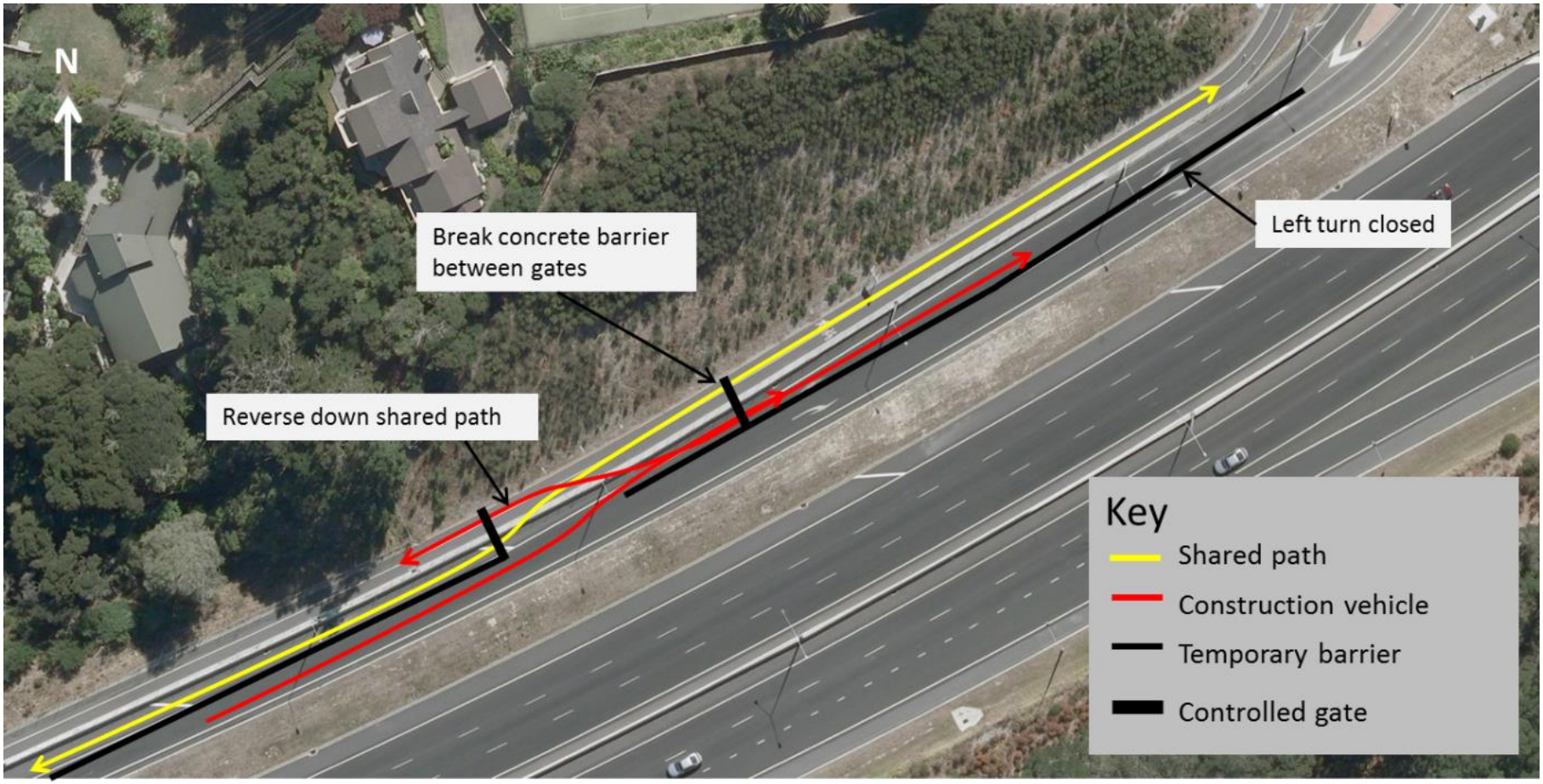


Figure 14 Option 3A access from Tauhinu off-ramp

- **Option 3B contraflow access from off-ramp –** as for Option 3A, the left turn onto Tauhinu Road from the off-ramp would be closed. Construction vehicles would travel in a contraflow direction down the left turn lane, separated by a barrier from the right turn lane as shown below. Access to the off-ramp would require construction vehicles to drive across the mountable kerb median on Tauhinu Road (see Figure 15 and Figure 16 below) or alternatively require the removal of a section of the traffic island which could be reinstated at completion. Construction vehicles would either turn around near the bridge or reverse back up the shared path.

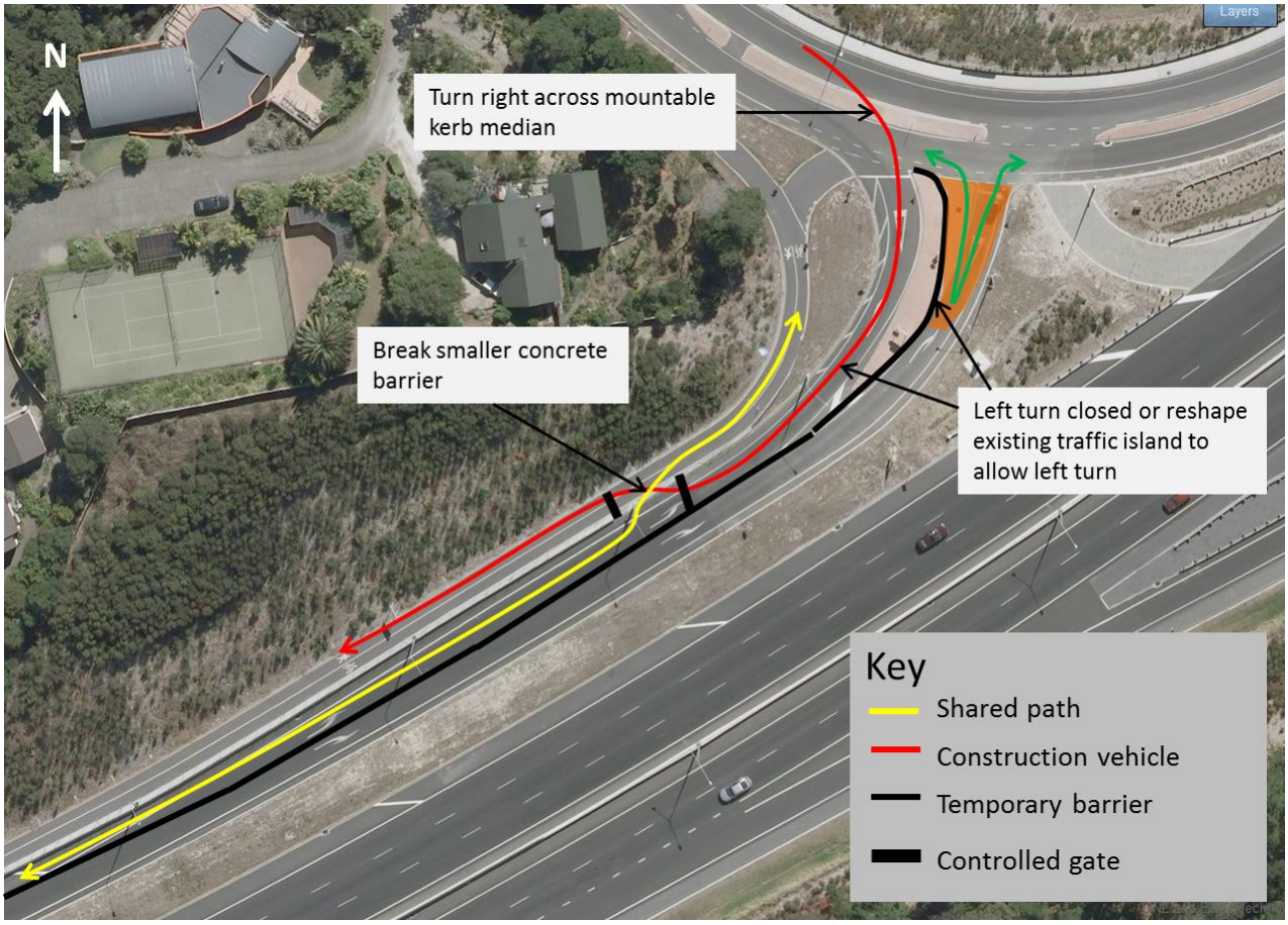


Figure 15 Option 3B contraflow access from Tauhinu off-ramp

Figure 16 Mountable kerb median - Tauhinu Road

7.1 Construction traffic volumes

The construction of the pipe connection and the valve chambers at the east end is estimated to take in the order of 140 days (seven months).

The traffic associated with the construction of pipe connection will potentially include the following:

- Daily trips made by site staff
- Daily delivery of supplies
- One-off delivery of heavy machinery
- Trucks delivering pipes
- Occasional visitor trips

The daily volume associated with this activity is likely to be in the order of 25 vehicles per day. In the absence of any other information, this has been based on the assumptions presented in Appendix A and discussions with a contractor have suggested that this volume is a conservative value. This volume is not considered to be of a significant quantum and will have a less than minor effect on the operation of SH18 and the local road network providing that staff car parking arrangements are managed.

7.2 Assessment of effects

Pedestrians and cyclists

In all options a similar gated system as at the western end would be required to cross the shared path. The effects of this are discussed in Section 5.3. The effect of all of the options on pedestrians and cyclists is considered to be similar and less than minor. As discussed in Section 5.3, the shared path could be reduced to a minimum of 2.5 m however a width below this is likely to have an adverse effect on the level of service for pedestrians and cyclists.

General vehicles

Option 1 will require the use of the crawler lane and therefore will have similar effects discussed in Section 6.2.

Option 2 will have an adverse effect on general traffic if it is necessary to close the Tauhinu Road off-ramp to ensure safe operation on the motorway. Table 4 shows the volume of vehicles that would be affected by this closure depending on length and time of day of the closure.

Table 4 Tauhinu Road off-ramp closure 2013 traffic volumes

Closure period	General vehicles affected during closure period
24 hour closure	1,800
9 am – 4 pm and 6pm – 7 am (hours outside peak periods)	1,100
6 pm – 7 am	420
11 pm – 6 am	40

The vehicles affected by the closure would be required to drive an additional 4 km to the Albany Highway off-ramp and depending on their destination, up to another 5 km back to Tauhinu Road. This

equates to a maximum total additional distance of 9 km – up to 10 minutes additional travel time assuming an average speed of 60 kph over the 9 km trip (on a combination of 100 kph motorway and 50 kph local roads).

Option 2 is therefore considered to have a minor adverse effect as long as access to the site is restricted to between 11 pm and 6 am or if a safe geometric design is provided so that the off-ramp can remain open.

Option 3A and 3B will require a detour to be set up for vehicles wishing to turn left from the off-ramp onto Tauhinu Road. The detour would use the roundabout at Upper Harbour Drive / William Pitcher Place which is approximately 250 m from the off-ramp. The volume of vehicles which would be detoured would be less than the total 1,800 vehicles per day using the off ramp. This is considered a less than minor effect on general vehicles as the additional distance they are required to travel is minimal.

A mitigation measure to keep the left turn open is to modify the existing traffic island to allow for larger vehicles to turn left. If adopted, the design of this modification would need to be undertaken as part of the contractor's TMP. It is noted that small vehicles would likely make the left turn without the detour or required modifications as there is no physical constraint to them turning left from this lane.

Option 3A and 3B are considered to be safer options as access to the site is from the end of the off-ramp / Tauhinu Road where general vehicle speeds will be lower than on SH18.

8 CONCLUSION

A number of options for construction access and egress as part of the Greenhithe Bridge Watermain Duplication and Causeway project have been suggested for the key elements of construction and the transport effects of these have been explored. In conclusion, the following options have the least adverse effect on the transport environment and are preferred from a transport perspective.

Construction elements 2 and 6: A combination of Option 1 for light vehicles (via Station Street) and Option 3B for heavy vehicles – alternative access from the east

Construction elements 1, 6 and 7: Option 1A – access and egress via the private road off Squadron Drive with construction traffic arriving from the east.

Construction elements 3 and 4: Option 1 – divert the shared path into the eastbound crawler lane.

Construction element 5: Option 3A – access from Tauhinu off-ramp with modifications to the existing traffic island to allow the left turn for larger vehicles. This requires construction vehicles to reverse approximately 350m down the shared path. Option 3B has a similar impact on the transport environment and may be a more practical option. If sufficient space is available at the construction site, vehicles can turn around which removes the need to reverse to or from the site.

Although these are the options with the least effect on the transport environment, it is recognised that they may not be the preferred options in terms of constructability or the preferred options of all stakeholders. If they are deemed unacceptable from a constructability or stakeholder perspective, an alternative option should be chosen. The potential effects of the alternative options presented in this report can be managed providing the following key outcomes are achieved:

- Shared path connectivity between Squadron Drive and Tauhinu Road must be maintained for the duration of the project. Any temporary closures necessary for construction should be limited to between the hours of 10 pm and 5 am where possible. Auckland Transport and the New Zealand Transport Agency should be consulted to agree an acceptable temporary closure period.
- The clear through width of any temporary shared path must be at least 2.5 m wide
- The successful contractor must complete detailed TMPs for all necessary stages of work in accordance with CoPTTM as per the normal requirements for proposed works within the road reserve.
- The New Zealand Transport Agency, Auckland Motorway Alliance and Auckland Transport are to be consulted on the contractor's TMP prior to construction beginning.
- A 0.9m safety /deflection zone must be provided between any temporary barrier separating motorway traffic from pedestrians and cyclists. This differs to the requirement in CoPPTM and reflects the current performance of temporary barriers available in Auckland.
- Closure of motorway on and off-ramps should be restricted to after 11 pm and before 6 am where possible
- Two traffic lanes must be operational in both directions on SH18 for the duration of the project. If necessary, one traffic lane may be temporarily closed between 11 pm and 6 am.
- Where possible construction materials and supplies shall arrive to site from the east via SH18
- A dedicated site staff car park should be provided
- Upon completion of the project the existing transport environment shall be restored to the pre-construction condition

If the above outcomes are achieved, the overall effect of the Greenhithe Bridge Watermain Duplication and Causeway Project is considered to have a less than minor effect on the transport environment.

APPENDIX A CONSTRUCTION TRAFFIC VOLUMES

Site/stage	Staff trips				Deliveries			
	Daily staff working on site	Daily trips per staff member	Adjustment for vehicle sharing	Adjusted trips per day	Daily deliveries made to site	Total daily trips to each site	Work hours per day	Average trips per hour
Construction elements 2 and 6	8	4	0.6	19.2	5	24	10	2
Construction elements 1, 6 and 7	20	4	0.6	48	5	53	10	5
Construction elements 3 and 4	6	4	0.6	14.4	5	19	10	2
Construction element 5	8	4	0.6	19.2	5	24	10	2