



# LOWER LEE (CORK CITY) DRAINAGE SCHEME

## ENVIRONMENTAL IMPACT STATEMENT

- VOLUME 1 -

NON-TECHNICAL SUMMARY

& MAIN REPORT

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Prepared By:

**RYAN HANLEY**

In Association With:



## NON-TECHNICAL SUMMARY

### 1. INTRODUCTION

This Environmental Impact Statement (EIS) has been prepared by Ryan Hanley in association with McCarthy Keville O'Sullivan Ltd. on behalf of the Office of Public Works (OPW). The Office of Public Works (OPW) is the lead agency for flood risk management in Ireland. The coordination and implementation of the Government's policy on the management of flood risk in Ireland, in conjunction with its responsibilities under the Arterial Drainage Acts, 1945-1995, form one of the four core services of the OPW.

The scheme will be designed to provide protection to properties in the study area from the 1 in 100 year fluvial / 1 in 200 year tidal flood events. It has been developed in close co-operation with all key stakeholders, in particular; Cork City Council, Cork County Council and the ESB.

The following are the key constituent parts of the proposed Scheme:

- Site Investigations.
- A new Fluvial Flood Forecasting system based on both predictive and real time rainfall, and real time river flows and reservoir level data, to be utilised in combination with the existing harbour tidal flood forecasting system.
- A new flood warning system to effectively disseminate warnings and information to landowners and river users during major flood events.
- Designation of floodplains (washlands) upstream of Cork City. This along with the Flood Forecasting system will facilitate the use of revised dam operation procedures resulting in a more aggressive lowering of reservoir levels in advance of a predicted flood event to maximise available reservoir storage and thus provide increased attenuation to reduce the peak flow during major flood events.
- Direct defences (walls and embankments) from downstream of Innishcarra Dam through to Cork Harbour to defend against the design flood event.
- Flow Control chamber at the upstream end of the South Channel to divert a greater proportion of flood flow along the higher capacity North Channel, thus minimising the extent of required direct defences on the Curragheen River and western end of the South Channel
- Demountable flood gates (tidal) at a limited number of key bridges and critical locations within the eastern part of Cork City.
- Re-grading of ground and road ramping at a number of locations.
- Associated groundwater cut off walls and back-of-defence drainage infrastructure to intercept and manage groundwater seepage.
- Bridge replacement.
- Associated drainage infrastructure (including non-return valves on drainage outlets) and pumping stations to manage surface water/groundwater at back of defences.
- Associated services/utility diversions.

A constraints study was carried out as part of this project. The Study Area at this constraints study stage was described as 'the channel, floodplain and immediate surrounding areas of the River Lee from the Innishcarra Dam extending along the main channel of the river' to Cork City. The River Bride (Blackpool)

Certified Drainage Scheme was pursued as a separate project to the Lower Lee (Cork City) Drainage Scheme, and so was subject to a separate EIS displayed in December 2015. For most studies conducted as part of this EIS, the Study Area was limited to the channel and immediate surrounding areas of the River Lee extending from downstream of Inniscarra Dam, downstream through Cork City, to downstream of the confluence of the north and south channels of the River Lee at Horgans Quay. This overall study area is shown on Figure 1.1. The Study Area for each aspect of the receiving environment is defined in each chapter of the EIS in order to clarify the extent of the area assessed for impacts relating to the proposed works.

### 3. BACKGROUND

The overall study area, which covers the River Lee between Kennedy Quay in Cork City and Innishcarra Dam extends across both Cork City and County. The site of the proposed flood relief works is located within both the environs of Cork City and within the townlands of Curraghbeg, Garravagh, Coolroe, Great Island, Coolyduff, Lackenshoneen, Coolymurragh, Carrigrohane, Inchigaggin and Mount Desert, County Cork. Where the 'site' is referred to in this Environmental Impact Statement (EIS), this refers to the Study Area for the assessments undertaken in order to prepare the EIS. The proposed development site is accessed via several routes along the length of the works. Various local roads provide most of the direct site access, while the N22 national road runs in a general east-west direction near the site. In addition, the R618 regional road runs alongside the eastern side of the study area.

There is a long history of flooding in Cork City and the River Lee valley. A number of severe floods have affected the city in the past. Since construction of the two dams at Innishcarra and Carrigadrohid in the 1950's, fluvial flooding in Cork has generally been less severe although there has been frequent flooding of land, roads and small numbers of properties. The flood event of November 2009 was an exception, with major damage caused to commercial and residential buildings in Cork City.

Tidal flooding in the east of Cork City centre is more frequent, with some flooding of the lowest lying parts occurring at least every other year with more significant tidal flooding occurring on average every ten years. Notable recent tidal floods occurred in 1994, 2004 and 2014. Appendix 2A shows the extent of flooding in the area surrounding the proposed works.

The risk of flooding may increase with time. Future changes, which have the potential to affect the risk of flooding include:

- Climate change resulting in higher rainfall;
- Geomorphological processes, such as (i) Sedimentation transport, which affects the area of conveyance of the river channel and (ii) Erosion;
- Development within the catchment of the River Lee, which does not conform with the principles of Sustainable Drainage, and which adversely affect the response of the catchment to rainfall;
- Changes in land use, including forestation and land drainage.

The design process comprises a number of steps involving co-ordination of project engineering and environmental teams. The following steps have been completed in the design and assessment process:

- Constraints Study
- Hydrology Study
- Hydraulic Modelling
- Preliminary Site Investigation
- Flood Risk Assessments
- Selection of Preferred Option
- Appropriate Assessment Screening
- Cost Benefit Analyses

**Environmental Impact Assessment** The possible flood risk management (FRM) methods were initially screened to identify those that would be applicable and viable considering the risks to society, the environment, cultural heritage and the economy and the objectives of the flood risk management plan for the project. The potentially viable options were developed so that they could be evaluated in more detail. This involved hydraulic modelling of options where flood levels and extents had to be considered. The options were assessed against the flood risk management objectives with the use of local weightings. The preferred option (Option 1: Flow reduction of South Chanel and direct defences) was then identified following discussion with the OPW and steering group. There are a number of prerequisite measures that must be implemented for this, including Optimised Dam Operating Procedures, Flood Forecasting and Early Warning System, and designation of Upland Storage (Washlands). In Area 1, west of the Waterworks Weir, only one measure - direct defences - is considered for this Option. This differentiator in this option is the inclusion of a flow control structure proposed to be located on the South Channel of the River Lee, downstream of the Salmon Weir. The proposed structure will be closed when the River Lee is in flood to prevent (or reduce) flow entering the South Channel and divert a greater proportion of the flow to the North Channel which has greater capacity.

### **3. DESCRIPTION OF THE SCHEME**

The Proposed Scheme for the Lower Lee (Cork City) Drainage Scheme comprises of a combination of flood walls, embankments, regrading of road and pavement sections, bridge construction, flow control measures and pen stock construction, culverting, and other minor works. The Scheme will be designed to cater for the 1% Annual Exceedance Probability (AEP) fluvial flood event (also known as the 100-year fluvial flood event) and the 0.5% AEP tidal flood event (also known as the 1 in 200-year tidal flood event).

#### **3.1 Proposed works**

The key features for the Lower Lee (Cork City) Drainage Scheme will comprise the following:

- Site Investigations.
- A new Fluvial Flood Forecasting system based on both predictive and real time rainfall, and real time river flows and reservoir level data, to be utilised in combination with the existing harbour tidal flood forecasting system.
- A new flood warning system to effectively disseminate warnings and information to landowners and river users during major flood events.

- Designation of floodplains (washlands) upstream of Cork City. This along with the Flood Forecasting system will facilitate the use of revised dam operation procedures resulting in a more aggressive lowering of reservoir levels in advance of a predicted flood event to maximise available reservoir storage and thus provide increased attenuation to reduce the peak flow during major flood events.
- Direct defences (walls and embankments) from downstream of Inniscarra Dam through to Cork Harbour to defend against the design flood event.
- Flow Control chamber at the upstream end of the South Channel to divert a greater proportion of flood flow along the higher capacity North Channel, thus minimising the extent of required direct defences on the Curragheen River and western end of the South Channel
- Demountable flood gates (tidal) at a limited number of key bridges and critical locations within the eastern part of Cork City.
- Re-grading of ground and road ramping at a number of locations.
- Associated groundwater cut off walls and back-of-defence drainage infrastructure to intercept and manage groundwater seepage.
- Bridge replacement.
- Associated drainage infrastructure (including non-return valves on drainage outlets) and pumping stations to manage surface water/groundwater at back of defences.
- Associated services/utility diversions.

### 3.2 Site Investigation

Targeted detailed site investigation may be required in advance of the construction works to inform the detailed design of the scheme. Trial pits, slit trenches, boreholes, rotary core boreholes and dynamic probes will be carried out in addition to utility identification.

### 3.3 Flood Forecasting and Warning System

The flood forecasting and early warning system provide advance warning of rainfall/storm events which have the potential to cause significant flooding and thus to allow pre-emptive lowering of levels in Carrigadrohid and Innishcarra Reservoirs to maximise available storage ahead of and during major flood events. A tidal flood forecasting system is already in place for Cork city and provides forecasts of extreme sea levels within Cork Harbour. This forecast will be incorporated into the overall forecasting system for the Lower Lee (Cork City) Drainage Scheme.

The new Fluvial Flood Forecasting system has been developed based on both predictive and real time rainfall, and real time river flows and reservoir level data. The system will use rainfall predictions provided by Met Éireann and/or the European Centre for Medium-Range Weather Forecasts (ECMRF) in the lead up to a flood event as well as real time data from rain gauges in the upper catchment during the event.

The Flood Warning System will be utilised for a number of purposes:

- Warning of increased advance discharges for recreational users of river and floodplain amenities downstream of Innishcarra;
- Warning to landowners of downstream agricultural lands to allow livestock to be relocated;

- Warning to Cork City Council to erect demountable elements if necessary; and activation of the control structure on the South Channel;
- Emergency Response Planning;
- Provide warning of a flood event which exceeds the 1 in 100-year standard of protection provided by the scheme.

### 3.4 Revised Dam Operations

For the vast majority of time, outside of flood events, the ESB will continue to operate the dams at Carrigadrohid and Innishcarra as at present, primarily as a hydroelectric enterprise.

When a potentially significant event is detected by the forecasting system, a 'flood protocol' will be triggered. This will advise the implementation of procedures developed as part of the flood scheme that will suggest that reservoir levels be safely drawn down to create storage in advance of the event. This will be achieved by allowing for greater discharges in advance of a forecasted event. This greater discharge will not result in the flooding of properties other than those washlands designated by the scheme, due to creation of downstream defences.

### 3.5 Designation of floodplains (Washlands) upstream of Cork City

The areas designated as "Washlands" are those areas adjacent to the river (and part of the Lee floodplain) which under the Scheme, will be deliberately flooded in advance of a forecasted extreme event, to facilitate pre-emptive lowering of water levels in Carrigadrohid and Innishcarra reservoirs, to create additional storage/attenuation capacity, and subsequently reduce the peak flow during the event.

### 3.6 Direct Defences (flood walls and embankments)

Direct defences on the scheme consists of the following:

- Circa 6,420m of new earthen embankments generally between 1m and 2m in height at a number of locations but predominantly west of Cork City at Innishcarra, north of Ballincollig, Inchiggagin, the Lee Fields and to a lesser extent in the green areas from Fitzgerald's Park to Presentation College on the North Channel.
- Circa 3,075m of new reinforced concrete walls with heights ranging up to circa 2m at various locations.
- Circa 1,815m of new sheet pile wall with heights ranging up to circa 2m at various locations.
- Circa 3,000m of new parapet flood defence.
- Circa 555m of glass flood defences in particularly sensitive amenity areas such as north of the Kingsley Hotel, the approach to Daly's Bridge, Fitzgerald's Park, Sundays Well Boating & Tennis Club, Lapp's Quay and shorter discrete sections along Union Quay, Georges Quay and Wandesford Quay.
- 115m of Demountable Flood Gates at 26 No. locations
- Circa 535m of modifications/strengthening of existing bridge parapets on Griffith Bridge, Christy Ring Bridge, Brian Boru Bridge, Clontarf Bridge, St Finbarre's Bridge, Lancaster Bridge and The River Lee Hotel Bridge.
- Modifications to several of the existing stepped river accesses along the city quays.

Defence walls will be finished in one of the following ways: Fair faced concrete, timber cladding, (salvaged or new) random rubble masonry cladding, salvaged cut cork limestone, new cut limestone. Locations of treatments are shown on the exhibition drawings.

### 3.7 Flow Control Structure

A flow control structure is proposed on the south channel of the River Lee, downstream of the Salmon Weir. The proposed control will be closed when the River Lee is in flood to prevent (or reduce) flow entering the south channel and divert a greater proportion of the flow to the North Channel which has greater capacity. This measure avoids the need for large lengths of high walls along the south channel and Curragheen.

### 3.8 Drainage and Pumping Stations

At a number of locations in the city centre, existing quays have no parapet and surface water drainage is either overland over open quays or else through discrete regular outfalls through the quay walls. In addition, a number of major piped or culverted drains outfall to the channel. To ensure that pluvial flooding is not worsened on the dry side of flood defences, new 'collector' drains and pumping stations will need to be constructed to safely discharge surface water during a flood event thus prevent back of wall surface water flooding. Pumping stations will incorporate permanent submersible pumps in underground wet wells with only control kiosks as above ground elements. It is envisaged that circa 36 No. pumping stations may be required.

### 3.9 Services/Utility Diversions.

It will be necessary to locate, uphold or divert numerous existing services/utilities. The full extent of such work cannot be known until detailed design stage, but every effort will be made to minimise the impact to existing services and the need for any diversions or outages. Such works will be particularly significant along the city quays on the central island.

### 3.10 Construction

Construction works will be preceded by geotechnical investigations. The construction works will be phased to address the needs of the project and will be subject to the following programme constraints:

- Instream works (including preparatory work) on all watercourses supporting salmonids will be undertaken in consultation with Inland Fisheries Ireland and will include mitigation for the protection of water quality and fisheries habitat. No instream works will be undertaken between October and June (inclusive) unless under exceptional circumstances and in agreement with IFI.
- To avoid impacting on bird nesting sites, the vegetation removal within the defined working area will not be carried out during the peak bird nesting season of March to August (inclusive) prior to the onset of works.
- Christmas non-working time is from the beginning of the second week of December to the end of the second week of January.

#### 4. HUMAN BEINGS

It has been decided to define the Study Area for the Human Beings Section of this EIS as all those DEDs in which the proposed works areas are located, as shown in Figure 4.1. The site of the proposed development lies within Carrigrohane Beg, Ovens, Ballincollig, St. Marys, Bishopstown, Bishopstown A, Shanakiel, Sundays Well A, Mardyke, Gillabbey C, Gillabbey B, Gillabbey A, Sundays Well B, Shandon B, Shandon A, Centre B, Centre A, South Gate B, South Gate A, City Hall A, City Hall B, St. Patricks A and Knockrea B DEDs, as shown in Figure 4.1, the first five of which are outside the city environs. The total Study Area has a combined population of 23,446 persons, and comprises of a total land area of 100.48 square kilometers. (Source: CSO Census of the Population 2011). The major settlement within the Study Area is Cork City and its environs, with Ballincollig being the largest settlement outside the city.

If the proposed development were not to proceed, the existing river channel would remain as it is, resulting in many of the same potential impacts on human beings as have occurred previously. The construction phase of the proposed development will last approximately 6-7 years. Potential impacts from the project are both positive and negative, and range both from short term to long term and from significant to neutral.

Many construction workers and materials will be sourced locally, thereby helping to sustain employment in the construction trade, and an increase in household spending and demand for goods and services in the local area. There will also be an influx of skilled people into the area, bringing specialist skills for both the construction and operational phases that could result in the transfer of these skills into the local workforce, thereby having a long-term positive impact on the local skills base. There is also the potential for short term moderate negative impact on economic activity due to the proposed construction activities. This would predominantly be as a result of traffic and access issues which could have the potential to reduce footfall into local businesses, with noise and dust from the works adding to this impact on local businesses. Riverside walks for residents and visitors alike are of importance to the area, with angling having a minor importance, though loss of recreational amenity will be limited to the areas where works are proposed and the area immediately downstream of these works. Although upstream stretches of the River Lee will remain unaffected by the works and impacts on the water quality of the river downstream of the works will be minimised through implementation of mitigation measures, the amenity value of the proposed works areas will be inaccessible to the public within the study area for the duration of the works. Therefore, the nature of the impact will remain moderate within and downstream of the works area for residents and visitors during the construction phase of the scheme.

A traffic management plan will be prepared in consultation with the local authorities at the detailed design stage of the project, and will be implemented for the duration of the works in order to ensure that any impacts on traffic mobility are minimised. This will also result in a minimised potential impact on local businesses, as traffic management will implement restrictions to local businesses only for the shortest practicable time. In addition, works will be limited to specified working hours, and will account for peak business periods, such as the Christmas shopping period. Therefore, the residual impacts will be temporary and slight.

There will be an increase in noise levels in the vicinity of the proposed development site during the construction phase, as a result of machinery and construction work. These impacts will be short-term in



duration on any particular day and temporary (for the duration of the construction phase). Construction noise at any given noise sensitive location will be variable throughout the construction project, depending on the activities underway and the distance from the main construction activities to the receiving properties. Best practice measures for noise control will be adhered to onsite during the construction phase of the proposed development. They will have a temporary negative slight impact in most areas, as works will be carried out in several phases and be temporary in nature at each location. Impacts on each service will vary, but overall the proposed drainage scheme will have a short-term moderate negative impact on services.

## 5. FLORA AND FAUNA

The location of the proposed works on the lower reaches of the River Lee in and around Cork City is largely urbanised, while the works area upstream of the Lee Fields becomes less urbanised and dominated by agricultural grassland, treelines, hedgerows and residential properties.

The River Lee between Innishcarra and the Port of Cork supports an array of wildlife including a number of species protected under the EU Habitats and Birds Directives including Otter, Kingfisher and Atlantic salmon.

The River Lee main channel from source to Cork City waterworks at Lee Road is a designated salmonid fishery under the EC (Quality of Salmonid Waters) Regulations of 1988. The Lee was found to support good stocks of Atlantic salmon parr and migrating adults. The river provides suitable spawning and nursery habitat, even in the vicinity of Cork City. No brook/river lamprey species were recorded from the two electro-fishing sites or during the dive survey on the River Lee, however, this is likely reflective of the lack of suitability of the sites surveyed as opposed to their absence in the river as suitable lamprey habitat is present in the lower Lee, downstream of Innishcarra Dam. Brown trout were the most frequent species recorded throughout the rivers European eel, which is critically endangered and protected under the European Eel Regulation EC No. 1100/2007 was also recorded on the River Lee.

The entire length of the River Lee offers suitable habitat for Otter (*Lutra lutra*) with ample vegetation for cover along the river banks and good fishing within the river. Numerous signs of Otter were recorded on the River Lee in the study area from as far upstream as Innishcarra Dam to as far downstream as the Port of Cork.

The River Lee is an important habitat for bats. The river acts as a vegetated corridor along which bats can commute from the wider countryside into the urban environment. The riparian habitat also provides a sheltered foraging area, a breeding site for invertebrate prey and, at night, screening from the surrounding artificial lighting of the urban area. Bridges, buildings and trees along and over the river also offer potential roosting sites for bats.

Kingfisher sightings were widespread on the Lee, with ample high-quality foraging and perching areas recorded. Although a number of kingfisher nests were identified, overall, optimum nesting site potential was low along the Lower River Lee, with its typically low lying banks.

The River Lee also supports a number of other bird species including Grey wagtail, Dipper, Cormorant, Grey heron and Oystercatcher.

Important habitats within the works area include treelines and hedgerow, small pockets of riparian woodland, mixed broadleaved woodland improved agricultural and amenity grassland. The River Lee downstream from Innishcarra is characterised by dense, often continuous riparian treelines bordering the

river consisting predominantly of Grey willow and Crack willow, with Alder and Sycamore. Within the city limits the river is contained by the quay walls. Discontinuous treelines in the city centre have been planted adjacent to the quay walls within the concrete structure of the pathways adjoining the River Lee. The sections of riparian and mixed broadleaved woodland, although small are of high local importance in the city environment. Within Cork City, the quay walls support an interesting and diverse flora.

Floating River Vegetation, a habitat protected under Annex I of the EU Habitats Directive, is distributed throughout the River Lee from Innishcarra Dam to Cork City. Although the Floating River Vegetation in the River Lee was not found to contain the species assemblage typical of high quality Annex I habitat *Watercourses of plain to montane levels with the Ranunculion fluitantis and Callitriche-Batrachion vegetation (3260)*, it nonetheless contains links to this Annex I habitat.

Invasive species are widespread throughout the works area. The most commonly recorded species was Japanese Knotweed, which was especially frequent within Cork City boundaries. Himalayan Balsam and Giant Rhubarb were also frequently recorded throughout the works area.

### 5.1 Impacts

The impact of the works varies between habitats and species. Impacts are considered to be moderate to significant for a number of habitats and species, including those listed below for the following reasons:

- Terrestrial habitat - Permanent loss of terrestrial habitat of high local importance including treelines, as well as small sections of riparian woodland and mixed broadleaved woodland.
- Aquatic habitat – Permanent loss of small areas of Floating River Vegetation and river bed habitat.
- Flora – Long term to permanent loss of quay wall flora.
- Otter – Potential for direct impact on otter holts as well as disturbance.
- Bats – Potential for loss of roosting bat habitat as a result of mature tree loss.
- Fisheries – Potential for direct and indirect impact on fish as a result of instream works.

### 5.2 Mitigation

It is anticipated that mitigation measures will reduce the impacts for many of the habitats and species impacted by the Scheme. Key mitigation measures will include replanting of trees and treelines where lost, re-instating grassland and in riverine habitat. Pre-construction surveys for mammals (including bats) with associated mitigation put in place. Detail design will be undertaken in consultation with stakeholders including IFI and NPWS

## 6. SOILS AND GEOLOGY

The Study Area to the North of the River Lee is underlain by Ballytrasna Formation purple mudstone and sandstone, Cuskinny Member Formation flaser-bedded sandstone and mudstone and Gyleen Formation sandstone with mudstone and siltstone. South of the Lee River lies an outcrop of Carboniferous Limestone comprising Waulsortian Limestone, Cork Red Marble Formation, Little Island Formation Limestone and Old Head Sandstone Formation. Bedrock in the study area is in general overlain by Made Ground, Alluvium, fill derived from mixed Devonian Sandstone, Glaciofluvial sands and gravels. The findings of the ground investigation, which was carried throughout the proposed Study Area are broadly in line with the bedrock and overburden as described above.

There is one proposed National Heritage Area (pNHA) within in the vicinity of the proposed works and a County Geological Heritage feature adjacent to the study area. As there no works proposed within the

vicinity of the pNHA and it is not anticipated that significant volumes of rock will be excavated the potential impact is regarded as being imperceptible.

## **7. WATER – HYDROLOGY AND HYDROGEOLOGY**

The River Lee flows into the Study Area from the west. It rises in the Shehy Mountains on the western border of County Cork and flows eastwards through Cork, where it splits in two for a short distance, creating an island on which Cork's city centre is built.

### **7.1 Water Quality**

Water quality within the study area is identified as being good to moderately polluted. The overall water quality on the River Lee main channel is not achieving the target water quality required under the Water Framework Directive. It is likely that diffuse agricultural enrichment in addition to waste water point sources are contributing to the localised declines in water quality of the River Lee.

#### **Impacts on Water Quality**

##### ***Generation of Silt-Laden Run-off & Increase in Suspended Solids***

Measures to minimise the suspension and transfer of sediment downstream will be implemented. An Environmental Management Plan (EMP) will be prepared prior to the commencement of any works in order to ensure all works are carried out in a manner designed to avoid and minimise any adverse impacts on the receiving environment.

##### ***Use of Potential Water Contaminants***

Numerous substances used on construction sites have the potential to pollute both ground and surface water if not properly managed and treated. Such substances include fuels, lubricants, cement, mortar, silt, soil and other substances which arise during construction.

All concrete works will be carried out in dry conditions. There will be no refuelling of machinery within the river channel. No vehicles will be left unattended when refuelling and a spill kit including an oil containment boom and absorbent pads will be on site at all times. Any fuel that is stored on the site will be in a double skinned, banded container. All vehicles will be regularly maintained and checked for fuel and oil leaks.

It is likely that with proper implementation of the above mitigation this impact will constitute a slight negative short term impact and a neutral long-term impact.

### **7.3 Hydrogeology**

The Study Area is underlain by Devonian Old Red Sandstone to the north of the River Lee with Dinantian Mudstone and sandstone and Dinantian Pure Unbedded Limestone to the south of the river. The site is located on a locally important aquifer with bedrock, which is moderately productive only in Local Zones. The groundwater body is generally covered by till derived from its sandstone parent material. The direction of groundwater flow is likely to be influenced by the topography of the surrounding area. Groundwater within the Study Area is more than likely hydraulically connected to the River Lee and its tributaries.

Groundwater vulnerability mapping indicates that the local aquifers range from moderate to high or extreme in places with pockets of rock at or near the surface or karst.

### **Impacts on Hydrogeology**

There are numerous substances that will be used during the construction phase such as fuel, oil, lubricants, cement, silt, soil and other hydrocarbons which have the potential to pollute groundwater. The impacts to hydrogeology as a result of the Lower Lee (Cork City) Drainage Scheme are temporary and significant. Any impacts associated with the scheme will occur during the construction or maintenance phase. Should any of the above-mentioned substances contaminate the groundwater in the Study Area, then there is a risk to groundwater quality. However, the poor yields from wells and the urban nature of the scheme suggests that the importance of groundwater as a drinking source is limited. Nevertheless, best practice construction measures will be put in place to ensure that the risk to ground water quality is limited and ground water quality will be maintained.

Taking into account the standard pollution control measures and water quality mitigation measures, it is considered that the impact will constitute a negligible impact.

### **7.5 Flooding**

There is a long history of flooding in Cork City and the River Lee valley. A number of severe floods have affected the city in the past. Since construction of the two dams at Innishcarra and Carrigadrohid in the 1950's, fluvial flooding in Cork has generally been less severe although there has been frequent flooding of land, roads and small numbers of properties. The event of November 2009 was an exception, with major damage caused to commercial and residential buildings in Cork City.

Tidal flooding to the east of Cork City Centre is more frequent, with some flooding of the lowest lying parts occurring at least every other year with more significant tidal flooding occurring on average every ten years. Notable recent tidal flood events occurred in 1994, 2004 and 2014.

#### **Impacts on Flooding**

The Lower Lee (Cork City) Drainage Scheme raises the bank levels along the River Lee within Cork City. This reduces the risk of water levels overtopping the bank and flooding the surrounding area. Providing flood defence walls and embankments will reduce the risk of flooding to roads, businesses and private properties in Cork.

When a potentially significant event is detected by the forecasting system, the 'flood protocol' will be triggered.

This will advise the implementation of optimised procedures developed as part of the flood scheme, which would suggest that reservoir levels be safely drawn down to create storage in advance of the event. This greater discharge will not result in the flooding of properties other than in washlands which are designated by the scheme, due to creation of downstream defences.

In creating washlands by pre-emptive advance spilling of water from the reservoirs at higher rates, 'artificial' or 'early' flooding of existing floodplains will occur. This will predominantly affect agricultural land to the west of the city. These lands will benefit from the scheme in terms of a reduction in the peak flows and, thus, magnitude of flooding from extreme events. However, as a result of the pre-emptive spilling of higher flows from the dams, these lands will be subject to a greater frequency of lower to medium flood events. In addition, the proposed scheme will result in peak flows extending for a longer duration during a given flood event.

Overall, the proposed project is considered significantly positive in terms of flood relief.

## 11 AIR QUALITY & CLIMATE / NOISE & VIBRATION

The proposed works will not have any air quality or noise and vibration impact during its operational phase. As a result, it is only considered necessary to assess the potential noise and vibration impact on the surroundings during the construction phase. The site of the proposed development lies within Zone B, which represents Cork city and its environs. County Cork has a temperate oceanic climate, resulting in mild winters and cool summers. During the construction phase, noise impacts at all receptors will be temporary and localised. At most of these, impacts will be imperceptible. At a small number of dwellings, particularly those immediately adjacent to wall or embankment construction works, impacts will range from slight negative to noticeable negative. Given the benefit which will accrue to these dwellings in particular, the overall long term impact is expected to be positive. Where ground conditions allow, it is possible that pressed-in piling could be a considered methodology. Vibration impacts are expected to be imperceptible where pressed-in piles are used. Any other piling methods are likely to result in temporary community-wide impacts, ranging from noticeable negative to substantial negative depending on separation distance.

In order to ensure that no dust nuisance occurs, a series of measures will be implemented. Site roads shall be regularly cleaned and maintained as appropriate. Hard surface roads shall be swept to remove mud and aggregate materials from their surface. Furthermore, any road that has the potential to give rise to fugitive dust must be regularly watered, as appropriate, during dry and/or windy conditions. There are no residual impacts expected on air quality and climate from the proposed development. Noise emissions associated with the construction phase will in general be satisfactory at most receptors. At each work zone, operations will be confined to a relatively short period. Apart from a small number of exceptions, noise emissions at each zone will comply with the daytime guideline limits. Many potential noise impacts may be readily mitigated by erecting hoarding between the operations area and nearby receptors. For others, it is considered more suitable to notify residents in advance of operations. With respect to sheet piling, no mitigation measures are considered necessary where pressed-in piles are used. If ground conditions require an alternative piling method, it is recommended that real-time monitoring of vibration levels is undertaken at surrounding receptors. There are no residual impacts expected on air quality and climate from the proposed development. Noise and vibration impacts during the construction phase, inclusive of mitigation, are expected to be temporary, localised and imperceptible at most locations. At dwellings close to proposed works zones, particularly adjacent to wall and embankment construction areas, impacts are likely to be slight negative to noticeable negative. Impacts may increase to noticeable negative or substantial negative where piling methods other than pressed-in piles are used. However, it should be noted that these impacts will be entirely temporary in nature, lasting several days or weeks locally in most cases. Implementation of mitigation measures described above will further reduce impacts. Moreover, the long term impact is expected to be positive, given the elimination of flood risk in these areas.

## 9 LANDSCAPE

There are a number of proposed types of flood defence works and these types of works and locations vary throughout the Study Area. Many of the areas of proposed works are in where they will be noticed by a large amount of people, as these occur within the city centre. Certain works are located where viewers will be using the areas for recreation where they are aware and focussed on the views around them, for example in the Lee Fields, or Fitzgerald's Park. Visual receptors in these locations are considered highly sensitive. The sensitivity of the visual receptor (groups of people) combined with the magnitude of

the change combine to give the likely visual impact. In areas where people are less likely to view the works,

Likewise, the visual impacts of these works vary and range from imperceptible impacts where there is little change, to Moderate/Significant impacts in some areas where works are more apparent and result in greater changes to the visual environment. Impacts are both positive and negative, and impacts of the various elements, while described separately, also need to be considered where a high concentration of these works are carried out in a specific location and therefore represent a high magnitude of change. Negative impacts include tree removal, construction of flood walls of increased height which prevent views of the river, and removal of other important elements (e.g. extinguishing access points to the river). While the wall height is designed to allow views where possible, reduction in visibility and change in views of the river are likely to result in certain areas. Neutral and positive impacts include areas where quay walls are to be refurbished, or public space is increased. Impacts will range from Permanent, Imperceptible to Significant visual impacts, with some impacts decreasing over time as trees are planted and mature.

Landscape impacts include impacts on the landscape character of the area, as well as changes to the fabric of the landscape, and to landscape as a resource. Proposed works which are likely to have landscape impacts include tree and vegetation removal, grass embankments, flood defence walls. Where these occur in places such as Fitzgerald's Park and the Lee Fields, and the Distillery Fields, where the landscape has a medium to high sensitivity to change, the character will be changed at a localised level, so in some locations, these change is considered of high magnitude and landscape impact is Moderate. In other areas, impacts are considered Slight, where changes are of a lesser magnitude, or in areas where the landscape is regarded as less sensitive to change, such as areas which are not covered by landscape designations. The overall landscape impact varies from Permanent, Slight to Moderate landscape impacts.

## 10. CULTURAL HERITAGE

The proposed scheme extends eastwards from the Innishcarra area through low-lying lands dominated by pasture farmland on the outskirts of Ballincollig and then continues into the western edge of the city suburbs. The scheme has been designed to avoid all recorded archaeological sites and architectural heritage structures within the lands to the west of the city. The scheme then follows the river as it branches into the north and south channels in the Sunday's Well and Western Road areas, extending through the 19th century suburbs before reaching the city centre. The present river channels within the city centre are delineated by the 19th century quays, constructed along the margins of infilled ground that was reclaimed during the 18th and 19th centuries in the marsh lands outside the walls of the medieval city. A wide range of archaeological investigations have been undertaken within the reclaimed ground adjacent to the existing channels and have typically uncovered thick deposits of dumped soils that, to date, have produced little of archaeological significance. The scheme does not extend into the walled medieval core of the city.

The proposed works in the city centre will involve a combination of construction of new quay parapet walls, raising of existing quay walls, construction of localised in-channel sheet pile walls and regrading of localised sections of adjacent road surfaces. The works in the city will also entail repairs to the existing quay walls where required.

There will be a positive impact due to repairs to boundary walls on the Lee Road and due to repairs to the Quay Walls.

There will be a positive impact to a significant number of features of archaeological and architectural significance as a result of flood protection works.

Negative impact includes indirect impact on the setting of structures in proximity to the works.

Slight direct impacts are identified at the waterworks engineer house, Thomas Davis Bridge, the weir at the Tennis Club, Alderman Reilly Bridge, Albert Quay wall, Bachelors Quay and former Bank of Scotland building.

Slight to moderate impacts occur to the quay walls at Grenville Place: North Mall/ Marsh ACA due to the removal of sections of historic bollards and railings; and Lee Maltings river elevation by in channel wall construction and fill.

There will be a moderate impact at the west end of North Mall due to the direct impact to cast-iron railings.

See Table 10.3 of the EIS for full details of impact and mitigation.

## 11. MATERIAL ASSETS

Due to the extensive works planned in Cork City Centre, the proposed scheme will have potential to impact on the following material assets: transport infrastructure, drainage network, water distribution network, Bord Gáis distribution network, electricity network, broadband network, telecommunications network, access to lands and land use.

With appropriate mitigations in place, there will be an imperceptible impact to the transportation infrastructure, drainage and utility infrastructure in Cork City resulting from construction works.

As the majority of flood defences are adjacent to the River Lee or existing roads, there is minimum land severance occurring as a result of the Lower Lee (Cork City) Drainage Scheme. The main impact on agricultural lands during the operational phase of the scheme will consist of slightly reduced use of land due to increased frequency of flooding in designated washlands.

Taking into account the proposed mitigation measures and the benefit of the scheme to Cork City and Environs, the residual impact overall will be significant, permanent and positive.

## 12. TRANSPORT AND TRAFFIC

The majority of the works in the Cork City central island area will comprise new parapet construction on existing walls, replacement or upgrade of existing walls, demountable defences, and bridge parapet raising or strengthening. In addition to these structural works, a number of ancillary measures are proposed, including construction of a number of surface water pumping stations; construction of a number of backing walls; and re-grading of the existing road surface. This will result in amendments to vehicle and pedestrian access during construction in order to accommodate embankment works.

It is estimated that the works will take several years to complete, and will be carried out in six phases. The individual phases will be carried out in sequence and have been arranged in the most advantageous order, in terms of interim benefits.

Although the construction, with mitigation measures in place, will result in a temporary moderate to significant negative impact across the scheme extents, in the longer term the Lower Lee (Cork City) Drainage Scheme will improve the resilience of the city transport network significantly. This will be done by lowering the risk of flooding events that would reduce the capacity of the city transport network, which

would typically cause it to break down. This improved resilience will be further enhanced by the improvement works to the numerous bridges connecting the north and south channels to the central island, which have, in the past, caused extensive and significant disruption across the entire city and the wider suburban areas when significant flooding events have occurred.

As evidenced by historic flood events in Cork City, the existing transport network is highly volatile at times and is sensitive to even moderate levels of disruption. This can lead to significant propagation of traffic congestion, queuing and associated delay, which can then rapidly spread outwards from the city centre to the suburban areas.

### 13 INTERACTIONS OF THE FOREGOING

All of the potential impacts of the proposed development and the measures proposed to mitigate them have been outlined under the preceding headings above. However, for any development with the potential for significant environmental impact there is also the potential for interaction amongst these impacts. The result of interactive impacts may either exacerbate the magnitude of the impact or ameliorate it.

The construction phase of the project will give rise to road closures and restrictions of traffic movements at times, and will create some short-term inconvenience for road users. By ensuring that these impacts occur at times and locations provided for in a traffic management plan, this will be mitigated in so far as is possible.

Site activities during the construction phase have the potential to give rise to some water pollution, and consequential impacts on flora and fauna that use that water within the same catchment. Extensive mitigation is proposed to minimise the potential for water pollution arising from the works which also minimises the potential for this interacting impact.

Site activity during the construction phase could give rise to noise that could be a nuisance for fauna. All construction activities will be temporary in nature and will progress across the works area of the entire scheme, minimizing the duration of works in any one area.

The removal of some vegetation within the development footprint and surrounding areas will result in a change to the visual landscape during the construction phase, which will become part of the normal landscape of the wider area for the duration of the operational phase.

The movement and removal of soils, overburden and rock during the construction phase has the potential to give rise to impact on water quality. The excavation of roads and other works areas has the potential to intercept larger volumes of drainage water that will require management.

The movement and removal of soils, overburden and rock during the construction phase has the potential to give rise to noise and dust impacts.

The movement of construction vehicles both within and to and from the site has the potential to give rise to noise and dust nuisance impacts during the construction phase.