RISING EXPECTATIONS – SEA LEVEL RISE EFFECTS ON THE STORMWATER SYSTEM AT AUCKLAND INTERNATIONAL AIRPORT

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ABSTRACT

Human-induced or not, climate change is inevitable and the latest predictions point toward rapid change within this century (IPCC, 2013). Auckland Council recommend that a temperature increase of 2.1°C by 2090 and sea level rise (SLR) of 1 m are considered for design and risk assessments (based on Ministry for the Environment guidelines). In their most recent assessment, the Intergovernmental Panel on Climate Change (IPCC) found the projected global mean temperature rise by 2100 is expected to exceed 1.5°C in all cases, bringing with it SLR in the order of 1 m (IPCC, 2013). Decision-makers, along with engineers and planners must therefore act to ensure climate change risks are mitigated before costly effects occur.

This abstract mainly addresses one predicted effect of climate change: SLR, but also considers the effect of increased storm frequency and intensity. These effects are expected to occur as global temperatures increase, ice reserves melt and storm energy increases. The case study presented is an assessment of Auckland Airport's stormwater system capacity and potential flooding during future SLR and climate change rainfall scenarios. This work informs practical steps and solutions to increase resilience in the Airport's stormwater system and addresses any identified future issues.

Background

Auckland International Airport Limited is New Zealand's largest international airport and borders the Manukau Harbour, south-west of Auckland City. The current airport consists of one main runway which services international and domestic terminals, along with a number of airport related facilities. The stormwater system is managed by Auckland Airport and stormwater treatment is mostly provided by six stormwater ponds/wetlands before discharging into the harbour at the airport perimeter.

In a 2016 study for Auckland Airport, NIWA found that large areas of the existing runway would be inundated in an event comprising of 1 metre SLR combined with a 1% AEP (annual exceedance probability) storm surge. This would obviously severely disrupt airport operations as it would become unsafe for normal aircraft operation. However, there is another consequence which must be considered: How will the Airport's stormwater system cope during these changing conditions, particularly near key building and transport infrastructure?

In 2013, Auckland Airport engaged URS Ltd for flood hazard modelling of the main airport operations area. This 2D flood model indicated only minor surface flooding would occur in the 10% AEP rainfall event (excluding climate change), as the stormwater system generally has capacity for the peak flows during this event. However, URS found there

would be a number of ponding and overland flow locations during the 1% AEP event (excluding climate change). The key assets highlighted as 'at risk' during the 1% AEP event were the international terminal, and George Bolt Memorial Drive - the main public road access to the domestic terminal.

Modelling Methods & Assumptions

PDP were engaged by Auckland Airport to undertake a preliminary risk assessment for the effects of SLR on the performance on the existing stormwater network. This was to be a targeted risk assessment for catchments identified with critical infrastructure and/or existing flooding (based on 2013 URS flood modelling). Each catchment had a single pipe outlet to a stormwater device or the harbour, allowing tailwater effects to be modelled. One dimensional pipe flow equations were used in combination with pipe and ground level data to determine the hydraulic grades. The scenarios modelled were the 10% and 1% AEP storm events (with climate change considerations) with 0.5 m and 1 m SLR. The climate change considerations were informed by:

- NIWA 2016 modelling which used 0.5 m and 1 m SLR scenarios (NIWA also used a 1.5 m SLR scenario). 1 m SLR was predicted to potentially occur as early as the year 2115.

- *Climate Change Effects and Impact Assessment: A Guidance Manual for Local Government* in New Zealand (Ministry for the Environment, 2008), using a temperature increase of 2.1°C by 2090. This is recommended for use in Auckland Council's *Stormwater Code of Practice* (2015).

The sensitivity of a modelled stormwater line to SLR effects was assessed based on the spillway crest level of the corresponding stormwater treatment pond. The tailwater level used for a given modelling scenario was the maximum of either sea level (with 1% AEP storm surge), or the level of flow over the spillway (either 10% or 1% AEP flow). The spillway levels used were based on as-built information provided by Auckland Airport. It was assumed that saltwater intrusion at levels below the spillway level was negligible as the majority of ponds were equipped with backflow prevention valves for their service outlets.

Where the pipe capacity was calculated to be exceeded, the surcharge was modelled as overland flow, using ground level information and open channel flow calculations. Modelling did not take into account overland flows between catchments which are expected to occur during large storm events.

Results

It was found that parts of the stormwater network were immediately affected by any SLR. These were pipes where the outlet inverts were at or below the current 1% AEP storm surge level. This was the case in many low-lying runway areas. All parts of the stormwater network modelled in the assessment were affected by a SLR of only 0.5 m.

The scenario of 1 m SLR with 1% AEP storm surge was found to considerably reduce the capacity of Auckland Airport's stormwater system. Areas which have existing drainage issues are likely to become large ponding and overland flow areas. Increases in overland flow due to 1 m SLR were generally found to be in the order of 0.5 – 1 m^3/s. However, overland flow between catchments was not included in this.

While the majority of ponding and overland flow is predicted to occur on roads, some buildings were identified as being at an increased risk of flooding due to SLR. Auckland

Airport's International Terminal is within an overland flow path which is currently managed by the existing stormwater network. However, it is predicted there will be future capacity issues for this stormwater line due to SLR. A ponding level increase of approximately 0.2 m was modelled in the 1 m SLR scenario although this is subject to confirmation of the overland flow path characteristics. To address future capacity issues in this area, Auckland Airport is proposing to divert the upper catchment flow through a new stormwater line and treatment device to the west.

Future Design Implications

As a result of this work, further investigation and modelling is being undertaken by Auckland Airport. There are other preventative actions also being considered:

- Verify overland flow paths at Auckland Airport with field investigation, assessing flood risk to nearby buildings and confirming overland flow catchment areas.
- Run the URS 2D flood model with climate change scenarios.
- Monitor water levels and salt water intrusion at key locations which are predicted to be first affected by SLR.
- Implement climate change design considerations when designing new stormwater infrastructure or new connections to the existing network.
- Include climate change wind effects in future modelling.

SLR effects on Auckland Airport's stormwater network are twofold: SLR reduces the hydraulic capacity of the stormwater system during peak flood events, whilst also affecting the treatment performance of ponds and wetlands. Saltwater intrusion into wetlands will affect what vegetation will be suitable for wetland marsh areas. This could be pre-empted by planting salt tolerant species such as Oioi (jointed wire rush).

Increasing the spillway levels of a stormwater device would reduce the likelihood of future saltwater intrusion. This may be advisable for salt sensitive treatment devices such as wetlands. However, caution must be taken. Increasing the spillway level will negatively affect the hydraulic performance of the stormwater network during extreme rainfall events. Therefore, it would be recommended that new stormwater devices are constructed with a permanent water level above the 1 m SLR and 1% AEP storm surge level.

The presentation for this topic will focus on modelling climate change effects on existing stormwater systems. The presenter will explain the modelling process and results which are summarised in this abstract. The presentation will also look at the specific implications of SLR for stormwater management at Auckland International Airport and how resilience is being incorporated in future design and construction at the Airport. The concepts discussed in the presentation are expected to apply to any stormwater project, particularly where stormwater systems discharge to the sea.

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KEYWORDS

Stormwater, treatment, climate change, sea level rise, flooding, infrastructure, resilience