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FLOOD IMPACT ASSESSMENT

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FLOOD IMPACT ASSESSMENT

JET ZERO, PROJECT ULYSSES - SUSTAINABLE AVIATION FUEL PROJECT - STUART, TOWNSVILLE

FOR
JET ZERO AUSTRALIA PTY LTD

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Phone: 07 4725 5550
Fax: 07 4725 5850
Email: mail@nceng.com.au
50 Punari Street Currajong Qld 4812
Milton Messer & Associates Pty Ltd
ACN 100 817 356 ABN 34 100 817 356

DOCUMENT CONTROL

Rev	Author	Approved		Date	Issued To:	Purpose
A	Andrew Wallace	Andrew Wallace (RPEQ 6743)		17/02/2025	Client	Draft for Review
B	Andrew Wallace / Brendan Blair	Andrew Wallace (RPEQ 6743)		25/03/2025	Client	Support Development Proposal

EXECUTIVE SUMMARY

Jet Zero are proposing Australia's first Alcohol to Jet (ATJ) plant converting ethanol feedstock into Sustainable Aviation Fuel (SAF) at the Cleveland Bay Industrial Park, Stuart in Townsville. The proposed project is known as 'Project Ulysses' and herein referred to as The 'Project'. The Project includes a plant to convert ethanol derived from agricultural byproducts to SAF and Renewable Diesel (RD) using the LanzaJet ATJ Process.

The site is proposed to be developed as depicted on the Jet Zero Conceptual Overall Layout Plan in Appendix G.

NCE were engaged by Jet Zero to carry out a flood impact assessment (FIA) in support of the proposal. The purpose of this FIA is to confirm that the proposal can be carried out without causing impacts off site in respect of the existing flooding characteristics in accordance with the Townsville City Council Planning Scheme Performance Outcomes of the Flood Hazard Overlay Code as well as the State Development Area (SDA) Development Scheme. The FIA report is prepared in support of the proposed development and outlines the flood mitigation arrangements.

A review of the Townsville City Council (TCC) Flood Hazard Overlay of the Planning Scheme shows the majority of the site is outside any flood hazard area. Refer to **Figure 1-2** and **Figure 1-3**. A portion of the site is within the low and medium hazard areas and a very small proportion within the high hazard area. According to the new flood risk areas[1], the vast majority of the site is either outside the flood risk area or within the very low risk area. A small portion of the site is within the medium and high risk areas as well as an existing flow path in the very high risk area. The site is located in the TCC Ross River flood study area (2021) and a small portion of the site is impacted by the 1% Annual Exceedance Probability (AEP) flood event.

The FIA has been carried out using a fine scale mini TUFLOW model based on inputs and boundary conditions derived from Townsville City Council's new Ross River Flood Study 2021. The mini model incorporates into the baseline model scenario the existing Colinta Road subdivision which is missing from the TCC model as well as the proposed, Cleveland Bay Industrial Park Far East Development including the new road from Colinta Drive to the site.

The outcome of the assessment has demonstrated that with minor modifications in the south-west of the site, the proposal does not result in any significant flood impacts off site.

All finished floor levels (FFL) of facilities associated with the regional fuel storage are to be at or above the 0.5% AEP flood level or the defined flood event as per the TCC flood hazard overlay code, whichever is the higher.

In addition to the FIA requirements, Townsville City Council planning scheme policy nominates that the minimum finished floor level of any development is to be at or above the defined storm tide event of 3.9m AHD if greater than 100m of the shoreline.

[1] The New Flood Risk areas are based on the Flood Information Portal available on Townsville City Council's website. https://flood.townsville.qld.gov.au/?page=Flood-Hazard%2FRisk-Overlay
The New Flood Risk areas are not formally adopted in the current planning scheme but are aligned with the Ross River 2021 flood study and are included in this report for completeness.

An assessment of the February 2025 storm event which caused moderate flooding across Townsville is observed to be up to an equivalent of between 10% AEP and 5% AEP when the longer period of rainfall, 24 hour period is considered. The maximum equivalent AEP experienced for the critical duration of 9 hours, is slightly more intensive than a 20% AEP. The extent of inundation observed anecdotally in the vicinity of the site from the drone image on the 3/2/25 is moderate and considered to be aligned with the anticipated flood extent expected for the 20% AEP.

This flood impact assessment demonstrates that the development proposal can proceed without any actionable flood impacts to the surrounding properties or environment. The assessment demonstrates the development can comply with the TCC Flood Hazard Overlay Code and Planning Scheme Policy and the SDA Development Scheme.

GLOSSARY

AEP	Annual Exceedance Probability - the probability of an event being equalled or exceeded within a year.
Afflux	Defined as the relative change in a flooding characteristic (eg. WSL , Velocity)
AHD	Australian Height Datum
AIDR	Australian Institute for Disaster Resilience
ARI	Average Recurrence Interval
ARR 2019	Australian Rainfall and Runoff (2019)
ATJ	Alcohol to Jet
BoM	Bureau of Meteorology
CC	Climate Change (Modelled scenario is the RCP8.5)
DEM	Digital Elevation Model
DFE	Defined Flood Event
EY	Average number of Exceedances per Year - 1EY is exceeded on average once per year
FFL	Finished Flood Level
FIA	Flood Impact Assessment
HAT	Highest Astronomical Tide – The highest level of water that can be predicted to occur under average meteorological conditions and any combination of astronomical condition
IFD	Intensity-Frequency-Duration
LiDAR	Light Detection and Ranging (Aerial Laser Survey)
Mannings n	Measure of resistance to flow in a channel influenced by the physical roughness of the surface
MHWS	Mean High Water Springs
NCE	Northern Consulting Engineers
PMF	Probable Maximum Flood
PO	Performance Outcome
QSpatial	Queensland Spatial Catalogue - Queensland Government geospatial data and information
QUDM	Queensland Urban Drainage Manual
RAFTS / XP-RAFTS	An urban and rural runoff-routing hydrologic model
RD	Renewable Diesel
ROG	Rain on Grid – Applies rainfall directly to the model domain
SAF	Sustainable Aviation Fuel
TSDA	Townsville State Development Area
SGS	Sub-grid Sampling
TCC	Townsville City Council
TUFLOW	Two-dimensional Unsteady Flow – Flood hydraulic modelling software
WSE	Water Surface Elevation
WSL	Water Surface Level (interchangeable with WSE)

TABLE OF CONTENTS

EXECUTIVE SUMMARY i

GLOSSARY iii

1.0 INTRODUCTION 1

1.1 Overview 1

1.2 Study Area 1

1.3 Scope of Works and Purpose of the Report 3

1.4 Storm Tide 4

1.5 Limitations 5

1.6 Proposed Development 5

2.0 AVAILABLE DATA 6

2.1 Topographic Information 7

2.2 Spatial Data 7

2.3 Aerial Imagery 7

2.4 Previous Reports 8

2.4.1 2021 Ross River Flood Study – Baseline Flooding Assessment 8

3.0 MODELLING METHODOLOGY 8

3.1 Hydrologic Modelling 10

3.1.1 Rain on Grid 10

3.1.2 ROG Modifications 11

3.1.3 Losses 11

3.1.4 Critical Duration Assessment 11

3.2 Hydraulic Modelling 12

3.2.1 TUFLOW 12

3.2.2 Hydraulic Roughness 12

3.2.3 Boundary Conditions 13

4.0 FINDINGS, RESULTS AND DISCUSSION 14

4.1 Baseline Scenario 15

4.1.1 Digital Elevation Model (DEM) Modifications – TUFLOW 15

4.1.2 Baseline Critical Duration – TUFLOW 15

4.1.3 Existing Culverts 16

4.2 Verification and Comparison to the Existing Ross River Flood Study 2021 16

4.3 Review of past events 17

4.4 Sensitivity Assessments 18

4.5 Developed Scenario 19

4.5.1 Digital Elevation Model (DEM) Modifications – TUFLOW 19
4.5.2 Rain-on-grid Design Discharge 21
4.5.3 Initial Water Levels 21
4.5.4 Fill Extents 21
4.5.5 Mitigation Measures 21
4.6 Results 22
4.6.1 Afflux 22
4.6.2 Peak Flood Elevations and Depths 23
4.6.3 Peak Velocity 24
4.6.4 Flood Hazard 24
4.6.5 Climate Change Assessments 25
4.6.6 Joint Probability Assessment 25
5.0 CONCLUSION AND RECOMMENDATIONS 26
6.0 REFERENCES 28

LIST OF TABLES

Table 3-1 Land use / materials inputs 13
Table 3-2 Flood events assessed 13
Table 3-3 Downstream Fixed Water Levels From Ross River Model 13
Table 4-1 Result map plots 14
Table 4-2 Culverts added to the baseline model 16
Table 4-3 Mitigation Measures 21
Table 5-1 Summary of the FIA mapping 27

LIST OF FIGURES

Figure 1-1 Study area locality 2
Figure 1-2 TCC Existing Flood Hazard 3
Figure 1-3 TCC New Flood Risk 4
Figure 1-4 Proposed development – preliminary site layout plan 6
Figure 1-5 Project Ulysess 3D Image 6
Figure 2-1 Model DEM (Inclusive of Cleveland Bay Industrial Park Far East Development) 7
Figure 4-1 TCC Drone image of the site during the February 2025 flood event. 17
Figure 4-2 Stuart Creek Alert Location 18
Figure 4-3 Intensity-Frequency-Duration AEP Assessment 18
Figure 4-4 Cleveland Bay Industrial Estate - Far East Development road configuration 20
Figure 4-5 Model General Arrangement 20
Figure 4-6 AIDR – Figure 6 - General flood hazard vulnerability curves 24

APPENDICES

APPENDIX A

Model Setup Maps

APPENDIX B

Flood Afflux Results

APPENDIX C

Water Surface Elevation Results

APPENDIX D

Flood Depth Results

APPENDIX E

Flow Velocity Results

APPENDIX F

Flood Hazard Results

APPENDIX G

Site Layout Plan

1.0 INTRODUCTION

1.1 Overview

Jet Zero are proposing Australia's first Alcohol to Jet (ATJ) plant converting ethanol feedstock into Sustainable Aviation Fuel (SAF) at the Cleveland Bay Industrial Park, Stuart in Townsville. The proposed project is known as 'Project Ulysses' and herein referred to as The 'Project'. The Project includes a plant to convert ethanol derived from agricultural byproducts to SAF and Renewable Diesel (RD) using the LanzaJet ATJ Process.

The site is proposed to be developed as depicted on the Jet Zero Conceptual Overall Layout Plan in Appendix G.

The model layout is shown in **Figure 1-1** and in **Appendix A**.

NCE were engaged by Jet Zero to carry out a flood impact assessment (FIA) in support of the proposal. The purpose of this FIA is to confirm that the proposal can be carried out without causing impacts off site in respect of the existing flooding characteristics in accordance with the Townsville City Council Planning Scheme Performance Outcomes of the Flood Hazard Overlay Code as well as the Townsville State Development Area (TSDA) Development Scheme. The FIA report is prepared in support of the proposed development and outlines the flood mitigation arrangements.

This FIA report is prepared in support of the proposed development and outlines the proposal including the flood outcomes.

It's based on inputs from the Townsville City Council (TCC) Ross River Flood Study (2021), TUFLOW baseline model in order to assess the proposed development.

NCE have developed a fine scale TUFLOW model that incorporates the Australian Rainfall & Run-off 2019 (ARR2019) hydrology to ensure the assessment accurately depicts the flood conditions provided in the new TCC Ross River model. Further detail on the model background is provided herein.

1.2 Study Area

The site is located in the suburb of Stuart within the Cleveland Bay Industrial Park and located approximately 1.1km east of Colinta Road, 1.5km north-east of JBS Foods beef production facility and 2.5km north-west of the Sun Metals plant.

A flood impact assessment has been carried out using a fine scale mini TUFLOW model based on inputs and boundary conditions derived from Townsville City Council's new Ross River Flood Study 2021. The mini model incorporates the existing Colinta Road subdivision which is missing from the TCC model as well as the proposed, approved new road from Colinta Drive to the site, as part of the baseline model scenario.

The mini model study area is bounded by the Bruce Highway near Hunter Street and Zinc Road in the south, Ron McLean Dr / Port Access Road at the west, a ridge to the north of the Cleveland Bay sewerage treatment plant and the Sandfly Creek estuary to the north, the Cleveland Bay coastal dunes to the north-east and the Sun Metals solar farm in the south-east.

The site and surrounds are represented entirety within the TCC Ross River (2021) TUFLOW baseline model and is dominated by the following drainage features.

- North of and adjacent to the site is dominated by widespread tidal salt plains.

- Sandfly Creek approximately 150m to the east of the site and which meanders towards the north-east and further downstream ultimately traverses towards the north-west.

- Minor drainage features from the south / south-west which discharge to a dam south of the site and discharges over an earth embankment into a drainage feature in the far south-west of the subject site.

- There are a number of tributaries of Sandfly Creek and other drainage features north-east of the site which, whilst are remote from the site, were considered to potentially influence flooding at the site, so therefore included in the model extent.

- A constructed drainage channel north-west of the site adjacent to Gartrell Dr and at the north at Stuart Drive.

- The existing subject site generally grades from the south to the north with levels that vary from approximately 4.75m to 3.5m AHD (This will be a minimum 3.9m AHD following completion of the unrelated Cleveland Bay Industrial Park Far East Development).

Access to the site is to be via the approved new road from Colinta Road which is approved for construction as part of an unrelated project. This road crosses the existing flow path and waterway downstream from the existing dam via a major culvert and high level crossing to the south-west of the site.

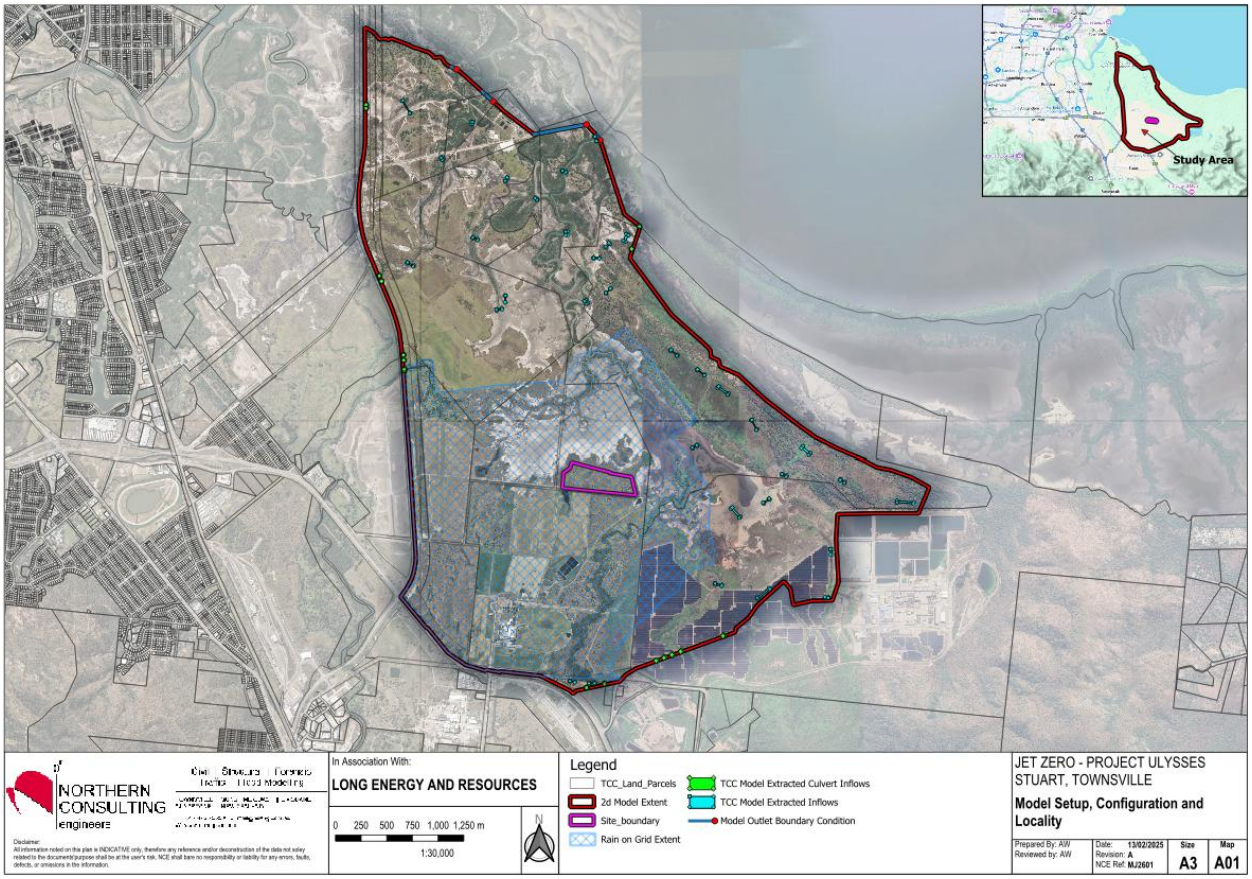


Figure 1-1 Study area locality

The site is currently vacant with the baseline flood mapping showing the site is largely immune from flooding across the site including during significant storm events. Refer to Section 4.3 for details of the recent storm events experienced in Townsville.

1.3 Scope of Works and Purpose of the Report

The purpose of this flooding impact assessment is to confirm the proposal can be carried out without causing impacts off site in respect of the existing flooding characteristics in accordance with the Performance Outcomes (PO) of the Flood hazard overlay code and the Townsville State Development Area (TSDA) Development Scheme.

A review of the Townsville City Council (TCC) Flood Hazard Overlay of the Planning Scheme shows the majority of the site is outside any flood hazard area. A portion of the site is within the low and medium hazard areas and a very small proportion within the high hazard area.

A review of TCC's new flood risk areas carried out on the 13/03/25, showed the vast majority of the site is either outside the flood risk area or within the very low risk area[2]. A small portion of the site is within the medium and high risk areas as well as an existing flow path in the very high risk area. The site is located in the TCC Ross River flood study area (2021) and a small portion of the site is impacted by the 1% Annual Exceedance Probability (AEP)[3] flood event.

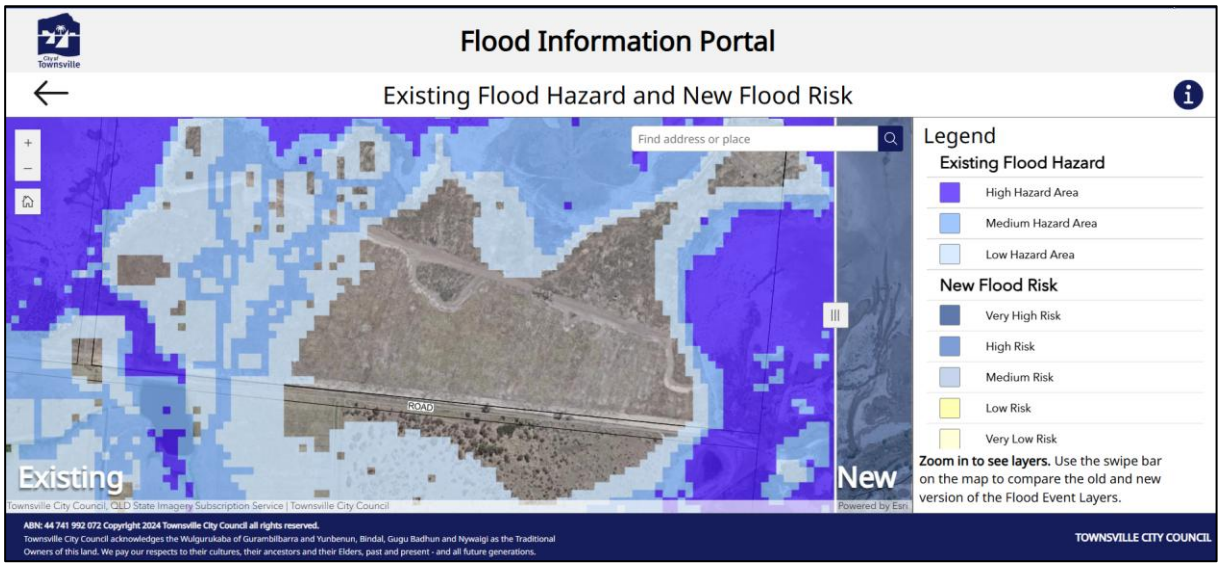


Figure 1-2 TCC Existing Flood Hazard

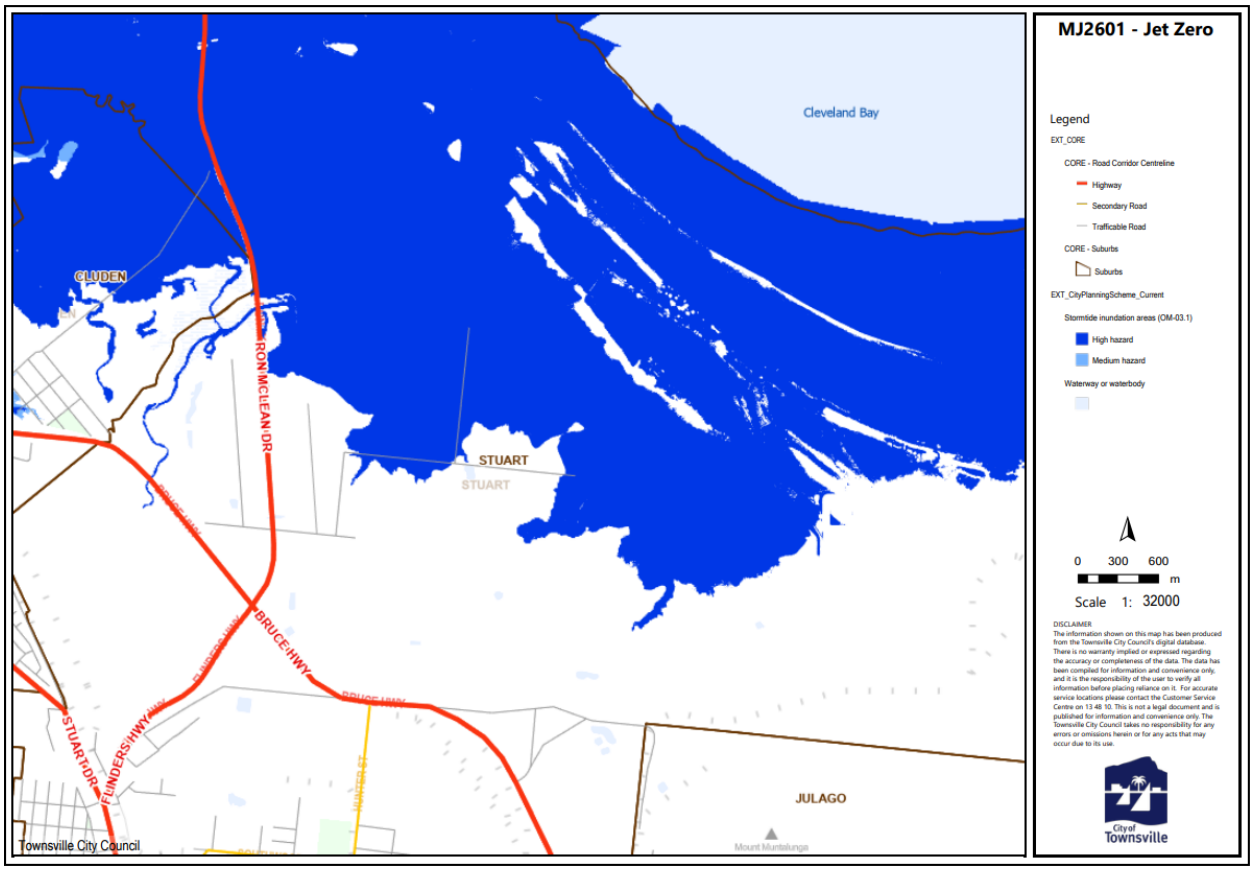
[2] The New Flood Risk areas are based on the Flood Information Portal available on Townsville City Council's website. https://flood.townsville.qld.gov.au/?page=Flood-Hazard%2FRisk-Overlay
The New Flood Risk areas are not formally adopted in the current planning scheme but are aligned with the Ross River 2021 flood study and are included in this report for completeness.

[3] AEP refers to the annual exceedance probability, given as a percentage and is defined as the probability of an event being equalled or exceeded within a year. For example, the 1% AEP event has a 1% chance of being equalled or exceeded in a given year. This had previously been referred to as the 100 year ARI (average recurrence interval), but was replaced as the AEP terminology best conveys the likelihood of flooding and is less open to misinterpretation by the public. For major events, the AEP = 1/ARI. For minor or more frequent events, the relationship varies. eg. The 20% AEP event varies from the 5 year ARI (equal to the 4.48years).

Figure 1-3 TCC New Flood Risk

1.4 Storm Tide

The coastal hazard overlay map from the Townsville City Council Planning Scheme shows the site is primarily outside the storm tide inundation areas. It is noted that the storm tide extents do not consider wave runup.



To achieve the above objectives, the scope of works incorporates:

- Develop a fine-scale 2D TUFLOW flood mini-model based on the provided TCC Ross River (2021) flood model;

- Adopt the hydrology and critical duration as provided in the Ross River Flood Report mapping and modelling;
- Model the 1% Annual Exceedance Probability (AEP) critical duration design event to compare the mini-model baseline to the Ross River (2021) model;
- Based on the proposal, it is understood this is regional fuel storage and as such triggers the level of flood immunity of 0.5% AEP;
- Model the 0.5% AEP, 1% AEP defined flood event and 20% AEP (minor event) critical duration events to determine the extent and magnitude of impacts to the existing flood characteristics;
- Identify mitigation measures necessary to reduce impacts to acceptable levels whilst maintaining as much of the proposed development, or reducing the development extent as required;
- Delivery of report and associated flood mapping.

1.5 Limitations

In order to assess the implications of the proposed development extent, NCE has acquired TCC's Ross River (2021) TUFLOW model under a Confidentiality Deed. Details regarding the development of this model are provided in the 2021 Ross River Flood Study report, which was provided in conjunction with the model. An audit of this model has not been undertaken, however, as the model has been calibrated, approved for use by TCC and promoted for use to inform planning and development decisions, it is reasonable to expect that industry standard modelling practices have been incorporated in both the hydrological and hydrodynamic components and is therefore suitable for this type of assessment.

Development or modification of the models necessary to undertake this assessment have been conducted in accordance with good engineering practices, however, is bound by the practical limitations of the accuracy of information and data used for the modelling, and the software. The information produced in this report is accurate at the time of issue and is based on the information available at the time of the analysis. The report has been prepared by NCE for Jet Zero and bound by the LERA services agreement as well as the TCC Confidentiality Deed. All information contained herein is considered to align with the content and intent of the agreement.

NCE otherwise disclaims responsibility to any person other than the client arising in connection with this report. NCE also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by NCE in connection with preparing this report were limited to those specifically detailed in the scope and limitations of the report.

The opinions, conclusions and any recommendations in this report are based on assumptions made by NCE described in this report. NCE disclaims liability arising from any of the assumptions being incorrect.

NCE has prepared this assessment on the basis of information provided by 3rd parties, which NCE has not independently verified or checked beyond the agreed scope of work. NCE does not accept liability in connection with such unverified information, including errors and omissions in the supplied information.

1.6 Proposed Development

In accordance with the scope of works, Jet Zero are proposing Australia's first Alcohol to Jet (ATJ) plant converting ethanol feedstock into SAF and RD. The preliminary layout is depicted in **Figure 1-4** and **Figure 1-5** below and in **Appendix G**.

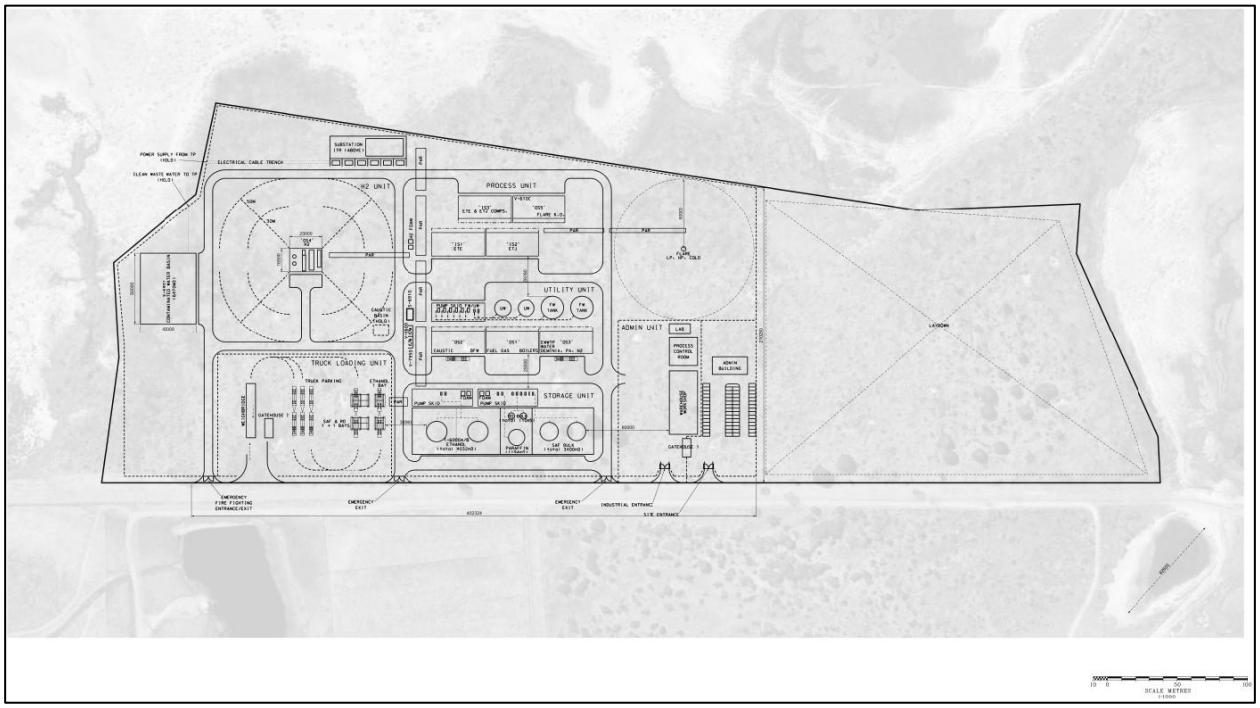


Figure 1-4 Proposed development – preliminary site layout plan

Figure 1-5 Project Ulysess 3D Image

2.0 AVAILABLE DATA

This report and the associated hydrologic and hydraulic models have been largely prepared based directly or indirectly on the information contained in reports from previous studies, including but not limited to the 2021 Ross River Flood Study.

2.1 Topographic Information

For the TUFLOW model, the digital elevation model (DEM) is based on Light Detection and Ranging (LiDAR) survey data over the entire hydraulic model extent that was captured as part of the Townsville City Council 2016 LiDAR project and sourced from the Open Data portal. NCE note that the 2016 LiDAR was utilised in place of the 2019 LiDAR as this was adopted by the 2021 Ross River flood model.

The available survey data in the vicinity of the site was incorporated to ensure better definition of key features.

Figure 2-1 depicts the model DEM in the vicinity of the site.

Where the model was shown to be inaccurate or not representative of the terrain on site, NCE incorporated areas where better definition terrain was available. The available survey data was incorporated to ensure better definition of key features.

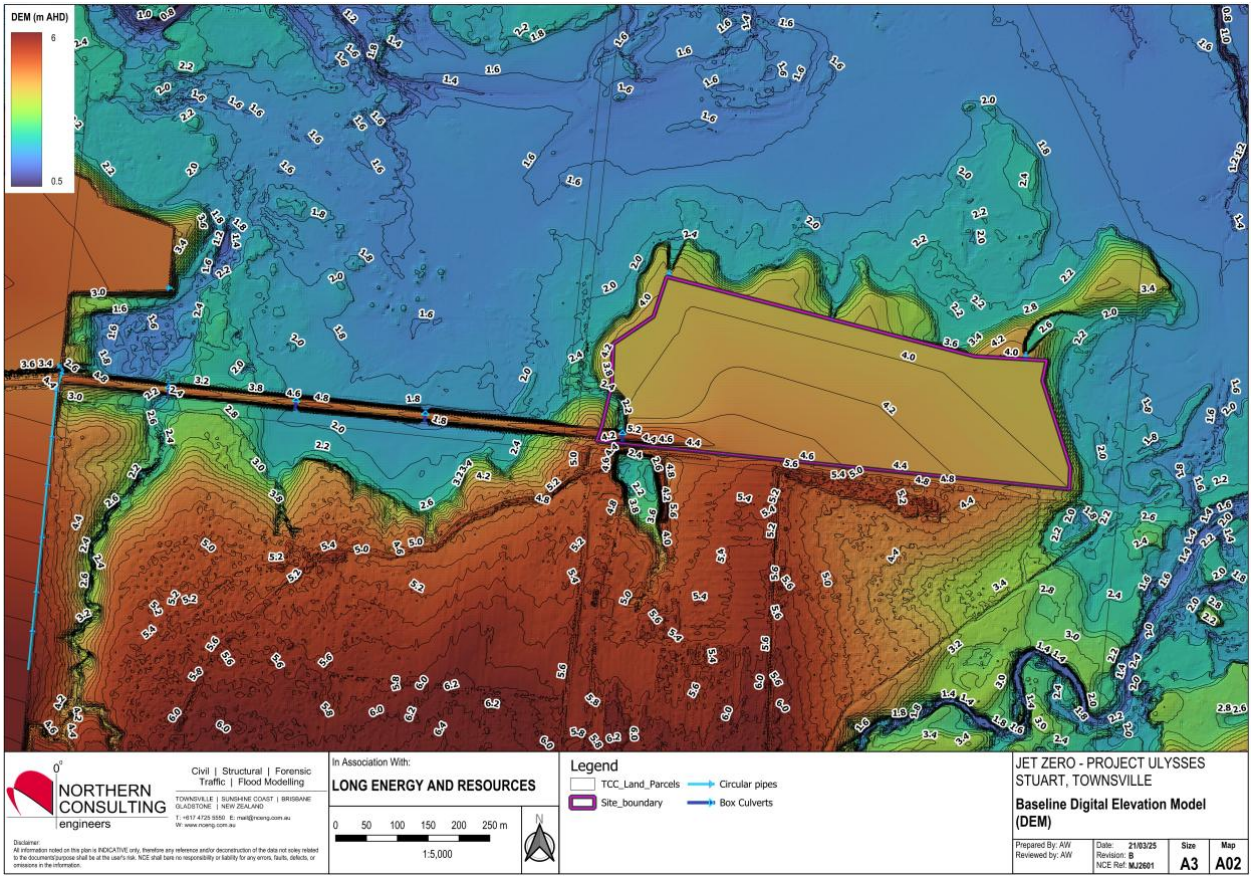


Figure 2-1 Model DEM (Inclusive of Cleveland Bay Industrial Park Far East Development)

2.2 Spatial Data

The following data was acquired to undertake this assessment:

- Cadastral data and other various data sources (i.e. watercourses, broad catchments, etc) of the site and surrounding area, sourced from the Queensland Government's QSpatial catalogue and TCC.

2.3 Aerial Imagery

Aerial imagery has been sourced from Google satellite sources. This imagery has been utilised verify and inform the roughness / land use mapping and flood results mapping. However the majority of the roughness values are aligned with the Ross River Flood Study 2021.

2.4 Previous Reports

2.4.1 2021 Ross River Flood Study – Baseline Flooding Assessment

The report details the technical setup and calibration of the TUFLOW model which includes:

- a DEM resolved to a 5 m grid, utilising sub-grid sampling (SGS);
- underground drainage network including everything captured in the TCC Open Data Portal and additional surveyed network items;
- bridges applied as layered flow constrictions within the model;
- application of direct rainfall over the majority of the grid model (rain-on-grid (ROG). [It is noted that the area of the mini model is not within the TCC model rain on grid extents.]
- additional inflows derived from XP-RAFTS hydrologic models for the:
    - Ross Creek catchment,
    - Lower Ross River catchment, and
    - Mundy Creek catchment;
- Storm tide inundation applied at the downstream end of the model.

The calibrated and verified model was used to assess design storm flood events with the results used to:

- quantify the floodplain hydraulic response;
- evaluate potential impacts on properties;
- identify flood hazard zones;
- inform planning and development works within the catchment;
- identify emergency management considerations.

The results of this model were used to verify / compare the results from NCE's fine scale TUFLOW model as outlined below. Map A04 in Appendix A shows the afflux map which depicts the difference between the Mini model and the Ross River water surface levels.

3.0 MODELLING METHODOLOGY

The basis for the updated hydraulic modelling has been undertaken using the Ross River (2021) TUFLOW model, which is a dynamically linked hydrodynamic model that couples 1D structure (culverts, bridges, etc) hydraulics and 1D subsurface drainage networks with a 2D terrain model. Technical details of the model set-up are described in the Ross River (2021) Flood Study report with technical changes to the model discussed below.

To undertake this study, a new fine scale 2D TUFLOW model has been developed to assess the potential impact associated with the proposed development. As this site is located within a broader catchment, external flows and downstream tailwater levels were adopted from the TCC flood model. The model was revised with flows as well as downstream levels extracted and incorporated into the fine scale model.

The 2021 TCC flood model was utilised to determine the critical duration event(s). Further detail on the critical duration is provided in Section 3.1.4 below.

NCE carried out an assessment of the development site baseline scenario which includes Cleveland Bay Industrial Park "Far East Development" fully completed.

Given the nature of the assessment, the modelling to identify the required mitigation measures was an iterative process, where one set of results was used to inform or refine the subsequent simulation. With this in mind, the following approach was taken.

TUFLOW

For this assessment, as discussed herein a site specific 1D / 2D TUFLOW model has been developed which has adopted the HPC solver, sub-grid sampling (SGS) and the following methodology:

- Development of a fine scale model, adopting similar or where justified, updated parameters as the calibrated Ross River (2021) TUFLOW model.
- Introduce flood reporting locations at the relevant inflow and downstream boundary locations and run the 2021 Ross River model to obtain the results required for the model inputs in the mini model.
- Incorporate the design terrain aligned with the design documentation of the Colinta Road subdivision, which is not part of the Ross River (2021) TUFLOW model, as part of the baseline scenario.
- Incorporate the design terrain aligned with the design documentation of Langtree Cleveland Bay Industrial Park "Far East Development" as part of the baseline scenario. This includes the access road to the Jet Zero site from Colinta Road as well as the associated drainage and site earthworks.
- Introduce rain on grid in the southern and central portion of the model extent to better represent runoff at all locations upstream and in the vicinity of the site.
- Simulate the 1% and 20% AEP event for the critical duration events outlined in the Ross River flood results to verify / compare the model results.
- Simulate the 0.5% AEP event for the critical duration outlined in the Ross River flood results to provide the design flood levels relevant to the site.
- Update hydrology and other model parameters where appropriate to better correlate with the provided Ross River (2021) flood results.
- Confirm the critical duration against the provided flood model results for the Ross River (2021) model and modify the adopted parameters if necessary.
- Incorporate the proposed development to determine any impacts off site.
- Reduce the development extent and / or introduce mitigation measures where required. Iterate until an acceptable outcome is identified.
- Carry out sensitivity assessments including for the 1% AEP climate change event.

In accordance with TCC Planning Scheme flood hazard overlay code, the defined flood event (DFE) is the 1% AEP, being the event which the development is to be assessed against. The fill extent and assessment to demonstrate non worsening is assessed based on the DFE critical duration(s).

The 20% AEP event was the adopted minor event as determined from the development manual planning scheme policy - Stormwater quantity. The actual event listed in the development manual for industrial sites is the 5 year ARI, however based on the new flood model and ARR 2019, the 20% AEP is considered

appropriate and is considered to align with the intent of the policy. It should be noted that the new TCC flood study does not include the 5 year ARI (Average Recurrence Interval) (nor the equivalent 0.2EY – Exceedances per Year) event.

In addition, as the development is for regional fuel storage, the relevant facilities' finished floor levels within the development are to be based on the 0.5% AEP flood level in accordance with the flood hazard overlay code.

All modelling was based on the Mean High Water Springs (MHWS) boundary condition within the Ross River flood study, i.e. initial water level of 1.254 m AHD, stage-discharge or stage-time curves, except for the 1% AEP climate change assessment which includes an additional 0.8m.

3.1 Hydrologic Modelling

The Ross River (2021) Flood model was obtained from Townsville City Council (TCC) under the Purpose and Confidentiality Deed dated and used for this assessment. Technical details of the model set-ups are described in the Ross River (2021) Flood Study report and therefore only a summary of the technical details is provided within this report. An audit of the hydrological models has not been undertaken as it's our opinion that models are fit for purpose as they have been approved and endorsed by TCC.

The hydrological response of the local catchment has been derived using source area inflows and a rain-on-grid approach. Technical details of the model set-ups are described in the Ross River (2021) Flood Study report with changes discussed herein.

The Ross River (2021) TUFLOW model ROG extent does not cover the Jet Zero flood model extents. Instead, the model contains a series of RAFTS hydrological model inflow source areas.

In order to provide an accurate representation of the site and surrounds, ROG was applied to the mini model in the southern and central portion of the mini model extent.

In these areas, the original Ross River 2021 TUFLOW model RAFTS hydrology inflow locations were removed to avoid duplication of the flows. Outside of the introduced ROG area, the original source areas are maintained within the mini model.

In addition, the upstream boundary inflows have been extracted from the Ross River 2021 TUFLOW model flows to replicated the inflow hydrographs at the upstream extents of the model.

Generally speaking, apart from the aspects discussed herein, there were no other changes applied to original hydrological models as the mini model generally showed good correlation to the Ross River (2021) model. The exception is in the locations of the Colinta Road development and at the proposed access road (Langtree "Far East Development" design). Furthermore, the rainfall applied to the Ross River (2021) model has been calibrated to multiple past events.

3.1.1 Rain on Grid

Rain-on-grid (ROG) is a method of hydrologic determination that applies rainfall directly to the surface of a 2D hydraulic model, rather than routing rainfall through a separate hydrologic model. This method is particularly advantageous in the fact that local catchment boundaries do not need to be defined, providing the 2D hydraulic model adequately represents that natural terrain.

In the TUFLOW model, the total rainfall depth is applied directly to the 2D grid with losses removed via soil infiltration, subject to the fraction impervious defined in the materials / land use mapping.

It is noted that the area of the mini model is not within the TCC model rain on grid extents. In order to provide an accurate representation of the site and surrounds, ROG was applied to the southern and central portion of the mini model extent.

In these areas, the original Ross River 2021 TUFLOW model RAFTS hydrology inflow locations were removed to avoid duplication of the flows. Outside of the introduced ROG area, the model domain and source area inflows remain consistent with the Ross River 2021 model.

3.1.2 ROG Modifications

Once the extent of the development had been defined, the area was modified to reflect the impervious land use, representing a 'design' discharge from the future potential development. NCE have updated the Manning's 'n' roughness coefficient utilised by the TUFLOW model to better represent the materials across the mini-model in the fine-scale. This also includes updating the percent impervious of the land uses. The imperviousness assumed for the developed site is 90% which is in accordance with the TCC planning scheme policy and consistent with the likely maximum developed impervious land use.

Updating the rain-on-grid hydrology in this manner maintains alignment with the current approved calibrated model adopted by TCC.

3.1.3 Losses

The losses in the mini-model rain on grid have been applied using a soils file with the initial loss varying based on the storm event and duration in accordance with ARR 2019. The percent impervious is applied to the model using the materials file. This method varies from the overall Ross River (2021) model which nominates the losses directly on a per soil type basis. However, NCE have utilised the same loss values for the impervious areas from the Ross River model. The adopted losses area as follows:

The losses applied in accordance with ARR 2019 are:

- IL - Varies in accordance with ARR 2019
- CL - 2.0 mm/hr CL (in accordance with 2021 Flood model)

3.1.4 Critical Duration Assessment

The ARR2019 approach as adopted by the flood study is to simulate the rainfall depth for a given duration under the ensemble of 10 (or 20) temporal patterns to determine the median flood characteristics for the site. This means that for every flood event of a given durations, there are 10 / 20 design storms that require assessment in order to identify the median temporal pattern.

Given the Ross River (2021) flood model has been previously calibrated to past events, the mapping provided within the Ross River (2021) flood study report has been assumed to accurately depict the critical duration and relevant temporal pattern over the development site. The mapping provided in the flood study report indicates the critical durations for each flood frequency from 50% AEP to 0.1% AEP.

The 2021 TCC flood study maps the critical duration for the model. The critical duration event individual results identified were checked in the vicinity of the site to confirm the actual durations that caused the highest flood levels.

The critical duration for the 1% and 0.5% AEP events as per the provided data files is the 9 hour event and for the 20% AEP, the 24 hour event is critical.

3.2 Hydraulic Modelling

For this assessment, a site specific 1D / 2D TUFLOW model has been developed which has adopted the HPC SGS solver on a 5m grid with an SGS sampling frequency of 11.

2016 LiDAR data was used for the DEM which was transposed onto a 2 m grid that covers an area of ~1,825 hectares. The extent of the model setup is shown in **Figure 1-1** and **Map A1** in **Appendix A**.

3.2.1 TUFLOW

The TUFLOW (Two-dimensional Unsteady FLOW) modelling software was utilised to undertake the hydraulic modelling required for this flood level assessment. TUFLOW is a powerful computational engine that allows the ROG method to be applied directly to the 2D hydraulic model which provides 1D and 2D solutions of the free-surface flow equations to simulate flood and tidal wave propagation. TUFLOW is specifically oriented towards establishing flow and inundation patterns in floodplains, coastal waters, estuaries, rivers and urban areas where the flow behaviour is essentially 2D in nature and cannot or would be onerous to represent using a 1D model. Subsequently, TUFLOW is ideally suited for this assessment.

TUFLOW currently incorporates two (2) grid-based solvers:

- TUFLOW Classic: A second order semi-implicit solution available for computations using CPU hardware on a single core; and
- TUFLOW HPC (Heavily Parallelised Compute): A second order explicit solver. TUFLOW HPC can run a simulation using multiple CPU cores, or alternately GPU hardware for high-speed execution without sacrificing model accuracy.

Outputs from TUFLOW include GIS maps of flood depths, water surface elevations (WSE), velocities, hazard and inundation extents.

TUFLOW also offers the use of sub-grid sampling (SGS). This method allows high resolution results and finer scale modelling while keeping run times low. This method calculates cell volume via a cell elevation-volume curve and cell face on cell width-elevation curve. SGS samples a specified number of points across the cell (eg. sampling frequency of 11 generating a 10x10 grid – 1/10th cell size) to create the elevation-volume curve and width-elevation curves for each cell. This allows more accurate calculation of storage transfer between cells, however the shallow water equations are only calculated on a cell-by-cell basis.

The Ross River (2021) flood model utilises a 5m grid with a default SGS sampling distance of 1m equating to a sampling frequency of 6.

3.2.2 Hydraulic Roughness

The hydraulic roughness is defined by the Manning's 'n' values applied to the materials defined within the TUFLOW model. These roughness values and areas have been defined via aerial imagery and by reference to various guidelines such as ARR2019 and QUDM in conjunction with site visits and photographs. The below **Table 3-1** indicates the Manning's 'n' values applied to each land use as depicted in the materials mapping in **Appendix A**.

Table 3-1 Land use / materials inputs

Material ID	Material Description	Manning's 'n'	Percent Impervious
1	Verge (generally maintained)	0.06	0
2	Concrete pavement	0.04	100
3	Smooth-bare packed earth	0.017	0
4	Rough-bare packed earth	0.032	0
5	Poor grass	0.035	0
6	Average grass close clip	0.04	0
7	Pasture / generic bushland	0.065	0
8	Unpaved road	0.025	0
9	Clear open water	0.011	100
10	Vegetated creek w/ heavy trees	0.08	0
12	Rural residential	0.055	60
13	Medium to dense shrubs and grass	0.1	0
14	Developed medium intensity	0.14	70
15	Roads buildings gardens fences combined	0.06	10
16	Buildings gardens fences combined (rougher)	0.08	10

The TUFLOW mini-model was used to determine flood levels for the events and durations listed in **Table 3-2**. These results were then post-processed to create flood extents, water surface elevations (WSE), depth, velocity and afflux plots.

Table 3-2 Flood events assessed

Flood event	0.5% AEP	1% AEP CC	1% AEP	20% AEP	1% AEP CC – Joint Prob
Duration (hours)	**9**	**9**	**9**	**24**	**9**
Baseline	✓	✓	✓	✓	x
Developed	✓	✓	✓	✓	✓

3.2.3 Boundary Conditions

Map A01 in Appendix A provides the model setup, configuration and the model boundary conditions. The mini model incorporated a series of model inflows and downstream tailwater conditions which were derived by running the Ross River model. The boundary conditions extracted from the Ross River model include a series of upstream culvert inflows, flow cut locations (in the form of TUFLOW PO flow lines) and RAFTS flows imported into the mini model using source areas and downstream tailwater levels.

The primary downstream tailwater levels were input as water level verses time hydrograghs boundary conditions extracted from the Ross River model and which were based on the fixed water levels from the Ross River model.

Table 3-3 Downstream Fixed Water Levels From Ross River Model

Design Event	Fixed Water Level (m AHD)
20% AEP and 1% AEP (MHWS)	1.254
1% AEP Climate Change	2.054
1% AEP Storm Tide at 2100 / Joint Probability	3.354

These fixed water levels in the vicinity of the model boundaries were used to verify the downstream water surface elevations results.

4.0 FINDINGS, RESULTS AND DISCUSSION

The development site has been represented generally unchanged from the existing arrangement which is based on the Cleveland Bay Industrial Park - Far East Development earthworks, roadworks and drainage drawings. The developed site is assumed to generally align with the existing site grades which fall towards the north / north-east.

Subsequent model refinement as discussed herein is based on this general arrangement.

Due to the nature of rain-on-grid, fine scale model results and to provide some clarity, the final maps have been filtered such that areas predicted to experience water depths less than 0.05 m and water velocities less than 0.5 m/s are shown free from flooding.

Table 4-1 lists the results that have been mapped and presented in the following appendices:

- Appendix B – Model setup
- Appendix B – Afflux plots
- Appendix C – WSL plots
- Appendix D – Depth plots
- Appendix E – Velocity plots
- Appendix F – Flood Hazard plots

Table 4-1 Result map plots

Scenario	Event (AEP)	Flood Characteristic and Event Duration			
		WSE	Depth	Velocity	Hazard
Baseline	0.5%	✓	x	x	x
	1% Climate Change*	✓	x	x	x
	1%	✓	✓	✓	✓
	20%	✓	✓	✓	✓
Developed	0.5%	✓	x	x	x
	1% Climate Change*	✓	x	x	x
	1%	✓	✓	✓	✓
	20%	✓	✓	✓	✓
Afflux	0.5%*	✓	x	✓	x
	1% Climate Change*	✓	x	✓	x
	1%	✓	x	✓	x
	20%	✓	x	✓	x
Storm Tide Review					
Afflux	*Joint Probability 1% Climate Change**	✓	x	x	x

*Sensitivity Assessments

The following sections discuss specific model modifications, in addition to those outlined in **Sections 4.5.2**, and the results of the assessment.

4.1 Baseline Scenario

4.1.1 Digital Elevation Model (DEM) Modifications – TUFLOW

At the time of preparing the TUFLOW mini model, 2019 LiDAR data was available, however given the Ross River (2021) adopted the 2016 LiDAR data which was deemed more appropriate, NCE have also adopted this, for consistency. The 2016 LiDAR was transposed onto a 5 m grid to define the baseline topography of the hydraulic model. It is noted that a number of locations were also altered slightly to better match the existing levels / conditions. These minor DEM alterations are outlined below:

- The survey of the immediate site as provided by the client has been incorporated into the model domain.
- Colinta Road subdivision. This isn't included in the Ross River (2021) TUFLOW model, therefore needed to be incorporated manually.
- Langtree Cleveland Bay Industrial Park "Far East Development" design terrain. This is understood to be approved for construction and included as part of the baseline scenario. It is noted that the road access is located directly adjacent to and north of the existing road reserve location.
- The culvert and drainage infrastructure associated with the above two components have been incorporated into the baseline model in the 1d network.

NCE note that some DEM modifications utilised in the Ross River (2021) flood model have not been adopted for the mini-model if they are not within or are deemed to not be critical to the development site.

4.1.2 Baseline Critical Duration – TUFLOW

NCE were supplied the flood results as part of the flood model agreement with TCC which a critical duration raster for the 1% AEP event. (A raster is a data matrix of grid cells displaying results across the model domain, in this case representing the flood event that results in the highest flood level at each grid point). The provided raster is generated by compiling all the flood model results and comparing the peak water surface elevations (WSE). The resultant raster indicates that the majority of the areas surrounding the development site have a peak water surface elevation dominated by the 9-hour event. The 6 hour and the 3 hour (TP 8797) were also found to be critical in small isolated portions surrounding the site but were found to only be marginally higher than the 9 hour event (<20mm) and as they were limited to small regions, were not included in this assessment.

NCE have utilised the provided results and confirmed via manual assessment that the critical duration raster accurately reflects the maximum flood level results.

NCE have not been provided a critical duration raster for the other event flood frequencies, thus have carried out a manual assessment of the 20% and 0.5% AEP durations and have adopted the dominant critical durations. The provided mapping shows the 24-hour storm durations as critical over the site for the 20% AEP. The 0.5% AEP event is dominated across the site by the 9 hour event.

NCE have not conducted any further assessment on the median temporal patterns and have instead adopted the patterns presented in Appendix D of the Ross River (2021) flood study report. The adopted critical duration events are indicated in **Table 3-2**.

It is noted that the 9-hour peak WSEs are largely controlled by tailwater levels from the sections of the model domain.

4.1.3 Existing Culverts

There were a number of culverts within the model area that weren't included in the TCC Ross River (2021) model. The client provided pdf copies of the design drawings which were used to updated the relevant sections. **Table 4-2** lists the primary culverts added to the TUFLOW model which were deemed to influence the flooding in the vicinity of the site. The below table is not an exhaustive list of all modifications carried out but includes all major and relevant culverts associated with the "Far East Development".

Table 4-2 Culverts added to the baseline model

ID	US IL (m AHD)	DS IL (m AHD)	Length (m)	Configuration	Manning's n value	Location
01	2.555	2.587	10.5	2/750 Poly Pipes	0.012	Far north-east of site
02	2.612	2.607	2.3	2/600 Poly Pipes	0.012	Central / north of site
03	2.808	2.675	10.5	600 Poly Pipe	0.012	North-west of site
04	2.586	2.4	20.3	2/1200x900 RCBC	0.012	South-west of site / eastern end of Access Road (approx. Ch 1140)
05	1.63	1.63	19.5	10/1200x900 RCBC	0.012	Access Road Approx Ch 820
06	1.90	1.90	19.5	5/1200x900 RCBC	0.012	Access Road Approx Ch 615
07	1.90	1.90	19.5	20/1200x900 RCBC	0.013	Access Road Approx Ch 405

4.2 Verification and Comparison to the Existing Ross River Flood Study 2021

A comparison of the water surface elevations (WSE) results showed close alignment between the Ross River (2021) model and the NCE fine-scale mini-model. The comparison of the flood depths which generally show good correlation in magnitude and extent as shown in Map A04 in **Appendix A**. However, NCE note the primary areas where more significant differences (but still considered minor), are observed as follows:

- Upstream of the Cleveland Bay Industrial Park Far East Development access road have increased WSEs which are considered to be a direct result of the road embankment which is not included in the Ross River (2021).

- Slightly lowered WSEs downstream of the new access road. This is considered to be resulting from the access road causing some minor inherent detention of flows from the south (and the resulting increases upstream of the road).

- Increased WSEs upstream of the site in the areas where rain on grid has been incorporated in to the model. This is considered to more accurately represent the flood levels in these areas as ROG results in flood results at all locations, not just downstream of the source area inflow locations. It also represents finer scale flooding across the model terrain.

- Increased WSEs at the downstream section of the model domain which is considered to be due to the slight differences in the model conditions downstream and is a slightly conservative outcome.

- Differences in WSEs on and in the vicinity of the Colinta Road subdivision (both increases and decreases), which are considered to be a direct result of the change in surface terrain and redirection of flows from the subdivision.

4.3 Review of past events

Townsville recently experienced a major storm event that resulted in evacuation of residential properties which may have been impacted by flooding. These properties were 5.5km from the site although the evacuation zone (black zone), extends to within 2km from the site.

Drone footage of the flooding that occurred in the vicinity of the site was taken as shown in **Figure 4-1**. This was taken at 10am on the 3/2/25 which was at the end of the relatively highest intensive period of rain.

Figure 4-1 TCC Drone image of the site during the February 2025 flood event.

In addition to the February 2025 event, Townsville also experienced an intense storm on the 19/03/2025 which also resulted in significant flooding within Townsville.

An analysis of the nearby Stuart Creek Alert station has been carried out to consider the equivalent AEP of these two events. The Stuart Creek Alert station location is shown in **Figure 4-2** below.

Figure 4-3 demonstrates that the February 2025 storm event which caused moderate flooding across Townsville is observed to be up to an equivalent of between 10% AEP and 5% AEP when the longer period of rainfall, 24 hour period is considered. The maximum equivalent AEP experienced for the critical duration of 9 hours, is slightly more intensive than a 20% AEP. The extent of inundation observed anecdotally in the vicinity of the site from the drone image on the 3/2/25 is moderate and considered to be aligned with the anticipated flood extent expected for the design 20% AEP.

The 19th March event at the Stuart Creek alert was observed to be slightly more intense than a 50% AEP.

It should be noted that other parts of Townsville experienced higher intensity storms during the same period.

Figure 4-2 Stuart Creek Alert Location

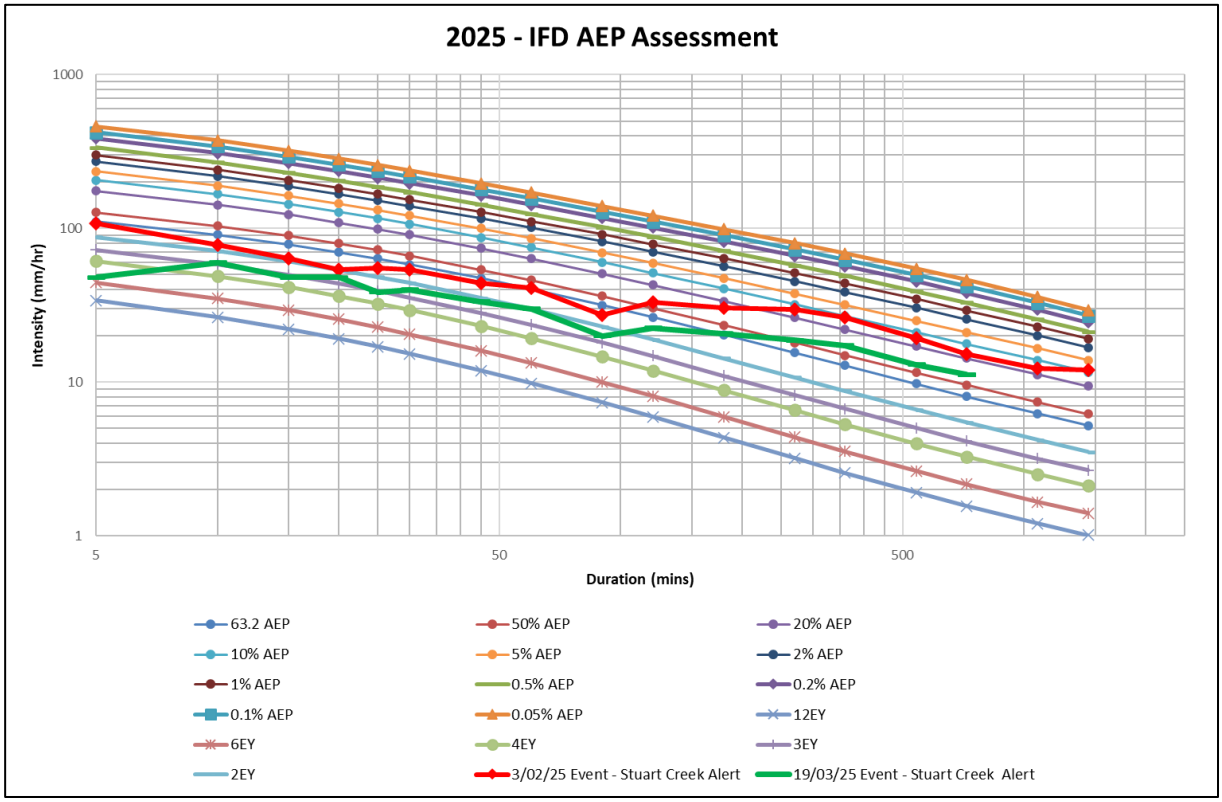


Figure 4-3 Intensity-Frequency-Duration AEP Assessment

4.4 Sensitivity Assessments

The general purpose of the assessment is to identify aspects of the model and influences that may impact the outcomes. Given that the Ross River Flood Study 2021 has undergone a comprehensive parameter assessment and given the mini model has resulted in close alignment with the Ross River model, further comprehensive assessment has not been carried out. Refer to Section 4.2 for further discussion on the comparison with the existing Ross River flood study results.

However, the model was deemed to potentially lie within the joint probability zone as discussed in the Ross River Flood Study Section 5.2, Joint Riverine and Coastal Flooding Evaluation. Refer to Section 4.6.6 below for further discussion on the joint probability assessment.

4.5 Developed Scenario

4.5.1 Digital Elevation Model (DEM) Modifications – TUFLOW

The development site has been represented generally unchanged from the existing arrangement which is based on the Cleveland Bay Industrial Park - Far East Development earthworks, roadworks and drainage drawings. The developed site is assumed to generally align with the existing site grades which fall towards the north / north-east.

Subsequent model refinement as discussed herein is based on this general arrangement.

Observations of the initial model iterations indicated that providing minimum fill levels across the entire of the proposed development resulted in some minor local afflux off site due to impacts to an existing drainage feature in the south-west. A second iteration was carried out which excluded filling in the far south-west of the site to allow for the drainage feature to remain unaffected and also reduced the majority of the filling from across the site. This drainage feature currently conveys flows from the drainage corridor at the south-west of the site and meanders across the south-west corner of the site.

Observations of this revised iteration indicated there are shallow flows that are conveyed across a portion of the existing site as shown of Maps C05 in Appendix C and D01 in Appendix D. This shallow flow is centred approximately 190m from the west site extent. There are a number of options to address this shallow flow across the site which include:

- Introduce a minor levee from the end of the access road along the southern boundary for 210m (270m from the western site extent), to the natural minor ridge and south for 15m to an adjacent existing levee. This prevents any flows from being conveyed across the site.

- Accept the flow within the site and convey the flow within the site drainage infrastructure via underground drainage, or surface flows. This option could alleviate any requirements for levees. The 1% AEP flow that crosses the southern boundary on to the site is 1.34m3/s.

- Introduce a minor levee from the end of the access road that extends along the entire southern boundary. This prevents any flows from being conveyed across the site.

- Upgrading the Far East Development eastern road culvert (approx. chainage 1142) – Currently 2/1200x900.

- Introducing a high level shallow surcharge channel that diverts the high level major flows overland from around the dam outlet across the access road and outlet into the downstream drainage feature.

The developed results mapped are based on the first option above and based on the following mitigation:

- Minor levee that extends from the end of the Cleveland Bay Industrial Park Far East Development road. Refer to **Figure 4-4** for the access road configuration (not part of the Jet Zero development). This levee deviates to the south-east to the southern boundary. The levee then extends approximately 210m east to the natural minor ridge. (270m from the western site extent). The levee commences at the end of the

- Minor levee extends 15m south to intersect an existing levee.

Following further model iterations, afflux off-site was reduced to insignificant levels and considered to result in non-worsening. This included afflux assessment of the 20% AEP and 1% AEP prescribed events as well as events in excess of the DFE being the 1% AEP climate change and 0.5% AEP. All events and sensitivity checks demonstrated similar, insignificant afflux.

It is noted that this is not the only option available to carry out on the site and the above alternatives or others that do not result in afflux off site, could be incorporated.

This is also considered to generally align with the Ulysees Water Management Study – Stormwater Management Plan, provided that the south-western drainage feature is not adversely impacted. It is noted there are underground pipes directed to the north-west bioretention. However these are understood to capture the low flows for stormwater treatment and do not significantly impact the majority of the overland runoff. Regardless, the downstream environment consists of extremely widespread low lying salt plains and any minor redirection of flow has an insignificant impact on flooding outcomes.

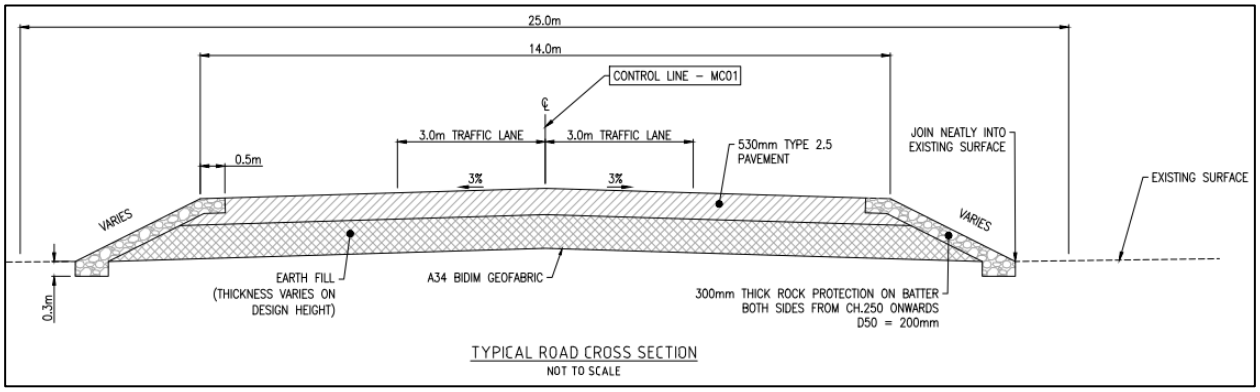


Figure 4-4 Cleveland Bay Industrial Estate - Far East Development road configuration

The updated model demonstrated there was no actionable impacts off-site for the 20% AEP, 1% AEP events as well as the 0.5% AEP and 1% AEP CC sensitivity reviews.

The concept arrangement is depicted in **Figure 4-5** as well in the NCE drawings in Appendix H.

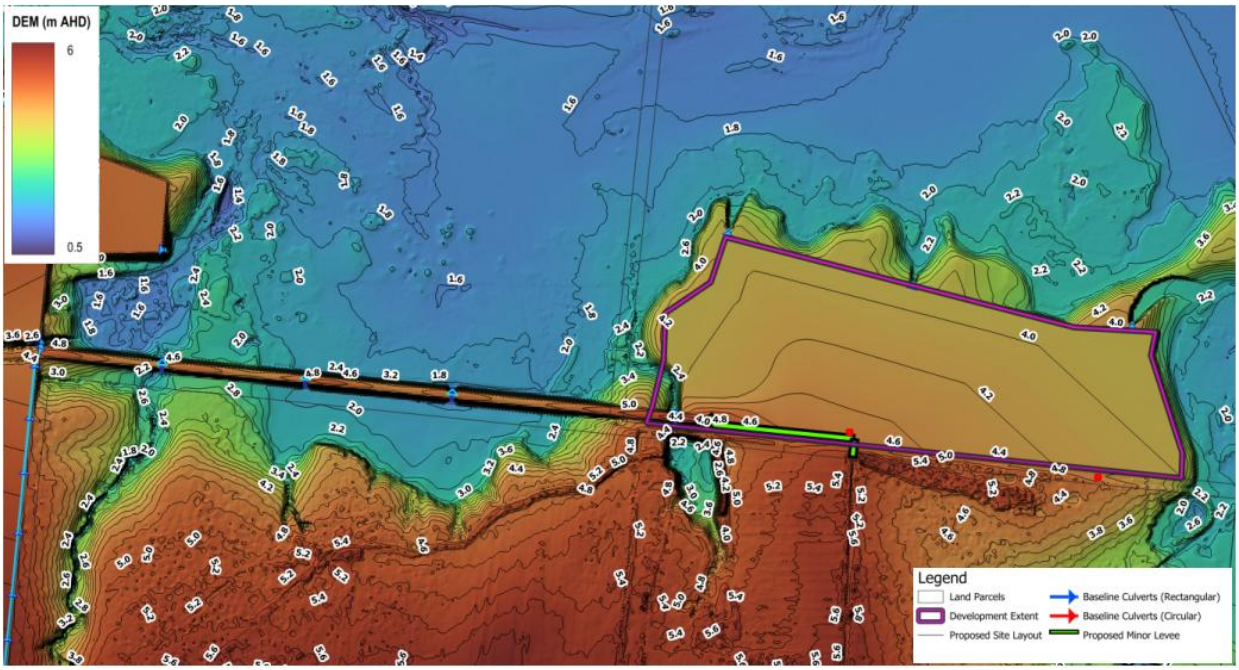


Figure 4-5 Model General Arrangement

4.5.2 Rain-on-grid Design Discharge

A technical summary of the rain-on-grid (ROG) setup, Ross River Flood Study (2021) flood report references, are provided in Section 3.1.1.

In the TUFLOW model, the developed scenarios were updated to reflect the changed fraction impervious defined in the materials / land use mapping.

In order to account for changes in impervious areas for the proposed development, the land use for the entire extent of each fill pad was modified to reflect a 90% imperviousness for the development and 50% for the roads, representing a 'design' discharge.

4.5.3 Initial Water Levels

Initial water levels have been adopted directly from the TCC Ross River (2021) flood model which are generally based on the Mean High Water Springs (MHWS) level of 1.254m, except for the climate change scenario which was based on raising by 0.8m above MHWS.

4.5.4 Fill Extents

The development layout outlines the extent of fill expected as depicted in **Figure 4-5**. The site is assumed to not undergo significant earthworks except for reprofiling to achieve local drainage requirements. The development of the site is depicted in the maps provided in **Appendix A**.

4.5.5 Mitigation Measures

Mitigation measures and/or alterations to the preliminary earthworks surface have been incorporated into the model using z-shapes and level points as discussed in Section 4.5.1.

Following an extensive series of model iterations as discussed herein, mitigation measures adopted including various options, in conjunction with removing any filling on site resulted in non-worsening off-site. The mitigation measures adopted include the following:

Table 4-3 Mitigation Measures

#	Location	Details	Purpose / Background
1	South-west corner of the site	Reduced development area in the vicinity of and avoid an existing drainage feature.	Removes minor / moderate afflux upstream and adjacent to the site and generally retains the existing site drainage regime.
2*	South of the site	Minor levee from the end of the existing Cleveland Bay Industrial Park Far East Development road to the south boundary extending 210m east (270m from the western site extent) Minimum levee level = 5.20m AHD	Prevent minor, shallow overland flows across the site

*Option provided for illustration purposes. It is noted that other options can be accommodated depending on the preferred site outcomes.

4.6 Results

Results associated with the maps provided in **Appendix A** to **Appendix F** are discussed in detail in the following sections.

The 20% AEP, 1% AEP, 1% AEP climate change scenario and 0.5% AEP events were found to be dominated by the critical durations as nominate above.

NCE carried out an assessment of the proposed Jet Zero ATJ development for the above events. This assessment demonstrated that the proposed development can be carried out without causing actionable nuisance off site. The flood levels are shown on the shown on Map MJ2601/A06 are based on the 0.5% AEP and the 1% AEP water surface elevations (WSE).

This flood impact assessment also shows that the development can proceed without impacting the existing waterways in the south-west of the site.

Further details are discussed in the following sections:

4.6.1 Afflux

The scope of works required the assessment of the proposed development layout which is undertaken by assessing the potential changes and impacts on the flood characteristics, and best analysed by assessing the afflux. Afflux is defined as the relative change in a flooding characteristic, namely WSE or velocity, between the baseline and developed situation. This is determined by subtracting the baseline peak results from the developed peak results, where a positive value represents an increase in the flood characteristic and a negative value is a decrease.

Afflux has been determined for two (2) flooding characteristics, WSE and velocity, which as discussed in detail in the following section.

4.6.1.1 WSE Afflux

WSE afflux has been assessed for both the 20% AEP and the 1% AEP climate change events for the proposed development. In reference to the afflux maps in **Appendix B** the TCC parameters for acceptable development is +/- 10 mm change in WSE (shown in white). Depending on the circumstances, in areas that are not sensitive to flooding and do not impact the function of infrastructure or properties, NCE are of the opinion that increases in excess of this (light green/aqua) may also be acceptable in some instances being non-actionable. With this in mind, the following commentary is provided.

- 20% AEP
    - No afflux observed.
- 1% AEP
    - Immediately south / south-west of the site within the unformed road reserve there is some minor, highly localised afflux. This is considered to be direct impacts due to the levee directly adjacent to the southern boundary. (Generally 25mm with a isolated spot up to 38mm). This afflux has no actionable impacts nor is the potential future reserve affected.

Overall, apart from the highly localised sections discussed above, any impact associated with this development is contained within the development site. This highly localised impact is non-worsening as there is no fundamental impact on the any property, carriageway or water feature.

4.6.1.2 Velocity Afflux

- 20% AEP
    - There are no velocity afflux offsite in the minor 20% AEP event. This is due to the minor event flow regime being maintained post-development.
- 1% AEP DFE
    - Immediately south-west of the site within the unformed road reserve there is very minor, highly localised velocity afflux. This is considered to be direct impacts due to the minor levee option shown. This afflux has no actionable impacts nor is the potential future reserve affected or trafficability impacted. Due to its minor and isolated nature, this afflux is considered negligible. In the event that another option for addressing the flows adjacent to and across the site, this velocity afflux may be completely removed.

4.6.2 Peak Flood Elevations and Depths

Peak WSE and depths are shown in **Appendix C and Appendix D respectively**. On the WSE map, 0.1m contours have been provided to help determine the minimum height of fill in order to achieve flood immunity. In addition to the information shown on the maps, the flood extents are contained within drainage corridors and existing flooding extents. The overall development is proposed to be carried out based on the following:

- The fill levels across the site are to be carried out to a minimum level of the 1% AEP.
- All finished floor levels (FFL) of facilities associated with regional fuel storage are to be at or above the 0.5% AEP flood level, as defined by the TCC flood hazard overlay code at the time that the report was drafted.
- The minor stormwater system designed to a minimum of the 20% AEP as per TCC planning scheme requirements for industrial areas.
- Hazards in areas of inundation to be maintained within acceptable limits. Hazards are assessed against the flood hazard classification from the Australian Disaster Resilience Handbook (and ARR Book 6 Figure 6.7.9). (However no adverse hazard areas are identified as part of this FIA aside from the drainage channel in the south-west of the site.
- The detailed design of the final uses is anticipated to include a combination of underground and overland stormwater network.
- Whilst the bulk of the proposed development site is above the 0.5% AEP / 1% AEP events as described above, shallow flooding or stormwater drainage may be experienced across the development site such as in roads, carparks, channels and pedestrian access areas and are to account for suitable safe hazard limits in accordance with the ARR / TCC guidelines.
- In addition to the FIA requirements, Townsville City Council planning scheme policy nominates that the minimum finished floor level of any development is to be at or above the defined storm tide event of 3.9m AHD if greater than 100m of the shoreline.
- Whilst the planning scheme does not nominate freeboard above flood levels in industrial areas, consideration should be given to any critical infrastructure and hazardous storages areas to be located at a suitable freeboard above the nominated event in accordance with SC6.7 flood hazard

planning scheme policy and / or above the natural ground level. NCE recommend a minimum freeboard of 300mm (above the relevant flood level and above the natural ground level).

- Additionally, whilst the development is well outside the 100m setback from the shoreline mapped as part of the TCC coastal hazard overlay, the site is in the vicinity of relatively open tidal salt flats at a low level and as such is relatively exposed to storm surge and coastal wave runup actions. Therefore, consideration should be given to locating any regional fuel storage facilities or other sensitive elements of the development at the higher, exposed site defined storm tide event level of 4.5m AHD.

4.6.3 Peak Velocity

The outcomes of this flood assessment demonstrated that there are no 1% AEP flow velocities on the site that resulted in adverse or high velocities, aside from the drainage channel in the south-west of the site and isolated areas off-site in the vicinity of existing culverts.

4.6.4 Flood Hazard

Hazards are assessed against the flood hazard classification from the Australian Disaster Resilience Handbook (and ARR Book 6 Figure 6.7.9). Refer to **Figure 4-6** below.

All results show outcomes unchanged from the baseline scenario and no high hazards on the site or on the access road to the site except for the drainage corridor in the south-west. Refer to **Appendix F** for the hazard maps.

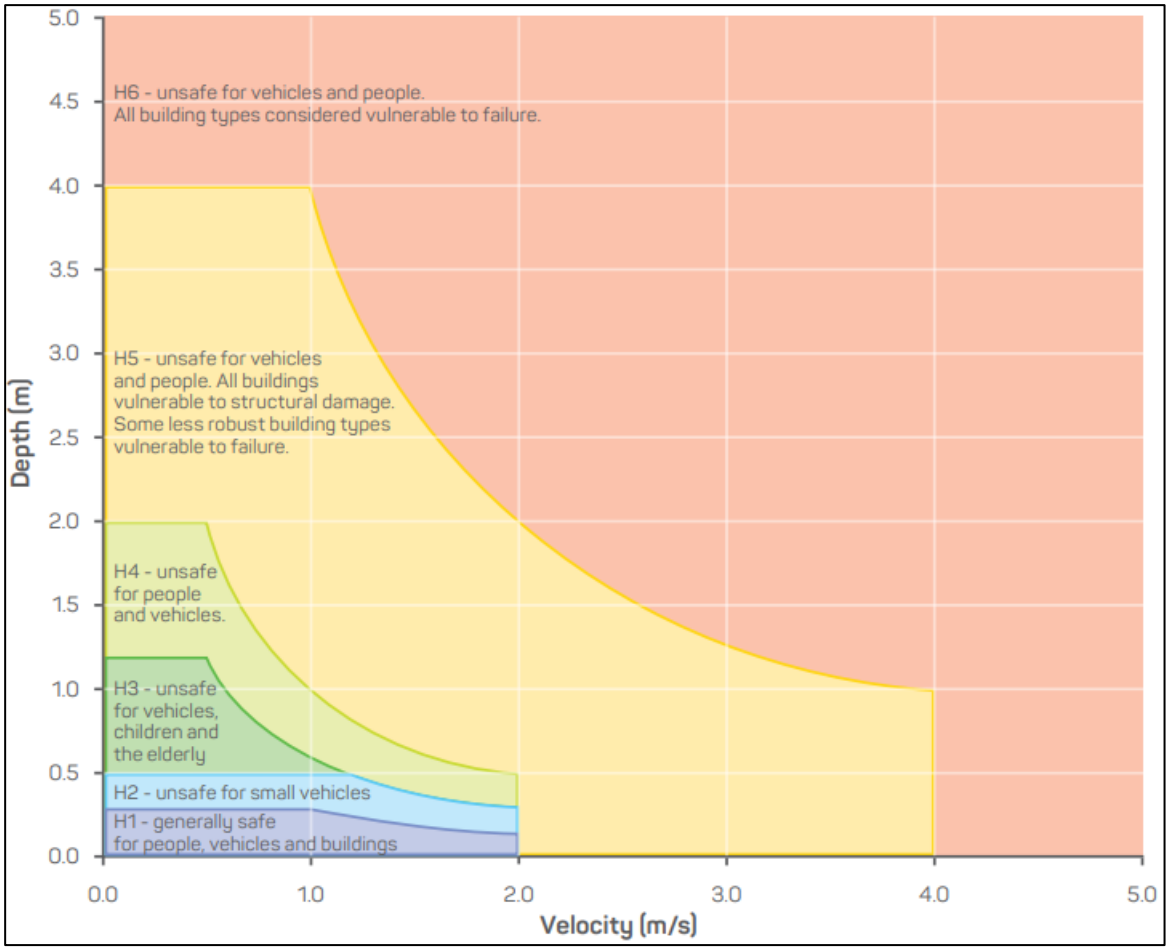


Figure 4-6 AIDR – Figure 6 - General flood hazard vulnerability curves

4.6.5 Climate Change Assessments

NCE carried out a sensitivity assessment of the 1% AEP climate change event for the site.

TCC's Guidelines for preparation of flood studies and reports from the Flood hazard planning scheme policy requires that the DFE should be assessed in combination with the climate change scenario as a sensitivity assessment to evaluate the additional risk.

Review of Hydrological Methods for the Townsville Region – Phase 4 and the Ross River Flood Study 2021 included a climate change sensitivity analysis based on the Representative Concentration Pathway (RCP) 8.5. This is the projected outcome for the 2100, although it is noted that ARR 2019 extends to 2090 only. This scenario is based on a 15.4% increase in rainfall intensity in combination with a sea level rise of 0.8m. These values are generally consistent with the Townsville City Council parameters (15% and 0.88m respectively). Based on these former reports, NCE have aligned with this climate change scenario.

The climate change assessment demonstrated that whilst there was a rise in the flood levels upstream and downstream of the site, the afflux increase was minor and did not result in an increased risk profile.

It is noted that due to the nature of the site, and the fact that the climate change assessment does not result in a significant increase in flood levels and without impact further impacts or increases in risk, NCE does not consider there is any benefit in assessing the climate change outcomes for a reduced period or RCP.

The afflux results of the 1% AEP climate change sensitivity assessment is provided in Map B07 and B08 and the maximum water surface elevations provided in Map C03 and C04. The assessment also demonstrated that the climate change sensitivity showed very similar levels and afflux outcomes to the 0.5% AEP event. At most locations, the 1% AEP climate change event results in slightly higher water surface elevations.

Given that this sensitivity assessment demonstrates very minor impacts for the 2100 climate change scenario as well as the 0.5% AEP event, the flood outcomes for the proposed use on the site are considered appropriate and do not result in a significantly increase risk profile.

4.6.6 Joint Probability Assessment

Sites within the coastal zones can be influenced by riverine flooding, elevated sea levels due to storm tides or can be a combination of both.

As the model was deemed to potentially lie within the joint probability zone as discussed in the Ross River Flood Study Section 5.2, Joint Riverine and Coastal Flooding Evaluation, NCE carried out a joint probability review.

The joint probability outcomes of the Ross River Flood Study 2021 are as follows:

- *Under present day conditions, the maximum flood level for the complete dependence scenario in the joint probability zone is less than 3.15 m AHD.*
- *Under climate change conditions, the maximum flood level for the complete dependence scenario in the joint probability zone is greater than 3.9 m AHD along the drains in Hyde Park and along areas around the Woolcock Street Drain. This means that a full design variable method assessment should be considered in these areas, if the Defined Flood Event is updated to include climate change, as peak flood levels considering coincident flooding and storm tide would change outcomes in relation to setting floor levels.*

Manual review of the 1% AEP climate change results demonstrates that the low lying areas of the salt plains, generally downstream of the site, shows the joint probability climate change scenario flood levels are up to

3.55m AHD and up to 0.51m higher than the non-joint probability climate change scenario. On and upstream of the site does not result in any difference from the joint probability scenario. This transition is observed to coincide with the "ledge" / elevation drop that occurs in the vicinity of the site. This elevation drop is noted at the edge of the visible vegetation and evident as the white salt plains. As discussed in the report, given that the minimum site levels are to be set at a minimum of 3.9m AHD in accordance with the flood hazard overlay policy for sites greater than 100m from the shoreline, the joint probability is not likely to influence the outcomes.

However, to ensure there was no influence, NCE carried out a joint probability sensitivity model run to confirm this. The model run results confirmed the above desktop assessment which did not alter the outcomes of the proposal which has a minimum level of 3.9m AHD. Refer to **Map A05** in **Appendix A**.

It is noted that the storm tide considerations do not allow for wave runup during cyclonic events.

5.0 CONCLUSION AND RECOMMENDATIONS

NCE were engaged by Jet Zero to carry out a flood impact assessment (FIA) in support of the proposal. The purpose of this FIA is to confirm that the proposal can be carried out without causing impacts off site in respect of the existing flooding characteristics in accordance with the Townsville City Council Planning Scheme Performance Outcomes of the Flood Hazard Overlay Code as well as the State Development Area (SDA) Development Scheme. The FIA report is prepared in support of the proposed development and outlines the flood mitigation arrangements.

The FIA has been carried out using a fine scale mini TUFLOW model based on inputs and boundary conditions derived from Townsville City Council's new Ross River Flood Study 2021. The mini model incorporates into the baseline model scenario the existing Colinta Road subdivision which is missing from the TCC model as well as the proposed, Cleveland Bay Industrial Park Far East Development including the new road from Colinta Drive to the site.

The outcome of the assessment has demonstrated that with minor modifications in the south-west of the site, the site does not result in any significant flood impacts off site.

All finished floor levels (FFL) of facilities associated with the regional fuel storage are to be at or above the 0.5% AEP flood level or the defined flood event as per the TCC flood hazard overlay code, whichever is the higher.

In addition to the FIA requirements, Townsville City Council planning scheme policy nominates that the minimum finished floor level of any development is to be at or above the defined storm tide event of 3.9m AHD if greater than 100m of the shoreline.

An assessment of the February 2025 storm event which caused moderate flooding across Townsville is observed to be up to an equivalent of between 10% AEP and 5% AEP when the longer period of rainfall, 24 hour period is considered. The maximum equivalent AEP experienced for the critical duration of 9 hours, is slightly more intensive than a 20% AEP. The extent of inundation observed anecdotally in the vicinity of the site from the drone image on the 3/2/25 is moderate and considered to be aligned with the anticipated flood extent expected for the 20% AEP.

This flood impact assessment demonstrates that the development proposal can proceed without any actionable flood impacts to the surrounding properties or environment. The assessment demonstrates the development can comply with the TCC Flood Hazard Overlay Code and Planning Scheme Policy and the TSDA Development Scheme.

A summary of the FIA maps is provided in **Table 5-1**.

Table 5-1 Summary of the FIA mapping

Map Number	Description
Appendix A	
Map A01	Model Setup, Configuration and Locality
Map A02	Digital Elevation Model (DEM) – Developed
Map A03	Land Use and Roughness
Map A04	Baseline Model Verification (NCE Mini Model Minus Ross River Model WSE)
Map A05	Developed Joint Probability Sensitivity (NCE 1% AEP CC Joint Prob Minus 1% AEP CC WSE
Appendix B	
Map B01	1% AEP Maximum WSE Afflux
Map B02	1% AEP Maximum Velocity Afflux
Map B03	20% AEP Maximum WSE Afflux
Map B04	20% AEP Maximum Velocity Afflux
Map B05	0.5% AEP Maximum WSE Afflux
Map B06	0.5% AEP Maximum Velocity Afflux
Map B07	1% AEP CC Maximum WSE Afflux
Map B08	1% AEP CC Maximum Velocity Afflux
Appendix C	
Map C01	0.5% AEP Maximum Baseline Water Surface Elevations
Map C02	0.5% AEP Maximum Developed Water Surface Elevations
Map C03	1% AEP CC Maximum Baseline Water Surface Elevations
Map C04	1% AEP CC Maximum Developed Water Surface Elevations
Map C05	1% AEP Maximum Baseline Water Surface Elevations
Map C06	1% AEP Maximum Developed Water Surface Elevations
Map C07	20% AEP Maximum Baseline Water Surface Elevations
Map C08	20% AEP Maximum Developed Water Surface Elevations
Appendix D	
Map D01	1% AEP CC Maximum Baseline Flood Depths
Map D02	1% AEP CC Maximum Developed Flood Depths
Map D03	20% AEP Maximum Baseline Flood Depths
Map D04	20% AEP Maximum Developed Flood Depths
Appendix E	
Map E01	1% AEP CC Maximum Baseline Flow Velocity
Map E02	1% AEP CC Maximum Developed Flow Velocity
Map E03	20% AEP Maximum Baseline Flow Velocity
Map E04	20% AEP Maximum Developed Flow Velocity
Appendix F	
Map F01	1% AEP CC Maximum Baseline Flood Hazard
Map F02	1% AEP CC Maximum Developed Flood Hazard
Map F03	20% AEP Maximum Baseline Flood Hazard
Map F04	20% AEP Maximum Developed Flood Hazard

6.0 REFERENCES

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