Chapter 3:

Description of Proposed Development

3 DESCRIPTION OF THE PROPOSED DEVELOPMENT

As described in Chapter 2, 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). The design of the proposed works is adaptable for future climate change in accordance with Office of Public Works guidance in relation to climate change and also includes an allowance for freeboard.

The proposed works are detailed on the scheme drawings included in Appendix 3A: *Proposed Flood Defences – Plan Layout;* and *Proposed Flood Defences – Sections* and are described generally in the following section. To undertake the proposed works on site, some access will be required to adjacent lands and the river channel, the extent of which can also be seen in Appendix 3A *Possible Access Route and Works Areas*. The locations of each of the proposed works features are marked on the relevant drawing with a reference code, with the adjacent table providing a description for each code.

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 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.

3.1.1 Site Investigation

Preliminary and detailed site investigations have been carried out in order to inform the design process to date. However further targeted detailed site investigation may be required in advance of the construction works to inform the detailed design of the drainage scheme. Trial pits, slit trenches, boreholes, rotary core boreholes and dynamic probes will be carried out in addition to utility identification.

3.1.2 Flood Forecasting and Warning System

A flood forecasting and early warning system can play a significant role in flood defence, firstly as a means of avoiding loss of life, and secondly to provide a warning which allows authorities, property owners and river users to take measures to mitigate against the effects of a flood event.

In the case of the Lower Lee (Cork City) Drainage Scheme, the single most important facet of the flood forecasting system is to provide sufficient advance warning of the type and scale 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 taking account of astronomical tides, atmospheric pressure, and wind speed and direction. This forecast will be incorporated into the overall forecasting system for the Lower Lee (Cork City) Drainage Scheme.

A 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 Forecasting System will operate as follows:

- Operate continuously based on predicted rainfall data provided by Met Éireann/ECMRF, monitoring for potential extreme events. The data feed will be provided automatically and seamlessly directly into the forecasting system.
- The forecasting system will predict future peak flows at critical locations (including predicted inflows) based on the live status of the Lee system, including catchment wetness and predicted rainfall. Forecasts will extend for a period of greater than 4 days in advance.
- Provide an alarm to the operator, from over 4 days out, when a predicted significant rainfall event or a predicted tidal surge event is above a predefined threshold that may otherwise result in flooding. This would allow reservoir levels to be lowered at pre-defined spill rates which would not flood dwellings/buildings, in preparation for/anticipation of the extreme event; and allow

management of discharges in real time (if required) taking account of inflow from the Shournagh/Western Bride and tide levels.

- Provide sufficient warning time to close the flow control structure on the south channel and erect demountable defences in the east of the city if required.

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.

The Flood Warning System dissemination may include the following:

- Direct notification to affected landowners (particularly agricultural lands);
- Provision of demountable flood gates;
- Sirens in public amenity floodplain areas;
- Local Authority websites and social media platforms;
- Local Authority 'text alert' system; and
- Radio and television public alerts if necessary.

3.1.3 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.

Continuous monitoring and simulation of predicted rainfall using the new flood forecasting system will allow potentially significant flood events to be detected further in advance.

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

This would advise the implementation of optimised procedures developed as part of the flood scheme that would suggest that reservoir levels be safely drawn down to create storage in advance of the event. This would 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. In principle, the revised operation of the dams before and during a flood event will consists of the following stages:

- From 4 to 2 days prior to the flood event, safely draw both reservoirs down to pre-determined levels (which are being termed FRL (Flood Relief Level), whilst not exceeding the safe maximum draw down rate at Carrigadrohid and unless needed, limiting discharges to the current advance discharge limit of 150m^3/s from Innishcarra.

- In the period on the run up to a flood event, from 2 days prior to the start of the event, make increasingly large releases from Carrigadrohid and Innishcarra at discharge rates based on pre-determined rules. The rates will depend on the scale and nature of the forecasted event but could be up to 350m^3/s.
- Closer to and during the main event, use specified procedures to trim the peak off the Lee flows to maintain a flow less than design flow in Cork city (taking account of contributions from the Bride and Shournagh).
- Restrict dam releases to pre-determined rates during extreme tidal events, so long as dam safety is not a concern.

The optimised procedures are being developed taking account of the following considerations.

- The normal range of operating levels in the dams are not amended (i.e. outside of 'flood protocol' times, ESB will continue to operate as normal)
- Minimum and maximum reservoir levels and/or seasonal variations in same, have not be amended so as to avoid impacting existing environmental receptors/constraints such as levels in the Gearagh, water supply requirements, fish life etc.
- Dam safety rules are not impacted, i.e. once levels in the reservoirs exceed ESB's safety thresholds, dam safety takes precedence and greater discharges will occur. In this scenario, emergency procedures will be put in place and warnings will be issued to advise of flooding as a result of a design exceedance event. These emergency measures will be under the control of the Local Authority (as the body responsible for emergency response) and the ESB (responsible for warning of flood events).
- The maximum draw down rate limit at Carrigadrohid remains for road embankment safety reasons.

3.1.4 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.

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 or medium flooding events. In addition, the proposed scheme will result in peak flows extending for a longer duration during a given flood event. The works will therefore impact on the use of these lands. The scheme documentation will demonstrate the likely change in frequency of lesser events, the extent to which pre-emptive spilling from the dam will extend, and will demonstrate the difference that the proposed changes would have had on the affected lands over the last 8 to 10 years.

3.1.5 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 within the study area but predominantly in rural areas to the west of Cork City at Innishcarra, north of Ballinacollig, Inchaggagin, the Lee Fields and to a lesser extent in the green areas from Fitzgerald's Park to Presentation College on the North Channel. Embankments will generally have 1 in 3 sides slopes, a 4m crest and be topsoiled and grassed. The embankment crests will generally be suitable to accept vehicular (for the purpose of maintenance) and pedestrian loading and some will be used as public amenity walks.
- Circa 3,075m of new reinforced concrete walls (suitably clad where relevant) with heights ranging up to circa 2m at various locations.
- Circa 1,815m of new sheet pile wall (suitably clad where relevant) with heights ranging up to circa 2m at various locations.
- Circa 3,000m of new parapet flood defence walls (suitably clad where relevant) built upon refurbished existing quay walls. All such defences on the lines of existing quay/river walls within the city centre are of heights at or less than guarding height of 1.2m so as to maintain the social connection with the river. This was a key constraint of the design.
- 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 Wandersford Quay.
- 115m of Demountable Flood Gates at 26 No. locations taking the form of both 'tilt-up' barriers and 'lift-hinge' gates.
- 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.

3.1.6 Flow Control Structure

A flow control structure is proposed to be located 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.

The proposed structure will consist of two different elements. Approximately two thirds of its width will take the form of traditional penstock type sluices gates. Even in the open position, these will not extend above the level of the existing pedestrian bridge and therefore will not have a significant visual impact. The final third will consist of a 'bottom up' flap gate.

The flap gate will be anchored to a sill in the bed of the channel and is hinged along the upstream edge of the gate. It will be stored submerged and flat to the bottom of the channel. To close the gate, the downstream edge of the gate is rotated upward. The gate can be rotated using a number of methods including hydraulic cylinders, air injection or the inflation of rubber bladders.

It has a low visual impact as the barrier is stored in the river bed and is only visible when closed in operation during a flood event. This section is included to retain passage for canoeists, kayakers and similar amenity users. The overall solution whilst restricting high flows, will not significantly impact low flows and therefore will have a negligible impact on the spilt of flow between the north and the south channel at low flows.

The moveable mechanical elements of the control structure will be automated with manual backup and will be remotely controllable as well as being linked to the flood forecasting system and river gauges on the Lee and Curragheen rivers.

The control structure will be capable of graduated opening to allow the flexibility of full or partial closure.

A penstock structure will be provided on the Distillery channel west of St Vincent's Bridge (C01 3350), the proposed penstock will be placed on the upstream face of the existing bridge and remedial works will be required to ensure masonry arch has the capacity for uplift. Further upstream of the Distillery channel on the Mill Race a Head wall and Penstock will be provided to prevent flow entering the channel during flood events.

3.1.7 Ramps and Regrading

At a number of locations, it is proposed to regrade roads, footpaths of other areas of ground either to raise ground level above flood defence level (and so provide a direct flood defence) or in other instances reduce the effective height of a flood defence wall relative to the dry side ground level to retain the social amenity relationship with the river.

Such regrading is generally limited to changes in elevation of less than 1m.

3.1.8 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. The construction of raised parapets and flood defence walls will prevent the existing drainage systems from functioning at present either permanently or more so in the majority of cases, in the temporary situation during a flood event. Therefore, 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. The greatest impact of these pumping stations is therefore likely to be in terms of traffic and noise restrictions during construction as they will require deep excavations of up to 5m in depth. Wet wells will typically be circa 3m to 4m internal diameter. Currently, it is envisaged that circa 36 No. pumping stations may be required, although there may be opportunity to rationalise the solution and reduce this number of pumps

later in the design. The sites of pumping stations have been chosen to minimise disruption during construction and to provide access locations for maintenance that will require minimum future traffic management. See Appendix 3A for details of Pumping Station Locations.

3.1.9 Culverts

The scheme involves the culverting or repair to culverts on a number of minor watercourses.

The design standard for culverts of have been established in consultation with the Office of Public Works.

Generally, culverts are constructed directly along the line of the watercourse being culverted and are not offset. However, there may be minor realignments. To prevent contamination of watercourses by silting, each watercourse will be either over pumped or temporarily diverted during the construction.

The scheme will include construction of culverts at the following locations:

Table 3.1 New and Repaired Culverts

Location	Chainage	Description
Townland: Coolyduff	C01_13180 to C01_13200	Proposed 0.9m diameter concrete pipe culvert **20m** to be constructed under the proposed embankment. Culvert is to tie into the existing culvert at the western end. The existing culvert (**68m**) is to be pressurised during a flood event.
Townland: Lackenshoneen	C01_12861	Existing stream to be culverted. The **25m** culvert will be pressurised during a flood.
Lee Road	C01_5793	Existing culvert to be pressurised during a flood event (**17m**). Existing stream to be culverted in a 2.0m wide, 1.2m high by **20m** long rectangular culvert which will be pressurised during a flood event.
North City Link Road	C06_250 to C06_10	Existing **126m** culvert to be pressurised during flood event. Existing bridge joints (approximately 11 joints) to be resealed to prevent upward seepage.
Proby's Quay	C02_1300	Existing **90m** culvert to be pressurised during a flood event. Repairs to the existing culvert and work to internal joints to be carried out where necessary. All drainage outfalls to be fitted with non-return valves.
Wandesford Quay	C03_0 to C03_135	Existing **105m** culvert to be pressurised during a flood event. Repairs to the existing culvert and work to internal joints to be carried out where necessary. All drainage outfalls to be fitted with non-return valves.

3.1.10 Bridges

Works are proposed to five bridges; three bridges require modification to the existing structure while the remaining bridge will be a replacement vehicular bridge for the existing footbridge which will be demolished.

Table 3.2 Bridge Works

Bridge	Chainage	Description
Clontarf Bridge	C02_250	Four no. proposed demountable pedestrian access gates to flood defence level of 3.50mOD across footpaths along Clontarf Bridge (no pedestrian access during flood event). Existing bridge structure to be modified to incorporate steel flood defence upstand circa 0.5m high to 3.50mOD between road and footpath.
Footbridge at Kingsley hotel/ Sacred Heart	C02_3540	Existing footbridge to be removed and replaced with a vehicular bridge adjacent to proposed flow control structure.
Brian Boru Bridge	C01_2050	Proposed steel flood defence parapet is to be constructed along bridge footpath to flood defence level of 3.50mOD. Parapet is to tie in with bridge steelwork. Demountable defences fitted along both footpaths to maintain historical bridge railings. Flooding will be contained on the bridge footpaths during a flood event.
Christy Ring Bridge	C01_2525	The existing steel bridge railing/parapet is to be removed and replaced with a new steel flood defence parapet, solid to flood defence level of 3.80mOD on west parapet with open railing above to 1.2m guarding height, to be sympathetic to existing bridge architecture.
Griffith Bridge	C01_3025	The existing steel bridge railing/parapet is to be removed and replaced with a new steel flood defence parapet, solid to flood defence level of 4.35mOD with open railing above to 1.2m guarding height, to be sympathetic to existing bridge architecture.

3.1.11 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.

3.2 ANTICIPATED CONSTRUCTION METHODS

3.2.1 Pre- Construction Works

The construction works will be preceded by geotechnical investigations, which will consist of a mixture of shell and augur boreholes, cable percussive boreholes, rotary drilled boreholes, trial pits and slit trenches at the locations of the proposed structures. In addition, it is proposed that archaeological investigation works including testing and any follow-on resolution works will be undertaken prior to the main works contract commencing on site.

Pre-construction works will also include certain diversion works of services and utilities, including electricity, gas, telecommunications, watermains and other sanitary services. Due to the nature of some of the diversions a number of these service diversions will only be possible during the main construction works.

Advanced tree clearance, hedgerow clearance, invasive species management, and fencing contracts may also be undertaken dependant on the anticipated seasonal timing of the award of the main contract. If appropriate, these advance works contracts would be used as a means to clear the site of vegetation during permitted seasonal periods so as to enable the main construction contract to proceed with reduced impediment on the main works.

3.2.2 Main Construction Works

The main construction will involve the excavation and placement of material for the construction of embankments, walls, pump stations and flood control measures as well as the haulage of material and importation of materials to complete the flood scheme. Material will be required for the following:

- Embankments – construction of earthen embankments, made up of suitable cohesive materials such clays, which is clean, inert and uncontaminated, ideally locally sourced; supported by topsoil and unbound or bound trackways
- Structures – the construction of retaining/flood walls, piling works, construction of bridge and bridge elements including their foundations, piers, abutments and parapets
- The diversion and construction of utilities and services.
- Road works – sub base and base construction, bituminous pavement surfacing
- Ancillary reinstatement roadworks including the installation of public lighting, signage and road marking.

3.2.2.1 Earthen Embankments

The construction of the earthen flood defence embankments is likely to comprise the following activities:

- Isolation of works area, including traffic management where the work area will overlap with a public road/ pedestrianised area,
- Temporary works,
- Excavation for formation,
- Placing and compaction in layers of suitable clay material, and
- Reinstatement of area, including grass seeding.

3.2.2.2 New Flood Defence Walls

The construction of the reinforced concrete flood defence walls is likely to be carried out by traditional methods comprising the following activities:

- Isolation of works area, including traffic management where the work area will overlap with a public road/ pedestrianised area;

- Temporary works where in stream works are required, including silt barrages, damming the river locally around the river bank/ wall, suspending scaffolding from the wall, or constructing a temporary pontoon or causeway on the river side of the wall;
- Excavation for foundations;
- Blinding of formation;
- Fixing of reinforcement, placing of formwork, placing of concrete, and stripping of formwork;
- Addition of security fencing if required; and
- Reinstatement of works area.

In certain locations, where there is a possibility of flood water passing underneath the flood defence wall foundations, either sheet piles or grouting techniques will be required to provide a cut-off. The sheet piles may be metal or plastic and will be driven to the required depth using a piling hammer or similar.

In other locations, where steel walls are proposed due to spatial restriction or other factors, such as access considerations, the concrete structure may be terminated above ground and a steel structure would be extended to achieve flood defence height. In some locations, such as Grand Parade, demountable defences will be constructed at locations in the flood defence line where it is necessary to maintain access routes which will only be cut off during flood events. At other limited locations of particular visual sensitivity, a glass wall may be constructed in lieu of a steel/ concrete wall.

The plan area/ extent of anticipated in-stream work is indicated on the working areas shown on the scheme drawings.

3.2.2.3 Modification/ Extension of Existing Flood Defence Walls

The construction of the reinforced concrete flood defence walls is likely to be carried out by traditional methods comprising the following activities:

- Isolation of works area, including traffic management where the work area will overlap with a public road/ pedestrianised area,
- Temporary works where in stream works are required, including silt barrages, damming the river locally around the river bank/ wall, suspending scaffolding from the wall, or constructing a temporary pontoon or causeway on the river side of the wall,
- Demolition of the existing wall/ structure where it is not possible to integrate it into the proposed flood defence structure,
- Excavation for foundations where required,
- Blinding of formation or preparation of existing structure where it will form part of the proposed flood defence (this may include pointing and grouting of existing quay walls),
- Fixing of reinforcement, placing of formwork, placing of concrete, and stripping of formwork,
- Addition of security fencing if required, and
- Reinstatement of works area.

In certain locations, where there is a possibility of flood water passing underneath the flood defence wall foundations, either sheet piles or grouting techniques will be required to provide a cut-off. The sheet piles may be metal or plastic and will be driven to the required depth using a piling hammer or similar.

In other locations, where steel walls are proposed due to spatial restriction or other factors, the concrete structure may be terminated above ground and a steel structure would be extended to achieve flood defence height. At other limited locations of particular visual sensitivity, a glass wall may be constructed in lieu of a steel/ concrete wall.

The plan area/ extent of in stream work is indicated on the working areas shown on the scheme drawings.

3.2.2.4 Typical Methodology for remedial works to existing masonry quay walls.

Temporary scaffolding will typically be erected in the channel along the face of the wall to be remediated. Temporary propping to the riverside face of the quay wall will be installed where necessary.

The face of the existing quay wall will be thoroughly cleaned with high pressure water jetting. All dirt and marine growth will generally be removed. All joints and cracks will be raked out and thoroughly cleaned, and then repointed with a high strength, rapid hardening, high-bond, polymer modified mortar. Any damaged stonework will be repaired.

Cement grout will then typically be injected into the wall, foundation and soil backing zone. Grouting will typically be carried out in three stages as follows:

- The wall will be gravity grouted initially, through holes drilled at maximum 2m centres down through the wall.
- When the wall gravity grouting has set, the wall and foundation zone will be pressure grouted through holes drilled at maximum 1m centres through the body of the wall, down into the foundation zone
- When the wall and foundation zone pressure grouting has set, the soil backing zone will be pressure grouted through holes drilled at maximum 2m centres down through the soil backing zone.

Where no access is available to drill grout holes from above, it may be necessary to carry out drilling and grouting from the river side.

Grouting of the existing quay wall is only to be carried out at low tide when the full height of the quay wall is exposed to view.

3.2.2.5 Pumping Stations

The footprint of the pumping station will be set out. Where the proposed excavation is located in a paved area, the pavement will be saw cut. Where the proposed excavation is located in a grassed area, the topsoil will be removed and stored in close proximity to the excavation. The excavation will take place to the required depth. Sheet piling will likely be required in order to facilitate construction of deep excavations in an urban area. Excavated material unsuitable for use as backfill material will be disposed of to an approved waste management facility. Lean mix concrete blinding will be placed, followed by formwork and steel fixing. Once concrete has been poured and has cured, the formwork will be stripped and the area outside the pumping station will be backfilled. Excavations in grassed areas will be backfilled with suitable excavated material, following which the original topsoil will be replaced.

Excavations in paved areas will be backfilled with granular material and reinstated to their original condition. Mechanical and electrical fit out of pumping stations will take place following backfilling.

3.2.2.6 Flow Control Structure and Replacement of Existing Bridge

The construction of the proposed flow control structure and replacement of the existing pedestrian bridge with a vehicular bridge are likely to be carried out in parallel. The construction of the proposed flow control structure is likely to comprise the following proposed works:

- The works area will be isolated and traffic/ management (including management of pedestrian traffic) set up as required.
- The existing bridge will be dismantled/ demolished and removed off site.
- The foundations will be excavated down to formation level.
- Utilities and drainage pipes will be diverted into permanent positions as required during/ following construction.
- Temporary works will be put in place where in stream works are required, including silt barrages, damming the river locally around the flow control structure/ bridge foundations,
- Excavated material will be transported off site to a licenced facility or stored for reuse on site. Blinding will be poured.
- The flow control and bridge structures will be constructed using either precast units or reinforced concrete placed in situ. A compound and access route will be established. Construction of an in-situ flow structure will involve:
    - The measure outlined above control:
    - Fixing of reinforcement for flow control structure foundations,
    - Placing of formwork for flow control structure foundations,
    - Placing of cast in-situ concrete for flow control structure foundations,
    - Stripping of formwork,
    - Similar works for the construction of a precast concrete flow control structure, with the option of using precast units.
    - The placing and fixing of a precast concrete bridge deck, and
    - Construction of bridge parapets.
- Where it is determined, following detailed site investigation, that there is a possibility of flood water passing underneath the structures, either sheet piles or grouting techniques will be required to provide a cut-off. The sheet piles may be metal or plastic and will be driven to the required depth using a piling hammer or similar.
- The excavation will be backfilled, the area reinstated, and the works area reopened. Permanent reinstatement of road surfaces may be required approximately six months following reopening of the road.
- The ground around the structure will be regraded.

3.2.2.7 Culverts

There are six locations identified for new or replacement culvert works proposed as part of the Scheme, some of which will be constructed in streams or drainage channels flowing into the River Lee.

Construction works to culverts, including all storm culverts along with quay wall will take place as follows:

For large masonry, arch culverts (typically shown with a cyan cross hatch on the drawings):

- Non-return valves will be installed on all existing lateral drainage connections into the culvert (i.e. the main culvert itself will not be blocked up). This will require working within the culvert.
- Repointing and masonry repairs will be carried out within the culvert
- Potential construction of a concrete ballast slab above the roof of the culvert to ensure structural stability during a flood (as the floodwater will be pressing up on the arch)

For large reinforced concrete culverts (also shown with a cyan cross hatch):

- Non-return valves will be installed on all existing lateral drainage connections into the culvert (i.e. the main culvert itself will not be blocked up)
- Any joints (such as joints between precast units) will be raked out and resealed. Resealing is typically done using a mechanical gasket hammered into the joint.

For smaller culverts / drainage outfalls through the quay walls:

- Non-return valves will be installed over the ope at the face of the quay wall.
- The existing rectangular-shaped outfalls (e.g. at Morrison's Quay, Union Quay etc.), are often circa 1m high x 0.5m wide. In these cases, we will typically seek to first reduce the size of the outfall before installing a smaller non-return valve. We will do this by inserting a pipe into the outfall and then blocking up the intervening space with concrete, with masonry facing at the face of the quay wall.

3.2.2.8 Bridge Parapets

New/ upgraded bridge parapets will be constructed as follows:

- Isolation of works area, including traffic management.
- One lane of the bridge will be closed at a time where possible. Where sufficient space is not available to accommodate a working area and live traffic, a road closure will be acquired and alternative access put in place.
- The existing bridge parapet/ railings will be removed where these exist.
- New steel parapet to be fixed to bridge structure.
- The lane will be opened, the second lane closed and the plant and equipment will be relocated to the location of the second parapet.

3.2.2.9 Drainage Works

The drains/ surface water sewers will be constructed by one of two methods as follows:

- Where the trench does not overlap with the footprint of the excavation for the flood wall, the trench of the drainage pipe will be set out. Where the trench is located in a road, the road will be saw cut. Where the trench is located in a grassed area, the topsoil will be removed and stored in close proximity to the trench. The trench will then be excavated to the required depth. Excavated material unsuitable for use as backfill material will be disposed of to an approved waste management facility. Pipe bedding will be placed, followed by the pipe and granular pipe surround. Trenches in roads will be backfilled with granular material or lean mix concrete, depending on its location in accordance with the Guidelines for Managing Openings in Public Roads. Trenches in grassed areas will be backfilled with suitable excavated material, following which the original topsoil will be replaced. The trench will be left to consolidate for approximately six months, following which the surface layer will be removed if necessary, the backfill material will be supplemented and the trench reinstated.
- Where the trench overlaps with the footprint of the excavation for the flood wall, the steps outlined above will be taken. The order of excavation, pipelaying, backfilling and reinstatement will depend on the sequence of construction of the retaining wall and the proximity of the proposed retaining wall to the pipe trench. The pipe may be laid and partially backfilling prior to pouring of concrete for the wall. Pipelaying may alternatively take place following pouring of the base of the wall or following construction of the wall.
- Where a drain is proposed along the toe of a proposed embankment, the drain will be constructed during excavation works and prior to construction of the above ground embankment.

3.3 CONSTRUCTION PROGRAMME AND SEQUENCING OF PROPOSED WORKS

The construction works will be preceded by geotechnical and archaeological investigations as necessary. The construction works themselves will be subject to the following programme constraints:

- Instream works (include preparatory work) on all watercourses supporting salmonids shall be undertaken from May to October (inclusive) and in consultation with Inland Fisheries Ireland to avoid accidental damage or siltation of spawning beds.
- 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.

It is proposed to undertake the scheme in a number of phases as follows:

- Phase 0 – Morrison's Island Advance Contract (Morrison's Quay, Fr. Mathew Quay, Trinity Footbridge) – This will provide greater protection against high frequency tidal events and will raise the threshold of flooding for South Mall, Oliver Plunkett Street etc., from circa 1 in 2 years to 1 in 10 years.

- Phase 1 – West of the City (everything west of Wellington Bridge) – will facilitate greater advance dam discharges at low tide and thus reduce fluvial flood risk
- Phase 2 – Wellington Bridge to Vincent's Bridge – eliminate fluvial flood risk for all but the most extreme flood events
- Phase 3 – Other city centre locations susceptible to high frequency tidal flooding
- Phase 4 – Complete remaining north channel defences (Full fluvial and tidal protection to the design standard to north channel)
- Phase 5 – Complete remaining south channel defences (Full protection to the design standard in study area)

The works are to be phased to ensure the following:

- Contract values of a scale that allows sufficient competition amongst suitable civil engineering contractors
- Manageable contract durations of circa 18 months to 24 months each
- Incremental reduction in flood risk (and increase in flood protection) as each phase is completed, with fast gains expedited.
- Mitigate impacts on residents, businesses, traffic etc. during construction
- Align with available State funding budgets

3.4 CONSTRUCTION COMPOUNDS AND TEMPORARY WORKS FACILITIES

The site compounds for each Contract will be located on a brownfield site in the immediate vicinity of the works. The selection of the compound will be by each Contractor appointed to construct the works in consultation with the Office of Public Works and the project ecologist. Due to the length of channel involved, the Contractors may choose to move the compounds during the construction periods, in which case the same selection process shall apply. Site compounds will be bound by the mitigation measures identified within this EIS in particular with regard to traffic management, ecology, archaeology and noise and air mitigation measures.

3.5 ESTIMATED COST OF PROPOSED WORKS

The estimated cost of the Lower Lee (Cork City) Drainage Scheme is €75M to €90M, excluding VAT, and Non-Contract Costs.