Appendix 11

Climate Change and Natural Hazards

Relevant to Fast-track Referral Application Form Section 3.7.4

Climate Change and Natural Hazards

Overview

The main changes predicted to the climatic conditions of the Project site area due to climate change are an increase in flooding (frequency, intensity, duration) and potential for landslides associated with rainfall. Climate change is also projected to increase wildfire risk in Canterbury due to hotter, drier summers and windier conditions.

Flooding could temporarily impact access to the site and affect operations to a degree in the lower river terrace area of the site. Landslide risk from the surrounding land to the east is a risk that could impact on the eastern boundary and watercourse of the site. Surrounding forestry and grass fires would impact on operations.

Seismic risk could impact on the waste and associated leachate containment.

Flood Risk

The Ministry for the Environment (MfE) recommends a climate change correction factor (MfE, 2018 [1]) to design rainfall intensities be applied to account for a 2.2°C temperature increase by year 2120. Increased intensities from climate change will correspond to increase flood flows in catchments.

WSP has completed flood modelling for the site from the contributing catchment to the Karetu River that flows past the site. Various hydrologic scenarios were undertaken including modelling of the 50yr, 100yr, and 250yr Average Recurrence Interval (ARI) [2] design events with and without climate change (WSP, 2022) [3].

The results (Figure 1 over page) showed that the flood risk for the existing buildings is highest during the modelled climate change events [4], although the northern building (store) appears susceptible during a 100yr ARI design even with climate event adjustment. The modelling also indicated a portion of the trafficable area on the western boundary would have flood depths greater than 50 mm in a 50yr ARI event both with and without climate change.

Reinstatement of the existing bund along the western boundary has been undertaken to alleviate flooding of these areas or divert flows away from buildings.

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[1] Ministry for the Environment. (2018). *Climate Change Projections for New Zealand: Atmosphere Projections Based on Simulations from the IPCC Fifth Assessment*, 2nd Edition. Wellington: Ministry for the Environment.

[2] The terms AEP (Annual Exceedance Probability) and ARI (Average Recurrence Interval) describe the probability of a flow of a certain size occurring in any river or stream. ARI is the average period between floods of a certain size. For example, a 100-year ARI flow will occur on average once every 100 years. Alternatively, AEP is the probability of a certain size of flood flow occurring in a single year.

[3] WSP. (2022). Protranz - Whiterock Lime Quarry - Hydraulic Modelling. Rev1.

[4] MfE climate change correction factor (MfE, 2018) applied to a 2.2°C temperature increase by 2120.

WSP have undertaken a hydrology analysis with the same methodology as the original flood modelling report to determine the 5% AEP (20yr) flow and flood extent. The maximum flood levels for the 5% AEP with climate change are approximately 210.6m NZVD2016 (vertical datum). This information has been used in the design of the proposed bridge and to set the soffit (underside) of the bridge to be at least 500 mm above the 5% AEP flood level.

No other areas of the site are subject to flood hazard.

Seismic Risk

WSP undertook a seismic assessment including proximity to active faults and potential for this to impact containment structures [5].

There are several faults near the site including the Mt Lawry Fault and the Mt Thomas Fault which are approximately 2 km south and 4 km west of the site respectively, and the Janet Fault and Grey Fault which are approximately 6 km and 10 km northeast of the site respectively.

Small scale faults have been observed onsite in the eastern quarry walls and there is a possible north-south striking fault along the western boundary of the quarry. It is expected these smaller scale faults are secondary to the larger faults in the area. The lack of any faulting through the surface loess soil layer indicates an absence of fault movement since the loess was deposited by westerly winds 10,000 to 20,000 years ago.

A dominant subvertical joint set was mapped within the existing quarry pit during a site visit by Golder Associates in 2012, striking perpendicular to the highwall and spaced at approximately 30 m – 40 m. Kinney (2004) [6] refers to these as a series of small normal and reverse faults with displacement up to 5 m.

These long-estimated time periods since fault movement on nearby active faults and small-scale faulting in the quarry indicate any nearby fault damaging the proposed landfill is acceptably low.

Quarry Surrounds - Landslides

WSP has assessed the landslide risk for the site [7].

Several existing landslides are evident in aerial imagery in the area east of the existing quarry, on slopes that are connected to the eastern watercourse. These landslides are interpreted to be shallow failures incorporating topsoil and weathered rock in the steeper parts of the natural slopes. The closest landslide is approximately 30 m wide and is located approximately 100 m east of the current quarry.

The landslide is located on the steepest part of an east facing slope and appears to have moved a few metres towards the quarry between 2010 and 2013 (based on Google Earth images). No further movement is evident from a review of more recent aerial images. It is possible that this and other landslides occurred as a result of earthquake shaking during the Canterbury earthquake sequence. Potentially climate change with higher intensity rainfall and durations could exacerbate the shallow failures.

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[5] WSP. (2024b). Whiterock Lime Quarry - Geotechnical Report. Rev2.

[6] Kinney, R. (2004). *White Rock Resource Estimate*. Unpublished internal memo from the Lime Division of Ravensdown Fertiliser Co-op Ltd, dated 9/3/2004.

[7] WSP 2024 CRC243699 to CRC243707 – Section 92 Response - Section-002-GEO-ECan-RFI-Rev0

The area of slope between the landslide and the quarry is considerably flatter and it is inferred that the likelihood of debris from this landslide reaching the proposed landfill is low. Other landslides identified in aerial imagery are of smaller size, are shallow and have not moved towards the quarry.

The quality of aerial imagery available on Google Earth is believed to be adequate to identify typical landslide features such as scarps and hummocky ground. No evidence of large-scale deep-seated landslides has been identified affecting the site.

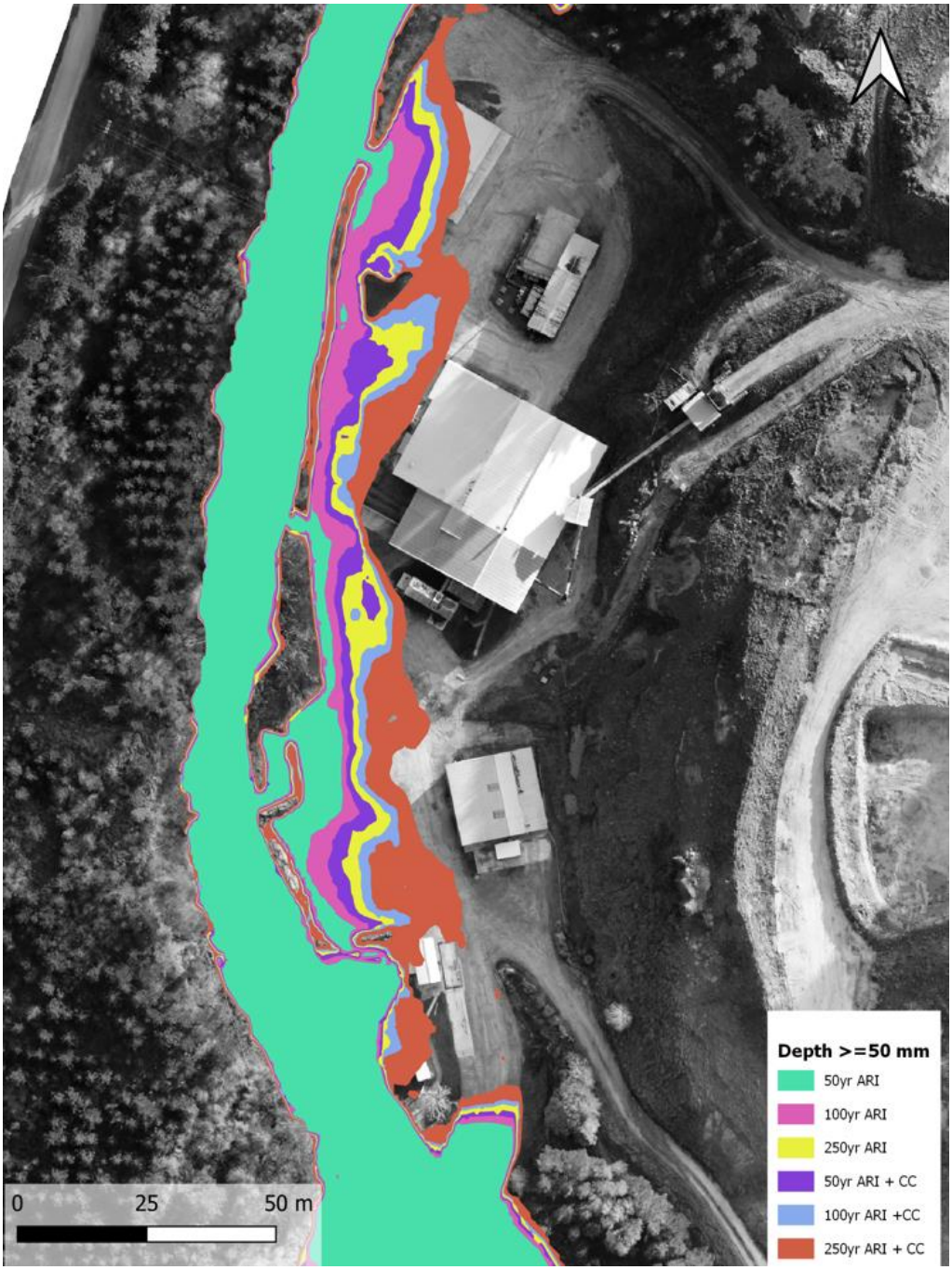

Figure 1: Inundation greater than or equal to 50 mm depth for 50yr, 100yr, and 250yr with climate change (+CC) and without climate change scenarios.

Project and Surrounds – Fire Risk

Climate change is projected to increase the risk of wildfires in Canterbury, New Zealand, due to rising temperatures, increased drought, and stronger winds. Warmer, drier conditions will lead to more hot days and less snow, creating ideal conditions for wildfires to start and spread. The fire season may also become longer, extending beyond the traditional summer months.

The adjacent property to the west of the Project site across the Karetu River is currently in pine plantation so is a high wildfire risk to the lower plant area. Some large trees are within the site lower river terrace near some plant buildings. The adjacent farm property to the east is grazed primarily by sheep so there is a low wildfire risk to the site.

Rank grass habitat is present on site, however the risk will be removed on completion of lizard salvage and relocation in accordance with the Wildfire Authority issued.

The adjacent Significant Natural Area (SNA) to the north of the project site will have rank grass and other vegetation, however this area is set back 200 m from the proposed managed fill footprint so represents a low wildfire risk.