

Overland Flow Study

Northside Clinic Development, Artarmon

Prepared for: Ramsay Health Care

Document no: SY140494_OFS

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Introduction

ACOR Consultants has been engaged by Ramsey Health Care to undertake an overland flow study as part of the Secretary's Environmental Assessment Requirements (SEARS) process for the proposed Northside Mental Health Facility development on Frederick St in Artarmon. It is understood that the site is being considered for a health facility development with basement car parking. The floor level of the proposed basement car parking is to be below the road level within Frederick Street. Access to the basement carpark will be via Frederick Street.

Willoughby City Council has advised that an overland flow study should be undertaken to determine the impact of the overland flow within the Flat Rock Creek Catchment area and in particular, any potential inundation of the site and its impact on the existing overland flow path. A number of council owned and private stormwater lines exist within the catchment area.

1.1 Background

The existing site comprising 5785 m² is situated on Frederick Street in Artarmon and is one property away from the intersection with Herbert Street. It is understood that the existing site has previously been subdivided and may be subdivided further into two properties as part of the proposal. The proposed development is to be constructed on one of the lots and the other is to be residual lot and may be developed as part of a separate proposal. It is assumed that the other site will be left undeveloped for the purposes of this study. An existing building covers the majority of both sites with the remainder covered by impervious hardstand areas.

The site is located within the bounds of the Flat Rock Creek Catchment area. The local catchment area above the proposed site upstream area forms a local depression in the surrounding land, channelling flow down through and across Frederick Street. The local upstream catchment area is highly developed and consists primarily of industrial developments, commercial developments, hospital buildings and hardstand areas. Some existing buildings within the local upstream area are both adjacent to and blocking the natural overflow path and also have filled sites to regrade away from the natural overflow path. Refer to Figure 1 for the extent of catchment modelled.

The catchment is serviced both by an existing Council drainage system and private drainage systems. Locations and sizes of some stormwater pits and pipes within the area were provided by Willoughby Council as GIS data, others were located via survey or inspection. It is understood that a number of existing privately owned upstream drainage systems were unable to be located or accessed and as such have been omitted from this assessment. This assessment has assumed the worst case scenario for surface flow where the existing system could not be located. Refer to Figure 2 for the underground drainage system modelled. A 50% blockage factor was assumed for all pipes and pit inlet capacities for the system in line with Willoughby Council guidelines.



Figure 1 – Extent of Catchment within the Local Area



Figure 2 – Existing Underground Drainage System within the Catchment

1.2 Proposed Development Area

The proposed development site and immediate local surrounding area can be seen in Figure 3. The following details about the development have been identified:

- The property is bordered on the North West by Frederick Street.
- The property is bordered on the South West by the property area to be subdivided and beyond this an industrial development. The industrial development has a 4.5m wide path on the property boundary of the proposed subdivided site that is to remain undeveloped as part of this proposal. A small existing concrete and brick wall topped with a Colorbond fence has been installed along the length of the boundary between the sites. The 4.5m wide path has been marked as Area 1 on all attached drawings.
- The property is bordered to the North East by an existing car dealership. A rear hardstand area containing an On-Site Detention (OSD) storage tank is located directly beyond the boundary to the proposed development site. The rear hardstand area has been marked as Area 2 on all attached drawings. Please note that the existing OSD tank has not been modelled within this flood study and as such, localised ponding in that area is misrepresented. Refer below for further discussion on ponding within this area.
- On the South-East the property is bordered by a commercial development. The border between the commercial development and the proposed site is formed from a large retaining wall topped by an impervious concrete barrier. No existing stormwater drainage point for this property was located and as such it is assumed that the stormwater will drain overland to Herbert Street as per the existing levels.

Figure 3 shows the location of the proposed subdivided property which is not to be considered as part of this study. It has been assumed that the site will be a hardstand undeveloped site and that any existing concrete walls along the boundary have been retained.

It is also noted that flow off the existing car showroom site up to the 1% AEP storm is contained within an existing on-site detention tank and discharged through an easement within the proposed development site. This is to be diverted as part of the proposed works.

The OSD storage within the car showroom area has not been modelled within this TUFLOW model. All flood waters ponding within the rear caryard of the existing car showroom which came from the site itself would be completely contained within the existing OSD system.

The car show room site is isolated from all external catchments due to the elevations around the side except at the street frontage along Frederick Street where flooding beyond 250mm deep would inundate the site. Should no flooding be modelled as within Frederick Street along the boundary of the existing car showroom at a depth of 250mm or greater, then any ponding that the flood modelling shows within this area should be discounted from the analysis as it has already been catered for within the existing OSD system.



Figure 3 – Proposed Development Local Site Layout (Orientated North)

Modelling

2.1 Model

An investigation of flood behaviour in a catchment requires both hydrological and hydraulic analysis to determine the 1% AEP flood levels, velocities and provisional hazard categorisation of surface flow as well as its interactions with the underground pit and pipe system within the area. The TUFLOW modelling software simulates depth-averaged, two-dimension surface flows from floods in addition to a one-dimensional network modelling based on the full one-dimensional free-surface St Venant flow equations. The model simulates the movement of floodwaters through the waterway reaches, storage elements and hydraulic structures. The model calculates flood levels, flow patterns and also models the complex effects of backwaters, roughness, overtopping of embankments, waterway confluences, bridge constructions and other hydraulic structures as applicable.

This model has been undertaken in accordance with Australia Rainfall and Runoff, the NSW Floodplain Management Manual (2005) and Willoughby Council's Floodplain Management Technical Standard.

2.2 Flood Data

For the purposes of this report, data has been obtained from numerous sources. This data is required for input into the hydrological and hydraulic models.

- **Survey:** The overland flow assessment is based on 2013 LIDAR survey provided by the Land and Property Information (LPI) Department of the NSW Government and local survey provided by the client. It is noted that the existing catchment wide LIDAR data was relatively inconsistent in the local area due to the density of industrial buildings. The survey has been adjusted in some areas within TUFLOW to more accurately match the existing levels for the local areas however may cause some localised anomalies within the TUFLOW model around adjusted areas which are unlikely to impact the remainder of the model. The existing adjusted data should generally reflect the catchment elevations to a sufficient extent for modelling.
- **Design Rainfall:** Design rainfall depths and temporal patterns for the 1% AEP events were developed using the guidelines outlined in AR&R(1987) and in line with the provided documentation within Willoughby City Council DCP Attachment 22 – Floodplain Management
- **Aerial Imagery:** Google (2016)
- **Historic Flood Information:** Historic flood information was not available for this site.

2.3 Hydrological and Hydraulic Modelling

General

The modelled area extends over the subject site and into the adjoining upstream and downstream catchment. The following parameters were assessed as part of the hydrological modelling associated with the catchment:

- Rainfall intensity-frequency-duration (IFD) relationships.
- Sub catchment diversions
- Slopes and overland flow paths
- Land use (pervious and impervious)
-

Variable Definition

Please refer to ACOR drawing C10.01 for the visual representation of the local upstream catchment from the site.

- **Catchment** - The local upstream catchment was delineated from existing elevation data.

- **Rainfall** - The predicted rainfall hyetograph for the 1% AEP storm was interpreted using the DRAINS program from the rainfall IFD data provided. This rainfall has been applied over the extent of the catchment as a direct rainfall boundary condition within TUFLOW.
- **Lower Boundary Condition** – A water level versus flow (stage-discharge) curve has been adopted which is generated by TUFLOW by specifying a boundary slope.
- **Model** – The study area is sampled by a 0.1m Digital Elevation Model (DEM) grid based on the LIDAR Survey. The model includes existing buildings and the proposed-redevelopment of the subject site. A TUFLOW 2D domain model resolution of 2m was adopted for the study area. It should be noted that TUFLOW samples elevation points at the cell centre, mid-sides and corners, so a 2m cell size results in DEM elevations being sampled every 1m. This resolution was selected to give necessary detail required for accurate representation of floodplain topography and its influence on surface flow.
- **Hydraulic Roughness Parameters** – The adopted roughness parameters for the hydraulic model are based on site-observations and aerial photography. The Table 1 identifies the roughness values adopted in the hydraulic model.

Roughness Parameters	
<i>Surface Description</i>	<i>Mannings 'n'</i>
Pasture	0.06
Roads	0.02
Commercial/Industrial Buildings	2.0
Other Hardstand	0.015
Parks/Reserves	0.03
Commercial/Industrial Land (Non-Building)	0.035
Concrete pipe/channel	0.013

Table 1 – Roughness Parameters

- **Blockages** – A 50% blockage factor with both the inlet capacity of the pits and the underground pipe network has been applied to the model.

Design Flood Estimation

The Peak 100 Year Rainfall Hyetograph was applied to the TUFLOW model to determine the predicted flooding behaviour for the 1% AEP storm event. The model was run at a low resolution for all 1% AEP storm durations to determine peak flood event at the site. The peak flood level occurred during a 1% AEP storm event with a 120 minute duration. All further modelling was completed at a higher resolution for this storm event.

Provisional Hydraulic Hazard Category

The degree of hazard which is attributed to flooding considered the outcomes of the hydraulic modelling in association with the following factors:

- Size of flood
- Effective warning time
- Flood awareness
- Rate of rise of floodwater

- Duration of flooding
- Evacuation problems
- Effective flood access
- Type of development

Hazard categories are defined as high, intermediate or low hazard and are based on the guidelines outlined in the NSW Floodplain Development Manual (2005) and in particular Figure L.2. The hazard categories for the 1% AEP flood waters affecting the site are mapped within the results.

Building Footprint and Barrier Modelling

Due to the heavy density of buildings and significant barriers to flooding within the local area, building footprints and barriers have been modelled as a combination of material roughness and break lines depending on which one was appropriate for the situation. Refer to Table 1 for roughness coefficients used within the site.

Climate Change Condition

To simulate the potential effects of climate change and an increase in rainfall intensity, the rainfall data has been increased by 10% for the climate change condition. It has been noted that the site will not be affected by sea level rises due to its location.

Results and Conclusions

3.1 Results

The predicted flooding characteristics for the 1% AEP Design storm event are mapped on the attached ACOR drawings:

- C10.01 – Catchment Plan
- C10.02 - Pre-Development 1% AEP Flood Depth and Contour Plan
- C10.03 – Pre-Development 1% AEP Flood Velocity Plan
- C10.04 – Pre-Development 1% AEP Flood Hazard Plan
- C10.05 - Post-Development 1% AEP Flood Depth and Contour Plan
- C10.06 – Post -Development 1% AEP Flood Velocity Plan
- C10.07 – Post -Development 1% AEP Flood Hazard Plan
- C10.08 – 1% AEP Flood Height Difference Plan
- C10.09 – Post-development 1% AEP Flood Depth and Contour Plan – Climate Change Adjusted

Overland flow mapping cut-off depth has been restricted to 0.1m for all results due to the direct rainfall boundary condition for the model. Please note that minor anomalies along breaklines within the model have not been considered as part of the modelling and refer below for further discussion as to ponding within Area 2.

3.2 Discussions

It is noted that due to the inconsistencies within the existing elevation data as discussed above and the methods used to rectify these, there are a number of minor anomalies within the flood mapping that have occurred along edges of break lines and within areas of elevation adjustment. These individual flood level anomalies will not be accounted for within the analysis or the recommendations.

The areas of flooding that have been identified within the model around the site include the overland flow path (denoted as Area 1 on C10.02) to the South West of the existing building and the ponding of water behind the existing car show room (denoted as Area 2 on C10.02).

For the developed site, the model allowed for a new building on the property as per the current proposal. The two areas of flood affection within the local area have been addressed below:

1. It was found that the location of the proposed building has no impact on the overland flow path within Area 1. The overland flow path encroached only upon the area designated to be subdivided separately from the proposed development (refer Figure 3). As this area was modelled as undeveloped, the proposal has no impact on this overland flow. Even if the existing low concrete wall was also removed, no significant impact on the proposed development would be apparent, rather any increased impact from this overland flow path would affect only the subdivided property.
2. The localised ponding of water the rear of the existing car show room (Area 2) does not form part of a localised overland flow path but is rather a localised depression where water ponds. As discussed within Section 1.2 above, as no floodwaters are shown within Frederick Street bordering the existing car show room boundary, the water ponding on-site can be attributed to the site itself. As the TUFLOW model has not modelled the existing OSD system, any localised ponding within the rear car yard of the car show room would be adequately catered

for by the existing OSD. No external flood catchments are draining into the site itself. As such, the localised ponding of water within Area 2 should not be considered as flood affectation.

3.3 Conclusion and Recommendation

The investigation of overland flow has found that the proposed development is not subject to flooding from overland flow and that the proposed structures will not impede the passage of floodwater to cause a rise (afflux) in water upstream or increase the downstream velocities of flow for the flood. Refer to attached drawing C10.08 for a 1% AEP Flood Height Difference Plan. No structures or filling are to be undertaken within the 1% AEP flood affected areas. Furthermore, no area of the proposed development will be subject to overland flows that would exceed a velocity –depth product of 0.4 m^2 .

While no flooding has been noted as affecting the property, the following recommendations have been made to prevent future nuisance water ingress into the property:

- As no flooding within Frederick Street is apparent from the overland flood study, the driveway ramps have no required crest level however it is recommended that a minimum crest level of 250mm above the highest invert of the gutter along the driveway crossing is maintained (or to council standards).
- The upstream OSD system should be assessed for adequacy to capture and discharge the 1% AEP flood volume. If the assessment of the OSD determines that the size is not sufficient, the easement pipe diversion works should include upsizing the pipe to cater for the entire site flow catering for 50% blockages. If the assessment of the OSD system determines that the size is sufficient, the easement pipe diversion works should still upsize the pipe to cater for 50% blockages for the OSD design outflow.
- A minimum 300mm high waterproof barrier above existing surface is maintained along the length of the North East boundary of the property to prevent inundation should the upstream OSD system fail and along the South West Boundary to prevent local surface runoff as a result of future development on that site.
- We further recommend that a basement pump-out pit be installed in the event that water does enter the building if gravity drainage of the basement cannot be adequately achieved.

Given the impact of the proposal is confined to the site itself and that the 1% AEP flood overland flow path is not affected, we support the proposed development based on the information provided and the recommendations above.

This flood study has been undertaken in line with the latest editions of Australian Rainfall and Runoff, the NSW Floodplain Management Manual and Council's Floodplain Management Technical Standards.

3.4 Attachments

- *C10.01 – Catchment Plan*
- *C10.02 - Pre-Development 1% AEP Flood Depth and Contour Plan*
- *C10.03 – Pre-Development 1% AEP Flood Velocity Plan*
- *C10.04 – Pre-Development 1% AEP Flood Hazard Plan*
- *C10.05 - Post-Development 1% AEP Flood Depth and Contour Plan*
- *C10.06 – Post -Development 1% AEP Flood Velocity Plan*
- *C10.07 – Post -Development 1% AEP Flood Hazard Plan*
- *C10.08 – 1% AEP Flood Height Difference Plan*
- *C10.09 – Post-development 1% AEP Flood Depth and Contour Plan – Climate Change Adjusted*



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North

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Project

ARTARMON MENTAL HEALTH FACILITY
NORTHSIDE DEVELOPMENT
FREDERICK ST, ARTARMON NSW 2064

Drawing Title

PRE-DEVELOPMENT % AEP
FLOOD DEPTH AND CONTOUR PLAN

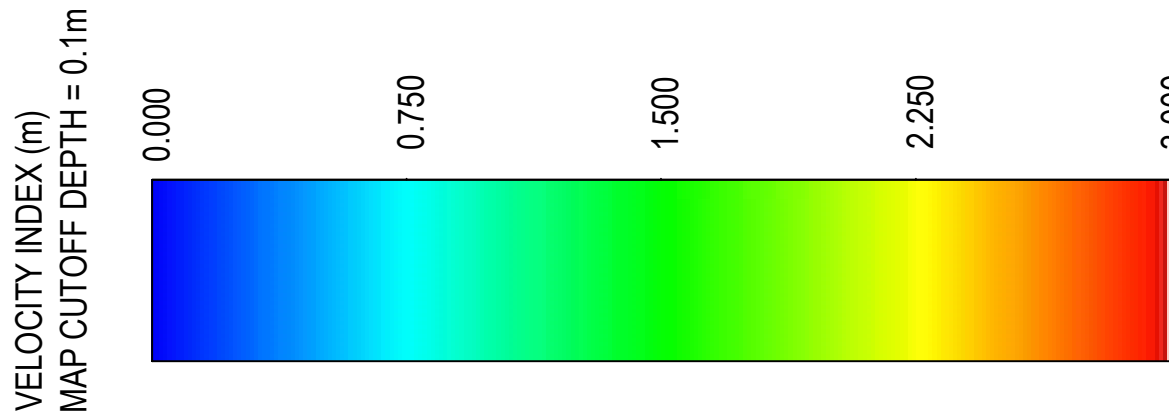
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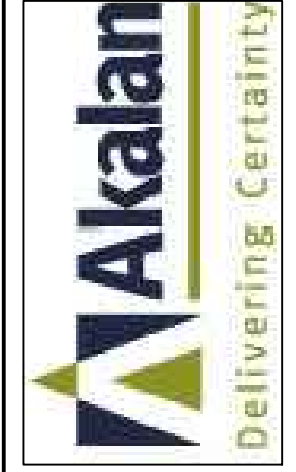
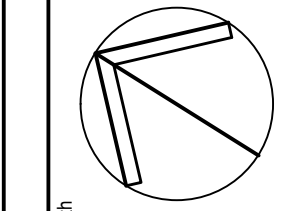
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Northside Development
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Drawing Title
PRE-DEVELOPMENT % AEP
FLOOD VELOCITY PLAN

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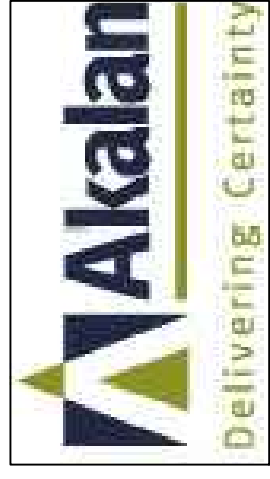
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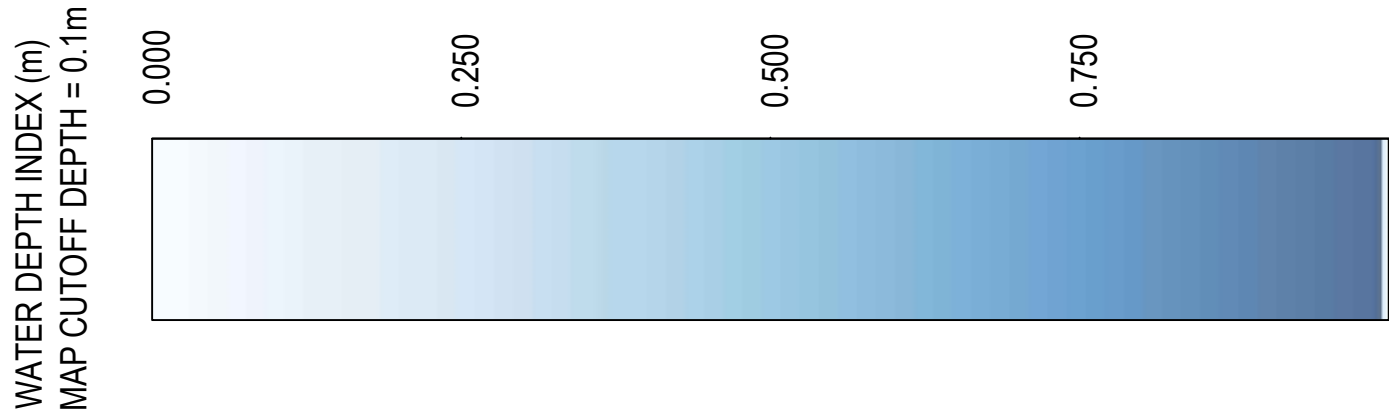
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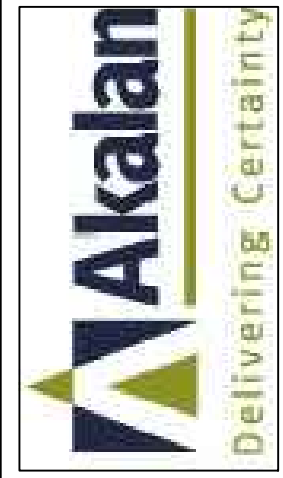
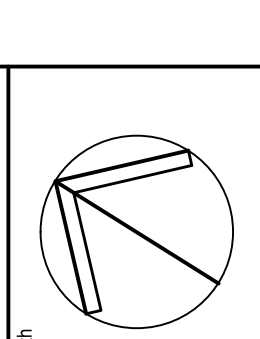
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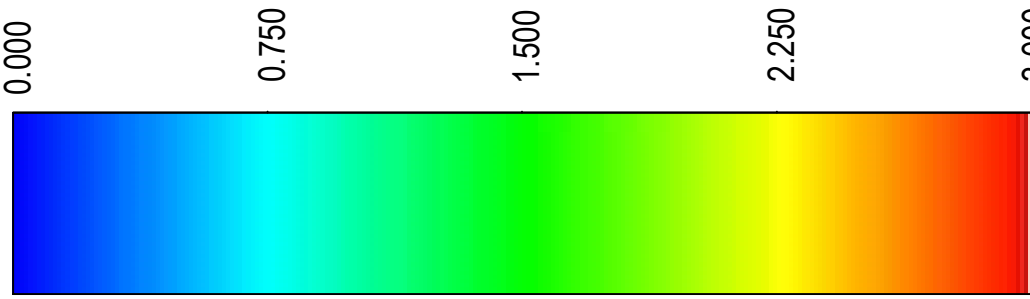
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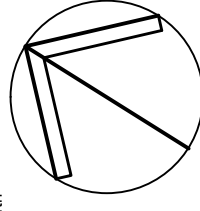


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Project
ARTARMON MENTAL HEALTH FACILITY

Drawing Title
POST DEVELOPMENT 1% AEP

FLOOD VELOCITY

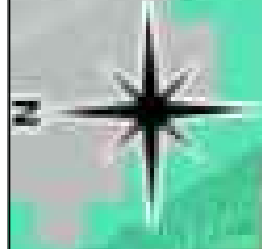
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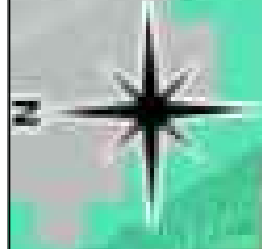
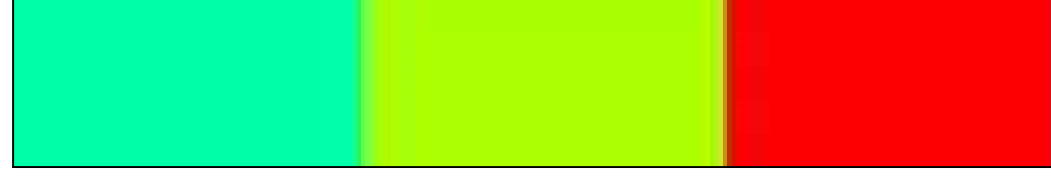


FLOOD HAZARD INDEX (m)
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LOW HAZARD

MEDIUM HAZARD

HIGH HAZARD



AREA 2

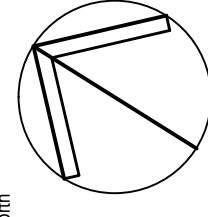
AREA 1

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NORTHSIDE DEVELOPMENT

FREDERICK S. I. ARJAMUN NSW Z084

Drawing Title
POST DEVELOPMENT 1% AEF

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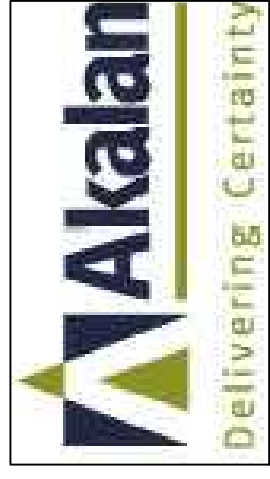
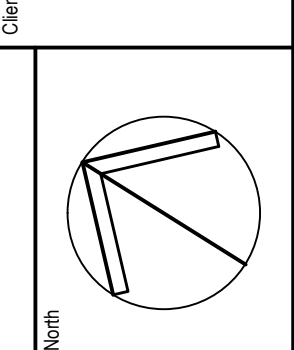
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Project
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Drawing Title
1% AEP FLOOD HEIGHT
DIFFERENCE PLAN

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