Proposed Subdivision

STORMWATER DRAINAGE STRATEGY

Lot 1307 & 1308 DP1141533

213 Station Lane, Lochinvar

21 April 2021

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Document Control

REVISION	DATE	REVISION DETAILS	AUTHOR	REVIEWER
A	30.03.21	Original Issue	Aline Sena	Kevin Urane
B	21.04.21	Lots Layout	Aline Sena	Kevin Urane

Contents

List of Acronyms

AHD	Australian Height Datum
ARI	Average Recurrence Interval
ARQ	Australian Runoff Quality, Engineers Australia, 2006
AR&R	Australian Rainfall and Runoff, Institution of Engineers, Australia, 1987
BASIX	Building Sustainability Index
BOM	Bureau of Meteorology
CC	Construction Certificate
DA	Development Application
DLWC	Department of Land and Water Conservation
FFL	Finished Floor Level
FPL	Flood Planning Level
IAD	Interallotment drainage
IFD	Intensity Frequency Duration
LGA	Local Government Area
MCC	Local Government Area
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
RL	Reduced Level
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids

1. INTRODUCTION

1.1 Background

High Definition Design Pty Ltd was commissioned by Tim Kenyon to formulate a Stormwater Drainage Strategy in accordance with the stormwater quantity and quality requirements of the Maitland City Council's Development Control Plan and the Engineering Guidelines to support a proposed Development Application for residential subdivision at 213 Station Lane, Lochinvar known as lot 1307 & 1308 DP 1141533 located within the Maitland City Council area, the site location is shown in Figure 01 Appendix A.

The report describes the principles and operation of the proposed stormwater system as well as the primary components of the drainage system. As the assessment and evaluation are required under the conditions of consent, the final stormwater system layout may need to be revised in the future during the application for a Construction Certificate.

The following information and documents were used in this investigation:

- Maitland City Council Development Control Plan (DCP) 2011.
- Maitland City Council, Manual of Engineering Standards, adopted April 2014.
- "Australian Runoff Quality – A Guide to Water Sensitive Urban Drainage", Engineers Australia (2006).
- "Australian Rainfall and Runoff – A Guide to Flood Estimation", Institute of Engineers Australia (1987).
- Flood study, "Hunter River Floodplain Risk Management" of Maitland City Council Release Area as per council website 16/7/2019.

The increase in impervious areas and alteration of the natural topography due to land development has the potential to increase and concentrate peak storm flows. This has the potential to impact on flow regimes and cause erosion of the downstream drainage network and associated waterways.

To avoid any adverse impact on the downstream drainage systems, the site's stormwater management system must be designed to ensure the safe conveyance of flows throughout the site and within the capacity of the downstream trunk drainage systems in a healthy environmental state for Ecological Sustainable Development.

1.2 Site Description

The site is generally bounded by Station Lane to the West, Main Northern Railway, rural land to the east and rural land to the North.

The site has average natural surface slopes from the west to the East approximately 4.63%. The total area of the site proposed for development is approximately 22.57Ha and varies in level from approximately RL 65.5m AHD adjacent to the Main Northern Railway to below RL 47.0m AHD adjacent to the Eastern boundary.

1.3 Proposed Development

The proposal for the site is for the creation of a residential subdivision with 224 lots, 223 residential lots and one lot, the 709, destinated for biodiversity reserve. The lot layout of the development has been prepared and is shown in Figure 02 Appendix A.

1.4 Drainage Catchment

The site generally drains from the site surface towards an existing watercourse inside of the proposed site.

1.5 Objective and Target of Work

This strategy has been undertaken to provide the following information is the support of the Development Application:

- Documentation of the requirements of Maitland City Council for this development site.
- Define the impacts of this proposed residential development on existing waterways and downstream properties.
- Provide stormwater controls that ensure the proposed development does not adversely impact on the quantity of stormwater flows within, adjacent and downstream of the site.
- Provide concept dimension of the proposed stormwater management services in accordance with the adopted approach by the council.

1.6 Strategy Purposes / Criteria

1.6.1 Stormwater Runoff Quantity Criteria

Stormwater flow management and design criteria of quantity include:

- The adoption of a major/minor flow approach to the design of the local stormwater management system.
- Delivery of major flows through the site to the stormwater system in a safe manner and to avoid impacting the site and downstream properties.
- Limiting the discharges rates of the proposed to development pre-development discharge rates.

1.6.2 Stormwater Runoff quality Criteria

Stormwater runoff from the development area should be treated prior to discharge to the public Stormwater system, consistent with normal practice criteria for new developments, and with consideration to opportunities for integration with developed site features and topography.

The design methodology for Stormwater Runoff Quality typically contains stormwater quality treatment devices based on identified opportunities for stormwater quality management referencing the development site and catchment.

Stormwater quality management for the proposed site could include a treatment train of structures consisting of:

- Water harvester for reducing runoff volumes;
- Gross pollutant trap (GPT);
- Stormwater Bioretention basin;
- Proprietary water quality improvement devices for runoff water treatment.

1.6.3 Flooding Criteria

For the purpose of assessing this development, the report utilises Maitland City Council Development Control Plan 2011, Part C Design guidelines, “C.10 Subdivision, Section 4. Design Element- EC.3 Hazards, Flooding”, States:

a) All lots Within new residential subdivisions shall have safe access available in a 1 in 100 year flood event.
b) All new residential lots are to be wholly above the Council’s adopted flood standard (the 1% AEP or 1 in 100 flood event). In exceptional circumstances, and where lot sizes have been increased to provide sufficient flood free area for erection of a dwelling and associated structures, parts of the lot may be permitted below the adopted flood standard.
c) If a basin is located in a flood plain the design should achieve its elevation (RL) to limit inundation by flood waters. The lowest desirable level of the spillway should aim to be higher than the 20 year ARI event in the flood plain.

Hence, all the proposed lots should be designed at or above the 1 in 100 year flood event level, and all residences should have 500mm freeboard above the flood planning level.

2. STORMWATER DRAINGE MANAGEMENT STRATEGY

The stormwater drainage management strategy involves:

- Roof areas of residences will drain to rainwater tanks/harvesters within each lot for re-use. Water Tanks will overflow through a piped connection to IAD or street drainage system.
- Output of the captured stormwater from drainage pipe system to gross pollutant traps (GPT's) for primary treatment prior to the discharge into the proposed bioretention basin for further treatment.
- Capture of stormwater from lot and road reserve areas by a convectional pit and pipe drainage network located in the street or in IAD easements where required.
- Discharge from the catchment's outlets will be conveyed overland towards the existing waterways or piped where required, generally similar to the discharge from the undeveloped catchments.
- Creation of stormwater bioretention basin, in accordance with Maitland City Council's standards

Detail drainage design of the pipped system will be provided during the Construction Certificate application, to Council's standard requirements.

3. METHODOLOGY

3.1 Stormwater Runoff Quantity

The hydrological modelling software has been used for flowrates estimation of the existing and post-development flows to demonstrate the magnitude of the local catchment discharge.

3.1.1 Stormwater Flow Model

The post-development release is compared to the pre-developed discharge, and if higher, detention is usually warranted in accordance with Council's standard requirements.

3.1.1.1 Catchment Plan and Model Data

Surface runoff flowrates from the proposed site were modelled in two differing scenarios (the pre-developed state and post-developed catchment) using the DRAINS – Urban Drainage Model.

The Horton/ILSAX model was used within the DRAINS software package for both scenarios.

The development site is two catchments, the catchment of the proposed lots to be discharged at the basin, and the catchment of the existing reserve that will be discharges at the existing water course, as shown in Figure 4 Appendix B. DRAINS model data is included in Appendix F.

The methodology for stormwater quantity comprised quantitative analysis of available data to estimate existing and future flow behaviour from the development site. The analysis involved examination of surface hydrology to identify runoff characteristics from the proposed site and determination if stormwater mitigation devices are required to negate the impact of site development on existing flowrates from the site.

This involved the following steps:

- Estimate the existing peak stormwater flowrates at the downstream drainage outlets of the site using the DRAINS drainage software package.
- Revise the existing scenario in the DRAINS drainage model to include the additional impervious areas that will arise due to development of the site. This resulted in the developed DRAINS drainage model.
- The critical storm was then selected for each ARI, based on the peak discharge from the site. The hydrographs of these 'critical' storms were plotted to enable comparison of the existing state storm event to the developed state storm event.

3.1.1.2 Rainfall Data

Rainfall for the 1 year, 2 year, 5 year ,10 year, 20 year, 50 year, and 100 year ARI design events, and storm durations from 5 minutes to 4.5 hours for each, were modelled in order to identify the critical storm duration (producing the highest peak flowrate) for each ARI from the site. The required rainfall Intensity Frequency Duration (IFD) rainfall data was obtained from the tables supplied in Australian Rainfall and Runoff, and the BOM website, and is reproduced below, as shown in appendix G.

3.1.1.3 DRAINS Model Parameters

Table 1 summarises the catchment storage and loss parameter values adopted in the DRAINS models for both the pre-developed and post-developed models.

Table 1: Storage and loss parameter values adopted in the DRAINS hydrological models

Parameter	Value
Paved depression storage (mm)	1
Grassed depression storage (mm)	5
Soil type	3

3.1.1.4 Model Catchment Data

Full DRAINS model Catchment data is provided in Appendix F. Surface roughness values, n*, used in the DRAINS models are summarised in Table 2.

Table 2: Roughness parameter values, n*, adopted in the DRAINS models

Model - surface type	Surface roughness ‘n*’ value
Pre-developed	0.15
Pervious areas	0.21
Impervious areas	0.01

Catchment impervious area percentage values used in the DRAINS models are summarised in Table 3.

Table 3: Impervious area percentage values adopted in the DRAINS models

Model - type	Impervious Area Percentage
Existing site area (Pre-development)	0%
Post-development – roads reserve	70%
Post-development – residential lots	60%

3.2 Stormwater Runoff Quality

The methodology for Stormwater Runoff Quality typically involves selection of stormwater quality treatment devices based on identified opportunities for stormwater quality management referencing the development site and catchment conditions, and normal best practice.

The performance of the stormwater management plan was undertaken using the MUSIC stormwater water quality model. MUSIC is a continuous simulation water quality model. The pollutants considered in the water quality modelling were total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN) which are typical components of urbanised stormwater runoff.

MUSIC input parameters include:

- Rainfall and potential evapotranspiration data
- Catchment area and percentage impervious
- Hydrologic parameters
- Statistical pollutant generation parameters

MUSIC outputs include:

- Average annual pollutant export loads
- Treatment train effectiveness expressed in terms of pollutant reduction.

Input parameters used for modelling were derived from BOM Climate Data, parameter values in the *MUSIC User Manual* and the publication *Using MUSIC in Sydney's Drinking Water Catchment, A Sydney Catchment Authority Standard* (Published by Sydney Catchment Authority, Penrith, December 2012).

The treatment criteria of stormwater quality of Maitland City Council are summaries in Table 4:

Table 4: Stormwater Treatment Objectives

Pollutant	Stormwater Treatment Objective
Total Suspended Solids (TSS)	80% retention of average annual load
Total Phosphorus (TP)	45% retention of average annual load
Total Nitrogen (TN)	45% retention of average annual load

3.2.1 MUSIC Parameters

3.2.1.1 Land Use Type

The post-developed land use was modelled using both the residential land use/zoning and surface type. The pollutant generation characteristics of the land use/zoning and surface type are shown in Table 6 below.

3.2.1.2 Rainfall and Evapotranspiration

The rainfall data used for the modelling was from Williamtown weather station (061078). The rainfall data used in the analysis was from the year 2000. The average annual rainfall during this period was 961mm.

Monthly average areal potential evapotranspiration (PET) values from MUSIC's default values for Newcastle were used in the modelling. Evapotranspiration values are given in Table 5. The estimated total annual areal PET is 1407 mm.

Table 5:Monthly Average Areal PET Values

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PET (mm/mont)	188	148	148	96	66	53	56	72	100	138	162	180

3.2.1.3 Time Step

The model was run with a time step of 5 minutes.

3.2.1.4 Hydrology

MUSIC hydrology parameters used are summarised below in Table 6.

Table 6: MUSIC Rainfall-Runoff Parameters

Parameter	Residential	Road	Landscape bypass
Impervious Area Properties			
Land Use Area (ha)	14.121	4.328	4.124
Impervious Area (%)	60	70	0
Rainfall Threshold (mm/day)	1.0	1.0	1.0
Pervious Area Properties			
Soil Storage Capacity (mm)	120	120	120
Initial Storage (% of Capacity)	25	25	25
Field Capacity (mm)	80	80	80
Infiltration Capacity Exponent - a	200	200	200
Infiltration Capacity Exponent - b	1.0	1.0	1.0
Groundwater Properties			
Initial Depth (mm)	10	10	10
Daily Recharge Rate (%)	25	25	25
Daily Baseflow Rate (%)	5	5	5
Daily Deep Seepage Rate (%)	0	0	0

3.2.1.5 Event Mean Concentrations

The MUSIC model requires pollutant generation parameters for baseflow and stormflow conditions. Baseflow is derived from the groundwater store, which is recharged from the previous soil store. Stormflow is generally generated from the impervious area, and under some conditions the pervious area as well.

The pollutant parameters for the adopted land use types were determined from the *Using* MUSIC in Sydney's Drinking Water Catchment, A Sydney Catchment Authority Standard (Published by Sydney Catchment Authority, Penrith, December 2012), and are provided in Table 7.

Table 7: Adopted Land Use Baseflow and Stormflow Concentration Parameters

Land Use and Flow Type	Total Suspended Solids (TSS) (log_{10} mg/L)		Total Phosphorus (TP) (log_{10} mg/L)		Total Nitrogen (TP) (log_{10} mg/L)	
	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev
Baseflow Residential Roof	1.10	0.17	-0.82	0.19	0.32	0.12
Stormflow Residential Roof	1.20	0.17	-0.85	0.19	0.11	0.12
Stormflow Road	1.20	0.17	-0.85	0.19	0.11	0.12
Stormflow Basin	1.10	0.17	-0.82	0.19	0.32	0.12

4. MODEL RESULTS

4.1 Stormwater Runoff Quantity

4.1.1 DRAINS Model Results

The pre and post-developed site conditions were modelled to establish the peak rate of discharge for each critical storm event from the 1 year to 100 year ARI events. The stormwater water plan is shown in Appendix B. The pre-developed flow rates were calculated using the Probabilistic Rational Method, the results are shown in Table 8 as allowable pre-developed peak discharge. The time of concentration for the per developed catchments was estimated using the Kinematic Wave Equation. Estimated peak rates of discharge for each pre-developed using the rational method and post-developed undetained storm event are shown below in Table 8 and 9.

Table 8: Estimated Pre and Post-Developed Peak Discharge

ARI (years)	Allowable Pre-Developed Peak Discharge (m^3/s)	Undetained Post-Developed Peak Discharge (m^3/s)
1	0.184	2.190
2	0.371	2.540
5	1.150	3.770
10	1.840	4.570
20	2.640	5.890
50	3.890	7.700
100	4.990	8.870

The incorporation of an outlet control structure configuration will reduce post-developed flowrates to less than, or equal to the pre-developed flowrates for all storm events up to and including the 100 year ARI event. The Post Developed flows with the outlet control structure in place are shown in Table 9.

Table 9: Estimated Pre and Post-Developed Peak Discharge

ARI (years)	Allowable Pre-Developed Peak Discharge with Bypass (m^3/s)	Post-Developed Peak Discharge (m^3/s)	Basin Top Water Level (RL)
1	0.184	0.155	47.918
2	0.371	0.301	48.055
5	1.150	1.118	48.182
10	1.840	1.762	48.253
20	2.640	2.556	48.328
50	3.890	3.690	48.421

100	4.990	4.720	48.497

The DRAINS model for each year has been attached to the report for assessment.

The bioretention basin calculations do not account for reduced runoff due to the presence of rainwater harvesting tanks. A noticeable reduction in peak runoff during larger storms (such as the 100 year ARI) would likely occur due to such tanks.

In accordance with Council's stormwater detention basin requirements, a spillway must be incorporated within the basin embankment. The spillway must be able to convey the 100-year ARI flood event.

Using the Manning Equation for Uniform Open Channel Flow a spillway width of 6m, with 1:5 side slopes the height of the basin spillway is 0.5m. The depth of water in the basin was modelled in Drains for the 100 year ARI storm event was found to be 48.497m with a max volume of 5,702.90m^3, therefore the bioretention volume 5,744.21m^3 will be adopted and the proposed spillway can adequately handle the discharge generated by the 100 year ARI storm event.

The summary DRAINS Output is provided for the 1, 2, 5, 10, 20-year ARI and the 100-year ARI in Appendix F.

4.2 Stormwater Runoff Quality

4.2.1 MUSIC Results – Post Development land Use (No Treatment)

The modelled average annual pollutant loads leaving the site in its post-development land use, without any treatment measures, is shown in Table 10. Pollutant load estimates are provided for total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN). Figure 10 Appendix D shows the node layout used in the MUSIC modelling.

Table 10: MUSIC Model Results for the Site's Post Development Land Use (No Treatment)

Land Use	Average Annual Pollutant Load (kg/yr)		
	Total Suspended Solids (TSS)	Total Phosphorous (TP)	Total Nitrogen (TN)
Catchment	12900	30.50	243

Standard engineering practice is to ensure that runoff from the proposed new impervious area of the development is treated to meet the established criteria previously documented in Table 4, and this is the basis for evaluation of the treatment train effectiveness as documented below.

4.2.2 MUSIC Results – Post Development land Use (With Treatment)

The MUSIC model results for the post-development land use, with treatment measures, is documented below, enabling the evaluation of the treatment train effectiveness.

4.2.2.1 Treatment Device

Treatment devices modelled in MUSIC for the treatment of runoff from the developments impervious surface areas include:

- Rainwater Tanks
- Gross Pollutant Trap (GPT)
- Sediment Basin

4.2.2.1.1 Rainwater Tanks

The rainwater tank node was included immediately following the roof area node, using the default rainwater tank treatment node within MUSIC. Rainwater tanks for all proposed lots within the catchment was modelled as one MUSIC treatment node.

Rainwater tank treatment node data included:

- Stored water would be utilised by internal reused on each lot;
- Rainwater tank volume is 3000L per lot; (Water NSW Table 5.3)
- Daily usage demand (consisting of internal and external) of 0.62kL/day per lot. (Water NSW Table 5.4)

4.2.2.1.2 Gross Pollutant Traps

The GPT node was included downstream of the development area and prior to the proposed sedimentation basin. A GPT node was created by using the Sydney Catchment Authority Standard parameter in MUSIC Modelling.

4.2.2.1.3 Sedimentation Basin

The proposed bioretention basin node was included in the MUSIC model immediately downstream of the proposed GPT node. The MUSIC model parameters used for the sedimentation basin node are shown below in Table 11.

Table 11: Bioretention Basin Treatment Parameters

Inlet properties	
Low Flow By-pass(m3/s)	0.0
High Flow By-pass(m3/s)	100.00
Storage Properties	
Surface Area (m2)	4803.60
Extend detention depth (m)	1.50
Exfiltration Rate (mm/h)	4.0
Evaporation Loss as % of PET	75
Outlet properties	
Equivalent Pipe Diameter	245
Overflow Weir Width (m)	8.0
Notional Detention Time (hrs)	11.70

4.2.2.2 Modelling Results

The modelled average annual pollutant loads leaving the site in its post-development land use, utilising treatment measures, is shown in Table 12. Pollutant load estimates are provided for total suspended solids (TSS), total phosphorus (TP), and total nitrogen (TN). Figure 11 Appendix D shows the node layout used in the MUSIC modelling.

Table 12:MUSIC Model Results for the Site's Post Development Land Use (with Treatment)

Land Use	**Average Annual Pollutant Load (kg/yr)**		
	Total Suspended Solids (TSS)	**Total Phosphorus (TP)**	**Total Nitrogen (TN)**
Post Development	2500	13.2	142

The results above show that the pollutant export for the post-development land use with treatment measures is significantly lower than the post-development land use with no treatment measures.

The treatment train effectiveness, expressed as a percentage reduction in post-development land use pollutant loads generated by the modelled sources, is summarised in Table 13.

Table 13: MUSIC Model Treatment Train Effectiveness Results

Pollutant	**Export Value**		**Treatment Train Effectiveness**
	Post Development	**Post Development with treatment measures**	
TSS (kg/yr)	12900	2500	81.20%
TP (kg/yr)	30.50	13.20	58.20%
TN (kg/yr)	243	142	45.80%

The treatment train effectiveness results above indicate that the pollutant reduction performance following the requirements of the Australian Runoff Quality pollutant removal criteria and Maitland City Council's Manual of Engineering Standards, Section 8.2.

4.3 Flooding

Following the stormwater modelling process, and the inclusion of any required stormwater detention measures and/or stormwater flow conveyance structures, proposed lots are reviewed against localised 100 year ARI stormwater flood levels to confirm that the lots are at or above the 1 in 100 year flood event level, enabling all dwellings to be above the flood planning level, which is the 1 in 100 year flood level plus 500mm freeboard for residential development.

Maitland City Council's LEP 2011, Flood Planning Map, shows that the subject site is in a mapped flood zone as shown in Appendix E Figure 12 and13. Therefore, the site is subject to flooding limitations:

- The Finished Floor level (FFL) of all buildings shall be 500mm above the 1 in 100 year ARI storm event.
- The basin spillway level shall be higher than the level of 1 in 20 year ARI storm event.

5. SOIL AND WATER MANAGEMENT DURING CONSTRUCTION

Soil and water management devices to minimise land disturbance during the subdivision construction phase are to be provided in accordance with the publication *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).

A detailed erosion and sedimentation control plan are to be undertaken during the detailed design stage of the proposed development. The erosion and sedimentation control plan should generally contain the following range of management practices for effective soil and water management during a land disturbance phase:

- Minimise the area of soil disturbed and exposed to erosion by phasing works so that land disturbance is confined to minimum areas.
- Erect barrier fencing to minimise disturbance by preventing vehicular and pedestrian access to restricted areas.
- Limit access for plant etc. to current construction area to limit the amount of disturbed area.
- Conserve topsoil for site rehabilitation/revegetation when site works are complete.
- Installation of sediment filters, such as silt fences, straw bales, or turf strips downstream of disturbed areas.
- Control water flows from the top of, and through the development area. In particular, it diverts upslope runoff around works and limits slope length to 80 metres on disturbed lands if rainfall is expected.
- Where appropriate, reduce the effects of wind erosion by controlling on-site traffic movement and watering bare soil areas.

  Provision of shaker humps/pads near construction entry and exit locations to remove excess soil materials from vehicle tyres and underbodies.
- Rehabilitate disturbed lands quickly.
- Ensure that all erosion and sediment control measures are kept in a properly functioning condition until all site disturbance works are completed and the site is rehabilitated.

6. SUMMARY AND CONCLUSIONS

Although a BASIX's requirements review is not a specific requirement of this stormwater management strategy, it is anticipated that BASIX's requirements would require all individual dwellings to provide rainwater tanks for re-use in conjunction with other BASIX's requirements. Where installed, rainwater tanks would provide at-source stormwater management benefits.

Stormwater Flow Management (stormwater runoff quantity and quality)

The strategy for management of stormwater runoff from the development is depicted in Figure 02 to 05 Appendix B and comprises:

- The capture of stormwater from lot and road reserve areas by a conventional pit and pipe drainage network located in the street.
- Conveyance of captured stormwater within the drainage pipe network to gross pollutant traps (GPT's) for primary treatment prior to discharge into the proposed bioretention basin.
- The bioretention basin will provide attenuation of developed stormwater flowrates to existing flowrate conditions for the development site.
- Discharge from the major catchment outlets will be conveyed over land within the existing waterway, generally similar to the discharge from the undeveloped catchments.
- The existing 900mm twins' pipes that discharge into the site will be extended around 14m. An open channel is proposed to receive this upstream catchment through the 900 twins' pipe and conduct this flow alongside the basin to be discharged on the downstream watercourse.
- The upstream flow from the Northern Railway will be piped in 825mm stormwater pipe that will be discharged at the downstream of the basin on the existing water course.

MUSIC modelling has demonstrated that the proposed treatment devices will treat developed stormwater runoff to meet requirements outlined in Manual of Engineering Standard 2014 Section 8.2 Stormwater Quality, and on this basis, it is considered that no further water quality controls will be required within the proposed subdivision development.

Details of the proposed local drainage system will be determined at the time of Construction Certificate application, to Council's standard requirements.

As illustrated by Figure 06 Appendix B, there is sufficient area within the site to provide stormwater drainage management measures to negate the impact of the proposed development.

The catchment area outside of the development portion of the site is not considered as part of this current application as the natural flow from this portion of the subject land will not be going to the proposed basin.

Flooding

From a review of Maitland City Council's Floodplain Risk Management Study and Plan 2015, Flood Planning Map, it is considered that the subject site is in a mapped flood zone. Therefore, the site is subject to flooding limitations.

The site's levels, including the lots regrading, shall be above the 1 in 100 year flood level, enabling future habitable dwellings to be located 500mm above the flood planning level.

7. STATEMENT OF COMPLIANCE

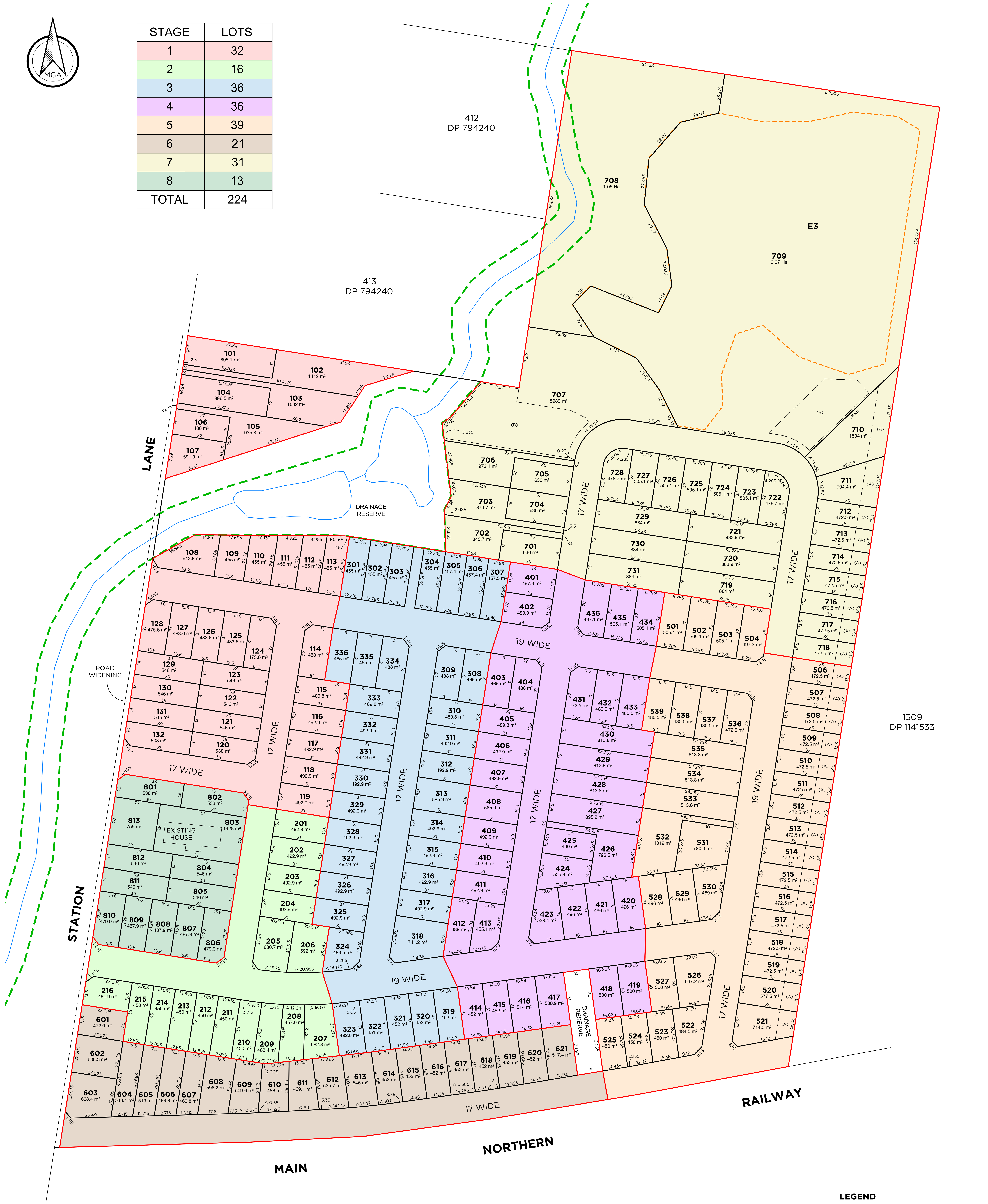
We confirm that he hydraulic design and calculations detailed in this Stormwater Strategy Report satisfy the requirements od Council's Stormwater specifications and Australian Standards listed below:

- Maitland City Council's Manual of Engineering Standards, 2014.
- Australian Rainfall and Runoff, Institution of Engineers, Australia, 1987.
- "Australian Runoff Quality – A guide to flood Estimation", Institute of Engineers Australia, 2006.
- Using MUSIC in Sydney's Drinking Water Catchment, A Sydney Catchment Authority Standard, Sydney Catchment Authority, Penrith, December 2012.

Appendix A: Site location and Leasehold Plan

Figure 01 – Sie location

STAGE	LOTS
1	32
2	16
3	36
4	36
5	39
6	21
7	31
8	13
TOTAL	224



LOTS 224
DRAINAGE RESERVES 2

LEGEND

(A) ASSET PROTECTION ZONE 10 WIDE
(B) BUILDING ENVELOPE
ZONE BOUNDARY (E3)
RIPARIAN BUFFER (10m)
WATER COURSE (FROM DCDB INFORMATION)

REV.	DATE	AMENDMENT(S)	SUR	DFT	CHK
A	31.03.21	ORIGINAL ISSUE	-	ND	ND
B	14.04.21	AMENDED LOT LAYOUT & LOT NUMBERING	-	TC	TC

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CAD REF: 20618_Site Plan_Rev B_Staging

SUBDIVISION LAYOUT-STAGING LOT 1307 & 1308 DP 1141533

SITE ADDRESS: STATION LANE LOCHINVAR
CLIENT: T. KENYON

POSITION DATUM: N/A
ORIENTATION: MGA (GROUND)
EASTING: -
NORTHING: -
CLASS: - ORDER: -
HEIGHT DATUM: N/A
CLASS: - ORDER: -
RL: - DATE: -

SURVEYED	DRAFTED	CHECKED
-	TC	TC

SCALE	PAGE SIZE	DATE
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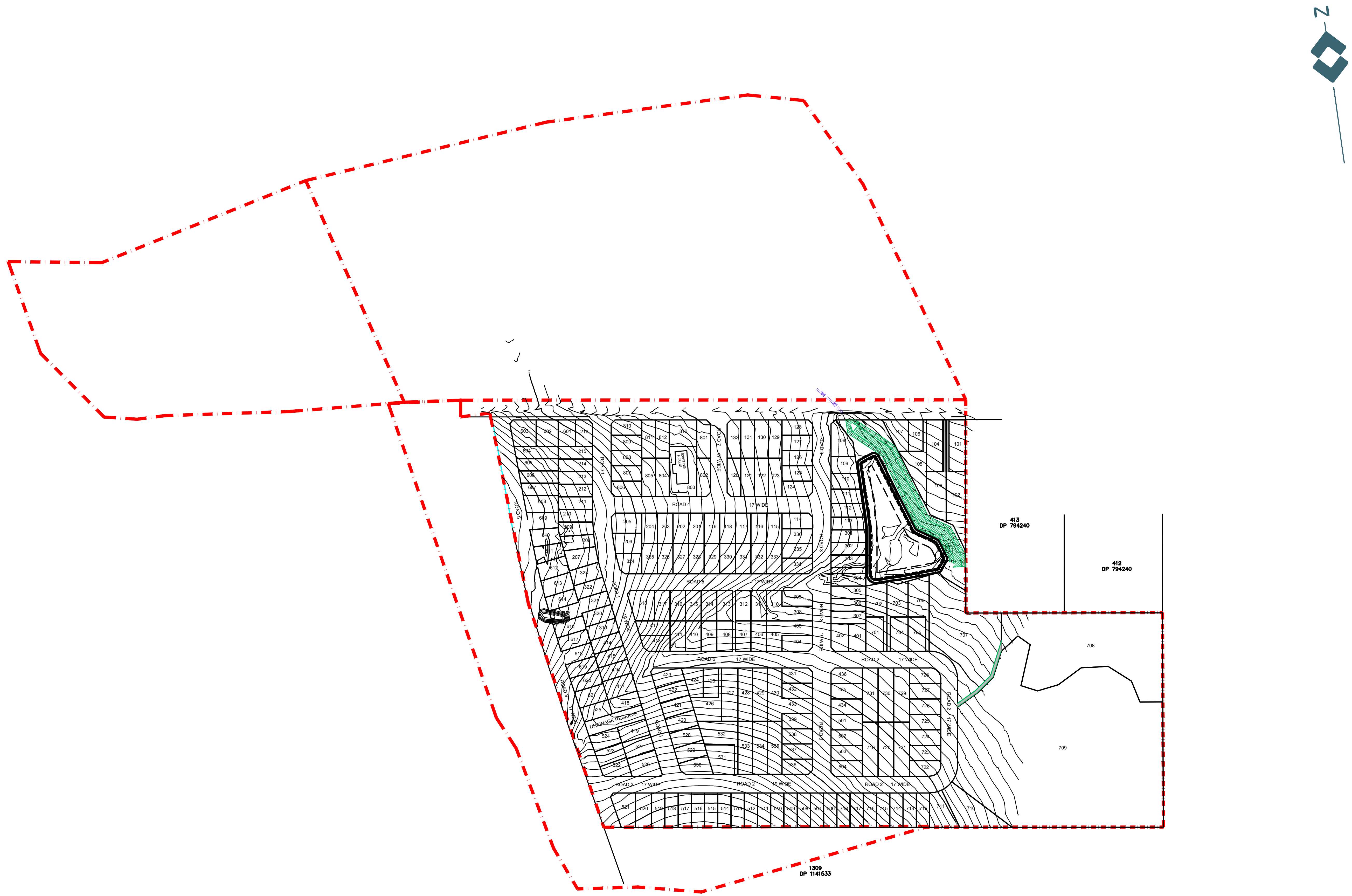
Appendix B: Stormwater Plan



LEGEND

UNDEVELOPED CATCHMENT BOUNDARY

TITLE: PROPOSED SUBDIVISION OF LOT 1307 & 1308 DP1141533
STATION LANE,LOCHINVAR

FIGURE 3 EXISTING CATCHMENT

High Definition Design Pty Ltd

KEVIN URANE 0412009891

SUBDIVISION PLAN

Date: 02.03.17 Scale: 1:4000 A3 Designed: AS

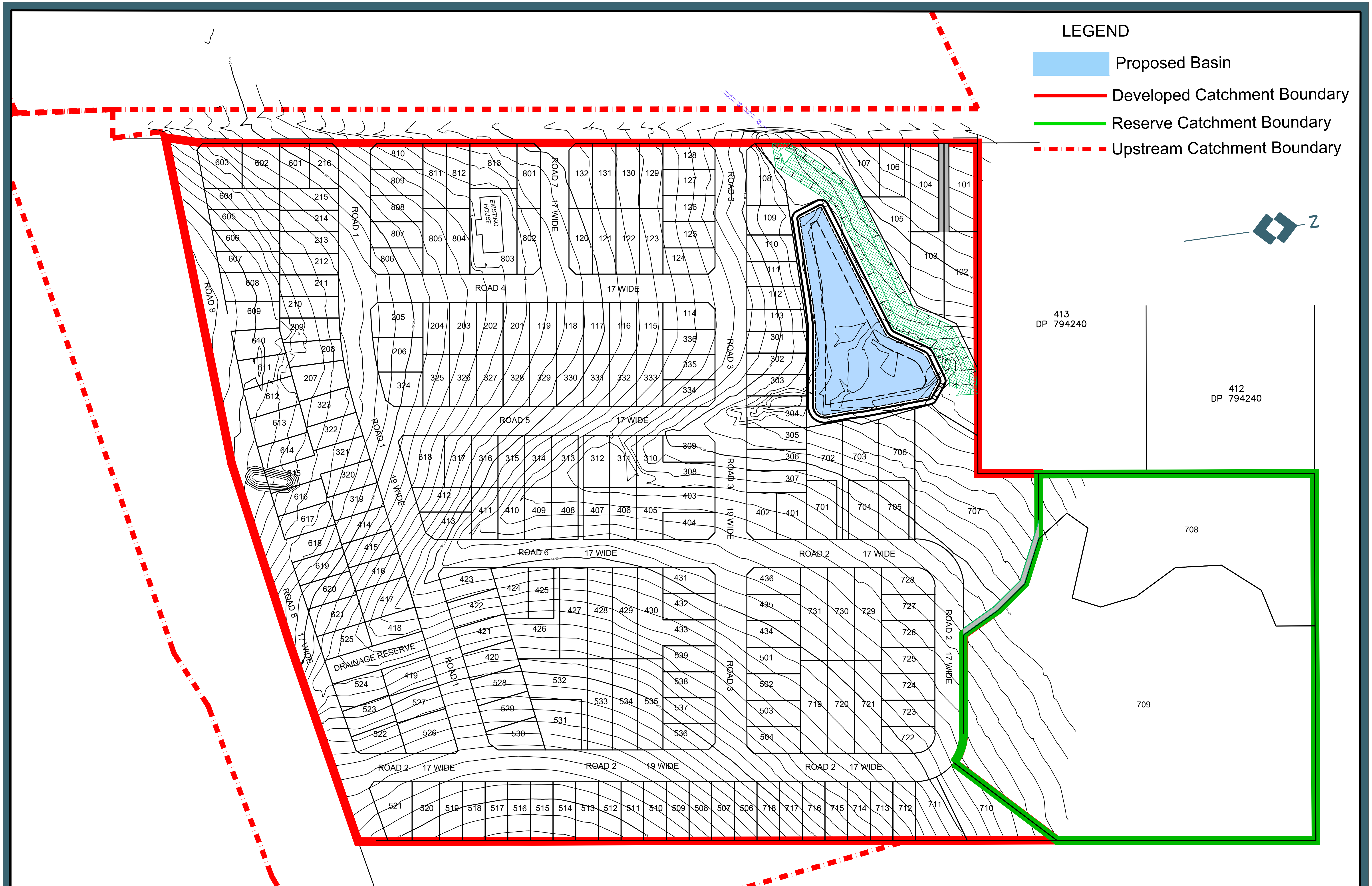
Cad Ref: hd312 stormwater management plan R2

No	Amendment	Drawn	Date
2	LOTS LAYOUT UPDATE	AS	21.04.21
1	ORIGINAL ISSUE	AS	30.03.21

Project No HD312

Drawing No FIG02

Revision 2



TITLE: PROPOSED SUBDIVISION OF LOT 1307 & 1308
DP1141533
STATION LANE,LOCHINVAR

FIGURE 4 BASIN CATCHMENT

KEVIN URANE 0412009891

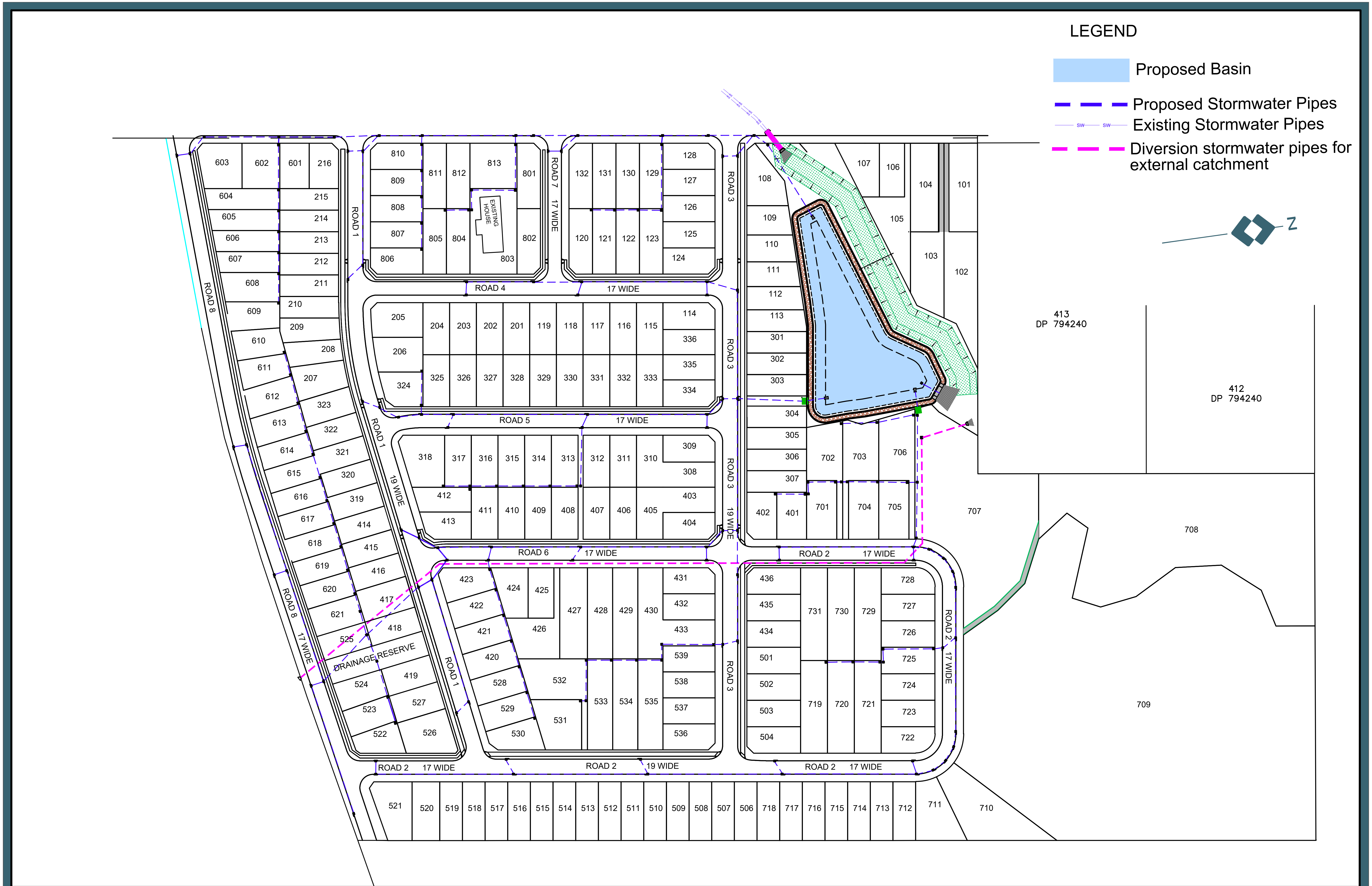
High Definition Design Pty Ltd

SUBDIVISION PLAN

Date: 02.03.17 Scale: 1:2000 A3 Designed: AS
Cad Ref: hd312 stormwater management plan R2

No	Amendment	Drawn	Date
2	LOTS LAYOUT UPDATE	AS	21.04.21
1	ORIGINAL ISSUE	AS	30.03.21

Project No HD312
Drawing No FIG03
Revision 2



TITLE: PROPOSED SUBDIVISION OF LOT 1307 & 1308
DP1141533
STATION LANE,LOCHINVAR

FIGURE 5 STORMWATER MANAGEMENT PLAN

KEVIN URANE 0412009891

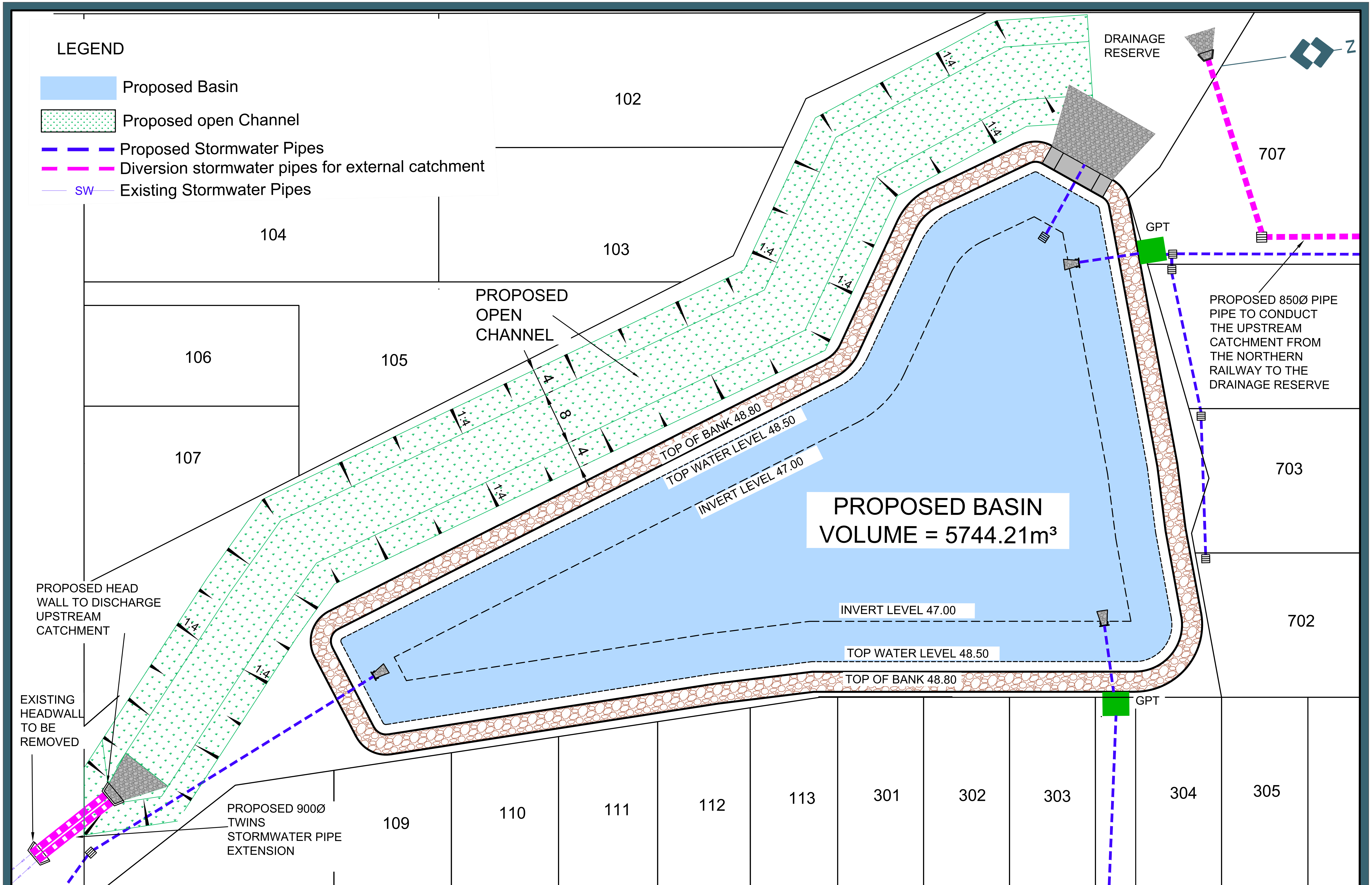
High Definition Design Pty Ltd

SUBDIVISION PLAN

Date: 02.03.17 Scale: 1:2000 A3 Designed: AS
Cad Ref: hd312 stormwater management plan R2

No	Amendment	Drawn	Date
2	LOTS LAYOUT UPDATE	AS	21.04.21
1	ORIGINAL ISSUE	AS	30.03.21

Project No HD312
Drawing No FIG04
Revision 2



TITLE: PROPOSED SUBDIVISION OF LOT 1307 & 1308
DP1141533
STATION LANE,LOCHINVAR

FIGURE 6 BASIN PLAN

High Definition Design Pty Ltd
KEVIN URANE 0412009891

SUBDIVISION PLAN

Date: 02.03.17 Scale: 1:500 A3 Designed: AS
Cad Ref: hd312 stormwater management plan R2

No	Amendment	Drawn	Date
2	LOTS LAYOUT UPDATE	AS	21.04.21
1	ORIGINAL ISSUE	AS	30.03.21

Project No: HD312
Drawing No: FIG05
Revision: 2

Appendix C: Drains Model

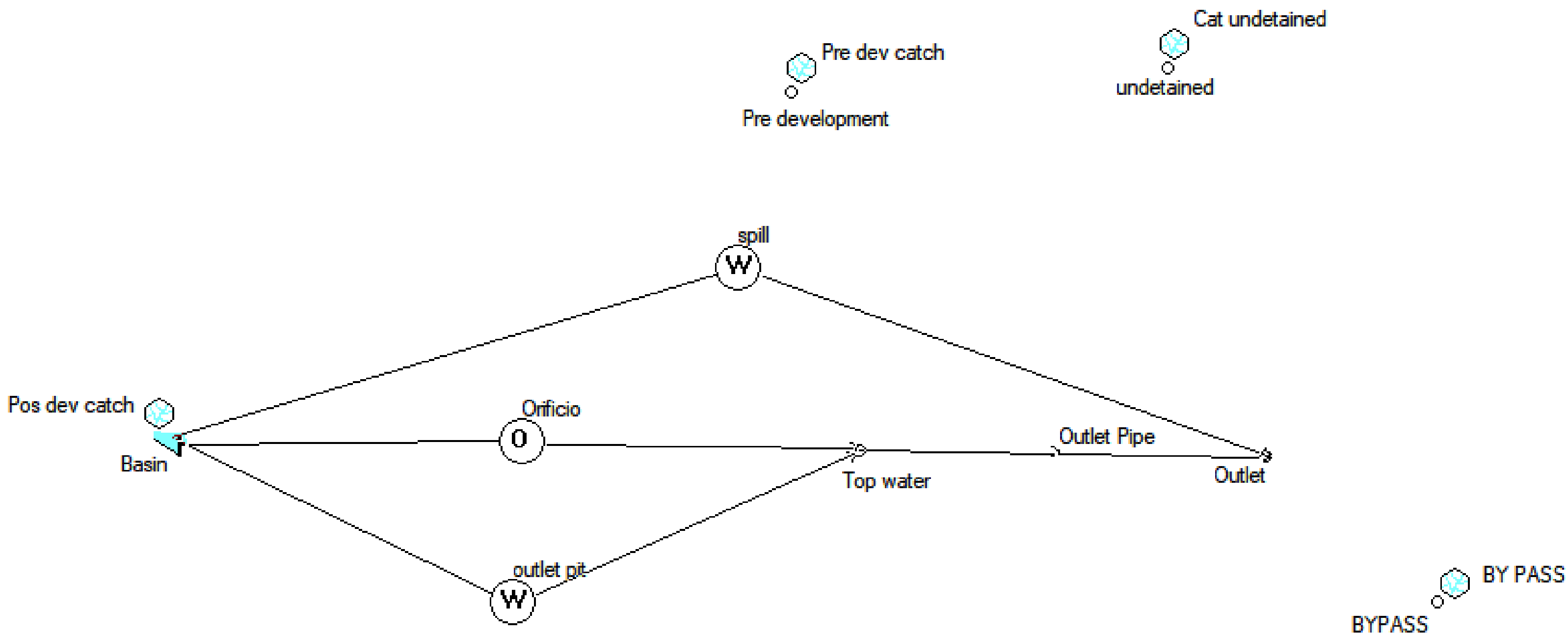


Figure 07 – Drain model

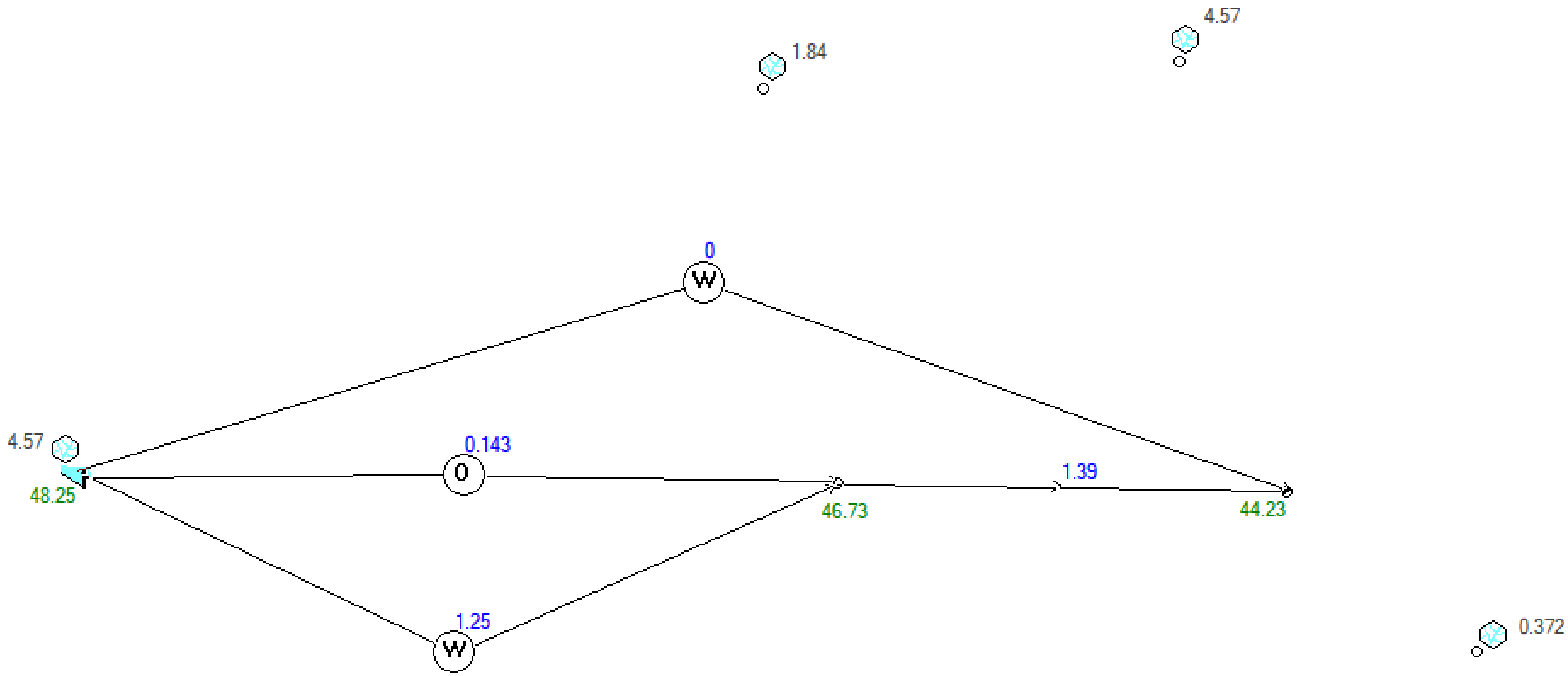


Figure 08 - Minor Storm

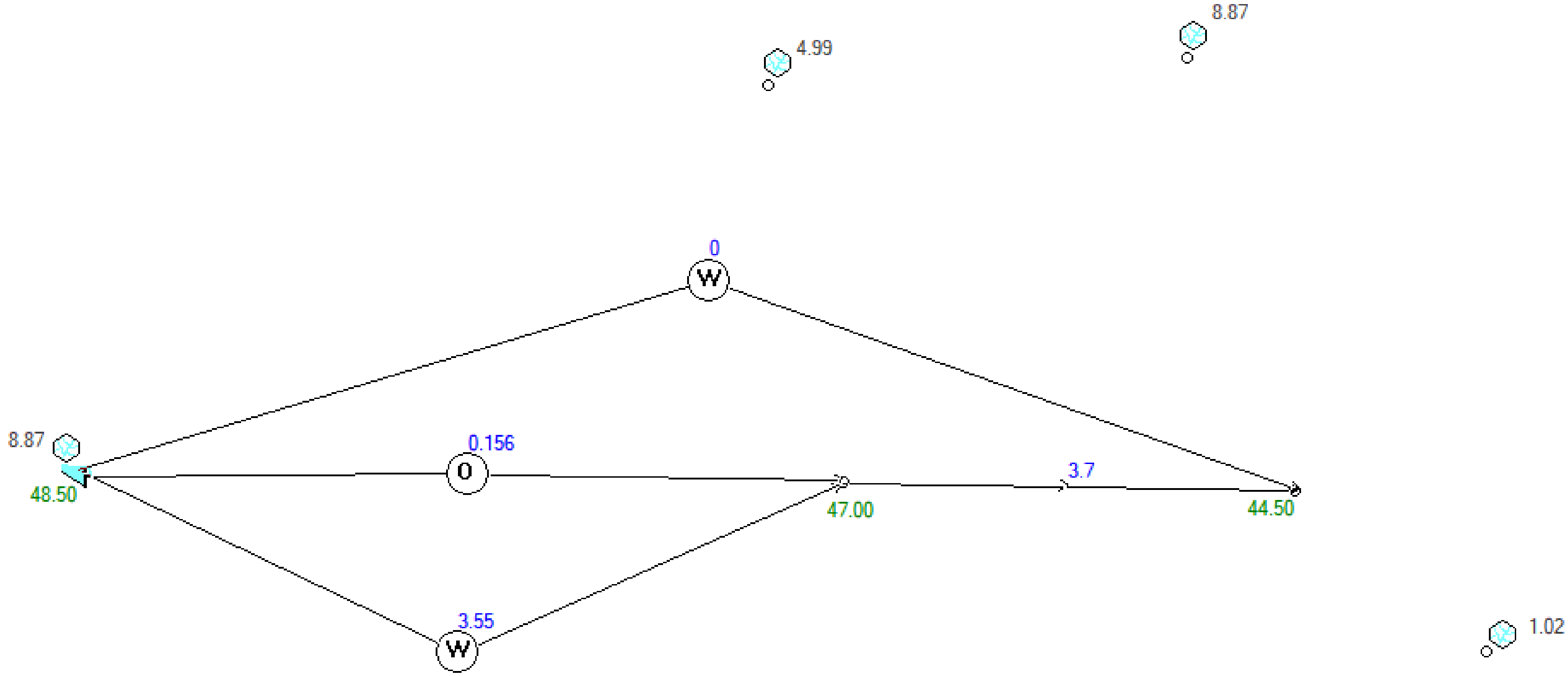


Figure 09 - Major Storm

Appendix D: MUSIC Modelling

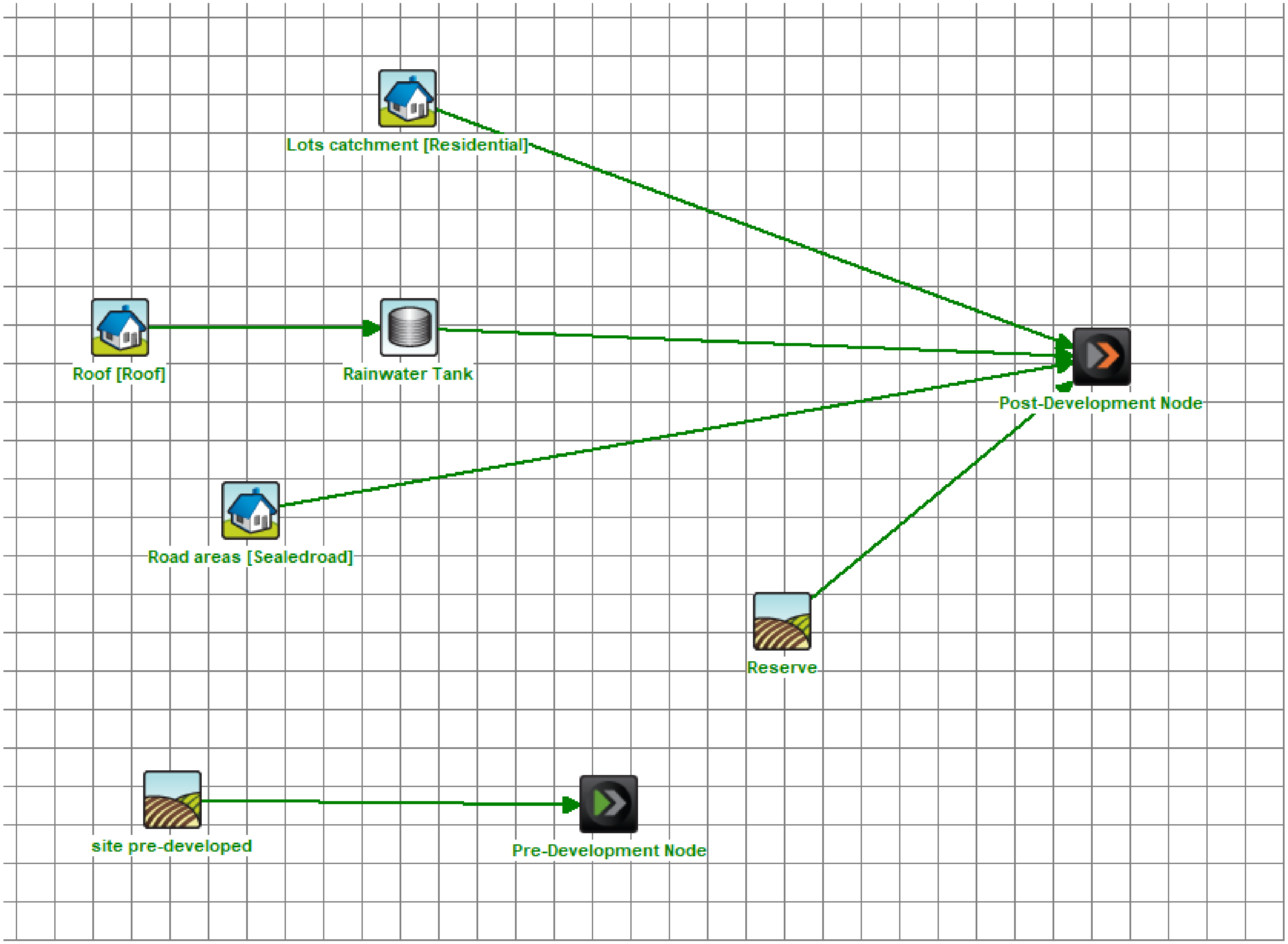


Figure 10: MUSIC model Layout without treatment

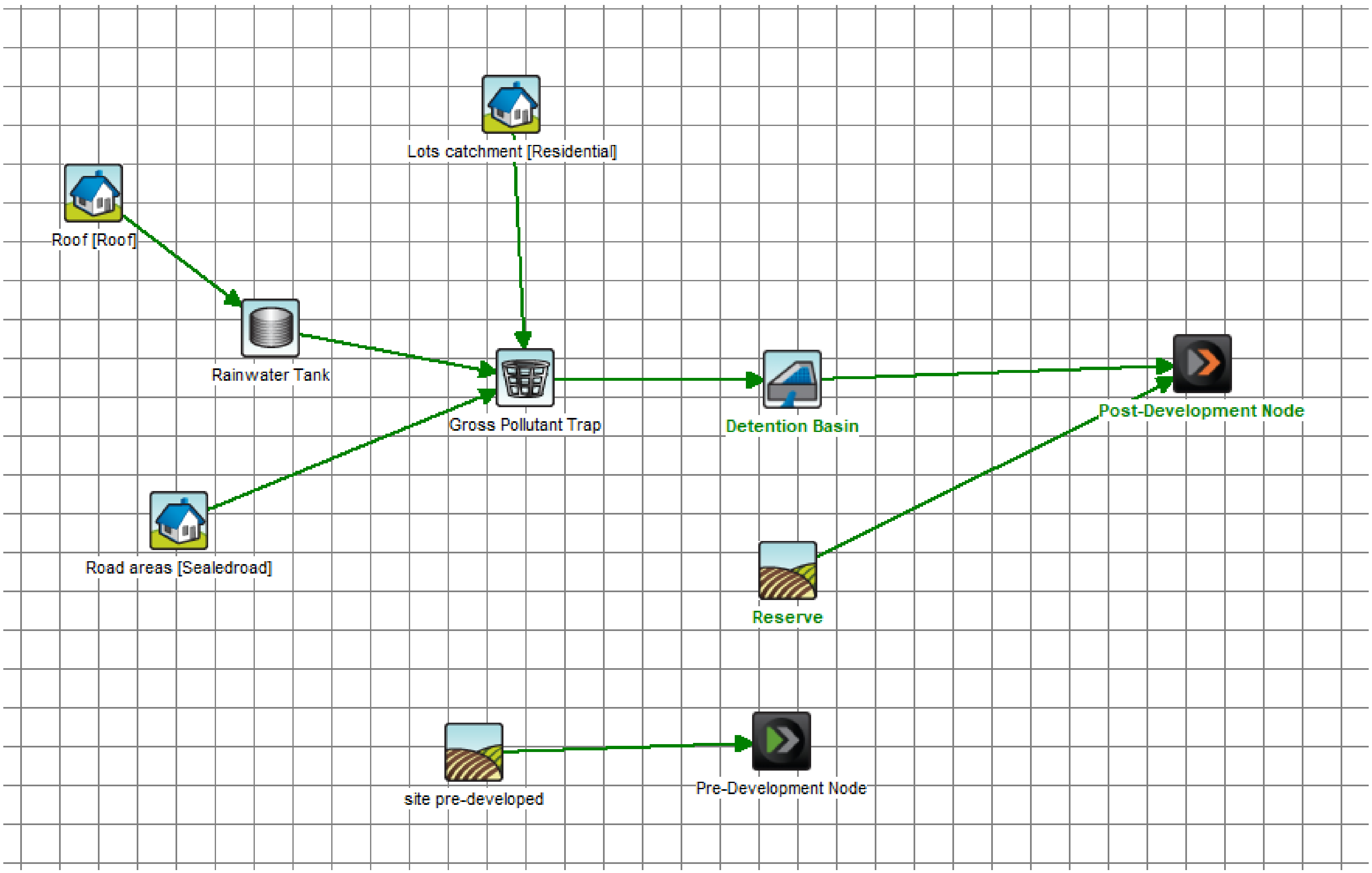


Figure 11: MUSIC model Layout with treatment

Appendix E: Floodplain Risk Management Study

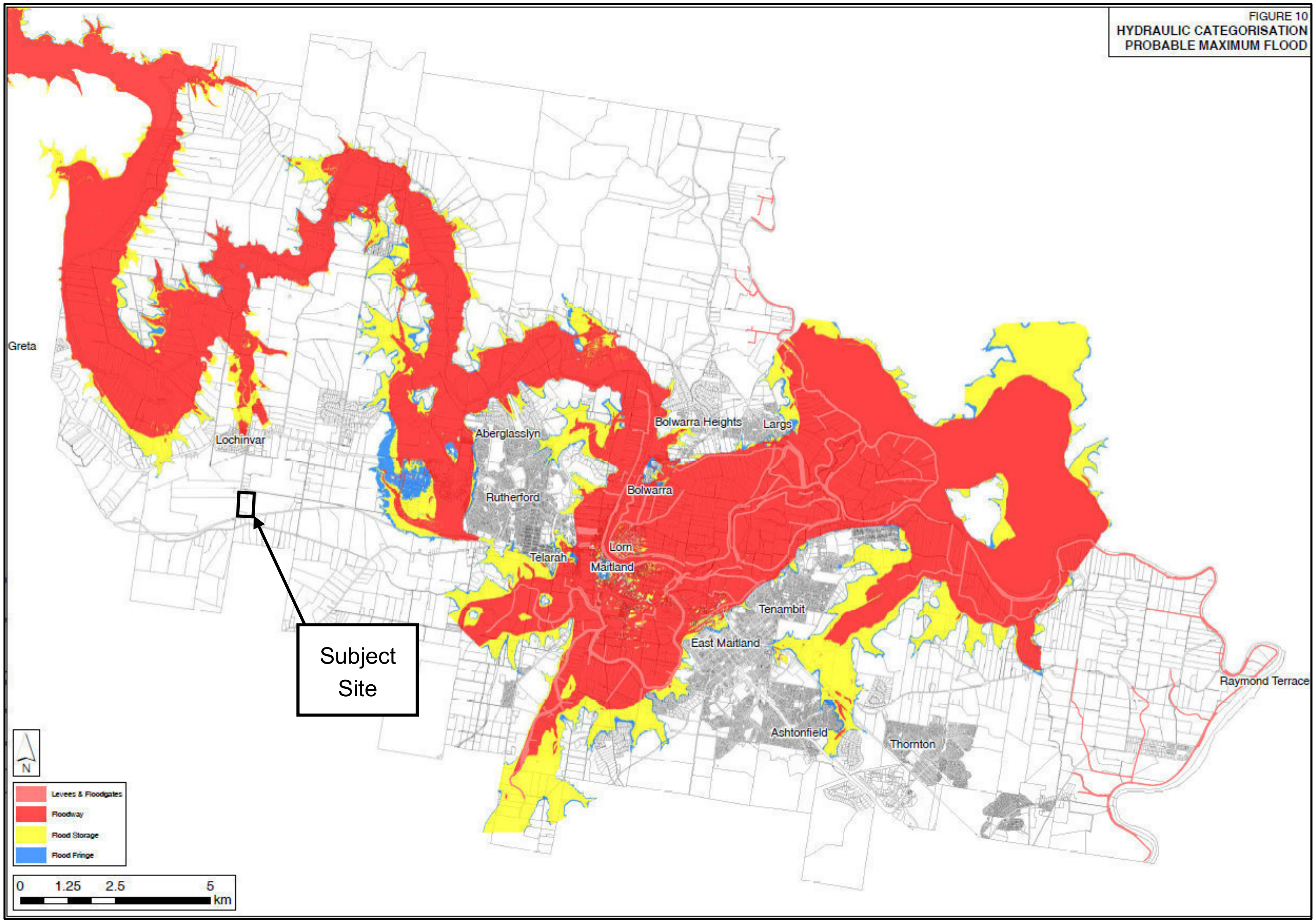


Figure 12: Probable maximum Flood map

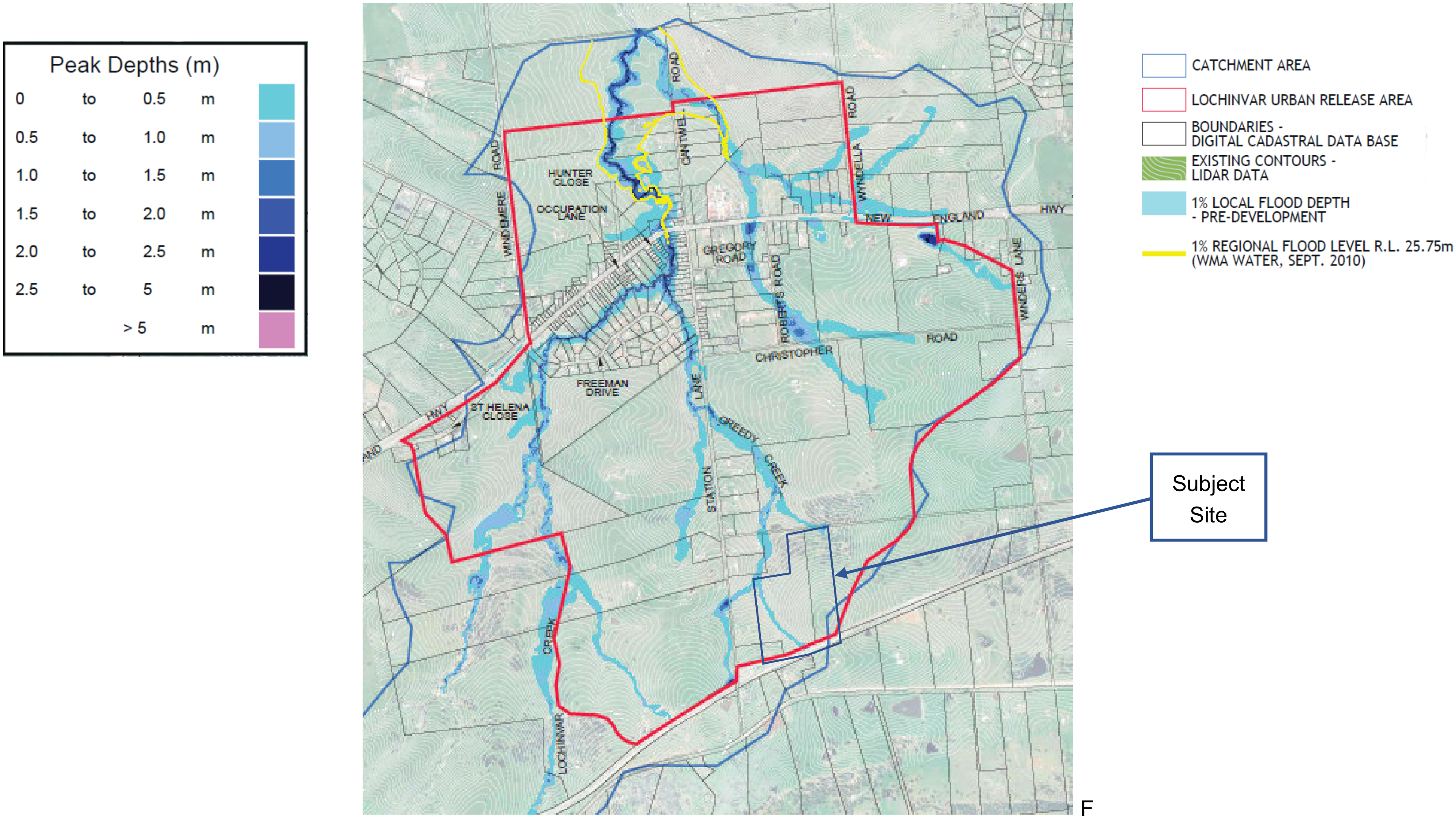


Figure 13: 1% Flooding Depth

Appendix F: DRAINS Data Spreadsheets

Table 14 - Minor Storm Data(10 years)

PIT / NODE DETAILS			Version 15																			
Name	Type	Family	Size	Ponding	Pressure	Surface	Max Pond	Base	Blocking	x	y	Bolt-down	id	Part Full	Inflow	Pit is	Internal	Inflow is	Minor Safe	Major Safe		
				Volume	Change	Elev (m)	Depth (m)	Inflow	Factor			lid		Shock Los	Hydrograph		Width	Misaligned	Pond Dept	Pond Depth		
				(cu.m)	Coeff. Ku			(cu.m/s)									(mm)		(m)	(m)		
Pre develo	Node					65.5		0		776.389	-194.444		1753		No							
BYPASS	Node					50		0		1068.056	-424.306		237897		No							
undetainec	Node					47		0		946.528	-183.333		310273		No							
Top water	Node					48.5		0		807.000	-356.000		3		No							
Outlet	Node					46		0		990.278	-359.028		4		No							
DETENTION BASIN DETAILS																						
Name	Elev	Surf. Area	Not Used	Outlet Typ	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Leng	id							
Basin	47	2899.07		None						496.000	-354.000	No			2							
	48.5	4803.63																				
	48.8	5318.96																				
SUB-CATCHMENT DETAILS																						
Name	Pit or	Total	Paved	Grass	Supp	Paved	Grass	Supp	Paved	Grass	Supp	Paved	Grass	Supp	Paved	Grass	Supp	Lag Time	Gutter	Gutter	Gutter	Rainfall
	Node	Area	Area	Area	Area	Time	Time	Time	Length	Length	Length	Slope(%)	Slope	Slope	Rough	Rough	Rough	or Factor	Length	Slope	FlowFacto	Multiplier
		(ha)	%	%	%	(min)	(min)	(min)	(m)	(m)	(m)	%	%	%					(m)	%		
Pos dev ca	Basin	18.4490	65.8	34.2	0.0	0	0	0	400	400	0	4.63	4.63	0	0.01	0.21	0	0				1
Pre dev ca	Pre develo	22.5730	1.1	98.9	0.0	0	0	0	400	400	0	4.63	4.63	0	0.01	0.15	0	0				1
BY PASS	BYPASS	4.1240	0.0	100.0	0.0	0	0	0	0	237	0	0	4.63	0	0	0.21	0	0				1
Cat undeta	undetainec	18.4490	65.8	34.2	0.0	0	0	0	400	400	0	4.63	4.63	0	0.01	0.21	0	0				1
PIPE DETAILS																						
Name	From	To	Length	U/S IL	D/S IL	Slope	Type	Dia	I.D.	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg	Rl	Chg	RL	etc			
			(m)	(m)	(m)	(%)		(mm)	(mm)						(m)	(m)	(m)	(m)	(m)			
Outlet Pip	Top water	Outlet	20	46.419	43.919	12.50	Concrete,	750	750	0.013	New	1	Top water	0								
DETAILS of SERVICES CROSSING PIPES																						
Pipe	Chg	Bottom	Height of S	Chg	Bottom	Height of S	Chg	Bottom	Height of S	etc												
	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	etc												
CHANNEL DETAILS																						
Name	From	To	Type	Length	U/S IL	D/S IL	Slope	Base Widt	L.B. Slope	R.B. Slope	Manning	Depth	Roofed									
				(m)	(m)	(m)	(%)	(m)	(1:?)	(1:?)	n	(m)										
PIPE COVER DETAILS																						
Name	Type	Dia (mm)	Safe Cover	Cover (m)																		
Outlet Pip	Concrete,	750	0.45	1.27																		
This model has no pipes with non-return valves																						

Table 15 - Minor Storm Results (10 years)

DRAINS results prepared from Version 2020.042								
PIT / NODE DETAILS				Version 8				
Name	Max HGL	Max Pond	Max Surface	Max Pond	Min	Overflow	Constraint	
		HGL	Flow Arriving	Volume	Freeboard	(cu.m/s)		
			(cu.m/s)	(cu.m)	(m)			
Top water	46.73		0.000					
Outlet	44.23		0.000					
SUB-CATCHMENT DETAILS								
Name	Max	Paved	Grassed	Paved	Grassed	Supp.	Due to Storm	
	Flow Q	Max Q	Max Q	Tc	Tc	Tc		
	(cu.m/s)	(cu.m/s)	(cu.m/s)	(min)	(min)	(min)		
Pos dev catch	4.568	4.409	0.160	5.37	33.35	0.00	10% AEP, 5 min burst, Storm 1	
Pre dev catch	1.837	0.069	1.799	7.34	37.28	0.00	10% AEP, 30 min burst, Storm 2	
BY PASS	0.372	0.000	0.372	0.00	36.96	0.00	10% AEP, 45 min burst, Storm 5	
Cat undetained	4.568	4.409	0.160	5.37	33.35	0.00	10% AEP, 5 min burst, Storm 1	
PIPE DETAILS								
Name	Max Q	Max V	Max U/S	Max D/S	Due to Storm			
	(cu.m/s)	(m/s)	HGL (m)	HGL (m)				
Outlet Pipe	1.393	8.15	46.727	44.228	10% AEP, 1.5 hour burst, Storm 8			
CHANNEL DETAILS								
Name	Max Q	Max V			Due to Storm			
	(cu.m/s)	(m/s)						
OVERFLOW ROUTE DETAILS								
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
spill								
outlet pit	1.251	1.251						10% AEP, 1.5 hour burst, Storm 8
Orificio	0.143	0.143						10% AEP, 1.5 hour burst, Storm 8
DETENTION BASIN DETAILS								
Name	Max WL	MaxVol	Max Q	Max Q	Max Q			
			Total	Low Level	High Level			
Basin	48.25	4574.0	1.394	0.000	1.394			
Run Log for HD 312 LOCHINVAR.drn run at 10:11:05 on 30/3/2021 using version 2020.042								

Table 16 - Major Storm Data (100 Years)

PIT / NODE DETAILS			Version 15																	
Name	Type	Family	Size	Ponding	Pressure	Surface	Max Pond	Base	Blocking	x	y	Bolt-down	id	Part Full	Inflow	Pit is	Internal	Inflow is	Minor Safe	Major Safe
				Volume	Change	Elev (m)	Depth (m)	Inflow	Factor			lid		Shock Los	Hydrograph		Width	Misaligned	Pond Dept	Pond Depth
				(cu.m)	Coeff. Ku			(cu.m/s)									(mm)		(m)	(m)
Pre develo	Node					65.5		0		776.389	-194.444		1753		No					
BYPASS	Node					50		0		1068.056	-424.306		237897		No					
undetainec	Node					47		0		946.528	-183.333		310273		No					
Top water	Node					48.5		0		807	-356		3		No					
Outlet	Node					46		0		990.278	-359.028		4		No					

DETENTION BASIN DETAILS															
Name	Elev	Surf. Area	Not Used	Outlet Typ	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Leng	id
Basin	47	2899.07		None						496	-354	No			2
	48.5	4803.63													
	48.8	5318.96													

SUB-CATCHMENT DETAILS																						
Name	Pit or	Total	Paved	Grass	Supp	Paved	Grass	Supp	Paved	Grass	Supp	Paved	Grass	Supp	Paved	Grass	Supp	Lag Time	Gutter	Gutter	Gutter	Rainfall
	Node	Area	Area	Area	Area	Time	Time	Time	Length	Length	Length	Slope(%)	Slope	Slope	Rough	Rough	Rough	or Factor	Length	Slope	FlowFacto	Multiplier
		(ha)	%	%	%	(min)	(min)	(min)	(m)	(m)	(m)	%	%	%					(m)	%		
Pos dev ca	Basin	18.449	65.8	34.2	0	0	0	0	400	400	0	4.63	4.63	0	0.01	0.21	0	0				1
Pre dev ca	Pre develo	22.573	1.1	98.9	0	0	0	0	400	400	0	4.63	4.63	0	0.01	0.15	0	0				1
BY PASS	BYPASS	4.124	0	100	0	0	0	0	0	237	0	0	4.63	0	0	0.21	0	0				1
Cat undeta	undetainec	18.449	65.8	34.2	0	0	0	0	400	400	0	4.63	4.63	0	0.01	0.21	0	0				1

PIPE DETAILS																			
Name	From	To	Length	U/S IL	D/S IL	Slope	Type	Dia	I.D.	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg	Rl	Chg	RL	etc
			(m)	(m)	(m)	(%)		(mm)	(mm)						(m)	(m)	(m)	(m)	(m)
Outlet Pipe	Top water	Outlet	20	46.419	43.919	12.5	Concrete,	750	750	0.013	New	1	Top water	0					

DETAILS of SERVICES CROSSING PIPES										
Pipe	Chg	Bottom	Height of S	Chg	Bottom	Height of S	Chg	Bottom	Height of S	etc
	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	etc

CHANNEL DETAILS													
Name	From	To	Type	Length	U/S IL	D/S IL	Slope	Base Widt	L.B. Slope	R.B. Slope	Manning	Depth	Roofed
				(m)	(m)	(m)	(%)	(m)	(1:?)	(1:?)	n	(m)	

PIPE COVER DETAILS				
Name	Type	Dia (mm)	Safe Cover	Cover (m)
Outlet Pipe	Concrete,	750	0.45	1.27

T+A1:W44his model has no pipes with non-return valves

Table 17 - Major Storm Result (100 Years)

DRAINS results prepared from Version 2020.042										
PIT / NODE DETAILS				Version 8						
Name	Max HGL	Max Pond	Max Surface	Max Pond	Min	Overflow	Constraint			
		HGL	Flow Arrivir	Volume	Freeboard	(cu.m/s)				
			(cu.m/s)	(cu.m)	(m)					
Top water	47		0							
Outlet	44.5		0							
SUB-CATCHMENT DETAILS										
Name	Max	Paved	Grassed	Paved	Grassed	Supp.	Due to Storm			
	Flow Q	Max Q	Max Q	Tc	Tc	Tc				
	(cu.m/s)	(cu.m/s)	(cu.m/s)	(min)	(min)	(min)				
Pos dev catch	8.873	8.372	0.5	4.41	27.43	0	1% AEP, 5 min burst, Storm 1			
Pre dev catch	4.993	0.139	4.93	6.02	30.54	0	1% AEP, 30 min burst, Storm 10			
BY PASS	1.017	0	1.017	0	27.3	0	1% AEP, 30 min burst, Storm 7			
Cat undetained	8.873	8.372	0.5	4.41	27.43	0	1% AEP, 5 min burst, Storm 1			
PIPE DETAILS										
Name	Max Q	Max V	Max U/S	Max D/S	Due to Storm					
	(cu.m/s)	(m/s)	HGL (m)	HGL (m)						
Outlet Pipe	3.704	10.13	46.997	44.503	1% AEP, 45 min burst, Storm 6					
CHANNEL DETAILS										
Name	Max Q	Max V			Due to Storm					
	(cu.m/s)	(m/s)								
OVERFLOW ROUTE DETAILS										
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm		
spill										
outlet pit	3.548	3.548						1% AEP, 45 min burst, Storm 6		
Orificio	0.156	0.156						1% AEP, 45 min burst, Storm 6		
DETENTION BASIN DETAILS										
Name	Max WL	MaxVol	Max Q	Max Q	Max Q					
			Total	Low Level	High Level					
Basin	48.5	5702.9	3.704	0	3.704					
Run Log for HD 312 LOCHINVAR.drn run at 10:11:05 on 30/3/2021 using version 2020.042										

Appendix G: Design Rainfall Data 2016

Table 19 – Design Rainfall Data

Copyright Commonwealth of Australia 2016 Bureau of Meteorology (ABN 92 637 533 532)																			
All Design Rainfall Depth (mm)																			
Issued:	4-Mar-21																		
Location Label:																			
Requeste	Latitude	-32.7189	Longitude	151.4524															
Nearest g	Latitude	32.7125 (S	Longitude	151.4625 (E)															
		Exceedan	Annual Exceedance Probability (AEP)																
Duration	Duration i	12EY	6EY	4EY	3EY	2EY	63.20%	50%	0.5EY	20%	0.2EY	10%	5%	2%	1%	1 in 200	1 in 500	1 in 1000	1 in 2000
1 min	1	0.725	0.844	1.06	1.23	1.47	1.93	2.19	2.43	3.06	3.12	3.7	4.37	5.32	6.1	6.83	8.03	9.02	10.1
2 min	2	1.25	1.46	1.82	2.09	2.48	3.2	3.63	4.03	5.04	5.14	6.05	7.09	8.49	9.57	10.8	12.7	14.3	16
3 min	3	1.72	2.01	2.52	2.9	3.45	4.45	5.05	5.61	7.02	7.16	8.45	9.92	11.9	13.5	15.2	17.9	20.1	22.5
4 min	4	2.13	2.5	3.14	3.62	4.32	5.6	6.35	7.05	8.85	9.03	10.7	12.6	15.2	17.2	19.4	22.8	25.6	28.6
5 min	5	2.5	2.93	3.7	4.27	5.1	6.63	7.53	8.36	10.5	10.7	12.7	15	18.1	20.7	23.2	27.3	30.6	34.2
10 min	10	3.93	4.6	5.83	6.74	8.09	10.6	12	13.3	16.8	17.2	20.4	24.1	29.4	33.8	37.8	44.5	49.9	55.9
15 min	15	4.95	5.79	7.32	8.46	10.1	13.3	15.1	16.7	21.1	21.5	25.6	30.2	36.9	42.5	47.5	55.9	62.7	70.2
20 min	20	5.76	6.72	8.46	9.76	11.7	15.2	17.3	19.2	24.2	24.7	29.4	34.7	42.4	48.7	54.5	64.1	72	80.6
25 min	25	6.42	7.48	9.39	10.8	12.9	16.8	19.1	21.2	26.7	27.3	32.3	38.2	46.5	53.4	59.9	70.4	79.1	88.5
30 min	30	6.99	8.12	10.2	11.7	14	18.1	20.6	22.8	28.8	29.3	34.8	41.1	50	57.3	64.3	75.6	84.9	95
45 min	45	8.34	9.65	12	13.7	16.3	21.1	23.9	26.6	33.4	34	40.3	47.5	57.6	65.8	73.9	86.9	97.7	109
1 hour	60	9.36	10.8	13.4	15.3	18.1	23.3	26.4	29.3	36.8	37.5	44.3	52.2	63.1	72	80.9	95.2	107	120
1.5 hour	90	10.9	12.5	15.4	17.6	20.7	26.5	30.1	33.4	41.9	42.7	50.5	59.3	71.6	81.5	91.6	108	121	135
2 hour	120	12.1	13.8	17	19.4	22.8	29.1	33	36.6	45.9	46.9	55.3	65	78.5	89.3	100	118	132	148
3 hour	180	13.8	15.9	19.5	22.2	26.1	33.1	37.6	41.8	52.5	53.6	63.3	74.4	89.9	102	115	135	151	169
4.5 hour	270	15.8	18.1	22.3	25.4	29.9	38	43.2	47.9	60.5	61.7	73.1	86.1	104	119	133	156	175	196
6 hour	360	17.3	19.9	24.6	28	33	42	47.8	53.1	67.3	68.7	81.6	96.3	117	134	149	175	196	220
9 hour	540	19.7	22.7	28.2	32.2	38.1	48.7	55.6	61.7	78.9	80.4	96	114	139	160	178	209	234	262
12 hour	720	21.5	24.9	31.1	35.6	42.2	54.2	62.1	68.9	88.6	90.3	108	129	158	182	203	238	267	299
18 hour	1080	24.2	28.3	35.6	41	48.9	63.3	72.6	80.6	105	107	128	154	190	219	245	287	323	361
24 hour	1440	26.3	30.8	39	45.1	54	70.5	81.1	90	117	120	145	174	215	249	279	328	368	412
30 hour	1800	27.9	32.9	41.8	48.5	58.3	76.4	88	97.7	128	131	158	191	236	273	316	378	430	484
36 hour	2160	29.3	34.6	44.2	51.3	61.8	81.4	93.9	104	137	140	170	205	253	293	344	413	472	531
48 hour	2880	31.4	37.2	47.8	55.7	67.4	89.5	103	115	151	154	188	227	280	323	379	455	518	583
72 hour	4320	34	40.6	52.6	61.6	75	100	116	129	170	173	211	256	313	360	413	487	548	615
96 hour	5760	35.4	42.5	55.5	65.2	79.8	107	124	138	181	185	225	272	331	379	427	497	553	621
120 hour	7200	36.2	43.6	57.3	67.6	82.9	111	129	143	188	192	233	280	340	388	433	501	555	625
144 hour	8640	36.5	44.1	58.5	69.2	85.1	114	132	147	193	197	237	284	344	392	435	505	558	632
168 hour	10080	36.6	44.2	59.2	70.3	86.6	116	135	149	195	199	239	285	344	392	437	509	564	643