

7 November 2017

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Subject: Bushfire assessment for proposed development at 81-161 Christensen Road, Stapylton, Queensland

1 Introduction

Land and Environment Consultants (LEC) was engaged to perform a bushfire hazard assessment for the proposed development (subdivision of industrial land in two stages) at 81-161 Christensen Road, Stapylton (the site), properly described as 344/SP193431.

The stage plans for the proposed development are attached at Appendix 1. The proposed development will seek to remove the stormwater easement on the east boundary of the stage 2 site as it is no longer required for stormwater management.

The site triggers the Gold Coast City Plan 2016 *Bushfire hazard overlay* (Bushfire hazard overlay) map for medium potential bushfire hazard and potential impact buffer. Therefore, under the Gold Coast City Plan 2016 *Bushfire hazard overlay code* (Bushfire hazard overlay code), a bushfire hazard assessment and bushfire management plan are required for the proposed development to ensure the risk of bushfire hazard associated with the site are identified and mitigated to a tolerable level.

Stage 1 is on the south side of Christensen Road. It consists of a balance lot and stormwater detention basin and is not affected by the Bushfire hazard overlay map. Therefore, the bushfire assessment focused on stage 2, which is on the north side of Christensen Road and is affected by the Bushfire hazard overlay map.

This report was prepared in accordance with relevant requirements of the Gold Coast City Plan 2016 Policy *Bushfire management plans* (Bushfire planning scheme policy). It documents the bushfire hazard assessment for the site and identifies *National Construction Code* requirements and mitigation measures which are required to demonstrate compliance with relevant development criteria in the Bushfire hazard overlay code and to mitigate the potential impacts of bushfire on life, property and the environment.

The bushfire assessment was performed by Robert Janssen who is a suitably qualified and experienced bushfire management consultant. He is the managing principal of LEC and has over 20 years of experience in bushfire planning and operations. He has prepared bushfire management plans for residential, commercial and industrial property developments, utilities, government facilities and conservation estates. Robert has university qualifications as an environmental scientist and 10 years of experience as a nationally accredited fire-fighter with the national parks and wildlife service in New South Wales and Queensland.

2 Site assessment

A site assessment was performed on 29 August 2017 and focused on land within 100 m of the north and east boundary of the stage 2 site which is mapped as medium potential bushfire hazard and potential bushfire impact buffer area. The stage 2 site assessment area is shown on Figure 1.



Figure 1: Stage 2 site assessment area (image Google Earth September 2017)

Land adjacent the east boundary of the stage 2 site is shown on Photograph 1 and is downslope 2-3 degrees. The site assessment generally agreed with version 10 regional ecosystem (RE) mapping which indicates the vegetation is RE 12.11.24 *Eucalyptus carnea*, *E. tindaliae*, *Corymbia intermedia* +/- *E. siderophloia* or *E. crebra* woodland. RE 12.11.24 is consistent with vegetation hazard class (VHC) 10.2 *Spotted gum dominated woodlands* which has a potential forest fuel load of 18 tonnes (t)/hectare (ha). Numerous vehicle access tracks were observed in the assessment area. Charring was observed on most trees in this area and indicates the area has been subject to a fire recently.

Land adjacent the north boundary of the stage 2 site is shown on Photograph 2 and is downslope 1-4 degrees. It has the same type of vegetation as the east boundary, although the vegetation occurs in a narrow corridor towards the north-west corner of the site. A vehicle access track runs along the boundary in this area and is on the adjacent property. Charring was not evident on *Melaleuca* trees in this area which suggests it has been a long time since the area was last subject to a fire.

The stage 1 and 2 sites are cleared of vegetation except for regrowth in the stormwater detention basin. Nevertheless, the regrowth in the stormwater detention basin will be removed as additional stormwater works are required for the stage 2 site.



Photograph 1: View east



Photograph 2: View north

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3 Bushfire hazard assessment

Land in the assessment area was assessed against the exclusion criteria for low threat vegetation and non-vegetated areas in the *Australian Standard for the Construction of Buildings in Bushfire Prone Areas* (AS 3959-2009) which are:

- a) Vegetation of any type that is more than 100 m from the site.
- b) Single areas of vegetation less than 1 ha in area and not within 100 m of other areas of vegetation being classified.
- c) Multiple areas of vegetation less than 0.25 ha in area and not within 100 m of other areas of vegetation being classified.
- d) Strips of vegetation less than 20 m in width (measured perpendicular to the elevation exposed to the strip of vegetation) regardless of length and not within 20 m of the site or each other, or other areas of vegetation being classified.
- e) Non-vegetated areas, including waterways, roads, footpaths, buildings and rocky outcrops.
- f) Low threat vegetation, including grassland managed in a minimal fuel condition, maintained lawns, golf courses, maintained public reserves and parklands, vineyards, orchards, cultivated gardens, commercial nurseries, nature strips and windbreaks.

Note: Minimal fuel condition means there is insufficient fuel available to significantly increase the severity of the bushfire attack (recognizable as short-cropped grass for example, to a nominal height of 100 mm).

Land adjacent the south and west boundaries of the stage 2 site is cleared of vegetation and/or is developed with roads, buildings and hardstand areas. These areas meet AS 3959-2009 exclusion criteria e) for non-vegetated areas and f) for low threat vegetation.

Land adjacent the north and east boundaries of the stage 2 site consists of *Spotted gum dominated woodlands* and does not meet any of the exclusion criteria for low threat vegetation or non-vegetated areas in AS 3959-2009 and is a bushfire hazard.

The potential bushfire hazard of land adjacent the north and east boundaries of the stage 2 site was further assessed using the Queensland Fire and Emergency Service *Potential Bushfire Intensity Calculator* (version November 2014) with the results presented in Table 1. A forest fire danger index (FFDI) value of 53 was used in the calculations and was taken from the Commonwealth Scientific and Industrial Research Organisation severe fire weather map for Queensland which was accessed on the Queensland Fire and Emergency Services redi-portal.

Table 1: Potential bushfire hazard on east elevation

Elevation	Vegetation hazard class	Slope (°)	Potential bushfire intensity (kW/m)	Potential bushfire hazard rating
North	10.2	3	13,095	Medium
East	10.2	4	14,031	Medium

The site assessment confirmed that land to the north and east of the stage 2 site is a medium potential bushfire hazard. Land within 100 m of a medium potential bushfire hazard area could be subject to significant bushfire attack from the medium bushfire hazard area. This 100 m wide area is referred to as a potential impact buffer and its location within the stage 2 site is shown on Figure 1.

Given that the stage 2 site is affected by potential impact buffer, the proposed development within the stage 2 site is subject to demonstrating compliance with relevant development outcomes in Part B of the Bushfire hazard overlay code.

4 Building design and lot layout

Under the Queensland Building Regulation 2006, lots affected by potential impact buffer are defined as 'bushfire prone areas'. The construction requirements for *National Construction Code* (NCC) building classes 2-9 in a bushfire prone area are defined in the NCC (volume 1). Pursuant to clause GF 5.1 of the NCC, setbacks required to achieve bushfire attack levels (BAL) and BAL construction requirements specified in AS 3959-2009 are only applicable to NCC class 2 or 3 buildings (residential buildings and apartments) and NCC class 10a buildings or decks associated with a NCC class 2 or 3 buildings.

The proposed development is for an industrial purpose and future buildings are likely to be NCC class 7b (warehouses) or class 8 (factories). Therefore, regarding compliance with the NCC (volume 1), bushfire requirements under AS 3959-2009, including setbacks and BAL construction requirements, should not be applicable to the assessment of any building application the proposed development will be subject to.

Nevertheless, buildings will need to comply with the fire resistance requirements of Section C of the NCC (volume 1) and provisions relating to the safe evacuation of occupants in the event of a fire, or other emergency, eg evacuation distances, exits, paths of travel, etc.

The proponent must seek the advice of a building certifier in relation to this matter.

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5 Recommendations

This chapter provides recommendations which are required to demonstrate compliance with relevant development outcomes in Part B of the Bushfire hazard overlay code. Assessment against Part B of the Bushfire hazard overlay code is provided at Appendix 2.

5.1 Land use

Industrial uses involving the manufacture or storage of hazardous material in bulk will be excluded from the potential impact buffer shown on Figure 1, which affects lots 14, 16 and 17 and part of lots 13 and 15.

5.2 Building design and lot layout

Advice is will be sought from a building certifier to confirm the fire resistance and evacuation requirements of buildings.

Fencing and retaining walls will be constructed with non-combustible materials. Landscaping will be designed so that plantings do not exacerbate bushfire hazard.

5.3 Vehicle access

The road design will provide access for fire-fighting and other emergency vehicles, and will meet the relevant design criteria in Gold Coast City Plan 2016 Policy *Land development guidelines*.

5.4 Water

The proposed development will be connected to reticulated water in accordance with the design criteria in Gold Coast City Plan 2016 Policy *Land development guidelines*.

Fire-fighter water supply and fire hydrants will be provided in accordance with the Queensland Fire and Emergency Services guideline, *Fire Hydrant and Vehicle Access Guidelines for Residential, Commercial and Industrial Lots 20156*

5.5 Advice to new owners

A copy of this report will be provided to new owners of the lots.

6 Conclusion

This report provides a site-based bushfire hazard assessment and management plan for the proposed development and is in general accordance with the Bushfire management plan policy.

It was concluded that the site is affected by potential impact buffer area and is subject to complying with relevant outcomes in Part B of the Bushfire hazard overlay code which is demonstrated at Appendix 2.

Yours sincerely,



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Disclaimer

Notwithstanding the precautions adopted in this report, it should always be remembered that bushfires burn under a range of conditions. An element of risk, no matter how small always remains, there can be no guarantee, because of the variable nature of bushfires, that any one building will withstand bushfire attack on every occasion.

It should be noted that upon lodgement of a development application, council and/or the fire service may recommend additional requirements.

Although every care has been taken in the preparation of this report, Land and Environment Consultants accept no responsibility resulting from the use of the information in this report.

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Appendix 1: Stage 1 and 2 site plans

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Stage One



Denotes conservation buffer zone.

! This plan has been prepared as a proposed subdivision and should not be used for any other purpose. The dimensions, areas and total number of lots shown herein are subject to final survey and may differ from the requirements of council and any other authority which may have requirements under any relevant legislation. Certificate of Title for this site has not been obtained. Therefore, no reliance should be placed on the information on this plan for any financial dealings involving the site.

Number of new lots (including park)	11
Lot sizes	2374 sqm - 7,699 Ha
PUL - Conservation Buffer area	4,563 Ha
Total Area of Common Property	1,377 Ha
Total Site Area	25,162 Ha

**Proposed Lots 1-9,99,100 and Common Property
Cancelling Lot 334 on SP 193431**



Scale 1:2000 - Lengths are in Metres.

REVISIONS	ASSOCIATED CONSULTANTS	DATE	BY	King and Co. Property Consultants	N/E: 81-161 Christensen Road, Stoneyton	SCALE 1:2000 (A3) PLAN REF: 80084/24
				N/A		

Stage Two



Denotes conservation buffer zone.

! This plan has been prepared as a proposed subdivision and should not be used for any other purpose. The dimensions, areas and total number of lots shown hereon are subject to field survey and are also subject to the requirements of Council and any other authority which may have requirements under any relevant legislation. Certificate of Title for this site has not been obtained. Therefore, no reliance should be placed on the information on this plan for any financial dealings involving the land.

Number of new lots	0
Lot sizes	5431 sqm - 1 868 m ²
Area of New Road	6179 sqm
Total Site Area	7 668 m ²

**Proposed Lots 10-17
Cancelling Lot 99**

Scale 1:2500 - Lengths are in Metres.

REVISIONS	ASSOCIATED CONSULTANTS	DATE	BY	FOR	PREPARED BY	CHECKED BY	DATE	SCALE	1:2500 (AS)
					King and Co Property Consultants			PLAN NO.	00004.P0

Appendix 2: Bushfire hazard overlay code assessment

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PART B – ASSESSABLE DEVELOPMENT BENCHMARKS

Table 8.2.3-2: Bushfire hazard overlay code – for assessable development

Performance outcomes	Acceptable outcomes	Compliance
Bushfire hazard		
PO1 In a bushfire hazard area, the fire mitigation methods used at the site are adequate for the bushfire hazard of the individual site, having regard to: (a) vegetation type (b) slope; (c) aspect; (d) bushfire history; (e) conservation values of the site; (f) ecological restoration, including forest succession; (g) ongoing maintenance; (h) climate change; and (i) on site and off-site¹ fire hazard implications Note¹: This includes potential hazard from land up to 10kms away from the site. For example, how might large tracts of forest away from the site impact on the bushland that surrounds the site.	A01 A written assessment by a suitably qualified and experienced bushfire management consultant confirms that the site is not in a bushfire hazard area. OR The development complies with an approved Bushfire management plan prepared in accordance with SC6.3 City Plan policy – Bushfire management plans. OR The development complies with an approved Bushfire management plan as referenced within the approved reconfiguration of a lot. Note: Prior to: (a) plan sealing for a Reconfiguration of a lot; or (b) the issue of a Building work; or (c) the commencement of use where building work is not proposed. Whichever comes first, the applicant must submit to Council, certification from an appropriately qualified and experienced person that the development has been completed in accordance with, and complies with the approved Bushfire management plan and that all risk treatments and functioning in accordance with the approved plan.	✓ The proposed development will comply with the recommendations in this report which was prepared in accordance with SC6.3 City Plan policy – Bushfire management plans.
Land use		
PO2 In a bushfire hazard area, development: (a) does not result in high concentration of people living, working or congregating in a bushfire hazard area; (b) does not result in the bulk manufacture or storage of hazardous materials; and (c) 'essential' community infrastructure is able to function effectively during and immediately after a bushfire event.	A02 The following land uses are not located in a bushfire hazard area: (a) Aged care facility; (b) Child care centre; (c) Community care centre; (d) Community use; (e) Development involving the manufacture or storage of hazardous material in bulk; (f) Education establishment; (g) Hospital; (h) Residential care facility; (i) Retirement facility; (j) Rooming accommodation;	✓ Industrial uses involving the manufacture or storage of hazardous material in bulk will be excluded from the potential impact buffer shown on Figure 1, which affects lots 14, 16 and 17 and part of lots 13 and 15.

Performance outcomes	Acceptable outcomes	Compliance
	(k) Sport and recreation uses; (l) Tourist attraction; (m) Tourist park; and (n) Utility installation (waste management facilities) AND In a bushfire hazard area permitted essential community infrastructure is designed to function effectively during and immediately after bushfire events, as demonstrated in a Bushfire management plan.	
Development design and lot layout		
PO3 In a bushfire hazard area, developments, including lot layout are designed to avoid bushfire hazard and provide safe sites for people, property and buildings. Notes – The development should be located: (a) away from the most likely direction of a fire front; and (b) so that element of the development least susceptible to fire are sited closest to the bushfire hazard	A03 Development, Lots and/or building envelopes are not located within bushfire hazard areas. OR The development is located in accordance with the approved Bushfire management plans as referenced within the approved reconfiguration of a lot. OR The development is designed to adequately demonstrate that the risk to life and property is minimized to achieve acceptable levels and ensure ongoing site management.	✓ The proposed development is for an industrial purpose and future buildings are likely to be <i>National Construction Code</i> (NCC) class 7b (warehouses) or class 8 (factories) which are not subject to the bushfire requirements under the <i>Australian Standard for the Construction of Buildings in Bushfire Prone Areas</i> (AS 3959-2009), including setbacks and BAL construction requirements. Nevertheless, buildings will need to comply with the fire resistance requirements of Section C of the NCC (volume 1) and provisions relating to the safe evacuation of occupants in the event of a fire, or other emergency, eg evacuation distances, exits, paths of travel, etc.
	A03.2 The development design incorporates bushfire radiation zone/s that: (a) use existing or natural fire breaks & minimize the need to clear native vegetation; (b) do not impact matters of environmental significance (c) are located entirely within the boundaries of the private property of the development site; and (d) incorporates landscaping species that are less likely to exacerbate a bushfire event.	N/A Bushfire radiation zones are not applicable to the proposed development (as stated above). Landscaping will be designed so that plantings do not exacerbate bushfire hazard.

Performance outcomes	Acceptable outcomes	Compliance
PO4 In a bushfire hazard area, when designing for bushfire hazard migration the lot layout must avoid impacts on matters of environmental significance.	AO4 Development design, Lot size and layout avoids impact on matters of environmental significance and minimizes impacts such as fragmentation, habitat loss and edge effects for any matters of environmental significance.	✓ The stage 1 and 2 sites are cleared of natural habitat and vegetation.
PO5 Development uses fencing that: (a) does not contribute to the spread of bushfire; (b) facilitates the safe movement of fauna; and (c) provides access for fire-fighting purposes.	AO5 Fences are constructed: (a) using non-combustible or fire retardant materials within 20m of any building used for accommodation; (b) that do not impede the safe movement of fauna (where applicable); and (c) has gates that can be freely accessed for fire-fighting purposes (if applicable).	✓ New fencing and retaining walls will be constructed with non-combustible materials.
Vehicular access		
PO6 In a bushfire hazard area, vehicular access (including internal roads) is designed to mitigate against bushfire hazard by ensuring adequate access for: (a) fire-fighting and other emergency vehicles, and (b) the evacuation of residents and emergency personnel, during a bushfire event.	AO6.1 The development design incorporates a perimeter road that: (a) is located between the boundary of the lots and/or buildings and the adjacent natural area and/or bushfire hazard area; (b) has a minimum cleared width of 20m; (c) has a constructed minimum road width of 6m; (d) has a maximum gradient of 12.5% (e) is constructed to an all-weather standard; and (f) is constructed to ensure all culverts and bridges have a minimum load bearing of 15 tones (if applicable)	✓ The road design will provide access for fire-fighting and other emergency vehicles, and will meet the relevant design criteria in SC6.9 City Plan policy – Land development guidelines . Vehicle access to the proposed development will be via an existing road (Christensen Road).
	AO6.2 The road design is capable of providing access for fire fighting and other emergency vehicles, in accordance with SC6.9 City Plan policy – Land development guidelines .	✓ As stated above

Performance outcomes	Acceptable outcomes	Compliance
	A06.3 The road design does not include dead end roads	✓ Lots will be accessed from a cul-de-sac which is about 250 m long. The cul-de-sac will be sufficient size to manoeuvre a B-double truck and will provide sufficient access for fire-fighter and other emergency vehicles.
Clearing		
PO7 In bushfire hazard area, the development and/or lot layout designed to minimize vegetation clearing and provide landscaping to minimize fire hazard.	A07 The Bushfire management plan details the required extent of vegetation clearing and landscaping and where required modify development design and/or lot layout to minimize clearing of vegetation	✓ The stage 1 and 2 sites are cleared of natural habitat and vegetation. Landscaping will be designed so that plantings do not exacerbate bushfire hazard.
Open space management plans		
PO8 For areas to be dedicated to Council as open space, management strategies to mitigate bushfire risk must be identified.	A08 The Bushfire management plan contains a separate section detailing management strategies for area to be dedicated to Council that can be included within the Open space management plan.	N/A The proposed development does not include area to be dedicated to Council as open space.
Fire trials		
PO9 In a bushfire hazard area, fire trails must be provided to: (a) enable access for fire fighters, residents and equipment; (b) contribute to (where required) bushfire radiation zone(s); (c) mitigate against bushfire hazard; and (d) allow access for hazard reduction management programs. Note – fire trails should be located, contracted and maintained with due regard for landscaping and ecological values and should not result in soil disturbance or erosion	A09.1 Fire trails are located on public land (including public open space areas) to facilitate access for fire brigades. OR Fire trails located on private property are located as close as possible to the property boundaries and the adjoining bushfire hazard area, and an access easement is granted in favour of City of Gold Coast and Queensland Fire and Emergency Services.	N/A A vehicle access track runs along the north boundary of the stage 2 site in the adjacent property. Fire trails are not required within the stage 2 site to contribute to bushfire radiation zones or for hazard reduction management programs within the site and are not proposed.
	A00.2 The fire trail as: (a) a minimum cleared width of 6m; (b) a minimum of 4.8m vertical clearance; (c) a cross fall of no greater than 10 degrees;	N/A As stated above

Performance outcomes	Acceptable outcomes	Compliance
	(d) a minimum formed width of 4m; (e) a maximum gradient of 12.5%, with adequate drainage to prevent soil erosion and minimize ongoing trail maintenance; and culverts and/or bridges with a minimum load bearing of 8 tonnes (if applicable).	
	A09.3 Vehicular links are provided along the fire trail either to existing fire trails or roads, and these links are designed having regard to the topography of the site, fire fighter safety and the need to regularly access water supplies. Note- where possible, these links should be intervals of approximately 200 m.	N/A As stated above
	A09.4 The fire trail has vehicular access at each end, and links either to existing fire trails or public roads.	N/A As stated above
	A09.5 The fire trail provides turning areas for fire-fighting appliances. The turning bay can be either: (a) a turning circle (b) a 'T' shaped turning bay; or (c) a 'Y' shaped turning bay.	N/A As stated above
	A09.6 The fire trail provides areas for vehicles to pass or turn at intervals of not more than 200m and with a maximum grade of 5% (1 in 20).	N/A As stated above
Areas with water reticulation		
PO10 In a bushfire hazard area, the development maintains the safety of people and property by ensuring that the water supply is reliable and has sufficient flow and pressure requirements for fire fighting purposes at all times	AO10.1 The development is proposed in a bushfire hazard area, and reticulated water is supplied in accordance with SC6.9 City Plan policy – Land development guidelines.	✓ Fire-fighter water supply and fire hydrants will be supplied in accordance with the Queensland Fire and Emergency Services 2015 guideline <i>Fire Hydrant and Vehicle Access Guidelines for Residential, Commercial and Industrial Lots.</i>
	AO10.2 Development involving new or existing buildings with a gross floor area of greater than 50m ² , each lot has a reliable reticulated water	✓ As stated above

Performance outcomes	Acceptable outcomes	Compliance
	supply that has sufficient flow and pressure characteristics for fire fighting purposes at all times. It must have a minimum pressure and flow of 10 litres a second at 200 kPa.	
Areas with no water reticulation (private water supply)		
PO11 In a bushfire hazard area, the development maintains the safety of people and property by ensuring that an adequate water supply for fire-fighting purposes is provided.	A011.1 For development with a combined GFA less than 500m ² where one or more buildings are proposed, dedicated fire fighting water storage is provided to protect each individual building. Each dedicated fire fighting water storage must have a volume of water not less than 10,000 litres for each building, be provided within 10m of each building and be: (a) a separate tank that is either below ground level or of non-flammable construction; or (b) a reserve section in the bottom part of the main water supply tank that is either below ground level or of non-flammable construction. Note- dedicated firefighting water storage is in addition to water supply for household use and does not include swimming pools, creeks and dams.	N/A The proposed development will be connected to reticulated water.
	A011.2 For development that proposes one or more buildings with a combined GFA greater than 500m ² there is no acceptable outcome provided.	N/A The proposed development will be connected to reticulated water.
PO12	A012 The outlet pipe is 50mm in diameter, fitted with a 50mm male camlock (standard rural fire brigade fitting) and an isolating valve.	N/A The proposed development will be connected to reticulated water.
PO13	A013.1 The water supply outlet is located at least 9m from any potential fire hazards, such as venting gas bottles and combustible structures.	N/A The proposed development will be connected to reticulated water.

Performance outcomes	Acceptable outcomes	Compliance
	AO13.2 A safe and accessible hard stand area capable of accommodating a fire fighting vehicle is provided not more than 3m from the water supply outlet.	N/A The proposed development will be connected to reticulated water.
PO14 Development in a bushfire hazard area must provide adequate fire-fighting water storage. This infrastructure must be provided on public land so as to be readily accessible to fire brigades for hazard reduction and fire fighting purposes.	AO14.1 Where public water supplies (e.g. fire hydrants or public water storage) do not exist, water supply tanks are provided for fire-fighting purposes on public land within the development. The water tanks must: (a) Be installed on land dedicated to Council; (b) Hold a volume of at least 22,500 litres per every 20 dwellings; (c) Be of concrete construction; and (d) Have an outlet pipe of 50mm in diameter, fitted with a 50mm male camlock (standard rural fire brigade fitting) and an isolating valve.	N/A The proposed development will be connected to reticulated water.
	AO14.2 Development on public land provides a safe and accessible hardstand area capable of accommodating a fire-fighting vehicle not more than 3m from the water supply outlet.	N/A The proposed development will be connected to reticulated water.
Storage of Hazardous Materials		
PO15 Development does not cause: (a) an unacceptable risk to people, property and the environment due to the impact of bushfire on hazardous chemicals; (b) excess danger or difficulty to emergency services for emergency response or evacuation.	AO15 Development involving the storage, handling or manufacture of hazardous chemicals is not located within a Bushfire hazard area.	✓ Industrial uses involving the manufacture or storage of hazardous material in bulk will be excluded from the potential impact buffer shown on Figure 1, which affects lots 14, 16 and 17 and part of lots 13 and 15.
Advice to new residents		
PO16 In a bushfire hazard area, new residents/occupants of a	AO16 A copy of the Bushfire management plan, complete with	✓ A copy of this report will be provided to new owners.

Performance outcomes	Acceptable outcomes	Compliance
development in a bushfire hazard area are informed about: (a) the potential bushfire hazard on their site; (b) their responsibility for fire management; (c) the measures required for ongoing fire hazard mitigation; and (d) emergency procedures during a bushfire or on bad fire weather days. Note- Further information on bushfire preparation can be found at www.ruralfire.qld.gov.au	the Queensland Fire and Emergency Services cover sheet and any other addendums is provided to each resident/occupant for their information. Note - the QFES cover sheet is attached to the approved Bushfire management plan and a notification will be placed on the property's rates notice.	

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Assessment of Urban Infrastructure

LOT 334 CHRISTENSEN ROAD, YATALA

within
GOLD COAST CITY COUNCIL

for

MS PROJECTS

Project 17-209.01



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31 October 2017

STATEMENT OF LIMITATION

Data and conclusions of this report are the findings and opinions of icubed consulting and are not an expressed or implied representation, warranty or guarantee. This report has been prepared for MS Projects.

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1. Introduction

icubed consulting have been commissioned to provide an engineering assessment of available urban infrastructure required to sustain the proposed industrial subdivision. The proposed development site is located at Lot 334 SP193431 Christensen Road, Yatala.

This report has been prepared following the completion of a comprehensive site evaluation by this office which included reviews of;

- Records from site visits completed by this office in October 2017
- DBYD advice
- GCCC As Constructed Services Drawing
- GCCC Historical Flood Records
- Development plans

This report summarises the findings of this investigation.

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2. Location

The subject site is described as Lot 334 on SP193431 and is located at Christensen Road, Yatala. The general site location and the study area are indicated in Figures 1 and 2 respectively.

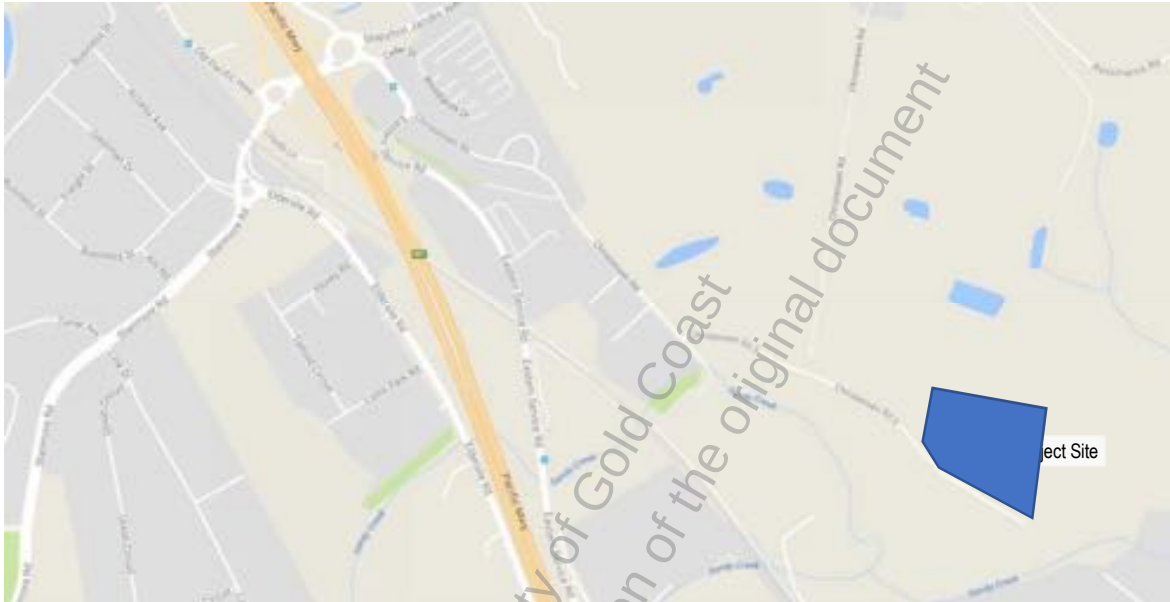


Figure 1 – Site Locality Plan – Copyright Google Maps



Figure 2 – Aerial Photo – Copyright Google Maps

3. Existing Urban Infrastructure

The proposed industrial subdivision is located within an existing industrial subdivision. The existing developments within the area are currently serviced by all urban reticulated services and the proposed subdivision can be serviced by the existing infrastructure, as discussed in below.

4. Flooding

The site is within the sandy Creek Catchment within Gold Coast City Council, and Flood Mapping indicates that the property has not been identified as being susceptible to flooding. Refer Appendix C for Flood Mapping.

5. Earthworks and Stormwater

The subject site has an average grade of approximately 2.0% from North to South to the Christensen Road Frontage.

The development will be connected to the existing stormwater system within Christensen Road via an existing property connection (Manhole 1/5b).

The existing stormwater line along Christensen Road consists of stormwater pipes between 1.20m and 1.65m diameter. The development is within the existing catchment stormwater system and therefore no alteration is required.

Refer Appendix B for details of the stormwater network.

6. Sewerage

There is an existing 225mm diameter sewer pipe along the southern side of Christensen Road which will adequately provide sewerage service to the proposed development. A cross road connection will need to be constructed. Refer Appendix B for details of the sewer network.

7. Water

There is an existing 150mm diameter water main on Christensen Road which will adequately provide water reticulation service to the proposed development. Refer Appendix B for details of the water network.

8. Power

The site is currently serviced by an underground powerline along the southern side of Christensen Road. As part of the development an underground property connection will be required. Refer Appendix B for details of the underground power network.

9. Communications

The site is currently serviced by a Telstra line in Christensen Road with a number of pits along the frontage. Refer Appendix B for details of the communications network.



10. Conclusion

icubed consulting has assessed the proposed development in relation to Gold Coast City Council's requirements. The proposed development is considered to be able to be adequately serviced in accordance with the requirements of Planning Scheme and subject to connections in accordance with the relevant statutory authority requirements. We see no reason why the proposed development should not be approved with reasonable and relevant conditions in respect of providing for connection to existing services.

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Appendix A – Drawings

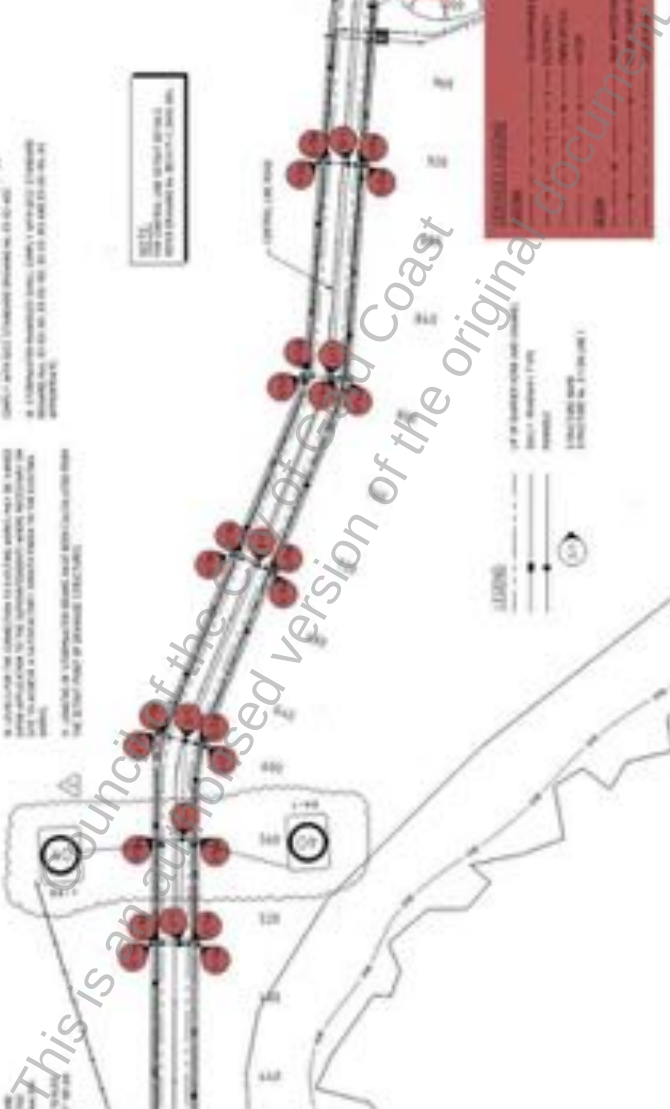
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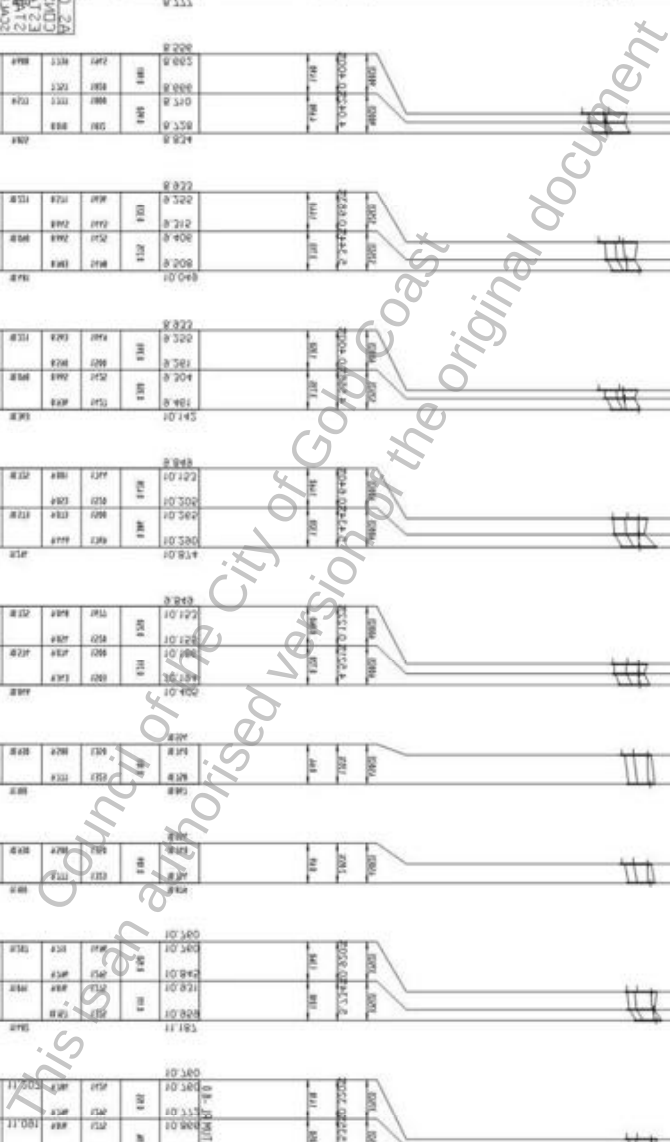


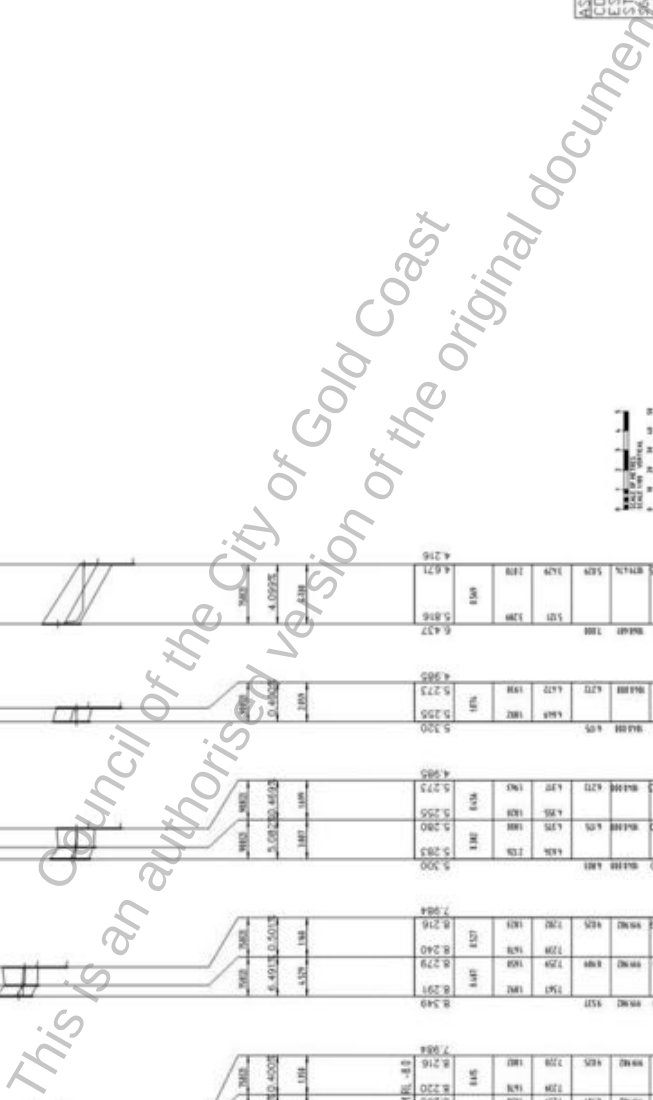
Appendix B – As Constructed Service Records

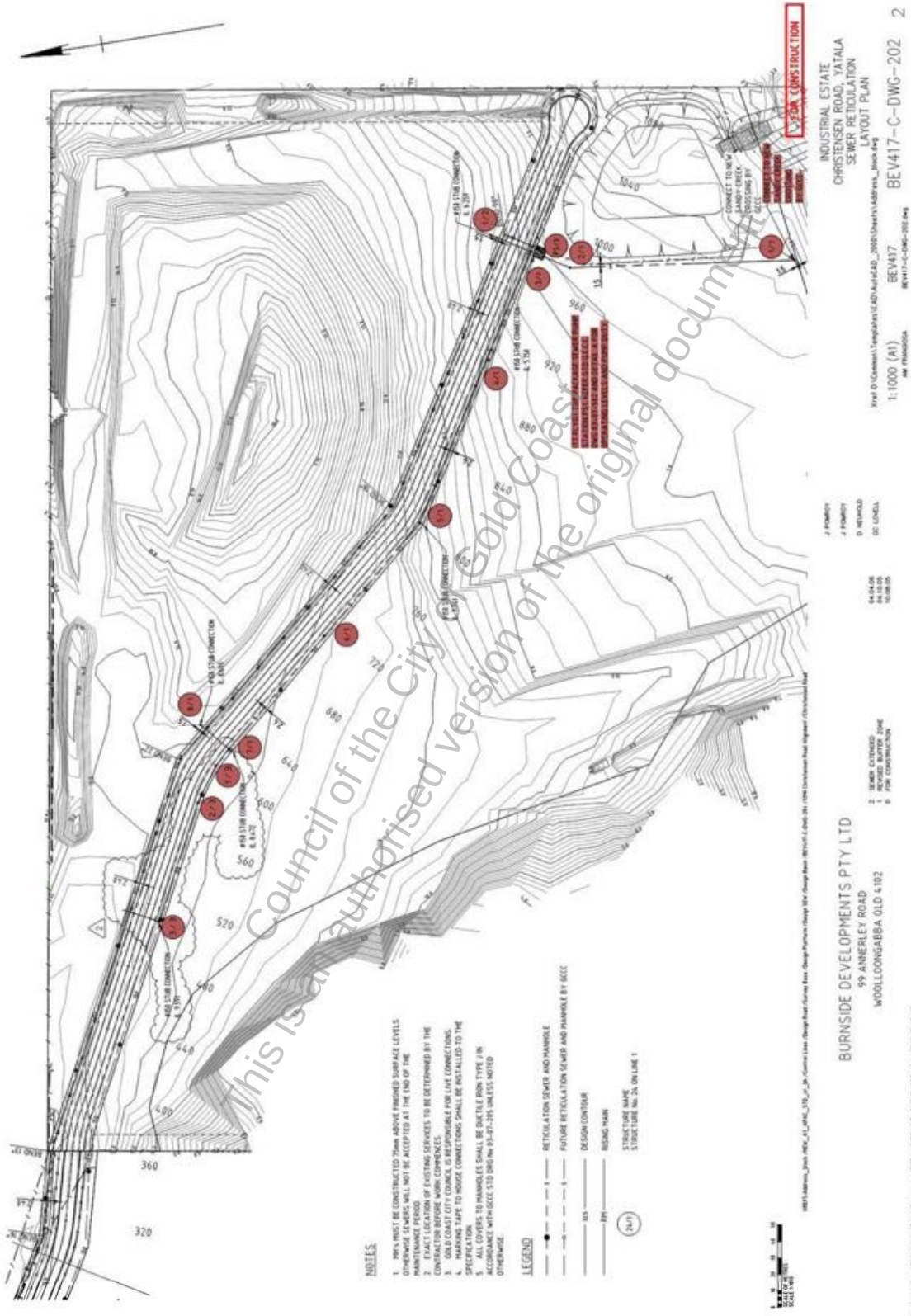
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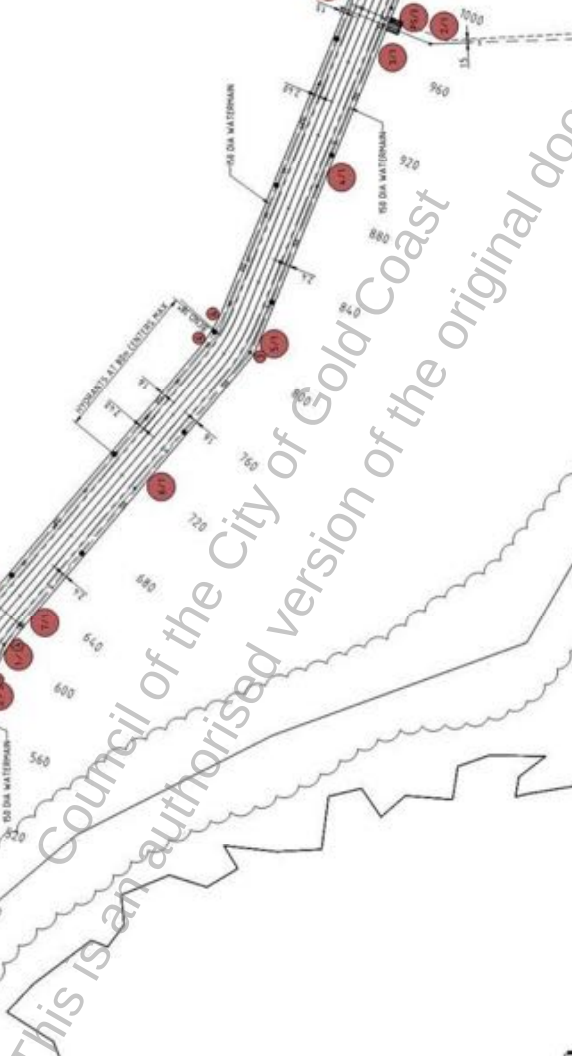


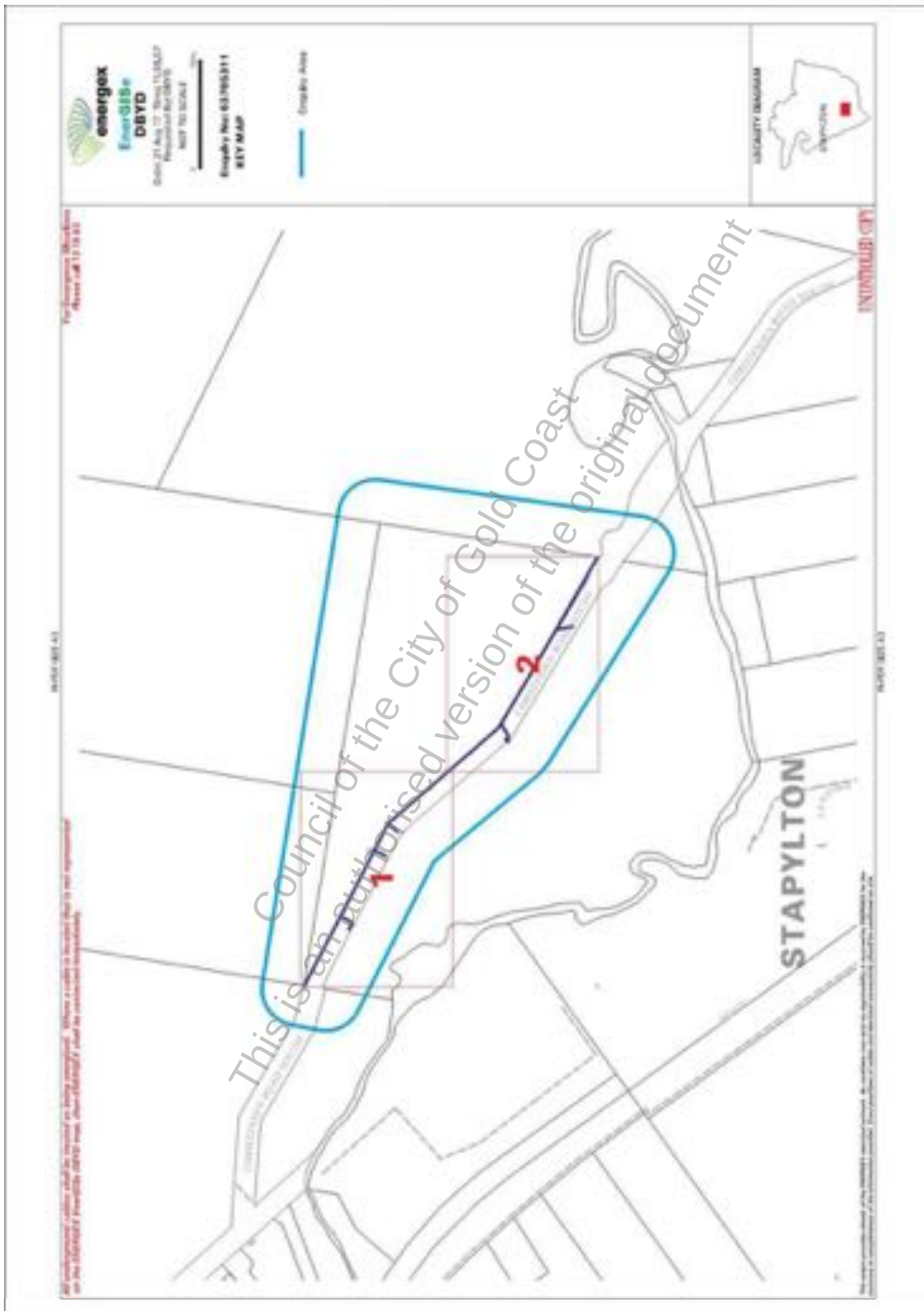


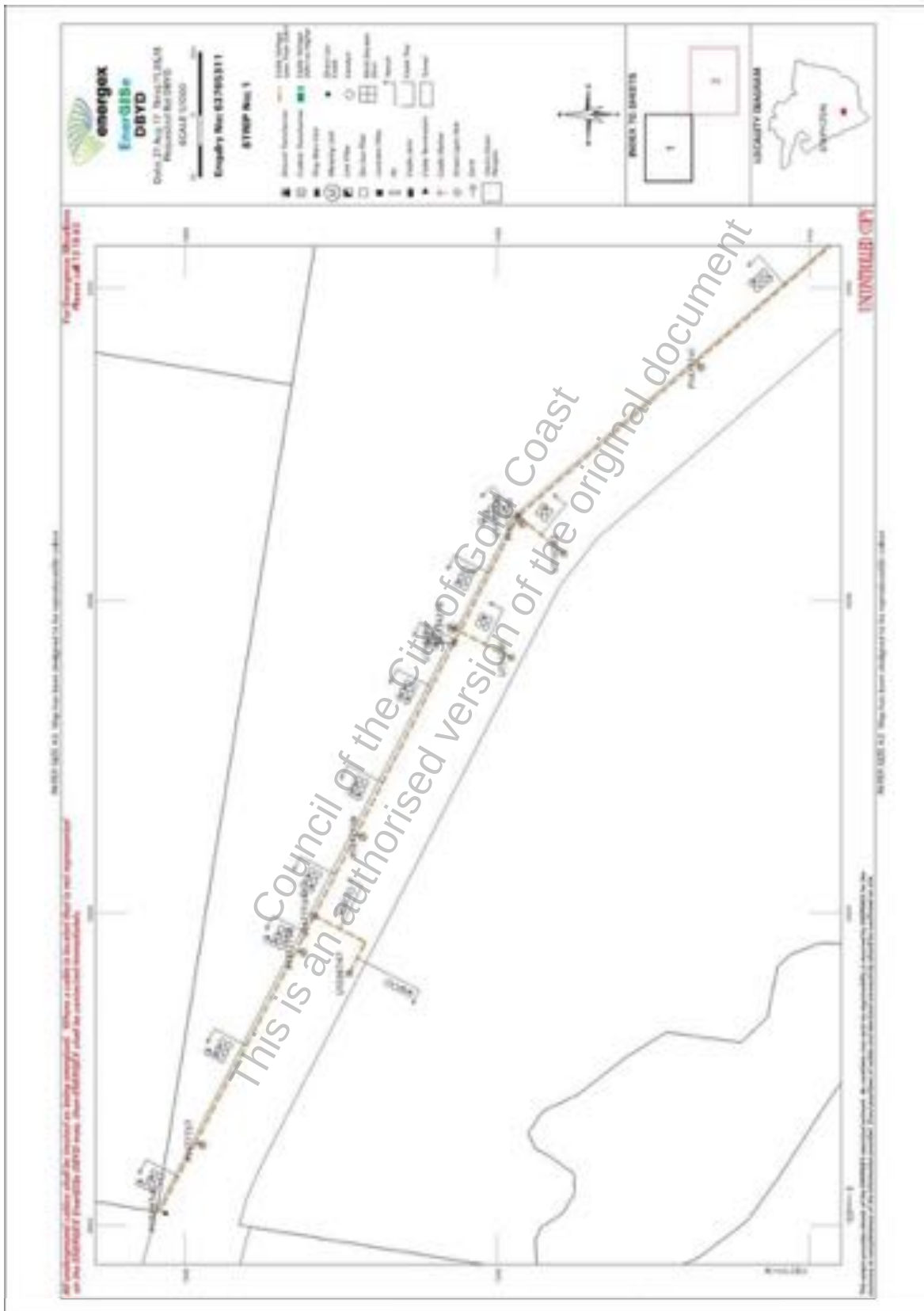




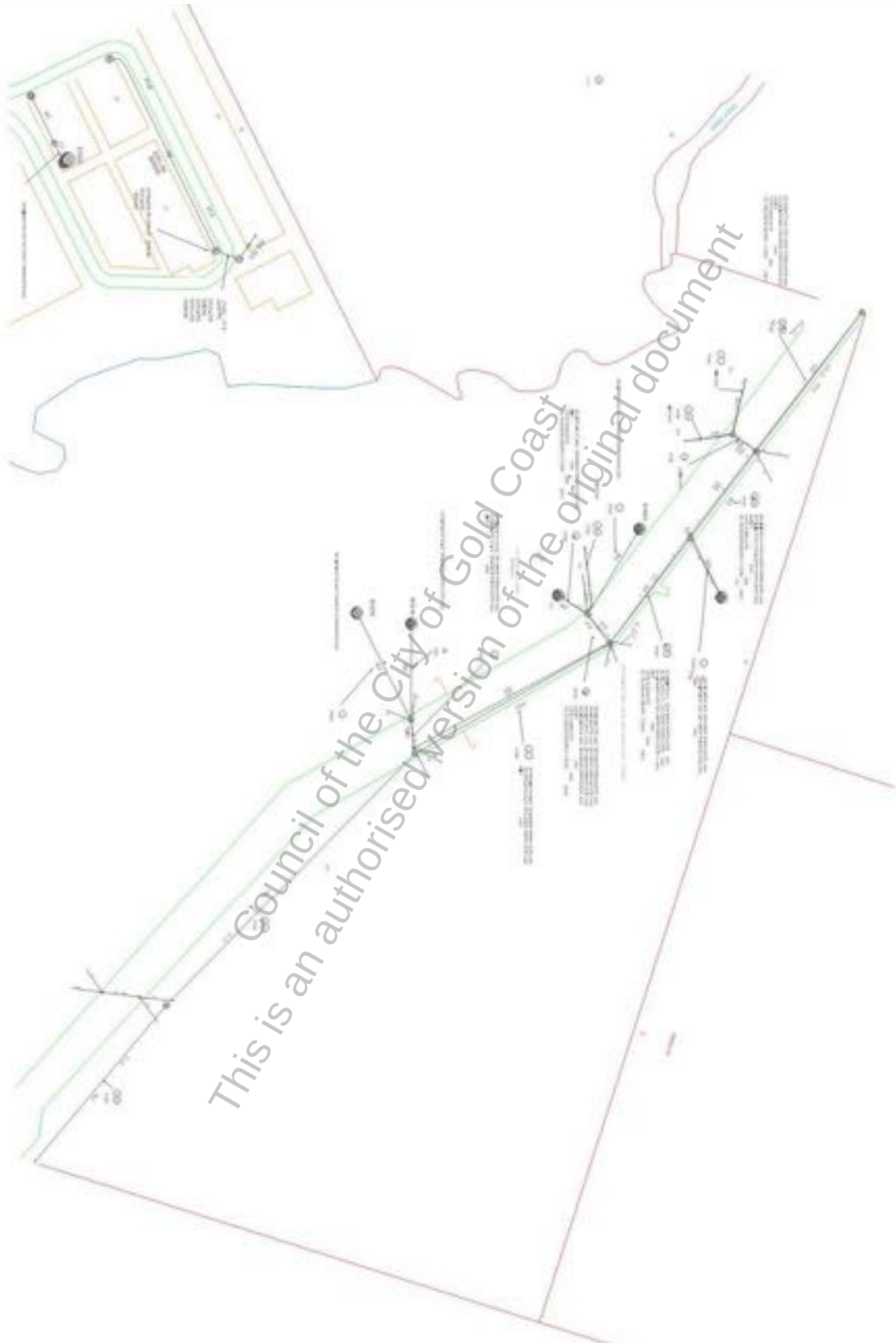














Appendix C – Flood Report

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City Plan

GOLD COAST



Stormwater Management Plan

Industrial Subdivision – 84-160 Christensen Road South, Stapylton

within
City of Gold Coast

for

MS Projects

Project 17-209

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c o n s u l t i n g

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Approved for release by:



Travis Smith
RPEQ 16400
26 October 2017

STATEMENT OF LIMITATION

Data and conclusions of this report are the findings and opinions of icubed consulting and are not an expressed or implied representation, warranty or guarantee. This report has been prepared for MS Projects.

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1. Introduction

1.1 Background

i³ consulting was commissioned by MS Projects to undertake the stormwater quality documentation for Stages 1 and 2 of the subdivision at 84-160 Christensen Road South, Stapylton (Lot 334 SP193431). This report covers the stormwater quality for the development approval. The proposed development is shown on drawing 17-209-DA01 in Appendix A.

Stage 1 of the development covers the Realignment of Lots. Lots 2-9 on drawing 17-209-DA01 have already incorporated stormwater quality in their development designs, while Lot 1 currently has a Material Change of Use application with Council (MCU201200768 / PN307555/01/DA7) which covers their site specific stormwater quality. Therefore, the CP Lot (0.0853ha) and Lot 110 (7.698ha) have been modelled according to the requirements of QUDM, whilst incorporating the existing GPT device and modifying the existing wetlands.

Stage 2 of the development details the stormwater quality requirements for the subdivision of Lot 110. Lot 110 will be subdivided to create new Lots 10-17 and a new road (Refer drawing 17-209-DA01 in Appendix A). Similar to Stage 1, the CP Lot and subdivision of Lot 110 have been modelled, and include the existing GPT device and modification of the existing wetlands.

1.2 Objectives

This report has been compiled to address the stormwater quality requirements of the State Planning Policy 2016, Water Sensitive Urban Design Guidelines for South East Queensland, the Environmental Protection Act 1994 and the Environmental Protection (Water) Policy 1997.

1.3 Scope

The scope of this report encompasses in detail the post construction phase of development; however the construction phase is briefly addressed.

2. Location

The proposed development is located at 84-160 Christensen Road South, Stapylton. The overall development site has Sandy Creek and undeveloped areas to the East, South and West. To the North is the Stapylton Landfill Facility.

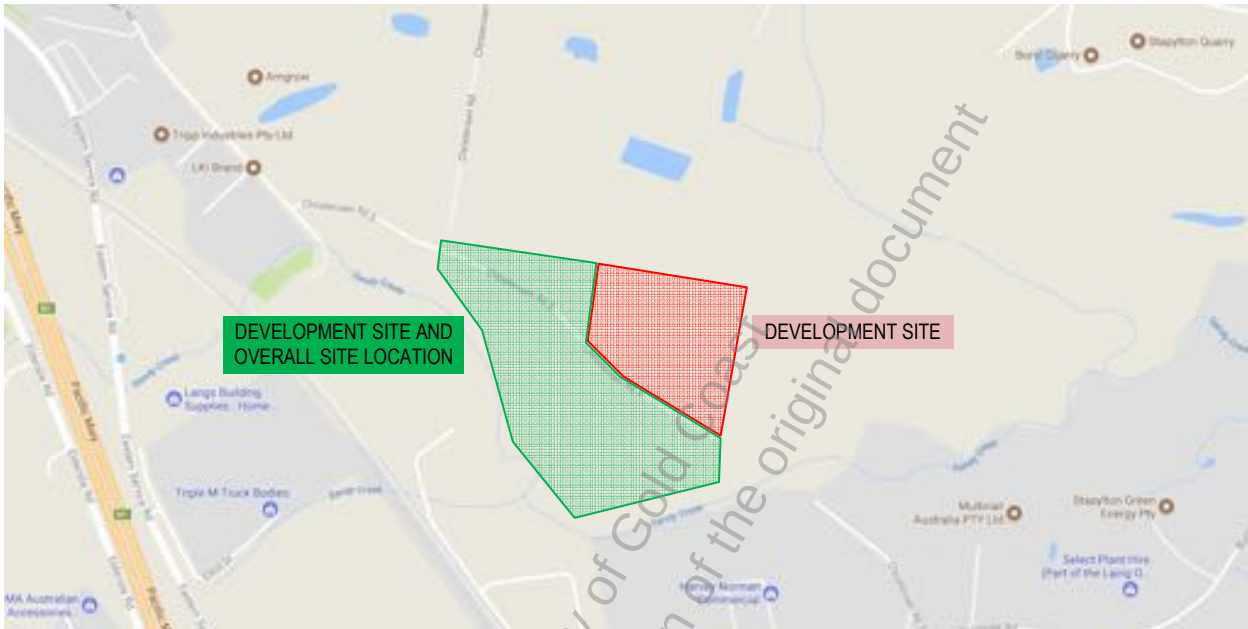


Figure 1: Locality Plan, (2017, Copyright Google Maps) – Not to scale, generally indicative only.
Source: Google Maps



Figure 2: Aerial Photo, (2017, Copyright Google Earth) – Not to scale, generally indicative only.
Source: Google Maps

3. Site Hydrology

3.1 Method and Approach

The stormwater discharges from this site were calculated using the rational method. This method as described in the Queensland Urban Drainage Manual (QUDM) is commonly used in municipal hydrology and is more than adequate for the design requirements. The Rational Method is based around the Rational formula:

$$Q_y = \frac{C_y \cdot I_y \cdot A}{360}$$

Where:

- Q_y = Peak flow rate (m³/s) for the average recurrence interval (ARI) of y years
- C_y = Coefficient of runoff for ARI of y years
- A = Area of catchment (ha)
- I_y = Average rainfall intensity (mm/hr) for design duration of t hours and an ARI of y years.

When designing the stormwater drainage system the following points have been considered:

Stormwater treatment shall be designed for a 3 month storm event, calculated as $Q_1 \times 0.5$; and Stormwater reticulation is to cater for $Q_{3 \text{ month}}$ and Q_{20} storm events.

For the purposes of this stormwater quality assessment, the area of the proposed development requiring stormwater quality treatment has been divided up into separate catchments for Stages 1 and 2.

Table 1 details catchment names, areas and storm event flows for each all catchments in Stages 1 and 2, based on the Rational Formula. Refer to Appendix B for details of catchment calculations and drawing 17-209-DA01 in Appendix A for catchment areas.

Table 1: Catchment and Flow

Stage	Catchment	Catchment Area	Major Storm Event Q_{100}	Minor Storm Event Q_{20}	Treatable Storm Event $Q_{3 \text{ month}}$
1	CP Ground	0.085 ha	0.071 m ³ /s	0.051 m ³ /s	0.010 m ³ /s
1	Lot 110 Roof	3.849 ha	3.218 m ³ /s	2.331 m ³ /s	0.452 m ³ /s
1	Lot 110 Ground	1.540 ha	1.288 m ³ /s	0.933 m ³ /s	0.181 m ³ /s
1	Lot 110 Road	2.310 ha	1.931 m ³ /s	1.399 m ³ /s	0.271 m ³ /s
2	CP Ground	0.085 ha	0.071 m ³ /s	0.051 m ³ /s	0.010 m ³ /s
2	Lot 110 Roof	3.540 ha	2.960 m ³ /s	2.144 m ³ /s	0.415 m ³ /s
2	Lot 110 Ground	3.540 ha	2.960 m ³ /s	2.144 m ³ /s	0.415 m ³ /s
2	Lot 110 Road	0.618 ha	0.517 m ³ /s	0.517 m ³ /s	0.073 m ³ /s

4. Water Quality

4.1 Construction Phase

Potential exists during the construction phase for sediment to become mobilised by stormwater as suspended solids from the erosion of exposed soil areas and stockpiles, and as a result of spillages from construction and plant operations.

Stormwater quality during the construction phase of the development should be addressed in an Erosion and Sediment Control Plan. The plan should address construction phase erosion and sediment control issues in accordance with the Institute of Engineers Australia (Qld) Erosion and Sediment Control Guidelines. The Erosion and Sediment Control Plan should also be in accordance with the Water Sensitive Urban Design Guidelines for South East Queensland.

The following measures should generally be implemented prior to the commencement of construction:

- Education of all site workers in sediment and erosion procedures;
- Specified storage areas for construction materials and plant that are bunded to prevent any spillages from escaping; and
- Construction of silt fences and catch drains adjacent to the downstream boundaries to divert runoff to temporary sediment basins.

The following measures should be implemented during the construction phase of the project:

- Temporary sedimentation basins should be constructed in accordance with Council's requirements;
- Silt fences should be erected downstream of all disturbed areas; and
- All erosion and sediment control devices should be regularly inspected and maintained following storm events.

4.2 Operational Phase

During the operational stage of the development, the following impacts have been identified in relation to stormwater runoff and water quality of the receiving waterways:

- Potential exists for gross pollutants which include human derived litter, coarse sediment and vegetation affecting the drainage capacity of stormwater systems. Gross pollutants are also typically unsightly reducing the visual amenity of the site. Gross pollutants can also physically affect the downstream waterway habitats and organisms such as entangling birds and marine animals in plastic;
- Sediment and Suspended Solids can become mobilised by stormwater as suspended solids from the erosion of exposed soil areas, un-mulched garden beds and sediment deposited on car park and hardstand areas by vehicles and by atmospheric deposition of sediment. Sediment can affect receiving waterways physically through smothering aquatic flora and fauna. Sediments can also block stormwater systems leading to local flooding. Suspended solids may also be used as a transport medium for nutrients and heavy metals making their way into waterways; and
- Nutrients can enter the waterways from stormwater runoff through many sources including, detergents used in car washing, fertilizers from landscaping and lawn areas, nitrous oxide deposition from vehicle exhausts, and organic waste. Large nutrient levels can lead to eutrophication of the receiving waterways resulting in algal blooms and excessive macrophyte growth.

Implementation of the appropriate SQID's would ensure that stormwater leaving the developed site shall be acceptable to Healthy Waterways, Water Sensitive Urban Design Guidelines for South East Queensland's requirements.

4.3 Selection of Stormwater Management Options

The Performance Criteria required to be met for discharges from development sites during the 'operational' (post-construction) phase of the development is detailed in Table 2.2 of the Urban Stormwater Quality Planning Guidelines 2010.

The load-reduction targets that must be achieved when assessing the post-developed sites treatment train, (comparison of unmitigated developed case versus developed mitigated case) are listed in Table 2.

Table 2: Stormwater Quality Objectives for the Site

Pollutant Issues	Load Reduction Objectives (%)
Total Suspended Solids	80
Total Phosphorus	60
Total Nitrogen	45
Total Gross Pollutants	90

4.4 Catchment Annual Pollutant Loads

An assessment of stormwater quality was undertaken for the developed unmitigated site. The discharge concentrations of key pollutants from the site were then compared to the WQO's. The pollutant concentrations were obtained by running a MUSIC model with the model parameters sourced from Water by Design Music Modelling Guidelines (Version 1.0 2010). MUSIC is the Model for Urban Stormwater Improvement Conceptualisation, developed by the MUSIC Development Team of the CRC for Catchment Hydrology.

MUSIC has the ability to simulate quality of runoff from catchments ranging from a single house block up to many square kilometres, and the effect of a wide range of treatment facilities on the quality of runoff downstream. By simulating the performance of stormwater quality improvement measures, MUSIC determines if proposed systems can meet specified water quality objectives.

Table 3 details the Stage 1 MUSIC parameters utilised in running the model.

Table 3: Stage 1 MUSIC Model Parameter Summary

Meteorological Data	040406 Beenleigh Bowls Club 1990-1999 6 minute BOM
Source Node	Industrial
Effective Impervious Area	Varies
Effective Pervious Area	Varies
Modelling Time Steps	6 Minute
Drainage Link	No Routing
Pollutant Concentration	Industrial
Soil Properties	Industrial
Treatment Devices	Existing GPT Wetlands

MUSIC calculated the following annual pollutant loads for the 4 combined Stage 1 catchments:

Table 4: Stage 1 Annual Pollutant Loads

Pollutant	Annual Load
Total Suspended Solids	12200 kg/yr
Total Phosphorus	26.4 kg/yr
Total Nitrogen	169 kg/yr
Total Gross Pollutants	1710 kg/yr

Table 5 details the Stage 2 MUSIC parameters utilised in running the model.

Table 5: Stage 2 MUSIC Model Parameter Summary

Meteorological Data	040406 Beenleigh Bowls Club 1990-1999 6 minute BOM
Source Node	Industrial
Effective Impervious Area	Varies
Effective Pervious Area	Varies
Modelling Time Steps	6 Minute
Drainage Link	No Routing
Pollutant Concentration	Industrial
Soil Properties	Industrial
Treatment Devices	Existing GPT Wetlands

MUSIC calculated the following annual pollutant loads for the 4 combined Stage 2 catchments:

Table 6: Stage 2 Annual Pollutant Loads

Pollutant	Annual Load
Total Suspended Solids	7750 kg/yr
Total Phosphorus	21.0 kg/yr
Total Nitrogen	164 kg/yr
Total Gross Pollutants	1650 kg/yr

4.5 Selection of Stormwater Treatment Options

Based on the understanding of City of Gold Coasts requirements for stormwater quality treatment for industrial sites, existing GPT devices and wetlands have been utilised as the SQID's for this site

4.5.1 Wetlands

Wetland systems are shallow, extensively vegetated water bodies that use enhanced sedimentation, fine filtration and biological uptake processes. Through these devices, pollutants are removed from the stormwater. The wetland systems are designed to slowly release the stormwater when water levels rise during heavy rainfall events, such that it returns to dry weather water levels in a number of days.

In addition to wetland systems detaining stormwater, it also treats the stormwater through designed inlet zones which remove coarse sediments, a macrophyte zone and high flow bypass channels.

Table 7: Stage 1 Wetlands MUSIC Parameters

Parameter	Value
Inlet Pond Volume (m ³)	50 m ³
Surface Area (m ²)	5300 m ²
Extended Detention Depth (m)	0.5 m
Permanent Pool Volume (m ³)	2052 m ³
Initial Volume (m ³)	0 m ³
Equivalent Pipe Diameter (mm)	90 mm
Notional Detention Time (hrs)	55.2 hrs

Table 8: Stage 2 Wetlands MUSIC Parameters

Parameter	Value
Inlet Pond Volume (m ³)	50 m ³
Surface Area (m ²)	5500 m ²
Extended Detention Depth (m)	0.5 m
Permanent Pool Volume (m ³)	2129 m ³
Initial Volume (m ³)	0 m ³
Equivalent Pipe Diameter (mm)	90 mm
Notional Detention Time (hrs)	57.2 hrs

4.6 Treatment Train effectiveness in Pollution Reduction

The MUSIC Models were run by calculating the effectiveness in pollution reduction based on treatment being undertaken by the existing GPT and Wetlands. Table 9 and 10 show the post treatment concentrations compared to the Water Quality Guidelines.

Table 9: Stage 1 MUSIC Output Results

Pollutant	Pre Treatment Load	Post Treatment Load	Water Quality Objective	Reduction in Pollutant
TSS	12200 kg/yr	1800 kg/yr	80 %	85.2 %
TP	26.4 kg/yr	8.46 kg/yr	60 %	68.0 %
TN	169 kg/yr	91.0 kg/yr	45 %	46.0 %
GP	1710 kg/yr	0 kg/yr	90 %	100 %

Table 10: Stage 2 MUSIC Output Results

Pollutant	Pre Treatment Load	Post Treatment Load	Water Quality Objective	Reduction in Pollutant
TSS	7750 kg/yr	1210 kg/yr	80 %	84.4 %
TP	21.0 kg/yr	7.26 kg/yr	60 %	65.5 %
TN	164 kg/yr	87.5 kg/yr	45 %	46.6 %
GP	1650 kg/yr	0 kg/yr	90 %	100 %

(Refer to Appendix B for Treatment Train Effectiveness)

The MUSIC treatment measures and assumptions adopted for this development include:

- Existing GPT
- Wetlands – 5500 sq.m

From these results it can be concluded that the use of the existing GPT and wetlands satisfies the requirements of Stages 1 and 2. The wetlands for Stages 1 and 2 will be 5500 sq.m as it satisfies the WQOs of both stages.

5. Water Quantity

No water quantity is required during Stages 1 or 2 of the works as the existing wetland/detention system adequately caters for the whole development as part of Lot 334 on SP193431.

6. Conveyance

Easement F SP193431 shown on drawing 17-209-DA01 has been granted for overland stormwater runoff. The *Existing Upstream Contours Detail* attached in Appendix A shows that there is no upstream catchment, as there is a high point on Lot 110.

Therefore it is proposed that this easement be relinquished by City of Gold Coast.

7. Maintenance

The following maintenance protocols have been adapted from City of Gold Coast's Planning Scheme (Policy 11, Section 13.7). They should generally be adopted as standard maintenance procedures upon the installation and or construction of a Wetland System.

7.1 Wetlands

Wetland systems require on-going maintenance to ensure there are adequate flow conditions and healthy vegetation. The main maintenance tasks include:

- Desilting of the inlet zone after the construction has been completed;
- Routine inspections of the wetland system to identify any damage to vegetation, scouring, formation of isolated pools, litter and debris build up or excessive mosquitoes;
- Routine inspection of all inlets and outlets to identify any areas of scour, litter build up and blockages;
- Removal of litter and debris in and around the wetland system;
- Removal and management of invasive weeds;
- Prevention of the formation of isolated pools by repairing the wetland profile;
- Periodic draining and desilting of the inlet pond – usually occurring every 5 years;
- Regular watering of vegetation during plant establishment;
- Control of the water level during plant establishment – usually takes 2 years to fully establish;
- Replacement of plants that have died with plants of equivalent size and species as detailed in the planting schedule;
- Vegetation pest monitoring and control.

It is recommended that inspections of the wetlands take place after large storm events to check for scouring and damage to the system. A Maintenance Plan is to be used to develop all associated maintenance protocols, which shall include:

- Inspection and maintenance frequency;
- Data collection and storage requirements of documentation (ie. during inspections);
- Detailed clean-out procedures, including but not limited to:
 - equipment needs;
 - maintenance techniques;
 - occupational health and safety, and public safety;
 - environmental management considerations;
 - disposal requirements (of material removed);
 - access issues and stakeholder notification requirements;
- Design details.

8. Conclusion

The MUSIC modelling results in Section 4.6 indicates that a bioretention basin will adequately treat the identified pollutants associated with the Q_{3 Month} stormwater runoff in Stages 1 and 2.

The required devices are:

- Existing GPT
- Wetlands – 5500sq.m

As stated in Section 4.6, the wetlands for Stages 1 and 2 will be 5500 sq.m as it satisfies the WQOs of both stages.

In addition, adherence to the maintenance measures detailed in Section 7 will ensure the ongoing effectiveness and longevity of the proposed SQID's.

Based on the above MUSIC results, i³ consulting considers that proposed treatment of identified pollutants of the existing GPT and wetlands will satisfy City of Gold Coast's requirements for stormwater quality treatment for the proposed development.

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9. Reference List

Healthy Waterways, Water Sensitive Urban Technical Design Guidelines for South East Queensland – Version 1, June 2006.

Water by Design, MUSIC Modelling Guidelines
Version 1.0, 2010

DERM, Queensland Water Quality Guidelines, 2009

Department of State Development, Infrastructure and Planning, State Planning Policy, 2016

City of Gold Coast's Planning Scheme

Water by Design, Wetland Technical Design Guidelines, May 2017

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Appendix A – Drawings

Table 11: Drawings prepared by i3 consulting pty ltd

Drawing Number	Drawing Description
17-209-DA01	Layout Plan
17-209-DA02	Water Quality Plan

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Appendix B – Calculations

Table 12: Discharge Calculation Table

Stage	Catchment	Area	Major Storm Event Q ₁₀₀		Minor Storm Event Q ₂₀		Treatable Storm Event Q _{3 month}	
			Intensity	Discharge	Intensity	Discharge	Intensity	Discharge
1	CP Ground	0.085 ha	301 mm/hr	0.071 m ³ /s	236 mm/hr	0.051 m ³ /s	60.0 mm/hr	0.010 m ³ /s
1	Lot 110 Roof	3.849 ha	301 mm/hr	3.218 m ³ /s	236 mm/hr	2.331 m ³ /s	60.0 mm/hr	0.452 m ³ /s
1	Lot 110 Ground	1.540 ha	301 mm/hr	1.288 m ³ /s	236 mm/hr	0.933 m ³ /s	60.0 mm/hr	0.181 m ³ /s
1	Lot 110 Road	2.310 ha	301 mm/hr	1.931 m ³ /s	236 mm/hr	1.399 m ³ /s	60.0 mm/hr	0.271 m ³ /s
2	CP Ground	0.085 ha	301 mm/hr	0.071 m ³ /s	236 mm/hr	0.051 m ³ /s	60.0 mm/hr	0.010 m ³ /s
2	Lot 110 Roof	3.540 ha	301 mm/hr	2.960 m ³ /s	236 mm/hr	2.144 m ³ /s	60.0 mm/hr	0.415 m ³ /s
2	Lot 110 Ground	3.540 ha	301 mm/hr	2.960 m ³ /s	236 mm/hr	2.144 m ³ /s	60.0 mm/hr	0.415 m ³ /s
2	Lot 110 Road	0.618 ha	301 mm/hr	0.517 m ³ /s	236 mm/hr	0.517 m ³ /s	60.0 mm/hr	0.073 m ³ /s

Sample Calculations

MINOR STORM EVENT Q₁₀₀

AREA = 0.085 ha
RAINFALL INTENSITY
I₁₀₀ = 301 mm/hr (From AR&R)
For 5 minute duration

COEFFICIENT OF RUNOFF

C₁₀₀ = 1
DISCHARGE
Q₁₀₀ = $\frac{CIA}{360}$ = 0.071 m³/s

MINOR STORM EVENT Q₂₀

AREA = 0.085 ha
RAINFALL INTENSITY
I₂₀ = 236 mm/hr (From AR&R)
For 5 minute duration

COEFFICIENT OF RUNOFF

C₂₀ = 0.924
DISCHARGE
Q₂₀ = $\frac{CIA}{360}$ = 0.051 m³/s

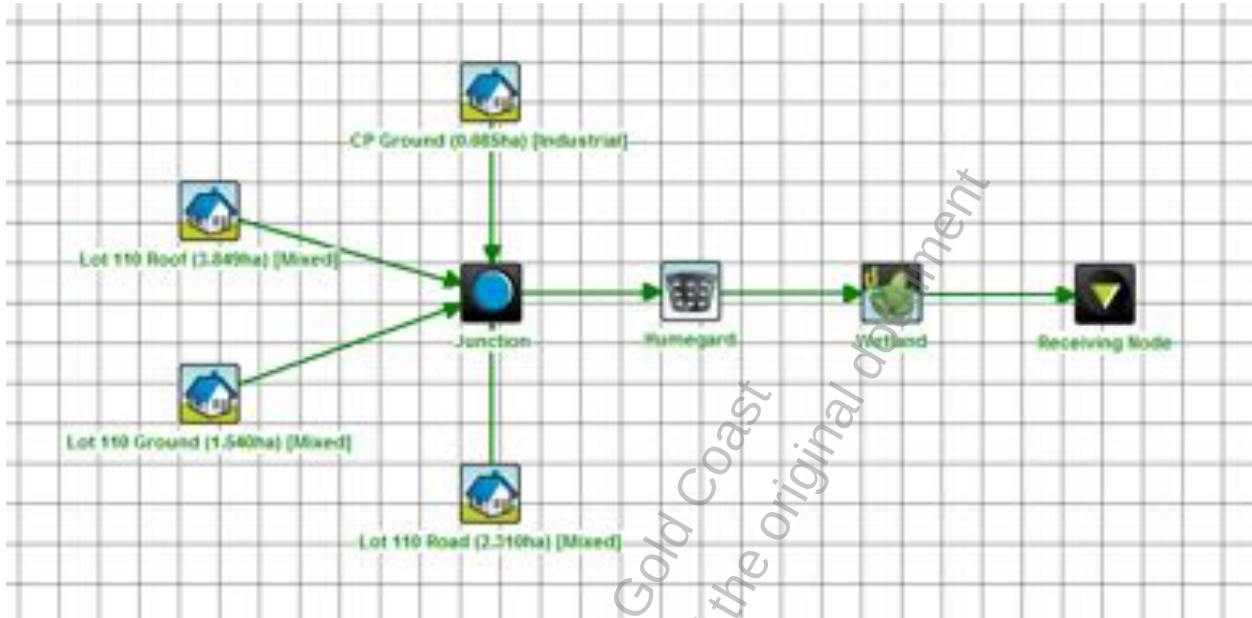
TREATABLE STORM EVENT Q_{3 month}

AREA = 0.085 ha
RAINFALL INTENSITY
I_{3 month} = 60.0 mm/hr (From AR&R)
For 5 minute duration

COEFFICIENT OF RUNOFF

C_{3 month} = 0.704
DISCHARGE
Q_{3 month} = $\frac{CIA}{360}$ = 0.010 m³/s

Appendix C – Stage 1 Music Output



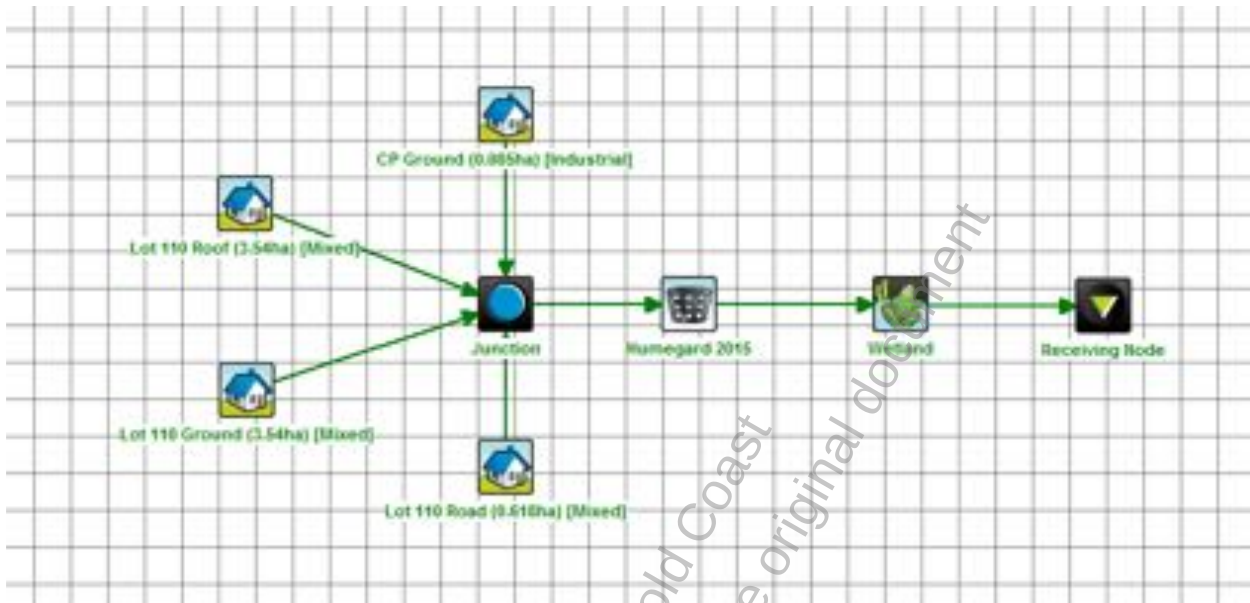
Music Model

Treatment Train Effectiveness - Receiving Node

	Sources	Residual Load	% Reduction
Flow (ML/yr)	72.4	62.3	13.9
Total Suspended Solids (kg/yr)	12200	1800	85.2
Total Phosphorus (kg/yr)	26.4	8.46	68
Total Nitrogen (kg/yr)	169	91	46
Gross Pollutants (kg/yr)	1710	0	100

Treatment Train Effectiveness

Appendix D – Stage 2 Music Output



Music Model

Treatment Train Effectiveness - Receiving Node

	Sources	Residual Load	% Reduction
Flow (ML/yr)	70.7	60.2	14.8
Total Suspended Solids (kg/yr)	7750	1210	84.4
Total Phosphorus (kg/yr)	21	7.26	65.5
Total Nitrogen (kg/yr)	164	87.5	46.6
Gross Pollutants (kg/yr)	1650	0	100

Treatment Train Effectiveness