SH1/SH29 Intersection Upgrade Project
Waka Kotahi NZ Transport Agency
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15 October 2021

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Dear Michael

SH1/SH29 Intersection Upgrade Project – Response to further information request from Waikato Regional Council

Thank you for your letter dated 20 September 2021 requesting further information pursuant to section 92 of the Resource Management Act 1991 (RMA) in relation to Waka Kotahi's application for resource consents for the SH1/SH29 Intersection Upgrade Project (Project).

Please find below Waka Kotahi's responses to the points raised on the following subject matters:

- Stormwater
- Ecology
- Construction water take
- Construction Air Quality

STORMWATER

Request 1.
The stormwater Assessment Report states that hydraulic modelling shows that there are only minor increases in flood depths across the project site as a result of the project and that this does not warrant the provision of peak flow attenuation. The report also presents some general discharge parameters which are applicable for the receiving environments i.e. Water Quality Treatment, no extended detention or flood attenuation, however there is no discussion of whether intermediate storm (2, 10 year ARI) management is required.

Given the receiving environment on the eastern side of SH29 and SH1 south consisting of small ephemeral drains with multiple driveway crossings intermediate storm management would be expected to mitigate any downstream effects of the proposed intersection upgrade.

Please provide justification of why intermediate storm management is not required, specifically in this catchment. Further, please provide pre and post impervious area comparisons and peak flow comparisons at each discharge location for the 2 and 10-year ARI events.

Response

Please refer to Figures E.3A to E.4A of the **attached** Hydraulic Modelling Report (**Attachment A** to this letter), which compare the predicted flood depth differences between the Project scenario and baseline scenario (without Project) for the 1 in 2 year annual recurrence interval (ARI) plus Climate Change (CC) event (Figure E3.A), and for the 1 in 10 year ARI plus CC event (Figure E.4A). Given the generous amount of flood plain storage available, and the small changes generated by the Project (no more than 50 mm flood level change outside the proposed designation boundary, except in one very localised area where the increase is still less than 100 mm), we consider that the provision of additional peak flow attenuation for intermediate storms within the stormwater devices is not warranted.

Pre and post impervious area comparisons for the 2 and 10 year ARI events are provided in Figure 4-1 and Table 4-2 of the Stormwater Assessment in Appendix G of Volume 3 of the Application.

Please refer to **Attachment B** to the letter which provides the pre and post peak flow comparisons for intermediate storm events at the discharge locations shown in Figure 1 below.

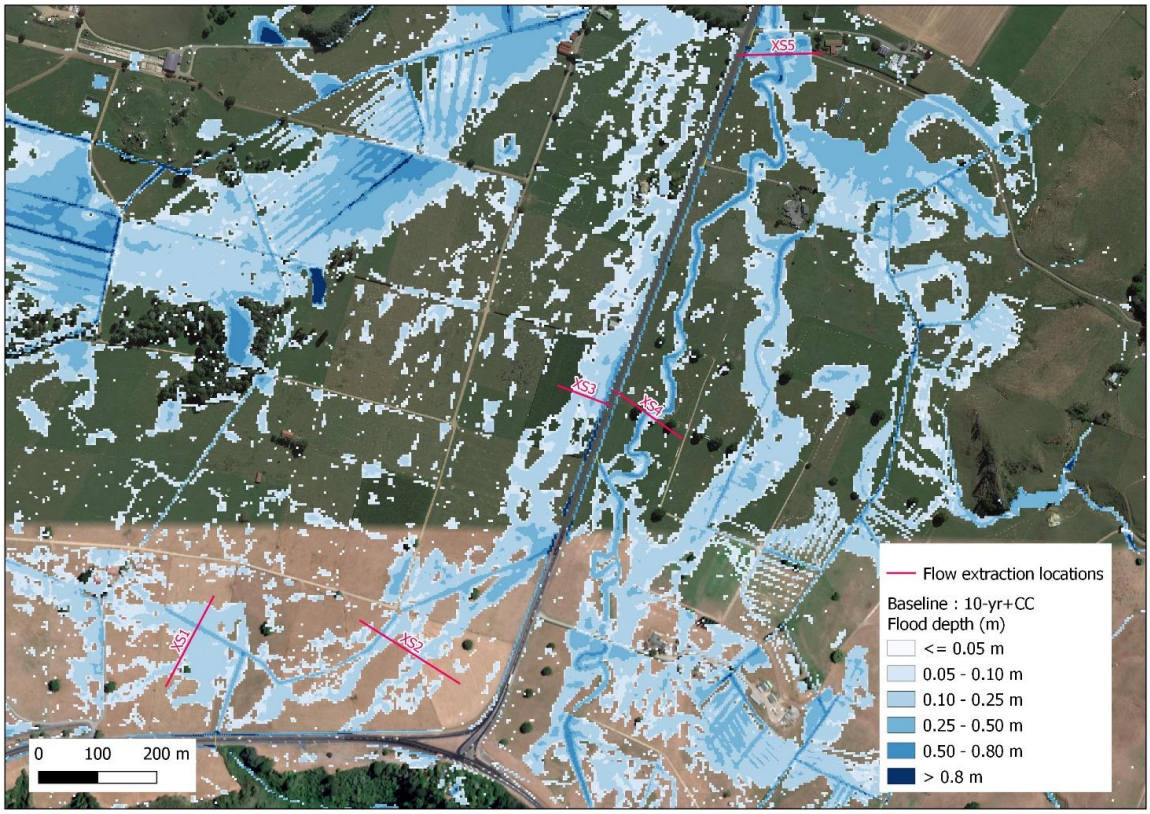


Figure 1 - Flow extraction at key watercourse locations (basemap shows 1 in 10 year ARI baseline scenario)

In most instances, the change in flow is negligible. There are minor increases in peak flow for the 1 in 2 year ARI event at XS2 and XS3 however the flow velocities remain well below the erosive threshold as shown in Figure 4-7 of the Stormwater Assessment Report.

Request 2.

Discussions with the Applicants consultants prior to lodgement confirmed a flood model report has been prepared however this was not included in the application. Please provide this flood report for review (as it may help answering several of these s92 queries). Figure 4-4 presents an increase in flood level of approximately 100mm in the general location of the 450mm culvert (culvert 2) which is

proposed to be removed under SH1 North (Karapiro Leg). To mitigate the increase flooding it is proposed to undertake minor filling in land outside the designation to remove the flood effects. The report mentions if this is not suitable then alternative pipe options are available. Given the land in question hasn't been able to be accessed and no detailed survey has been undertaken of levels, there is concern that the effects of removing this culvert could be worse than presented in the report.

Response
Please find **attached** the Hydraulic Modelling Report and refer to the response to Request 3 below.

Request 3.
If the 450mm culvert is to be removed, please provide further detailed topographic survey to define the extent of the catchment and fall of the drains. Please also include a plan to show the extent of the fill required on the adjacent land and confirm whether permission from the landowner has been obtained for this to occur. If approval has been obtained, please provide a copy. Alternatively, please provide more detail of the alternative pipe options discussed in the report.

Response
As discussed in the Stormwater Assessment Report, Culvert 2 (being the 450mm culvert) primarily functions to convey stormwater runoff from the northern SH1 roadside drain over to the southern SH1 roadside drain before discharging to the head of the western gully via an existing outlet structure. The hydraulic model results indicate that this culvert also receives some incidental stormwater flows from the adjacent farmland during large storm events, however most of the flood flows tend to travel northward following SH29.

The stormwater management system proposed for the Karapiro leg is to replace Culvert 2 by collecting road runoff via gravity piped networks and/or swales before conveying runoff to Wetland Pond 01 on the other side of SH1 for treatment, and finally, to discharge runoff via a piped outfall to the base of the Unnamed River water level.

The existing roadside drains and Culvert 2 need to be replaced by this system because these assets will not be compatible with the proposed road layout. Further, the existing discharge location at the western gully head is in an area that is highly erosion-prone and is at risk of slip failure at the gully-head. The instability of the gully, and proposed road layout were key factors that led to the decision to move the discharge location from the gully-head to the Unnamed River water level and replacement / relocation of Culvert 2.

The current Digital Elevation Model is considered to be an accurate representation of the topography for this area. The site is flat pastoral land with a shallow grassed 'watercourse' with no surrounding features that would risk obstructing the LiDAR scan performance. A detailed topographical survey is not expected to yield flood modelling results that would significantly differ to the current results.

In response to recent feedback and guidance from Waikato Regional Council (WRC), the Waikato Regional Plan rules relating to the proposed removal of consented structures requires evaluation against the 1 in 50-year ARI event. Subsequently, the 1 in 50-year ARI event was run in the hydraulic model in order to compare the change in flood extent and depths between the baseline and proposed scenario (i.e. with the Project). The model results indicate that there are no flood level increases greater than 50 mm outside of the proposed designation boundary at Culvert 02 for the 1 in 50-year ARI storm event, as shown in yellow in Figure 2 below.

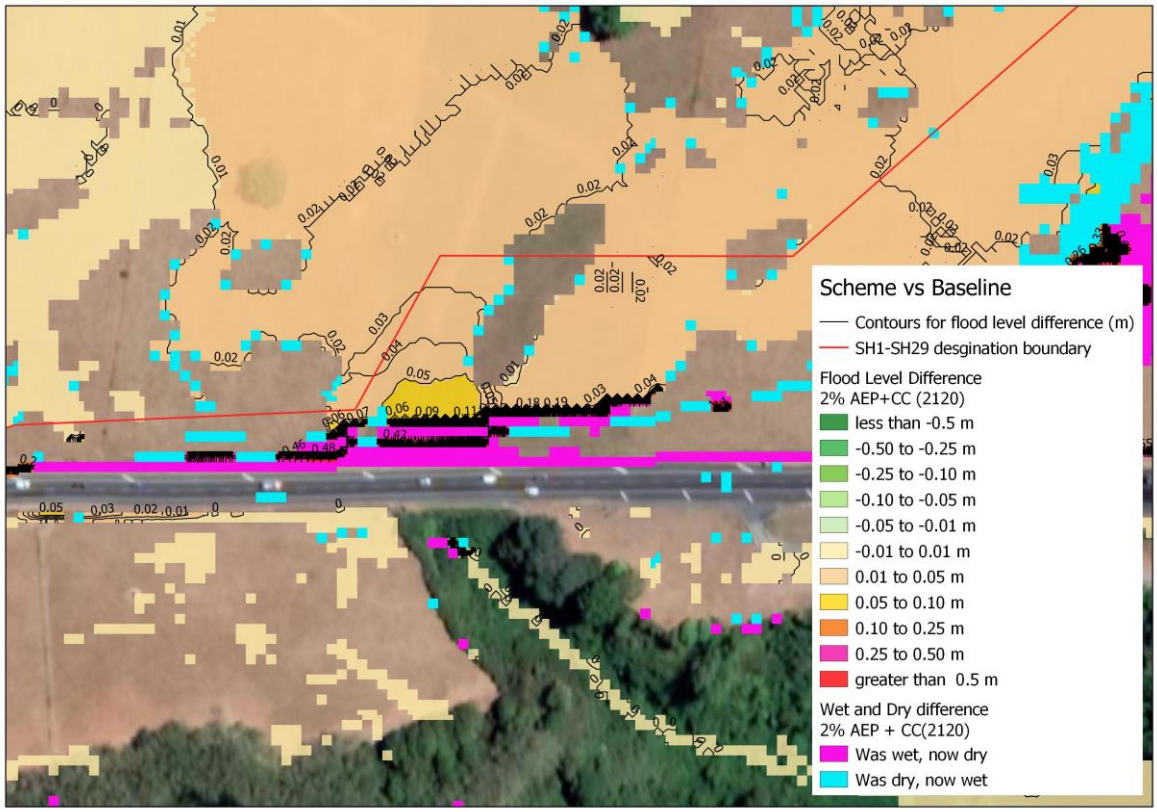


Figure 2 - Change in flood extent and depth at Culvert 2 for the 1 in 50-year ARI storm

The hydraulic model shows that the increase of flood depth in the 1 in 50-year event, that is ≤40 mm from the baseline, lasts for a duration of less than 1 hour. Given the rural context i.e. open pastoral land clear from any structures, the impact of the increased flood depth for a duration of less than 1 hour on a small section of land is a potential transitory flooding effect that is considered to be de minimis. Therefore, the removal of Culvert 02 can be considered a permitted activity under Rule 4.2.5.1 of the Waikato Regional Plan.

Given the minimal effect, mitigation by earth filling is not considered to be warranted. As such, no plan or written approval from the landowner is required.

Request 4.

The application proposes specific stormwater devices however, it also discusses that other devices (mainly soakage) may be considered during detailed design. The application states the soakage devices will provide the same function as wetland swales i.e. treat, convey and dispose of stormwater runoff. Given as various options are proposed for stormwater management devices, please provide a table presenting required discharge parameters for each discharge location. Please note that a draft consent condition will be required to ensure the final stormwater management system achieves the discharge parameters at each discharge point.

Response

The stormwater design provided as part of the resource consent application is at a concept stage, to demonstrate that stormwater runoff can be managed appropriately in accordance with WRC's *Waikato stormwater management guidelines May 2020* (WSMG). As such, design parameters are not considered necessary at this stage. However, Waka Kotahi proposes a new condition for the

stormwater discharge permit to ensure that the stormwater runoff is treated in accordance with WSMG as follows:

> *Stormwater runoff from the state highway carriageway shall be treated in accordance with WRC's 'Stormwater Management Guideline' (WRC Technical Report 2020/07).*

Request 5.

Soakage is generally not suitable as a primary means of treatment for stormwater runoff due the risk of pollutants being conveyed to the underlying groundwater table. If soakage is proposed for management of runoff from carriageway surfaces, then pre-treatment of stormwater runoff will be required. Please provide detail of pre-treatment measures that will be adopted if soakage devices are utilised.

Response

Where soakage is pursued for management of stormwater runoff, pre-treatment will be provided by swales designed in accordance with Figure 8-14 of the WSMG. The swale design will ensure a minimum of 300 mm depth of filter media for runoff to percolate through before reaching the groundwater system.

Request 6.

A 750mm culvert located on the eastern side of SH29 which discharges runoff from the farm drain to the roadside drain is proposed to be removed. Please confirm that the farm drain will continue to discharge to the proposed roadside drain/watercourse diversion i.e. confirm that removing the 750mm culvert will not prevent water discharging from the farm drain to the road drainage system.

Response

As explained in the Stormwater Assessment Report, Waka Kotahi intended to remove the existing DN750 culvert and therefore, to remove the connection from the eastern watercourse to the new roadside drain. The culvert was probably installed by a past or present landowner to divert low flows from the eastern watercourse to the roadside drainage system for the purposes of improving grass yield to the farm. We can find no evidence that the existing DN750 culvert was consented.

As a result of this request, Waka Kotahi has reconsidered this approach and will reinstate connectivity between the eastern watercourse and the new roadside drain by relocating the DN750 culvert to suit the new road configuration. The hydraulic model results indicate there are no substantial differences in terms of stormwater effects between reinstating or removing this connectivity.

Request 7.

The SH1 Karapiro leg has an existing water table drain on the northern side of the carriageway. Please confirm whether the existing water table drain west of the extent of works will discharge to the new swale drain (and ultimately the proposed wetland)? If so, please confirm the design catchment assumed for the swale drain and whether the wetland been sized for this catchment beyond the extent of works.

Response

This section of the existing water table drain drains directly west of the Karapiro leg and forms part of the sub-catchment of wetland pond WP01. It has been accounted for when sizing this device.

Request 8.

All stormwater treatment devices will be required to be designed in accordance with WRC Stormwater Management Guidelines 2020 (Technical report 2020/18). This is acknowledged in various parts of the Stormwater Report, although the is some ambiguity in terms of refence to other guidelines. Please ensure and explicitly confirm that the designs are based on Technical Report 2020/18.

Response

Please note that the technical report reference to the WRC Stormwater Management Guidelines should be TR2020/07, not TR2020/18 as stipulated in the above request. As required by Waka Kotahi's proposed consent conditions, all stormwater treatment devices will be designed to meet the WRC Stormwater Management Guidelines 2020 TR2020/07.

Request 9.

An important element of wetland function is the need to maintain hydric conditions for wetland plants. Please provide a detailed description of soils analysis that will be undertaken to determine whether a liner is required for the proposed wetland and wetland swales. The WRC Stormwater Management Guidelines 2020 (Technical report 2020/18) Section 8.5.7.1 provides recommendations for soil analysis and impermeable liner design.

Response

Pages 21 and 23 of the Stormwater Assessment confirm that the wetland pond and wetland swales will be lined (to meet the recommendations in Section 8.5.7.1 of WSMG) and that there will be periods when the devices will dry out. As such, plant species would be carefully selected to suit these conditions.

ECOLOGY

Request 10.

No evidence or detail is provided to support the quantum or efficacy of the proposed 1:1 ratio for compensation replacement of lost habitat with 'higher quality' habitat. In our review it has been assumed that some form of planting to replace lost long-tailed habitat is what is meant by 'higher quality' habitat. Please provide further clarification of the rationale for the sufficiency of the 1:1 2. planting ratio.

Response

The vegetation within the western gully that will be removed is dominated by exotic weed species, such as privet and blackberry, but will also include some native shrubs. Therefore, 'higher quality habitat' refers to replacement of that vegetation with native vegetation. This native vegetation will result in betterment of the intrinsic botanical values of what currently exists. Furthermore, this replacement planting will also result in better quality riparian habitat, improving freshwater values and habitat for birds and lizards. It is also noted that privet is classified as a plant pest WRC, and blackberry is a weed banned from sale. The removal of these pest plant species is therefore beneficial from an ecological perspective.

Planting of trees for the loss of bat habitat should be considered independent of the proposed replacement planting. Planting for the loss of bat habitat has been proposed as an additional measure.

The 1:1 quantum is based on a qualitative assessment of what is considered appropriate, based on generally very low botanical values and dominance of plant pest species within the impacted vegetation. The efficacy and success of the proposed replacement planting will be ensured through the development of the Vegetation Management Plan (condition 43, Schedule One to the consents) which will detail the extent and location of plantings and how these will be maintained, monitored and protected over time.

Request 11.

The applicant's assessment of effects of aquatic ecology is generally accepted in that adverse effects on the aquatic biota of Lake Karapiro (including the arm referred to in the application as the Unnamed River) are likely to be a Net Low after suitable mitigation is applied. Mr Kessels does not consider sufficient evidence has been presented to suggest there will be a Net Gain in ecological value as the EIA does. You are invited to comment on this if the applicant considers this to be of material significance to the overall assessment of effects of the proposal.

Response

Currently, some of the road runoff from SH1/SH29 is discharged into the western gully untreated, which then enters the Unnamed River. As a result of the Project, stormwater will be treated through the use of a wetland pond, wetland swales and planted swales (which is discussed in Section 4.4 of the Assessment of Effects on the Environment- Ecology, Appendix D of Volume 3 of the Application). The wetland pond will result in the treatment of contaminants, such as heavy metals and hydrocarbons, before they enter the Unnamed River, and therefore result in betterment from the current situation. Furthermore, the removal of mainly exotic weeds and their replacement with natives will likely have a positive effect on the Unnamed River in the long term, by improving native biodiversity and ecological function. For these reasons, Waka Kotahi's ecologist reiterates his view that there will be a Net Gain in ecological value.

Request 12.

Please respond to the following questions and update the Bat Management Plan accordingly.

Request 13.

Please provide further evidence to support the assumption that the extent and type of planting and lighting proposed will be sufficient to address the loss of habitat for bats.

- *Lighting should typically be no greater than 0.3 Lux and 27000 Kelvin at the boundary of key bat habitats.*

Response

With respect, the reference to "27000 Kelvin" in this request is an error, and it should read "2700 Kelvin". Waka Kotahi confirms that the lighting will be no greater than 0.3 Lux and 2700 Kelvin at the boundary of areas of vegetation that are considered key bat habitats, as shown by the pink lines in Figure 3 below (taken from the **attached** updated Bat Management Plan (BMP, **Attachment C** to this letter)). These areas are the riparian vegetation to the south west of the existing intersection and the stands of tree to the north west of the existing intersection.

Figure 3 – Illustration of the key bat habitats, identified by the pink lines, where light levels will not exceed 0.3 Lux.

Request 13. continued

- *Installation of artificial bat roosts should be included in addition to the proposed replacement planting, to address the time lag effects associated with loss of potential bat roost trees. Please provide detail on the extent and location of plantings and how these will be maintained, monitored and protected over time*.

Response

For each confirmed active bat roost tree that is to be removed, Waka Kotahi will install four artificial bat boxes of the "kent" design on a suitable tree(s) adjacent to the designation. Aluminium predator exclusion banding will be placed on the trees situated both above and below the boxes. The BMP has been amended accordingly (**Attachment C** to this letter).

The detail of the extent and location of plantings and how these will be maintained, monitored and protected over time will be incorporated into the Vegetation Management Plan (see proposed condition 43), which is to be certified by WRC.

Request 14.

It is accepted that the risk of discovering an occupied bat [roost tree] *is low, but the potential effects of removal of an occupied bat roost is Very High. For that reason, it is not accepted that compensation planting of 8 trees (1:8) ratio for replacement of trees for loss of occupied bat roost trees would be sufficient. Please confirm whether wording such as follows will be accepted to provide a contingency for that occurrence.*

if it is identified that the tree containing an occupied roost cannot be retained, then consultation should be undertaken with WRC and the Department of Conservation. The Wildlife Act s 63 (1c) indicates it would be an offence without authorisation to rob, disturb, or destroy, or have in his or her possession the nest of any absolutely protected or partially protected wildlife or of any game.

Response
Waka Kotahi's ecologist considers the proposed 1:8 ratio for replacement of trees for the loss of an occupied bat roost tree is sufficient compensation for the long term loss of a roost tree. To address the short to medium term loss of a roost tree habitat, which appears to be Council's ecologists main concern, Waka Kotahi proposes the inclusion of artificial bat boxes.

Waka Kotahi's ecologist considers that the effects of removal of an occupied roost would be Very High only if it was a maternity roost. The effects of the removal of a solitary bat roost would be High, as that removal is unlikely to have a major effect on the population level.

Waka Kotahi does not agree to include WRC's proposed wording as a condition because this requirement is already included in the Vegetation Removal Protocol as follows:

> *The Project Bat Ecologist will notify the Waikato Regional Council and Department of Conservation within 12 hours of when the occupied bat roost was discovered and provide relevant information such as photos, GPS co-ordinates.*

This notification will trigger the involvement of WRC and Department of Conservation (DOC).

Request 14. continued
For the removal of any trees which are or have been occupied by bats, provide details of the type of roosting and development of avoidance, remediation, mitigation and offset/compensation ratios commiserate to the type of roost tree found (including extent of and type of planting, ratio of artificial bat boxes for each roost tree removed and ongoing maintenance and protection measures).

This shall include assessing a suitable offset or compensation measure to address the period between the loss of roost tree habitat and new roost habitat being functional provision of alternative roosting sites, including suitable indigenous or exotic trees for roost habitat, number of artificial roost boxes, their ongoing protection and management to enhance their roosting potential (for example, encouraging cavity formation, extending the planting of high quality bat habitat, translocation of roost trees or providing artificial bat houses and/or targeted pest control.

Response
Waka Kotahi has considered the above two paragraphs of Request 14 and has amended Section 3.2.2 of the Bat Management Plan (BMP) to include additional mitigation:

- For the loss of each tree assessed as having "high" roosting suitability Waka Kotahi has increased the 1 to 4 planting ratio to 1 to 8 planting ratio.
- Should roosting bats be confirmed within any of the vegetation to be removed, consultation with WRC and DOC is required and four artificial bat boxes of the "kent" design on a suitable tree(s) will be installed adjacent to the designation, and with aluminium predator exclusion banding situated both above and below the boxes. The bat boxes are considered to be a suitable mitigation measure to address the period between the loss of roost tree habitat and new roost habitat being functional.

To address the matters in paragraph two of Request 14 above, Waka Kotahi proposes to require expanded BMP reporting, as outlined in Section 5 of the updated BMP (**Attachment C** to this letter). It is proposed that a Tree Clearance and Mitigation Report will be submitted to WRC and including the following matters:

- Details of all trees felled (GPS location, species, DBH, photos and roost suitability rating), and actions taken to ensure no bats were harmed during clearance;
- Details of measures taken to avoid wherever possible, felling of trees assessed as having high roosting suitability, or of confirmed bats roost trees;

- Details and quantities of required mitigation based on number and quality of roost trees removed. This will include proposed planting sites and their protection and management, locations of artificial roost boxes and proposed management; and
- Confirmation that mitigation for habitat loss (if required) has been implemented.

This report will be provided to WRC, 2 months following the completion of all tree felling associated with the Project. Please refer to Section 5 of the updated Bat Management Plan for these changes.

Additional Matter 1.

Pages 11 and 12 of the Bluewattle Ecology review proposes inclusions for the BMP. We note that in discussions with you on 28 September 2021 you confirmed that our section 92 response should address those matters, as they were inadvertently left out of your section 92 letter.

Suggested change number 28.

A suitably qualified Bat Ecologist (defined as an ecologist who has been approved by the Department of Conservation with a Bat Competency Class D or Class E certificate – or redefined categories) shall undertake the following measures to minimise the risk of injury or mortality of bats in any trees or shrubs with a diameter at breast height greater than 15 cm identified by the Bat Ecologist as potential bat roost trees which are required to be felled during construction:

Response

Section 1.3 of the BMP, lodged as part of Appendix D of Volume 3 of the Application requires that the Project Bat Ecologist (PBE) is a Class D or Class E DOC competency. It is noted that Class C2 can assess and identify roost trees and supervise arborists but a Class D ecologist must be present for felling in case there are bats remaining in tree (monitoring and inspection protocols should eliminate this risk altogether).

Suggested change clause (a).

a) Automated bioacoustic monitors (ABMs) will be placed on site at least two nights prior to works commencing at potential bat roost trees to gain further understanding as to whether bats could be present in potential roosting sites within the trees. During this monitoring period overnight weather conditions must meet the following criteria;

- *i. Air temperature does not drop below ten degrees Celsius from sunset until four hours after sunset;*
- *ii. Mean overnight wind speed does not exceed 20km/h;*
- *iii. Maximum overnight wind gust does not exceed 60km/h; and*
- *iv. Rainfall of no more than 2.5mm in the first two hours after dusk.*
- *v. No monitoring shall take place during a full moon, or one night either side of full moon.*
- *vi. Where a night of monitoring is lost to adverse weather or presence of a full moon, or equipment failure, further monitoring will take place until two consecutive nights of monitoring is achieved.*

Response

Waka Kotahi's ecologist does not agree that all trees to be felled should rely solely on acoustic monitoring via Automated Bat Detectors (ABMs). Waka Kotahi's ecologist agrees that acoustic monitoring could be used to supplement visual inspections (which are a more efficient and reliable method to eliminate trees as bat roosts – particularly in areas of high activity).

Therefore, the lodged Vegetation Removal Protocol (VRP) (Appendix A to the BMP) includes Section 2.2.3 - *Acoustic monitoring via Automated Bat Detectors.* This section outlines that visual inspections and roost watches will be the primary pre-felling methods used. To supplement tree inspections, the use of acoustic monitors may be used as a back up to further understand bat activity prior to felling.

Suggested change clause (b).
Potential or vacant bat roost trees will only be removed between 1st October and 30th April.

Response
Section 2.3 - *Protocol C: Felling Protocol* of the lodged VRP includes this requirement. For clarity, this requirement is also now included at Section 2.1 point 2 of the updated VRP (**Attachment D** to this letter).

Suggested change clause (c).
If bats are not recorded on the ABMs at any time during the monitoring period, immediately prior to tree felling works, then the Bat Ecologist will indicate to the arborist that the trees can be removed by sectional felling prior to dusk the same day.

Response
This requirement is included at Section 2.2.1 point 6 and Section 2.2.2 point 7 of the lodged VRP.

Suggested change clause (d).
If the trees cannot be removed prior to dusk the same day, then monitoring for bats using ABMs will continue and the arborist cannot commence works the following day until the Project Ecologist has indicated that they can do so, due to the continued absence of bats.

Response
This requirement is included at Section 2.3 point 2 of the lodged VRP.

Suggested change clause (e).
Potential or vacant bat roost trees will only be removed between 1st October and 30th April.

Response
This restriction is addressed under Suggested change clause (b) above.

Suggested change clause (f).
The Bat Ecologist will be on site during the removal of all potential bat roost trees.

Response
Section 1.1 of the lodged VRP states that the PBE is expected to be available to oversee vegetation removal. We have amended this sentence to clearly state that the PBE must be present on site during the removal of all potential bat roost trees, please refer to Section 1.1 of the **attached** updated VRP.

Suggested change clause (g).

If bats are detected on the ABMs, then the tree will be climbed and inspected by the Arborist under the supervision of the Bat Ecologist. All suitable features will be viewed with an endoscope to confirm the presence or absence of bats, prior to the tree's removal will be viewed with an endoscope to confirm the presence or absence of bats, prior to the tree's removal. Utmost care will be taken not to disturb any roosting bats. Photographs will be taken of any roosts or roost evidence found. If the tree cannot be climbed or viewed from a lift, an emergence, a dawn survey will be undertaken over two consecutive valid nights (see above – ABM weather conditions), to observe if bats are leaving or entering a roost within the trees.

Response

Visual inspections as suggested in this request are required to be undertaken as detailed in Sections 2.2.1 and 2.2.2 of the lodged VRP.

Suggested change clause (h).

If bats are confirmed to be roosting within a tree, the following provisions shall be adhered to:

i. The immediate area will be cordoned off with safety fencing and signage erected in a 10 m radius around the roost, alerting any person approaching the area that a bat roost is present and to stay clear.

ii. The Bat Ecologist will notify the Waikato Regional Council and the Department of Conservation (DOC) within 12 hours of when the occupied bat roost was discovered.

iii. All project staff will be made aware of the presence of the roost. The Bat Ecologist will determine whether all tree clearance works should be suspended or whether inspections and clearance can continue away from the roost.

iv. The roost will be monitored (acoustic or visual (emergence/return)) until bats no longer occupies the roost.

v. If the tree is a maternity roost tree removal works shall be scheduled to only occur within the period 1 March to 31 April inclusive.

vi. The Bat Ecologist will review whether it is possible to relocate the roost into an area that would remain of value to bats, for example. could the hollow be kept and attached to another tree as a bat box? Could the tree be relocated as standing dead timber? Therefore, preventing the loss of the roost through careful repositioning.

vii. If bats are still in the tree after fourteen nights, the Bat Ecologist will contact Waikato Regional Council to decide an appropriate way forward.

Response

Section 2.3 point 1 of the lodged VRP includes similar wording, but excludes monitoring in clause (iv). The VRP has now been updated to replicate this requirement. Please refer to Section 2.3 clauses (a) to (g) of the updated VRP **attached** to this letter as **Attachment D**.

Additional Matter 2.

The following additional matter was not identified as a request in the formal section 92 letter, however Waka Kotahi wishes to respond.

In Gerry Kessels' letter to Jorge Rodriguez dated 16 September 2021, page 3, 2nd paragraph, it states:

> *The roost tree assessment (s3.5.3) is thorough. I am concerned however, that the path of the access track the stormwater discharge has not been finalised and hence the exact number of potential roost trees to be removed has not been quantified in the report. This needs to be confirmed and finalised in order to determine a suitable mitigation package for the loss of these*

potential trees. I agree with the EIA that the access track should be designed to only remove the low-quality potential bat roost trees, and this should be included as a consent condition.

Response
Section 4.5.1 of the Ecology Assessment acknowledges that while the majority of the trees in the gully are considered low potential roost trees, there are some moderate-high potential roost trees. While, the intention is to avoid the moderate-high potential roost trees, this may not be possible.

Should it be necessary to remove a moderate-high potential roost trees, section 3.2.2 of the BMP, states that Waka Kotahi will plant eight trees should a moderate-high potential roost trees be removed. If roosting bats are confirmed in a tree to be removed, in addition to the planting of eight new trees, Waka Kotahi will install four artificial bat boxes of the "kent" design on a suitable tree(s), including predator proof banding on the tree.

Waka Kotahi therefore considers that appropriate mitigation is proposed for the removal of moderate-high potential roost trees (if removal cannot be avoided), and a condition limiting removal of low-quality potential bat roost trees only is unnecessary. As such, Waka Kotahi does not agree to include such a consent condition.

CONSTRUCTION WATER TAKE

Request 15.
Section 7.3.4 of the AEE states that the contractor will be required to identify construction water supply and obtain resource consent (if necessary) prior to the commencement of works. WRC does not support this deferral approach on the basis that.

- *The Waikato River above Karapiro is over allocated so there is no water readily available.*

- *The Piako Catchment is also over allocated, and companies like Fonterra and Matamata Piako DC are struggling to progress their water takes consent applications currently lodged with WRC.*

Please engage with the WRC Water Allocation Team (Cameron King or Charlotte Fransen), confirm the construction water source, and identify if transfer of an existing allocation, or a new take consent is required. In the event that a transfer or new consent is required, please lodge an application accordingly. This requirement (if needed) is requested under s91 of the RMA.

Response
Waka Kotahi has spoken with Cameron King of WRC's Water Allocation Team. Mr King has informed Waka Kotahi that water is available for allocation from the Waikato River, and therefore Waka Kotahi (or its contractor) could apply for a resource consent to take water from the Waikato River.

Construction water could also be obtained from a commercial supplier. A resource consent would not be required for such an arrangement.

Either of these options would provide adequate water for construction purposes. Both options are feasible, and the construction water take activity is a discrete activity. If a consent application is required, Waka Kotahi or its contractor will apply in the future prior to commencement of construction. Such a water take application is not required at this time to better understand the nature of the Project.

AIR QUALITY

Please find **attached** a Construction Air Quality Assessment prepared for the Project, which addresses the matters raised in Request 16 of the section 92 request (**Attachment E**).

If you have any queries regarding these applications, then please contact Mike Wood on 09 928 8756 or mike.wood@nzta.govt.nz in the first instance.

Yours sincerely

Mike Wood

Principal Planner

Environmental Planning – Transport Services

Waka Kotahi NZ Transport Agency

Attachments

A Hydraulic Modelling Report

B Spreadsheet of the pre and post peak flow comparisons for intermediate storm events

C Updated Bat Management Plan

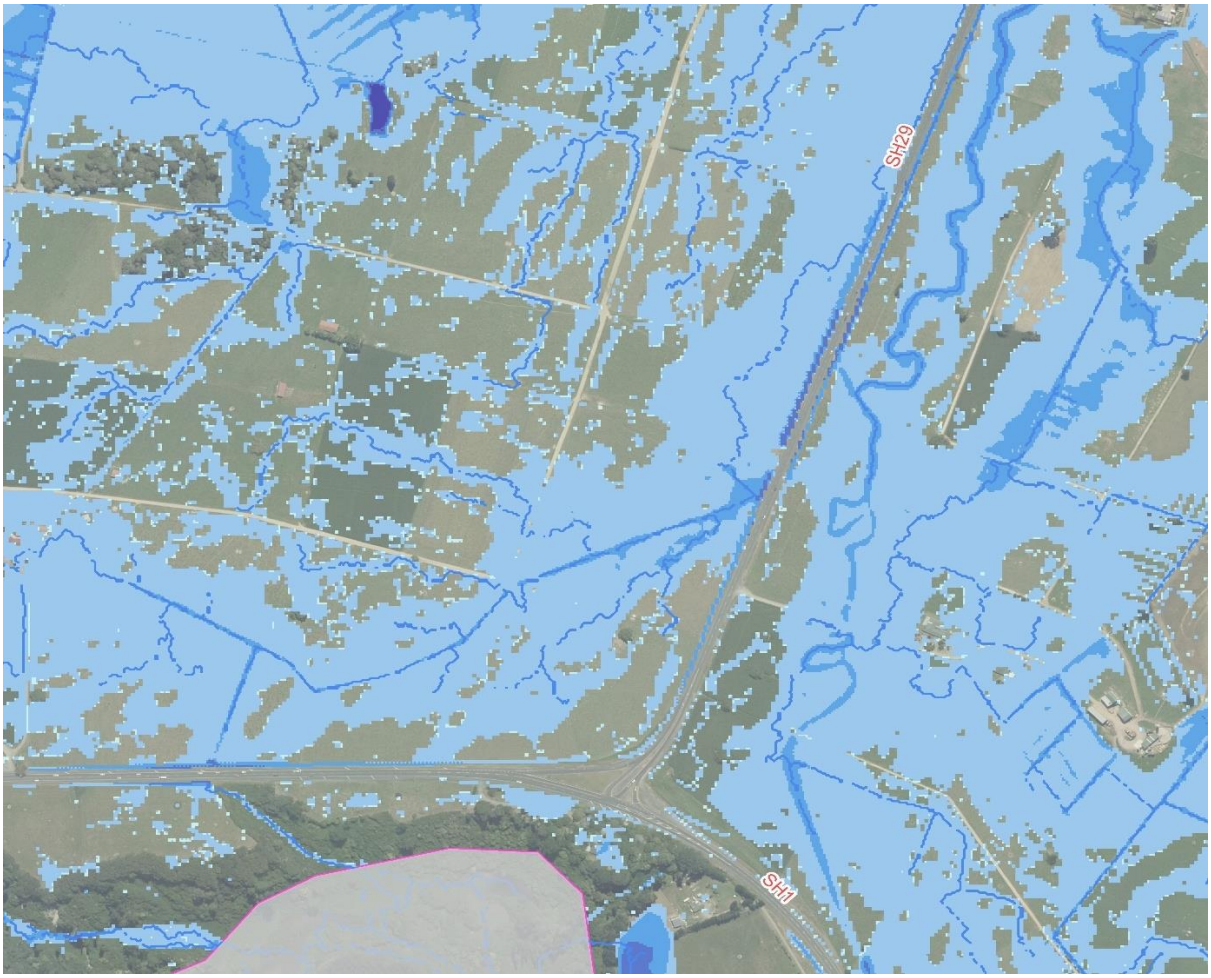
D Updated Vegetation Removal Protocol

E Construction Air Quality Assessment

Attachment A: Hydraulic Modelling Report

Project Number: 2-A0012.05

State Highway 1 and State Highway 29 Intersection Upgrade



Flood Risk Assessment and Hydraulic Modelling Report

wsp

150 YEARS IN AOTEAROA

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1 Introduction

This report forms part of a suite of technical reports prepared for Waka Kotahi NZ Transport Agency (Waka Kotahi) for the State Highway 1 (SH1) and State Highway 29 (SH29) Intersection Upgrade Project (the Project). The SH1/SH29 intersection is located partly within the Waikato River catchment, and partly within the Waitoa River catchment (draining to the Firth of Thames). Catchment boundaries are discussed further in Section 3.1.

1.1 The Project

The Project is the construction and operation of a new two-lane roundabout connecting SH1 and SH29, north-west of the existing intersection of SH1 and SH29 at Piarere. The key components of the Project are:

a) A two-lane roundabout with a 60m diameter central island.

b) Realignment of parts of the SH1 and SH29 approaches to connect to the new roundabout.

c) The roundabout will be elevated approximately 3.5m above the existing ground level to provide for cycle and pedestrian underpasses.

d) A stormwater management system, including a wetland, wetland and planted swales and a discharge structure and associated rip rap armour.

e) Construction activities, including a construction compound, lay down area and establishment of construction access.

A full description of the Project including its current design, construction and operation is provided in Section 6 of the AEE and shown in the Project Drawings in Volume 4: Drawing Set.

1.2 Purpose

The purpose of this report and associated maps is to detail the results of the hydrologic and hydraulic modelling, undertaken to inform the design and assessment of effects for the SH1/SH29 intersection upgrade.

1.3 Background

The key drivers for undertaking hydrologic and hydraulic analysis on this Project are:

1. **Complex Hydraulic Mechanisms:** To understand the predicted extent of flooding under a range of design events, both now and in the future, and its interaction with the proposed road alignment. This includes providing design flows, levels and velocities for culverts/bridges in complex locations.

2. **Comparative Analysis:** Provide a tool that will enable comparative analysis of the pre-and post-construction flood hazard, thereby informing the assessment of the potential environmental effects. Where required, provide appropriate pre- and post-construction mapping.

3. **Mitigation Testing:** Identify where mitigation of effects caused by the Project is required, and demonstrate that the proposed solutions mitigate those effects appropriately.

4. **Highway Level of Service:** Provide information on predicted flood levels to inform corridor design and resilience, noting the P46 requirement for 1% AEP plus freeboard for the edge of road.

Appendix A includes a memorandum describing the hydrologic and hydraulic modelling methodology for the Project.

1.4 Consultation

Two meetings have been held with Waikato Regional Council (WRC) to discuss hydrologic and hydraulic modelling:

28/09/2020 – The purpose of this meeting was to seek agreement from WRC on the following aspects:

- The proposed rainfall analysis and rainfall-runoff methodology
- The recommended climate change allowance and time frame over which climate change will be considered
- The model schematisation
- The outputs to be provided to support resource consent decision making

4/02/2021-The purpose of this meeting was to:

- Present and review the baseline modelling results for the Project
- Present and review stormwater management options for the Project
- Discuss the methodology adopted in identifying the stormwater options.
- Discuss and gain feedback on the basis of design.

The methodology was discussed with WRC at a meeting on the 28/09/2020 and confirmed as appropriate (refer correspondence in Appendix A).

In the meeting on the 04/02/21 it was agreed the hydraulic model could be used to test downstream effects, and determine whether stormwater attenuation is required, based on effects.

Table 1 describes the amendments made to the modelling methodology.

Table 1 Required Amendments to Agreed Modelling Methodology

Modelling Methodology Amendment	Reason	Impact
Open channels have only been represented using the 2 m Digital Elevation Model (DEM)	Survey of watercourses was planned to verify LiDAR generated channel capacity. Land access has prevented survey. No surveyed information is provided.	Invert level and size of the channel may not represent the actual capacity. LiDAR often under-estimates channel capacity due restricted laser penetration through vegetation. Using 2m DEM only is considered precautionary.
Culvert 1 Removed	The existence of the culvert has not been verified due to land access restriction. Excluded at this stage before confirmed.	A sensitivity test was run with a conceptual 450mm diameter culvert. Minimal flood impact was identified at the upstream of culvert 1. The maximum water level difference is 30mm.
Rainfall Temporal Pattern	The Chicago Storm/NCRS has been adopted as the temporal pattern for the analysis rather than the critical duration storm. This is a more	Larger flood extent and flows in study area.

	precautionary approach in the absence of data to enable calibration or validation (Refer to Appendix B).	
Extending the catchment boundary for Catchment 4 to the Waikato River	The boundary was extended to allow a free flow for water discharging out of the system.	Water discharges out of the model without unrealistic tailwater condition

The extent of work is located entirely within "Catchment 4" in Appendix A. **Therefore, only modelling and analysis of Catchment 4 has been undertaken to date.** Catchment 4 shall be referred to in this report as "the Catchment" hereafter.

2 Hydrologic and Hydraulic Model Build

2.1 Model Schematisation

Section 5 in Appendix A provides details on model schematisation. Figure 1 below shows the model extent and schematisation for the Catchment, revised slightly from that in Appendix A. As noted in Table 1, the model downstream boundary has been extended to the Waikato River, compared to the model extent originally proposed.

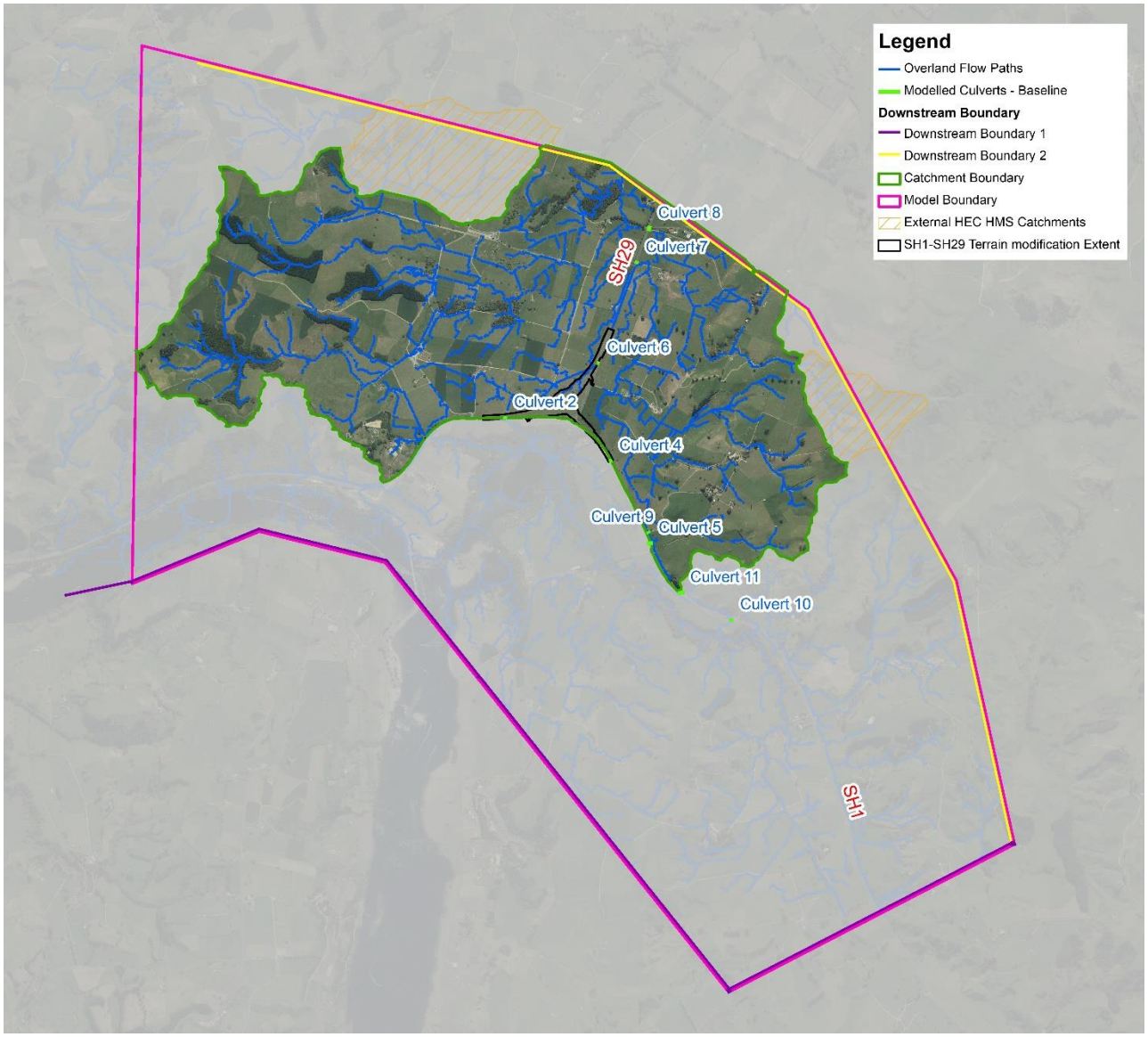


Figure 1 Model Extent and Schematisation

2.2 Hydrologic Modelling

2.2.1 Rainfall Data

High Intensity Rainfall Design System (HIRDS) Version 4 as developed by NIWA (Trevor, C., Roddy, H., Shailesh, S. 2018), has been used to determine rainfall depth for the area, with a single rainfall depth applied for the whole catchment (refer Appendix B).

2.2.2 Selecting a Rainfall Distribution

As noted in the WRC Guidelines (TR2020/07).

Developing normalised storms for a variety of locations within the Waikato Region has not yet been undertaken.

The Modelling Methodology noted:

As noted in the Rainfall Analysis report (Appendix B), there is not one temporal distribution that fits all duration events for the Project. It is recommended that the temporal distribution set out in the WRC runoff guidelines be used to represent the distribution of storm rainfall in the study area for catchments with Tc of less than 1-hour. Further analysis will be undertaken to support the most appropriate temporal distribution for catchments where Tc is longer than 1-hour. A sensitivity analysis will be undertaken to clearly quantify the potential effects of residual uncertainty.

2.2.3 Time of Concentration – Catchment

The time of concentration (T_c) for the Catchment has been calculated using different methods as set out in Table 2. Calculations are provided in Appendix C. The estimated average flow velocity within the catchment result shows the Ramser-Kirpich Method and US Soil Conservation Service Method with a velocity value of 1.4 m/s are the most reasonable flow velocity to represent reality. As a result, the estimated T_c of Catchment 4 is 58 min.

Table 2 Time of Concentration for the Catchment

T_c Calculation Method	Estimated T_c (min)	Estimated Tc (hr)	Average flow velocity within the catchment (m/s)
Standard Method for Rural Catchments	125	2.08	0.6
Ramser-Kirpich Method	58	0.97	1.4
Bransby-Williams Method	123	2.05	0.7
US Soil Conservation Service Method	58	0.97	1.4

As the T_c of the Catchment is less than 1-hour, it is considered appropriate to use the 24-hour nested storm temporal distribution from the WRC runoff modelling guideline for Catchment 4.

A 1-hour critical duration storm has also been tested, with NRCS curve number method, to understand the impact of a different rainfall-runoff methodology (refer to Section 2.4.2).

2.2.4 Climate Change

RCP6.0 has been used for rainfall analysis (refer Appendix B). Assuming the Project has a 100-year life, the potential effects of climate change have been projected to 2120 (refer Section 7, Appendix B).

The climate change factors (RCP6.0) were applied in the model is listed in Table 3 to compute the future situation by assuming 2.3 ˚C increase.

Table 3 Climate Change Factor Applied in Hydraulic Model

Stormwater Event	Climate Change Factor (%)
50% AEP	17.81
10% AEP	18.75
1% AEP	19.78

Detailed design can assess the implications on level of service of an alternative climate change timeframe or temperature change scenario, if appropriate.

2.2.5 *Hydrologic Modelling Parameters*

Hydrological parameters follow the guidance set out in Waikato Stormwater Runoff Modelling Guidelines (May 2020) (TR2020/06) and are based on an assessment of the land use and topography.

Figure 2 shows the soil groups within the Project area based on the FSL New Zealand Soil Classification GIS layer sourced from Land Information New Zealand (LINZ). The soils are classified in accordance with TR2020/06 and listed in Table 4. Table 5 sets out the corresponding curve number applied for these soil groups.

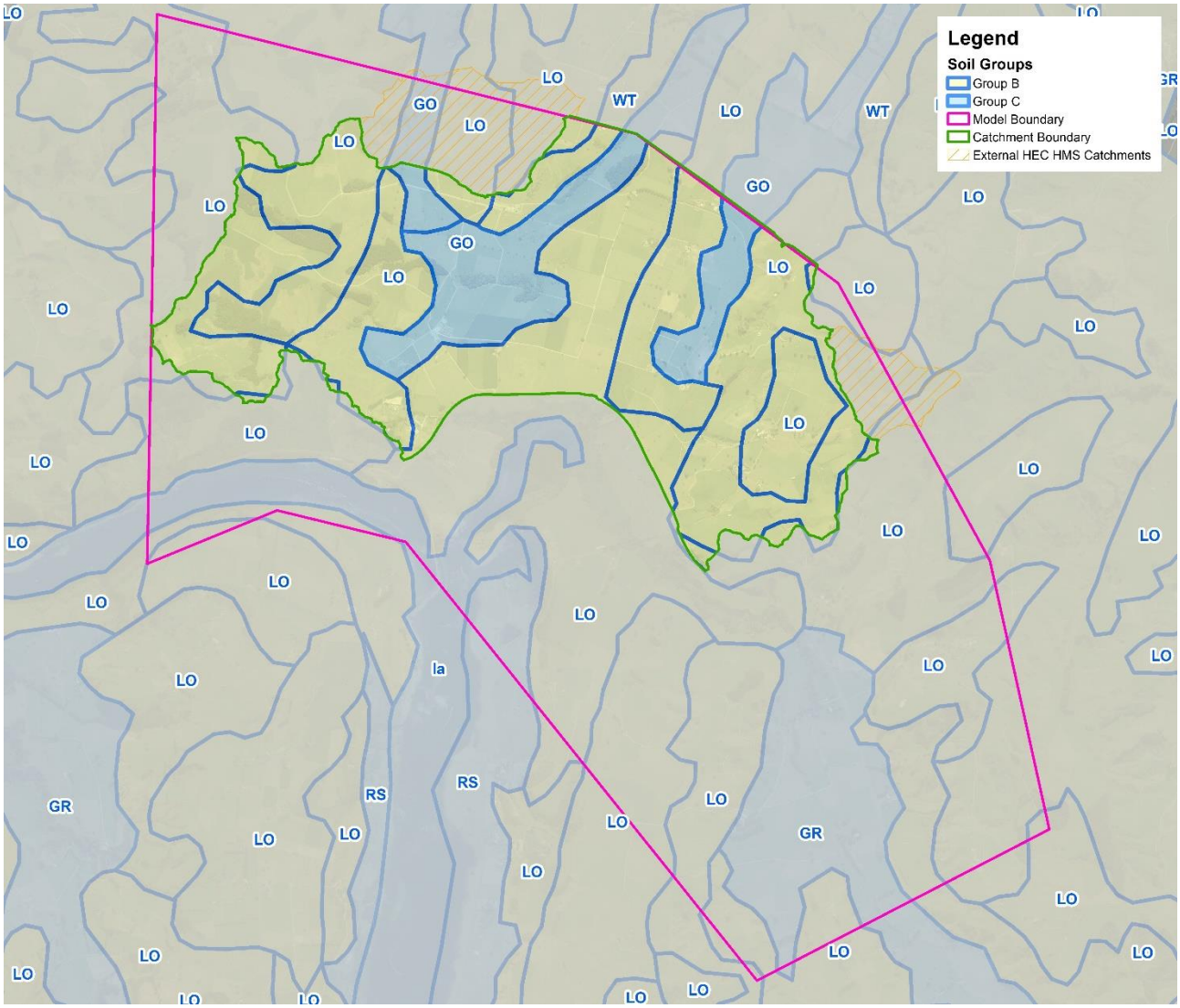


Figure 2 Soil Groups within the Catchment

In terms of soil classification, soil GO type is considered as HSC (Hydrologic Soil Group) Group C, because soils in areas of high groundwater table or groundwater seepage and often waterlogged. Typically, light grey subsoil due to chemical leaching by groundwater.

Soil LO type is mainly dominated by allophane, imogolite or ferrihydrite minerals. Orthic allophanic soils are deep allophanic soils. Allophane is a clay material derived from weathering of volcanic glass and feldspars. This soil maintains a porous, low density structure with weak strength. Therefore, LO materials are designated as the sharpest drained soils class in the soils database. It was treated as HSC group B for this Project.

A desktop assessment has not been done to determine the HSC Group of Tephric Raw Soils (WT). It currently covers 2.7 % of the catchment and assumed to be Group B. Further

assessment of the various types can be considered in detailed design stage once further geotechnical data is available.

Table 4 Soils Group Classification

Soils ID	Soils Description	Soil Type in WRC Stormwater Runoff Modelling Guideline
GO	Orthic Gley Soils	Group C
LO	Orthic Allophanic Soils	Group B
WT	Tephric Raw Soils	Group B

Table 5 Catchment numbers (CN), Waikato Stormwater Runoff Guidelines

Land Cover Type	Group B	Group C
Pervious Areas	61	74
Impervious Areas	98	98

2.2.6 Rainfall Runoff Application

The hydrological model for the catchment utilises the rainfall-runoff model outlined in the (TR2020/06).

Rainfall profiles were developed using 24-hour rainfall depths from the rainfall analysis (refer Appendix B) and climate change factors as described in Section 2.2.4.

Effective Rainfall for 2D Model Extent

Soil losses were applied to the rainfall profile to calculate the expected infiltration as per the SCS (Soil Conservation Society) CN (Curve Number) methodology presented in TR2020/06. The effective rainfall (i.e. runoff after adjustment to allow for infiltration) was then applied directly to the 2D grid.

Table 6, below, summarises the rainfall depths and relevant hydrologic parameters applied in the model to produce the effective rainfall for 2D model extent. The climate change scenario is assuming 2.3 ˚C increasing (i.e. RCP6.0) and out to 2120.

Table 6 Summary of Rainfall Depth for 24-hour Nested Storm and with Climate Change (RCP6.0, 2120) and Hydrologic Parameters for Effective Rainfall Calculation

Catchment ID	24-hour Nested Storm Rainfall Depth (mm)						CN	Ia (mm)	Impervious %
	50% AEP	10% AEP	1% AEP	50% AEP + CC	10% AEP + CC	1% AEP+ CC			
Catchment - Baseline	73	112	173	86	133	207	65.02	4.76	4.75
Catchment – Developed Scheme							65.13	4.75	5.08

Note: Ia = Initial Abstraction

Flow calculations for HEC HMS catchments external to 2D model extent

The Soil Conservation Service (SCS) unit routing model was used to transform rainfall into runoff and to generate HEC HMS catchment flows. This is a dimensionless hydrograph with key parameters such as time of concentration (Tc), CN, imperviousness and initial abstraction (Ia) calculated based on the procedure described in TR2020/06 (refer to Table 7).

Table 7 Summary of Rainfall Depth for 24-hour nested storm and with climate change (RCP6.0, 2120) and Hydrologic Parameters for HEC HMS external catchments flow calculation

Catchment ID	24-hour Nested Storm Rainfall Depth (mm)						CN	Ia (mm)	Impervious %	Lag Time (mm)
	50% AEP	10% AEP	1% AEP	50% AEP + CC	10% AEP + CC	1% AEP + CC				
HEC HMS catchment 1	73	112	173	86	133	207	65.13	4.74	5.10	29.4
HEC HMS catchment 2							62.44	4.81	3.89	19.8

2.3 Hydraulic Modelling Methodology

2.3.1 Modelling Software

TUFLOW software version 2020-10-AB has been used as the platform for rain-on-grid hydraulic modelling of the catchment.

2.3.2 Asset Data

Figure 3 and Table 8 shows existing, known stormwater assets, including those that have been surveyed. As noted in Table 1, there is no evidence (survey or visual inspection) of Culvert 1 therefore it has not been included to date.

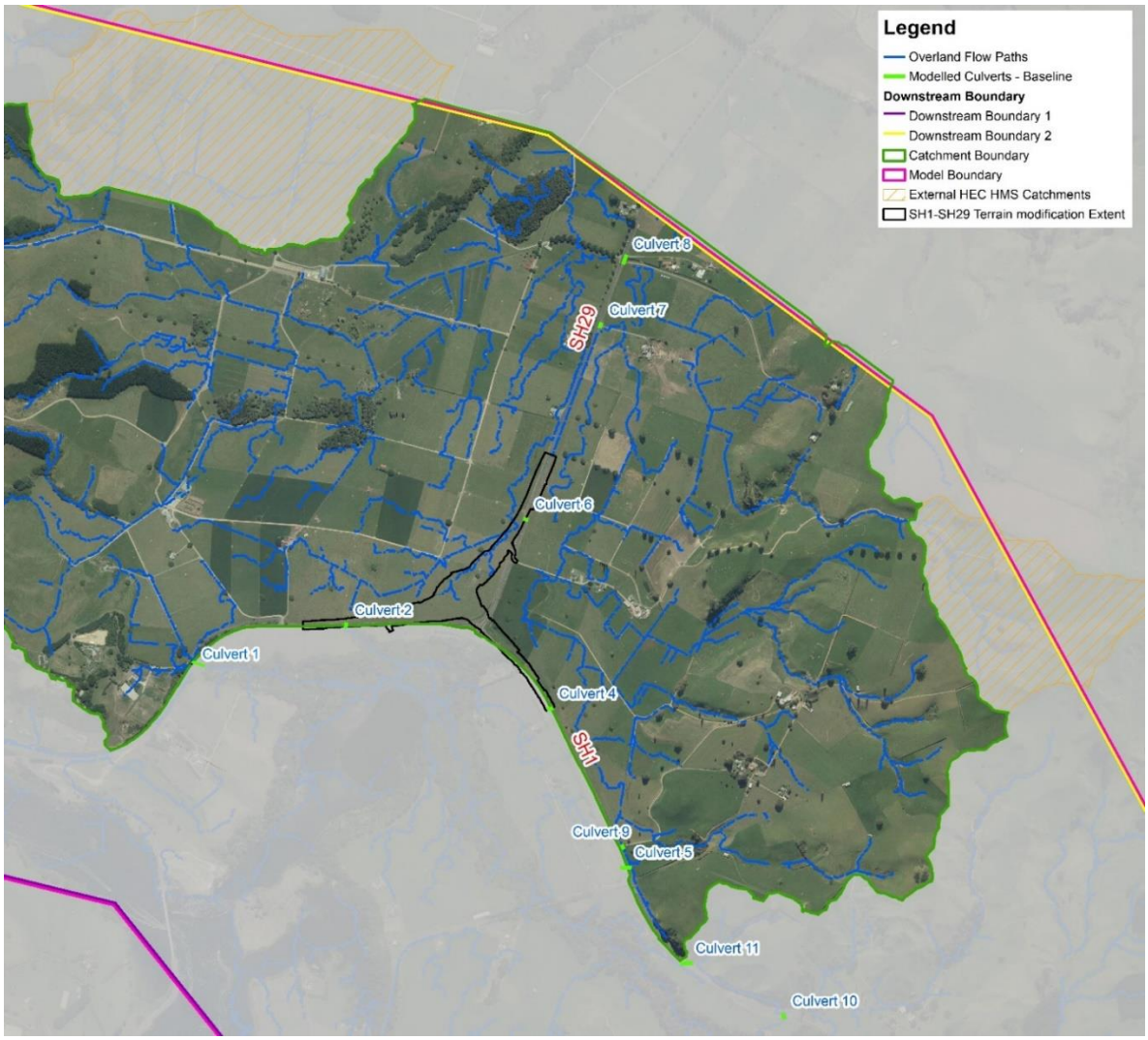


Figure 3 Existing Stormwater Asset Data Modelled in Baseline

Table 8: Stormwater Infrastructure Asset Data

Culvert ID	Diameter (mm)	U/S Invert (m RL)	D/S Invert (m RL)	Length (m)
CULV2	375	100.96	101.07	19.00[1]
CULV4	450	101.68[2]	101.40	21.46[1]
CULV5	450	106.00[2]	104.04[2]	37.05[1]
CULV6	400	100.23	100.08	16.26
CULV7	450	99.09	99.03	20.11
CULV8	750	98.19	97.98	34.52
CULV9	300	105.08	105.07	17.77
CULV10	300	104.9	104.25	20.54
CULV11	600	104.28	103.31[2]	41.06[1]

[1]Culvert lengths were extracted from GIS features in the model, they were not a surveyed length.

[2]Invert levels estimated from LiDAR.

2.3.3 Topographic Data

Topographic data was provided as a 2m regular grid DEM. The DEM for the area shown in Figure 4 is sourced from LiDAR, flown in 2016. Outside of this area an 8m grid DEM was used, sourced from LINZ. The latter data was only used for the defining the boundary of the HEC HMS catchments.

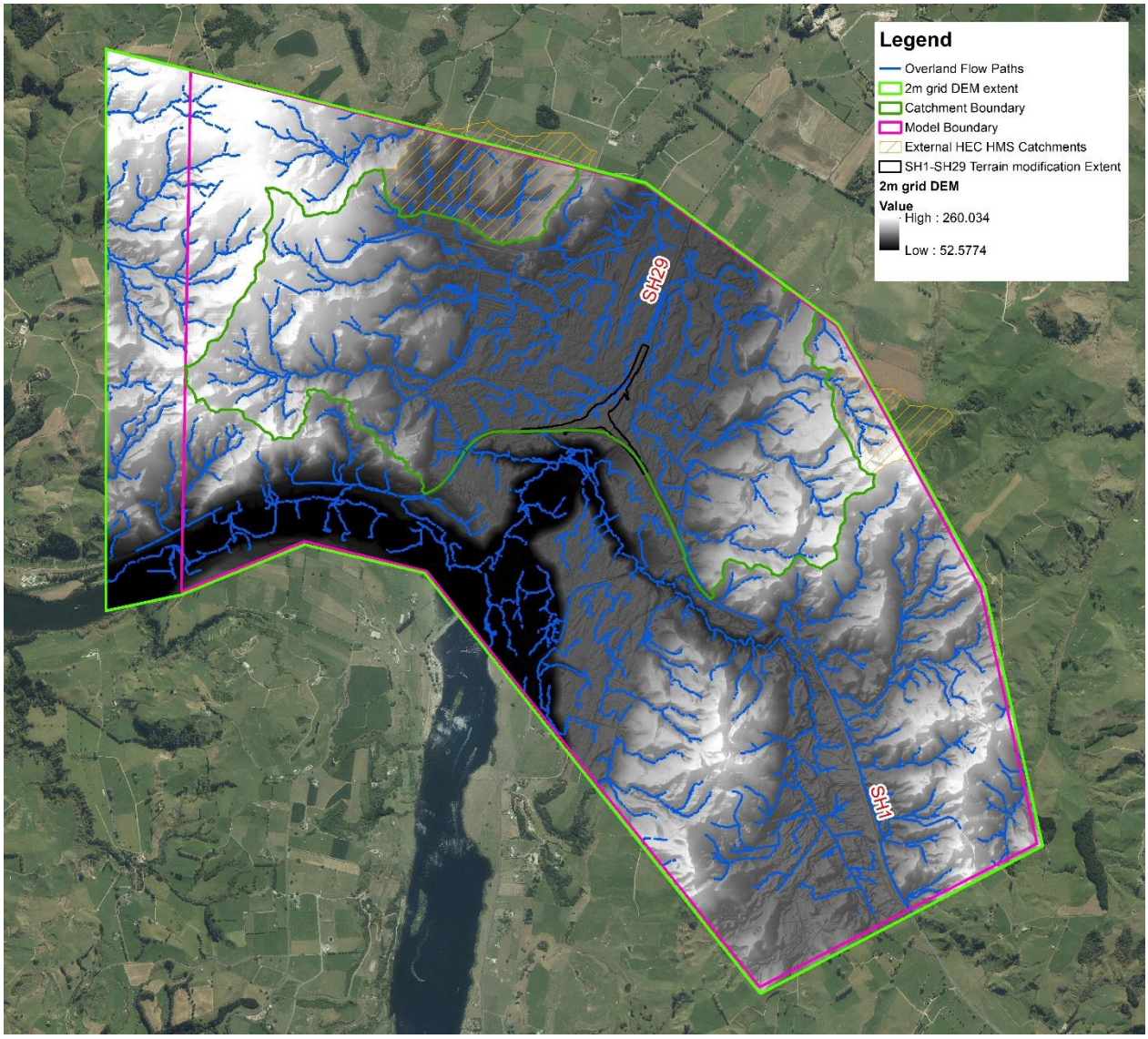


Figure 4 Topographic Data Overview

A ground surface 4 x 4m grid was created for the hydraulic model using the 2m regular grid DEM. LiDAR techniques generally struggle to accurately determine ground profile where there is significant vegetation. The terrain surface becomes an interpolation following the screening out of vegetation. This can particularly effect vegetated open channels, like the farm drains in the Catchment, potentially under-estimating their capacity in the hydraulic model.

2.3.4 Boundary Conditions

The elevation of the Waikato River embankment changes rapidly with an estimated slope 9% (elevation extracted from 2m grid LiDAR). Therefore, a freefall boundary condition (refer to Figure 1, downstream boundary condition 1), was applied to the Waikato River to allow water to freely flow out of the system.

A slope boundary condition (refer to Figure 1, downstream boundary condition 2), with value of 1 % was also applied at the northeast model boundary. It allows water to gradually discharge out of the system as it is flat farmland at the northeast area of the Catchment. A sensitivity test of this boundary condition was undertaken (refer to Section 2.4.4).

2.3.5 Roughness Zone

Roughness zones were defined and agree in the modelling methodology memo (Appendix A). Table 9 lists the manning's n value applied in the model for each type of land use.

Table 9 Manning's n applied in different Land Use Areas

Land Use	Manning's n
Water Bodies	0.02
Pasture/Cultivated Areas	0.05
Roads/Rail	0.025
Bush	0.07
Urban/School/Cemetery	0.15
Industry/Commercial	0.2

2.3.6 Culverts

The recommended entrance and exit loss values documented in the TUFLOW manual (BMT WBM, 2016) were adopted. Entrance loss and exit loss values of 0.5 and 1 were adopted respectively.

The recommended contraction coefficients documented in the TUFLOW manual (BMT WBM, 2016) were adopted. Height contraction coefficient for box culverts and circular pipes of 0.6 and 1 were adopted respectively. Width contraction coefficient for box culverts and circular pipes of 0.9 and 1 were adopted.

Table 10 Culvert Parameters in Hydraulic Model

Culvert parameters	Values	Remark
Height contraction coefficient	0.6	For square edged entrance (only applicable for rectangular culvert, underpass in this study)
Width contraction coefficient	1	For sharp edges (only applicable for rectangular culvert, underpass in this study)
Entry loss coefficient	0.5	Applicable for both circular and rectangular culverts
Exit loss coefficient	1.0	Applicable for both circular and rectangular culverts

2.4 Model Checking and Sensitivity Testing

Sensitivity analysis was carried out to identify the impact changes in key model parameters have on the model outcomes (i.e. flood flow estimation and flood level estimation).

The climate change scenario (RCP 8.5, assuming 3.8 ˚C increase, 2120) were applied for all sensitivity tests to understand the changes in the extreme situation. The sensitivity tests under RCP 6.0 scenario were also carried out for changes of Manning's n coefficients and change of downstream slope.

The difference between sensitivity tests done with the RCP 6.0 scenario and the sensitivity tests using RCP 8.5 scenario is insignificant and thus this report shows the sensitivity results using the climate change RCP 8.5 scenario.

Analysis in this section demonstrates flood levels in the area are not particularly sensitive to changes in modelling parameters, primarily due to the large storage volume in the floodplain. Although there remains uncertainty in absolute levels for the reasons described in Section 2.6, the lack of sensitivity to parameters provides confidence in the use of the predicted flood levels for design and assessment purposes.

2.4.1 Mass Balance

A mass balance check has been carried out to check the difference between the volume of water loading to the model and the outflows of the model as well as the volume of water retained.

Table 11 lists the volume balance report from the 1% AEP model run results.

Table 11 Mass Balance Report

Items	Volume (m^3)
Initial Volume (IV)	0
Final Volume (FV)	1,156,567
Total Inflow (IT)	1,745,789
Total Outflow (OT)	589,295
Volume Balance Error (VBE)	73

Mass Balance calculation equation: **VBE = FV-IT-IV+OT**

The calculated volume balance error (VBE) is 73 m^3 and the volume balance error percentage is less than 0.01%. This is considered an acceptable difference.

2.4.2 Hydrologic Loss Model and Temporal Pattern

A 1-hour critical duration storm was run through the hydraulic model to understand how sensitive results were to hydrologic method. Figure 5 below shows the difference in rainfall profile (1% AEP storm event plus climate change (RCP8.5, 2120)) used. The NRCS method was applied for determining hydrological losses.

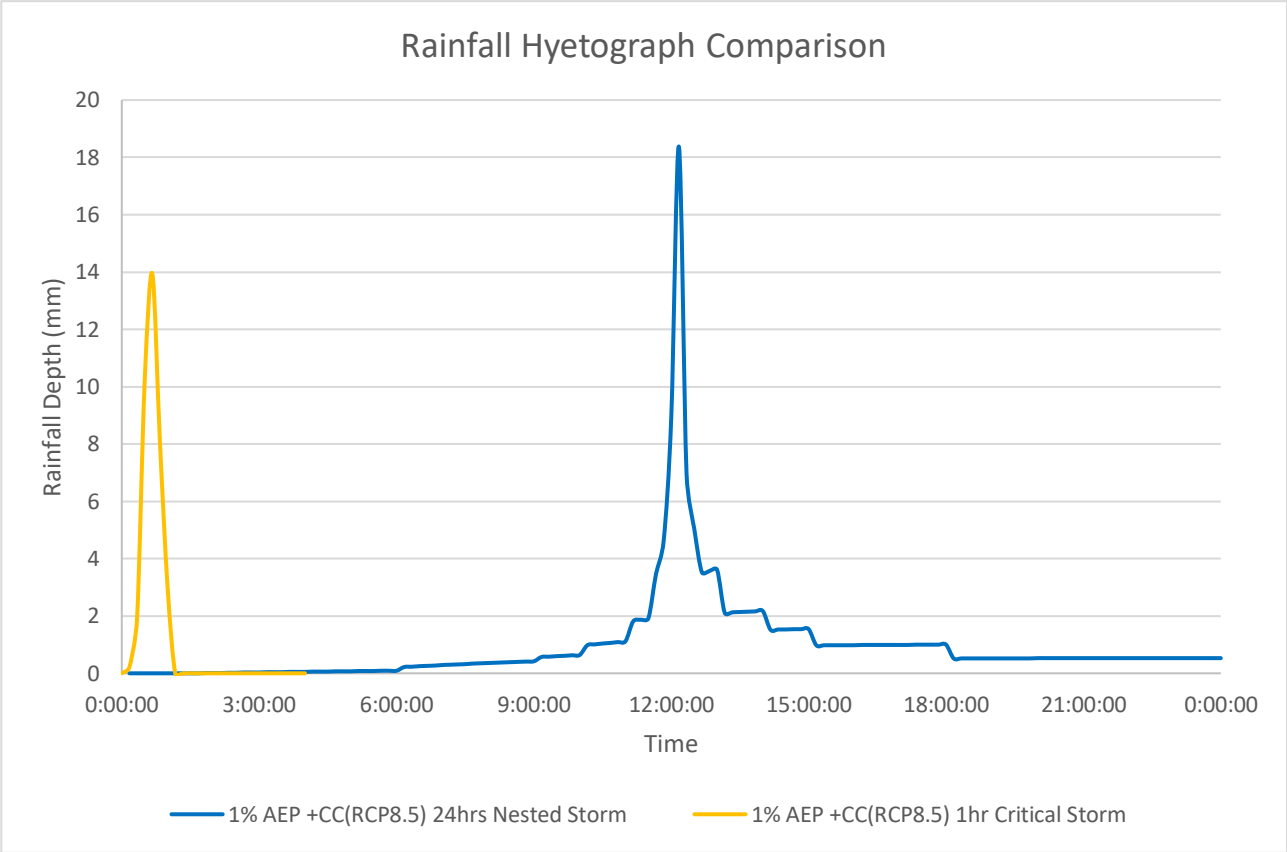


Figure 5 Rainfall Hyetograph

Figure 7 shows three hydrographs near the interchange with the nested storm and 1-hour critical duration 1 % AEP event with climate change (RCP8.5, 2120) (locations refer to Figure 6). The difference in peak flow is approximately 57 % to 77 % as listed in Table 12. The large difference in flow translates to the difference in flood extent and depth of flooding on Figure D.1 in Appendix D for the 1 % AEP plus climate change event. Flood depths are 50-500mm lower for the critical duration storm.

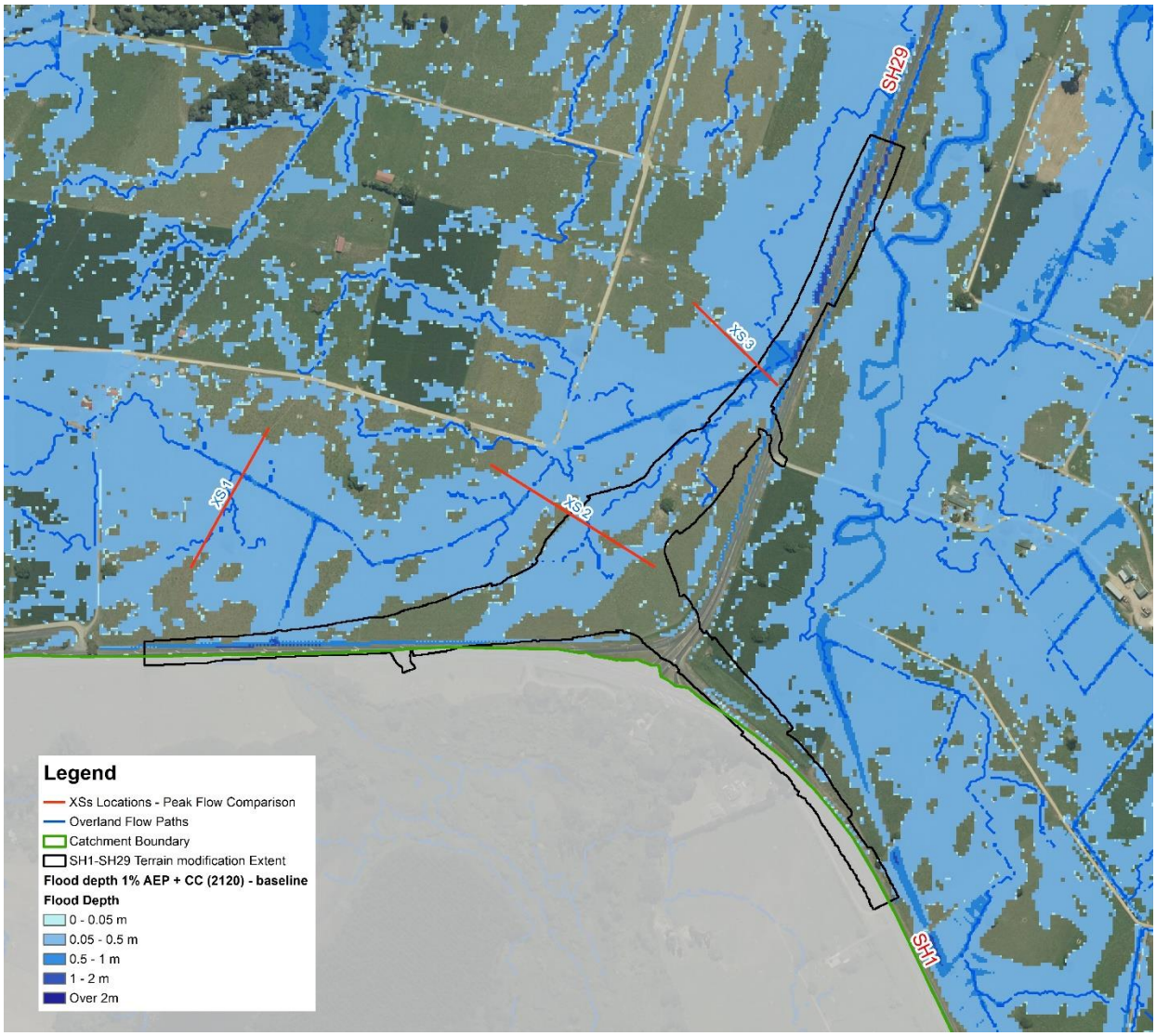


Figure 6 Peak Flow Cross-section Locations

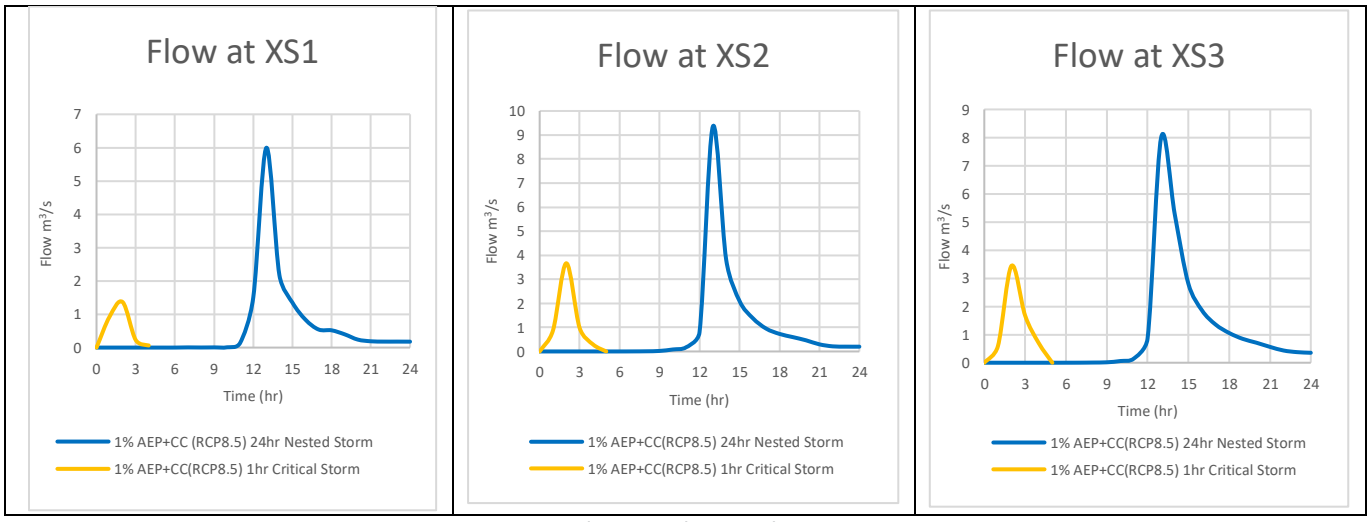


Figure 7 Hydrographs at Three Location

Table 12 Peak Flow Comparison Results

Locations	Peak Flow (m^3/s) during 1 % AEP Storm Event with Climate Change (RCP8.5, 2120)		Peak Flow Difference (%)
	24-hour Nested Storm	1-hour Critical Storm	
XS1	6.0	1.4	77
XS2	9.4	3.7	61
XS3	8.0	3.4	57

In the absence of data to calibrate or validate the hydraulic model, a precautionary approach is appropriate for assessing the effects of proposed works. The effects of applying the 1-hour critical duration storm can reasonably be expected to be less than described in Section 4.

It is recommended that detailed design consider the implications of sizing infrastructure for both of these temporal patterns.

2.4.3 Manning's Roughness

The Manning's roughness coefficient represents the resistance to flow in channels and across floodplains. The Manning's roughness coefficients for all land use types were increased and decreased by 20 % to investigate the impacts of changes in Manning's roughness. Changes in flood extent and depth under 1 % AEP event maps were generated for both increased and decreased Manning's roughness. (refer to Appendix D, Figure D.2.A and D.2.B). The analyses predict minor changes in depth of between 10mm and 100mm thus showing that the model is not particularly sensitive to roughness parameters.

2.4.4 Downstream Boundary

A downstream boundary condition of 1 % slope was applied in the baseline model. It allows water discharge out of the system gradually rather than having a large drop at the boundary. A downstream boundary sensitivity simulation with 0.1 % slope was computed to understand the effect of downstream boundary condition. A flood extent and depth difference between 1 % slope scenario and 0.1 % slope under 1 % AEP + CC (RCP8.5) storm event map was produced (refer to Appendix D, Figure D.3). The figure showed there is minor impact (depth less than 10mm) on flood depth.

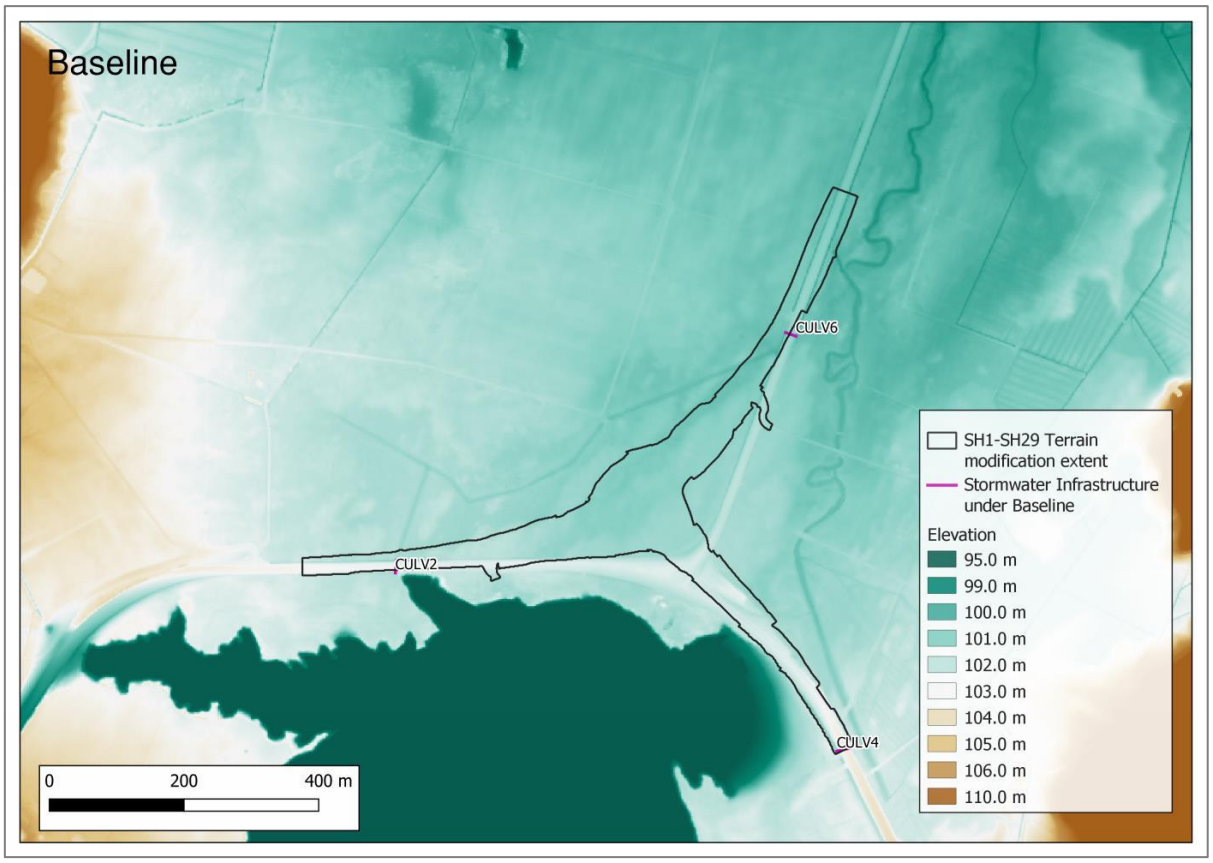
2.4.5 Climate Change

Two climate change scenarios (RCP6.0 and RCP8.5) were simulated to understand the impact of higher RCP on flood levels. A change in flood extent and depth map under 1 % AEP event was generated (refer to Appendix D, Figure D.4). The model result predicted the change in flood extent and depth is minimum (depth difference within 50mm).

2.5 SH1-SH29 Schematisation

2.5.1 Road Alignment and Levels

The proposed roundabout design (version 1) was received as a 1m grid DEM on 22March 2021. The updated surface model in the scheme combined the existing 2m grid DEM with the proposed 1m grid DEM. Where the proposed DEM has no value, the elevation from the existing 2m grid DEM is adopted.



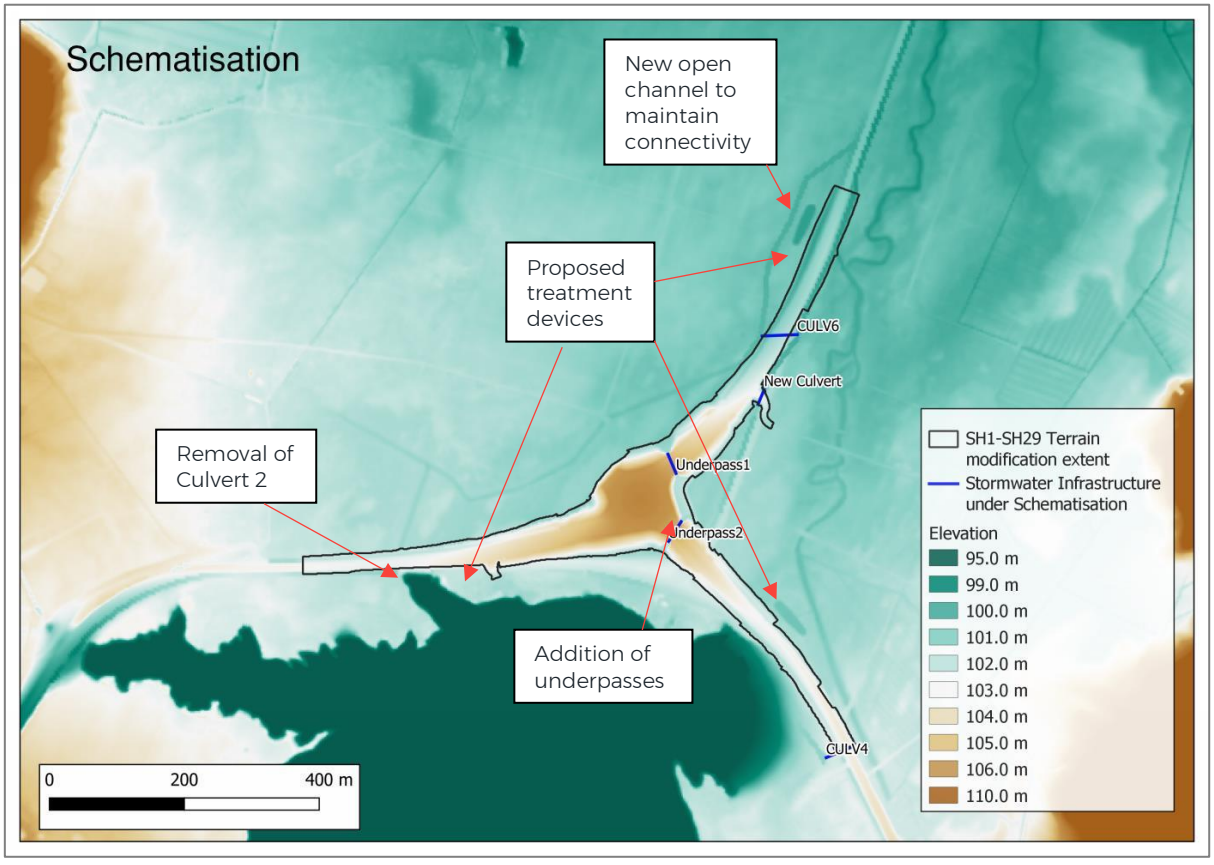


Figure 8 DEM and Stormwater Infrastructure for Baseline (top) and Schematisation (bottom)

2.5.2 Stormwater Management Infrastructure

The proposed cycle underpasses have been modelled as a box culvert in the hydraulic model. Although the underpasses are not proposed as stormwater infrastructure, they can convey

water during extreme storm events. The same modelling technique used for culverts is applied for the modelling of an underpass. Two underpasses are included as shown in Figure 8. Information on the underpasses is set out in Table 13.

Table 13 Information of Underpasses

Underpass ID	Dimension (width by height, mm)	U/S Invert (m RL)	D/S Invert (m RL)	Length (m)	Remark
Underpass 1	2500 x 2500	101.97	101.67	31	New asset
Underpass 2	2500 x 2500	102.12	101.79	29.5	New asset

For the scheme modelling, some culverts are modified by extending the culvert lengths and invert levels to represent the flow conditions in the scheme.

- Culvert 2 (Karapiro Leg): The culvert conveys flow from and to the road side drain on each side of the highway. This existing culvert may also discharge south of the highway into a gully and then to the Waikato River, however this has not been verified to date via survey (land access issues). It is assumed that Culvert 2 is not required post development (subject to detailed design).
- Culvert 4 (Tirau Leg): The culvert conveys flow from and to the road side drain on each side of the highway. It is interpreted that discharge from the culvert flows to the southwest road side drain and then overland on to the Waikato River. The culvert length has been extended beyond the proposed batter slope to allow the discharge from the culvert to continue to run overland to the southwest.
- Culvert 6 (SH29 Leg): The culvert conveys flow from and to the road side drain on each side of the highway (possible west to east). The culvert size has been increased in diameter and its length extended to collect overland flow from the west to the swale on the east.

Table 14 summarises the information of the culverts that were updated in the scheme.

Table 14 Information on the Culverts that are Modified under the Schematisation

Culvert ID	Dia (mm)	U/S Invert (m RL)	D/S Invert (m RL)	Length (m)	Remark
Culvert 2	-	-	-	-	Removed
Culvert 4	450	101.675	101.40	41.88	Extended length
Culvert 6	450	100.40	100.08	52.06	Extended length Changed invert level Increased culvert size
New Culvert	450	100.62	100.52	30	New culvert

A new open channel is proposed to maintain the existing connectivity of open channels along SH29. The DEM has been modified by decreasing the ground level to burn the open channel. The modified terrain has been used as an input for the hydraulic model, representing the overland flow and side drain along the highway. The open channel is assumed to have 6-7 m top width and 4-5 m bottom width with the 0.5m depth. The modified terrain including burned channels and side drains is displayed in Figure 8. The channel dimensions will be verified during detailed design.

2.6 Model Limitations and Assumptions

This study provides a prediction on likely flood levels, velocities and depths. It has focussed on producing outputs on a catchment-scale. Anyone using the outputs of this study should be aware of the assumptions and limitations included in the model, which can lead to variability in results. The key assumptions and limitations made in preparing this study are included below. The model has been sensibility checked to improve overall confidence in the outputs, however the combined

effects of the uncertainties, as well as the particular local conditions when a storm occurs (e.g. rainfall pattern, antecedent conditions) could mean that flood levels can differ to those shown in the modelled results.

Computational models are only as accurate as the information input into them, and the data available to verify their accuracy. The limitations of the stormwater flood model include:

- TR2020/06 has not been validated for the Waikato Region and the accuracy of this method is unknown. Testing using an alternative method (refer sensitivity testing) has been performed to improve confidence in the results.
- The model and mapping were prepared using LiDAR elevation data. The LiDAR data is 2-metre derived data which has an accuracy of ± 100mm vertical and ± 500mm horizontal at 68 % confidence level (AAM 2016) therefore flood extents may vary from those shown on the mapping. It is intended the LiDAR will be verified through future surveying work (not available at the time of writing this report). Vertical and horizontal adjustments may be needed following verification. Appropriate precaution should be applied when referencing the flood levels and extents and a freeboard allowance applied in accordance with relevant Waka Kotahi guidance documents.
- Overland flow paths have been modelled in the 2D domain based on the LiDAR generated DEM. Open channels are burned into DEM to allow overland flow paths as mentioned in section 2.5.2 of this report. Channel capacity may be underestimated in LiDAR. Detailed surface features such as retaining walls, kerbs, smaller surface drains are not expected to be represented in this model.
- Culvert 1 has not been included in the hydraulic model at this time. If a culvert is located in this location it is expected to reduce the extent of flooding within the project area by conveying water to the Waikato River.
- The model can be used for identifying areas in the catchment where changes in hydraulics and flooding mechanisms may impact velocity. Due to the identified model limitations, the model is not suitable for determining absolute in-channel velocity values.
- The existing and proposed culvert inlet and outlet connection configurations with the 1D river reach may require further refinement to more closely represent expected performance during detailed design.
- Explicit calibration of the model has not been undertaken.
- The accuracy for the extent of floodplains and peak flow rate of river reach will be dependent on the initial ground conditions and ponding areas. No antecedent rainfall was applied for depression filling in the ground model.
- No blockage or sedimentation in culverts or open channels has been allowed for, therefore assumed culvert capacity is a best-case scenario. Pipe condition and maintenance has not considered.
- Culverts do not currently consider fish passage.

3 Results

3.1 Catchment Boundaries and Flood Mechanisms

Inspection of historical aerial photography and contour data indicates that at least part of the catchment north of SH1 discharged to the Waikato River – incised channels indicate significant flow at one stage. The historic construction of SH1, and creation of farm drains on the north side of SH1 have altered the natural drainage pattern in the area.

Figure 9 Aerial Photography, June 1943 of interchange site (source: retrolens.co.nz)

Currently, narrow farm channels near the intersection of SH1 and SH29 flowing towards the Waitoa River have capacity for low flow events less than the 50 % AEP (refer to Figure E3.B). Small culverts associated with the drainage of SH1 currently pass minimal flow towards the Waikato River. When rainfall exceeds the capacity of these farm drains, a wide, shallow floodplain stores and conveys water to the north.

3.2 Performance of Existing Infrastructure

Table 15 and Table 16 sets out the predicted flow and level of existing infrastructure. Table 16 includes changes to the existing infrastructure, as described in Section 2.5.2.

Table 15: Performance of Existing Infrastructure (Baseline, including Climate change)

Culvert ID	Dia (mm)	Peak Flow (L/s)			Peak U/S Water level (m RL)		
		50% AEP	10% AEP	1% AEP	50% AEP	10% AEP	1% AEP
CULV1	Unknown	N/A	N/A	N/A	N/A	N/A	N/A
CULV2	375	121.00	135.00	133.00	101.54	101.77	102.00
CULV4	450	3.00	5.00	149.00	101.73	101.82	102.31
CULV5	450	29.00	35.00	76.00	106.00	106.00	106.00
CULV6	400	166.00	196.00	238.00	100.90	100.99	101.16
CULV7	450	4.00	10.00	22.00	99.32	99.51	99.86
CULV8	750	408.00	581.00	665.00	98.64	98.73	98.95

Table 16: Performance of Existing Infrastructure (Scheme, including climate change)

Culvert ID	Dia (mm)	Peak Flow (L/s)			Peak U/S Water level (m RL)		
		50% AEP	10% AEP	1% AEP	50% AEP	10% AEP	1% AEP
CULV1	Unknown	N/A	N/A	N/A	N/A	N/A	N/A
CULV2	375	N/A	N/A	N/A	N/A	N/A	N/A
CULV4	450	0.00	1.00	64.00	101.69	101.69	101.92
CULV5	450	32.00	42.00	76.00	106.00	106.00	106.00
CULV6	400	92.00	169.00	203.00	100.73	100.85	101.06
CULV7	450	3.00	11.00	23.00	99.31	99.49	99.87
CULV8	750	383.00	647.00	665.00	98.63	98.72	98.95

3.3 Proposed Scheme Analysis

The results from the scheme representation described in Section 2.5 are shown in Table 17 and the associated figures provided in Appendix E.

Table 17: Summary of Results from Hydraulic Modelling.

Figure No.	Annual Exceedance Probability Event (AEP), including climate change	Title	Summary of Results
E.1	1% AEP	Flood extent and depth (Baseline)	The proposed physical works are located partly within the predicted floodplain. Floodplain depths are typically 50-500mm deep and relatively slow moving (generally 0.1 – 0.5m/s) due to the flat topography in the area.
E.2	1% AEP	Flood extent and depth (Scheme)	Change in landform as a result of the scheme reduces floodplain conveyance. Hydraulic modelling predicts the loss of floodplain conveyance has a localised effect on flood levels, when considered in combination with proposed stormwater infrastructure.
E.3A and E.3B	50% AEP	Change in flood extent and depth based on proposed works	Hydraulic modelling predicts: • The majority of the existing floodplain has minimal change in flood extent and depth, within ±50mm change in depth. • Localised 50-250mm decrease downstream due to proposed hydraulic improvements to the existing culvert (Culvert 6) crossing SH29 and open channel.
E.4A and E.4B	10% AEP	Change in flood extent and depth based on proposed works	
E.5A and E.5B	1% AEP	Change in flood extent and depth based on proposed works	Hydraulic modelling predicts: • The majority of the existing floodplain has minimal change in flood extent and depth, within ±50mm change in depth. • Although there is a significant reduction in floodplain extent due to the construction of the new intersection, there is a large conveyance capacity in the remaining floodplain, therefore the increase in depth and extent is minimal. • The proposed new infrastructure also contributes to minimal effects through maintaining and improving overall conveyance capacity within the system. • Localised 50-250mm decreases downstream due to new open channel.
E.6	50% AEP	Change in velocity based on proposed works	Hydraulic modelling predicts localised increase in peak channel-averaged velocity in the farm drains upstream of culvert 6 (increasing by 0.05-0.5m/s).

4 Conclusions

- A hydrologic and hydraulic model has been built for the Catchment to provide flood risk information to inform the design and assessment of effects for the Project.
- The model has been built in accordance with the methodology agreed with WRC, described in Appendix A, noting some amendments were required due to data availability. Where data is not available, or there is uncertainty regarding data, a precautionary approach has been adopted. As improved data becomes available, the review and potential refinement of this analysis is recommended.
- A Rainfall Analysis (Appendix B) has been completed to inform the hydrologic analysis. For the Catchment, a 24-hour nested storm temporal distribution from the WRC runoff modelling guideline was applied to represent rainfall scenarios. A 1-hour critical duration storm has also been adopted, with NRCS curve number method to understand the difference result for different rainfall-runoff methodology.
- Climate change (RCP6.0), assuming 2.3 ˚C increase was applied, with a 2120 timeframe horizon. A sensitivity test with RCP8.5 was also considered, however this showed limited change in flood extent and depth compared to RCP6.0. Detailed design can assess the implications on level of service of climate change timeframe (e.g. to 2090), if appropriate.
- No data is available to calibrate or validate the hydraulic model. Further sensitivity analysis of other key model parameters has been undertaken, including temporal pattern, manning's roughness change, and downstream boundary change. The results indicate the model is relatively insensitive to these parameters. This is likely due to the large storage available in the floodplain.
- The effect of the Project has been tested through amending the existing DEM, and including key infrastructure, such as culvert extensions and underpasses. The conceptual nature of the scheme representation means review and potentially refinement of this analysis is recommended as design of infrastructure progresses.
- Scheme analysis shows the change in landform as a result of the scheme reduces floodplain storage. The overall effect of this floodplain loss is ±50mm change in depth and minimal increase in flood extent for the events analysed. Localised larger changes in depth and extent are a result of infrastructure improvements, such as new channels, treatment devices and culvert improvements. No formal flood attenuation has been represented in the model.

5 Reference

AAM 2016. Opus International Consultants, Cambridge Area Mapping Volume *27042A01NOK*.

Trevor, C., Roddy, H., Shailesh, S., 2018, *High Intensity Rainfall Design System Version 4* . NIWA.

Waikato Regional Council 2020. *Waikato stormwater runoff modelling guideline TR2020/06*. Waikato Regional Council.

Waikato Regional Council 2020. *Waikato stormwater management guideline TR2020/07*. Waikato Regional Council.

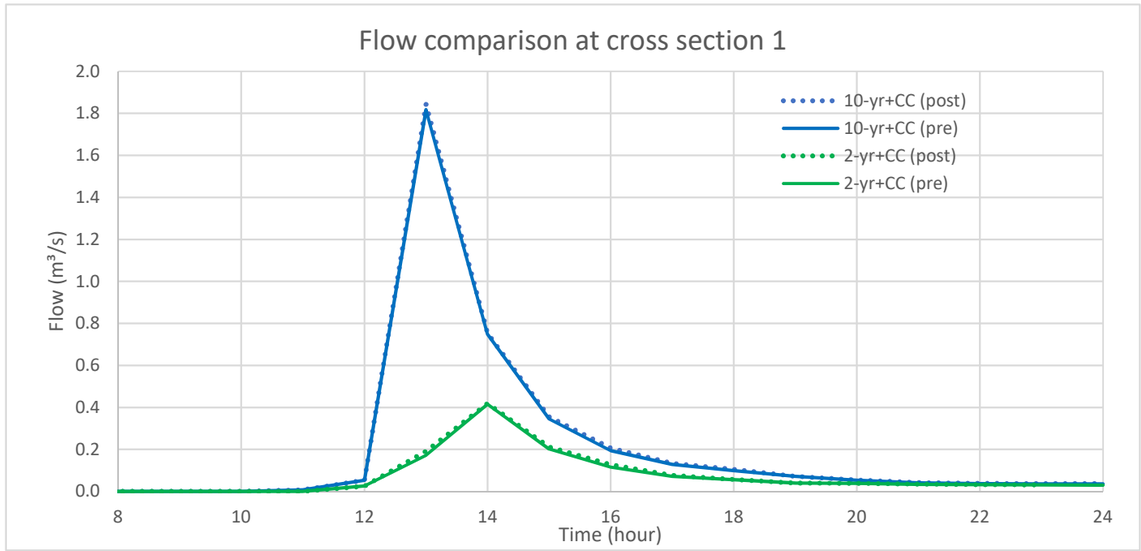
wsp.com/nz

Attachment B: Spreadsheet of the pre and post peak flow comparisons for intermediate storm events

FLOW COMPARISON- 2YRCC AND 10YRCC -PRE VS POST XS1- 30 SEPTEMBER 2021

XS1

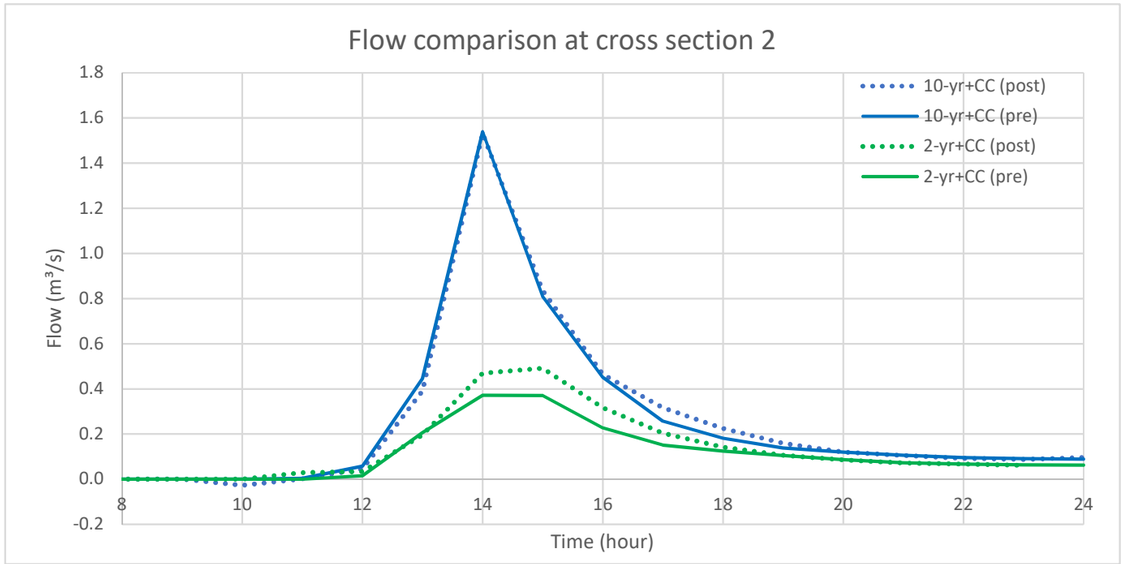
	Flow (m^3/s)			
Time(hrs)	10-yr+CC (post)	10-yr+CC (pre)	2-yr+CC (post)	2-yr+CC (pre)
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0.0003	0.0002	0	0
11	0.0075	0.0071	0	0
12	0.0533	0.0538	0.0255	0.0261
13	1.843	1.818	0.1913	0.1718
14	0.7527	0.7485	0.4188	0.4152
15	0.3557	0.3455	0.2112	0.202
16	0.2062	0.1948	0.128	0.1157
17	0.1332	0.1283	0.0766	0.0724
18	0.1051	0.099	0.0572	0.0563
19	0.0724	0.0722	0.04	0.0395
20	0.055	0.0532	0.0383	0.0383
21	0.0422	0.0414	0.0347	0.0342
22	0.0384	0.037	0.0322	0.0319
23	0.0368	0.036	0.0311	0.0309
24	0.0368	0.0362	0.0305	0.0304



FLOW COMPARISON- 2YRCC AND 10YRCC -PRE VS POST XS2- 30 SEPTEMBER 2021

XS2

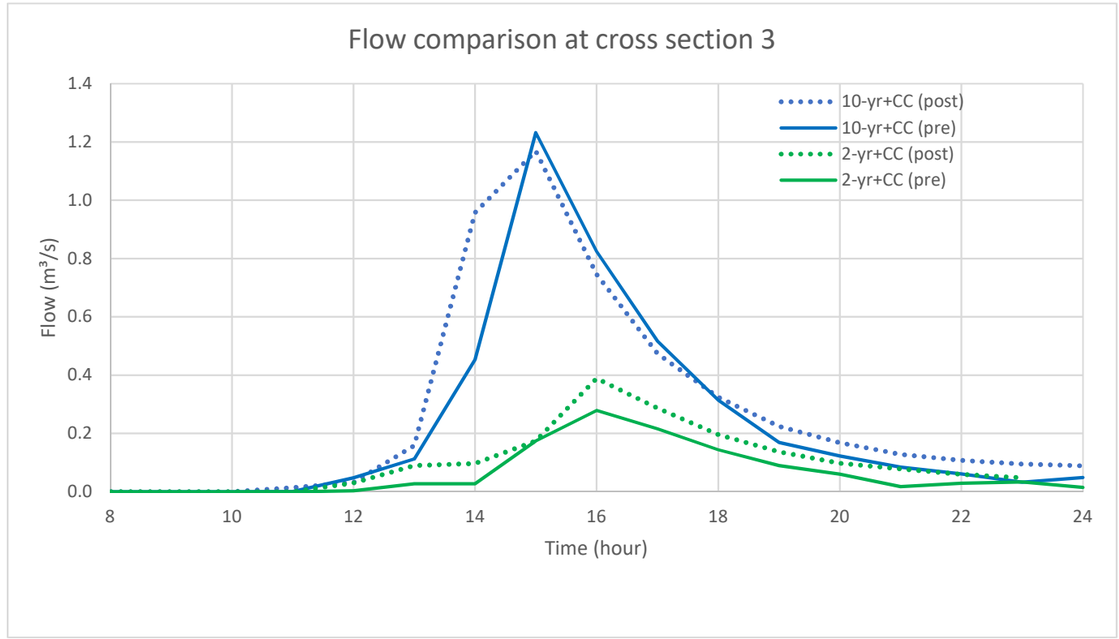
	Flow (m^3/s)			
Time(hrs)	10-yr+CC (post)	10-yr+CC (pre)	2-yr+CC (post)	2-yr+CC (pre)
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	-0.0271	0.0002	0	0
11	0.0018	0.0035	0.0296	-0.0005
12	0.0452	0.0574	0.0336	0.0148
13	0.3908	0.4457	0.1958	0.2062
14	1.532	1.539	0.4695	0.3717
15	0.8351	0.8101	0.4914	0.3708
16	0.4633	0.4516	0.3171	0.2264
17	0.3169	0.2573	0.2039	0.1507
18	0.2243	0.1805	0.1418	0.1242
19	0.1593	0.1388	0.1059	0.1047
20	0.1194	0.1202	0.0855	0.0861
21	0.1049	0.1057	0.0717	0.0733
22	0.0925	0.0963	0.0674	0.067
23	0.0879	0.0912	0.0612	0.0636
24	0.0955	0.0892	0.064	0.0625



FLOW COMPARISON- 2YRCC AND 10YRCC -PRE VS POST XS3- 30 SEPTEMBER 2021

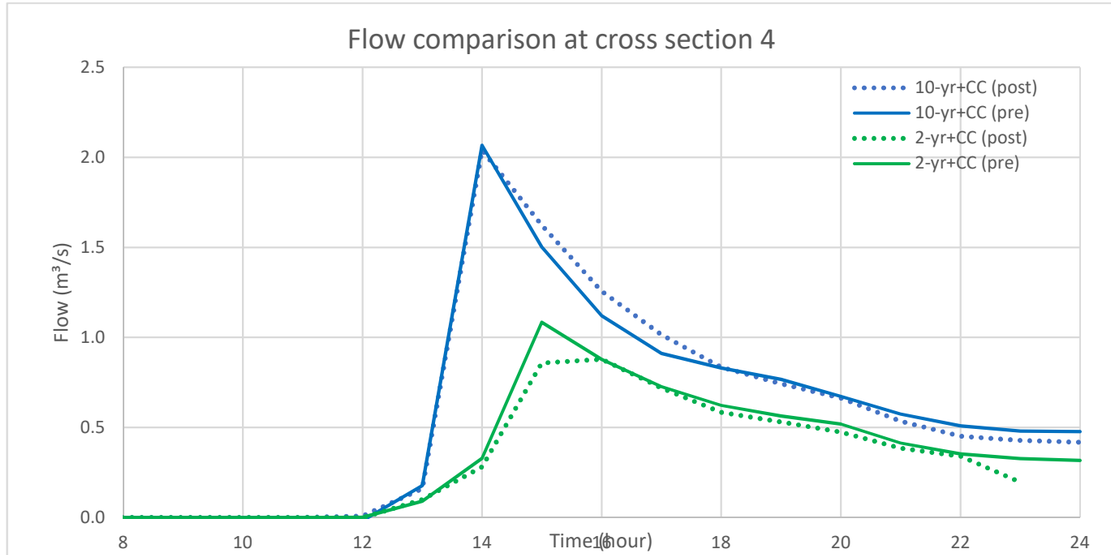
XS3

	Flow (m^3/s)			
Time(hrs)	10-yr+CC (post)	10-yr+CC (pre)	2-yr+CC (post)	2-yr+CC (pre)
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0	-0.0003	0	0
11	0.0135	0.0005	0	-0.0003
12	0.0319	0.0479	0.0301	0.003
13	0.158	0.1122	0.0895	0.0269
14	0.9578	0.453	0.0965	0.0274
15	1.169	1.232	0.1743	0.1743
16	0.7459	0.8251	0.3886	0.2787
17	0.4739	0.5167	0.2862	0.2155
18	0.3244	0.3142	0.1955	0.1436
19	0.2244	0.1689	0.1365	0.0896
20	0.1683	0.1225	0.0979	0.0604
21	0.128	0.084	0.0776	0.0178
22	0.1078	0.0612	0.0595	0.0291
23	0.095	0.0325	0.0481	0.0337
24	0.0886	0.0483	0.0407	0.0145



XS4

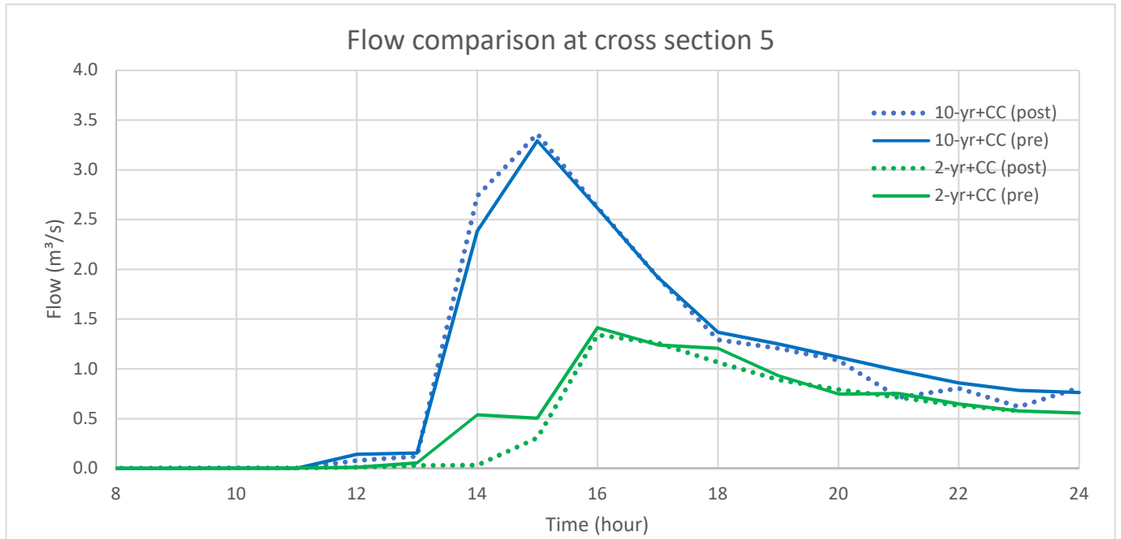
	Flow (m^3/s)			
Time(hrs)	10-yr+CC (post)	10-yr+CC (pre)	2-yr+CC (post)	2-yr+CC (pre)
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0.008	-0.0184	-0.0012	0.0007
13	0.1595	0.1776	0.0993	0.091
14	2.04	2.067	0.2808	0.3276
15	1.623	1.502	0.8582	1.084
16	1.256	1.12	0.8785	0.8783
17	1.015	0.9106	0.7197	0.7264
18	0.8341	0.8297	0.5829	0.622
19	0.742	0.7668	0.5305	0.564
20	0.663	0.6715	0.4737	0.5181
21	0.5345	0.5734	0.384	0.414
22	0.4513	0.5085	0.3396	0.3523
23	0.4271	0.4799	0.1958	0.3262
24	0.4179	0.477	0.3149	0.3172



FLOW COMPARISON- 2YRCC AND 10YRCC -PRE VS POST XS5- 30 SEPTEMBER 2021

XS5

	Flow (m^3/s)			
Time(hrs)	10-yr+CC (post)	10-yr+CC (pre)	2-yr+CC (post)	2-yr+CC (pre)
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0.002	0.0015	0	0
10	0.0027	0.0028	0.0019	0.0012
11	0.0012	0.0015	0.0032	0.0026
12	0.0795	0.1401	0.0101	0.0104
13	0.1208	0.1541	0.0291	0.0564
14	2.739	2.385	0.0319	0.537
15	3.362	3.292	0.3054	0.5047
16	2.624	2.616	1.341	1.414
17	1.921	1.92	1.258	1.241
18	1.293	1.368	1.064	1.207
19	1.207	1.25	0.8909	0.9329
20	1.086	1.116	0.7907	0.7456
21	0.7124	0.9811	0.7136	0.7517
22	0.8044	0.8591	0.633	0.6482
23	0.6183	0.7831	0.5773	0.576
24	0.8087	0.7621	0.5543	0.5564



Attachment C: Updated Bat Management Plan

Project Number: 2-A0011.04

State Highway 1 and State Highway 29 Intersection Upgrade

Draft Bat Management Plan

October 2021

wsp

150 YEARS IN AOTEAROA

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Status: Final

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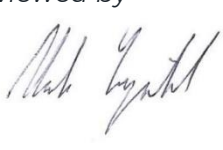
Reviewed by



Mark Yungnickel I Senior Ecologist

John Turner I Technical Principal

Approved for release by

Zaid Essa I Project Manager

Contents

1 Introduction

1.1 Purpose

This document presents a draft adaptive Bat Management Plan (BMP), prepared by WSP, for Waka Kotahi New Zealand Transport Agency (Waka Kotahi), for the proposed intersection upgrade of State Highway 1 (SH1) and State Highway 29 (SH29) (the Project). This BMP outlines and guides implementation of the required management of effects on long-tailed bats. This document accompanies the Assessment of Effects on the Environment (AEE) in relation to ecology, which forms part of the resource consent lodgement package submitted to Waikato Regional Council (WRC).

The scope of this BMP includes:

- Summary of potential effects on long-tailed bats resulting from the Project;
- Details of measures to avoid, remedy and/or mitigate adverse effects; and,
- Vegetation Removal Protocol to be implemented.

1.2 Long-tailed bats

The long-tailed bat *(Chalinolobus tuberculatus),* a species classified as 'Threatened -Nationally Critical'[1] is found widely throughout the North Island and is common within the Waikato Region. The species roosts in cavities and damaged trunks/branches of mature native and exotic trees and often utilise sheltered areas of woody vegetation for foraging and commuting. If bats are confirmed present within an area, it is necessary for potential effects on bats to be identified and appropriate mitigation measures implemented to avoid any harm or disturbance to the species. As a native species they are protected under the Wildlife Act 1953. Therefore, any harm (direct or indirect) caused to bats during construction activities can result in prosecution, if all practical steps to avoid this are not demonstrated.

1.3 Project Bat Ecologist

A nominated Project Bat Ecologist (PBE), who has been approved by the Department of Conservation (DOC) as competent with bat competency Class D or Class E (or redefined categories), will be responsible for the implementation of this BMP and the associated Vegetation Removal Protocol (VRP) presented in Appendix A[2].

[1] O'Donnell, C.F.J.; Borkin, K.M.; Christie, J.E.; Lloyd, B.; Parsons, S.; Hitchmough, R.A. (2018). Conservation status of New Zealand bats, 2017. *New Zealand Threat Classification Series 21, Department of Conservation, Wellington, New Zealand.*

[2] Vegetation Removal Protocol presented in Appendix A are industry standard (Smith et al., 2017). These protocol are currently under review by industry professionals and are subject to changes in the near future (pers. comm, Moira Pryde, Department of Conservation Technical Advisor, April 2021).

2 Potential effects on long-tailed bats

There are potential direct and indirect effects on long-tailed bats that have been identified, both during- and post-construction. These effects are:

- Construction phase
  - mortality/injury during vegetation removal;
  - habitat loss; and
  - noise, vibration and light disturbance during construction.
- Operation phase
  - fragmentation; and
  - artificial light pollution.

The management of these effects are addressed in sections 3 to 6 below.

3 Construction phase

3.1 Avoiding mortality/injury during vegetation removal

3.1.1 Assessment of vegetation for roosting potential

Potential roosting habitat has been identified within the designation boundaries of the roundabout and the stormwater discharge works (as detailed in the AEE) and will be impacted by construction. Prior to the earthworks and vegetation clearance required for the construction of the access track, discharge and associated erosion protection structures, the PBE will undertake a roost tree suitability assessment of the vegetation proposed to be removed.

All potential roost trees will be marked, given an ID number and their location recorded on a GPS device. This information will be used as a reference to improve efficiency during tree clearance, and to ensure no potential roost trees are accidentally felled.

3.1.2 Avoiding direct harm to bats

There is a possibility that vegetation to be felled could be an active bat roost and, as mentioned in section 1.2, it is important that measures are taken to avoid direct harm to bats. Strict protocol (VRP, Appendix A) therefore must be implemented for **all** vegetation to be removed or pruned for construction purposes. The protocol outline monitoring and inspection methods to be used to ensure bats are not occupying vegetation immediately prior to removal, such as:

a) Visual inspections

This method requires arborists to climb all vegetation (where safe to do so), under the supervision of the PBE, and inspect all identified roost features or areas of the tree the PBE cannot see from the ground. Arborists will relay any potential evidence of bats (e.g. urine staining, cavities, droppings) by way of live audio-visual equipment and/or photographs for review by the PBE. This inspection must be undertaken immediately prior to (same day) removal. At the time of visual inspections, the PBE may also use a thermal camera to inspect roost features from the ground.

b) Dawn/dusk roost watches

This method will be used when vegetation is not safe or not practical (i.e. dense ivy covering tree) for arborists to climb. Vegetation will be subject to two consecutive nights of watches at both dusk and dawn, carried out by PBE and at least one other experienced ecologist where health and safety considerations allow. A thermal camera and handheld acoustic detectors will be used to assist with observations. If the PBE is confident after the second dawn watch that bats are not occupying the subject vegetation, then it can be removed on that same day.

c) Active bat roosts

If bats are confirmed, via the methods above, to be roosting within the subject vegetation, it must not be felled. The roost will be isolated and marked, and all relevant staff will be notified to ensure the roost is not removed or disturbed by nearby construction activities. Monitoring will be continued until the PBE can confirm that no bats are roosting within the vegetation in question. If bats are found to be consistently using the roost (i.e. after seven nights of monitoring), then a meeting with be held with council and DOC representatives to decide an appropriate way forward.

3.2 Habitat Loss

3.2.1 Avoidance

To minimise the effects of roost habitat loss, tree clearance will be kept to a minimum, and only removed when absolutely necessary. A total of six exotic trees of moderate roosting suitability have been proposed for removal within the roundabout footprint, which will be unavoidable.

However, for the stormwater discharge and associated access track works, there will be opportunities for avoidance. Several mature trees with varied moderate to high roosting suitability have already been identified by ecologists, and as a result these trees will not be removed. The approximate location and path of the access track has now been decided but there are further opportunities for avoidance of roost trees achieved through minor adjustments to the track design.

To guide these alterations and finalisation of the track design, a walkover meeting between the PBE, contractors and engineer representatives will be held. The PBE will then identify any high value roost trees that will be affected by construction and will discuss options for avoidance by moving the access track away from the potential roost tree and its dripline.

The finalised access track will be clearly delineated using tape and/or marker pegs to ensure that no trees are unnecessarily removed.

3.2.2 Mitigation

Mitigation for the loss of potential roost trees will be offered in the form of planting of both native and exotic tree species. Exotic tree species tend to mature and produce roosting features much faster than native species. Table 1 provides a list of both exotic and native species, known to provide such habitat for bats, and will be considered for mitigation planting.

For the loss of **each** tree assessed as having "high" roosting suitability the following mitigation will be provided:

- Planting of eight trees (1:8 ratio); four of which will be exotic species and four will be native species.

If roosting bats are confirmed within any of the vegetation to be removed (while implementing the Vegetation Removal Protocol), and the tree cannot be retained by any means, then consultation will be undertaken with Waikato Regional Council and the Department of Conservation. The following mitigation will also be provided:

- Planting of eight trees (1:8 ratio); four of which will be exotic species, and four will be native species; and

- Installation of four artificial bat boxes of the "kent" design on a suitable tree(s) adjacent to the designation, and with aluminium predator exclusion banding situated both above and below the boxes. Locations and installation will be under the guidance and supervision of the PBE.

The PBE shall also determine whether any natural roosts found during tree clearance. (i.e. cavities and their extents) can be relocated and attached to another tree that will be unaffected by construction, therefore preventing the loss of the roost.

If planting of trees is required (due to loss of high suitability and/or confirmed roost trees). The formation and location of the plantings will be considered in a way that will naturally encourage foraging and commuting behaviours. Trees can be planted to provide further edge habitat; whether this is a single external edge, or in a tunnelling formation to provide both internal and external flyways. Trees will also be planted in areas that they are able to grow and eventually decay

naturally without encroaching into road corridors or areas that will pose future threats to safety and therefore as a result, have to be felled.

Table 1. List of exotic and native tree species that will be considered for mitigation planting, if required.

Common name	Latin name
Exotic species	
Giant gum	*Eucalyptus regnans*
Brown Barrel	*Eucalyptus fastigata*
Messmate	*Eucalyptus obliqua*
Tasmanian Blackwood	*Acacia melanoxylon*
Radiata pine	*Pinus radiata*
London plane	*Platanus x acerifolia*
Sessile oak	*Quercus petraea*
Native species	
Ti kouka	*Cordyline australis*
Kahikatea	*Dacrycarpus dacrydioides*
Rimu	*Dacrydium cupressinum*
Kanuka	*Kunzea var.*
Manuka	*Leptospermum var.*
Mahoe	*Melicytus ramiflorus*
Totara	*Podocarpus totara*
Matai	*Prumnopitys taxifolia*
Tawa	*Beilschmiedia tawa*

3.3 Minimising fragmentation

Embankment planting (from a landscape architecture aspect) is currently planned on all sides of the roundabout, as well as specimen trees along the cycleway for shading. The PBE will work with landscape architects to incorporate tall growth tree species into the vegetation management plan to encourage commuting bats through the landscape. These trees will also help to guide bats safely over the roundabout, reducing the already minor risk of collision with vehicles. Minimising fragmentation will also be achieved by the installation of best practice lighting as outlined in Section 4.1, whereby bats will tend to avoid the lit zones (pers. obs. Caitlin Dodunski, Simon Chapman) and oncoming traffic by flying over the top or around. In addition, the general improvement of road lighting from the current situation should encourage bats to commute within the adjacent landscapes more often.

3.4 Minimising noise and vibration disturbance to active roosts

While long-tailed bats can roost and remain very active close to lit sections of road and appear tolerant in many situations of the associated traffic noise and vibration, the variability and less predictable nature of construction related disturbance potentially risks affecting the bats normal behaviour. Noise and vibration, or even light from vehicles and plant could cause disturbance, including causing them to abandon roosts or emerge later than is optimal for foraging. Considering these risks, measures need to be implemented to minimise the potential for disturbance associated with active roost trees.

In the event that a roost is located by the PBE during vegetation clearance (while enacting the requirements of the VRP) the following actions will be taken:

a) The immediate area of the roost will be cordoned off with safety fencing and signage erected, alerting any person approaching the area that a bat roost is present and to stay clear;

b) The existence of the roost will be widely publicised to all construction staff and work instructions for the immediate area will be updated to reflect the presence of the roost and the measures to minimise disturbance; and

c) No construction activities will take place within 50m of the roost from 2 hours before official dusk to 1 hour after official dawn unless approval is given by the PBE.

4 Operational Phase

4.1 Minimise artificial light pollution

To minimise light spill into the surrounding environment, low intensity, longer-wavelength and warm colour LED lighting will be installed. The following specifications will be followed for installation of all lighting:

- Luminaires shall produce no direct upwards light;
- Luminaires shall have a maximum colour temperature of 2700K (white); and
- Light levels on the boundary of key bat habitats (as presented in Figure 1) will not exceed 0.3 Lux.

Figure 1. Key bat habitats where light levels will not exceed 0.3 Lux.

Artificial lighting currently present along the SH1/SH29 intersection will also be decommissioned.

Landscape planting on all sides of the roundabout will block the majority of headlight glare from vehicles therefore reducing effects of headlight glare from what is currently present.

5 Reporting

A Tree Clearance and Mitigation Report will be submitted to Waikato Regional Council within 2 months following completion of all tree felling associated with this Project and will include:

- Details of all trees felled (GPS location, species, DBH, photos and roost suitability rating), and actions taken to ensure no bats were harmed during clearance;
- Details of measures taken to avoid wherever possible, felling of trees assessed as having high roosting suitability, or of confirmed bats roost trees; and
- Details and quantities of required mitigation based on number and quality of roost trees removed (as outlined in Section 3.2.2). This will include proposed planting sites and their protection and management, locations of artificial roost boxes and proposed management.
- Confirmation that mitigation for habitat loss (if required) has been implemented.

Appendix A
Vegetation Removal Protocol

wsp.com/nz

Attachment D: Updated Vegetation Removal Protocol

Appendix A
Vegetation Removal Protocol

Adapted from:
Smith, D.; Borkin, K.; Jones, C.; Lindberg, S.; Davies, F.; Eccles, G. 2017. Effects of land transport activities on New Zealand's endemic bat populations: reviews of ecological and regulatory literature. NZ Transport Agency research report 623. Annex DH*.

*The protocol outlined in this document are currently under review by industry professionals are subject to change in the near future.

1 Introduction

This document presents Vegetation Removal Protocol (VRP) to be implemented prior to removal of all vegetation for construction of the SH1/29 Intersection upgrade (the Project). These protocol follow industry best practice adhering to both the Bat Management Framework set out by Waka Kotahi New Zealand Transport Agency (Smith et al., 2017) and the Department of Conservation's (DOC's) best practice manual of conservation techniques (Sedgeley et al., 2012).

These protocol are specific to this Project and they aim to provide clear, concise procedures that are to be followed prior to the removal of all vegetation for the Project, with the goal of avoiding mortality or injury to long-tailed bats during clearance activities.

There are four protocol that must be adhered to:

Protocol A: Identification of potential bat roost habitat;

Protocol B: Pre-felling procedures;

Protocol C: Felling procedures; and

Protocol D: Bat Injury or Mortality.

1.1 Project Bat Ecologist

The implementation of these protocol must be undertaken by a nominated Project Bat Ecologist (PBE). The nominated PBE must be approved by the Department of Conservation (DOC) as competent with Bat competency Class D or E (or redefined categories) (Appendix A). Class A, B and C2 bat ecologists may form part of their team and undertake tasks outlined within this VRP under supervision from the PBE. The PBE is not required to be present at the site all the time but must retain sufficient oversight of their team to be confident good decisions are being made regarding presence/absence of bats and potential roost sites. However, the PBE must be present on site during the removal of all potential bat roost trees.

2 Vegetation Removal Protocol

2.1 Protocol A: Identification of potential bat roost habitat

Prior to undertaking this protocol, ensure the designation boundaries have been visually delineated using flagging tape or boundary pegs, to ensure all trees that are required for removal are assessed appropriately. This also ensures that no more vegetation than necessary is removed.

1 All vegetation that might be disturbed and/or removed for construction must first be assessed by the PBE for presence of roost features. Vegetation identified as potential bat roosts1 are those >15 cm Diameter at Breast Height (DBH) and have one or more of the following attributes:

- Cracks, crevices, cavities, fractured limbs, or other deformities, large enough to support roosting bat(s);
- Sections of loose flaking bark large enough to support roosting bat(s);
- A hollow trunk, stem or branches; and/or
- Deadwood in canopy or stem of sufficient size to support roost cavities or hollows.

Based on the presence (or absence) of the above, vegetation must then be categorised[2] as to their suitability as bat roosts (Table 1). This method was adapted from roost tree assessments conducted for the Southern Links Project (AECOM, 2019).

Table 1: Criteria for assessing vegetation for their suitability as bat roosts.

Suitability as a roost	Justification of assessment	Further survey required?
Low	A tree of at least 15cm DBH but no roost features visible or with only limited roosting potential i.e. loose bark present, but not sufficient to provide shelter for roosting bats.	No
Moderate	A tree of at least 15cm DBH with one or more roost features that could be used by individual bats or where it is not clear from the ground inspection whether roost features are present or not and therefore requires further inspection.	Yes
High	A tree of at least 15cm DBH with one or more roost features which could provide habitat for several bats due to their size and ability to provide sufficient shelter and protection.	Yes
Confirmed	A tree known to have been used by bats as a roost tree.	Yes

[1] Roosts tend to be observed in mature trees that are >15cm DBH; however, native bats have also been observed in tree ferns, cabbage trees and epiphytes, therefore this vegetation should also be considered as High-Risk.
[2] This method was adapted from roost tree assessments conducted for the Southern Links Project (AECOM, 2019).

2 Potential (those assessed as moderate suitability or higher) or vacant bat roost trees must only be removed between 1st October and 31st April.

3 All trees of at least moderate suitability shall be subjected to pre-felling monitoring as per Protocol B. Pre-felling vegetation assessments using visual methods (see Protocol B for details) shall be undertaken under the supervision of the PBE.

4 No trees or vegetation identified as potential roosts can be felled or cleared without the approval of the PBE.

2.2 Protocol B: Pre-felling procedures

Once all vegetation has been assessed as having moderate or high suitability as bat roosts using Protocol A, occupancy will be confirmed using one or a combination of methods outlined below, immediately prior to vegetation clearance. The most effective method will be determined by the PBE on a case-by-case basis.

2.2.1 Visual inspections

This method will be used in the first instance, where the extents of all potential roost features will be inspected for presence of bats. If roost features are low enough, the PBE will undertake the inspection, however if they cannot be reached, or the full extent of the vegetation cannot be seen by the PBE from the ground, arborists will be required to climb and inspect the tree, under supervision of the PBE. The following guidelines are to be used:

1 All vegetation identified as having moderate-high suitability as a roost may be inspected to confirm occupancy by roosting bats.

2 An arborist may undertake a visual inspection of vegetation by climbing (under guidance and supervision of the PBE) and relaying any potential evidence of bats (e.g. urine staining, cavities, droppings) by way of live audio-visual equipment and/or photographs for review of the PBE. This must be undertaken immediately prior to (same day) removal. The arborist will also check for signs of roosting bats using a handheld bat detector (to detect social and echolocation calls from roosting bats).

3 Arborists may carefully inspect and check the extents of split branches, and if necessary, use an endoscopic camera to inspect cavities for presence of roosting bats.

4 If potential roosts are located within tree ferns or other 'delicate' vegetation, climbing will only be undertaken if it is safe to do so for the climber and if this will not damage the roost or disturb potentially roosting bats at the time of inspection. All climbing must take place under the careful supervision of the PBE to prevent roost damage or disturbance/injury to roosting bats. Photographs will be taken of any roosts or roost evidence found.

5 A thermal camera may also be used from the ground to inspect any roost features at the time of tree inspections. This technique is useful when a particular branch or tree cannot be climbed to provide certainty that a tree is unoccupied.

6 If no bat activity or evidence of roosting bats at the potential roost trees is identified and the PBE determines the vegetation can be removed, this information should be relayed to the contractors in sufficient time to allow clearance of vegetation to be completed prior to dusk the same day.

2.2.2 *Dusk/Dawn Roost Watches*

This method will be used if potential roosts cannot be ruled out using visual inspection techniques and/or a tree cannot be climbed (e.g. vegetation that is unsuitable for climbing, dense ivy covering. In this instance, the following methodology should be implemented.

1 Observations should begin before sunset. Bats begin to leave their roosts while there is still light outside, therefore, there is potential to observe bats without the aid of cameras or video equipment.

2 During this monitoring period overnight weather conditions must meet the following criteria;

(a) Air temperature does not drop below ten degrees Celsius from sunset until four hours after sunset;
(b) Mean overnight wind speed does not exceed 20km/h;
(c) Maximum overnight wind gust does not exceed 60km/h; and
(d) Rainfall of no more than 2.5mm in the first two hours after dusk.
(e) No monitoring shall take place during a full moon, or one night either side of full moon.
(f) Where a night of monitoring is lost to adverse weather or presence of a full moon, or equipment failure, further monitoring will take place until two consecutive nights of monitoring is achieved.

3 Observations shall be carried out close to potential roost sites where flying bats are back-lit against the sky (where possible). It may be useful to have more than one person observing potential roost sites from different angles to determine precise trees or vegetation and exit holes.

4 A thermal imaging camera should be used wherever possible to assist in the detection of bats and provides the opportunity to review footage should there be any bat passes observed and/or heard.

5 Hand-held bat detectors should be used to alert the ecologist(s) to the presence of bats nearby, narrowing down the potential roost site locations and allowing roosts to be confirmed.

6 This method should be repeated at dusk and dawn (return observations) for two consecutive nights prior to felling.

7 If no bat activity at the potential roost trees is identified after the second dawn watch and the PBE is confident the vegetation can be removed, this information should be relayed to the contractors in sufficient time to allow contractors to clear vegetation prior to dusk the same day.

2.2.3 *Acoustic monitoring via Automated Bat Detectors*

1 Relying on acoustic data is difficult in areas where bat activity is common, such as in this Project area. Therefore, for this Project, visual inspections and roost watches will be the primary pre-felling methods used. However, to supplement tree inspections, the use of acoustic monitors will be used to further understand bat activity prior to felling.

2 Where acoustic monitors are used, the identified potential roost trees will be acoustically monitored for two consecutive nights immediately prior to felling. Monitors will be programmed to detect activity from one hour before dusk until one hour after dawn.

3 If acoustic data is to be solely relied on for determining roost occupancy, the monitoring criteria as outlined in Section 2.2.2 (2a-f) will be adhered to.

4 The Automatic Bat Monitors (ABMs) should be placed so that detection of bats is likely if they are using the potential roosts.

2.3 Protocol C: Felling Protocol

1 If bats are confirmed via either of the methods detailed above, to be roosting within the tree, it must not be felled. The following actions will be taken:

(a) Roost trees should be clearly marked, and the immediate area will be cordoned off with safety fencing and signage erected in a 10 m radius around the roost, alerting any person approaching the area that a bat roost is present and to stay clear.

(b) The PBE will notify the Waikato Regional Council (WRC) and DOC within 12 hours of when the occupied bat roost was discovered and provide relevant information such as photos, GPS co-ordinates.

(c) All relevant Project staff will be briefed to ensure the tree is not removed. The PBE will determine whether all tree clearance works should be suspended or whether inspections and clearance can continue away from the roost.

(d) Further monitoring must continue until the PBE can confirm that no bats are roosting within the vegetation in question.

(e) If the tree is a maternity roost tree removal works shall be scheduled to only occur within the period 1 March to 31 April inclusive.

(f) The Bat Ecologist will review whether it is possible to relocate the roost into an area that would remain of value to bats, for example. could the hollow be kept and attached to another tree as a bat box? Could the tree be relocated as standing dead timber? Therefore, preventing the loss of the roost through careful repositioning.

(g) If bats are confirmed to still be roosting within the vegetation after fourteen nights of monitoring, then a meeting will be set up by the PBE between suitable WRC and DOC staff to decide on an appropriate way forward. This will be a risk assessment-based approach dependent on the type of roost identified.

2 The PBE should be onsite to supervise all potential vegetation clearance operations and to advise staff should bats be detected (either leaving trees or injured) and to inspect each felled tree or vegetation for signs of bats. Removal must occur on the same day as per the pre-felling procedures listed in Protocol B. If this is not possible then monitoring and/or repeat inspection of roost features must be continued until the tree can be removed in its entirety.

3 Potential or vacant bat roost trees will only be removed between 1st October and 30th April. However, trees that are identified as “potential roost trees” from the ground based on limited visibility but are later climbed by an arborist to find that no roost features are present, are exempt from this period, and can be felled at any time.

4 If bats are detected while felling is in progress, felling must stop long enough to allow any uninjured bats to escape (if it is safe to do so). Every effort should be made to relocate the section of the trunk/branch where the bats were roosting before felling may recommence.

5 Attempts should be made to capture any observed bats by the PBE for injury assessment.

6 Uninjured bats will be released immediately and if any injured or deceased bats are salvaged, Protocol D shall be implemented.

7 All potential bat roost vegetation shall be thoroughly inspected immediately after felling with the aid of a handheld detector by the PBE, to check for any roosting bats remaining within the tree.

8 If any injured bats are observed during/after vegetation clearance, then Protocol D must be implemented.

2.4 Protocol D: Bat Injury or Mortality

In the event of finding a dead or injured bat(s) the following procedures will be implemented:

1 Injured bats will be placed in a dark material-lined bag by the PBE to ensure the bat is handled appropriately.

2 Injured bats will be taken immediately to the nearest available veterinarian for assessment/treatment. The vet will make a decision as to whether to euthanise the bat or not (this does not require DOC approval). If the vet decides that the bat can be rehabilitated, the vet will contact DOC on the emergency hotline (0800 362 468).

3 If the bat is dead or has been euthanised by the vet, it will be taken to the local DOC office as soon as practicable (required under the Wildlife Act 1953). The bat(s) must be stored in a fridge at less than 4˚C.

References

Sedgeley, J.; O'Donnell, C.; Lyall, J.; Edmonds, H.; Simpson, W.; Carpenter, J.; Hoare, J.; & McInnes, K. 2012. DOC best practice manual of conservation techniques for bats, Version 1.0. Inventory and Monitoring Toolbox: Bats, Department of Conservation.

Appendix A
Bat Ecologist Competency Levels*

*These are currently under review by industry professionals and are subject to change.

Class	Key Field Activity	Competency	Individual Experience/Knowledge
A	*ABMs*	*Setting up automatic bat detectors monitoring systems (ABMs)*	*Recent previous experience in installing ABMS in at least 2 comprehensive surveys.*
B	*Analysing ABMs*	*Setting up ABMS, and analysing and interpreting results.*	*Recent previous experience at analysing and interpreting ABM results in at least 2 comprehensive surveys.*
C1	*Identifying bat roosts (short tailed bats)*	*Finding and identifying short-tailed bat roosts that are either occupied or unoccupied. This competency may also include arborists.*	*Recent extensive experience in searching for and finding active and inactive roosts (by radio tracking, exit observations, and/or visual inspections).*
C2	*Identifying bat roosts (long tailed bats)*	*Finding and identifying long-tailed bat roosts that are either occupied or unoccupied. This competency may also include arborists.*	*Recent extensive experience in searching for and finding active and inactive roosts (by radio tracking, exit observations, and/or visual inspections).*
D	*Handling bats*	*Handling bats (in one or more field methods), as outlined in DOC's best practice manual (Sedgeley et. al. 2012).*	*Has undertaken field training from a competent trainer demonstrating the required technique to the trainer's satisfaction and meets DOC's best practice manual standards (Sedgeley et. al. 2012) to carry out one or more of the following specialised field methods:* • *extracting bats from mist net using harp traps at roost sites* • *handling bats* • *marking bats (e.g. forearm band, temporary marks)* • *using wing biopsies for genetic sampling attaching transmitters* • *inserting transponder tags*

			• *applying release technique*
E	*Trainer for class X*	*Competent at the relevant class plus capable of training staff.*	*Has a high level of knowledge and experience regarding the competency they are training people in.*
F	*Bat Management*	• *Survey/monitoring programme design*[2] • *Survey data analysis and interpretation*[1] • *Preparation of bat impact assessment reports*[1] • *Can recommend impact management strategies (e.g. mitigation) for projects*[1] • *Prepare, co-author, or certify the appropriateness of BMMPs*[1] *Presentation of expert evidence for projects impacting bats*	• *Competency in 3 or more of A/B/C/D activities (field experience relating to competency classes A/B/C/D activities)* • *Experience writing ecological assessments and/or species restoration or recovery plans. Thorough knowledge of available bat survey techniques and methodology, and their limitations. Thorough knowledge of the threat's bats face and national recovery actions.* • *Thorough knowledge of measures to avoid, mitigate or compensate for impacts of infrastructure projects on bat populations* • *Understands seasonality and conditions of bat activity, and how these might affect surveys* • *Can recognise and articulate how the practical constraints of a survey affect the conclusions in an impact assessment* • *Understand the importance of sampling design and sample size (effort) in determining whether monitoring results will have sufficient statistical power to detect changes in the variable of interest*

1 http://www.DOC.govt.nz/our-work/biodiversity-inventory-and-monitoring/bats/
2 May be undertaken by individuals or a team which collectively has these competencies.

Attachment E: Construction Air Quality Assessment

Project Number: 2-A0012.00

State Highway 1 and State Highway 29 Intersection Upgrade

Assessment of Effects on the Environment
Construction Air Quality

October 2021

wsp

150 YEARS IN AOTEAROA

Document Details:

Date: 7 October 2021
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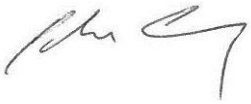

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Contents

Disclaimers and Limitations

This report ('**Report**') has been prepared by WSP exclusively for Waka Kotahi NZ Transport Agency ('**Client**') in relation to an application for notices of requirement and regional resource consents ('**Purpose**') and in accordance with our contract with the Client dated May 2020. The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

Glossary of Abbreviations

Abbreviation/acronym	Term
AEE	Assessment of Effects on the Environment
CEMP	Construction Environmental Management Plan
CO	Carbon monoxide
CWS	Compact weather station
°C	Degrees Celsius
Deposited dust	Dust that is no longer suspended in the air and has settled onto a surface
DRI	Dust risk index
HSR	Highly Sensitive Receptor, as defined in the NZ Transport Agency Guide to assessing air quality impacts from state highway projects (2019)
m	Metres
m^2	Square Metres
m^3	Cubic Metres
mm	millimetres
m/s	Metres per second
$\mu g/m^3$	Micrograms per cubic metre
MfE	Ministry for the Environment
MfE Dust Guide	Ministry for the Environment Good Practice Guide for Assessing and Managing Dust 2016
MfE Odour Guide	Ministry for the Environment Good practice guide for Assessing and Managing Odour 2016
MPDC	Matamata-Piako District Council
MPDP	Matamata-Piako District Plan
MSL	Mean sea level
NES	National Environmental Standard
NES Air	Resource Management (National Environmental Standard for Air Quality) Regulations 2004
NIWA	National Institute of Water and Atmospheric Research
NO_x	Oxides of nitrogen
NO	Nitrogen monoxide
NO_2	Nitrogen dioxide
NZTA	New Zealand Transport Agency
%	Percent
PAHs	Polycyclic aromatic hydrocarbons

Abbreviation/acronym	Term
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10 micrometres
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of less than 2.5 micrometres
RMA	Resource Management Act 1991
SO_2	Sulphur dioxide
SVOCs	Semi-volatile organic compounds
SWDC	South-Waikato District Council
SWDP	South-Waikato District Plan
TSP	Total suspended particulates
VOCs	Volatile organic compounds
WRC	Waikato Regional Council

1 Executive Summary

This report addresses potential air quality effects during construction for the State Highway 1 (SH1) and State Highway 29 (SH29) Intersection Upgrade Project (the Project).

The existing environment is characterised using publicly available information for local topography, meteorology, air quality and the nearest sensitive receptors (R1, R2, R3, R4, R5, R6, R7 and R8) most likely to be affected by dust of varying size fraction (deposited dust, PM_{10} and $PM_{2.5}$) from construction activities. This information was used in the assessment of the risk of adverse dust effects during construction.

A qualitative assessment of the air quality effects during construction of the SH1/SH29 roundabout has been undertaken at eight sensitive receptor locations (R1 to R8) for the Project.

The assessment focusses on potential dust effects using the Dust Risk Index (DRI) and Frequency, Intensity, Duration, Offensiveness and Location (FIDOL) approaches as recommended by the MfE Dust Guide and Waka Kotahi NZ Transport Agency guidance. The outcomes of both approaches indicated a moderate risk of adverse dust effects at six sensitive receptors (R1, R2, R3, R4, R6 and R7) with R1, R2 and R3 likely to be most affected, given they are closer to the main construction activities (earthworks, construction and use of the haul road, and construction and in-fill of the roundabout). In addition, these sensitive receptors are anticipated to be relatively frequently affected by high-risk dust events (i.e. wind greater than 5 m/s and no rainfall) due to being located downwind of the main dust generating activities.

The only potential source of odour that may occur will be during road laying works using asphalt. This activity is expected to occur over a short period (weeks). Any odour generated will be localised and is likely to result in a less than minor potential for offensive odour beyond the boundary of the designation footprint.

On-site vehicle and mobile plant and machinery will generate exhaust containing combustion emissions. Additionally, disruptions to existing vehicle traffic patterns on SH1 and SH29 in the vicinity of the construction site may result in increased traffic and congestion and therefore higher vehicle related emissions.

Given the relatively small number of vehicles and plant machinery operating on-site at any given time and the temporary nature of the construction works, combustion emissions generated are expected to be minimal and are unlikely to have any adverse effect on the receiving environment.

The outcomes of the FIDOL and DRI assessment indicate a moderate risk for adverse dust effects with a corresponding minor magnitude of the effects at sensitive receptors R1, R2, R3, R4, R6 and R7. It is recommended that proven dust management measures be implemented during construction works, the details of which will be outlined in the Construction Environmental Management Plan (CEMP) for the Project. These measures will minimise the potential for adverse effects at all the identified sensitive receptors with the magnitude of dust effects considered to be minor or less.

2 Purpose and scope

This report forms part of a suite of technical reports prepared for Waka Kotahi NZ Transport Agency (Waka Kotahi) for the Project. The purpose of this Construction Air Quality Report is to inform the Assessment of Effects on the Environment Report (AEE) and support the two Notices of Requirement (NoRs) for alterations to designations to Matamata-Piako District Council (MPDC) and South-Waikato District Council (SWDC) and applications for regional resource consents to Waikato Regional Council (WRC).

A full description of the NoRs and regional resource consents required for the Project is provided in Section 4 of the AEE. A full description of the background and need for the Project is provided in Section 2 of the AEE.

The purpose of this report is to qualitatively assess the potential air quality effects from construction works and recommend measures to mitigate these effects to ensure impacts on the receiving environment are minimised.

3 Project Description

The Project is the construction and operation of a new two-lane roundabout connecting SH1 and SH29, north-west of the existing intersection of SH1 and SH29 at Piarere. The key components of the Project are:

a) A two-lane roundabout with a 60 m diameter central island.

b) Realignment of parts of the SH1 and SH29 approaches to connect to the new roundabout.

c) The roundabout will be elevated approximately 3.5 m above the existing ground level to provide for cycle and pedestrian underpasses.

d) A stormwater management system, a wetland, wetland and planted swales and a discharge structure and associated rip rap armour.

e) Construction activities, including a construction compound, lay down area and establishment of construction access.

A full description of the Project including its current design, construction and operation is provided in Section 6 of the AEE and shown on the Project Drawings in Volume 4: Drawing Set.

The final design of the Project (including the design and location of ancillary components such as stormwater treatment devices), will be refined and confirmed at the detailed design stage.

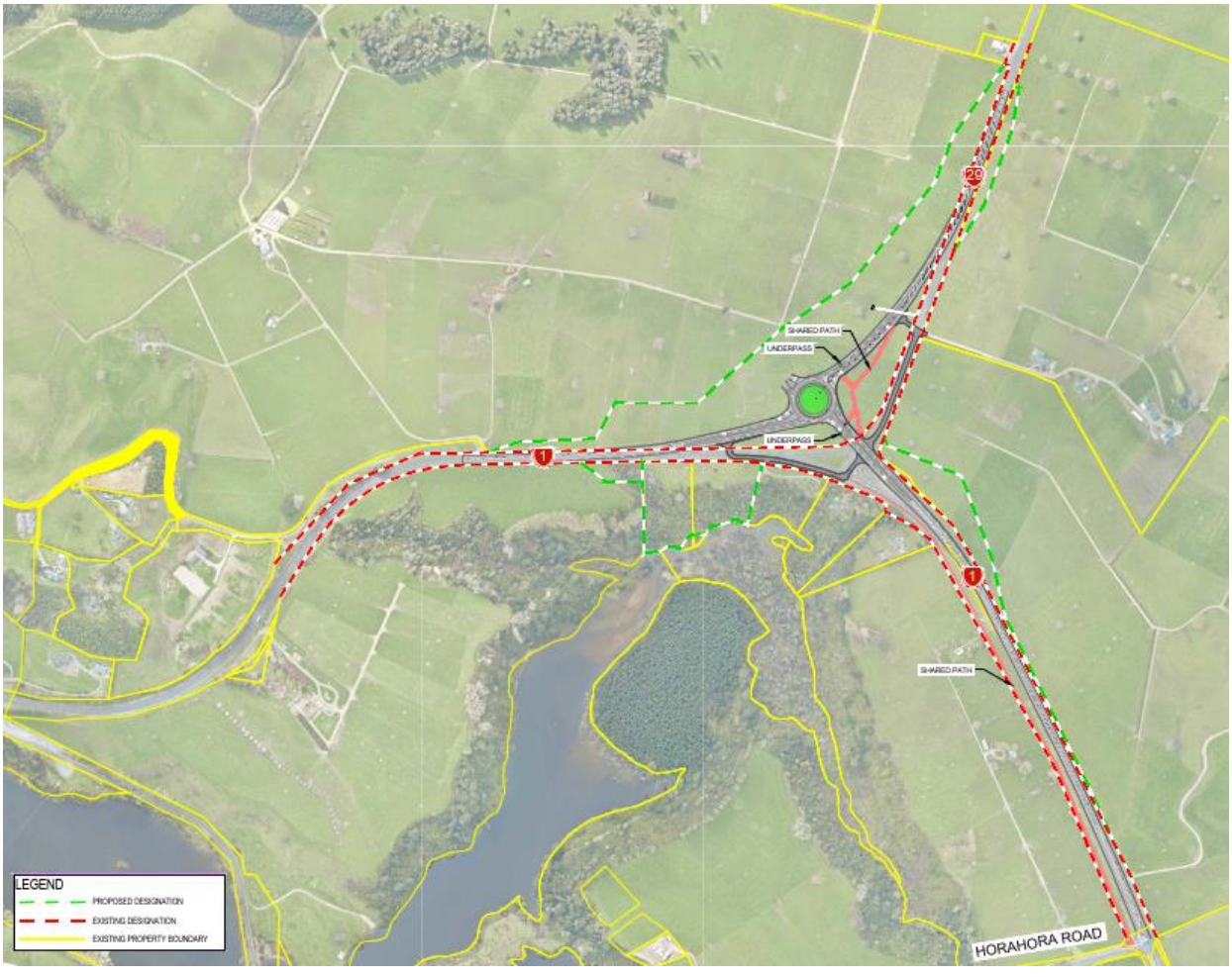


Figure 3-1 Layout Plan of the proposed roundabout

4 Legislative context and assessment methodology

This section lists the pollutants of interest for the Project and provides an outline of the legislation context for the Project.

4.1 Pollutants of interest

During construction of the Project, the following pollutants are expected to be emitted, either from mobile plant machinery and vehicles associated with construction, or as a result of earthworks and other activities associated with road construction:

- Particulate matter (or dust[1]) including:
    - Particulate matter with an aerodynamic diameter of less than 10 micrometres (PM_{10})
    - Particulate matter with an aerodynamic diameter of less than 2.5 micrometres ($PM_{2.5}$)
    - Total suspended particulates (TSP)
    - Deposited dust
- Oxides of nitrogen (NO_x comprising of nitrogen dioxide (NO_2) and nitrogen monoxide (NO))
- Carbon monoxide (CO)
- Volatile organic compounds (VOCs) including benzene, toluene, ethylbenzene and xylene isomers
- Semi-volatile organic compounds (SVOCs) including polycyclic aromatic hydrocarbons
- Odour

The regulatory framework prescribes the air quality criteria for the pollutants of interest listed above. These are contained within the following legislative instruments and guideline documents:

- Resource Management (National Environmental Standards for Air Quality) Regulations 2004
- Ambient air quality guidelines 2002
- Objectives and policies of the Waikato Regional Plan 2007

Details of the air quality criteria are provided in the following sections.

4.2 Resource Management (National Environmental Standards for Air Quality) Regulations 2004 (amended 2011)

Pursuant to section 43 of the RMA, the *Resource Management (National Environmental Standards for Air Quality) Regulations 2004* (NES Air) prescribes air quality standards for common pollutants with the aim of protecting the air quality in New Zealand.

Schedule 1 of the NES Air provides ambient air quality standards for common pollutants including CO, NO_2, ozone, PM_{10} and sulphur dioxide (SO_2). The relevant standards that apply to the Project are presented in Table 4.1.

[1] Particulate matter and dust are often used interchangeably. For the purposes of this report the term 'dust' has been used to include particles that give rise to soiling and human health effects.

Table 4.1 Relevant standards from the NES Air

Pollutant	National Environmental Standard	Averaging period	Number of exceedances allowed
CO	10 mg/m^3	8 hour (rolling average)	1 in a 12-month period
NO_2	200 µg/m^3	1 hour	9 in a 12-month period
SO_2	350 µg/m^3	1 hour	9 in a 12-month period
	570 µg/m^3	1 hour	None
PM_{10}	50 µg/m^3	24 hour	1 in a 12-month period

4.3 Ambient Air Quality Guidelines 2002

The Ministry for the Environment (MfE) has developed *Ambient Air Quality Guidelines 2002* which provides ambient air quality (AAQ) guideline values (MfE 2002) for a range of pollutants including particulate matter, combustion pollutants (e.g. NO_2, CO and SO_2), air toxics and heavy metals. The guideline values are the minimum requirements that outdoor air quality needs to meet to protect human health and the environment. The guideline values have no regulatory status but may be adopted by regional councils as part of their regional plans.

Table 4.2 presents the air quality guidelines for relevant pollutants.

Table 4.2 Ambient air quality guidelines

Pollutant	Guideline	Averaging period
CO	30 mg/m^3	1-hour
	10 mg/m^3	8-hour
NO_2	200 µg/m^3	1-hour
	100 µg/m^3	24-hour
SO_2	350 µg/m^3	1-hour
	120 µg/m^3	24-hour
PM_{10}	50 µg/m^3	24-hour
	20 µg/m^3	Annual
Benzene	3.6 µg/m^3	Annual
1,3-Butadiene	2.4 µg/m^3	Annual
Formaldehyde	100 µg/m^3	30-minute
Benzo(a)pyrene (as an indicator of polycyclic aromatic hydrocarbons (PAHs)	0.0003 µg/m^3	Annual

4.4 Waikato Regional Plan 2007

Regional councils have the primary responsibility for the management of air quality in New Zealand. Under the provisions of the RMA, councils develop regional plans that control discharges to air from a range of activities. The Waikato Regional Plan specifies regional levels to reflect the air quality of the region. The objectives of the plan in terms of air quality are to protect and enhance the existing ambient air environment by ensuring no significant adverse effects from individual site sources or cumulative effects from discharges.

Regional air quality plans give effect to the NES Air. Where regional air quality criteria are more stringent than an AAQ guideline, they supersede the standard.

Table 4.3 presents the regional ambient air quality guideline levels for the relevant pollutants. The main difference between the NES Air and the Waikato Regional Plan AAQ guideline levels is the

latter includes additional standards for 1 hour CO, 24 hour and annual NO_2, annual PM_{10} and annual benzene.

Table 4.3 Waikato Regional Plan ambient air quality guideline levels

Pollutant	Waikato region levels	Averaging period
CO	30 mg/m^3	1 hour
	10 mg/m^3	8 hours
NO_2	200 µg/m^3	1 hour
	100 µg/m^3	24 hours
	30 µg/m^3	Annual
PM_{10}	50 µg/m^3	24 hours
	20 µg/m^3	Annual
Benzene	3.6 µg/m^3	Annual

4.5 Good Practice Guide for Assessing and Managing Dust

MfE's Dust Guide (MfE 2016a) provides information and recommendations for the assessment and management of the environmental effects from fugitive dust sources.

For this Project, as significant adverse effects due to dust are not expected (see Section 6), only visual monitoring of dust is proposed (as outlined in Section 7.2 of this report).

5 Existing environment

5.1 Introduction

The existing environment of the Project area is characterised by the following aspects:

- Land use and topography
- Sensitive receptors
- Local meteorology
- Air quality.

5.2 Land use and topography

The land use in the immediate vicinity of the Project is pastoral farmland, predominantly dairy pasture. The Project area is located at the junction of the SH1 and SH29 at an elevation of approximately 102 m above mean sea level (MSL). Most of the area surrounding the Project is flat, except for in the south where the topography drops steeply towards the Waikato River / Lake Karapiro.

Immediately south of the Project the topography is gently undulating with Pukeatua Hill approximately 10 km south-west. The Kaimai mountain range lies approximately 22 km east stretching from Karangahake in the north to Rotorua in the south.

Undulating topography is capable of steering and channelling the wind such that the spatial distribution of wind patterns across a region can be localised. The Kaimai mountain range plays a role in not only steering and channelling the prevailing wind direction but also influencing night-time drainage flow regimes. Night-time drainage flows, or katabatic drift, occur at night when air at the top of the mountain cools and becomes heavier and is forced by gravity to move downslope. The steeper the slope, the faster these winds move. Inversions are also often associated with such conditions, where cold dense air pools form in the bottom of valleys under calm conditions and are strongest in the early hours of the morning just before dawn. When assessing the potential impact from a ground level air pollutant source, it can be important to consider these local drainage flows. For this Project they are not likely to be of concern.

5.3 Sensitive receptors

The MfE Dust Guide (MfE 2016a) categorises the sensitivity of the receiving environment into high, moderate and low ratings. Highly sensitive receptors (HSRs) include:

- Hospitals, schools, childcare facilities, rest homes, marae
- Residences
- Tourist, cultural and conservation areas

HSRs are receptors that have the greatest potential to be adversely affected by air emissions generated during construction activities and the potential air quality risk associated with road construction impacts is largely determined by the number of HSRs within 200 m of the works under consideration (NZTA 2019). A threshold distance of 200 m to sensitive receptors is used in the preliminary risk assessment to evaluate the construction air quality risk. At or beyond 200 m, dust impacts at sensitive receptors are likely to be minimal given the small scale of the Project, the number of earth-moving vehicles operational at any given time and the intermittent nature of the construction works

The nearest HSRs to the Project area are identified and presented in Table 5.1 and shown in Figure 5.1. There are six HSRs (R1, R2, R3, R4, R6 and R7) within 200 m of the designation boundary that have the potential to be affected by construction activities. These receptors are further assessed in Section 6 of this report. The other two HSR receptors (R5, and R8) are 200 m or more from the

designation boundary. Given their distance to the dust generating activities, and the scale of Project, they have not been considered in the assessment of dust risk effects in Section 6. In addition to receptors R1 to R8, there are another eleven receptors within 500 m of the Project. These receptors are located at the furthest extents of the designation boundary where dust generating activities would be low and any potential effects are anticipated to be minimal. These receptors have not been considered further in this assessment.

Table 5.1 Nearest sensitive receptors to the Project

Sensitive receptor ID	Address	Approximate distance to SH1/SH29 (m)[1]	Coordinates (Eastings, Northings)	Direction from SH1/SH29	Type
R1	38 and 40 SH1	40 (SH1)	383217 m, 5799348 m	West	Residence
R2	36 SH1	40 (SH1)	383095 m, 5799529 m	West	Residence
R3	2 SH1	35 (SH1)	382991 m, 5799591 m	South	Residence
R4	N/A	90 (SH1)	382900 m, 5799560 m	South	Unnamed River Kaitiaki (Conservation) zone
R5	1831 and 1833 SH1	280 (SH1)	382380 m, 5799906 m	North	Residence
R6	5920 SH29	50 (SH29)	383235 m, 5800365 m	North	Piarere Hall (community hall)
R7	5969A SH29	190 (SH29)	383316 m, 5799862 m	East	Residence
R8	5969B SH29	280 (SH29)	383391 m, 5799823 m	East	Residence

Note 1: Distance from nearest designation boundary to the receptor.

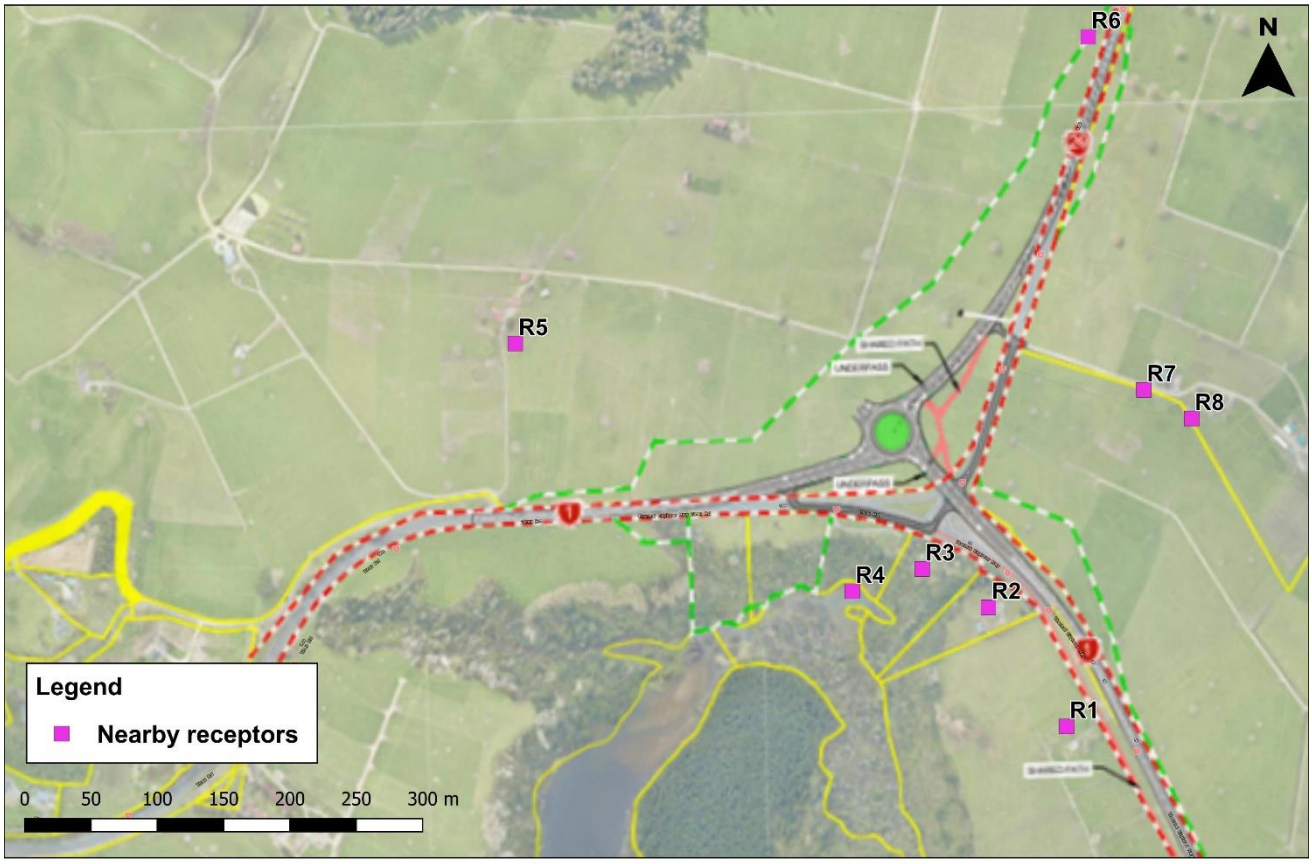


Figure 5-1 Location of nearest sensitive receptors to the Project.

5.4 Local meteorology

Meteorological conditions are important for determining the direction and rate at which emissions from a source disperse. The key meteorological parameters that can affect the dispersion of pollutants during construction include:

- Wind speed and direction
- Temperature
- Rainfall

The nearest meteorological station that continuously measures these parameters is operated by National Institute of Water and Atmospheric Research (NIWA) and located at the Lake Karapiro compact weather station (CWS). However, as the sensors are at a height of 2.5 m, which is considerably less than the standard meteorological mast height of 10 m, this CWS is not considered ideal to represent the meteorology at the Project location. The Cambridge meteorology station was not considered suitable for this Project, as it does not measure wind.

The next nearest meteorological station where wind speed and direction are monitored is a MetService-operated station at Hamilton Airport. The station is 30 km to the west of the Project site (see Figure 5-2) but is expected to be representative of conditions in Waikato valley in general, and considered more appropriate than the nearest Lake Karapiro CWS for this assessment.

The following sections describe conditions at Hamilton Airport for the years 2017 and 2018.

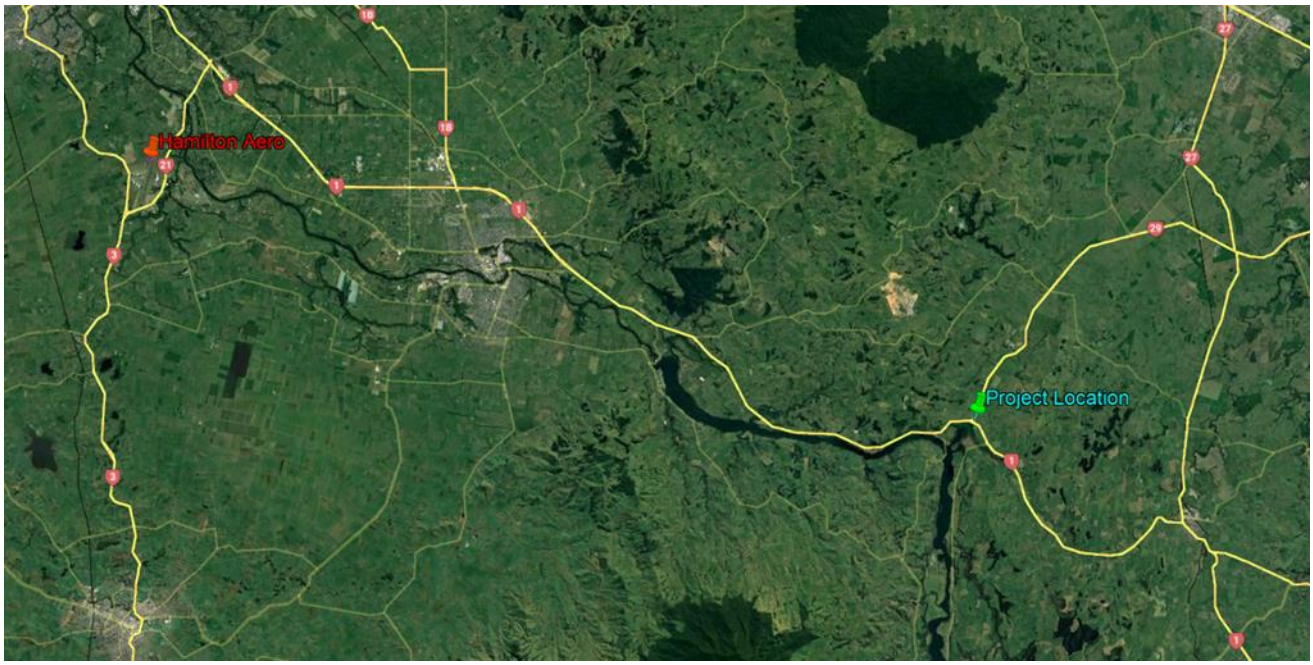
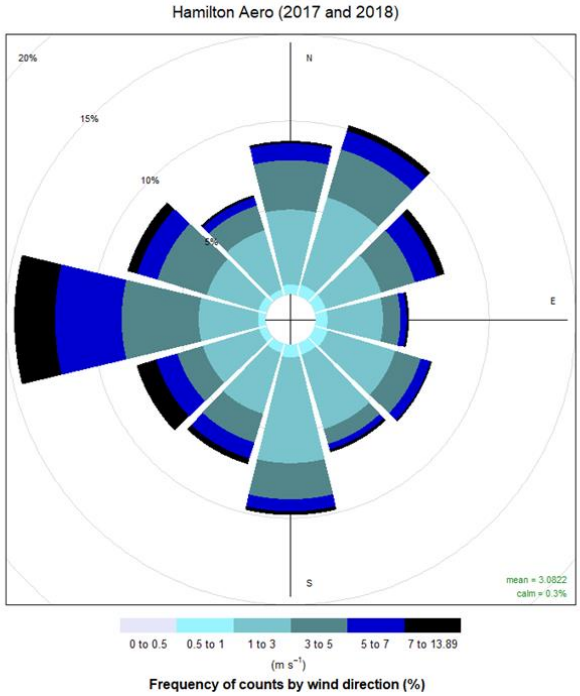


Figure 5-2 Location of Hamilton Airport AWS.

5.4.1 Wind speed and direction

The annual and seasonal wind roses at Hamilton Airport for the years 2017 and 2018 are presented in



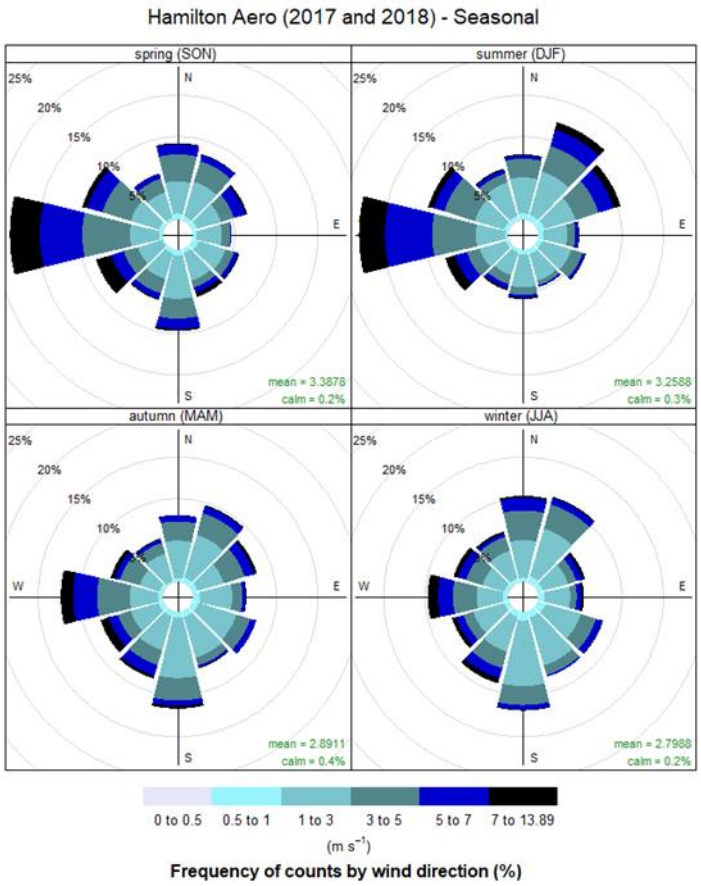


Figure 5-3. The annual wind rose shows westerly, southerly and north-easterly flows are more common than other directions. The average wind speed is 3 m/s and winds are calm (speeds less than 0.5 m/s) for 0.3 % of the time. There are seasonal variations at the Hamilton Airport monitoring site, although the prevailing wind directions are the same. The key seasonal observations to note are as follows:

- Stronger winds are predominantly from the west, followed by southwest. A small component of strong north-easterly winds is also observed at the Airport site. These winds also more frequent in spring and summer months.
- The highest seasonal-mean wind speeds of around 3.3 m/s occur in spring and summer.
- Calm conditions across all seasons are in the similar range, between 0.2 % and 0.4 %.

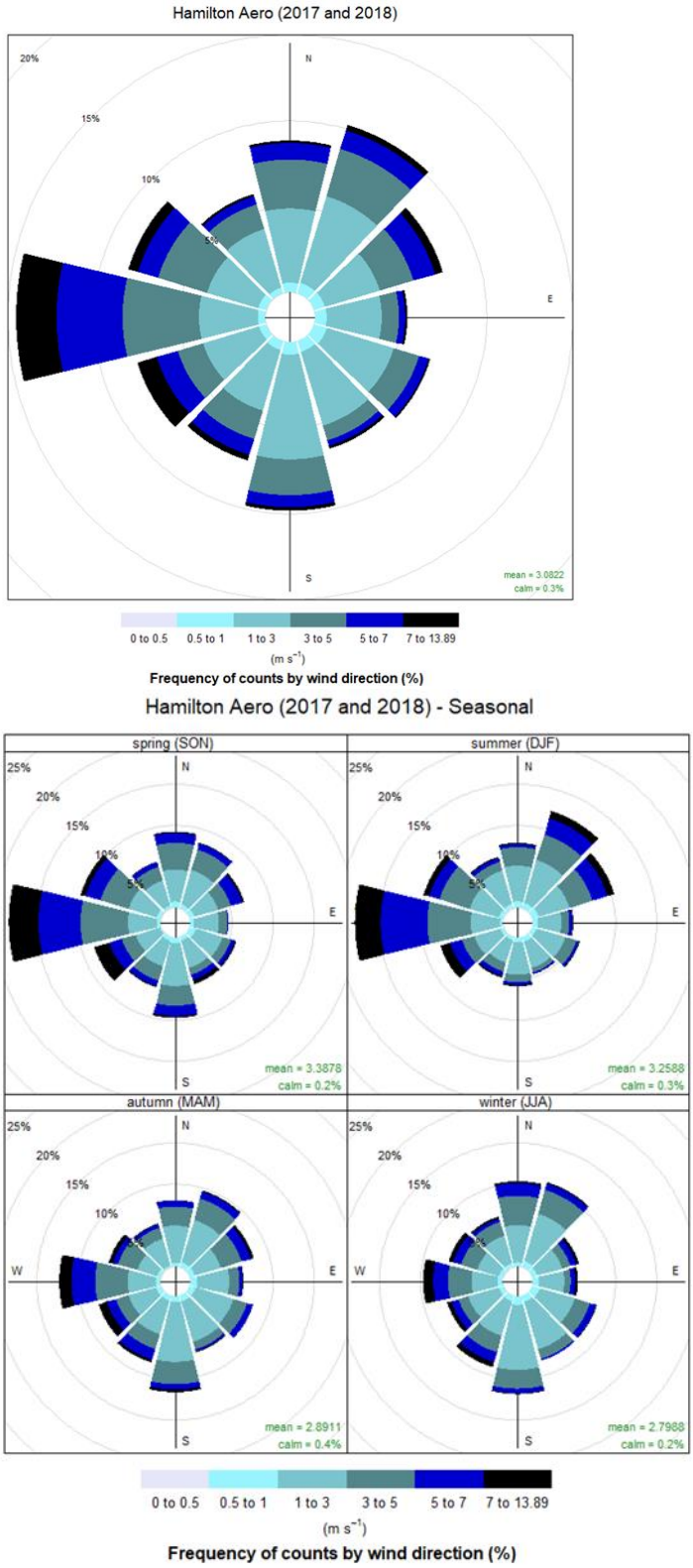


Figure 5-3 Seasonal and annual wind roses at Hamilton Airport weather station (data from years 2017 and 2018).

5.4.2 Temperature

Figure 5-4 depicts seasonal temperature variations with coolest temperatures in the winter and hottest in the summer. The minimum temperature of -2.6°C occurred in July 2017 and May 2018. The maximum temperature of 29.9°C occurred in January 2018.

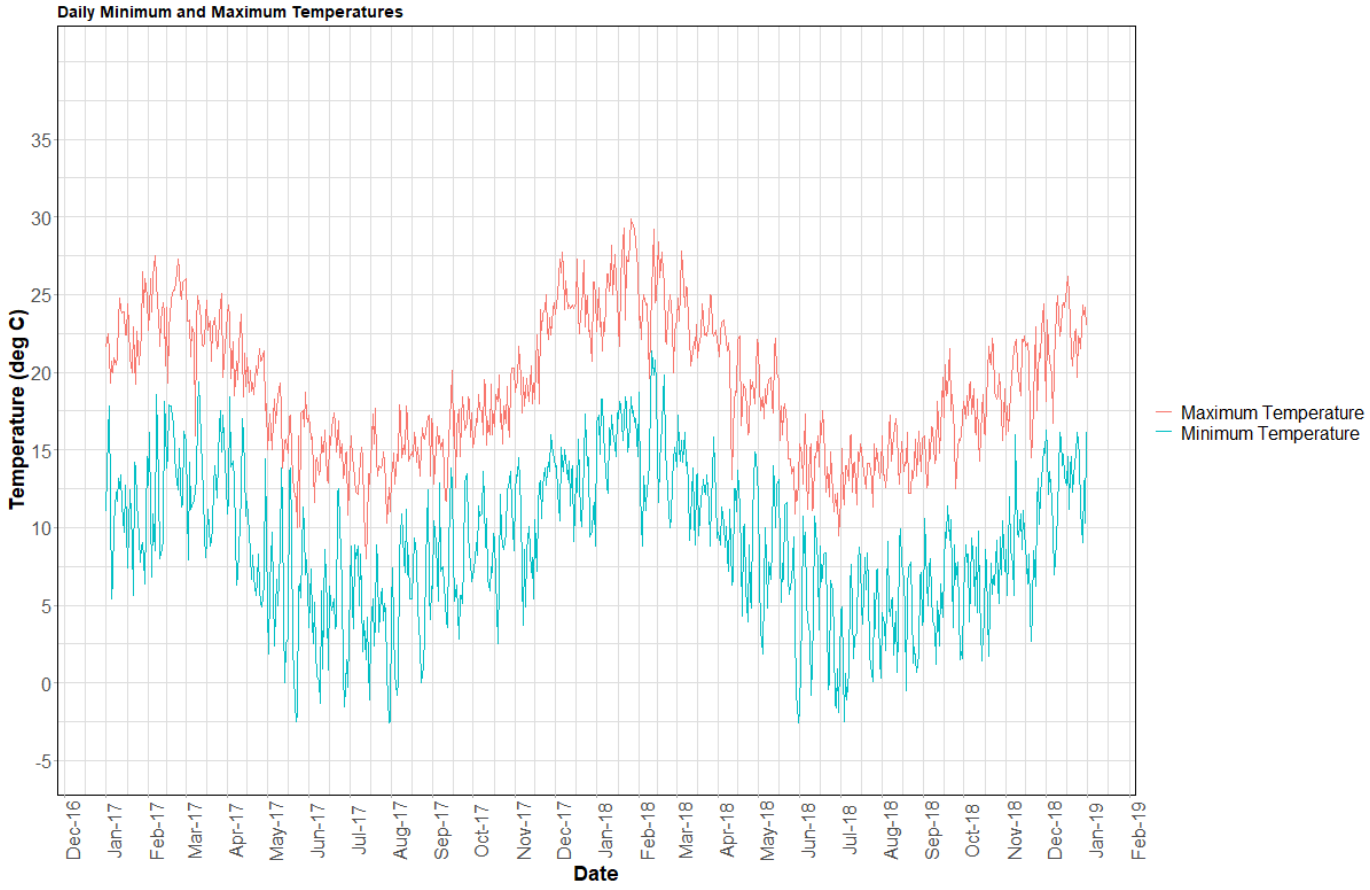


Figure 5-4 Daily maximum and minimum temperatures at Hamilton Airport.

5.4.3 Rainfall

Figure 5-5 shows the monthly rainfall levels (mm) at Hamilton Airport for the years 2017 and 2018. There is some variability in monthly rainfall across the two-year period with a maximum monthly rainfall of 217 mm in March 2017 and a minimum monthly rainfall of 15 mm in December 2017. In general, rainfall tends to be lower during the summer months. High rainfall has the potential to reduce dust emissions generated during construction activities.

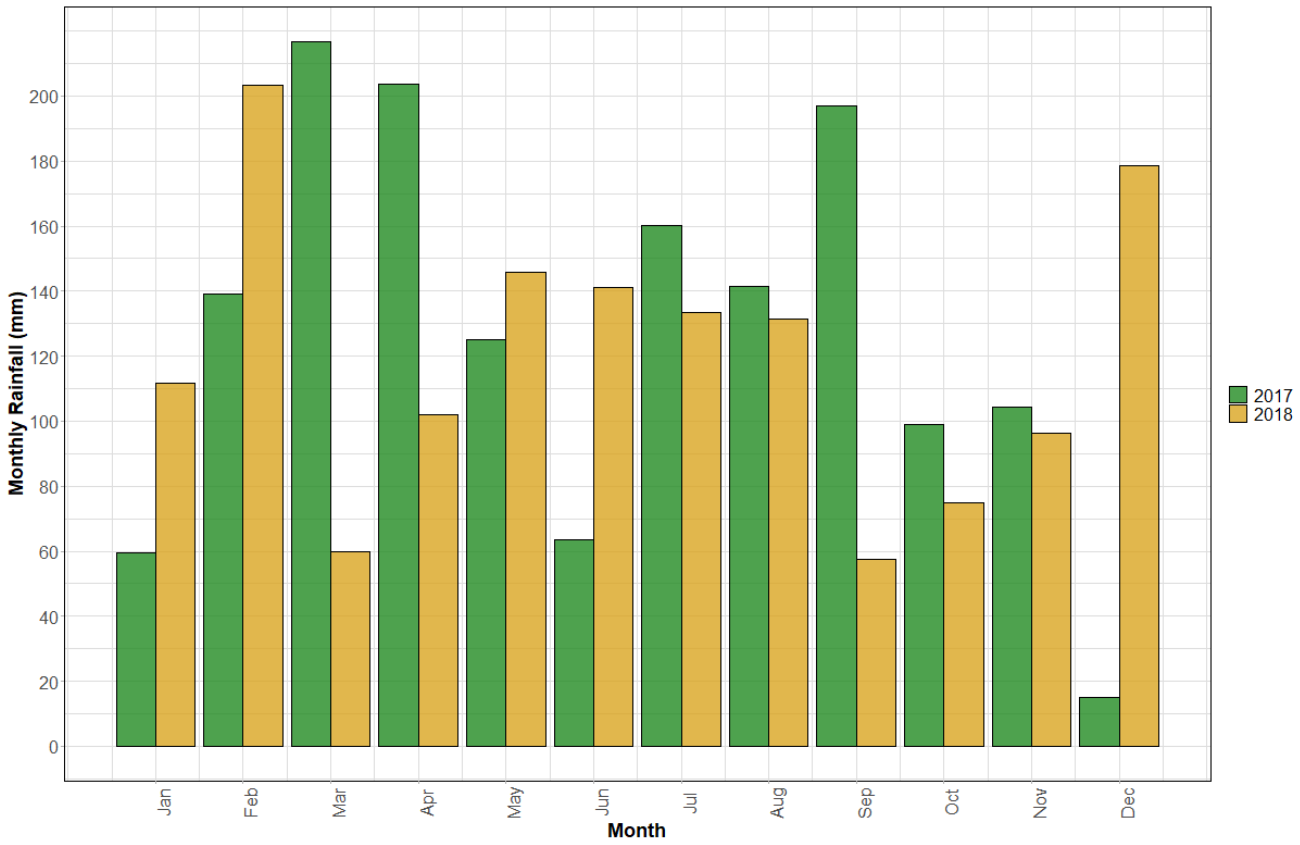


Figure 5-5 *Monthly rainfall at Hamilton Airport.*

5.5 Air quality

There is no local ambient air quality monitoring data for the Project area. Waka Kotahi has developed the Background Air Quality guide (NZTA 2014 draft) for selecting default background air quality values for PM_{10} and NO_2 in urban and rural areas in all airsheds in New Zealand. An interactive map (www.nzta.govt.nz) shows background air quality concentrations across New Zealand for two pollutants: PM_{10} and NO_2, which exclude the contribution of nearby roadways.

The background values selected are conservative, are assumed to stay the same over time and be consistent at all locations with a defined area (i.e. either an airshed or census unit).

The Project area sits on the boundary of MPDC and SWDC and falls within two separate airsheds (Matamata and Putaruru respectively). For the purposes of this assessment, it is assumed that the air quality within both airsheds are the same.

Table 5.2 presents the PM_{10} and NO_2 background concentrations of the Project area which are likely to be experienced by the identified sensitive receptors.

Table 5.2 Default background PM_{10} and NO_2 concentrations

Pollutant	Averaging period	Default background concentration	Relevant NES standard / Waikato Regional Plan AAQ guidelines
PM_{10}	24 hour	18.8 µg/m^3	50 µg/m^3
NO_2	1 hour	37 µg/m^3	200 µg/m^3
	24 hour	23 µg/m^3	100 µg/m^3
	Annual	4 µg/m^3	30 µg/m^3

6 Assessment of effects on the environment

This section qualitatively assesses the potential air quality effects during construction of the Project.

6.1 Construction air quality

6.1.1 Construction overview

Construction works are scheduled to take place over an 18-month period with an expected start date of late 2022. The total area of the designation footprint including the existing road corridor is 198,750 m^2. Table 6.1 presents selected metrics that provides a sense of the scale of the proposed construction work.

Table 6.1 Construction metrics

Construction area / volume of material handled	Construction metrics
Total site area (incl. existing road corridor)	198,750 m^2
Total earthworks footprint	79,000 m^2
Unsuitable material to be removed from site	< 10,000 m^3
Topsoil strip/stockpile/re-spread	24,000 m^3
Imported fill	90,000-95,000 m^3
Granular pavement and surfacing	45,000 m^3

The maximum number of heavy earth-moving vehicles on-site at any given time is anticipated to be fifteen, including four excavators, one front end loader and eight trucks. During the import fill stage, up to twenty truck and trailer units per hour will transport fill material from two nearby quarries.

There will likely be up to three possible access points to the site, SH1 at the western end of the construction footprint, SH29 at the northern end, and immediately to the north of the existing intersection. One haul road will be constructed at the SH1 access point and extend north to the access point at SH29.

The proposed designation footprint for the Project including the extent of proposed earthworks (cut and fill) is indicated on Figure 3-1. Earthworks will take place along the entire SH1/SH29 alignment upgrade, with in-fill works occurring at the proposed new roundabout. Stripped topsoil will be stored on-site for re-use. Other materials (e.g. pipes, catchpits, drainage aggregates) will be stored at three locations on-site during various stages of construction. There will be no blasting or piling on-site.

6.1.2 Potential emission sources

Air emissions, primarily dust, combustion emissions from vehicles and mobile machinery, and odour are likely to be generated during the following construction activities:

- site establishment, machinery mobilisation, construction of access tracks (dust)
- clearing and grubbing vegetation (dust)
- earthworks (dust)
- generation of spoil and road surface materials (dust)
- waste/spoil handling, transfer and storage (dust and odour)
- handling, transfer and storage of material (dust)
- wind erosion from exposed surfaces and stockpiles (dust)
- civil construction works including (dust):
    - cut and fill,
    - excavation,

  - placement of in-fill material at the new roundabout
  - demolition of the existing roadway
  - recontouring
- road laying and asphalt works (odour source)
- site demobilisation (dust)
- operation of mobile machinery and vehicles (combustion emissions).

6.1.3 Effects of odour and combustion emissions

Odour emissions from construction activities have been assessed on a case by case basis against the MfE Odour Guide. Contaminated soil and hence, odorous emissions from excavation works are not expected on-site. The only other potential source of odour that may occur will be during road laying works using asphalt. This activity is expected to occur over a short period (weeks). Any odour generated will be localised and will not result in '...an *odour discharge that has a noxious, dangerous, offensive or objectionable effect* (MfE 2016b, section 3.2.1) beyond the boundary of the construction footprint.

On-site vehicle and mobile plant and machinery will generate exhaust containing combustion emissions. Additionally, disruptions to existing vehicle traffic patterns on SH1 and SH29 in the vicinity of the construction site may result in increased traffic and congestion and therefore higher vehicle related emissions.

Given the relatively small number of vehicles and plant machinery operating on-site at any given time and the temporary nature of the construction works, combustion emissions generated are expected to be minimal and are likely to have a less than minor adverse effect on the receiving environment.

6.1.3.1 Preliminary dust risk assessment

Waka Kotahi's document *Update to NZTA Guide to assessing air quality impacts from state highway projects* is a guide to assessing air quality impacts from highway projects (NZTA 2019) (*Waka Kotahi Guide*). The Waka Kotahi Guide provides direction on how air quality risks and impacts from state highway improvement projects should be assessed for operation and construction phases.

For construction, the Waka Kotahi Guide discusses the main sources and pollutants likely to be generated, how to manage them, recommends trigger levels for road transport related dust and a methodology for assessing construction air quality effects.

Using the Waka Kotahi Guide, the first step is a preliminary risk assessment designed to determine the level of risk for the Project (i.e. low, moderate or high). Table 6.2 presents a checklist of questions to evaluate the construction air quality risk. Where the answer to all questions is no, then the air quality risk is low. If more than one answer is yes then the risk is high. Otherwise, the risk is moderate. Table 6.2 sets out responses to the questions with respect to the Project.

The total site area is 198,750 m^3 and the volume of material to be moved on-site is greater than 100,000 m^3. There are six HSRs within 200 m of the construction footprint and there will be less than 50 outward truck movements per day even during the most intense construction period. Overall, the air quality risk during construction is assessed as being moderate, based on the yes/no answers provided in Table 6.2. A more detailed dust risk assessment for receptors R1, R2, R3, R4, R6 and R7 is presented in Section 6.1.3.2 below.

Table 6.2 Preliminary construction air quality risk assessment

Topic	Key question	Yes/No
Scale of earthworks	Is the total site area > 10,000 m^2 or the total volume of material to be moved > 100,000 m^3?	Yes
Proximity to highly sensitive receptors	Are there more than 50 HSRs within 200 m?	No
Anticipated truck movements	Will there be more than 50 outward truck movements per day?	No

6.1.3.2 Dust risk assessment

The Waka Kotahi Guide recommends the Dust Risk Index (DRI) for projects with a high air quality risk. Although the preliminary risk index indicated an overall moderate risk for this project, sensitive receptors R1, R2, R3, R4, R6 and R7 are in proximity to the designation footprint and may experience dust effects during certain construction activities (earthworks, trucks on haul roads, exposed areas). There are five sensitive receptors within 100 m of the construction works with sensitive receptor R3 closest (35 m) to where the most intense activities are expected to occur (large earthworks, location of haul road and in-fill of the roundabout). Sensitive receptor R4 is located 90 m from the main construction works. Sensitive receptor R7 is located 190 m from the main construction works.

The methodology of applying the DRI to the Project is outlined below. The DRI has been applied to the six sensitive receptors within 200 m of the construction footprint. The greater the DRI, the higher the likelihood of dust related issues. Table 6.3 presents the DRI value and corresponding risk level.

Table 6.3 DRI risk level

DRI value	Risk level
0 to 100	Low
100 to 200	Moderate
200 to 300	High

The DRI is calculated using the following formula:

DRI = (E+P+T+WS+D+A)*M*WD

Where:

E = surface exposure

P = exposure periods

T = time of year

WS = wind speed

D = distance to nearest receptor

A = construction activity

M = mitigation

WD = wind direction

The DRI parameters are summarised in Table 6.4 and discussed further with respect to this Project in Section 6.1.4.

Table 6.4 DRI parameters

Parameter	Detail	Value
E: surface exposure	Recognises that the degree of surface disturbance will influence the potential for dust generation	1 = area less than 1 hectare (Ha) 5 = are between 1 and 5 Ha 10 = greater than 10 Ha
P: exposure period	Potential for dust effects exists as long as the surface is unstabilised	1 = exposure times < 1 month 5 = between 1 and 5 months 10 = up to a year 20 = greater than 1 year
T: time of year	Certain periods of the year are more likely to be periods of higher risk due to low soil moisture levels or higher winds	0: June to September 20: April, May, October and November 50: December to March 10: Default
WS: wind speed	Recognises the direct relationship between increased wind speeds and increased dust emissions	100: Project exposed to prevailing winds 50: Project in moderately exposed location 10: Project in sheltered location 100: No available information
D: distance to nearest receptor	The distance of construction works to sensitive receptors is one of the primary factors in determining the potential for dust effects	100: 0 – 50 m 50: 51 – 100 m 10: 101 to 150 m 5: 151 – 200 m 0: > 200 m
A: construction activity	Certain construction activities are more or less likely to contribute to dust related issues.	5: Vegetation removal 20: excavator cutting and shaping of natural ground 20: pavement construction 50: fill shaping and compaction (bulldozer) 100: Fill placement 100: haul operations
M: mitigation	Recognises that mitigation measures can be implemented to control dust.	0.5: effective mitigation that will control 90% or more of dust 0.8: mitigation that will control more than 50% of dust 1: no data is available

Parameter	Detail	Value
WD: wind direction	The potential for dust effects is strongly influenced by whether sensitive receptors are up or downwind or prevailing winds	1: receptor downwind of the of the works under a prevalent wind direction 0: prevailing wind direction is away from the sensitive receptor

6.1.3.3 FIDOL factors

Qualitative dust assessments must also consider all FIDOL factors (MfE Dust Guide), some of which are not specifically considered in the DRI approach.

FIDOL stands for:

- Frequency – how often a sensitive receptor is exposed to the dust
- Intensity – the concentration of the dust
- Duration – the length of exposure to dust
- Offensiveness – the type of dust emitted during construction works
- Location – the type of land use and receptor

The FIDOL factors are considered in conjunction with the DRI approach.

6.1.4 Assessment of construction dust effects

6.1.4.1 DRI approach

This section outlines the approach to calculating a DRI for sensitive receptors R1, R2, R3 R4, R6 and R7 based on the methodology described in Section 6.1.3.2 of this report.

The proposed area of the earthwork's footprint is 79,000 m^2 (7.9 hectares) and so a factor of 10 (E) is assigned for all sensitive receptors.

The exposure period for disturbed surfaces (e.g. from earthworks) is not known although the construction works is proposed to take place over an 18-month period commencing in late 2022. It has been assumed that the site will be exposed for the duration of the construction period and assigned a value of 20 (P) for all sensitive receptors. Except for the haul road, exposed surfaces will not be exposed for the duration of construction works and will be appropriately managed (i.e. compacting, contouring and shrub/grass planting) to ensure dust effects are minimised.

The construction period is greater than 1 year and works will occur across all seasons and weather conditions. Conservatively, a value of 50 (T) [applicable for the months of December to March] has been applied for all sensitive receptors.

Dust pickup by wind is generally only significant at wind speeds greater than 5 m/s. The area adjacent to the Project is flat with undulating terrain characteristic of the area beyond the Project. The Project area is not considered to be exposed to high wind speeds. For the period 2017 and 2018, wind speeds of 5 m/s or above at the Hamilton Airport were observed for up to 19 % of the time. The observed annual average wind speed at this station was 3 m/s. A value of 50 (WS) has been applied for '*a moderately exposed location*' at all sensitive receptors.

Sensitive receptors R1, R2, R3 and R6 are located 50 m or less to the nearest construction works area with a value of 100 (D) applied. R4 and R7 are 90 m and 190 m, respectively, from the construction works with values of 10 and 5 (D) assigned to these receptors.

For sensitive receptors R1 and R2, the nearest construction activities will comprise minor earthworks along SH1 in the direction east to Tirau (see Figure 3-1) The more intensive construction works (earthworks, haul road and, roundabout (RAB) infill and construction) will occur further away (greater

than 150 m) and these sensitive receptors are expected to be much less affected from dust emissions. The value for distance (D) applied to these sensitive receptors is considered conservative.

A value of 100 (A) was applied as in-filling, earthworks and hauling operations are the main construction activities for the Project.

Management measures to control dust will be implemented through a Construction Environmental Management Plan (CEMP) for the Project. A factor of 0.5 (M) has been applied assuming that proposed mitigation measures will be stringently enforced to achieve a 90% control efficiency.

It is noted that sensitive receptors R2 and particularly R3 and R4, are surrounded by trees which can act as a vegetative barrier further reducing exposure to dust. The efficiency at which this may occur during construction works is difficult to quantify. Notwithstanding, vegetation will provide some additional protection against dust exposure at these sensitive receptors.

The potential for dust effects at sensitive receptors will be strongly influenced by the prevailing wind direction. The Hamilton Airport data indicate that wind can blow at speeds greater than 5 m/s from most directions, particularly the west. As the construction works surround sensitive receptors R1, R2, R3 and R4 to the west, north and east, they have the potential to be affected by dust generation under a range of wind directions. Given this, a value of 1 (WD) has been applied to all receptors.

Using the values assigned for each parameter, a DRI value was calculated for each sensitive receptor.

Table 6.5 presents the DRI values for sensitive receptors R1, R2, R3, R4 R6, and R7.

Table 6.5 DRI values

Sensitive receptor	Factors	DRI value
R1	$(10^{E}+20^{P}+50^{T}+50^{WS}+100^{D}+100^{A})x0.5^{M}x1^{WD}$	165
R2	(10+20+50+50+100+100)x0.5x1	165
R3	(10+20+50+50+100+100)x0.5x1	165
R4	(10+20+50+50+10+100)x0.5x1	120
R6	(10+20+50+50+100+100)x0.5x1	165
R7	(10+20+50+50+5+100)x0.5x1	118

Notes: E: surface exposure, P: exposure period T: time of year, WS: wind speed, D: distance to nearest receptor, A: construction activity, M: mitigation, WD: wind direction

The DRI values for all sensitive receptors are moderate (according to Table 6.3). This means there is a moderate risk that adverse dust effects may occur during construction activities. In practice, given the conservative approach adopted, the potential for dust generation at sensitive receptors R1 and R2 is anticipated to be lower than the DRI value determined, given their increased distance to the main dust generating activities.

6.1.4.2 Conservative approach

There are a number of unknowns in relation to the construction methodology. Where construction information is not available, a conservative approach has been adopted in the determination of a DRI for sensitive receptors R1, R2, R3, R4, R6 and R7. These assumptions are presented in Table 6.6.

Table 6.6 Conservative assumptions

Parameter	Assumption	Comment
P: exposure period	Exposure period is not known. It has been assumed that all disturbed surfaces from earthworks will be exposed for the duration of the construction period.	This is not expected to occur in practice and exposed surfaces will be appropriately managed (i.e. through compacting, contouring and shrub/grass planting).
T: time of year	Construction works assumed to occur in summer and the highest factor applied (50).	Construction works are proposed to start in late 2022 indicating approximately one third of the works will occur in summer.
D: distance to nearest receptors	For sensitive receptors R1 and R2, the distance to the nearest, albeit minor construction work used and corresponding factor applied.	For sensitive receptors R1 and R2, the nearest construction activities will comprise minor earthworks along SH1. The more intensive construction works (earthworks, haul road and, roundabout infill and construction) will occur further away (greater than 150 m) and these sensitive receptors are expected to be much less affected from dust emissions
Vegetation barrier	Sensitive receptors R2 and particularly R3 are surrounded by trees which can act as a vegetative barrier further reducing exposure to dust.	No factor applied

6.1.4.3 FIDOL assessment

The nuisance effects of dust emissions are influenced by the nature of the source, the sensitivity of the receiving environment and the perception by individuals. Whether a dust event has an objectionable or offensive effect will depend on the frequency, intensity, duration, offensiveness or character and the location of the dust event (FIDOL) and different combinations of these factors can result in adverse effect.

The FIDOL assessment for the Project is discussed in the following sections.

Frequency

The frequency of dust events is primarily determined by dry and windy meteorological conditions. The term 'windy conditions' is defined as hourly wind speeds of 5 m/s or above and 'dry days' means when there is no rainfall during that day. Windy conditions during dry days are higher-risk meteorological conditions. The location of receptors R1, R2, R3 and R4, relative to the location of construction works indicates a range of wind directions between 270 degrees and 70 degrees (including zero degrees, northerly) are most likely to carry dust from the Project area to the receptors.

Over the period 2017-2018, the Hamilton Airport data contains 571 hours when the wind speed is greater than 5 m/s and wind direction is between 270 and 70 degrees[2], on dry days.

[2] Hamilton wind directions are available at 10-degree intervals. Values 270 to 70 degrees may also include true wind directions between 265 and 75 degrees.

This is 3.3% of the time. The distribution of high-potential hours for dust events affecting receptors R1 to R4 is shown in *Figure 6-1*. A tendency for a higher frequency of events is apparent during non-winter months.

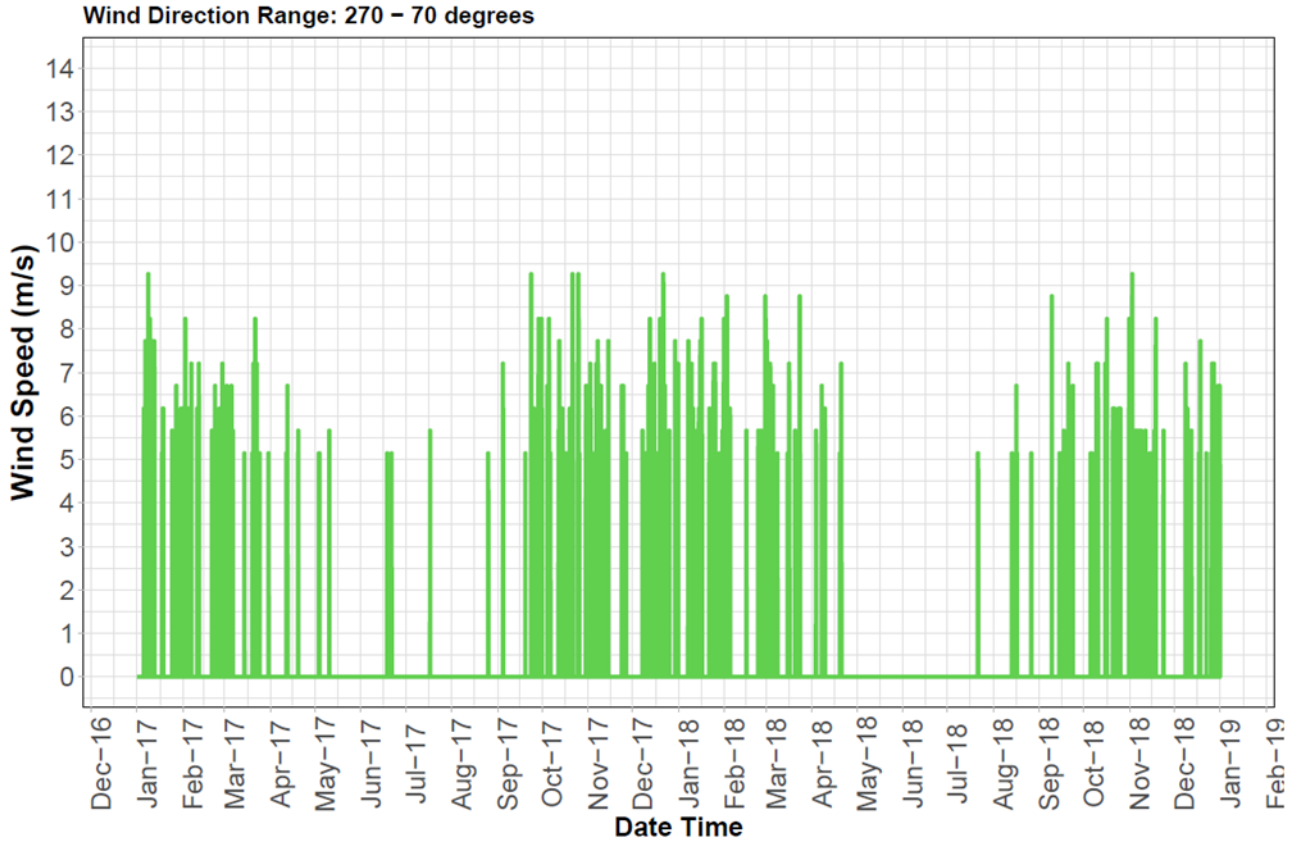


Figure 6-1 Wind speeds above 5 m/s on dry days, against hour of occurrence (data not shown for other hours)

The sensitive receptors R1, R2, R3 and R4 are located downwind of the main construction area for a range of wind directions and may be susceptible to the effects of dust generation. The meteorological data analysed for the years 2017 and 2018 indicate the potential for high-risk dust events (under dry and windy conditions) for 3.3 % of total hours. The potential for dust events occurring at receptors R1, R2, R3 and R4 is therefore considered moderate to high.

Receptor R7 is downwind of construction activities within a smaller range of wind directions than the other sensitive receptors, and therefore the potential for dust events is considered moderate.

Receptor R6 is downwind of potential dust events from the main construction activities for a small range of wind directions. However, with R6 being close to the northern site access, there is a high potential for dust events from use of the haul road, irrespective of the wind conditions.

Intensity

The intensity of dust events that may be experienced by the sensitive receptors will be primarily driven by the size of the source and the distance between the dust generating activities and the receptor. There are five sensitive receptors (R1, R2, R3, R4 and R6) within 100 m of the construction works with sensitive receptor R3 closest to where the most intense activities are expected to occur (large earthworks, location of haul road and in-fill of the roundabout). Sensitive receptor R4 is located 90 m from the main construction works. Sensitive receptors R1 and R2 are anticipated to be less affected by these works given their greater distance from the main dust generating sources.

In summary, without mitigation, the potential intensity of dust impacts from the construction of the Project is relatively high at R1, R2, R3 and R6. At sensitive receptor R4, the potential intensity is considered to be moderate.

Duration

The duration of potential dust exposure events plays a large role in the assessment of the effects on sensitive receptors. The distribution of potential event durations at receptors R1 to R4 is shown in *Figure 6-2*. Although there are very occasional events lasting eight or more hours, they are most commonly short, of duration one or two hours. As pointed out above, the frequency of potential dust events at the nearest sensitive receptors is considered moderate to high, and the analysis of event duration shows that they would be short events. Additionally, as this is a construction dust, the duration of the overall activity is considered to be relatively short term (18 months).

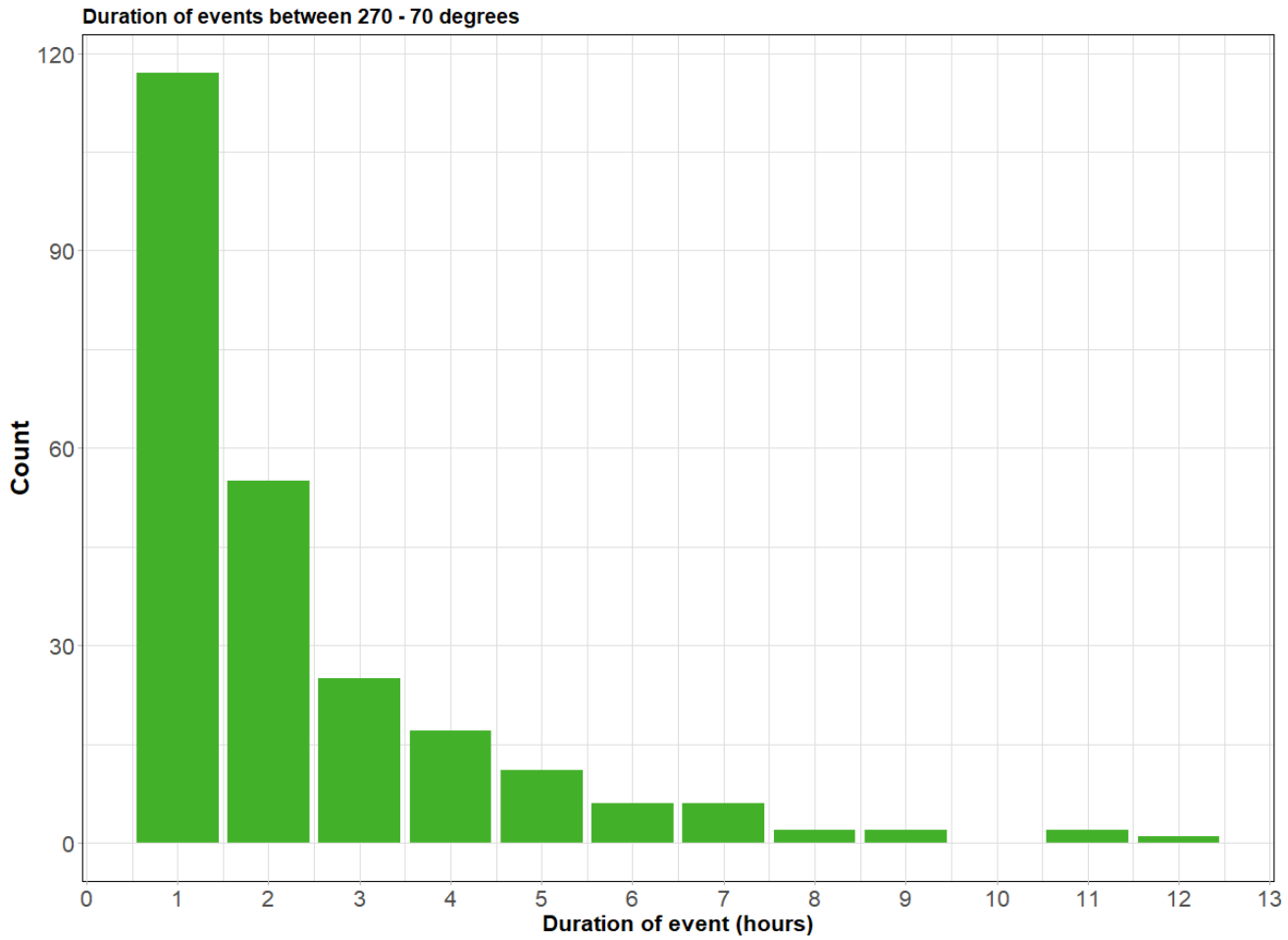


Figure 6-2 Histogram of event duration. The count is the number of events in the two-year period

Offensiveness

The offensiveness of dust is mainly determined by the size and colour of the particles. Smaller dust particles have a relatively high offensiveness as they can penetrate smaller spaces (including closed doors and windows) and can be harder to clean off surfaces than larger particles. The majority of dust emitted during construction activities is likely to be in the larger particle size range greater than 20 micrometres). The colour of dust varies greatly with the source. They are most likely to be coloured either grey (from road construction materials) or yellow (from the excavation of clay soils during construction).

In summary, due to the size and colour of the dust discharge from construction activities, the offensiveness of the material is considered to be moderate.

Location

Sensitive receptors R1, R2, R3 and R6 are located less than 50 m from the nearest construction works area. R4 is 90 m from the construction works. However, sensitive receptor R3 (at 35 m) is closest to the more intense on-site activities and therefore its sensitivity to dust is considered to be high. Sensitive receptors R1 and R2 are approximately 390 m and 180 m respectively from the area of intense construction activity and are considered to have moderate sensitivity to dust together with sensitive receptor R4.

The overall FIDOL assessment indicates that there is a moderate risk to dust effects during constructions works with the potential for greater adverse effects at sensitive receptor R3, given it is closer to construction works of greatest intensity.

6.1.4.4 Summary

The FIDOL and DRI assessments indicate there is a moderate risk for adverse dust effects to occur at sensitive receptors R1, R2, R3, R4, R6 and R7, with the potential for greater risk of adverse effects at sensitive receptor R3. Management and mitigation measures should therefore be implemented during construction works to ensure the effects of dust generation are minimised at these HSRs.

7 Recommended mitigation of effects on the environment

7.1 Management and mitigation measures

Site-specific mitigation measures presented in Table 7.1 are recommended to minimise the identified low to moderate risk and potential air quality effects associated with the construction of the Project. These measures are based on relevant MfE good practice guides and should be incorporated into the CEMP during Project implementation.

Table 7.1 Management and mitigation measures

Impact	Management Measures	Timing Phase
Management	A Construction Environmental Management Plan (CEMP) will be prepared and implemented. It will include measures to minimise the potential for air quality impacts on the local community and environment. The CEMP shall include a contingency section which outlines what additional management measures will be undertaken in the event of off-site dust impacts.	Pre-construction /Construction
Communication	Develop and implement a Stakeholder and Communications Management Plan (SCMP) plan that includes community engagement before work commences on site. Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary.	Pre-construction/ Construction
Site management	If dust is observed migrating offsite, or complaints received in relation to dust, an intensification of existing dust control measures and/or the application of additional dust controls should be considered. Record all dust and air quality complaints, and make the complaints log available to the local authority when asked. Record in the log book, any exceptional incidents that cause dust and/or air emissions, and the action taken to resolve the situation. Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site if required and practicable to do so.	Construction
Monitoring	Undertake daily on-site and off-site visual inspections to monitor dust and record inspection results. Carry out regular site inspections to monitor compliance with the CEMP.	Construction
On-site traffic movements on haul road	Use water sprays and dust suppression surfactants as appropriate. Strictly limit vehicles movements to designated entries/exits, on-site haul roads, contractor yard, material storage and parking areas. Limit vehicle speed limits to 15 km/hr for construction traffic on unsealed roads. Cover vehicles transporting spoil or material to/from the construction site immediately after loading.	Construction

Impact	Management Measures	Timing Phase
	Avoid dust generating works during dry and windy conditions (i.e. wind speed 7 m/s to 10 m/s) or when prevailing winds are likely to result in dust impacts to sensitive receptors.	
Earthworks	Use water sprays and dust suppression surfactants (soil binders), as required. Remove materials that have the potential to produce dust from site as soon as possible. Cease work immediately in the affected area, if contaminated materials are encountered and refer to the CEMP for steps to be followed.	Construction
Wind erosion from stockpiled material	Stabilise all disturbed areas as soon as practical in accordance with the Erosion and Sediment Control Management Plan. Place stockpile's location as far from sensitive receptors as far as practicable. Use water sprays and sprinklers as required. Limit the size and slope of stockpiles. Limit drop heights from loaders/conveyors.	Construction
Material handling	Minimise drop heights. Immediate clean-up of any spillages.	
Track out activities	Use sweepers, vacuum trucks and water sprays and/or water carts on the access and local roads, to remove, as necessary, any material tracked out of the site. Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport. Access routes, driveways and parking areas must be stabilised with suitable material as soon as possible after their formation, where required. Control vehicle access/egress to prevent tracking of material onto paved roads, particularly during wet weather or when the sites are muddy. Install a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	Construction
Diesel exhaust emissions	Ensure proper maintenance and tuning of engines in accordance with manufacturers recommendations for all vehicles, plant and diesel generators. Turn off idling plant and trucks when not in use. Avoid overloading trucks.	Construction

7.2 Monitoring

A visual dust monitoring program will be implemented for the Project, the details of which will be presented in the CEMP. Visual dust monitoring is considered appropriate for the Project given the small scale of works, the number of earth-moving vehicles likely to be operational at any given time, the expected intermittent nature of the construction works and the proposed management that would be implemented for the Project.

8 Relevant planning policy context

8.1 Introduction

This section addresses the relevant planning policy context for the Project in relation to the potential air quality effects during construction.

The Project is located on the boundary of Matamata-Piako district and South Waikato district with most of the Project within Matamata-Piako district as shown in

Figure 8-1. The surrounding land is zoned rural in both District Plans.

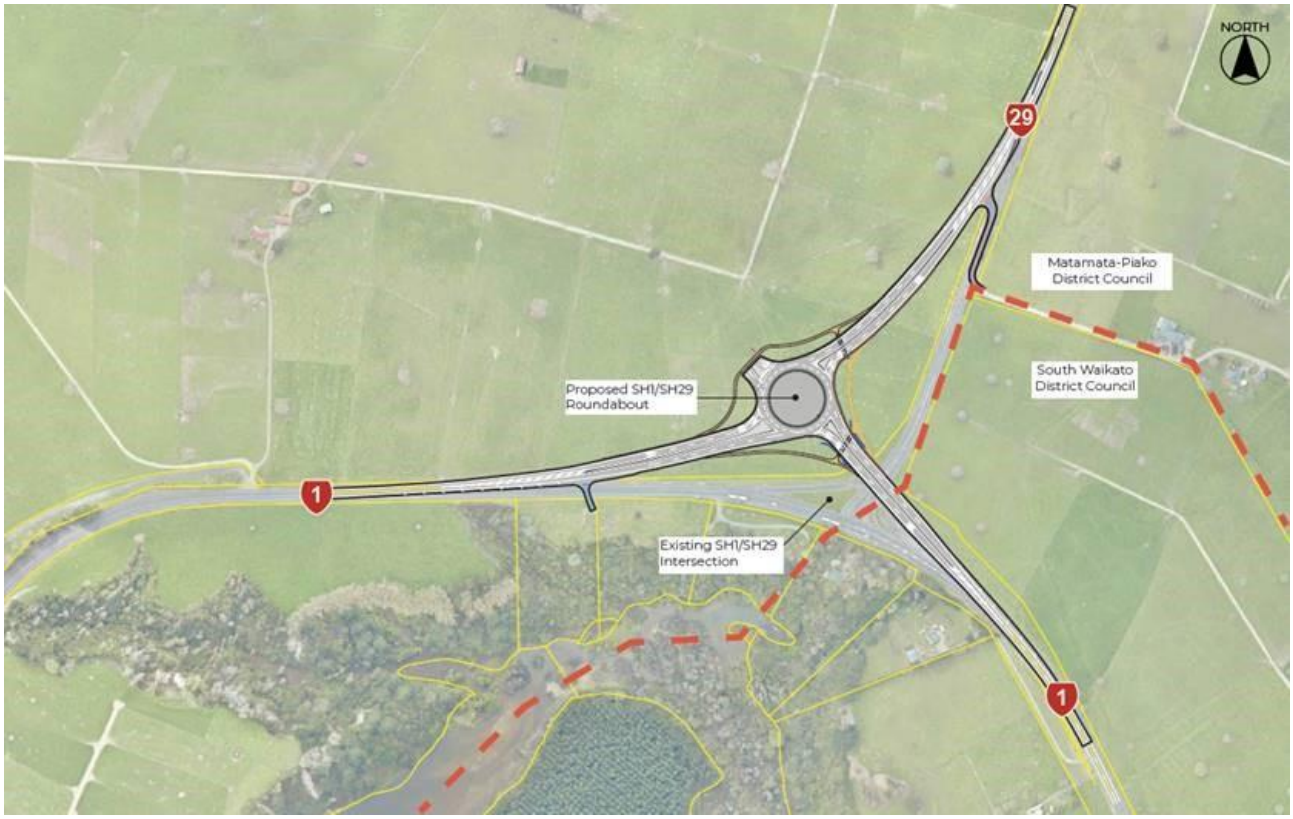


Figure 8-1 Project location and local authority boundaries.

8.2 Waikato Regional Policy Statement 2018

Objective 3.11 in relation to Air Quality of the Waikato Regional Policy Statement states:

Air quality is managed in a way that:

a. ensures that where air quality is better than national environmental standards and guidelines for ambient air, any degradation is as low as reasonably achievable;

b. avoids unacceptable risks to human health and ecosystems, with high priority placed on achieving compliance with national environmental standards and guidelines for ambient air; and

c. avoids, where practicable, adverse effects on local amenity values and people's wellbeing including from discharges of particulate matter, smoke, odour, dust and agrichemicals, recognising that it is appropriate that some areas will have a different amenity level to others

The Project will ensure that potential adverse air quality effects on the receiving environment during construction will be minimised through the implementation of management measures, the details of which will be included in a CEMP.

8.3 Waikato Regional Plan 2007

Policy 5.1.3 in relation to accelerated erosion of the Waikato Regional Plan states the following:

> *Policy 1: Managing Activities that Cause or Have the Potential to Cause Accelerated Erosion and Encouraging Appropriate Land Management Practices*
>
> *g. the potential to compromise air quality objectives as identified in Module 6 Air.*

The effect of erosion from exposed surfaces will be managed through management measures detailed in the CEMP and with reference to the *Erosion and Sediment Control Guidelines for State Highway Infrastructure* (NZTA 2014b) and Waikato Regional Council's *Erosion and Sediment Control: Guidelines for soil disturbing activities*.

8.4 Matamata-Piako District Plan 2020

Section 3.5 of the MPDP relates to Amenity. The following objective and policy are considered relevant to this Project as follows:

> *O1: To ensure that residences are free from the effects of unreasonable and excessive noise, odour, dust, glare and vibration.*
>
> *P1: To protect residential and rural amenity by the use of performance standards for noise, glare, odour, particulates and vibration control which generally ensure that generated effects do not exceed background or ambient levels.*

The Project will ensure odour and dust are minimised through implementation of a CEMP, together with proposed trigger levels for controlling dust concentrations during construction works.

8.5 South Waikato District Plan (2015)

Section 3 of the SWDP provides objectives and policies for managing the District's Tangata Whenua values.

Policy 3.4.2 states:

> *To achieve the objectives of the Waikato River Vision and Strategy within the catchment area identified on the planning maps by plan provisions relating to:.....*
>
> *c) earthworks and silt control.*

Section 5 of the SWDP provides objectives and policies for District's rural areas.

Policy 5.3.11 states:

> *Avoid, remedy or mitigate the adverse effects of activities on the existing character and amenity of the surrounding rural area and avoid those activities that would cause reverse sensitivity concerns for established rural based activities (including existing network utilities and infrastructure).*

The Project will ensure that dust emissions from earthwork activities are minimised through management measures outlined in a CEMP.

9 Conclusion

A qualitative assessment of the air quality effects at eight sensitive receptor locations arising from construction of the Project was conducted.

This assessment has focussed on potential dust effects using the DRI and FIDOL approaches, as recommended by the MfE Dust Guide and the Waka Kotahi Guide. The outcomes of both approaches indicate a moderate risk of adverse dust effects at sensitive receptors R1 to R4, R6 and R7., with R3 likely to be affected most, given it is closer to the main construction activities (earthworks, construction and use of the haul road, and construction and in-fill of the roundabout). In addition, these sensitive receptors are anticipated to be affected relatively frequently by high-risk dust events (i.e. wind greater than 5 m/s and no rainfall) due to being located downwind of the main dust generating activities up for up to 3.3 % of the time. The risk of dust effects at receptors, R5, and R8 is considered to be low, given their distance to construction activities.

The outcomes of the FIDOL and DRI assessment indicates a moderate risk for adverse dust effects with a moderate magnitude of the effects at sensitive receptors R1, R2, R4, R6 and R7. Receptor R3 has a moderate to high risk of dust. For sensitive receptors R5 to R8 there is a low risk with a minor magnitude of the effects.

It is recommended that the dust management measures set out in Table 7-1 above be implemented during construction works, the details of which will be outlined in the CEMP for the Project. These measures will minimise the potential for adverse effects at all the eight identified sensitive receptors. With these measures implemented, the magnitude of dust effects arising from construction of the Project is considered to be minor.

10 References

MfE 2004, Resource Management Act 1991, Ministry for the Environment

MfE 2002. Ambient Air Quality Guidelines 2002 Update

MfE 2016a. Good practice guide for assessing and managing dust

MfE 2016b. Good practice guide for assessing and managing odour

NES Air. Resource Management (National Environmental Standards for Air Quality) Regulations 2004

NZTA 2014a. Background air quality guide, Draft version

NZTA 2014b. Erosion and Sediment Control Guidelines for State Highway Infrastructure

NZTA 2019. Guide to assessing air quality impacts from state highway projects

Waikato Regional Policy Statement 2018

Waikato Regional Plan 2007

Matamata Piako District Plan 2020

South Waikato District Plan 2015

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