

9.3. North East Valley Flood Risk Mitigation

Prepared for: Safety and Resilience Committee

Report No. OPS2412

Activity: Governance Report

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PURPOSE

- [1] To update committee on the programme for investigations into reducing the flood risk in North East Valley (Lindsay Creek).

EXECUTIVE SUMMARY

- [2] The flood hazard risk for large parts of the Lindsay Creek floodplain is significant and is higher than what is generally considered tolerable in New Zealand and in Otago for an urban area.
- [3] A comprehensive flood protection scheme and a scaled back version have been presented to Council previously, in 2011 and 2013 respectively.
- [4] Council previously decided not to pursue both versions of the scheme. The decisions were informed by the economic climate at the time, feedback from community consultation, and the potential impact of costs on residents vs. the benefits provided by the proposed work.
- [5] Limited flood hazard and erosion mitigation is provided in the Lindsay Creek floodplain but the flood hazard risk remains largely unmitigated. The residual risk is significant.
- [6] Given the level of risk for North East Valley, and considering ORC strategic directions, it is prudent to take a fresh look at the flood hazard associated with the Lindsay Creek floodplain and to investigate options to reduce the flood risk in the floodplain and for North East Valley.
- [7] To enable a reconsideration of the flood hazard, an initial multi-year programme of investigations into reducing the flood risk in North East Valley has been included in the Long-Term Plan 2024-2034 and in the Infrastructure Strategy 2024-2054. This paper outlines the approach that will be taken to implementing those investigations and the associated community engagement.

RECOMMENDATION

That the Committee:

- 1) **Notes** this report.
 - 2) **Notes** the significance of the flood hazard risk in North East Valley.
 - 3) **Endorse** the need to revisit a programme for investigations into reducing the flood risk in North East Valley.
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- 4) **Notes** the proposed programme for investigations into reducing the flood risk in North East Valley part of the Long-Term Plan 2024-2034 and the Infrastructure Strategy 2024-2054.

BACKGROUND

- [8] Lindsay Creek rises on the flanks of Mount Cargill and runs southwest, draining North East Valley and joining the Water of Leith at the Botanic Garden. The catchment is compact with an area of about 12km², and the main channel is relatively short being about 7km long (Figure 1).
- [9] The valley-floor floodplain is intensely developed and populated, with urban land use occurring immediately next to the channel (Figure 2). Several hundred residential properties and few thousand people have some degree of exposure to flood hazard, along with three schools, a Police Station, Ross Home and the Otago Community Hospice, roads (including North Road, which is the main access to North East Valley) and a number of commercial properties.

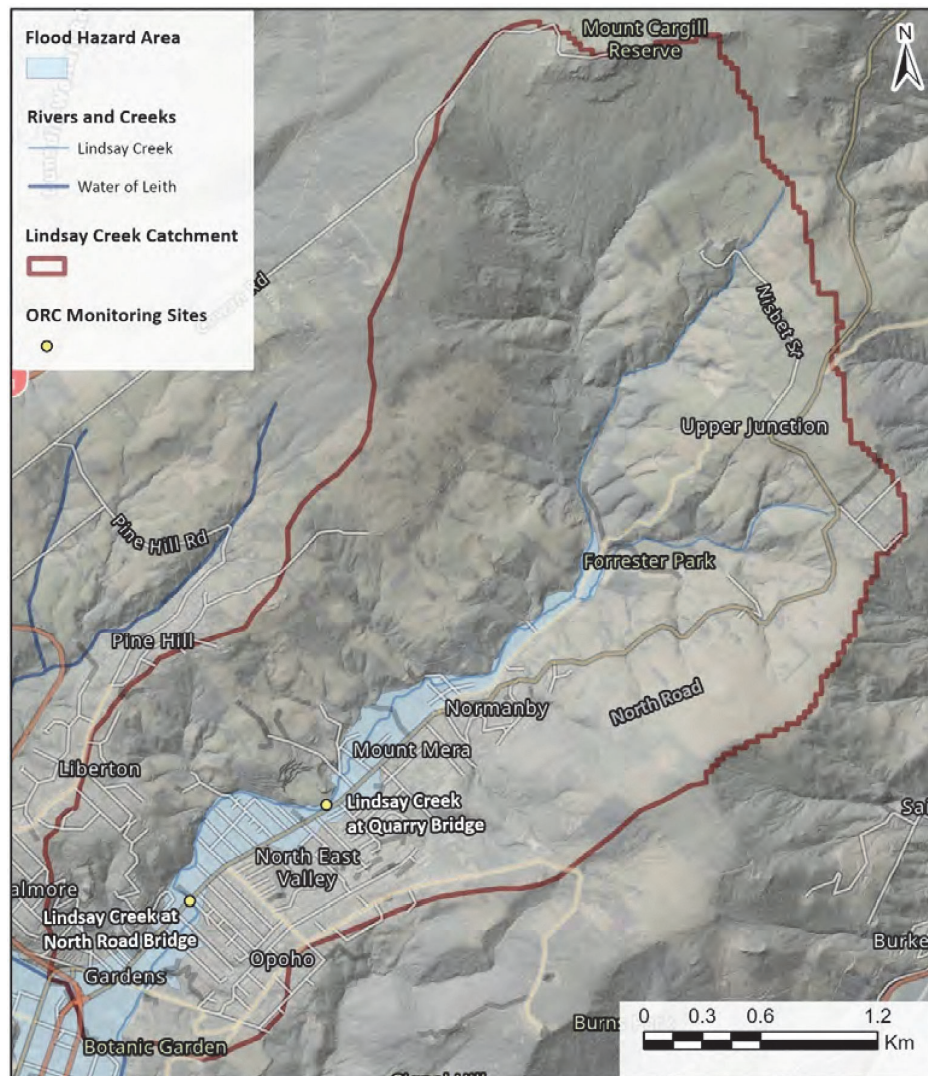


Figure 1. The Lindsay Creek catchment and North East Valley.

- [10] In the upper catchment, the streambed is steep, and the stream has the characteristics of a mountain torrent. Under high flows, it can erode its banks and carry large volumes of debris and detritus. In the lower catchment, the slope of the streambed decreases through the urbanised area of North East Valley.
- [11] All along the catchment, short tributaries (also with short, steep catchments) contribute to the flow in Lindsay Creek. The western slopes are mainly bush covered, with farmland and some urban development on the lower slopes, while the sunnier, eastern slopes are more densely populated.
- [12] During large flood events, the steep upper reaches of Lindsay Creek can produce large volumes of debris. Accumulations around bridges or other instream structures is likely, resulting in full or partial blockage of the creek channel. Floodwater would then back up behind the debris and this could lead to floodwater spilling onto the floodplain.

- [13] Lindsay Creek has a relatively narrow channel including in the lower sections (sometimes a few meters wide only, particularly susceptible to blockage (full or partial)).





Figure 2. Typical sections of the Lindsay Creek channel in North East Valley (all looking upstream). Note the narrowness of the channel, the steepness of the right bank and the proximity of the houses and residential activities at many locations along the stream channel. The concrete channel lining and floodwall are ORC assets, some infrastructure is also owned, controlled and maintained by Dunedin City Council and adjacent private landowners.

- [14] High flow velocities in Lindsay Creek can cause bank erosion affecting properties and structures close to the channel or resulting in premature overtopping and inundation of the floodplain.
- [15] Dormant and creeping landsliding above some sections of the channel could be activated in a heavy rainfall event and partially or fully block the channel, causing substantial out-of-channel overflow. For example, a number of landslide features on the steep true-right (northern) bank of Lindsay Creek between Palmers Quarry and Allen

Street were identified¹, and the toe (or base) of these landslides encroach into the main channel. If a landslide were to fully block the stream channel, which is already relatively narrow, the full river flow would break out and travel overland through roads and residential areas.

- [16] Most of the stormwater network in North East Valley discharges into Lindsay Creek. During heavy rainfall events, high water levels in Lindsay Creek will prevent the free discharge of the stormwater network. Stormwater overflows contribute to surface flooding and can compound the effects of river flooding.
- [17] The characteristics of the catchment (steep and compact) result in the flood peak reaching the urbanised part of North East Valley quickly (less than 2 hours from the onset of heavy rain). This leaves a very limited ability for residents and Emergency Services to plan a response during a heavy rainfall event. Precautionary evacuation is also a matter usually considered in response to a heavy rainfall event.
- [18] Assessments of channel capacity have showed that some sections of Lindsay Creek are very restricted resulting in various overtopping locations (Appendix 1): for example the section between Watts Road and Felix Street (adjacent to Palmers Quarry) has a capacity of approximately 30m³/s. It is estimated that this flow has approximately a 79% probability of occurring in a 10-year period and a 95% probability of occurring in a 20-year period.
- [19] Once this flow is exceeded, floodwater will overtop the left bank into North Road and, depending on the volume of water spilled, inundate large parts of the residential area between Felix Street and Allen Street. The flood hazard characteristics (depth and velocity) are likely to create unsafe conditions for people and result in building damages. North Road could also be unsafe for all types of vehicles, restricting the ability for people and emergency services to safely access parts of North East Valley.
- [20] Records and observations indicate that flooding from Lindsay Creek has been a regular occurrence. A number of floods in Lindsay Creek have caused damage to properties through bank erosion and from floodwater overtopping the river banks. Severe flooding and consequent damage were reported for example in 1868, 1877, 1912 (Figure 3), 1923, 1929, 1968, 1971 and 1991 (Table 1).
- [21] The flow record from ORC's Lindsay Creek monitoring station at North Road bridge is shown in Figure 4. This illustrates the frequent occurrence of high flows in the catchment, with three high flow events of up to about 30 m³/s (February 1991, April 2006, June 2015) in the 45-year period this monitoring station has been in operation.

¹Lindsay Creek Value Engineering Study Geotechnical Appraisal, Coffey Geotechnics, 2010. Report prepared for Otago Regional Council.



Figure 3. View from Blacks Road across the North East Valley floodplain and North Road, during a flood event in 1912. Note the water flowing on North Road.



Figure 4. View downstream on Lindsay Creek at Palmers Quarry Bridge during a January 2002 flood event (12 January 2002). Note the very limited freeboard remaining until floodwaters would overtop the left bank onto North Road. The peak flow in this 2002 event was $\sim 19 \text{ m}^3/\text{s}$, well below peak flows of $30\text{--}32 \text{ m}^3/\text{s}$ recorded in 1991, 2006 and 2015. Photograph is not necessarily taken at the peak of the high flows for the event.

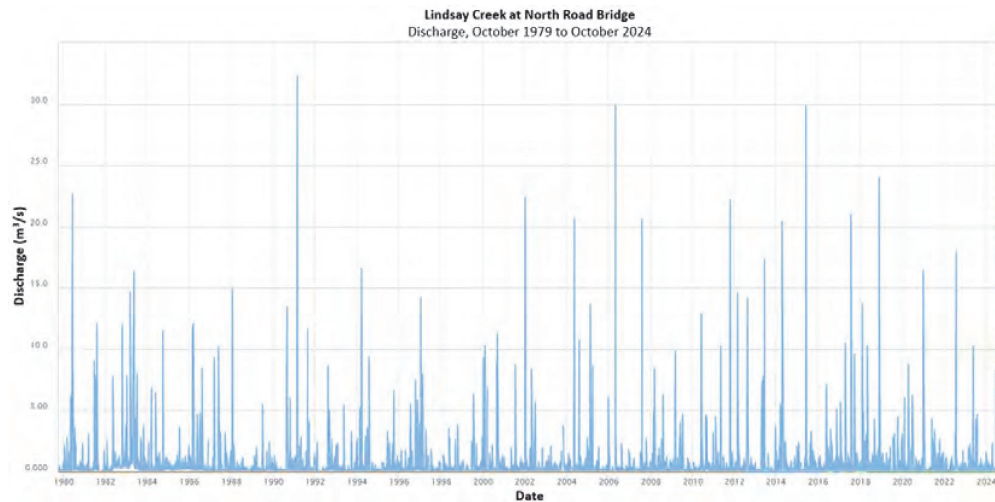


Figure 5. Lindsay Creek discharge for the 45-year period since October 1979. The three highest flows in this period are; February 1991 (32 m³/s), April 2006 (30 m³/s), and June 2015 (30 m³/s).

Table 1. Recorded major floods in Lindsay Creek and damage description (from Lindsay Creek Flood Hazard Report, ORC, 2001)

Date of Flood	Comments
February 1868	Considerable damage was done to properties in North East Valley.
February 1877	In North East Valley the low-lying sections were inundated and numerous residences suffered considerably.
July 1882	At Lindsays Bridge, the water rose 3 or 4 inches above the roadway and the last tram at night was unable to get through.
November 1883	Inundation occurred at North East Valley and it occurred with suddenness that gave little or no time for preparation.
April 1923	Flooding was extensive and caused serious damage in Dunedin.
May 1923	The Botanic Gardens area was inundated to a considerable depth.
March 1929	This was one of the largest floods in recorded history. Caused general flooding of the valley floor and inundation of the Botanic Gardens.
March 1936	Lindsay Creek overflowed its banks, causing flooding in North East Valley. Some residents were forced to leave their homes.
November 1938	Serious flooding in Dunedin City.
April 1944	A rapid rise of Lindsay Creek caused the creek to scour badly and undermine the foundations of a house, leaving it overhanging the creek bed.
May 1945	Lindsay Creek and the Water of Leith rose to high flood within a few hours, causing some houses in North East Valley and many suburban gardens to become flooded. Tram services to Normanby were suspended.
September 1946	Several parts of Dunedin were flooded and many people were forced to leave their homes.
March 1968	Severe flooding occurred in Lindsay Creek, with overtopping at Chingford Park and at the Quarry. Ten houses in the Felix Street to Allen Street area were flooded.
June 1971	Lindsay Creek overtopped its banks at Crown Street, the quarry and upstream of Watts Road. Large sections of bank were eroded and walling collapsed in Chingford Park. A house in Norwood Street was isolated by a tributary inflow. Flooding of property occurred on North Road in the vicinity of Northumberland and Craighleith Streets. Flows in some places were higher than in 1968.
February 1991	Bank erosion occurred at the end of Tannadice Street. The creek broke out and flooded properties in the area. Aggradation of the riverbed at Bonnington Street occurred.

- [22] Flooding hazard risks are projected to be exacerbated by potential impacts of climatic changes².
- [23] The ORC proposed Regional Policy Statement (2021³) provides a methodology for natural hazard risk assessment (APP6) based on flood hazard characteristics and consequences.
- [24] An initial assessment of the flood hazard risk using this methodology (details in Appendix 2) indicates that the flood hazard risk for parts of the Lindsay Creek floodplain is significant and is higher than what is generally considered acceptable in New Zealand and in Otago for an urban area.

Current management of the flood hazard risk

Green-fields areas

- [25] In 2014, ORC worked closely with the Dunedin City Council to provide flood hazard information related to Lindsay Creek to inform the development of the Second-Generation District Plan (2GP)⁴. This information was incorporated into the 2GP as a flood hazard overlay. The overlay informs future land use decisions.
- [26] The flood hazard overlay developed for the 2GP is also displayed publicly in the ORC Natural Hazards Database (Figure 6).⁵ This mapping identifies the geomorphic floodplain area which may be affected if water overtops the main channel, and subsequently flows in a downslope direction across the floodplain.
- [27] More recently, the flood hazard information associated with Lindsay Creek has been included in the draft Dunedin Future Development Strategy 2024-2054⁶ (FDS). The FDS identify natural hazards as development constraints that remove or severely limit opportunity for growth.

² Otago Climate Change Risk Assessment, prepared by Tonkin + Taylor Ltd for ORC, 2021
<https://www.orc.govt.nz/media/9653/tt-otago-climate-change-risk-assessment-2021.pdf>

³ <https://www.orc.govt.nz/media/12992/porps-edited-version-identifying-non-freshwater-parts.pdf>

⁴ Dunedin City Urban Streams Flood Hazard, ORC, 2014.

[https://maps.orc.govt.nz/hazards/NHDBDocuments/Dunedin%20City%20Urban%20Streams%20Flood%20Hazard%20\(2014\).pdf](https://maps.orc.govt.nz/hazards/NHDBDocuments/Dunedin%20City%20Urban%20Streams%20Flood%20Hazard%20(2014).pdf)

⁵ [hazards.orc.govt.nz](https://maps.orc.govt.nz/hazards/NHDBDocuments/Dunedin%20City%20Urban%20Streams%20Flood%20Hazard%20(2014).pdf)

⁶ https://www.dunedin.govt.nz/_data/assets/pdf_file/0004/1026589/Draft-Dunedin-Future-Development-Strategy-2024-2054.pdf

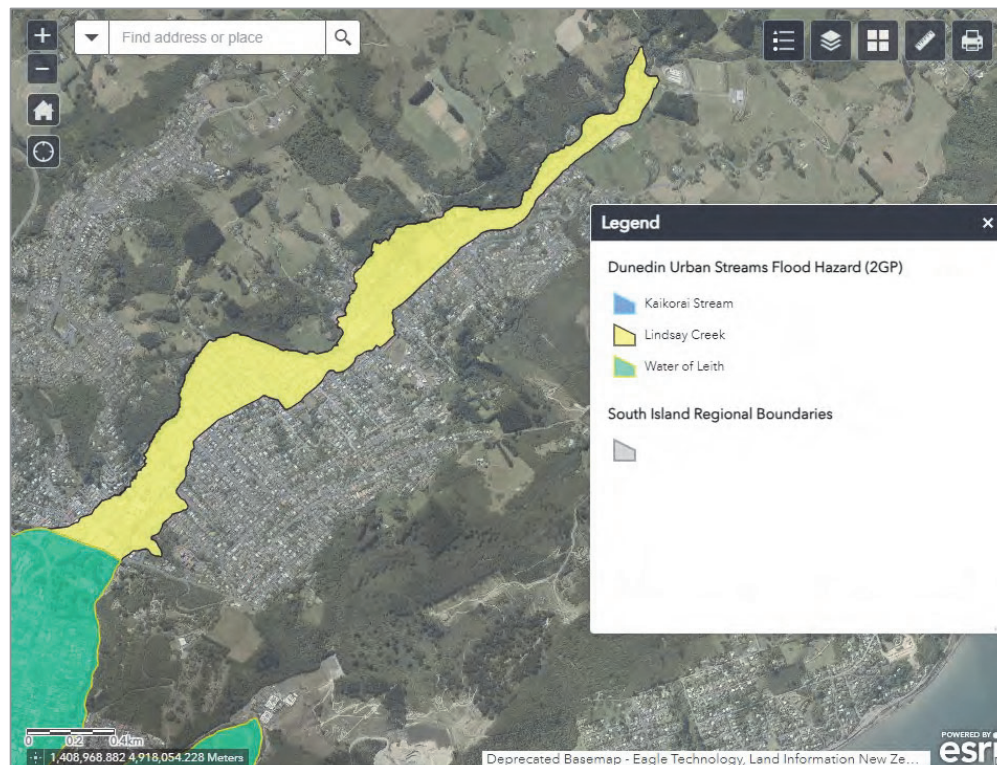


Figure 6. Lindsay Creek flood hazard mapping developed for the Dunedin City Council's 2GP, this is shown as a screenshot from the ORC Natural Hazards Database, which can be viewed at hazards.orc.govt.nz.

Existing development areas

- [28] Physical flood and erosion mitigation work in Lindsay Creek has generally been constructed in response to issues arising from specific flood events. As a result, there is currently no continuous and comprehensive flood and erosion mitigation work for the Lindsay Creek floodplain.
- [29] In addition to ORC-owned structures, some infrastructure such as bank protection works are owned, controlled and maintained by Dunedin City Council and adjacent private landowners.
- [30] Appendix 3 provides an overview of the past flood and erosion mitigation work constructed since 1929.
- [31] Between approximately 2005 and 2011, ORC has extensively investigated and developed a concept design for a more comprehensive flood and erosion mitigation scheme for Lindsay Creek between Potters Road and the confluence with the Water of Leith⁷. This work was part of the development of the Leith Lindsay Flood Protection Scheme.
- [32] Physical flood mitigation work in Lindsay Creek is challenging due to the density of the existing developments in the floodplain. Dealing retrospectively with the flood hazard for Lindsay Creek is more difficult than if it were a green-fields area. Intense subdivision

⁷ Water of Leith and Lindsay Creek - Design Philosophy for Achieving Minimum Design Flood Standard, Opus 2005

has occurred, constraining the river, restricting the space available for public works and increasing the vulnerability of houses and their occupants to the impacts of flooding. Road bridges have been constructed in a way that impede and/ or redirect flood flows in Lindsay Creek and which limit the ability to alter the channel.

- [33] Due to the above, the developed scheme had a complex combination of bank raising, bunding, wall construction, channel widening, bed regrading and bridge replacement or modification. It also required land acquisition along the Lindsay Creek channel to enable some of the work.
- [34] The land presently owned by ORC is shown in Figure 7. ORC does not presently own or have legal access to all of the land which would be required for implementation of a flood protection scheme.
- [35] In 2011, Council decided, when adopting the 2011-12 Annual Plan and amendments to the 2009-19 Long Term Plan, to complete the Water of Leith component of the Leith Lindsay Flood Protection scheme, and defer the Lindsay Creek portion pending further investigations into options for the Lindsay Creek. The magnitude of the estimated construction cost of the proposed work was a key factor to this decision.
- [36] Between 2011 and 2013, ORC developed and presented to Council an updated, scaled back flood mitigation proposal⁸. The updated proposal provided a lesser degree of protection but was simpler and less expensive and potentially more affordable.
- [37] It relied on temporary storing floodwater in the area upstream of Forester Park and in Chingford Park, completed by small scale localised channel work (such as bed regrading and bunding) between Palmers Quarry bridge and Pentland Street.
- [38] In 2013, however, Council resolved not to pursue the revised, smaller scale package of works. The decision was informed by the economic climate at the time, feedback from community consultation, and the potential impact of costs on residents vs. the benefits provided by the proposed work.

⁸ *Lindsay Creek Flood Hazard Mitigation*, Report 2012/1032, ORC Engineering and Hazards Committee and *Lindsay Creek Flood Mitigation – Works Programme, Costs and Benefits*, Report 2013/0604, ORC Engineering and Hazards Committee.

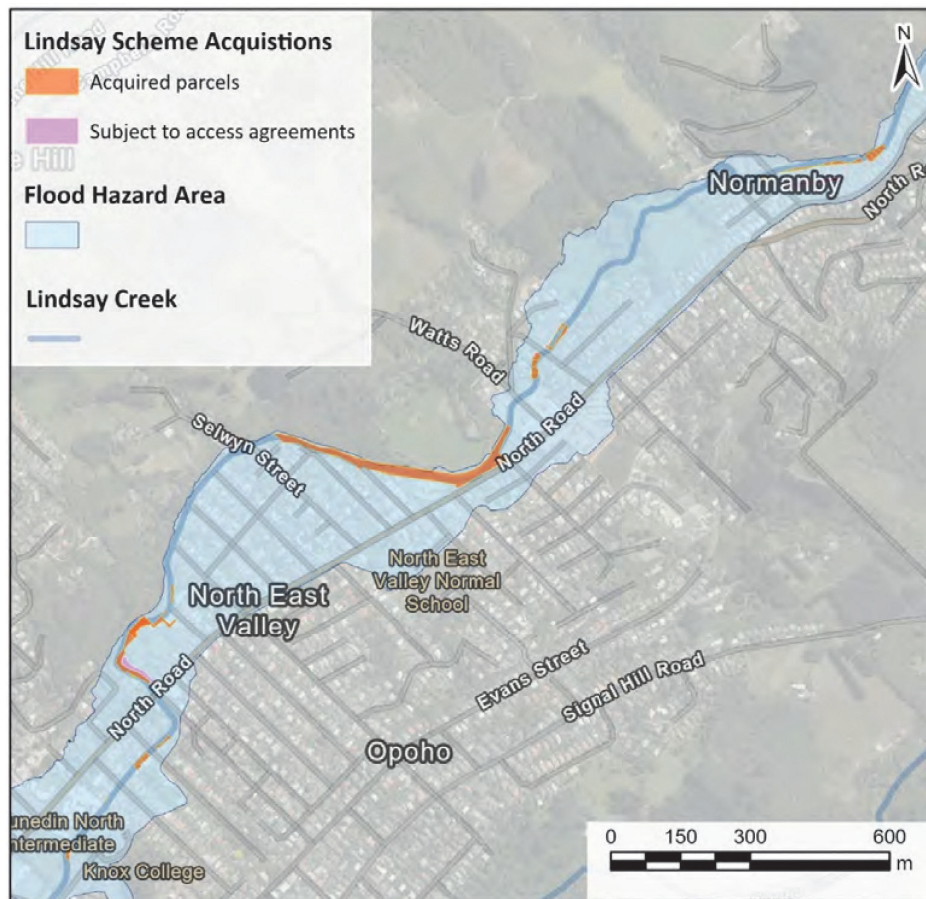


Figure 7. Lindsay Creek floodplain, showing land parcels which have been acquired by ORC, or which are subject to access agreements.

River management and bank protection infrastructure

- [39] The Lindsay Creek channel is part of the Dunedin river management area and is actively managed (at a basic level) by ORC to ensure flows and sediments are transported as efficiently as possible (e.g. routine monitoring, vegetation control, removing obstructions, bank erosion repairs where applicable).
- [40] ORC also maintains some rockwork and concrete walls designed to minimise erosion and help retain the creek within its existing channel (e.g. Figure 2)⁹.
- [41] In 2005 ORC has constructed a debris trap below Bethunes Gully (Figure 8). This structure help reducing the volume of debris in the channel and the likelihood of blockage.

⁹ ORC does not own or maintain all the bank protection work in Lindsay Creek. Some infrastructure is owned, controlled and maintained by Dunedin City Council and adjacent private landowners.



Figure 8. Lindsay Creek debris trap (looking upstream), 3 June 2015. The peak flow in this event was ~30 cumecs (measured at North Road Bridge), however the photo is not necessarily showing the period of peak flows.

Flood warning and response

- [42] The Lindsay Creek catchment is part of ORC flood monitoring areas.
- [43] To inform the flood warning and flood response, ORC operates a water level/flow site located at the North Road bridge and a water level site at Quarry Bridge (Figure 1), rainfall stations in Pine Hill and Sullivans Dam. The Musselburgh rainfall station (operated by NIWA) is also used.
- [44] The water level site located near the Palmers Quarry bridge is used to monitor Lindsay Creek water level in relation to the level of the left bank and to identify potential overtopping into North Road (this section has very limited channel capacity with potential major consequences if significant overtopping occurs, refer to paragraphs 18 and 19).
- [45] The catchment is also well covered by the MetService rain radar^{10 11} which provides detailed spatial rainfall information that is also used to inform the flood warning and ORC flood response (Figure 9).
- [46] A flood forecasting model specifically developed for the Lindsay Creek catchment assists the flood warning and ORC flood response. It uses rainfall data (forecast and observed) to estimate the flood peak and timing for Lindsay Creek at North Road. The model

¹⁰ Otago Rain Radar – Rainfall Analysis and Nowcasting Service, ORC Safety and Resilience Committee, November 2023. <https://www.orc.govt.nz/media/15475/2023-11-09-sr-committee.pdf>

¹¹ The rainfall radar service is generally reliable, but can not be guaranteed as there are occasional outages.

provides an indication for the approximate magnitude of potential peak flows, but cannot give a highly reliable forecast for the timing or peak discharge.

- [47] The information from the ORC monitoring network, the MetService rain radar and from the flood forecasting model is analysed and provided to the public when relevant and to various stakeholders such as ORC Engineering Team and Emergency Management services.

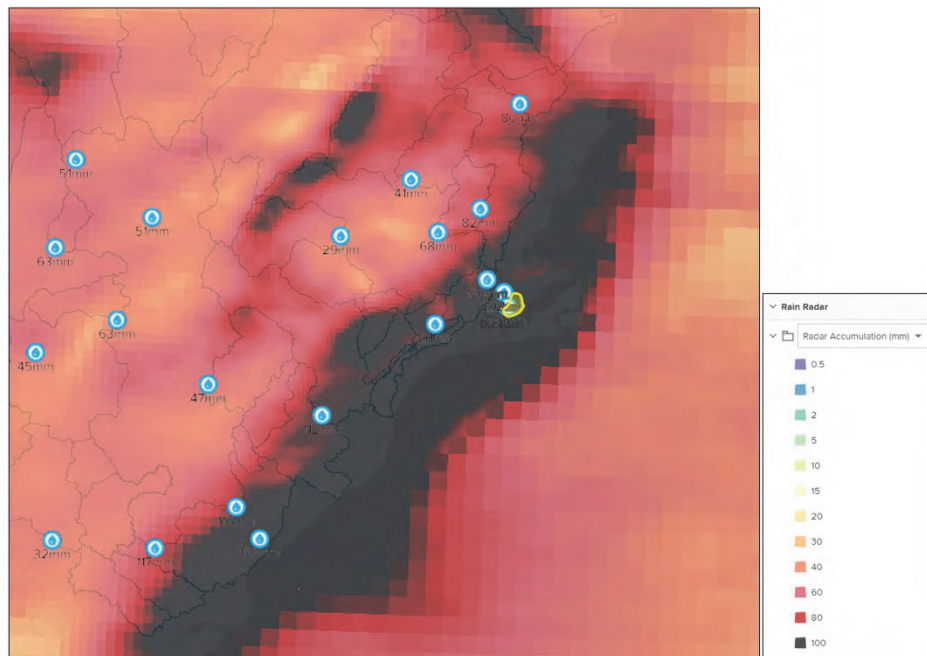


Figure 9. Rainfall accumulations for the early October 2024 weather event, derived from rainfall radar. Areas shaded dark grey received precipitation of 100mm or greater for the event. Lindsay Creek catchment is highlighted yellow.

DISCUSSION

- [48] As described in the previous section, limited flood hazard and erosion mitigation is provided in the Lindsay Creek floodplain but the flood hazard risk remains largely unmitigated, significant and higher than what is generally considered acceptable for an urban area. The residual risk is high.
- [49] Communities' resilience in the face of natural hazards and climate change are focus areas of both the current ORC Strategic Directions¹² and the draft Strategic Directions 2024-2034¹³. One of the goals of the draft Strategic Directions 2024-2034 is "*Plans are in place to ensure that the region's most vulnerable communities (geographic and demographic) and ecosystems are resilient in the face of natural hazards*".
- [50] Given the level of risk for North East Valley, and considering ORC strategic directions, it is prudent to take a fresh look at the flood hazard associated with the Lindsay Creek

¹² <https://www.orc.govt.nz/our-council-our-region/our-council/strategic-directions>

¹³ <https://www.orc.govt.nz/media/16481/draft-strategic-directions-2024-2034-otago-regional-council.pdf>

floodplain and to investigate options to reduce the flood risk in the floodplain and for North East Valley. A higher and more uniform standard of flood protection will need to be considered to provide a standard of flood protection that is more comparable with other urban areas across New Zealand.

- [51] There have been changes in the social, environmental and economic setting that have occurred in the past 12 years, following Council's decision to not reduce the flood hazard for North East Valley. These include:
- Heightened awareness of flood risk amongst the general community, especially following the Auckland and Hawkes Bay events;
 - Improved understanding of future climate change and the need for pro-active adaptation;
 - Changes in community tolerance of flood risk;
 - The need to consider maximum credible events and not limit consideration to a design event;
 - The possibilities that nature-based solutions present;
 - The potential to achieve wider objectives such as active transport, public amenity and ecological restoration;
 - The potential for central government co-investment for investment-ready flood resilience projects;¹⁴
- [52] To enable a reconsideration of the flood hazard, a multi-year programme of investigations into reducing the flood risk in North East Valley has been included in the draft Long-Term Plan 2024-2034 and in the Infrastructure Strategy 2024-2054.
- [53] The proposed programme is part of the "Resilience and Climate Change" activity in the draft Long-Term Plan 2024-2034 and is integrated to the ORC Natural Hazards, Flood Protection, Drainage and River Management and Emergency Management activities.
- [54] It is proposed that the programme will be staged and will adopt a principled approach based on the framework described in the New Zealand Standard 9401:2008 Managing Flood Risk and on the approach described in the Infrastructure Strategy 2024-2054 (refer section 4, Figure 1 of the Infrastructure Strategy) including the Protect, Avoid, Retreat, Accommodate (PARA) Framework (Ministry for the Environment¹⁵).

¹⁴ ORC's suite of climate resilience co-investment projects do not presently include work on Lindsay Creek.

¹⁵ <https://environment.govt.nz/publications/aotearoa-new-zealands-first-national-adaptation-plan/adaptation-options-including-managed-retreat/>



Figure 10. Key areas of infrastructure management and their relationship.

[55] The high-level programme and timeframe are described in the Infrastructure Strategy 2024-2054 (11).

	Estimated Expenditure \$,000's														
Year	Y1 2024/25	Y2 2025/26	Y3 2026/27	Y4 2027/28	Y5 2028/29	Y6 2029/30	Y7 2030/31	Y8 2031/32	Y9 2032/33	Y10 2033/34	Y11-15 2035-39	Y16-20 2040-44	Y21-25 2045-49	Y26-Y30 2050-54	
Routine / Business as Usual Activities															
Dunedin Area: Channel and Riparian Management*					6,587						3,427	3,765	3,967	4,315	
Clutha Area: Channel and Riparian Management*					7,321						4,315	4,450	4,922	5,100	
Central Otago Area: Channel and Riparian Management*					5,366						3,268	3,457	3,783	4,041	
Wakatipu Area: Channel and Riparian Management**					4,945						2,830	2,985	3,203	3,578	
Wanaka Area: Channel and Riparian Management***					3,026						1,701	1,807	1,895	2,103	
Waitaki Area: Channel and Riparian Management*					4,684						2,634	2,841	3,040	3,256	
Lower Waitaki River Control Scheme: Contribution to Scheme Operation					2,545						1,463	1,586	1,695	1,817	
Dunedin Area Projects - Infrastructure Related Only															
Middlemarch: Hazard Mitigation Investigations			156												
Middlemarch: Tactical Maintenance			154												
Middlemarch: Hazard Mitigation Improvements						335					6,546				
Lindsay Creek / North East Valley Resilience: Flood Response Plan	5														
Lindsay Creek: Legalisation of land ownership		101													
Lindsay Creek: Identification of flood mitigation options			155												
Lindsay Creek: Hydraulic Modelling				450											
Lindsay Creek: Implementation of Flood Mitigation								1,525			12,692	13,692	14,692	15,692	
Lindsay Creek: Quarry Bridge	3,000														
Kaikorai Stilling Basin: Resilience and Environmental Enhancement					1,556							3,171	3,423		
Kaikorai Stream: Improvements					154										
River Mouth Monitoring Technology Installation					123										

Figure 11. Proposed investment programme for the Dunedin Area (Infrastructure related only). Work related to the programme for investigations into reducing the flood risk in North East Valley is highlighted by the red rectangle

[56] The investigations phases are planned between financial year 2024/25 (year 1) until 2026/27 (year 3). During those phases, it is planned to complete a detailed assessment of the Lindsay Creek flood hazard that will inform the flood mitigation investigations but also the emergency flood responses. The investigation will consider all the sources of flooding (river, stormwater and surface runoff), account for the effects of climate change on river flows, will assess the effects of “maximum credible” events and will incorporate geo-hazards (e.g. landslides) due to their impact on the channel capacity and floods.

[57] One of the outcomes of the investigations phases is the development of a flood mitigation plan for the Lindsay Creek catchment. The plan will not only focus on hard engineering measures and will consider all the approaches available to reduce the flood hazard in accordance with the New Zealand Standard 9401:2008 Managing Flood Risk and the PARA framework.

[58] It is proposed to have a decision point in 2027/28 (year 4) to consider the following options (as described in the Infrastructure Strategy 2024-2054):

- Status quo: ongoing maintenance of waterway and existing infrastructure, update of flood hazard information and collaboration with DCC as required, emergency response planning
- Implement flood mitigation options that focus on nature-based solutions where practicable
- Build a flood protection scheme that consists of hard engineering infrastructure

[59] Depending on the decision made, it is proposed to start the implementation of the flood mitigation works from 2028/29 (Year 5). The implementation will span several years.

CONSIDERATIONS

Strategic Framework and Policy Considerations

[60] The proposed programme aligns with both the current ORC Strategic Directions and the draft Strategic Directions 2024-2034 (focus area: Communities' resilience in the face of natural hazards and climate change). Refer to the Discussion section also.

Financial Considerations

[61] The proposed budget for this work included in the draft Long-Term Plan 2024-2034 is approximately \$800,000 for the investigations phases (2024/25 until 2026/27), \$3.5M for the implementation phases in Years 5-10, and further funding through the remainder of the Infrastructure Strategy (refer to Figure 11 for details).

Significance and Engagement

[62] Engagement planning will consider and be designed to be consistent with organisational commitments made through He Mahi Rau Rika: ORC Significance, Engagement and Māori Participation Policy.

Legislative and Risk Considerations

[63] Powers contained in the Local Government Act and in the Soil Conservation and River Control Act provide legal authority to investigate flood mitigation works.

[64] The proposed programme for investigations into reducing the flood risk in North East Valley contributes to fulfil ORC's responsibilities under the Resource Management Act and the Civil Defence Emergency Management Act.

Climate Change Considerations

[65] The effects of climate change will be considered in flood hazard assessments for Lindsay Creek and in the assessment of risks and potential hazard management responses.

Communications Considerations

[66] Communication is a key component of the proposed programme of work. A comprehensive communications plan will be developed as part of this work programme.

[67] Communications and engagement planning will be integrated, complementary and build off each other.

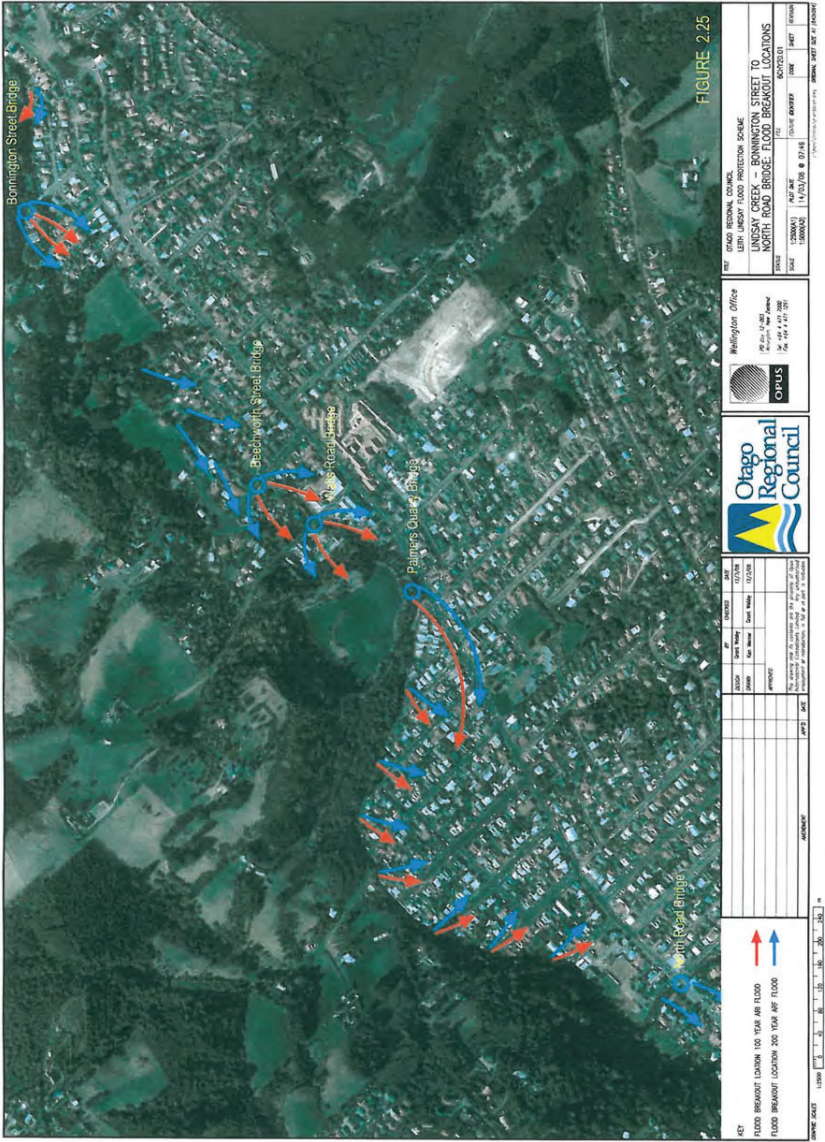
NEXT STEPS

[68] Refer to the Discussion section.

ATTACHMENTS

1. NEV Flood hazard Appendices [**9.3.1** - 8 pages]

**Appendix 1: Overtopping locations in the Lindsay Creek catchment
from Potters Road to the confluence with the Water of Leith
(prepared by OPUS for ORC, 2008)**





**Appendix 2: Preliminary flood hazard risk assessment for the
Lindsay Creek mapped flood hazard area using the ORC proposed
Regional Policy Statement (2021)**

Acceptable risk	Tolerable risk	Significant risk
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Appendix 3: Historic work along the Lindsay Creek channel (Lindsay Creek Flood Hazard Report, ORC, 2001)

4. Existing Works

Flood protection works in Lindsay Creek have generally been constructed in response to issues arising from specific flood events. Protection works are therefore in areas that were most badly affected in earlier floods. As a result there are no continuous protection works, with the exception of the channel downstream of North Road, and protective walling is of varying age and quality.

The most significant works in Lindsay Creek were undertaken following the 1929 flood. Work involved the realignment, deepening and reinforced walling of the channel from Chambers Street to the Water of Leith. The reach from Opoho Road to the Water of Leith through the Botanic Gardens has stone pitched batters with grouted stone weirs. The channel between Opoho Road and Chambers Street is fully concrete lined.

In 1962, the Dunedin City Council submitted a proposal to the Soil Conservation and Rivers Control Council, through the Otago Catchment Board, to extend and realign the concrete channel from Chambers Street to the North Road Bridge. The work included a minor realignment in the vicinity of North Road to eliminate the need for a bridge on Craigleith Street and the renewal of the North Road Bridge. While there was some debate over the design flow for the works, an amended proposal was approved in late 1963 and the works were completed by the end of 1965.

Following the flood in March 1968, the concrete lined channel was extended immediately upstream of North Road. This was done to prevent further erosion of the bridge approaches.

In 1974, the Dunedin City Council submitted a further proposal to the Soil Conservation and Rivers Control Council, through the Otago Catchment Board, to construct a concrete flood wall on the left bank of Lindsay Creek between Allen Street and Selwyn Street. This proposal was extended in 1975 to include the upgrading of the full length of Lindsay Creek from North Road to Bonnington Street. Works were to be carried out in stages over a 10-year period. Stage One of the works was proposed in 1974 and resulted in the walling of the left bank between Allen Street and Selwyn Street, with limited widening and trimming of the right bank. This work was approved and completed by the end of 1976. The balance of the

work outlined in the 1975 proposal, including further widening and walling on the right bank between Allen Street and Selwyn Street, was never carried out. Subsequent works have been piecemeal in response to localised erosion or flooding.

Numerous minor protective works of varying age and quality are scattered along the length of Lindsay Creek above North Road.