PROPOSED NEW DEVELOPMENT ON FARM 216 PORTION 29, BELVEDERE ROAD, UITZICHT, KNYSNA

STORMWATER MANAGEMENT PLAN

Prepared for:

CRABS CREEK (PTY)LTD
P.O. Box 41041
CRAIGHALL PARK
GAUTENG, 2024
For Attention: J. Sayers
082 905 2587

Prepared by:

Graeme McGill consulting
Tel: 021 976 0386
Mobile: 082 550 9108
graeme@mcgillconsulting.co.za

FRASER Consulting Civil Engineers cc
Tel: 044 343 2093
Mobile: 083 292 9047
fraser@fcce.co.za

Report No.: MC411-01
Revision: 00
Date: 2023-04-13

PROPOSED NEW DEVELOPMENT ON FARM 216 PORTION 29, BELVEDERE ROAD, UITZICHT, KNYSNA

STORMWATER MANAGEMENT PLAN

CONTENTS

EXECUTIVE SUMMARY

It is proposed to re-develop the site of Crabs Creek to a Farm Stall, Restaurant and four bed and breakfast units. The site is Portion 29 of the farm Uitzicht 216, Knysna.

The total site area is 3894 m^2, with the proposed building footprint being approximately 1084 m^2. The parking area extends to the adjacent erf and the total area to be formalized with brick paving will be approximately 1800m^2.

This report deals with the management of the quantity and rate of stormwater runoff, as well as the management of the water quality of the runoff. It is a Stormwater Management Plan (SMP). The goal of the SMP Report is to implement Sustainable Drainage Systems (SuDS) which maintain or mimic the natural flow systems as well as prevent pollutants entering receiving waters. The objectives are attenuation for flows up to the 50 year Recurrence Interval (RI), and wrt water quality, an 80% reduction of suspended solids and a 45% reduction in total phosphate content leaving the site.

The system was modelled using the SWMM 5.1 hydrology-hydraulic water quality simulation model.

The previous buildings have been demolished. The existing stormwater infrastructure was fairly minimal with only a diameter 375mm pipe collecting water from the Divisional Road. The pipeline is fairly derelict and causes erosion at the Estuary.

The external catchments are described by Drawing MC410-C900 and are catchments A1(64 ha), A2(150 ha), A3(1.4 ha) and A4 (0.54ha). The flow routes of catchments A1 and A2 are ill-defined and appear to drain informally to the Estuary to the north-west of Crabs Creek. Catchment A3 drains down the Divisional Road. Upstream of Crabs Creek it flows over the road to the Crabs Creek side and along a kerb and channel alongside the road. From the kerb and channel it enters an informal channel that leads to the derelict diameter 375mm pipe that leads to the Estuary. Catchment A4, which is immediately to the south of the study area, drains over a retaining wall to the site.

As far as mimicking the pre-development situation, the pre-development was taken as an undeveloped site. The estimated 50 year and 100 year RI runoffs were estimated as 125 l/s and 168 l/s respectively.

The post-development stormwater management has roof runoff directed towards the landscaped areas and thereafter the paved parking areas; the parking areas geometrics lead all site runoff to an attenuation/infiltration pond at the north-western corner of the site. Besides the geometrics leading runoff to the north-western corner, a Vee channel, catchpits, and a diameter 375mm pipe system convey the runoff to the attenuation/infiltration pond. The piped system convey flows to the 1:5 year RI peak runoff, with the higher flows being conveyed over the parking area to the attenuation pond. This is shown in Drawing MC410-C901.

The external flows from the Divisional Road (Catchment A3) are picked up by a double catchpit on the northern (Crabs Creek) side of the Divisional Road. From this catchpit a new diameter 375mm pipeline leads the flow to downstream of the attenuation pond. Drawing MC410-C901 shows a watershed (red line) at the bellmouth entrance to the site. This is a mild hump to avoid excessive flows entering the Crabs Creek parking area. The excess flows from Catchment A3 continue down the Divisional Road.

Stormwater from Catchment A4 flows over the boundary wall. Whilst it can be accommodated in the proposed parking area and Stormwater pipe system leading to the attenuation/infiltration pond, we recommend that a W4 Channel be installed at the base of the wall to convey the flow eastwards. A Reno mattress should be installed at the outlet to dissipate the flow energy. The Reno mattress should be a land-based feature discharging to grass so as not to trigger any Water Use License Applications (WULA) or similar.

To attenuate the flow from the Crabs Creek precinct (portion 29 of farm 216), as well as the additional parking on portion 150, an attenuation pond of size 73m^3 is required. This is shown on Drawing MC410-901. The controlled outlet structure of the pond should have an orifice, trapezoidal weir and spillway as described in Table 5 and on Drawing MC410-901. With these attenuation mechanisms the post-development runoff is 112 l/s for the 50 year RI flows, and 151 l/s for the 100 year RI flows. This is less than the pre-development flows of 125 l/s and 168 l/s respectively. Figure 9 of the Report shows that the attenuation pond and controlled outlet structure achieves similar results (post development no more than pre-development) over the full range of RI's from 1 year to 100 year RI peak flows. The SuDS objective wrt quantity and rate of runoff is therefore achieved.

Part of the SMP is to improve stormwater quality by reducing suspended solids by 80% and total phosphorus by 45%. Due to the developments limited available space, an enhanced swale/pond was the only method considered for treatment.

It is expected that general site maintenance will limit the accumulation of litter. Sediment traps are proposed for each catchpit by lowering the base of the catchpits by 100 mm below the invert level of the outgoing pipe. A forebay is provided at the entrance to the attenuation pond where litter and sediment will be collected.

Runoff from the site will be discharged into the attenuation/infiltration pond. Plan and schematic views are shown in drawing MC410-C901. The pond will comprise of a forebay basin and an enhanced swale area. The entire pond and swale surface area will be covered with cynodon or similar grass.

Stormwater inflow will be conveyed to the forebay from where it overflows onto the swale area of 50m^2, which is designed to accommodate the ½ year RI Peak Volume of 5m^3 from the site through infiltration. The treatment volume will have a depth of 100mm which will drain through the swale area by infiltration over a maximum of 24 hours, to a 110mm perforated underdrain pipe discharging to the outlet structure. The anticipated total phosphorus removal rate by natural infiltration is 50%. The SuDS objective wrt total phosphorus removal is therefore achieved.

The forebay basin is designed to facilitate the removal of suspended solids before they can enter the attenuation pond. Catchpits within the development will have sediment traps as part of the structure, which will further enhance the removal of suspended solids before they enter the attenuation pond. The suspended solids removal rate is expected to be 80%. The SuDS objective wrt suspended solids removal is therefore achieved. Therefore, together with the total phosphorus removal, the Water Quality Objectives of SuDS have been achieved.

A Maintenance Schedule is issued as Section 7 which lists activities as either: Inspection, Routine or Other. Time frames are given. The ongoing sustainability of the system is dependent upon it's effective maintenance.

PROPOSED NEW DEVELOPMENT ON FARM 216 PORTION 29, BELVEDERE ROAD, UITZICHT, KNYSNA

STORMWATER MANAGEMENT PLAN

1. PROPOSED DEVELOPMENT

Farm 216 Portion 29 in the Knysna Municipal region, is situated just east of the N2 national road between the Belvidere/Brenton-on-sea Divisional Road and the Knysna Lagoon.

The 3894m² property previously consisted of a building which was used as a restaurant, but has since been demolished.

The new proposed development will consist of a Farm Stall and Restaurant building with adjacent Bed and Breakfast units and a parking area. The building footprint will be approximately 1084m². The existing gravel road entrance from the main road will be upgraded and surfaced with brick paving, which will lead to a paved parking area. The parking area will extend further into the adjacent property Portion 150 of Farm 216. The area to be formalised with brick paving will be approximately 1800m².

Figure 2 shows the layout for the proposed development prepared by Moffett & Moffett Architects.

The subject of this report is the management of the quality, volume and rate of stormwater runoff from the site, with a view to preparing a Stormwater Management Plan(SWMP) which satisfies the objectives of the Knysna Municipality.

FIGURE 1: LOCALITY OF THE DEVELOPMENT SITE: FARM 216 PTN 29, BELVEDERE ROAD, UITZICHT, KNYSNA

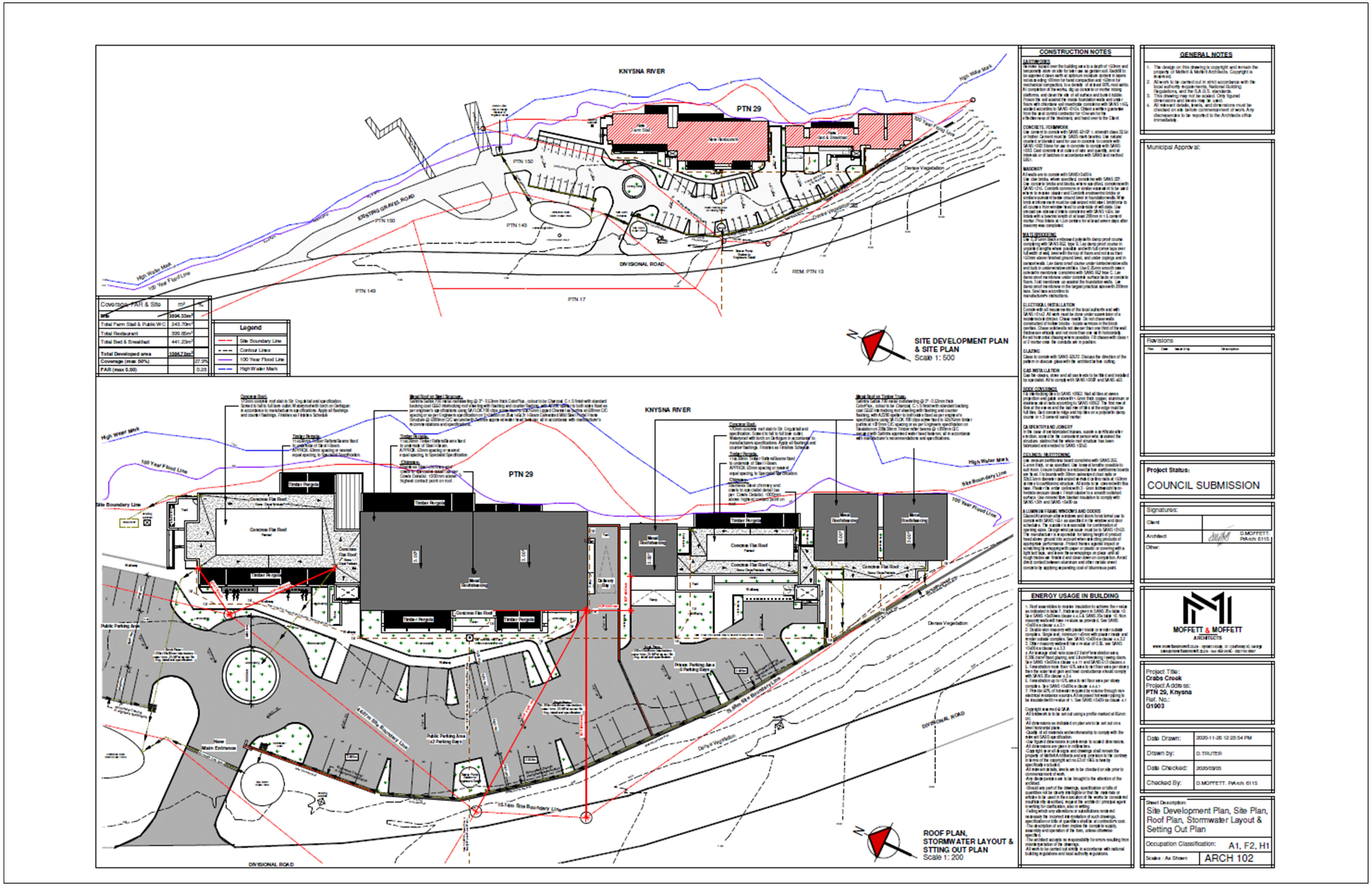


FIGURE 2: PROPOSED SITE DEVELOPMENT PLAN

2. APPLICABLE CONDITIONS

2.1 STORM MANAGEMENT

The goal of the Stormwater Management Report is to implement Sustainable Urban Drainage Systems (SuDS). These systems attempt to maintain or mimic the natural flow systems as well as prevent the wash-off of urban pollutants to receiving waters. The objectives for this report are set out below in Table 1.

TABLE 1: STORMWATER POLICY OBJECTIVES TO BE SATISFIED IN THE STORMWATER MANAGEMENT PLAN

NO.	DESCRIPTION	OBJECTIVE CRITERIA 4 000-50 000 m²
1	**IMPROVE QUALITY OF RUNOFF**	
1.1	Reduction of post-development annual stormwater pollutant load discharged from the development site:	Design storm: 1:0.5 year 24 hour duration storm Suspended solids SS – 80% reduction Total phosphorus TP – 45% reduction
2	**OBJECTIVE: CONTROL QUANTITY AND RATE OF RUNOFF**	
2.1	Protect the stability of downstream channels	Provide extended detention of the 1:1 year 24 hour duration storm
2.2	Protect downstream properties from fairly frequent nuisance floods	Up to the 1:10 year peak flow to be reduced to pre-development level.
2.3	Protect floodplain developments and floodplains from adverse impacts of extreme floods	Up to 1:50 year peak flow to be reduced to existing development level.
		Evaluate effects of 1:100 year storm event on the stormwater management system, adjacent property and downstream facilities and property.

Notes:

1. Items 2.1 and 2.2 are not applicable to this case, as runoff from the property discharges directly to the Knysna Lagoon and therefore does not have any impact on downstream properties.

2. The manner in which the SWMP achieves the objectives listed in this table, is described in Sections 4 and 5.

3. PRE-DEVELOPMENT STORMWATER ANALYSIS

3.1 STORM RUNOFF MODELLING

3.1.1 METHODOLOGY

SWMM is a dynamic hydrology-hydraulic water quality simulation model. It is used for single event or long-term (continuous) simulation of stormwater runoff quantity and quality from primarily urban areas. The runoff component operates on a collection of sub catchment areas that receive precipitation and generate runoff and pollutant loads. The routing portion transports this runoff through a system of pipes, channels, storage/treatment devices, pumps, and regulators.

SWMM tracks the quantity and quality of runoff made within each sub catchment. It tracks the flow rate, flow depth, and quality of water in each pipe and channel during a simulation period made up of multiple time steps. SWMM 5.1 used for the development can also model the hydrologic performance of specific types of Low Impact Development (LID) controls. The LID controls that the user can choose include the following; Permeable pavements, Vegetative swales and Infiltration trenches.

3.1.2 STORM RAINFALL

The storm data used for this stormwater management plan is derived from SA Weather Bureau station 0013873 BELVEDERE, which is located 1 km from the site (Table 2).

TABLE 2: POINT STORM RAINFALL DEPTHS FOR THE DEVELOPMENT SITE

RETURN PERIOD (YR)	POINT STORM RAINFALL DEPTHS (mm) FOR EVENT DURATIONS (MINUTES) OF:							
	10	**30**	**60**	**120**	**240**	**360**	**720**	**1440**
0.5	3.3	5.3	6.8	8.3	10.1	11.2	13.4	16.0
1	6.9	11.3	14.3	17.7	21.4	23.8	28.5	34.0
2	11.0	17.9	22.8	28.1	34.0	37.8	45.3	54.0
5	16.3	26.6	33.8	41.6	50.3	56.0	67.1	80.0
10	20.6	33.6	42.6	52.5	63.5	70.8	84.7	101.0
20	25.0	40.9	51.9	63.9	77.4	86.2	103.1	123.0
50	32.0	52.2	66.2	81.6	98.8	110.0	131.6	157.0
100	38.1	62.2	78.9	97.2	117.7	131.0	156.8	187.0

NOTES:
1. This data is for positions 34˚02’ S, 22˚59’ E (BELVEDERE Rain Station)
2. The 1:0.5 year and 1:1 year return period rainfall depths have been extrapolated.

3.2 EXISTING STORMWATER INFRASTRUCTURE

The site naturally drains towards the Knysna Lagoon in a north-easterly direction. Stormwater from the site currently runs overland to the lagoon.

There is an existing 375mm Ø pipe from the main road, which conveys stormwater runoff from the higher lying properties opposite the main road and the main road itself to the lagoon where the pipe discharges.

Although the main divisional road is formalised with a kerb and channel up to about 5m from the existing entrance, stormwater runoff does overtop the kerb and enter the site during larger storm events.

Catchments A1 and A2 drain to the main divisional road, and what flow does not pass through the 375mm Ø culvert opposite Crabs Creek, will accumulate in the low lying area to the west of the divisional road and extending up to the N2. If this low lying area reaches its maximum capacity the flow will overtop the divisional road at the low point some 70m south of the N2 and north of the development site.

Catchments A3 and A4 drain towards the site and this runoff was taken into account by diverting it to the south of the proposed buildings.

See drawing no. MC410-C900 for the pre-development conditions and catchment areas.

3.3 PRE-DEVELOPMENT RUNOFF PEAKS

The site previously consisted of a main building with a gravel access road with onsite parking. The remains of the top structure have since been demolished and removed leaving only the existing slab area.

No geotechnical investigation was done, but the area does appear to be sandy. No visible rock outcrops could be seen. The Mean High Water Spring is 1.122 msl with the highest recorded water level at 2.2 msl. The site has an average slope of 3.5% towards the lagoon.

As the parking and road area for the proposed development extends into the adjacent property, Farm 216 Portion 150, sub-catchment areas were drawn up accordingly to ensure the pre- and post-development areas matches to calculate the pre- and post-development peak runoffs. The total catchment area of 4848m² was used for the proposed development.

For the purpose of this report the pre-development site was treated as completely undeveloped, draining directly to the lagoon.

The pre-development runoff peaks for the development site have been calculated by using the Autodesk Stormwater and Sanitary Analysis software by means of the EPASWMM modelling method. The development site has been modelled as a single catchment. The results are listed in Table 3 and in Annexure A.

TABLE 3: PRE-DEVELOPMENT SWMM MODEL PARAMETERS AND PEAK FLOWS

RECURRENCE INTERVAL (YRS)	1	2	5	10	50	100
PEAK (l/s)	0.32	4.99	28.47	53.21	125.26	168.27

NOTE:

1. The development catchment area is 4569 m^2.
2. The runoff factor is CN 67 Soil Type B.
3. The peak flows have been determined by the SWMM method.

PRE DEVELOPMENT SWMM PARAMETERS

Subcatchment	Land Use	Reach Length (m)	Outlet	Area (m2)	Width (m)	Average Slope %	% Imperv	N-Imperv	N-Perv	D-store Imp	D-store Perv	CN
Site Pre B1&B2		55		4569.000	83	3.49%	0	0.015	0.15	2	5	67.0
Site Pre A1		1741		643885.000	370	10.83%	0	0.015	0.15	2	5	65.0
Site Pre A2		2643		1499985.000	568	6.50%	0	0.015	0.15	2	5	65.0
Site Pre A3		350		13358.000	38	12.43%	0	0.015	0.15	2	5	65.0
Site Pre A4		17		537.000	32	41.00%	0	0.015	0.15	2	5	56.0

FIGURE 3: PRE-DEVELOPMENT VIEW OF SITE SHOWING ORIGINAL BUILDING SLABS

FIGURE 4: EXISTING CONDITIONS OF THE SITE EXTENT

FIGURE 5: EXISTING CONDITIONS GROUND LEVEL VIEW

4. POST-DEVELOPMENT STORMWATER MANAGEMENT – QUANTITY AND RATE OF RUNOFF

4.1 REQUIREMENTS

In Chapter 2, the conditions to be applied to the quantity and rate of runoff for the proposed development are listed:

(i) Attenuate the peak post-development runoff to pre-development levels for recurrence intervals up to the 1:50 year event.

(ii) Safely discharge the runoff from the 1:100 year storm event so as not to cause downstream damage.

4.2 RUNOFF ANALYSIS

4.2.1 PROPOSED ON-SITE STORMWATER CONFIGURATION

In order to achieve the attenuation on site for the 4848m² portion to be developed, it is intended to make use of a dry attenuation pond with an enhanced swale type infiltration bed for treatment purposes.

Rooftop runoff from the buildings will discharge through a gutter and downpipe system to the landscaping and continue in an underground pipe system leading to the pond.

The parking and road area will be formalised with kerbs and channels and will be designed to slope away from the buildings and drain overland to the attenuation pond, which will be at the low point of the development. The road and parking area will drain to a catchpit and 375mm Ø underground pipe system, sized to convey at least the 1:5 year RI peak runoff from the development to the attenuation pond.

The attenuation pond will have a controlled outlet structure discharging to a new 375mm stormwater outfall main, which will discharge to a gabion stilling chamber at the lagoon.

4.2.2 PROPOSED OFF-SITE (EXTERNAL) STORMWATER CONFIGURATION

External Catchments A3 and A4 can also contribute to the peak runoff from the site, and therefore it is important to include it in the model to ensure that overland flow can safely be conveyed through the site to the lagoon.

The divisional road is kerbed up to approximately 5m from the entrance to the site. The kerb and channel diverts to an existing open channel which discharges to a 375mm Ø stormwater pipe draining to the lagoon. Excess stormwater runoff from the road will accumulate in the low lying area to the west of the divisional road and from there may overtop the road to the north of the development as described in 3.2.

It is proposed to construct a hump in the access road to prevent surface flow on the divisional road from flowing into the parking area on the site.

A new 375mm Ø stormwater pipe will be installed from the catchpit to the of the pond stilling basin.

FIGURE 6: EXISTING KERB AND CHANNEL IN DIV. ROAD SILTED UP

FIGURE 7: CHANNEL LEADING TO EXISTING 375MM PIPE

The parking area will be shaped to allow overland flow that might occur during major storm events to safely discharge to the lagoon should there be a blockage in the outlet pipe.

See drawing MC410-C901.

Stormwater runoff from the external Sub-Catchment A4 situated between the Divisional Main Road and the site has a steep slope of 41% towards the site. There is an existing boundary wall at the toe of the embankment acting as a retaining wall. Stormwater runoff that might overtop from this area will be diverted to the parking area to the west and the landscaped area to the east by installing a W4 concrete channel below the retaining wall. Flow diverted to the landscaped area to the east will discharge to a Reno mattress to evenly spread flow to the landscape area.

MODEL LAYOUT AND PARAMETERS

The SWMM model layout matches the proposed layout for the new stormwater system (Drawing No MC410-C901). As can be seen from this layout, the entire site was modelled draining to the proposed attenuation pond, with a controlled outlet structure connecting to the 375mm stormwater outfall pipe leading to the outfall stilling chamber at the lagoon.

A summary of the parameters used to model the post-development are shown in Table 4. The model consists of 2 sub-catchments for the development and 4 external sub-catchments.

TABLE 4: POST DEVELOPMENT SWMM MODEL PARAMETERS

POST DEVELOPMENT SWMM PARAMETERS												
Subcatchment	**Land Use**	**Reach Length (m)**	**Outlet**	**Area (m2)**	**Width (m)**	**Average Slope %**	**% Imperv**	**N-Imperv**	**N-Perv**	**D-store Imp**	**D-store Perv**	**CN**
Site Post B1		88.00		3369.00	36.80	0.50%	0.00%	0.015	0.15	2	5	92
Site Post B2		45.00		1200.00	35.70	0.50%	0.00%	0.015	0.15	2	5	83

4.2.3 MODEL RUNOFF AND ATTENUATION (DEVELOPMENT SITE ONLY)

The SWMM model was run for storms ranging from 1:0.5 to 1:100 years. The results in Table 7 summarise the effectiveness of the attenuating pond in each scenario towards achieving compliance w.r.t. Quantity and Rate of Runoff. Details of the outlet structure details for the attenuation pond are provided in Table 5.

The controlled outlet structure orifices and weir have been sized to attenuate peak runoff over the full range of recurrence intervals (1:10 to 1:100 years), to pre-development peak flows as per Table 6 and 7.

Details of the proposed outlet are provided in drawing MC410-C901.

TABLE 5: OUTLET CONTROLS FOR ATTENUATION POND

OUTLET	POND
ORIFICE 1	DIA 60mm @ RL1.5m
WEIR 2	Trapezoidal 130(crest w)x270(h)mm side slopes 1:1(V:H) @ RL1.93m
SPILLWAY 3	Rectangular 3000(crest w)x200(h)mm side @ RL2.2m

TABLE 6: ATTENUATION PERFORMANCE OF ATTENUATION POND FOR A RANGE OF RECURRANCE INTERVALS (DEVELOPMENT SITE ONLY)

ATTENUATION SUMMARY	
RI 1:10 YEARS	
PARAMETER	**POND**
PEAK INFLOW (l/s)	62.24
PEAK OUTFLOW (l/s)	46.97
BASE ELEVATION (m)	1.40
1:10 YEAR PEAK WATER LEVEL (RLm)	2.10
RI 1:50 YEARS	
PARAMETER	**POND**
PEAK INFLOW (l/s)	123.07
PEAK OUTFLOW (l/s)	111.84
BASE ELEVATION (m)	1.40
1:50 YEAR PEAK WATER LEVEL (RLm)	2.20
RI 1:100 YEARS	
PARAMETER	**POND**
PEAK INFLOW (l/s)	160.78
PEAK OUTFLOW (l/s)	151.29
BASE ELEVATION (m)	1.40
1:100 YEAR PEAK WATER LEVEL (RLm)	2.23

The results of the post development attenuated peak runoff are provided in Table 7 together with the pre-development peak runoff.

TABLE 7: PRE- AND POST DEVELOPMENT PEAK RUNOFF FLOWS (l/s)

RECURR. INT. YR	0.5YR	1YR	2YR	5YR	10YR	20YR	50YR	100YR
POST DEVELOPMENT	Infiltrate	2.06	4.9	25.49	46.97	71.98	111.84	151.29
PRE DEVELOPMENT		0.32	4.99	28.47	53.21	80.18	125.26	168.27

Figure 8 compares the attenuation of post-development peak flows with the pre-development peak flows (Table 7). The post-development peak flows were found to be less than the pre-development peak flows for the recurrence intervals 1:1 year to 1:100 year.

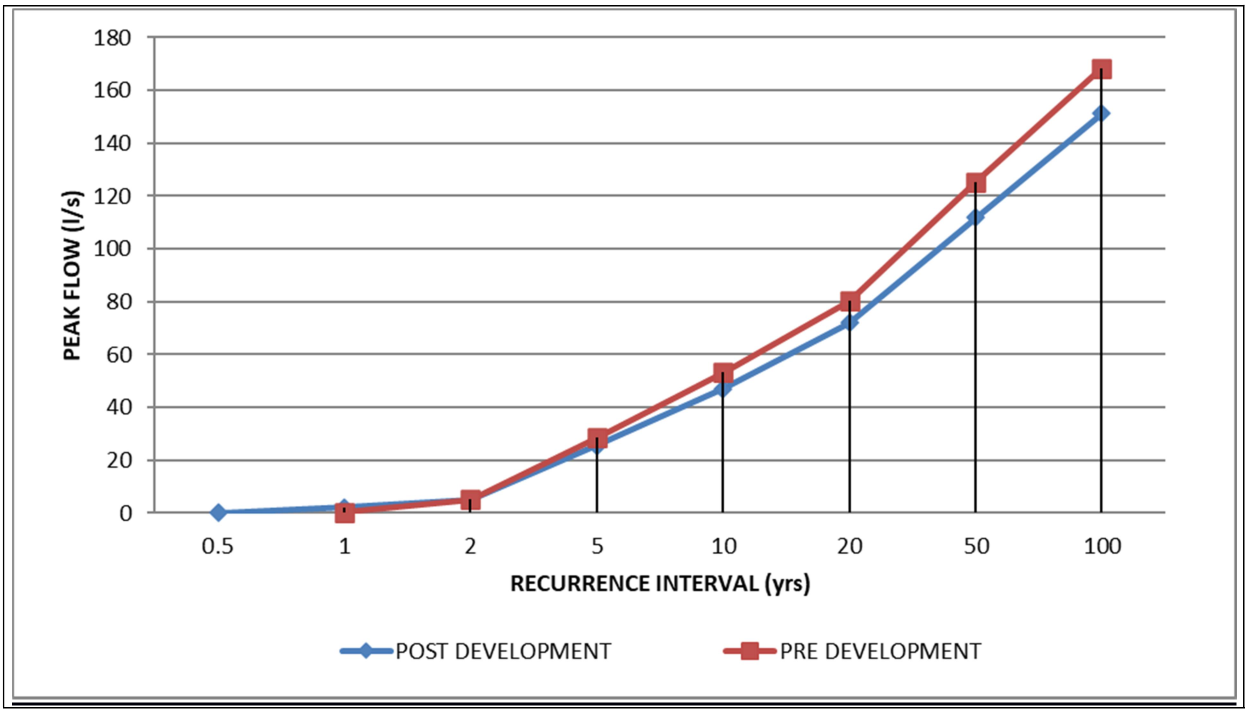


FIGURE 8: ATENUATION OF POST-DEVELOPMENT PEAKS TO PRE-DEVELOPMENT VALUES

4.3 OUTLET STRUCTURE

The outlet structure for the attenuation pond will consist of a single chamber structure. The structure will have a hinged steel safety grid for easy access to the orifices and outlet should they become blocked. A summary of the orifices, weirs and spillways is provided in Table 5. Schematic drawings of the outlet structure are shown in drawing MC410-C901.

The 375mm Ø outfall stormwater main, from the outlet structure to the gabion stilling outlet structure, will have a capacity of 159 l/s which is more than the attenuated 1:100 year runoff of 151 l/s.

In the event of a blockage occurring in the 375mm stormwater outfall pipe, the spillway weir will provide sufficient capacity for the unattenuated 1:100 year runoff from the site of 174.9 l/s to be safely conveyed off-site to the lagoon.

4.4 SUMMARY: QUANTITY AND RATE OF RUNOFF

4.4.1 ATTENUATION OF THE 1:10 TO 100-YEAR RI, 24 HOUR STORM

The attenuation of the 1:10 to 100-year RI, 24 hour storm runoff peaks needs to be controlled, in order for the peak outflow to be less than the calculated pre-development flows.

Table 8 summarises the objectives achieved for the 10 to 100year RI storm.

TABLE 8: ATTENUATION SUMMARY

PARAMETER	RI 1:1 YEARS	RI 1:10 YEARS	RI 1:50 YEARS	RI 1:100 YEARS
PEAK INFLOW (l/s)	3.76	28.37	61.29	78.42
BASE ELEVATION (RLm)	1.40	1.40	1.40	1.40
PEAK WATER LEVEL (RLm)	1.60	2.10	2.20	2.23
PEAK WATER DEPTH (m)	0.20	0.70	0.80	0.83
PEAK STORAGE (m^3)	12.30	60.82	73.58	77.27
PEAK RUNOFF FROM PRE-DEVELOPMENT (l/s)	0.32	53.21	125.26	168.27
PEAK RUNOFF FROM POST DEVELOPMENT SITE AFTER ATTENUATION (l/s)	2.06	46.97	111.84	151.29

Conclusion:

1. The SuDS objective to attenuate post development peaks to pre-development levels up to 1:50 years, is achieved up to the 1:100 year RI.
2. The 1:100-year post-development peak is attenuated to the pre-development level and an spillway weir from the attenuation pond to the lagoon is provided. This satisfies the objective to minimise or remove the risk of damage or danger to adjacent or downstream properties.

5 POST-DEVELOPMENT STORMWATER MANAGEMENT – QUALITY TREATMENT

5.1 OBJECTIVES

Part of the stormwater management plan is to formulate measures required to achieve runoff of an acceptable quality. For a development such as this, suspended solids (SS) should be reduced by 80% and total phosphorus should be reduced by 45%. Furthermore, the measures utilised should promote urban biodiversity and enhance amenity and aesthetics of the site and its surroundings.

Due to the development's limited available space, an enhanced swale/pond was the only method considered for treatment and attenuation.

5.2 LITTER AND SEDIMENT TRAPS

Litter and sediment control should be a priority in the design and management of the stormwater system. In a development such as the proposed development, it is anticipated that the building's management will have pride in the appearance of the development and thus littering is not expected to be a significant issue.

The provision of sediment traps are proposed for each catchpit by lowering the base of the catchpits with a depth of 100mm below the outlet pipe invert before entering the stormwater pipe system. A forebay is provided at the entrance point to the pond where litter and sediment will be collected.

5.3 SUSPENDED SOLIDS (SS) AND TOTAL PHOSPHORUS (TP) REMOVAL

As described above, runoff from the site will be discharged to the attenuation pond.

This pond will be designed as a dry extended detention (ED) pond (Georgia Stormwater Management Manual, Volume 2 – August 2001). A plan and schematic sectional views are shown in drawing MC410-C901. The pond will comprise of a forebay basin and enhanced swale area. The entire pond and swale surface area will be vegetated with cynodon grass.

Stormwater inflow will be conveyed to the forebay, from where it overflows onto the swale area of 50m^2, which is designed to accommodate and treat the ½ Year RI peak flow volume of 5m^3 from the site through infiltration. The treatment volume will have a depth of 100mm which will drain through the swale area by infiltration over a maximum of 24 hours, to a 110mm perforated underdrain pipe discharging to the outlet structure. The anticipated TP removal rate by natural infiltration through the pond/swale surface is 50%.

The forebay basin is designed to facilitate the removal of SS before it enters the attenuation pond. Catchpits within the development will have sediment traps as part of the structure, which will further enhance the removal of SS before it enters the attenuation pond. The SS removal rate is expected to be 80%.

6 STORMWATER MANAGEMENT

6.1 STORMWATER VOLUME AND RATE OF RUNOFF

Compliance with the SuDS requirements relating to volume and rate of runoff has been achieved, by providing a dry attenuation pond to be located on site next to the delivery entrance. All runoff from the site will be diverted to the pond and outflow peaks will be attenuated to pre-development levels (Figure 9).

6.2 STORMWATER QUALITY

Compliance with the stormwater SuDS objectives is achieved by providing a forebay and enhanced swale & pond combination. The Water Quality Volume will be infiltrated through the swale surface to remove pollutants.

6.3 OVERLAND ESCAPE ROUTES

An overland escape route, comprised of a weir outflow and Armorflex channel discharging into the lagoon, will be provided.

7 MAINTENANCE OF THE STORMWATER SYSTEM

The ongoing sustainability of the stormwater system is dependent upon its effective maintenance. It is anticipated that the development will not generate much sediment, particularly once established, and that the catchpits and forebay will efficiently intercept any sediment which is generated. As a result, the need to remove litter and sediment from the catchpits and forebay will have to be monitored on a regular basis along with the pond on a more long-term basis.

Due to the location and shallow depth of the forebay, grass swale and pond, with side slopes of 1:2, it is easily accessible by maintenance personnel to perform the actual maintenance on the stormwater system. Warning and instructive signs shouldl be erected near the pond to warn of rising water levels during storm events.

In Table 9 the main elements of the maintenance schedule are listed with recommended frequencies.

TABLE 9 STORMWATER SYSTEM MAINTENANCE SCHEDULE

COMPONENT	NO.	INSPECTIONS (I)		NO.	ROUTINE MAINTENANCE (R)		NO.	CORRECTIVE AND IRREGULAR MAINTENANCE			ANNUAL SPREAD OF MAINTENANCE ACTIVITIES (I=INSPECTION; R=ROUTINE; OTHER AS SPECIFIED)											
		ACTIVITY	FREQUENCY (months)		ACTIVITY	FREQUENCY (months)		ACTIVITY	FREQUENCY (months)		J	F	M	A	M	J	J	A	S	O	N	D
Stormwater overland routes and road corridor	1.1	Inspect overland routes for obstructions, sediment or spalling	1	1.1	Remove obstructions, sediment from overland flow routes	3	1.1	Repair sagging/low points, spalling in overland flow routes	On occurrence		I,R	I	I	I,R	I	I	I,R	I	I	I,R	I	I
Stormwater underground pipe system	2.1	Main Pipes(Concrete): Check that it is clear of obstructions	6	2.1	Main Pipes(Concrete): Remove litter and obstructions by rodding, bucket machine or jetting	6	2.1	Main Pipes(Concrete): a) If blockage occurs rod, bucket machine or jet pipeline from manhole b) Replace damaged pipes	On occurrence		I,R						I,R					
	2.2	Manholes: Check structures, covers and frames	4	2.2	Manholes: Remove litter and obstructions	6	2.2	Manholes: Repair any damages	On occurrence		I	R			I			R	I			
	2.3	Catchpits: Check structures, covers and frames	4	2.3	Catchpits: Remove litter, sediment and obstructions	6	2.3	Catchpits: Repair any damage	On occurrence		I	R			I			R	I			
Forebay	3.1	Inspect forebay of any obstructions and sediment	1	3.1	Removal of obstructions and sediments deposits	1	3.1	Repair any damages to forebay	On occurrence		I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R
Enhanced Swale	4.1	Swale: Check that vegetation and grassblocks are in place and that it is clear of obstruction and sediment deposits	3	4.1	Swale: Maintain vegetation and remove any obstructions and sediment deposits	1*	4.1	Swale: Repair erosion and damages to swale bed and side slopes	On occurrence		I,R	R	R	I,R	R	R	I,R	R	R	I,R	R	R
	4.2	Check health of cynodon grass cover	3	4.2	Mow grass cover and maintain	1					I,R	R	R	I,R	R	R	I,R	R	R	I,R	R	R
	4.3	Check 24hr infiltration rate and ponding	3				4.3	Remove sediment deposits on base of swale	On occurrence		I			I			I			I		

TABLE 9: CONTINUED

CONTENT	NO.	INSPECTIONS		NO.	ROUTINE MAINTENANCE		NO.	CORRECTIVE AND IRREGULAR MAINTENANCE			ANNUAL SPREAD OF MAINTENANCE ACTIVITIES(I=INSPECTION; R=ROUTINE; OTHER AS SPECIFIED)											
		ACTIVITY	FREQUENCY (months)		ACTIVITY	FREQUENCY (months)		ACTIVITY	FREQUENCY (months)		J	F	M	A	M	J	J	A	S	O	N	D
Attenuation Pond	5.1	Inspect debris at inlet pipes and outlet structure	1	5.1	Remove debris from inlet pipes and outlet structure	1	5.1	Repair any undercut or eroded areas	On occurrence		I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R
	5.2	Inspect pond for growth of invasive vegetation	1	5.2	Remove any invasive vegetation	1					I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R
	5.3	Monitor sediment deposits at inlets	6	5.3	Remove excess sediment	6					I,R						I,R					
	5.4	Check that weir wall is clear of any obstructions	1	5.4	Remove any obstructions	1	5.4	Repair any structural damage	On occurrence		I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R
	5.5	Inspect pond side slopes for any damages and erosion	1	5.5			5.5	Repair any damages to the side slopes or structures	On occurrence		I	I	I	I	I	I	I	I	I	I	I	I
	5.6	Check health of cynodon grass cover	3	5.6	Mow grass cover and maintain	1					I,R	R	R	I,R	R	R	I,R	R	R	I,R	R	R
Outlet Structure:	6.1	Check that orifices are clear and not blocked	4	6.1	If a orifice becomes obstructed, the obstruction should be removed by hand	4	6.1	Repair any structural damage	On occurrence		I,R				I,R				I,R			
	6.2	Check that outlet opening is not blocked	4	6.2	Remove any obstructions	4					I,R				I,R				I,R			
	6.3	Ensure that the steel hinged grid can open and close	4	6.3	Fix any access problems with hinged grid	4					I,R				I,R				I,R			
Outlet Weir	7.1	Check that weir is clear of any obstructions	1	7.1	Remove any obstructions	1	5.1	Repair any structural damage	On occurrence		I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R
Spillway channel to Knysna Lagoon	8.1	Inspect channel for any obstructions	1	7.1	Remove any obstructions in the channel	1	7.1	Repair any structural damage	On occurrence		I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R
Reference: The South African Guidelines for Sustainable Drainage Systems. N Armitage, M Vice, L Fisher-Jeffes, K Winter, A Spiegel, J Dunstan. Water Research Commission report TT558/13, May 2013.																						

8 CONCLUSIONS

8.1 PROPOSED DEVELOPMENT

Farm 216 Portion 29 of the Knysna Municipal region, is situated just south of the N2 national road between the Belvidere/Brenton-on-sea Divisional Road and the Knysna Lagoon.

The 3894m² property previously consisted of a building, which was used as a restaurant, but have since been demolished.

The new proposed development will consist of a Farm Stall, Restaurant building, adjacent Bed and Breakfast units and a parking area .

8.2 EXISTING CONDITIONS

The pre-development conditions for the site were treated as totally undeveloped with brush veld and sandy soil conditions. The site has an average slope of 3.5% and drains overland in a north-eastern direction to the Knysna Lagoon.

8.3 RUNOFF PEAK ATTENUATION

Estimates of the pre-development runoff have been computed for a range of recurrence intervals (Table 3).

The permitted peak outflow from the site is limited to these pre-development peaks.

It is proposed to develop the entire site as indicated on Figure 2. The runoff will be attenuated in one dry attenuation pond located in the north-western corner of the site next to the entrance road from the divisional road. The attenuation objectives are achieved as summarised in Table 8.

8.4 RUNOFF WATER QUALITY TREATMENT

Runoff water quality standards are achieved through the use of a forebay and natural infiltration through the enhanced swale area of the attenuation pond.

8.5 STORMWATER MANAGEMENT

Compliance with all the stormwater management requirements are shown and summarised in the section.

8.6 MAINTENANCE

The owners are responsible for the maintenance of the stormwater system. Maintenance procedures should follow those provided in Section 7.

G A McGILL Pr Eng
2023-04-13

ANNEXURE A

PRE-DEVELOPMENT RUNOFF

PRE-DEVELOPMENT SUB-CATCHMENTS SUMMARY

SN	Element ID	Description	Area (m²)	Drainage Node ID	Weighted Curve Number	Conductivity (mm/hr)	Drying Time (days)	Average Slope (%)	Equivalent Width (m)	Impervious Area (%)	Impervious Area No Depression (%)	Impervious Area Depression Depth (mm)	Impervious Area Manning's Roughness	Pervious Area Depression Depth (mm)	Pervious Area Manning's Roughness	Curb & Gutter Length (m)	Rain Gage ID	Total Precipitation (mm)	Total Runon (mm)	Total Evaporation (mm)	Total Infiltration (mm)	Total Runoff (mm)	Peak Runoff (lps)	Time of Concentration (days hh:mm:ss)
1	{Site 1}.Catchment A1	10YR RI	643885.00	Jun-A1	65.00	0.1500	7.00	10.8200	370.00	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	101.00	0.00	0.0000	65.5620	34.20	979.98	0 03:32:34
2	{Site 1}.Catchment A2	10YR RI	1499985.00	Jun-A2	65.00	0.1500	7.00	6.5000	568.00	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	101.00	0.00	0.0000	66.4910	32.12	1425.43	0 05:18:07
3	{Site 1}.Catchment A3	10YR RI	13358.00	Jun-A3	65.00	0.1500	7.00	12.4000	38.17	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	101.00	0.00	0.0000	63.0930	36.69	65.88	0 01:17:57
4	{Site 1}.Catchment A4	10YR RI	537.00	Jun-A4	56.00	0.1500	7.00	40.0000	31.60	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	101.00	0.00	0.0000	70.9700	29.00	7.25	0 00:08:55
6	{Site 1}.Catchment B1 B2	10YR RI	4569.00	Jun-Pre01	67.00	0.1500	7.00	3.5000	83.10	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	101.00	0.00	0.0000	60.2110	39.63	53.21	0 00:37:31
1	{Site 1}.Catchment A1	50YR RI	643885.00	Jun-A1	65.00	0.1500	7.00	10.8200	370.00	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	157.00	0.00	0.0000	81.0520	74.71	3175.93	0 02:58:10
2	{Site 1}.Catchment A2	50YR RI	1499985.00	Jun-A2	65.00	0.1500	7.00	6.5000	568.00	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	157.00	0.00	0.0000	81.6430	72.35	4564.07	0 04:26:38
3	{Site 1}.Catchment A3	50YR RI	13358.00	Jun-A3	65.00	0.1500	7.00	12.4000	38.17	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	157.00	0.00	0.0000	78.3000	77.53	204.75	0 01:05:20
4	{Site 1}.Catchment A4	50YR RI	537.00	Jun-A4	56.00	0.1500	7.00	40.0000	31.60	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	157.00	0.00	0.0000	91.8050	64.20	15.01	0 00:07:29
6	{Site 1}.Catchment B1 B2	50YR RI	4569.00	Jun-Pre01	67.00	0.1500	7.00	3.5000	83.10	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	157.00	0.00	0.0000	74.0530	81.91	125.26	0 00:31:27
1	{Site 1}.Catchment A1	100YR RI	643885.00	Jun-A1	65.00	0.1500	7.00	10.8200	370.00	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	187.00	0.00	0.0000	87.0880	98.68	4815.58	0 02:46:08
2	{Site 1}.Catchment A2	100YR RI	1499985.00	Jun-A2	65.00	0.1500	7.00	6.5000	568.00	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	187.00	0.00	0.0000	87.3780	96.28	6954.13	0 04:08:37
3	{Site 1}.Catchment A3	100YR RI	13358.00	Jun-A3	65.00	0.1500	7.00	12.4000	38.17	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	187.00	0.00	0.0000	84.2740	101.61	293.94	0 01:00:55
4	{Site 1}.Catchment A4	100YR RI	537.00	Jun-A4	56.00	0.1500	7.00	40.0000	31.60	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	187.00	0.00	0.0000	100.4830	85.56	19.68	0 00:06:58
6	{Site 1}.Catchment B1 B2	100YR RI	4569.00	Jun-Pre01	67.00	0.1500	7.00	3.5000	83.10	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	187.00	0.00	0.0000	79.3980	106.64	168.27	0 00:29:19

ANNEXURE B

POST DEVELOPMENT RUNOFF

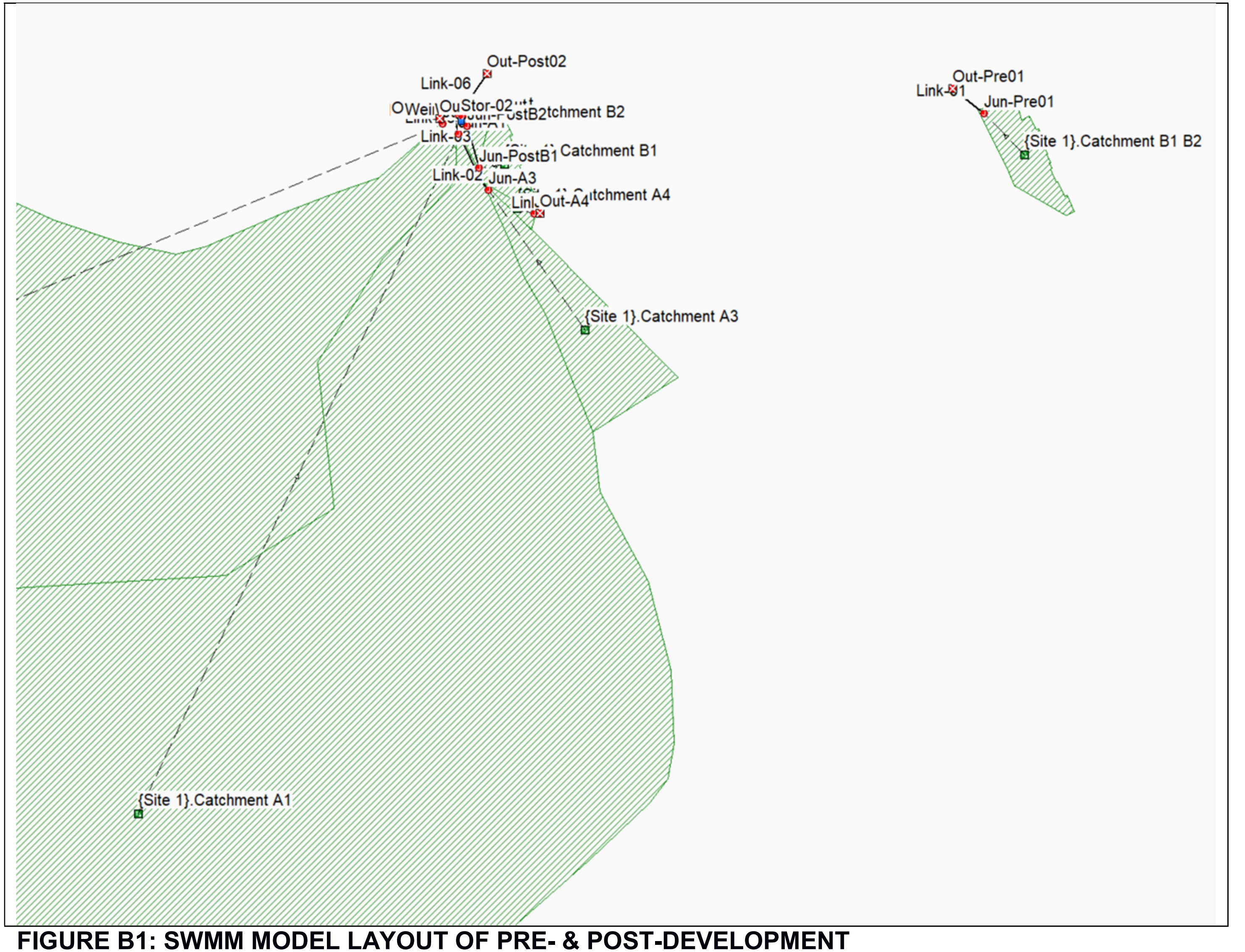


FIGURE B1: SWMM MODEL LAYOUT OF PRE- & POST-DEVELOPMENT

1:0.5YR SUB-CATCHMENTS SUMMARY

SN	Element ID	Description	Area (m²)	Drainage Node ID	Weighted Curve Number	Conductivity (mm/hr)	Drying Time (days)	Average Slope (%)	Equivalent Width (m)	Impervious Area (%)	Impervious Area No Depression (%)	Impervious Area Depression Depth (mm)	Impervious Area Manning's Roughness	Pervious Area Depression Depth (mm)	Pervious Area Manning's Roughness	Curb & Gutter Length (m)	Rain Gage ID	Total Precipitation (mm)	Total Runon (mm)	Total Evaporation (mm)	Total Infiltration (mm)	Total Runoff (mm)	Peak Runoff (lps)	Time of Concentration (days hh:mm:ss)
1	{Site 1}.Catchment A1		643885.00	Jun-A1	65.00	0.1500	7.00	10.8200	370.00	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	16.00	0.00	0.0000	14.7370	0.00	0.00	0 07:24:23
2	{Site 1}.Catchment A2		1499985.00	Jun-A2	65.00	0.1500	7.00	6.5000	568.00	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	16.00	0.00	0.0000	14.7370	0.00	0.00	0 11:05:01
3	{Site 1}.Catchment A3		13358.00	Jun-A3	65.00	0.1500	7.00	12.4000	38.17	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	16.00	0.00	0.0000	14.7370	0.00	0.00	0 02:42:57
4	{Site 1}.Catchment A4		537.00	Jun-A4	56.00	0.1500	7.00	40.0000	31.60	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	16.00	0.00	0.0000	14.8120	0.00	0.00	0 00:18:40
5	{Site 1}.Catchment B1		3369.00	Jun-PostB1	91.25	0.1500	7.00	0.5000	38.30	0.00	0.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	16.00	0.00	0.0000	11.1620	0.87	0.10	0 03:06:26
6	{Site 1}.Catchment B1 B2		4569.00	Jun-Pre01	67.00	0.1500	7.00	3.5000	83.10	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	16.00	0.00	0.0000	14.7330	0.00	0.00	0 01:18:26
7	{Site 1}.Catchment B2		1200.00	Jun-PostB2	83.20	0.1500	7.00	0.5000	26.70	0.00	0.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	16.00	0.00	0.0000	14.5970	0.00	0.00	0 02:04:37

1:0.5 YR STORAGE SUMMARY

SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation (m)	Max (Rim) Elevation (m)	Max (Rim) Offset (m)	Initial Water Elevation (m)	Initial Water Depth (m)	Ponded Area (m²)	Evaporation Loss	Constant Flow Rate (lps)	Max Exfiltration Rate (mm/hr)	Min Exfiltration Rate (mm/hr)	Decay Constant (1/hrs)	Exfiltration Rate (mm/hr)	Peak Inflow (lps)	Peak Lateral Inflow (lps)	Peak Outflow (lps)	Peak Exfiltration Flow Rate (cmm)	Maximum HGL Elevation Attained (m)	Maximum HGL Depth Attained (m)	Average HGL Elevation Attained (m)	Average HGL Depth Attained (m)	Time of Maximum HGL Occurrence (days hh:mm)	Total Exfiltration Volume (1000-m³)	Total Flooded Volume (ha-mm)	Total Time Flooded (minutes)	Total Retention Time (seconds)
1	Stor-02	-726.21	-3767370.72		1.40	2.40	1.00	1.40	0.00	0.00	0.00	0.2600					0.10	0.00	0.00	0.02	1.40	0.00	1.40	0.00	0 00:00	0.00	0.00	0.00	0.00

1:0.5 YR ORIFICES

SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	From (Inlet) Node Invert Elevation (m)	To (Outlet) Node Invert Elevation (m)	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (mm)	Rectangular Orifice Height (m)	Rectangular Orifice Width (m)	Orifice Invert Elevation (m)	Orifice Invert Offset (m)	Orifice Coefficient	Peak Flow (lps)	Time of Peak Flow Occurrence (days hh:mm)
1	Orifice-01		Stor-02	Jun-BOut	1.40	1.50	SIDE	CIRCULAR	NO	200.00			1.50	0.10	0.6140	0.000	0 00:00

1:0.5 YR WEIRS

SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	From (Inlet) Node Invert Elevation (m)	To (Outlet) Node Invert Elevation (m)	Type	Flap Gate	Crest Elevation (m)	Crest Offset (m)	Length (m)	Weir Total Height (m)	Discharge Coefficient	Peak Flow (lps)
1	Weir-02		Stor-02	Jun-BOut	1.40	1.50	TRAPEZOIDAL	NO	1.85	0.45	0.10	0.25	2.40	0.00
2	Weir-03		Stor-02	Jun-BOut	1.40	1.50	TRAPEZOIDAL	NO	2.20	0.80	1.50	0.20	2.40	0.00

1:0.5 YR LINK FLOW SUMMARY

SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	Length (m)	Inlet Invert Elevation (m)	Inlet Invert Offset (m)	Outlet Invert Elevation (m)	Outlet Invert Offset (m)	Total Drop (m)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (mm)	Pipe Width (mm)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (lps)	Flap Gate	Lengthening Factor	Peak Flow (lps)	Time of Peak Flow Occurrence (days hh:mm)	Max Flow Velocity (m/sec)	Travel Time (min)	Design Flow Capacity (lps)	Max Flow / Design Flow Ratio	Max Flow Depth / Total Depth Ratio	Total Time Surcharged (min)	Max Flow Depth (m)	Reported Condition
1	Link-01		Jun-Pre01	Out-Pre01	41.48	1.00	0.00	0.50	0.00	0.50	1.2100	CIRCULAR	400.000	400.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	0.000	0 00:00	0.00		198.17	0.00	0.00	0.00	0.00	Calculated
2	Link-02		Jun-A3	Jun-A1	66.07	2.75	0.00	2.00	0.00	0.75	1.1400	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	0.000	0 00:00	0.00		6527.65	0.00	0.00	0.00	0.00	Calculated
3	Link-03		Jun-PostB1	Jun-PostB2	45.54	1.75	0.00	1.60	0.00	0.15	0.3300	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	0.100	1 00:01	0.08	9.49	3516.23	0.00	0.00	0.00	0.01	Calculated
4	Link-04		Jun-PostB2	Stor-02	8.29	1.60	0.00	1.50	0.10	0.10	1.2100	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	0.100	1 00:02	0.11	1.26	6729.01	0.00	0.00	0.00	0.01	Calculated
5	Link-05		Jun-A1	Jun-ABOut	20.06	2.00	0.00	1.00	0.00	1.00	4.9900	Rectangular	1000.000	1000.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	0.000	0 00:00	0.00		5907.40	0.00	0.00	0.00	0.00	Calculated
6	Link-06		Jun-ABOut	Out-Post02	52.25	1.00	0.00	0.50	0.00	0.50	0.9600	Rectangular	1000.000	2000.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	0.000	0 00:00	0.00		6270.84	0.00	0.00	0.00	0.00	Calculated
7	Link-07		Jun-BOut	Jun-ABOut	10.00	1.50	0.00	1.40	0.40	0.10	1.0000	CIRCULAR	380.000	380.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	0.000	0 00:00	0.00		151.96	0.00	0.00	0.00	0.00	Calculated
8	Link-09		Jun-A2	Out-A2	6.93	2.00	0.00	0.50	0.00	1.50	21.6500	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	0.000	0 00:00	0.00		28504.09	0.00	0.00	0.00	0.00	Calculated

1:10YR SUB-CATCHMENTS SUMMARY

SN	Element ID	Description	Area (m²)	Drainage Node ID	Weighted Curve Number	Conductivity (mm/hr)	Drying Time (days)	Average Slope (%)	Equivalent Width (m)	Impervious Area (%)	Impervious Area No Depression (%)	Impervious Area Depression Depth (mm)	Impervious Area Manning's Roughness	Pervious Area Depression Depth (mm)	Pervious Area Manning's Roughness	Curb & Gutter Length (m)	Rain Gage ID	Total Precipitation (mm)	Total Runon (mm)	Total Evaporation (mm)	Total Infiltration (mm)	Total Runoff (mm)	Peak Runoff (lps)	Time of Concentration (days hh:mm:ss)
1	{Site 1}.Catchment A1		643885.00	Jun-A1	65.00	0.1500	7.00	10.8200	370.00	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	101.00	0.00	0.0000	65.5620	34.20	979.98	0 03:32:34
2	{Site 1}.Catchment A2		1499985.00	Jun-A2	65.00	0.1500	7.00	6.5000	568.00	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	101.00	0.00	0.0000	66.4910	32.12	1425.43	0 05:18:07
3	{Site 1}.Catchment A3		13358.00	Jun-A3	65.00	0.1500	7.00	12.4000	38.17	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	101.00	0.00	0.0000	63.0930	36.69	65.88	0 01:17:57
4	{Site 1}.Catchment A4		537.00	Jun-A4	56.00	0.1500	7.00	40.0000	31.60	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	101.00	0.00	0.0000	70.9700	29.00	7.25	0 00:08:55
5	{Site 1}.Catchment B1		3369.00	Jun-PostB1	91.25	0.1500	7.00	0.5000	38.30	0.00	0.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	101.00	0.00	0.0000	20.5820	75.83	45.77	0 01:29:11
7	{Site 1}.Catchment B2		1200.00	Jun-PostB2	83.20	0.1500	7.00	0.5000	26.70	0.00	0.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	101.00	0.00	0.0000	36.8930	61.40	17.60	0 00:59:36

1:10YR STORAGE SUMMARY

SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation (m)	Max (Rim) Elevation (m)	Max (Rim) Offset (m)	Initial Water Elevation (m)	Initial Water Depth (m)	Ponded Area (m²)	Evaporation Loss	Constant Flow Rate (lps)	Max Exfiltration Rate (mm/hr)	Min Exfiltration Rate (mm/hr)	Decay Constant (1/hrs)	Exfiltration Rate (mm/hr)	Peak Inflow (lps)	Peak Lateral Inflow (lps)	Peak Outflow (lps)	Peak Exfiltration Flow Rate (cmm)	Maximum HGL Elevation Attained (m)	Maximum HGL Depth Attained (m)	Average HGL Elevation Attained (m)	Average HGL Depth Attained (m)	Time of Maximum HGL Occurrence (days hh:mm)	Total Exfiltration Volume (1000-m³)	Total Flooded Volume (ha-mm)	Total Time Flooded (minutes)	Total Retention Time (seconds)
1	Stor-02	-726.21	-3767370.72		1.40	2.40	1.00	1.40	0.00	0.00	0.00	0.2600					62.24	0.00	46.97	0.02	2.10	0.70	1.53	0.13	0 12:23	0.03	0.00	0.00	0.00

1:10YR ORIFICES SUMMARY

SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	From (Inlet) Node Invert Elevation (m)	To (Outlet) Node Invert Elevation (m)	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (mm)	Rectangular Orifice Height (m)	Rectangular Orifice Width (m)	Orifice Invert Elevation (m)	Orifice Invert Offset (m)	Orifice Coefficient	Peak Flow (lps)	Time of Peak Flow Occurrence (days hh:mm)
1	Orifice-01		Stor-02	Jun-BOut	1.40	1.40	SIDE	CIRCULAR	NO	60.00			1.50	0.10	0.6140	5.790	0 12:23

1:10 WEIRS SUMMARY

SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	From (Inlet) Node Invert Elevation (m)	To (Outlet) Node Invert Elevation (m)	Type	Flap Gate	Crest Elevation (m)	Crest Offset (m)	Length (m)	Weir Total Height (m)	Discharge Coefficient	Peak Flow (lps)
1	Weir-02		Stor-02	Jun-BOut	1.40	1.40	TRAPEZOIDAL	NO	1.93	0.53	0.13	0.27	2.40	41.18
2	Weir-03		Stor-02	Jun-BOut	1.40	1.40	RECTANGULAR	NO	2.20	0.80	3.00	0.20	1.84	0.00

1:10 YR LINK FLOW SUMMARY

SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	Length (m)	Inlet Invert Elevation (m)	Inlet Invert Offset (m)	Outlet Invert Elevation (m)	Outlet Invert Offset (m)	Total Drop (m)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (mm)	Pipe Width (mm)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (lps)	Flap Gate	Lengthening Factor	Peak Flow (lps)	Time of Peak Flow Occurrence (days hh:mm)	Max Flow Velocity (m/sec)	Travel Time (min)	Design Flow Capacity (lps)	Max Flow / Design Flow Ratio	Max Flow Depth / Total Depth Ratio	Total Time Surcharged (min)	Max Flow Depth (m)	Reported Condition
1	Link-01		Jun-Pre01	Out-Pre01	41.48	1.00	0.00	0.50	0.00	0.50	1.2100	CIRCULAR	400.000	400.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	52.600	0 12:10	1.34	0.52	198.17	0.27	0.35	0.00	0.14	Calculated
2	Link-02		Jun-A3	Jun-A1	66.07	2.75	0.00	2.00	0.00	0.75	1.1400	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	65.500	0 12:11	1.18	0.93	6527.65	0.01	0.07	0.00	0.11	Calculated
3	Link-03		Jun-PostB1	Jun-PostB2	45.54	1.75	0.00	1.60	0.00	0.15	0.3300	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	45.190	0 12:11	0.69	1.10	3516.23	0.01	0.08	0.00	0.12	Calculated
4	Link-04		Jun-PostB2	Stor-02	8.29	1.60	0.00	1.50	0.10	0.10	1.2100	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	62.240	0 12:11	1.19	0.12	6729.01	0.01	0.07	0.00	0.10	Calculated
5	Link-05		Jun-A1	Jun-ABOut	20.06	2.00	0.00	1.00	0.00	1.00	4.9900	Rectangular	1000.000	1000.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	1023.800	0 12:40	4.38	0.08	5907.40	0.17	0.23	0.00	0.23	Calculated
6	Link-06		Jun-ABOut	Out-Post02	52.25	1.00	0.00	0.50	0.00	0.50	0.9600	Rectangular	1000.000	2000.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	1058.070	0 12:40	2.19	0.40	6270.84	0.17	0.24	0.00	0.24	Calculated
7	Link-07		Jun-BOut	Jun-ABOut	10.00	1.40	0.00	1.00	0.00	0.40	4.0000	CIRCULAR	380.000	380.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	46.970	0 12:23	2.00	0.08	303.92	0.15	0.27	0.00	0.10	Calculated
8	Link-09		Jun-A2	Out-A2	6.93	2.00	0.00	0.50	0.00	1.50	21.6500	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	1425.430	0 13:30	8.42	0.01	28504.09	0.05	0.15	0.00	0.23	Calculated

1:50YR SUB-CATCHMENTS SUMMARY

SN	Element ID	Description	Area (m²)	Drainage Node ID	Weighted Curve Number	Conductivity (mm/hr)	Drying Time (days)	Average Slope (%)	Equivalent Width (m)	Impervious Area (%)	Impervious Area No Depression (%)	Impervious Area Depression Depth (mm)	Impervious Area Manning's Roughness	Pervious Area Depression Depth (mm)	Pervious Area Manning's Roughness	Curb & Gutter Length (m)	Rain Gage ID	Total Precipitation (mm)	Total Runon (mm)	Total Evaporation (mm)	Total Infiltration (mm)	Total Runoff (mm)	Peak Runoff (lps)	Time of Concentration (days hh:mm:ss)
1	{Site 1}.Catchment A1		643885.00	Jun-A1	65.00	0.1500	7.00	10.8200	370.00	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	157.00	0.00	0.0000	81.0520	74.71	3175.93	0 02:58:10
2	{Site 1}.Catchment A2		1499985.00	Jun-A2	65.00	0.1500	7.00	6.5000	568.00	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	157.00	0.00	0.0000	81.6430	72.35	4564.07	0 04:26:38
3	{Site 1}.Catchment A3		13358.00	Jun-A3	65.00	0.1500	7.00	12.4000	38.17	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	157.00	0.00	0.0000	78.3000	77.53	204.75	0 01:05:20
4	{Site 1}.Catchment A4		537.00	Jun-A4	56.00	0.1500	7.00	40.0000	31.60	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	157.00	0.00	0.0000	91.8050	64.20	15.01	0 00:07:29
5	{Site 1}.Catchment B1		3369.00	Jun-PostB1	91.25	0.1500	7.00	0.5000	38.30	0.00	0.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	157.00	0.00	0.0000	21.7970	130.51	90.42	0 01:14:45
7	{Site 1}.Catchment B2		1200.00	Jun-PostB2	83.20	0.1500	7.00	0.5000	26.70	0.00	0.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	157.00	0.00	0.0000	41.0510	112.87	36.80	0 00:49:57

1:50YR STORAGE SUMMARY

SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation (m)	Max (Rim) Elevation (m)	Max (Rim) Offset (m)	Initial Water Elevation (m)	Initial Water Depth (m)	Ponded Area (m²)	Evaporation Loss	Constant Flow Rate (lps)	Max Exfiltration Rate (mm/hr)	Min Exfiltration Rate (mm/hr)	Decay Constant (1/hrs)	Exfiltration Rate (mm/hr)	Peak Inflow (lps)	Peak Lateral Inflow (lps)	Peak Outflow (lps)	Peak Exfiltration Flow Rate (cmm)	Maximum HGL Elevation Attained (m)	Maximum HGL Depth Attained (m)	Average HGL Elevation Attained (m)	Average HGL Depth Attained (m)	Time of Maximum HGL Occurrence (days hh:mm)	Total Exfiltration Volume (1000-m³)	Total Flooded Volume (ha-mm)	Total Time Flooded (minutes)	Total Retention Time (seconds)
1	Stor-02	-726.21	-3767370.72		1.40	2.40	1.00	1.40	0.00	0.00	0.00	0.2600					123.07	0.00	111.84	0.02	2.20	0.80	1.57	0.17	0 12:14	0.03	0.00	0.00	0.00

1:50YR ORIFICES SUMMARY

SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	From (Inlet) Node Invert Elevation (m)	To (Outlet) Node Invert Elevation (m)	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (mm)	Rectangular Orifice Height (m)	Rectangular Orifice Width (m)	Orifice Invert Elevation (m)	Orifice Invert Offset (m)	Orifice Coefficient	Peak Flow (lps)	Time of Peak Flow Occurrence (days hh:mm)
1	Orifice-01		Stor-02	Jun-BOut	1.40	1.40	SIDE	CIRCULAR	NO	60.00			1.50	0.10	0.6140	6.270	0 12:14

1:50YR WEIR SUMMARY

SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	From (Inlet) Node Invert Elevation (m)	To (Outlet) Node Invert Elevation (m)	Type	Flap Gate	Crest Elevation (m)	Crest Offset (m)	Length (m)	Weir Total Height (m)	Discharge Coefficient	Peak Flow (lps)
1	Weir-02		Stor-02	Jun-BOut	1.40	1.40	TRAPEZOIDAL	NO	1.93	0.53	0.13	0.27	2.40	105.57
2	Weir-03		Stor-02	Jun-BOut	1.40	1.40	RECTANGULAR	NO	2.20	0.80	3.00	0.20	1.84	0.00

1:50 YR LINK FLOW SUMMARY

SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	Length (m)	Inlet Invert Elevation (m)	Inlet Invert Offset (m)	Outlet Invert Elevation (m)	Outlet Invert Offset (m)	Total Drop (m)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (mm)	Pipe Width (mm)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (lps)	Flap Gate	Lengthening Factor	Peak Flow (lps)	Time of Peak Flow Occurrence (days hh:mm)	Max Flow Velocity (m/sec)	Travel Time (min)	Design Flow Capacity (lps)	Max Flow / Design Flow Ratio	Max Flow Depth / Total Depth Ratio	Total Time Surcharged (min)	Max Flow Depth (m)	Reported Condition
1	Link-01		Jun-Pre01	Out-Pre01	41.48	1.00	0.00	0.50	0.00	0.50	1.2100	CIRCULAR	400.000	400.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	123.610	0 12:10	1.68	0.41	198.17	0.62	0.57	0.00	0.23	Calculated
2	Link-02		Jun-A3	Jun-A1	66.07	2.75	0.00	2.00	0.00	0.75	1.1400	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	203.320	0 12:10	1.68	0.66	6527.65	0.03	0.12	0.00	0.18	Calculated
3	Link-03		Jun-PostB1	Jun-PostB2	45.54	1.75	0.00	1.60	0.00	0.15	0.3300	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	88.180	0 12:11	0.83	0.91	3516.23	0.03	0.11	0.00	0.16	Calculated
4	Link-04		Jun-PostB2	Stor-02	8.29	1.60	0.00	1.50	0.10	0.10	1.2100	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	123.070	0 12:10	1.46	0.09	6729.01	0.02	0.09	0.00	0.14	Calculated
5	Link-05		Jun-A1	Jun-ABOut	20.06	2.00	0.00	1.00	0.00	1.00	4.9900	Rectangular	1000.000	1000.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	3316.000	0 12:20	6.08	0.05	5907.40	0.56	0.55	0.00	0.55	Calculated
6	Link-06		Jun-ABOut	Out-Post02	52.25	1.00	0.00	0.50	0.00	0.50	0.9600	Rectangular	1000.000	2000.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	3414.310	0 12:20	3.22	0.27	6270.84	0.54	0.53	0.00	0.53	Calculated
7	Link-07		Jun-BOut	Jun-ABOut	10.00	1.40	0.00	1.00	0.00	0.40	4.0000	CIRCULAR	380.000	380.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	111.790	0 12:14	2.54	0.07	303.92	0.37	0.42	0.00	0.16	Calculated
8	Link-09		Jun-A2	Out-A2	6.93	2.00	0.00	0.50	0.00	1.50	21.6500	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	4564.000	0 12:40	11.81	0.01	28504.09	0.16	0.27	0.00	0.41	Calculated

1:100YR SUB-CATCHMENTS SUMMARY

SN	Element ID	Description	Area (m²)	Drainage Node ID	Weighted Curve Number	Conductivity (mm/hr)	Drying Time (days)	Average Slope (%)	Equivalent Width (m)	Impervious Area (%)	Impervious Area No Depression (%)	Impervious Area Depression Depth (mm)	Impervious Area Manning's Roughness	Pervious Area Depression Depth (mm)	Pervious Area Manning's Roughness	Curb & Gutter Length (m)	Rain Gage ID	Total Precipitation (mm)	Total Runon (mm)	Total Evaporation (mm)	Total Infiltration (mm)	Total Runoff (mm)	Peak Runoff (lps)	Time of Concentration (days hh:mm:ss)
1	{Site 1}.Catchment A1		643885.00	Jun-A1	65.00	0.1500	7.00	10.8200	370.00	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	187.00	0.00	0.0000	87.0880	98.68	4815.58	0 02:46:08
2	{Site 1}.Catchment A2		1499985.00	Jun-A2	65.00	0.1500	7.00	6.5000	568.00	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	187.00	0.00	0.0000	87.3780	96.28	6954.13	0 04:08:37
3	{Site 1}.Catchment A3		13358.00	Jun-A3	65.00	0.1500	7.00	12.4000	38.17	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	187.00	0.00	0.0000	84.2740	101.61	293.94	0 01:00:55
4	{Site 1}.Catchment A4		537.00	Jun-A4	56.00	0.1500	7.00	40.0000	31.60	0.00	25.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	187.00	0.00	0.0000	100.4830	85.56	19.68	0 00:06:58
5	{Site 1}.Catchment B1		3369.00	Jun-PostB1	91.25	0.1500	7.00	0.5000	38.30	0.00	0.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	187.00	0.00	0.0000	22.1740	160.12	116.12	0 01:09:42
7	{Site 1}.Catchment B2		1200.00	Jun-PostB2	83.20	0.1500	7.00	0.5000	26.70	0.00	0.00	2.0000	0.0150	5.0000	0.1500	0.00	Rain Gage-01	187.00	0.00	0.0000	42.4260	141.36	47.88	0 00:46:35

1:100YR STORAGE SUMMARY

SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation (m)	Max (Rim) Elevation (m)	Max (Rim) Offset (m)	Initial Water Elevation (m)	Initial Water Depth (m)	Ponded Area (m²)	Evaporation Loss	Constant Flow Rate (lps)	Max Exfiltration Rate (mm/hr)	Min Exfiltration Rate (mm/hr)	Decay Constant (1/hrs)	Exfiltration Rate (mm/hr)	Peak Inflow (lps)	Peak Lateral Inflow (lps)	Peak Outflow (lps)	Peak Exfiltration Flow Rate (cmm)	Maximum HGL Elevation Attained (m)	Maximum HGL Depth Attained (m)	Average HGL Elevation Attained (m)	Average HGL Depth Attained (m)	Time of Maximum HGL Occurrence (days hh:mm)	Total Exfiltration Volume (1000-m³)	Total Flooded Volume (ha-mm)	Total Time Flooded (minutes)	Total Retention Time (seconds)
1	Stor-02	-726.21	-3767370.72		1.40	2.40	1.00	1.40	0.00	0.00	0.00	0.2600					160.78	0.00	151.29	0.02	2.23	0.83	1.59	0.19	0 12:12	0.03	0.00	0.00	0.00

1:100YR ORIFICES SUMMARY

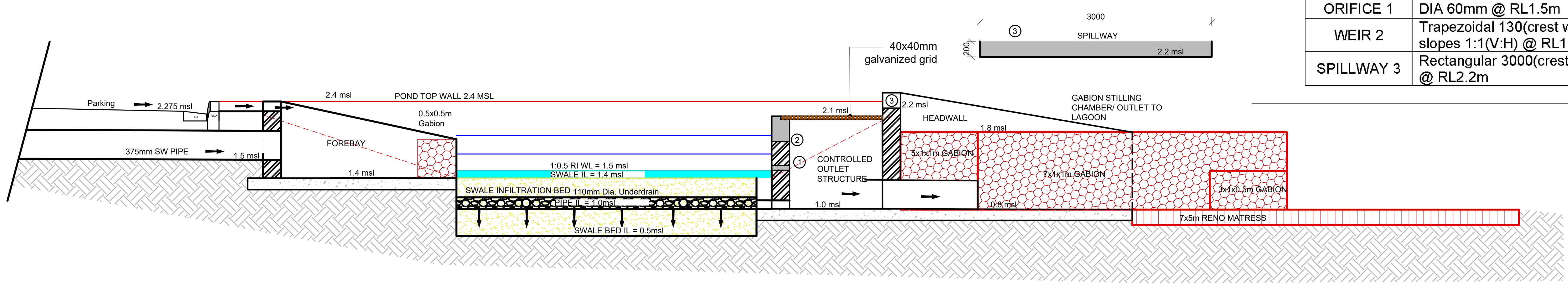
SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	From (Inlet) Node Invert Elevation (m)	To (Outlet) Node Invert Elevation (m)	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (mm)	Rectangular Orifice Height (m)	Rectangular Orifice Width (m)	Orifice Invert Elevation (m)	Orifice Invert Offset (m)	Orifice Coefficient	Peak Flow (lps)	Time of Peak Flow Occurrence (days hh:mm)
1	Orifice-01		Stor-02	Jun-BOut	1.40	1.40	SIDE	CIRCULAR	NO	60.00			1.50	0.10	0.6140	6.420	0 12:12

1:100 YR WEIRS SUMMARY

SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	From (Inlet) Node Invert Elevation (m)	To (Outlet) Node Invert Elevation (m)	Type	Flap Gate	Crest Elevation (m)	Crest Offset (m)	Length (m)	Weir Total Height (m)	Discharge Coefficient	Peak Flow (lps)
1	Weir-02		Stor-02	Jun-BOut	1.40	1.40	TRAPEZOIDAL	NO	1.93	0.53	0.13	0.27	2.40	120.20
2	Weir-03		Stor-02	Jun-BOut	1.40	1.40	RECTANGULAR	NO	2.20	0.80	3.00	0.20	1.84	24.67

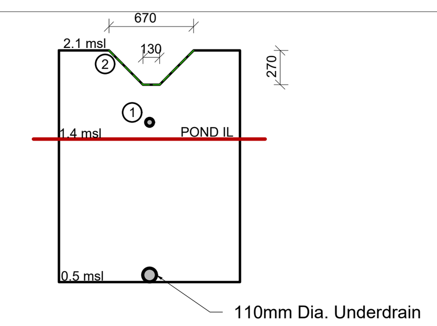
1:100 YR LINK FLOW SUMMARY

SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	Length (m)	Inlet Invert Elevation (m)	Inlet Invert Offset (m)	Outlet Invert Elevation (m)	Outlet Invert Offset (m)	Total Drop (m)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (mm)	Pipe Width (mm)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (lps)	Flap Gate	Lengthening Factor	Peak Flow (lps)	Time of Peak Flow Occurrence (days hh:mm)	Max Flow Velocity (m/sec)	Travel Time (min)	Design Flow Capacity (lps)	Max Flow / Design Flow Ratio	Max Flow Depth / Total Depth Ratio	Total Time Surcharged (min)	Max Flow Depth (m)	Reported Condition
1	Link-01		Jun-Pre01	Out-Pre01	41.48	1.00	0.00	0.50	0.00	0.50	1.2100	CIRCULAR	400.000	400.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	166.070	0 12:10	1.78	0.39	198.17	0.84	0.70	0.00	0.28	Calculated
2	Link-02		Jun-A3	Jun-A1	66.07	2.75	0.00	2.00	0.00	0.75	1.1400	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	288.520	0 12:10	1.87	0.59	6527.65	0.04	0.14	0.00	0.21	Calculated
3	Link-03		Jun-PostB1	Jun-PostB2	45.54	1.75	0.00	1.60	0.00	0.15	0.3300	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	114.580	0 12:10	0.92	0.83	3516.23	0.03	0.12	0.00	0.18	Calculated
4	Link-04		Jun-PostB2	Stor-02	8.29	1.60	0.00	1.50	0.10	0.10	1.2100	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	160.780	0 12:10	1.54	0.09	6729.01	0.02	0.11	0.00	0.16	Calculated
5	Link-05		Jun-A1	Jun-ABOut	20.06	2.00	0.00	1.00	0.00	1.00	4.9900	Rectangular	1000.000	1000.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	5037.450	0 12:20	6.68	0.05	5907.40	0.85	0.75	0.00	0.75	Calculated
6	Link-06		Jun-ABOut	Out-Post02	52.25	1.00	0.00	0.50	0.00	0.50	0.9600	Rectangular	1000.000	2000.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	5154.110	0 12:20	3.63	0.24	6270.84	0.82	0.71	0.00	0.71	Calculated
7	Link-07		Jun-BOut	Jun-ABOut	10.00	1.40	0.00	1.00	0.00	0.40	4.0000	CIRCULAR	380.000	380.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	151.500	0 12:12	2.75	0.06	303.92	0.50	0.50	0.00	0.18	Calculated
8	Link-09		Jun-A2	Out-A2	6.93	2.00	0.00	0.50	0.00	1.50	21.6500	CIRCULAR	1500.000	1500.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	6954.110	0 12:40	13.31	0.01	28504.09	0.24	0.34	0.00	0.50	Calculated



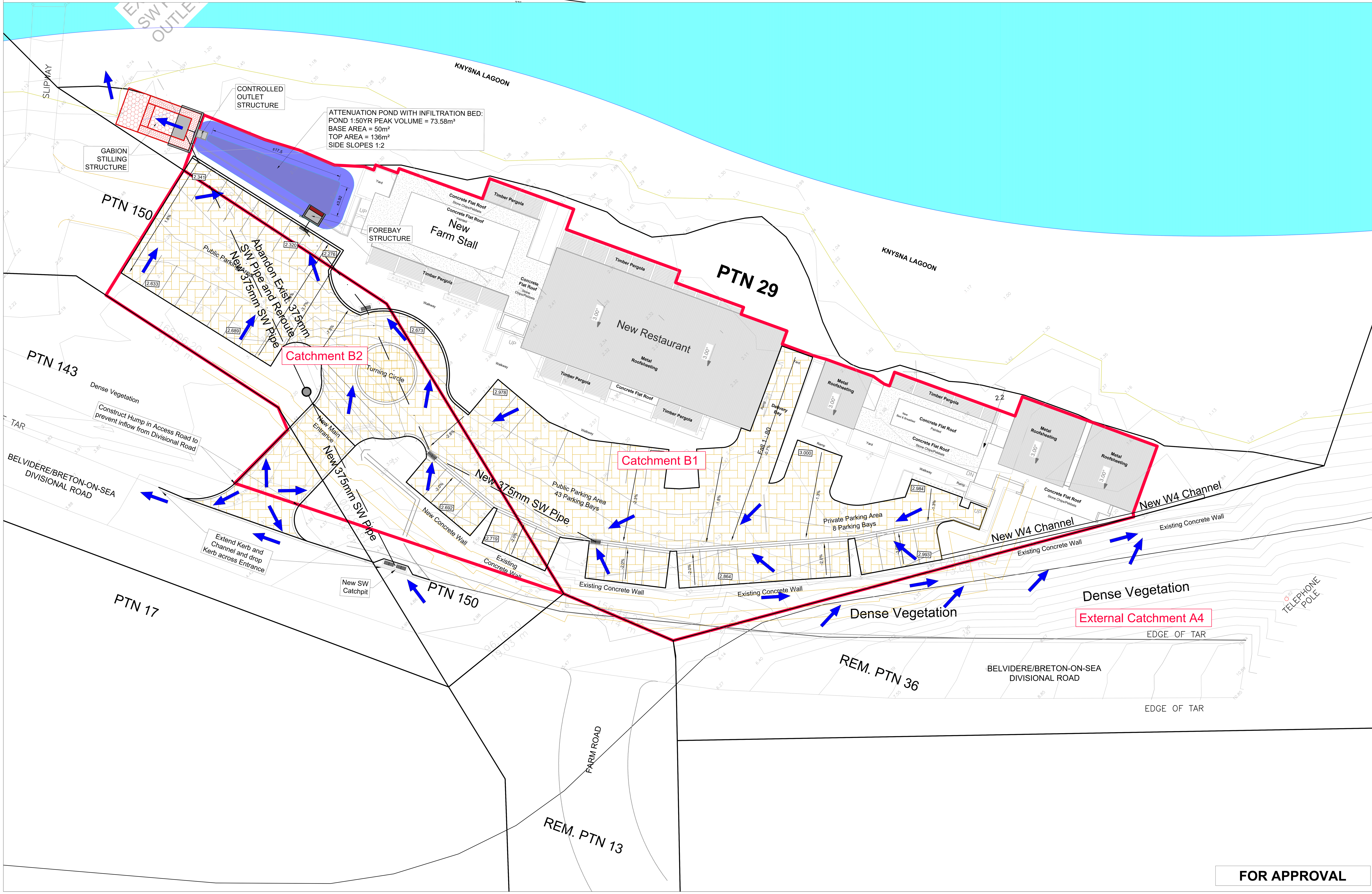
- ATTENUATION POND SECTION -

OUTLET	POND
ORIFICE 1	DIA 60mm @ RL1.5m
WEIR 2	Trapezoidal 130(crest w)x270(h)mm side slopes 1:1(V:H) @ RL1.93m
SPILLWAY 3	Rectangular 3000(crest w)x200(h)mm side @ RL2.2m



- OUTLET STRUCTURE WALL DETAIL -

PARAMETER	RI 1:1 YEARS	RI 1:10 YEARS	RI 1:50 YEARS	RI 1:100 YEARS
PEAK INFLOW (l/s)	3.76	28.37	61.29	78.42
BASE ELEVATION (RLm)	1.40	1.40	1.40	1.40
PEAK WATER LEVEL (RLm)	1.60	2.10	2.20	2.23
PEAK WATER DEPTH (m)	0.20	0.70	0.80	0.83
PEAK STORAGE (m³)	12.30	60.82	73.58	77.27
PEAK RUNOFF FROM PRE-DEVELOPMENT (l/s)	0.32	53.21	125.26	168.27
PEAK RUNOFF FROM POST DEVELOPMENT SITE AFTER ATTENUATION (l/s)	2.06	46.97	111.84	151.29



REVISION:

No.	DATE	DESCRIPTION

GENERAL NOTES:

1. DRAWING IS FOR STORMWATER MANAGEMENT PURPOSES ONLY AND IS NOT A DETAIL DESIGN OR FOR CONSTRUCTION PURPOSES.

LEGEND:

- Development Sub-Catchments
- Interlocking Paving
- Overland Escape Route
- Stormwater Pipe 375mm or as otherwise shown
- Stormwater Manhole
- BK2 Kerb
- BK2 Kerb & C1 Channel
- C1 V-Channel
- Runoff Flow Direction

PROJECT:

FARM 216 PTN.29, UITZICHT, KNYSNA

DRAWING TITLE

STORMWATER MANAGEMENT PLAN

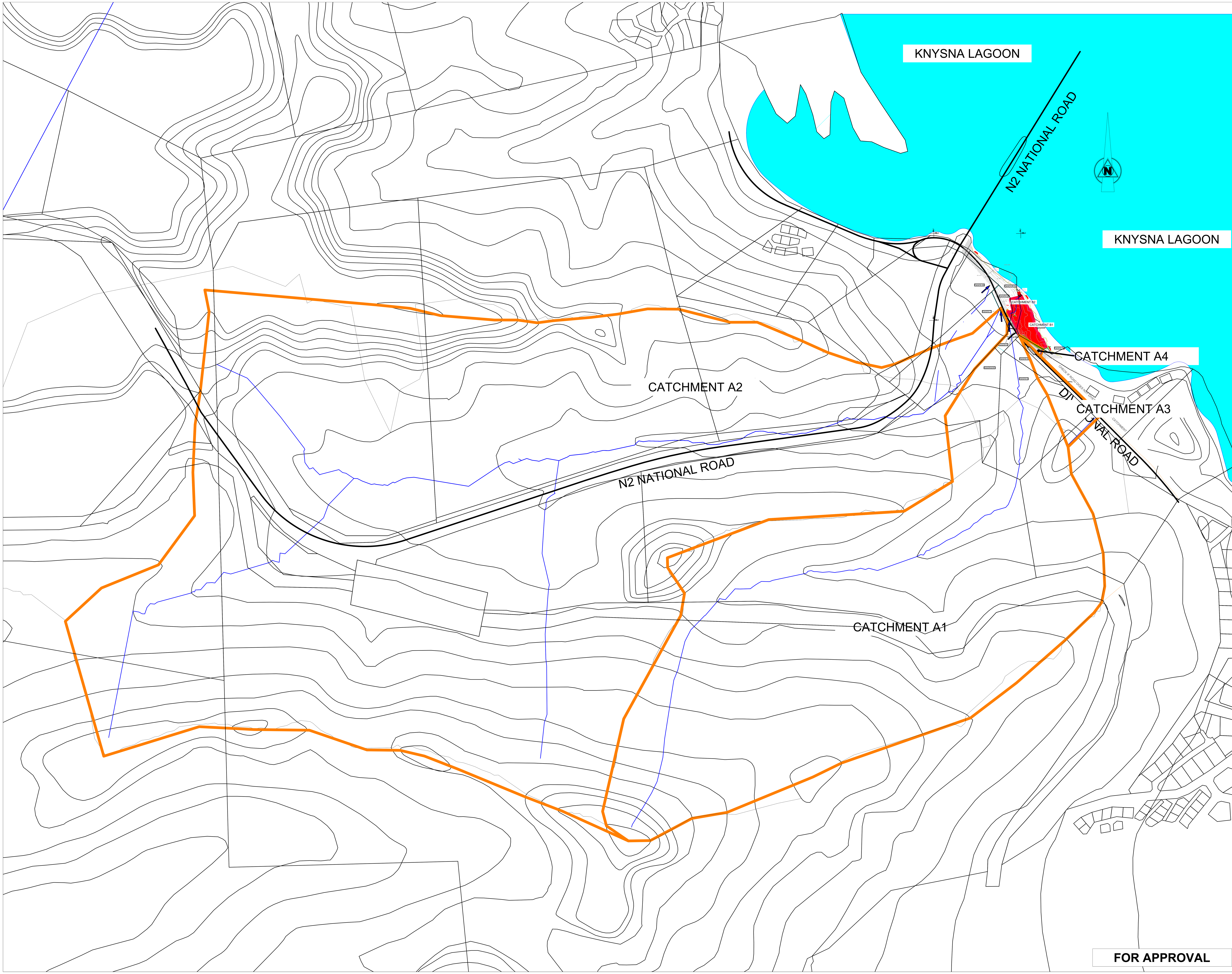
CLIENT

CRABS CREEK (PTY) LTD
PO BOX 41041
CRAIGHALL PARK
2024

Graeme McGill consulting
Tel : 021 976 0386
Cell: 082 550 9108
graeme@mcgillconsulting.co.za
PO Box 332
Private Bag X1
KLEINMOND 7195
Tel : 044 343 2093
Cell: 083 292 9047
fraser@fcce.co.za

DRAWN BY	DESIGNED BY
C Beneke	GA McGILL Pr Eng No. 780269
DATE	2023-04-13
SCALE	1:250 (A1)
DRAWING NO	MC410-C901
REVISION	01

FOR APPROVAL



FOR APPROVAL

REVISION:		
No.	DATE	DESCRIPTION

LEGEND:

- Sub-Catchments External
- Development Site
- Main Roads
- River

PROJECT:

FARM 216 PTN.29, UITZIGT, KNYSNA

DRAWING TITLE

CATCHMENT AREAS

CLIENT

CRABS CREEK (PTY) LTD
PO BOX 41041
CRAIGHALL PARK
2024

Graeme McGill consulting

Tel : 021 976 0386
Cell: 082 550 9108

PO Box 332
Private Bag X1
KLEINMOND 7195

graeme@mcgillconsulting.co.za

FRASER Consulting Civil Engineers cc

Tel : 044 343 2093
Cell: 083 292 9047

fraser@fcce.co.za

DRAWN BY	DESIGNED BY
C Beneke	.... GA McGILL Pr Eng No. 780269
DATE	2023-03-29
SCALE	1:4000 (A1)
DRAWING NO	MC410-C900
REVISION	01