HARMONY IN BROWNFIELD REVITALISATION: A HOLISTIC NATURE-BASED APPROACH

B. Pathirage, S. Singh & P.Wadan (Woods as part of the LEAD Alliance)

ABSTRACT

Continued urban expansion leads to redevelopment in brownfield areas that are often susceptible to flooding, posing significant challenges for sustainable development and intensification. This paper explores the strategic approach of using nature-based solutions to enable development in existing flood hazard areas while intensifying land use. The paper specifically focuses on a brownfield development area in the Waikōwhai suburb of Auckland, where residential intensification is proposed as part of Kāinga Ora large scale developments. Woods, as part of the LEAD Alliance, has been involved in this project on behalf of our alliance owner participant Kāinga Ora. A Stormwater Management Plan (SMP) was prepared to support the development, with the solution discussed in this paper proposed as the flood mitigation measure. The SMP has been adopted under the regionwide Network Discharge Consent by Auckland Council.

The Waikōwhai neighbourhood, approximately 90ha, is located within the upstream portion of the Te Auaunga Awa (Oakley Creek) catchment. Te Auaunga Awa is one of the major waterways in central Auckland with its headwaters in Molley Green Reserve in Waikōwhai. The creek is partially piped in Molley Green Reserve and conveyed to discharge to Keith Hay Park, located immediately downstream of the neighbourhood.

A comprehensive assessment was undertaken to understand existing flood risk in the area and how potential adverse flood effects from intensification can be mitigated. Several nature-based solutions were explored in conjunction with traditional infrastructure upgrades such as pipe network upgrades, re-alignment of existing roads and landform changes. These were simulated using flood models to understand the impact on the development, other third-party lots and public roads.

The proposed solution consists of providing flood storage by utilising existing green infrastructure, including increasing storage capacity at Molley Green Reserve and creation of a new attenuation basin, referred to as Albrecht Basin. The proposed solution also includes daylighting streams to promote integration of ecosystem into the existing built form. This innovative strategy embraces the principles of green infrastructure, encourages community wellbeing by providing green areas for recreation, and incorporates natural elements to manage stormwater and reduce flood impacts.

The basins were proposed to ensure the volumes stored would mitigate flood flows and be sufficient to reduce the downstream flood risk and enable development. The proposed solution enabled connection of waterways and effectively increases the upstream reach of Te Auaunga Awa by approximately 300m. The daylighted portion of Te Auaunga Awa stream is proposed to continue to Keith Hay Park from Molley Green Reserve, which will allow for additional conveyance and the connection of the waterways. This is proposed to be constructed in the later stages of development.

The proposed solution is holistic as it also creates cultural connections to waterways, while reducing flood risk and improving overall water quality, ecology, and community wellbeing. This paper discusses a sustainable and forward-thinking model for brownfield development that prioritises nature-based solutions in existing flood-prone areas - demonstrating the potential for coexistence between urban expansion and ecological restoration.

KEYWORDS: NATURE-BASED SOLUTIONS , BROWNFIELD DEVELOPMENT, FLOOD MITIGATION, URBAN SUSTAINABILITY, KĀINGA ORA

PRESENTER PROFILE

Bidara Pathirage is a Chartered Professional Engineer with Woods working on the LEAD Alliance. She specialises in stormwater planning, management, hydrological and hydraulic modelling, and infrastructure design.

Shakti Singh is a 3 Waters Engineer with Woods. He is currently involved with various water related projects including LEAD Alliance, undertaking design and modelling of critical three waters infrastructure.

Pranil Wadan is a Chartered Professional Engineer with Woods who works on the LEAD Alliance. He has expertise in stormwater management, stormwater infrastructure design, flood modelling, flood hazard and overland flow-path assessments. His projects span the range of development scales and types including greenfield and brownfield sites, multi-unit housing, and commercial projects.

1 INTRODUCTION

Auckland's suburbs are undergoing one of the largest urban regeneration projects in New Zealand's history led by Kāinga Ora. LEAD Alliance is playing a pivotal role in this transformative change.

LEAD stands for Land Enablement and Delivery. As an alliance it leads the design and construction of infrastructure and enables Kāinga Ora land for development. LEAD Alliance's participants Kāinga Ora (the owner participant) along with Dempsey Wood, Harrison Grierson, Hick Bros Group, Tonkin + Taylor and Woods (non-owner participants), have come together to transform Auckland's future. The alliance collaborates with Auckland Council, Auckland Transport, Watercare, Vector and other stakeholders including mana whenua partners, in taking a joined-up approach in revitalising and replacing infrastructure.

Like many growing cities, Auckland grapples with an infrastructure deficit and a housing shortage. The government has entrusted the alliance's owner participant Kāinga Ora with a vital mission: replace ageing state homes by delivering suburb-scale projects and build the infrastructure and amenity to support them.

LEAD Alliance's responsibilities include civil design and construction; removal of old state houses no longer fit for purpose; land remediation; arranging consents for earthworks and infrastructure; construction of roads, parks and utilities, and looking after the communities they work in as they go.

2 BACKGROUND

The Waikōwhai neighbourhood is one of a number of areas in Auckland where Kāinga Ora is redeveloping state homes and intensifying residential areas as part of the urban large-scale projects. Kāinga Ora has been tasked with increasing the supply of housing in Auckland while also creating sustainable, inclusive and thriving communities.

Urban expansion presents challenges for sustainable development, particularly in brownfield areas that are susceptible to flooding. This paper examines the strategic implementation of nature-based solutions to facilitate development in flood hazard zones while intensifying land use.

Through collaboration, the LEAD Alliance, in partnership with its owner participant Kāinga Ora, has prepared a Stormwater Management Plan (SMP) to support the development. This has been adopted and integrated into the regional Network Discharge Consent (NDC) by Auckland Council.

This paper outlines the comprehensive approach undertaken, which incorporates flood risk assessment, simulation of nature-based solutions, and integration of green infrastructure to mitigate flood impacts and promote overall community wellbeing.

3 WAIKŌWHAI NEIGHBOURHOOD AND WIDER CATCHMENT CONSIDERATIONS

The Waikōwhai neighbourhood is located within the upper reaches of the Te Auaunga Awa catchment and sits to the south of Richardson Road, bound by Dominion Road Extension to the west and Hillsborough Road to the east. The ultimate discharge point for the Waikōwhai neighborhood (comprising of a catchment area of 91ha) is Te Auaunga Awa which comprises of a total catchment area of 1200ha. The headwaters of Te Auaunga Awa start within Molley Green Reserve, which is to the south of Richardson Road. The Creek is partially piped within Molley Green Reserve and conveyed to discharge into Keith Hay Park.

Figure 1 shows Waikōwhai neighbourhood, Molley Green Reserve, Te Auaunga Awa, Keith Hay Park and Akarana Golf Course.

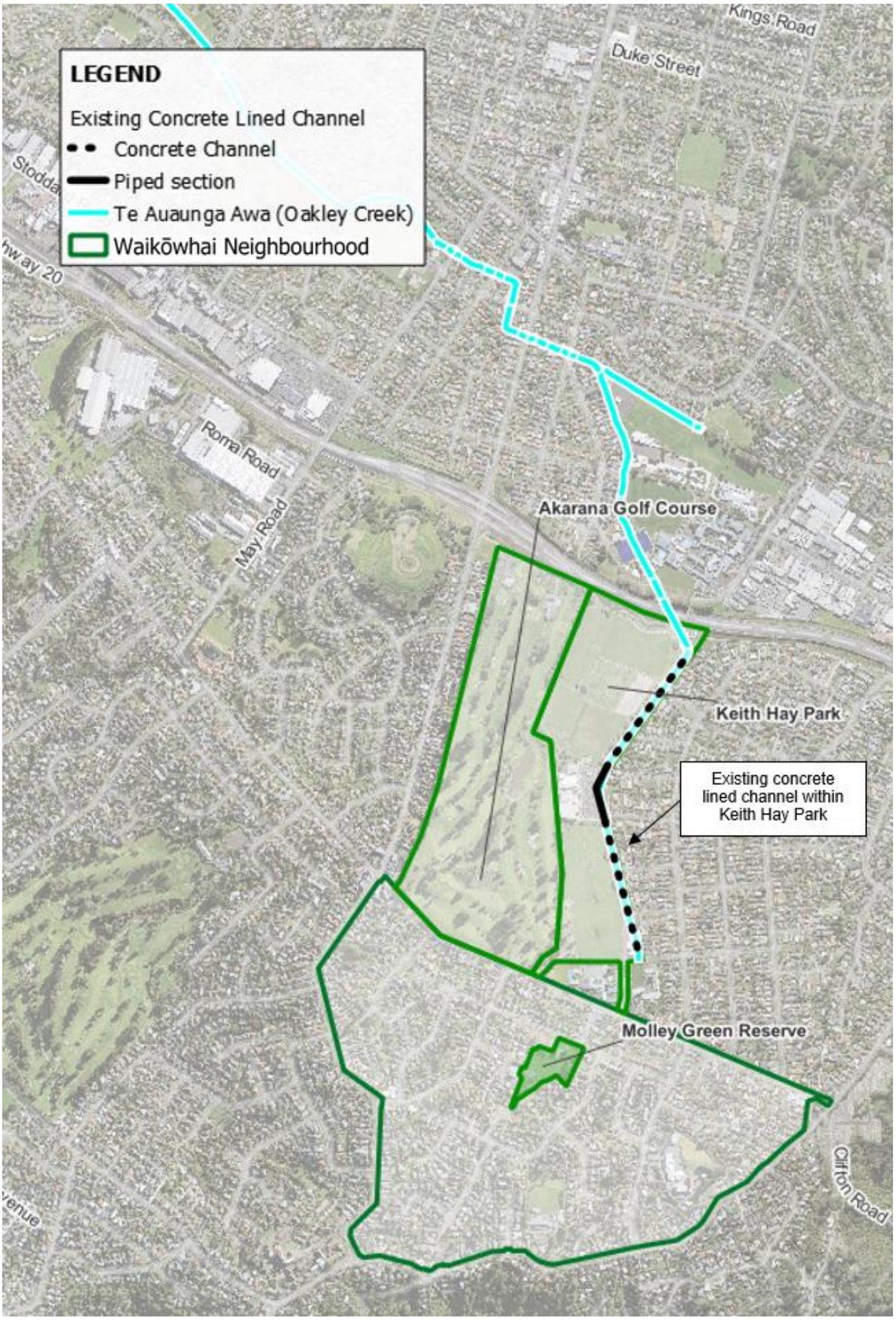

Figure 1: Waikōwhai neighbourhood, Molley Green Reserve, Te Auaunga Awa, Keith Hay Park and Akarana Golf Course

The Te Auaunga Awa catchment remains largely unpiped. The awa runs for a total of approximately 15km starting at Waikōwhai across the isthmus to Waterview Inlet at the Waitemata Harbour.

Te Auaunga Awa catchment is urbanised with significant levels of growth through re-development and further redevelopment is forecast within the catchment over the next 10-15 years. Work traditionally undertaken to address stormwater issues within Te Auaunga Awa catchment has been at a 'neighbourhood' or sub-catchment level to coincide with resource consenting requirements. At this small scale, the management solutions do not necessarily take into consideration what is best for the whole of the awa and the consideration of cumulative effects can be missed.

4 INTEGRATION WITH HE RAUTAKI WAIORA O TE AUAUNGA FRAMEWORK STORMWATER MANAGEMENT PLAN

The He Rautaki Waiora o Te Auaunga Awa Framework Stormwater Management Plan (V4 dated 27/04/2023) has been developed for the Te Auaunga Awa catchment. It considers the whole catchment from an integrated stormwater management perspective to ensure the long-term management of the catchment and deliver the best possible outcome for the awa.

It identifies stormwater opportunities and/or interventions that should be further developed as the Best Practicable Option (BPO) for improving Te Auaunga Awa on a sub-catchment level. It is noted while this document was being developed in parallel with the Waikōwhai SMP, relevant recommendations and findings were considered during optioneering for the neighbourhood.

Based on the above, the flood mitigation options for Waikōwhai neighborhood had to be considered to achieve the best outcome for the neighborhood as well as the wider Te Auaunga Awa catchment.

A schematic of the Waikōwhai neighbourhood in relation to Te Auaunga Awa catchment is shown in Figure 2 below.

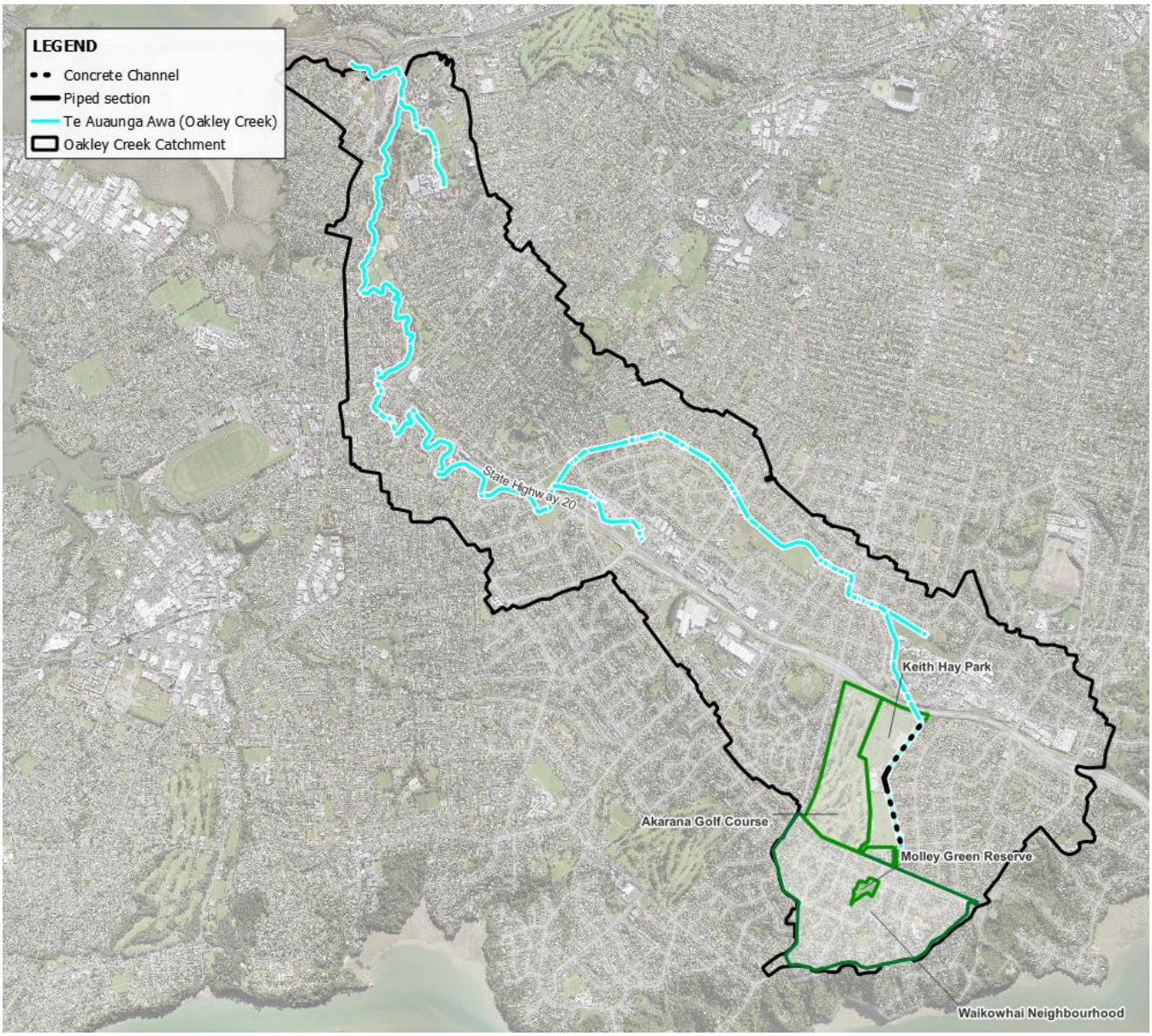

Figure 2: Waikōwhai neighbourhood in relation to Te Auaunga Awa catchment

5 PROPOSED DEVELOPMENT

The Waikōwhai neighbourhood is bound by Richardson Road to the north, Dominion Road Extension to the west and Hillsborough Road to the east. Kāinga Ora proposes to increase housing within this area through land acquisition and increasing density on existing Kāinga Ora owned land.

The development will also include the creation of super lots, with some intended for use by Kāinga Ora and some to be sold to the private market.

An indicative masterplan of the development is shown in Figure 3 below. The development proposes to increase housing from approximately 350 to 1110.

Figure 3: Indicative masterplan of the proposed development

6 EXISTING FLOOD HAZARDS

This section discusses the key existing flooding issues within the neighbourhood and its major contributors.

Existing flood hazard mapping highlights flooding, and overland flow paths being generated within the Waikōwhai neighbourhood. The neighbourhood has two key discharge locations along low points at Richardson Road as seen in Figure 4 below. Four significant overland flows from the neighbourhood travel towards Richardson Road, overtopping the road at its two significant sag areas, and travel to Akarana Golf Course and to Keith Hay Park (see Figure 5).

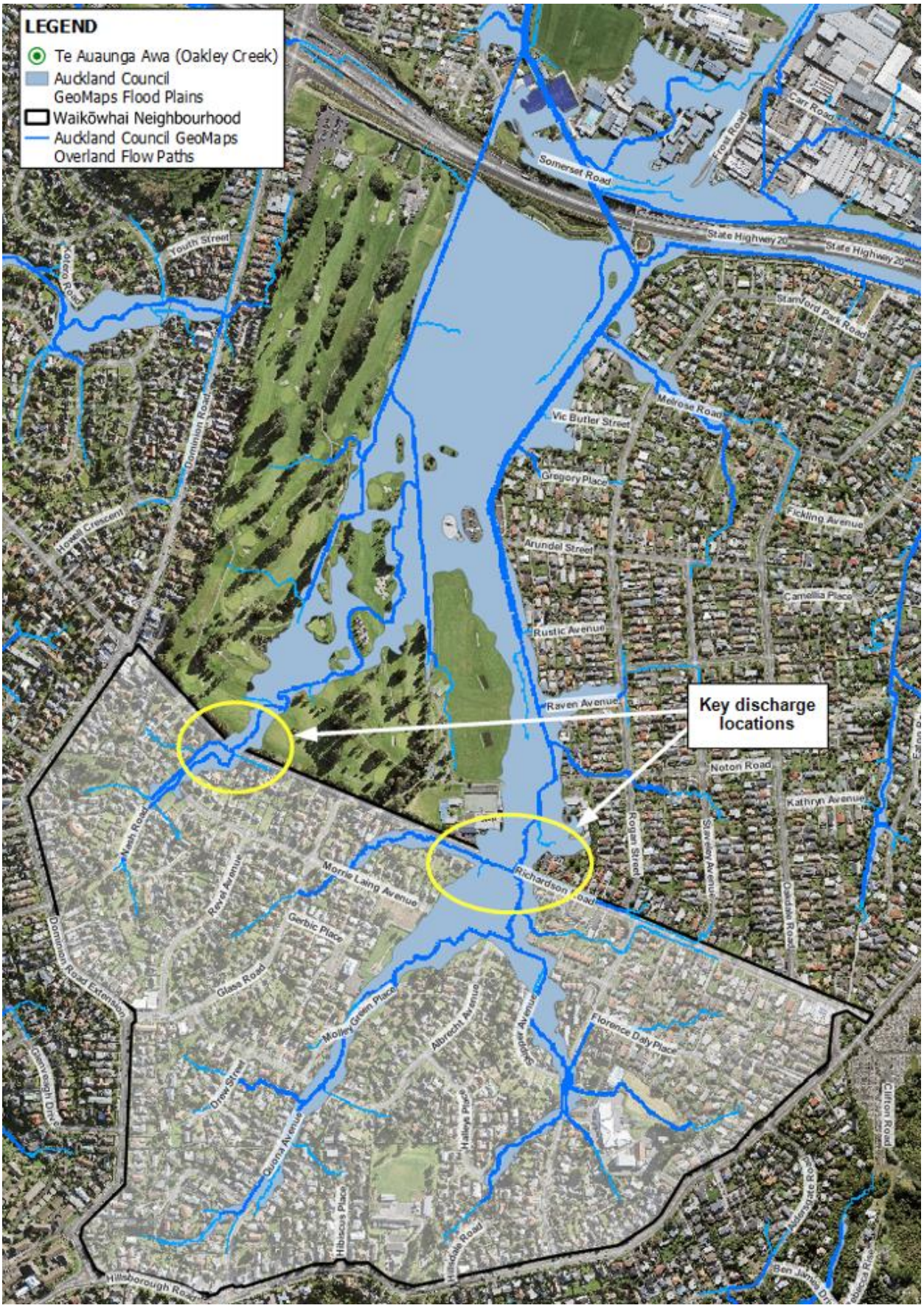

Figure 4: Two key discharge locations along low points at Richardson Road

6.1 EXISTING FLOODING ISSUES AND CONTRIBUTORS

Flood management for any site requires assessing the factors contributing to existing flooding issues. This approach has been undertaken for the redevelopment of the Waikōwhai neighbourhood. The key issues contributing to the existing flood risk are discussed below.

- **Overland flow paths and topography**

  Topography influences the trajectory of overland flows, which in turn causes flooding. As discussed above, four major overland flow paths traverse the neighbourhood. Overland flow path 1 (OLFP 1) travels north along Nash Road, overtopping Richardson Road towards the existing golf course.

  The majority of the flooding observed occurs along the natural low point at Richardson Road/ McKinnon Street shops where three of the major overland flow paths (OLFP 2-4) naturally converge. This then ultimately discharges to Keith Hay Park which serves as large flood storage basins during a flooding event.

Figure 5: Four significant overland flows from the neighbourhood

Due to the deep flooding observed in the low-lying area of Richardson Road and adjoining neighbouring area, optioneering around flood management for the Waikōwhai neighbourhood was centered around this area.

- **Impervious coverage**

  The Waikōwhai neighborhood is significantly developed, with the existing impervious coverage being approximately 43%. As per Auckland Unitary Plan Operative in Part (AUP), the Waikōwhai neighborhood includes a mixture of residential and commercial zonings. Therefore, if the entire neighbourhood develops to the

permitted Maximum Probable Development (MPD) levels, the neighborhood's impervious coverage will increase to an average of 62.7%. This is also expected to exacerbate existing flooding.

- **Existing stormwater network (primary network)**

  The primary stormwater network plays an important role in conveyance of runoff. As is normal for older neighbourhoods such as Waikōwhai, the bulk of the primary network was installed in the late 1950s and early 1960s. As guidelines for designing primary networks have significantly changed over time, it was to be expected that the existing stormwater network will likely not be able to meet the current design guidelines. The majority of the existing primary network within the neighbourhood has serviceability for the five-year ARI storm event (without allowance for any future climate change) or less.

7 FLOOD MODELLING OPTIONEERING

Assessment of flooding issues can be difficult as it requires multiple parameters to be considered. Therefore, a base (or pre-development) flood model was developed so that the effects of the proposed development can be compared, and any benefits related to options can be assessed.

The options considered for flood mitigation are discussed below, with options modelled to understand benefits.

1. **Increase of storage within Molley Green Reserve**

Molley Green Reserve is an existing basin in the neighbourhood that receives a significant overland flow path from the upstream Waikōwhai neighborhood. As the reserve was already at a strategic location for flood storage, it was proposed to increase storage in the reserve. Additionally, enhancing Molley Green Reserve provides stream daylighting opportunities, improving water quality and ultimately increases connectivity with the wider Te Auaunga Awa catchment.

In parallel with increasing storage at Molley Green reserve, an option to increase flood storage at alternative locations was also considered. An option that looked at a Kāinga Ora Superlot (WA-025B) which was located at the lowest point in the neighborhood was considered for additional flood storage. The option considered transforming this area into a storage basin. The model showed there were limited benefits of providing additional storage at WA-025B as the basin would fill up before the peak of the storm and overtopping at Richardson Road would still occur.

2. **Infrastructure upgrades within the neighbourhood**

Due to the existing pipes in the neighbourhood having inadequate capacity, infrastructure upgrades were considered to change pipes receiving runoff from Glass Road to discharge into Keith Hay Park directly. Pipe diameters have also been changed as flows surcharging from the system eventually also end up on Richardson Road.

Options were also considered to increase the capacity of the downstream pipes discharging underneath Richardson Road to Keith Hay Park. These options were deemed to have limited benefits as backwatering within Te Auaunga Awa prevents lines from draining as the peak of the storm approaches. Therefore, large scale pipe upgrades were not considered viable.

3. Landform changes

As the majority of flooding at the low-lying area of the neighborhood is caused by convergence of three major overland flow paths, landform change options were assessed to separate these from discharging to the natural depression located on Richardson Road.

One of the routing changes included landform changes around the western side of the existing school to create a channel and discharge one of the overland flow paths directly to Keith Hay Park.

Another significant landform change assessed included re-grading of an existing road, Glass Road, to alter the discharge point of OLFP 1. Re-grading of this road results in fill areas in excess of 800mm and cuts in excess of 1000mm. Consequently, the existing berms which were already reasonably steep became extremely steep (greater than one in three in places). Maintaining existing vehicle access to these properties would be extremely difficult to manage as most of the properties are privately owned. In addition, the cut and fill would require existing underground services to be re-laid to maintain minimum cover. Minimal benefits, along with construction practicalities, led to this option not being assessed further. Therefore, this was not considered to be suitable.

Figure 6 shows a summary of the various options discussed above.

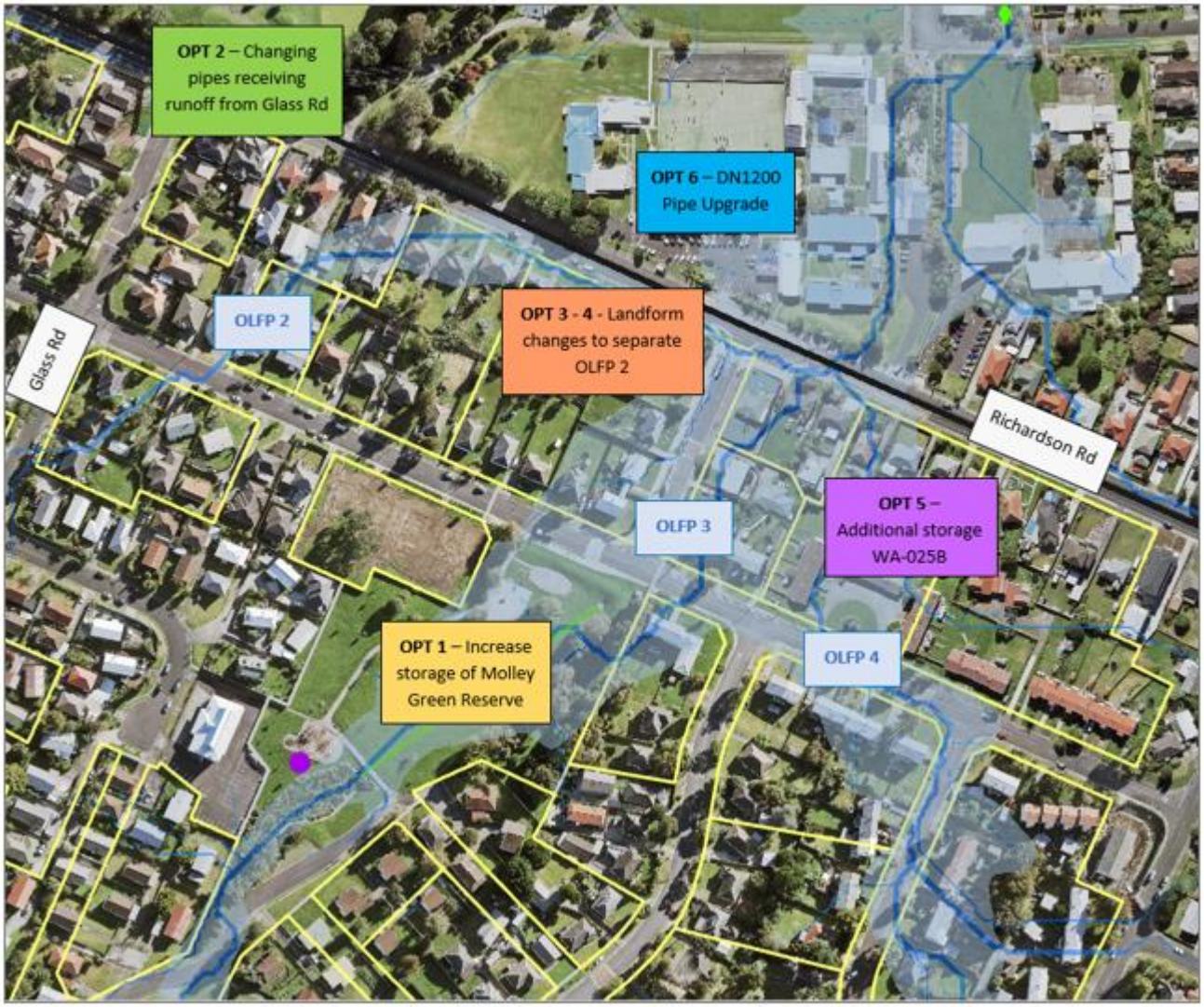

Figure 6:Flood mitigation options considered

The options initially simulated are more traditional, consisting of large infrastructure upgrades and considered to be 'hard engineering' solutions. Through development of the SMP process, due to limited benefits of these options, other alternatives including incorporating green infrastructure solutions were further considered.

Inclusion of green infrastructure aligns with the principles of GD04 incorporating water sensitive design. They also provide harmony with nature as they mimic the natural process and are aesthetically pleasing.

Therefore, an option of creating another reserve was proposed in conjunction with increasing storage at Molley Green Reserve. An area, now referred to as Albrecht Basin, was considered as it had pockets of deep flooding and was within Kāinga Ora ownership. While this area is zoned as residential in the AUP, due to the flooding risk, it was highly unlikely to be developable. In the masterplan, it was earmarked to be a potential park/ open space. Additionally, creation of basin upstream of Molley Green reserve, in the trajectory of overland flow path would mean increase in the connectivity of Te Auaunga Awa.

Albrecht Basin, located upstream of Molley Green Reserve, has been designed to attenuate the peak of the storm event from overland flows. There is allowance for base flows to enter the basin, however larger piped flows are bypassed with the basin largely reserved as flood storage for overtopping of secondary flows. Modelling confirms that the storage within the basin is utilised during the peak of the storm and is effective in reducing flows the impacts of flooding downstream i.e., Richardson Road.

Utilising basins also allowed for the concept of daylighting streams to be considered providing a wider connectivity.

Figure 7 shows the location of Albrecht Basin and Molley Green Reserve.

Figure 7: Albrecht Basin and Molley Green Reserve

8 INTEGRATION OF NATURE-BASED SOLUTIONS

The assessment was conducted to evaluate existing flood risks and identify potential mitigation measures. As discussed, this involved exploring nature-based solutions alongside traditional infrastructure upgrades through flood modeling simulations.

The proposed solution entails enhancing flood storage capacity at Molley Green Reserve, establishing a new attenuation basin (Albrecht Basin), and daylighting of streams to integrate ecosystems into the built environment.

This integrated solution was key as Waikōwhai neighborhood area sits within the headwaters of Te Auaunga Awa. The proposed development provided an opportunity for enhancing water quality of Te Auaunga Awa which already receives majority runoff from urban areas. Utilising a green infrastructure solution would align with GD04 principles, which promote mimicking nature and improving environmental values of existing stream networks. Furthermore, new blue-green spaces mean more amenities for community and recreation.

This proposal also provided an opportunity for stream daylighting. Auckland Council had naturalised 50m of the stream at the upstream part of Molley Green Reserve. This was proposed to be extended downstream, to the existing reserve outlet. Albrecht basin provided visual connectivity towards Molley Green and enhanced the blue green network.

Further to Albrecht Basin and Molley Green Reserve, the opportunity to further create a connection between the basins and Keith Hay Park was also explored as shown in Figure 8.

An extension of the channel providing runoff conveyance from Molley Green Reserve, through McKinnon Street to Richardson Road was considered by Kāinga Ora. Picking this up at Richardson Road and through to Keith Hay Park was considered as an opportunity to complete the connectivity by Healthy Waters. These options were modelled conceptually during the development of the SMP. The results indicated this would provide further flood improvement; however, this extension was not recommended as the preferred flood option due to various stakeholder dependencies. It is noted concept of daylighting past Molley Green Reserve to Richardson Road is currently being worked through by LEAD and Kāinga Ora. Therefore, the alignment indicated in Figure 8 is subject to change based on the design being undertaken.

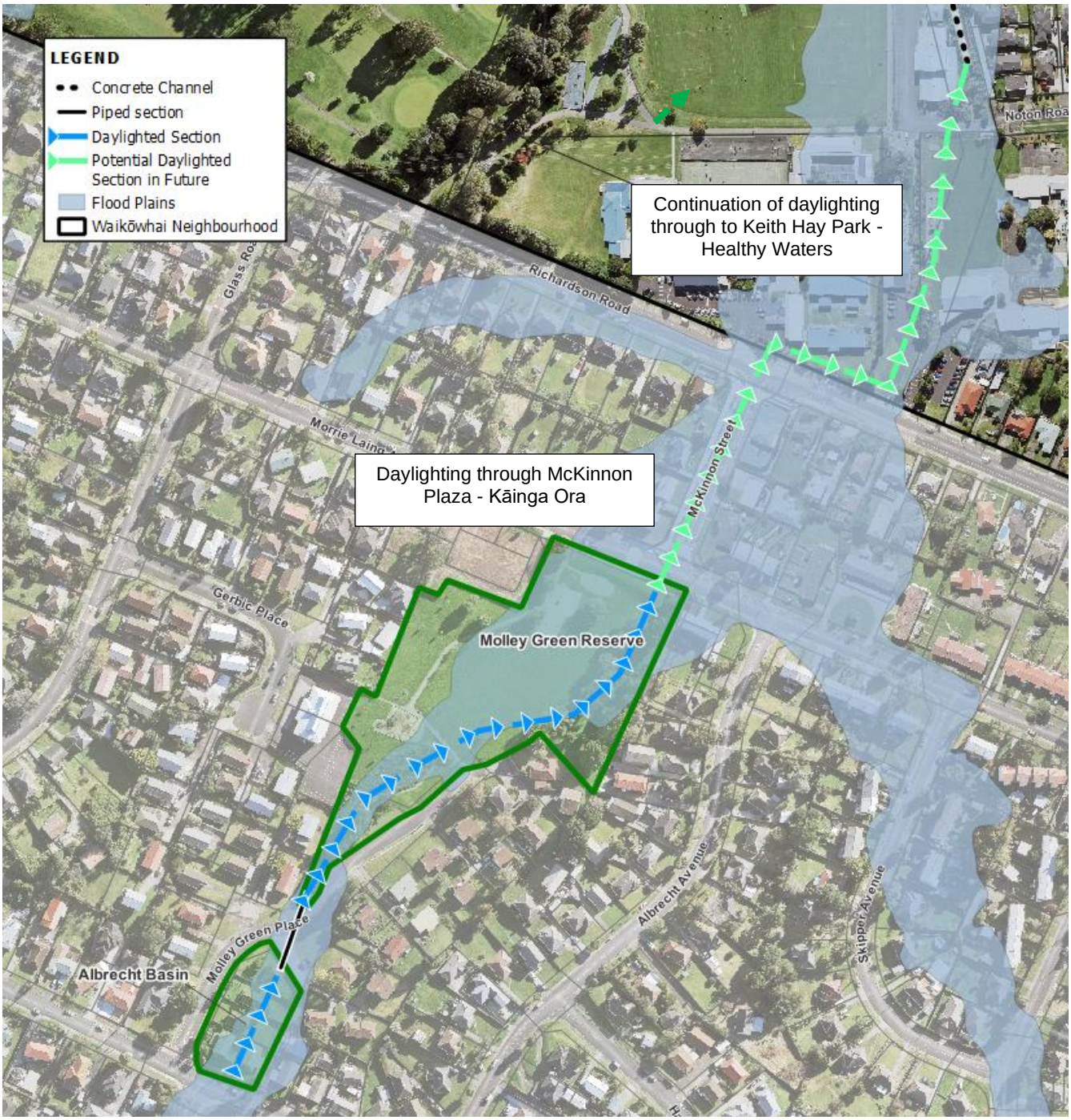

Figure 8: Extent of daylighted stream and potential daylight section in future

9 RESULTS & DISCUSSIONS

The proposed solution aims to mitigate flood impacts while promoting community wellbeing and ecological restoration. By utilising existing green infrastructure and creating new attenuation basins, the plan increases flood storage capacity and extends the upstream reach of Te Auaunga Awa. Additionally, the daylighting of streams enhances water conveyance and ecological connectivity, contributing to improved water quality and biodiversity.

10 CONCLUSION

The headwaters of the Te Auaunga Awa start from Molley Green Reserve. With the Waikōwhai neighbourhood flood mitigation option implemented, there is a significant increase in the connectivity of Waikōwhai catchment with the overall Te Auaunga Awa catchment.

The integration of nature-based solutions offers a holistic approach to brownfield development in flood-prone urban areas. By prioritising ecological restoration and community wellbeing, this paper demonstrates a sustainable model for urban expansion. Through the case study of Waikōwhai, Auckland, this paper highlights the potential for coexistence between urban development and environmental conservation, paving the way for future initiatives in similar contexts.

ACKNOWLEDGEMENTS

The authors would like to extend a special thanks to James Gregory, Rebecca Allington, Lucy Smith from Kāinga Ora, Todd Fraser from LEAD Alliance, and Richard Smedley, Hillary Johnston and Gemma Chuah from Auckland Council.

REFERENCES

Waikōwhai Stormwater Management Plan (V6), (2023), LEAD Alliance