RS Sand Limited – Newcombe Road Sand Quarry

1 Assessment of Environmental Effects

Section 88 and Schedule 4 of the RMA require RS Sand to assess any actual or potential effects that the proposal may have on the environment and the ways in which any adverse effects may be mitigated. Schedule 4 of the RMA requires that the assessment is in such detail as corresponds with the scale and significance of the actual and potential effects that the activity may have had on the environment.

1.1 Permitted Baseline

The permitted baseline is a concept designed to disregard effects on the environment that are permitted by a plan or have been consented to regarding who is affected and the scale of the effects.

1.1.1 Tree Planting

Rule 4.4.2.58 of the District Plan states that:

> *No trees within a woodlot forest, commercial forest or shelterbelt which are or are likely to grow to more than 6m in height shall be planted closer than any of the distances specified below:*
>
> *(a) 30m from any dwelling on an adjoining site; or*
>
> *(b) 30m from any site boundary of the Residential Zone or Large Lot Residential Zone or Marae Development Zone; or*
>
> *(c) 20m from any strategic arterial road and 10m from any other road or railway; or*
>
> *(d) 10m to a vertical line directly below an overhead power or telephone line; or*
>
> *(e) 5m from the edge of any lake or from the banks of any water bodies except trees which are planted for river protection works, soil conservation or for conservation planting.*

In reverse, the rule permits up to 6m high woodlot forests, commercial forests or shelterbelts to be planted on the Site boundaries, 30m from a dwelling on an adjoining property, 20m from any strategic arterial road and 5m from the banks of Karapiro Stream.

1.1.2 Noise

Rule 4.4.2.15 of the District Plan requires that operational noise levels from permitted activities do not exceed the following limits within the notional boundary (20m from the most exposed external walls) of any dwelling:

(a)	Day time - 7.00am to 10.00pm	50dBA (L_{eq})
(b)	Night time - 10.00pm to 7.00am	40dBA (L_{eq})
(c)	Night time single noise event	70dBA (L_{max})

Additionally, Rule 4.4.2.15 of the District Plan permits construction noise levels in accordance with New Zealand Standard (NZS) 6803:1999 Acoustics – Construction Noise (NZS6803). Refer to **Table 6** below for the construction noise limits under NZS 6806.

Time of week	Time period	Typical duration (dBA)		Short term duration		Long term duration	
		L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
Weekdays	0630-0730	60	75	65	80	55	75
	0730-1800	75	90	80	95	70	85
	1800-2000	70	85	75	90	65	80
	2000-0630	45	75	45	75	45	75
Saturdays	0630-0730	45	75	45	75	45	75
	0730-1800	75	90	80	95	70	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75
Sundays and public holidays	0630-0730	45	75	45	75	45	75
	0730-1800	55	80	55	85	55	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75

Where:

(a) "Short-term" means construction work at any one location for up to 14 calendar days;

(b) "Typical duration" means construction work at any one location for more than 14 calendar days but less than 20 weeks; and

(c) "Long-term" means construction work at any one location with a duration exceeding 20 weeks.

TABLE 6: NZS 6806 Recommended Upper Limits for Construction Noise received in Residential Zones and Dwellings in Rural Areas

1.1.3 Conclusion

As the above adverse effects are permitted under the District Plan, they form the permitted baseline. In accordance with Section 104(2) of the RMA, the Proposal's adverse effects on the environment within the limits above should be disregarded.

1.2 Landscape and Visual Effects

RS Sand engaged Mansergh Graham Landscape Architects Limited (MGLA) to undertake a Landscape and Visual Assessment (LVA) on the proposal, refer to **Appendix H**. Below is a summary of the findings of the LVA.

The LVA included a combination of mapping analysis and field assessment, and evaluates:

- The existing landscape character of the site and its place in the local and regional context.
- The potential landscape and visual effects of the proposal from typical viewer locations.
- An overview of the effects of the proposal on landscape and rural character values.

1.2.1 Existing Landscape and Visual Character

The relationship between the surrounding major geographical features and the human modifications that have occurred upon them are important factors to consider when assessing how the proposal will influence existing amenity values and the rural character.

The surrounding area is characterised by alluvial plains and terraces of the Waikato Basin, as well as hill country to the east. Spurs and ridges are legible due to pastoral landcover across much of the area. The Karapiro, Mangaone and Mangawhero streams have cut down through the river terraces to form deep and incised gullies and channels within the wider landscape. The profile and paths of these streams have been progressively modified by the surrounding land use.

Although the landscape is predominantly rural in appearance, some small businesses, lifestyle blocks and urban development has influenced the landscape and natural character of the Site and surrounding environment. Sanatorium Hill (495m), Te Tapui (492m) and Maungatautari Mountain / Sanctuary Mountain (1296m) are key features within the wider landscape.

The Site is located on a flat and open river terrace on the upper edge of the Karapiro Stream gully and is characterised by its pastoral land use and mix of native and exotic vegetation, hedgerows, rural housing, and farm buildings and fencing. Most of the taller terrestrial vegetation is located on the steeper lands associated with the Karapiro Stream gully and its tributaries to the east.

1.2.2 Effect Ratings

The LVA used a rating system consistent with the recommended 7-point scale contained within Te Tangi a te Manu - Aotearoa New Zealand Landscape Assessment Guidelines, **Table 7** below compares the effect ratings with the RMA thresholds.

Document	**Effect Ratings**						
Te Tangi a te Manu – Aotearoa NZ Landscape Assessment Guidelines	Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	Very High
Act	**Threshold**						
RMA	Less Than Minor	Minor		More Than Minor		Significant	

TABLE 7: Landscape Assessment Guidelines Ratings and RMA Thresholds

1.2.3 Landscape and Character Effects

The Proposal will have ***No*** adverse effects on the surrounding steeply undulating terrain and hill country. Dominant ridgelines and spurs, large and small tracts of native bush and pastoral land with hedgerows, shelterbelts, post and wire fencing, and scattered rural buildings make up the existing landscape and character. The proposed sand quarry is not of sufficient scale to affect the key characteristics of the landscape.

The landscape and character effects on the flat alluvial plains and river terraces associated with the Waikato River and Karapiro Stream will be ***Low*** on the wider landscape and ***Moderate-High*** within the Site during operation. The Proposal will not directly affect the plains and terraces in the wider landscape but will result in a noticeable change to the topography of the Site (reduction in height from RL75 to RL40). Once operation is completed, the proposed rehabilitation works will make the Site look like the terrace landforms associated with the Waikato River and reduce the effect rating on the Site to ***Low***.

Although the proposal will not directly affect the Waikato River, the Proposal will have ***Low*** adverse effects on the wider landscape of the valley and riparian margins of the Karapiro Stream. Additionally, the Proposal will have ***Moderate-High*** effects within the Site during operation as the edge of the valley will recede and approximately 3.4ha of vegetation will be removed. The rehabilitation to emulate the terrace landforms and planting of the remnant gully slopes will reduce the adverse effects on the Site to ***Low***.

1.2.4 Visual Effects

Zone of Theoretical Visibility

Zone of Theoretical Visibility (ZTV) analysis was used to identify areas from where the Proposal would potentially be visible from. As the ZTV analysis used a Digital Elevation Model (DEM) from a combination of lidar and site-specific survey data, above ground features are not included and the ZTV maps identify the “worst-case scenario”. Additionally, not all areas of the quarry will necessarily be visible at any one time, with different parts of the working faces becoming visible in different locations over time as the extraction occurs. Refer to Appendix Four of the LVA for the ZTV maps.

The key findings from the ZTV analysis and site investigation include:

a. Intervening vegetation in combination with the gently undulating to flat terrain means that the application site and the proposed sand quarry is reasonably contained within a small visual catchment (within 1km).

b. Although theoretically visible from elevated locations to the north and west including Sanitorium Hill/Maungakawa Scenic Reserve (approximately 4km), parts of Leamington to the southwest, and parts of Cambridge to the north-west, a combination of intervening vegetation, which will largely obscure views of the Site, and the large separation distances mean that the proposed sand quarry will not be easily discernible (if visible at all) from these locations.

c. The proposed quarry will be visible from locations directly west and south-west of the application site, along SH1.

d. The application site may be viewed from locations along French Pass Road, through gaps in roadside vegetation.

As views into the pit will be screened by the upper (undisturbed) edges of the quarry and the earth bund around the outside of the extraction area, the Proposal will become less visible as the pit depth increases.

Visual Absorption Capability

The Visual Absorption Capability (VAC) of the surrounding landscape is one of the main factors that will influence a proposals' visual effect. This is the landscape's ability to integrate a development, or feature, into its existing visual character without significant change.

The Site's ability to visually absorb the change associated with the Proposal is considered to range between ***Poor-Neutral*** to ***Very Good***. From a VAC perspective, the wider river terrace landscape is well suited for the Proposal. Although the Proposal will excavate the existing farming landscape, the proposed rehabilitation will create a new landform that will be similar in appearance to other naturally occurring terrace landforms in the wider landscape and will be able to be returned to pasture. Additionally, notable views are generally restricted to within 1 km of the Site due to intervening vegetation and wider views diminish to the point where the Proposal will be less notable. The Site is not likely to be visible from locations to the south of State Highway 1.

Identified View Locations

Based on existing views, viewing frequency, viewer types, availability of the view from public property, viewer distance and the viewing time and framework available at the time of the study, five representative View Locations (VL) have been identified from within the ZTV.

View Location 1 – Newcombe Road

VL1 is located at the existing entrance to the Site and represents one of the few opportunities to view the Site from Newcombe Road. Most views from visitors to the Site and people travelling along Newcombe Road are limited due to the screening provided by existing vegetation.

The view is typical of those able to be attained from the wider surrounding rural landscape and is characterised by the flat to gently undulating pastoral farmland interspersed with shelter belts, hedge rows, post and wire fencing, farmhouses, and ancillary buildings. The Karapiro Stream gullies are not visible from this location and views beyond are largely screened by the existing dense vegetation on the sides of the gullies. This view is backdropped by the Maungakawa hills, which derives its visual amenity from a relatively uncluttered rural vista with few buildings visible.

This view does not have high public amenity value. While initial works and excavations will be visible and the movement of equipment and machinery will draw attention to the Site, as Stage 1 and plant area are lowered into the landscape, activity within the Site will become increasingly difficult to see until the floor of the extraction area and stockpile area are completely crested by the leading edge of the working face. The bund proposed around the plant area will increase the height of the gully edge and partially obscure existing views across the landscape beyond.

As excavation progresses towards Newcombe Road, the leading edge of the pit will become increasingly visible with proximity. As the pit expands to the west, the existing pine growing in the northeast part of the site will be lost, opening views to the landscape beyond. The tops of the stockpiles and the screening and processing plant may be visible above the surrounding natural landform.

Due to the generous amount of visual screening along Newcombe Road, there are minimal opportunities to view the Site from Newcombe Road and State Highway 1, or the dwelling at the end of the road. Additionally, the proposed planted earth bund along the eastern and southern site boundaries will screen views into the Site and the rural landscape beyond from this viewer location. Although the Proposal will change the landscape from open pastoral to compartmentalised by planted earth bunds along the Site boundaries, it is unlikely to change the overall rural character of the view or result in a loss of visual amenity.

The proposal will therefore have a ***Low*** adverse effect on the surrounding landscape visual and amenity values from this location during its operation, and a ***Very Low*** adverse effect following completion and restoration.

View Location 2 and 3 – State Highway 1

VL2 is located directly south of the Site and represents the most direct/clear view from the surrounding public locations, while VL3 is located to the west of the Site on the Expressway and represents views first attained when travelling from the north. Both views are slightly elevated and most of the viewing audience is expected to be transient, only obtaining fleeting views of the Site.

From these views, visual amenity is derived from a rapidly changing series of rural landscape features in the foreground juxtaposed against the constant backdrop of the hill country beyond. Viewer attention is drawn towards the skyline ridge and does not have particularly high public amenity value. While initial works and excavations will be visible and the movement of excavation equipment and machinery will draw attention to the Site, the views will be fleeting, and the planted earth bund will mitigate the differentiation from a normal farming activity.

Like VL1, these views are typical of the wider surrounding rural landscape, the Karapiro Stream gullies are not visible, views beyond are largely screened by the existing dense vegetation on the sides of the gullies and backdropped by the Maungakawa hills. Similarly, while the Proposal will change the landscape from open pastoral to compartmentalised by planted earth bunds along the Site boundaries, it is unlikely to change the overall rural character of the view or result in a loss of visual amenity.

The Proposal's adverse effect on the surrounding landscape visual and amenity values will **Low-Moderate** from VL2, and ***Low*** to ***Low-Moderate*** from VL3 due to the greater separation distance. Following completion and restoration, the Proposal will have a ***Very Low*** adverse effect.

View Location 4 – 41 Newcombe Road

VL4 is representative of the views from the two dwellings at 41 Newcombe Road, one located approximately 20m from the Site boundary and the other approximately 120m from the boundary.

While the occupiers of the dwelling closest to the Site boundary are expected to have panoramic views across the open pastoral landscape from Maungatautari Mountain to the hill country north of French Pass, views of Maungakawa are screened by the existing pine trees with the Site's western gully. The visual amenity associated with the existing rural character from VL4 is largely derived from the available hill country views (which forms the backdrop to the east) and the open nature of pastoral grassland in the fore-midground.

While the proposed 3m high earth bund along the western boundary of the Site will completely screen the work associated with overburden stripping VL4, the loss of visual amenity is likely to occur during construction of the bund. Large machinery would temporarily operate within 20m of the dwelling, and the completed bund will partially obstruct views across the open rural landscape to the east and is likely to shade the dwelling, creating adverse effects on existing amenity values. However, it will not be high enough to visually dominate the dwelling or create a sense of containment to the extent that perceptions of open space, commonly associated with the rural environment, are lost. Additionally, taking into account that 6m high woodlot forests, commercial forests or shelterbelts are permitted 30m from the nearest dwelling on 41 Newcombe Road (refer to Section 8.1.1 above), the effects of the combined bund and planting height of 5-6m will not result in adverse effects over and above the permitted baseline. Once the bund and planting are completed, the occupants of this dwelling are unlikely to be able to see the working faces of the pit or the pit floor.

Like VL1-3, the compartmentalisation of the open pastoral landscape is a common occurrence within the wider surrounding rural environment and while the Proposal will result in a change from an open pastoral landscape to a landscape compartmentalised by the planted earth bunds along the western site boundary, the landscape character will remain rural.

The proposed earth bund is likely to result in a ***Low-Moderate*** to ***Moderate*** adverse visual and landscape effects on the dwelling closest to the Site, reducing to ***Low*** to ***Low-Moderate*** for the dwelling further to the west (depending on the design and configuration of the earth bund and planting). Following completion and restoration, the landform will have a ***Very Low*** adverse effect on the landscape and visual amenity values.

View Location 5 – French Pass Road

VL5 is northeast of the Site on French Pass Road and represents one of the few publicly accessible views for road users and adjacent residents.

Most of the Site is screened from views from VL5 by foreground vegetation and the terrace landform. Visual amenity is derived from directed views across the rural landscape and does not have particularly high public amenity value. There may be clear views of the Site from private property and dwellings along French Pass Road, particularly those located near the northern edge of the Karapiro Stream gully.

Unlike views from VL1-4, the working faces, floor of the pit and machinery will be visible from this location. As the quarry progresses, the working face of the pit will move southwards towards SH1 and the floor of the pit will be rehabilitated to reduce the amount of the open pit visible and extent to which the pit sand is seen in contrast to the surrounding pastoral and vegetation. Once completed and restored, the Site will not appear out of place within the context of the surrounding river terraces.

The combination of limited views of the Site and vehicle speed and will mean that viewers travelling along French Pass Road will only have fleeting views of the Proposal and will experience it the context of the wider rural landscape and similar land-use activities.

The Proposal will have a ***Low*** adverse effect on the surrounding landscape visual and amenity values VL5 during operation and ***Very Low*** adverse effect Following completion and restoration.

Private View Locations to the North

The Proposal has the potential to be viewed from elevated locations along the northern site of the Karapiro Stream gully and most of the effects on views from the dwellings located between French Pass Road and the Site will be like those from VL5.

Requests to visit private property on the northern side of the Karapiro Stream were declined at the time of the LVA, and therefore the assessment of effects from these private view locations have been undertaken remotely, using aerial photography, ground inspection from surrounding public locations, reverse sighting from the application site and the use of the analytical and the 3D interactive digital models and simulations.

No dwellings have been identified as having a direct view into the proposed sand quarry from an identifiable living court or living area. Although some locations within each property are likely to have views of the Site. Refer to Appendix Six of the LVA for a digital simulation of the changes that will occur within the Site (from Location A of the LVA's Figure 9).

The processing area will be screened from view from the private properties to the north by the surrounding bund, with only the tops of the processing plant and tops of the sand stockpiles potentially visible. While the working face and floor of the pit will likely be visible from elevated locations along the northern side of the gully, they will progressively move southwards towards SH1 and the floor of the pit will be rehabilitated to reduce the amount of the open pit visible, reducing the extent to which the pit sand is seen in contrast to the surrounding pastoral and vegetation. Once the quarry is completed and restored, the Site will not appear out of place within the context of the surrounding river terraces.

The adverse visual and landscape effects of the Proposal from along the top and within the gully will likely range between ***Low-Moderate*** and ***Moderate*** during the operation, ***Moderate*** level effects are likely to occur during Stage 1-3 (when working benches are open and closer. The beginning of Stage 1 will have temporary ***Moderate-High*** effect until the temporary Stage 1 bund is constructed and grassed. The effects will further decrease to ***Low-Moderate*** for Stage 4 and 5 as quarrying proceeds south and the previous stages are rehabilitated.

Following completion and restoration, the adverse effect on the landscape and visual amenity values will ***Very Low***.

1.2.5 Recommended Mitigation Measures

The LVA recommends the following mitigation measures to minimise the extent of quarry and/or overburden disposal areas open at any one time, reducing effects on visual amenity and allowing the quarry to better integrate with the surrounding landscape:

a. The implementation of the Ecological Restoration proposed in the Newcombe Road Sand Quarry: Ecology Report prepared by Alliance Ecology.

b. The establishment of planting capable of growing up to 2-3m high, on the earth bunds. Only low growing species should be planted along the top of the bund adjacent to the dwellings located adjacent to the western boundary (VL 4), to ensure the overall height of the bund is minimised at this location, and potential shading effects are reduced.

c. The establishment of a bund and/or planting to prevent headlight glare along the main accessway to the site.

d. The retention of all existing vegetation (outside of the quarry footprint) within the site which screens or partially screens the site from surrounding locations. This should include existing hedgerows and the mature specimen trees lining the entranceway to the site.

e. The progressive rehabilitation of the site back to pasture (as quarrying progresses) including the recontouring of all excavated areas to resemble a natural river terrace, the reestablishment of a topsoil and subsoil profile suitable for the pastoral land use, and the re-grassing of the site.

1.2.6 Conclusions

While the Proposal will change the appearance of the Site, the establishment and operation of the sand quarry will not change the extent that it affects the wider rural landscape. Once completed and rehabilitated, the Site will integrate back

into the landscape. Accordingly, the adverse landscape character and visual amenity effects on the surrounding areas accessible to the public and 41 Newcombe Road will be ***less than minor*** or ***minor***.

The adverse landscape character and visual amenity effects from Stages 1, 2 and 3 on private view locations to the north will be ***more than minor***. However, as quarrying proceeds south, and the eastern walls and floor of these stages are rehabilitated, the effects will reduce to ***minor*** for Stages 4 and 5 (until stage 5 is rehabilitated). As above, once rehabilitated, the effects on private view locations to the north will be ***less than minor***.

1.3 Noise Effects

Hegley Acoustic Consultants Limited (Hegley Acoustic) has modelled the noise effects of the proposal and prepared a Noise Assessment, refer to **Appendix I** for more details. Below is a summary of the assessment.

The Proposal's noise has been modelled using the Brüel & Kjær Predictor programme v2021.1, which is an environmental noise calculation software package that uses a digital terrain model with ground conditions and noise sources at the various locations on the ground. During construction, the noise model is based on plant being at the closest point to the dwellings when forming the proposed bunds. Operational noise is based on each activity being undertaken at the most exposed location to the neighbours with the maximum plant operating at any one time. Accordingly, the Noise Assessment predicts the worst case experienced by the neighbours and most of the time the level of noise received will be 5 – 10dBA Leq lower.

1.3.1 Predicted Noise

Refer to Figures 10-12 of the Noise Assessment for the predicted noise contours during construction, extraction from the west and extraction at half the final depth (RL57.5).

The existing dwellings at 41 Newcombe Road (1 and 2 in Figure 13 and Table 1 of the Noise Assessment) are the closest to the proposed sand quarry and have the highest predicted noise levels, refer to **Figure 13** and **Table 8** below.

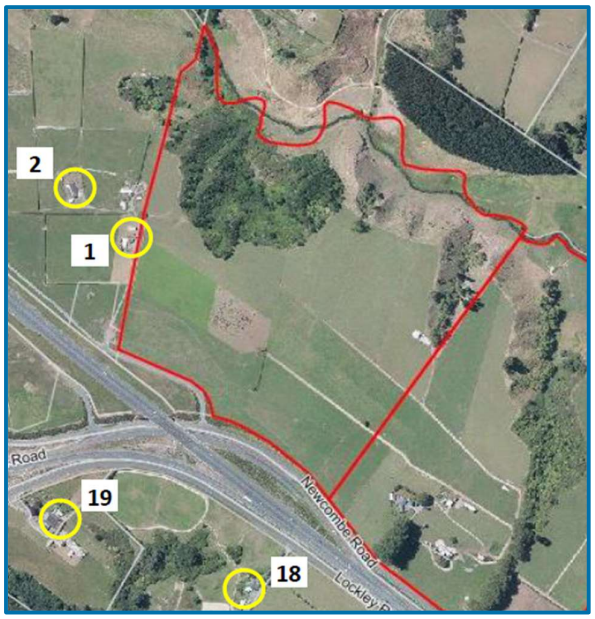

FIGURE 13: Extract from Figure 13 of the Noise Assessment

Dwelling	Physical Address	Construction	Initial Excavation	Excavation Half Depth
1	41 Newcombe Rd	69	47	36
2	1/41 Newcombe Rd	56	40	33

TABLE 8: 41 Newcombe Road Predicted Noise Levels (dBA L_{eq})

As the Proposal's predicted noise levels on the dwellings at 41 Newcombe Road do not exceed the 75dBA L_{eq} construction limit set out in NZS6803 or the District Plan 50dBA L_{eq} daytime noise limit, the Proposal's will not result in adverse noise effects on the environment beyond the permitted baseline.

Additionally, the plant noise predicted for dwellings to the south and east of the Site will be masked by traffic noise from the SH1.

1.3.2 Conclusion

As the noise model used the worst case experienced by the neighbours, most of the time the noise levels will be lower than predicted as there will be less equipment operating than has been assumed and the plant will be further from the closer dwellings.

The noise levels predicted for the dwellings to the north, east and south of the Site will be well within the limits of NZS6803 and the permitted activity standards of the District Plan.

Similarly, although the two dwellings on 41 Newcombe Road are the closest to the Proposal and have the highest predicted noise levels, construction of the proposed bund along the western boundary of the Site will allow compliance with the limits of NZS6803 and the bund will ensure that the Proposal's noise levels will be well within the requirements of the District Plan.

Accordingly, the adverse noise effects of the Proposal will be less than minor.

1.4 Air Quality Effects

Appendix J contains an Air Quality Assessment of the Proposal by Pattle Delamore Partners Limited (PDP). Below is a summary of the findings of the Air Quality Assessment.

The assessment has been undertaken in accordance with the Ministry for the Environment (MfE) Good Practice Guide for Assessing and Managing the Environmental Effects of Dust Emission – November 2016 (MfE GPG Dust). PDP has undertaken a qualitative assessment of the potential effects of the large earth moving project and bulk handling of materials, and used the Frequency, Intensity, Duration, Offensiveness, Location (FIDOL) assessment tool to predict the effects of the Proposal.

1.4.1 Meteorological

Wind can have a significant effect on dust generation and transportation, and when wind speeds at ground level reach 5 m/s they have the highest potential to transport dust off-site.

While the Karapiro Automatic Weather Station (AWS) is the closest, PDP consider that the data obtained indicates that the wind direction appears to be heavily influenced by the local terrain features and would not represent the likely wind conditions at the Site. Therefore, PDP have used the Hamilton Airport AWS data as a more accurate representation of the meteorological conditions on the Site. The prevailing wind directions at the Hamilton Airport AWS are from the west, and to a lesser extent from the north and south. Winds from the northeast to southwest have the potential to transport dust to the nearest receptor of the Site and exceed 5 m/s 0.4 and 1.1 percent of the time respectively.

1.4.2 Potential Emission Sources

Particulate matter in the environment generally comprises on suspended and deposited particulate. Suspended particulate matter stays suspended in the atmosphere for long periods of time and are normally measured as Total Suspended Particulate (TSP). Deposited particulate matter falls from the air due to its aerodynamic diameter and density and normally has a diameter of greater than 20 µm.

A subfraction of finer particulate matter generated by quarry activities fall into the category of PM_{10}, which is regulated by the NES for Air Quality. PDP's quarry experience indicates that PM_{10} is normally not measurable above background levels withing a few hundred metres from processing and handling areas.

Dust generated from quarries can contain Respirable Crystalline Silica (RCS) if siliceous materials are disturbed. PDP have assessed the potential risk of silica in Section 8.4.6 below and also noted that any mitigation measures to control dust will also control RCS emissions.

The following quarry activities have the potential to generate dust:

- Enabling works.
- Material excavation and processing.
- Operational vehicles on haul roads.

- Wind erosion of working areas.
- Rehabilitation of completed areas.

Mitigation measures that control suspended and deposited particulate, also control PM_{10} and RCS. The following measures are proposed to mitigate the potential effects of the Proposal:

1. Minimising the area of vegetation, overburden and soil removal.
2. Establishing vegetation on final exposed areas or areas that will not be disturbed for long periods of time.
3. Use of water to dampen/suppress exposed areas, material to be processed and internal roads.
4. Chemical stabilization.
5. Speed reduction (20 km/h) on internal roads.
6. Locate stockpile below the existing ground level.

1.4.3 Receptors

Refer to **Figure 14** and **Table 9** below for the location of the receptors considered by the Air Quality Assessment.

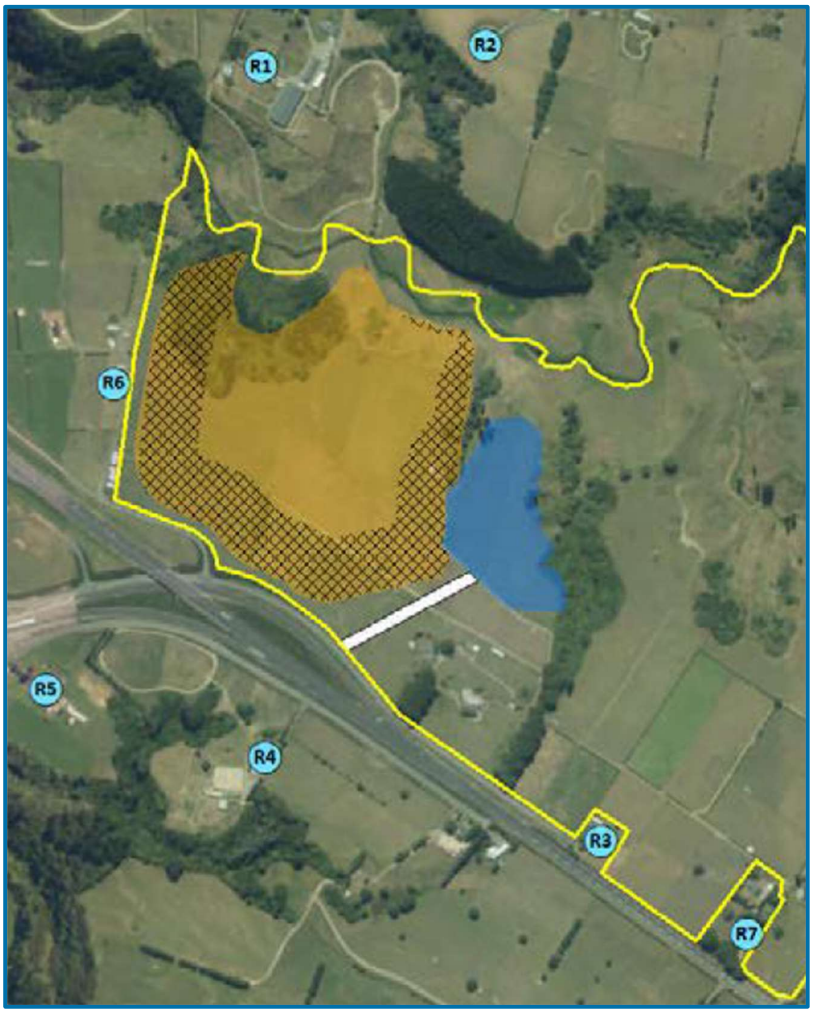

FIGURE 14: Extract from Figure 3 of the Air Quality Assessment

Receptor	Address	Distance to Pit (m)	Direction to Pit (m)
R1	42 French Pass Rd	300	North
R2	94 French Pass Rd	450	North
R3	111A Newcombe Rd	380	Southeast

R4	64 Lockley Rd	275	South
R5	12 Lockley Rd	330	Southwest
R6	41 Newcombe Rd	50	West
R7	333 Tirau Rd	530	Southeast

TABLE 9: Location or Receptors Located Close to the Site (Table 2 of the Air Quality Assessment)

1.4.4 Dust Emissions

The size and density, wind speed and direction, height of release and the distance from discharge to receptor are important factors when considering dust effects. They are interconnected and how they combine determines the potential for an effect to occur. Typically:

- Heavier and larger particles required higher wind speeds to become airborne.
- Large particles will deposit faster than smaller particles of a similar density.
- More dense particles will deposit faster than less dense particles of a similar size.
- Particles will travel further before depositing with a stronger wind.

While PDP consider that the Proposal's mitigation measures above will likely reduce particles of 50 and 100 µm to within 50m of sources that are located at ground level (typical height that dust is released from earth moving activities), the Air Quality Assessment has used the MfE GPG Dust distance of 300m from unmitigated dust sources as a conservative indication if no mitigation measures were applied.

As identified in **Table 9** above, Receptors R1, R4 and R6 are between 50m and 300m from the Proposal. Receptors R2, R3 and R5 are more than 300m away, are unlikely to be affected by dust during any wind speed and were not considered further under the Air Quality Assessment.

1.4.5 Dust Effects

The effects assessment was based on quarrying activities and wind speed at the existing ground level. As most of the activities will occur below the existing ground level, PDP's assumptions are very conservative and dust effects are likely to be significantly less once the enabling works are completed.

Frequency

Frequency relates to how often dust discharges have an effect on sensitive receptors. For dust nuisance to occur, dust producing activities need to occur at the same time as winds above 5 m/s.

As identified above, data from the Hamilton Airport AWS shows that northeast to southwest winds above 5 m/s blow between 0.4 and 1.1 of the time, and they have the potential to blow dust towards receptor R6 (the closest receptor). Given that the activities and winds need to coincide, the chances of dust nuisance occurring at receptor R6 are smaller than 1.1 percent and less likely to occur. Additionally, as excavations deepen below the existing ground level, dust producing activities will be more sheltered and the frequency of a dust nuisance on receptor R6 will be further reduced.

Receptors R1 and R4 will likely experience very similar frequency of wind speeds as receptor R6, less than 1.1 percent. Winds from the west southwest, west, and west northwest have a higher frequency of stronger winds (1.7 to 7.2 percent of the time), but the closest receptor downwind of the Proposal is over 2km away and is unlikely to experience dust nuisance even if no mitigation measures were used.

Based on guidance from the Institute of Air Quality Management, the nearby receptors will experience infrequent strong winds. Given the proposed mitigation and monitoring measures, PDP considers that the frequency of any effects from the Proposal will be low.

Intensity

Intensity relates to the concentration of dust that is likely to be experienced at any potential receptor.

While receptor R6 is only 50m from the Stage 4 excavations, the intensity of dust will be reduced with good mitigation measures and by the time works get to Stage 4, the excavations will be below the existing ground level and the proposed bunds and vegetation will be well established. Therefore, PDP consider that the Air Quality Assessment is conservative. As the remaining receptors are 275m or more form the Proposal, the dust concentrations experienced at the receptors should be minimal.

Given the proposed mitigation measures and the distances to the receptors, PDP considers that any off-site concentrations are unlikely to cause adverse effects.

Duration

Duration is the length of time that dust discharges are likely to occur.

Based on the monitoring programme in Table 3 of the Air Quality Assessment, if an event were to occur, PDP considers that the worst duration would be limited to no more than 1-2 hours.

Offensiveness

While the type of material in dust can have different levels of offensiveness, the material on-site comprises of soils and sand that form part of the existing environment. As the Site and neighboring properties are used for farming activities, it is not unusual for such properties to experience higher levels of dust and have a higher tolerance for dust effects. Therefore, PDP consider that any dust from the Proposal is less likely to be considered offensive.

Due to the limited frequency of strong winds, the proposed activities, distance to sensitive receptors and the proposed mitigation measures, PDP considers that dust emissions are unlikely to result in any off-site offensive or objectionable effects.

Location

While the Proposal's dust emissions will reduce with distance, the proposed processing and most of the excavations below ground level will have the greatest effects on dust emissions.

Although receptor R6 is 50m from the proposed quarry pit and has a greater potential for dust effects than the other receptors, the low frequency of stronger winds towards receptor R6 mean that any dust effects will be low.

FIDOL Conclusion

PDP considers that it is unlikely that most of the receptors will be affected by dust. All but receptor R6 would be 275m or more from the potential emission sources and nuisance dust is likely settle out before reaching the dwellings.

While receptor R6 would be 50m from emission sources, with appropriate mitigation measures and the low frequency of strong winds towards the receptor, the potential for dust emissions can be controlled to acceptable levels. Additionally, once works excavate below the existing ground level, there will be virtually no dust effects beyond the boundary.

Subject to appropriate mitigation measures, PDP consider that it is unlikely that the Proposal will create any nuisance dust.

1.4.6 Silica Effects

As there are no New Zealand standards or guidelines for silica concentrations, PDP assessed the potential risk of community silica exposure using a United States Environmental Protection Agency (US EPA) methodology. The US EPA data indicates that exposure levels below 1 mg/m^3 year have no increased risk of developing silicosis.

Nine samples (including overburden, fines, and sand) were collected from the Site and analysed for silica content. The samples ranged from 7 to 16 percent silica, with an average content of approximately 11 percent. PDP used the highest silica content of 16 percent in the risk assessment to be conservative.

Based on an average ambient Total Suspended Particulate (TSP) of 9 µg/m^3 and a 16 percent silica content, PDP estimated silica exposure from the proposed sand quarry to be 0.10 mg/m^3. Additionally, the TSP data likely overestimates the actual PM_{10} averages for the area and the estimated exposure is based on the standard 70 years rather than the 25 years proposed.

Given the above, PDP do not consider that there would be any significant additional silicosis risk to the community living near the proposed sand quarry.

1.4.7 Conclusion

As dust producing activities need to occur at the same time as winds above 5 m/s for dust nuisance to occur and mitigation measures are proposed, there is a low likelihood of off-site dusts effects on nearby sensitive receptors.

While receptor R6 is the closest to the Proposal at 50m, winds above 5 m/s only blow towards the receptor 0.4 to 1 percent of the time and the proposed mitigation measures will further reduce the likelihood of dust sources during stronger winds. The remaining receptors surrounding the Site are further away from the Proposal and are less likely to be affected by dust.

As the Site and surrounding area are used for rural activities, they are likely to experience an existing higher level of dust and therefore dust from the Proposal may not be considered unusual. Additionally, once excavations are 3m below existing ground level or the height of the proposed bunds, any potential dust emissions from the Proposal should be well contained on the Site.

The Proposal will not pose significant additional risk to people in the surrounding area developing silicosis. Using an US EPA methodology and the highest silica percentage from the samples (16 percent), PDP estimated the silica exposure from the proposed sand quarry to be 0.10 mg/m^3, well within the US EPA limit of 1 mg/m^3 year to have no increased risk of developing silicosis.

1.5 Transportation Effects

RS Sand engaged CKL NZ Limited (CKL) to undertake an ITA for the proposal, refer to **Appendix K**. Below is a summary of the findings of the ITA.

1.5.1 Existing Environment

Newcombe Road is a two-way, two-laned no exit Local Road (under the District Plan) with a posted speed limit of 100 km/hr. It intersects with Tirau Road approximately 300m west of the Expressway and generally runs parallel to the Expressway on-ramp. The intersection is a give-way priority T-intersection which is offset from Lockley Road by approximately 50m. Right turn bays to both Newcombe and Lockley roads are provided in the centre of Tirau Road and are offset to avoid conflicts with each other.

Tirau Road/former SH 1 is identified as a Major Arterial Road under Appendix T5 of the District Plan.

Traffic numbers on Newcombe Road are estimated to be 20 Vehicles Per Day (VPD), while in 2021, Tirau Road was recorded as having 6,865 VPD (including 12.4 percent or 2,356 Heavy Commercial Vehicles (HCVs) per day). Prior to the Expressway being completed, the 2013 traffic count for Tirau Road was over 19,000 VPD.

The only crash in the area (Newcombe Road and within 100m of the intersection with Tirau Road) recorded on Waka Kotahi's Crash Analysis System was a single vehicle crash on the Expressway off-ramp to Tirau Road (approximately 50m east of Newcombe Road). The driver lost control and hit the wire barrier on the side road, the crash did not result in any injuries. Driver distraction and fatigue were identified as potential factors in the crash, no road related factors were identified. Given the low severity and frequency of crashes reported, no road safety issues have been identified in the vicinity of the Site.

1.5.2 Traffic Generation

Two types of truck are expected to transport sand from the Site, 28 tonne truck and trailers, and 10 tonne truck only units. Some of the truck and trailer units will likely be replaced with 36 tonne High Productivity Motor Vehicles (HPMVs), which will reduce the overall number of trucks. However, the ITA adopted the truck and trailer units for the purpose of assessing traffic volume effects.

Up to 19,862 trucks are anticipated per year, comprising of 11,188 (56%) truck and trailers, and 8,674 (44%) truck only units. On average, 78 trucks per weekday and 8 trucks per hour (16 truck movements) are expected. Depending on the extraction rate and demand, up to 200 trucks per day and 20 trucks per hour (40 truck movement) are anticipated on the busiest days (once every couple of months).

Rule 16.4.2.22 of the District Plan measures VPD car equivalents, vehicles exceeding a gross mass of 3.5 tonnes are taken as 10 Car Equivalent Movements (CEM). Therefore, the Proposal is expected to generate around 800CEM on average and up to 4,000CEM per day on the busiest days.

1.5.3 Traffic Effects

Trip Distribution

The likely markets for sand from the Proposal are the Waikato Region and the upper North Island. **Figure 15** and **Table 10** below show the expected truck distribution proportion and numbers.

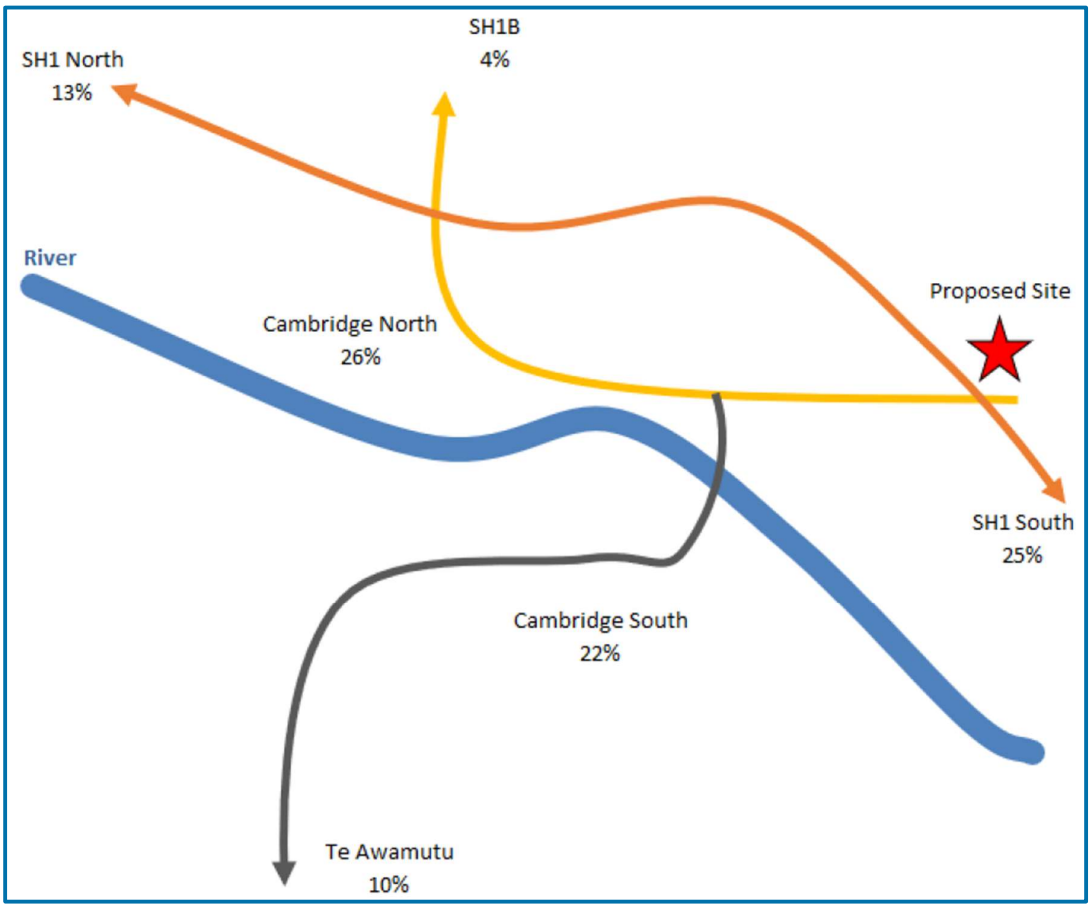

FIGURE 15: Expected Truck Distribution (Figure 5 of the ITA)

Direction	Expected Proportion	Typical Trucks / Day	Peak Trucks / Day
SH1 North	13%	10	25
SH1B North	4%	3	7
SH1 South	25%	20	49
Te Awamutu	11%	9	21
Cambridge North	26%	20	52
Cambridge South	22%	17	45
Totals	**100%**	**78**	**200**

TABLE 10: Truck Distribution Summary (Table 1 of the ITA)

As the 2017 Waipā Growth Strategy and District Plan (Appendix S1 – Future Growth Cells) identify significant residential and industrial/commercial growth to the north and south of Cambridge, approximately 48% of sand from the proposed quarry is anticipated to be used within the Cambridge area. Accordingly, restricting or confining truck access to certain routes is not considered to be practical. Sand from a local source would reduce the overall effect on the wider roading network by reducing the length of delivery truck trips and would also reduce the amount of carbon emissions.

Waipā District Roads

While all vehicles to the Site would use Tirau Road, as identified above, the road previously formed part of SH1 and carried some 19,000 vehicles per day, of which 2,356 were HCVs (around 230-240 HCV trips per hour). Tirau Road currently carries around 6,285 vehicles per day, of which 754 are HCVs (110-120 trips per hour). While the Proposal would result in an additional 16 truck movements per hour on average, Tirau Road is a Major Arterial Road under the District Plan and an increase to 770 HCVs per day would be approximately a third of what was previously carried on Tirau Road. While measures to protect the town centre from HCV access have been implemented on Tirau Road since

the opening of the Expressway, the road has a primarily through traffic function, including carrying HCVs. Therefore, CKL considered that vehicles from the Proposal can be accommodated by the surrounding road network.

At peak times approximately 15 trucks per hour would turn right out of Newcombe Road onto Tirau Road, following the old main road right onto Albert Street, onto Queen Street, turn right at the roundabout onto Victoria Street and then continue north on SH1B to the Hautapu interchange with Expressway. The route is also used by other trucks associated with the industrial areas within Cambridge and is therefore considered appropriate for the proposed sand quarry. The Proposal would increase truck movement frequency on this route from around one truck movement approximately every 1 minute 30 seconds to one truck movement every 1 minute 5 seconds, a level of change that is unlikely to be discernible day to day.

To avoid central Cambridge and local residential roads, trucks could head west on Kaipaki Road and reconnect with the state highway network at SH3 (Ohaupo Road) or SH21. Both options are notable detours from the most direct route. While they would result in an increased Vehicle Kilometres Travelled (VKT) of 3km (2-3 minutes longer) to Hamilton, they would add approximately 25km (18 minutes) to the northern Cambridge growth cells and have a greater impact on Waipā district roads.

Trucks delivering to the south or east will turn left out of Newcombe Road onto Tirau Road and use the interchange to access SH1 to the southeast. It is anticipated that an average of one truck (two movements) per hour would use this route.

A review of the Newcombe Road pavement has been undertaken. The current pavement of Newcombe Road is designed to accommodate approximately 800 trucks per year. The trucks associated with the Proposal would likely result in the pavement failing within 1-2 years and will need to be completely rebuilt. The following maintenance plan is proposed for 3-4 years to maximise the life of the current pavement structure:

- Inspection of the pavement surface on a quarterly basis including Benkelman Beam testing.
- Rut filling and pothole repairing. This would be undertaken annually within April/May before the wet season with any potholes being repaired as soon as they are identified.
- Flushing of the chip seal will require localised water cutting.
- Rehab proposal based on 25-year design life:
    - Import 80 mm M/4 AP 40 over the high spots.
    - In situ Stabilise 180 mm depth 1.5% Cement, compact to subbase industry standard.
    - Import 160 mm M/4 AP40 cement modify 1.5% cement compact to basecourse industry standard.
    - Chipseal Grade 2/4 or 3/5, followed by a single coat grade 5 three months after Grade2/4.

The pavement will be considered to have failed if the Benkelman Beam test results show rutting more than 20mm and this would trigger the reconstruction of Newcombe Road from the Site access to the intersection of Tirau Road. Conditions of consent can require the above maintenance plan and appropriate reconstruction of Newcombe Road.

State Highway Roads

Although Waipā DC Roading Team's would like slip lane/s or other direct accesses to the north from the southern interchange of the Expressway (as identified Section 7.1.2 above), Waka Kotahi have confirmed that they have no appetite to investigate northern slip lane/s or other direct accesses. Additionally, there is relatively low demand (average of 7 trucks per day (1 per hour) are anticipated to travel north out of Cambridge) and that the cost of constructing northern lanes or direct access is likely to be high.

The Safe Intersection Sight Distance (SISD) from Austroads is at least 285m for an operating speed environment of 110km/h. As the visibility from Newcombe Road east towards the Expressway interchange offramp is 290m, it is considered appropriate. The visibility west from Newcombe Road is currently reduced to 110m due to vegetation on the western side of the intersection. Accordingly, CKL recommend that the vegetation is trimmed back and maintained so that it does not reduce visibility. Subject to trimming and maintenance, CKL consider that the visibility west from Newcombe Road will be appropriate.

Figures 8 and 9 of the ITA show turning 23m truck movement movements into and out of Newcombe Road. Trucks can turn at the intersection in an appropriate manner, while allowing concurrent inbound and outbound manoeuvres, and not coming into conflict with a truck waiting to turn right in. While it is unlikely that there will be more than one truck wishing to turn right at any one time as the average traffic demands to and from the south are less than 2 VPH, the right turn lane and hatched area is long enough to accommodate two truck and trailers.

The length of the southbound Expressway on-ramp from Newcombe Road is approximately 1km and has a 1% upgrade. Austroads states that for a 1% upgrade, trucks require 2km to reach 80km/h and 890m to reach 70km/h. Therefore, the likely operating speed of southbound trucks joining the Expressway via the interchange on-ramp is 70km/h.

The ITA considered alternative routes for southbound trucks to join the Expressway or SH1. Southbound trucks using the Victoria Street / Hautapu interchange likely join the Expressway at 70km/h as the southbound on-ramp is only approximately 650m long and trucks must accelerate from rest as the interchange is controlled by signals. As the posted speed limit of the Expressway at the Victoria Street / Hautapu interchange is 110km/h (rather than 100km/h at the Tirau Road / Southern interchange), the speed difference between trucks using the on-ramp and vehicles on the Expressway is likely to be larger at the Victoria Street / Hautapu interchange. CKL consider that southbound trucks are therefore trucks are not expected to join the Expressway travelling at 90km/h.

Southbound trucks could also travel through Leamington and re-join SH1 at Maungatautari Road. This would result in trucks joining SH1 from rest without any auxiliary acceleration lanes and a significant increase in distance. Accordingly, this route is impractical based on the sand quarry operations and does not allow for trucks to join the mainline at a higher speed.

From the above options, CKL consider that using the existing southern interchange of the Expressway is the optimal route as it has the longest on-ramp length, allows trucks to merge with mainline traffic and does not affect the function of the Expressway and SH1. As an average of only seven trucks per day are expected to head south on SH1 and the length of the on-ramp will allow trucks to join the mainline at a similar speed to a regular interchange, the effects on the Expressway and SH1 is assessed as being less than minor.

1.5.4 Access Effects

The new vehicle crossing proposed to the sand quarry will have sight distances of at least 200m in both directions, which complies with Waka Kotahi's 190m visibility requirement under RTS6 for roads with operating speeds of 110km/h.

The proposed access is at least 600m from the intersection with Tirau Road but is approximately 160m from the nearest vehicle crossing to the east. While the location of the access does not meet the 200m District Plan requirement to the nearest vehicle crossing, the neighbouring crossing serves a single dwelling, will not cater for large volumes of traffic. and the reduced separation is expected to result in less than minor effects.

CKL consider that the proposed access is appropriate for the Proposal and is likely to result in less than minor effects on the wider road network.

1.5.5 Road Safety Effects

As the road safety record within the Cambridge urban area and along Kaipaki Road (as a possible alternative route) over the last five years has a relatively low number and severity of crashes involving trucks (24 out of 329 and 4 out of 56 respectively), CKL consider that there are no existing safety issues or significant differences with trucks using the roads within Cambridge or Kaipaki Road. When traffic within Cambridge is higher, Kaipaki Road is likely to be the more efficient option and during off-peak time, travelling through Cambridge may be the preferable route. CKL therefore consider that truck drivers and operators will be able to select their route based on the present conditions at the time of travel and that no consent conditions are considered necessary to restrict truck movements.

1.5.6 Expressway Extension

The ITA has considered the potential extension of Newcombe Road as part of Waka Kotahi's Cambridge to Piarere (C2P) project. While the design of the extension has not been confirmed, it would be adjacent to the state highway through to Karapiro Road to provide access to properties that would no longer have direct access to SH1.

The extension to Hickey Road would provide access to an additional six properties, it is possible that an extra six vehicles per hour or 60 vehicles per day may use Newcombe Road. CKL consider that the properties south of Hickey Road would be more likely to head towards Karapiro Road as this is more direct route to get to SH1 with a new interchange proposed at that location. Given Newcombe Road's existing low volumes of traffic and that Tirau Road use to carry over 19,000 VPD, CKL are of the view that the additional traffic from the C2P project is unlikely to create any notable congestion in conjunction with trucks from the proposed sand quarry.

In terms of the wider road network, the additional vehicle from the C2P project already exist on the network and therefore the potential extension of Newcombe Road is not considered to have a perceivable effect on the wider network.

1.5.7 Parking

As the District Plan does not include parking requirements for quarry activities, an industrial activity is the closest activity that best represents quarrying and requires a minimum of one space to be provided per 100m^2 of floor area. Given the Proposal only includes an office and workshop, it is unlikely to include more than 100m^2 floor area and therefore only one car park is required. As it is unlikely that more than 10 staff will operate from the Site at any time, no bicycle parking is required under the District Plan.

Given at least one car park can be provided and that the parking demands of the activity can be contained within the Site, the parking effects will be less than minor on the wider road network.

1.5.8 Conclusions

There is sufficient network capacity to accommodate these traffic demands with routes used by trucks being part of, or formerly part of the State Highway network. The trucks generated by the Proposal will be significantly less than when these roads operated under state highway conditions.

The ITA has considered alternative routes for trucks and concluded that there is no requirement to restrict certain routes given local trips will use local roads, and that the Hautapu and southern interchanges of the Expressway and SH1B are the best options for regional trips.

CKL conclude that there are no traffic or transportation reasons not to grant consent to the proposed sand quarry, subject to consent conditions being applied requiring the vegetation on the western side of the Newcombe Road intersection to be trim back and maintained, and the maintenance and reconstruction of Newcombe Road pavement.

1.6 Ecological Effects

Alliance Ecology Limited (Alliance Ecology) has prepared an Ecology Assessment on the proposal, refer to **Appendix L** for more details. The Ecology Assessment also includes a Long-Tail Bat Assessment by Bluewattle Ecology Limited (Bluewattle Ecology). Below are summaries of the assessments.

1.6.1 Ecological Characteristics and Values

Flora

While the predominant vegetation type on the Site is pasture, there are three stands of mature exotic trees along the driveways and around buildings near Newcombe Road, and several side gullies that contain vegetation. Refer to **Figure 16** below for the gullies and vegetation identified by the Ecology Assessment.

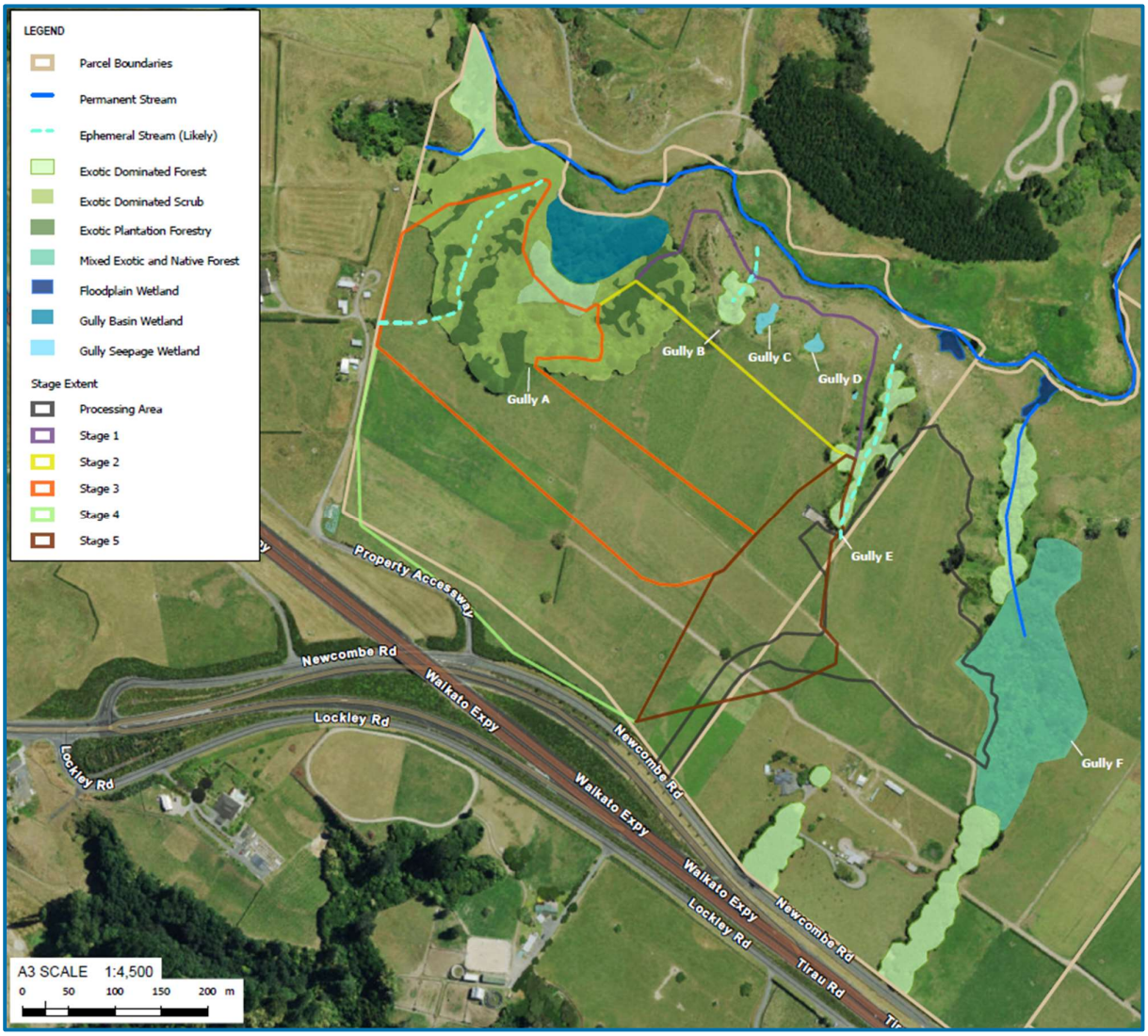

FIGURE 16: Extract from Figure 1 of Appendix A of the Ecology Assessment

The habitat/vegetation types identified in the figure above comprises of:

- Exotic Dominated Forest – Dominated exotic crack willow, poplar, grey willow, English privet, Eastern buckthorn, and hawthorn.
- Exotic Dominated Scrub – Mixed exotic scrub dominated by blackberry, Chinese privet, exotic bindweed, gorse, pampas, Himalayan honeysuckle, Japanese honeysuckle raspberry, inkweed, and broom.
- Exotic Plantation Forest – Exotic pine is approximately 20 – 25 years old with sparse understory.
- Mixed Exotic and Native Forest – Even mix of native mahoe, treefern, cabbage tree and karamu, with exotic crack willow, poplar, grey willow, English privet, Eastern buckthorn, and hawthorn.

Long-Tailed Bats

Two baseline acoustic surveys for long-tailed bats were undertaken in December 2019 and June 2020, refer to the Long-Tailed Bat Report by Bluewattle Ecology in Appendix B of the Ecology Assessment. Bat detectors were positioned at the locations in **Figure 17** below.

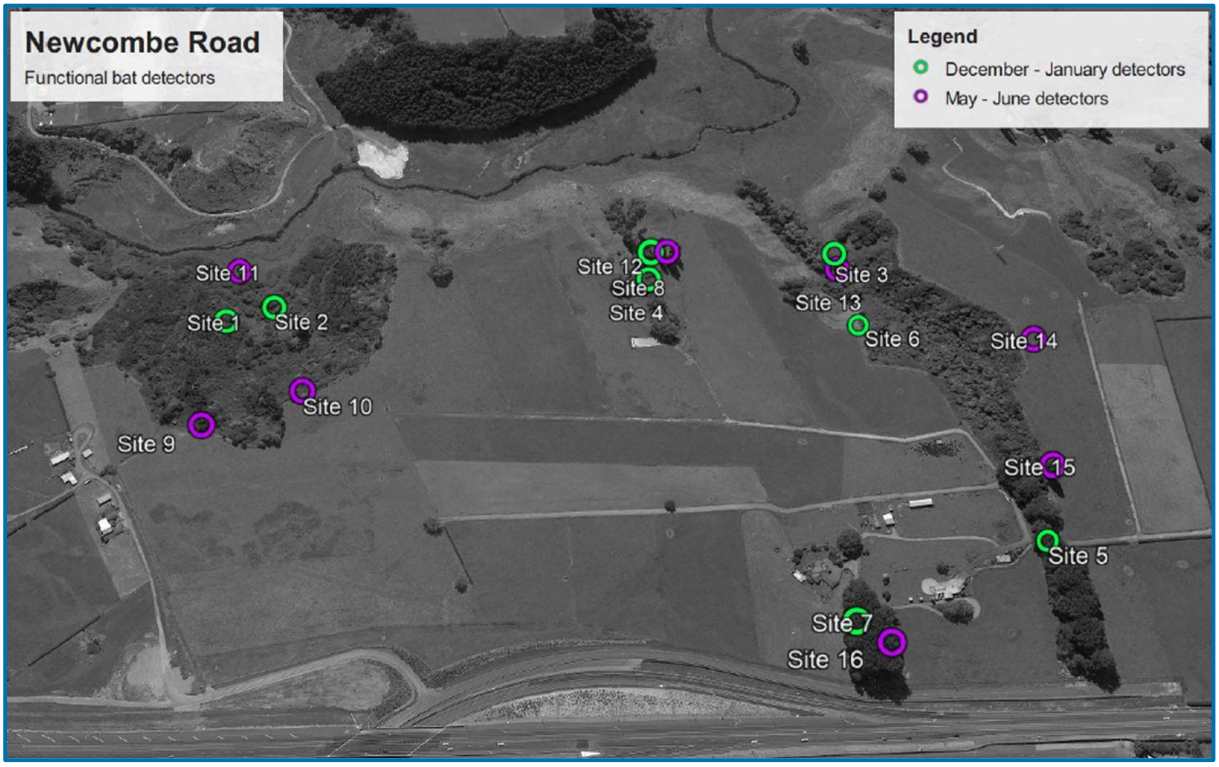

FIGURE 17: Location of Detectors Deployed (Figure 2 of the Long-Tailed Bat Report)

The December 2019 to January 2020 survey weather conditions were optimal for bat emergence (greater than 10°C, mean rainfall was low at 0.37 mm and wind conditions were mild). The survey recorded 159 bat passes over 21 monitoring nights. As the total bat passes averaged 0.95 passes per detector per night, Bluewattle Ecology considered the results an indication of a low level of bat activity.

The weather conditions for the May to June 2020 survey were reasonable (one night's dusk temperature dropped to 7.4°C, the coldest temperature recorded was -1.9°C, rainfall was present once and the wind conditions were mild). A total of 4,709 bat passes over 41 nights were recorded, averaging 14.4 bat passes per functional detector per night. Bluewattle Ecology consider the bat activity level to be low-moderate, although Site 13 detected a high-level average of 177 bat passes per night, indicating a potential bat roost.

Other Fauna

The Site may also support the following birds or fish:

- New Zealand pipit – At Risk (Declining).
- New Zealand Falcon – At Risk (Declining).
- Kaka – At Risk (Recovering).
- Bellbird – Regionally Uncommon.
- Kereru – Not Threatened.
- Tui – Not Threatened.
- Australasian bittern – Threatened (Nationally Critical).
- Spotless crake – At Risk (Declining).
- Copper kink – Not Threatened.
- Auckland tree weta – Regionally Uncommon.
- Peripatus novaezelandiae – Regionally Uncommon.
- Black mudfish – At Risk (Declining).

Refer to Table 3.4 of the Ecology Assessment for more details of the species and likely habitat and populations on the Site.

1.6.2 Potential Adverse Effects

Construction and operation of the proposed sand quarry has the potential to result in a range of adverse effects on terrestrial and wetland values.

Construction activities would/could result in:

- Approximately 27.09 ha of terrestrial and wetland vegetation/habitat loss, comprising of:
    - 23.72 ha of pasture grassland.
    - 1.55 ha of exotic pine plantation forest.
    - 0.98 ha of exotic dominated scrubland.
    - 0.53 ha of mature exotic-dominated forest.
    - 0.309 ha of native gully seepage wetland.
- The creation of habitat edge effects, altering the composition and health of adjacent vegetation.
- Direct mortality or injury to species.
- Habitat fragmentation and isolation due to the loss and reduction of available habitat types, and severance of habitat.
- Noise, vibration or dust effects.
- Sediment runoff to wetlands and watercourses.

1.6.3 Measures to Avoid, Remedy or Mitigate Potential Effects

To avoid, remedy or mitigate the above potential adverse effects on flora and fauna (excluding bats), the following measures are proposed:

- Vegetation clearance and earthworks footprint is kept to a minimum.
- Seasonal constraints on vegetation clearance to avoid or minimise effects on fauna that are legally protected under the Wildlife Act (1953).
- Vegetation clearance protocols (including physical delineation and directional felling to avoid vegetation).
- Sediment control measures will be undertaken to avoid or minimise effects on wetlands and the aquatic receiving environment.
- Vegetation/habitat clearance salvage and relocation operations for nationally ‘Threatened’, ‘At Risk’, Regionally uncommon or legally protected species present or potentially present.
- The use of bunding and mitigation plantings to primarily reduce potential effects on surrounding habitats associated with general disturbance.

To avoid, remedy or mitigate the above potential adverse effects on long-tailed bats, the following measures are proposed:

- A survey and risk profile inventory of all potential bat roost trees is undertaken in accordance with best practice before sand extraction begins;
- A Bat Management Plan (BMP) should be prepared by a recognised bat expert and implemented across the site which will outline detailed protocols around potential bat roost tree removal and ongoing monitoring; and
- The loss of habitat of bats within the site is suitably mitigated, including appropriate offset measures such as buffer planting, animal pest control, erection of artificial bat roosts, habitat restoration, and long-term protection of high quality bat habitat areas. The type and quantum of any mitigation measures is best determined by biodiversity offset compensation or quantitative modelling.

1.6.4 Level of Effects

Subject to the measures above, the Proposal’s levels of effects range from Very Low to High. The Ecology Assessment notes that:

- The level of residual effects on bats is expected to be High due to the loss of long-tailed bat habitat.

- The effects on other individual native terrestrial fauna species are Very Low or Low, and the overall cumulative level of residual effects on the native fauna assemblage is Moderate.
- The level of residual effects on gully seepage wetlands is assessed as being Moderate.

The Ecology Assessment identifies that Moderate or higher effects levels warrant habitat restoration or enhancement measures to offset or compensate for the loss in value. Refer to Section 8.6.7 below and Section 5 of the Ecology Assessment for details of the proposed offset or compensation measures.

1.6.5 Ecological Values

The ecological values of each habitat type for nationally 'Threatened' or 'At Risk species informed the overall Level of Effects assessment. Below is a summary of the terrestrial vegetation and wetland habitat types from Table 4.3.1 of the Ecology Assessment with Moderate or higher ecological value.

Ecosystem Type	Value of Habitat Type	Ecological Value
Mixed exotic native secondary forest (Gully B)	Representativeness – Moderate • Indigenous species common but exotic species also common, grazed by stock in the more accessible areas and indigenous biodiversity is compromised by the full suite of introduced mammalian browsers. Rarity/distinctiveness – Moderate • Not a threatened ecosystem type but forest with a high proportion of native plant species is locally uncommon in the landscape. Diversity and Pattern – Moderate • Several indigenous plant species are present, but diversity is compromised by livestock browsing and predation and browsing from introduced mammalian pests and from the abundance of invasive weeds. Ecological Context – Moderate • Relatively large tract of forest that provides ecological connectivity in the landscape	Moderate
Gully seepage wetlands	Representativeness – Moderate • Representative species composition but indigenous biodiversity compromised by livestock browsing and trampling as well as browsing and predation pressure from introduced mammalian pests Rarity/distinctiveness – High • Wetlands are a nationally threatened ecosystem type. Diversity and Pattern – Low • Several indigenous plant species are present, but diversity is compromised by livestock browsing and predation and browsing from introduced mammalian pests and from the abundance of invasive weeds. Ecological Context – Moderate • Small size so limited value for ecological buffering or ecological connectivity but do provide hydrological function in the landscape.	Moderate
Gully Basin Wetland (bottom of Gully A outside the footprint)	Representativeness – Moderate • Representative species composition but indigenous biodiversity compromised by livestock browsing and trampling as well as browsing and predation pressure from introduced mammalian pests. Rarity/distinctiveness – High • Nationally threatened ecosystem type and possibly one of more nationally "Threatened' or 'At Risk' wetland bird species are present. Diversity and Pattern – Moderate • Several indigenous wetland plant species are present, but diversity is compromised by livestock browsing and predation and browsing from introduced mammalian pests and from the abundance of invasive weeds. Ecological Context – High • Small size so limited value for ecological buffering or ecological connectivity but do provide hydrological function in the landscape.	High

Floodplain wetlands (Floodplain outside the project footprint	Representativeness – Low • Representative species composition but indigenous biodiversity compromised by livestock browsing and trampling as well as browsing and predation pressure from introduced mammalian pests. Rarity/distinctiveness – High • Wetlands are a nationally threatened ecosystem type and possibly one of more nationally "Threatened' or 'At Risk' wetland bird species are present. Diversity and Pattern – Low • Several indigenous wetland plant species are present but diversity is compromised by livestock browsing and predation and browsing from introduced mammalian pests and from the abundance of invasive weeds. Ecological Context – Moderate • Moderate size so limited value for ecological buffering or ecological connectivity but do provide hydrological function in the landscape.	Moderate

TABLE 11: Moderate and Higher Habitat Values from Table 4.3.1 of the Ecology Assessment

Similarly, below are the species from Table 4.3.2 of the Ecological Assessment that are Moderate or higher ecological value.

Fauna	Observed Within, or Close to the Site	Ecological Value
Long-tailed bat (Pekapeka)	Yes	Very High
Pipit (Pīhoihoi)	No, but expected to be present	High
New Zealand Falcon (Kārearea)	No, but possibly present	Moderate
Kaka	No but possibly present on occasion	Moderate
Bellbird (Korimako)	No, but assumed present in low numbers	Moderate
Kererū	No, but assumed present in low numbers	Moderate
Tūī	Yes	Moderate
Australasian bittern (Matuku hūrepo)	No, but assumed present on occasion in floodplain wetlands	Very High
Spotless crake (Pūweto)	No, but possibly present in Gully basin wetland	High
Auckland tree wētā	No but assumed present	Moderate
Peripatus	No but assumed present	Moderate

TABLE 12: Moderate and Higher Species Values from Table 4.3.2 of the Ecology Assessment

1.6.6 Magnitude of Effects

The Ecology Assessment assessed the magnitude of effects based on the extent, intensity, duration and timing of effects associated with the Proposal, and the assessment is independent of the Ecological Value assigned to each habitat/vegetation type and species.

Table 13 below summarises the Moderate or higher magnitude of effects from Table 4.3.2.1 of the Ecology Assessment, which considers the measures to avoid, remedy or mitigate in Section 8.6.3 above.

Biodiversity Value	Project Effects	Efforts to Avoid, Remedy or Mitigate	Magnitude of Effects
Exotic plantation forest (Gully A)	Permanent loss of 1.55 ha of forest.	• Further refinement of project footprint. • Vegetation clearance protocols. • Native mitigation plantings to buffer potential indirect effects.	Moderate
Exotic dominated forest (gullies A, B C, F, G)	Loss of 0.53 ha of forest.	• Further refinement of project footprint. • Vegetation clearance protocols. • Native mitigation plantings to buffer potential indirect effects.	Moderate

Exotic dominated scrub	Loss of 0.98 ha of scrub.	• Further refinement of project footprint. • Vegetation clearance protocols. • Native mitigation plantings to buffer potential indirect effects.	Moderate
Gully seepage wetlands	Loss of an expected 0.309 ha of wetlands.	• Further refinement of project footprint. • Vegetation clearance protocols. • Native mitigation plantings to buffer potential indirect effects.	Moderate
Long-tailed bats	Loss of up to 23.72 ha of variable quality habitat. Potential indirect negative effects associated with general disturbance and effects on ecological connectivity.	• Further refinement of project footprint. • Avoidance of clearance during bat breeding season when detection of roost sites is less likely. • Implementation of bat tree felling protocols to reduce the potential for harm to roosting bats.	Moderate
Copper skink	Loss of at least 3.06 ha of variable quality habitat.	• Further refinement of project footprint. • Salvage and relocation protocols.	Moderate

TABLE 13: Moderate and Higher Magnitude of Effects from Table 4.3.2.1 of the Ecology Assessment

1.6.7 Proposed Compensation Package

Alliance Ecology undertook Qualitative Biodiversity Models (QBMs) to determine the type and amount of compensation required to achieve expected No Net Loss and Net Gain outcomes for long-tailed bats, the native forest fauna assemblage, and wetlands. QBMs provide:

- Additional transparency, process and rigour to the process of addressing residual adverse effects through compensation measures at proposed habitat restoration/ enhancement site(s).
- Guidance on whether No Net Loss or Net Gain outcomes are expected to be achieved.
- 'As close to offset as possible' end of the compensation continuum.

To achieve No Net Loss and Net Gain for key biodiversity values in each location within 10 years of the Proposal's impacts, the QBMs confirmed that the following is required:

- Approximately 12.5 ha of habitat restoration and enhancement within the existing Karapiro stream floodplain and associated gully slopes along the northern boundary of the Site to:
    - Create additional habitat and ecological connectivity for bats and other native forest fauna along approximately 2 km of riparian margin and to linking up two SNAs.
    - Provide buffering and ecological connectivity for approximately 3.73 ha of floodplain and gully seepage wetlands through the native revegetation of associated wetland margins.
- Approximately 1.2 ha of native mitigation planting along the northern boundary of the Site to reduce the potential for adverse effects on adjacent wetlands.

The native revegetation is proposed to be staged over a five-year period commencing in the first winter planting season following obtaining consents. The plantings will be protected from livestock browsing through stock exclusion fencing and will also include a 20-year weed control programme with relatively intensive control until canopy-cover is achieved (between 5 – 10 years). Infill planting and control of mammalian browsers (e.g. rabbits and hares) will be undertaken as required.

All native plants will be eco-sourced and plant composition will include species that:

- Were historically present onsite.
- Have a high chance of survival and establishment within planted areas due to the appropriateness of site conditions for associated species.
- Provide a diversity and early supply of resources for fauna (e.g. year-round availability of fruits and flowers for native birds).
- Provide good roosting habitat for bats and other indigenous terrestrial fauna in the longer term.
- Are supported by iwi partners through iwi consultation and inputs.

Felled trees and fallen logs in various states of decomposition are ecologically important to forest regeneration processes and as habitat for a wide range of flora and fauna. Felled native (preferably) or exotic log deployment into revegetation sites will be undertaken and a minimum of 20 m / ha of cut up stockpiled logs will be deployed into restoration sites that

cannot move or enter streams. Long-term protection of all restoration and habitat enhancement sites be achieved through protective covenants.

Alliance Ecology considers that all biodiversity compensation principles of the Draft National Policy Statement for Indigenous Biodiversity (NPS IB) will be met through the proposed measures to address adverse residual effects on biodiversity values that cannot be adequately avoided, remedied or mitigated.

1.6.8 Conclusion

While the Proposal would result in potential adverse effects on moderate and high value habitats and species on the Site, the proposed measures to avoid, remedy or mitigate the adverse effects will reduce their magnitude to no more than Moderate levels. For those potential adverse ecological effects that cannot be avoided, remedied or mitigated, a compensation package is proposed to ensure that they are addressed to an expected Net Gain standard within 10 years of impact.

Conditions of consent can ensure that the above measures and compensation package are developed and implemented through Ecological Management Plans (EMPs), including biodiversity outcome monitoring at impact and habitat restoration sites to verify that intended ecological outcomes have been achieved (where feasible). The EMPs should also include contingency measures to set out the process if the intended ecological outcomes are not met within the specified timeframes.

1.7 Hydrology Effects

Attached in **Appendix M** is a Hydrology Assessment prepared by Te Miro Water Limited (Te Miro Water). Below is a summary of the findings of the assessment.

The Site gently slopes north towards the Karapiro Stream gully edge at a very flat grade with minor depression. There are three side gullies which are steep, protrude into the Site from the main Karapiro gully, and display no permanent water other than seepage flows in the lower reaches (approximately 2-3 m above the top of stream bank. The gullies are remnant features from a time when the Karapiro Stream was much larger and an actively incising river system. Given the well-drained in situ sub soils and deep groundwater table, no farm drains or underdrain network was identified on the Site.

Te Miro Water undertook a 2D rain on grid model using TUFLOW software to check the proposed quarry floor level in relation to the 100yr flood level for Karapiro Stream. The model confirmed that the maximum flood level is at least 5m below the proposed lowest quarry floor level due to the incised stream and wide floodplain in this area, refer to Appendix A of the Hydrology Assessment for the 100yr flood map.

The gully between the proposed plant and pit areas has no noticeable flow in the gully head, however seepage was apparent where the side gully joined the main Karapiro Stream (approximately 2-3 metres above the top of Karapiro Stream bank). The side gullies therefore do not have a permanent baseflow in their upper reaches and seepage zones emerge within the lower level. The 2D model supports this with depression storage areas within the Site, but no noticeable overland flow paths or watercourses leading to the small side gullies (only minor sheet flows less than 100mm in extreme events).

Te Miro Water did not observe any other channels or obvious overland flow paths/ephemeral streams across the Site which gives further indication that the side gullies are remnant features from when the Karapiro Gully was in an active channel forming phase as part of the main Waikato River. The side gullies may display some surface flows during extreme events due to local runoff from the side walls, however most of the water that lands on the site will not reach these gullies due to the flat typography and well drained soils.

As there are no permanent or ephemeral channels or streams within the Site and the 100 year floodplain is at least 5m below to lowest level of the pit floor, surface flows are not expected to be impacted because there is no identifiable catchment flowing to each side gully and no permanent stream flow within the gully for most of its length until seepage flow where it drops to the gully floor.

1.8 Groundwater Effects

RS Sand engaged Wallbridge Gilbert Aztec Limited (WGA) to undertake a Groundwater and Groundwater Take Assessments for the Proposal, refer to **Appendix N**. Below is a summary of the findings of the Assessments.

1.8.1 Groundwater

Hydrology

The Site is situated within the Hamilton Basin (a 2,000 km^2 tectonic basin traversed by the Waikato River), which is filled with up to 300 m thick Tauranga Group alluvial sediments (gravels, sands, silt, muds, and peats of fluvial, lacustrine and distal ignimbritic origin). The Hinuera Formation of the Tauranga Group underlies much of the Hamilton basin and was deposited by braided river systems of the Waikato River.

The Hinuera Formation contains the aquifers used most extensively across the Hamilton Basin for water supplies. The most productive aquifers consist of well sorted coarse sands and gravels, and the lithological variability generally results in several zones of higher permeability within each of the formations rather than a single, continuous aquifer. The upper layers within the formation contain perched aquifers which can dry out over the summer period and will drain to the closest gully system.

Regional groundwater flows around Cambridge are generally towards the northwest and major groundwater discharge occurs into the Waikato River and its tributaries located in deeply incised gullies. The Hinuera Aquifer is used in nearby rural areas for domestic and stock water supplies, and the deeper Hautapu Aquifer is used by the Fonterra Hautapu Dairy Factory to supply water to the plant and other irrigation bores in the area.

WGA reviewed the drilling information gathered for geotechnical purposes and a production bore was drilled on Site, and considers there to be at least three aquifers on the Site:

- A Perched Aquifer at approximately 65 m RL (7 m deep).
- An Unconfined Aquifer at approximately 33 m RL (39 m deep).
- A Confined Aquifer at approximately 19 m RL (53 m deep).

In terms of groundwater quality, water in the shallow Hinuera Aquifer to the north of the Karapiro Stream has been identified locally as having high nitrate-nitrogen concentrations. Local groundwater quality data is not available to confirm if shallow water quality on the Site is similar and a search of the WRC's bore database revealed no local groundwater quality information.

WGA estimates the current average groundwater flow within the proposed pit area is 1.5 L/s to 2.5 L/s over one year derived from recharge. Their estimate is based on a catchment area of 16 ha and a local annual recharge of between 288 mm and 500 mm per year. WGA considers that some of the recharged water is slowly percolating down to the regional aquifer, which is likely locally discharging directly to the Karapiro Stream and the Waikato River.

Effects on Groundwater

The Proposal's effect on groundwater will be limited to close to the pit area. The gullies to the east and south of the Site will restrict the extent of any potential effects on the perched aquifer in those directions. Similarly, the Karapiro Stream gully will limit the extent to which any groundwater drawdown effects to the north and seepage in this direction is likely significantly less than approximately 2.5 L/s averaged over one year.

The groundwater level in the perched aquifer to the west could reduce within about 400 m of the proposed pit area, as it will form a new groundwater discharge area closer than the current situation.

Recharge groundwater is still anticipated to flow to the Karapiro Stream under the proposed quarry but will drain through the floor of the pit area, rather than through farmland soils and the current perched aquifer. Recharge to the regional aquifer may be slightly higher once the quarry has been developed compared to the current farming land use.

Refer to **Figure 18** below for the consented groundwater takes within 1 km of the Site listed on the WRC's database.

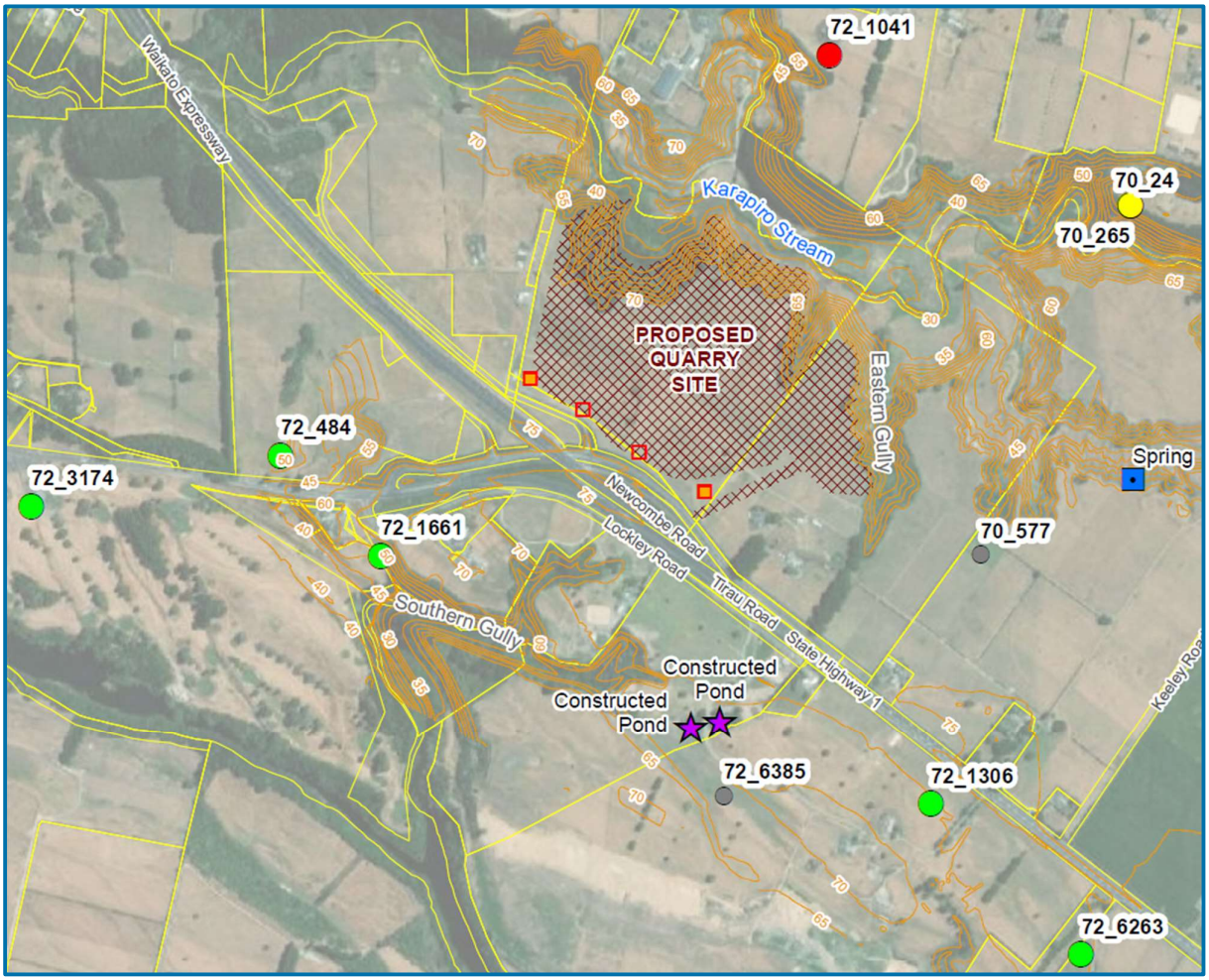

FIGURE 18: Consented Groundwater Takes within 1 km of the Site (Extract from Figure 1 of the Groundwater Assessment)

There are 12 bores within 1 km of Site (Table 1 of the Groundwater Assessment), 6 of which are to the north of Karapiro Stream, and WGA consider they will not to be affected by the Proposal. Most of the remaining 6 bores are closer to the gully to the south of the Site than to the proposed sand quarry and are 60 m deep or more, which results in the gully to the south having a stronger influence on local groundwater levels than the Proposal. While Bore 70_577 is located to the east of the Site, has an unknown depth and could be tapping the perched aquifer, the gully to the east of the Site will restrict drawdown effects in that direction.

There are two artificial ponds to the south of the Site that appear to have been constructed to approximately 65 m RL. The ponds may be sourcing shallow groundwater from the perched aquifer, but WGA has not visited the property. The Proposal would result in the discharge area for the perched aquifer moving from approximately 850 m to approximately 500 m north of the ponds. However, WGA consider that the strong influence of the nearby gully approximately 150 m to the west of the ponds will be the main controlling factor in controlling groundwater levels in the ponds.

Recommended Monitoring

To monitor the groundwater drawdown effects of the Proposal on the perched aquifer in the direction of the Expressway and the two artificial ponds, WGA recommends a series of at least four shallow piezometers and two deeper piezometers along the southern boundary of the quarry.

At least two piezometers screened in the regional aquifer approximately 150 m apart are recommended to be installed along the southern boundary of the quarry. The piezometers are to have pressure transducers installed to automatically record water levels and be downloaded every 3 months, recording for at least 6 months but preferably 1 year prior to the excavation starting is recommended to establish a baseline.

Conclusion

The Site contains an interpreted perched aquifer at approximately 65 m RL and two regional aquifers below approximately 33 m RL. The effect of the Proposal on groundwater will be limited to drawdown of the perched aquifer in

the immediate vicinity of the excavated pit. The gullies to the north, east and south of the Site will limit the extent of any drawdown effects in these directions.

Nearby registered bores and springs are not considered to be potentially affected due to the limiting effect of the gullies on quarry-induced drawdown or their proximity to other discharge locations such as the Waikato River. If the neighbour to the west of the Site has an unregistered bore, it could be materially affected and WGA recommends that a discussion with the landowner take place to determine the depth and location of any bore on the property, and whether deepening of the bore or the provision of another water supply to the property is required.

Groundwater level monitoring in both the perched and regional aquifers is recommended for the southern boundary of the property in at least six piezometers in four locations.

1.8.2 Groundwater Take

As identified in Section 5.4 above, a maximum groundwater take of 1,100m^3 of water is required per day, comprising of 500m^3 at 29 litres per second (105 m^3/hr) for sand processing and 600m^3 for dust suppression. Below is an explanation of the required groundwater take.

While 1.5 m^3 of water is normally required to process a tonne of sand, the proposed processing plant reuses approximately 75% of the water. Therefore, the Proposal only requires 0.4 m^3 of water to process a tonne of sand. As 1,455 tonnes of sand are anticipated to be processed each day, the Proposal requires approximately 582 m^3/day of water for processing.

To suppress dust, up to 50 m^3 of water per day is proposed to be used on 0.8 ha (20%) of the plant area, 2 ha of internal roads, and a maximum open quarry area of 7.25 ha (Stage 3). Therefore, the total area of 10.05 ha requires approximately 503 m^3/day of water for dust suppression.

Stepped Rate Pumping Test

A four-hour stepped rate pumping test was undertaken on bore 72_10873 (refer to Section 3 above) and the results indicate that the aquifer is confined by small silt layers unit between 43.45 m and 53.11 m below ground level. The water and drawdown levels of the step test are in **Table 14** below.

Step	Pump Rate (L/s)	Water Level (m)	Drawdown (m)
1	16	44.57	1.72
2	22	45.43	2.58
3	29	46.19	3.34
4	33	46.89	4.04
Recovery	0	42.87	0.02

TABLE 14: Results Test Bore Step Test (Table 4of Groundwater Take Assessment)

The results of the test have been analysed by using the AQTESOLV Pro v4 software package from HydroSolve Inc. and the measured drawdown curves were matched against type curves for a confined aquifer using the Theis method. The analysis indicates that the aquifer has a transmissivity of 4,000 m^2/day.

At a flow rate of 33 L/s, the efficiency of the bore is approximately 77%. However, lower flow rates normally increase the efficiency of bores. Most of the drawdown generated by pumping from the bore is due to the performance of the aquifer, rather than the performance of the bore itself.

Constant Rate Pumping Test

The bore was pumped at a rate of 29 L/s for 1,440 minutes and monitored using a water level logger recording at one-minute intervals along with manual monitoring. The recovery was monitored for a further 1,450 minutes. An observation bore was also installed 4.7 m from bore 72_10873 and monitored with a transducer logging at minute intervals.

The maximum water level in bore 72_10873 was 46.88 m below ground level at 1,440 minutes, equating to a maximum drawdown of 4.03 m. The bore recovered to 42.93 m below ground level 1,450 minutes after the end of pumping, a recovery of 98 % of the total drawdown. While the test results indicates that the drawdown would be approximately 6 m after 300 days of continuous pumping at 29 L/s, water for dust suppression will not be required continuously and the pump will not be operated continuously. Therefore, the long-term drawdown is not expected to exceed 50 m below ground level, which provides a buffer for seasonal fluctuations, or if the efficiency of the bore were to reduce.

The observation bore is screened at the same interval as bore 72_10873 and is therefore expected to have the same initial standing water level as bore 72_10873. The maximum drawdown of 0.93 m was record on the observation bore at 1,429 minutes. The results from the pumping test analysis are in **Table 15** below.

Bore	Analysis Method	Transmissivity (m^2/day)	Storativity
72_10873	Theis (Drawdown and recovery)	1,250	-
	Theis (Recovery – early time)	2,350	-
	Theis (Recovery – late time)	4,950	-
	Cooper Jacob (Drawdown – early time)	2,750	-
	Copper Jacob (Drawdown – late time)	485	-
Observation	Theis (Drawdown and recovery)	2,850	0.0007
	Theis (Recovery – early time)	2,650	-
	Theis (Recovery – late time)	4,950	-
	Copper Jacob (Drawdown – late time)	1,650	3×10^{-6}

TABLE 15: Results from Pumping Test Analysis (Table 5 of Groundwater Take Assessment)

WGA consider that bore 72_10873 is drawing water from a high hydraulic conductivity zone (potentially a paleochannel) that has a transmissivity 485 m^2/day and the storativity value of 0.0007 (indicative of a confined aquifer).

Effects on Neighbouring Bores

The closest known bore to the proposed take is approximately 450 m to the east (70_577 on the WRC database) and has an unknown depth. If the bore is drawing from the same aquifer, the drawdown would be approximately 1.34 m and result in an interference of between 2 % and 3 % of the bore depth. If the bore is drawing from the perched aquifer, the hydraulic boundary for the eastern gully separates it from the proposed take. The calculated interference for other bores in the area drawing from the same aquifer also ranges between 2 % and 3 % of bore depths. Given the projected drawdowns and the distances, WGA consider that if neighbouring bores are drawing from the same aquifer, the interference and drawdown effects on other users would be less than minor.

Effects on Consented Takes

The following groundwater takes are consented within one kilometre of the Site:

- AUTH122320.01.01 – In association with the Expressway.
- AUTH126930.01.01 – Agricultural farming – Dairy.
- AUTH126762.01.01 – To take water from a spring.

As the construction of the Expressway has been completed, the projected drawdown on the AUTH126930.01.01 take is expected to be approximately 1 m, and AUTH126762.01.01 take is drawing water from the perched aquifer, WGA consider that the effects will be less than minor.

Stream Depletion

WGA undertook a conservative stream depletion analysis using the Hunt (2003) method. The Karapiro Stream depletion after 220 days of continuous pumping is calculated to be 0.12 L/s (10 m^3/day), which is less than the permitted take rate of 15 m^3/day. WGA consider that the actual effect will be lower and less than minor as the bore will be operated in response to climate conditions to provide dust suppression rather than for 220 days continuously.

Aquifer Sustainability

The proposed groundwater take is from the Hamilton Basin - South Aquifer, which is not currently fully allocated. As the nearby consented abstractions are for small quantities, WGA considers that the proposed take will not cause any long-term sustainability issues.

1.8.3 Conclusion

Groundwater

The Site contains an interpreted perched aquifer at approximately 65 m RL and two regional aquifers below approximately 33 m RL. The effect of the Proposal on groundwater will be limited to drawdown of the perched aquifer in the immediate vicinity of the excavated pit. The gullies to the north, east and south of the Site will limit the extent of any drawdown effects in these directions.

Nearby registered bores and springs are not considered to be potentially affected due to the limiting effect of the gullies on quarry-induced drawdown or their proximity to other discharge locations such as the Waikato River. If the neighbour to the west of the Site has an unregistered bore, it could be materially affected.

Groundwater level monitoring in both the perched and regional aquifers is recommended for the southern boundary of the property in at least six piezometers in four locations.

Groundwater Take

The results of the stepped and continuous rate pumping tests identify a drawdown of 4.0 m was observed in bore 72_10873 and 0.93 m in the observation bore. Analysis of the results has enabled WGM to derive transmissivity values of 485 to 4,950 m^2/day and a storativity value of 0.0007.

The closest nearby bore (70_577) is located approximately 450 m to the east of the proposed take and has an unknown depth. WGM consider that the drawdown interference effects on the bore would be less than minor, as the projected drawdown would be 1.34 m (2-3 % based on bore depth) if it is drawing from the same aquifer or the hydraulic boundary for the eastern gully separates it from the proposed take if it is drawing from the perched aquifer.

As the Karapiro Stream depletion analysis indicates that the potential depletion would be less than 0.12 L/s (10 m^3/day), WGM considers that the proposed take will have less than minor effects on flows in the Karapiro Stream.

There is sufficient groundwater allocation available within the Hamilton Basin – South aquifer to accommodate the proposed take of up to 290,000 m^3/year.

1.9 Erosion and Sediment Effects

Southern Skies Environmental Limited (Southern Skies) has prepared a draft Erosion and Sediment Control Plan (ESCP) for the proposal, refer to **Appendix O**. Below is a summary of the draft ESCP.

The ESCP has been prepared in accordance with WRCs Technical Report No. 2009/02 Erosion and Sediment Control Guidelines for Soil Disturbing Activities, January 2009 (ESC Guidelines).

Appendix A of the ESCP includes draft drawings Stages 1 and 2, as well as the processing area.

1.9.1 Design and Principles

The design of the ESCP provides operational flexibility for the proposed quarry to meet the possible fluctuations in demand for sand. It is expected that conditions of consent will require updated ESCPs will be prepared and submitted to the WRC for certification prior to works.

The ESC's methodology is based the high soakage rates and on the use of Sediment Retention Ponds (SRPs), supported by progressive stabilisation as areas are completed. Existing vegetation will also be retained wherever possible.

Catchment areas (both clean and dirty) will be adjusted during the life of the quarry and regular audits and as-built revisions will be undertaken. Areas will be stabilised as soon as practical and in a progressive manner.

The general principles to be adopted during the quarry activities, and which will be incorporated in the ESCP, are as follows.

- Minimise the necessary area of disturbance as far as practicable.
- Stage the quarry and progressively stabilise exposed areas following completion.
- Divert clean water runoff away from the quarry works site to reduce contributing to the catchment of exposed working areas.

- Intercept, divert and impound any sediment laden runoff from exposed working areas to either prevent discharges (via soakage) or as a minimum, provide treatment via sediment control devices.
- Regularly inspect the ESC measures and undertake any maintenance necessary to maximise the sediment retention efficiency.
- Undertake ongoing assessment of the ESC methodology and, if required, adjust as the work progresses.
- Ensure staff are aware of the requirements of the ESCP and the relevant resource consent conditions.

1.9.2 Processing Area

To enable construction of the processing area, an SRP (SRP-1) will be constructed within the future water processing pond location and will be sized for a catchment of 5ha and a length to width ratio of 5:1 to fit in the processing pond footprint.

Topsoil will then be stripped from the processing area and stockpiled around the perimeter of the area to form the bunds. The bunds will be progressively stabilised with grass seed and hay mulch.

On completion of the processing area and internal road earthworks, the areas will be stabilised with aggregate.

Refer to Sheet 1 in Appendix A of the ESCP for more details of the draft measures.

1.9.3 Stage 1

To reach the bottom of the proposed pit area (RL40), a series of benches will be from the top to the bottom of Stage 1. Each bench will be bunded and will be sloped back into the bank and any runoff (not expected due to soakage rates) will be contained within the bench cut.

Once there is sufficient room at the bottom of Stage 1, an SRP (SRP-2) will be constructed to treat stormwater. Although high soakage rates are expected, the SRP will be sized for a catchment area of 5ha to enable the transition between Stages 1 and 2. Given the above, Southern Skies considers that discharges from the SRP will be limited to heavy rain events, if at all.

Overburden from Stage 1 will be placed along the northern boundary of Stage 2 up to 5m high and re-grassed for screening and storage for the future reinstatement of Stage 1.

At the completion of each stage or portion of stage, the floor of the pit area and any final batters will be rehabilitated back to grass using topsoil stockpiled during stripping operations and regrassed, fenced and water reticulation installed.

Refer to Sheets 2-4 in Appendix A of the ESCP for more details of the draft measures.

1.9.4 Stages 2 to 5

The erosion and sediment control measures for Stages 2 to 5 will be a continuation of Stage 1, the SRP built during Stage 1 will continue to be used by the later stages.

As the final RL's are achieved through the completion of Stage 1, areas will be covered in topsoil, grassed, separated from the work areas and any runoff diverted away from the SRP.

Refer to Sheet 5 in Appendix A of the ESCP for the draft measures for Stage 2.

1.9.5 Erosion and Sediment Control Details

The draft ESCP includes the following measures to avoid, remedy and mitigate the potential erosion and sediment effects of the Proposal:

- On-site soakage.
- Clean water diversions (away from work areas).
- Dirty water diversions (to SRPs).
- Sediment retention ponds.
- Chemical treatment (to improve sediment removal efficiency of SRPs).

- Silt fences.
- Stockpiles.
- Dust management.
- Stabilisation.

Refer to Section 4 of the ESCP for details of the above measures.

1.9.6 Conclusion

As the design and principals of the ESCP have been prepared in accordance with WRCs ESC, Southern Skies consider that any adverse erosion and sediment effects of the Proposal will be acceptably minimised.

1.10 Geotechnical Effects

Appendix P of this report contains a Preliminary Geotechnical Assessment of the proposal by HD Geo Limited (HD Geo). Below is a summary of the findings of the assessment.

1.10.1 Geological Setting

The Site is underlain by soils of the Hinuera Formation, which is described as “cross-bedded pumice sand, silt and gravel with interbedded peat”. In this area, the Hinuera Formation is over 35 m deep and sandy soils generally increase in density with depth due to confinement.

1.10.2 New Zealand Geotechnical Database

Two Cone Penetration Tests (CPTs) recorded on the New Zealand Geotechnical Database (NZGD) near the Site identify alternating sand and silt layers with low to moderate cone resistances (<1 to 8 MPa) within 8 m of the surface. Cone resistance increased to moderate to high values (5 to >30 MPa) in the deeper soils. HD Geo consider that these results are characteristic of the Hinuera Formation.

Four bore holes recorded on the NZGD identifies interbedding of silt and sand with Standard Penetration Test Number (SPT N) values generally between 0 and 12 in the upper 8 to 15 m. An insitu shear vane was completed in a thick silt layer at 7.5 m and record 12/1 kPa. N values increase at 9 m bgl to more than N = 19 for the remainder of the bore hole. The sand was also more consistent with the absence of interbedded silt from RL 46.

1.10.3 Site Investigations

Cone Penetration Tests

The Site ground conditions consist of:

- Topsoil assumed to be up to 0.4 m below ground level.
- Interbedded layers of moderately dense silt and sand to at least 17 m depth
- Consistently dense to very dense sand soils to at least 35 m below ground level.
- CPT refusal (>30 MPa cone tip) occurred at between 30 and 35 m due to the dense sands.

Soakage Tests

HD Geo undertook 4 falling head permeability tests on the Site and the following near surface ground conditions are consistent with the Hinuera Formation:

- 0.2 to 0.4 m of topsoil overlying.
- Alternating layers of silt, silty sand and sand to at least 4.0 m below ground level.
- Perched ground water at a depth of 1.9, 2.7 and 1.6 m respectively.

Groundwater

Ground water was encountered at between 2.1 and 10.5 m below ground level in the recent CPTs and 1.6 to >4.0 m in the soakage tests. The CPT and soakage tests confirm that the groundwater is perching within the upper silty sand and silt layers across the Site, and naturally drains towards Karapiro Stream.

HD Geo assessed that the underlying regional ground water table is at approximately 35 to 40 m below the existing ground level and generally trend towards the Karapiro Stream.

1.10.4 Geotechnical Assessment

Natural Hazards

Given the Site subsoil class is D 'Deep or soft soils', HD Geo calculated the design peak ground acceleration for the 1 in 500-year average recurrence interval earthquake event to be 0.25 g for liquefaction and 0.2 g for stability. HD Geo consider that earthquake induced liquefaction and lateral spreading are low risk.

There are no know tsunami, volcanic, geothermal, or sedimentation risks.

HD Geo has assessed the risk from landslips to be low and consideration of the proximately of the final batter in relation to surrounding properties and assets will be required.

No indications of erosion were observed during HD Geo's site investigations, and they consider the Site to be at low risk of damage due to erosion.

The general subsidence/settlement risk on the Site is low.

Liquefaction

Given the regional groundwater table is approximately 40 m below current ground level and CPT data only extend to a maximum depth of 35 m below ground level, HD Geo undertook a qualitative assessment of the risk from liquefaction.

HD Geo used a worst-case scenario where a 10 m thick profile of the very dense sands below the water table can liquefy and assumed an undrained shear strength from the CPT testing.

Liquefaction is unlikely to occur in the sand soils above 40 m due to the absence of a regional ground water table, and the CPT and bore hole testing also indicate that the deeper, older sand soils (>30m depth) are of a density that is unlikely to liquefy. The risk of liquefaction is expected to be low due to the geometry of the proposed pit area and the Proposal should not significantly impact the liquefaction risk of the neighbouring properties.

Slope Stability

HD Geo undertook a quantitative slope stability assessment using the proprietary software 'SLIDE'. The Factor of Safety (FoS) requirements for the final geometry are:

- No less than 1.5 for long term, normal, static conditions.
- No less than 1.2 for short term, seismic, and high groundwater conditions.
- No less than 1.0 for liquefied (lateral spreading) conditions.
- >1.0 assumes no deformation has occurred.

While the slopes adjacent to the Site appear relatively stable with no signs of recent instability, near surface soil creep is present and aerial images indicate an area of historical instability to the west of CPT01. The circular type of scarp and longer, shallower angles at the base of the slope indicted failures have occurred more than 80 years ago. The vegetation that is now present may indicate localised groundwater that has been seeping and causing the slope to regress further compared to the surrounding slopes.

Although aerial imagery and geomorphology also show that slopes are marginally stable and may experience failures during higher ground water conditions or due to undermining of the slopes, HD Geo were able to iterate the model until representative FoS values were achieved. The results of HD Geo's assessment indicate that the final batters will have FoS values above those required in all scenarios.

A worst-case liquefaction scenario of soil parameters for 10 m below and assumed groundwater level at 40 m was used by HD Geo to assess the risk of lateral spreading. They consider that the Site has a low risk of lateral spreading as the liquefied model indicates a FoS of 1 is achieved.

HD Geo consider that the final batters of the proposed pit area have FoS values above those required in all scenarios, and therefore the risk from instability is low and the Proposal is not likely to affect any of the neighbouring properties or infrastructure. HD Geo recommend that a Building Restriction Zone (BRZ) of 10 m should still be applied to the top of

final quarry batter, and apply to bunds, power poles and other infrastructure. Any future development or earthworks proposed within this 10 m BRZ should be assessed by a geotechnical engineer.

They also recommend that the soils used for the bunds are well compacted and re-vegetated to mitigate erosion. Small scale slumping may occur but can be remediated with an excavator when required.

In relation to the processing area, the proposed bund must be set back from the top of the slope so it does not have a negative effect on the stability of the existing slope and the water storage pond must have an impermeable membrane to stop any water decreasing the stability of the surrounding slopes.

As no modifications are proposed to the slopes surrounding the Transpower pylon HAM-KPO-A0013 (refer to Figure 4 above) HD Geo consider that the Proposal will not have a negative effect on the pylon.

Settlement

During the establishment and operation of the proposed sand quarry, de-watering of the perched water table may occur, HD Geo consider that a worst-case scenario could draw water down 2 to 3 m and result in between 20 to 30 mm of settlement in the silt layer at between 7 to 9 m below the current ground level.

Due to the current geometry of the area with gullies and tributaries present, HD Geo anticipate that if any settlement does occur, it will be localised to within the Site.

1.10.5 Conclusion

HD Geo considers that the Proposal is unlikely to cause any adverse geotechnical effects on the adjacent properties subject to the following recommendations:

- The final batters are constructed at 3H:1V.
- Further assessment occurs for any change in geometry.
- The slope geometry around the power paillon will remain unchanged and therefore current stability will be unaffected.
- The bund should be well compacted and vegetated to mitigate erosion.
- Groundwater seepage must be controlled appropriately to avoid erosion.
- The water storage pond in the processing area must be fully lined.
- The processing plant bunds will need specific assessment to determine how close they can be constructed to the surrounding slopes.

1.11 Cultural Effects

Te Hira Consultant Limited (Te Hira) has undertaken a CIA of the Site and Proposal for both the resource consents and an archaeological authority from Heritage New Zealand Pouhere Taonga (HNZPT), refer to **Appendix Q**. This CIA outlines the position of Ngaati Korokii-Kahukura and Ngaati Hauaa, and is endorsed by Waikato Tainui. Below is a summary of the assessment.

1.11.1 Tāngata Whenua

The following three iwi have confirmed rights and interests within the area of the Proposal.

Waikato-Tainui

The rohe (tribal region) of Waikato-Tainui encompasses Auckland in the north, Te Rohe Potae (King Country) in the south, the west coast, and the mountain ranges of Hapuakohe and Kaimai in the east. The iwi of Waikato-Tainui comprises 33 hapu, 68 marae and 80,000 registered tribal members, and are tāngata whenua and exercise mana whakahaere within their rohe.

Waikato-Tainui have an intrinsic relationship with the natural environment, are kaitiaki of their environment and consider the holistic integrated management of all elements of the environment to be of utmost importance. Landmarks of significance to Waikato-Tainui in proximity to the Site include the Waikato River and the sacred mountain of Maungatautari.

The iwi of Ngaati Korokii-Kahukura descends from the high chief Korokii and are 16 generations removed from Hoturoa, the captain of the Tainui canoe. The rohe of Ngāti Korokī Kahukura stretches south of Hamilton City, along the Waikato

River to the northern end of Lake Arapuni, to the western side of Te Awamutu and back to the southern portion of Hamilton City. Ngaati Korokii-Kahukura comprises of several hapū (Ngaati Waihoro, Ngaati Ueroa, Ngaati Huakatoa, Ngaati Houruamua, Ngaati Werewere and Ngaati Poorangi) that lived around the base of Mount Maungatautari and the Waikato River. Ngaati Korokii-Kahukura exercised tikanga to manage, defend and develop their tribal area for the benefit of all its members.

Mount Maungatautari is the tuupuna maunga, a living taonga and a symbol of mana to the people of NKK. The forests offered shelter to the people in hard times and provided foods such as birdlife and native flora and fauna. The Waikato River is the tuupuna awa and also a living taonga to Ngaati Korokii-Kahukura, its waters had traditional healing powers and was a source of aquatic foods. The Waikato River was the principal highway of trade and transport for Ngaati Korokii-Kahukura wheat, flax and potatoes to Auckland.

Ngaati Hauaa

The iwi of Ngaati Hauaa descends from Hauaa, son of Korokii and Tumataura. Ngaati Hauaa's area of interest is generally associated with the maunga of Taupiri, Maungatautari and Te Aroha. The area encompasses lands and waters east and north of Mount Maungatautari, Tauwhare, parts of Hamilton City, Morrinsville up to Te Aroha, and across the kaimai ranges into Matamata and Hinuera.

1.11.2 Matters of Significance

Ngaati Korokii-Kahukura and Ngaati Hauaa noted the following matters when considering the Proposal and undertaking the site visits:

1. There could be the potential for archaeological findings. Appendix 2 and Appendix 3 of this report should be implemented if this occurs.
2. The location of wetlands and the Karapiro Stream within and near the site area. Ecological mitigation and compensation developed by RS Sands will help with the restoration and enhancement of the site area.
3. The site visit by the cultural advisor (tohunga) for tāngata whenua revealed that there are no spiritual matters of concern for the Site or Proposal.
4. Much of the activities and its impacts will be managed on site. There is an opportunity for tāngata whenua to be involved in the rehabilitation of the site in the future and the wider vision for the area.
5. Extraction of groundwater will be required to operate the plant.

1.11.3 Known Sites of Significance

The CIA identifies the following known sites of significance to iwi in proximity to the Site:

- Horotiu Paa.
- Paa – Sentry Lookout.
- Te Paa o Taowhakairo.
- Borrow Pits and Archaeological Sites.

Refer to **Figures 19** and **20** from their location in relation to the Site.

FIGURE 19: CIA Paa Extract (paa identified by green houses and Site's property boundaries in yellow)

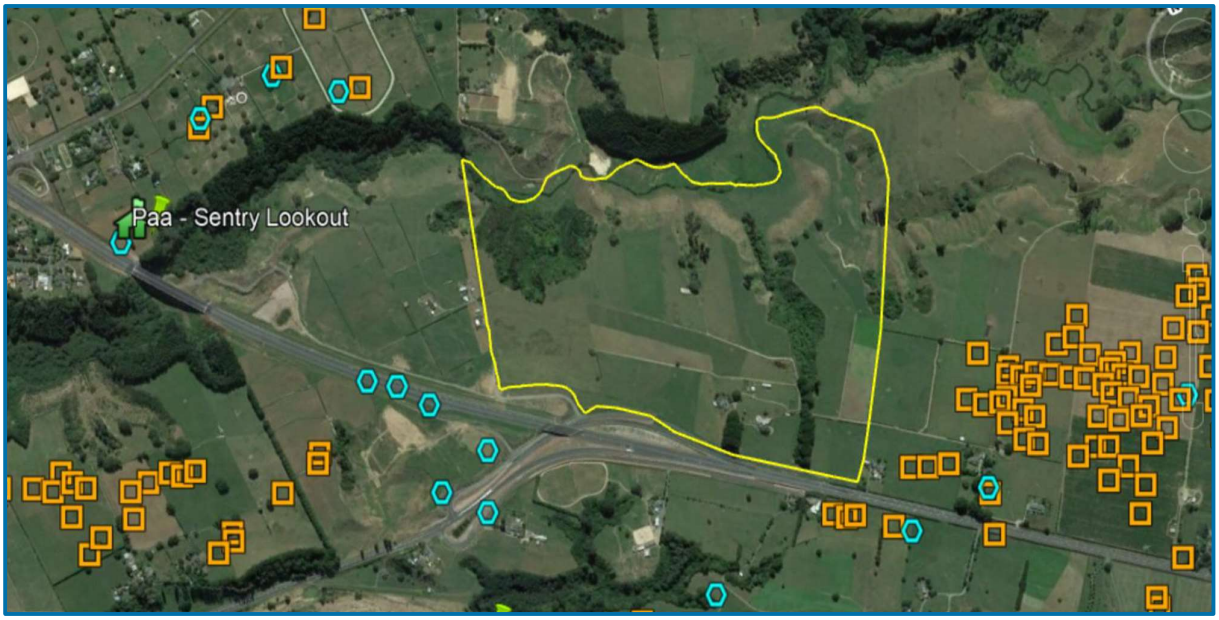

FIGURE 20: CIA Borrow Pit and Archaeological Sites Extract (borrow pits shown as orange squares, archaeological site are blue hexagons and Site's property boundaries in yellow)

While the Site does not contain any known sites of significance to iwi, given the surrounding borrow pits and archaeological sites, iwi consider that there is a high likelihood that the taonga may be discovered within the Proposal area.

1.11.4 Assessment and Recommendations

Te Hira has assessed the Proposal against the provisions of Te Ture Whaimana o te Awa o Waikato / The Vision and Strategy for the Waikato River and Tai Tumu, Tai Pari, Tai Ao / The Waikato-Tainui Environmental Plan, and below is a summary of the assessment:

- RS Sand has considered opportunities to further the Vision and Strategy for the Waikato River, and ecological mitigation and compensation on adjacent wetlands and Karapiro Stream floodplain is proposed.

- Both Ngaati Korokii-Kahukura and Ngaati Hauaa continue to practice their relationships with the Waikato River and its resources. Taangata whenua should be engaged in all conditions noted in this table to provide for the restoration and protection of their relationship with the whenua and its waterbodies.
- Understanding the history and significance of the area can better improve work practices and care on-site. Tāngata whenua are to lead cultural induction, cultural safety and protocol training to onsite staff to improve awareness of the area and its cultural importance to the Iwi.
- RS Sand have demonstrated a desire to minimise future impacts from the Proposal.
- That restorative planting occurs near water sources and streams to improve stability in surrounding soils and minimise impacts on water courses.
- If taonga or koiwi are found, the protocols attached to the CIA (Appendices 2 and 3) must be applied to the Site, Ngaati Korokii-Kahukura and Ngaati Hauaa are traditional custodians of any newly discovered taonga or artefacts and are to be notified immediately if any koiwi are discovered.
- Ngaati Korokii-Kahukura and Ngaati Hauaa should be included in rehabilitation of the Site to reflect the surrounding environment.
- Recommend that RS Sand grow opportunities for the benefit of the community and tāngata whenua.
- Tāngata whenua have applied tikanga Māori to the Proposal through the site visits and application of protocols to protect cultural values.
- Ngaati Korokii-Kahukura and Ngaati Hauaa consider that a of consent should require the material leaving the site should be sealed, covered, or wet to minimise material escaping the transport.
- RS Sand are discussing directly with tāngata Whenua in relation to a koha (gift) beyond consent conditions that leaves a legacy of ‘betterment’ and ‘gifting’ to the taonga that are impacted by the Proposal.

1.11.5 Conclusion

The Site does not contain any known wāhi tapu or sites of significance to iwi. As there are recorded borrow pits and archaeological sites in the surrounding area, iwi consider that there is a high likelihood that taonga may be discovered within Site and recommend that accidental discovery protocols to avoid, remedy and mitigate potential adverse cultural effects. In addition, RS Sand’s archaeologist also considers that there is potential for unrecorded sites to be present and recommends that an archaeological authority be sought from HNZPT for works within 40 m of the Karapiro Stream gully edge as a precautionary measure to enable better management of archaeological risk should archaeological material be encountered (refer to Section 8.12 below).

Ngaati Korokii-Kahukura and Ngaati Hauaa have confirmed a neutral position in relation to the Proposal, subject to the conditions and recommendations by RS Sand. Waikato-Tainui endorses the recommendations and position of Ngaati Korokii-Kahukura and Ngaati Hauaa as tāngata whenua of the area where the Site is located.

1.12 Archaeological Effects

Sian Keith Archaeology Limited (SKA) has undertaken an Archaeological Appraisal of the Site and Proposal, refer to **Appendix R**. Below is a summary of the findings of the appraisal.

1.12.1 Recorded New Zealand Archaeological Association Sites

The Archaeological Appraisal area covers north of the true right bank of the Waikato River and is bounded to the north by the Karapiro Stream. **Figure 21** and **Table 16** below show the location and summaries of the archaeological sites recorded on the New Zealand Archaeological Association (NZAA) database in the vicinity of the Site.

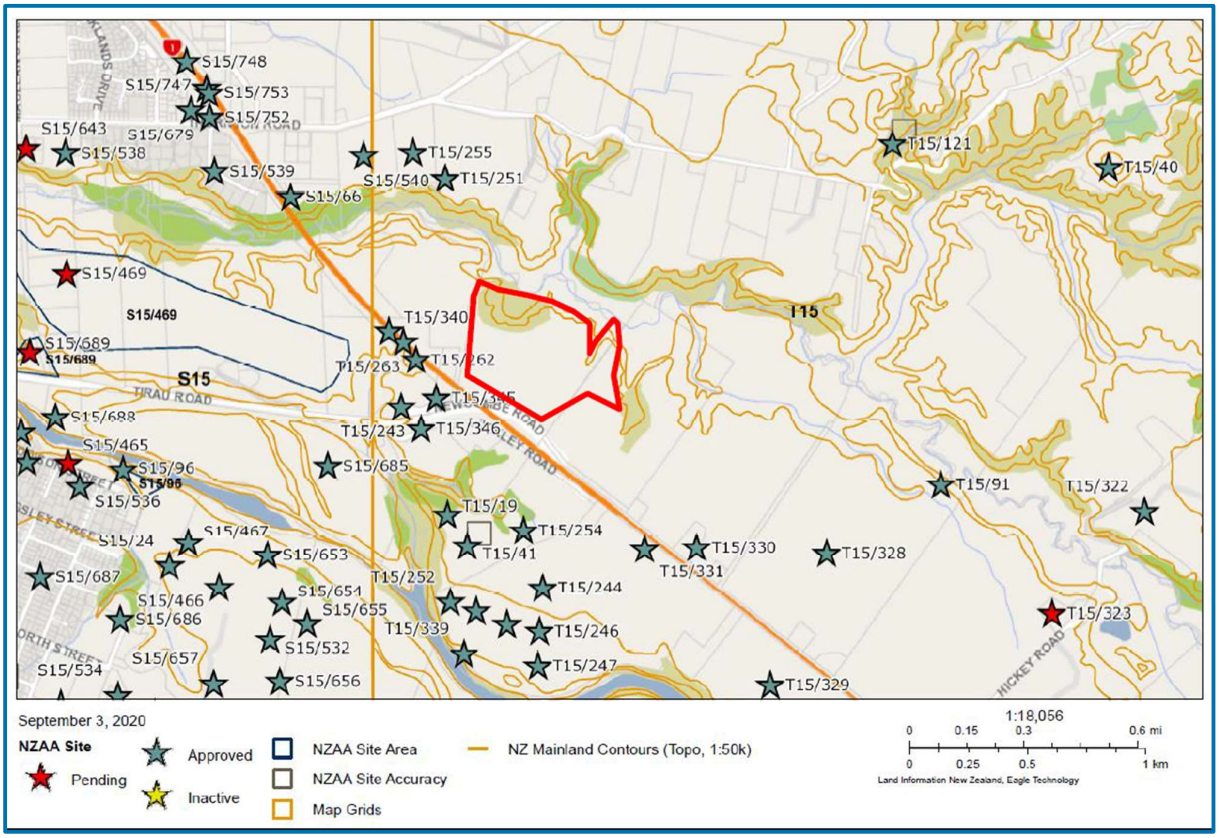

FIGURE 21: NZAA Recorded Archaeological Sites (Figure 1 of the Archaeological Appraisal)

NZAA Site	Type	Distance from Site	Risk (Y/N)
T15/243	Two borrow pits	325 m	N
T15/262	Māori-era ovens and pits	200 m	N
T15/263	Māori-era ovens and pits	265 m	N
T15/340	Historic ditch & bank fence	330 m	N
T15/345	Māori-era ovens and postholes	240 m	N
T15/346	Borrow pits	340 m	N

TABLE 16: Summary of the NZAA Sites (Table 1 of the Archaeological Appraisal)

Given the above, the archaeological landscape is dominated by Māori-era horticultural activity, namely borrow pits, garden soils, fire features and storage pits. The closest recorded paa to the Site is T15/19, which is approximately 510m to the south-west. There are no archaeological sites currently recorded within the Proposal area, but it is likely that the study area has not been surveyed by an archaeologist in the past.

1.12.2 Historic Survey Plans

The earliest survey plan reviewed by SKA dates to around 1866 and likely represents the earliest formal survey of the study area. No annotations of archaeological interest are visible on the plan and there is no evidence that any of the allotted soldiers had immediately occupied these sections.

Survey plan SO2847 is dated 1898 and there are no annotations of archaeological interest visible within the Site.

1.12.3 1940's Aerial Imagery

Aerial imagery of the Site from the 1940s shows open farmland in pasture with development limited to field boundaries, shelterbelts, and small buildings (probably farm sheds) and water troughs. SKA considers that there is no clear evidence for pre-1900 archaeological activity on the images assessed.

1.12.4 LiDAR Imagery

The Site is relatively flat and contains evidence of field drains and ploughing. SKA identified four anomalies which may represent borrow pits within the Site. The anomalies are sub-circular/ oval, are visible as depressions, and three of them are situated along the eastern side of the Site and are focused on a former levee of the underlying Hinuera Surface.

1.12.5 Site Visit

A visual pedestrian survey of the Site on 14 September 2020 and focused on the margin of the gullies and four anomalies on the LiDAR imagery. Minor spade-cut test pitting and hand-auguring was undertaken by SKA to determine the nature of the subsoil, the soils profiles, and to look for evidence for horticultural activity.

SKA excavated 2 test pits along the northern edge of the Karapiro Stream gully. The eastern pit provided a natural soil profile consisting of topsoil formed from organic material and parent subsoil overlying natural tephra. The western pit indicated a possible cut edge with a fill deposit like pit fill, suggestive but not conclusive of archaeological activity.

Tests were also undertaken at the four anomalies on the LiDAR imagery. They did not indicate modified garden soils or suggest that the anomalies are the result of pre-European quarrying. One augur located in the centre of south-eastern most depression has a fill deposit deeper that the length of the augur (<0.8m). While there is no immediate explanation for this, SKA consider the lack of evidence for sand in the surrounding ground does not support that it is a borrow pit and it could be due to more recent activity.

No visible field evidence for archaeological activity was identified across the remainder of the Site.

1.12.6 Archaeological Assessment

Although there is evidence for pre and post European archaeological activity in the surrounding landscape, there are no recorded or identified sites within the Proposal area. The soil profiles tested indicate that the Site is intact and if archaeological activity is present, it has likely survived in good condition beneath the topsoil.

SKA consider that the geographic location of the Site suggests a relatively favourable aspect for pre-European activity. Specifically with access to the Karapiro Stream gully.

1.12.7 Conclusion

Given the general attractiveness of the Karapiro Stream and gully, the proximity of gardens and recorded paa in the wider landscape, and the potential pit features identified in the western test pit, there is potential for archaeological evidence to being encountered during works along the edge of the Karapiro Stream gully.

SKA recommend that an archaeological authority is sought from HNZPT for works within 40 m of the Karapiro Stream gully edge as a precautionary measure, and to enable better management of archaeological risk should archaeological material be encountered. Accordingly, RS Sand will obtain an archaeological authority prior to starting works within the 40m setback.