PLANS AND DOCUMENTS
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DEVELOPMENT APPROVAL

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Queensland Government

Flood Emergency Management Plan

67-69 Shore St East, Cleveland

Project Number: 23191
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Revision: A

PITCH BLACK GROUP

Flood Emergency Management Plan

67-69 Shore St East, Cleveland

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1 Introduction

Pitch Black Group has been commissioned by Karote ATF Chippers Trust to prepare a Flood Emergency Management Plan for the proposed development at 67-69 Shore St East, Cleveland, in order to respond to item 5a of the 'Further Issues' letter received in regards to the Development Application from Economic Development Queensland (ref: DEV2024/1488).

The primary objectives of this report are to:

- Identify the applicable flood levels and flood warning time for the site;
- Identify the safest evacuation routes and means of travel; and
- Formulate an emergency evacuation procedure in the event of a flood that will be incorporated into the emergency procedure documentation for the development.

Throughout this report, the developable area is referred to as the 'site' which covers Lots 12 and 13 on C14563.

2 Site Details

2.1 Location

The subject site is located at 67-69 Shore St East, Cleveland (Lot 12 on C14563 & Lot 13 on C14563), approximately 30km south-east of Brisbane's CBD and occupies a total area of 2,226m².

The site is bounded by Shore Street East to the north, residential dwellings to the east and west and a park to the south, as shown below in Figure 2-1.

Figure 2-1: Locality Plan

2.2 Topography

The subject site generally falls toward the south, with a level building pad of approximately RL 4.40m on the northern half of the site and the rear boundary falling to a low point of RL 2.11m as can be seen in Figure 2-2.

The northern boundary of the site sits 0.5m to 1.0m above the Shore Street East frontage pavement level and there is a poorly defined, shallow table drain in the verge running to the west.

2.3 Existing Use

The existing structures on the development site consist of two single storey residential dwellings, a single storey granny flat and a number of sheds and water tanks as shown below in Figure 2-2. The eastern lot also features a paved driveway area.

Refer to the site survey by Axis Surveys in Appendix B for further details.

Figure 2-2: Aerial Imagery showing 0.25m contours (QLD Globe, 2023)

2.4 Easements

The site is not encumbered by any existing easements.

2.5 Planning Scheme

The site falls within the Queensland State Government Toondah Harbour Priority Development Area as shown in Figure 2-3.

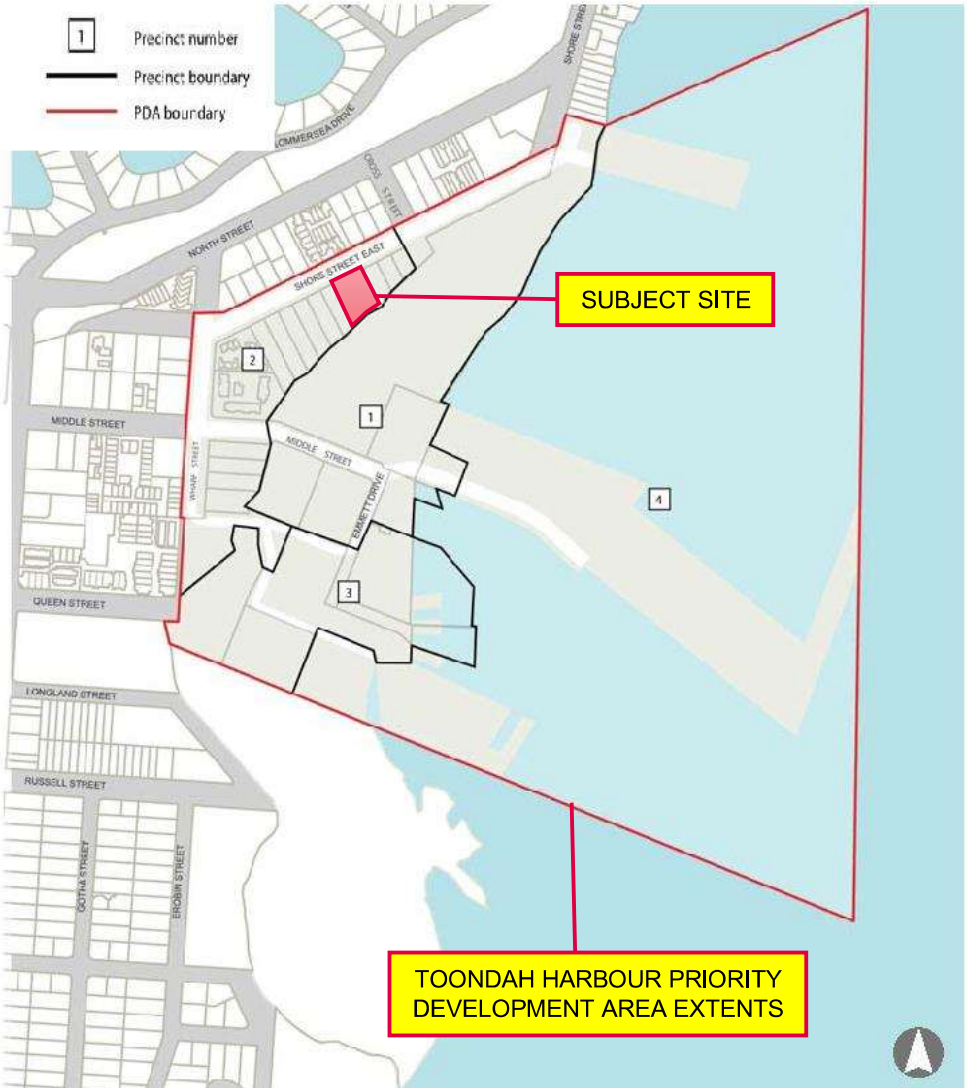

Figure 2-3: Toondah Harbour Priority Development Area Precinct Map (from Toondah Harbour PDA Development Scheme)

Under the Toondah Harbour Development Scheme, Precinct 2 will accommodate predominantly residential development with a preference for dual occupancy, multiple dwelling and residential care facilities.

3 Proposed Development

The proposal consists of a Material Change of Use application for a six (6) storey multi-unit development consisting of thirty (30) units and sixty-three (63) car parks on the ground floor. A 3D perspective of the development by RC+ Design is shown below in Figure 3-1.

Vehicular access to the development is proposed to be via a new 6.5m wide driveway crossover on Shore Street East. The section of Shore Street East fronting the proposed development will be upgraded to a 7m wide carriageway and new kerb and channel will be constructed along the southern edge, along with a new 2.5m wide multi-use footpath. Pedestrian access will be provided from Shore St East.

Figure 3-1: 3D Perspective by RC+ Design

Refer to Appendix A for the proposed site layout and elevation plans by RC+ Design.

4 Flood Behaviour

4.1 Flooding Types

Redland City Council's Flood and Storm Tide Hazard Overlay plan (version 8) has flagged the site as susceptible to flooding by storm tide inundation.

4.1.1 Storm Tide Flooding

Storm tide flooding happens when a storm surge creates higher than normal sea levels. A storm surge is caused when a low-pressure system or strong onshore winds force sea levels to rise above normal levels. The impact of a storm tide or storm surge is increased during high tides and king tides and can affect low-lying areas close to tidal waterways and foreshores.

Tidal flooding is the temporary inundation of low-lying areas and streets during high tide events, such as at full and new moons. The highest tides of the year may be known as king tides. Areas connected to the foreshore and tide-affected areas of the river, tidal creeks and other waterways are susceptible.

4.2 Flooding Probabilities

The main terminology used to describe the probabilities of flood events occurring are:

- *Annual exceedance probability (AEP):* the probability or likelihood of an event occurring or being exceeded within any given year, usually expressed as a percentage.
- *Average Recurrence Interval (ARI): The average or expected value of the periods between exceedances of given rainfall total accumulated over a given duration. For example, a flood may be described as being a 1 in 100-year event.*

Note that the use of ARI terminology is no longer preferred due to the common public misconception that that a 100-year flood event only occurs every 100 years. Where in reality, it is possible to have floods of this size in consecutive years or even two in the same year, which occurred in Queensland in 2011.

Table 4-1 below shows the equivalent AEP and ARI flood event descriptions for the purposes of understanding the two terminologies, as ARI references such as "*a 100-year event*" or "*1 in 100-year flood*" are still commonly referred to in the media.

Table 4-1- Comparison of the same flood events using AEP and ARI terminology

Annual Exceedance Probability (AEP)	Average Recurrence Interval (ARI) Commonly expressed as a 1 in X year event
63%	1
39%	2
18%	5
10%	10
5%	20
2%	50
1%	100
0.5%	200
0.2%	500
0.1%	1000
0.05%	2000
0.02%	5000

The references to flooding characteristics in the below report will refer to AEP, in accordance with industry best practice terminology.

4.3 Flood Levels

Table 4-2 and Table 4-3 below summarise the relevant current and projected tidal/flood levels for the site.

Table 4-2- Current Relevant Tidal/Flood Levels

Tidal/Flood Event	Level (m AHD)
MHWS (year 2023)	0.99
HAT (year 2023)	1.58
1% AEP storm tide flood (year 2016)	2.36*

Table 4-3- Projected Relevant Tidal/Flood Levels

Tidal/Flood Event	Level (m AHD)
MHWS (year 2100)	1.79 **
HAT (year 2100)	2.38 **
1% AEP storm tide (year 2070)	2.77m AHD* (allowing for 410mm sea level rise)
1% AEP storm tide (year 2100)	3.16

Mean High Water Springs (MHWS) - The average throughout a year of the heights of two successive high waters during those periods of 24 hours (approximately once a fortnight) when the range of the tide is greatest.

Highest Astronomical Tide (HAT) - The highest level of water that can be predicted to occur under average meteorological conditions and any combination of astronomical conditions. This level may not be reached every year.

* Note: The 1% AEP storm tide levels for 2016 and 2070 are based on estimates from contour information and mapping extent.

** Note: MHWS & HAT levels for year 2100 are estimated to be 800mm higher than current MHWS & HAT levels to account for sea level rise caused by climate change.

The extent of storm tide inundation across the site is shown in Figure 4-1 and Figure 4-2. The 2070 storm tide projections were produced on a separate plan by RCC for information purposes only and have been included in this report for additional context.

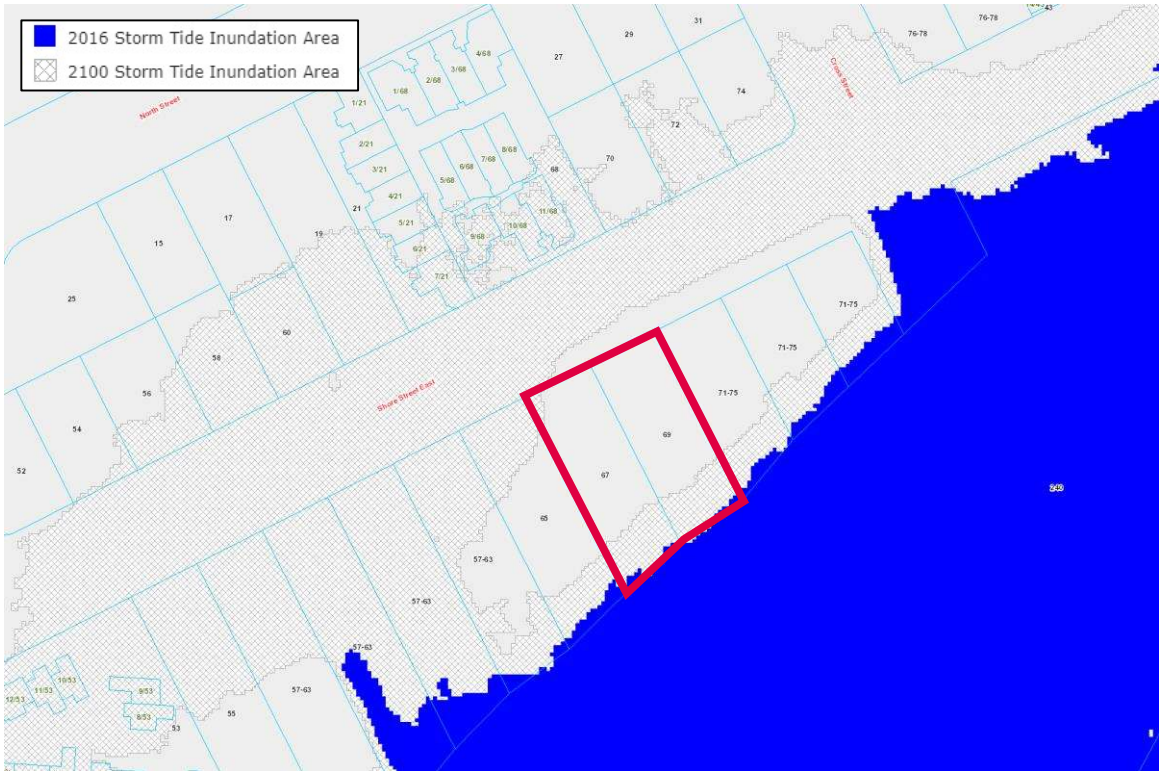

Figure 4-1 – Extract from RCC Flood and Storm Tide Hazard Overlay (Version 8)

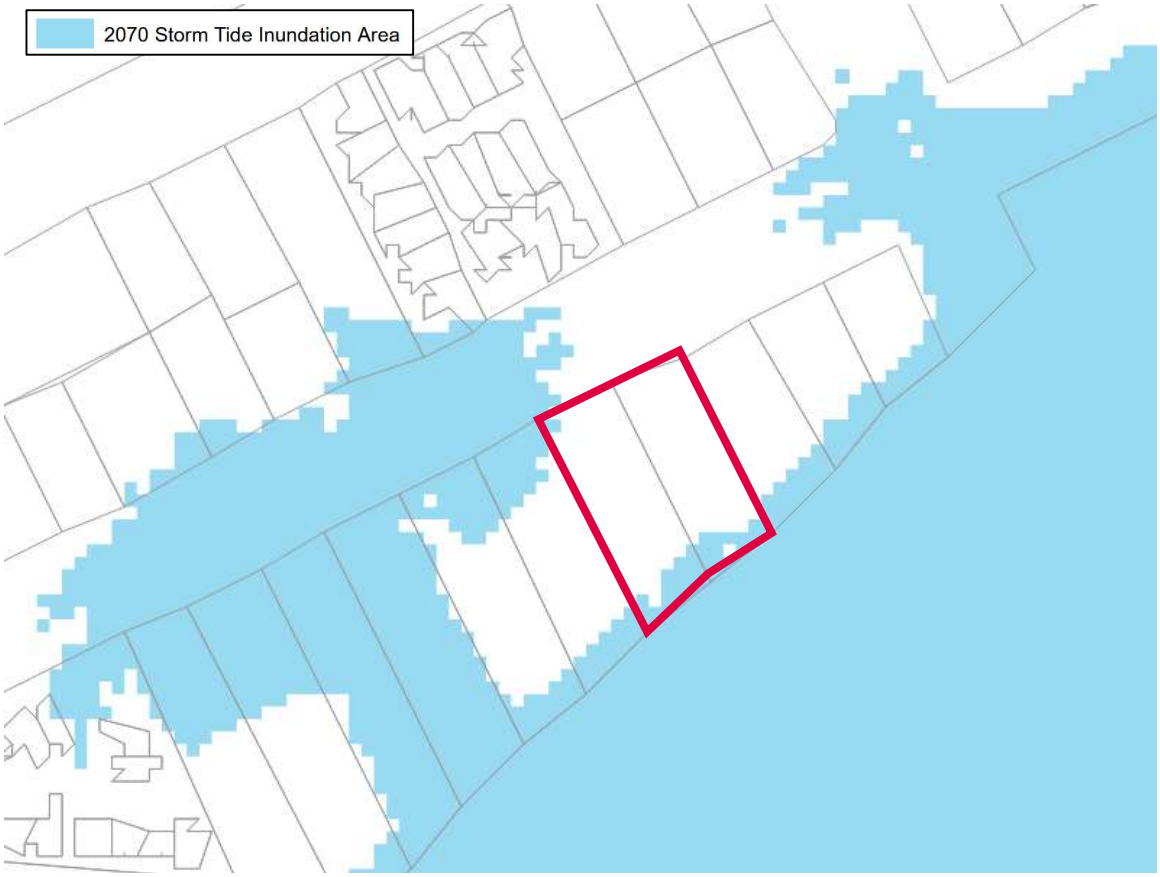

Figure 4-2 – Extract from RCC 2070 Storm Tide Hazard Map

It is important to highlight that the flood levels presented in this report are based on probability models only and that the emergency management plan is based on a 1% AEP event occurring. This does not mean that a much larger and more devastating storm tide flooding event may occur which may result in greater inundation within the site.

4.4 Hazard

Flood hazard represents the impact that flooding would have on people, vehicles and buildings and is represented as a function of flood water depth and velocity. Figure 4-3, Table 4-4 and Table 4-5 below shows the general Australian classification of flood hazard rating from Australian Rainfall and Runoff.

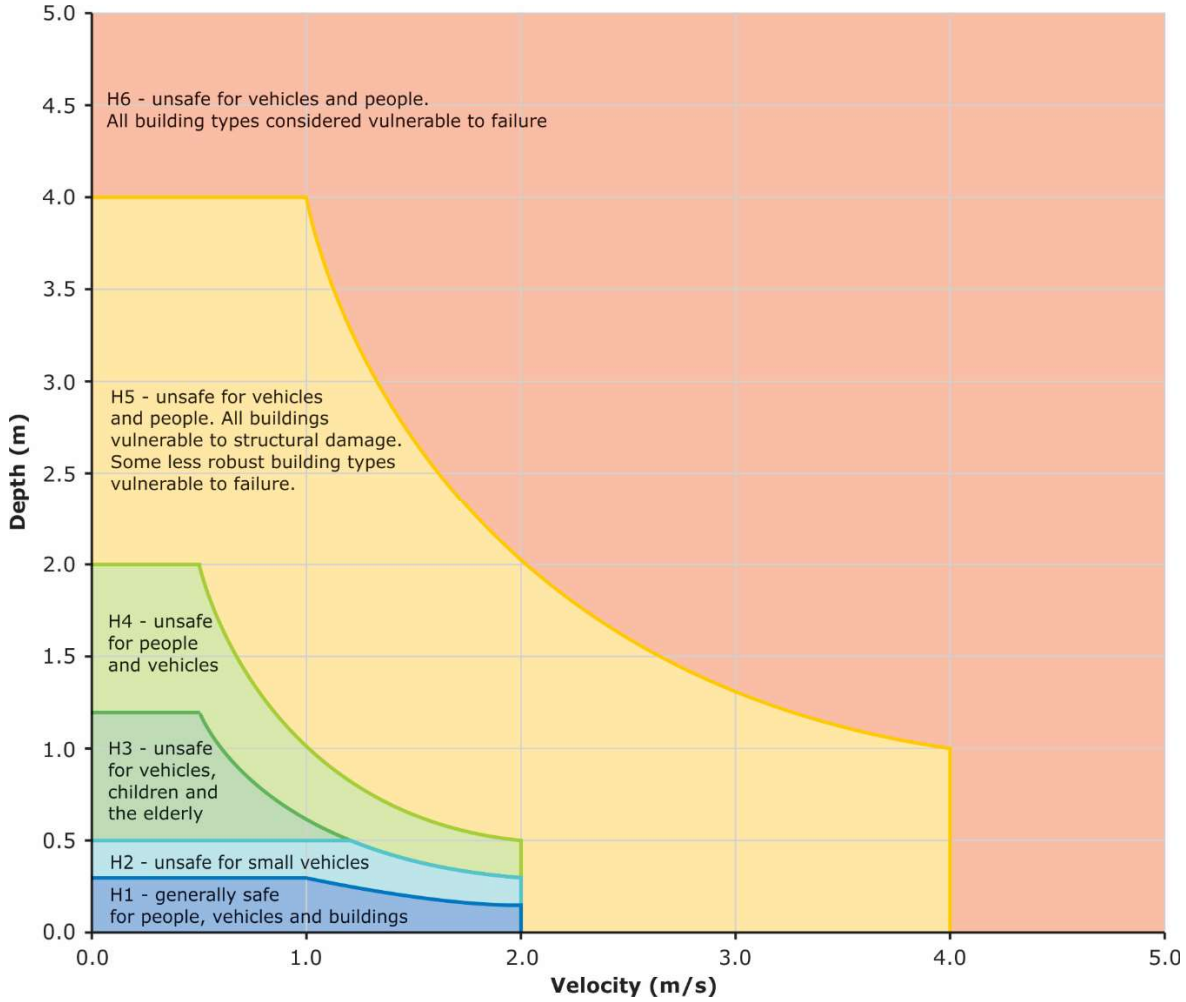

Figure 4-3 - Flood Hazard Rating (Smith et al., 2014)

Table 4-4 - Hazard Vulnerability Classification (Smith et al., 2014)

Hazard Vulnerability Classification	Flooding Source
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles. children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

Table 4-5 - Vulnerability Threshold Classification (Smith et al., 2014)

Hazard Vulnerability Classification	Classification Limit (D and V in combination)	Limiting Still Water Depth (D)	Limiting Velocity (V)
H1	D*V ≤ 0.3	0.3	2.0
H2	D*V ≤ 0.6	0.5	2.0
H3	D*V ≤ 0.6	1.2	2.0
H4	D*V ≤ 1.0	2.0	2.0
H5	D*V ≤ 4.0	4.0	4.0
H6	D*V > 4.0	-	-

The velocities of floodwaters in storm tide events on site are expected to be very low, as the presence of Minjerribah (North Stradbroke Island) provides protection from wave run-up in a storm tide event. For the purposes of hazard analysis, all velocities will be assumed as **less than 0.5m/s**.

The finished floor levels of the ground floor carpark in the proposed development are proposed to be at or above 3.46m AHD to achieve 300mm freeboard above the 1% AEP year 2100 storm tide event and therefore vehicles and belongings on the ground floor level are unlikely to be affected by storm tide inundation. The landscaped area at the rear of the site will remain at or close to existing ground level and will therefore experience some storm tide inundation up to 1.1m deep at the property boundary, however the retaining wall around the proposed building will act as a barrier to the floodwaters.

Shore St East is expected be affected by storm tide inundation in the future, which may limit the ability of residents to access or evacuate the site during large storm tide events. Three critical flood hazard locations were identified as being relevant to the movement of residents to and from the site as shown in Figure 4-4.

Figure 4-4 – Proposed flood evacuation plan

Table 4-6 summarises the depth of inundation and hazard classifications for these critical flood hazard locations based on the existing road levels and expected peak storm tide levels for the site.

Table 4-6 - Subject Site Vulnerability Classification

Flood Event	Inundation depth / Hazard class		
	Hazard Location #1 (RL 2.67m)	Hazard Location #2 (RL 2.50m)	Hazard Location #3 (RL 2.25m)
1% AEP storm tide flood (year 2016) RL 2.36m	0mm (H1)	0mm (H1)	110mm (H1)
1% AEP storm tide flood (year 2070) RL 2.77m	10mm (H1)	270mm (H1)	520mm (H3)
1% AEP storm tide flood (year 2100) RL 3.16m	490mm (H2)	660mm (H3)	910mm (H3)

As can be seen, there is very low risk of inundation of the evacuation route along Shore St East under current day modelling however as sea level rise takes effect the 1% AEP storm tide levels will slowly increase to the stage where this route could become be un-trafficable by the year 2100.

4.5 Rate of Rise and Duration of Inundation

The rate of rise provides an indication as to how quickly flood waters can rise over time for various flood events. It is an indicator as to how quicky the site could be inundated and helps inform people of the imminent flood risk on site.

The duration of inundation gives an indication as to the period of time in which the site will be inundated for various flood events.

Both the rate of rise and duration of inundation for a storm tide event is difficult to predict with accuracy as variables such as storm intensity and duration, wind direction, wave height and tide levels all play a part. To give some idea, the highest rate of rise would occur under a scenario where a fast moving storm event caused a rapid storm surge which coincided with a rising tide. Based on a storm surge that built to a peak over a duration of two hours, the rate of rise for the subject site would be **approximately 0.72m/hr**. This estimation is to be used as a guide only as the rate may be higher under certain circumstances.

The duration of inundation would be at a maximum under a scenario where a slower moving storm event caused a gradual build up of storm surge and the peak coincided with a high tide. For the subject site, this means the critical egress from the site along Shore St East (Hazard Location #2) would be inundated for a period of up to **approximately 3.5 hours** (based on a minimum tidal rate of rise/fall of 0.40m/hr and the 0.660m of predicted inundation in 2100). This estimation is to be used as a guide only as the duration may be longer under certain circumstances.

4.6 Warning Time

The available warning time for storm tide inundation of Shore St East will be dependent on the local weather forecasting agencies and the frequency of their weather updates. Residents will generally have ample warning of approaching large low pressure systems/cyclones or be warned of conditions favoring the formation of these events via updates from agencies such as the Bureau of Meteorology. Significant storm surges are generally associated with larger low pressure systems which often build over days rather than the short intense tropical storms that can rapidly form. It is likely that residents will have **in excess of 24-48 hours** of warning time of an approaching low pressure system which could lead to possible inundation in Shore St East.

4.7 Climate Change

The Intergovernmental Panel on Climate Change (IPCC) have predicted that climate change will influence weather patterns and contribute to a rise in sea levels over time. The storm tide level predictions given by RCC incorporate the widely adopted expected sea level rise of 800mm by the year 2100. The severity and frequency of storms and cyclones is also expected to become more extreme due to climate change, however the additional allowance for wave run-up does not apply to the subject site as the bay is adequately sheltered from the open ocean by Minjerribah (North Stradbroke Island).

This document is intended to give advice based on the currently understood knowledge of the impact of climate change and will need to be reviewed and updated over time to ensure the information remains accurate.

5 Emergency Response Considerations

5.1 Flood Warning

Monitoring the weather forecasts and warnings will be an important step in managing the flood risk for the site.

The Bureau of Meteorology issues weather forecasts for the Cleveland region at this link – http://www.bom.gov.au/places/qld/cleveland/Queensland Weather Warnings are issued via the Bureau of Meteorology's website and can be reviewed at this link - http://www.bom.gov.au/qld/warnings/. The key warnings that the nominated Flood Warden will need to look out for are 'severe weather warnings' that apply to the Redland Bay region, including the surrounding waters.

As the severity of the inundation will be affected by the tide levels, the nominated Flood Warden may also take into consideration the tide patterns when developing a response to a flooding threat. The tide levels for the nearest tidal monitoring station (the Brisbane Bar) can be found at the following link - http://www.bom.gov.au/australia/tides/#!/qld-brisbane-bar

Redland City Council has an excellent disaster dashboard website that posts all current community alerts including storm and flood alerts and allows users to sign up to receive free alert notifications via SMS or email. The disaster dashboard can be found at the following link - https://disaster.redland.qld.gov.au/

5.2 Evacuation Considerations

The flood modelling shows that although the proposed development site itself is unlikely to be affected by inundation, Shore St East may become un-trafficable during a 1% AEP storm tide event for a number of hours. Residents of the proposed development will need to be warned to move their cars from the street and advised to evacuate to higher ground to prevent being cut off from critical services. Evacuation will also need to cease once the inundation depth at critical flood hazard location #2 in Shore St East reaches 300mm and becomes unsafe for vehicles.

5.3 Time Required to Evacuate

The time required for the residents of the site to evacuate was calculated using the following assumptions:

- Number of apartments: 30
- Number of car parks: 63
- Warning SMS was sent at an appropriate time
- Door knocks are required for each apartment
- Residents should be made aware of the possibility of evacuation prior and asked to move their cars from Shore St East
- Assume the facility is completely full
- Evacuation during the night (worst case)

Table 5-1 - Evacuation time summary

Activity	Time Required (hours)	Notes
Door knocking	2.5	Assume approximately 5 minutes per apartment
Evacuation preparation	3	Allow time for human error/panic, children, confusion, etc.
Cars existing facility	2	Assume 1 car leaves the facility every 2 minutes due to traffic
TOTAL	7.5 hours	

The total time estimated for the residents of the site to evacuate to higher ground is approximately 7.5 hours. This is significantly shorter than the approximate warning time for the storm tide flooding event outlined in section 4.6 (24-48 hours +).

It is noted the above evacuation time is an estimate for the worst-case scenario of a completely full residence for a night evacuation and thus it is possible an evacuation will require less time than specified above.

5.4 Evacuation Route

The nominated vehicular evacuation route is shown below in Figure 5-1. All vehicles are to be moved to a higher location above the 1% AEP flood level, with suitable carparking spaces available along both sides of North St. Residents will be encouraged to remain on higher ground for the duration of the flooding event to ensure access to critical or emergency services.

Figure 5-1 – Proposed flood evacuation plan

5.5 Emergency Contacts

Table 5-2 and Table 5-3 below show the contact details for relevant local emergency contacts, infrastructure providers and government agencies which could be used in the event of an emergency.

Table 5-2 - Emergency Contacts

Name	Address	Telephone Number
Ambulance, Fire, Police (Emergency)		000
Queensland Police – Redland Bay Station	60 Hamilton St, Redland Bay	3829 4111
Queensland Police – Non-Urgent Main Number 24 Hours		3364 6464
Medical	**Emergency**	**000**
QLD HEALTH	www.health.qld.gov.au	13 43 25 84
Redland Hospital	Emergency Centre	3488 3111
Mater Private Hospital	Emergency Centre	3163 1000
Princess Alexandra Hospital		3240 2111
Queen Elizabeth II Hospital		3169 9700
St Andrews Private Hospital		3834 4444
St Andrews Private Hospital	Emergency Centre	3834 4455
Wesley Private Hospital		3232 7000
Government & Emergency Services		
State Emergency Services		13 25 00
Energex	Loss of Supply	13 62 62
Energex	Fallen Power Lines or Emergencies	13 19 62
Poison Information Centre		13 11 26
Redland City Council		3829 8999
Urban Utilities	Faults and emergencies	13 23 64
Telstra (Smart Community Help)		1800 008 994

Table 5-3 - Government Contact Information

Name	Telephone Number or Description	Website
Bureau of Meteorology	Weather updates, weather warning and tsunami warning information	http://www.bom.gov.au/
Queensland Disaster Management Services	Information on preparing, Emergency Alerts issued and current information on disaster events.	https://www.disaster.qld.gov.au/
Queensland Tropical Cyclone Warnings	1300 659 212	http://www.bom.gov.au/cyclone/index.shtml

Name	Telephone Number or Description	Website
Queensland Land Weather and Flood Warnings	1300 659 219	www.bom.gov.au/hydro/flood/qld
Queensland Coastal Marine Warnings	1300 360 427	http://www.bom.gov.au/marine/
Queensland General Warnings	1900 969 922 (call costs apply)	http://www.bom.gov.au/qld/warnings/
Australian Tsunami Threat Information	1300 878 6264 (1300 TSUNAMI)	http://www.bom.gov.au/tsunami/
Road Closures – South East Queensland	13 19 40	https://qldtraffic.qld.gov.au/
Animals and wildlife RSPCA	1300 ANIMAL (1300 264 625)	https://www.rspcaqld.org.au/

6 Flood Emergency Management Plan

The Body Corporate Manager will be responsible for implementation of the Flood Emergency Management Plan unless other personnel have been nominated as the designated Flood Warden. It is critical that multiple people are familiar with the procedures and are in a position to enact the evacuation in the event of the Body Corporate Manager being away from site.

6.1 Before a Flood

Trigger for action – Always

Actions

- All residents will be made aware of the possibility of flooding along Shore St East, the Flood Emergency Management Plan and the procedures to be followed if a flood were to occur.
- All residents to register for Redland City Council Disaster Dashboard alert service to stay informed of flood and severe weather warnings in the area.
- All residents to have a personal evacuation strategy in the event of a flood.
- Body Corporate to nominate the Flood Warden/s who can enact the evacuation procedures of this FEMP.
- A contact list for residents will be maintained with residents' names, email addresses, mobile phone numbers and next of kin/emergency contact details.
- A fully charged and functional mobile phone will be kept by the Flood Warden/s at all times.
- A computer with internet access and at least six hours independent power supply will be kept on site at all times.
- An automated messaging software program is to be installed on the computer so that SMS and emails can be sent to residents promptly. Pre-written message templates are to be prepared for each of the typical messages which need to be issued to residents.
- Management is to maintain an emergency kit including a portable radio to listen to ABC Radio warning broadcasts, torches, spare batteries and a first aid kit.
- The weather forecast and warnings will be checked by the Flood Warden every morning to identify any potential heavy rainfall forecast in the area.

6.2 When a Flood is Possible

Trigger for action – A storm tide or tidal inundation warning is issued for the Redland Bay area

Actions

- The nominated person responsible for forecast and observation monitoring will monitor forecasts, severe weather warnings, weather radar and the RCC disaster dashboard at least every 60 minutes.
- Residents are to be notified by email or SMS of a possible storm tide or tidal inundation event and that they should be prepared for evacuating their vehicles to higher ground along North St.
- Residents and visitors are encouraged to proactively move vehicles to higher ground, especially if they are expecting to be away from the site for any length of time before the warnings are lifted.

6.3 During a Flood

<u>Trigger for action</u> – A storm tide or tidal inundation flood alert is issued for the Redland Bay area

Actions

- The nominated person responsible for forecast and observation monitoring will monitor forecasts, severe weather warnings, weather radar and the RCC disaster dashboard continuously.
- Residents are to be notified by email, SMS and/or door knock that they are required to evacuate their vehicles and move them to higher ground as per the suggested evacuation areas shown on the evacuation plan.

<u>Trigger for action</u> – Floodwaters inundate Shore St East at critical flood hazard location #2 (near the Cross St intersection) and it becomes non-trafficable (>300mm depth of water measured at the crown of the road).

Actions

- Residents will be notified by email or SMS that that Shore St East is no longer safe to evacuate vehicles and they are to keep them on site and remain in their apartments until the flood waters have receded. There is no need for residents to personally evacuate, as they can stay in their apartments without risk of being stranded for an extended period of time.

6.4 After a Flood

<u>Trigger for action</u> – Flooding did not enter the ground floor of the building

Actions

- Clean accumulated debris away from areas affected by flooding to remove any slip hazards
- A hazard assessment is to be undertaken for the clean-up, safe work methods statements will be prepared and personal protective equipment supplied consistent with the known hazards which can be associated with floods:
    - Slips, trips and falls
    - Heavy debris
    - Contaminated water and sediments
- Notify residents by email and/or SMS that it is safe for them to return (if they have left the complex)
- Following the return of residents, a de-brief will be held with the residents, body corporate members and Flood Wardens to review the flood event, the response and the procedures in the Flood Emergency Management Plan.
- Changes are to be made to the Flood Emergency Management Plan where required to ensure future emergency evacuations are improved.
- Residents are to be provided with a copy of the updated Flood Emergency Management Plan if changes are made.

Trigger for action – **Flooding entered the ground floor of the building AND emergency services have given the all clear to return to the buildings**

Actions

- No residents will be allowed to return to the buildings until floodwaters have subsided and the emergency services have given the all-clear to return.
- All flood affected parts of the premises will be appropriately cleaned and utilities checked by professionals before residents can return.
- A hazard assessment is to be undertaken for the clean-up, safe work methods statements will be prepared and personal protective equipment supplied consistent with the known hazards which can be associated with floods:
    - Slips, trips and falls
    - Heavy debris
    - Contaminated water and sediments
- Notify residents by email and/or SMS that it is safe for them to return (if they have left the complex)
- Following the return of residents, a de-brief will be held with the residents, body corporate members and Flood Wardens to review the flood event, the response and the procedures in the Flood Emergency Management Plan.
- Changes are to be made to the Flood Emergency Management Plan where required to ensure future emergency evacuations are improved.
- Residents are to be provided with a copy of the updated Flood Emergency Management Plan if changes are made.

7 Conclusions

Pitch Black Group was engaged by Karote ATF Chippers Trust to prepare a Flood Emergency Management Plan to support a development application at 67-69 Shore St East, Cleveland.

The development is prone to flooding from storm tide inundation and the modelling carried out by Redland City Council shows that by the year 2100 a 1% AEP storm tide (3.16m AHD) event could cause Shore St East to be inundated by up to 660mm to the east of the development near Cross St and up to 910mm in the low point to the west, making the street un-trafficable for a period of time.

This possible flooding could cause vehicles on the street to become inundated and residents in the development to become cut off from critical services for multiple hours however the risk to personal injury remains low as the floodwaters are expected to have very little velocity and a short duration of inundation.

Provided the Flood Emergency Management Plan is incorporated into the emergency procedure documentation for the development, the risk of damage to property would be very low for future residents.

8 References

Redland City Council Storm Tide Mapping Information - <https://www.redland.qld.gov.au/info/20292/redland_city_plan/915/storm_tide_mapping_information>

Queensland Fire and Emergency Services 2016, *Tropical Cyclone Storm Tide Warning Response System Handbook*, State of Queensland, viewed 17 February 2023, <https://www.disaster.qld.gov.au/dmp/Documents/Storm-Tide-Handbook.pdf#search=storm%20tide>

Redland City Council Disaster Dashboard - <https://disaster.redland.qld.gov.au/>