Cardno
Shaping the Future

LJ2888 Filling of Hornsby Quarry Access Options Assessment

Prepared for Hornsby Shire Council

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1 INTRODUCTION

Hornsby Shire Council (HSC) resolved to fill the Hornsby Quarry with Virgin Excavated Natural Material (VENM) in August 2009, and have commissioned Cardno to seek the necessary approvals to enable the quarry to be filled.

The location of the quarry, and the local geography of the area, means any filling of the quarry will require movement of fill material through both major roads and residential/commercial areas and will lead to some disruption for local residents. To assist in minimising disruption for local residents, an options assessment has been undertaken to identify and evaluate the most appropriate access route to the quarry to facilitate the transportation of fill to Hornsby Quarry, with the results presented in this report.

This document:

- Identifies the potential access options considered,
- Sets out criteria for project success (screening criteria),
- Compares each potential access option against the agreed screening criteria,
- Establishes a list of access options which satisfy the screening criteria and may be feasible,
- Compares access options which satisfy the screening criteria using a multi criteria analysis,
- Provides the results of the multi criteria analysis, and
- Identifies the access option for filling the quarry which is determined by the multi criteria analysis to have the lowest level of impact, and is therefore recommended as the preferred access option for future detailed evaluation.
- Identifies access options which are recommended for future detailed evaluation.

2 ACCESS OPTIONS CONSIDERED

The objectives of this report are to identify all feasible methods and routes for transporting VENM to the quarry rim and then, through a logical and documented process, determine a preferred option which will be subject to a more detailed assessment of environmental and social impact as part of a separate exercise.

The Cardno team identified the access options through:

- Review of local maps, aerial imagery and GIS data,
- Review of past documents and assessments provided to Cardno by Council,
- A workshop with the Cardno team, and discussions with Cardno staff familiar with the local area,
- Travelling the local road network,
- Desktop research and database searches,
- Review of the findings of traffic modelling of key sections of the study area, and
- Discussions with Council.

At this stage, no detailed consideration of how VENM fill material will be transported from the quarry rim to the active point of fill has been undertaken. This has been considered to be a common process to all options.

Table 2.1 identifies the complete list of potential access options identified by Cardno for the transport of VENM to the quarry rim. These 20 Access Options can be categorised into 3 delivery mechanisms as follows:

- Transportation of fill primarily by road (13 options),
- Transportation of fill primarily by rail (6 options), and
- Transportation of fill by air (1 option).

The local road access options to the quarry are shown in **Figure 2.1.**

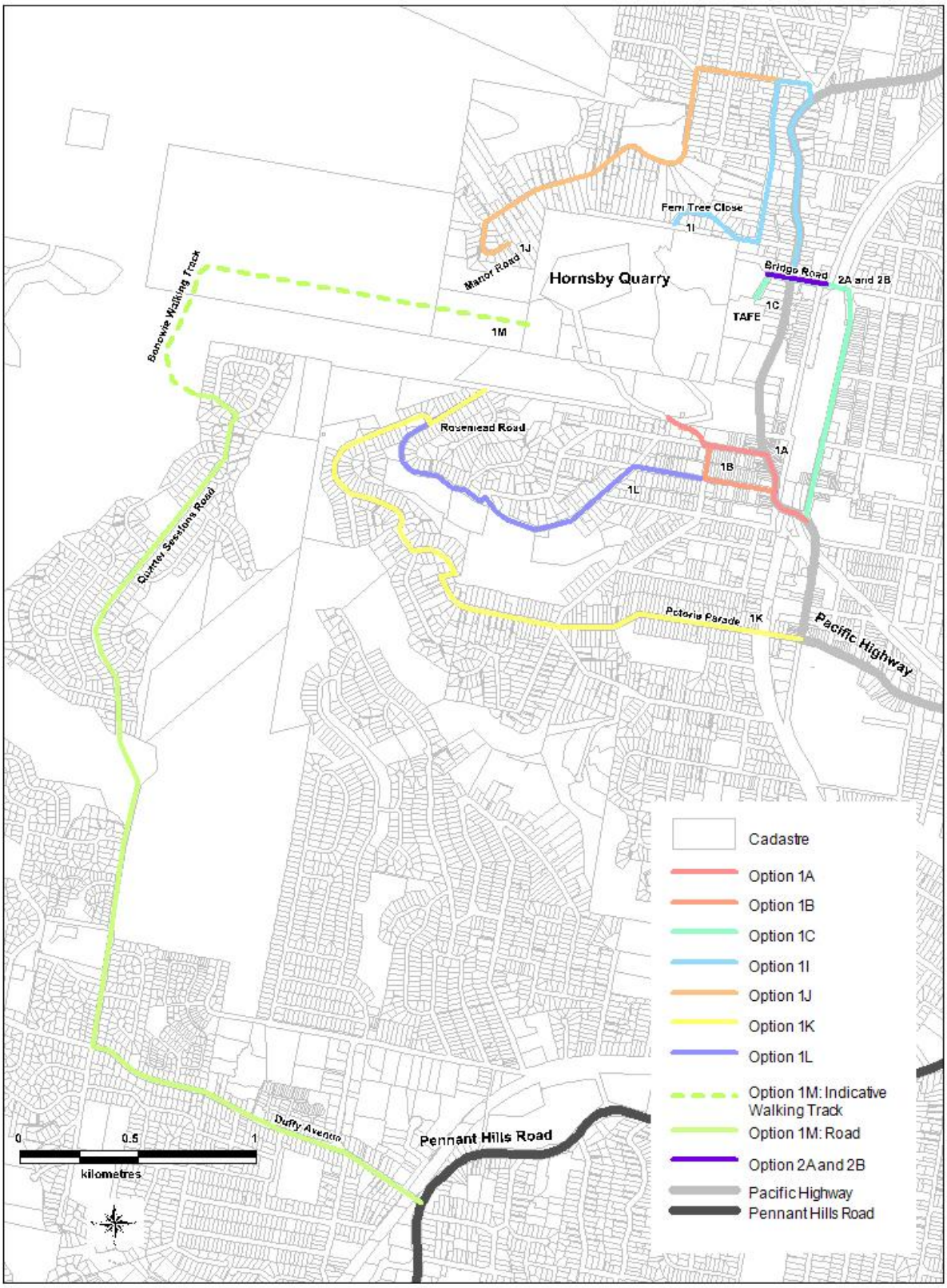

Figure 2.1 Access Route Options

Table 2.1 List of Access Options Considered

Option Number	Access Option
Scenario 1: Transportation of VENM by Road	
1A	Access via Quarry Road / Dural Street / Pacific Highway.
1B	Access via Quarry Road / Fredrick Street / William Street / Pacific Highway.
1C	Extension of Bridge Road to facilitate direct access to quarry.
1D	Creation of transfer station at the end of existing Bridge Road with tunnel access to quarry.
1E	Creation of transfer station at the end of existing Bridge Road with no tunnel access to quarry.
1F	Creation of transfer station from Pacific Highway with tunnel access to quarry.
1G	Creation of transfer station from Pacific Highway with no tunnel access to quarry.
1H	One-way loop access via two preferred route options (determined to be Options 1B and 1C – refer to Section 4.3.5).
1I	Access via Fern Tree Close / Silvia Street / Carrington Road / Galston Road / Pacific Highway.
1J	Access via Manor Road / Rosamond Street / Carrington Road / Galston Road / Pacific Highway.
1K	Access via Rosemead Road / Valley Road / Pretoria Parade the Pacific Highway.
1L	Access via Rosemead Road / William Street.
1M	Access via Benowie Walking Track / Quarter Sessions Road / Duffy Avenue / Pennant Hills Road.
Scenario 2: Transportation of VENM by Rail	
2A	Creation of rail spur along Bridge Road from main northern line extending to the quarry.
2B	Creation of conveyor along Bridge Road from main northern line extending to the quarry with transfer station.
2C	Creation of a tunnel from the existing rail line, with a transfer station at the tunnel entrance and a conveyor running through the tunnel.
2D	Creation of a tunnel from the existing rail line, with direct train access to the quarry through the tunnel.
2E	Creation of a tunnel from the existing rail line, with a transfer station and direct truck access to the quarry through the tunnel.
2F	Truck access to the quarry from the northern rail line utilising preferred Option 2 route.
Scenario 3: Transportation of VENM by Air	
3	Transport of VENM by helicopter from the material source direct to the quarry pit.

The subsequent sections of this report will:

- Consider each of the options in **Table 2.1** in the context of known constraints to determine which of the options are (or may be) compatible with the stated Council objectives for filling the quarry, and
- Explain the reasons for discounting any option from further consideration.

3 SCREENING OF OPTIONS

In this analysis, Cardno identified three screening criteria against which each option was initially assessed, namely:

- Number of residential dwellings impacted;
- Site availability for any required associated infrastructure; and
- Compatibility with the Proposed Hornsby Westside Revitalisation Masterplan.

3.1 Number of Residential Dwellings Impacted

One of Council's key objectives is for the works associated with filling the quarry to affect the minimum number of residents in the community. Potential impacts will occur at the quarry site, and along the transport routes, and are expected to include:

- Noise,
- Vibration,
- Dust,
- Safety, and
- Amenity.

Analysis was undertaken to determine the number of dwellings located adjacent to each of the route options identified. **Table 3.1** summarises the results of the assessment, and the analysis undertaken is presented in more detail in **Appendix A.**

The results in **Table 3.1** show that options 1K, 1L and 1M pass a significantly higher number of dwellings than routes 1A to 1E, 1I and 1J.

In light of these findings, options 1K, 1L and 1M have been excluded from further assessment, noting that they do not exhibit significantly lower impacts in relation to any of the other criteria considered.

The outcome of applying this constraint is to minimise the disturbance to Hornsby Quarry's surrounding community.

It is also considered that a significant number of dwellings would be impacted, and that there is a significant health (noise) risk associated with the transportation of VENM to the quarry by air (ie the use of helicopter), particularly noting the close proximity of Hornsby Town Centre and residential properties. It is also likely to be cost prohibitive and pose possible safety concerns. As a result, **access option 3 – transport to the quarry by air (helicopter) – was discounted from further assessment.**

Table 3.1 Calculated Number of Dwellings Impacted by Route Access Options

Option Number	Access Option	Number of Dwellings Impacted
Option 1: Transportation of VENM by Road		
1A	Access via Quarry Road / Dural Street / Pacific Highway.	131
1B	Access via Quarry Road / Fredrick Street / William Street / Pacific Highway.	149
1C	Extension of Bridge Road to facilitate direct access to quarry	99
1D	Creation of transfer station at the end of existing Bridge Road with tunnel access to quarry	104
1E	Creation of transfer station at the end of existing Bridge Road with no tunnel access to quarry	104
1F	Creation of transfer station from Pacific Highway with tunnel access to quarry	N/Q
1G	Creation of transfer station from Pacific Highway with no tunnel access to quarry	N/Q
1H	One-way loop access via two preferred route options (determined to be Options 1B and 1C – refer to Section 4.3.5).	N/Q
1I	Access via Fern Tree Close / Silvia Street / Carrington Road / Galston Road / Pacific Highway	157
1J	Access via Manor Road / Rosamond Street / Carrington Road / Galston Road / Pacific Highway.	208
1K	Access via Rosemead Road / Valley Road / Pretoria Parade the Pacific Highway.	**227**
1L	Access via Rosemead Road / William Street	**226**
1M	Access via Benowie Walking Track / Quarter Sessions Road / Duffy Avenue / Pennant Hills Road.	**287**
Option 2: Transportation of VENM by Rail		
2A	Creation of rail spur along Bridge Road from the main northern line extending to the quarry	N/Q
2B	Creation of conveyor along Bridge Road from the main northern line extending to the quarry with transfer station	N/Q
2C	Creation of a tunnel from the existing rail line, with a transfer station at the tunnel entrance and a conveyor running through the tunnel.	N/Q
2D	Creation of a tunnel from the existing rail line, with direct train access to the quarry through the tunnel.	N/Q
2E	Creation of a tunnel from the existing rail line, with a transfer station and direct truck access to the quarry through the tunnel.	N/Q
2F	Truck access to the quarry from the northern rail line utilising preferred Option 2 route.	Truck access to the quarry TBC
Option 3: Transportation of VENM by Air		
3	Transport of VENM by helicopter from the material source direct to the quarry pit	N/Q (>200)

N/Q = Not Quantified

3.2 Site Availability for Associated Infrastructure

A number of the options identified required ancillary infrastructure such as transfer stations or rail sidings to be developed. The likely availability of sites for these facilities is considered in this section. Transfer station requirements for the project have been considered in general terms only at this stage, however it is noted that the purpose of these facilities is to enable the fill material to be transferred from one mode of transport to another (for example from a train to a truck or a conveyor system). The facilities may be covered, partially covered or uncovered and are typically expected to contain a delivery area, loading and unloading machinery moving within the facility, a stockpile area, and staff facilities.

Options 1D through to 1G require the creation of a transfer station at either the end of the existing Bridge Street or from the Pacific Highway. Cardno undertook spatial analysis using available GIS data combined with local site knowledge in an attempt to identify any suitable locations for the transfer stations.

Options 1D and 1E require a transfer station to be established in the general vicinity of the existing end of Bridge Street. Part of this area is occupied by TAFE NSW – Northern Sydney Institute. However, the lot of land north of the TAFE is currently undeveloped, making it a possible site for a transfer station.

Options 1F and 1G require a transfer station to be established just off the Pacific Highway. Through the inspection of GIS data of the sites in the vicinity of Hornsby Quarry along the Pacific Highway, no available sites for a transfer station were identified, however it is noted that HSC has the option of acquisition of lots in order to facilitate this option.

In light of the findings on the need to secure sites for associated infrastructure, Options 1D-1G have been excluded from further assessment. However, it is noted that further consideration of these options may be warranted if suitable locations for the required infrastructure can be made available to HSC.

Options 2A to 2F all involve transport of VENM to Hornsby by rail and present associated logistical constraints. The infrastructure required for the transportation by rail includes:

- A rail spur between the location at which VENM is loaded onto trains and the existing freight rail line,
- A transfer station at the point of loading VENM onto trains,
- A transfer station at the point of offloading VENM from trains at Hornsby, and,
- A rail spur from the freight line to the transfer station at which VENM will be offloaded in Hornsby.

At the rail delivery point in Hornsby, a transfer station in the vicinity of the rail line would need to be established in order to unload the VENM from the freight train to the access point of the quarry.

Cardno understands that there has been a recent upgrade to Hornsby Railway Station, where an additional Platform (Platform 5) and pedestrian concourse were added and completed in 2009. Additionally, works were undertaken to widen tracks and construct 1.7 km of new tracks (PB, 2005), to accommodate the anticipated increase in demand for the Main Northern Rail Line for freight and passenger services to Newcastle (Railcorp, 2003 cited by PB, 2005). Hornsby Railway Station's upgrade was also used to increase the Main Northern Rail Line's terminating capacity. These upgrade works encroached upon the bus interchange and other sites within the Railway Corridor boundary which were reconfigured (PB, 2005).

Following these works, it is understood by Cardno that there is no available space at the station to accommodate the additional rail spurs or sidings that would be needed to deliver VENM to the quarry by rail. Additionally, inspection of aerial images and GIS data supplied by Council shows there is no appropriate site, unless Council is prepared to undertake property acquisitions, adding significantly to the overall cost of the project.

Due to the lack of suitable locations at which the required rail infrastructure could be located, **it is considered that all options that involve delivery of VENM by rail are not practical. Therefore, Options 2A-2F have not been considered further in this assessment.**

3.3 Compatibility with the Proposed Hornsby Westside Revitalisation Masterplan

A proposed Hornsby Westside Revitalisation Masterplan has been developed to provide a basis for a program of street upgrades to be designed and implemented over a number of years. The main elements of the Masterplan include:

- 40 km/h High Pedestrian Activity Area along Pacific Highway from William Street to Hornsby TAFE (Western Campus).
- One through lane each way for the entire length of the Pacific Highway between Dural Lane and Bridge Road.
- Dedicated right turn lane into William Street from the Pacific Highway.
- Dedicated right turn lane into Station Street from the Pacific Highway.
- Raised platforms on existing pedestrian crossings on the Pacific Highway at Station Street and Hornsby TAFE.
- Traffic signals at Pacific Highway/Coronation Street intersection (subject to 50:50 funding from RTA).
- Angle parking in front of Hornsby Park.
- Angle parking in front of Council Chambers and Courthouse.
- Introduction of street trees (species yet to be determined).
- Paving remaining footway areas in clay pavers.
- New street furniture.

Option 1A would result in trucks entering the 40km/h High Pedestrian Activity Area along Pacific Highway. Therefore this option has not been considered further in this assessment. All other options avoid truck movements through this zone.

3.4 Results of initial screening of Access Options

After applying the initial screening criteria and considering the constraints which have been outlined in earlier sections, the remaining access options considered to be potentially feasible are listed in **Table 3.2**. These options are assessed in more detail through multi criteria analysis in **Section 4**.

Table 3.2 Potentially Feasible Access Options Requiring Further Assessment

Option Number	Access Option
1B	Access via Quarry Road / Fredrick Street / William Street / Pacific Highway.
1C	Extension of Bridge Road to facilitate direct access to quarry.
1I	Access via Fern Tree Close / Silvia Street / Carrington Road / Galston Road / Pacific Highway.
1J	Access via Manor Road / Rosamond Street / Carrington Road / Galston Road / Pacific Highway.
1H	One-way loop access via two preferred route options (determined to be Options 1B and 1C).

Table 3.3 identifies additional options which would be considered to be viable only if a suitable site for associated infrastructure can be identified and made available to Council. No further assessment of these options has been made, however they could be evaluated using the multi criteria analysis framework described in **Section 4** if suitable locations for the required infrastructure become available.

Table 3.3 Potentially Feasible Options if Sites for Infrastructure Are Available

Option	Description of Work Required
1D	Creation of transfer station at the end of existing Bridge Road with tunnel access to quarry.
1E	Creation of transfer station at the end of existing Bridge Road with no tunnel access to quarry.
1F	Creation of transfer station from Pacific Highway with tunnel access to quarry.
1G	Creation of transfer station from Pacific Highway with no tunnel access to quarry.

4 MULTI CRITERIA ANALYSIS OF FEASIBLE ACCESS ROUTE OPTIONS

The five potentially feasible access options identified in Table 3.2 all comprised road options accessed from the Pacific Highway. To determine the best access option, a multi-criteria assessment of the five options was conducted. This section of the report describes the assessment methodology utilised in the assessment which leads to the recommendation of a preferred access route.

4.1 ASSESSMENT METHODOLOGY AND CRITERIA

A set of criteria was developed to quantitatively analyse each access option (scenario). Each scenario was then scored against the criteria defined in **Section 4.1.1**. Scoring of the five options has been based on a range of 1 to 5, where 1 is the best performing option and 5 is the worst performing option with respect to the criterion being considered. As a result, a low score in an assessment category signifies a lower environmental or social impact and a better solution in general terms. An overall lower score indicates a higher preference for the route option.

It is noted that, using this approach, the total score for each criterion will always add up to 15 (1+2+3+4+5). Where options were determined to perform equally, equivalent scores were assigned at a value which preserved the total score of 15. (For example, if 2 options were determined to perform equally well, and better than all other options both options were scored as 1.5, being the average of 1 and 2).

4.1.1 Criteria

The assessment criteria considered are as follows:

- **Number of dwellings on the route –** this criterion considers the number of dwellings which are directly adjacent to or fronting the route. Routes with a higher number of dwellings can be expected to lead to greater nuisance impacts including increased traffic volumes, noise, vibration, dust generation and associated safety issues. The number of dwellings along each access option is shown in **Table 3.1.**
- **Length of route –** this criterion considers the distance a vehicle is required to travel from the common point at the southern Pacific Highway / George Street intersection to the quarry rim (with the exception of 1K and 1M which are measured along the routes as shown on **Figure 2.1**). A shorter distance can be expected to have lower impacts on the surrounding environment, involve less travel time and place less stress on the existing infrastructure. The length of each route to the quarry following the route shown on **Figure 2.1** is shown in **Table 4.1.**
- **Ease of getting the VENM from the quarry rim to the quarry base –** the different access options lead to different points around the quarry rim. This criterion considers the ease at which the VENM would likely be transported from the quarry rim to the base of the quarry, and the relative level of additional environmental or social impacts which would be expected to result from this step of the quarry filling process.
- **Technical challenges –** this criterion considers the level of technical complexity associated with each access option. This includes consideration of factors such as steep gradients which must be overcome.

- **Road Network Operation** – This criterion considers the road network design and capacity along each route. An access option which has a greater traffic carrying capacity is generally expected to perform better, and receive a lower score.

Table 4.1 Calculated Length of Route to the Quarry for Access Options by Road

Option Number	Access Option	Length of Route (km) (shown on Figure 2.1)
Option 1: Transportation of VENM by Road		
1A	Access via Quarry Road / Dural Street / Pacific Highway.	0.68
1B	Access via Quarry Road / Fredrick Street / William Street / Pacific Highway.	0.71
1C	Extension of Bridge Road to facilitate direct access to quarry.	1.20
1D	Creation of transfer station at the end of existing Bridge Road with tunnel access to quarry.	1.20
1E	Creation of transfer station at the end of existing Bridge Road with no tunnel access to quarry.	1.20
1F	Creation of transfer station from Pacific Highway with tunnel access to quarry.	N/A
1G	Creation of transfer station from Pacific Highway with no tunnel access to quarry.	N/A
1H	One-way loop access via two preferred route options (determined to be Options 1B and 1C – refer to Section 4.3.5).	0.96#
1I	Access via Fern Tree Close / Silvia Street / Carrington Road / Galston Road / Pacific Highway.	2.77
1J	Access via Manor Road / Rosamond Street / Carrington Road / Galston Road / Pacific Highway.	3.44
1K	Access via Rosemead Road / Valley Road / Pretoria Parade the Pacific Highway.	2.69
1L	Access via Rosemead Road / William Street.	2.06
1M	Access via Benowie Walking Track / Quarter Sessions Road / Duffy Avenue / Pennant Hills Road.	5.86

Calculated as the average of options 1B and 1C

4.1.2 Criteria Weighting

The criteria described above have been considered by this assessment to be of equal importance. No weightings have therefore been used in the assessment.

4.1.3 Overall Scoring

Scores were given to each route option for each criteria and summed to determine an overall score. The lower the overall score the better the option. The options are discussed in further detail below and include the assigned scoring for each criterion.

4.2 PRO's AND CON's OF EACH OPTION ANALYSED

Prior to applying the scoring a qualitative assessment was undertaken to consider key pro's and con's of each option analysed. These are further explained in **Table 4.2** below.

Table 4.2 Pro's and Con's of Each Option

Option (refer to Figure 2.1)	Pro's	Con's
Option 1B Access via Quarry Road / Fredrick Street / William Street / Pacific Highway	Enables existing quarry roads to be used to transfer VENM to the quarry base, and provides a low level of technical challenge	Impacts to dwellings located along the route.
Option 1C Extension of Bridge Road to facilitate direct access to quarry. Access via Bridge Road / George Street.	Minimal use of local residential streets.	Technical challenges in moving VENM from the existing road network to the quarry base. Impacts to dwellings located along the route.
Option 1I Access via Fern Tree Close / Silvia Street / Carrington Road / Galston Road / Pacific Highway / George Street	No significant pros identified	Technical challenges in moving VENM from the existing road network to the quarry base. Length of route. Impacts to dwellings located along the route.
Option 1J Access via Manor Road / Rosamond Street / Carrington Road / Galston Road / Pacific Highway / George Street.	No significant pros identified	Technical challenges in moving VENM from the existing road network to the quarry base. Length of route. Impacts to dwellings located along the route.
Option 1H One-way loop access via two preferred route options (determined to be Options 1B and 1C – refer to Section 4.3.5).	Option to reduce impact at any one location by use of a one way loop, effectively halving traffic movements at any location.	Leads to an impact along two separate locations increasing the number of affected dwellings (although only subject to one way movements). Technical challenges in moving trucks between the existing road network at Bridge Road and the quarry base. Impacts to dwellings located along the route.

4.3 INDIVIDUAL OPTION SCORING

4.3.1 Option 1B - Access via Quarry Road / Fredrick Street / William Street / Pacific Highway

Option 1B provides a transport route from the Pacific Highway to the southeast side of the quarry, from where existing internal quarry roads can be used to transport VENM to the quarry base.

OVERVIEW

- Transport of VENM material will occur by road from the southern junction of Pacific Highway and George Street to the quarry along:
  - Pacific Highway,
  - William Street,
  - Frederick Street, and
  - Quarry Road.
- VENM transport from the quarry rim to the base could be undertaken using existing internal quarry roads.

Table 4.3 Option 1B Scores

Criteria	Scoring / Comments	
Number of dwellings on the route	3	149 dwellings have been determined to lie along the route. Many of these dwellings are part of multi-unit residential developments.
Length of route	1	At 0.71 km, the route from the common intersection (Pacific Hwy / George St) to the quarry rim is the shortest of the 5 options being considered.
Ease of getting the VENM from the quarry rim to the quarry base	1	This option provides the simplest means of transferring VENM from the quarry rim to the base, as there is an existing haul road inside the quarry with its origin at the end of Quarry Road.
Technical challenges	1	This option is considered to provide the least technical challenges. Roads to the quarry rim are generally close to horizontal, and the quarry face at this point is stable. Transfer of material into the quarry from the rim is relatively simple due to the presence of the existing haul road.
Road Network Operation	2	The majority of the route from the Pacific Highway to the quarry rim is on major roads, with key turns generally being made at signal controlled intersections. Options 1B, 1C and 1H were found to perform significantly better than options 1I and 1J, and have been scored equally for this criterion.
TOTAL SCORE	8	

4.3.2 Option 1C - Extension of Bridge Road to Facilitate Direct Access to Quarry

Option 1C provides a transport route from the Pacific Highway to the northeast side of the quarry. From this point, new infrastructure will be required to transport VENM to the quarry base, with either significant extension to Bridge Road, or a transfer station and conveyor system, being required.

OVERVIEW

- Transport of VENM material will occur by road from the southern junction of Pacific Highway and George Street to the quarry along:
  - George Street, and
  - Bridge Road.
- VENM transport from the quarry rim to the base could be undertaken using either a new road system which would need to be constructed, or by installing a transfer system to transfer VENM to a new conveyor system.

Table 4.4 Option 1C Scores

Criteria	Scoring / Comments	
Number of dwellings on the route	1	99 dwellings have been determined to lie along the route. Many of these dwellings are part of multi unit residential developments. This is fewer than the other four options being considered.
Length of route	3	At 1.2 km the route from the common intersection (Pacific Hwy / George St) to the quarry rim is the third shortest of the 5 options being considered.
Ease of getting the VENM from the quarry rim to the quarry base	2	There is no existing infrastructure to convey the VENM from the quarry rim to the quarry base at this location. This area of the quarry is relatively stable. There is a significant gradient between the existing Bridge Road and the quarry base.
Technical challenges	5	The topography and change in height between the end of Bridge Road and the quarry base, coupled with the horizontal distance, means that there are a number of technical challenges to be overcome if VENM is to be successfully transported to the base of the quarry. In particular, there is a constraint on the maximum gradient that trucks can climb or descend, which means construction of an access road from this point is technically challenging.
Road Network Operation	2	The majority of the route from the Pacific Highway to the quarry rim is on major roads, with key turns generally being made at signal controlled intersections. Options 1B, 1C and 1H were found to perform significantly better than Options 1I and 1J, and have been scored equally for this criterion.
TOTAL SCORE	13	

4.3.3 Option 1I - Access via Fern Tree Close / Silvia Street / Carrington Road / Galston Road / Pacific Highway / George Street

Option 1I provides a transport route from the Pacific Highway to the north side of the quarry. From this point, new infrastructure will be required to transport VENM to the quarry base.

OVERVIEW

- Transport of VENM material will occur by road from the southern junction of Pacific Highway and George Street to the quarry along:
  - George Street,
  - Pacific Highway,
  - Galston Road,
  - Carrington Road,
  - Silvia Street, and
  - Fern Tree Close.
- VENM transport from the quarry rim to the base could be undertaken using either a new road system, which would need to be constructed, or by installing a transfer station to transfer VENM to a new conveyor system.

Table 4.5 Option 1I Scores

Criteria	Scoring / Comments	
Number of dwellings on the route	4	157 dwellings have been determined to lie along the route. There is a combination of single dwelling and multi-unit dwellings (mostly on Pacific Highway) along this route.
Length of route	4	At 2.77 km, the route from the common intersection (Pacific Hwy / George St) to the quarry rim is the fourth shortest of the 5 options being considered.
Ease of getting the VENM from the quarry rim to the quarry base	4.5	There is no existing infrastructure to convey the VENM from the quarry rim to the quarry base at this location. This area of the quarry is described as having a moderate risk of instability (PSM, 2007). There is a significant gradient between the end of Fern Tree Close and the quarry base.
Technical challenges	2.5	The topography and change in height between the end of Fern Tree Close and the quarry base, coupled with the horizontal distance, means that there are a number of technical challenges to be overcome if VENM is to be successfully transported to the base of the quarry.
Road Network Operation	4	A significant length of the access route is on roads not well suited to heavy vehicle transport, and uses access roads through areas of low density housing.
TOTAL SCORE	19	

4.3.4 Option 1J - Access via Manor Road / Rosamond Street / Carrington Road / Galston Road / Pacific Highway / George Street

Option 1J provides a transport route from the Pacific Highway to the northwest side of the quarry. From this point, new infrastructure will be required to transport VENM to the quarry base.

OVERVIEW

- Transport of VENM material will occur by road from the southern junction of Pacific Highway and George Street to the quarry along:
  - George Street,
  - Pacific Highway,
  - Galston Road,
  - Carrington Road,
  - Rosamond Street, and
  - Manor Road.
- VENM transport from the quarry rim to the base could be undertaken using either a new road system, which would need to be constructed, or by installing a transfer system to transfer VENM to a new conveyor system.

Table 4.6 Option 1J Scores

Criteria	Scoring / Comments	
Number of dwellings on the route	5	208 dwellings have been determined to lie along the route. This is the greatest number of any of the five options being considered.
Length of route	5	At 3.44 km, the route from Pacific Highway to the quarry rim is the longest of the 5 options being considered.
Ease of getting the VENM from the quarry rim to the quarry base	4.5	There is no existing infrastructure to convey the VENM from the quarry rim to the quarry base at this location. This area of the quarry is described as having a moderate to high risk of instability (PSM, 2007).
Technical challenges	2.5	The topography and change in height between the end of Manor Road and the quarry base, coupled with the horizontal distance, means that there are a number of technical challenges to be overcome if VENM is to be successfully transported to the base of the quarry.
Road Network Operation	5	A significant length of the access route is on roads not well suited to heavy vehicle transport, and uses access roads through areas of low density housing.
TOTAL SCORE	22	

4.3.5 Option 1H - One-way Loop Access via Two Preferred Route Options

Option 1H provides a one way transport loop, with vehicles accessing and exiting the quarry at different locations. Based on the assessment above, the one way loop is assumed to combine Options 1B (southern access point) and 1C (the northern access point), which were shown to be the best performing two way options. Infrastructure enabling access at Quarry Road is available, however an egress road will need to be provided at Bridge Road.

OVERVIEW

- Transport of VENM material will occur by road from the southern junction of Pacific Highway and George Street to the quarry along:
  - Pacific Highway,
  - Dural Street,
  - Quarry Road,
  - Internal quarry movement,
  - Bridge Street (new infrastructure), and
  - George Street.
- VENM transport from the quarry rim to the base would be undertaken using a road system part of which is present and part of which would require construction.

Table 4.7 Option 1H Scores

Criteria	Scoring / Comments	
Number of dwellings on the route	2	149 dwellings have been determined to lie along the entry route. 99 dwellings have been determined to lie along the exit route. (Vehicle movements past each dwelling will occur in only one direction, whereas for all other access options considered impact will occur as traffic moves in both directions).
Length of route	2	At 0.96km the route from Pacific Highway to the quarry rim is one of the shortest of the 5 options being considered. (To give a fair comparison with other options, this distance has been calculated as the average of the route lengths of Options 1B and 1C).
Ease of getting the VENM from the quarry rim to the quarry base	3	It will be relatively easy to get VENM to the quarry base from Quarry Road due to the presence of the existing internal haul road. However, there is currently no infrastructure present at Bridge Road to allow the trucks to exit the quarry at this point.
Technical challenges	4	The topography and change in height between the end of Bridge Road and the quarry base, coupled with the horizontal distance, means that there are a number of technical challenges to be overcome if a route for trucks to exit the quarry at this location is to be provided.
Road Network Operation	2	The majority of the route from the Pacific Highway to the quarry rim is on major roads, with key turns generally being made at signal controlled intersections. Options 1B, 1C and 1H were found to perform significantly better than Options 1I and 1J, and have been scored equally for this criterion.
TOTAL SCORE	13	

4.4 SUMMARY OF SCORES

The scores from the evaluation applied to each of the five access route options are summarised in **Table 4.8.**

Table 4.8 Summary of Scores (Summary Evaluation of Options)

Criteria	Route Option Score*				
	1B	1C	1I	1J	1H
Number of dwellings on the route	3	1	4	5	2
Length of route	1	3	4	5	2
Ease of getting the VENM from the quarry rim to the quarry base	1	2	4.5	4.5	3
Technical challenges	1	5	2.5	2.5	4
Road Network Operation	2	2	4	5	2
TOTAL SCORE	8	13	19	22	13
RANK	1	2	4	5	2

* Best Rated Option = 1, Poorest Rated Option = 5.

It can be seen from **Table 4.8** that, based on the multi-criteria analysis undertaken, **the preferred option would be Option 1B which proposes access to the quarry from the Pacific Highway via Dural Street and Quarry Road and had the total lowest score of 8**.

The next best options were Options 1C and 1H, which both scored 13.

5 CONCLUSIONS

This report has considered a total of 20 potential route access options to fill Hornsby Quarry. Of the 20 options:

- 1 option (Option 3) for filling by air has been determined not to be feasible due to a number of reasons, but primarily the inherent health and safety risks and noise associated with this method of filling.
- 6 options (options 2A-2F) included a significant rail transport component and have therefore been determined not to be feasible for a number of reasons including:
    - The requirement for ancillary infrastructure to be provided including transfer stations and rail sidings, and the fact that no suitable sites could be readily identified for this purpose;
    - The current rail infrastructure at Hornsby does not allow for retrofitting of additional sidings or rail lines to accommodate the VENM transport into Hornsby Railway Station; and
    - Although not discussed within this report, rail transfer of the material is not practical where the VENM will be sourced from multiple locations (noting that the VENM source is not yet known, and this constraint will not apply in all cases), and that transport of VENM over short distances will be more expensive by rail than by road.
- 3 Options (Options 1K-1M) for transport of VENM by road were discounted from more detailed consideration, as they will result in significantly greater disturbance of local residents than other routes.
- 1 Option (Option 1A) was found to be incompatible with the proposed Hornsby Westside Revitalisation Masterplan. This option was therefore not investigated further.
- 4 Options (1D-1G) for transport of VENM by road may warrant further investigation, only if suitable locations for a transfer station can be identified in the vicinity of Bridge Road or Pacific Highway to allow transfer of VENM from road trailers to a local transport system. These options were not assessed in the multi-criteria analysis.
- Following a screening of the options, five options for transport of VENM by road were found to warrant further investigation, and have been the subject of a multi-criteria analysis. These options are:
    - Option 1B: Access via Quarry Road / Fredrick Street / William Street / Pacific Highway.
    - Option 1C: Extension of Bridge Road to facilitate direct access to the quarry. Access via George Street / Bridge Road.
    - Option 1H: One-way loop access via two preferred route options (determined to be Options 1B and 1C).
    - Option 1I: Access via Fern Tree Close / Silvia Street / Carrington Road / Galston Road / Pacific Highway / George Street.
    - Option 1J: Access via Manor Road / Rosamond Street / Carrington Road / Galston Road / Pacific Highway / George Street.

Based on the multi-criteria analysis, it has been determined that Option 1B will have the lowest overall social and environmental impact. This scenario which routes trucks from the Pacific Highway to the quarry via William Street, Fredrick Street and Quarry Road is the shortest of the five routes evaluated by the analysis, and enables existing internal quarry access roads to be used to convey VENM to the quarry base. It receives the best scores for both technical feasibility and operation of the road network.

Despite the Option 1B route being relatively short compared to most other options and the preferred route based on the multi-criteria analysis, it will still pass approximately 149 dwellings, the residents of which are likely to be subject to disruption, noise, minor local air pollution, and some health and safety risks. Cardno therefore recommends that further, more detailed investigations of the impacts associated with this preferred route option be undertaken in order to determine if the level of impact is justified and acceptable prior to the granting of approval to proceed with the quarry filling.

The Council may also consider undertaking more detailed analysis of the access options ranked second and third best (Options 1C and 1H) and/or those options which may be feasible and more environmentally acceptable if sites for associated required additional infrastructure become available.

Table 5.1 provides a summary of the overall assessment outlined in this report and shows for each option considered whether they satisfied the initial screening criteria and, for those that did, the results of the multi-criteria analysis. The table also provides reasons for the exclusion of options from further consideration following the initial screening.

Table 5.1 Overall Summary of Options

		Screening Criteria			
Option ID	**Access Option**	**Residential Dwellings Impacted**	**Site Availability for Associated Infrastructure**	**Compatibility with Hornsby Westside Masterplan**	**Comment**
Scenario 1: Transportation of VENM by Road					
1A	Access via Quarry Road / Dural Street / Pacific Highway.				Not compatible with the proposed Hornsby Westside Revitalisation Masterplan.
1B	Access via Quarry Road / Fredrick Street / William Street / Pacific Highway.				**The most feasible access option determined through multi-criteria analysis and therefore the preferred access option with a score of 8.**
1C	Extension of Bridge Road to facilitate direct access to quarry. Access via George Street / Bridge Road.				A feasible option determined through multi-criteria analysis to be the equal second ranked access option with a score of 13.
1D	Creation of transfer station at the end of existing Bridge Road with tunnel access to quarry.		Further Assessment Required		Potentially feasible but requires further consideration of suitable sites and their feasibility for the construction of infrastructure.
1E	Creation of transfer station at the end of existing Bridge Road with no tunnel access to quarry.		Further Assessment Required		

		Screening Criteria			
Option ID	**Access Option**	**Residential Dwellings Impacted**	**Site Availability for Associated Infrastructure**	**Compatibility with Hornsby Westside Masterplan**	**Comment**
1F	Creation of transfer station from Pacific Highway with tunnel access to quarry.		Further Assessment Required		Potentially feasible but requires further consideration of suitable sites and their feasibility for the construction of infrastructure.
1G	Creation of transfer station from Pacific Highway with no tunnel access to quarry.		Further Assessment Required		
1H	One-way loop access via two preferred route options (determined to be Options 1B and 1C).				A feasible option determined through multi-criteria analysis to be the equal second ranked access option with a score of 13.
1I	Access via Fern Tree Close / Silvia Street / Carrington Road / Galston Road / Pacific Highway / George Street.				A feasible option determined through multi-criteria analysis to be the forth ranked access option with a score of 19.
1J	Access via Manor Road / Rosamond Street / Carrington Road / Galston Road / Pacific Highway / George Street.				A feasible Option determined through multi-criteria analysis to be the fifth ranked (least preferred) access option with a score of 22.
1K	Access via Rosemead Road, Valley Road, Pretoria Parade the Pacific Highway.				In comparison with Options 1A-1E, significantly greater number of dwellings are subject to increased disturbance while little difference with respect to any other constraints.
1L	Access via Rosemead Road / William Street.				In comparison with Options 1A-1E, significantly greater number of dwellings are subject to increased disturbance while little difference with respect to any other constraints.
1M	Access via Benowie Walking Track / Quarter Sessions Road / Duffy Avenue / Pennant Hills Road.				In comparison with Options 1A-1E, significantly greater number of dwellings are subject to increased disturbance while little difference with respect to any other constraints.
Scenario 2: Transportation of VENM by Rail					
2A	Creation of rail spur along Bridge Road from main northern line extending to the quarry.				Not viable due to inability to install required rail infrastructure.
2B	Creation of conveyor along Bridge Road from main northern line extending to the quarry.				Not viable due to inability to install required rail infrastructure.

		Screening Criteria			
Option ID	**Access Option**	**Residential Dwellings Impacted**	**Site Availability for Associated Infrastructure**	**Compatibility with Hornsby Westside Masterplan**	**Comment**
2C	Creation of a tunnel from the existing rail line, with a transfer station at the tunnel entrance and a conveyor running through the tunnel.				Not viable due to inability to install required rail infrastructure.
2D	Creation of a tunnel from the existing rail line, with direct train access to the quarry through the tunnel.				Not viable due to inability to install required rail infrastructure.
2E	Creation of a tunnel from the existing rail line, with direct truck access to the quarry through the tunnel.				Not viable due to inability to install required rail infrastructure.
2F	Truck access to the quarry from the northern rail line utilising preferred Option 2 route.				Not viable due to inability to install required rail infrastructure.
Option 3: Transportation of VENM by Air					
3	Transport of VENM by helicopter from the material source direct to the quarry pit.				Significant health and safety risk due to close proximity of Hornsby town centre and other areas of habitation.

Key

	Satisfied constraint
	Did not satisfy constraint or further assessment required

6 RECOMMENDATIONS

Based on a multi-criteria analysis, it has been determined that Option 1B is likely to have the least overall environmental and social impact.

Option 1B – comprising access via William Street, Fredrick Street and Quarry Road from Pacific Highway – is therefore considered to be the preferred option.

It is noted however, that the preferred option still passes 149 dwellings, the residents of which are likely to be subject to disruption, noise, minor local air pollution, and additional health and safety risks. Cardno therefore recommends that further more detailed investigations of the impacts associated with this preferred route option are undertaken in order to determine if the level of impact is justified and acceptable prior to the granting of approval to proceed with the quarry filling.

Such an assessment should include a consideration of the following factors:

1. Environment,
2. Heritage,
3. Safety and risk,
4. Traffic,
5. Noise,
6. Costs / Economics (to determine if the stated objective of cost neutrality can be achieved),
7. Logistical constraints, and
8. Project lifetime.

This report also notes that Option 1C was the second ranking stand-alone access option (second to Option 1H, which is the combination of 1B and 1C). This access option (involving the extension of Bridge Road to facilitate direct access to the quarry) scored well with respect to most criteria, but scored poorly (fifth of five) with respect to technical challenges. These challenges should be further explored through detailed design should Option 1B not prove suitable as a result of more detailed investigations of impacts.

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