

New Dunedin Hospital – Outpatients Building

Flooding and Liquefaction Issues

A short review – W R Howie – 29 June 2022

1. Judge Newhook has asked me to consider the application documents, comments received and the applicant's response in so far as they refer to flooding at the site, to flood effects nearby from the development and to possible liquefaction from an earthquake. This review is limited to some of the more major issues presented by the location of the project in the most flood prone area in the CBD.
2. The applicant has evaluated the extent of flooding at the site from overflows from the Leith, from stormwater from the local catchment and from storm surge and sea level rise.
3. For each source of flood water, flood events with return periods of 10 years (10% probability), 100 years (1% probability) and 500 years (0.2% probability) have been evaluated and flood levels at the site estimated.
4. Coincident timing of the flood waters from the three sources has been assumed and flood levels estimated accordingly. Jacobs NZ Ltd, the consultant that analysed the flooding issues, observed that this coincident timing of the flood water sources is a conservative assumption and I agree.
5. Flooding from all three sources may well arise from a single storm and peak flooding from each source may coincide. But they are variables that make the probability of the assumed combined flood effects considerably less. For example, if the land-based flooding is considered an event independent from the storm surge flooding from the sea, then for the 10-year event the combined coincident flood probability is 1% or once in 100 years. The actual probability of the flooding events analysed will be considerably less than the probabilities 10%, 1% and 0.2% assumed.
6. A more thorough analysis of the probability of flooding from coincident flood events from the Leith, the local catchment, storm surge and sea level rise might refine these probabilities down and give greater assurance of the acceptability of the flooding threat to the hospital.
7. Peak flood level at the site from the rare 500+ year flood has been estimated at 103.32m OMD. With an appropriate freeboard of 500mm the floor level of the building has been set at 103.82m OMD. This is some 1.8 – 2.0m above the existing surrounding streets. The building will effectively sit on a plinth and will necessitate stairs and ramps to the entrance level.
8. The hydrological and hydraulic analysis has been comprehensive and thorough. No comments have been received that question this. Stantec, another consulting firm, has reviewed the analysis and Jacobs has adopted significant increases in design rainfall, sea level rise and coincident tide peaks. Analysis of multiple sources of flood water from very rare events in a built environment is tricky. The results will have a level of accuracy that would not allow the distinguishing of effects from a +/-50mm difference in flood level.
9. Restricted access to the building due to flooding will occur for floods greater than the 10+ year event and for the rare 500+ year flood event the building would not be able

to be used, although with a floor level above the flood level no internal damage would be expected and use of the building could be resumed once the flooding had eased. A condition should require there to be an emergency plan for various flood events, not just the 500 +year event. Flooding in the neighbouring streets in the 500+ year event would be of the order of 1.5 m.

10. Whether access to the building and its services is adequate could be challenged but ultimately it is a risk for the applicant to assess. Normal public access to the building will be curtailed during 10-year return interval flood events and greater. No estimate of the duration of flooding is given. Similar flood impacts can be expected for the Inpatients Building, which houses the Emergency Department, and the Logistics Building.
11. The site is in the more floodable parts of the CBD. It is low lying and drainage is inhibited by the overflow levels into the harbour, as shown in figure 5 of the Jacobs report. A lower overflow level into the harbour would significantly reduce the flood vulnerability at the Outpatients Building. Whether or not the overflow level to the harbour can be reduced is not clear but it may be an option to reduce the susceptibility of the hospital to flooding.
12. The effect on flood levels beyond the site, of filling around the Outpatients Building for landscaping and access, amounts to less than 20mm in the 500+ year event. For lesser floods the effect is greater and up to 90mm on the site boundary in Cumberland Street for the 10+ year event. The volume of filling is 1658m³ and is a smaller proportion of the flood water volume in the large flood than in a smaller flood. Hence the greater effect on flood levels in the smaller flood.
13. The applicant says the increase in flood levels due to the filling around the Outpatients Building may increase the cost of flood damages to other nearby buildings but the increase in flood water depth is small relative to existing flood depths and so the increase in damage will be minor.
14. In respect to the New World site, the existing flood levels can be deduced from figures 6, 7 and 8 of the Jacobs report. They seem to be up to 300mm for the 10-year event, between 300mm and 500mm for the 100-year event and 1000mm to 1500mm for the 500-year event.
15. Increases in the flood level at the N/W site with the Outpatients Building constructed can be approximately deduced from figure 16. For the 10-year event the increase in flood depth at the N/W site is between 50mm and 100mm. Possibly a 30% increase, as quoted in the N/W submission, but not sufficient to change the DCC flood hazard rating. For the 500-year event the increase is 10mm to 50mm or a 10% - 3.3% increase on the existing flood depth estimate. As N/W says no estimate was given for the 100-year event, but it will probably lie between these two estimates.
16. The applicant has responded to Foodstuff's concerns saying in the 10-year event the increase in flood levels at the N/W site is less than 10mm and for the 500-year event is less than 17mm, both increases the applicant says is at or below the detection level. The 100-year event was not modelled but the increase would lie between these results. No substantiation of these estimates was provided.
17. The latest and presumably more accurate assessment certainly shows a minimal effect on the existing significant flood levels at the N/W site.

18. The ORC encouraged the panel to consider the effect of liquefaction on the flood mitigation work. Liquefaction is a risk in an earthquake. The building is designed to withstand earthquake forces, the foundations are deep, and the floor level is well above flood level. No identification or analysis of a liquefaction risk to the building has been provided and none should be expected. Proper building design would cope with this risk if there is one. Liquefaction in the surrounding streets may occur if there is sufficient shaking from an earthquake and that may require remedial work that might delay reopening the Outpatients Building. The applicant responded that the risk of subsidence is a matter for the building designers and that a risk from elevated groundwater is unlikely.
19. ORC also recommended undertaking a more up to date tsunami examination, but the applicant is satisfied with the accuracy of the present understanding.
20. An emergency plan, as required by a condition, was sought by the ORC.
21. Foodstuffs operate the New World in Cumberland Street and are concerned that their flood risk is aggravated by the Outpatients Building. The applicants acknowledge there will be some increase in flood levels in Cumberland Street affecting the Foodstuffs site but says the increase in flood level is not great and that any additional flood damage would be small.
22. The Hon James Shaw has commented that consideration of the incremental flooding risks and effects of each stage of the hospital project does not allow for consideration of the cumulative effects of the whole project. Existing consents are viewed as part of the existing environment and only the effects of the new stages are evaluated. He says the overall access issues to all parts of the hospital created by flood events (depth and water velocity) need to be considered. Similarly, he says the overall effects on the surrounding properties need consideration.
23. The applicant accepts the risks associated with incremental assessment of the stages of the project but that does not help with the assessment of the effects of the whole project. Whether or not the access limitations to all the buildings under flood conditions is acceptable has not been presented and evaluated. Only the assertion that... *overall the hospital will remain accessible during a flood event.* (Applicant's response to comments.)
24. Incremental effects of the Outpatients Building on neighbouring flood levels and the consequent increase in damage has been assessed as small but there is no information about the cumulative effects of all the buildings proposed, other than an assertion that it has been considered.
25. He also notes that MfE guidance on allowance for sea level rise for significant infrastructure extends to 100 years not just to 2090 as reported. The applicant considers the actual analysis of the effects of sea level rise over more than 100 years is provided for by the design floor levels.
26. The DCC has accepted the flood analysis and effects assessment and requires an adverse event plan to be adopted.
27. That completes my overview on the items as requested. It is not an analysis and leaves open, questions on the cumulative effects of the whole project and on the acceptability of access to the Outpatients Building and to all the buildings under even modest flood events (i.e., 10-year event).