Appendix J. Flood Mitigation for Anna Bay and Surrounds

J.1 Locations of Assessed Mitigation

The locations around Anna Bay and surrounds where mitigation has been assessed include:

- Clark Street low point
- Low point in the vicinity of Gan Gan Road and Morna Point Road intersection
- McKinley Swamp and Gan Gan Road low points to the east (Anna Bay shops)
- Trapped low point at Gan Gan Road and Blanch Street
- Fern Tree Drain floodplain.

These locations were agreed with Council to alleviate existing flooding problems in and around Anna Bay, in addition to supporting proposed future development associated with the Anna Bay Strategy and Town Plan, and to realise the full development potential of the proposed development areas.

The first three locations are areas earmarked for future redevelopment in line with the Anna Bay Strategy and Town Plan, as well as being areas of significant flooding in currently developed urban areas. The trapped low point at Gan Gan Road and Blanch Street causes flooding of Gan Gan Road which results in this main thoroughfare being cut for potentially extended durations due to the existing 375mm pipe draining this area being ineffective.

Each of these areas are trapped points with very limited drainage capacity. Hence, the mitigation strategy broadly involves providing sufficient additional drainage to reduce flooding in the 1% AEP event.

The fifth flooded area, the Fern Tree Drain floodplain, is described in the scenarios table as this area experiences increases in flooding due to the mitigation options conveying increased flood volumes to this area. Mitigation in the way of increasing the Fern Tree Drain capacity has been assessed to reduce the impacts in this area.

J.2 Description of Options

The assessed options are described in Table J-1. The additional flow capacity achieved, and issues relating to each option are also summarised. The options were assessed across several modelling scenarios to test their effectiveness, given that the different flood problem areas are largely drained independently of each other. The scenarios are summarised in Table J-2 and range from combination of limited options (Scenario 1, which is a preliminary scenario) to combining the majority of options (Scenarios 2 and 3) to a combination of the full range of options (Scenario 4). The progression from Scenario 1 up to Scenario 4 incrementally increases the drainage capacity from upstream to downstream. The options are illustrated on Diagram J-1 to Diagram J-4.

The existing climate rainfall event, combined with the future development catchment conditions (increased development and higher runoff potential) has been assumed for the assessment. The future development conditions relate to the Anna Bay Strategy and Town Plan.

J.3 Assessment of Future Development Scenario Flooding – No Mitigation

The future development scenario flooding was assessed by increasing the imperviousness in the hydrologic modelling of sub-catchments which would be redeveloped as part of the Anna Bay Strategy and Town Plan. Updated inflow hydrographs were input into the Anna Bay urban TUFLOW model. The additional infiltration areas in the urban model were also adjusted to reflect the increased impervious areas in the catchment, such as roads and buildings.

The updated flood depths and change in flood levels from the design flood (existing climate, LEP 2013 development) are mapped in Appendix J. Flood depths in the main Clark Street low point are increased by 0.18m in the 5% AEP and 0.14m in the 1% AEP, while depths in the minor low points to the west of the main low point increase by up to 0.45m in the 5% AEP and up to 1.1m in the 1% AEP. Depths in the Fern Tree Drain floodplain are increased by up to 0.03m with localised increases of 0.07m in the 1% AEP. The depth increases are a result of increased runoff rates and volumes associated with the increased level of development, with no mitigation works.

J.4 Mitigation Assessment Results

The Anna Bay urban TUFLOW model was run to assess the mitigation options. Flood depth mapping is provided in Appendix J for the future development (no mitigation) and future development (mitigation scenarios) cases, for the 5% and 1% AEP events. The change in flood level is also mapped for each mitigation scenario, compared to the future development (no mitigation) case as a baseline. The change in flood depth at the main flood problem locations around Anna Bay as a result of the increased mitigation are summarised for each mitigation scenario in Table J-2, which describes the incremental improvement in flooding as additional drainage capacity is implemented.

Table J-1 Assessed Mitigation Options

Option	Description	1% AEP flow	Comments
1	Clark Street low-point: 5 x 1200mm diameter pipes through the sand hill to discharge to Main Drain. Three feeder branches of pipes connected to the 5x pipe branch to intercept flows from around the main low point. “Unlimited” pit capacity assumed i.e. sufficient pit capacity to be provided during the future actual design.	Total pipe flows approx. 7m^3/s.	· Downstream channel and scour protection works in the vicinity of Main Drain has not been determined at this stage · Works required in private property in vicinity of Main Drain · Creation of drainage easement required · Challenges and issues include: - installation of the pipes through the sand hill (thrust-boring an approximate length of 180m for each pipe) - insufficient existing downstream drain capacity (minor drain and possibly Main Drain) - high discharge velocities in currently low flow velocity environment in Main Drain – increased scour potential
2	Upgraded “Lutheran Church” branch: 3 x 1200mm diameter pipes in addition to existing 1200mm diameter pipe through the Lutheran Church property, discharging to Fern Tree Drain. “Unlimited” pit capacity assumed	Additional pipe flows approx. 5m^3/s. Existing pipe flows are approx. 1.2m^3/s.	· Downstream channel and scour protection works in Fern Tree Drain has not been determined at this stage. · Enlargement of Fern Tree Drain and waterway structures have not been assessed · Trench up to 3 – 4m deep required in localised sections to install pipes. · Works required in private property in vicinity of Main Drain · Creation or widening of drainage easement required · Upgrades to existing drainage in Gan Gan Road not assessed. Note that the existing pipes have low capacity due to flat grades and high tailwater conditions
3	Re-route downstream end of Gan Gan Road main stormwater branch. Instead of discharging to McKinley Swamp, reroute by installing additional 900mm diameter pipe to discharge directly to Fern Tree Drain to take advantage of lower tailwater levels.	Additional pipe flows approx. 0.6m^3/s. Existing pipe flows are approx. 1.4m^3/s.	· Downstream channel and scour protection works in Fern Tree Drain has not been determined at this stage · Works required in private property · Creation or widening of drainage easement required

Option	Description	1% AEP flow	Comments
4	Floodway approx. 15m wide (assumed width is preliminary only) and up to 1m deep linking Gan Gan Road sag point to Fern Tree Drain. Removes high points in the terrain preventing free overflows from McKinley Swamp and Gan Gan Road. A culvert under Old Main Road is required.	Floodway surface flows approx. 0.9m^3/s in addition to the flows identified for Option 3 above.	· Downstream channel and scour protection works in Fern Tree Drain has not been determined at this stage. · Works required in private property · Creation or widening of drainage easement required
5	Upgrade of pipe capacity draining McKinley Swamp. Additional 1200mm pipe draining McKinley Swamp to Fern Tree Drain. Existing 900mm pipe outlet retained.	Additional pipe flows approx. 1.5m^3/s in addition to the flows identified for Option 3 and Option 4 above.	· Debris control structure installed on both existing and additional pipe inlets to minimise risk of blockage. A 25% blockage factor on the pipe inlets assumed · Downstream channel and scour protection works in Fern Tree Drain has not been determined at this stage · Works required in private property · Creation or widening of drainage easement required
6a	Widening of Fern Tree Drain main branch by 3m (existing typical top width is 6 – 6.5m). Between Old Main Road and Nelson Bay Road. This allows the increased flows conveyed by Options 2 to 5 to more freely drain away, reducing the increases in flood levels in the floodplain area to the north of Old Main Road.	Additional 2.5m^3/s capacity.	· Approximately 3 access track crossings of Fern Tree Drain required · Widening of drainage easement required · Nelson Bay Road culverts assumed to be retained in existing condition. Increasing culvert capacity could increase backflow flooding from downstream areas, particularly in the climate change (sea level rise) scenario.
6b	As per 6a plus widening of Fern Tree Drain eastern branch by 2m (existing typical top width is 6 – 6.5m) + doubling existing cross culvert capacity (currently 3m x 0.6m box culverts or equivalent). This potentially allows the increased flows conveyed by Options 2 to 4 to more freely drain away, reducing the increases in flood levels in the floodplain area to the north of Old Main Road.	Additional 0.7m^3/s capacity.	· Approximately 6 access track crossings of Fern Tree Drain required · Widening of drainage easement required · Nelson Bay Road culverts assumed to be retained in existing condition. Increasing culvert capacity could increase backflow flooding from downstream areas, particularly in the climate change (sea level rise) scenario.

Option	Description	1% AEP flow	Comments
7	New 2x 1200mm pipes at inlet level 2.6m AHD draining Blanch Street low point. Lower inlet level cannot be achieved due to minimum pipe grades with 2.6m AHD inlet invert level.	Additional 1.2m^3/s capacity.	· Challenges and issues include: - installation of the pipes through ridge in the terrain (thrust-boring an approximate length of ~150m for each pipe) - insufficient existing downstream drain capacity (minor drain and possibly Main Drain). Requirement for upgrade of open drains not assessed at this stage - high discharge velocities in currently low flow velocity environment in Main Drain – increased scour potential. Downstream channel and scour protection works in upper Main Drain has not been determined at this stage · Works required in private property · Creation or widening of drainage easement required.

Diagram J-1 Illustration of Option 1

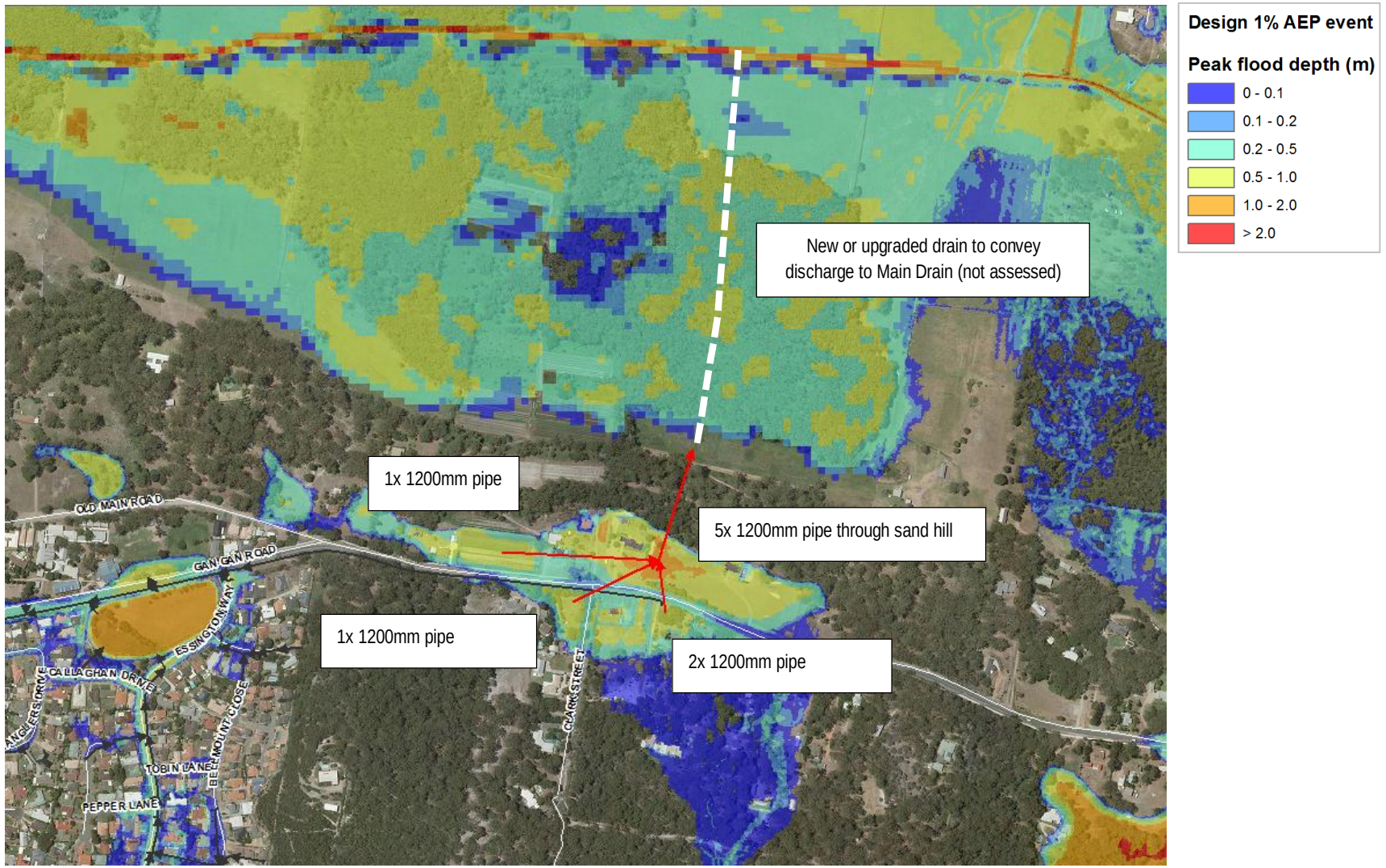


Diagram J-2 Illustration of Option 2, Option 3 and Option 5

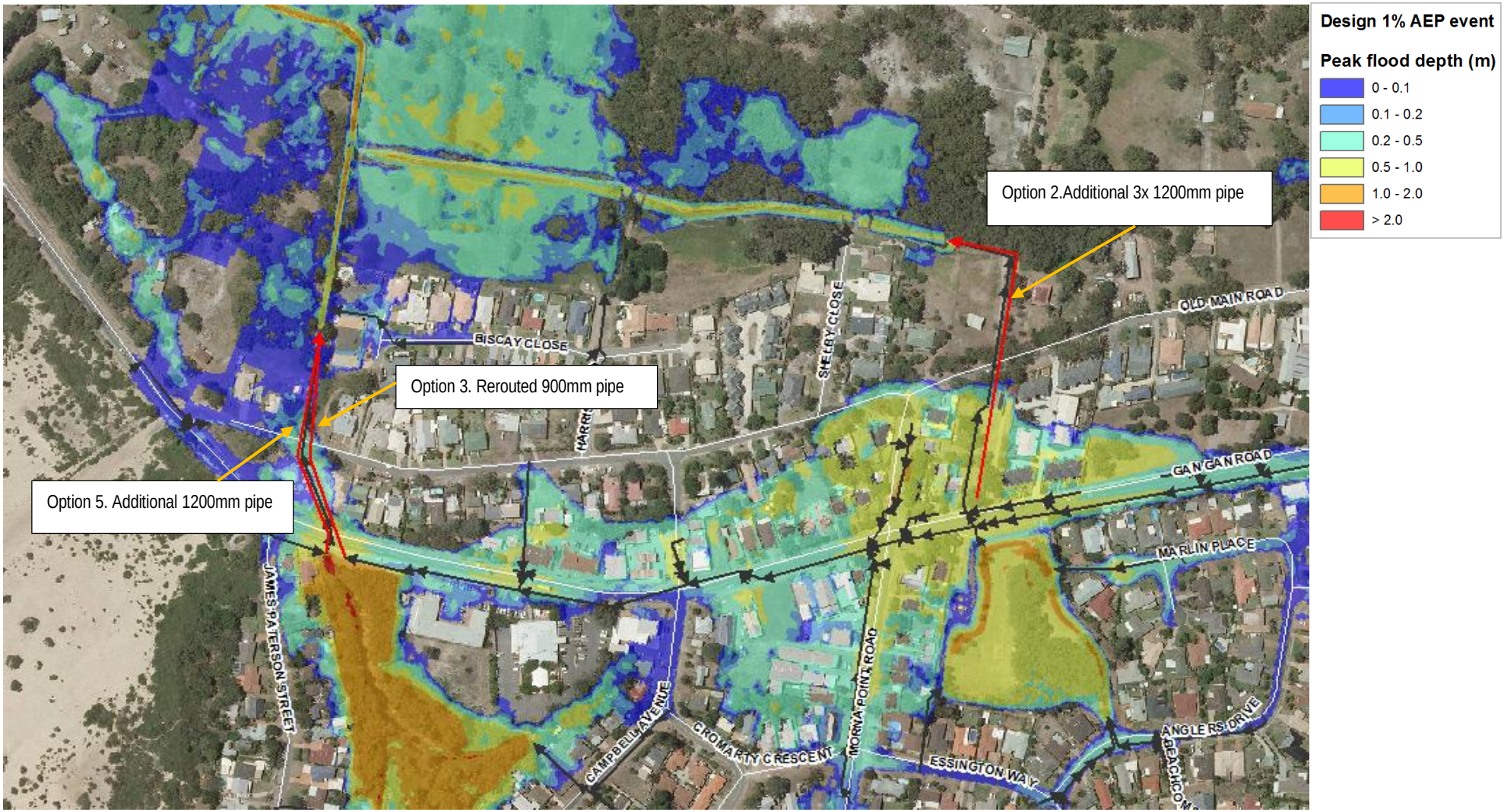


Diagram J-3 Illustration of Option 4, Option 6a and Option 6b

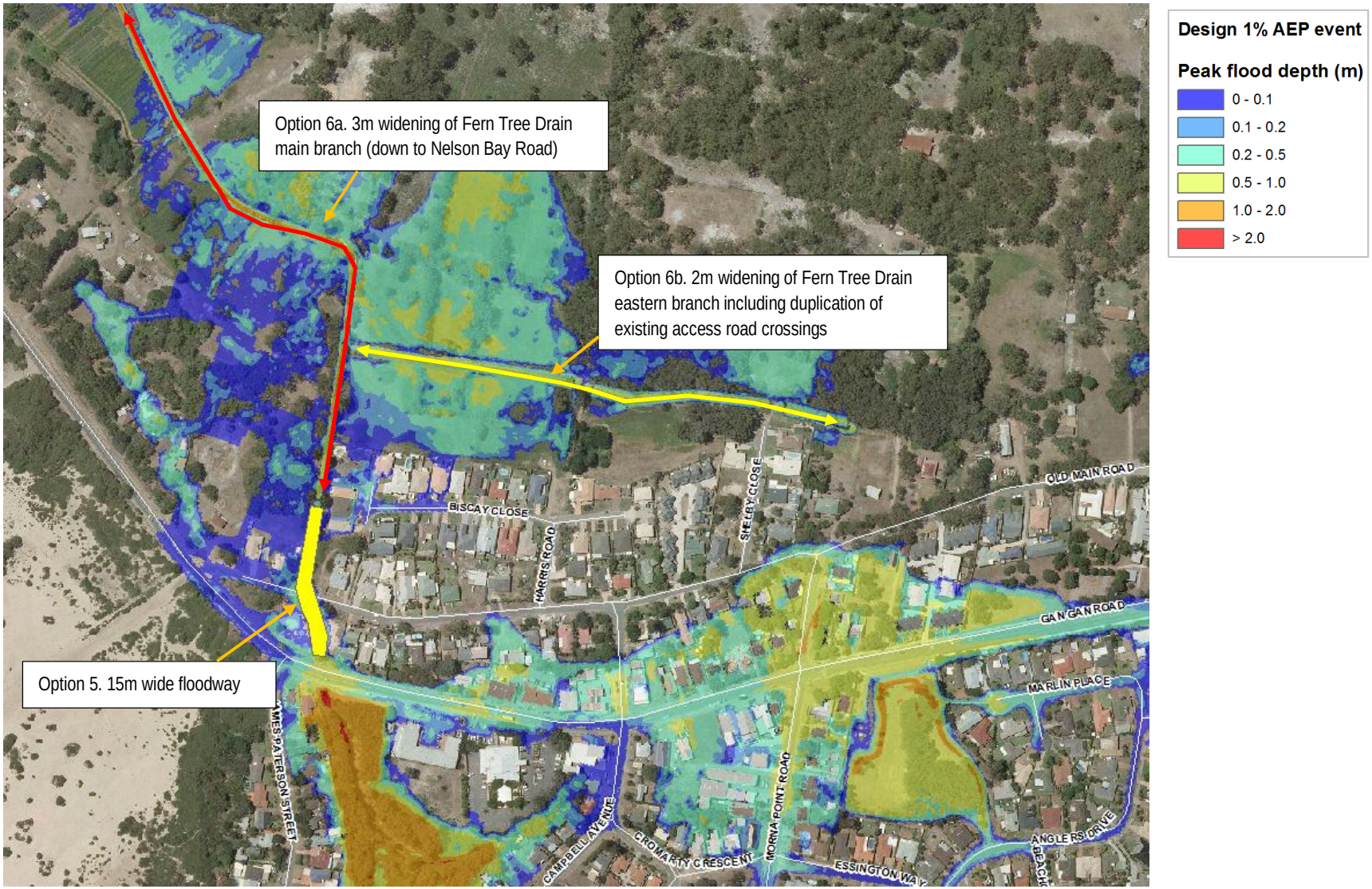


Diagram J-4 Illustration of Option 7

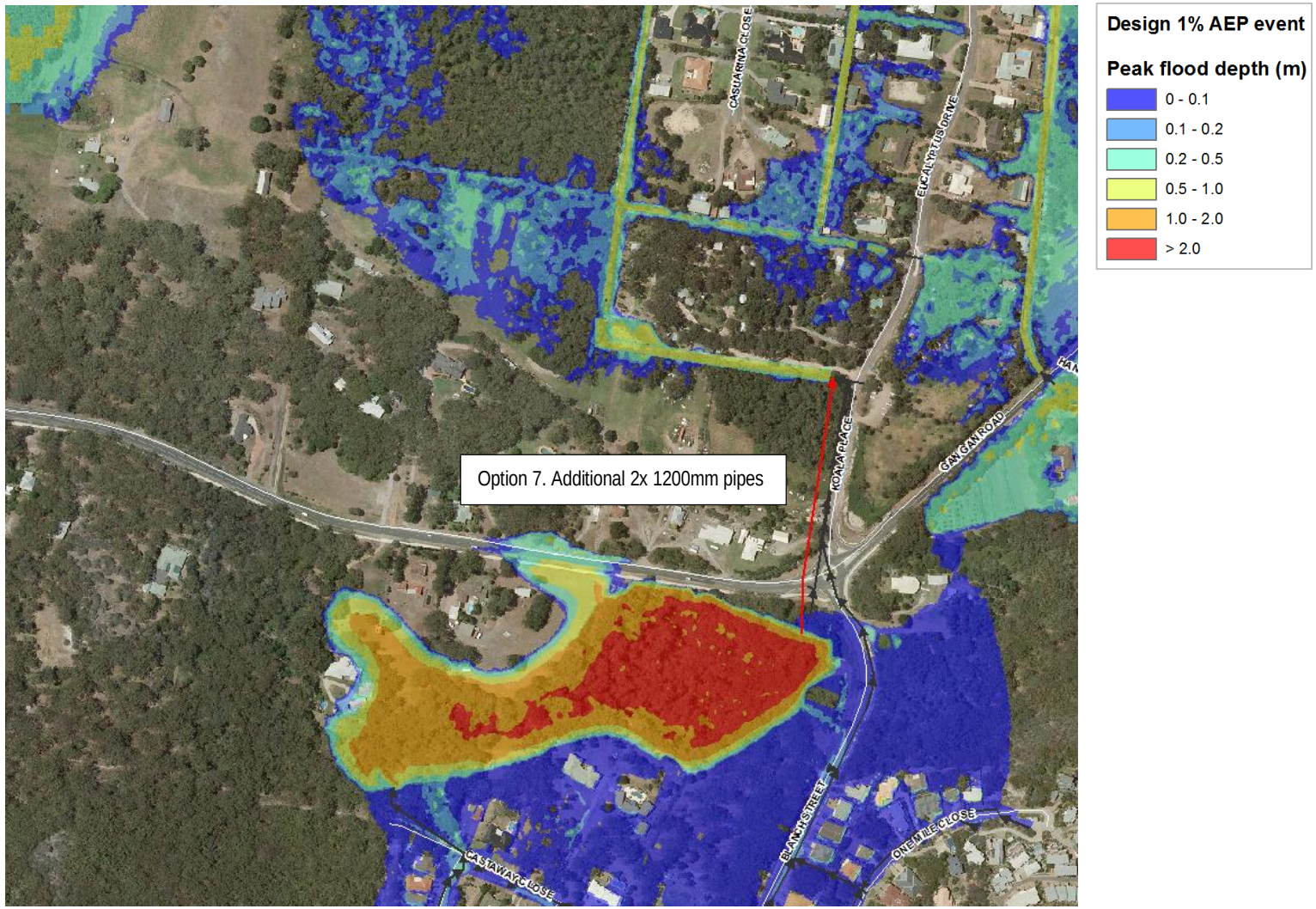


Table J-2 Modelling Scenarios for Mitigation Options Assessment

Flood Issue Area	Options	Unmitigated Flood Depth (m, future development case)	Mitigated Case Flood Depth (m)	Change in Flood Depth (m) compared to Baseline (No Mitigation)	Comment
Scenario 1 (Preliminary scenario – 1% AEP modelled only)					
Clark Street low point	Option 1	1% AEP: 0.7m to 1.3m	1% AEP: 0.3m to 0.5m	1% AEP: -0.4m to -1.1m	· Anomalous flood level increases in the flow path at higher elevations above/south of the sag point. This is a modelling issue related to distribution of the inflows in the mitigation case and **is not a real impact.**
Morna Point Road intersection	Option 2 + 3	1% AEP: 0.7m to 1.1m	1% AEP: 0.3m to 0.7m	1% AEP: -0.4m	· Some existing dwellings still affected by depths 0.3 – 0.6m in 1% AEP.
McKinley Swamp and east on Gan Gan Road	Option 3 + 4	1% AEP: 0.5m to 1.1m on properties	1% AEP: 0.3m to 0.6m	1% AEP: -0.2m to -0.6m	· Depths at existing dwellings up to 0.6m in particular at rear of property on Gan Gan Road immediately west of McKinley Swamp. · Floodway flow depths up to 0.3m in 1% AEP.
Blanch Street low point	No mitigation assessed	-	-	-	
Fern Tree Drain floodplain	No mitigation assessed	1% AEP: 0.4m to 0.6m	1% AEP: 0.6m to 0.8m	1% AEP: +0.2m to +0.3m	· Increase in flood depths/levels resulting from the proposed drainage upgrades (Options 2 to 5).
Scenario 2					
Clark Street low point	Option 1	5% AEP: 0.5m to 1.2m 1% AEP: 0.7m to 1.3m	5% AEP: 0.3m to 0.5m 1% AEP: 0.3m to 0.5m	5% AEP: -0.3m to -0.8m 1% AEP: -0.4m to -1.1m	· As per Scenario 1
Morna Point Road intersection	Option 2 + 3	5% AEP: 0.5m to 0.9m 1% AEP: 0.7m to 1.1m	5% AEP: 0.2m to 0.5m 1% AEP: 0.3m to 0.7m	5% AEP: -0.3m to -0.5m 1% AEP: -0.4m	· As per Scenario 1
McKinley Swamp and east on Gan Gan Road	Option 3 + 4 + 5	5% AEP: 0.3m to 0.7m on properties 1% AEP: 0.5m to 1.3m on properties	5% AEP: 0.2m to 0.4m 1% AEP: 0.3m to 0.4m	5% AEP: -0.05m to -0.7m 1% AEP: -0.2m to -0.85m	· Option 5 (additional new 1200mm pipe draining McKinley Swamp) reduces flooding by -0.25m in 1% AEP, compared to Scenario 1. · Depths at existing dwellings up to 0.35m in particular at rear of property on Gan Gan Road immediately west of McKinley Swamp.
Blanch Street low point	No mitigation assessed	-	-	-	
Fern Tree Drain floodplain	No mitigation assessed	5% AEP: 0.35m to 0.55m 1% AEP: 0.4m to 0.6m	5% AEP: 0.55m to 0.75m 1% AEP: 0.7m to 0.9m	5% AEP: +0.15m to +0.25m 1% AEP: +0.3m	· Option 5 (new 1200mm pipe draining McKinley Swamp) increases flooding on floodplain by +0.1m, compared to Scenario 1.
Scenario 3					
Clark Street low point	Option 1	As per Scenario 1			
Morna Point Road intersection	Option 2 + 3	As per Scenario 1			

Flood Issue Area	Options	Unmitigated Flood Depth (m, future development case)	Mitigated Case Flood Depth (m)	Change in Flood Depth (m) compared to Baseline (No Mitigation)	Comment
McKinley Swamp and east on Gan Gan Road	Option 3 + 4 + 5 + 6a	5% AEP: 0.3m to 0.7m on properties 1% AEP: 0.5m to 1.3m on properties	5% AEP: 0.2m to 0.4m on properties 1% AEP: 0.3m to 0.4m on properties	5% AEP: -0.05m to -0.7m 1% AEP: -0.2m to -0.9m	· Minor improvement in flooding of -0.05m around McKinley Swamp in the 1% AEP from Option 6a (Fern Tree Drain main branch widening) compared to Scenario 2. No change to 5% AEP. · Depths at existing dwellings up to 0.3m in particular at rear of property on Gan Gan Road immediately west of McKinley Swamp.
Blanch Street low point	No mitigation assessed	-	-	-	
Fern Tree Drain floodplain	Option 6a	5% AEP: 0.35m to 0.55m 1% AEP: 0.4m to 0.6m	5% AEP: 0.35m to 0.65m 1% AEP: 0.6m to 0.7m	5% AEP: +0.01m to +0.25m 1% AEP: +0.1m to +0.3m	· Reduced flood impacts of -0.2m in the 1% AEP on the floodplain at the main branch and eastern branch junction, compared to Scenario 2.
Scenario 4					
Clark Street low point	Option 1	As per Scenario 1			
Morna Point Road intersection	Option 2 + 3 + 6b	No change from Scenarios 1, 2 and 3. Widening of Fern Tree Drain eastern branch not effective for this location.			
McKinley Swamp and east on Gan Gan Road	Option 3 + 4 + 5 + 6b	No change from Scenario 3. Widening of Fern Tree Drain main branch not effective for this location.			
Blanch Street low point	Option 7	5% AEP: Up to 0.6m next to existing buildings. Minor ponding on Gan Gan Road. 1% AEP: Up to 1.1m next to existing buildings. Up to 0.5m on Gan Gan Road.	5% AEP: Up to 0.3m next to existing buildings. Minor ponding remains on Gan Gan Road. 1% AEP: 0.1m to 0.2m next to existing buildings. Up to 0.2m on Gan Gan Road.	5% AEP: -0.35m 1% AEP: -0.25m to -0.6m	· This section of Gan Gan Road becomes trafficable in the 1% AEP as a result of the mitigation option. · No effect on minor ponding on Gan Gan Road in 5% AEP, which occurs on the northern side of the road. Additional road drainage would be required (low priority). · Flood level increases in the open drains in One Mile residential area of 0.03m to 0.1m in the 1% AEP as a result of increased discharge.
Fern Tree Drain floodplain	Option 6b	5% AEP: 0.35m to 0.55m 1% AEP: 0.4m to 0.6m	5% AEP: 0.35m to 0.6m 1% AEP: 0.6m to 0.7m	5% AEP: +0.01m to +0.2m 1% AEP: +0.1m to +0.25m	· Minor improvements only as a result of the eastern branch widening.

J.5 Discussion on Flood Impacts to Downstream Areas

J.5.1 Fern Tree Drain Floodplain

Flood depths are markedly reduced in the trapped low points along Gan Gan Road around Anna Bay by the mitigation options. The increased drainage capacity allows the floodwaters collecting at these low points to drain away more freely. Conversely, the mitigation works convey this floodwater to Fern Tree Drain and its adjacent floodplain, which results in an increase in flood depths in the 1% AEP event by 0.2 – 0.35m (refer to Scenario 1 and 2) in the floodplain area to the north of Old Main Road if the capacity of Fern Tree Drain is not improved. There are hydraulic constrictions along the Drain which prevent this floodwater spreading to the downstream floodplain areas near Nelson Bay Road. By widening the Drain this allows the floodwaters to spread downstream, reducing the increase in flood depths on the floodplain to 0.1 – 0.3m (refer to Scenario 4).

Further reductions could be achieved by:

- Further increasing Fern Tree Drain capacity by widening the Drain
- Regrading sections of the floodplain to remove localised high areas of land, mostly consisting of embankments for access roads on private property to allow trapped floodwaters to flow away more freely
- Higher levees on the banks of the Drain to further contain flows and reduce overtopping and overflows onto the floodplain.

Consultation with land owners is required to confirm the impact of these increases in flood depths, and what further mitigation works should be considered. This consultation and further investigation is recommended during the subsequent Floodplain Risk Management Study (FRMS).

Note that peak flood levels in the floodplain area immediately upstream of Nelson Bay Road are not increased by the proposed mitigation works, as the peak flooding in this area is caused by backwater flooding from downstream areas,

J.5.2 Upper Main Drain

The proposed new drainage for Blanch Street low point (Option 7) increases flows in the open drains in the One Mile residential area at the upper end of Main Drain. This results in increases in flood levels of 0.03 – 0.10m in the 1% AEP event. Freeboard to the existing dwellings is reduced, although the increases in flows are generally contained in the drains and there do not appear to be any dwellings directly impacted by the increases in flows. There may be several sheds and structures which are affected.

J.6 Summary on Mitigation Assessment

Flood depths in the 1% AEP event may be reduced generally by 0.2-0.3m and up to over 1m by implementation of a combination of all assessed options, which is considered a marked improvement from existing flooding conditions. Staging of the works should be considered to target current flood problem areas where existing development is currently at risk, most notably around Morna Point Road and McKinley Swamp/Anna Bay shops.

Significant drainage upgrade works are required at the locations considered and are expected to be relatively high in cost due to the size of the upgrades and construction techniques required. In particular, thrust-boring of 5x 1200mm pipes for Clark Street low point and 2x 1200mm pipes at Blanch Street low point for lengths of up to 180m are expected to be high in expense but would be necessary to facilitate drainage of these trapped low points in up to the 1% AEP event.

The proposed mitigation results in flood level increases of up to 0.3m in trapped points on the Fern Tree Drain floodplain. The affected areas are currently rural and pasture areas with no impact to existing dwellings or structures. Additional mitigation works in Fern Tree Drain and on its floodplain may be considered to reduce these flooding impacts.

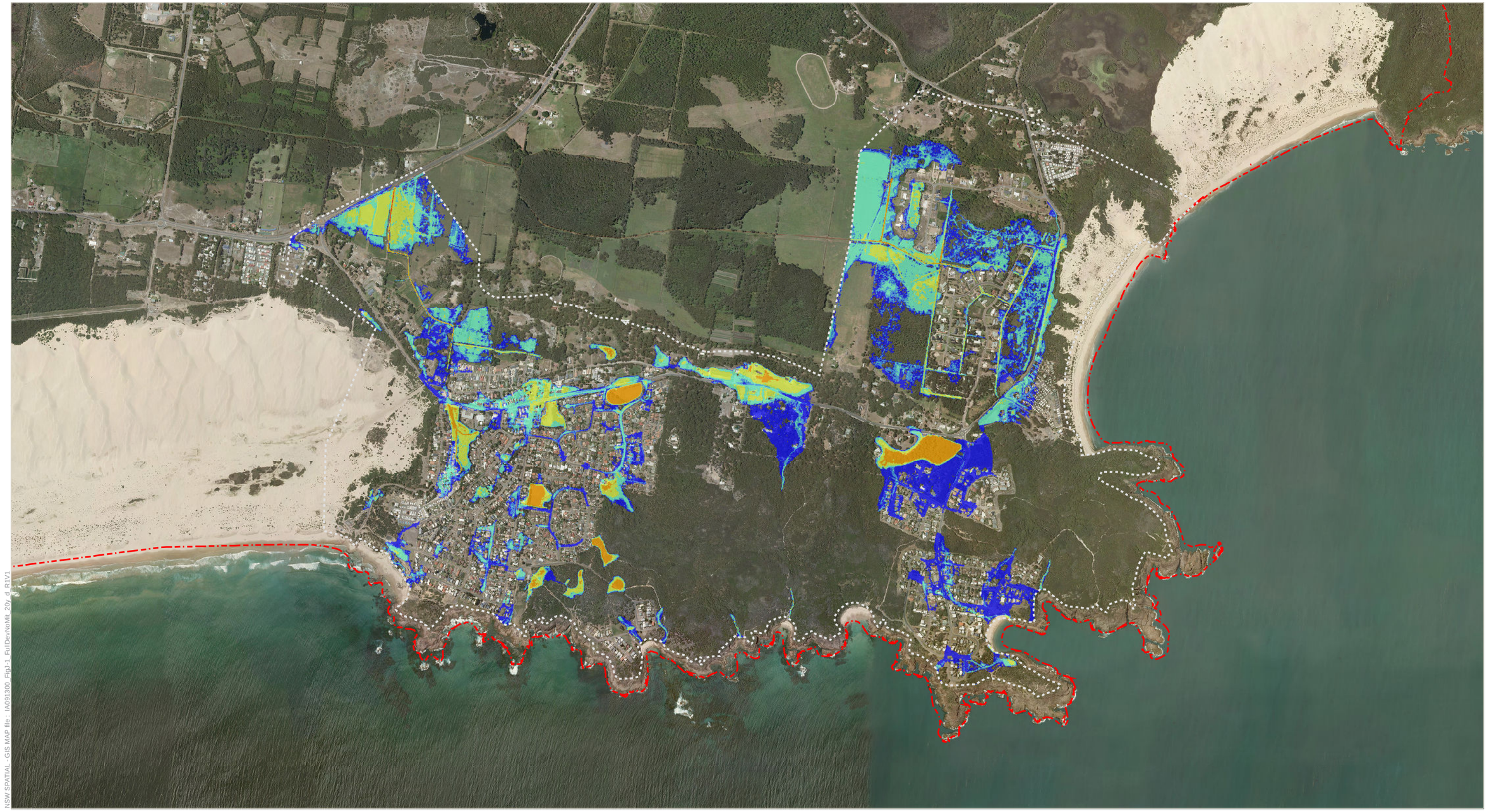
J.7 Recommendations for Further Mitigation Assessment

The following recommendations are made for ongoing mitigation assessment in the FRMS stage:

- Assess the feasibility and constructability of the mitigation options proposed.
- Consider further enlargement of Fern Tree Drain capacity including the Drain itself and potential improvement of drainage in the floodplain, to reduce the flood level and depth increases from Anna Bay drainage upgrades. Undertake land owner consultation to clarify impacts and confirm acceptable mitigation options.
- Confirm if upper Main Drain area open drains in One Mile residential area require upgrade due to increased discharge and flood levels from Blanch Street low point drainage upgrade.
- Consider integrating the Anna Bay urban model with the Tilligerry Creek regional model to assess potential impacts of increased flows from the Anna Bay mitigation works to downstream areas.
- Consider assessment of climate change and impacts to the mitigation case flooding and effectiveness of the mitigation options. The assessment to date has considered existing climate (ARR 1987 rainfall, sea level) conditions for indicative sizing and performance of identified options. Update mitigation options sizing if required.
- Community consultation should be undertaken on the potential mitigation options in regards to flooding impacts and community concerns.

J.8 Future Development and Mitigation Assessment Flood Mapping

List of Figures



NSW SPATIAL - GIS MAP file - JA091300_Fig3-1_FullDevNoMit_20y_d_R1V1

Legend

Peak flood depth (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

Kilometres 0 1

N

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Figure J-1 5% AEP Flood Depth - Anna Bay Future Development No Mitigation - Anna Bay Urban Area

JACOBS

Legend

Change in Flood Level (m)

- < -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- > 0.5

Change in Flood Extent

- Previously Flooded
- New Areas Flooded

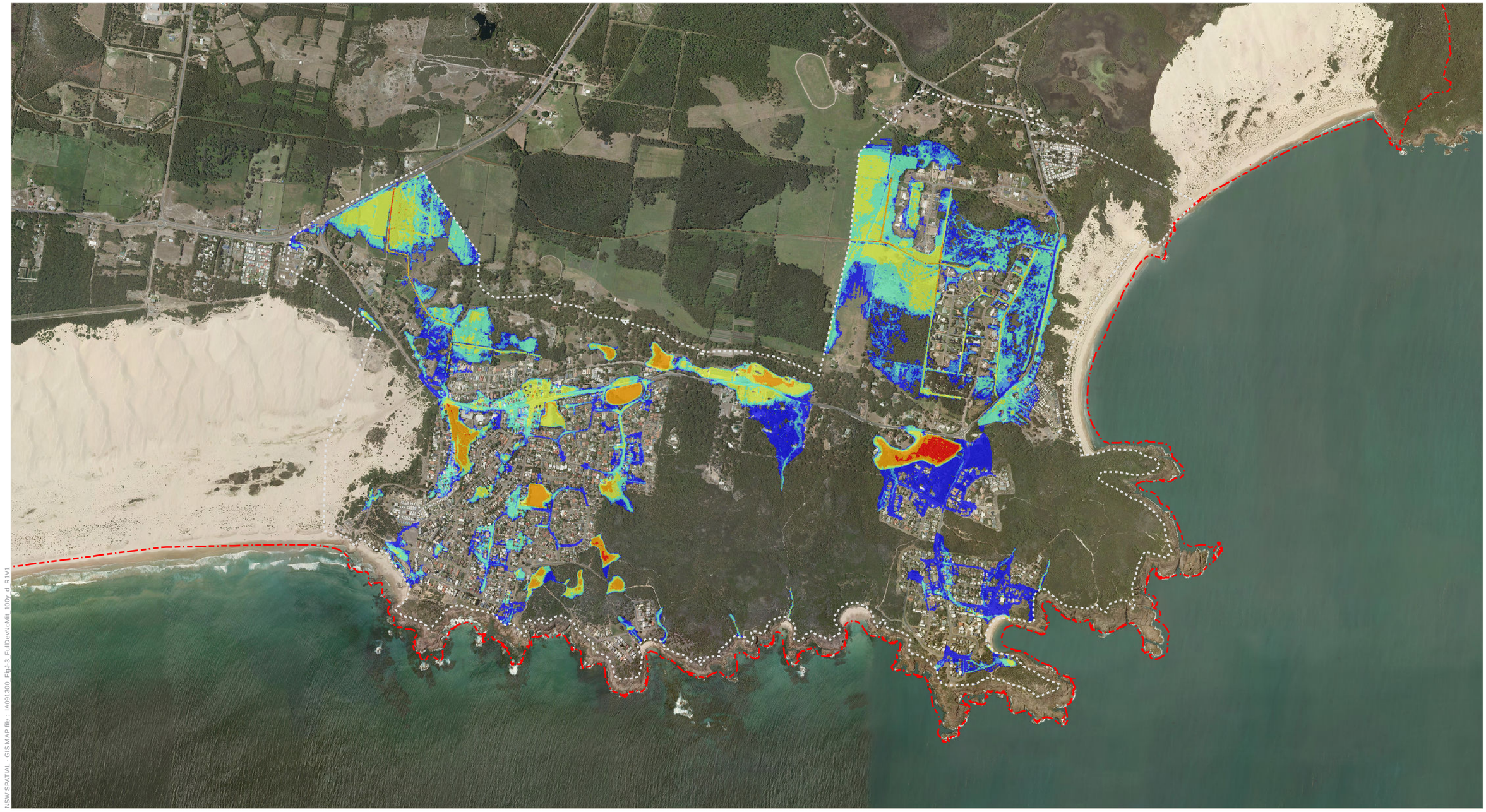
- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

N

1:20,000@ A3

Figure J-2 5% AEP Change in Flood Level - Anna Bay Future Development No Mitigation - Anna Bay Urban Area

JACOBS



Legend

Peak flood depth (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

- Study
- Urban Area TUFLOW model (Extent of Mapping)

Kilometres 0 1

N

1:20,000@ A3

Figure J-3 1% AEP Flood Depth - Anna Bay Future Development No Mitigation - Anna Bay Urban Area

JACOBS

Legend

Change in Flood Level (m)

- < -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- > 0.5

Change in Flood Extent

- Previously Flooded
- New Areas Flooded

- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

Kilometres 0 1

N

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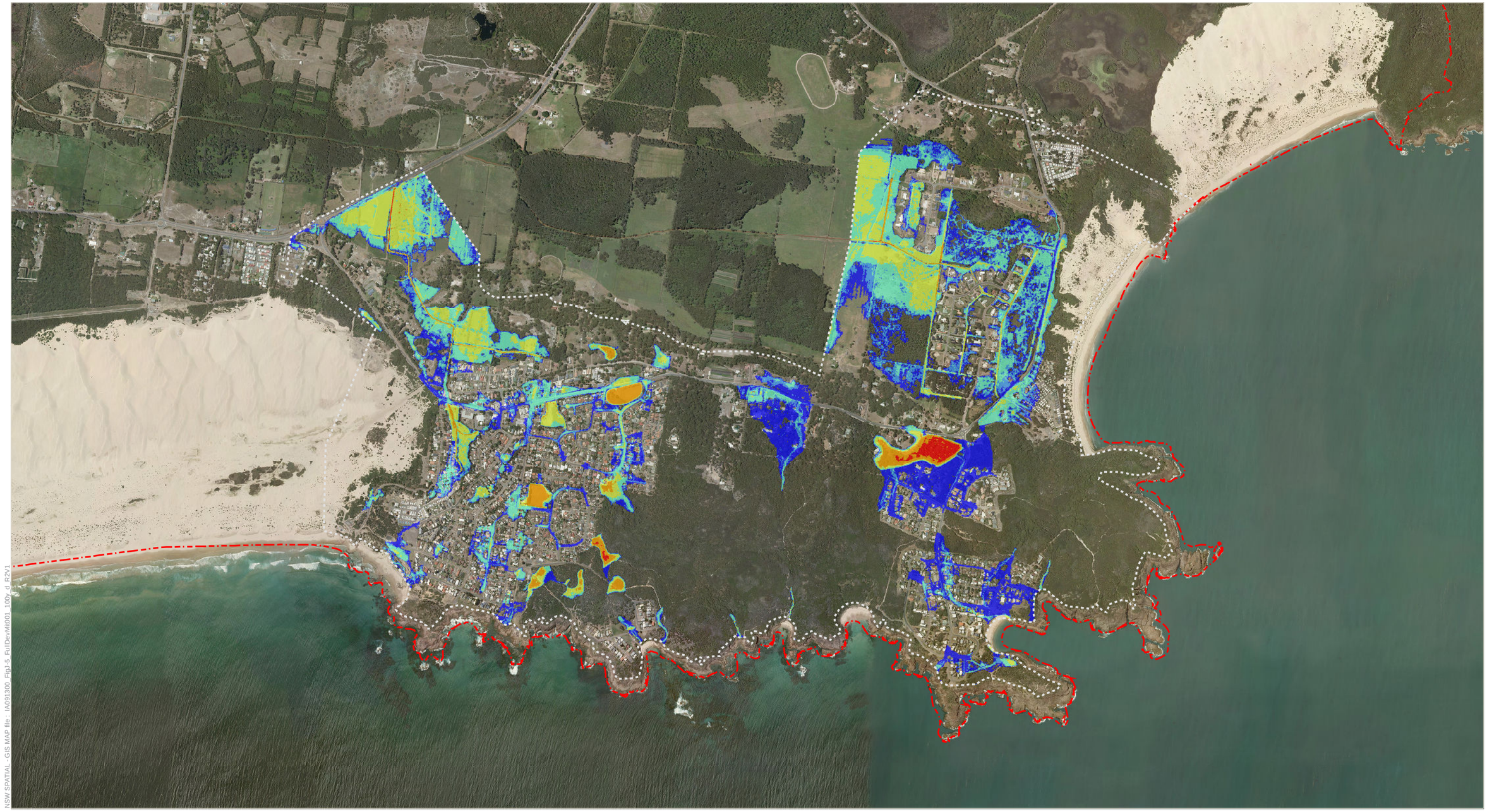
Figure J-4 1% AEP Change in Flood Level - Anna Bay Future Development No Mitigation - Anna Bay Urban Area

JACOBS



NSW SPATIAL – GIS MAP file - IA091300_Fig3-5_FullDevMit01_100y_d_R2V1

Legend

Peak flood depth (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

Kilometres 0 1

N

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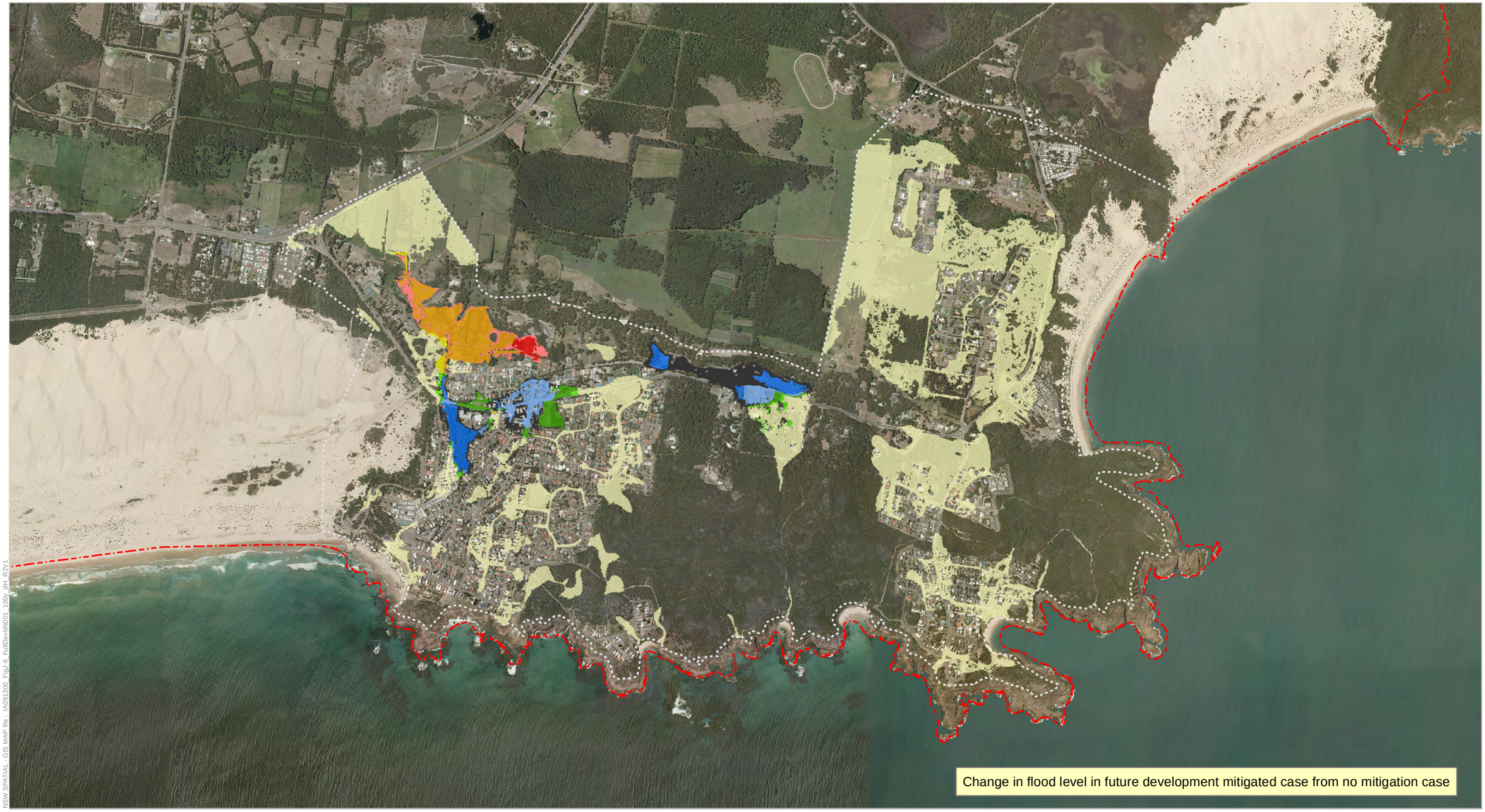
Figure J-5 1% AEP Flood Depth - Anna Bay Future Development Mitigation Scenario 1 - Anna Bay Urban Area

JACOBS



NSW SPATIAL – GIS MAP file - IA091300_Fig3-6_FullDevMit001_100y_dH_R2V1

Legend

Change in Flood Level (m)

- < -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- > 0.5

Change in Flood Extent

- Previously Flooded
- New Areas Flooded

- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

Kilometres 0 1

N

1:20,000@ A3

Figure J-6 1% AEP Change in Flood Level - Anna Bay Future Development Mitigation Scenario 1 - Anna Bay Urban Area

JACOBS

NSW SPATIAL - GIS MAP file - JA091300_Fig3-7_FullDevMit602_20y_d_R2V1

Legend

Peak flood depth (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

Kilometres 0 1

N

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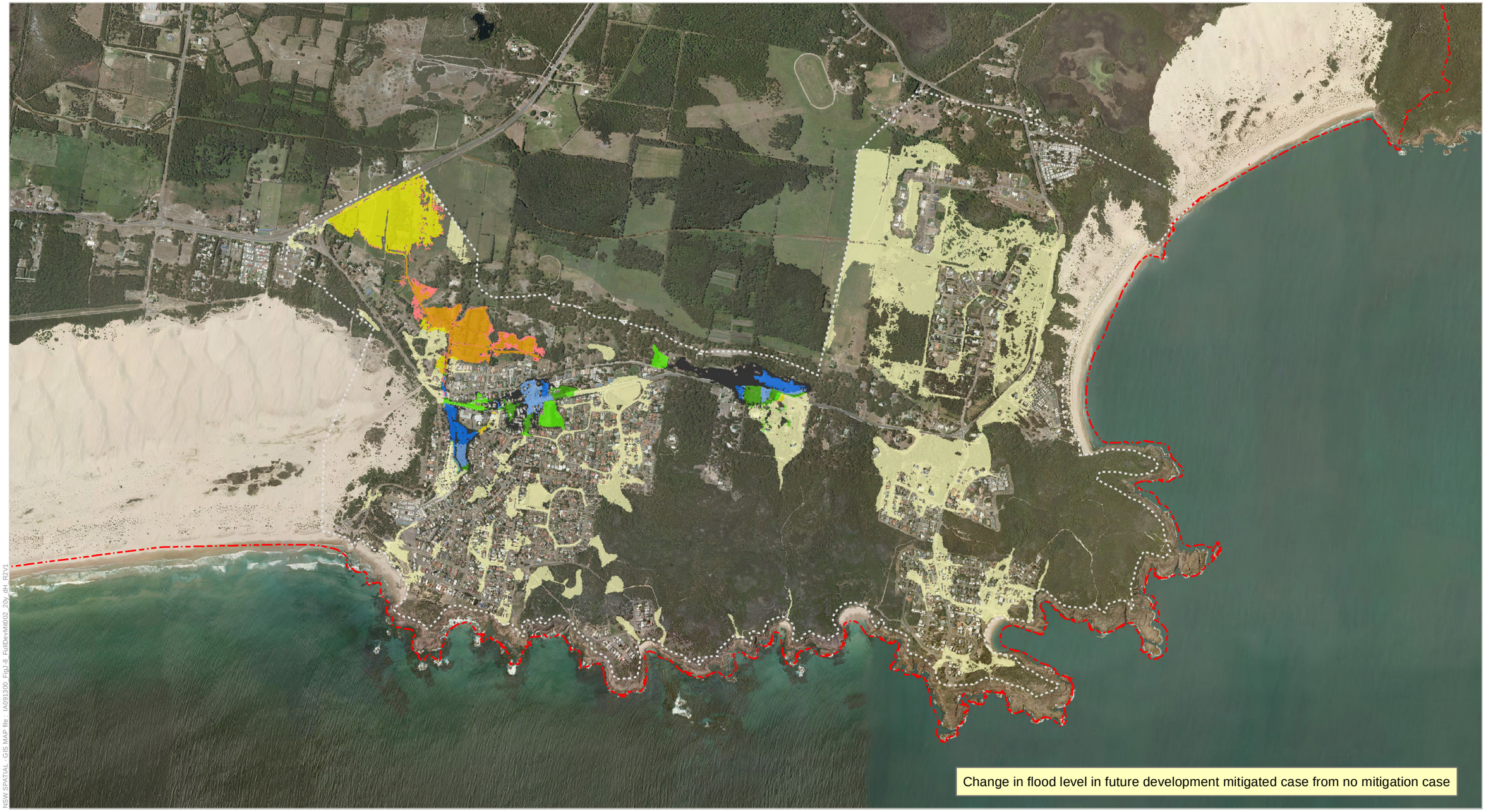
Figure J-7 5% AEP Flood Depth - Anna Bay Future Development Mitigation Scenario 2 - Anna Bay Urban Area

JACOBS



NSW SPATIAL – GIS MAP file - IA091300_Fig3-8_FullDevMit02_20y_dH_R2V1

Legend

Change in Flood Level (m)

- < -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- > 0.5

Change in Flood Extent

- Previously Flooded
- New Areas Flooded

- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

Kilometres 0 1

N

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Figure J-8 5% AEP Change in Flood Level - Anna Bay Future Development Mitigation Scenario 2 - Anna Bay Urban Area

JACOBS

NSW SPATIAL – GIS MAP file - IA091300_Fig3-9_FullDevMit002_100y_d_R2V1

Legend

Peak flood depth (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

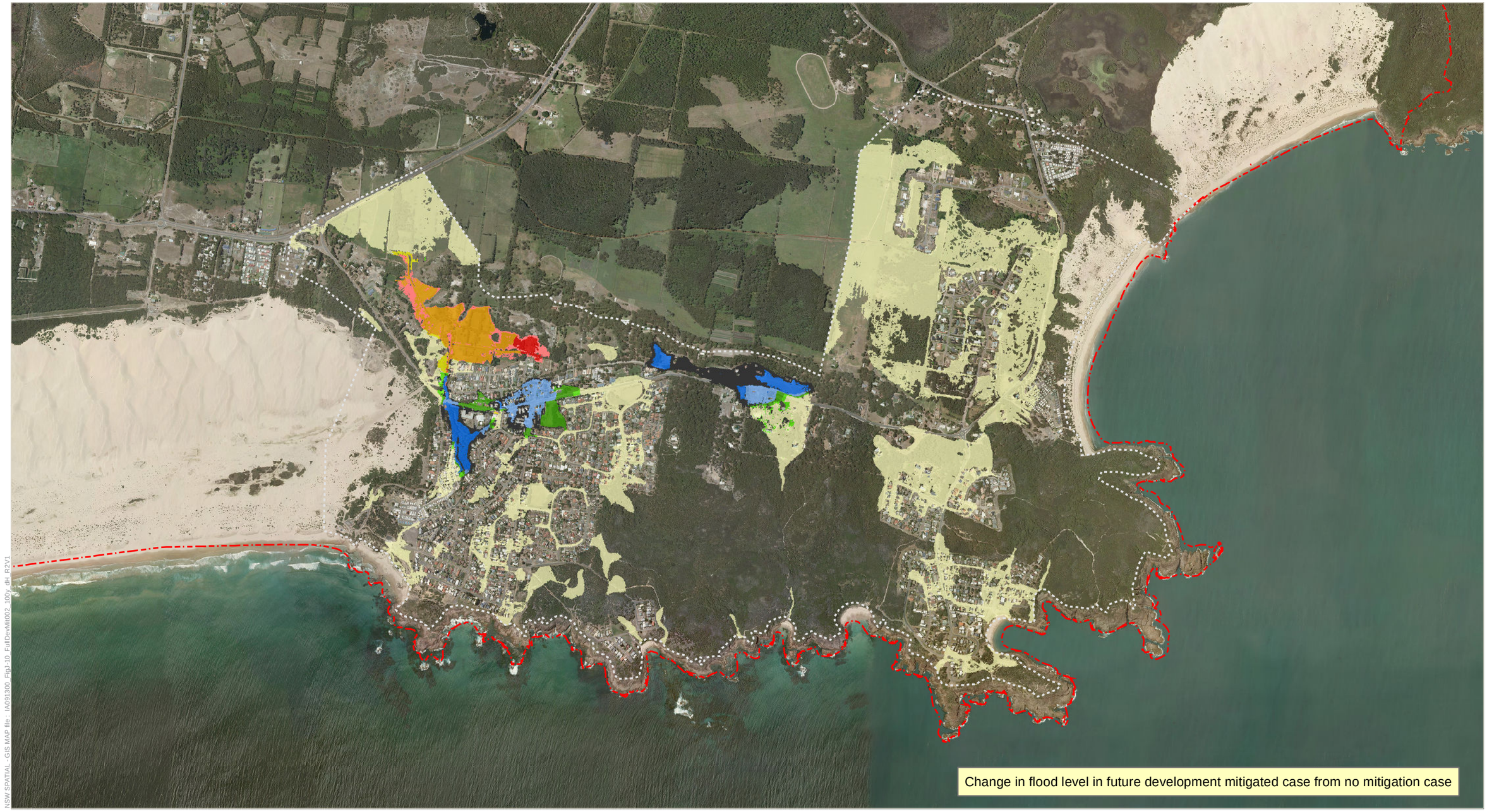
Kilometres 0 1

N

1:20,000@ A3

Figure J-9 1% AEP Flood Depth - Anna Bay Future Development Mitigation Scenario 2 - Anna Bay Urban Area

JACOBS



Legend

Change in Flood Level (m)

- < -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- > 0.5

Change in Flood Extent

- Previously Flooded
- New Areas Flooded

- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

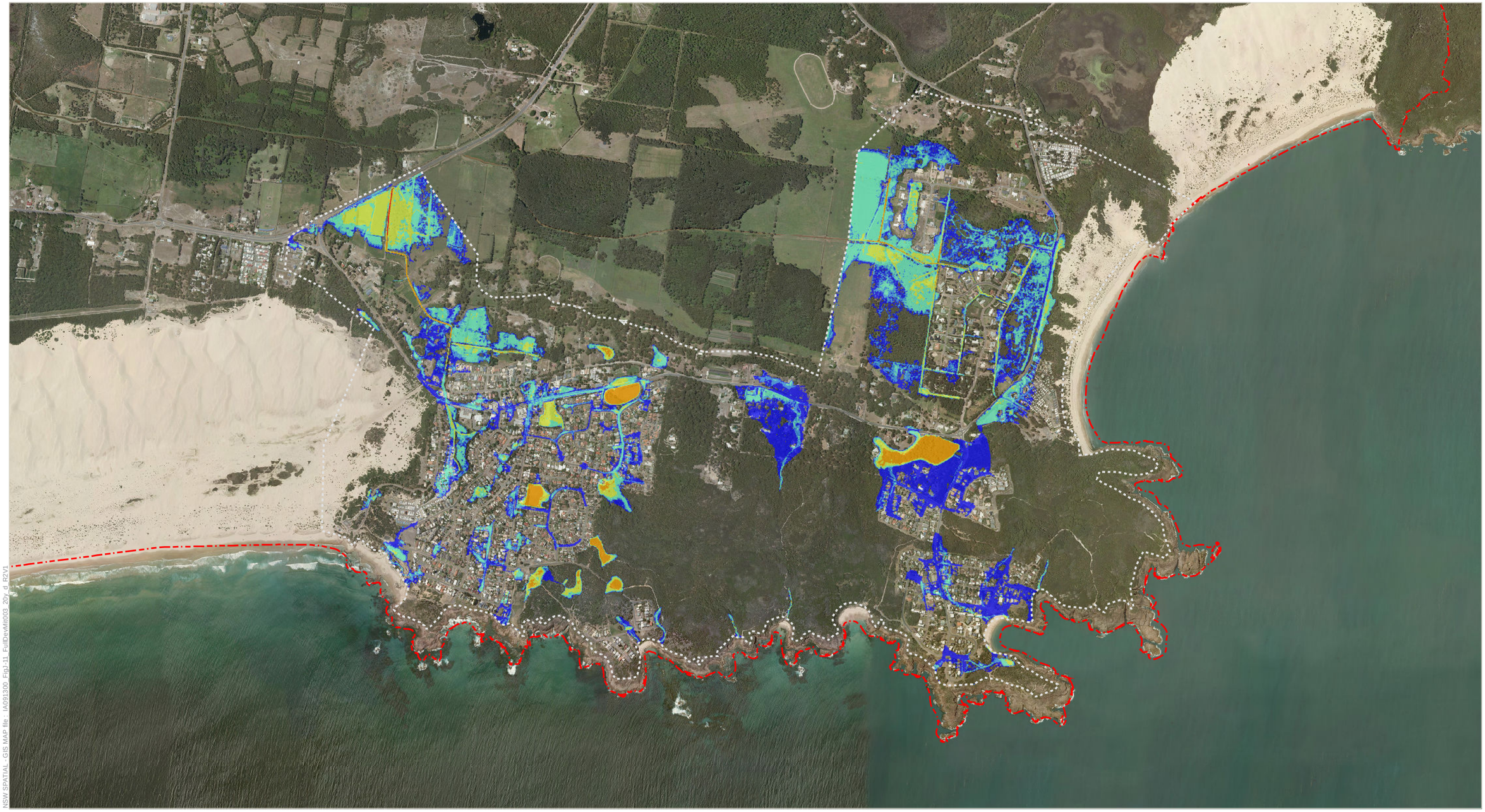
Kilometres 0 1

N

1:20,000@ A3

Figure J-10 1% AEP Change in Flood Level - Anna Bay Future Development Mitigation Scenario 2 - Anna Bay Urban Area

JACOBS



NSW SPATIAL – GIS MAP file – JA091300_Fig3-11_FullDevMit003_20y_d_R2V1

Legend

Peak flood depth (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

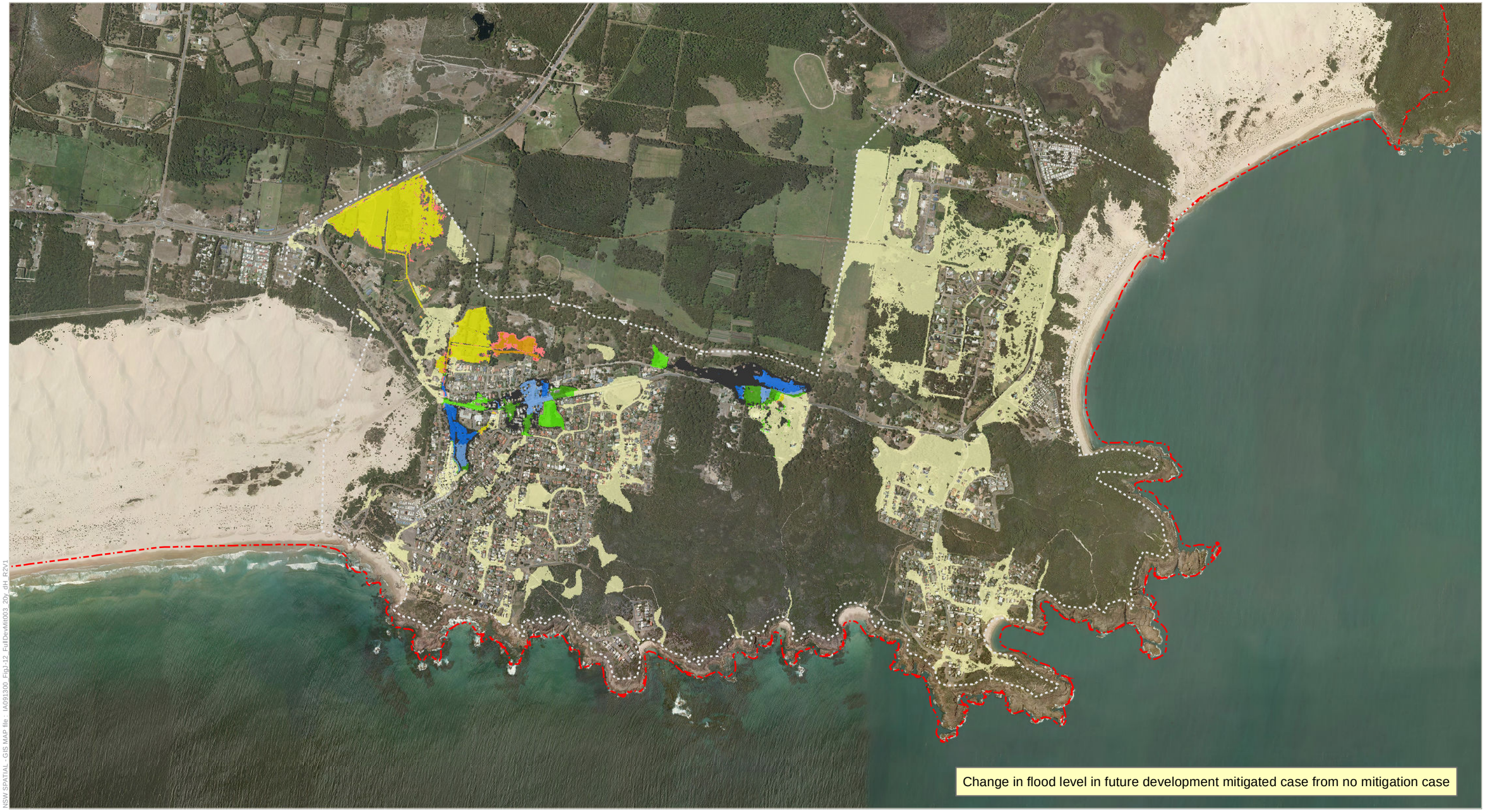
Kilometres 0 1

N

1:20,000@ A3

Figure J-11 5% AEP Flood Depth - Anna Bay Future Development Mitigation Scenario 3 - Anna Bay Urban Area

JACOBS



Legend

Change in Flood Level (m)

- < -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- > 0.5

Change in Flood Extent

- Previously Flooded
- New Areas Flooded

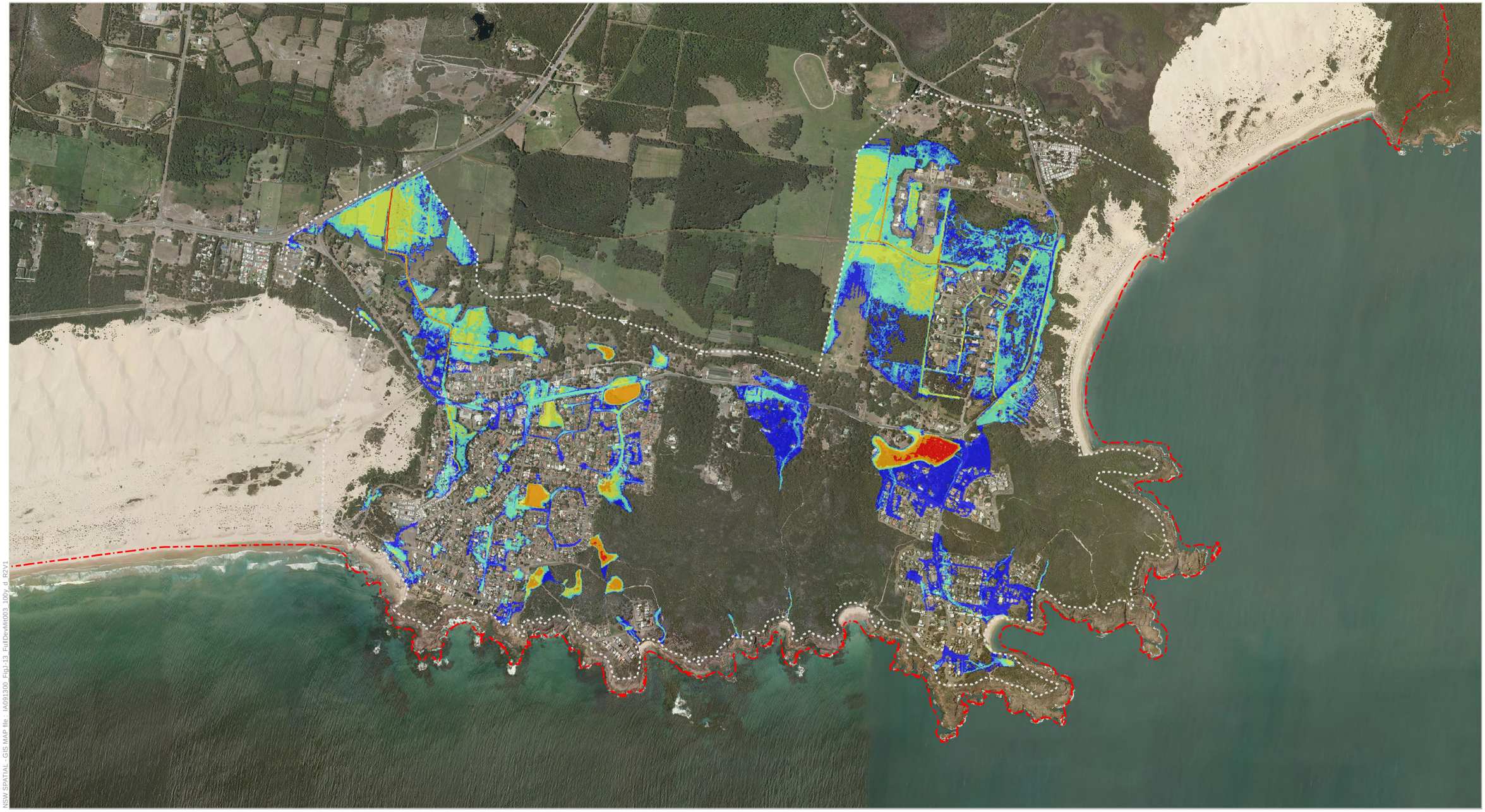
- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

N

1:20,000@ A3

Figure J-12 5% AEP Change in Flood Level - Anna Bay Future Development Mitigation Scenario 3 - Anna Bay Urban Area

JACOBS



NSW SPATIAL – GIS MAP file - IA091300_Fig3-13_FutDevMit003_100y_d_R2V1

Legend

Peak flood depth (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

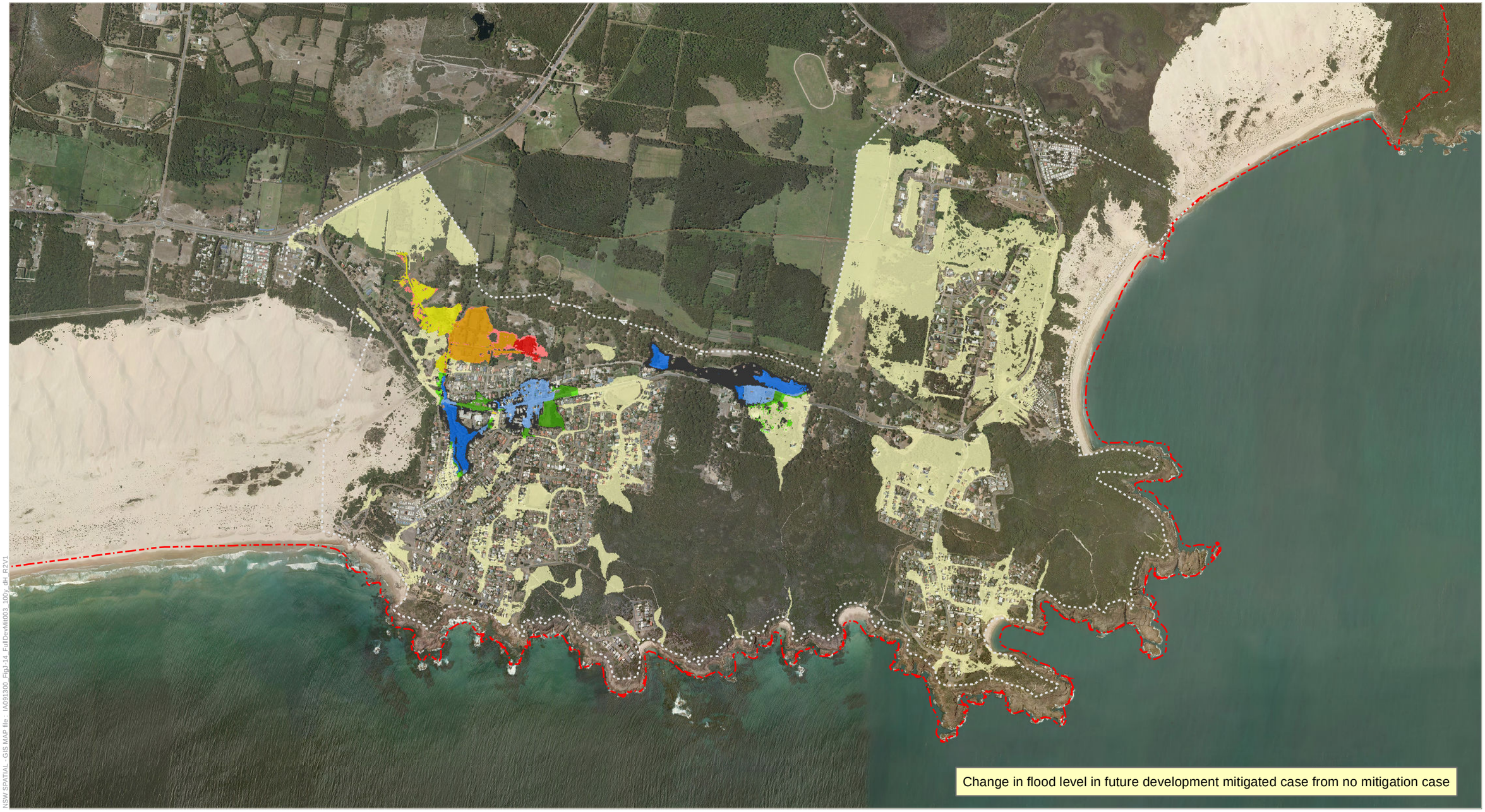
Kilometres 0 1

N

1:20,000@ A3

Figure J-13 1% AEP Flood Depth - Anna Bay Future Development Mitigation Scenario 3 - Anna Bay Urban Area

JACOBS



NSW SPATIAL – GIS MAP file - IA091300_Fig3-14_FutDevMit003_100y_dH_R2V1

Legend

Change in Flood Level (m)

- < -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- > 0.5

Change in Flood Extent

- Previously Flooded
- New Areas Flooded

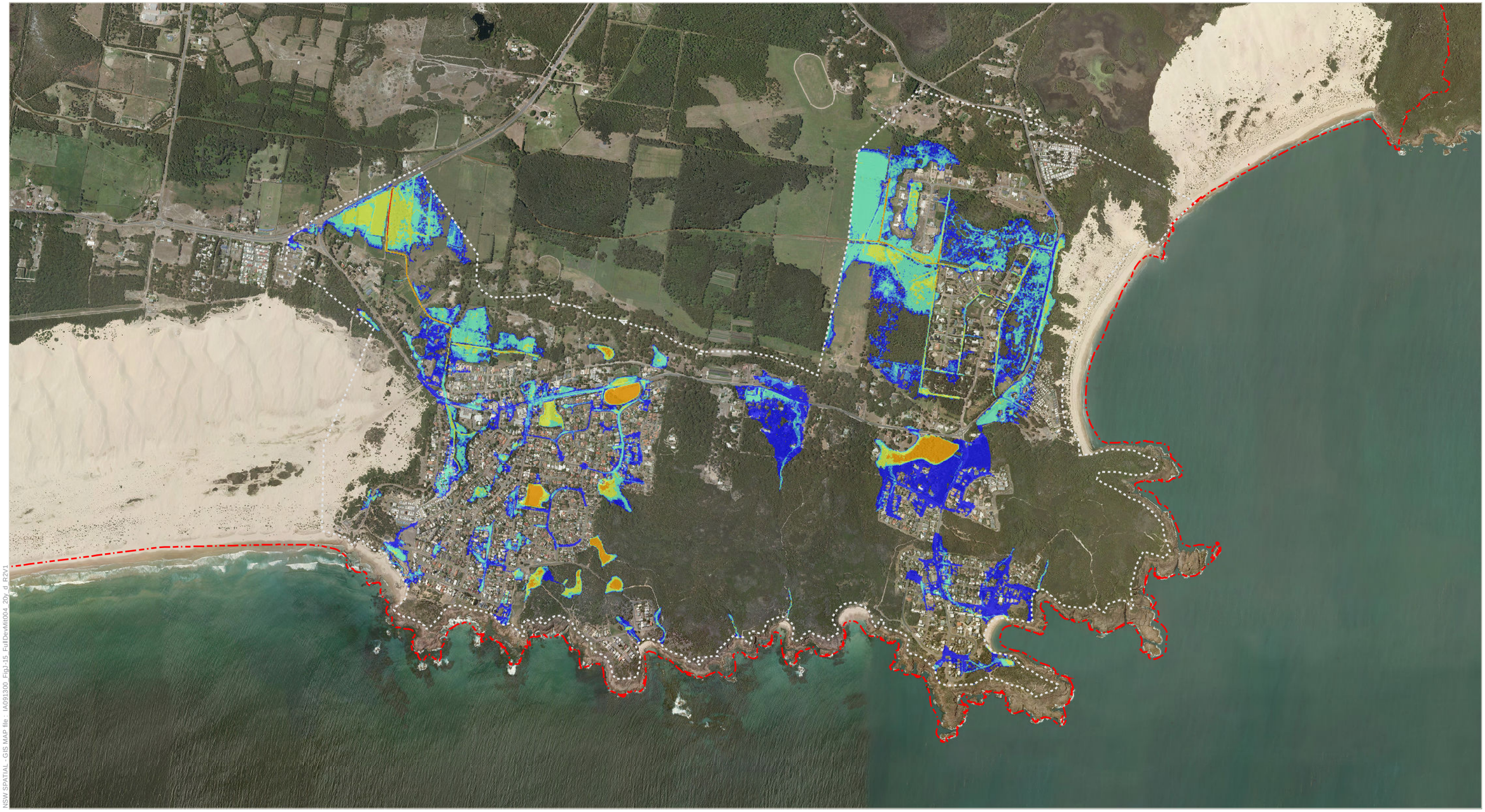
- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

N

1:20,000@ A3

JACOBS

Figure J-14 1% AEP Change in Flood Level - Anna Bay Future Development Mitigation Scenario 3 - Anna Bay Urban Area



NSW SPATIAL – GIS MAP file – JA091300_Fig3-15_FullDevMit004_20y_d_R2V1

Legend

Peak flood depth (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

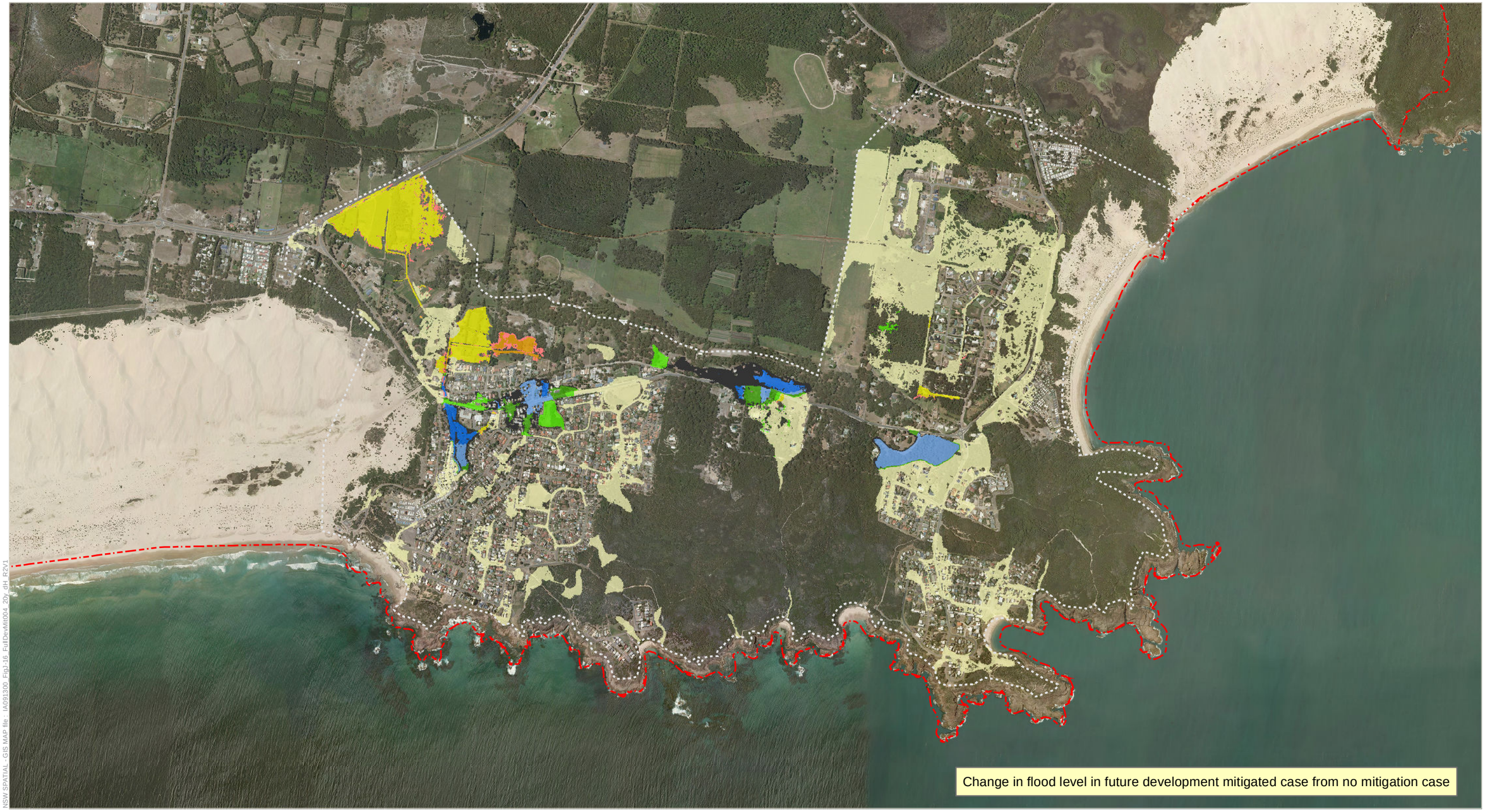
Kilometres 0 1

N

1:20,000@ A3

Figure J-15 5% AEP Flood Depth - Anna Bay Future Development Mitigation Scenario 4 - Anna Bay Urban Area

JACOBS



NSW SPATIAL – GIS MAP file - IA091300_Fig3-16_FutDevMit004_20y_dH_R2V1

Legend

Change in Flood Level (m)

- < -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- > 0.5

Change in Flood Extent

- Previously Flooded
- New Areas Flooded

- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

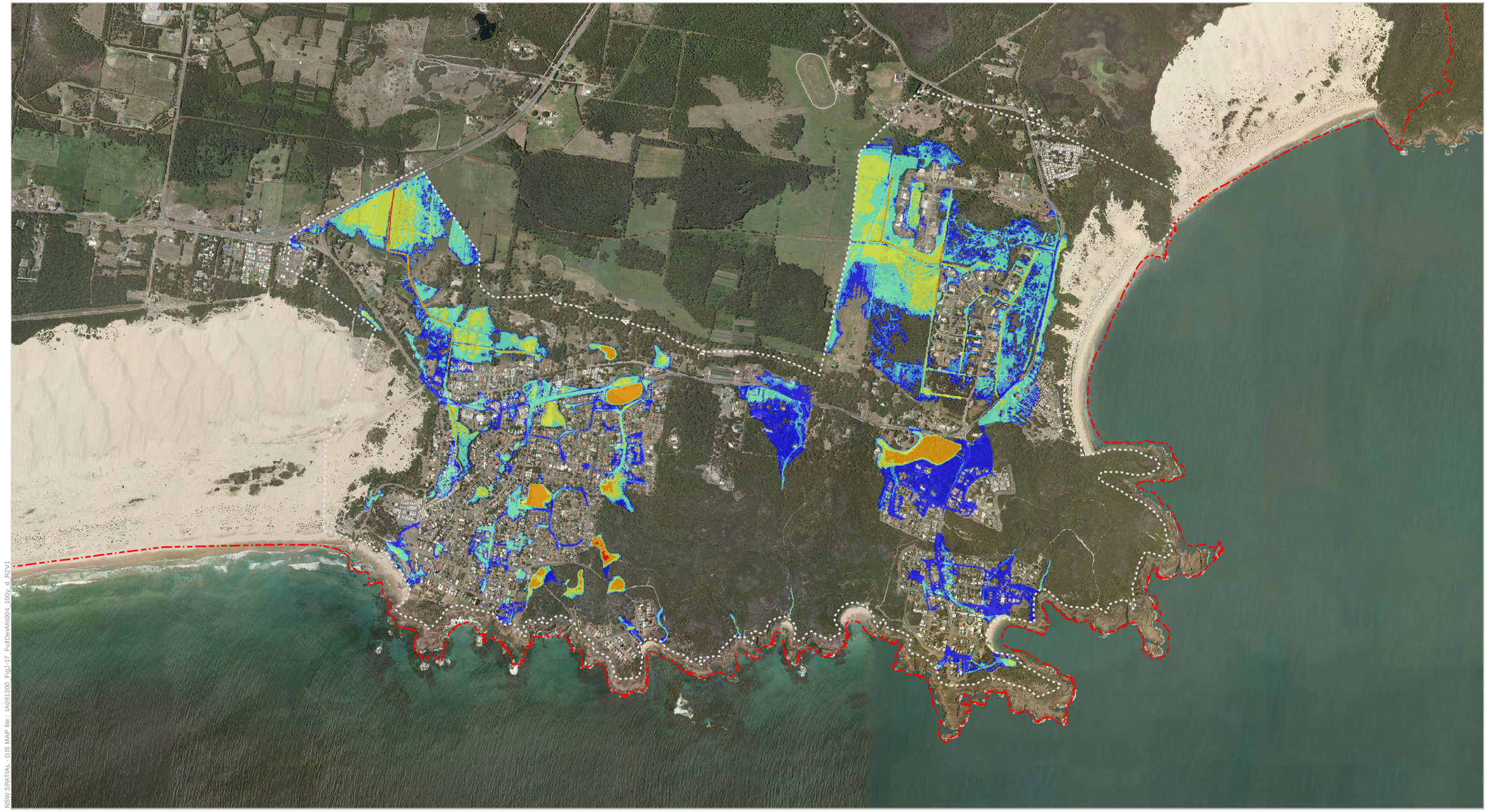
Kilometres 0 1

N

1:20,000@ A3

Figure J-16 5% AEP Change in Flood Level - Anna Bay Future Development Mitigation Scenario 4 - Anna Bay Urban Area

JACOBS



NSW SPATIAL - GIS MAP file - IA091300_Fig3-17_FutDevMit004_100y_d_R2V1

Legend

Peak flood depth (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

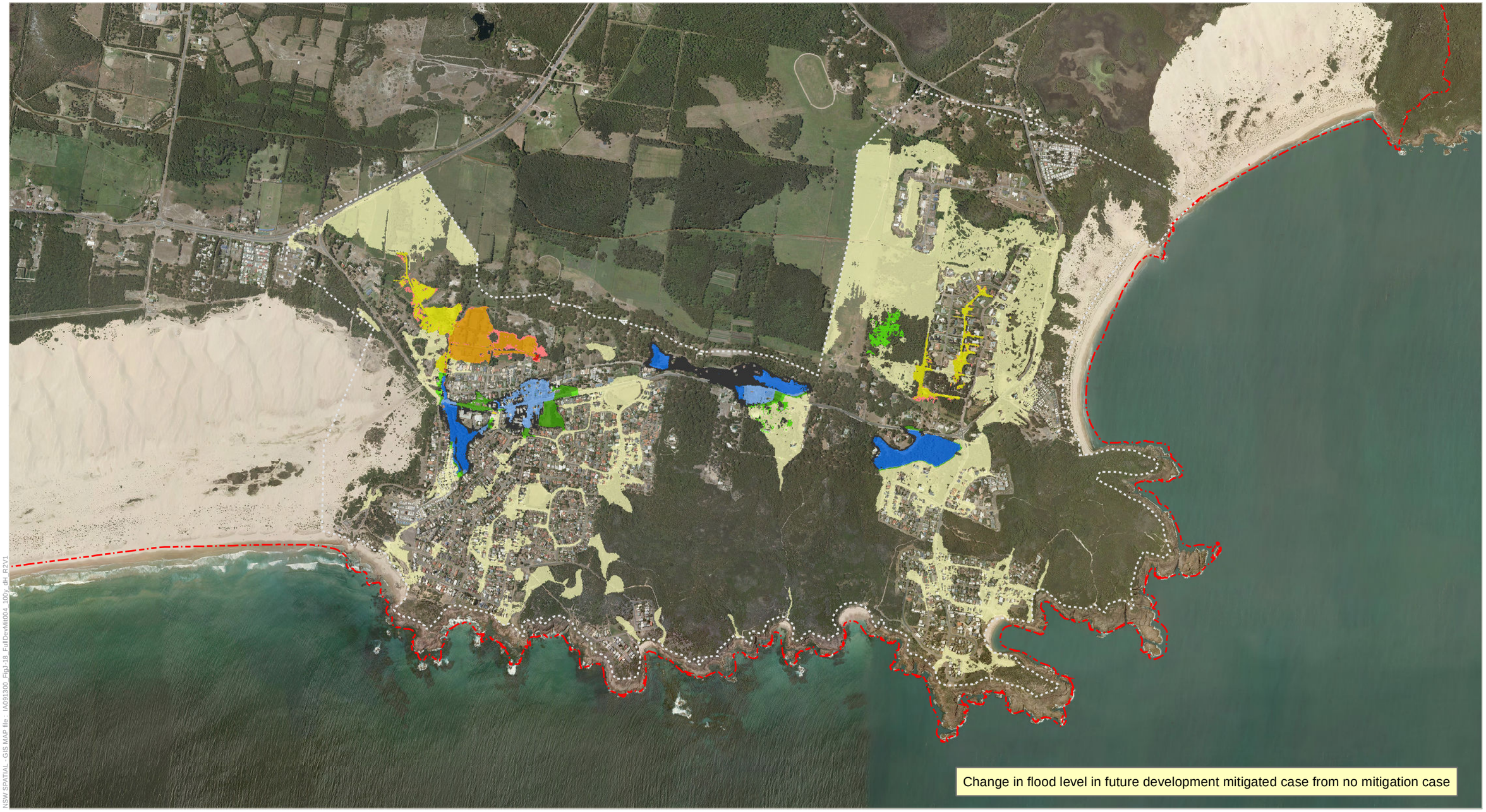
Kilometres 0 1

N

1:20,000@ A3

Figure J-17 1% AEP Flood Depth - Anna Bay Future Development Mitigation Scenario 4 - Anna Bay Urban Area

JACOBS



Legend

Change in Flood Level (m)

- < -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- > 0.5

Change in Flood Extent

- Previously Flooded
- New Areas Flooded

- Study Area
- Urban Area TUFLOW model (Extent of Mapping)

Kilometres 0 1

N

1:20,000@ A3

Figure J-18 1% AEP Change in Flood Level - Anna Bay Future Development Mitigation Scenario 4 - Anna Bay Urban Area

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