ICAO

ENVIRONMENT

Water Management at Airports

ECO AIRPORT TOOLKIT

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Foreword

Water resources are under increasing pressure due to growing demand, urbanisation and climate change. Some regions of the world are facing water scarcity and these situations are likely to multiply in the future. In addition, competition between various water uses is increasing as demand intensifies, potentially leading to conflicts.[1] Airports need to consider water in three primary ways. The first is supply, the water entering the airport facility and whether there are ways that the airport can reduce its demand for water. Secondly, handling capacity, airports experience water events such as flooding, drainage issues, erosion and other impacts. Thirdly, disposal, airports need to ensure water leaving the airport facility is clean and is safe for the surrounding environment. Airport systems manage these processes in various ways.

Supply: Airports rely on the local availability of water for their own activities. They are also indirectly affected by the regional water situation. When the levels of water stress[2] are too high, the activities of the whole region may be compromised. In the Middle East, for example, cities are increasingly reliant on costly seawater desalinisation infrastructure for their drinking water supply. Airports are encouraged to put in place responsible water consumption policies as well as water efficiency measures. Simple technologies like aerators, low-flush toilets and rainwater capture systems can significantly reduce overall water use.[3][4]

Handling Capacity: Managing stormwater quality and quantity are especially challenging tasks for airports. To address water issues, airports can work closely with local water stakeholders and adopt an Integrated Water Resources Management (IWRM)[5] approach. Airports need to examine future climate predictions and design runoff systems to handle predicted rainfall events. This will help the airport avoid flooding events and will also reduce pollution reaching nearby waters. Specific stormwater management plans should be developed, as well as flood contingency plans for locations susceptible to flooding. Particular attention must be paid to the maintenance of water networks and the detection of leaks, which in some regions has resulted in water losses of up to 50%.

Climate change will also affect the water levels, especially near coastlines. In addition, airports will increasingly experience more adverse climate change induced effects specifically associated with increasing precipitation intensities, sea level rise and storm surge. Coastal airports need to consider

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[1] See UN Water documentation. https://www.unwater.org/water-facts/

[2] According to the United Nations Environment Program (UNEP), water stress occurs when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use, causing deterioration of fresh water in terms of quantity.

[3] In *UN City Copenhagen*, the building's overall water use decreased by over 60%. https://un.dk/about-un-city/green-un-city-leed-3/water-efficiency

[4] At Paris Charles De Gaulle Airport, more than 72,600 cubic meters of rainwater is collected per year, equivalent of 5% of its annual consumption of drinking water, and generating an annual saving of around 150 k €. https://www.parisaeroport.fr/docs/default-source/groupe-fichiers/rse/information-rse-2018---groupe-adp-pdf.pdf?sfvrsn=4533f8bd_6

[5] See UNESCO report - Integrated water resources management in action. https://unesdoc.unesco.org/ark:/48223/pf0000181891

future tidal elevations and seawall protection measures when replacing old or designing new infrastructure. This can also be a factor near rivers which can rise above historical flood level if intense storms release heavy amounts of rainfall upstream. ICAO discusses these concerns in the recently released Climate Adaptation Synthesis Report and associated fact sheets.[6]

Disposal: Water quality is essential to human health, food security and economic development, and many National and local governments have policies and/or regulations regarding water management and pollution prevention. Pollution from the airport has the potential to affect not only the immediate area, but also the surrounding areas.[7]

Water quality is often classified by its use, using the terms wastewater, grey water, and black water. Wastewater generally refers to any water that has been subjected to a human use, whether domestic or industrial. Grey water is the term for relatively clean wastewater from baths, sinks, laundry facilities and other appliances.[8] Grey water can sometimes be collected and used in other applications, such as landscape irrigation. Black water contains sewage, or water from toilets. Black water must be treated in municipal treatment facilities. Some wastewaters are so polluted with industrial substances as to require special handling, treatment, and disposal methods, while some wastewaters, after treatment, can be discharged back into local water sources.

Airports have focused on methods to decrease the pollutant level in airport water. Areas of concern are the amount of de-icers and anti-icers used on runway surfaces and aircraft. Limiting the amount of pollutants used on airport is a major focus in reducing the amount of treatment and facilities devoted to treatment that need to take place. Proper storage and handling of pollutants is key to preventing spills, and airports are also isolating the pollutants that they use from non-polluted water flowing on the airport to avoid contamination.

All these measures will help reduce the cost of water for an airport, reduce environmental impacts, and improve resilience to risks associated with water shortages, floods, and climate hazards. Airports can also participate in innovative initiatives such as projects focusing on the re-use of treated wastewater for agriculture purposes.[9] These actions will help to collectively decrease the demand for clean water. In hot regions, such projects can also help reduce the local air temperature at airports, thus decreasing energy needs for cooling systems and improving resilience to heat peaks.[10]

Water Conservation and Green Infrastructure

In some areas of the world, water is a finite resource and water uses must be carefully considered. When planning and designing new airport structures considering the water resources of the area is

[6] https://www.icao.int/environmental-protection/Pages/Climate-Adaptation.aspx#:~:text=The%20International%20Civil%20Aviation%20Organization,information%20on%20those%20potential%20risks.
[7] ICAO Airport Planning Manual Part 2, Section 1.2.3.
[8] From Oxford's Lexico: https://www.lexico.com/definition/grey_water
[9] See FAO - Exploring the use of wastewater in agriculture. http://www.fao.org/news/story/en/item/463433/icode/
[10] The Adelaide Airport heat reduction trial. https://www.sawater.com.au/current-projects/adelaide-airport-heat-reduction-trial

essential. Water management is easiest if considerations are made early on in airfield design and development. Avoiding impacts to geographic water features, including underground aquifers, are recommended practice along with avoiding sites prone to flooding. Some elements to consider during the planning and design phase are changing flood frequencies, rising sea levels, and ensuring that construction of the facility does not negatively impact the watershed within the surrounding area.

In addition, numerous actions can be taken to reduce the consumption of potable water at a facility including installation of low flow toilets, or utilizing rainwater collected from roofs. Graywater from the airport may be useful for other activities, such as irrigation of landscaping. Such practices to reduce water use help extend the availability of water resources in the region and lowers demand on local water utility providers. Water infrastructure like drains, culverts and catch basins should be designed for adequate capacity, and kept clear and functioning. Some airports have systems that monitor water flow and sound alarms when peak capacity is reached or a pipe is blocked.

When developing new facilities, the use of smart building and design practices helps airports minimize their water consumption. The certification systems for green building designs and sustainable infrastructure such as ISO 14001 standards, Boma Go Green, BREEAM, LEED, or ENVISION all consider issues of water use and conservation within their rating systems.[11] For more information on the Eco-designing of Airport Buildings, see the Eco-Airport Toolkit dedicated publication and case studies.[12]

Water Sensitive Airports

Airports play a vital role in economic growth and are essential hubs for connectivity and trade. The locations of major airports can be vulnerable to water extremes, which have been intensifying due to the effects of climate change. Planning for resiliency is critical, particularly for those airports situated in densely populated areas next to rivers, in deltas or in coastal areas. Implementing good stormwater practices early on can help build climate resilience for the future. Planning and construction of facilities should consider the potential for rising sea-levels and/or increased frequency of storms and precipitation. New projects should identify opportunities to combine environmentally friendly water management with resilience aspects.

One approach that could be used to identify such opportunities is to consider using the 'Water Sensitive Airport' framework with five overarching key dimensions, which is inspired by the three pillars of 'Water Sensitive Cities' framework (Brown et al, 2008).[13] This principle is applied at Amsterdam Airport Schiphol, and described below.[14]

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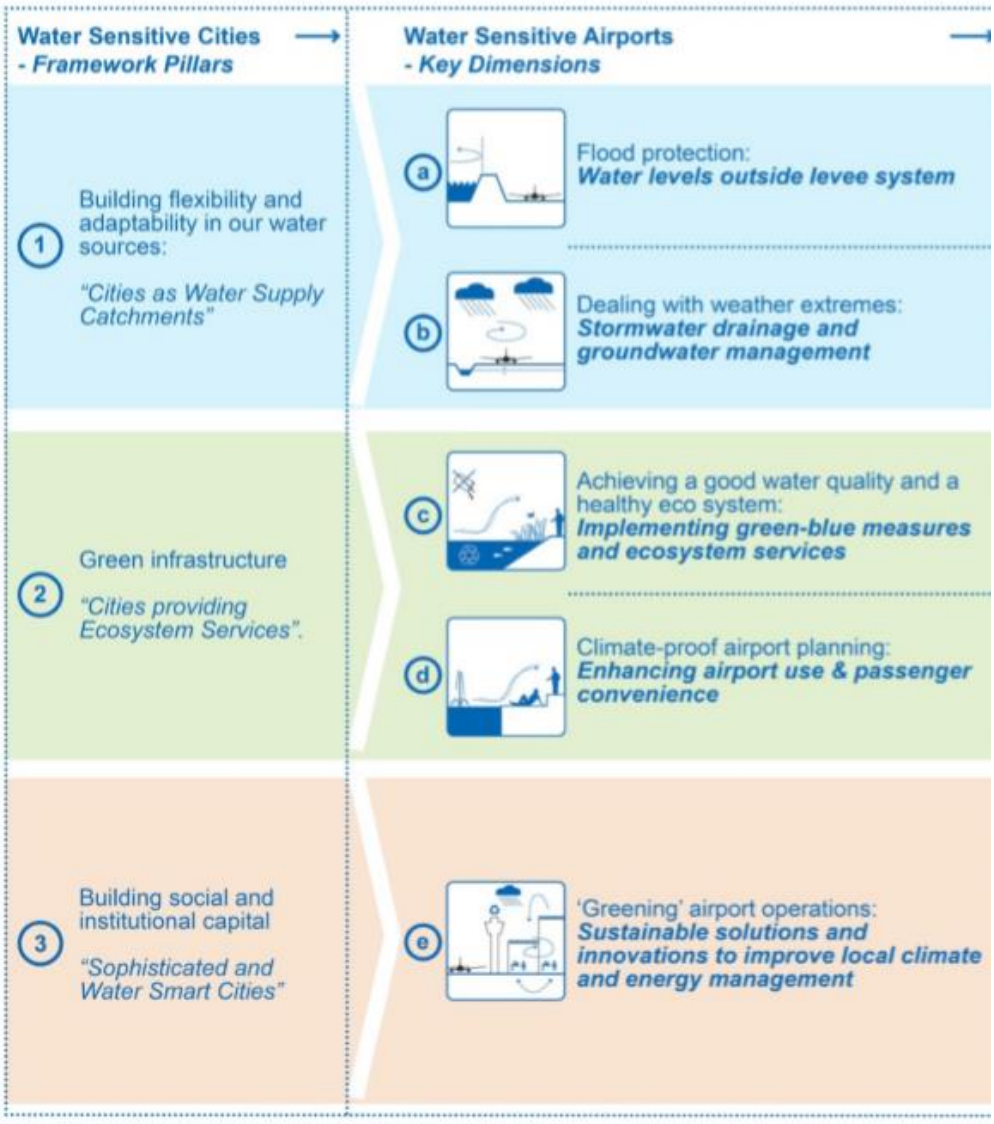
[11] For information on these certification and rating systems see: https://www.iso.org/iso-14001-environmental-management.html; https://www.boma.org/; https://www.breeam.com/; https://www.usgbc.org/leed; or https://sustainableinfrastructure.org/envision/overview-of-envision/

[12] Available at: https://www.icao.int/environmental-protection/Pages/Ecoairports.aspx

[13] Brown R., Keath N. and Wong T. (2008) Transitioning to water sensitive cities: ensuring resilience through a new hydrosocial contract. 11th International Conference on Urban Drainage, Scotland, UK.

[14] Creating water sensitive airports in times of climate change (2016). International Water Week at Singapore, Volume: 2016. Available at - https://www.researchgate.net/publication/305477965_Creating_water_sensitive_airports_in_times_of_climate_change

a. Flood protection
b. Dealing with weather extremes
c. Achieving a healthy ecosystem
d. Climate-proof airport planning
e. 'Greening' airport operations



Water Quantity

Airports are required at the state and local level to manage the quantity of stormwater that is discharged from large impervious areas needed to park and operate aircraft and their associated support facilities. Effectively managing the quantity of stormwater runoff is important to reduce downstream flooding, pollution and streambank erosion. The need to manage the quantity of stormwater being discharged will become even more challenging as climate change impacts the characteristics of precipitation events, as more intense and extreme precipitation increase flooding potential both onsite and offsite, and as potential for erosion increases. Conventional methods of

quantity control include onsite retention or detention with controlled discharge over hours and days following the precipitation event.

Safe Aircraft Operations

Many stormwater management options could become wildlife attractants (if no protection is put in place) and thus create potential hazards for aviation. Birds, mammals, and reptiles are attracted to open water features, as well as waste processing facilities. It is imperative that airports evaluate options for stormwater quantity management that do not compromise aircraft safety. Most airports establish wildlife management plans that identify potential hazards and outline procedures for managing water, wildlife, and to support the operational safety of aircraft. In Amsterdam Schiphol Airport, bird control efforts make waterways around the runway area less attractive to water birds by installing green lasers, fixing ropes and/or netting across ditches and canals or floating hopper balls in them.[15] In the US, the FAA recommends any stormwater or wastewater features have a separation distance of 10,000 feet from the airport's aircraft operations area (for airports serving turbine-powered aircraft).[16] The report *Balancing Airport Stormwater and Bird Hazard Management* reviews applicable regulations and guidance documents as well as airport stormwater management options and potential risks from wildlife, especially waterfowl.[17] The tool discussed in that treport allows users to evaluate risks associated with stormwater management options using a conventional Safety Management System framework. Additionally, the FAA recommends stormwater detention ponds be designed, engineered, constructed, and maintained for a maximum 48–hour detention period after the storm, and to remain completely dry between storms. The 48-hour detention period reduces the attractiveness of ponds to facilitate the control of hazardous wildlife.

Water Quality Overview

Stormwater runoff from the airport runways, taxiways and aprons picks up contaminants from aircraft activities, and there is a risk those substances will contaminate surrounding water supplies. De-icing activities have received the most attention, but many activities at the airport have potential to impact water quality.

Water contaminants at airports and their sources include:

— ethylene or propylene glycols, from de-icing/anti-icing of aircraft;

— urea, acetates, formates from de-icing/anti-icing of runways, aprons, and taxiways;

— fuel, from spills during refuelling and leaks from pipes or tanks;

— fire suppressant chemicals and foams dispersed in firefighting exercises;

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[15] See Bird Control at Schiphol airport. https://www.schiphol.nl/en/download/b2b/1524742453/6eMg60eBX2Ges0MkkuUiK0.pdf

[16] See Advisory Circular 150/5200-33C - Hazardous Wildlife Attractants on or near Airports. https://www.faa.gov/airports/resources/advisory_circulars/index.cfm/go/document.information/documentID/1037215

[17] ACRP Report 125, Balancing Airport Stormwater and Bird Hazard Management, 2016. http://www.trb.org/Publications/Blurbs/172035.aspx

— dust, dirt and hydrocarbons from paved surfaces and engine leaks; and

— herbicides and pesticides.[18]

As water flows into and out of the airport through usage as well as from stormwater run-off, facilities have a responsibility to ensure that airport activities are not negatively impacting surface and groundwater quality. In some areas, the use and conservation of potable water by the facility are also of concern. Many airports have developed water management programs and procedures designed to comply with local water regulations, contain spills and other potential contaminants, and to ensure routine activities are carried out efficiently. The type and nature of airport operations, as well as the general availability of water, will be central factors an airport examines when considering water management activities it requires.

Water Pollution Issues

Common activities at a commercial service airport can impact surface and ground water quality. For instance, chemicals discharged from airports can contaminate water supplies and diminish water quality in surrounding areas. Some of the main concerns related to this contamination are toxic effects on aquatic life. Levels as low as 1 part per million of substances such as ethylene glycol, jet fuel, heavy metals, and ammonia can be lethal to sensitive plants, fish, and amphibians, and can cause disturbances in the overall ecosystem. Eutrophication (the prolific growth of algae or plants caused by an excess of the nutrient nitrates, phosphates, and organic carbon) can be caused by the breakdown of chemicals in de-icing fluids. Oxygen depletion is another major problem that can arise when glycols and hydrocarbons break down in water.[19]

Well-designed water retention and isolation basins at airports help to contain pollution. Treatment plants can be operated by airports and combine grey water infrastructure and nature-based solutions in order to reduce discharges into the environment. Paris-Orly Airport developed a 6,500 square meter filtering marsh that optimizes the treatment of rainwater and brings other positive environmental benefits.[20]

Water Policies

Airports Council International (ACI) has a specific policy statement on water management: Airports should work to minimize the use of potable water, to process wastewater (de-icing and sewage) in the most efficient way possible, reuse of treated water and to manage the quantity and quality of storm water run-off. [21]

Airports must be familiar with all National, regional, and local regulations for water quality and drinking water. Guidelines and testing/reporting will generally address total suspended solids in the water, as

[18] From APM section 2.6.2
[19] TP 12233: Airport Water Quality Manual, Transport Canada, January 1995.
[20] One example of treatment plant using nature based solutions at Paris Orly Airport. https://www.parisaeroport.fr/docs/default-source/groupe-fichiers/presse/cp_avril-juin-2014/2014_04_08-presse-adp_inauguration_marais_filtrant_traitement_eaux.pdf
[21] ACI Policies and Recommended Practices, 2018.

well as substances such as oils and engine de-greasers. Additional water monitoring tracks the level of Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), as some substances frequently used at airports, such as de-icing chemicals, can reduce the level of dissolved oxygen in waters, which can lead to aquatic toxicity. Airports test for these in retention ponds and discharge sources, and often must report the monitoring data to a State regulatory organization. Depending on State laws, fines and other penalties can be levied for non-compliance with water quality standards.

Water Quality Monitoring Plans

Airports need a proper water quality monitoring program. These can include collecting different types of samples at different locations for different parameters. A sampling program shows due diligence on the part of the Airport and dedication to environmental protection.[22] The plan should define frequency of sampling, sampling locations, and parameters sampled. Sampling both airside and landside portions of the airport is important to quantify the pollution produced on property. Appropriate site selection is essential to ensuring the validity of monitoring results, and special attention should be paid to the Airport boundaries and end of pipe locations (where water enters and leaves airport property and meets rivers/streams). Generally, sampling should occur at all end of pipe locations and any high-risk areas. Multiple sample sites may be required at a given airport and these sites should be made accessible under all conditions (e.g., vegetation or snow clearing may be required). This should include both underground and above ground channels that are fed by aprons, fueling compounds, runways and taxiways, hangars, oil separators, parking lots, etc. Regulations may specify the type and frequency of sampling activities and different limits for various parameters may exist based on the location of the airport or the regulatory requirements and may vary depending on the season.

Critical drainage basins should be identified and ranked according to the likelihood of pollutant release. Consideration should be given to known volumes of released pollutants, quantities of runoff, how quickly a drainage basin will produce runoff (percent impervious surface). There are many potential receptors for stormwater runoff, the most sensitive being natural water bodies with little flow (streams, lakes, ponds, sloughs, and to a lesser extent, rivers). The following is an example of a potential guideline for ranking of sampling locations, starting with the highest priority location:

1. At discharge points from pipes draining high-use operational areas, straight into a water body, at the property line (both airside and landside).
2. Where open channels from high-use operational areas discharge straight into a water body.
3. Where pipes flow directly from high-use operational areas into municipal storm sewer pipes (at the property line).
4. Where pipes from high-use operational areas flow to ditches on site.
5. Where open ditches flow off-site from retention or treatment facilities.
6. Where open ditches or pipes discharge from non-operational or rarely-used areas.
7. Where ditches or pipes discharge onto the property.

[22] One example of continuous monitoring program at Boston Logan Airport. http://www.massport.com/massport/business/capital-improvements/sustainability/water-quality/

This list should be adapted to fit local interests indicated by airport operators, environmental authorities, and the public.[23]

If contamination is found in a sample, it is important to determine the contamination source. If needed, sampling up-stream of the Airport property can be conducted to reveal if contamination may be entering the airport from nearby properties.

Airports should consider installing stormwater retention facilities where water can be collected from many different airport areas. These facilities can have the water tested for compliance before release into the public waterbodies. Facilities can have automatic samplers, composite sampling devices, and oil water separators. If facilities cannot be installed for all end of pipe locations, prioritizing the high activity areas is recommended.

In addition to sampling surface runoff, groundwater sampling should also be conducted at key locations. This will help the airport understand water quality issues in the area, and help identify any contamination. Boreholes can be dug and groundwater sampled at a determined frequency.

Water Quality Sampling Parameters and Frequency

Water quality monitoring will include testing water samples for contaminants. State regulations will influence the type and frequency of sampling. In most cases, regular baseline sampling requires bimonthly sampling, though in some cases increased frequency may be necessary. Most pollutants flow through the drainage system during major flow events, such as snowmelt or up to 48 hours after rainfall. Monitoring during these periods requires either automated, flow-triggered equipment, or on-call dedicated staff who can respond to these events.

1. Parameters should be selected by what is stated in regulations and any other parameter which the airport deems significant.
2. The airport must use an accredited laboratory for analysis of samples. The lab will provide correct bottles for each parameter.
3. Staff conducting water sampling should be trained in sampling techniques, project objectives, and safety rules in order to obtain proper samples.
4. Sampling frequency at a particular location should correspond to the likelihood of contamination.
5. Both sampling frequency and parameters can be expected to change from year to year (i.e., for a location in which contamination is found during monitoring, sampling frequency should increase).
6. Additional sampling is required when a known pollutant is released.[24]
7. Data from sample results should be logged and retained by the airport as per their records retention policy. In some states this data must be reported to a regulatory authority.

[23] TP 12233: Airport Water Quality Manual, Transport Canada, January 1995.
[24] Adapted from TP 12233: Airport Water Quality Manual, Transport Canada, January 1995.

Pollution Prevention Planning

To prevent pollution, airports should develop a water pollution control program. This program would list detailed practices and procedures for managing activities and preventing pollution events. It is easier and less costly to prevent pollution than it is to clean up spills. Additionally, many water management procedures can be implemented through other management plans, such as an Environmental Management System (EMS). A water management program might, for example, provide detailed procedures for what to do during severe storm events, and specify training of personnel in the handling and use of certain products.

Airports have also developed systems that help them in preventing pollution. Technologies include built systems that collect surface water run-off and separate out contaminants from water. Some airports use infrared de-icing which is a chemical-free method for removing ice from aircraft that eliminates the need for containment.

Spill Containment and Response

In order to protect water quality, it is important to have a spills response plan at all airports. Proper spill response plans and infrastructure can significantly reduce the possibility of water contamination leaving the airport and can demonstrate that every reasonable effort was made to prevent a release offsite. Spill containment and clean up is a last resort. It is more efficient to practice spill prevention. Airports and all stakeholders working at the airport site should establish safe practices for storage and use of substances such as oils, fuels, hydraulic fluids and other potential contaminants, and thus reduce the need for containment and clean up.

1. Contaminants (aircraft fuels, hydraulic fluids, oils, etc.) should be kept away from catch basins and any storm drainage whenever possible.
2. Oil/water separators should be installed on aprons and any high vehicular traffic areas. Water storage facilities (properly designed to prevent wildlife hazards) can also hold contaminated water for treatment or to divert water away from public waterbodies
3. In the event of a spill, sampling should not be limited to the regular stormwater locations. Any location where contamination is present or is suspected should be sampled. This could include sampling from snow, catch-basins, manholes, or existing groundwater monitoring wells.
4. Containment and recovery plans, as well as emergency clean-up procedures should be prepared in advance and personnel trained on them so that they can be used in the event of a spill. [25]

De-icing Runoff Management

A common activity at commercial service airports that is significant for water quality is de-icing and anti-icing.[26] Removing ice from aircraft is important for safe operations in freezing temperatures. However,

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[25] One example: the management of a fuel leakage at O.R. Tambo International Airport - Project Blaauwpan Dam, fact sheet and lessons learned. https://www.airports.co.za/about-us/making-a-difference/the-environment/project-blaauwpan-dam

[26] Procedures and practices for de-icing are described by ICAO at: https://www.icao.int/safety/airnavigation/OPS/Pages/Aircraft-Ground-De-IcingAnti-Icing-Operations.aspx, and in ICAO Doc 9640-AN/940, *Manual of Aircraft Ground Deicing/Anti-Icing Operations*. http://code7700.com/pdfs/icao/icao_doc_9640_manual_of_aircraft_ground_de-Icing_anti-Icing_operations.pdf

the methods for de-icing and anti-icing usually involve chemical fluids which can potentially contaminate water supplies. Other activities, such as refueling and gate servicing of aircraft, also have potential to impact surface waters. In short, any activity that uses chemical agents should consider methods to prevent those substances from entering surface or ground waters.

Most airports will track the amounts and types of fluids used annually, as well as the amount of waste generated by the activities. If the airport conducts aircraft de-icing, it is important that they use the minimum amount of de-icing fluid necessary to effectively deice the aircraft. Blending to temperature is a process where the sprayers blend de-icing fluids and water in portions set by the outdoor temperature, so operators should be careful to ensure those settings are appropriate to the conditions. For de-icing at the gate, butterfly valves can be utilized to contain any contamination on the apron. Some major airports carry out sampling for de-icing fluids in the drainage structures directly connected to main aprons and de-icing areas, in snow piles, and in groundwater wells under the apron and in its vicinity.

To the extent possible, any spent de-icing fluids should be collected after use and segregated from stormwater systems. Most often an aircraft parks on a de-icing pad, and mobile vehicles move around the aircraft spraying the aircraft with fluids. At a minimum, a liner underneath the facility will protect against groundwater contamination. Some states, such as the United States, require collection of some or all de-icing fluid. Spent glycol can be collected, separated from other water, and recycled. Spent fluids are usually not considered hazardous waste, but will require treatment in an approved facility. It is a best practice to have runoff mitigation structures for capturing de-icing fluids. The use of a centralized de-icing facility can assist greatly in the segregation, recovery and reuse of the glycol. Dedicated de-icing facilities "enhance the feasibility and economic benefits of recycling glycols by collecting higher glycol concentrations, as compared to drainage systems where glycols are further diluted with other runoff and precipitation."[27]

Some airports have anaerobic bioremediation systems, which consist of a glycol contaminated storm water collection and storage system, a bioreactor treatment system, and a gas/heat recovery system. The process of the bioreactor system uses bacteria to degrade the glycol. This process reduces the BOD concentration of the runoff significantly and can thus allow unrestricted disposal or transfer to a public treatment facility. Another economical method is to have detention basins for the de-icing runoff. This can be a single or a series of basins, with impermeable liners to protect ground water. The basins hold the glycol contaminated fluids until the glycols have been degraded to acceptable levels.

In some cases, anti-icing fluids are applied directly to airport surfaces to keep them free from ice. The fluids differ chemically from aircraft de-icing fluids, but also have similar environmental issues. In the US, the Environmental Protection Agency (USEPA) has put severe restrictions on the use of urea because of water quality impacts.[28] Replacement fluids have been developed, however, it is now recognized that components of replacement anti-icing fluids may have negative effects on carbon brake components of aircraft landing gear, as well as on water quality.[29]

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[27] FAA Advisory Circular 150/5300-14D, Design of Aircraft Deicing Facilities. 2018.
[28] 2012 EPA. Airport Effluent Limitations Guidelines.
[29] See, for example, Oda et al 2010, *Safe Winter Operations*.
https://www.boeing.com/commercial/aeromagazine/articles/2010_q4/2/

Wastewater Sanitary Regulation

Certain types of water at airports, including from aircraft lavatories and recaptured de-icing fluids, are wastewater. It is important to know the local regulation for wastewater treatment. Wastewater, which is not compliant for storm disposal, can not be discharged into local water systems, but instead must be disposed of in specific ways. Wastewater may be treated on site, if the airport has the facilities to do so, or sent to a nearby municipal treatment system. Local water quality regulations may require pre-treatment of wastewater before it can be discharged into a municipal system. In addition, local regulation may also set limits on the quantity of wastewater a facility can process.

PFAS Management

Airport rescue and fire fighting (ARFF) equipment often uses fire suppressant foams containing per- and polyfluoroalkyl substances (PFAS). Research increasingly shows negative human health effects of these substances.[30] Many European airports have switched to a different firefighting foam, F3 Foam, which does not contain PFAS.[31] These new foams are still going through testing in some States to determine what environmental hazards they may pose. Some States are looking at modified procedures to test and discharge fire fighting systems that result in less contamination of soils or water.

Some States still require PFAS based foam to fight these fires. When the situation is not an emergency, airports should take steps to ensure these fire fighting foams do not contaminate water and soils managed by the airport, including groundwater that could be discharged via a storm drain system. In some cases, training exercises may be able to be conducted with specific training products that do not contain the same chemicals, so as to greatly reduce the possibility of PFAS contamination during non-emergency situations. If the airport conducts fire training activities with foam containing PFAS, it is important that any foam be collected and segregated from stormwater systems.

The scientific research work is continuing, into both the health impacts of the thousands of PFAS formulations, as well as clean-up approaches for contaminated areas, as well as contaminated ARFF equipment. Airports should be aware there are other potential sources of contamination at their airports (for example foams in hangar fire-suppression systems, which many insurance policies have required). As the science and regulatory requirements continue to evolve, airport staff should make sure to stay abreast of the developments. Airports should also develop spill management and clean-up plans, so that they know how they will manage a release of foam, as a result of either responding to an emergency or accidental release.

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[30] One example is the US EPA website Drinking Water Health Advisories for PFOA and PFOS; https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos

[31] See Ross, Ian. Is the burst of the AFFF bubble a precursor to long term environmental liabilities? *International Airport Review*, 29 July 2019. Available at: https://www.internationalairportreview.com/article/98795/fire-fighting-foam-chemicals-water/

Water and Airport Construction

Airport construction often starts with the clearing of vegetation and brings with it the potential to introduce pollutants into the water system. Vegetation clearing can alter natural watershed systems, which can lead to soil erosion and other issues.[32] Post-construction water quantity and quality controls may be incorporated to reduce downstream flood potential as well as reduce discharge of pollutants due to industrial activities occurring within the newly constructed airport area.

1. During construction at airports it is important that there is a stormwater monitoring program in place to protect nearby waterbodies from construction activities such as soil erosion and pollutants.
2. Nearby waterbodies should be monitored for any evidence of construction pollution.
3. At construction sites, filter cloths should be used around storm drains and filter fence on slopes around ditches. Water ponding areas can be installed to drain construction sites, to let sediment settle, and allow floating pumps to drain water.
4. After construction, sites should be stabilized to reduce erosion and soil transport caused by water runoff, and detention facilities maintained to ensure proper function and operation.

Examples of Action

Kuala Lumpur International Airport (Malaysia) - Improvement Effluent Water Quality Standard at Sewerage Treatment Plant KLIA (Sep 2018)

The project, completed within seven months, is an innovative and drastic approach to improve quality of effluent discharge at Sungai Labu, Sepang, Selangor through rectification of aeration process at SBR Tank at the KLIA Sewerage Treat Plant (STP) of the Mitsui Outlet Park KLIA Sepang (MOP) shopping mall.

The plant is designed as a Sequential Batch Reactor (SBR) system with a treatment capacity of 5000PE. After the improvement implementation, there is a total of 99.9% cost savings that translate to USD 574K per year, contributing to the efficiency of maintenance clogging activity at SBR with 100% improvement. On average, the efficiency of the aeration process improved significantly as its duration decreased from six (6) hours to three (3) hours. Discharged sludge KLIA STP design standard ratio improved from (80% of sludge: 20% of water) to (40% of sludge: 60% of water). It also can contribute to 9,015kgCo2/year carbon emission reduction as using recycle tube diffuser, logistic, and electricity reduction. The project has also reduced cases of tripping and double handling activities, allowed easy supervision, aeration process running smoothly, and created a safer environment. Besides, this initiative is integrated with the Early Warning System (EWS) for 24h monitoring[33]. The performance monitoring activities of STP KLIA are conducted daily through in-situ sampling analysis.

This initiative will be replicated to other airports in Malaysia to practice the same improvement replication. This outstanding project is compliant with Standard A, EQA 1974 Act (discharge upstream of any raw water intake), and the Company's Environment Policy signed by MAHB's Group Chief Executive Officer. It has received numerous high recognitions during internal and external competitions such as

[32] see ICAO Airport Planning Manual, Part 2, Section 2.5

[33] EWS system is an IoT devices which is activated through integration of satellite signal to mobile data for notification and reporting.

MAHB World Class Maintenance (WCM) Internal Evaluation, Regional Team Excellence, and National Team Excellence.

Parameter	Before	After
Biological Oxygen Demand (BOD),	15-27 mg/L	0-15 mg/L
Chemical Oxygen Demand (COD)	20-130 mg/L	10-50 mg/L
Ammoniacal Nitrogen	5-35 mg/L	6.7-9.8 mg/L

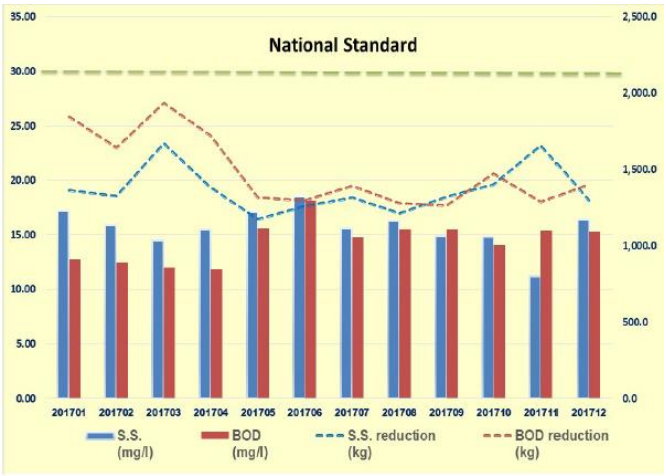
Taoyuan International Airport (Chinese Taipei) – Smart water resources management IoT system installation project (Sept 2017)

In the past 10 years, Taoyuan International Airport has experienced a multiplier increment in passenger traffic. Coupled with the expansion of the terminals, the difficulty of maintenance has raised. After diagnosed by the "Utility Supervision Task Force" in 2017, under the direction of the Vice President, Taoyuan International Airport introduced the Internet of Things (IoT) technology to further monitor and control those major facilities and to implement a preventive maintenance inspection mechanism for constructing a smart airport.

Through the establishment of the cloud electronic patrol system (including 1,800 RFID inspection points) and SOP, the initiation of the intelligent management of water supply and drainage and sewage facilities, the effective improvement of the equipment reliability and process efficiency, and by integrating the resources of 16 airport partners, and providing integrated training, three big goals were achieved: the advancement of water facility and equipment maintenance standards, the fulfilment of pre-preventive maintenance to replace post-fault repairs, and the improvement of patrol efficiency.

After conducting the project in 2017, the environmental performances included:

- Water-saving devices have been adopted for all sinks and urinals in airport toilets, while 20% of water outflow from the faucet has been reduced.
- About 6,000 tons of underground water are recovered annually and applied for the cooling of the incinerator.
- The wastewater effluent is monitored daily, and compared with national standards, it has a 20% reduction of discharged suspended solids and biochemical oxygen demand (16,376.1 kg and 17,850.7 kg).
- Wastewater is recycled and then used for planting.
- Tight cooperation with 16 airport partners and the e-cloud smart management reduced 30% labour required for maintenance, and decreased water consumption per passenger by 1.3% that means 29,990 tons of water conservation.
- In areas such as toilets where passengers use water regularly, information related to the project was marked to enhance passengers' water-saving willingness.
- A total of more than 50 Water resource management training courses for airport company staffs and partners have been conducted, and more than 1,000 people have been trained, the project's outcomes and effects have been deepened and widened.



Reducing discharged water pollutants

Rajiv Gandhi International Airport (RGIA), (India) - Water Sustainability at RGIA through efficient devices, recycling and replenishment (2018)

The Water Conservation Project has been implemented at Rajiv Gandhi International Airport, Shamshabad, Hyderabad, India by GMR Hyderabad International Airport Limited. The total project cost was INR 338 million and has had savings to the tune of INR 361 million during the past 3 years (120 million/year). Environmental benefits include reduction of stress on water resources like water board, improvement of ground water table, flood and soil erosion control.

With its efforts, RGIA has achieved water sustainability by replenishing this precious resource back to the nature for wellbeing of the Airport stakeholders including local communities. RGIA has become self-sustainable in water management by applying national and international best practices of the airports and guidance documents of the United Nations, U.S. Environmental Protection Agency, and GMR Group's Project Water initiative. Under its Environmental Policy by Reduction, Recycling, Reuse and Replenishment to the nature, GHIAL implemented several practices for efficient use of water by partnering with the airport community and implementing:

Reduction is achieved through automation of the airport's landscape irrigation system across the vast 278 hectares through a cloud-based central control system established for the drip and sprinkler network which allows real-time monitoring of water consumption through SCADA based flow meters. In all the terminal buildings and offices sensor based water taps along with aerators were installed.

Reuse by recovering the 103 Air Handling Units (AHU) of the air conditioning system condensate and feeding it to the cooling tower circuit thus enhancing water use efficiency of the chiller plant.

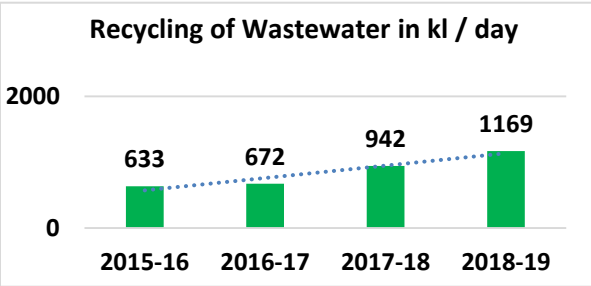
Recycling of the airport wastewater from STPs (1850 kl) through multistage treatment for WCs flushing and irrigation within the airport premises.

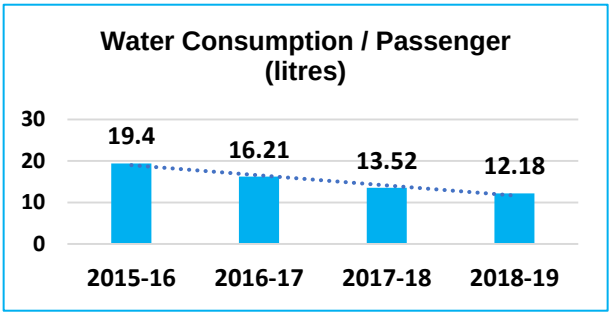
Replenishment is achieved through rainwater harvesting by collecting runoff from paved areas, rooftops, and open areas within the airport. Rainwater harvesting structures (0. 735 million m^3) have been made. The specially made recharge wells enhance the infiltration of the water.

The above stated efforts by adopting 4R strategy, and engagement of the airport stakeholders through awareness sessions, case studies and signage has resulted in a significant amount of water savings to the tune of:

- 30.92% water use efficiency in 2018-19 over 2015-16 in overall consumption.
- Reduction water footprint of 6, 86,414 kiloliters (kl) in the past 3 years.
- Significant reduction of domestic water use per passenger brought down from 19.40 to 12.18 liters
- About half of total airport water demand is met from internal resources (4,61,685 kiloliters/year) like treated wastewater and surface water.
- The automation of irrigation water usage is saving water 20-40% i.e. 200 to 500 kl/day facilitating irrigation during early morning/late evening resulting in water saving due to less evaporation.
- The recovery of AHU Condensate is saving 36 kiloliters/day of fresh water with monetary benefit of INR 0.24 million/year.
- 4,26,685 kl of treated wastewater was recycled for flushing of WCs and irrigation to the landscape in 2018-19 (cost saving INR 72 million).
- The Rainwater harvesting: developed innovatively using satellite mapping, leveraging natural contour eliminating need for water pumping.
    - Every year 35,000 kl of surface water is used.
    - Rainwater net recharge is 1.729 million m^3/ annum in the total airport area measuring 2225ha.
    - Augmentation of ground water table by 3 –5 m at and around the airport, which enables ground water availability to the local communities for drinking and irrigation use for entire year.

RGIA is a self-sustained airport in terms of water resources management and will continue the water stewardship initiatives further. These initiatives are also aligned to U.N. Sustainable Development Goal 6: Ensure Availability & Sustainable Management of Water and Sanitation for All. Every year, the water management team works on the proposals with tangible/intangible benefits and project cost. The senior management approves these projects after detailed deliberation and expert consultation. The management reviews periodically on the progress of the water conservation projects and results. To meet passenger growth, new water projects are being initiated like capacity enhancement of water storage, wastewater treatment and rainwater harvesting.





Note: The water consumption / pax has been taken for Passenger Terminal Building area.

Hong Kong International Airport (Hong Kong) - Implementation of Aircraft Dry Wash (Jun 2019)

Hong Kong International Airport (HKIA) adopts a "triple water system" to improve the efficiency of its three primary water sources: freshwater, seawater, and treated wastewater. Seawater is used for flushing toilets and as the cooling medium in the air-conditioning systems of major airport buildings, significantly reducing the demand for both portable water and greywater. Potable water is still being used in several critical aircraft and airport operations processes, including aircraft washing.

In June 2019, AAHK approved Hong Kong Aircraft Engineering Company Limited (HAECO) to carry out dry wash at HKIA. Traditionally, aircraft wash at HKIA was allowed only in 10 designated parking bays equipped with drainage to collect effluent for treatment. Before approving dry wash for other 29 pre-designated parking bays, which reduces the distance of aircraft towing by relaxing the requirements to use parking bays for cleaning, AAHK reviewed the physical and chemical properties of the products, assessed the environmental risks, and provided advice on the Dry Wash Procedures.

The benefits of dry wash are significant in various aspects. Compared with wet wash, HAECO expects dry wash to use 90% less water, equivalent to saving more than 860,000 liters of water a year and produces less effluent. The reduction of aircraft towing helps reduce the traffic on the apron and fuel consumption by aircraft and ground services equipment (GSE), hence the airport-wide greenhouse gas emissions. It is estimated that 189 tonnes of CO_2 per year could be saved from less towing. Dry wash also reduces the need for aircraft cleaning to 4-6 times a year, compared to 8-9 times a year for wet wash, which increases aircraft availability for airlines. Moreover, dry wash enables aircraft zonal cleaning, rather than washing the whole aircraft, which is a new cleaning option for airlines and saves aircraft grounding time. In May 2020, AAHK approved another aircraft maintenance service provider, China Aircraft Services Limited (CASL), to conduct aircraft dry wash on the maintenance apron.

As a result of the potential for saving water, it is especially suitable for use in airports located in water-constrained areas.

Kaohsiung International Airport (Chinese Taipei) - Water Efficiency Management (Dec 2019)

KHH is in southern Chinese Taipei, a moderate-risk water-scarcity area classified by Aqueduct Water Risk Atlas Tool from World Resources Institute. With the increasing number of passengers and increased water demand coupled with water rationing due to low rain in the region and the increasing influence of climate change, KHH must prepare early for the adaptations.

KHH launched their annual Water Efficiency Project to effectively manage the water resource since 2015. with the total investment of $94,609, the water-saving practices of KHH's Water Efficiency Project could annually reduce 346,300 tons of water consumption and save the cost of $56,101 with an estimated payback period of 1.7 years.

(KHH) regards water efficiency as one of key sustainability topics and set the target of 2% annual reductions. In 2018, KHH reduced 31,161 tons of water consumption compared to 2015, showing a 7.2% decreased from 432,698 tons to 401,537 tons; the total water consumption per passenger was reduced from 72 L/person to 58 L/person, leading to a reduction of 20.1%. Furthermore, the reduction of 31,161 tons of water leads to 4.9 tons of CO_2 emissions Environmental benefits and Applicability.

For a comprehensive management, KHH set the Water Conservation Committee chaired by the deputy director and regularly monitors the status of water consumption. The Committee holds regular meetings twice a year to review the water-saving progress and performance.

The KHH's water efficiency project was implemented via the following four major aspects:

1.Hotspots inspection
Through the water meter setting and monthly record review, KHH identified two critical water hotspots including residential water (including faucets, toilets, and air-conditioning equipment) and construction water. In addition, KHH performs pipelines leakage detection and water pumps efficiency evaluation by regular inspection. The replacement with new pipelines and high-efficiency water pumps could save 96,000 tons/year of water.

2.Efficiency improvement
KHH replaced all old toilets (12 L/use) and faucets (9 L/min) with water-saving toilets (6 L/use) and induced faucets (7.5 L/min), which could save 68,645 tons/year of water. Besides, the replacement with high-efficiency cooling towers could decrease 72,154 tons/year of water consumption.

3.Recycling
The KHH's wastewater treatment plant has the capacity to recycle 109,500 tons/year of water, which could be used for irrigation or road cleaning.

4.Promotion and stakeholder engagement
The Water Conservation Committee promotes water-saving awareness via posters in public area for passengers, and regularly holds environmental training and online courses for staffs and tenants. Collaboration with suppliers to implement water-saving practices:

Water Consumption Trend in Kaohsiung International Airport			
	Cost (U.S. dollars)	Water Saving (tons / year)	Cost Saving (U.S. dollars / year)
Pipeline replacing	560	96,000	15,552
Toilet replacing	27,440	53,145	8,609
Faucet replacing	43,768	15,501	2,511
Cooling tower replacing	22,841	72,154	11,689
Wastewater Recycling	0	109,500	17,739
Total	94,609	346,300	56,101
Paybacl period (Cost / Cost Saving)		1.7 years	

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CASE STUDIES

Water management at airports

ICAO Eco-Airport Toolkit

Form

Step 1: Please provide your contact details in case further information is needed.

	Respondent
Name	Marion Town
Organization/Company	Vancouver Airport Authority
Job Title	Director, Environment
Email Address	Marion_Town@yvr.ca
Telephone	Direct: 604-276-6138/Cell: 604-760-6121
Airport (Name and 3 Letter Code)	Vancouver International Airport (YVR)

Step 2: Please provide the following basic information of your Project/Case Study:

Project/Case Study Title: Water Conservation at YVR

Timeframe (e.g., start and end month/year if applicable): From 2015 to present

Description:

Through the 2020-2024 Environmental Management Plan, the Vancouver Airport Authority is committed to achieving four environmental goals, one of which is to continue to reduce use of potable water. With challenging 50% water efficiency reduction target, the Vancouver Airport Authority (the "Airport Authority") has implemented numerous water conservation initiatives and has invested in several water reduction capital projects. These efforts fall under three themes, "Sustainable Design & Operations," "Water Conservation Studies," and "Education Community Engagement Initiatives & Programs."

Purpose:

The Airport Authority is a community-based, not-for-profit organization, which manages the Vancouver International Airport or YVR under the provisions of a long-term ground lease with the Government of Canada since 1992. The Airport Authority's mandate is to operate YVR in the best interests of the region, expand the contribution that YVR makes to local economic development, and ensure the airport can respond to the demands of the community and aviation industry in a safe, efficient, and environmentally responsible manner. As YVR is located on Sea Island and bound by rapid residential growth and environmentally sensitive areas, including fish and bird habitat, our connection with the natural environment surrounding the airport is important to us. As factors such as

population growth and climate change impact these resources, the Airport Authority's Water Conservation Program provides the framework for key water conservation and non-potable water initiatives and investments to sustain the availability of clean and safe potable water at YVR for years to come.

Step 3: Please identify which water management technologies are used at your airport:

( ) Filtration

( ) Nanotechnology

( ) Sedimentation

( ) Sewage treatment

( ) Bioreactor

(X) Other – Sustainable Design & Operations, Water Conservation Studies, and Education Community Engagement Initiatives & Programs.

Step 4: Please identify and prioritize the driver(s) for the water management project. Number 1-6, where 1 is a high priority and 6 is a low priority.

(2) Economic

(1) Environmental

( ) Political

(3) Social

( ) None

( ) Other

Step 5: Please give more details on the driver(s) chosen in the previous question. For instance, was there any available incentives for the development of such programs? Can you describe it?

(1) Environmental

Through the 2020-2024 Environmental Management Plan, the Airport Authority is committed to achieving a 50% water efficiency improvement by 2024 from a 69 L per passenger baseline in 2012. To achieve this target, the Airport Authority's Water Conservation Program focuses on identifying reduction opportunities and outlines

YVR's key actions to improve water efficiency. Given the impacts of climate change, water conservation is critical to a sustainable future.

(2) Economic

Although current water costs, such as treatment and distribution, are relatively low in the Metro Vancouver region, these costs are anticipated to increase over time as water demand increases in the future. Our water conservation efforts help to minimize our water costs and avoid the need for additional water infrastructure and treatment, which are typically expensive capital investments. They also support our tenants in retrofitting their water and equipment appliances to lower their utility costs.

(3) Social

Water is not only a valuable natural resource for YVR, but also for the communities the airport is a part of and serves. Our water conservation activities are intended to our reduce water consumption, as well as aimed at educating and raising awareness of water issues to our tenants and bringing us together to act on how to reduce our impact on this valuable resource. Ultimately, conserving water at YVR ensures that water supplies are protected for everyone, including other community groups and uses.

Step 6: Did you engage with internal and external stakeholders? If so, please identify which stakeholders you engaged with.

The Airport Authority has engaged extensively with internal and external stakeholders with the YVR Water Conservation Program. Internal stakeholders mainly consist of Airport Authority employees, while external stakeholders include neighbouring municipalities and a wide range of businesses, such as catering, cargo, airlines, restaurants and retailers. YVR's Water Conservation Program has offered tenants access to low-flow pre-rinse spray valves, facility audits, and incentives for infrastructure that significantly reduces use.

Step 7: Which department oversees the water management development in your organization?

With the Airport Authority's Vice President of People & Sustainability and Director of Environment as leads, the Environment Department oversees water management at YVR.

Step 8: Please insert Text and Images of your project/case study below here:

Decision-Making Process:

Estimated Cost and Financial mechanisms available:

Images:

Results (Environmental Benefit/Cost Benefit):

Lessons Learned:

Sustainable Design & Operations

The Airport Authority is a leader in sustainability; whether it be design, facility improvements or airport operations, the principles of sound environmental management are integrated into our policies, procedures and project lifecycles.

Rainwater Collection System at the Airside Operations Building

A new Airside Operations Building was constructed at the end of 2014 at YVR (Figure 1). The building was designed with many sustainable features, including a rainwater collection system to use non-potable water for toilet flushing and vehicle washing. It has been estimated that 620 m^3 of water savings are achieved annually as a result of this collection system.

Figure 1 – Airside Operations Building

Optimization of Heat Exchangers

Starting in 2015, the Airport Authority changed the use of the heat exchangers in the International Terminal Building from all year-round to only from July to September. The cooling towers in the Domestic Terminal and the air-cooled rooftop chillers on the International Terminal are now used to provide primary cooling service for the terminal building from October to June. The estimated water savings from this operational change is 97,000 m^3 per year.

Improved Water Metering & Monitoring

Water metering is necessary for managing water use more effectively by detecting leaks and improving the accuracy of unaccounted and unmetered usage. In 2017, the Airport Authority installed new water meters in all terminal buildings (Figure 2). The Airport Authority has also improved water metering of its irrigation system.

Figure 2 – A New Water Meter

Sanitary Sewer Pump Station Flushing Reduction

The Airport Authority operates and maintains sanitary sewer pump stations on Sea Island, several of which require potable water for cleaning. In 2017, the Airport Authority upgraded three of these stations with new agitators to minimize the need for flushing. Estimated water savings from these upgrades are 6,250 m^3 per year.

Water Fixture Upgrades at the Main Terminal Building

At YVR, a major source of water consumption comes from washroom fixtures, such as toilets and urinals. Starting in 2018, the Airport Authority has completed the first and second phases of a washroom fixture upgrade project, replacing over 1,100 fixtures including toilets, urinals, faucets and aerators with WaterSense models (Figure 3). After completion of the final phase of this project, these updates will have a total estimated water savings of 65,000 m^3 per year.

Figure 3 – A New Low-Flow Toilet

Water Conservation Studies

To explore progressive and alternative approaches for improving water efficiency at YVR, the Airport Authority has conducted several water conservation related studies.

Recent water conservation studies have been completed to better understand how water is used on Sea Island and assess solutions. These include partnerships with our tenants to offer water audits of their facilities and incentives to action improvements, leak detection studies (Figure 4), and non-potable water feasibility assessments.

Figure 4 – A Leak Detection Study Underway

Educational Community Engagement Programs & Initiatives

Achieving the Airport Authority's water efficiency target requires the collaborative effort of all internal and external stakeholders, including airport business partners, contractors and tenants, who have a role in how water use is managed at YVR. Knowing this, the Airport Authority has implemented various community engagement initiatives to educate and support these audiences in improving water efficiency at the airport.

Pre-Rinse Spray Valve Program

During the summer of 2018, the Airport Authority offered free water assessments to all food and beverage tenants, followed by free low-flow pre-rinse spray valve replacements and aerator installations. As part of the program, 49 pre-rinse spray values were replaced and 96 aerators installed, resulting in an estimated 16,862 m^3 of water savings per year (Figure 5).

Figure 5 – A New Pre-Rinse Spray Valve Installed

Tenant Water Audits & Rebates

From 2017 to 2019, the Airport Authority offered free water audits to tenants to better understand how water is used within their facilities and operations and to identify water reduction opportunities. Although no direct water savings were achieved from the audits

themselves, water savings have been achieved as tenants have begun to act on the recommended water conservation initiatives as highlighted in their audit findings.

Following up on the audits, the Tenant Water Fixture Rebate Program supports land and terminal tenants in retrofitting or replacing high water-using equipment and appliances through rebates to encourage water reduction. Since 2017, the Airport Authority has provided rebates to two tenants for retrofitting and/or replacing outdated washroom fixtures (Figure 6).

Figure 6 – New Low-Flow Urinals

BC Water Week

For the past two years, the Airport Authority has celebrated BC Water Week in the first week of May to raise employee awareness about water resource management and conservation. Different forms of engagement, including educational videos, trivia questions and internal blogs are used. It is estimated that educational programs can achieve water savings of approximately 250 m^3 per year.

Metro Vancouver Watershed Tour

In 2017, the Airport Authority partnered with Metro Vancouver to offer an educational tour of the Capilano watershed, one of three watersheds providing drinking water to the Metro Vancouver region, including YVR. The tour educated 28 Airport Authority employees on how our drinking water originates from source to tap, the importance of conservation, and how they can make positive contributions in reducing their water use (Figure 7).

Figure 7 – Airport Authority Employees at the Capilano Watershed

Next Steps

Through the 2020-2024 Environmental Management Plan, the Airport Authority aims to continue to implement a variety of water conservation initiatives, such as supporting water fixture upgrade projects, reviewing landscape irrigation for efficiency opportunities, conducting additional leak detection investigations, upgrading sanitary pump stations to minimize flushing, and engaging with Sea Island businesses to identify water reduction opportunities within their facilities. While these water conservation activities will continue to improve water efficiency at YVR, the Airport Authority understands that non-potable water will need to be used in order to meet the 2024 water efficiency improvement target. Consequently, the Airport Authority is pursuing the development of a rainwater collection system as a part of a new parkade project near the Main Terminal. This rainwater collection system will harvest rainwater from the highest level of the new parkade, which will be used to offset potable water for vehicle washing and emergency firefighting. Also, the Airport Authority intends to examine the potential for additional non-potable water or reuse projects for existing systems and future expansions, as well as explore the potential for treated wastewater reuse.

Water management at airports

ICAO Eco-Airport Toolkit

Form

Step 1: Please provide your contact details in case further information is needed.

	Respondent
Name	Rodrigo Tavares
Organization/Company	VINCI Airports
Job Title	Environmental Manager
Email Address	Rodrigo.tavares@salvador-airport.com.br
Telephone	+55 41 988021877
Airport (Name and 3 Letter Code)	Salvador Bahia Airport - SSA

Step 2: Please provide the following basic information of your Project/Case Study:

Project/Case Study Title: Salvador Bahia Airport WWTP – a Zero Effluent discharge Airport

Timeframe (e.g., start and end month/year if applicable): Operation started in October 2019

Description: Salvador Bahia Airport installed a new high-technology, modular and compact WWTP, with 750 m3/ day treatment capacity and 99,5% BOD removal efficiency. By doing it, Salvador Bahia Airport´s effluent is compliant with water reuse standards and the Airport reuses 100% of its treated effluent for non noble purposes as toilets, chillers, cleaning and gardening, reducing by 37% its potable water consumption. This makes Salvador Bahia Airport the first Zero Discharge Airport in Brazil and within VINCI Airports network.

Purpose: Before the beginning of Salvador´s airport concession, VINCI Airports identified that the existing WWTP efficiency was non-compliant, as it did not reach the minimum requirements required by the Brazilian legislation standards. Given that, a new WWTP construction was included at the business plan, but the idea was to go further the legislation and to produce reused water instead of just treating effluent, eliminating the discharge necessity, reducing the potable water consumption at the airport and reducing these impacts on the environment.

Step 3: Please identify which water management technologies are used at your airport:

( ) Filtration

( ) Nanotechnology

( ) Sedimentation

( ) Sewage treatment

( ) Bioreactor

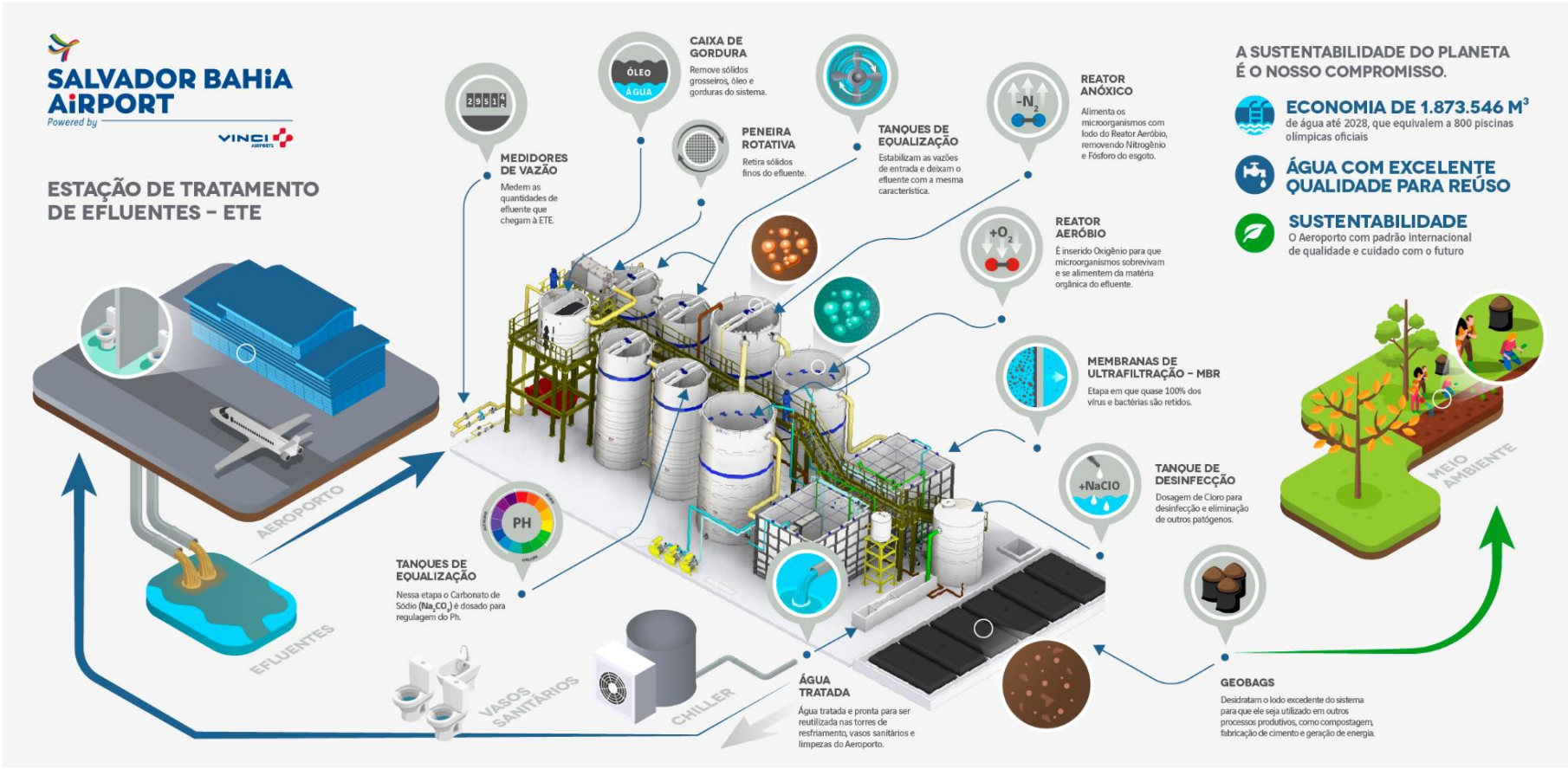
(x) Other

Which one?

The main technology is the ultrafiltration membranes, but the full system has the following composition:

- Individual effluent flow meters;
- solids, fat and sand removal;
- a rotary sieve; 4 equalization tanks;
- 1 anoxic tank;
- 2 aerobic tanks with diffuse air;
- 2 ultrafiltration membrane tanks;
- 1 disinfection tank and
- 1 treated water meter.

Follow below an infographic showing the WWTP equipment and process flow:


SALVADOR BAHIA AIRPORT
Powered by VINCI AIRPORTS
ESTAÇÃO DE TRATAMENTO DE EFLUENTES – ETE
AEROPORTO
EFLUENTES
MEDIDORES DE VAZÃO
Medem as quantidades de efluente que chegam à ETE.
CAIXA DE GORDURA
Remove sólidos grosseiros, óleo e gorduras do sistema.
ÓLEO
ÁGUA
PENEIRA ROTATIVA
Retira sólidos finos do efluente.
TANQUES DE EQUALIZAÇÃO
Estabilizam as vazões de entrada e deixam o efluente com a mesma característica.
REATOR ANÓXICO
Alimenta os microorganismos com lodo do Reator Aeróbio, removendo Nitrogênio e Fósforo do esgoto.
-N2
REATOR AERÓBIO
É inserido Oxigênio para que microorganismos sobrevivam e se alimentem da matéria orgânica do efluente.
+O2
MEMBRANAS DE ULTRAFILTRAÇÃO – MBR
Etapa em que quase 100% dos vírus e bactérias são retidos.
TANQUE DE DESINFECÇÃO
Dosagem de Cloro para desinfecção e eliminação de outros patógenos.
+NaClO
PH
TANQUES DE EQUALIZAÇÃO
Nessa etapa o Carbonato de Sódio (Na_2CO_3) é dosado para regulagem do Ph.
VASOS SANITÁRIOS
CHILLER
ÁGUA TRATADA
Água tratada e pronta para ser reutilizada nas torres de resfriamento, vasos sanitários e limpezas do Aeroporto.
GEOBAGS
Desidratam o lodo excedente do sistema para que ele seja utilizado em outros processos produtivos, como compostagem, fabricação de cimento e geração de energia.
MEIO AMBIENTE
A SUSTENTABILIDADE DO PLANETA É O NOSSO COMPROMISSO.
ECONOMIA DE 1.873.546 M³
de água até 2028, que equivalem a 800 piscinas olímpicas oficiais
ÁGUA COM EXCELENTE QUALIDADE PARA REÚSO
SUSTENTABILIDADE
O Aeroporto com padrão internacional de qualidade e cuidado com o futuro

Step 4: Please identify and prioritize the driver(s) for the water management project. Number 1-6, where 1 is a high priority and 6 is a low priority.

(3) Economic

(1) Environmental

( ) Political

(4) Social

( ) None

(2) Other

Which one? AIRPACT - VINCI Airports Environmental Policy.

Step 5: Please give more details on the driver(s) chosen in the previous question. For instance, was there any available incentives for the development of such programs? Can you describe it?

The main motivation for the WWTP implementation was Brazilian regulatory compliance and world standards because the structure received from VINCI Airports was very poor and below the local legislation requirements. To solve the problem, we made a viability study to identify if it would be better to build a new WWTP or to connect the airport directly to the municipality treatment facility and was finally decided to built and operate a new WWTP.

VINCI Airports has a Global Environmental Policy, named AIRPact, and one of its commitments is to reduce 50% of the group water consumption, this was another great motivation for us to implement this project.

During the WWTP project development, we studied an alternative possibility: instead of just treating the effluent, we could also reuse this treated water to the toilets of the airport. This would result at a 37% reduction of the quantity of potable water consumed and also we would be in alignment with AIRPact targets.

Another very important social aspect of this WWTP installation and operation, is that there is no organic charge or contaminants contribution in the hydrological system around the airport, all the effluent is kept in a close system. In addition, there was the employment of new people, improving other social indicators.

Step 6: Did you engage with internal and external stakeholders? If so, please identify which stakeholders you engaged with.

During this project there was a huge engagement with the Environmental Agency from Bahia (INEMA), which is responsible for the environmental permits in the state and also with the Brazilian Health Agency (ANVISA), that is responsible for health legislation in ports and airports in Brazil.

Step 7: Which department oversees the water management development in your organization?

At Salvador Bahia Airport, the Environmental Department is responsible for the water management in partnership with the maintenance team.

Step 8: Please insert Text and Images of your project/case study below here:

Decision-Making Process:

During the decision-making process, we have looked for a solution that could solve the environmental issue existing before we take over the concession and that could reduce our potable water consumption and OPEX during the operation. During this process we decided to do not treat effluent but to be a water reuse supplier to the airport, being the first Zero Effluent Discharge Airport in Brazil and reducing the airport potable water consumption in 37%. For this calculation, we are already considering the new Salvador Bahia Airport scenario, with a new pier construction with air conditioning system.

Estimated Cost and Financial mechanisms available:

- Investment for a traditional WWTP (civil, pipes, WWTP): EUR 1 012 489. No pay back.
- Investment for a high-efficiency WWTP with water reuse technology (civil, pipes, WWTP, laboratory for analysis): EUR 1 585 182. Pay back in 3,5 years
- OPEX (technicians, leader, chemicals, reagents, lab kits): EUR 60.000/ year
- Saving: EUR 480.000/ year

Images:

Treated effluent/ reuse water

Comparison between the treated water and the effluent

Salvador Bahia Airport WWTP

Treatment at the MBR tank

Infographic installed to explain the operation flow in site visits

Analysis at the WWTP internal laboratory

Treated water

Results (Environmental Benefit/Cost Benefit):

- First Zero Effluent Discharge Airport in Brazil
- 37% potable water reduction
- Savings with potable water: EUR 480.000/ year (this value depends on the potable water costs at the region and on the airport effluent generation. This calculation was made on an hypothesis of an effluent generation flow around 250m3/ day)
- Increase of 5 people at the environmental team (1 WWTP leader and 4 technicians)
- No water contamination risk in the surroundings around the airport (rivers)
- Water consumption reduction – Preservation of water resources & reduction of the airport’s environmental impact
- Modern, compact, high-technology and automatized WWTP
- Environmental reference in the region, receiving schools, Universities and community visits to spread the initiative and to raise awareness about the environmental conservation importance.

Lessons Learned:

This choice of investment changes the conception about effluent treatment: once the airport stops treating it as a problem and starts to see it as an opportunity for water supply, giving extra value to it.

Many positive impacts resulted from this project: environmental indicators and risks, cost and water consumption reduction, environmental team expansion, positive image and reference for universities and schools' site visit.

Water management at airports

ICAO Eco-Airport Toolkit

Form

Step 1: Please provide your contact details in case further information is needed.

	Respondent
Name	Susana Gallart
Organization/Company	Aena SME SA
Job Title	Department of Sustainable Projects
Email Address	srgallart@aena.es
Telephone	+34671728230
Airport (Name and 3 Letter Code)	Alicante-Elche Airport (ALC)

Step 2: Please provide the following basic information of your Project/Case Study:

Project/Case Study Title: Regenerated water plant in Alicante-Elche Airport

Timeframe (e.g., start and end month/year if applicable): December 2019-ongoing

Description:

The equipment for reuse of second-use water consists of a water withdrawal network that uses the water from the Terminal's restrooms, the condensed water from the air conditioning units and the reject water from the cooling towers. All this water goes through a storage system and then through a disinfection and filtering treatment system. Once the water is suitable for use, it passes to a second use tank, where water is accumulated exclusively for flush valves. In addition, the airport has a centralized osmotic water plant for the supply of the entire Terminal building. Instead of losing the rejection water by sending this to sanitation, a centralized system recovers all the rejection water and stores it into a second-use deposit. This way, the airport accumulates two types of water and these go to a treated second-use return network.

Purpose:

The objective of the project is the reuse of water obtained from the terminal's restrooms, the air conditioning condensates, and the rejection of the osmosis plant, giving them a second use in the 350 terminal's flush valves at the restrooms and reducing the water consumption.

Step 3: Please identify which water management technologies are used at your airport:

(x) Filtration

( ) Nanotechnology

( ) Sedimentation

(x) Sewage treatment

( ) Bioreactor

(x) Other

Which one?

Disinfection and filtering treatment

Step 4: Please identify and prioritize the driver(s) for the water management project. Number 1-6, where 1 is a high priority and 6 is a low priority.

(2) Economic

(1) Environmental

(4) Political

(3) Social

( ) None

(5) Other

Which one?

Efficiency

Step 5: Please give more details on the driver(s) chosen in the previous question. For instance, was there any available incentives for the development of such programs? Can you describe it?

In the province of Alicante and in general, in the Levante area of Spain, rains are infrequent, which is leading to this area of the coast to water impoverishment, the consequences of which range from supply cuts in homes to desertification.

Alicante-Elche Airport is aware of the need to make responsible use of this valuable resource in its facilities. Therefore, to ensure efficient water supply to over 15 million passengers who visited the airport last year, as well as to employees and other users, it has implemented an innovative system, pioneering among Spanish airports, whose objective is to reuse reject water from various processes to improve management efficiency.

Step 6: Did you engage with internal and external stakeholders? If so, please identify which stakeholders you engaged with.

Yes, the airport engaged with the on-site restaurants to centralize the osmosis system and they are assuming a part of the production costs.

Step 7: Which department oversees the water management development in your organization?

The Engineering and Maintenance Department of the airport is in charge of water management. At the corporate level, the Environmental Management Division of Aena is working on a Strategic Water Plan for the 46 airports of the net.

Step 8: Please insert Text and Images of your project/case study below here:

Decision-Making Process: We identified all the water sources used at the airport and all the possible destinations. Among these sources, there are showers, restaurants, rainfall, etc. The possible destinations are WC´s, irrigation, and cooling towers. We chose the source-destination that better took advantage of the current facilities and complied with the water re-use regulations. We also took into consideration which of them could amortize the investment in a reasonable time.

Estimated Cost and Financial mechanisms available: 843,000 €

Images:

Results (Environmental Benefit/Cost Benefit):

The airport obtains 1,700 m3 per month of second-use water and 400 m^3/month of rejection water from its osmosis plant. This allows 15% of consumption water saving at Alicante-Elche Airport, which is equivalent to the total volume of seven Olympic swimming pools every year.

Moreover, this system has a lower electricity consumption rate to produce one m3 of regenerated water if compared to other systems like desalination plants, which are frequently used in the area and cause other environmental problems.

Lessons Learned: Measurements are required to know how a facility works. Estimations are useful when there is no real data to work with, but once a facility is running, measuring how it is performing is critical, as sometimes estimations are too far from reality and can lead to wrong decisions.

It was also important to analyze what was on the market and try to apply it, better than starting from zero. Our questions to water re-use associations were key in the application of some techniques.

Water management at airports

ICAO Eco-Airport Toolkit

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Step 1: Please provide your contact details in case further information is needed.

	Respondent
Name	Lyne Michaud
Organization/Company	Aéroports de Montréal
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Email Address	Lyne.michaud@admtl.com
Telephone	514-346-7932
Airport (Name and 3 Letter Code)	YUL

Step 2: Please provide the following basic information of your Project/Case Study:

Project/Case Study Title: DE-ICING FLUID RECOVERY AND REUSE FACILITY

Timeframe (e.g., start and end month/year if applicable):

October 2014 : the New glycol recycling centre opened

Description:

Ethylene glycol recovery, recertification and reuse facility at Montréal-Trudeau International Airport's de-icing centre that has significantly reduced the airport's environmental record while reducing de-icing charges for airlines.

Representing a $10 million investment, the facility uses a sophisticated process to concentrate ethylene glycol employed in aircraft de-icing operations and restore it to at least 99.5% purity for reuse. This process is considered a world first. ADM contributed $7.1 million to the construction of the facility while Aéro Mag invested $2.9 million.

At the new ethylene glycol recycling facility, collected de-icing fluid is brought to a 50-50 concentration in a first phase, and then to a purity of 99.5% through the use of high-technology distillation tower supplied by Vilokan Sweden AB. Once it has been recertified for quality assurance, the glycol can then be used again for de-icing aircraft. All water generated by the process is filtered and reused.

Purpose:

Enhance efficiencies at our de-icing operations while reducing the use of potable water by 2 million litres a year. It will also help to lower ethylene glycol costs by up to 30% for our airline customers during the winter months."

Step 3: Please identify which water management technologies are used at your airport:

( ) Filtration

( ) Nanotechnology

( ) Sedimentation

( ) Sewage treatment

( ) Bioreactor

(X) Other : Distillation

Step 4: Please identify and prioritize the driver(s) for the water management project. Number 1-6, where 1 is a high priority and 6 is a low priority.

(1) Environmental

(2) Economic

(3) Social

(4) Political

( ) None

( ) Other

Step 5: Please give more details on the driver(s) chosen in the previous question. For instance, was there any available incentives for the development of such programs? Can you describe it?

- Integrated life-cycle management approach: the product does not become waste but is treated and re-used.
- Significant de-icing cost reductions of up to 30% for air carriers operating out of Montréal–Trudeau.
- Pressureion from the local municipality to reduce the amount of glycol disposed to the sewer system

Step 6: Did you engage with internal and external stakeholders? If so, please identify which stakeholders you engaged with.

City of Montreal and boroughs

AéroMag 2000

NavCanada

Airline's company (YUL's carriers)

Step 7: Which department oversees the water management development in your organization?

Sustainability and Environment

Step 8: Please insert Text and Images of your project/case study below here:

Decision-Making Process:

Estimated Cost and Financial mechanisms available:

$10-million project investment, broken down as follows:

- ADM contribution: $7.1 million
- Funding from Aéro MAG: $2.9 million

Results (Environmental Benefit/Cost Benefit):

- Integrated life-cycle management approach: the product does not become waste but is treated and re-used.
    - Becomes a prime material in the de-icing process.
- Amount of drinkable water required for aircraft de-icing is reduced by 2 million litres annually.
    - The water used to dilute the glycol to the concentration required for de-icing is also recovered during the concentration and distillation process, and re-used to dilute the glycol once again for de-icing.
- Heat generated by the recycling equipment is recovered to heat the building.
- Substantial reduction in discharge of glycol into the sanitary sewer system
- De-icing products are available at a cost approximately 30% below market price.

Lessons Learned:

Over the years we've found that Glycol Recovery management is key to ensure a stable and maximized production treatment rate. Since the recovered glycol varies in concentration, we were able to find an optimal concentration range in order to maximize the treatment of recovered glycol.

An optimized treatment rate equals a bigger storage capacity, thus lessening discharge to the sewer system.

The energy (heat) and by products (distillate) of the treatment process can be reused to other ends (i.e. heating of the building, using distillate to mix in de-icing trucks.)

With the ever-changing climate, recovered glycol varies from one year to the next, modifications to the initial installation were performed, in agreement with our partnership, so that the equipment is better equipped to cope with the variances of recovered glycol.

A close monitoring of the equipment paralleled with a preventive maintenance program, assures us of good treatment rate as well as less downtime.

With the growing concerns for the environment as well as the economic challenges faced by the industry, glycol treatment and recovery is the way of the future.

Images and Process :

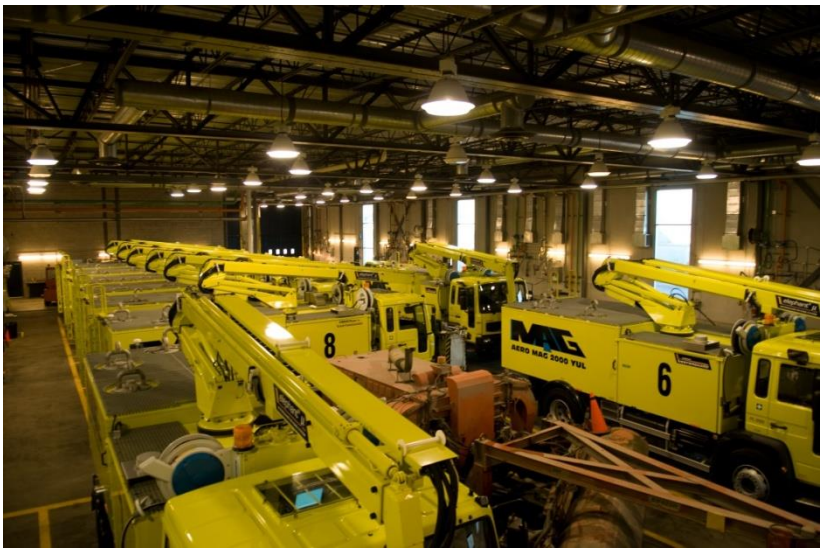
Step 1
Tank rooms.
Glycol recovered from the de-icing apron flows into these storage tanks.

Step 2
Glycol is transferred to holding/buffer tanks for the start of the recycling process.
Process: Separation of water and particles. Glycol concentration is increased to 50–55%.

Step 3
Distillation tower
Glycol concentration is increased by distillation to 99.5%.

Step 4 – Quality-control tanks.

Step 5
The large white tank at left receives distilled product awaiting re-certification.



Step 6
Recycled, re-certified glycol is pumped into trucks to be re-used.

Step 7
Aircraft de-icing.

Water management at airports

ICAO Eco-Airport Toolkit

Form

Step 1: Please provide your contact details in case further information is needed.

	Respondent
Name	Mr Florent de Warren
Organization/Company	Cambodia Airports
Job Title	QHSE Manager
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Telephone	+855 78 777 822
Airport (Name and 3 Letter Code)	PNH, REP, KOS

Step 2: Please provide the following basic information of your Project/Case Study

Project/Case Study Title: Waste Water Treatment Plant

Timeframe (e.g., start and end month/year if applicable): inaugurated end of 2016

Description: construction of 2 Waste water treatment plants for the airports of REP and PNH in 2017

Purpose: to treat all wastewater coming from airport facilities and blue water from aircrafts internally and avoid using the city's wastewater drainage system

Step 3: Please identify which water management technologies are used at your airport:

( ) Filtration

( ) Nanotechnology

( ) Sedimentation

(*) Sewage treatment

( ) Bioreactor

( ) Other

Which one?

Step 4: Please identify and prioritize the driver(s) for the water management project. Number 1-6, where 1 is a high priority and 6 is a low priority.

( ) Economic

(*) Environmental

( ) Political

( ) Social

( ) None

( ) Other

Which one?

Step 5: Please give more details on the driver(s) chosen in the previous question. For instance, was there any available incentives for the development of such programs? Can you describe it?

The city wastewater facilities are not able to cope with the city's demand. For the airport to offer its own solution was a way to avoid overcharging the already busy city.

Step 6: Did you engage with internal and external stakeholders? If so, please identify which stakeholders you engaged with.

The investment decision was made at the same time of the major terminal extension. The Civil Aviation of Cambodia supported both projects since such private owned WWTP would be unique in Cambodia.

Step 7: Which department oversees the water management development in your organization?

The Maintenance department is in charge of the operation and maintenance of the WWTP while the technical department is in charge of the master plan and the development of the facility (when the traffic will require such an adjustment)

Step 8: Please insert Text and Images of your project/case study below here:

Decision-Making Process: Both airports are under a concession agreement. Cambodia Airports is responsible to operate, maintain, and develop the infrastructures. Projects are presented to the Civil Aviation Authority for review and approval.

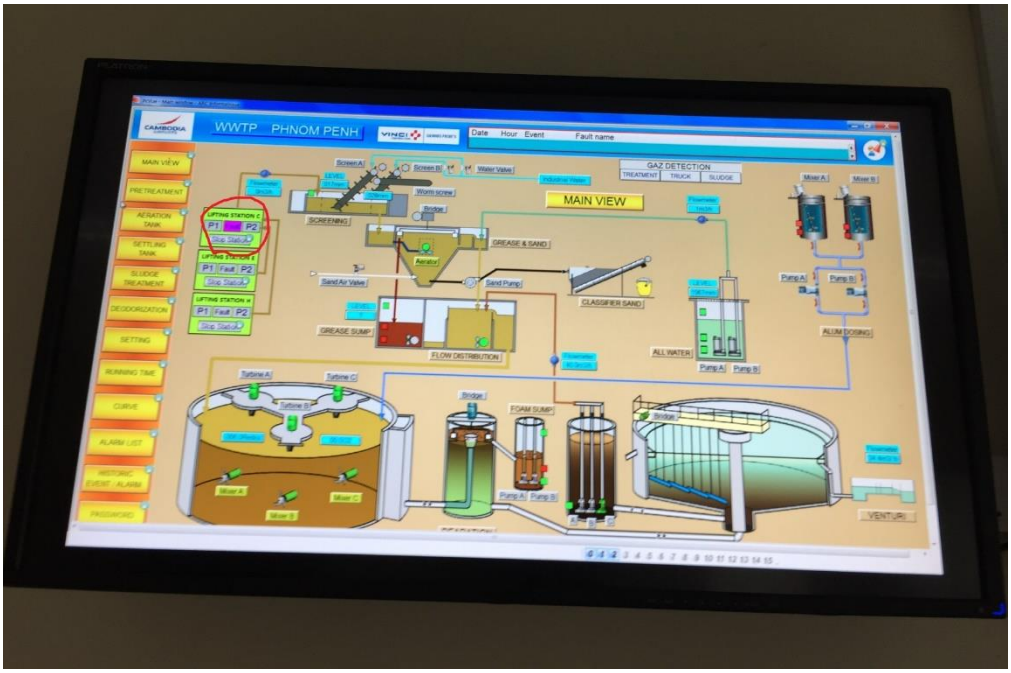
Estimated Cost and Financial mechanisms available: USD 4.2 millions (PNH) and 3.28 millions (REP) self financed by the concession.

Images:

Above, the WWTP of Phnom Penh International Airport

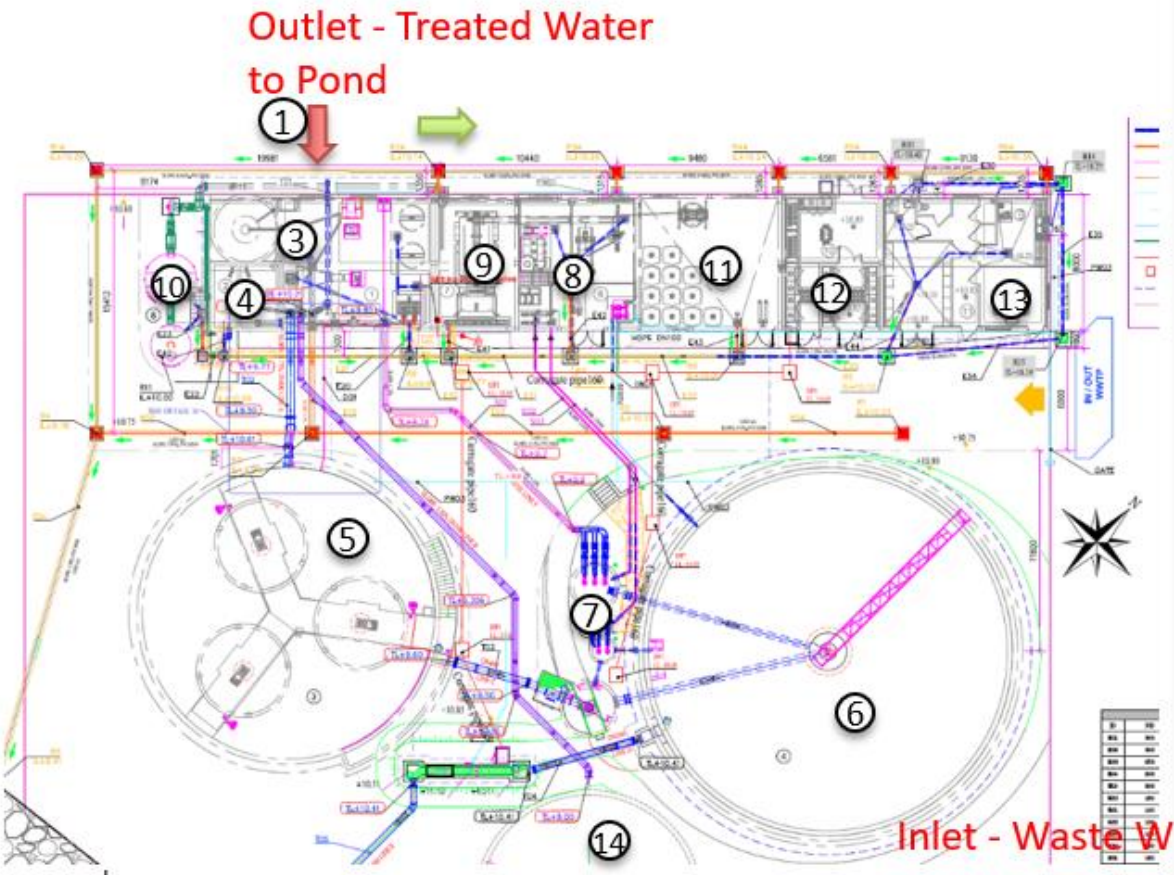
Above, the WWTP of Siem Reap International Airport

Above: the WWTP is often visited by students as part of the environment awareness program of our CSR policy.



Daily monitoring of key parameters

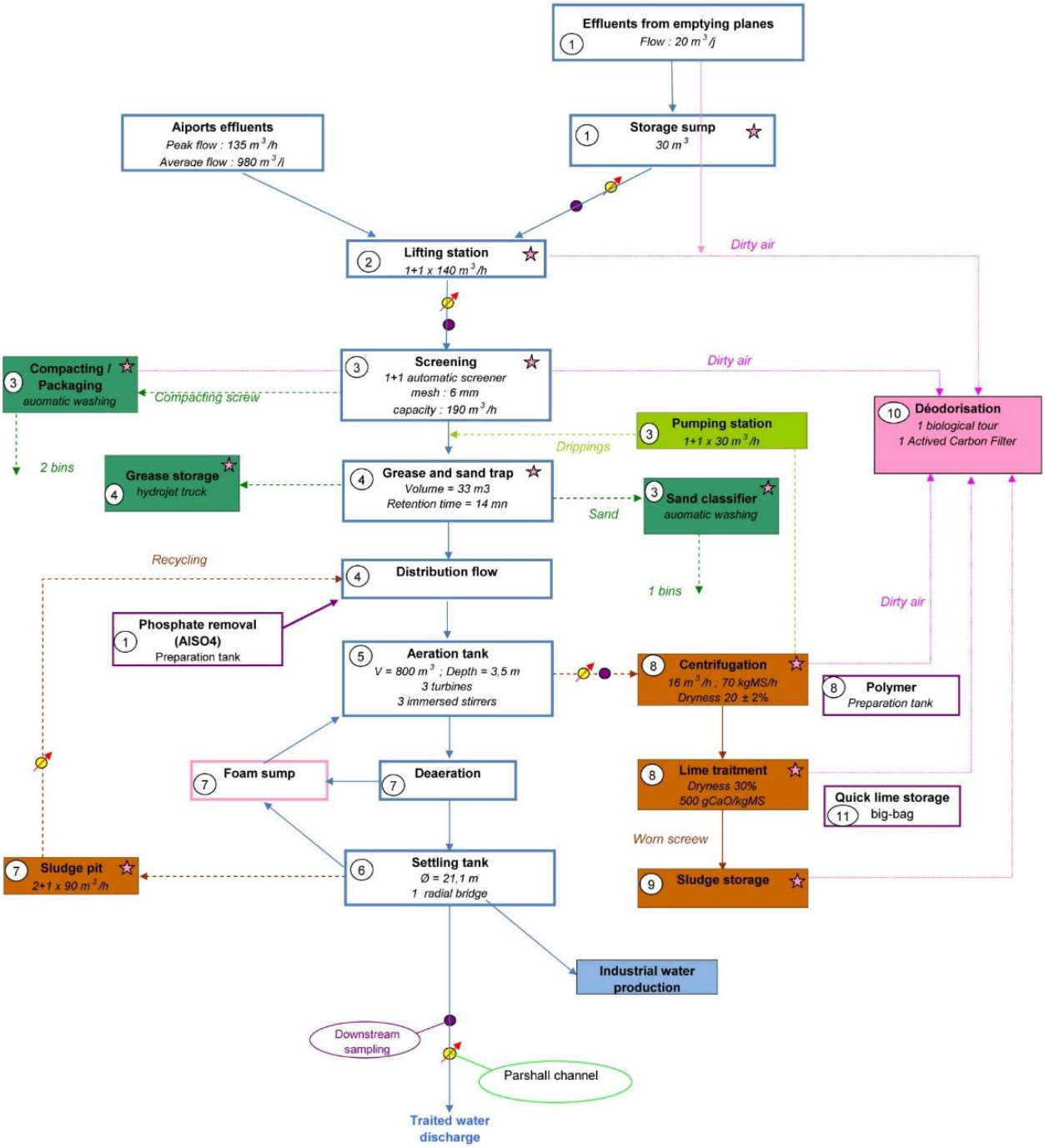
FLOW DIAGRAM



Legend :

1-Effluents from airport and emptying planes
2-Emptying Tank - Lifting station
3-Pretreatments Room
4-Grease and Sand Trap/Flow Distribution
5-Aeration Tank
6-Settling Tank
7-Secondary Pits (sludge pit, deaeration, foam sump)
8-Sludge Treatment
9-Sludge Storage
10-Odour Removal Unit
11-Chemical Room
12-Electric Room
13-Facilities
14-Aeration Tank Extension (long term)

Main sewer line
Site drainage / overflow line
Chemical dosing lines
Sludge extraction & recirculation lines
Drinking water lines
Frost resistant hose connection
Industrial water lines
Odour treatment lines
Electicity
Draw pit
Earth circuit
Fence



Results (Environmental Benefit/Cost Benefit): The environmental benefit is the most important with water tests showing excellent results. The Ministry of Environment is please with such initiative as it reduces the pressure on the city infrastructure. Yet such an investment is not available for everyone.

Lessons Learned: The model used for REP and PNH is not easy to optimize/extend with traffic variations. A different proposal is being studied for KOS airport (traffic 1.4 million before Coronavirus).

Water management at airports

ICAO Eco-Airport Toolkit

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Step 1: Please provide your contact details in case further information is needed.

	Respondent
Name	Marisa Olim
Organization/Company	ANA
Job Title	Expert technician II
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Telephone	218413500 ext. 21082
Airport (Name and 3 Letter Code)	Lisbon Airport - ALS

Step 2: Please provide the following basic information of your Project/Case Study:

Project/Case Study Title: Reuse of water from firefighter´s vehicle tests

Timeframe (e.g., start and end month/year if applicable): 2016

Description: Reuse of water from firefighter´s vehicle tests

Purpose: Reuse of water instead of using mains water

Step 3: Please identify which water management technologies are used at your airport:

( ) Filtration

( ) Nanotechnology

( ) Sedimentation

( ) Sewage treatment

( ) Bioreactor

(X) Other

Which one? For this case, in order to reuse the water, a class 1 hydrocarbon separator, with a built-in 4000 liter decanter and a storage capacity of 1350 liters of separate oils.

Step 4: Please identify and prioritize the driver(s) for the water management project. Number 1-6, where 1 is a high priority and 6 is a low priority.

(2) Economic

(1) Environmental

(5) Political

(3) Social

( ) None

(4) Other

Which one? Environmental awareness of airport employees.

Step 5: Please give more details on the driver(s) chosen in the previous question. For instance, was there any available incentives for the development of such programs? Can you describe it?

This project had as main objective the reduction of the water consumption of tap treated water for activities that do not require it and had the financial support of the Airport Directorate for this purpose. Communicating its implementation, also raise awareness of the rationalization of water consumption in the Airport.

Step 6: Did you engage with internal and external stakeholders? If so, please identify which stakeholders you engaged with.

No, there was no engage with external stakeholders, only one contractor involved in the contract.

Step 7: Which department oversees the water management development in your organization?

Environmental area, that belongs to the Maintenance department.

Step 8: Please insert Text and Images of your project/case study below here:

Decision-Making Process: Airport Direction

Estimated Cost and Financial mechanisms available: 51.076,76 €

Images:

Results (Environmental Benefit/Cost Benefit): Reuse of water with the necessary quality for the activity, as well as rainwater collection and reuse/ saving euros.

Lessons Learned: All airport activities that we know that, in the long run, will always consume a lot of water, should be subject to analysis and investment in projects that rationalize this consumption.

Water management at airports

ICAO Eco-Airport Toolkit

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Step 1: Please provide your contact details in case further information is needed.

	Respondent
Name	- Rula Dawood - Ghayth Azar
Organization/Company	Airport International Group
Job Title	- Manager, Environment, health and Safety - Airside Utilities Maintenance Manager
Email Address	- Rula.dawood@aig.aero - Ghayth.Azar@AIG. aero
Telephone	- 00962797115263 - 00962797115221
Airport (Name and 3 Letter Code)	

Step 2: Please provide the following basic information of your Project/Case Study:

Project/Case Study Title: Wastewater treatment plant

Timeframe (e.g., start and end month/year if applicable): 1985- rehabilitation in 2012

Description:

Purpose:

Step 3: Please identify which water management technologies are used at your airport:

( ) Filtration

( ) Nanotechnology

( ) Sedimentation

(X) Sewage treatment

( ) Bioreactor

( ) Other

Step 4: Please identify and prioritize the driver(s) for the water management project. Number 1-6, where 1 is a high priority and 6 is a low priority.

(X) Economic

(X) Environmental

( ) Political

( ) Social

( ) None

( ) Other

Step 5: Please give more details on the driver(s) chosen in the previous question. For instance, was there any available incentives for the development of such programs? Can you describe it?

On national level, Water in Jordan consider one of major challenges due to the limited water resources, the increase of the demand on fresh water due to increase of population and the developing style of life are putting additional pressure on already scarce resources, add to the impact of climate change related to reduced rainfall levels leading to decreased recharge of surface water and groundwater reserves. In the long term, this impact will extend to cause serious soil degradation, due to the fact that QAIA is the only International Airport at Jordan, AIG has significant roles, to implement an Environment sustainable development management system to be aligned with national strategy and focus on secure the water resources at airport at same time reduce the emission generated from airport operation and enhance the green area insider the airport.

There are no incentives from the government, still AIG management set the environmental management as a strategic objective to demonstrate that it is a national and regional leader in the environmental management.

Fromother side, to purchase water from external sources is consider one of financial challenges, due to the expenses related to water purchase process.

Accordingly, the Waste Water Treatment Plant (WWTP) establish since 1983 to collect/treat the waste water generated from airport activities and utilize to irrigate the green area inside airport.

In 2012, AIG rehabilitated the WWTP to enhance the quality of treated waste water and increase the areas irrigated with treated waste water, currently in summer season, 97% of treated waste water is utilized to irrigate the airport's landscaped and green areas.

Step 6: Did you engage with internal and external stakeholders? If so, please identify which stakeholders you engaged with.

The WWTP was designed to treat the domestic waste water, some stakeholders discharge industrial waste water in the sewer network, which is affecting the treatment process in WWTP, thus AIG is working closely with airport stockholders to have better action to collect and treat the industrial wastewater generated from their activities prior discharge to airport sewer network; and

Encourage the stakeholders to stop using the potable water in irrigation system and use the treated wastewater

Step 7: Which department oversees the water management development in your organization?

Reducing the water consumption at airport is the responsibility of every one, each of the airport staff and concessionaires playing significant rules in water management as below:

- Chief Executive Offices: Approve the water saving strategy for the company
- Human Resources Department: Focus on staff training and awareness to change staff behaviour, and reduce consumptions
- E&M Division - Airside Utilities Maintenance Department: responsible to operate/maintain/monitor the potable water and fire fighting water networks, provide the water to QAIA premises, identify and implement the water management strategies and saving strategies, execute the projects related to water management, operate and maintain the irrigation water, and operate /maintain the wastewater treatment plant/network,
- Commercial Department: focus on concessionaires and investors to ensure from follow the water saving techniques within their activities
- Environment, health and Safety Department: Conduct water saving studies and monitor the implement water saving actions plan & water quality at airport

Step 8: Please insert Text and Images of your project/case study below here:

Queen Alia International Airport WWTP was designed for an average flow of (1,889 m3/d) and a BOD5 load of (755 kg/d), and a BOD5 inlet concentration of (400 mg/L)1. Wastewater is pumped to the inlet channel in which it is screened using a manual screen and then passes to three oil separator tanks before going to an equalization tank. Biological treatment based on activated sludge extended aeration technology takes place in two aeration tanks working in parallel, followed by secondary clarifiers. Reclaimed water is then disinfected by adding chlorine before being discharged to two irrigation tanks. The effluent is currently used for irrigating the green areas within the premises of the airport

The average efficiency of the WWTP in removing BOD5, COD and TSS reach to 96% which is indicate that the treatment & operation process at WWTP are in excellent level

Decision-Making Process: As mentioned before, due to the water limited resource, and cost issue, AIG is focusing to maintain the WWTP in good operational condition , and encourage/support the idea of using the treated waste water in irrigation purpose to the farmers located around airport.

Estimated Cost and Financial mechanisms available: the cost related to operate and maintain the WWTP is around the cost it was divided between three category :

1. Maintenance and operation material around 50,000
2. Electrical fees 70,000
3. Man power fees 100,000 JOD

Images:

Results (Environmental Benefit/Cost Benefit):

35% of water consumption is considered as wastewater and treated at WWTP, 77% of received wastewater utilize in irrigation purpose, if no waste water treatment plant, then the water consumptions will increase to utilize in irrigation the green area, the estimate cost of I cubic meter of water pumping and treatment around 1.24JD/m3.

In 2019, total amount of received wastewater is 183924m3, total treated waste utilizes in irrigation =140885m3.

If no wastewater treatment plant at airport, will assume that the 140884m3 utilize in irrigation is potable water, the cost related to water pump/treat=1.24JD/m3 which will cost AIG annually around 174,696JD

Lessons Learned:

Utilizing treated wastewater in irrigation purpose is considered one of major actions identified in the national water strategy, the challenges we face is mainly related to the culture and cost related to provide the network OR transport the treated wastewater to the farmers.

AIG is considering the possibility to support the farmers around the airport to transport the treated wastewater that over airport needs to the farmers around the airport and organize several awareness session to enhance the level of understanding at the farmers on the benefit from using the treated waste water

-- END --