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Southern Midlands Council

Kempton Stormwater Modelling Report



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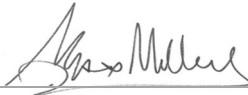


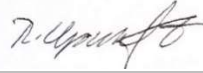

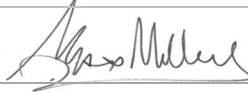
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Acronyms

AEP: Annual Exceedance Probability
 ARR: Australian Rainfall and Runoff
 CFT: Climate Futures Tasmania
 ICM: Infoworks Integrated Catchment Modelling software
 SMC: Southern Midlands Council

Executive Summary

Flüssig Engineers was engaged by Southern Midlands Council to investigate hydraulic conductivity within a localised catchment affecting the town of Kempton. The investigation involved reviewing a combined hydrological and hydraulic model to better understand flood behaviour and assess the performance of the existing stormwater infrastructure under the 5% Annual Exceedance Probability (AEP) event. This event was selected as it represents the most intense storm that Council's piped and minor drainage systems are generally expected to convey. Council sought to determine whether the current infrastructure provides adequate capacity under existing development conditions and to identify any issues that may need to be addressed for future developments.

The model was developed in InfoWorks ICM (version 2024.5.0), an integrated software platform that allows both hydrologic and hydraulic modelling within a single environment. The hydrologic component divided the overall catchment into sub-catchments that convert rainfall into runoff using the Laurenson routing procedure. Each sub-catchment was connected to the 2D hydraulic model via the nearest inlet pits, enabling detailed analysis of stormwater flow paths and flood behaviour during design storm events.

The 5% AEP flood modelling identified two key areas at risk of inundation. For Area 1, located along Glenfern Creek east and west of the Midland Highway, recommended mitigation measures include channelising waterways, constructing a table drain linking culvert inlets, and rehabilitating the creek to restore hydraulic capacity through removal of accumulated weeds and debris. For Area 2, along Green Ponds Rivulet, targeted maintenance works are proposed to improve flow and reduce localised flooding.

These mitigation measures are designed to provide relief during a 5% AEP storm by reducing the extent and severity of inundation, lowering the risk of property damage, and improving overall catchment resilience. Implementation of the works would be subject to feasibility considerations, including access agreements with landowners, and should be undertaken with care to minimise disturbance to the natural values of the waterways.

1. Introduction

Flüssig Engineers was engaged by **Southern Midlands Council (Council)** to undertake a hydraulic analysis of the catchment influencing the township of Kempton. The contributing catchment area analysed extends from the crest of the Midland Highway in the south to the TasWater Treatment Lagoons adjacent to Green Ponds Rivulet in the north. The total catchment area is approximately 1,570 hectares. Within this area, the township itself is predominantly zoned as Village (around 98 hectares), while the majority of the surrounding land is zoned Agricultural (approximately 1,200 hectares).

Figure 1 below shows the catchment area that affects the town of Kempton and the extent of the study area.

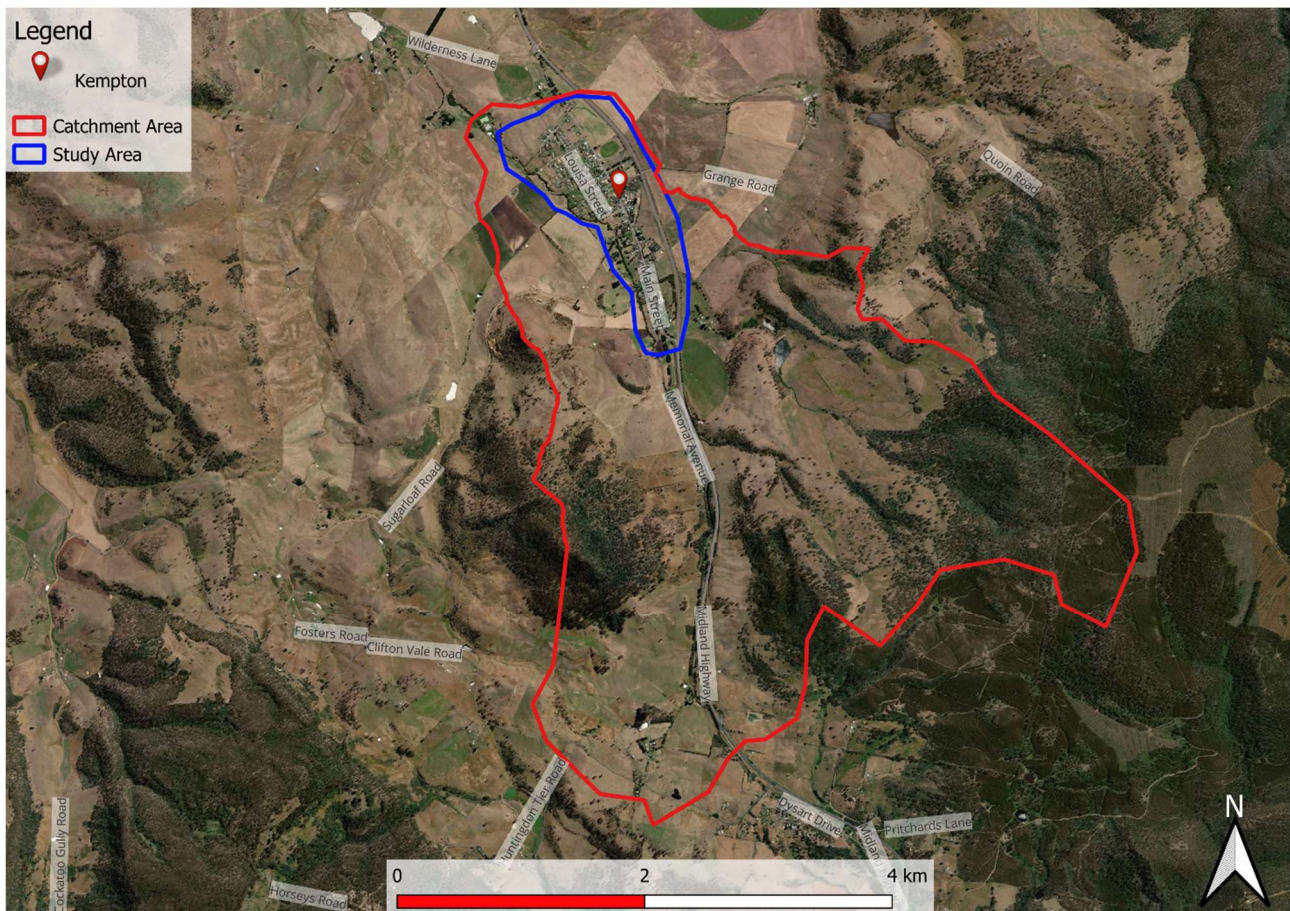


Figure 1. Catchment area and study area for the town of Kempton

The purpose of this study is to assess the hydraulic inflow and outflow characteristics of the Kempton township catchment and to identify locations where stormwater performance issues occur.

The report focuses on the 5% AEP design event, assessing areas of surcharge, ponding, and capacity limitation within the existing stormwater network. The 5% event was selected as it represents the most intensive storm that Council's piped and minor drainage infrastructure is generally expected to convey. Based on this assessment, key problem areas are identified, and feasible mitigation and upgrade options are outlined to address these deficiencies.

The findings will assist Southern Midlands Council in better understanding, managing, and planning improvements for both the current and future stormwater systems within the Kempton study area.

Tasks undertaken in this project included:

- Data collection and review of existing information relevant to the analysis of the given catchment
- Review of the hydraulic model for the determination of flood characteristics through Kempton and an analysis of current risks from flooding in the 5% AEP scenario.
- Identification of most appropriate problem area to address.
- Reporting of results, including the preparation of flood maps.

1.1 Study Area

The study area encompasses the Kempton township (approximately 150 hectares), extending from Burnett Street in the north to the Main Street/ Midland Highway intersection in the south, and bounded by Green Ponds Rivulet to the west and the Midland Highway to the east. The extent of the study area was determined based on Council's objective to assess the performance of stormwater infrastructure within the township and to focus on the area containing the majority of the existing piped drainage network.

Figure 2 below illustrates the extent of the study area.



Figure 2. Study area for the town of Kempton

The township contains a mix of historic buildings on large lots and newer subdivisions with lots generally less than 700 m². It also includes several community and recreational facilities, including a football oval. Kempton is located at the start of an agricultural plain adjacent to Green Ponds Rivulet, which receives runoff from undeveloped hills situated to the south on either side of the Midland Highway. These hills are relatively steep, with slopes reaching up to 50%, and are predominantly

zoned for agricultural use. The topography flattens towards the township, which has an average slope of approximately 3% and is primarily zoned as Village.

The agricultural hills west of the Midland Highway drain relatively freely towards Green Ponds Rivulet via natural watercourses. In contrast, the construction of the Midland Highway has created a barrier to overland flow from the eastern hills. Runoff from these eastern slopes is conveyed beneath the highway into the township through a series of large culverts of varying sizes. Within the township, overland flow is managed through a combination of open drains and piped stormwater systems before discharging to Green Ponds Rivulet.

1.2 Past Studies

No similar past studies into the specific study area in Kempton catchment were found.

2. Data

2.1 Available Data

The stormwater piped system data was supplied by Southern Midlands Council for the Council managed assets and further compiled/verified from aerial photography and site inspections. Other catchment data used for modelling was compiled from the following publicly available data sets/sources:

- Photogrammetry/ LiDAR
- The Land Information Service Tasmania (the LIST - DPIPWE)
- Bureau of Meteorology
- DEM/LAS data (available via ELVIS)
- Cadastral information
- Aerial photography
- Council layers, such as ownership and planning scheme zones
- Available records of past flooding events
- Any previous reports regarding relevant catchment analysis, if available
- Past storm rainfall recordings
- Land use layers

All data collected was assessed for its availability, completeness, and suitability for the model as the first step in the catchment investigation.

2.2 Topography/ Aerial Imagery

The following topographic data was sourced from the ELVIS (Elevation Information System) website, as it was the most recent data set that covers the entire catchment.

- Kempton 2019 DEM 1m LiDAR

2.3 GIS Data

Council supplied the available stormwater network GIS layers for the study area. However, these layers did not include information on the stormwater infrastructure associated with the Midland Highway. Culverts crossing the highway were identified using aerial imagery, and their sizes were verified during site inspections. Additional GIS layers were compiled from LISTmap datasets and field observations. The compiled GIS information includes the following:

- **Stormwater Pits** - Pit assets supplied by Council had information on surface levels, invert levels and location. Where stormwater infrastructure was inferred (see above paragraph for inferred areas), these assets were located on site or via aerial photography and levels were filled using best practice assumptions for pipe inverts.
- **Stormwater Pipes** - Pipe assets supplied by Council have information on invert levels and pipe size, generally. Where stormwater infrastructure was inferred (see above paragraph for inferred areas), these assets were connected to observable pits/headwalls located on site or via aerial photography. Invert levels were then filled using best practice assumptions for pipe cover.
- **Roads Areas** - All relevant road areas accounted for.
- **Building Areas** - All relevant building areas accounted for.
- **Manning's Layer** - Derived from supplied planning zone layers and associated Manning's n values.
- **Sub-catchments** - Derived using hydrological methods in QGIS using pit inlets as an outflow point.
- **Easements** - All displayed easements have relevant data and description attached.

2.4 Hydraulic Structures

Hydraulic structures such as pipes, pits, culverts, and bridges are critical for flood conveyance, and their accurate representation is essential to achieving reliable modelling outcomes. Council's stormwater asset data was generally accurate across the township, with only minor adjustments required to pipe locations and lengths along Elizabeth Street and Old Hunting Ground Road. However, data gaps were identified along the Midland Highway, and no information was available for the stormwater infrastructure at the junction of Sugarloaf Road and Green Ponds Rivulet, or for the culverts conveying Glenfern Creek beneath the paddock access within the Dysart House property.

Where information was missing, it was inferred using aerial imagery and site inspections. It is also recommended that Council survey and incorporate the Dysart House property culverts into their asset system, along with the stormwater infrastructure at the Sugarloaf Road and Green Ponds Rivulet intersection.

2.5 Planning Layers

Planning layers were sourced from LISTmap. Planning layers along with aerial imagery were used to assist in land use definition (effective impervious area) as well as aid in the creation of 2D roughness zones.

2.6 Flood Frequency/ Past Events/ Anecdotal

No stream gauges or historical records exist for the Kempton catchment, meaning the model could not be calibrated against observed flows or past events. Discussions with Council staff did not reveal any anecdotal evidence of known flooding issues within the catchment.

3. Methodology

3.1 Hydrology Model

The hydrology model was created using Infoworks ICM hydrology (RAFTS) module, which uses the Australian designed Laurenson method to calculate runoff. RAFTS is an industry adopted hydrology method as outlined in ARR 2019 guidelines. The catchment characteristics (slope, % impervious, roughness etc.) were taken from best practice manuals. The hydrology catchment was connected to the main infrastructure to the closest node.

3.1.1 Catchment/ Sub-catchment Delineation

Sub-catchments were delineated using QGIS Whitebox hydrology packages which utilise the DEM to determine flow direction and accumulation of each cell in a raster to determine watershed areas.

Slope for each catchment was applied as a median slope value from the DEM within the area of each catchment. Figure 3 below shows the sub-catchments created for the hydraulic model.

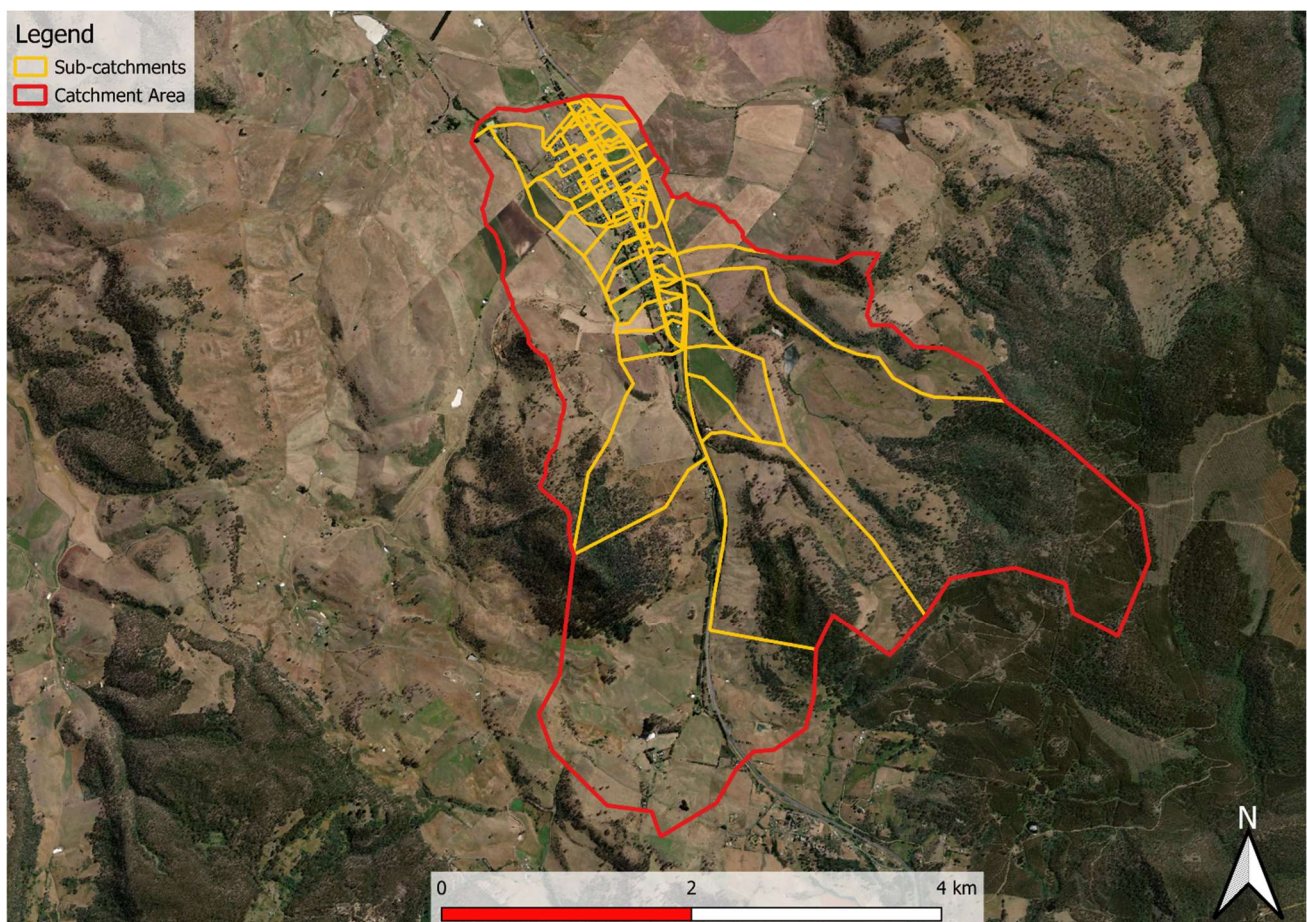


Figure 3. Kempton Catchment Hydrology Sub-catchments

3.1.2 Losses

As the catchment has no gauge to calibrate losses against, initial rainfall losses were sourced from the ARR data hub 2016 for the Kempton area, Table 1.

Table 1. Rainfall losses

Layer type	IL (mm)	CL (mm/hr)
Pervious	24 (ARR datahub)	4.7 (ARR datahub)
Impervious	1 (ARR)	0 (ARR)
Adopted losses	24	4.7

3.1.3 Rainfall

Design rainfall temporal patterns were sourced from the ARR data hub 2016 and combined with the BOM IFD curves (BOM 2016) for the 5% AEP frequency, for durations spanning between 10 min to 6 hours. Table 2 below shows the result of the worst-case median duration hydrology runs.

Table 2. Catchment flows for worst case design storms at 5% AEP

Duration (min)	10	15	20	25	30	45	60	90	120	180	270	360
Catchment flow (m³/s)	5.5	6.8	7.8	8.6	9.6	10.8	11.0	10.5	10.9	10.3	8.7	8.0

3.1.4 Pre-burst Rainfall

As per ARR 2019 guidelines, pre-burst rainfalls should be considered in any modelling scenario. Pre-burst rainfall considers rainfall leading up to the main storm event falling onto the catchment and filling some storage losses prior to the main storm. Median pre-burst depths were downloaded from the ARR data hub.

3.2 Hydraulic Model Set-up

3.2.1 DEM and Grid

The DEM for the Kempton catchment was sampled at 1m cell sizes for consistency; this cell size is more than adequate to represent the topography at this scale. For this model, the Infoworks ICM computational grid works off a flexible mesh (triangle) design, the mesh was given a cell range from 0.5 m² to 10 m². This allows the mesh to produce detail where it is required (around structures and topography changes) and allows a coarser grid where elevation/ structural variance is minimal.

For areas of interest (buildings, roads etc.) a refined mesh was applied to the boundaries to ensure a more detailed mesh is captured in these areas. This mesh ranges from 0.5 m² to 5 m².

3.2.2 Roughness 'n'

Hydraulic roughness values for this model were derived from the ARR 2019 Guidelines. The Manning's values are listed in Table 3

Table 3. Manning's Coefficients (ARR 2019)

Land Use	Piped Infrastructure	Roads	Parks	Residential	Buildings	Inner Residential	Commercial/ Industrial
Manning's n	0.013	0.018	0.05	0.1	0.3	0.4	0.5

The values are placed in the model as land use polygons and sampled by the computational grid. To derive the land use categories, we used the planning layer from the Council along with road, building polygons and aerial images. Figure 4 shows the adopted Manning's values for the hydraulic model for the Kempton study area.

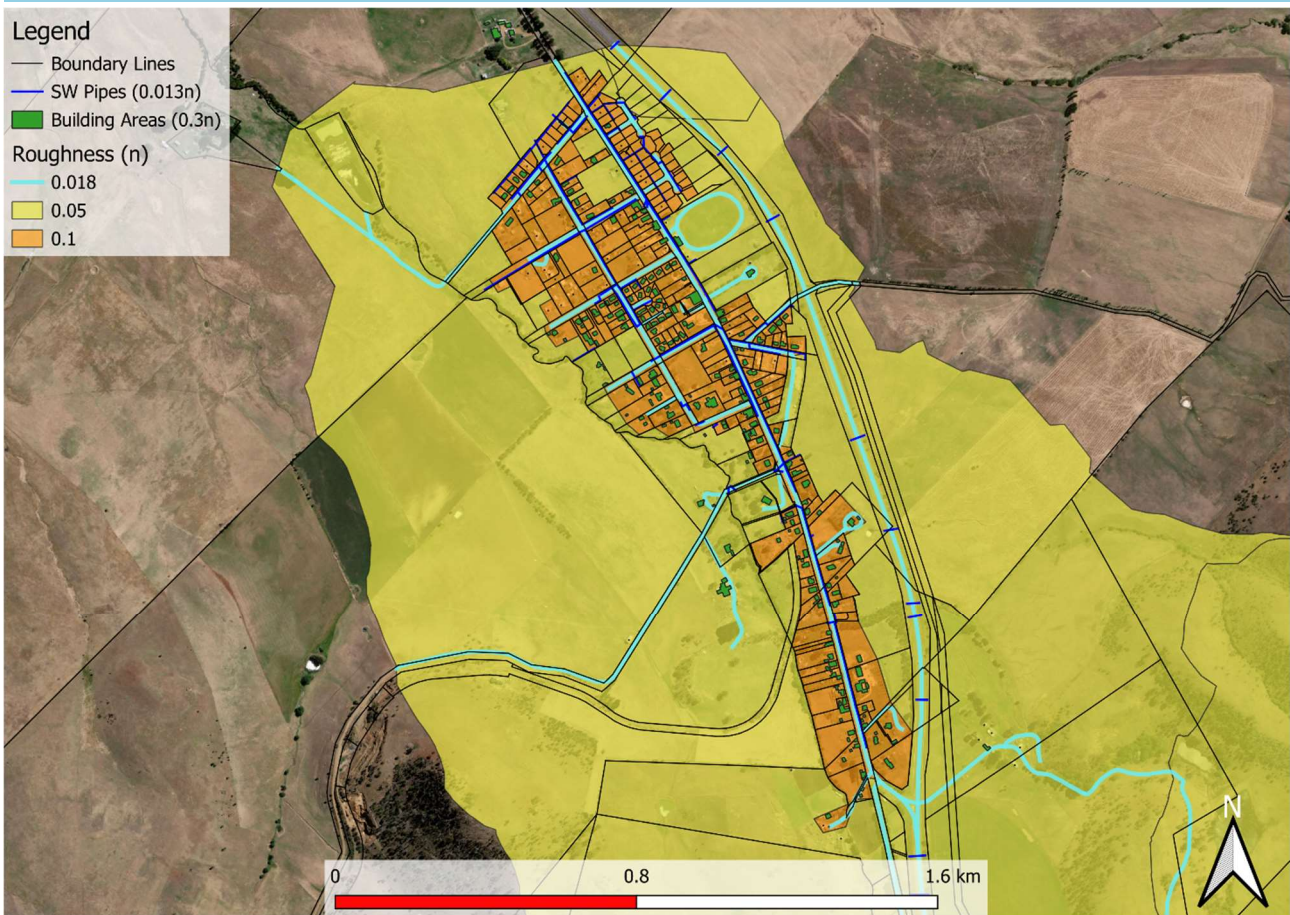


Figure 4. Manning's n derived polygons for the 2D hydraulic model for the study area

3.2.3 Hydraulic Structures

Hydraulic structures are included as either 1D or 2D structures throughout the model, where 1D structures exist a 1D/2D link is provided to allow flow to transition to and from the 2D surface.

Pipes and pits

Pipes and pits were modelled as 1D underground network within catchment area. Pipe and pit data was supplied by the Council for inclusion in the model. Underground pipes were connected via 1D/2D connected pits. Pits adopted an inlet flow limitation based off a double grated pit constants using the following equation.

$$Q = ay^b$$

Where:

Q = flow

a = constant defined in User Equation A value field

y = depth of flow at inlet

b = constant defined in User Equation B value field

Roads

Roads often form the basis for overland flow in low frequency events; however, the kerb and channel are not always picked up by DEM surface. To correct for the drainage lines, mesh polygons were used to delineate road corridors with the roads being lowered by 0.1m to ensure that the kerb is represented in the mesh.

Buildings

Buildings were represented as mesh polygons with a high Manning's n value within the model. This method allows for flow through the building if the flood levels/ pressure become great enough. The aim is to mimic flow through passageways such as doors, windows, and hallways.

3.2.4 Boundary Conditions

Infoworks ICM is a single use software meaning that the hydrology and hydraulic models can be run using the same model. This removes the requirement to have inflow boundary conditions as the hydrology model connects directly to the hydraulic model via a 1D or 2D link.

3.2.5 Calibration/Validation

This catchment has no stream gauge to calibrate the model against a real-world storm event. Similarly, there is little historical information available, and limited available past flood analysis undertaken to validate against the flows obtained in the model.

4. Summary of Results

4.1 Modelling Scenarios

Hydraulic modelling for the Kempton study area was undertaken using Infoworks ICM, supported by the incorporation of the supplied GIS datasets and verified through ground-based site observations. This combined approach allowed for a comprehensive understanding of the stormwater system's behaviour and ensured that the model reflected both the constructed infrastructure and the local catchment conditions.

The results show that, under the 5% AEP design storm, the majority of the stormwater network has adequate capacity to convey flows without causing unacceptable impacts to adjoining properties or creating risks to public safety. The network generally directs flows through the intended drainage paths, with ponding limited to areas where it does not pose significant hazard. See Figure 5 for 5% AEP flood map of Kempton.

However, the integration of GIS data, field observations, and detailed hydraulic modelling also highlighted areas of concern. These are localised points where the system is either constrained by limited hydraulic capacity or affected by local topographic conditions that promote surcharge and surface ponding. While these issues are not widespread, they are important to note for targeted management and potential upgrades. Figure 6 illustrates these locations, which represent the key areas requiring further consideration.



Figure 5. Study Area Flood Map – 5% AEP

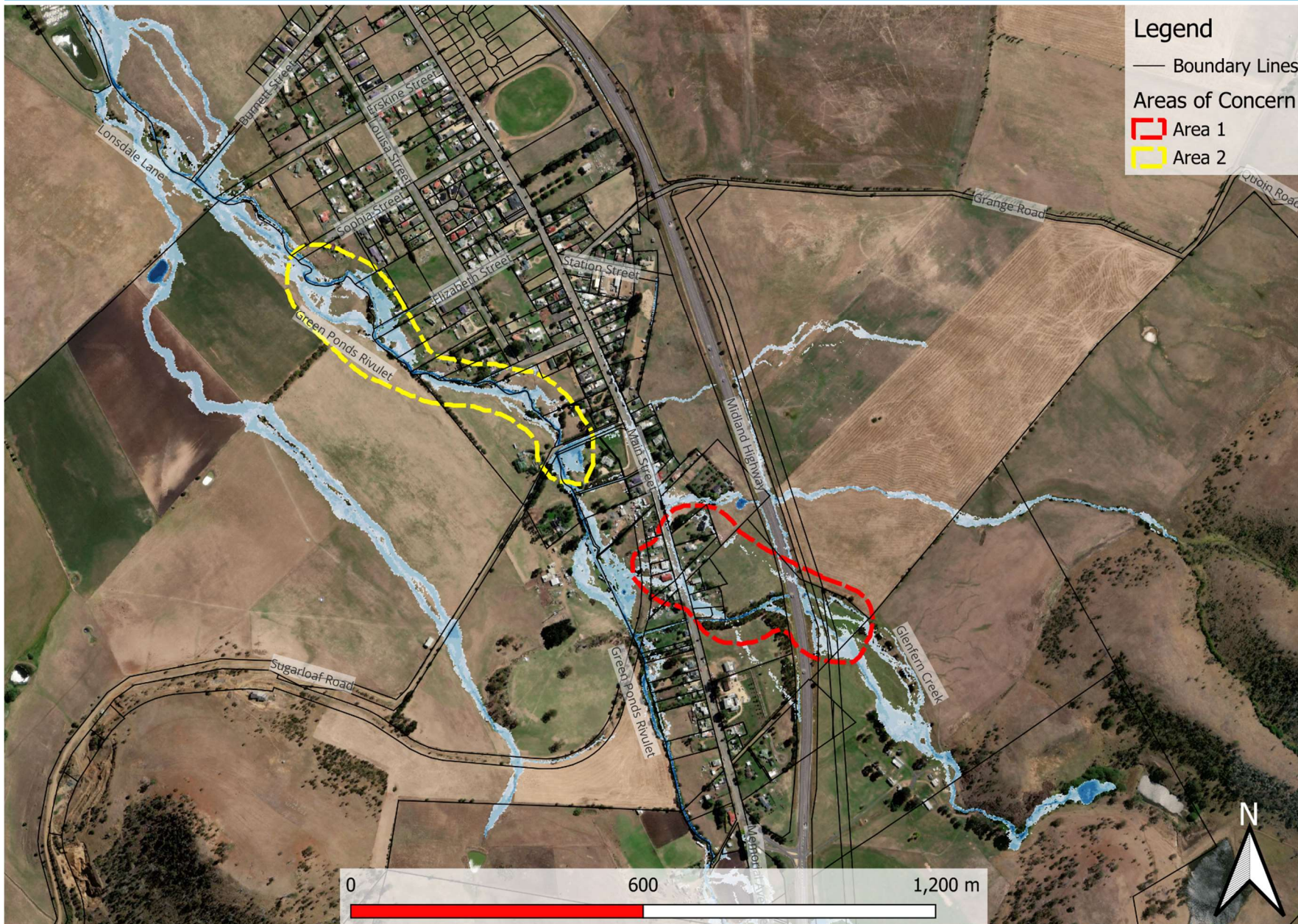


Figure 6. Areas of Concern

4.2 Areas of concern

- **Area 1 – Glenfern Creek from Midland Highway to Green Ponds Rivulet**

Glenfern Creek originates on the hills east of the Midland Highway. During a 5% AEP storm, the creek breaches its banks before crossing the highway and converges with an unnamed watercourse to the south. The combined flow then moves toward the culverts as dispersed overland flow. Because the flow is spread out, it is not fully captured by the two culverts beneath the Midland Highway (Figure 7); some flow bypasses the culvert entrances and is collected in the roadside table drain adjacent to the highway. As this bypass flow moves north, it breaches the table drain where a section is in cut and has reduced capacity. This results in shallow overland flow across the highway, with depths typically ranging from 30–50 mm. While these depths are generally below those required to cause aquaplaning at 110 km/h, they are potentially hazardous due to reduced visibility from wheel spray, particularly for heavy vehicles.

The overland flow from the highway then continues northwest across open paddocks, causing inundation at the rear of habitable buildings at 62 Main Street, with depths ranging from 30–250 mm.

While the uncaptured flow causes some inundation of the highway, the majority of Glenfern Creek’s flow passes through the existing culverts under the highway and traverses the Dysart House property (26 Main Street), conveyed in a heavily overgrown channel approximately 2–3 m deep (Figure 8). When this channel is not functioning at full capacity due to vegetation overgrowth, the model shows that the creek can breach its banks at 44 Main Street and inundate several lots along Main Street before discharging to Green Ponds Rivulet. Typical inundation depths for affected properties are:

- Undeveloped lot Nos. 46 and 44: 30–240 mm
- Habitable buildings Nos. 41, 47, 48, 49, 51, 53, 54, 56, 57: 30–250 mm



Figure 7. Glenfern Creek and unnamed watercourse culvert entries under Midland Highway



Figure 8. (L) Discharge culvert beneath Midland Highway (R) Overgrown Glenfern Creek



Figure 9. (L) Culvert under paddock access at Dysart House (R) Culvert under Main Street

- **Area 2 – Green Ponds Rivulet: Sugarloaf Road to Sophia Street**

Green Ponds Rivulet flows relatively straight until it passes beneath the Sugarloaf Road bridge (Figure 10). Downstream of the bridge, the rivulet meanders between agricultural land to the west and residential lots to the east before reaching Burnett Street to the north.

At the Sugarloaf Road crossing, the rivulet narrows (Figure 11) and receives additional flow from the table drain on the southern side of Sugarloaf Road. This table drain is fed by a DN900 pipe conveying runoff from Main Street and an unnamed watercourse that crosses beneath the Midland Highway. The confluence of these flows, combined with the reduced channel width at the crossing, results in inundation of the north-western corner of 1 Sugarloaf Road, with flood depths of up to 800 mm.

Further downstream, the meandering alignment and constrained channel cross-section of the rivulet cause inundation across multiple lots extending to Sophia Street, with depths ranging from 50 to 400 mm. Although habitable structures along this corridor are not directly affected, there is a high likelihood of property damage, particularly for residential lots east of the rivulet, during a 5% AEP event. The inundation also presents a significant risk of local erosion. Additionally, both habitable and non-habitable structures at 12 Elizabeth Street are located close to areas of substantial inundation, with depths up to 400 mm.



Figure 10. (L) Sugarloaf Road bridge (R) Culvert under Sugarloaf Road



Figure 11. Green Ponds Rivulet downstream of Sugarloaf Road bridge

5. Stormwater Management Recommendations

Analysis of the 5% AEP flood model has highlighted the following areas of concern. Recommended mitigation measures for these locations include:

- **Area 1**
 - Channelise Glenfern Creek and the unnamed watercourse to the east of the Midland Highway. Construct a table drain linking the two culvert inlets on the eastern side of the Highway.
 - Rehabilitate and restore hydraulic capacity of Glenfern Creek running between Midland Highway and Main Street by removing built up weeds and debris.
- **Area 2**
 - Maintenance work along Green Ponds Rivulet.

These works have been proposed as they provide a degree of relief to the immediate flooding for the 5% AEP storm event by either easing or reducing the severity of risk and damages to the catchment and properties. A detailed description of the mitigation options for each have been outlined below where the recommendations are feasible.

5.1 Stormwater Recommendations

- **Area 1 – Proposed watercourse channelisation and rehabilitation of Glenfern Creek.**

Under existing conditions, runoff flowing into Glenfern Creek is generally conveyed under the Midland Highway and through the channel between the Midland Highway and Main Street. However, hydraulic modelling of the 5% AEP storm event indicates that the culverts beneath the Midland Highway cannot fully capture the combined flow from Glenfern Creek and the unnamed watercourse. This results in the downstream highway table drain having insufficient capacity and inundation of the highway to depths of up to 50 mm occurs.

The modelling also shows that the vegetated channel conveying Glenfern Creek between the Midland Highway and Main Street, when overgrown, lacks sufficient capacity to safely convey runoff from a 5% AEP event through to Green Ponds Reserve. This leads to overtopping of the creek banks and inundation of several properties along Main Street, with depths ranging from 30–250 mm, affecting a majority of habitable structures as described in Section 4.2.

To address these issues, the following measures are recommended:

- 1. Channelise Glenfern Creek and the unnamed watercourse to the east of the Midland Highway. Construct a table drain linking the two culvert inlets on the eastern side of the Highway.**

Channelising Glenfern Creek and the unnamed watercourse directs runoff from the eastern hills into the culvert inlets beneath the Midland Highway, ensuring that flow does not bypass the culverts and enter the downstream highway table drain. This is critical because the downstream table drain is in cut and has reduced capacity; while it can safely convey highway runoff, it cannot accommodate the combined flows from Glenfern Creek without overtopping.

Modelling also indicated the importance of connecting the culvert inlet from the unnamed watercourse to the inlet from Glenfern Creek via a cutoff drain. This connection allows for greater storage of runoff at the culvert inlets. Without it, combined flows from Glenfern Creek and the unnamed watercourse could bypass the southern culvert inlet and inundate the shallow table drain downstream. These channels and cutoff drains should be stabilised with dense grass or native vegetation to reduce soil loss and improve infiltration.

- 2. Rehabilitate and restore hydraulic capacity of Glenfern Creek running between Midland Highway and Main Street by removing built up weeds and debris.**

Rehabilitation and ongoing maintenance of Glenfern Creek between the highway and Main Street are critical. The hydraulic model demonstrates that when the channel is under capacity, significant inundation occurs at multiple habitable buildings along Main Street. Once the channel is restored to the required capacity in the post-upgrade model, overland flow no longer breaches the creek bank at 44 Main Street, and all habitable buildings along Main Street up to 64 Main Street are no longer subject to inundation.

The recommended rehabilitation approach for Glenfern Creek between the highway and Main Street includes:

- Vegetation Management
 - Clear excessive or woody vegetation that restricts flow, particularly in the low-flow zone.

- Retain stabilising vegetation on channel batters where possible to prevent erosion.
- Remove invasive species such as blackberries and selectively replant with low-growing native riparian grasses or sedges.
- Sediment and Obstruction Removal
 - Excavate accumulated sediment to re-establish the original channel invert and flow path.
 - Remove debris, fallen branches, and other blockages, especially at culverts or crossings.
- Erosion Control
 - If required, line the low-flow channel with rock or concrete matting to prevent scouring during high flows.
- Ongoing Maintenance
 - Establish a regular maintenance schedule for vegetation trimming, sediment removal, and debris checks, particularly after major rainfall events.

To visualise the flood extent under existing conditions and following the recommended mitigation measures, see Figure 12 and Figure 13.



Figure 12. 5% AEP Pre-Mitigation Option Area 1

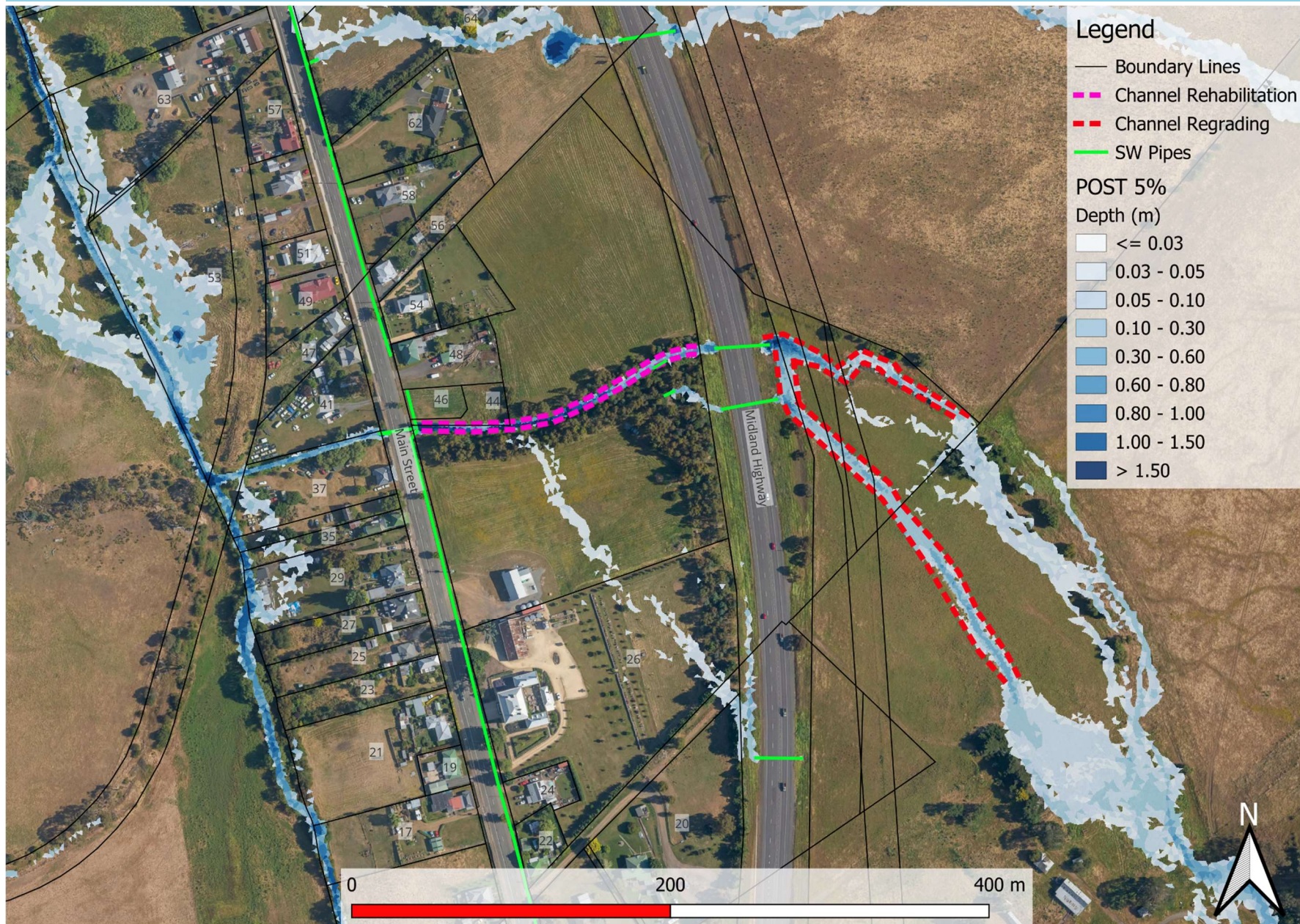


Figure 13. 5% AEP Post-Mitigation Option Area 1

- **Area 2 – Proposed maintenance of Green Ponds Rivulet.**

As noted in the model results in section 4.2, during a 5% AEP storm, Green Ponds Rivulet overtops its banks at several locations between the Sugarloaf Road bridge and Sophia Street. Unlike Area 1, no habitable structures are directly affected, but there is a high risk of property damage to residential lots along the rivulet, with inundation depths ranging from 30–800 mm.

To reduce the extent and depth of inundation along these residential lots, it is recommended that maintenance works be undertaken along the rivulet, focusing on the removal of weeds, debris, and accumulated sediment to restore the channel’s conveyance capacity. Modelled outcomes of these maintenance activities are as follows:

- Inundation has been removed from 2 Sugarloaf Road and 5 Louisa Street.
- Inundation has been significantly reduced at 7 Louisa Street, 15 Old Hunting Ground Road, and 11 Elizabeth Street.
- Minor reductions in inundation extent and depth are observed at 12 Elizabeth Street and 1 Sugarloaf Road.

The recommended maintenance activities include the following:

- Vegetation Management
 - Clear excessive or woody vegetation that restricts flow, especially in the low-flow zone (the base).
 - Retain stabilising vegetation on batters where possible to prevent erosion.
 - Remove invasive species such as blackberries.
- Sediment and Obstruction Removal
 - Excavate accumulated sediment to re-establish the original channel invert and flow path. Care should be taken to minimise disturbance to existing habitat and maintain the natural values of the waterway during this process.
 - Remove debris, fallen branches, and blockages especially at bends.
- Erosion control
 - If necessary, install localised scour protection such as rock armouring or concrete matting in areas prone to erosion.
- Ongoing Maintenance
 - Establish a maintenance schedule for vegetation trimming, sediment removal, and debris checks, especially after major rainfall events.

It was also investigated whether increasing the DN600 culvert under Sugarloaf Road to a DN900 would reduce inundation at 1 Sugarloaf Road. This measure had no noticeable effect on flood extent. Since no habitable buildings are affected in this area, further investigation was not undertaken. However, the modelling suggests that the table drain along Sugarloaf Road may not have sufficient capacity to convey stormwater to the headwall, allowing flows to reach 1 Sugarloaf Road. Addressing this issue would require more detailed investigation but does not form part of this report.

To visualise the flood extent under existing conditions and following the recommended mitigation measures, see Figure 14 and Figure 15.

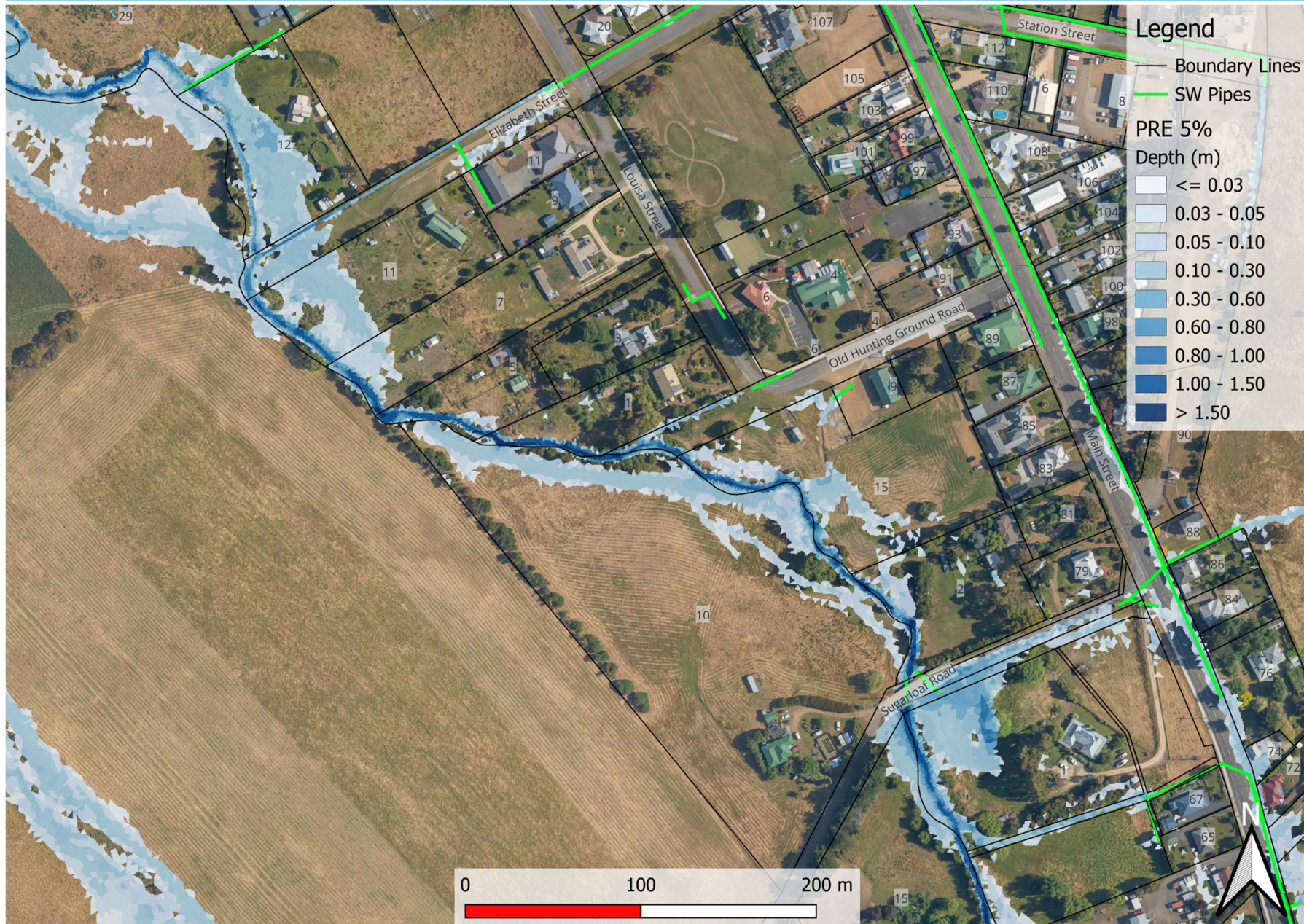


Figure 14. 5% AEP Pre-Mitigation Option Area 2



Figure 15. 5% AEP Post-Mitigation Option Area 2

6. Conclusion

Hydrologic and hydraulic modelling of the Kempton catchment has been undertaken to provide a detailed understanding of the existing stormwater infrastructure and flood behaviour within the catchment. Mapping of the 5% AEP event under current conditions has provided the information necessary to support informed decisions regarding infrastructure improvements and potential mitigation measures.

The stormwater modelling identified two areas of concern (Figure 6), which were assessed for feasibility and potential mitigation measures, including upgrades or modifications to the stormwater infrastructure. These areas of concern, along with the level of investigation and feasibility, are summarised in Table 4.

Table 4. Summary of mitigation options

Area	Description	Feasibility
1	Proposed watercourse channelisation and rehabilitation of Glenfern Creek.	Feasible; however, implementation would require negotiation with State Growth and private landowners to gain access. This is a critical mitigation measure for highway safety and to reduce inundation of habitable properties.
2	Proposed maintenance of Green Ponds Rivulet.	The works are considered feasible but not critical, as they do not directly affect habitable buildings. Undertaking maintenance of the rivulet would require consultation with affected landowners to facilitate vehicular access, and care should be taken to avoid disturbance to the natural values and ecological functions of the waterway.

As shown in Table 4, the mitigation options for Area 1 were feasible and provided the greatest benefit to the community. Channelising and rehabilitating Glenfern Creek would remove overland flow from the highway and reduce the risk of inundation to several properties along Main Street during a 5% AEP event.

Area 2 demonstrated significant inundation of residential lots adjacent to Green Ponds Rivulet. While the inundation levels were considerable in some lots, no habitable buildings were directly affected. Rivulet maintenance was shown to reduce inundation at these lots; however, the overall community benefit is minimal compared to the benefits provided by mitigation in Area 1.

7. General Recommendations

Flüssig Engineers recommends the following:

- Inspect all stormwater pits, pipes, culverts, and open channels at least twice per year and after all significant rainfall events.
- Remove debris, sediment, and vegetation that obstructs flow from all pits, headwalls, inlets, and outlets.
- Ensure grates, lintels, and lids remain secure, undamaged, and free of blockages.
- Clean all stormwater pipes and culverts using high-pressure flushing or mechanical rodding when evidence of siltation or debris accumulation is observed.
- Conduct vegetation trimming and clearing along creeks and open drains to maintain flow paths while preserving stabilising vegetation on embankments.
- Regularly check erosion protection structures such as rock riprap, gabions, and energy dissipators for displacement, settlement, or scouring.
- Inspect bridge openings and culverts for trapped logs, branches, and sediment build-up that could restrict flow.
- Maintain grass cover or ground stabilisation in swales and open channels to prevent erosion.
- Monitor bank stability within creeks and waterways and repair localised slumping or scouring as soon as detected.
- Remove litter, gross pollutants, and leaf matter from side entry pits, inlets, and open channels, particularly in autumn and spring.

8. Limitations

Flüssig Engineers was engaged by **Southern Midlands Council** for the purpose of a Stormwater Modelling Report of the specific Kempton catchment area. This report is deemed suitable for purpose at the time of undertaking the report. If the conditions of the site should change, the report will need to be reviewed against all changes.

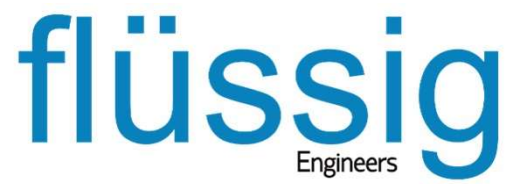
This report is to be used in full and may not be used in part to support any other objective other than what has been outlined within, unless specific written approval to do otherwise is granted by Flüssig Engineers.

Flüssig Engineers accepts no responsibility for the accuracy of third-party documents supplied for the purpose of this flood report.

9. References

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