PROJECT:

Castletroy Wastewater Treatment Plant Upgrade Project

REPORT:

Engineering Services Report

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SECTION 1: INTRODUCTION

1.1 Scope of the Report

J.B. Barry and Partners Ltd. Have been commissioned by Uisce Éireann (formerly Irish Water) to prepare a planning application for permission for the upgrade of Castletroy Wastewater Treatment Plant (WwTP) at Dromroe, Castletroy, Limerick.

The applicant for this planning application is:

- Name: Uisce Éireann
- Address: Colvill House, 24-26 Talbot Street, Dublin 1

As of 14th January 2014, Uisce Éireann assumed responsibility from local authorities for water services functions nationally. Uisce Éireann is a regulated water services utility. The Environmental Protection Agency (EPA) is the technical and environmental regulator and, amongst other things, issues and enforces authorisations for wastewater discharges. The Commission for Regulation of Utilities (CRU) is the financial regulator and aims to ensure water services are delivered in a safe, secure and sustainable manner and that Uisce Éireann operates in an efficient manner. One of the key ways in which the CRU does this is through the revenue control process.

This report should be read in conjunction with the entire planning package which includes:

- Planning Statement;
- Engineering Drawings;
- Appropriate Assessment (AA) Screening;
- Appropriate Assessment Stage 2 Natura Impact Statement (NIS);
- Outline Construction Environmental Management Plan (CEMP);
- Flood Risk Assessment (FRA);
- Invasive Species Survey Report;
- Environmental Impact Assessment Report (EIAR);
- Statutory notices, application form; etc.

1.2 Purpose of this Report

The purpose of this Engineering Services Report is to support a planning application being made as a Strategic Infrastructure Development (SID) under Section 37B of the Planning and Development Act 2000 (as amended), and it provides a description of the proposed development, how it will function and how it will serve Castletroy and the surrounding areas.

1.3 Brief Outline of Development

Castletroy WwTP was constructed in the early 1990's. The plant is situated 3km north-east of Limerick City and adjacent to the University of Limerick. An overview of the site and local surrounds is presented in Figure 1.

The sources of wastewater loading are from the residential population, University of Limerick, commercial and industrial sectors. The plant also treats imported sludges and leachates, and pumped loads from Castleconnell and Annacotty. Incoming flows from Castleconnell Pumping Station (PS) and Mountshannon PS feed into the 1050mm gravity sewer serving Castletroy WwTP. There is a sewer connection upstream of the main inlet wet well which serves as a discharge point for leachate. Discharge of effluent from the plant is to the Lower River Shannon. The agglomeration was issued a wastewater discharge licence by the EPA in April 2009 (EPA ref D0019-01).

Figure 1: Location Map

1.4 Planning Application

Castletroy WwTP is projected to be overloaded within 10-years. The objective of the project is to upgrade the existing Castletroy WwTP to cater for a 10-year growth period up to the year 2028 to 77,500 PE (with provision in the civil infrastructure to meet the +25-year growth period of 81,100 PE). This upgrade will allow for domestic, commercial, institutional, and industrial future projected loadings. The planning application is for development within the existing site boundary.

This upgrade will ensure compliance with the minimum requirements of Urban Waste Water Treatment Directive and with Waste Water Discharge Authorisations requirements while providing appropriate capacity as per relevant Uisce Éireann polices.

1.4.1 Strategic Infrastructure Development

Pre-application discussions have been entered with An Bord Pleanála (ABP) under Section 37B of the Act to determine whether the proposed development project for Castletroy will be classified as Strategic Infrastructure Development (SID).

SID development is defined in the 7th Schedule of the Planning and Development Act 2000 (as amended). It is any development that is of strategic economic or social importance to the state or a region. It includes development that contributes significantly to the fulfilment of the objectives of the National Spatial Strategy or Regional Spatial and Economic Strategy (RESES) for an area, or which would have a significant effect on the area of more than one planning authority. It also includes 'Environmental Infrastructure' development, which refers to wastewater treatment plants with a capacity greater than 10,000 PE. Planning applications for SID are made directly to An Bord Pleanála and not to the Local Authority.

The existing plant exceeds the 10,000PE threshold and the proposed development will provide for an uplift of 42,100PE. Therefore, it constitutes Environmental Infrastructure and requires an EIA to be conducted. Based on this condition and considering impacts in relation to other terms within the 7th Schedule, and as such the proposed development is classed as SID.

1.4.2 Environmental Impact Assessment Report (EIAR)

An Environmental Impact Assessment (EIA) for the proposed upgrade is being carried out in parallel with this report, undertaken as part of the planning process and in accordance with the EIA Directive (2014/52/EU). The Environmental Impact Assessment Report (EIAR) details the potential environmental impacts which may arise as result of the construction and operational phases of the proposed development.

SECTION 2: OVERVIEW

2.1 Proposed Development

The proposed development comprises of the construction of new wastewater treatment plant upgrades at the existing Castletroy WwTP site. All upgrades will be located within the existing site boundary.

The constituent elements are described below:

- Replacement of the existing storm pumps in the inlet pumping station including the modification of pipework and fittings.
- A 4,500m^3 capacity stormwater tank with sufficient capacity for the projected 10-year and 25-year loadings.
- Stormwater return pumping station to return flows from the stormwater tank for primary and secondary treatment.
- Upgrade of the existing preliminary treatment screens to cater for higher flows.
- Construction of a new grit trap to provide redundancy to the preliminary treatment process.
- Installation of decking over the existing inlet works structure and installation of odour abatement equipment.
- A new forward feed pumping station which will transfer flows to primary treatment. Wastewater will be pumped to an elevated splitter chamber to allow flows gravitate through the primary treatment process.
- Installation of primary treatment filtration units in a proposed treatment building. The structure will also be used for the installation of control panels, operational equipment and instrumentation.
- Construction of a new primary sludge holding tank which will store sludge removed from primary treatment. Sludge will be pumped to the upgraded dewatering plant within the site.
- Upgrade of the existing secondary treatment tanks with an integrated fixed film activated sludge (IFAS*)* process.
- Installation of stamford baffles (or similar) around the perimeter of two of the existing 20m dia. clarifiers to increase flow through each tank.
- A new scum pumping station will collect and transfer scum removed from the clarifiers to the thickened sludge storage tank.
- The existing 7.1m diameter 'Picket Fence Thickener' (PFT) will be repurposed as a thickened sludge storage tank.
- A new larger diameter PFT will be constructed.
- The existing sludge dewatering equipment will be upgraded with new centrifuges. Internal modifications to the existing sludge treatment building first floor will be required for the equipment.
- Sludge storage skips will be located on external concrete plinths. Sludge transfer pipework and valves will be installed to control sludge transfer from the dewatering units to the skips.
- An odour abatement unit will be installed external of the sludge and primary treatment buildings.
- One bulk storage tanks will be installed with an integrated bund to contain Ferric Sulphate (Fe_2SO_4) for phosphorous removal, complete with eye-wash station and dosing pumps.
- A flood event pumping station is required to allow the plant to remain operational during high river levels. The walls of the existing final effluent inspection chamber will be increased to protect from flood water.
- A tank will be installed adjacent the existing groundwater well on site to provide storage. The borehole is used to supply washwater to various existing treatment processes and will also be used for proposed upgrades. The storage tank will ensure sufficient supply is available to meet peak demands.
- Solar Panels will be installed on the Primary Filter Building.

SECTION 3: PROJECT BACKGROUND

3.1 Existing Wastewater Facilities

Flows arrive at the Castletroy WwTP via 1,050 mm diameter gravity sewers from the east and west. These combine into a single 1,050 mm diameter gravity sewer within the site boundary. This sewer then combines with the return supernatant liquors from the sludge dewatering process before entering the inlet pump sump through a 1,100 mm diameter pipe.

Three dry weather flow pumps and two storm pumps operate to maintain levels within the pumping station sump. Both sets of pumps transfer flows to the preliminary treatment (inlet) works. If the combined capacity of the pumps is exceeded, levels within the wet well rise and wastewater discharge through an emergency gravity overflow. The overflow discharges to a 1,050mm diameter final effluent pipe which also collects secondary overflows from the inlet works, as well as final effluent from the secondary treatment clarifiers. Flows are transferred to the final effluent inspection chamber before discharge to the Lower River Shannon.

The EPA Licence refers to the storm water overflow at Castletroy WwTP inlet pumping station as SWO (SW5) however this was reclassified as an EO in the "Castletroy Agglomeration Storm Water Overflow Assessment" contained in Appendix 7.5 of the Annual Environmental Report 2014. SW5 is only designed to operate if there is failure of the dry weather flow and storm pumps. There are no stormwater storage tanks within the existing plant. Storage is utilised within the split-level inlet pumping station.

Influent is currently dosed with ferric sulphate from a chemical storage tank installed adjacent to the inlet works to assist in the removal of phosphorus.

Flows from the foul and storm pumps discharge to the inlet works for preliminary treatment which consists of screening (duty/standby) and grit removal. Screenings are washed and compacted before discharge to a skip. The inlet works is sufficiently sized for incoming flows into the plant however mechanical equipment, including screens, are near end of life.

A single mechanical filter is installed downstream of the grit removal process to reduce the Suspended Solids (SS) and Biological Oxygen Demand (BOD) prior to secondary treatment. Sludge removed from the filter is discharged to a skip for removal of site.

Flows then pass through an overflow channel followed by a mechanical flume. The overflow channel controls 'flow to full treatment (FFT)' by limiting flow, with excess flows overtopping the channel and discharging to the final effluent pipe. This pipe also collects flows from the emergency gravity overflow and treated final effluent prior to discharging to the final effluent inspection chamber.

The secondary treatment process consists of a conventional secondary treatment activated sludge plant. The volume of the twin stream activated sludge tanks is approximately 2,900m^3 each following an increase of the top water level under an upgrade project. The aeration system was also upgraded to a functional fine bubble diffused aeration (FBDA) system during the same upgrade in 2016.

Three no. secondary clarifiers are in operation as part of the treatment works. Two original clarifiers measure 20m in diameter, with the more recent constructed clarifier in 2010 having a larger diameter of 25m. From the secondary clarifiers, settled 'Return Activated Sludge' (RAS) is pumped back to the aeration tank. 'Waste Activated Sludge' (WAS) is pumped forward to the Picket Fence Thickeners (PFT).

Two picket fence thickeners are in operation as Castletroy WwTP. Three no. secondary clarifiers are in operation as part of the treatment works. The original constructed PFT has a diameter of 7.1m and a volume of 195m^3. The more recent PFT was built in 2010 and has a larger capacity with a diameter of 12m and a volume of 470m^3. The PFTs are operated on an alternating basis which involves a weekly manual changeover and manual decant. The clarified water is discharged to the final effluent inspection chamber before discharge to the Lower River Shannon.

Sludge is dewatered through a belt press and centrifuge installed on the first floor of the sludge dewatering building. The centrifuge has not operated for a number of years due to maintenance issues. Sludge from the dewatering process is dropped into a storage skip located directly beneath at ground level.

The final effluent inspection chamber is located close to the Lower River Shannon. The chamber comprises of three sections. The third section of the chamber is further divided into three smaller 'Outlet Chambers', each servicing one of the three 630mm diameter outfall pipes. Each outfall pipe is connected to two 355mm OD risers and 180mm OD Diffuser Heads. The diffuser heads have four individual legs to disperse flows into the Lower River Shannon.

At present, only the centre outfall pipe is in operation. The final effluent flows from the second section of the final effluent inspection chamber over the V-notch weir into the outlet chamber and through the outfall pipe to the diffuser. The remaining two outlet chambers are currently isolated by steel plates. Problems are periodically experienced during high river flows when the inspection chamber is flooded. This prevents accurate flow measurement of the final effluent.

Operation of the plant can be viewed and managed through SCADA systems installed in the administration building and sludge dewatering building.

The associated existing Wastewater Discharge License (WWDL), registration number D0019-01, issued on the 22nd of April 2009 for the Castletroy and environs agglomeration is for a Population Equivalent (PE) of 39,000. From the Annual Environmental Report (AER) prepared for the Castletroy agglomeration in 2021 (latest available report), it is noted that:

- The WwTP discharge was not compliant with the Emission Limit Value's (ELV's) set in the wastewater discharge licence for the following: ortho-Phosphate (as P) - unspecified mg/l.
- The ambient monitoring results do not meet the required Environmental Quality Standard (EQS) at the downstream monitoring location. The EQS relates to the Oxygenation and Nutrient Conditions set out in the Surface Water Regulations 2009.
- Based on ambient monitoring results a deterioration in BOD concentrations downstream of the effluent discharge is noted.
- The discharge from the wastewater treatment plant does not have an observable negative impact on the Water Framework Directive status.

Specified improvement programmes are included as part of the EPA AER. These are listed as follows:

Table 1: EPA Specified Improvement Programme

Specified Improvement Programmes (under Schedule A and C of WWDL)	Description	Licence Schedule	Completion Date	Status of Works	Timeframe for Completing the Work
D0019-SIP:02	SW-4 Upgrading of Storm Water Overflows to comply with the criteria outlined in the DoEHLG 'Procedures and Criteria in relation to Storm Water Overflows, I995	C	31/12/2009	Complete	N/A

Specified Improvement Programmes (under Schedule A and C of WWDL)	Description	Licence Schedule	Completion Date	Status of Works	Timeframe for Completing the Work
D0019-SIP:03	SW-5 Upgrading of Storm Water Overflows to comply with the criteria outlined in the DoEHLG 'Procedures and Criteria in relation to Storm Water Overflows, I995	C	31/12/2020	At Planning Stage	2033

Uisce Éireann are currently preparing a Drainage Area Plan (DAP) to be completed in 2024 for the Limerick City and Castletroy agglomerations. The DAP will provide recommendations on optimum solutions to achieve SWO compliance taking into account the downstream impact on the wastewater treatment plants, including Castletroy WwTP. The provision of stormwater storage within the Castletroy WwTP forms part of the proposed upgrade for this project.

3.2 Existing Effluent Quality

The 2021 AER reports the organic load PE, peak week collected load, of 35,362 PE. This reduced from the 2020 peak week collected load of 40,200 PE. The EPA AERs show that the plant has been non-compliant with Licence Conditions in recent years. This was due to a breach in ortho-phosphate ELVs in 2018 and 2021, and the ammonia ELV in 2019.

The plant was compliant in 2020, however there were 13 no. environmental incidences that year. Environmental incidences common to the plant include spillages, uncontrolled releases and breaches in ELVs, caused mainly by adverse weather (no stormwater storage) and plant or equipment breakdown (aging plant). Since 2018, the plant has had an annual average of 10 no. EPA reportable incidences.

3.3 Need for Development

The key objectives for the Castletroy agglomeration include:

- The provision of sufficient treatment to consistently meet the required discharge standards.
- The provision of adequate capacity to facilitate the planned development and growth of the agglomeration.
- The provision of stormwater storage to reduce the number of independent storm events discharged via the storm water overflow.

It is proposed to upgrade the existing Castletroy WwTP to cater for a 10-year growth period up to the year 2028 to 77,500 PE (with provision in the civil infrastructure to meet the 25-year growth period of 81,100 PE). This upgrade will allow for domestic, commercial, institutional, and industrial future projected loadings. Upgrade work will be undertaken within the existing site.

As noted previously, no stormwater storage is currently provided at Castletroy WwTP. Some storage is available within the inlet pumping station sump through managing the operation of the pumps. Stormwater which exceeds the hydraulic treatment capacity of the plant currently discharges treated final effluent to the Lower River Shannon via the final effluent inspection chamber.

The Lower River Shannon is classified as contact/recreational waters, therefore the parameters as set out within Uisce Éireann's Technical Standard "Storm Water Overflows" (Document No. IW-TEC-800-03) require the overflow to be designed so that the maximum number of independent storm events discharged via the storm water overflow must, on average, not exceed 7 per bathing season. The bathing season in Ireland runs from 1st June to 15th September each year.

Stormwater storage volumes were calculated based on providing 2-hours retention for Formula A flows less flow to full treatment. Formula A was calculated based on the design projected loadings (domestic, commercial, institutional, and industrial) previously calculated. Allowances for water consumption and infiltration per head per day are in accordance with Uisce Éireann Document No. IW-TEC-700-99-02 "*Inlet works & stormwater treatment (wastewater)*". A further allowance of 20% was included to account for additional future storm flows resulting from climate change. Stormwater storage for a volume of 4,500m^3 is proposed for the development as agreed with Uisce Éireann.

As noted previously the Drainage Area Plan study for the Limerick City and Castletroy agglomerations is ongoing. Data from this study were taken into consideration for the design of the upgraded wastewater treatment plant.

Further details of the WwTP and storm storage tank will be provided in the later sections of this report, with details of both shown on the drawings in this planning application submission.

SECTION 4: DESIGN REQUIREMENTS

4.1 Organic Loading

4.1.1 Domestic, Commercial, and Institutional Contribution

A detailed population assessment (desktop) using census, geodirectory, water usage etc. data was carried out to establish the domestic and non-domestic contributions, as listed in Table 2. Institutional loading (schools, university) assessments were also carried out. A growth rate of 3.28% over 10 years was used. The 2018 flow and load Survey was assessed to validate the current calculated desktop PE figures.

Projections were broken down into two categories; a 10-year growth period up to 2028 and a 25-year growth period up to the year 2042. Headroom of 20% is provided after the growth rates are considered. Growth rates are broken down against domestic, commercial and institutional categories and includes a 20% headroom allowance. Further Information is provided in Section 3.3.1 Volume 2 Part A of the EIAR.

The projected loading for the 10-year growth period from 2017 up to the year 2028 is taken as 35,942 PE, as per Table 2. Further to this, the projected loading for the 25-year growth period up to the year 2042 is taken as 39,492 PE.

As noted previously, this planning application is for the 10-year growth projections, however, 25-year projections were also assessed regarding the sizing of civil infrastructure(s). These are elements of the Proposed Development that are not feasible to replace or expand upon in the medium term, such as the stormwater storage tank and underground pipework. A new planning application will need to be submitted for the phase 2 uplift from 77,500PE to 81,100PE, whereby the remaining available volumes will be utilised.

Table 2: Design PE - 10-year Loading Projections (Domestic, Commercial, and Institutional)

Populations	Year 2017 (with 2016 CSO figures)	Year 2022 (Current) with 3.28% Growth	Growth Rate (3.28%) to Year 2028	Growth Rate (0,63%) to Year 2033	Headroom (20% on 10 year Growth)	Total Future 10-year Loading
Domestic Population	15,517	18,234	21,427	22,250	4,285	25,713
Commercial Loading	2,483	2,917	3,428	3,538	686	4,114
Institutional Population	3,690	4,336	5,096	5,258	1,019	6,115
Total Loading	**21,690**	**25,488**	**29,951**	**31,046**	**5,990**	**35,942**

From Table 2 above the projected loading for the 10-year growth period up to the year 2028 is taken as 35,942 PE.

The 2016 CSO provided significant details and information, including small area populations and house count, required to estimate the 2017 baseline population which was validated with a flow and load survey undertaken in 2018. 2022 CSO detailed figures will not be available until December 2023 and therefore we have applied the agreed growth rate of 3.28% to estimate the 2022 domestic population. The current loading to the WwTP (2022) as contained in Appendix 3A of the EIAR is c. 22,500 PE (excluding the Trade Effluent Industrial Loading which currently accounts for 16,500 PE).

Applying the agreed growth rates to the current year (2022) and projecting to 2033 there is a difference of c. 1,100 PE when compared to 2028 projected growth. Should this growth rate of 3.28% occur up to 2028 and 0.63% up to 2033, there is provision made in the design PE for 20% headroom which equates to 5,990

PE and therefore adequate redundancy is provided to cater for this growth variation. Headroom is spare capacity above demand to cater for production risk and provide flexibility in capacity to meet new demands, also to cater for variability in demand arising from factors such as weather and operational risk and some upward variation around projected development demand. Refer to Growth and Headroom TGN contained in Appendix 3A of the EIAR.

Table 3: Design PE - 25-year Loading Projections (Domestic, Commercial, and Institutional)

Populations	Year 2017	Growth Rate (0.63%) Year 2028 to 2042	Headroom (20% on 25 year Growth)	Total Future 25 year Loading
Domestic Population	15,517	23,544	4,709	28,253
Commercial Loading	2,483	3,767	753	4,520
Institutional Population	3,690	5,599	1,120	6,719
Total Loading	**21,690**	**32,910**	**6,582**	**39,492**

From Table 3, the projected loading for the 25-year growth period up to the year 2042 is taken as 39,492 PE.

4.1.2 Industrial Contribution

The current Integrated Pollution Control (IPC) Licenses total committed load to the Castletroy agglomeration is 2,170 kgBOD/day (36,667 PE where 1 PE is defined as 0.06 kg BOD/day) of which a significant industrial contributor has a licence to discharge 1,650 kg BOD/day (maximum) to sewer, which equates to 27,500 PE for a maximum emitted volume of 1,800m^3 in any one day (20.8 l/s). The maximum rate per hour is stipulated at 145m^3 (40 l/s). The 2021 average discharge from this significant contributor was 16,460 PE, refer to Appendix 3A of the EIAR.

An additional uplift to 1,965 m^3/day has been sought from Uisce Éireann for an increased flow rate of 1,965 m^3/day by 2023 (from 1,800 m^3). A flow rate of 2,500 m^3/day is therefore assumed for design calculations.

This projected flow of 2,500 m^3/day is inclusive of a 5,500 PE loading committed by the IDA, which assuming a concentration of 1,000 mg/l equates to a flow rate of 330 m^3/day and loading of 330 kg BOD/day.

This provides a loading of 2,500 kg BOD/day and equates to a Population Equivalent of 41,667. The projected industrial projections for Castletroy WwTP are shown in Table 4.

Table 4: Design PE – Committed Allowances as per Existing IPC (Industrial) Licences

Facility	Daily Average Flow (m3/d)	BOD Concentration (mg/l)	Organic Loading kg/BOD/day	Total Future Loading
IDA Committed Load	330	1,000	330	5,500
Existing IPC Licences	2,170	1,000	2,170	36,167
Total Loading	**2,500**	**1,000**	**2,500**	**41,667**

4.1.3 Summary of Design Loadings

Table 5 provides a summary of all projected 10-year growth PE figures including for domestic, commercial, institutional, and industrial PE loading. The total 10-year design capacity for Castletroy WwTP is 77,609 PE. Table 6 lists the relative average daily organic loading (kg/day) to the WwTP.

Table 5: Design PE - 10-year PE Loading Projections Summary

Facility	Total Future Loading
Domestic, Commercial, and Institutional	35,942
Industrial	36,167
IDA Committed Load	5,500
Total	**77,609**

Table 6: Average Daily 10-Year Organic Loading Projections

Parameter	Value
Carbonaceous Biological Oxygen Demand (CBOD)[1]	4,650 kg/day
Chemical Oxygen Demand[2]	9.765 kg/day (CBOD:COD ratio is 2.1)
Total Suspended Solids[2]	3,375 kg/day
Total Nitrogen[2]	540 kg/day
Total Phosphorus[2]	90 kg/day

**Figures do not include Vistakon loading and assumed to negligeable for TSS, ammonia and TP.*

Table 7 provides a summary of all projected 25-year growth including for domestic, commercial, institutional, and industrial loading. The total design capacity for Castletroy WwTP is 81,159 PE. Table 8 lists the relative average daily organic loading (kg/day) to the WwTP.

Table 7: Design PE - 25-year PE Loading Projections Summary

Facility	Total Future Loading
Domestic, Commercial, and Institutional	39,492
Industrial	36,167
IDA Committed Load	5,500
Total	**81,159**

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[1] Average daily CBOD loads have been based on per-capita contributions of 60 g BOD/c/d.

[2] Average daily loads of 75 g TSS/PE/d, 2g TP/PE/d and 12g TN/PE/d is used on the domestic, institution and commercial contributions. In addition COD:BOD ratio for industrial trade effluent organic loading is 1.8 therefore an overall CBOD:COD ratio of 2.1 is used.

Table 8: Average Daily 25-Year Organic Loading Projections

Parameter	Value
Carbonaceous Biological Oxygen Demand (CBOD)[1]	5,068 kg/day
Chemical Oxygen Demand[2]	10.64 kg/day (CBOD:COD ratio is 2.1)
Total Suspended Solids[2]	3,679 kg/day
Total Nitrogen[2]	589 kg/day
Total Phosphorus[2]	98 kg/day

4.2 Hydraulic Loadings

4.2.1 Domestic, Commercial, and Institutional Contribution

The projected 10-year and 25-year loading rates were used to determine incoming design flows to Castletroy WwTP, both Dry Weather Flow (DWF) and flow to full treatment (FFT). The following flows were used for the purpose of calculations and are obtained from Uisce Éireann specification 'Inlet works & stormwater treatment (wastewater)' (Document No. IW-TEC-700-99-02). Summary of values used are listed below:

- Water Consumption: 175 l/head/day
- Infiltration: 50 l/head/day
- Population served (P): 35,942
- Trade effluent(E): 2,500 m^3/day (from Table 4)

Hydraulic loads have been based on per-capita contributions of 225 l/PE/d for 'Dry Weather Flow' in line with industry practice. Average daily flows uses the actual infiltration to the network which is reasonably well aligned with the 'Dry Weather Flow'.

The following formulas were used in calculating 'Dry Weather Flow' and 'Flow to Full Treatment' for Castletroy WwTP and is based on a Fully Combined System:

- DWF: (P x C) + I + E
- FFT: 3(P x C) + I + E

Table 9: Design Hydraulic Loading Projections (Domestic, Commercial, and Institutional)

Projection Period	Population Equivalent	DWF m^3/day	DWF l/s	FFT m^3/day	FFT l/s
10-Year	35,942	8,087	94	860	239
25-Year	39,492	8,886	103	946	263

4.2.2 Industrial Contribution

Projected industrial loadings for the 10-year growth period were previously established. As already noted, recent laboratory testing at the major industrial contributor reports a BOD concentration of 1,000mg/l. Using this concentration with the estimated PE of 41,667, the projected average industrial flow to Castletroy WwTP is calculated at 2,500m^3/day.

Table 10: Design Hydraulic Loading Projections (Industrial)

Population Equivalent	Organic Loading kg/BOD/day	BOD Concentration (mg/l)	Max. Daily Flow (m^3/day)	Peak Flow (l/s)
41,667	2,500	1,000	2,500	58

4.2.3 Summary of Design Loadings

The summary of the10 and 25 year hydraulic loading outlooks to be used for design purposes are presented in Table 10 below.

Table 11: Summary of Hydraulic Loading Projections

Projection Period	Total Average Flow (m^3/day)	Total Average Flow (l/s)	Total Peak Flow (FFT) (m^3/hour)	Total Peak Flow (FFT) (l/s)
10-Year	10,541	122	1,069	297
25-Year	11,386	132	1,155	321

SECTION 5: WATER QUALITY AND DISCHARGE REQUIREMENTS

5.1 Introduction

The proposed WwTP at Castletroy will be designed to provide treatment to result in a discharge standard that complies with the relevant Irish and European legislation. The following sections set out the approach that has been undertaken with respect to the assessment of the discharge standard requirements, and wastewater treatment process options and design.

5.2 Proposed Wastewater Treatment Standard

5.2.1 Urban Waste Water Treatment Regulations

The Urban Waste Water Treatment Regulations, 2001 (S.I. No. 254 of 2001) have replaced the Environmental Protection Agency Act, 1992 (Urban Waste Water Treatment) Regulations, 1994, as amended in 1999. These Regulations give effect to the Council Directive 91/271/EEC of 21st May 1991, as amended, concerning Urban Wastewater Treatment. In these Regulations, requirements for the provision of urban wastewater collection systems and wastewater treatment, together with an associated timeframe in which these requirements must be met, are set out.

As discussed previously, the EPA issued a wastewater discharge licence (WWDL) for the agglomeration of Castletroy of 39,000 PE and its environs on the 22nd April 2009. The WWDL was issued under Regulation 28(1) of the Waste Water Discharge (Authorisation) Regulations 2007. The licence register number is D0019-01 and the Licensee was Limerick County Council. The discharge location is the Lower River Shannon (WFD Code: IE_SH_25_3904).

On the 16th December 2016 the EPA issued a Technical Amendment A to the original WWDL. This amendment included changing the Licensee to Uisce Éireann, an amendment to the Glossary of Terms and some changes to monitoring frequency and exceedances. It did not change the ELV values.

Table 12: Castletroy WwTP Discharge License ELVs

Parameter	ELV
BOD	25 mg/l
COD	125 mg/l
Suspended Solids	35 mg/l
Ammonia (as N)	5 mg/l
Orthophosphate (as P)	1 mg/l
Total Phosphorus (as P)	2 mg/l
pH	6.0 – 9.0

Chapter 14 Water of the Environmental Impact Assessment Report (EIAR) Part B applied reduced ELVs more stringent limits for the purpose of assessing the impact of final effluent on the receiving water. There should be no reduction in WwTP performance compared to the current situation with regard to quality of the final effluent. And therefore, meeting more stringent ELVs will be achievable.

Future ELVs will be subject to licence review, but for the purposed of the assessment undertaken the following limits Table 13 were applied.

Table 13: Proposed Castletroy WwTP Discharge License ELVs

Parameter	ELV
BOD	20 mg/l
COD	125 mg/l
Suspended Solids	35 mg/l
Ammonia (as N)	2 mg/l
Orthophosphate (as P)	0.75 mg/l
Total Phosphorus (as P)	1.5 mg/l

Chapter 14 of the EIAR Part B indicated that by reducing the ELVs, downstream water quality will remain within high status mean Environmental Quality Standards (EQS) values.

SECTION 6: PROJECT DESCRIPTION AND PROPOSED DEVELOPMENT WORKS

6.1 Overview

The proposed upgrades will be developed at the existing Castletroy WwTP site and will provide preliminary, primary, secondary and tertiary treatment of the wastewater prior to discharge to the Lower River Shannon. Stormwater storage, sludge treatment and ancillary process elements such as pumping, control and measurement will also be provided. Ancillary site works such as buildings, kiosks, and site roads will also be constructed.

6.2 Stormwater Storage

6.2.1 Stormwater Volume

Formula A was calculated based on the 25-year design projected loadings (domestic, commercial, institutional, and industrial). Allowances for water consumption and infiltration per head per day are in accordance with Uisce Éireann Document No. IW-TEC-700-99-02 'Inlet works & stormwater treatment (wastewater)':

Formula A flows are the industry standard for design that considers the Dry Weather Flow (DWF) and an allowance for storm flows as a factor of population as per HMSO (1970) Report of the Technical Committee on Storm Overflows and the Disposal of Storm Sewage.

Summary of values used are listed below:

- Water consumption I: 175 l/head/day
- Infiltration (I): 50 l/head/day
- Population served (P): 39,492
- Trade effluent(E): 2,500 m^3/day

The following formulas were used in calculating Formula A for Castletroy WwTP and is based on a Fully Combined System:

- Dry Weather Flow = (P x C) + I + E
- Flow to Full Treatment = 3(P x C) + I + E
- Formula A = DWF + 1360P + 2E

The following formula was used to calculate the required volume for the storm storage tank which is taken from Uisce Éireann Document No. IW-TEC-700-99-02 'Inlet works & stormwater treatment (wastewater)'.

- Required Volume = 2 hours retention at Formula A – FFT

The design Formula A flow rate and required volume for the Storm Tank are produced in Table 14.

Table 14: Formula A and Storm Tank Sizing (25-year Loading)

DWF (m^3/hour)	Formula A (m^3/hour)	FFT (m^3/hour)	Storm Tank Volume (m^3)	+20% Climate Change (m^3)	+1.05m Freeboard (m^3)
474	2,921	1,050	3,741*	4,500	5,445

**volume rounded to 3,750m³*

A storm storage tank with a minimum volume of 3,750m^3 is required as part of the Castletroy WwTP upgrade works calculated in accordance with Uisce Éireann specifications. It was agreed with Uisce Éireann that an additional 20% capacity should be added to the stormwater storage tank to allow for climate change. This results in an increased required storage volume of 4,500m^3 with an additional 945m^3 to include freeboard.

The two existing emergency overflows connecting to the 1,050mm pipe will be retained for emergency measures. The 900mm overflow from the SWO chamber will be intercepted and diverted to a new storm tank via a 1,000mm diameter pipe. A manhole will be constructed at the point of interception and constructed in accordance with Uisce Éireann Standard Details. There are no records or reports of an emergency overflow event at the inlet pump station.

6.2.2 Stormwater Tank Design

Due to the available area on the existing site for constructing a stormwater storage tank and given that a portion of the current site lies within Flood Zones A and Flood Zone B, a rectangular structure is proposed to provide a more efficient design. The proposed stormwater tank will be constructed partially above ground with the top of walls located at an elevation above the 1% AEP fluvial design flood level of +6.97mOD which includes suitable freeboard and climate change allowance.

Specific design criteria for a rectangular storm tank as per IW-TEC-700-99-02 is as follows:

- The length: breadth ratio shall be in the range 3:1 to 4:1.
- The maximum width of a horizontal flow tank shall be 20.0 m.
- An inlet baffle shall be fitted to each tank.
- A suitable tank cleaning system shall be provided.
- The weir loading shall have a maximum of 450 m^3/m/day.
- Overflow weirs shall be protected with scum boards.

Due to constraints with associated with the location of existing infrastructure, the above requirements cannot be fully satisfied without increasing the depth of the structure and as such construction costs. Maximising available space between the 25m diameter Clarifier and the proposed primary treatment system allows for a tank length of 45m (internal dimension). Allowing for a width of 20m (internal dimension) an operating depth of 5m is required. The length:breadth ratio for the above dimensions is 2.25:1. This depth does not allow for lost storage volume as a result of benching and internal dividing walls.

Uisce Éireann is currently preparing a Drainage Area Plan (DAP) the Limerick City and Castletroy agglomerations. Model outputs for the current baseline versus future spill frequency, following the Proposed Development works, can be seen in Table 15. It is predicted that there will be an average less than 7 spills per bathing season, which ensures recreational water quality standards will be met. Therefore, the installation of the stormwater storage tank will result in a long term, significant, positive impact on receiving water quality.

Table 15: Limerick City and Castletroy Agglomerations Model Outputs

Year	Model Output	Average Annual Spills	Average Bathing Season Spills	Average Annual Spill Volume	Average Bathing Season Spill Volume
2018	Current Baseline	123	33	48,312	16,767
2028	Future Scenario	7	3	4,839	290

6.2.3 Stormwater Tank Cleaning System

Tipping Buckets

Tipping buckets are currently proposed for the tank cleaning system. The following are design requirements as per Uisce Éireann specifications:

- Static plus dynamic loading.
- Low noise tipping mechanism.
- Max drop height 6 m.
- Max flushing length 8 m.
- Curved wave wall.
- The minimum floor slope shall be 7.5° or '1 in 13.3'.

Design of the stormwater tank was undertaken which incorporates a tipping bucket cleaning system with reference to manufacture literature. The tank is proposed to be split into two cells connected through a high-level opening. Each cell will comprise of four lanes for a total of eight lanes.

Storm water will discharge into a lane located within the first cell which will concentrate the first flush of solids during a storm event. Each lane will be separated by a low internal wall to improve flushing performance. The second cell will start filling only when the first cell has reached capacity. Each cell is connected to a storm water return pumping station, which will return flows to the inlet works when incoming flows have reduced below flow to full treatment'.

Each lane will have a flushing length of approximately 22m with a drop height of over 4m. The floor has a design slope of 1:100 which discharges into a collection sump sized at 1.2 times the volume of the tipping buckets. The proposed flushing lengths are in exceedance of the maximum length of 8m specified in IW-TEC-700-99-02 and will therefore require a derogation. Jacopa technical literature shows that 20m flushing lengths, as proposed for Castletroy WwTP, are achievable subject to flushing volume, drop height, and floor slope. Tipping buckets are currently installed in Bunlicky WwTP and Enniscorthy WwTP for reference.

Flushing Bells

Flushing bells were also investigated as a potential alternative cleaning system. Information was provided by ELIQUO HYDROK.

The CWF Storm Flush system is a non-powered cleaning system which utilises storm water for the flushing process therefore requiring no additional wash water. The images below are from installations at Lifford WwTP.

Selected advantages of this system are noted as follows:

- Requires no power, water supply or controls
- Flushes even after partial fillings
- Fully self-priming and flushing operation
- No moving parts
- Utilises storm water for the flushing process
- Retains total volume of storm tank
- Final flush polishing stage utilizes settled storm water

A preliminary design was provided by ELIQUO HYDROK for the Castletroy WwTP stormwater tank. The design involved dividing the tank into four lanes, with each lane containing one 3.0m x 3.0m CWF and one 2.5m x 2.5m CWF.

While tipping buckets are proposed as the stormwater tank cleaning system, flushing bells offer an alternative solution and can be designed within the overall tank dimensions which form the planning application.

Figure 2: Lifford WwTP CWF Storm Flush Image 1

Figure 3: Lifford WwTP CWF Storm Flush Image 2

6.2.4 Stormwater Tank Overflow Screen

It is proposed to install a Huber Storm Screen ROTAMAT® RoK2 (or similar approved) as shown in the images below. The requirement for this screen is set out in Section 6.3. The screen will be installed along the length of the high level overflow weir of the structure. Any screenings will be retained within the storm tank and removed via the agreed storm tank cleaning system.

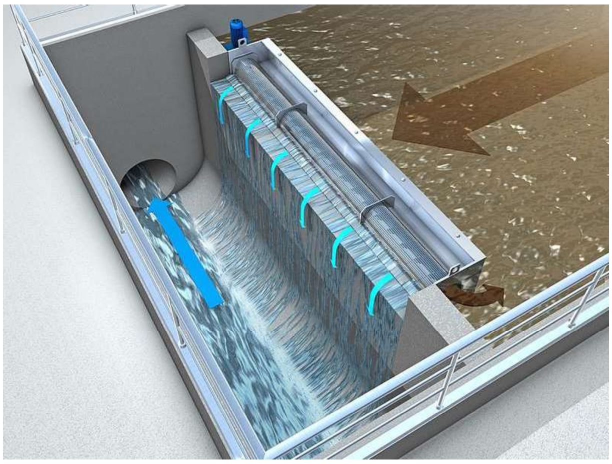

Figure 4: HUBER ROTAMAT® RoK2 Design Sketch

Figure 5: HUBER ROTAMAT® RoK2 Photograph

The following text is provided from Huber in relation to the above product:

"RoK2 screens are horizontally installed before the downstream side of overflow weirs. A screw flight is mounted on a half cylinder of perforated plate. As the stormwater flows down to up through the horizontal perforated half-pipe of the screen trough the solids are retained. A screw, with a brush attached on ist flights, rotates within the semi-circular screen trough. It cleans the screen and pushes the screenings gently towards the end of the trough. At the end of the trough, the screenings are returned into the sewer and carried to the wastewater treatment plant. During storm conditions the screen is automatically started and then works fully automatic".

The screen can be visually inspected from an overhead walkway. Maintenance will be undertaken when the tank is empty and using working at height equipment. Extracts from the Revit 3D model are shown in Figure 9.

6.2.5 Stormwater Return Pumping Station

Stormwater will be returned upstream of the inlet works stormwater overflow and downstream of the grit removal process. A pipework manifold will connect pipework from the stormwater return rising main with influent prior to entering the filtration process. The stormwater return pumping station will be integrated as part of the stormwater tank structure. A sump of 12m^2 capacity is required based on a maximum return flow rate of 132l/s and 10 starts per hour.

Stormwater will be returned at a rate not exceeding 1 time 'Dry Weather Flow' when incoming flow have been reduced to 2 times 'Dry Weather Flow'. The storm return sequence will terminate should the incoming flow rate increase to the point that the combined incoming flow and storm return flow is above 'Flow to Full Treatment'.

Figure 6: View of proposed area for storm tank

The area proposed for the construction of the storm tank is the green area shown on Figure 6. The views are from the existing Picket Fence Thickener overlooking the most recent constructed clarifier (25m diameter), and from the inlet works overlooking the existing 500mm inlet pipe in the direction of the sludge building.

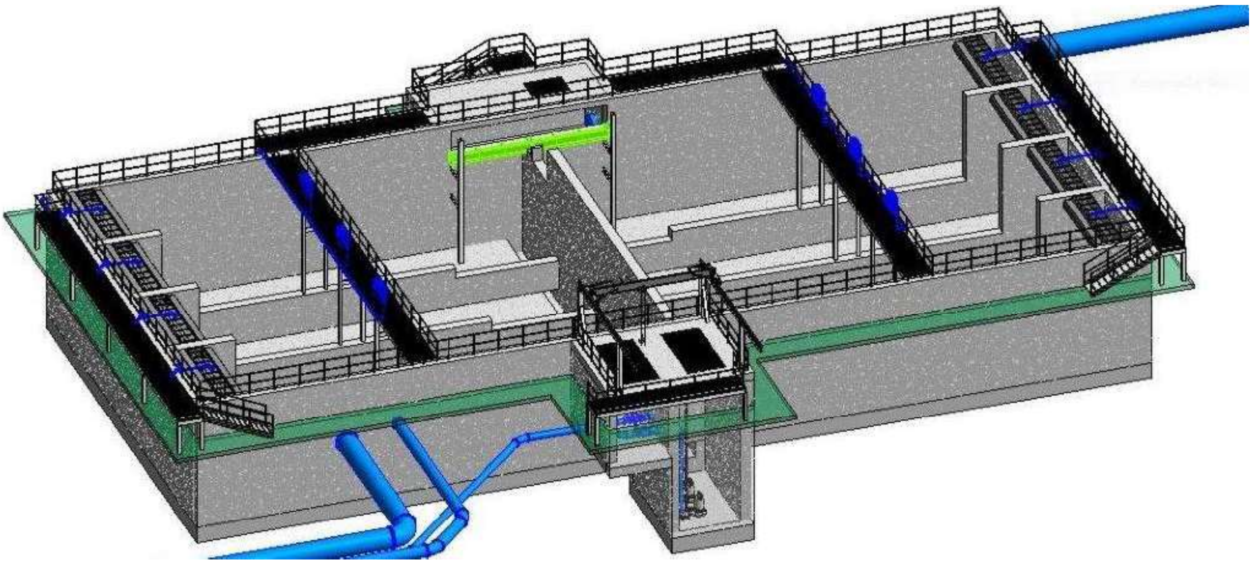

Figure 7: Revit model of proposed storm tank and return pumping station

Figure 7 shows a Revit model of the proposed twin cell storm tank, tipping bucket cleaning system, stormwater return pumping station, pipework, gantry beams, and access platforms. The tank is partially above ground and with the top of walls at a level above the 1% AEP design flood level.

6.3 Inlet Pumping Station

The Drainage Area Plan (DAP) study, which is being undertaken in parallel with the wastewater treatment plant upgrade, reported high incoming flows to the plant based on a 30-year storm event. During this scenario, incoming flows to the inlet pumping station would reach a maximum 1,200 l/s, which is greater than the 25-year Formula A flow calculated of 811 l/s. This would result in unscreened spills upstream of the inlet works which would discharge directly the Lower River Shannon. It was reported that incoming flows will exceed the 25-year Formula A flow of 811 l/s approximately 20 times per annum. On this basis, provision for managing this flow is required.

A summary of the design Formula A flows calculated previously are as follows:

Table 16: Summary of Formula A Flows

Growth Period	Formula A (l/s)
10-year	746
25-year	811

All incoming flows greater than Formula A will be screened, and consideration given to lifting excess storm water directly to the new stormwater storage tank, avoiding the scenario of a spill event where storm storage volume is not fully utilised. As these flows will bypass preliminary treatment and be unscreened, it is proposed to install a screen on the overflow weir of the stormwater tank with screenings retained within the tank.

The works required to be undertaken for this option include the following:

a. Replacement of the existing storm pumps.
b. Increase of suction pipework to cater for larger flows (400mm to 600mm).
c. Increase of delivery pipework to cater for larger flows (400mm to 500mm).
d. Construction of a new 500mm rising main from inlet pumping station to storm water overflow.

The 2 no. storm pumps will be replaced to cater for the increased flows during the 30-year storm event. Modification to pipework and valving is required to allow a single pump to convey the additional flows to the storm tank, while the second pump would operate to assist the 'Dry Weather Flow' pumps deliver Formula A flows forward to preliminary treatment. Proposed upgrade pumps are shown in Table 17.

Table 17: Storm Pump Replacement

Scenario	Motor Power	Duty Point
Existing	2 no. 55 kW pumps	320 l/s
Future	2 no. 80 kW pumps	540 l/s

A series of actuated valves would allow the pumps operate simultaneously during the 30-year event, while also allowing the pumps operate on a duty/standby arrangement during normal operating conditions i.e. Formula A flows.

A new 500mm diameter rising main will be constructed and connect to the storm water overflow located downstream of the grit removal process. A discharge manhole will be constructed prior to connecting to the

1,000mm diameter storm water overflow pipe. This 1,000mm diameter gravity pipe will convey flows to the stormwater tank.

6.4 Preliminary Treatment

6.4.1 Screening

Replacement of the existing screens with higher capacity band screens within the existing inlet works structure is proposed. The existing screens are near their end of life and should be replaced.

6.4.2 Grit Removal

The Irish Specification IW-TEC-700-99-02 for 'Inlet works & stormwater treatment (wastewater)' specifies an additional grit trap is to be considered for plant sizes in excess of 25,001 PE. This requirement was discussed with Uisce Éireann and agreed that a standby grit trap is included as part of the proposed upgrade development. The single existing grit trap has caused operational issues in the past and poses a risk to the treatment downstream processes, particularly the current Salsnes Filter. The additional grit trap would not only benefit the primary filtration system proposed, but also the proposed IFAS process upgrade.

The proposed location of the additional grit trap is shown in Figure 8. The structure would be constructed adjacent to the storm water overflow. Storm water overflow from this chamber will be intercepted and diverted to the proposed new storm tank. The area proposed for the standby grit trap is underlain with pipes, cables, and ducts. Services and pipework will require relocating to accommodate construction. Construction using pre-cast concrete rings connected to the main inlet works structures through pipework could be used to reduce the working space required and the impact on services.

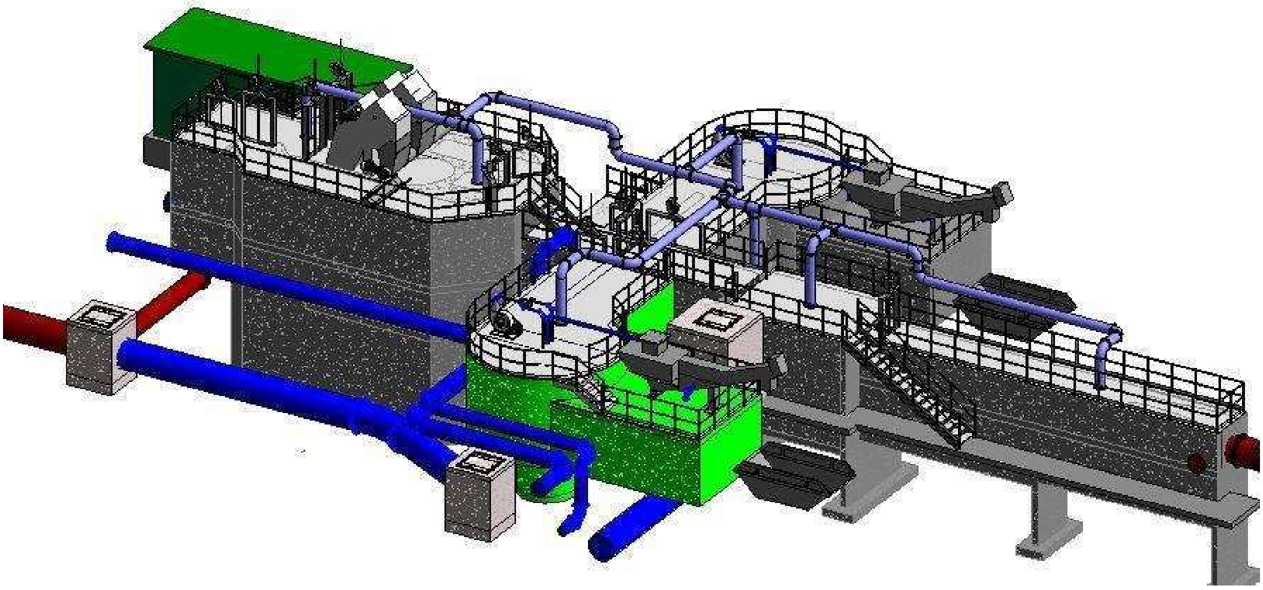

Figure 8: Proposed Additional Grit Trap

6.4.3 Odour Control

It is proposed to cover the inlet works with solid decking and install odour abatement equipment to improve working conditions for operators. ATEX rated extraction fans will ensure positive air displacement of 6-8 air changes per hour to minimise odour emissions and ensure a <3OU/m^3 at the site boundary as typically stipulated as part of planning conditions. An example of proposed odour control units is shown in Figure 9.

Figure 9: Example of proposed odour control unit

6.5 Primary Treatment

6.5.1 Primary Sludge Mechanical Filtration

Primary treatment is required to reduce the loading on the secondary treatment process, while also reducing sludge volumes at the end of the works. The proposed solution for handling sludge removed at the primary treatment system is outlined further in the report.

A mechanical filtration system is proposed an alternative option to conventional primary treatment. A single filtration unit is currently in operation at Castletroy WwTP as noted previously in the report. There are several suppliers available in the market which offer similar treatment technology of the existing unit.

The following are benefits compared to conventional primary treatment[3]:

- Circa. 50% lower investment cost.
- Significantly less land requirements.
- The additional benefit of grit removal in the separation stage.
- Significantly lower lifecycle costs.
- Less civil works.
- Equal to, or greater removal of Total Suspended Solids (TSS) and BOD (on average 50% and 20% respectively).
- Smaller secondary/biological treatment processes (less aeration and/or space needed).
- Primary sludge with higher energy value.
- Fully-automated equipment.

[3] The benefits identified in this report are taken from a product brochure titled “Eco-Efficient Solids Separation” prepared by Salsnes filter which is available for download on their website (https://www.salsnes-filter.com).

- Lower operating costs (no chemicals to purchase).

Four number primary sludge mechanical filtration units are proposed to allow for increased capacity to the design 77,500 PE. Flow to full treatment can be achieved through operating four number units on a duty/assist/assist/standby basis. Average flow through the plant can be achieved operating the filters on a duty/assist/standby/standby arrangement. The assessment is based on the capacity of the unit currently installed, which has a maximum hydraulic flow of 576m^3/hour and a treated flow specified of 325m^3/hour.

The existing filtration unit is currently installed in an uncovered area adjacent to the inlet works. This filter will be relocated to accommodate other upgrade works and will be installed with the additional new filters required. An above ground pipe manifold will include any necessary flow control and measurement fittings.

It is proposed to construct a building for the primary treatment process which will provide protection to the treatment units while also allowing for the installation of control panels, equipment and monitoring instrumentation within the structure. A steel frame structure with blockwork and insulated composite roof and wall panels is proposed.

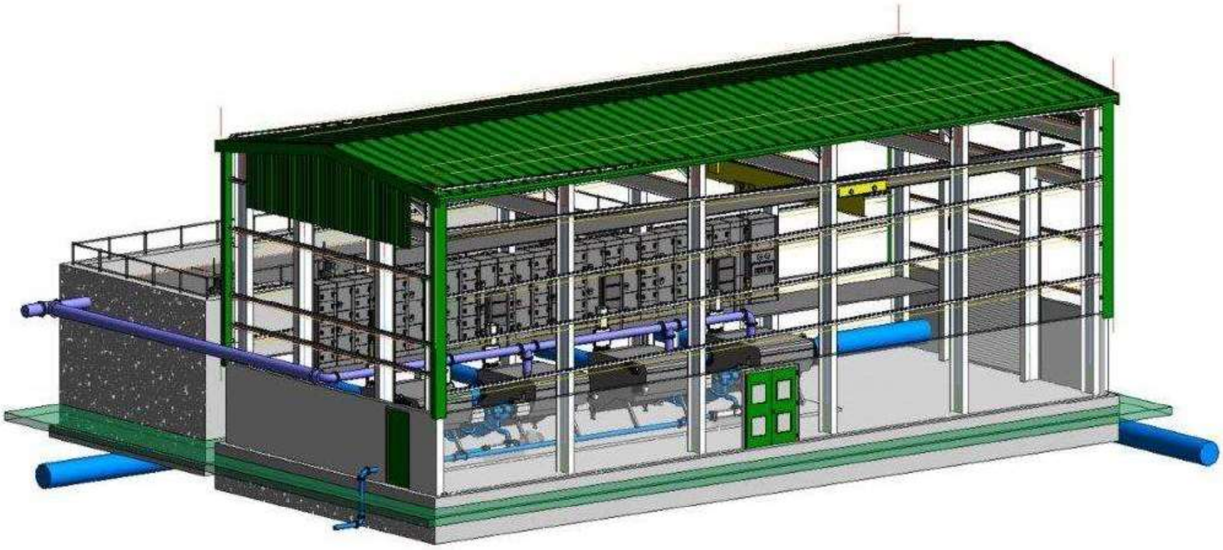

Figure 10: Revit model of proposed structure over primary treatment system

A floor drainage system will connect to the forward feed pumping station to avoid contamination of surface water drainage. Overhead travelling cranes with sufficient clearance will allow individual units to be lifted and relocated to a service area located within the building without impacting the treatment process. A roller shutter door will provide access to the servicing area and allow for the removal of plant and equipment.

Construction of a superstructure over the filter will have the following advantages:

- Improved operator comfort during routine operation and inspection.
- Clean and dry area for servicing and maintenance work.
- Removes the requirement to install external kiosks required to house control panels and ancillary equipment.
- Control panels required for the forward feed pumping station and secondary treatment upgrade discussed later in this report can be located within a common area.

Compliance with the Building Control Amendment Regulations (BCAR) will be required, and a Fire Safety Certificate required to comply with Part B (Fire) of the regulations. An exemption from a Disability Access Certificate could be obtained as the purpose of the building will be used solely to enable inspection, repair, or maintenance.

6.5.2 Primary Sludge Management

Primary sludge from the filtration process will be recovered and stored as liquid sludge. The proposed sludge holding tank will provide thickening of the sludge up to 5% dry solids and will be sized for 5-days storage.

The industrial contribution which represents approximately 50% of the total flow contains a very low solids contribution. Therefore, solids in the influent is calculated by 39,492 PE (domestic, commercial, and institutional) with a solids load of 0.075 kg/head/day which corresponds with current flow and load and future projections. The required 5-day storage volume is 150m^3 allowing for peak removal at 50%.

The mild steel or concrete storage tank will be constructed adjacent to the structure housing the primary treatment system. Sludge will be transferred to the holding tank through inline progressive cavity pumps operating on a duty/standby arrangement.

Sludge will be removed in liquid form from the primary sludge treatment process and pumped to the sludge dewatering area within the site. The sludge will be mixed with the 'Waste Activated Sludge' (WAS) in the repurposed 'Thickened Sludge Storage Tank' (TSST) before de-watering on site. The expected dry solids from the primary sludge is expected to be 3%. Both sludges will be mixed to provide a consistent sludge and stored prior to entering the dewatering stage. The capacity of the existing sludge stream is proposed to be increased to cater for the increased sludge volumes.

The storage tank will be fitted with a bauer connection to allow a tanker remove liquid sludge in emergency situations (i.e. no dewatering available). A lay bye will be constructed to allow a vehicle park next to the storage tank. An allowance for a mobile sludge dewatering unit to be connected to the tank will also be provided under the Contract. Decanting of the primary sludge holding tank will be available to reduce volumes pumped to the sludge treatment process.

6.5.3 Splitter Chamber

Influent from the forward feed pumps will enter a splitter chamber upstream of the primary treatment system. The splitter chamber will be constructed of reinforced concrete and will promote even distribution across a total number of four weirs prior to entering primary treatment. The weirs will be installed with actuated penstocks to control flow based on operational requirements.

An overflow within the splitter chamber will be installed in the event of an emergency. The overflow can also operate as a controlled bypass of the treatment process if required by closing all penstocks within the chamber. The splitter chamber will be covered to allow odour extraction and an odour control until installed. Access covers will be provided to allow inspection and entry to the chamber when required. The odour control unit will also be connected to the primary treatment building.

6.5.4 Pipework

A 600mm diameter section of pipework is required to gravitate flows from the inlet works to the proposed forward feed pumping station. A connection will be made to the concrete inlet works structure immediately downstream of the existing measurement flume. A new 500mm rising main pipe will run from the forward feed pumping station to the splitter chamber located upstream of the primary treatment process.

A new 600mm pipe is required to convey flows from primary treatment to secondary treatment. This pipe will cross beneath the existing internal access road prior to connecting through the wall of the secondary aeration tank structure. The existing above ground 500mm diameter pipe can be retained and used as a secondary bypass of the primary sludge filtration system and forward feed pumping station.

It should be noted that existing pipework is piled, and similar design requirements are likely required for any new or upgraded sections of pipework.

6.6 Secondary Treatment

6.6.1 IFAS System

It is proposed to upgrade the secondary treatment process with an 'Integrated Fixed-Film Activated Sludge' (IFAS) system. The stainless steel cages are designed to be lifted to allow inspection work on the curtains without interrupting the process treatment. Due to the bespoke nature of the cages, the curtain material can be positioned directly over the diffusers of the biological treatment tank. The curtains allow horizontal effluent flow to pass between them. The effluent flow combined with the vertical rising air bubbles from the diffusers allows continued rather than periodic shock sloughing (shedding) of excess biomass. Sloughing of the biomass continually promotes aerobic conditions within the biofilm, essential for the process treatment. The benefits of the flexible curtain material are summarised as:

- Enhances aerobic conditions within the biomass, essential for optimum process treatment.
- No blockages within the media, therefore greater oxygen supply to the biological active surface; and no shock loads to the final settlement tanks (FSTs).
- Promotes excellent biomass settling properties, typically sludge volume index (SVI) of 70 to 90.
- Allows the opportunity to operate the treatment plant at lower oxygen concentrations.
- No additional scour or mixing required, therefore lower operational costs.
- Low transportation volume.
- Minimal hydraulic head loss.
- No treatment loss during maintenance, as the media can be lifted for inspection during process treatment.

An overview of the proposed specimen design solution to upgrade the treatment capacity of the oxidation tanks is as follows:

- Installation of a system of textile curtains housed in a removable Integrated Fixed-Film Activated Sludge (IFAS) frame in the oxidation tanks.
- Retain the existing air blowers and install additional units including a new control panel.
- Provision of IFAS frame lifting cranes.
- Retain the existing 3 no existing final settlement tanks / clarifiers as this will be sufficient for IFAS system.

The 'Aerostrip' diffusers installed as part of a previous upgrade were supplied by Jaegar and are suitable for use with the IFAS system. The FBDA diffuser can be integrated into the IFAS Frame. The operational life of a FBDA diffuser is typically in the range of 14 – 20 years, and with the unique way in which the membranes self-clean, whole-life costs are reduced, and man entry into tanks for maintenance purposes is minimised.

By positioning a system of textile sessile media housed in a removable IFAS frame directly above the aeration diffusers, a large surface area is created on which the biomass can grow. The configuration of the material allows for flexibility and movement within the flow of the tank, increasing the process performance, this in turn increases the capacity of the wastewater treatment plant. The textile sessile media is made of 100% polypropylene and the construction of this material permits good oxygen supply and prevents excessive growth of thick layers of biomass thus maintaining the optimum efficiency of the process.

The IFAS frames are specifically designed to accommodate both FBDA diffusers and sessile media, allowing the operator to remove and maintain them without the costly need to drain the aeration tank. The IFAS frames will not require removal for routine operation and maintenance.

The advantages of IFAS is that it operates very similar to a conventional activated sludge process (DO, MLSS and Ammonia monitors can be provided for optimised and energy efficient aeration control). The additional capacity is provided to allow biofilm/biomass develop on the biotextile sessile media. Media surface area provided in addition to the suspended biomass (3,500 mg/l x 5,500m^3 = 19,000 kg) is an important part of IFAS design. This media allows for an additional 33,000 kg (52,000 kg in total) of Biomass which gives an equivalent suspended biomass of 9,000 mg/l within same volume.

The specific requirements of this specimen design are identified below:

- 36 No. IFAS Frames (18 frames per tank) consisting of the following elements: stainless steel grade 304 Frames. Length = 8.20m, width = 2.20m, total height = 4.70m 27 approx.
- 11,232 no. sessile curtains in total: Length of curtain = 4.7m, Width of curtain = 0.96m. Each curtain fixed in the IFAS frame.
- 2 no. lifting spreader beams (for erecting and deploy/retract IFAS Frames)
- Header pipework
- Stainless steel grade 304 thin wall metric tru-bore, DN250 tapering to DN80.
- Stainless steel grade 304 pipe supports and isolation valves.
- 2 no. control valves (serving the common standby blower).
- 5 no. blowers – (duty/assist/common standby/duty/assist): Blowers (75kW), c/w acoustic hood: 74dB(A) per blower.
- Pipe extensions stainless steel grade 304 thin wall metric tru-bore, DN80 (to reach their central location in the tank).

Figure 11: Example of IFAS frames and textile curtains (courtesy of Eliquo Hydrok))

Figure 12 shows a 3D model of the upgraded aeration tanks with 36 no. IFAS frames integrated into the existing structure. Existing chambers located external of the tank are also shown as well as existing and proposed pipework.

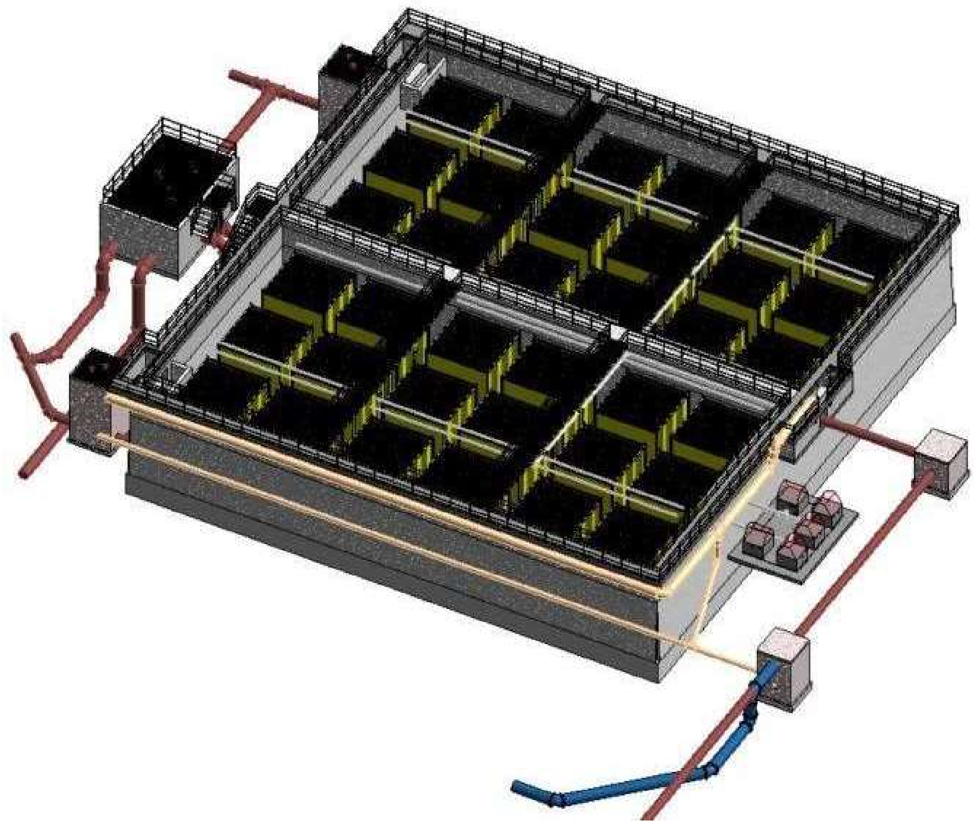

Figure 12: Revit model of upgraded aeration tanks with IFAS system

The full design PE loading will not be available at the time of commissioning. The following is proposed to allow handover of the plant to Uisce Éireann following the upgrade:

1) Process guarantees will be required as part of the Contract.
2) Oxygenation capacity test will be completed to calculate the KLa and SOTR to ensure sufficient oxygen is available to treat the BOD load (in line with the requirements of '*EN 12255-15:2003 Wastewater treatment plants – Part 15: Measurement of the dissolved oxygen transfer in clean water in aeration tanks of activated sludge plants)*'.
3) In addition, Day 1 load will be in excess of 40,000 PE and consideration will be given to operating/process proving 1 tank (with IFAS retro-fit) for a period time (minimum 28 days) before returning 2nd tank to service. once all works is substantially complete and all commissioning checks are completed (IW Testing, Commissioning and Handover SOP IW-TEC-600-05), a minimum Process Proving period of 3 months (daily SS, COD, BOD, Ammonia and Ortho-P) will be required before successful completion of the Design-Build Period stage and final handover to the Operate Service Period.

6.6.2 Final Settlement Clarifiers

The clarifier flow splitter chamber was installed in 2010 during construction of the 25m diameter clarifier. The inlet pipe diameter to each of the 20m diameter clarifiers from the splitter is 500mm, and 600mm to the larger 25m dia. clarifier. All 3 no. clarifiers have 250mm diameter sludge return pipe to the RAS/WAS.

IFAS can achieve a (supplier's) reported SVI design of less than 80 ml/g (compared to 110 – 120 ml/g in conventional activated sludge). A figure of 90 ml/g has been used in the clarifier design check and is sufficient to cater for the hydraulic and solids loading.

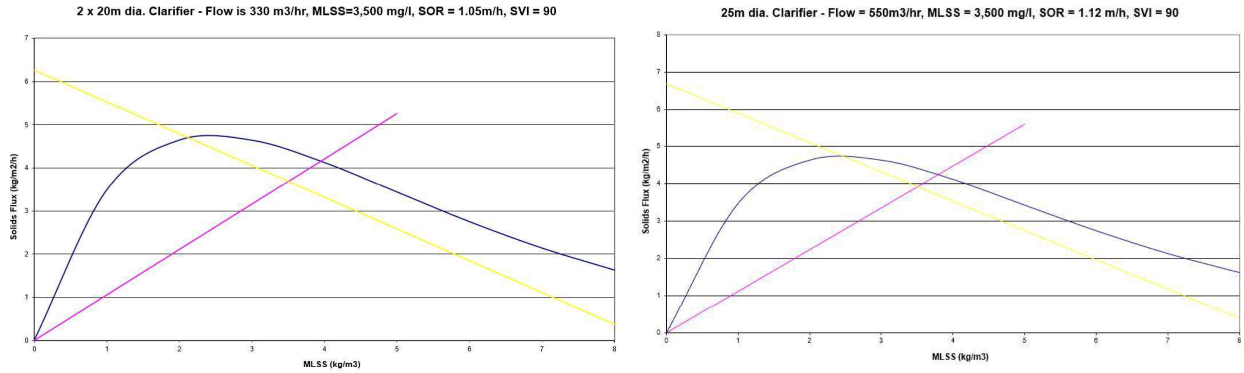

Figure 13: Solids Flux Curve at operating MLSS of 3,500mg/l and SVI 90 ml/g

It is proposed to increase the capacity of each of the existing 20m diameter clarifiers to the capacity of the larger 25m diameter clarifier. The installation of stamford baffles within the existing structures will improve current flow balancing issues being experienced. Density current baffles mounted inside the clarifier are an effective method of minimising the effects of short-circuiting and improving effluent quality. Flow will be equally split to each clarifier and the increased capacities will provide future redundancy should a tank be required to be taken offline for maintenance.

Stamford baffles are proposed to be installed in a tangential arrangement along the outer edge of the two 20m diameter tanks. A 3D model of the proposed works is shown in Figure 14. The rotating bridge scrapers will require modification or replacement to accommodate the works.

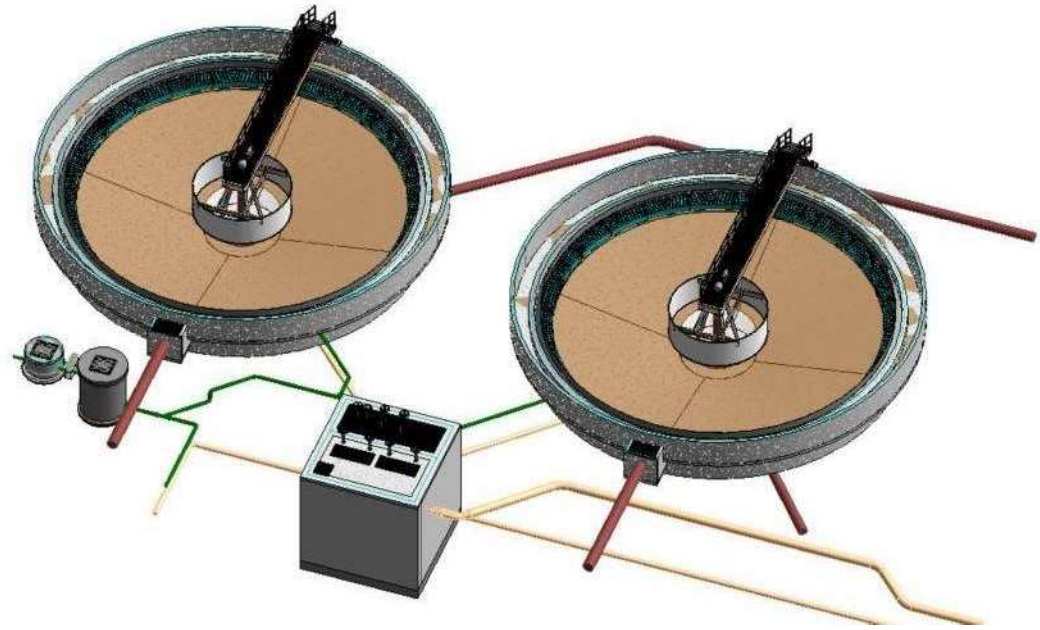

Figure 14: Revit model of upgraded clarifiers

In addition, McKinney baffles can also act to separate the stilling zone from the settling zone and this design can increase the volume flow rate. A McKinney baffle cuts the density current and, if designed correctly, completely separates the stilling and settling zones.

Figure 15: Stamford Baffle

Figure 16: McKinney Baffle

6.6.3 Scum Pumping Station

Nocardia is currently an issue at Castletroy WwTP which can be improved through separating scum from the RAS/WAS chamber. Scum removed from the surface of the clarifiers will be discharged to a proposed chamber where it is pumped directly to the sludge treatment process, therefore separating it from the existing RAS/WAS chamber.

6.6.4 RAS/WAS Pumping Station

The existing RAS pumps will be upgraded to a higher capacity of approximately 30kW. The existing scum inlet pipes which discharge from the clarifiers into the chamber will be intercepted and diverted to a new scum pumping station. The existing manual bellmouth arrangement to control the rate of sludge draw off will be removed and replaced with actuators.

6.6.5 Pipework

The capacity of the RAS pipework will be increased to cater for increased hydraulics through the plant. The existing 250mm diameter above ground pipe will be replaced to allow increased return activated sludge be pumped to the aeration tank. It is proposed to install a new 450mm pipe from the RAS pumping station directly to the inlet to the activated sludge tank. This option will allow the full flow to be catered through the newly installed pipe. The 250mm existing underground pipe will be retained for redundancy.

6.6.6 Crane Access

Concrete hard standing area(s) will be provided for the set-up of a crane required for the removal of IFAS frames from the aeration tank. The existing access road which runs parallel to the activated sludge tank can be used as a temporary crane set-up area. A new secondary road which runs along the Western boundary of the site is proposed to improve traffic management within the site. The road will be required for construction traffic during the upgrade and is proposed to be retained permanently. This new road will also allow access for sludge tankers to the sludge treatment building while a temporary crane is setup on the existing access road.

6.7 Chemical Phosphorus Removal

It is proposed to install 1 no. new 20m^3 bulk storage tanks (to supplement the existing bulk storage tank) with integrated bunds to contain Ferric Sulphate (Fe_2SO_4) for phosphorous removal. The tank will be installed adjacent to the inlet works structure where an existing ferric sulphate bulk storage tank is installed. An eye wash station will be provided beside the chemical storage area for the Health and Safety of personnel. Two dosing pumps will be installed each suitable for the required doing rate and will operate on a duty/standby configuration.

Figure 17: 2 no. 20m^3 tanks installed at Bunlicky WwTP (courtesy – Silotank)

6.8 Sludge Treatment

6.8.1 Sludge Thickening and Storage

A new 12m diameter PFT with a volume of 450m^3 is proposed to be constructed. This new PFT along with the existing 12m diameter PFT will be used to thicken WAS. The existing 7.1m diameter PFT will be repurposed as a 'Thickened Sludge Storage Tank' (TSST). Thickened WAS from the PFT's and sludge from the primary treatment will be collected into the TSST. The tank will include a mixer and provide a more consistent sludge feed for dewatering, improving the effectiveness of the dewatering system.

The TSST will be fitted with a bauer connection to allow the removal of liquid sludge via tankers in emergency situations (i.e. no dewatering available). An allowance for a mobile sludge dewatering unit to be connected to the PFT's will also be provided under the Contract.

6.8.2 Sludge Dewatering Options

Sludge from the TSST will be conveyed using progressive cavity pumps to the dewatering units. A full upgrade of the sludge dewatering systems is required taking into consideration the age and condition of the existing units.

2 no. duty/assist centrifuges with a capacity of 400kgDS/h/unit are required, operating for approximately 6 hours per day. Centrifuges can dewater sludge up to 20-24% Dry Solids (DS) and have an approximate power consumption of 25kW/unit based on manufacturers literature. Wash water will be required for cleaning the centrifuge when not in dewatering mode.

Figure 18 is taken from manufacturer's literature and is representative of centrifuges suitable for installation as part of the upgrade works. Dimensions for the length (L), width (W), and height (H) of a preliminary selected unit are 4.749m, 1.060m, and 1.376m respectively.

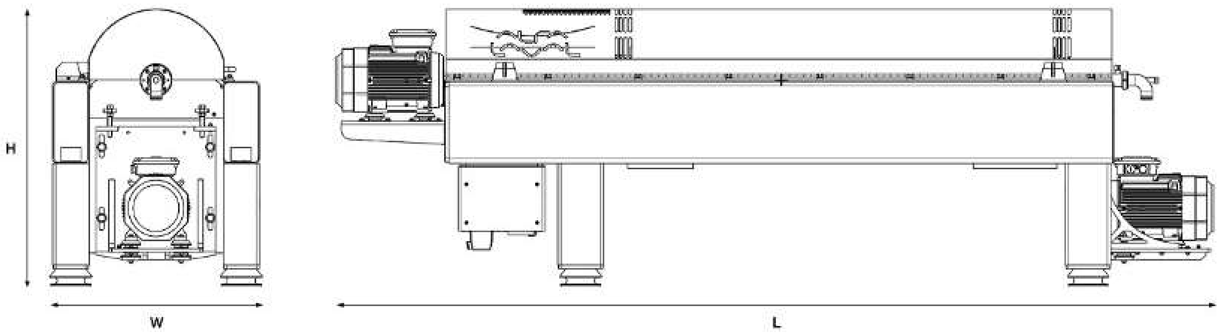

Figure 18: Required Centrifuge Dimensions

Centrifuges are considered the most suitable upgrade for Castletroy WwTP, offering a higher percentage dry solids when compared to alternative options including belt and screw presses. Uisce Éireann draft requirements specify a minimum sludge dry solids concentration of 18% dry solids which can be achieved through centrifuges.

The centrifuges will be installed on an elevated platform within the sludge dewatering building requiring removal of the first floor. The steel supports holding up the first floor will be dismantled, allowing the building to be modified internally to accommodate the centrifuges. A pumping station will be required to return supernatant to the RAS/WAS chamber. A feed pump set (duty/standby) is required for each centrifuge. A single pump is also required for each centrifuge to transfer cake sludge to covered skips located externally. An odour control unit will also be installed externally to manage odours arising from the sludge dewatering building.

A new automatic polymer make up system will be installed which can use both liquid or powder forms.

6.8.3 Storage of Dewatered Sludge

Two skips will be required based on peak loadings, with a third skip provided for additional capacity. An automated system will be installed to control the filling of each skip. Trailers are currently being moved by Limerick City and County Council operators using an on-site shunter. It is envisaged that transport and replacement of the skips will be undertaken by a contracted third party. Storage skips will be covered and connected to the odour control equipment.

Storage of dewatered sludge will be more appropriately facilitated in larger skips mounted outside (minimum 3 days storage). Refer to the similar applications shown in Figure 19 and Figure 20.

Figure 19: Enniscorty WwTP Dewatered Sludge Storage

Figure 20: Bunlicky WwTP Dewatered Sludge Storage

Figure 21 is the indicative future installation for Castletroy WwTP.

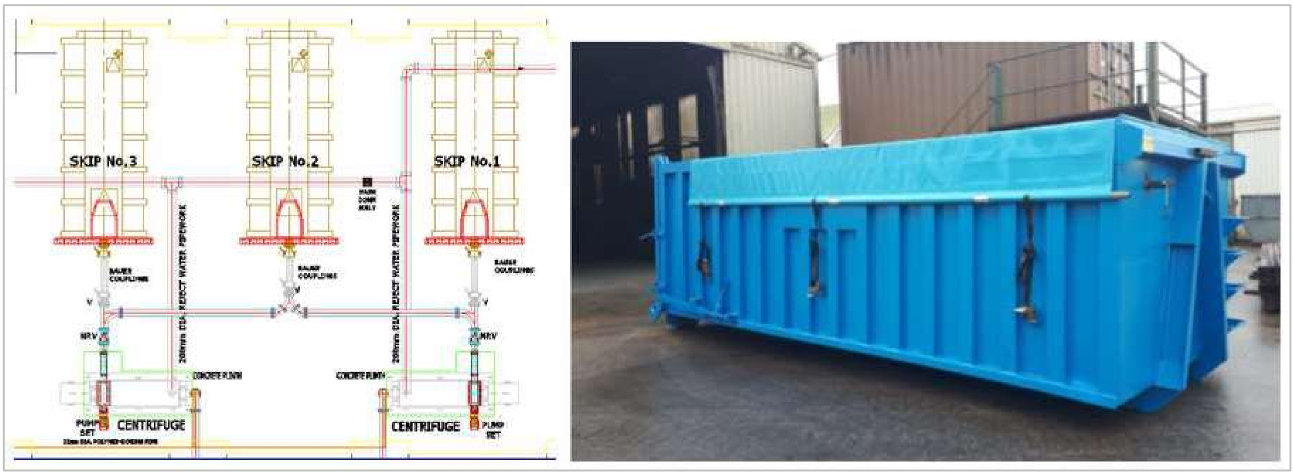

Figure 21: Suggested installation and larger skips c/w cover for odour control

6.9 Flood Event Pumping Station

A flood event pumping station is required to allow the plant to remain operational during a flood event. A large portion of Castletroy WwTP is located within Flood Zone A and B. Catchment Flood Risk Assessment and Management (CFRAM) mapping indicates that the 1% Annual Exceedance Probability (AEP) fluvial flood level (Flood Zone A) is +6.37mOD and the 0.1% AEP fluvial flood level is +6.93mOD. Water levels are also presented in Table 18.

Table 18: CFRAM fluvial mapping water levels

10% AEP (1 in 10 year)	1% AEP (1 in 100 year)	0.1% AEP (1 in 1000 year)
5.77 mAOD	6.38 mAOD	6.94 mAOD

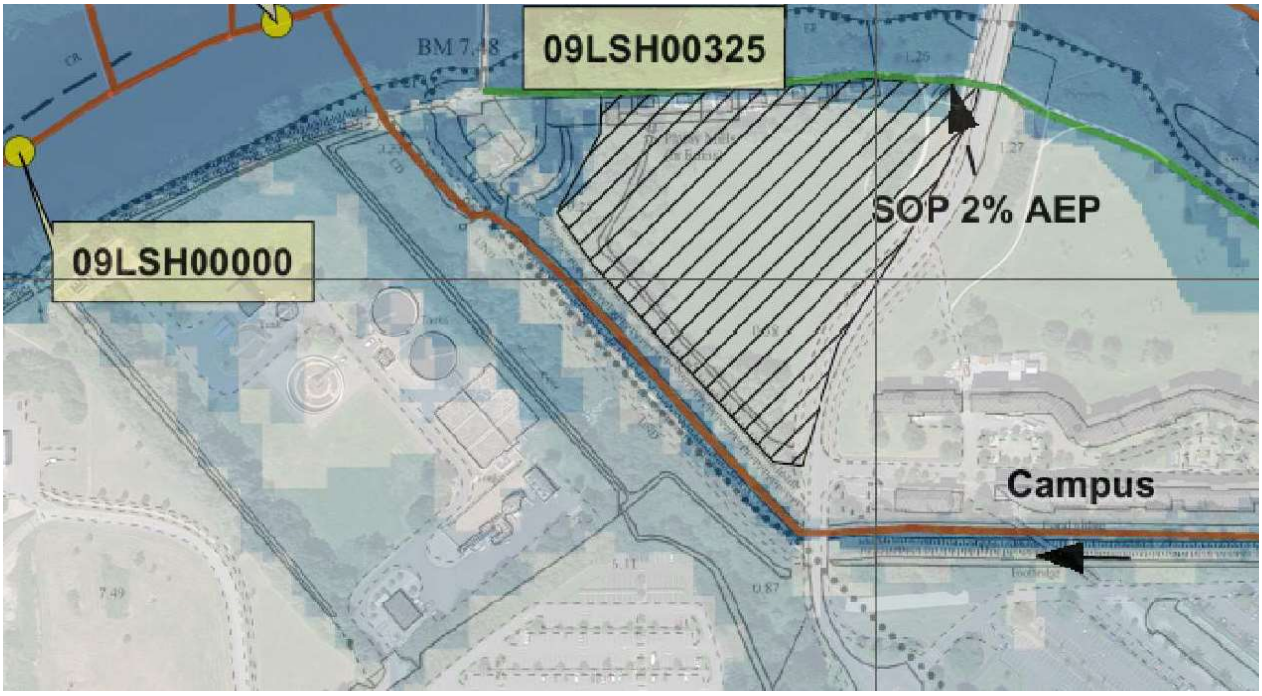

Figure 22: CFRAM mapping overlain on satellite imagery

Figure 22 shows the existing site layout overlain with CFRAM fluvial flood zone mapping. The map is presented in full in the Flood Risk Assessment which differentiates the flood zones more clearly together with a legend. Flood Zone A and B are defined in shades of blue with Flood Zone C designated as all land outside of these flood zones.

Surcharging of the plant was not previously reported as final effluent will currently overtop the final effluent inspection chamber if flows cannot discharge freely through the outfall.

6.9.1 Hydraulics

Figure 23 shows the existing outfall details as included in the EPA Waste Water Discharge license application documents. Three outfall pipes exit the final effluent pumping station which can be seen on the complete drawing. These outfall pipes extend approximately 75m into the watercourse.

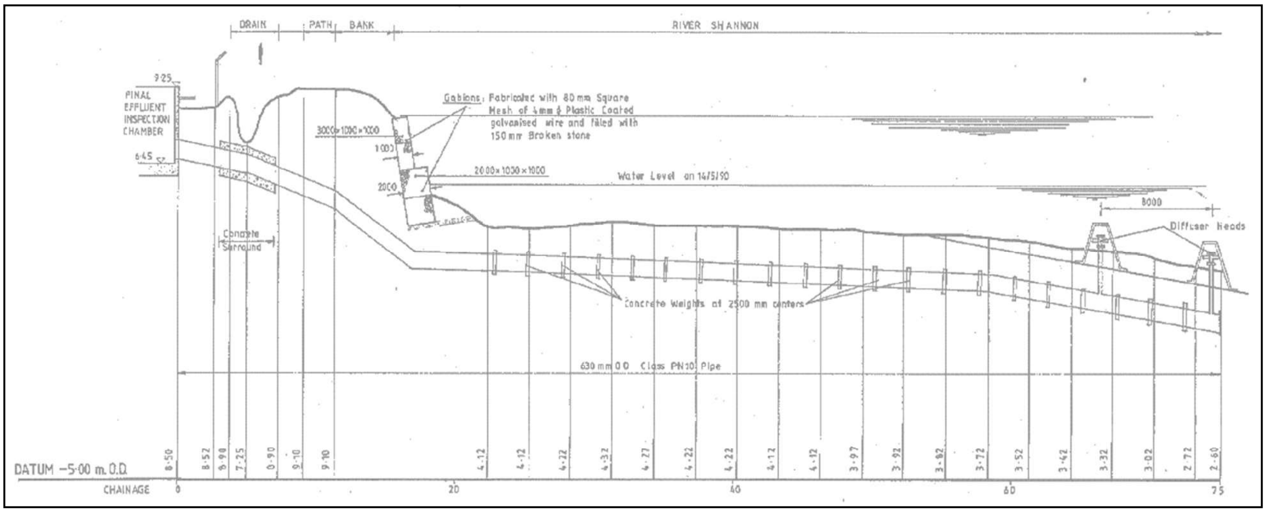

Figure 23: Longitudinal Section of Outfall

Figure 24 shows that each outfall comprises of a 630mm OD Polyethylene pipe connected to two 355mm OD risers and 180mm OD Diffuser Heads. Each diffuser head has 4 individual legs to disperse flows into the Lower River Shannon.

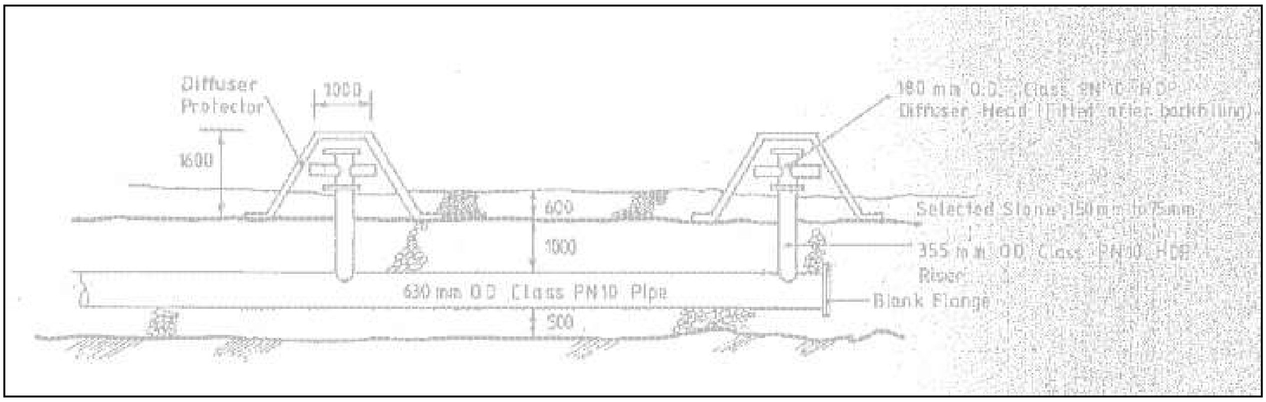

Figure 24: Section of Outfall

During a 30-year storm event flows leaving the final effluent pumping station will total 1,200 l/s, therefore each individual outfall will discharge a flow of 400 l/s. Head loss through the existing outfall is estimated at a total of 0.907m.

A 1,050mm diameter pipe will connect overflows from the stormwater holding tank with final effluent at a manhole upstream of the inspection chamber. From the connection manhole to the inspection chamber, flows will increase to 1,200 l/s as both 'flow to full treatment' and storm overflows will be conveyed.

The overflow weir level in the storm tank is proposed at 7.2mOD. Head loss from the storm water overflow to the final effluent inspection chamber is 0.465m. A further head loss of approximately 0.3m occurs over the weir penstock located in the chamber. These head losses combined with the calculated head loss through the outfall results in a total head loss of 1.672m. The storm tank will not be able to free discharge at the 0.1%, 1%, and 10% AEP flood levels.

The 'Top Water Level 'in the secondary clarifiers is 7.0mOD. Flow from the clarifiers to the manhole connecting with the storm tank overflow will be 'Flow to Full Treatment' of 330l/s. The existing final effluent pipe is a 1,050mm diameter and is currently used to discharge storm and emergency overflows directly to the Lower River Shannon. Following the proposed upgraded works, storm water will be diverted to the storm tank and the 1,050mm section will be used only to convey flow from the clarifiers and potentially emergency storm overflows.

Head loss from the clarifiers to the final effluent inspection chamber is estimated at 0.326m. A further head loss of approximately 0.3m occurs over the weir penstock located in the chamber. These head losses combined with the calculated head loss through the outfall results in a total head loss of 1.533m. The clarifiers will not be able to free discharge at the 0.1%, 1%, and 10% AEP flood levels.

6.9.2 Proposed Infrastructure

To overcome the hydraulic constraint during periods of high flood level, a flood event pumping station is proposed to increase head to the final effluent inspection chamber and allow gravity discharge from the inspection chamber to the outfall. The walls of the inspection chamber structure are proposed to be increased in height from 6.55mOD to approximately. 8.2mOD which includes a free board allowance to prevent overtopping during the 0.1% AEP flood event.

The structure is proposed to be constructed offline from the final effluent pipework, downstream of the connection manhole with the storm water overflow. The pumping station would be bypassed during normal river conditions. During higher river levels, levels within the pumping station sump would trigger operation of the pumps. The pumps would lift final effluent to the inspection chamber where it will gravitate through the existing outfall. The final effluent pipework entering the inspection chamber is already fitted with a non-return valve to prevent backflow through the plant resulting in potential surcharging of the system. This valve will be replaced due to its age.

Figure 25 shows an example of submersible cannister pumps which are proposed to be installed in the 108m^3 wet well sump of the pumping station.

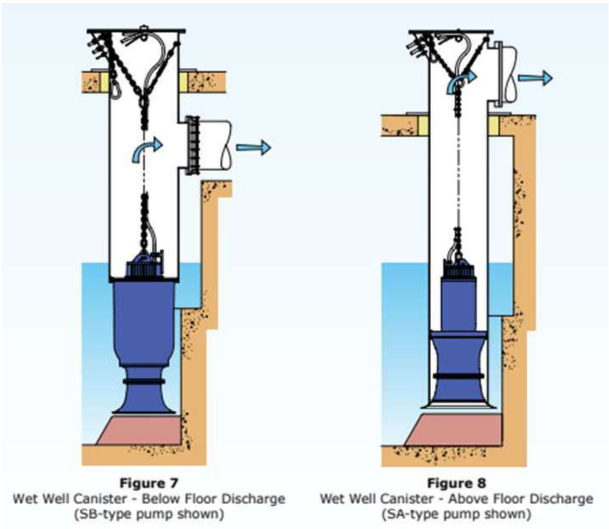

Figure 25: Submersible Pump Example (Bedford Pumps)

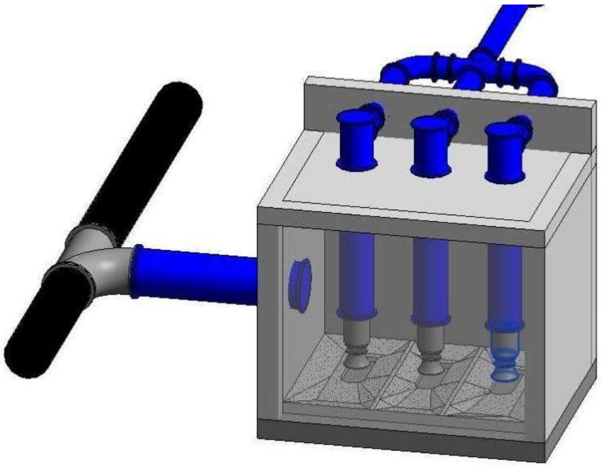

Figure 26: Revit 3D Model of Flood Event Pumping Station

Pumps could be installed operating on either a duty/duty/assist (3 no.) or a duty/assist basis (2 no.) depending on the model of pump selected. The pumps are required to deliver a high flow rate of 1,200 l/s with a low dynamic head of approximately 3m.

6.10 Wash Water

Increased wash water supply will be required for the additional treatment processes as part of the Castletroy WwTP upgrade. At a minimum, supply will be required at the following locations:

- Storm tank and return pumping station (filling of tipping buckets cleaning system and washdown points).
- Forward feed pumping station (washdown point).
- Primary sludge mechanical filtration (cleaning system and washdown point).
- New sludge holding tank (washdown point).
- New sludge thickening tank (washdown point).
- Scum removal pumping station (washdown point).
- Sludge building (increased supply to 20m^3/hr only if belt presses are proposed, if centrifuge there be a reduced supply).

The stormwater tank cleaning system and proposed primary treatment will require the largest demand of wash water. Preliminary selected tipping buckets have a capacity of 500 litres per metre, with a bucket width of approximately 4.6m located within each of the eight lanes.

Screens will generally use 2 to 3 l/s when required, and centrifuges have a much lower wash water usage compared to alternatives. Salsnes filters belt cleaning typically use 1.5 l/s per machine during a cleaning operation. Wash water is not required during the filtration process (normal operation). Cleaning can also be via an air scouring negating the need to wash water.

There may be additional capacity in the existing borehole source which could be utilised. Yield testing reports were not available at the time of this report, however will be investigated and additional yield testing undertaken if required. A second well can be drilled if it is found that the capacity of the existing well is insufficient. A pre-cast concrete storage tank of circa 36m^3 is proposed to be installed adjacent to the borehole to provide storage which can be drawn down during periods of increased wash water demand.

6.11 Power Supply

A transformer was previously installed to cater for 630 kVA as part of a recent electrical upgrade including an LV mains incomer and autochanger panel suitable for 1,250 Amps. A concrete base was also constructed to allow for the temporary or permanent installation of a generator.

Provision of a permanent generator as part of the upgrade works was considered as it was raised previously by the EPA. The only power outage reported was as a result of vandalism on the network. Due to the plant being located on a high priority line adjacent to the University Limerick, the installation of a permanent generator deemed not to be required. Provision of a permanent generator would result in ongoing maintenance, servicing, and fuel costs.

It is proposed to upgrade the transformer to 1,000 kVA to accommodate for the proposed and any future upgrade and any future works. No works in relation to provision of a generator are proposed.

6.12 Site Drainage

Storm water runoff from the new hard standing areas and structures will require on-site attenuation before discharging to the Lower River Shannon at an agreed flow rate through a hydro break. Typical solutions are shown in Figure 27 and Figure 28. Existing site drainage may be incorporated into the proposed attenuation storage area if required.

Figure 27: StormTech Storm Storage Tank

Figure 28: StormCell Storm Storage System

Appendix 1: Process Calculations

Your Reference	06-May				
Water Company	JB BARRY	P.E	78,000		
Our Reference	AS11407				
Scheme Name	CASTLETROY				Peaking Factor
Option	78,000 PE REV02				1.30
Date	20/05/2020	Flow Split	100%		

Settled Load	Min Flow		DWF		Average		FFT	
Flow (m^3/d)	8352		8352	97l/s	12528	145l/s	25920	300l/s
Total COD_5 load (kg/d)	1019	122mg/L	1019	122mg/L	1530	122mg/L	4427	171mg/L
Total BOD_5 load (kg/d)	785	94mg/L	785	94mg/L	4680	374mg/L	6084	235mg/L
Total TKN Load (kg/d)	0	0mg/L	0	0mg/L	0	0mg/L	0	0mg/L
Total Ammonia Load (kg/d)	418	50mg/L	418	50mg/L	624	50mg/L	811	31mg/L
Total Dissolved Solids Load (kg/d)	0	0mg/L	0	0mg/L	0	0mg/L	0	0mg/L
Suspended Solids (kg/d)	1019	122mg/L	1019	122mg/L	1530	122mg/L	4427	171mg/L
Phosphate (kg/d)	0	1mg/L	0	0mg/L	0	0mg/L	0	0mg/L
Min Wastewater Temperature (°C)	11							

☑ IFAS Enhancement

Operating MLSS	3500	mg/l			
Anoxic Volume	0.0	m^3			
Anaerobic Volume	0	m^3			
Aerobic Volume	5800	m^3	Suspended Biomass (anoxic)	0	kg
No. of aeration cells	2		Suspended Biomass (anaerobic)	0	kg
Length (aerobic)	32.5	m	Suspended Biomass (Aerobic)	20221	kg
Width	16.3	m	Sessile Biomass	31994	kg
Depth	5.49	m	Total Biomass	52215	kg
			Eqv. MLSS	9003	mg/l

Cleartec® IFAS accommodation

	Total		per lane				
No. Cages	36		18	Media Specific Surface Area		23.0	m^2/m^2
no. Rows per Cage	2	m	2	Media Specific Surface Area/Vol.		417.2	m^2/m^3
Cage Width	8.60	m	8.60	Volumetric Loading		0.0001	$L/m^2.s$
No. Textiles per row	156	/row	156	Total Media Surface Area		1211886.3	m^2
textile density	18.14	/m	Density OK	BOD Loading @	DWF	0.6	$g/m^2/d$
textile length	4.7	m	4.7	BOD Loading @	FFT	5.0	$g/m^2/d$
No. Support Loops	4.0		4.0	Volumetric Loading @	FFT	21.4	$L/m^2/d$
No. Textiles	11232		5616	Media Volume		2904.7	m^3
Total Biotextil accommodated	52691	m	26345	BOD Loading @	DWF	0.3	kg/m^3 Media
				BOD Loading @	DWF	0.1	kg/m^3 Tank

Total Media Displacement	13.17	m^3	16099.94	kg	max sludge/cage
Total Cage Displacement	9.28	m^3	2037.90	kg	cage weight
Total Displacement	22.45	m^3	18137.83	kg	Design Maximum Lift

Calculate Actual Oxygen Demand (AOR)

AOR = 0.75B + 0.048MV + 4.3AmmN - 2.85Y(AmmN)

BOD oxygen demand =	0.75 x (BODinf - BODeff)		☑ Primary Settlement Tanks	
Endogenous respiration =	0.048 x M x V	Est.	25%	BOD reduction
Nitrification requirement =	4.3 x (NH_3N_i - NH_3N_e)	Est.	50%	SS Reduction
Denitrification credit =	2.85 x 0.25 x (NH_3N_i - NH_3N_e)		☑ Anoxic Zone	

Where

			Target	Consent	
BODi =	Influent BOD (kg/d)				
MLSS =	Mixed liquor suspended solids in aeration tank (mg/l)				
BODe =	Effluent BOD(kg/d)	BOD	5.00	10.00	mg/l
NH_3N_e =	Effluent NH_3 as N (kg/d)	NH3-H	2.50	5.00	mg/l
NO_3N_e =	Effluent NO_3 as N (kg/d)	NO3Ne	0.00		mg/l
P_e =	Effluent P (kg/d)	Pe	0.00		mg/l
		SS	10.00	20.0	mg/l

	Min Flow	DWF	Average	FFT
Effluent BOD (kg/d)	42	42	63	130
Effluent NH_3 (kg/d)	21	21	31	65
Effluent NO_3 (kg/d)	-	-	-	-
Effluent P (kg/d)	-	-	-	-
Effluent SS (kg/d)	84	84	84	84
Required Alkalinity (mg/l)	2,964	339	338	206
1. Growth oxygen demand (kgO2/d)	557.50	557.50	3,463	4,466
2. Endogenous respiration (kgO_2/d)	2,506	2,506	2,506	2,506

☑ Nitrification

Your Reference	06-May				
Water Company	JB BARRY	P.E	78,000		
Our Reference	AS11407				
Scheme Name	CASTLETROY				Peaking Factor
Option	78,000 PE REV02				1.30
Date	20/05/2020	Flow Split	100%		

Conversion to SOTR

Alpha	0.60		Alpha (calculated)				
Beta	0.95						
Altitude (m)	100						
D.O field (mg/l)	1.5		1.7		2.0		
Water Temp. (°C)	13		13		13		
Omega, W	0.99						
Surface Saturation $Csat_{20}$ (mg/l)	9.09						
Surface Saturation $Csat_{Tw}$ (mg/l)	10.54		10.54		10.54	mg/l	
Diffuser Submergence, Ds (m)	5.37					☑ Lift Out Grids	
Probe depth Factor, F	0.367						
Corrected C^{*}_{20}(mg/l)	10.825						
Corrected C^{*}_{T}(mg/l)	12.546		12.546		12.546	mg/l	
Theta, Θ	0.847		0.847		0.847		

	Min Flow	DWF	Average		FFT
SOTR (kgO2/d)	9326	9326	17149		21072
SOTR (kgO2/h)	388.58	388.58	714.55		877.99
F:M, q (kgBOD/kgMLSSd)	0.014	0.014	0.058		0.114
Aerobic F:M (kgBOD/kgMLSSd)	0.014	0.014	0.058		0.114
NH_3 Loading Factor (kgNH_3-N/kgMLSS	0.008	0.008	0.011		0.014
Aerobic Sludge Age, Θ (d)	71.0	71.0	11.4		6.9
HRT (hrs)	16.7	16.7	11.1		5.4
Theoretical Yield, Y (kg/kg)	0.99	0.99	0.99		0.99
WAS kg/d	735	735	4564		5885
	1.5640979	1.564097891	0.96150984		1.22195638

Airflow - Assumed SOTE

SOTE (%/m)	6.6	6.6	6.6		6.6
Airflow - Nm³/h (0°C, 1013mbar, 0%RH	3,666	3,666	6,741		8,283
Airflow - m³/h (20°C, 1013mbar, 36%RH	3,974	3,974	7,308		8,980

Final Settlement Tanks

SELECT MLSS	3500	mg/l	**Given Capacity**					
SSVI	80	Range 80-120						
max flow, Q_0	25920	m^3/d						
Velocity of sludge in water, V_0	7.03	m/h						
Constant, k	0.0003666							
Max Upflow Velocity U_{max}	1.56	m/h				2	1	
Area of Clarifiers	692.96	m^2	Req'd Dia			20.0	25.0	
Assumed RAS concentration	6000	mg/l						m
Required Recycle ratio R	1.40		FST's	628.3	490.9 m^2			
Max size of RAS pumps	420.0	L/s						
Downward loading on Clarifier	2.18	m/h			1.5157E+13			
Critical downward loading $(Q_0/A)_{crit}$	0.95	m/h		Fmax	10.167865 kg/hm2			
Critical RAS pump flowrate	183.2	L/s		V	1.94975631 m/h			