Appendix 11-1: Drainage Report

Proposed Order for Amendment of 32mppa Conditions

Drainage Report



November 2026

NICHOLAS O'DWYER
an RSK company

daa plc

PROPOSED ORDER FOR AMENDMENT OF 32MPPA CONDITIONS

DRAINAGE REPORT

Nicholas O'Dwyer Ltd
Consulting Engineers
Nutgrove Office Park
Nutgrove Avenue
Dublin 14

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GLOSSARY

Abbreviation	Definition
ADP	Airfield Drainage Project
ATC	Airfield Trunk Culvert
BOD	Biochemical Oxygen Demand
CD&R	Contamination Detection and Response
COD	Chemical Oxygen Demand
CPCF	Central Pollution Control Facility
CPSRA	Controlled Part of the Security Restricted Area
FDS	Flow Diversion Structure
GRV	Glycol Recovery Vehicle
MEICA	Mechanical, Electrical, Instrumentation, Control and Automation
PCF	Pollution Control Facility
PWHT	Polluted Water Holding Tank
SADIP	South Apron Drainage Intervention Project
SCADA	Supervisory Control and Data Acquisition
SuDS	Sustainable Drainage Systems
TEDL	Trade Effluent Discharge Licence
TOC	Total Organic Carbon
UÉ	Uisce Éireann
WFD	Water Framework Directive

1 INTRODUCTION

1.1 Experience of Authors

This report was prepared by Conor Dennehy. Conor (BSc, MSc, PhD) is an Associate with Nicholas O'Dwyer Consulting Engineers with over 14 years of experience in environmental engineering, environmental monitoring, drainage design and wastewater treatment. Conor holds a degree in Environmental Science from the University College Cork, a Masters of Science Degree in Environmental Diagnostics from Cranfield University and a PhD in Environmental Engineering from the University of Galway. He has worked on a wide of range of projects including feasibility, optioneering and design of drainage networks and wastewater treatment plants, wastewater system optimisation studies, and planning, procurement, contract administration and technical assurances. He is a chartered member of the Chartered Institute of Water and Environmental Management (CIWEM) and a member of Engineers Ireland (MIEI).

1.2 Background and Purpose

The Proposed Order will consist of the amendment of condition no. 3 of ABP Ref. No. PL06F.220670 (F06A/1248) and condition no. 2 under ABP Ref No. PL06F.223469 (F06A/1843); collectively referred to as "the 32mppa Conditions". The Proposed Order therefore will result in future increase in airfield activity. No physical works are included as part of the Proposed Order.

Consideration of the impact of additional airfield activity on the existing drainage infrastructure is required. This report has been prepared by Nicholas O'Dwyer Ltd to consider the impact of the Proposed Order on the operation of drainage infrastructure at Dublin Airport.

1.3 Objective of Report

The objective of this report is to assess the impact of the Proposed Order on the operation of drainage infrastructure at Dublin Airport.

This report presents;

- An overview of the existing airfield surface water drainage and pollution control system and associated operational practices;
- An overview of the airfield drainage project (ADP) and other future drainage works which daa are progressing towards implementation and their potential benefits in terms of pollution control at Dublin Airport;
- An overview of additional embedded operational mitigation measures to enhance drainage system operation;
- An overview of the potential impact of the Proposed Order on system performance.

2 AIRFIELD DRAINAGE AND POLLUTION CONTROL

2.1 Introduction

This section focusses on the airfield surface water management system as this is the area impacted by potential surface water contamination due to airfield operational activities such as the application of anti-icing and de-icing chemicals. For the purpose of this report, the "airfield" is defined by the areas inside the Controlled Part of the Security Restricted Area (CPSRA - see Figure 2-1).

The surface water currently drains to three primary catchments, subdivided into a further six sub catchments, as illustrated in Table 2.1 and Figure 2-1 below.

The Ward River sub-basin is presented in Figure 2-1. The Ward River's natural catchment extends across the western part of the North Runway; however, it does not receive drainage from the North Runway (microdrainage diverts surface water flows to the Forrest Little Stream). As such it is not directly hydrologically connected to the Proposed Order.

Table 2.1: Waterbodies within Study Area

Catchment	Sub-catchment
Sluice	Kealy Stream
	Wad
	Forrest Little Stream
Santry	Santry
Mayne	Mayne
	Cuckoo Stream

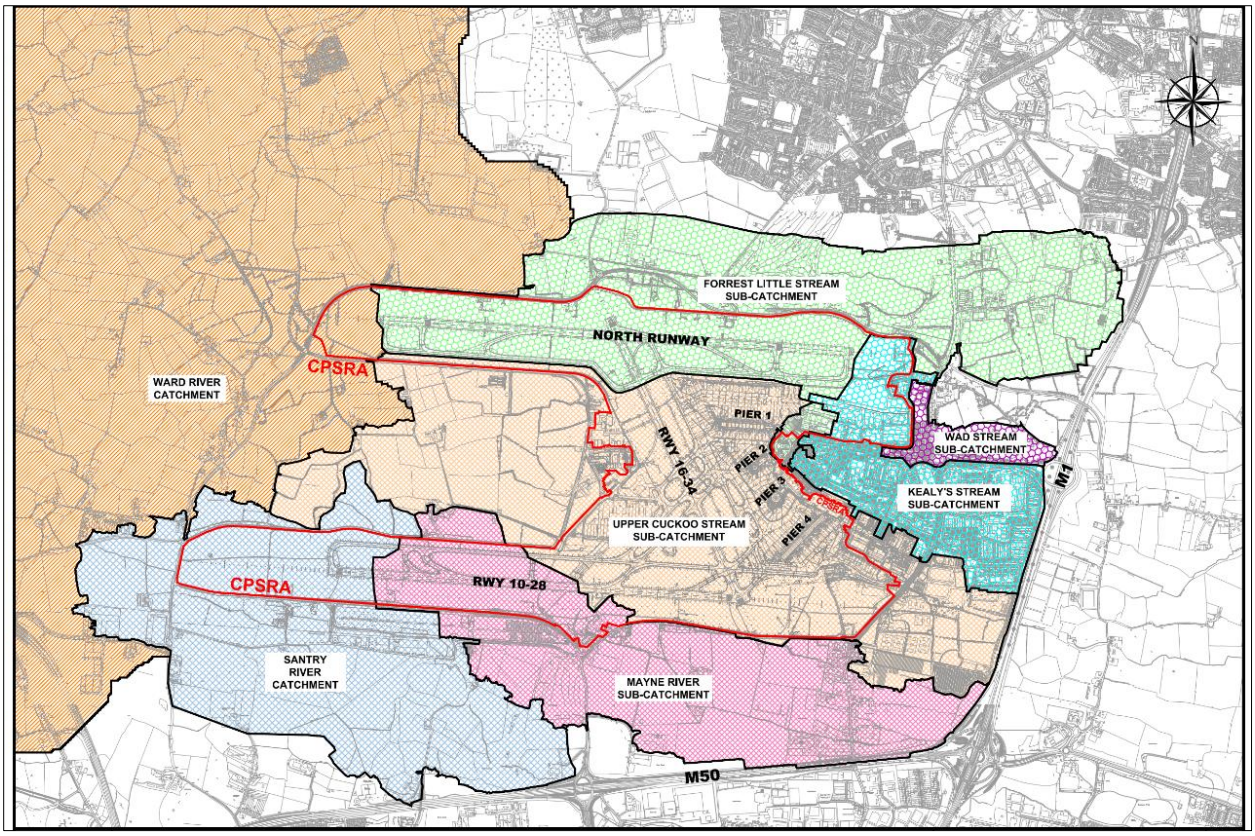


Figure 2-1: Existing Rivers and Catchments

As shown in Figure 2-1, the majority of airfield surface water network discharges to Cuckoo Stream sub-catchment. The Cuckoo Stream sub-catchment is the largest sub-catchment at Dublin Airport and includes a large proportion of the operational airfield area. There is also a large greenfield area (approx. 170HA), which consists of mostly agricultural lands, located in the upper reaches of the Cuckoo Stream sub-catchment, to the west of the airfield at a landside location (i.e. outside the CPSRA). Stormwater runoff from this area is drained into the airfield, collected and conveyed by the existing Airfield Trunk Culvert, which discharges these flows to the open channel section of the Cuckoo Supply Channel adjacent to the South Apron.

Surface water runoff from the majority of the northern part of the airfield, upgraded as part of the recently completed North Runway development, is located within the Forrest Little sub-catchment and discharges to the Forrest Little Stream. However, surface water runoff from the north-eastern part of airfield (east of the North Runway) discharges to Kealy Stream. A small section of grassed area in the north-west of the airfield drains to the Ward catchment (this area is not subject to airfield operational activities).

Runoff from the south-west part of the airfield drains to the Santry River and Mayne catchments.

2.2 Surface Water and Pollution Control System

An overview of the surface water network at Dublin Airport is shown in Figure 2-2. The below image shows the key trunk pipelines in the airfield surface water network, which serves areas within the Critical Part of the Security Restricted Area (CPSRA) boundary.

The surface water drainage system at Dublin Airport consists of local collection pipework comprising a series of slot drains, gullies and carrier pipelines, to serve the hardstand areas. Petrol/oil interceptors are located throughout the network to remove hydrocarbons from surface water in advance of discharge to receiving waters.

Runoff is conveyed to attenuation facilities (which reduce the rate at which clean flows are released to surface waters). The surface water attenuation facilities within the airfield at Dublin Airport consists of a number of local attenuation tanks, to serve specific local developments, and regional attenuation facilities which attenuate flows conveyed to the flow diversion structures. The key regional attenuation facilities for airfield surface water runoff are the Cuckoo Cleanwater Attenuation Tank and the North Runway Cleanwater Attenuation Tanks.

When runoff the airside areas where the de-icing activities occur is detected by monitoring points to be contaminated, it is directed to the pollution control facilities described in Section 2.2.3.

The drainage system collecting the runoff from sub-catchments within the CPSRA boundary is described in the following sub-sections. Since the majority of the de-icing activities occur in the Cuckoo and Forrest Little sub-catchments, the surface water collection systems in these two catchments include a centralised pollution control facility, which are described in the following sub-sections.

The following sub-sections describe the drainage configuration prior to the implementation of ongoing embedded operational measures targeted at enhancing system performance.

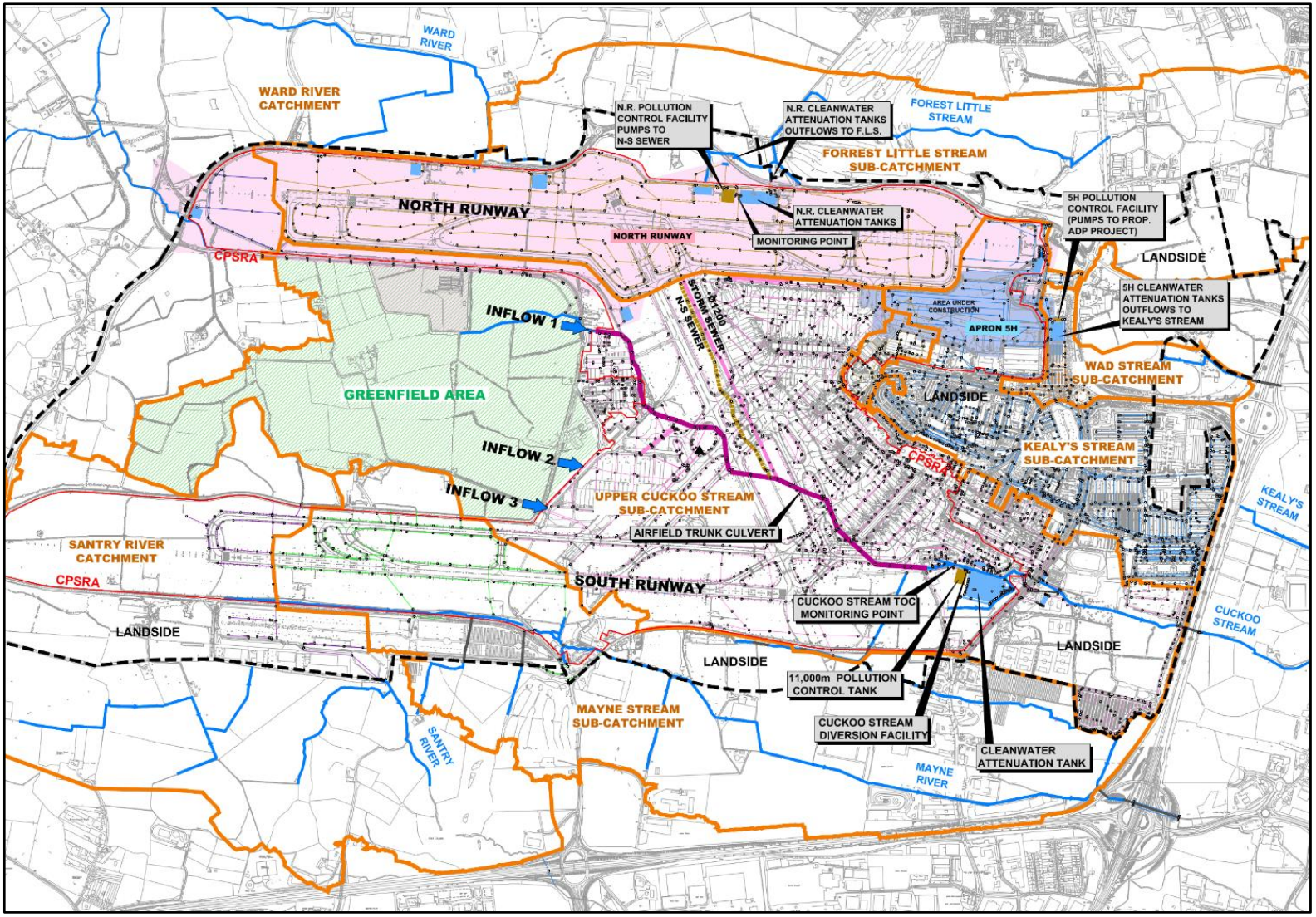


Figure 2-2: Indicative Existing surface water network at Dublin Airport

2.2.1 Storm (Clean) Drainage Network

2.2.1.1 Cuckoo Stream Sub-Catchment

The upper Cuckoo Stream Sub-Catchment receives the majority of runoff in the airfield areas, including the aprons and taxiways surrounding the terminal buildings and piers, West Apron, the eastern portion of the South Runway and Runway 16/34. This sub-catchment also receives runoff from a greenfield area upstream of the airfield.

The runoff from areas within Cuckoo Stream sub-catchment, are received and conveyed to the existing Airfield Trunk Culvert (ATC), which is the main surface water pipeline serving the airfield network. The runoff sources can be considered under the following two categories:

1. **Greenfield Inflows**: The culvert conveys the inflows from grassed areas upstream of the airfield. Surface water runoff from the greenfield areas is currently collected via a series of land drains and ditches before being received by the Airfield Trunk Culvert at a number of contribution points. The extent of grassed areas contributing runoff to the Airfield Trunk Culvert, and the inflow points (1, 2 and 3), are shown in Figure 2-2.

2. **Airfield Hardstand Runoff**: The ATC also acts as the main trunk surface water pipeline which serves most of the existing hardstand areas within the upper Cuckoo Stream sub-catchment. The existing surface water pipelines that discharge to the Airfield Trunk Culvert are indicatively detailed on Figure 2-2.

The Airfield Trunk Culvert (ATC) commences to the east of the R108 and traverses the airport campus in a south-easterly direction towards the existing Cuckoo Supply Channel (open-channel drainage system) adjacent to the South Apron. The Cuckoo Supply Channel runs in an easterly direction and conveys flows across the R132 in a culverted system before continuing to the Cuckoo Stream. The Cuckoo Stream ultimately conveys flows through landside areas to the east of R132 and they are discharged from daa lands, via a culverted system under the M1 motorway.

The Cuckoo Supply Channel includes a flow diversion facility (Refer to Figure 2-5 and Figure 2-6). This facility permits a specified rate of flow (determined by settings of the actuated sluice gate on the structure[P/D1 in Figure 2-5]) to be released from the structure to the downstream Cuckoo Supply Channel. If flows greater than this rate occur, levels at the structure increase, and additional flow spills via a weir to the Cuckoo Cleanwater Attenuation Tank inlet (P/D2 in Figure 2-5). This tank then stores additional flow, and discharges this at a controlled rate (79 l/s) to the Cuckoo Supply Channel.

The flow diversion structure also includes a diversion facility to convey flows to the pollution control system if they are detected as contaminated. Clean flows below the specified outflow rate continue directly to the Cuckoo Stream.

It is to be noted that the existing surface water infrastructure within Cuckoo Stream Sub-Catchment is the subject of planned upgrades as part of the ADP planned development (refer Section 3.1).

2.2.1.2 Forrest Little Stream Sub-catchment

Forrest Little Stream Sub-Catchment receives runoff from the North Runway development.

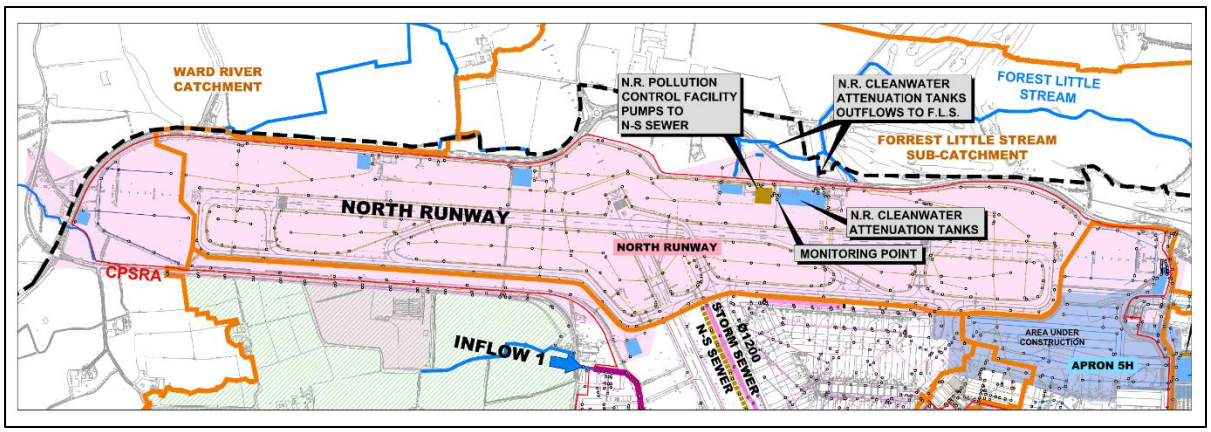


Figure 2-3: Existing drainage network configuration in North Runway Development

The drainage system in the North Runway development is divided into four separate networks, one draining the runway and taxiway pavements and three to drain the grassed areas. The runway development is served by a clean water attenuation tank, which attenuates the portion of the clean flow exceeding the allowable outflow rate, prior to discharging to the Forrest Little Stream. The grassed area drainage network comprises of filter drains with perforated carrier pipes along their invert. The filter drains contribute to the storage of runoff, reducing the surface ponding / flooding. Small attenuation tanks included at the outlet of each grassed area network ensure that greenfield runoff rates are maintained.

The western end of the North Runway is within the Ward River catchment, however the stormwater drainage does not discharge from hardstanding areas into this catchment as they could potentially contain contaminants from airport operational activities and the Ward River catchment is considered as a salmonid water course. Hence, all runoff from the North Runway is conveyed to a contamination monitoring point within the Forest Little Stream sub-catchment.

Similarly, the eastern end of the North Runway overlaps with the Kealy Stream sub-catchment. However, due to the contamination risk associated with runoff from the hardstanding areas in the airfield, runoff from the hardstand areas is also diverted for monitoring and pollution control within the Forrest Little sub-catchment.

The surface water from the North Apron which falls within the Kealy sub-catchment discharges northwards to Forrest Little Sub-Catchment. The details of the planned development within North Apron and Apron 5H are described under Section 3.

2.2.1.3 Santry and Mayne Sub-catchments

Figure 2-4 presents the surface water drainage serving the western portion of the South Runway. The majority of runway and taxiways of this portion of the airfield are within the Mayne sub-catchment, with a minor portion located within the Santry sub-catchment. The are no aircraft stands in this area.

There is no pollution control or surface water attenuation infrastructure in these areas, with hardstand runoff combining with greenfield runoff before entering drainage channels which then flow to the streams.

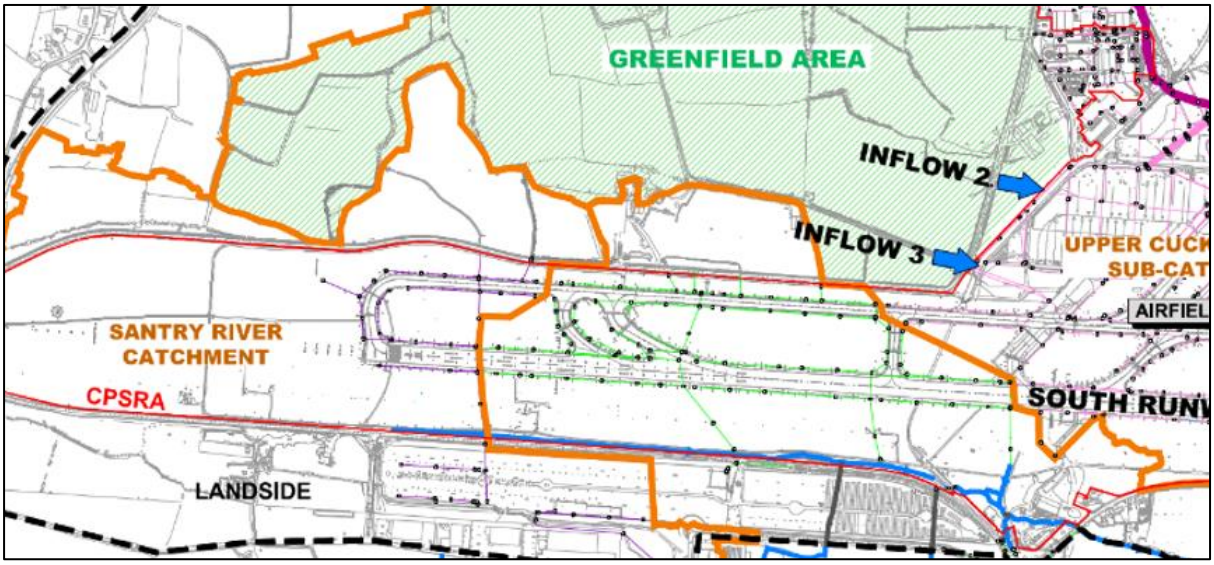


Figure 2-4: Existing drainage network configuration at the South Runway

2.2.2 De-icing and Anti-icing Activities

The use of chemicals in the support of safe and efficient airport operations at Dublin Airport comprises of aircraft de-icing / anti-icing and also pavement de-icing / anti-icing, as described below.

Pavement Anti-Icing/Deicing

Application of anti-icing / deicer fluids and granular material to areas trafficked by aircraft is essential for airfield safety during low temperature conditions.

Provifrost KF ECO a Potassium Formate-based solution, is the chemical used for airfield pavement anti-icing / de-icing at Dublin Airport. The rates of pavement anti-icer application are dependent on the weather conditions and pavement condition testing and inspections undertaken on the airfield by the Airport Fire Service and Operations teams. However, it is generally applied only in frost/freezing conditions (i.e. When dew point less than or equal to 0°C and difference between dew point and temperature is less than or equal to 1.67°C). The daa airside operations team are responsible for pavement anti-icing on the ramp areas and the Airfield Asset Management Team carry out the preventative anti-icing of the runways and taxiways. The daa Winter Plan sets out what areas are to be subject to pavement anti-icing and in what order of priority; typically stands, taxiways and runways are highest priority, with roadways and service areas lower priority. It should be noted that the airfield perimeter road is gritted with sand based salt not Potassium Formate during normal anti-icing operations.

Asset Management control and manage all chemicals deployed via fleet telematic systems to prevent over spray and excessive spraying of paved areas.

Aircraft Deicing/Anti-Icing

Application of deicing and anti-icing fluids to aircraft prior to departure is essential for airfield safety during low temperature conditions. The chemicals used to carry out aircraft deicing/anti icing is dependent on the carrier/handler. At Dublin Airport Type I (Kilfrost DF Plus) and Type IV (Kilfrost ABC-S), in combination, are utilised for de-icing and anti-icing of aircraft respectively. Alternatively, Type II fluids (Kilfrost ABC-K Plus) are utilised for both anti-icing and de-icing. The volumes applied are dependent on the aircraft type, the prevailing temperature and the level of dilution applied to the deicer chemicals, with each carrier/handler having specific preferences. Generally, aircraft deicing occurs when temperatures are at or below 4°C, with increased volumes applied as temperatures reduce. Aircraft deicing at Dublin airport is carried out on stands by service providers employed by airlines, immediately prior to aircraft taxi and departure.

2.2.3 Pollution Control System

In the current arrangement, there is a pollution control system in place to reduce the risk to surface water from the application of pavement anti-icing / de-icing chemicals and aircraft anti-icing / de-icing chemicals applied for airfield safety purposes.

The existing pollution control system at Dublin Airport operates under the runoff management train approach, in accordance with SuDS principles. This system includes a combination of source control, site control and regional control measures as detailed below.

a) Source Control: The current pollution control approach at Dublin Airport includes the collection of de-icing and anti-icing chemicals by Glycol Recovery Vehicles (GRVs). A significant portion (between 23% and 90% depending on chemical type applied and weather conditions- refer to Appendix A for further details) of the applied compounds is collected by GRVs, resulting in a reduction in the compounds which are mobilised to the network. This in turn reduces the contamination of surface water runoff and reduces the potential impact of runoff on surface waters.

b) Site Control: The site control measures in the existing surface water network at Dublin Airport comprise of a series of oil interceptors, which are positioned throughout the network to remove hydrocarbons which may be present within the surface water.

c) Regional control: Regional control measures involve monitoring points, flow diversion structures/chambers, contaminated water storage tanks and pumped discharges to the sewer. The regional pollution control facilities which are part of the existing surface water management system are described in the following sub-sections.

2.2.3.1 Cuckoo Pollution Control Facility

The Airfield Trunk Culvert carries the flows to the existing Cuckoo Supply Channel which has a single water quality flow monitoring point, comprising a Total Organic Carbon (TOC) monitor, to determine whether the flows from the upstream airfield network are clean or contaminated. The channel includes a Flow Diversion Structure (FDS) which diverts the flows from the Cuckoo Supply Channel, depending on the contamination status and flow rate, to one or more of the following:

- Cuckoo Stream – receives clean flow that is below the allowable outflow rate

- Cuckoo Cleanwater Attenuation Facility – receives clean flow that is above the allowable outflow rate
- Pollution Control Facility – receives contaminated flow.

In the event that the TOC monitor indicates runoff contamination exceeds the diversion concentration limit (a set COD [chemical oxygen demand] concentration above which runoff is deemed contaminated), the flows in the existing Cuckoo Supply Channel are diverted by the FDS, in their entirety, to an existing pollution control tank by the closing of the sluice gates to the downstream Cuckoo Supply Channel (P/D1 in Figure 2-5) and the Cleanwater Attenuation Tank (P/D2 in Figure 2-5). This tank acts as a buffer system for the contaminated flows before being discharged via a pumped outlet to the North Fringe Sewer (owned and operated by Uisce Éireann). Discharges to the public foul sewer are managed in accordance with the conditions of the existing Trade Effluent Discharge Licence (TEDL) which is regulated by UÉ. The arrangement of the FDS on Cuckoo Supply Channel is shown on Figure 2-5 and operational control philosophy is schematically shown in Figure 2-6.

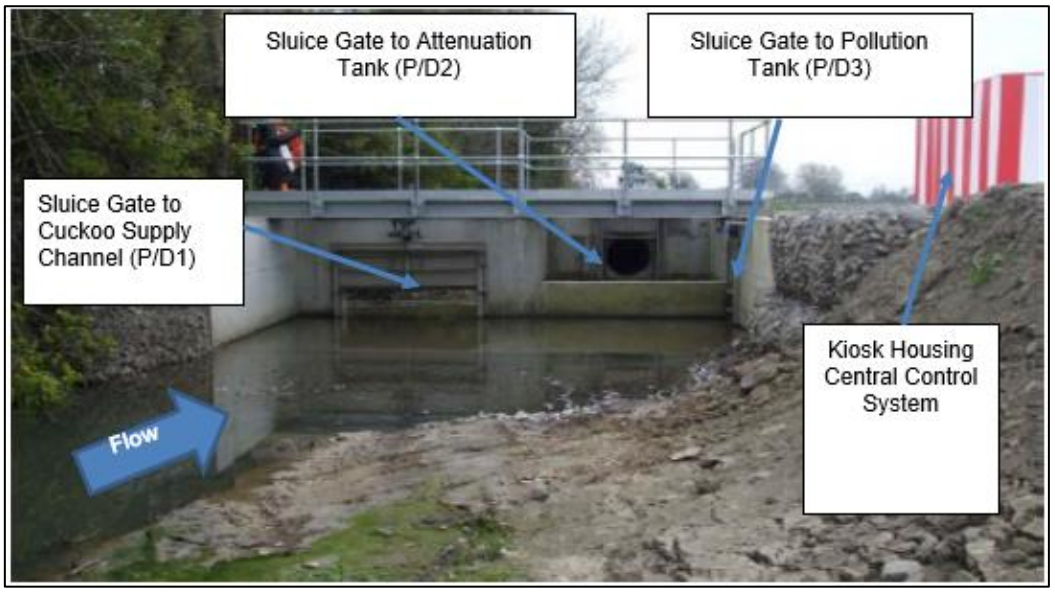


Figure 2-5: FDS Arrangement on Cuckoo Supply Channel

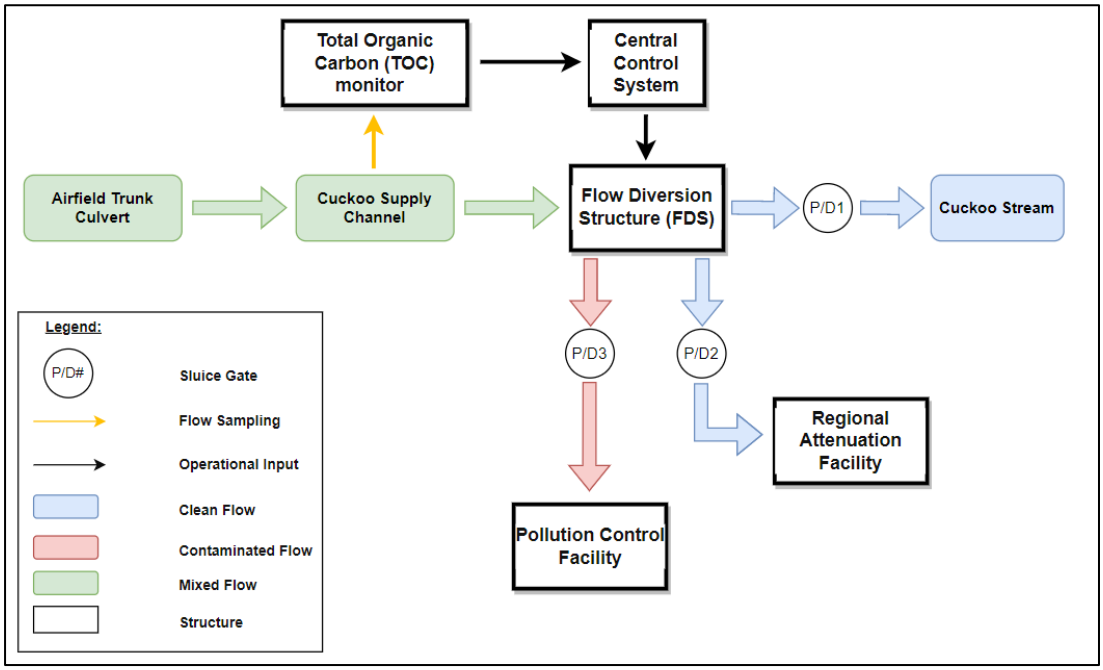


Figure 2-6:Cuckoo Stream Pollution Control Operational Philosophy

2.2.3.2 North Runway Pollution Control Facility

The North Runway development includes a local contamination detection and response (CD&R) system to identify contaminated runoff and a pollution control facility (PCF) for storing contaminated runoff prior discharging it to the North Fringe Sewer. The operational philosophy is shown in Figure 2-7.

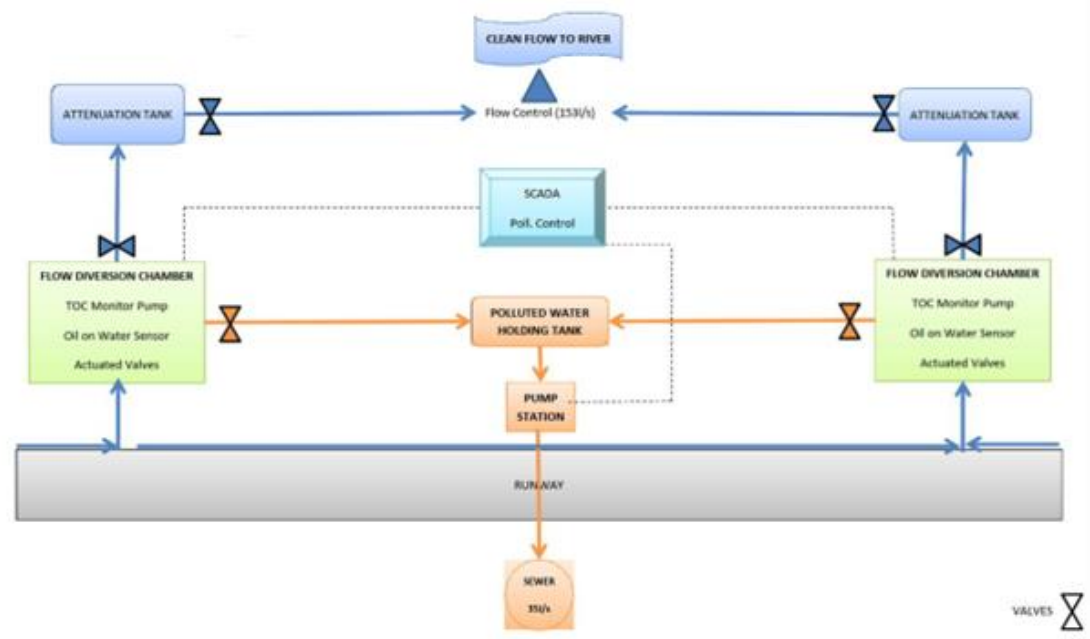


Figure 2-7 North Runway Pollution Control Operational Philosophy

Runoff from paved areas is continuously monitored via online Total Organic Carbon (TOC) analysers. These TOC results returned by these analysers are calibrated to equivalent BOD and Chemical Oxygen Demand (COD) limits to measure compliance with permitted discharge levels. If monitoring shows that the surface water is contaminated, it is automatically diverted to the polluted water holding tank (PWHT), from there pumped to the Uisce Éireann owned North Fringe Sewer. If the pollution is below the threshold it is diverted into the clean water attenuation tank from where it is discharged at green-field rates. The thresholds determining whether the run-off is diverted to the contaminated or clean water holding tanks are set at 5 mg/l BOD for the period October to April inclusive (Winter Operation) and 3 mg/l BOD for the period May-September inclusive (Summer Operation) in accordance with the planning conditions set for the North Runway.

3 AIRFIELD DRAINAGE PROJECT AND FUTURE PLANNED DEVELOPMENTS

This section outlines the key planned developments at Dublin Airport which involve upgrades of the surface water drainage network and associated pollution control infrastructure. The surface water infrastructure upgrades proposed by these projects have been developed to ensure that any impacts on water quality of the waterbodies surrounding the airport campus will be positive and support compliance with the water quality objectives of the Water Framework Directive (WFD).

3.1 Airfield Drainage Project

The Airfield Drainage Project (ADP) [F23A/636, ABP-320815-24] is a consented development which proposes significant upgrades to the key airside surface water and pollution control infrastructure. It is expected to be operational by 2031. The ADP and interfacing planned developments are outlined in the below sub-sections.

The ADP proposes significant upgrades to the surface water management infrastructure at Dublin Airport. The ADP comprises a series of drainage system enhancement measures and infrastructure proposals, including the upgrade of existing drainage infrastructure and the construction of additional infrastructure to supplement the performance of the existing surface water management system.

An overview of the planned drainage developments associated with the Airfield Drainage Project are presented in Figure 3-1 and described below.

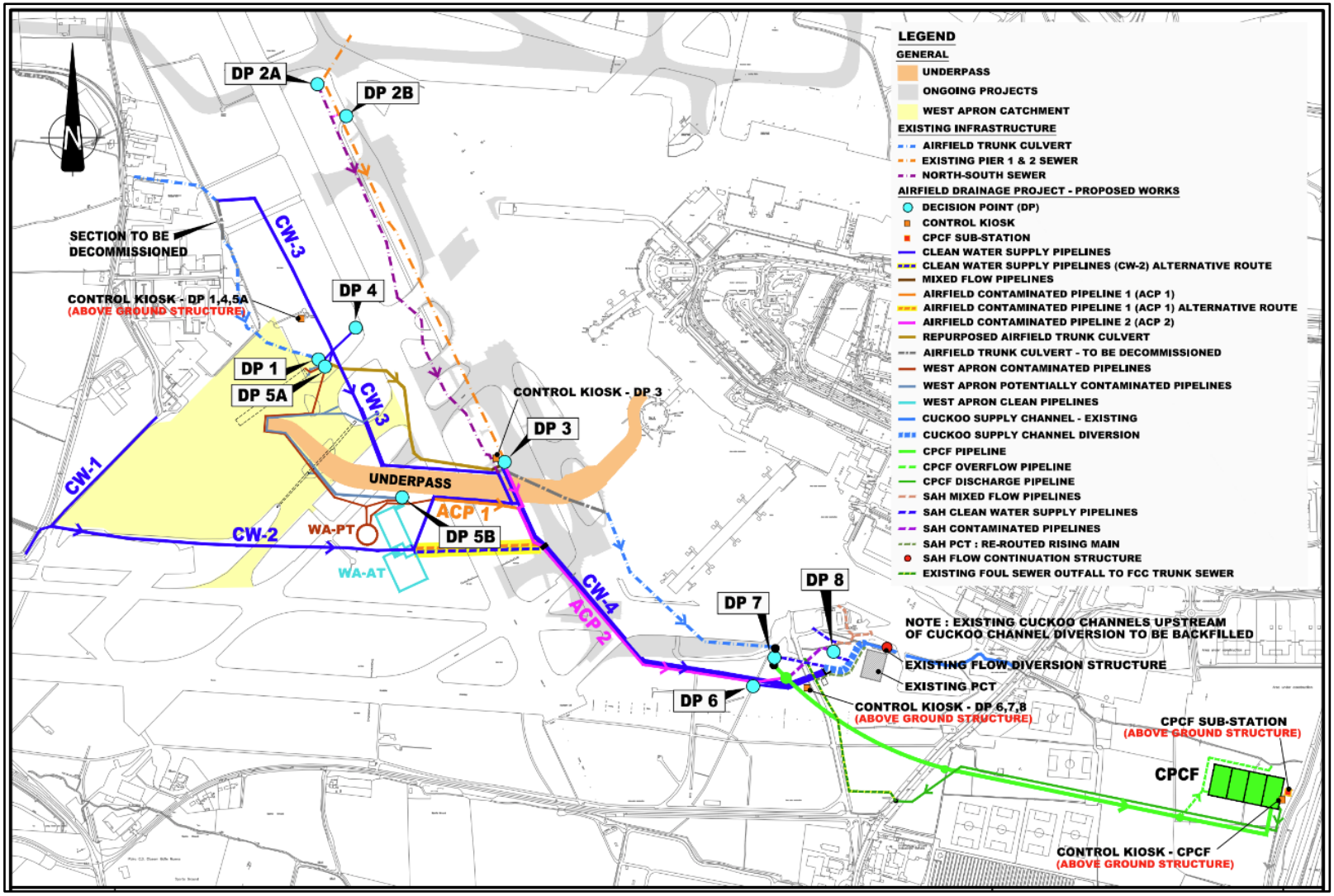


Figure 3-1: Proposed ADP Drainage Developments (Indicative Layout)

The planned development consists of the following elements;

3.1.1 Contamination Detection and Response System

A CD&R system has been designed strategically to segregate clean and contaminated flows from various 'zones' within the airfield. This will avoid clean flows from one zone being mixed with, and contaminated by, runoff from another zone. This will serve to increase clean flow to receiving waters and to protect the receiving waters from contaminated runoff. This system consists of detection devices, network 'decision points' (DPs), control kiosks and ancillary infrastructure.

3.1.2 Clean Water Supply Pipelines

New clean water supply pipelines are planned to convey flows from greenfield inflows, and runoff from the airfield which has been identified as clean by CD&R System, to the receiving waters.

3.1.3 Airfield Contaminated Pipelines

Airfield Contaminated Pipelines (ACPs) are planned to provide additional hydraulic capacity for contaminated flows from the airfield surface water network. The ACPs will receive flows identified as contaminated by the CD&R and convey them to the planned CPCF Pipeline. From here these contaminated flows will be conveyed to the CPCF for storage and discharge to sewer.

3.1.4 West Apron Network Upgrades

It is proposed to upgrade the surface water infrastructure in West Apron through the provision of a new West Apron Attenuation Tank (WA-AT), a new West Apron Pollution Tank (WA-PT), local CD&R system and associated pipework.

3.1.5 Downstream Network Re-Configuration

It is proposed to upgrade the existing downstream surface water collection network in the vicinity of the South Apron (SA), Pier 3 and Pier 4. This is required to integrate the existing network with the proposed ADP network layout and the planned approach to flow segregation and pollution control. The planned upgrades include reconfiguration of the existing network, construction of network decision points, upgrade of the existing Flow Diversion Structure (FDS) and reconfiguration of the existing Cuckoo Supply Channel.

3.1.6 Central Pollution Control Facility (CPCF) Trunk Contaminated Pipeline

A new trunk contaminated pipeline is planned to convey contaminated surface water from the airfield surface water network to the planned Central Pollution Control Facility (see below).

3.1.7 Central Pollution Control Facility

A CPCF is planned to protect receiving waters from contaminated runoff from the airfield, which has been identified and segregated by the CD&R system. The CPCF structure would store contaminated surface water runoff prior to discharge to the public foul sewer.

3.1.8 Airfield-wide Supervisory Control and Data Acquisition (SCADA) System

An airfield-wide SCADA system will control the operation of the upgraded surface water management system, including the CD&R system, CPCF, West Apron Pollution Tank (WA-PT), local Pollution Control Facilities (PCFs) for existing and planned developments and ancillary Mechanical, Electrical, Instrumentation, Control and Automation (MEICA) equipment throughout the airfield surface water network.

The planned airfield-wide SCADA system will provide operational control for all existing and planned drainage infrastructure, to ensure a fully integrated system across the entire airfield surface water network.

3.1.9 Infrastructure Application (IA)-Based ADP Elements

The pending Infrastructure Application (IA) includes a series of infrastructure upgrades and planned developments for Dublin Airport. The IA drainage proposals are addressed across several Project Elements.

The Airfield Drainage Project (ADP) was included as an IA Project Element. The ADP version included in the Infrastructure Application included all of the elements listed in Section 3.1 but also included the following additional elements which were designed to serve the overall Infrastructure Application:

- **Flood alleviation measures** will be provided at Eastlands to ensure there is no downstream flooding impact as a result of the planned IA developments.
- **Stream naturalisation** measures will be implemented along the section of the Cuckoo Stream at Eastlands (east of the R132 road and west of the M1 motorway). These naturalisation measures comprise the introduction of stream meanders, a naturalised flood plain and planting of suitable species of vegetation to promote reoxygenation of water in the Stream and a reduction in sediment content.

3.2 Apron 5H

The ongoing development at Apron 5H, which is permitted under F20A/0550, includes a local pollution control facility (PCF) with a pumped discharge pipeline. The pumped discharge line will discharge to the existing North South Sewer to be conveyed to the public wastewater system, in accordance with the limits of the existing TEDL. This system expected to be fully operational by end of Q3 2026.

4 EMBEDDED OPERATIONAL MEASURES

Per Section 3.1, the ADP is the long-term measure by which pollution control will be implemented at Dublin Airport. It is expected to be operational by 2031.

In the interim, a range of embedded operational measures are being progressed which will improve the pollution control system performance, thereby progressively reducing risk of impacts to receiving waters.

These ongoing measures comprised improvements to the existing pollution networks and control systems, upgrades to operating control and discharge mechanisms and increased numbers of glycol recovery vehicles.

4.1 Pollution Control System Enhancement & South Apron Drainage Intervention Project

Improvements to the operation of the existing Cuckoo Pollution Control Tank are being delivered to contribute to improved management of contaminated surface water runoff.

These improvements are being delivered by the South Apron Drainage Intervention Project (SADIP) [scheduled for completion Q2/3 of 2026]. SADIP measures are made solely to improve drainage operation and reduce environmental risk, without introducing new infrastructure or altering the existing use of the site.

SADIP measures comprise a series of localised modifications to the existing drainage and pollution control system and operational measures. These were developed to address identified capacity and operational constraints. These measures are discussed in more detail in the following sections.

4.1.1 Improved Outlet Facility at Cuckoo Stream

Localised drainage related improvements have been made to the existing Cuckoo Pollution Control Tank:

- Construction of a second outlet to improve the functioning of the weir outlet.
- Connection of the new outlet to the existing pollution control storage tank.

These improvements increase the ability of the existing system to divert contaminated runoff away from the Cuckoo Stream and into on site storage during periods of high flow.

This reduces the risk of overflow discharges to the receiving environment during co-incident high flow (as driven by rainfall) and low temperature (i.e. when deicing is occurring) events.

4.1.2 Use of Existing Surface Water Attenuation

Modifications to the existing surface water attenuation system have been completed. Two of the three existing tanks have been reconfigured to store contaminated runoff when required. These tanks will be hydraulically isolated from the remaining tank when used to store contaminated runoff. This approach boosts contaminated storage when required, while ensuring attenuation and storage for clean surface water is available at all times.

A total of 15,660m³ of the existing 20,500m³ global attenuation capacity (Tanks 2 and 3) have been connected to the Pollution Tank for additional contaminated runoff storage when required. Tank 1 remains unchanged and will continue to attenuate clean water only at all times.

This represents a 142% increase in available contaminated runoff storage capacity when required and results in a significant reduction in risk of overflow discharges caused by the system reaching maximum storage capacity.

4.2 Operation and Control of Discharge System

The discharge from daa's pollution control infrastructure to the public sewer is governed by a site-wide trade effluent discharge licence granted by Uisce Éireann. This licence permits discharges that do not exceed 165 l/s and meet prescribed effluent concentration limits. As of 2025, the limits were allocated internally by daa on a fixed basis to each pollution control system. This results in latent capacity in the system i.e. if all tanks are not discharging, the maximum possible discharge rate is not achieved.

Reconfiguration the site-wide control system to ensure that the maximum discharge rate is utilised when necessary, where contaminated runoff is entering tanks, will reduce the amount of storage utilised, thereby increasing the effective storage capacity of tanks. For the existing Cuckoo Pollution Control Tank, this would reduce the frequency and volume of overflow events.

This upgrade would not result in any increase in maximum discharge rate beyond the rate agreed with Uisce Éireann under the existing trade effluent discharge licence, and will facilitate the maximum utilisation of all onsite storage tanks to buffer discharges to sewer.

daa is progressing upgrades to control systems to ensure such optimised system controls are in place.

4.3 Glycol Recovery Vehicles Fleet Expansion

The purpose of Glycol Recovery Vehicles (GRV) is to collect the glycol-heavy runoff from aircraft de-icing operations before it is conveyed to the downstream drainage network. Collected glycol is stored airside and disposed of in accordance with relevant waste classification requirements. In 2025 there were 5 GRVs operating at Dublin Airport; 4 dedicated GRVs and 1 combi sweeper. An additional GRV has recently been brought into operation (2026).

5 IMPACT OF PROPOSED ORDER ON AIRFIELD DRAINAGE OPERATION

5.1 Hydrological/Flood Risk

The Proposed Order will see increased aircraft movements on the airfield however introduces no changes to the configuration of the existing drainage. There will therefore be no change to the hydrological operation of the system.

5.2 Deicer Pollution Control

5.2.1 At Source Implications of Proposed Order

The Proposed Order will result in an increase in flight movements. This will have implications with respect to pollution control.

The Proposed Order would increase the frequency of aircraft deicing activity. The Proposed Order would result in the deicing of additional aircraft during days in which deicing is required.

The current drainage configuration results in all runoff from stands on which aircraft are deiced combining in the Cuckoo Stream. Considering that deicing of a single aircraft is sufficient to result in this flow being classified as contaminated, additional aircraft being deiced at the same time as the current flight schedule would not increase the volume classified as contaminated.

However, it would increase the concentration of runoff (as a greater amount of deicer may be applied) and the overall annual mass of deicer contamination to be managed.

5.2.2 Surface Water Impact of Proposed Order

When mobilized by rainfall, this additional load will enter the drainage infrastructure and increase the risk posed by deicer impacted runoff to receiving waters.

Per Section 4, interim embedded operational measures are being implemented to enhance surface water protection. To assess the impact of the Proposed Order on system operation the embedded operational measures are considered as part of the proposed scenario.

The impact of the proposed operation (40 mppa) compared with both a 2025 permitted operation (32 mppa) and 2025 current operation (36 mppa) is presented in the Appendix A Deicer Pollution Modelling Report.

This report concludes that under a scenario where flight movements reach 40mppa, as a result of the embedded operational measures presented in Section 4, there is no increase in the mass load of deicer pollution lost to receiving surface waters (on a Chemical Oxygen Demand [COD] basis).

APPENDIX A- DEICER POLLUTION MODELLING REPORT

Gresham Smith

DUB Pollution Model Analysis for Proposed Order

Assessment of De-icer Pollution Impacts from Airport Passenger Growth

June 2026

Provided to: Nicholas O'Dwyer

Gresham Smith Project No. 43560.02

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DUB Pollution Model Analysis for Proposed Order

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Gresham
Smith

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Appendices

Appendix A

Model Input Data Tables and Charts

Acronyms/Abbreviations

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
mppa	Million passengers per annum
TOC	Total Organic Carbon

Definition of Units

g	gram
ha	hectare
l/s	litres per second
m	meters
m^2	square meter
m^3	cubic meters
mm	millimetre
kg	kilogram
mg/L	milligram per litre

Executive Summary

daa is seeking to evaluate the impact of the changes in passenger numbers from a 2025 permitted operation (32 mppa) and 2025 current operation (36 mppa) scenarios to the proposed operation (40 mppa) scenario. As part of the evaluation, assessment of the impact of increased flight operations and de-icing activities on receiving waters is required.

Separate de-icer pollution control facilities serve the Cuckoo Stream and Forrest Little River catchments under the current state of the environment. The purpose of the systems is to intercept de-icer contaminated runoff generated by the airfield pavement. The pollution control systems are intended to detain de-icer contaminated storm water runoff prior to its discharge to foul sewer.

Time series models of the de-icing operations for the 2025 permitted operation (32 mppa) and 2025 current operation (36 mppa) and the proposed operation (40 mppa) scenarios were developed to assess impact of increased flight operations on receiving waters. Utilising hourly weather data (1995 – 2025), hourly flight schedules, and data on Dublin Airport's current de-icing practices as primary inputs, the models used representations of de-icing operations as well as hydraulic processes to simulate stormwater flows, BOD/COD loadings and BOD/COD concentrations in the airfield runoff. Through application of Dublin Airport's de-icer pollution control facilities and foul sewer discharge limits, the models were used to estimate the impact of increased flight operations on COD discharges to stream.

The model results for all four drainage catchments (Cuckoo Stream, Forrest Little River, Mayne River, Santry River) suggest that the existing infrastructure is sufficient for supporting the growth of passenger numbers from the 2025 permitted operation (32 mppa) and 2025 current operation (36 mppa) scenarios to the proposed operation (40 mppa) scenario without a significant impact to receiving waters.

1 Background

daa are evaluating the impact of increased passenger numbers and flight operations on receiving waters from 2025 permitted operation (32 mppa) and 2025 current operation (36 mppa) scenarios to the proposed operation (40 mppa) scenario associated with the Proposed Order. The additional aircraft traffic associated with the increased passenger numbers will result in increased de-icing activity.

The purpose of de-icer pollution control is to intercept and manage de-icer contaminated runoff generated by aircraft and pavement de-icing activities to achieve compliance with environmental regulatory standards. The existing de-icer pollution control facilities at Dublin Airport collect and detain de-icer contaminated stormwater runoff prior to its discharge to the foul sewer per the permitted limits specified in the Trade Effluent Discharge Licence, granted by Uisce Éireann.

To support ongoing airfield activities until the Airfield Drainage Project is complete, the existing de-icer pollution control infrastructure at Dublin Airport has been supplemented by embedded operational drainage measures. This report summarizes the de-icing pollution model simulations undertaken to estimate the baseline impacts of flight operations, and the impact of the future scenario accounting for the additional pollution control infrastructure. In doing so, a comparative assessment of the losses of mass loads of COD to receiving waters for each growth scenario was developed. This report solely concerns the de-icing pollution model simulations used to estimate the impact of increased flight operations on discharges to receiving waters.

Time series models of the de-icing operations at Dublin Airport under the 2025 permitted operation (32 mppa), 2025 current operation (36 mppa) and the proposed operation (40 mppa) conditions were established to undertake this analysis. The model was developed to estimate the de-icer contaminated runoff from the airfield. Primary inputs of the model included hourly weather data (1995 – 2025), an hourly flight schedule, and guidance on Dublin Airport's current and proposed future de-icing practises. The model also included programmed representations of de-icing operations and hydraulic processes with the given inputs to simulate stormwater flows, BOD / COD mass loadings, and BOD / COD concentrations in the airfield runoff. The simulated de-icer contaminated runoff was then routed through the stormwater network to local pollution control facilities (if applicable), then discharged to the foul sewer or stream, enabling the comparison of releases of flows and COD mass loadings to receiving waters for various development levels.

2 Scope and Objectives

The objective of this study is to develop a comparison for the quantities of COD mass loads released to receiving waters at different growth scenarios. The scope for the technical work includes:

- Development of de-icing pollution models to represent the 2025 permitted operation (32 mppa), 2025 current operation (36 mppa) scenarios and a proposed operation (40 mppa) scenarios. Summarized within **Section 3**.
- Use of the de-icing pollution model to estimate and compare the impact of COD mass loads released to receiving waters from the 2025 permitted operation (32 mppa) and 2025 current operation (36 mppa) scenarios to the proposed operation (40 mppa) scenario . Summarized in **Section 4.**

3 Model Development, Calibration and Validation

3.1 Model Boundary

Runoff from hardstand and greenfield areas across the airport is conveyed through the Cuckoo Stream, Forrest Little River, Mayne River, and Santry River drainage catchments. Runoff from the North Runway and Apron 5H convey to the Forest Little River, and portions of the South Runway convey to the Mayne River and Santry River. The remainder of the airport runoff is conveyed to the Cuckoo Stream. The catchments described are presented in **Figure 3-1**.

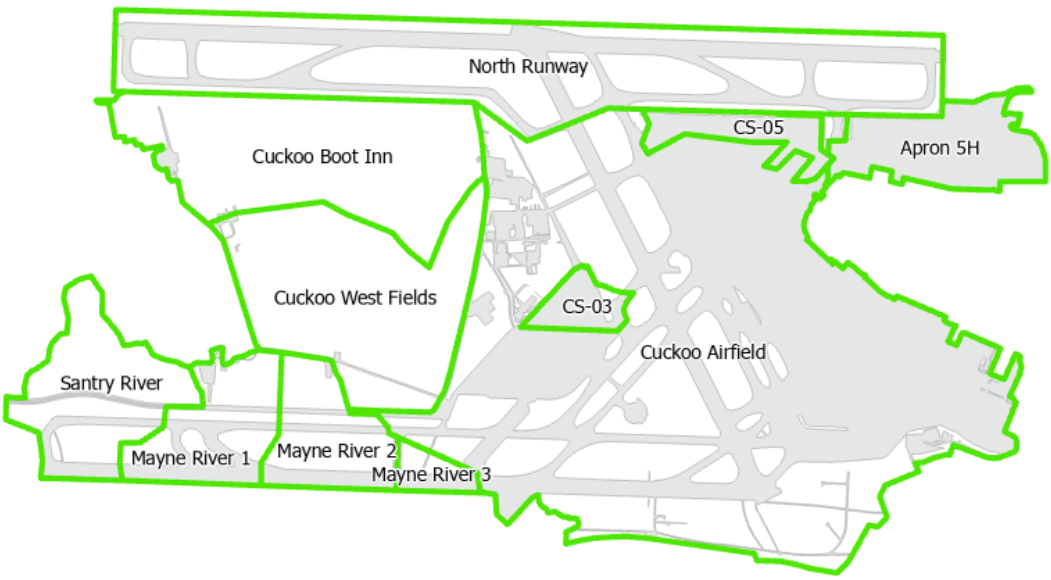


Figure 3-1: Airfield Drainage Catchments

3.2 Model Function Summary

A simplified schematic of the seasonal time-series de-icing pollution model is presented **Figure 3-2**.

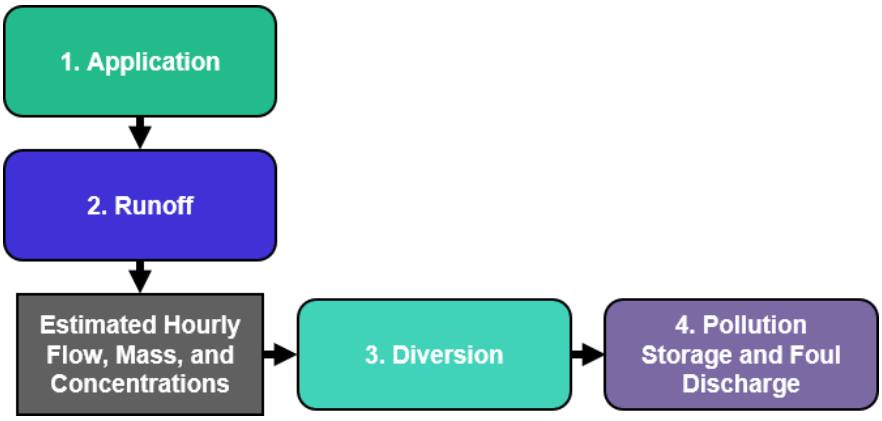


Figure 3-2: De-icing Pollution Model Simplified Model Schematic

The following is a high-level description of overall model function:

1. *Application*

The model determines whether aircraft de-icing is occurring and estimates the volume of de-icer applied in each hour by using:

- the temperature and precipitation data (type and depth);
- the flight schedule;
- existing de-icer/anti-icer application practises.

Similar logic is applied to estimate the volume of pavement de-icer applied to the catchment per hour. The volume of each chemical applied is then converted to an equivalent BOD/COD mass based on the reported concentration of the chemical.

2. *Runoff*

The model estimates the total volume of runoff per hour using hourly rainfall data, in addition to other factors such as snowmelt. The BOD/COD concentration of the runoff is determined via mass balance calculation using the simulated BOD/COD load and the runoff volume.

3. *Diversion*

Runoff is classified as either “contaminated” or “uncontaminated” based on the diversion set point concentration value. The model reflects the diversion of contaminated runoff to pollution control tanks based on a set point value. Flows enter the pollution control system based on the inlet capacity and storage volume availability within the tanks.

4. *Pollution Storage and Foul Discharge*

The outflows from pollution control tanks to foul sewer are governed by discharge limits set out in the Trade Effluent Discharge Licence.

The model limits the discharge to sewer in accordance with the licence conditions. The limits on discharge result in accumulation of contaminated runoff in the pollution tanks. Typically, the volume of runoff detained in pollution storage accumulates throughout the de-icing season, generally peaking toward the end of the season due to de-icing events occurring in series.

3.3 Simulation of De-icing Pollution Loads

The need to apply de-icing chemical is triggered by weather conditions. The mobilisation of the chemical into the drainage network is also affected by weather conditions (precipitation). The pollution model is therefore largely driven by hourly meteorological data (primarily precipitation rates and temperature). However, a number of additional airfield operational factors impact the net mass and volume of aircraft de-icer chemicals which accumulate on the surface of the airfield pavement and enter the drainage network. These factors are illustrated in the schematic of key model state variables, presented in **Figure 3-3**.

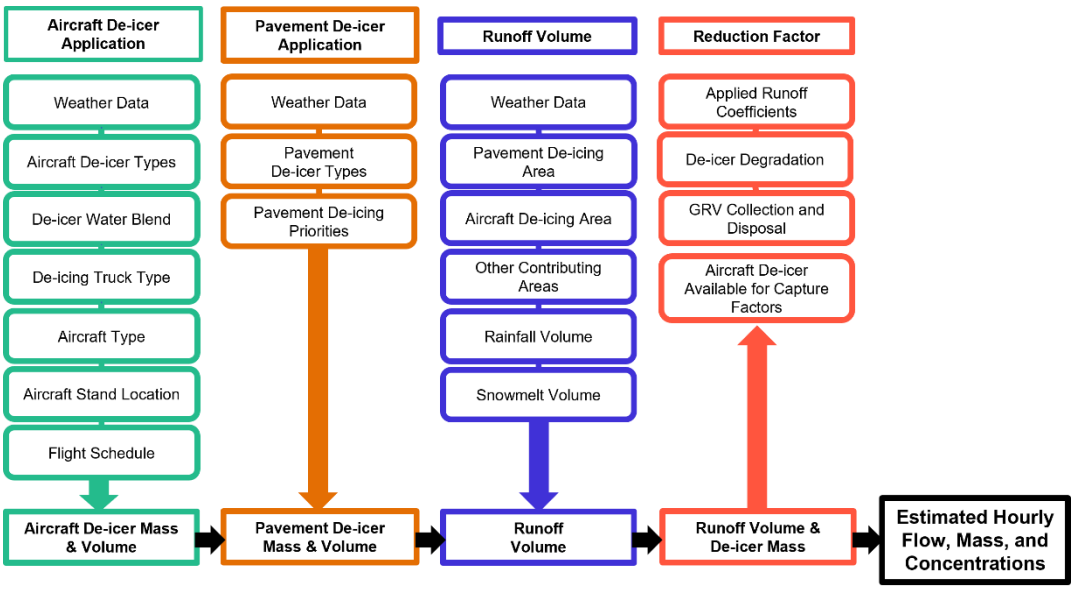


Figure 3-3: Application and Runoff Model Components Schematic

Summary descriptions of each of these key state variables are set out in the following sub-sections. Note, the input values and calibration process applied to the model are described in Sections 3.4 and 3.5, respectively.

3.3.1 Aircraft De-icer Mass and Volume

- **Weather** – The temperature and precipitation dictate the volume of de-icer and anti-icer required to defrost a given aircraft.
- **Aircraft de-icer types** – Different de-icer and anti-icer chemicals may be used (separately or in combination) to treat an aircraft. The volumes of each chemical required to achieve de-icing/anti-icing of a given aircraft differ. The BOD/COD of each de-icer/anti-icer chemical also

differ. Therefore, the model must represent the chemicals used when simulating the total volume of chemical applied (and the resulting organic load).

- **De-icer water blend** – Depending on the de-icer/anti-icer chemical used, the "neat chemical" may be diluted with warm water. This reduces the total volume of product applied. As this has a direct impact on the resulting pollution load, accounting for this factor is essential.

- **De-icing truck type** – The type of de-icer truck used to apply the chemical impacts the efficiency at which the chemicals are applied. In particular, the ability of de-icer trucks to provide forced air de-icing or blend to temperature functions (both functions greatly reduce the volume of chemical required for de-icing) impacts the net volume of "neat" de-icer chemical applied.

- **Aircraft type** – Larger aircraft require greater volumes of aircraft de-icer/anti-icer due to the greater surface area of the aircraft body. Therefore, the volume of chemical applied will vary depending on the class of aircraft scheduled to be on stand.

- **Aircraft stand location** – The configuration of stands and taxi-ways allows for a delineation of locations where aircraft de-icing will occur. Defining stand locations, and in adjacent areas, is necessary to estimate the volume of de-icer chemical introduced or removed from the application area by flight movements, snow ploughing and snow piling.

- **Flight schedule** – This input defines the number and type of aircraft on stand in any given hour.

3.3.2 Pavement De-icer Mass and Volume

- **Weather** – Air and pavement temperatures affect the potential for formation of frozen precipitation as well as the bonding and accumulation of frozen precipitation on runways, taxiways, and aircraft ramp. Weather conditions therefore trigger pavement de-icer use.

- **Pavement De-icer Types** – A range of pavement de-icer chemicals can be used on airfields. The BOD and COD concentrations vary between chemicals. Therefore, accounting for the type of chemical used is a critical model input.

- **Pavement De-icing Application Area Prioritisation** – Airport winter operations plans define the snow and ice removal approach for runway, taxiway, and apron areas, including the application of pavement de-icers. The approach typically includes prioritisation criteria which are incorporated into the model.

3.3.3 Runoff

- **Weather** – Weather data from MET Eireann provides inputs for precipitation type and depth per hour. Rain events result in direct runoff. Snow events contribute to accumulation of snow on surfaces.

- **Area** – The total area is subdivided into impervious (paved) and pervious (grassy) area. The area is used with the precipitation depth and area weighted runoff coefficient in the calculation of hourly runoff volume.
- **Rainfall volume** – Rainfall volume is based on precipitation depth during rain events and the area on which the rainfall occurs and which is collected by the system.
- **Snowmelt volume** – Snow is simulated to accumulate on surfaces and within snow piles. It is subject to melting based on atmospheric condition data. The snowmelt volume each hour is a product of the snow accumulation volume from previous hours and the estimated snow melt rate based on the current hour's atmospheric conditions.

3.3.4 Reduction Factors

A reduction factor is used to represent the environmental and mechanical processes that reduce the runoff volume, and COD/BOD mass loading, captured in the pollution control system.

- **Runoff coefficient** – Runoff coefficients are the factors that account for the proportions of runoff that pass over a given surface area and infiltrate into the soil. Impervious (paved) surfaces allow less infiltration and lead to higher runoff volumes. Pervious (grassy) surfaces lead to lower runoff volumes, although the fraction running off increases through an event as soils become saturated.
- **Glycol recovery vehicles (GRVs)** – GRVs are used to collect de-icer and anti-icer chemical from the pavement surfaces. A significant portion of the applied chemicals can be collected when GRVs are used, resulting in a reduction of chemical available for mobilisation within runoff.
- **Aircraft de-icer available for capture factors** – The fraction of the de-icing fluid volume that is applied and that lands within the application area is considered the de-icer available for capture. The factor accounts for the export of applied volumes to outside the application area (due to adhering to the aircraft).
- **Degradation on pavement** – De-icer chemicals that are not removed and remain on the pavement will begin to biodegrade. Although the rate of this biodegradation is low, it is captured in the model function.

3.4 De-icing Pollution Model Input Parameters

A description of values used for each key model input, and sources thereof, is presented in **Table 3-1**.

Table 3-1: Summary of Key Model Inputs

Factor	Model Input	Description	Data Source	Specific Data	Notes
Hourly Weather Data	Hourly weather classification and quantitative precipitation and temperature data	The full downloadable dataset of consecutive hourly weather data covering October 1994 to June 2025 was obtained from MET Éireann for Dublin Airport[1]. These 30 seasons represent a wide range of varying de-icing conditions. This facilitates the evaluation of de-icing operations and the resulting volumes and concentrations of contaminated runoff for a wide spectrum of seasons. Utilising this data, the weather conditions at each hour of the 30 seasons simulated were classified into one of nine weather categories to facilitate simulating de-icing operations. See **Appendix A** for further details on weather classification.	MET Éireann	• Precipitation Type • Precipitation Amount • Temperature • Dew Point • Mean Sea Level Pressure • Mean Wind Speed • Synop Codes for Weather	30 years of hourly data (maximum extent of complete data available)
Aircraft De-icer Chemical Types Dilution Rates De-icer Truck Type	De-icer types applied Propylene glycol fractions in neat chemical mix Type I and IV glycol:water ratio	Two seasons of aircraft de-icer application records, and records of the latest application methodologies used by Handlers, were used to profile the application practises of each Handler operating at Dublin Airport. This data is used to define key model inputs (de-icer truck types, chemicals applied, patterns of chemical application and chemical dilution practises[2]). Direction from daa on the de-icer application practises to be applied at 40 mppa was provided to assist in developing 40 mppa representation of the airfield. Based on this data, the model was executed with the following de-icer practises considered- • **Trucks** do not have forced air or blend to temperature functions i.e. fixed mixture blending de-icer trucks • **Proportion of planes on stand simulated as de-iced** varied depending on weather conditions i.e. when temperatures were between 4°C and 1.67°C 75% of flights on stand are de-iced (see **Appendix A**) • **Two Stage de-icing/anti-icing procedure** applied to aircraft, with Type I de-icer applied when flights report to stand, and Type IV applied prior to take-off. Re-application of de-icer/anti-icer occurs during peak traffic hours. • **Type I De-icer Chemical** (Kilfrost DF Plus (Type I) used for de-icing of aircraft. Neat chemical diluted to 41% product before application. • **Type IV De-icer Chemical** (Kilfrost ABC-S (Type IV) used for aircraft anti-icing. Applied neat. • **Type II De-icer Chemical** (Kilfrost ABC-K Plus (Type II) used for both de-icing and anti-icing of aircraft. Chemical is applied either diluted or as neat. See **Appendix A** for details of chemical composition and COD/BOD Conversion rates	daa	• 2 years of aircraft de-icing records; volumes and chemical types • Kilfrost DF Plus (Type I) MSDS • Kilfrost ABC-S (Type IV) MSDS • Kilfrost ABC-K Plus (Type II) MSDS	Records used during calibration. Most prevalent de-icer chemical practises currently in place simulated (Signature).
Flight Schedule Stand Location Aircraft Type	Hourly number and aircraft class at each stand	Projected peak winter flight schedules representative of 32 mppa, 36 mppa, and 40 mppa were provided by daa. These were integrated into the model to simulate the number of flights, and type of aircraft projected to be on stand during the de-icing season.	daa	• 32 mppa, 36 mppa, and 40 mppa departures and stand plans	
Aircraft De-icer and Anti-icer Application Rates	Volume of de-icing and anti-icing chemical type per aircraft class per weather classification	Volumes of aircraft de-icer application simulated by the model in each timestep are dependent on weather condition classification, aircraft size scheduled to be on stand, and number of flights scheduled to be on stand (determined from the projected flight schedule)[2]. The estimated rates of application were established based on 2 years of aircraft de-icing records provided by daa. Utilising this data, this input parameter was subject to calibration (see Section 3.4). Specific aircraft de-icer application rates per chemical applied per aircraft type are presented in **Appendix A.**	daa	• 2 years of aircraft de-icing records • Volumes applied per aircraft type and weather conditions	Application rate varies by Handler. Rates of Handler with highest application volumes applied (Signature). Factor values calibrated
Aircraft De-icer Available for Capture Factors	Reduction factors applied to de-icer volumes applied	The fraction of the de-icing fluid volume that is applied and that lands within the application area is considered the de-icer available for capture. The factor accounts for the export of applied volumes to outside the application area (due to adhering to the aircraft) but is also inclusive of degradation of chemical on the pavement. The factor is based on industry standards and was subject to calibration (see Section 3.5 and **Appendix A**).	Transport Canada- See Appendix A		Considers adhesion of chemical to aircraft

[1] Copyright Met Éireann. Source www.met.ie. This data is published under a Creative Commons Attribution 4.0 International (CC BY 4.0). https://creativecommons.org/licenses/by/4.0/. Met Éireann does not accept any liability whatsoever for any error or omission in the data, their availability, or for any loss or damage arising from their use.
[2] De-icer application and management practises currently varies by flight Handler. In order to conservatively simulate pollution storage volume requirement, the rates and chemicals applied to the model were based on the de-icing records of the Dublin Airport Flight Handler with consistently the highest de-icer chemical application rates.

Factor	Model Input	Description	Data Source	Specific Data	Notes
Pavement De-icer Application Rates	Volume of pavement de-icer applied per hour per weather classification	Based on a review of 6 years of records and the "Dublin Airport Airside Winter Operations Plan", it was established that Safegrip Standard, a potassium acetate-based solution, was historically the chemical used for airfield pavement de-icing at Dublin Airport. The rates of pavement de-icer application simulated by the model are dependent on the weather condition classification (classified based on the hourly weather data) and the priority with which the area is subject to pavement de-icing. The estimated rates of application per weather classification utilised in the model are based on the ranges provided within the "Dublin Airport Airside Winter Operations Plan". This input parameter was subject to calibration (see Section 3.5). Details of pavement de-icer application rates are presented in **Appendix A**. It was established that Provifrost KF ECO, a potassium formate-based solution, is currently being used in place of potassium acetate. For the purposes of the model, it was assumed that the potassium formate solution is being applied at the same calibrated rates as the potassium acetate solution.	daa	• 6 years of pavement de-icing and anti-icing records • Dublin Airport Airside Winter Operations Plan	Factor values calibrated Potassium acetate chemical has been replaced with potassium formate chemical.
BOD Conversion Factors BOD to COD Conversion Factors	Kg BOD/kg De-icer BOD:COD Ratio	Converting chemical mass to BOD mass is necessary to determine runoff concentration. The model converts the pavement de-icer mass applied based on the BOD concentrations reported in the MSDS. For aircraft de-icers, BOD conversion was determined based on the specific glycol content of each chemical type (as reported from the respective MSDS), with glycol subsequently converted to BOD. Model inputs and outputs are converted between COD and BOD via established conversion factors. The conversion approaches are presented in detail in **Appendix A.**	Kilfrost DF Plus (Type I) MSDS Kilfrost ABC-S (Type IV) MSDS *Corsi, (2011)*[3] *Johnson (2001)*[4] Dow Chemical density values for glycols Provifrost KF ECO SDS	• Fraction of propylene glycol in each chemical • glycol:water ratio • Average BOD for propylene glycol • Propylene glycol density • Oxygen demand for potassium formate • Conversion between BOD and COD as required	Convert aircraft de-icing / anti-icer to litres of propylene glycol. Convert litres of propylene glycol to BOD kg using the factor developed from data provided within the listed sources.
Catchment Area Delineations	Catchment area hectares	The total area included in the de-icing pollution model is 519.3 hectares and is 47% impervious. The areas delineated include hardstand and greenfield areas within the Cuckoo, Forest Little, Mayne, and Santry catchments. Combined with precipitation data, the area delineation is used to estimate the gross runoff volume. The proportion of impervious surface area (and pervious surface area) is used within the area weighting of runoff coefficients to estimate the net runoff from the area. Additional area delineations for de-icing application areas (surrounding stands) are also included in the model to simulate aircraft de-icing fluid in ploughed snow.	daa	• Hectares per catchment areas based on delineated drainage boundaries • Hectares of area for aircraft de-icing • Hectares of area for pavement de-icing and snow clearing	Aircraft de-icing boundary definition developed to consider chemical captured within snow ploughed.
Runoff Coefficient	Runoff coefficient value	Base runoff coefficients values used to represent runoff rates on surfaces were based on industry standards. Adjustments of the base values to consider precipitation depth were guided by industry standards and calibration (see Section 3.5). The selected runoff coefficients are presented within **Appendix A**.	Industry standards	• Runoff coefficients adjusted to amend runoff rates based on precipitation depth	Factor values calibrated
Residual Removal Proportions	Aircraft de-icer wash off curve Pavement de-icer wash off curve	Residual de-icing chemicals sit on the pavement after de-icing and are simulated to be proportionately removed from the pavement based on rainfall hourly intensity. The rate of removal is dependent on precipitation intensity i.e., a wash off curve determines the rate at which de-icer chemicals are mobilised and enter the drainage system. This factor was subject to calibration (see Section 3.5). Calibrated residual removal proportions are presented within **Appendix A**.	Gresham Smith	• Industry standards and engineering judgement	Factor values calibrated
Glycol Recovery Vehicle Operation	Glycol recovery vehicle operation	Operation of GRVs reduces the volume of de-icer chemical available for capture. GRVs are already in use at Dublin Airport, and the fleet is expected to be expanded in the coming years. Four total GRVs are assumed for the 2025 permitted operation (32 mppa) and 2025 current operation (36 mppa) scenarios, and two additional GRVs are assumed for the proposed operation (40 mppa) scenario. The GRVs only operate during frost de-icing. The model represents the GRV operations ability to collect on average a set number of stands within an hour through a maximum hourly volume limit (568 litres / hour / frost event). The model also simulates the ability to vacuum up most but not all of the spent aircraft de-icer fluid at each stand using a volume collection efficiency factor of 85%. The GRV operations are simulated in the model to start at 6 am and end at 5 pm.	daa	• 2 seasons of collected GRV volume data	Factor value calibrated
Diversion Set Point	Diversion set point	A diversion set point concentration of 50 mg COD/L was utilised in the model for the Cuckoo catchment. A diversion setpoint concentration of 5 mg BOD/L was utilised for the North Runway and Apron 5H areas.	Stakeholder feedback		
Pollution Control Infrastructure	Pollution control infrastructure	The pollution control infrastructure assumed constructed for the 2025 permitted operation (32 mppa) and 2025 current operation (36 mppa) scenarios will include the Cuckoo and North Runway pollution control facilities as they were in 2025. The 40 mppa proposed order will include the Cuckoo pollution control facility interim drainage enhancements and reflect operation of Apron 5H pollution control facility.	daa		

[3] Corsi, *Oxygen Demand of Aircraft and Airfield Pavement Deicers and Alternative Freezing Point Depressants*, 6 July 2011.
[4] Johnson, *Comparative Toxicity of Formulated Glycol Deicers and Pure Ethylene and Propylene Glycol, August 2001*

Factor	Model Input	Description	Data Source	Specific Data	Notes
Foul Sewer Discharge Limits	Sewer hydraulic limit Sewer organic limit	daa hold consent to discharge up to 165 l/s from the North Runway, Apron 5H and Cuckoo Pollution Control Facilities. This sitewide limit is allocated as follows; 100 l/s discharge limit for the Cuckoo catchment, 35 l/s discharge limit for the North Runway area, and 15 l/s discharge limit for Apron 5H. For the 40 mppa proposed order simulation, to reflect drainage enhancements, if the North Runway and Apron 5H are not discharging to foul sewer, the discharge limit for the Cuckoo catchment is boosted to 150 l/s (max pump limit).	Uisce Éireann daa	• Proposed sewer allocation	Impact of factor on storage volume evaluated in sensitivity analysis

3.5 De-icing Pollution Model Calibration

The model simulations associated with the current pollution model analysis were performed using a previously calibrated DUB model. Model calibration was undertaken in order to fine-tune values used in the model analysis to achieve satisfactory correlation between the measured field values and simulated values.

The following input factors were subject to calibration:

- Aircraft de-icer application rates;
- Pavement de-icer application rates;
- Proportion of flights de-iced;
- Runoff coefficients;
- Residual removal proportions.

Calibration of these inputs was undertaken using a campus-wide de-icing pollution model of the historic (2019) airfield. Model simulation results were compared to operational records and measured data, with iterative adjustments made to the parameter values to improve alignment of the model output with operational and measured data. The factors listed were calibrated using the following records:

1. Aircraft de-icer/anti-icer chemical application records;
2. Pavement de-icer chemical application records;
3. Cuckoo stream flow and COD concentration measurements.

The calibrated input factors were applied to the 32 mppa, 36 mppa, and 40 mppa de-icing pollution models. The following sections summarise the calibrations undertaken:

- **Aircraft de-icer applied volumes calibration** – The model was calibrated using historical recorded applied volumes of aircraft de-icing/anti-icing fluid at Dublin Airport. Specifically, aircraft de-icing/anti-icing fluid volume application data for two seasons (2017-2018 and 2018-2019) were collated. The volumes recorded were compared with the volumes simulated by the model. The final calibration resulted in slightly higher simulated seasonal applied volumes compared to measured data for 2017-2018, where both Type I and Type IV simulated applied volumes were within 9% of the recorded volumes. The calibration for the 2018-2019 season resulted in slightly lower simulated seasonal applied volumes compared to measured data for Type I and Type IV (-2% and -19%, respectively). The 2017-2018 season had two times the applied volumes compared to the 2018-2019 season. Prioritizing the calibration of the 2017-2018 provides a factor of safety for the model analysis.

- **Pavement de-icer applied volumes calibration** – The model was calibrated using recorded applied volumes of pavement de-icer at Dublin Airport for five seasons (2012-2018). The final calibration resulted in slightly higher simulated seasonal applied volumes compared to measured data for all calibration seasons. The simulated pavement de-icer applied volumes were within 2-5% for the seasons with over 200,000 L (2012-2013 and 2017-2018) of measured applied pavement de-icer (potassium acetate). The simulated

pavement de-icer applied volumes total for all the seasons were within 11% of the measured volumes. This provides a factor of safety for the model analysis and associated infrastructure capacity.

- **Cuckoo Stream flow volume calibration** – Real-time flow data measured in the Cuckoo Stream at a location adjacent to the Pollution Control Facility from February to April 2019 was used to calibrate the flow simulation algorithms in the model. It should be noted that the pollution model does not provide high resolution simulations of the hydraulic characteristics of the drainage network. Such simulations, utilised for detailed network design, are executed using hydraulic modelling software. Nevertheless, the seasonal volumes simulated correlated with the volumes measured during the period surveyed, with values within an acceptable 5% of each other.

3.6 Analysis Limitations and Exclusions

The modelling of the baseline and proposed order conditions has the following limitations and exclusions:

- COD/BOD loading from sources other than winter operations (i.e. aircraft de-icer/anti-icer and pavement de-icers) have been excluded from the model.
- The modelled impacts to streams are based on GRVs operating in line with the logic presented in Section 3.4. GRV collected volumes are managed separately from other pollution control storage and discharges.
- The model is based on projected stand utilisation provided by daa. No allowance has been made for increases in usage beyond the projected.
- The de-icing pollution model uses historical weather data from a recent 30 season dataset. The use of recent weather data captures the more recent understanding of the climate but does not include climate change projections (e.g., projected changes in temperature or rainfall). Current climate change projections for Ireland forecast warmer, wetter winters. The change may have an effect on the need and/or frequency of de-icing, but currently there is not sufficient detailed local data to change the outcome
- The analysis assumes no degradation of COD/BOD within pollution control tanks.
- The model represents the existing approaches to aircraft de-icing undertaken by Handlers at Dublin Airport. It does not consider future planned improvements in de-icer operations which will reduce the rate of de-icer application per aircraft; thereby, providing a factor of safety.
- Rates of application, and de-icer chemical type used, currently varies depending on specific Flight Handler practices. In order to conservatively simulate pollution volumes and mass, the rates and chemicals applied to the model were based on the de-icing records of the Dublin Airport Flight Handler with consistently the highest de-icer chemical application rates. This approach provides an additional factor of safety.

4 Results and Discussion

4.1 Comparison of Increased Flight Operation Impacts to Receiving Waters

A comparison of the mass load of COD released to receiving waters across all 30 modelled seasons for each catchment area serves as the basis of identifying the impact of increased flight operations. An impact to each receiving water has been classified as an increase in COD bypassing pollution control measures and discharging to stream. A box and whisker plot of the 30 seasons of data for each passenger growth level provides relative distribution comparisons. The plots represent the mean, median, and quartiles of each distribution, allowing for visual comparisons of the results.

4.1.1 Cuckoo Stream

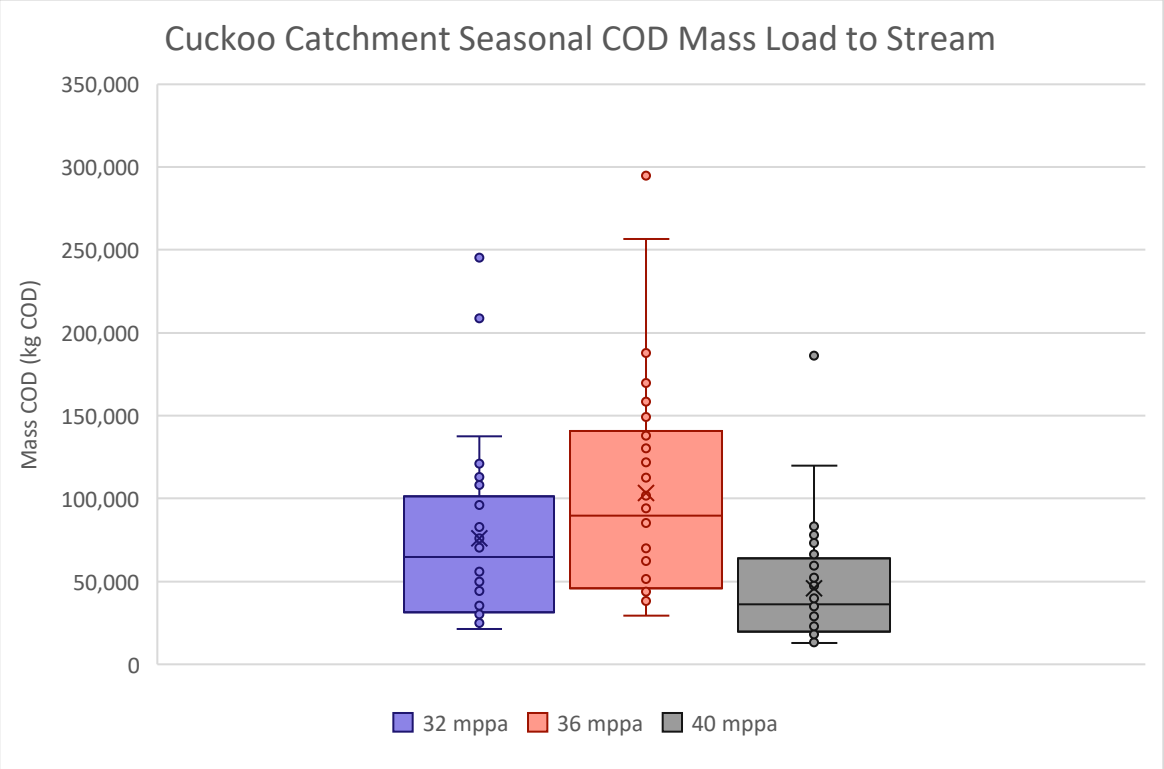


Figure 4-1: GlyCAST™ Modeling Results for the Cuckoo Stream Catchment

The modeling results suggest that from the 2025 permitted operation (32 mppa) and 2025 current operation (36 mppa) scenarios, the COD released to stream trended higher across the 30 seasons of data than the proposed order scenario. The increase is likely attributed to an increase in flight operations without the implementation of interim drainage enhancements. The 40 mppa proposed order results trended lower than both 32 and 36 mppa baselines, due to the implementation of interim drainage enhancements capturing more contaminated runoff.

4.1.2 Forrest Little River

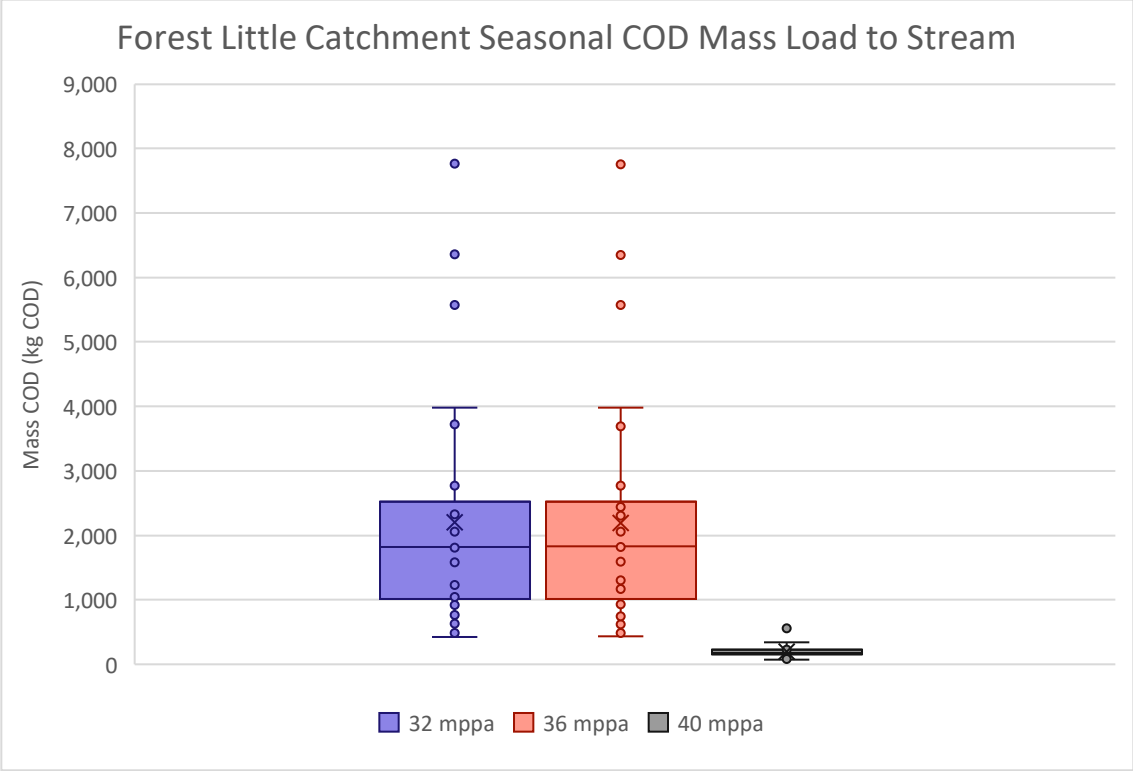


Figure 4-2: GlyCAST™ Modeling Results for the Forrest Little River Catchment

The modeling results suggest that for the 2025 permitted operation (32 mppa) and 2025 current operation (36 mppa) scenarios, the COD released to stream was similar. The proposed order (40 mppa) results trended significantly lower than both the 32 and 36 mppa baselines due to the pollution control infrastructure incorporated for the Apron 5H development becoming operational.

4.1.3 Mayne River

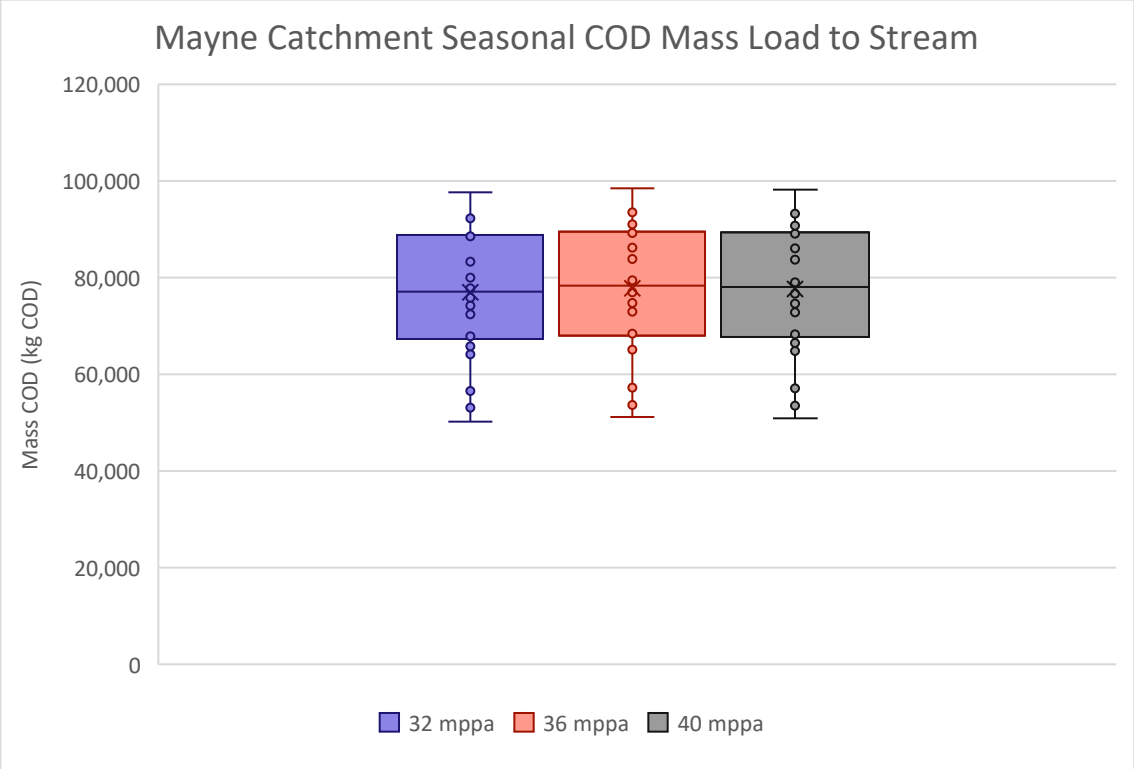


Figure 4-3: GlyCAST™ Modeling Results for the Mayne River Catchment

The modelling results suggest that the COD released to stream is relatively consistent between the 2025 permitted operation (32 mppa) 2025 current operation (36 mppa) scenarios and the proposed operation (40 mppa) scenario. The results are likely due to pavement de-icing being the primary source of COD for the catchment, with pavement deicing practices generally being independent of flight operations.

4.1.4 Santry River

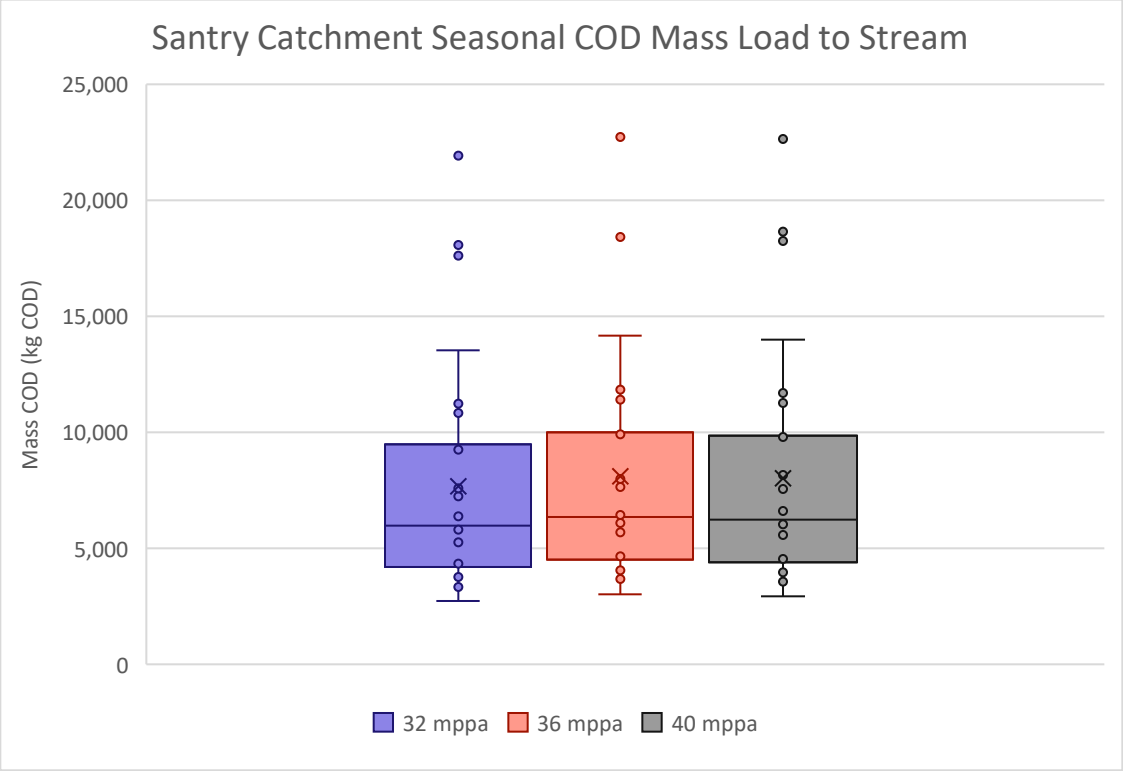


Figure 4-4: GlyCAST™ Modeling Results for the Santry River Catchment

The modelling results suggest that the COD released to stream is relatively consistent between the 2025 permitted operation (32 mppa) 2025 current operation (36 mppa) scenarios and the proposed operation (40 mppa) scenario. Similar to the Mayne River catchment, the results are likely due to pavement de-icing being the primary source of COD for the Santry River catchment.

5 Conclusions

De-icing pollution models were developed and used to estimate if a growth in passenger numbers from the 2025 permitted operation (32 mppa) and 2025 current operation (36 mppa) scenarios to the proposed operation (40 mppa) scenario while maintaining existing infrastructure would increase impacts on receiving waters at DUB. The model used in the estimation of these impacts considers a number of factors of safety (no changes to de-icer management practises, highest de-icer application rates, no additional proposed works).

The model results for all four drainage catchments (Cuckoo Stream, Forrest Little River, Mayne River, Santry River) suggest that, when considered alongside the interim drainage enhancements, the growth of passenger numbers 40 mppa in 2029 would not increase the risk of an impact to receiving waters from aircraft or pavement deicing.

Appendix A

Model Input Data Tables and Charts

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The following input data tables and charts provide additional detail to support the understanding of the de-icing pollution models input parameters. Please refer to Section 3.4 for the overview of the parameter listed.

- **Hourly weather data**

Table A-1: Precipitation Type Classification Summary

Precipitation Description	Precipitation Type Assumptions
Rain	When there is precipitation and the event is not also categorized as either snow or ice.
Discretionary Defrost	When temperature is less than or equal to 4 C.
Defrost	When dew point less than or equal to 0 C and difference between dew point and temperature is less than or equal to 1.67 C.
Light Snow	When temperature is less than or equal to 1.4 C and precipitation depth is greater than or equal to 0.25 mm.
Medium Snow	When temperature is less than or equal to 1.4 C and precipitation depth is greater than or equal to 0.64 mm.
Heavy Snow	When temperature is less than or equal to 1.4 C and precipitation depth is greater than or equal to 2.5 mm.
Light Ice	When weather observation indicates ice conditions and precipitation depth is greater than or equal to 0.25 mm.
Medium Ice	When weather observation indicates ice conditions and precipitation depth is greater than or equal to 0.64 mm.
Heavy Ice	When weather observation indicates ice conditions and precipitation depth is greater than or equal to 2.5 mm.

- **Flight schedules**

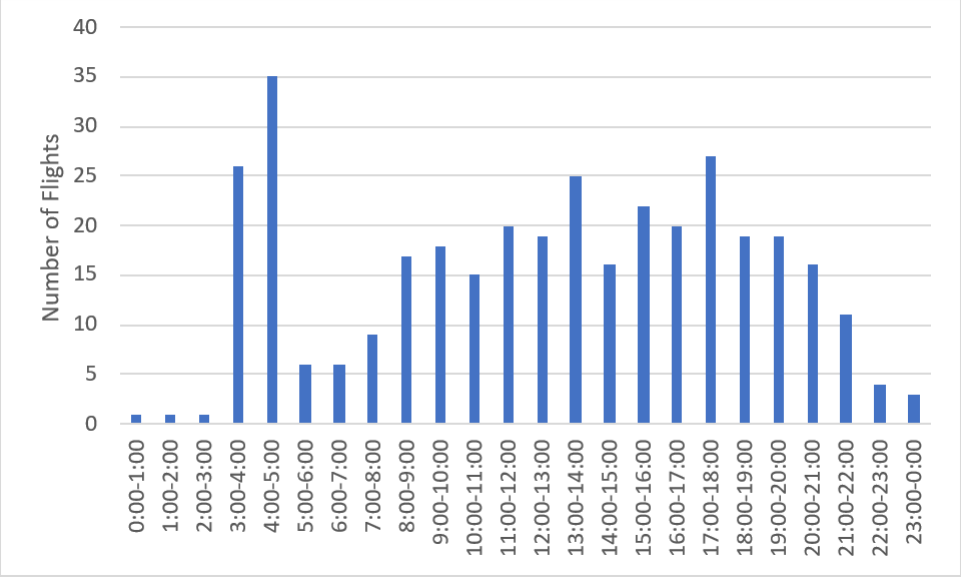


Figure A-1: 32 mppa Winter Flight Schedule with Early and Repeat De-icing

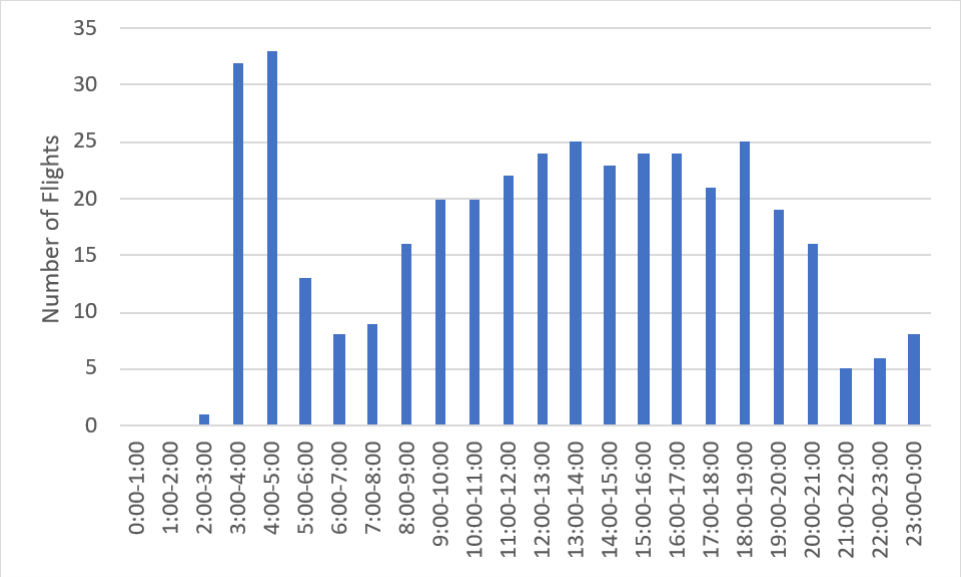


Figure A-2: 36 mppa Winter Flight Schedule with Early and Repeat De-icing

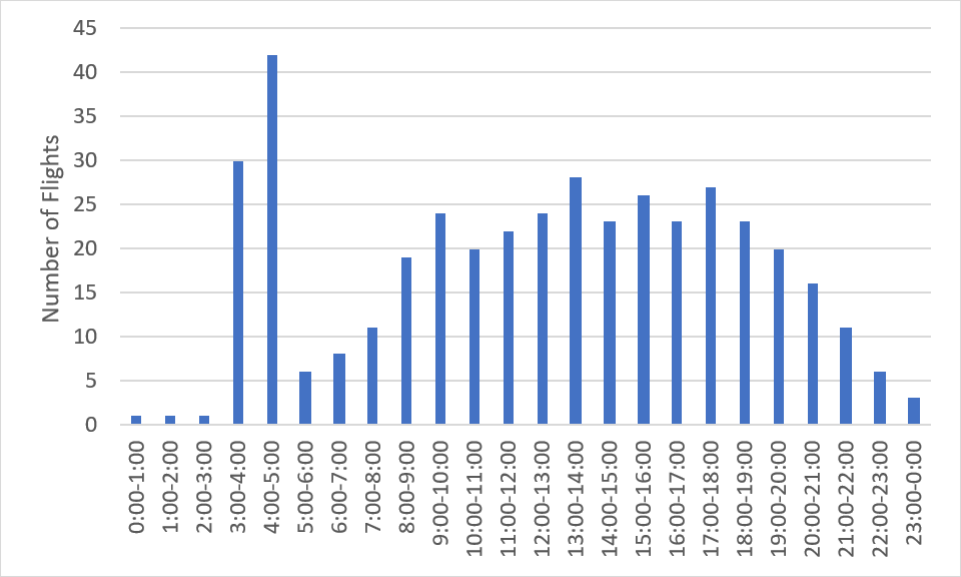


Figure A-3: 40 mppa Winter Flight Schedule with Early and Repeat De-icing

Aircraft de-icer application rates

Table A-2: Type I Application Volume (litres)

Wingspan (m)	Discretionary Defrost	Defrost	Light Snow	Medium Snow	Heavy Snow	Light Ice	Medium Ice	Heavy Ice
15 - < 24	83	83	201	519	583	390	443	776
24 - < 36	138	138	333	609	666	500	776	1,105
36 - < 52	193	193	466	700	772	609	1,105	1,768
52 - < 65	248	248	598	791	908	719	1,548	2,211

Table A-3: Type II Application Volume (litres)

Wingspan (m)	Discretionary Defrost	Defrost	Light Snow	Medium Snow	Heavy Snow	Light Ice	Medium Ice	Heavy Ice
15 - < 24	13	13	98	242	386	91	91	91
24 - < 36	25	25	159	341	519	132	132	132
36 - < 52	72	72	621	901	1177	727	727	727
52 - < 65	83	83	715	1041	1370	890	890	890

Table A-4: Type IV Application Volume (litres)

Wingspan (m)	Discretionary Defrost	Defrost	Light Snow	Medium Snow	Heavy Snow	Light Ice	Medium Ice	Heavy Ice
15 - < 24	51	51	174	174	261	57	114	136
24 - < 36	68	68	238	238	326	68	129	151
36 - < 52	74	74	261	261	341	76	144	170
52 - < 65	98	98	341	341	428	114	201	246

Conversion of applied de-icer chemicals to Biochemical Oxygen Demand (BOD) mass load (kg) were based on the following factors:

- 88% propylene glycol in neat Type I chemical
- 75% propylene glycol in neat Type II chemical
- 50% propylene glycol in neat Type IV chemical
- Type I neat chemical is mixed onsite prior to application with a proportion of 41% chemical
- Type II neat chemical is mixed onsite prior to application with a proportion of 77% chemical
- Propylene glycol Biochemical Oxygen Demand (BOD) per litre is 1.07 Kg

Additional factors used in the modelled aircraft de-icer application operations were a result of the calibration process and are as follows:

- 75% Aircraft Type I Defrost Treated
- 100% Aircraft Type I Discretionary Defrost Treated

- 88% Aircraft Type II Treated
- 100% Aircraft Type II Snow Treated
- 100% Aircraft Type II Defrost Treated
- 90% Aircraft Type IV Treated
- 95% Aircraft Type IV Snow Treated
- 95% Aircraft Type IV Defrost Treated

- **Pavement de-icer application rates**

Table A-5: Pavement De-icer (Potassium Formate) Application

Precipitation Type Description	Potassium Formate Application Rate (g/m^2)
Rain	0
Discretionary Defrost	0
Defrost	15.6
Light Snow	26
Medium Snow	41.6
Heavy Snow	58.5
Light Ice	26
Medium Ice	41.6
Heavy Ice	58.5
Event Pre-treat Rate	20

Potassium formate is applied ahead of forecasted event that results in accumulation of snow or ice on the pavement. This is considered as pre-treatment. In addition, potassium formate application is simulated after snow has been ploughed from the apron.

Conversion of applied de-icer chemicals to BOD mass load (kg) were based on the following factors.

- 0.0008 (L/m2) / (g/m2)
- Potassium Formate BOD per litre is 0.079 kg

- **De-icer available for capture factors**

The available-for-capture values used in the model are from the Transport Canada “Data Collection and Analysis to Advance the Development of an Airport Deicer Management System (ADMS) Model” (May 2005). The available-for-capture values are as follows:

- 90% of the applied Type I volumes
- 60% of the applied Type II volumes
- 23% of the applied Type IV volumes

- **Runoff coefficients**

Table A-6: Runoff Coefficients

	Runoff Coefficient Low Precipitation Depth	Runoff Coefficient Medium Precipitation Depth	Runoff Coefficient High Precipitation Depth
12 hour rolling precipitation depth	*Less than or equal to 2.5 mm*	*Greater than 2.5 mm and less than or equal to 5 mm*	*Greater than 5 mm*
Pervious Runoff Coefficients	0.3	0.5	0.7
Impervious Runoff Coefficients for Cuckoo West Greenfield Areas*	0.8	0.85	0.9
Impervious Runoff Coefficients for Remaining Areas	0.9	0.95	0.99

**Includes Cuckoo Boot Inn and Cuckoo West Fields Areas*

- **Residual removal proportions**

The “removal rate” represents the fraction of de-icer that is washed off (removed) from the pavement

Table A-7: Residual Frost Removal Proportions

Precipitation Intensity (mm/hr)	Removal Proportion Aircraft De-icing	Removal Proportion Pavement De-icing
>= 5.1	1.0	1.0
>= 4.6 – 5.1	0.9	1.0
>= 4.1 – 4.6	0.8	1.0
>= 3.6 – 4.1	0.7	1.0
>= 3.0 – 3.6	0.6	1.0
>= 2.5 – 3.0	0.5	1.0
>= 2.0 – 2.5	0.4	0.8
>= 1.5 – 2.0	0.3	0.6
>= 1.0 – 1.5	0.2	0.4
>= 0.5 – 1.0	0.1	0.1
>0.0 – 0.5	0.05	0.05

The residual de-icer was also simulated to degrade over time a rate of 0.0025 per hour.

- **BOD to COD conversion**

The BOD concentrations produced from the previously mentioned calculations are converted to COD using the factor of 1.72. The COD used in this ratio is from Johnson, *Comparative Toxicity of Formulated Glycol Deicers and Pure Ethylene and Propylene Glycol, August 2001, p. 71*. and agrees with 100% of the theoretical oxygen demand (1.68 g O2 / g propylene glycol). The BOD used is 0.98 mg/mg. Corsi lists the BOD as (0.99 mg/mg, p. 2452 and 0.96 & 0.98 mg/mg, p.

2453) Corsi, *Oxygen Demand of Aircraft and Airfield Pavement Deicers and Alternative Freezing Point Depressants, 6 July 2011*. COD/BOD = 1.68/0.98 = 1.72. This value has been used for Gresham Smith studies at Dublin Airport dating back to 2015.

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