Tonkin+Taylor

Job No: 1001107.0000
30 November 2017

Ministry of Education
48 Hereford Street
Christchurch
8013

Attention: Deb Taylor

Dear Deb

Redcliffs Park
Flood Hazard

1 Introduction

The Ministry of Education (MoE) are looking to relocate Redcliffs School to a new site at Redcliffs Park. The new site is shown in Figure 1 (below). The MoE has asked Tonkin & Taylor Ltd (T+T) to provide further detail on the potential flood hazard relating to the site, which also responds to feedback provided on the Proposal from the strategic partners under section 66 of the Greater Christchurch Regeneration Act 2016. We have included relevant aspects arising from tidal inundation, although our previous report[1] on potential coastal inundation and coastal erosion provides more detail relating to these coastal hazards.

2 Background

The Redcliffs Park site has the following existing characteristics:

- The Redcliffs Park site can be characterised into the playing fields area that is generally at an average ground elevation of approximately 10.6 m relative to Christchurch Drainage Datum (CDD). The playing field portion of the site ranges in elevation from approximately 10.5 mCDD to approximately 11.0 mCDD. The area adjacent to Main Road is at an elevation of around 14.0 mCDD.
- It is expected that new school buildings will likely be located largely on the elevated Main Road portion of the site. However, given the required floor area for the primary school development some building footprint may extend out over the existing playing fields area.
- The finished floor level (FFL) for any new buildings located within the Redcliffs Park site is expected to be at an elevation of at least 12.36 mCDD. This will require the foundations for any buildings that extend beyond the Main Road portion of the site to be elevated above the existing ground surface to achieve the required FFL.
- Virtually all of the lower lying portion of the site is shown to be within the areas of inundation due to events (rainfall-induced flooding) with an Average Recurrence Interval (ARI) of 50 years and 200 years (as per the on-line CCC Floor Level Viewer, which shows that the inundation

[1] T+T letter to Ministry of Education dated 26 May 2017.

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levels from such events are virtually coincident, as illustrated on Figure 1), which are the basis for the Floor Level Control Area and the Flood Management Area (FMA) (refer Figure 2, below).

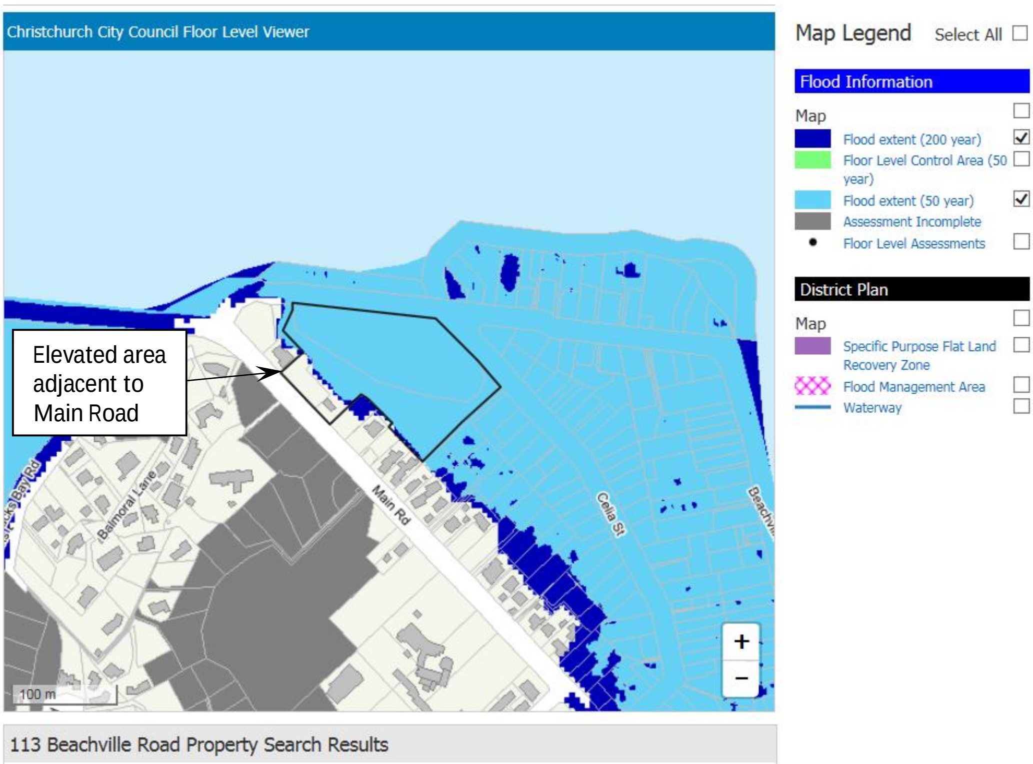

Figure 1: CCC 50-year and 200 year ARI inundation extents (includes 0.5 m sea level rise)
(source: https://www.ccc.govt.nz/services/water-and-drainage/stormwater-and-drainage/flooding/floorlevelmap/)

Figure 2: CCC Floor Level Control Area and Flood Management Area
(source: https://www.ccc.govt.nz/services/water-and-drainage/stormwater-and-drainage/flooding/floorlevelmap/)

- Figure 3 (below) is from the Christchurch City Council (CCC) website and shows the lower lying part of the site falling within the Fixed Minimum Floor Level Overlay (FMFLO) boundary, within the FMA.
- Figure 3 also shows that the lower lying part of the site falls within the District Plan High Flood Hazard Management Area (HFMA). The HFMA is an area subject to inundation events where the water depth (in metres) times the velocity (in metres per second) is greater than or equal to 1, or where inundation depths are greater than 1 m in a 500 year ARI flood event. The HFMA is within the boundary of FMA.

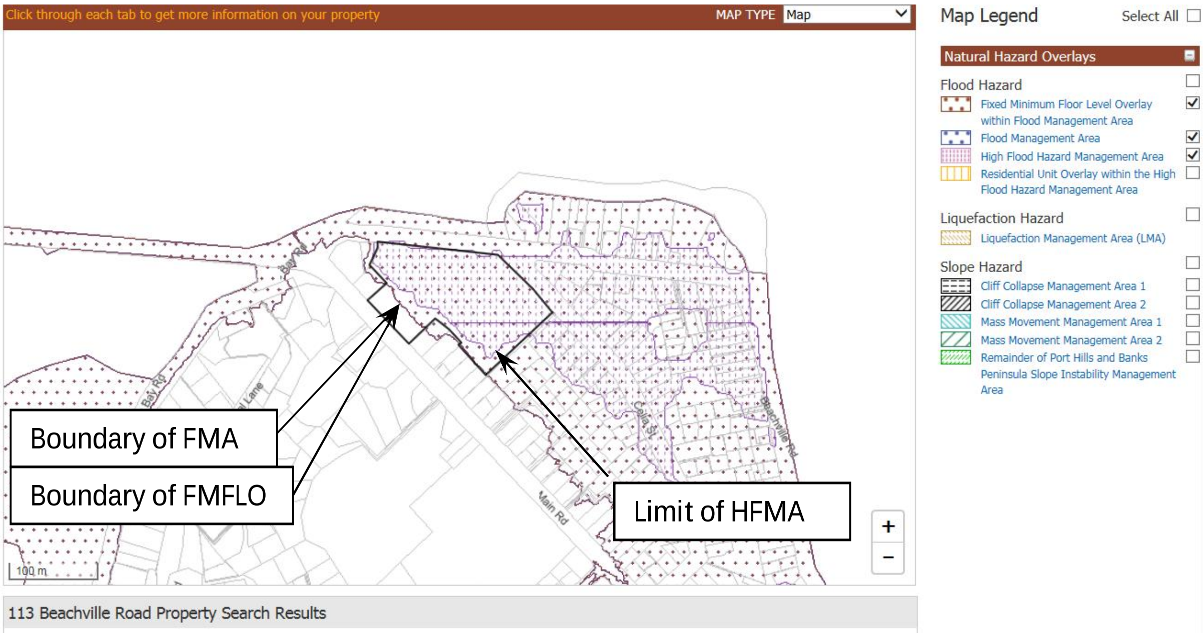

Figure 3: District Plan natural hazards map
(source: http://districtplan.ccc.govt.nz/pages/plan/book.aspx?exhibit=DistrictPlan)

3 Site flood assessment

3.1 General

The lower part of the site (to the north, adjacent to Beachville Road) is separated from the estuary by the existing road, a narrow section of shoreline and an existing revetment. Between the site and the estuary the minimum embankment elevation is some 11.2 mCDD. When the water level in the estuary exceeds this elevation, the site is prone to inundation from the estuary. Present-day extreme estuary levels (up to at least a 200-year ARI level) do not exceed this.

However, under future sea level rise (SLR) scenarios the existing embankment protection will be less effective. Future sea level rise is governed by future global emissions, although even under the least extreme emissions scenario currently considered (RCP2.6 as described in IPCC 2015[2]), the projected inundation for the year 2065 will result in overtopping of the current embankment crest level under the 200-year ARI event.

Under extreme rainfall conditions the playing fields area of the site is prone to surface flooding. Under such conditions runoff from higher up in the catchment accumulates over the lower lying ground as it cannot drain by gravity to the estuary. A pump located adjacent to Beachville Road

[2] IPCC (2015). Climate Change 2014: Synthesis Report. Report by Intergovernmental Panel on Climate Change

facilitates drainage under these conditions. Thus, the existing playing fields area provides flood storage volume, although this area is not identified as a flood ponding management area under the District Plan.

Figure 4 (below) presents the inundation elevations for a range of extreme events, along with selected key features associated with the site such as the expected building FFL, the elevation of the top of the existing seawall/revetment and the average ground surface elevation for the lower lying part of the site. The extreme event inundation elevations are plotted for three time horizons being present day, 2065 and 2120. The latter two represent commonly referenced time horizons for considering SLR. For most events the 2065 and 2120 elevations are estimated by adding 0.5 m and 1.0 m to the present day elevations to accommodate sea level rise over the respective future time horizons, which is the approach we understand is taken by CCC. Elevations are provided for:

- Mean High Water Springs (MHWS)
- Mean Sea Level (MSL)
- Tidal inundation due to storm surge (including wave setup and barometric pressure) with annual exceedance probability (AEP) of 1% AEP (equivalent to an event with 100 year ARI)
- 50 year ARI flood (2% AEP) and 500 year ARI flood (0.2% AEP)
- Tide inundation for 2 year ARI (50% AEP), 50 year ARI (2% AEP), 100 year ARI (1% AEP) and 200 year ARI (0.5% AEP)
- The approximate elevation of inundation due to the March 2014 flood event

For more extreme events with high runoff volumes the peak inundation level is likely to be controlled by weir overflow to the estuary, which will occur at 11.2 mCDD. That is, once the lower portion of the site fills to a level at or above 11.2 mCDD, it is likely to be controlled at about this level by overflow to the estuary. Once the inundation exceeds the level of the current seawall embankment the storage volume increases substantially, which results in only relatively modest incremental increase in the level of inundation as the runoff volume (and event return period) increases.

Ponded water within Redcliffs Park is currently removed via the stormwater pumps located along Beachville Road. At this stage the operating curves for these pumps have not been reviewed. However, if we assume that the pumps deliver 50 L/s (which would not be unexpected for such low head pumps, although the actual pump discharge rate needs to be confirmed) then a total volume of approximately 4,000 m^3 of water would be pumped over one day (24 hours). The estimated volume of storage within the north western corner of the site, below an elevation of 10.6 mCDD is approximately 500 m^3, which would take around 3 hours to pump away. The volume between elevations of 10.6 and 10.8 mCDD within the Redcliffs Park footprint is approximately 3,000 m^3. Therefore, the volume of water that might be contained within the Redcliffs Park area below an elevation of 10.8 mCDD would take of the order of one day to pump away (noting that this does not include any areas of ponding that might be hydraulically connected to Redcliffs Park).

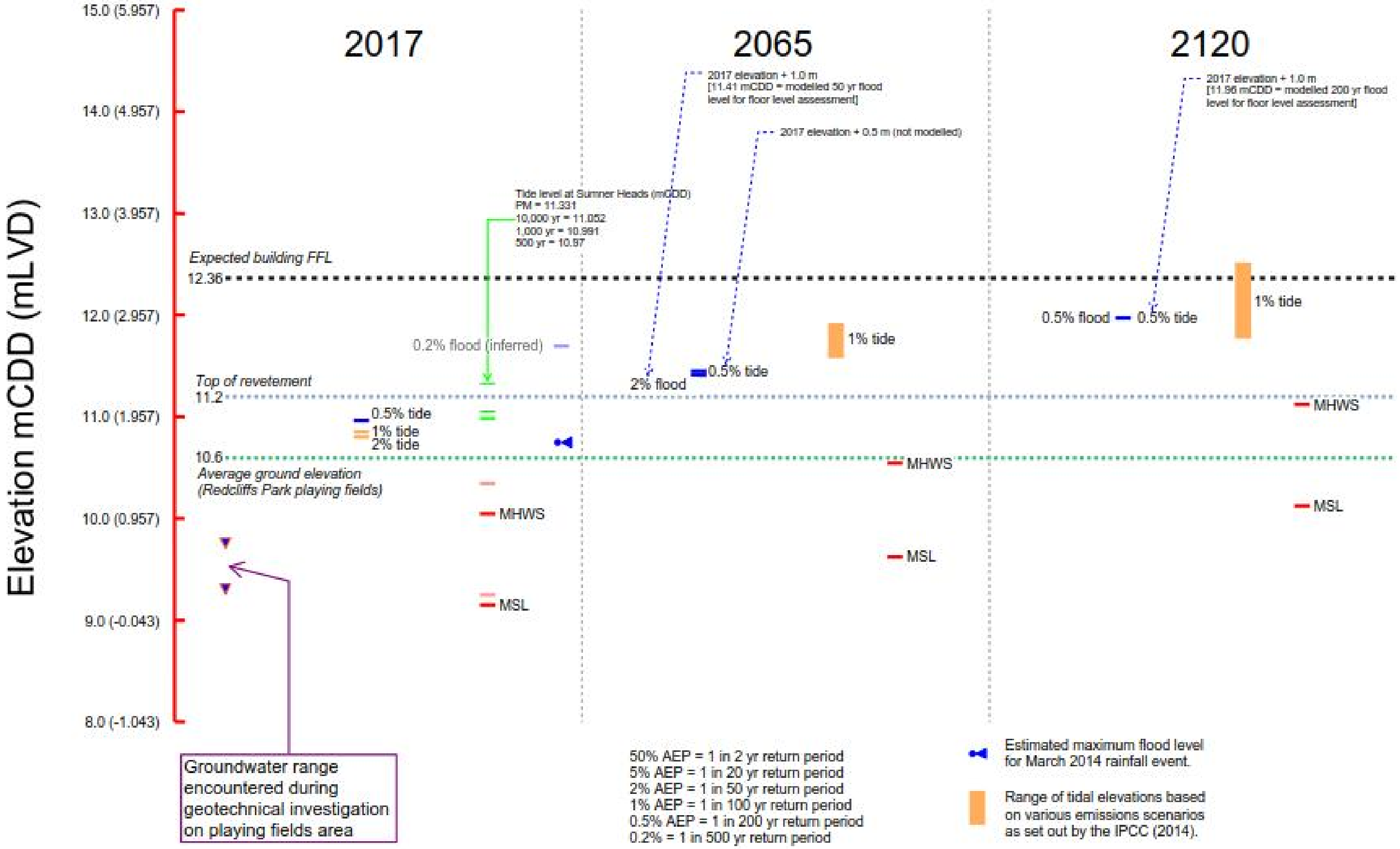

Figure 4: Elevation diagram

3.2 Tidal inundation

3.2.1 Present-day

Inspection of Figure 4 indicates that under present day conditions tidal inundation of Redcliffs Park would not be expected to occur until overtopping of the current seawall/embankment, which would only likely be for events with an ARI of more than 200 years (0.5% AEP). This is based on the assumption that existing stormwater infrastructure that drains the road in this area is fitted with adequate backflow-prevention.

3.2.2 2065 time horizon

While it is possible (or even likely) that over the next 50 years covering this future time horizon some further works would be undertaken to provide a continuous degree of inundation protection to this area, this assessment is based only on current levels.

With 0.5 m SLR the MWHS elevation is considerably lower than the current seawall crest elevation and overtopping would only occur for more extreme events. The 50-year ARI and 200-year ARI extreme tide levels are both above the existing seawall crest. The depth of inundation within Redcliffs Park for either of these events is difficult to predict without detailed modelling, but could be up to the causative sea level in elevation. In these scenarios the school buildings would be situated well above likely inundation levels although it would likely take several days for any accumulated water to clear from the playing fields area.

3.2.3 2120 time horizon

With 1.0 m SLR (time horizon around 2120) the MHWS is slightly lower than the top of the existing seawall, but it would be reasonable to expect that on occasion (potentially a few days per year) the tide might overtop the seawall and result in some ponding on the lower lying area of the Park, particularly within the north western corner. Any overtopping would be for a limited period of time around the high tide mark and ponded water could either be allowed to drain by gravity, at lower tide, or be pumped away. This would occur if no further upgrading or topping up of the seawall were undertaken as global sea levels rise.

For an extreme tide with an ARI of 100 years the school buildings would be above the inundation level, except in the case of the most pessimistic climate change scenario at the 2120 time horizon. For this extreme tide event the projected inundation level would be above the current seawall crest and accumulated water on the playing fields would likely take many days to clear. It may also be of relevance to note that under such a set of circumstances, and without any intervention, there would be many adjacent houses and roads that would be impassable.

3.3 Surface water flooding

For rainfall-induced surface water flooding the school buildings will have a floor level set above the 200 year ARI flood event taking into consideration 0.4 m freeboard and 1.0 m SLR, and therefore these fixed assets are considered to be adequately protected from flood hazard.

The lower lying areas of the playing fields are already subject to inundation due to runoff from extreme rainfall events, as was demonstrated by the March 2014 storm. Although subject to some challenge, the March 2014 storm was generally considered to be a 100 year ARI event. We understand that the level of inundation within the playing fields area was up to approximately 10.8 mCDD (based on interpretation of photos taken at the time) during this event. With an approximate ground elevation of some 10.6 mCDD this indicates ponding to a depth of some 0.2m. Anecdotal information also suggests that it took 1 to 2 days for the ponded water to clear from the Park, which reduced the short-term availability of the playing fields.

Surface water flooding resulting in an inundation level of 11.2 mCDD (current seawall crest elevation) would be expected to occur due to an event with an ARI of somewhere between 100 and 200 years, although further detailed hydrological modelling would be required to estimate this more accurately. Ponded water to this elevation would likely take many days to clear from the Park. This level (11.2 mCCD) is an approximate upper bound elevation for rainfall-related flooding, when the sea level is lower than this. This is because overflow over the seawall will occur at a rate that can vary for little change in water level (i.e. the seawall crest acts as a weir level control structure). At this elevation the school playing fields will be inundated to an average depth of about 600mm, although there will probably be localised areas of greater depth.

There is limited modelled data available on inundation levels on Redcliffs Park due to other rainfall events. However, as an example, comparison of the outline of the HFMA (refer Section 2, above) with the LiDAR-based topographical plan of the site (refer Figure 5, attached) indicates that 1.0 m depth of inundation line (representing the boundary of the HFMA) corresponds approximately to an elevation of 10.7 mCDD. This infers that the 500 year ARI flood event inundation elevation could be 1.0 m higher, at an elevation of approximately 11.7 mCDD. This elevation is above the current seawall elevation and therefore the water level above Redcliffs Park would be directly connected with the Estuary, in this particular 500 year ARI event. In this case, it is presumed that it would take of the order of weeks for ponded water to clear form the Park. Also, from Figure 5 it can be seen that the area of likely inundation due to this event would include all of the Redcliffs area coloured blue, green and yellow (let along the rest of lower-lying areas of Christchurch), which would suggest that the impacts of such an event would be very significant across many parts of Christchurch.

3.4 Groundwater

We have also looked at groundwater beneath Redcliffs Park to further understand potential aspects relating to the use (operation) of the playing fields under various SLR scenarios.

T+T has undertaken groundwater level modelling work at other coastal locations in New Zealand, which shows that the 95th percentile groundwater elevation appears to correlate with MHWS at the coast. The 95th percentile level is that which will be equalled or exceeded, on average, about 18 days per year. The 50th percentile groundwater level (or the average level) tapers off to a lower sea level at the coast. These aspects are illustrated in Figure 6 (below).

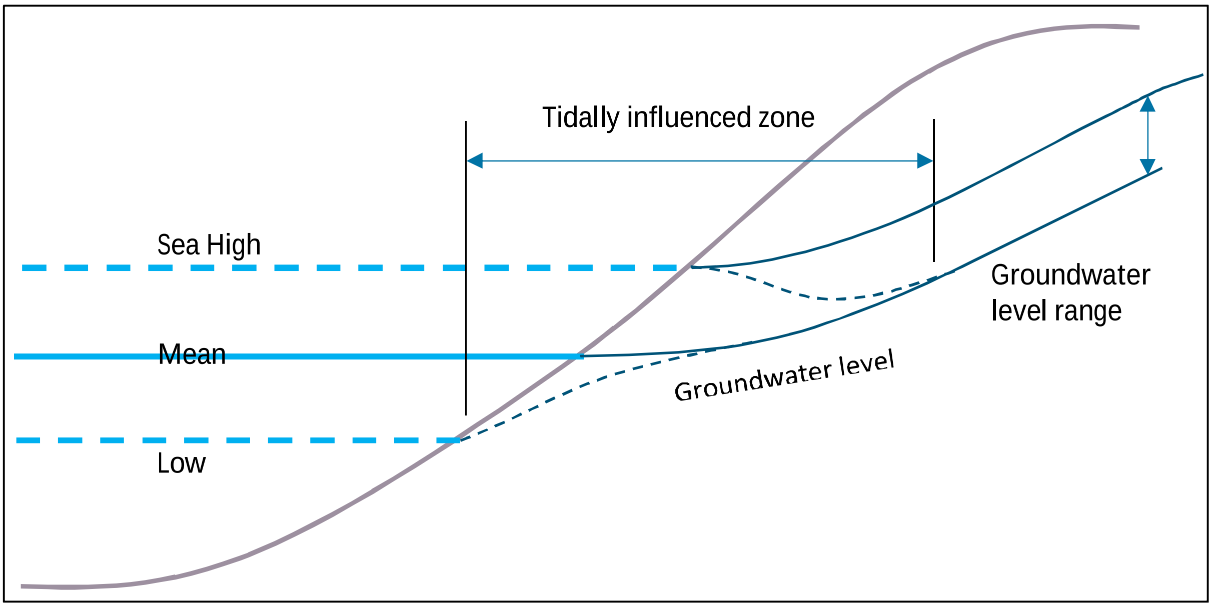

Figure 6: Tidal zone schematic

Due to the lag time with the change in groundwater levels associated with the tidal cycle, the groundwater surface typically seeks equilibrium with the sea levels that are experienced over long periods of time. Therefore, it is appropriate to use mean sea levels (MSL) which represent 50% of the duration or on an annual basis at/or below six months of the year. It is for this reason that extreme sea levels (for example those with 1% AEP) have little influence on groundwater level due to their relatively short duration over which the extreme sea level exists (a storm surge typically lasts no more than 6 to 12 hours). Therefore, assessment of groundwater levels during a period of extreme sea levels (1% AEP) is of no relevance.

To assess the potential groundwater level rise at the site as a result of the various SLR scenarios, at least for the purposes of this report, we consider it appropriate to add the projected SLR to the MHWS level to obtain an estimate of the changes to groundwater elevations.

A range of groundwater elevations was observed in test pits excavated on the site during the geotechnical investigations (17 January 2017) of between 9.2 m and 9.9 mCDD. It would be expected that following periods of prolonged rainfall (typically winter periods), the groundwater level would be higher than following dry weather. Table 1 (below) provides our assessment of possible groundwater levels based on the addition of the predicted SLR. Evident from data contained within this table is that observed groundwater levels are slightly above the MSL, but below MHWS. This is as anticipated, as shown in Figure 6.

Table 1 – Summary of estimated groundwater levels associated with SLR

	Existing	2065 (0.5 m SLR)	2120 (1.0 m SLR)
Mean High Water Springs (MHWS)	10.05 m CDD	10.55 m CDD	11.05 m CDD
Mean Sea Level (MSL)	9.1 m CDD	9.6 m CDD	10.1 m CDD
Typical site groundwater level	9.2 – 9.9 m CDD	9.7 – 10.4 m CDD	10.2 – 10.9 m CDD

It is unlikely that groundwater level would rise significantly above existing ground level as shown for the 2120 scenario, as the excess water would be likely to drain towards the sea. At such times the groundwater level would remain very close to the ground surface.

This assessment indicates that groundwater levels at some locations may rise to the existing ground surface elevation (based on an average of 10.6 m CDD) at some locations across the playing fields in the longer-term time horizon. These effects would also depend on the nature of the near-surface subsoil conditions, which can vary across the site between relatively low permeability silt and silty sand, and higher permeability sand.

Further monitoring over a complete seasonal cycle of the groundwater levels at the site would help to better understand the correlation between groundwater level at the existing MSL and MHWS. This would help confirm if the typical site groundwater levels presented in Table 1 are truly representative of likely conditions.

Assessment should also consider the effects of rainfall and storm events and how infiltration contributes to localised short-term rises in groundwater levels.

In summary it is expected that under current conditions, the depth to groundwater below the surface of the playing fields is likely to be 0.7 to 1.4 metres during summer conditions. This is likely to be less during winter. Under future climate conditions the depth will reduce further, to the point at which groundwater level is at ground surface. It is possible to locally control groundwater level by drainage.

4 Measures to help manage inundation hazards and usability of the playing fields

If any of the areas shown as potentially inundated in Figure 1 and 2 are to be filled, then this fill will represent a reduction in the storage volume able to be achieved over the existing flood-prone area. This reduction in storage volume will translate to either a reduction in flood level of service to surrounding areas, or will place additional demand on the installed pump capacity to maintain flood level control.

Filling can be avoided by either ensuring buildings are located only over areas not within the floodable area, or by elevating buildings, such as on piles, above existing ground level (with negligible loss of floodplain storage volume).

Compensatory storage could be provided on site by excavation of an equivalent volume from an area that would otherwise not be flooded, and do this at an elevation above groundwater level. There is some potential for this on the site, although further evaluation would be required to better understand whether a suitable volume could be economically developed.

Some enhanced pump capacity could be developed to remedy the effects of loss of floodplain storage volume to control flood levels. This would require further design input.

We understand that some areas of the playing fields already have subsurface drainage installed and the Ministry is investigating measures to enhance the drainage network. This would assist in reducing the duration of any inundation as well as the extent and duration of potential "boggy" areas. A discharge elevation of around 10.0 mCDD would place the outfall above the current MSL and above the MSL with 1.0 m SLR. However, any drainage pipeline would still need protection from tidal backflow, which should be readily achievable using a flap valve.

5 Lives risk due to inundation

5.1 Background

To appropriately assess life risk there needs to be adequate understanding of the hazardous event (including the nature of the event and the possible consequences along with the likelihood, or frequency, of the event giving rise to the particular consequences), the exposure of the elements that might be exposed to the specific hazard and the likelihood of the consequences, given the hazard and exposure. It is normal to consider annualised risk i.e. the risk over a year. This is useful given that there are reasonably well established quantitative risk criteria for annualised lives risk.

In algebraic context, this can be represented as:

$$R = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V \times E$$

Where:

R = annualised risk (which may be thought of as the annual probability of fatality or property damage in financial terms)

$P_{(H)}$ = annual probability of the hazardous event (in this case depth of ground surface inundation)

$P_{(S:H)}$ = probability of spatial impact (or accident) given the hazardous event (this is typically the product of a number of conditional probabilities of contributing events that all have to occur to end up with the element at risk being physically exposed to the hazard)

$P_{(T:S)}$ = temporal probability of the consequence occurring i.e. probability of the element at risk being present within the impact zone at the time that the hazard occurs (often this is a function of the length of time that the element at risk is exposed to the hazard)

V = vulnerability of the element at risk given the presence of the element at risk within the impact space or zone, due to the hazardous event, at the time the event occurs

E = the element at risk i.e. an individual, a group or community, or property (in this case the key element is an individual school user at risk due to the hazard)

5.2 Inundation hazard

For inundation at Redcliffs Park (specifically the lower lying area of the Park that might be used for car parking, student pick-up/drop-off (PUDO) and playing fields) the main considerations could be thought of as:

- Inundation due to tidal overtopping of the current revetment (either the seawall to the north of the Park or the low concrete wall running alongside that portion of Beachville Road to the east of Redcliffs Park that runs approximately north-south), which reportedly has an elevation of 11.2 m relative to the Christchurch Drainage Datum (CDD). Can be caused by severe storm and/or tidal surge. This is impacted by sea level rise and also to some degree by barometric pressure.
- Inundation due to excessive rainfall resulting in water ponding on Redcliffs Park.

These represent two quite separate causes of inundation on Redcliffs Park, although the result is similar, in that ponding occurs. There is also the obvious link whereby a major storm causing a tidal surge is typically associated with low barometric pressure and heavier than usual rainfall. Therefore, the hazardous event is regarded as inundation of Redcliffs Park to whatever elevation, with a particular frequency (or probability or return period) that may be due to rainfall and/or tidal surge. The depth of inundation is linked to the size/severity of the event, which is usually described in terms of return period. Therefore, the hazard is the return period of a particular depth of inundation over Redcliffs Park, above the average ground level elevation of 10.6 mCDD.

The general fall of the playing fields is mostly towards the estuary, from the Main Road side. As a flood progresses the flooding will initially begin at the northern edge of the site, adjacent to Beachville Road, and then gradually fill in a southwards direction, towards the south. Similarly with tidal inundation, the northern part of the site would be expected to be impacted first with the inundation “front” spreading north to south.

5.3 Element at risk

The element at risk can be a person, or group of people, that are exposed to the inundation. In this case, a child, or group of children, may be exposed to inundation of the lower lying area of the Park. This exposure only arises if the person is present in the path of the rising water. This would give rise to a potential lives risk. Other elements at risk could be parents or visitors to the school.

5.4 Vulnerability

In this case, the vulnerability of the element(s) at risk depends on the depth of inundation that the person(s) is exposed to, the velocity of the water flowing around the person(s) and the ability of the person(s) to cope/progress through the body of water and make it to higher ground. So, it matters whether the element at risk is a child, or an adult. It seems obvious that a child would have a greater level of vulnerability, and therefore level of lives risk, so our discussion will focus on students.

Since peak rainfall-related flood depths at the site are likely to be controlled by the embankment crest elevation (at 11.2 mCDD), the maximum flood depth anticipated over the lower part of the site during a heavy rainfall flood event is about 600 mm, this being the difference between the elevation of the ground over the lower part of the site (approximately 10.6 mCDD) and this control level of 11.2 mCDD. Shand *et al* (2011)[3] showed via experimental data that the low hazard area for children is defined as a combination of flood depth and flood velocity, with a maximum flood depth tolerance of 500 mm. This is shown in Figure 7 (below). Given that the flooding in the area of the proposed school is ponding, by definition, the flow velocities are expected to be less than 0.5 m/s. Therefore, the flood hazard over the low part of the site is likely to remain low over most rainfall-induced flood conditions for current climate conditions.

Depths and flow velocities are likely to be greater in, say, a 500 year ARI flood event. However, it would be unrealistic to expect that anyone would be in the area of inundation in very extreme climatic conditions such as this.

5.5 Spatial probability

For the lives of students to be potentially threatened by inundation on the lower lying areas of Redcliffs Park he/she/they would need to be physically present within a body of water with a depth over around 0.5 m and flowing at a velocity of greater than around 1.0 m/s. These values are taken from Shand et al (2011). This influences the spatial probability.

The spatial probability would also need to consider whether anyone would be present within the lower lying areas of Redcliffs Park when an event that could result inundation greater than approximately 0.5 m depth. Such inundation is likely to occur during a tidal surge or heavy rainfall, both associated with a storm event. At such times the school may not be open due to other factors occurring within the community and there would be no students (or parents) present to be exposed to the hazard.

[3] Shand, TD, Smith GP, Cox, RJ and Blacka, M (2011), Development of appropriate safety criteria for the safety and stability of persons and vehicles in floods, *Proceedings of the 34th IAHR Conference, Brisbane, 26 June – 1 July 2011.*

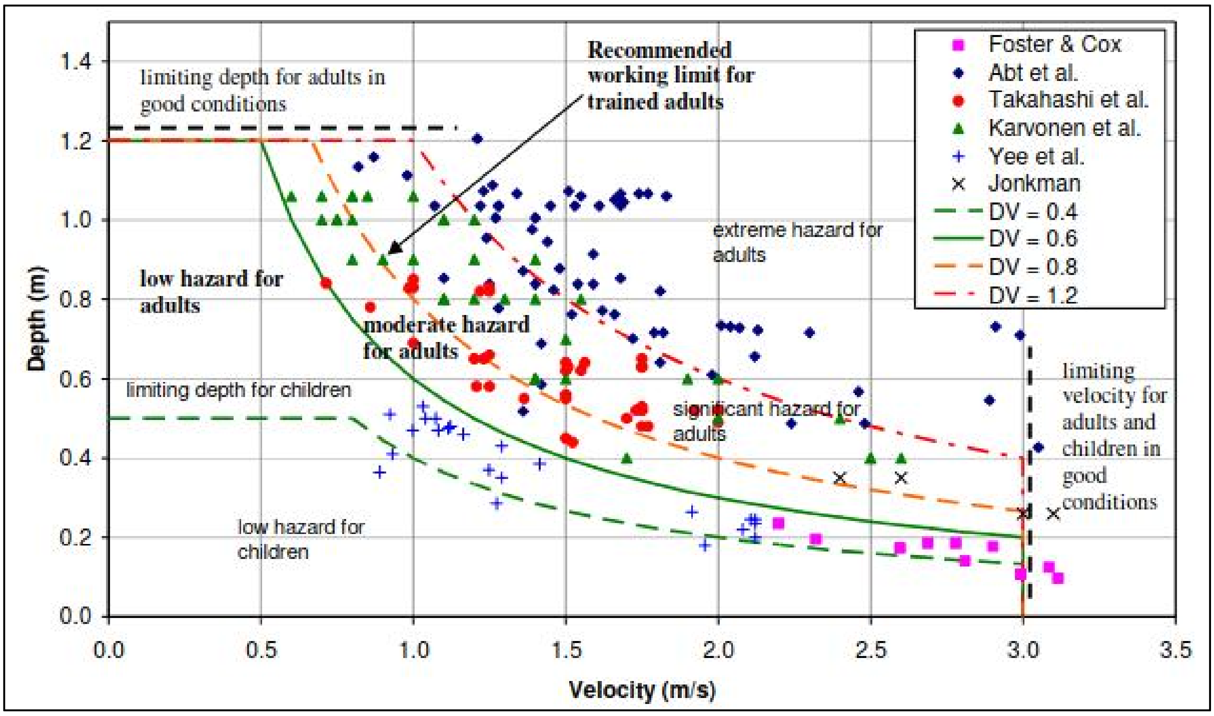

Figure 7: Vulnerability to flood depth/velocity

5.6 Temporal probability

Temporal probability considers the amount of time that they might be within that body of water, as a proportion of a year (given that we are looking at annualised risk). Factors to do with time, such as whether the hazardous event occurs during the daytime or night-time, also impact on the vulnerability of the person(s), since it is conceivable that the potential for someone to be drowned (and also whether they are likely to be within the body of water) depends on whether the exposure occurs at night or during the day. In the case of a student, temporal probability would also need to consider whether the hazard occurred on a school day, given that it would be expected that students would not normally be expected to be present within the lower lying areas of the Park outside of school hours, during holidays and weekends.

Both the spatial and temporal probability that a student finds themselves within a body of water greater than approximately 0.5 m depth are also influenced by the speed with which the hazard develops i.e. the rate of rising water. It is somewhat obvious that if someone, even a child, can see a hazard, then they are more often than not likely to take some action to try and avoid the hazard i.e. move away from the rising water. Given that the level of inundation on the lower lying areas of the Park increases relatively slowly, such as with a rising tide that occurs over several hours, and not instantaneously, it would appear reasonable that the potential for anyone to be unexpectedly caught within a body of water greater than about 0.5 m depth, is very remote. Such a situation could also be described as virtually not credible. These considerations could also equally be considered as part of the hazard assessment i.e. if there is no credible scenario that can be envisaged where a person is within an area of inundation resulting from a tidal surge or accumulation of surface runoff, then there is no hazard (and no risk).

Thus, the following aspects (amongst others) need to be factored into estimating the level of risk:

- The depth of inundation (and thus the AEP of the event resulting in that depth of water) and velocity of the ponded water.
- The length of time that it takes for the depth of inundation to develop.

- The likelihood that the inundation develops at a time coincident with students being picked up or dropped off
- Whether the climatic conditions that drive the depth of inundation preclude the presence of students within the potential area of inundation
- Whether an element at risk that does happen to be within the area of inundation can see that water levels are rising and can take appropriate action to avoid the area (i.e. move away).

5.7 Overall qualitative lives risk evaluation

Given the above discussion there is no credible scenario where there would likely be a person exposed to the hazard. Therefore, the lives risk would be expected to be extremely low and further, more quantitative risk assessment is not considered warranted. Overall, the mitigation to be applied is evacuation, which is reasonable in that the propagation of the flood will be sufficiently slow so as to allow for this. Furthermore, both flood mechanisms (tidal and rainfall-related) will progress in a direction leading towards the safe areas, so that evacuation to higher ground is possible without needing to wade.

6 Conclusion

Based on our understanding of the factors contributing to inundation, we believe that it will be feasible to adequately defend the proposed school infrastructure over a 50 to 100 year timeframe. Furthermore, in our opinion the development of a school at the proposed site can be expected to adequately manage inundation hazards, with management measures likely to include:

- Elevation of buildings to appropriate levels
- Provision of egress from all parts of the site, since the rate and direction of propagation of any inundation is able to be predicted
- Development of a flood management plan that includes identification of high tides and evacuation of areas prone to tidal flooding over critical times
- If required, any fill that is placed within the FMA will need to be adequately compensated for, such as by providing compensatory storage excavation or flood pump enhancement.

The resilience and usability of the lower-lying playing fields can be enhanced with augmented subsoil drainage and improving flood pump redundancy with, for example, having duty and standby pumps.

In the event of future tidal flooding, which is likely if sea level rise occurs as currently projected, the peak inundation levels will occur at high tide and will therefore be predictable. A site management plan that includes keeping people away from the areas of potential inundation when predicted, would address associated lives risk, in the same way that public know to avoid the parts of the Estuary (located immediately adjacent to the site) that are prone to tidal inundation.

7 Applicability

This report has been prepared for the exclusive use of our client Ministry of Education, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
....	....
Gordon Ashby	Mark Pennington
Senior Engineer	Senior Water Resources Engineer

Attachment:

Figure 5 – LiDar Topographical Plan

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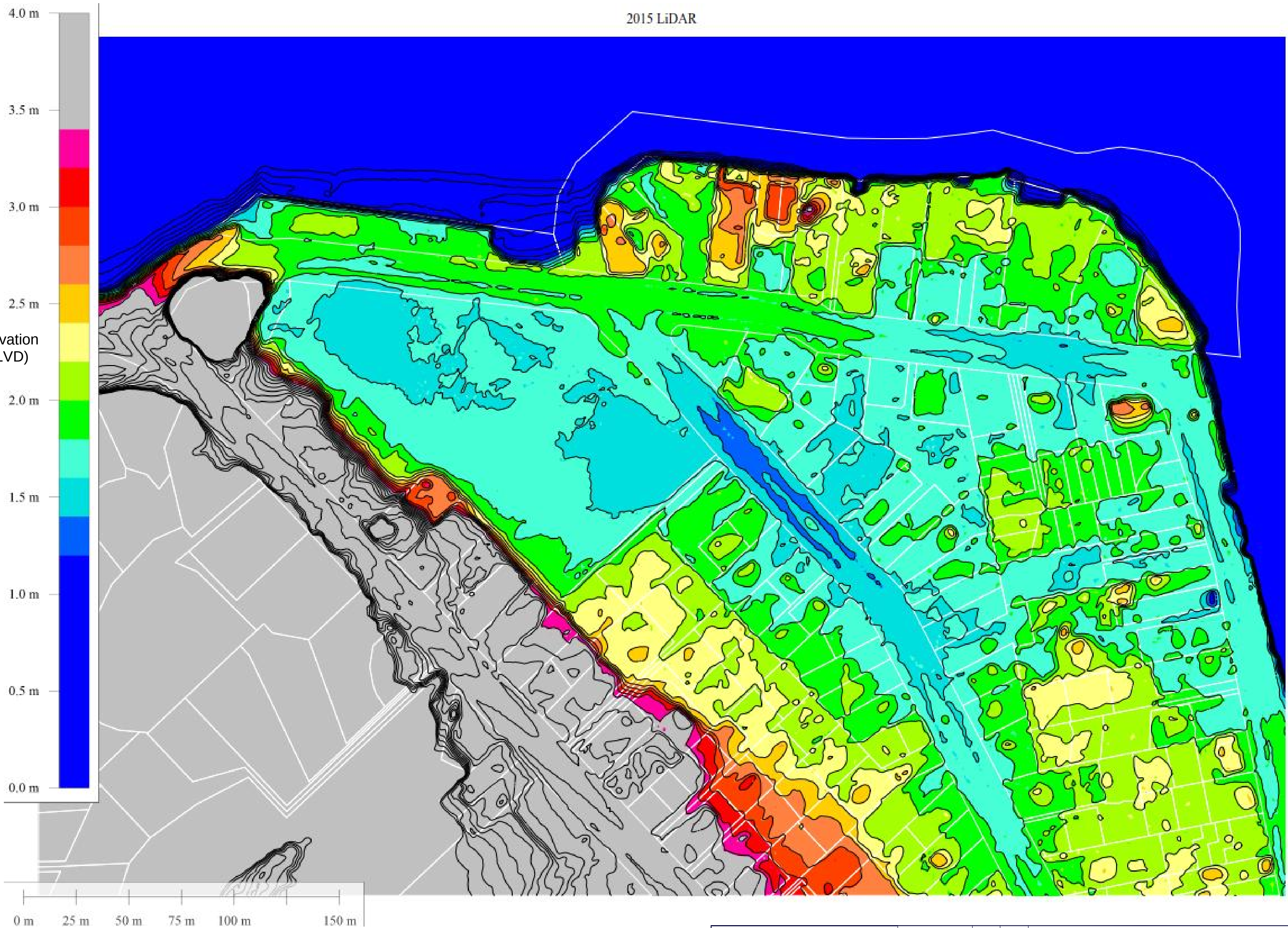

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PROJECT No.	1001107	

Ministry of Education
Redcliffs Park
LiDAR Topographical Plan

FIG. No. Figure 5

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