Appendix I: Transport Investment in the *National Development Plan*

The *National Development Plan* (NDP) sets out national investment priorities for the transport sector to 2027.

I.1: Rail and Buses

National Strategic Outcome 4: **Sustainable Mobility**

National Strategic Outcome 6: **High-Quality International Connectivity**

National Strategic Outcome 8: **Transition to a Low-Carbon and Climate-Resilient Society**

- Investment in train and bus fleets and infrastructure to maintain safety and service standards, including expansion where necessary
- Rail and bus station development including traffic management investment, passenger information programmes, public bicycle share schemes, accessibility enhancements etc.
- Investment in high-speed rail links between Dublin, Belfast and Cork
- North-West Multi-modal Mobility Hub
- *C.* €3 billion investment in Metro Link (Dublin) from Swords via Dublin Airport and Luas Green Line to Charlemont
- *C.* €2 billion investment in the DART Expansion Programme including electrification of services to Drogheda, Celbridge/Hazelhatch, Maynooth and M3 Parkway, hybrid-electric fleet expansion and new interchange stations with bus, LUAS and Metro networks
- Park-and-Ride Programme serving Irish Rail, Luas and bus stations
- Complete construction of the National Train Control Centre
- *C.* 2.5 billion investment in BusConnects Programme for Dublin; Cork; and Galway, including:
    - Redesign of the bus network
    - Bus corridors including segregated cycling facilities
    - New bus stops and shelters
- Transition to low-emission buses in the public urban fleets

Figure I.1: Proposed public transport network in the GDA in 2027 under the NDP. Source: Government of Ireland, 2018.

II.2: Roads

National Strategic Outcome 2: Enhanced Regional Accessibility

National Strategic Outcome 4: Sustainable Mobility

National Strategic Outcome 6: High-Quality International Connectivity

National Strategic Outcome 8: Transition to a Low-Carbon and Climate-Resilient Society

- Investment to support the ambition for development of the border region, including:
  - N2/A5 Road serving Meath, Monaghan and Donegal
  - N14 Manorcunningham to Lifford
  - N52 Ardee Bypass
  - N2 Slane Bypass
  - N4 Collooney to Castlebaldwin
  - N5 Westport to Turlough and Ballaghadereen to Scramogue
  - N56 Dungloe to Glenties and Mountcharles to Inver
  - Support for the Narrow Water Bridge project in Co. Louth
- Investment in road projects including:
  - Sallins Bypass
  - Adamstown and Nangor Road Improvements
  - Portlaoise Southern Distributor Road
  - Shannon Crossing
  - Laytown to Bettystown Link Road
  - Garavogue Bridge Scheme
  - Dingle Relief Road
  - Athy Southern Distributor Road
  - Sligo Western Distributor Road
  - Coonagh to Knockalisheen Main Contract
  - Realignment of R498 Nenagh/Thurles Road at Latteragh
  - Killaloe Bypass/R494 Upgrade
  - Carrigaline Western Distributor Road
- Planned progression of regional and local road projects including:
  - R157 Maynooth Road, Dunboyne (safety upgrade)
  - R162 Navan to Kingscourt Road (safety upgrade)
  - Thurles Relief Road
  - Carlow Southern Relief Road
  - Tralee Northern Relief Road
- Ongoing investment in port access routes including:
  - M11 development
  - Planned N28 Cork to Ringaskiddy
  - N21/N69 Limerick to Adare to Foynes Road
  - Carlow Southern Relief Road
  - Tralee Northern Relief Road
- Additional electric charging infrastructure for targeted growth in electric vehicles
- Comprehensive urban cycling and walking network for metropolitan areas, including 200km of cycle lanes under *BusConnects*
- Expanded Greenways, including North-West Greenways, Carlingford Lough Greenway and Ulster Canal Greenway.

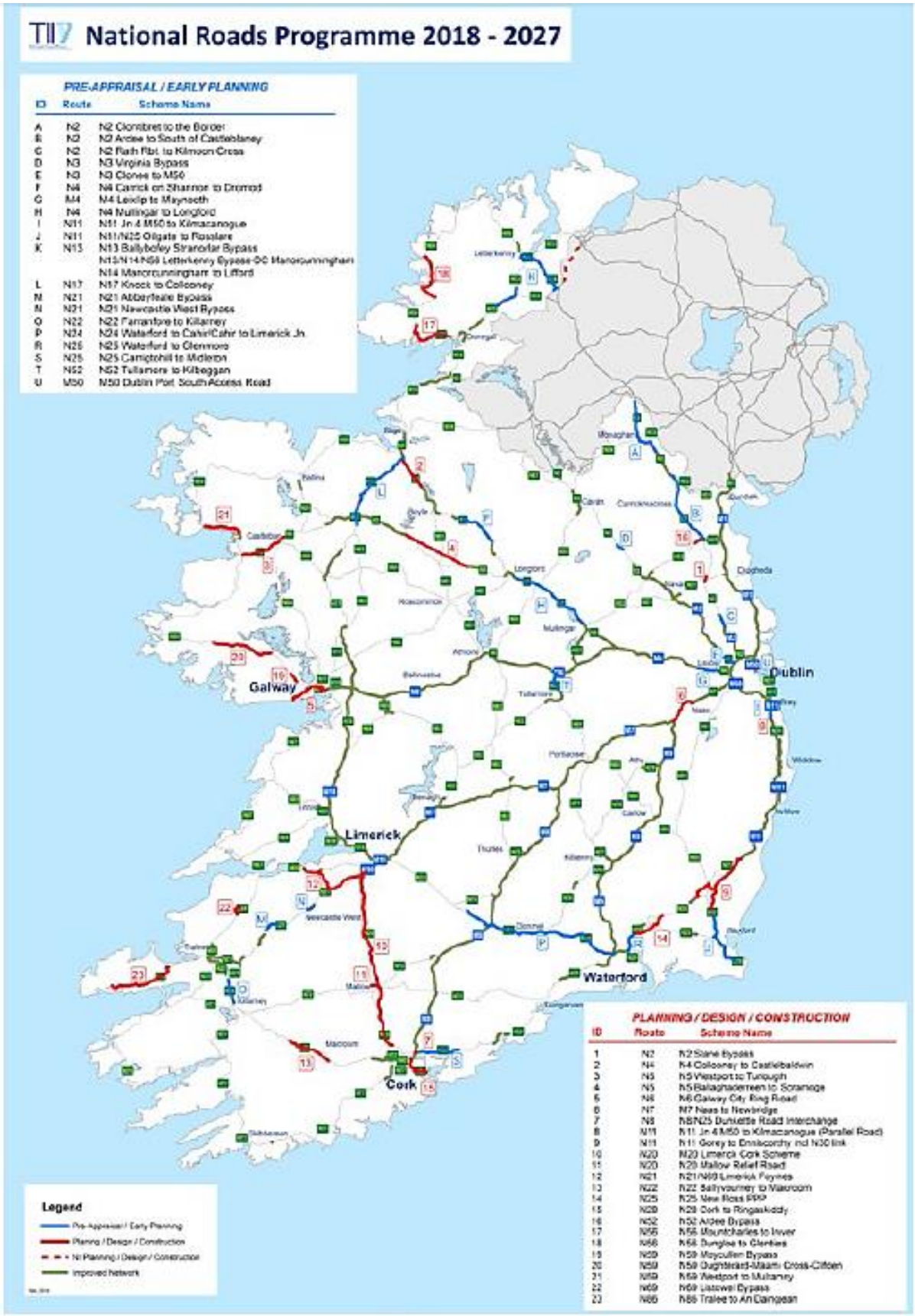

Figure II.2: National roads investment programme 2018-2027 under the *NDP*. Source: TII.

II.3: Airports and Ports

Where planned investment does not include Exchequer funding, the relevant parties are noted in parentheses.

National Strategic Outcome 2: **Enhanced Regional Accessibility**

National Strategic Outcome 6: **High-Quality International Connectivity**

- Second Parallel Runway for Dublin Airport (DAA)
- New Visual Control Tower at Dublin Airport (IAA)
- National Aviation Policy which provides support for Cork and Shannon Airports to develop as regional tourism and business gateways
- Regional Airports Programme which provides financial support towards safety and security projects at the smaller regional airports, including Ireland West Airport Knock, Waterford, Donegal and Kerry Airports
- *C.* €230 million infrastructural investment at Dublin Port to accommodate larger sea-going vessels; and increase capacity (Dublin Port Company)
- *C.* €90 million redevelopment of existing port facilities at Ringaskiddy to accommodate larger sea-going vessels and increase capacity (Port of Cork)
- €27 million towards capacity extension works at Shannon Foynes Port (Shannon Foynes Port Company)

Appendix II: Climate Impact Chains

Transport Subsector	Climate Impact	Observed Risks	Projected Risks	Consequences
Bus	Increased Precipitation	• Disruption; overcrowding; heavy traffic; service delays etc. • Heavy rain can cause flash flooding of depot buildings	• Disruption; overcrowding; heavy traffic; service delays etc. • Increased risk of flash flooding • Damage to bus depots • Damage to buses caused by driving on flooded roads	• Impact on economy and education sectors if people cannot travel to work or school • Health & safety of passengers - overcrowding, dangerous to embark/disembark vehicles during snow etc. • Cancellation of services can leave passengers stranded • Economic impact of repairing damaged vehicles/buildings following fallen trees/debris/flooding • Increased risk of traffic/road accidents in extreme weather such as snow
	Storms/High Wind/Storm Surges	• Diversion, curtailment or cancellation of routes	• Fallen trees and debris can cause disruption to services	
	Heat Waves	• Passengers overheating on buses	• Issues with air quality • Increased passenger overheating	
	Cold Spells	• Passengers discomfort	• Heavy snow and ice can cause delays to buses leaving depots • Increased risk of passengers falling due to snow/ice • Inability of staff to travel to work • Risk of black ice/poor road conditions require a reduction in vehicle speeds, which increases journey time	
	Sea Level Rise		• Disruption of services due to coastal flooding	

Transport Subsector	Climate Impact	Observed Risks	Projected Risks	Consequences
Road	Increased Precipitation	• Heavy rain and subsequent flooding can cause damage to pavements, roads and underpasses; can strain or overwhelm drainage systems; can increase the risk of landslides	• Increased damage to paving and roads	• Increased danger to motorists due to damage to roads • Higher risk of accident caused by debris on roads during storms • Economic cost of necessary repairs to roads following extreme weather events • Negative economic impact of restricted movement of passengers and goods • Blocked roads can cause disruption to motorists, passengers, public transport and importantly emergency service vehicles
	Storms/High Wind/Storm Surges	• Storm surges caused by high tides can lead to prolonged flooding, particularly on the west coast of Ireland. This can disintegrate road surfaces. • Fallen trees and vegetation due to high winds can block roads	• Increased coastal flood risk of roads	
	Heat Waves	• Higher possibility of melting tarmac and degradation of road surfaces	• Asphalt road surfaces can degrade quicker in heat	
	Cold Spells	• Road degradation due to the freeze-thaw effect	• Freeze-thaw cycle during extremely low temperatures may cause damage to roads and asphalt surfaces	
	Sea Level Rise		• Flooding and erosion along coastal routes may cause damage to pavements and roads	

Transport Subsector	Climate Impact	Observed Risks	Projected Risks	Consequences
Active Travel	Increased Precipitation	• Roads blocked for cyclists and pedestrians due to flooding	• Roads blocked for cyclists and pedestrians due to flooding	• Extreme weather events mean that less people are likely to expose themselves to the elements through active travel • Subsequent overcrowding on public transport or increased car traffic on the roads can cause delays for people going to work, school or important appointments • Increased risk to health & safety of those who continue to use active travel during the various climate impacts e.g. dehydration, hypothermia, falls, falling debris • Effect on active tourism; bad weather can discourage tourists who would engage in outdoor pursuits or active travel from travelling to Ireland • Less active travel due to extreme weather could lead to higher use of private cars which has a detrimental effect on transport emission levels
	Storms/High Wind/Storm Surges	• Risk to cyclists and pedestrians due to falling trees or debris • Coastal walking runs the risk of pedestrians being swept off land by high tides and storm surges	• Risk to cyclists and pedestrians due to falling trees or debris • Coastal walking runs the risk of pedestrians being swept off land by high tides and storm surges	
	Heat Waves		• Risk of dehydration and sunburn to cyclists and pedestrians if the correct precautions are not taken • Air quality for active travellers worsened in hot temperatures	
	Cold Spells	• Increased risk of falls due to slippery walking or cycling surfaces	• Risk of hypothermia to cyclists and pedestrians if the correct precautions are not taken • Increased risk of falls due to slippery walking or cycling surfaces	
	Sea Level Rise		• Integrity of coastal roads may become compromised due to erosion caused by sea level rise, which could cause harm to walkers or cyclists	

Transport Subsector	Climate Impact	Observed Risks	Projected Risks	Consequences
Heavy Rail	Increased Precipitation	• Increase in landslides due to a reduction in slope stability • Drainage systems overwhelmed • Service cancellations due to line closures • Passengers unable to undertake their journeys • Bridge scour damage • Flooded depots	• Disruption; overcrowding; service delays etc. • Increased risk of flash flooding • Increased risk of scour damage at bridges	• Impact on economy and education sectors if people cannot travel to work or school • Health & safety of passengers - overcrowding, dangerous to embark/disembark vehicles during snow etc. • Cancellation of or delays to services can leave passengers stranded • Economic impact of repairing damaged trains/depots/tracks or other equipment following fallen trees/debris/flooding
	Storms/High Wind/Storm Surges	• Damage to automatic level crossing barriers • Damage to signalling, power equipment and tracks due to falling trees, debris etc. • Trees and leaves on railway lines requires slower average speeds • Structural damage to stations following storms	• Disruption, overcrowding, service delays etc.	
	Heat Waves	• Increase risk of rail buckling and misalignment of tracks which would increase the need for network-wide speed restrictions • Overheating of equipment could affect performance	• Disruption; overcrowding; delays etc.	
	Cold Spells	• Overhead electrification systems failing to	• Disruption; overcrowding; service	

		operate • Decreased braking performance of trains • Potential passenger falls on icy walking surfaces such as platforms, stations entrances and exits, pavements and roads • Increased risk of damage to tracks and overhead catenary system due to extreme cold weather	delays etc.	
	Sea Level Rise	• Flooding and erosion can result in damage to or loss of coastal rail infrastructure • Track damage • Need for increased railway flood defences	• Increased risk of damage to tracks	

Transport Subsector	Climate Impact	Observed Risks	Projected Risks	Consequences
Light Rail	Increased Precipitation	• Disruption; overcrowding; service delays etc. • Closure of depot due to flooding	• Disruption; overcrowding; service delays etc. • Increase in flash flooding risk, particular for low-lying junctions and substations	• Impact on economy and education sectors if people cannot travel to work or school • Health & safety of passengers - overcrowding, dangerous

	Storms/High Wind/Storm Surges	• Danger from overhead contact wires in high winds • Necessary speed restrictions due to high winds		to embark/disembark vehicles during snow etc. • Cancellation of or delays to services can leave passengers stranded • Economic impact of repairing damaged trains/depots/tracks or overhead wires following fallen trees/debris/flooding
	Heat Waves	• Increase risk of rail buckling/misalignment of track which would increase the need for network-wide speed restrictions • Overheating of equipment could affect performance		
	Cold Spells	• Overhead electrification systems can fail in extreme cold • Decreased braking performance of trains • Increased risk of passenger falls on icy surfaces such as platforms, station entrances and exits, pavements and roads • Ice and snow damage to overhead catenary systems and rail joints		
	Sea Level Rise			

Transport Subsector	Climate Impact	Observed Risks	Projected Risks	Consequences
Aviation	Increased Precipitation	• Pressure on airport run-off and drainage systems • Runway drainage systems overwhelmed • Pressure on flood defences, particular in Shannon Airport • Potential damage to Shannon Airport due to proximity to river	• Challenges to storm-water management • Danger of flooding from River Shannon • Emergency planning requirements for staff/passengers from flooded areas	• High volume of international and domestic passenger disruption during airport closures • Increased risks to health & safety during landing and take-off in stormy conditions • Impact on economy when business travellers are disrupted, and tourism when leisure passengers are disrupted • Economic cost of damage to aircraft, airport buildings and related infrastructure • Health and safety of passengers in warm weather if air conditioning/water not available or operational on aircraft
	Storms/High Wind/Storm Surges	• Damage to aircraft and airport buildings from high winds	• Increased safety risks during landing and take-off • Damage to airport buildings and related facilities including flood defences • Risks to aircraft on the ground • Disruption of services	
	Heat Waves		• Potential issues with aircraft climb • Increased need for air-conditioning on aircraft and in airport buildings	
	Cold Spells	• Operation disruption	• Quicker degradation of runways/tarmac from freezing temperatures • Issues for aircraft landing on damaged surfaces	
	Sea Level Rise	• Pressure on flood defences, particularly at Shannon Airport	• Operation disruption	

Transport Subsector	Climate Impact	Observed Risks	Projected Risks	Consequences
Maritime	Increased Precipitation	• Decreased ability of radar during heavy precipitation	• Challenges to storm-water management • Risk of pollution if drainage services are overwhelmed • Risk of flooding for storage facilities • Positive or negative impacts on dredging requirements depending on the location • Gradual impact on natural scouring capability of estuarial ports	• Impact on freight if services are cancelled • Economic impact of damage to vessels, buildings and other port infrastructure • Impact on tourism if ferry sailings are delayed or cancelled • Health and safety of passengers, port workers and vessels operators during extreme weather
	Storms/High Wind/Storm Surges	• Damage to port infrastructure and vessels in ports • Ability of equipment to discharge at high water can be compromised	• Damage to port infrastructure, vessels in port, navigational aid and safety equipment • Risk to safety of passengers while in transit/embarking/ disembarking	
	Heat Waves		• Extreme heat can cause degradation to road surfaces and felt type roofing products • High temperatures may cause glass boxes on cranes to become too hot to work in • Drought may impact on natural scouring leading to increased siltation	
	Cold Spells		• Increased damage to roads, walls, paving, water pipes and storage tanks • Possibility that operational fuel may freeze in extremely low	

			temperatures	
	Sea Level Rise		• Impact on capabilities of existing infrastructure and equipment i.e. ability to discharge at the top of high water	

Appendix III: Summary of measures outlined in *Developing Resilience to Climate Change in the Irish Transport Sector* (2017)

Table III.1: Summary of measures outlined in *Developing Resilience to Climate Change in the Irish Transport Sector* (2017). A traffic light system was employed to illustrate the progress achieved in relation to each measure outlined; whereby the green colour indicates that the measure has been completed; orange indicates that progress towards implementation remains ongoing; and red indicates that progress towards implementation has not been commenced.

Objective	Action		Indicator	Implemented
Policy Integration	1	Publish this Adaptation Plan under the provisions of the *National Climate Change Adaptation Framework 2012*	Recognition within sectoral work programmes (mainstreaming)	
	2	Participate and engage with the cross-sectoral Adaptation Governance group	Co-operation with other sectors/sub-national levels	
	3	Continue to engage with the Climate Change Advisory Council and consider their findings and recommendations in relation to adaptation	Co-operation with other sectors/sub-national levels	
	4	Participate in National Dialogue on Climate Change	Co-operation with other sectors/sub-national levels	
	5	Contribute to the development of sectoral adaptation planning guidelines by the EPA	Co-operation with other sectors/sub-national levels	
	6	Consider potential opportunities and costs for adaptation mechanisms in the development of the national strategy on Intelligent Transport Systems (ITS)	Recognition within sectoral work programmes (mainstreaming)	
	7	TII to publish *Strategy for Adapting to Climate Change on Irelands' Light Rails and National Roads Network*	Recognition within sectoral work programmes (mainstreaming)	
	8	Support the RSA educational policy for freight drivers in extreme conditions.	Recognition within sectoral work programmes (mainstreaming)	
	9	Ensure that climate change is mainstreamed in general policy and strategic objectives to 2050	Recognition within sectoral work programmes (mainstreaming)	
	10	Ensure climate considerations are fully addressed in the *NPF*	Recognition within sectoral work programmes (mainstreaming)	
	11	Support actions highlighted in the sectoral contribution to the *NMP* which carry co-benefits for adaptation	Recognition within sectoral work programmes (mainstreaming)	

	12	Examine the potential for incorporating climate adaptation awareness in the general driver theory testing process	Recognition within sectoral work programmes (mainstreaming)	

Objective	Action		Indicator	Implemented
Research & Collaboration	13	Support collaborative and sector specific research among its stakeholders by engaging expert speakers, disseminating information on new technologies etc.	Level of adaptation research; Co-operation with other sectors/sub-national levels	
	14	Through the cross-sectoral adaptation governance group, assist in the further development of *Climate Ireland*	Level of adaptation research; Co-operation with other sectors/sub-national levels	
	15	Continue to keep informed of developments in other EU countries	Level of adaptation research	
	16	Identify likely vulnerabilities for the transport network through inter-alia, continued participation in the CIVIC steering group	Level of adaptation research	
	17	Support the proposed establishment of regional offices to coordinate the local authority response to climate action	Co-operation with other sectors/sub-national levels	
	18	Support the use by Local Government of the forthcoming *Local Authority Adaptation Support Wizard* in the development of coordinated local and regional-level adaptation strategy	Co-operation with other sectors/sub-national levels	

Objective	Action		Indicator	Implemented
Investment & Development	19	Through the Adaptation Steering group investigate potential EU funding sources to advance adaptation projects	Co-operation with other sectors/sub-national levels	
	20	Future requests for funding for repair of infrastructure will also need to identify the cost of installing preventative measures	Recognition within sectoral work programmes (mainstreaming)	

Objective	Action		Indicator	Implemented
Risk Assessment	21	Establish a data collection system, in tandem with stakeholders, for periodically collating information in relation to climate incident impacts on transport stakeholders	Baseline monitoring	
	22	TII to complete a detailed flood risk assessment of the national road and light rail network	Baseline monitoring	
	23	TII to implement and further develop a flood protocol to manage flood events and remediate identified vulnerable sections	Launch of adaptation measures/level of spending collected; Baseline monitoring	
	24	Iarnród Éireann to develop a Coastal Vulnerability Index (CVI) model to pinpoint areas of extreme vulnerability	Baseline monitoring	
	25	Dublin Port to build higher quay walls and raise hinterlands to future-proof against long-term SLR as part of the Alexandra Basin Redevelopment project	Launch of adaptation measures/level of spending collected	
	26	Consider appropriate mechanisms to identify vulnerable areas and critical transport assets as part of a detailed risk assessment across the entire transport system; vis-à-vis CIViC and C-Risk projects	Level of adaptation research; Co-operation with other sectors/sub-national levels; Baseline monitoring	

Appendix IV: Acronyms and Abbreviations

AA	Appropriate Assessment
CAP	*Climate Action Plan* (2019)
CARO	Climate Action Regional Offices
CCAC	Climate Change Advisory Council
CCMA	County and City Management Association
CIÉ	Córas Iompair Éireann
CIViC	*Critical Infrastructure Vulnerability to Climate Change* (EPA Research Report)
COP21	2015 United Nations Climate Change Conference
CNG	Compressed Natural Gas
CoCo	County Council
CSO	Central Statistics Office
CVI	Coastal Vulnerability Index
DAA	Dublin Airport Authority
DAFM	Department of Agriculture, Forestry and the Marine
DART	Dublin Area Rapid Transit
DCCAE	Department of Communications, Climate Action and the Environment
DECLG	Department of Environment, Community and Local Government (defunct)
DHPLG	Department of Housing, Planning and Local Government
DTTAS	Department of Transport, Tourism and Sport
EEA	European Environment Agency
EC	European Commission
EPA	Environmental Protection Agency
ESB	Electricity Supply Board
EU	European Union
FDI	Foreign Direct Investment
GDA	Greater Dublin Area
GHG	Greenhouse Gas
GNI	Gas Networks Ireland
GSI	Geological Survey Ireland

hPa	Hectopascals
IAA	Irish Aviation Authority
ICHEC	Irish Centre for High-End Computing
ICT	Information and Communications Technology
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
ITS	Intelligent Transport Systems
JOC	Joint Oireachtas Committee
KM	Kilometres
LAs	Local Authorities
LNG	Liquefied Natural Gas
MCCAE	Minister for Communications, Climate Action and the Environment
MSLP	Mean Sea Level Pressure
MTTAS	Minister for Transport, Tourism and Sport
NAF	*National Adaptation Framework* (2018)
NCCAF	*National Climate Change Adaptation Framework* (2012)
NDP	*Project Ireland 2040: National Development Plan* (2018)
NECG `	National Emergency Coordination Group
NECP	*National Energy and Climate Plan*
NI	Northern Ireland
NPF	*Project Ireland 2040: National Planning Framework* (2018)
NTA	National Transport Authority
OPW	Office of Public Works
PLUTO	*Planning Land Use and Transport Outlook* (forthcoming)
PSO	Public Service Obligation
PT	Public Transport
RCM	Regional Climate Model
RCP	Representative Concentration Pathway
RH	Relative Humidity
SAA	Shannon Airport Authority
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment

SDG	(United Nations) Sustainable Development Goals
SLR	Sea Level Rise
SPSV	Small Public Service Vehicle
TEN-T	Trans-European Transport Networks
TfI	Transport for Ireland
TII	Transport Infrastructure Ireland
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change