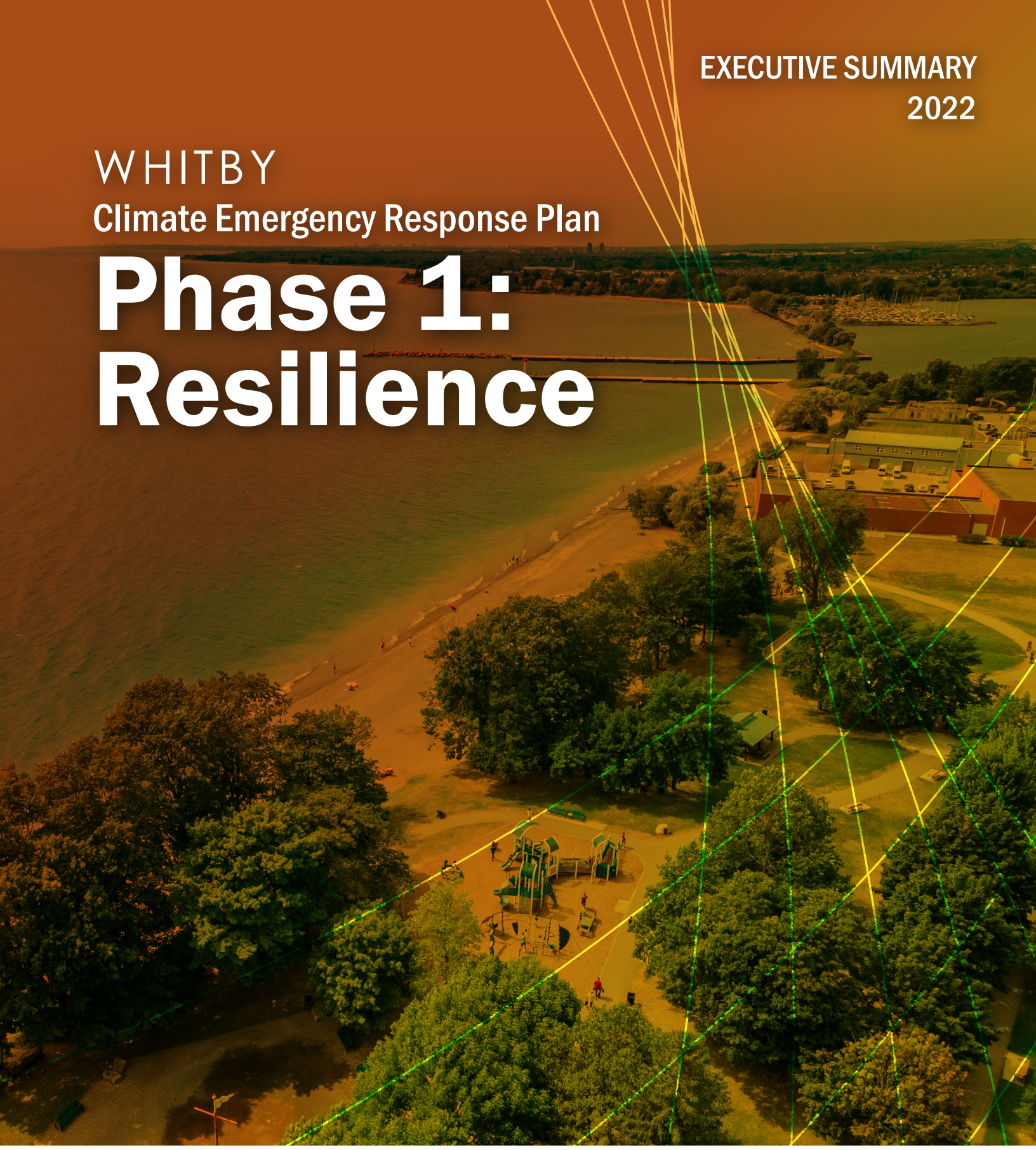
EXECUTIVE SUMMARY
2022

WHITBY

Climate Emergency Response Plan

Phase 1: Resilience



whitby.ca/ClimateChange

Whitby

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A Derecho in Whitby

While this document was being finalized, a powerful windstorm called a derecho moved across Ontario, causing at least 11 deaths and resulting in untold damage[1] in various areas, such as Whitby. While it is difficult to directly correlate the derecho with climate change,[2] the storm is a stark reminder that climate risks can take many forms. Derechos are not directly addressed in this plan, but many of the measures identified will increase Whitby's resilience against windstorms and risks that are location-specific, such as flooding. In particular, this approach reduces the impact of compounding hazards, for example, when wind storms are combined with floods.

[1] Canadian Press (2022). 11th person dies from weekend storm, tens of thousands Ontarians still without power. Retrieved from: https://www.thestar.com/news/canada/2022/05/26/tens-of-thousands-in-southern-ontario-still-without-power-after-deadly-storm.html

[2] Canadian Underwriter (2022). Was derecho storm damage caused by climate change? Retrieved from: https://www.canadianunderwriter.ca/catastrophes/was-derecho-storm-damage-caused-by-climate-change-1004221681/

Contents

1. The Town of Whitby

The Town of Whitby lies on the shores of Lake Ontario, to the east of Toronto. The southern regions of the town are more urbanized, with residential development along naturalized areas, and agricultural and undeveloped lands predominantly in the north. With a total area of approximately 150 km2, Whitby is nested within the Regional Municipality of Durham.

Whitby is a community of 137,00 people, and it is expected to grow to 331,000 people by 2070, an increase of 140%. Many Whitby residents commute to other regions within the Greater Toronto Area for work.

2. A Strategic Assessment

This analysis is one of the first adaptation plans in Canada to quantify the financial impacts of climate risks and the benefits of climate adaptation measures for a municipality.

The Resilience Plan details the programs, policies, initiatives, and infrastructure that will increase the protection of the people, places, businesses, and infrastructure in the town. The document is a strategic-level plan that supports planning processes and the prioritization of adaptation measures. It is not a detailed engineering-level analysis of site-specific conditions for locations and activities within Whitby.

The analysis used to support this plan represents state-of-the-art adaptation planning. It is the first adaptation plan to quantify the financial impacts of climate risks and the benefits of climate adaptation measures in Canada. However, it is limited by the availability of data and uncertainty with respect to future climate changes and the town' s development. Data sources and methods are described in detail in the Data, Methods, and Assumptions section of the Appendix.

2.1 The Community Speaks

A community and stakeholder engagement process complimented and enhanced the technical analysis, ground-truthing the modelling and providing additional insights on the risks and adaptation measures. The interactive online tool, ISeeChange, was used to collect real-time information from people in Whitby about climate events, storms, the weather, and other relevant details. This was paired with online workshops and surveys to collect feedback on the progress of the project and on how community members could participate in the plan's implementation.

The residents of Whitby are experiencing climate change impacts today, and they would be willing to participate in programs designed to help protect them, their properties, and their communities from climate risks. Education about climate risks, resources to reduce risk and improve preparedness, and current and future community supports will be essential to ensuring all of Whitby is resilient to climate impacts.

2.2 State-of-the-Art Modelling

The climate adaptation modelling was a multiphase approach to understand the dynamics of climate change, development, the built environment, and the natural environment in Whitby. Based on the CityInSight platform, people, places, and spaces were modelled both in time and in space.

Spatial Analysis

Identify areas in Whitby that are more vulnerable to climate change impacts.

Temporal Analysis

Compare the climate change impacts today vs. 2070, and compare a business-as-usual (BAU) and adapted 2070.

100 year flood today, 100 year flood in 2070.

Financial Analysis

Determine the financial costs of inaction and action, based on the value of assets and costs of damage.

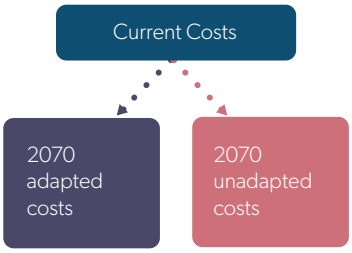

Figure 1. The technical approach.

Locally downscaled climate change modelling completed for the Region of Durham was used as a key input, using a global climate scenario called RCP8.5 that represents an increasing trajectory of GHG emissions. This scenario was used because global GHG emissions are still trending upwards in alignment with this scenario. Hopefully, new policies and investments by governments will reverse this trend; however,it is not yet prudent to assume that this will be the case.

The spatial and temporal analysis (Figure 1) allows for the development of multiple scenarios for Whitby. The first, a present-day scenario, acts as the base map upon which all changes are made. This scenario represents the physical environment of Whitby today, as well as the scale and probability of climate events today. This scenario is then projected into the future (2070) in two ways: the first with growth, development, and actions as they are planned today; the second with deliberate actions taken to reduce the risk of damages and impacts from climate change. The second scenario, the adapted 2070 scenario, represents the possible future for Whitby if careful consideration is taken now to adapt for the future.

In addition to spatial and temporal modelling, the costs and benefits of adapting to climate change need to be understood. Financial modelling of the damages from climate change in the present day, and in the two future scenarios, allows for a comparison of the costs of action to adapt to climate change and the costs of inaction.

2.3 Climate Risks

Climate change represents a threat to Whitby residents' quality of life and the economic vitality of Whitby. Whitby faces a wide range of climate hazards, and this analysis focussed on those deemed most significant for Whitby, specifically increased flooding and heat. Flooding can take three forms: coastal, riverine, and overland. Additional hazards, such as severe storms and weather events, are also addressed but were not modelled. Hazards were prioritized based on the anticipated climate impacts as well as input from the advisory groups and the public. Flooding and heat were the highest priority hazards with a spatial variation within Whitby. Other hazards, such as disease, agricultural impacts, and severe storms, were identified as having serious potential impacts to the people and places of Whitby, but could not be modelled spatially.

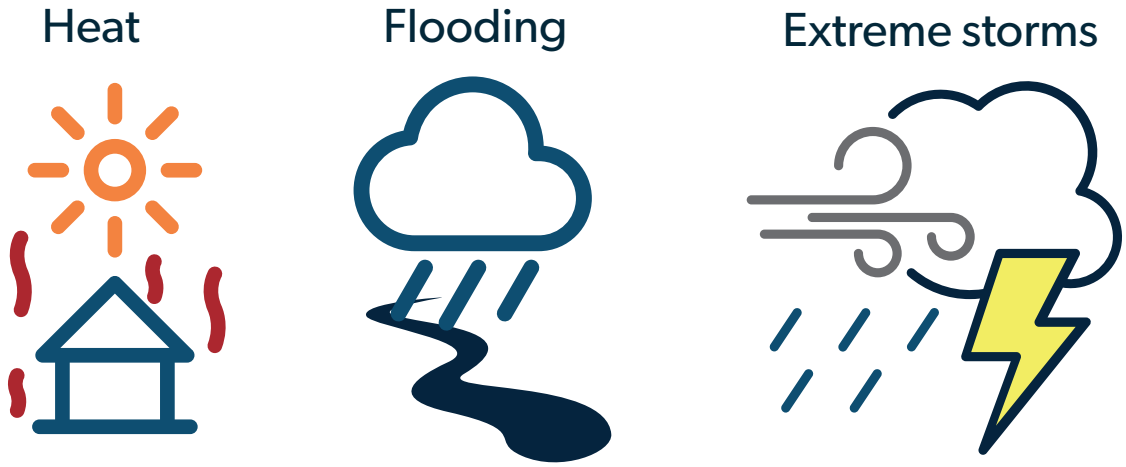

Figure 2. Climate hazards and impacts facing Whitby.

3. The Benefit of Action

Annualized damages from flood and heat in Whitby could increase sevenfold by 2070 to more than $700 million per year in the absence of action in a worst-case scenario.

Annualized damages from the evaluated climate hazards increase dramatically from $89.6 million in 2020 to $783 million in 2070—a 770% increase. The adaptation actions described in Table 1 reduce the annualized damages in 2070 to $65.8 million, representing a 27% decrease from 2020 levels and a 90% decrease over 2070 levels.

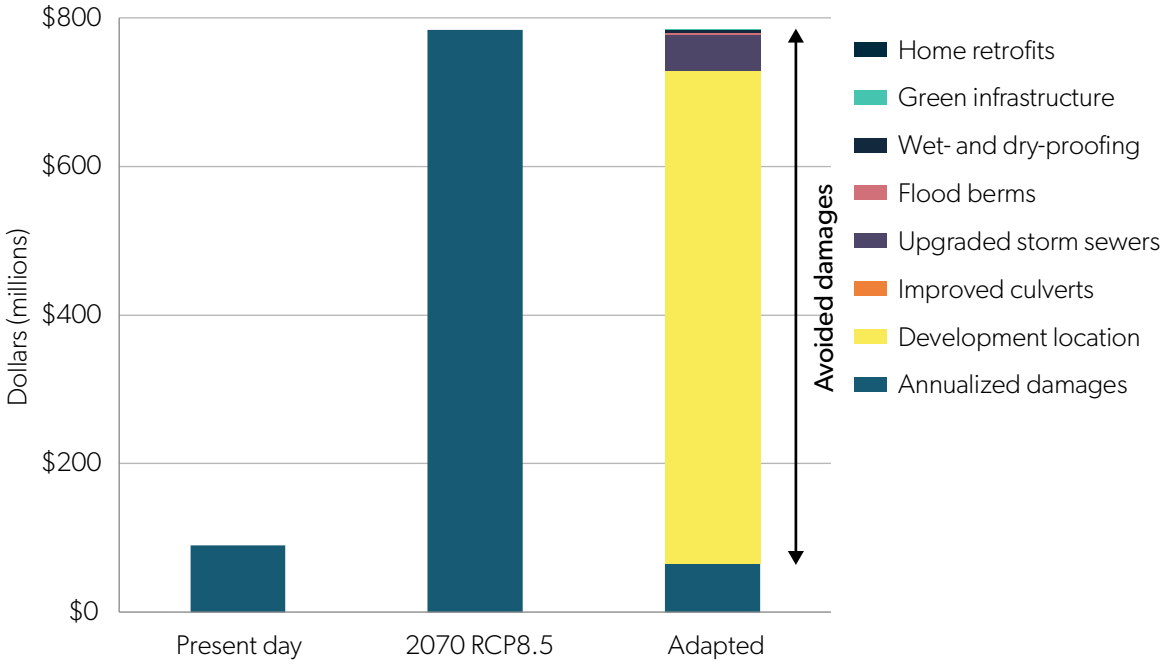

Figure 3. Impact of adaptation action on annual climate-related damages in 2070 in the three modelled scenarios.

The total capital costs and the project lifetime operations and maintenance costs show how much an action will cost to implement and maintain. The project lifetime avoided damages are shown for the current climate and the future climate scenarios. This allows us to understand the relative impact of climate change on the scale of damage, as well as the return on investment of the action without climate change (future projection of current conditions) and with climate change.[3]

In addition to reducing the damage from climate change, the actions result in other benefits. For example, the co-benefits from building retrofits are a result of energy efficiency improvements to the buildings, reducing the energy costs associated with space heating, space cooling, and other uses within buildings.

[3] The projection of climate change impacts uses a downscaled climate model called RCP8.5. The details of this projection are included in the technical report.

Table 1. The financial return from hazard mitigation investments (2020$, discounted at 3%[4]).

CLIMATE RISK	ACTION	HAZARD PREVENTION (CAPITAL COSTS)	HAZARD PREVENTION (LIFETIME OPERATIONS AND MAINTENANCE COSTS)	CUMULATIVE VALUE OF AVOIDED DAMAGES	ADDITIONAL FINANCIAL BENEFITS	CUMULATIVE NET FINANCIAL BENEFIT OF THE INVESTMENT
Coastal and Riverine Flooding	**A.** Restrict new development from future flood zones[5]	$0[6]	N/A	$17.03 billion	Not assessed	$17.03 billion
	B. Construct flood berms in West Lynde and along Pringle Creek	$7.7 million	$930,000	$77 million	Not assessed	$68 million
	C. Dry-proof and wet-proof buildings	$1.2 million	$0	$60 million	Not assessed	$59 million
Urban Flooding	**D.** Upgrade stormwater sewers for future climate conditions	$537 million	$0	$1.26 billion	Not assessed	$727 million
	E. Improve culverts for future climate conditions	$104 million	Not assessed	Not assessed	Not assessed	-$104 million
Urban Flooding/ Heat	**F.** Expand green infrastructure	$151 million	$34.0 million	$4 million	$605 million	$423 million
Heat	**G.** Undertake building retrofits with heat pumps	$419 million	$0	$0	$229 million	-$190 million

[4] 3% is the social discount rate recommended by the Treasury Board of Canada (Treasury Board of Canada Secretariat, Canadian Cost-Benefit Analysis Guide Regulatory Proposals, 2007, at 38).

[5] New development is shifted within a given traffic zone to parcels outside of the 100-year floodplain.

[6] This action is a regulatory change, so no capital costs are assigned.

3.1 The Importance of Land-Use Policy

Shifting development out of projected 2070 100-year floodplains can prevent over $17 billion in cumulative flood-related damages to the town.

The most impactful adaptation is shifting where new development occurs in Whitby. Over $17 billion in cumulative damages can be prevented by 2070 by shifting development out of projected 2070 100-year floodplains. Current development approvals are based on historical floodplains, not future climate-projected floodplains. A spatial review of traffic zones showed that current planned levels of development can occur within the planned traffic zone, but accurate floodplain mapping should inform which parcels are approved for development.

3.2 Climate-Ready Infrastructure

All actions, with the exception of improved culverts and building retrofits, show a positive return on investment in the millions of dollars for both current and future climate conditions. Culvert improvements are completed to reduce the risk of road flooding, improving residents' safety. The value of reducing road-related flooding on dwellings has not been quantified, so there is only a cost and no benefit for this action. Building retrofits will be assessed in more detail in Phase 2 of the Climate Change Master Plan, which will include a deeper evaluation of the energy efficiency and building improvements, including benefits such as improved health and safety of at-risk residents and their families.

3.3 Keeping People Safe

More than half of the people at risk from future climate threats are protected by the actions in this analysis.

Dollars of damage are not the only metric by which the value of adaptation should be measured. Figure 4 shows the changes in people at risk of climate hazards in the three modelled scenarios. People who are either partially or entirely protected from climate hazards are included in this calculation. Location of development is still the most important factor in protecting people from damage and risk, but improved culverts to control road flooding and home retrofits to provide space cooling are also important.

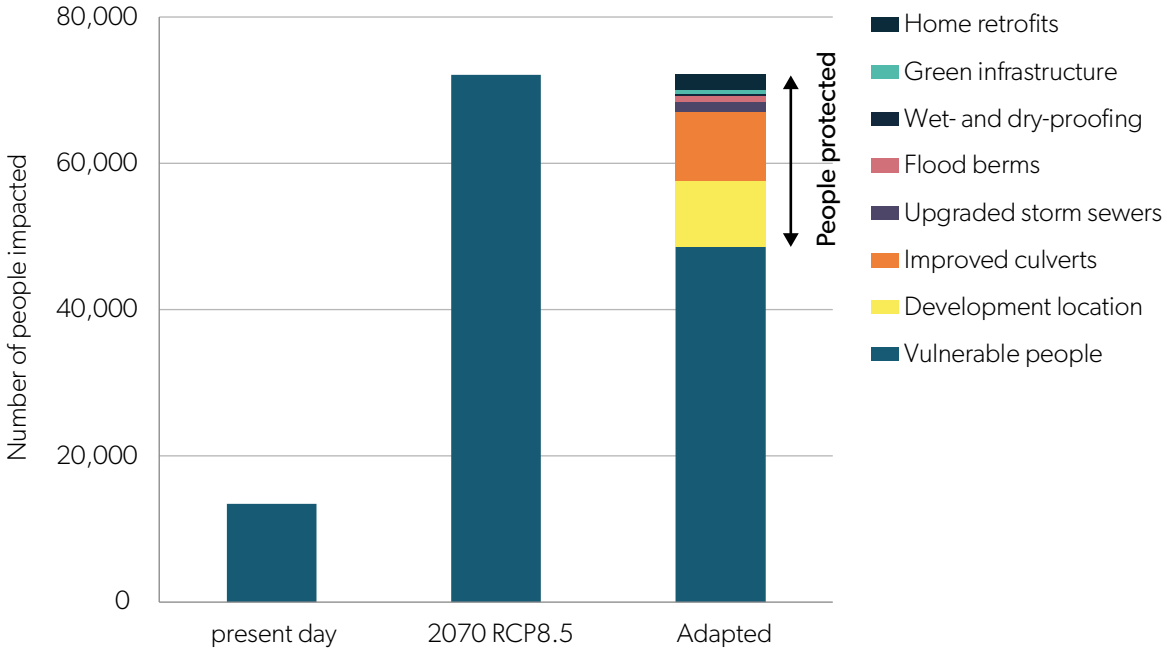

Figure 4. Number of people affected by climate change hazards in 2020 and in the 2070 unadapted scenario, and the number of people who are fully or partially protected from hazards from each adaptation scenario.

Table 2. The number of people protected by adaptation investments.

CLIMATE RISK	ACTION	TOTAL NUMBER OF PEOPLE WITH RISK PARTIALLY OR FULLY ELIMINATED	NUMBER OF VULNERABLE PEOPLE PARTIALLY OR FULLY PROTECTED
Coastal and Riverine Flooding	Restrict new development from flood zones	9,060	9,060
	Construct flood berms in West Lynde and along Pringle Creek	880	880
	Dry-proof and wet-proof buildings	200	200
Urban Flooding	Upgrade stormwater sewers	1,520	1,520
	Improve culverts	9,270	9,270
Urban Flooding/ Heat	Incorporate green infrastructure	31,360	540

CLIMATE RISK	ACTION	TOTAL NUMBER OF PEOPLE WITH RISK PARTIALLY OR FULLY ELIMINATED	NUMBER OF VULNERABLE PEOPLE PARTIALLY OR FULLY PROTECTED
Heat	Retrofit buildings with heat pumps	56,280	2,030

4. Future-Proofing Whitby

4.1 Implementation

The plan draws on insights from the technical analysis and engagement process to identify resources, partners, and funders that will enable implementation of the actions. The following table describes the implementation approach. The implementation plan will guide stakeholders and the Town of Whitby in their future work plans and budgeting. Timing of the implementation will be determined by the available budget and funding, human resources, and alignment with current projects and plans.

Table 3. Implementation plan.

1. GOVERNANCE AND LEADERSHIP	
1.1	Incorporate climate change adaptation and resilience into all decision-making and planning in current and future processes
1.2	Town promotes inclusive resilience with an equity lens
1.3	Ensure staff are protected against climate risks
1.4	Integrate future climate risks into emergency management planning
1.5	Develop and implement a community wide education campaign on climate risks, preparedness and recovery
1.6	Conduct community outreach immediately before and during periods of high risk
1.7	Monitor climate change predictions and update the Adaptation Plan

2. ADAPTED BUILDINGS AND BUILT INFRASTRUCTURE	
2.1	Ensure new construction and retrofits increase resilience
2.2	Retrofit buildings with heat pumps for at-risk people
2.3	Wet-proof and dry-proof homes for flooding reduction
2.4	Increase culvert capacity in high-risk areas
2.5	Upgrade storm sewers
2.6	Manage flood risk from new development using zoning policies
2.7	Plan for emergency response in overtopped areas
2.8	Integrate future climate risk into the Townwide Urban Flood Study
2.9	Enhance the redundancy of the energy system

3. NATURAL SPACES, GREEN INFRASTRUCTURE AND TREES	
3.1	Conserve, expand, and protect natural spaces and urban forest for flood risk reduction, cooling and improved human well-being
3.2	Apply green infrastructure for flood reduction and heat management
3.3	Monitor for invasive species on trees, natural heritage features and agricultural crops

4. HUMAN WELL-BEING	
4.1	Ensure a network of cooling centres, splash parks and drinking fountains
4.2	Develop shaded structures for public protection
4.3	Promote urban agriculture

5. Conclusion

Impacts from the changing climate are evident around the world today, with highly disruptive and often tragic results, and wilder storms, less predictable weather, and hotter temperatures will increase these impacts. While climate change represents an existential risk, this analysis highlights actions that can be taken by the Town of Whitby to enhance the safety of its community.

The most significant change the Town of Whitby can make is to ensure that no new development is allowed in current or future floodplains. A deeper understanding of hydraulic flows, in both constrained and unconstrained flow regimes, will be essential for ensuring the safety of Whitby's growing population.

Heatwaves, and especially hot nights, lead to illness and death in at-risk people. Actions in this study focus on reducing the risk of exposure to prolonged extreme heat for those who are at risk because of health (aged 0-4 and aged 65+ years) and because of a lower household income. Retrofitting buildings for at-risk people within the community will ensure their safety and comfort during prolonged heat waves and will reduce energy consumption in these homes. Additionally, clearly communicating with the public about the facilities available for cooling off during these events will allow others to manage this hazard safely.

In the Plan, actions are taken to reduce basement flooding in homes and to reduce the number of roads that are unintentionally overtopped in storm events. This will help protect people, building contents, and structures and allow for travel and movement throughout Whitby in emergencies.

Finally, clear and open communication with the public about the ways to prepare for climate emergencies, as well as the services available in major climate events, will ensure as many people as possible are prepared and resilient in the face of these inevitable and serious events.

By working together with the community and the many knowledgeable and connected organizations within Whitby, the Town of Whitby can ensure that decisions today will serve and protect the community now and into the future.