Part E Chapter 3 Sonstraal to Van der Stel Street Hybrid Flood Alleviation Concept Note

Prepared by AIVIA for Drakenstein Municipality and the GIZ

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Abbreviations

BA – Basic Assessment

CAPEX – Capital Expenditure

CCAP - Climate Change Action Plan

CFRPS - Community Flood Risk Perception Study

DFFE – Department of Forestry, Fisheries and the Environment

DM - Drakenstein Municipality

DWS - Department of Water and Sanitation

EA – Environmental Authorisation

EAP - Environmental Impact Assessment Practitioner

ECO - Environmental Control Officer

ECSA - Engineering Council of South Africa

EIA - Environmental Impact Assessment

EPWP - Expanded Public Works Programme

FAES – Flood Alleviation Ecosystem Services

HGM - Hydrogeomorphic

HFA - Hybrid Flood Alleviation

IDP - Integrated Development Plan

KPA – Key Performance Area

KPIs - Key Performance Indicators

LCA - Landscape Character Assessment

LiDAR – Light Detection and Ranging

MMC - Members of the Mayoral Committee

NEMA – National Environmental Management Act

NbS – Nature-based Solutions

NGO - Non-governmental Organisation

NPO - Non-profit Organisation

OHSA – Occupational Health and Safety Act

OPEX – Operational Expenditure

PCSWMM – Personal Computer Storm Water Management Model

PDO - Pre-determined Objective

PES – Present Ecological State

PPP – Public-Private Partnerships

PSOC – Personnel Specification Occupational Classification

SACPLAN – South African Council for the Planners

SAGC - South African Geomatics Council

SDBIP - Service Delivery and Budget Implementation Plan

SDF - Spatial Development Framework

SDG – Sustainable Development Goals

SOP - Standard Operating Procedure

DM SSN – Drakenstein Municipality Smart Safety Network

TLB – Tractor-Loader-Backhoe

WET-Health – Wetland Health

WULA – Water Use Licence Application

Project Summary: Palmiet River Management – Sonstraal to Van der Stel (Strelitzia Street Focus Area) HFA Project

Project rationale, objectives and approach of project

The Palmiet Catchment is drained by the Palmiet River. For most of its length, it is a cobble, boulder, and gravel river, with pools, riffles and runs. The Upper Palmiet status quo flood extents for the 100-year flood indicates that the low-lying residential area to the north of the Palmiet River is exposed to flooding from the river. This is due to this area being low-lying compared to the residential area to the south. Once the 100-year flood has 'broken' the Palmiet River's banks, it flows through the residential area in a westerly direction. This flow is then largely trapped in Van der Stel Street by the existing landfill to the west due to the landfill being significantly higher than Van der Stel Street, preventing flow back into the Palmiet River. In addition, the low point in the road appears to be located here according to the LiDAR data.

The proposed Hybrid Flood Alleviation Measure for the Palmiet River between Sonstraal and Van der Stel Street focuses on managing flood risk while incorporating environmental restoration and recreational features. The intervention prioritises bank stabilisation, flood management, and improving community access through green infrastructure along the river. The site boundary spans the stretch of the Palmiet River that runs from Sonstraal Road in the east toward Van der Stel Street in the west. The concept plan focuses on a specific component of this stretch where space was identified for flood attenuation infrastructure on the banks of the river – referred to as the Strelitzia Street Focus Area.

The concept includes:

- Check Dams with fishways
- Bank Stabilisation and Erosion Control
- Riparian Planting and Ecological Restoration
- Trapezoidal Retaining Wall
- Stormwater Management
- Recreational and Green Space

The impact of the proposed intervention of a flood berm / flood wall for the 100-year return period flood is that the flooding extent and depth is significantly reduced compared to the current situation. The reduction in flood depth in the northern residential ranges from 0.25m up to 2.0m in some areas. The flood berm/wall does however result in an increase in flood depths in the Palmiet River itself but appears to be contained within the Palmiet only. An increase in the flood berm/wall could be explored to effectively remove floods in the northern residential area in the 100-year flood.

The proposed flood interventions in the upper and lower Palmiet sections, modelled with PCSWMM, show a significant reduction in flood exposure near the project sites, indicating the effectiveness of these measures. A key component, the construction of a flood wall, is intended to protect nearby communities by containing the river flow. However, the wall may also increase downstream flood extents, particularly west of Jan van Riebeeck Drive, as water is channelled further downstream. Additionally, the current modelling has limitations in fully capturing the effects of check dams and river widening on flood attenuation. To address these issues, the Drakenstein Municipality must conduct additional modelling and testing during the detailed design phase. This

should include assessing the downstream impact of the flood wall and exploring potential interventions along the Palmiet River below Jan van Riebeeck Drive to ensure a balanced flood resilience strategy that does not shift risk downstream.

Alignment With Municipal Objectives:

The project aligns with all municipal objectives. It is particularly relevant to Strategic Objective 4, given the strong alignment with maintenance and provision of infrastructure for sustainable service delivery.

Municipal Strategic Objective	Alignment
To ensure good governance and compliance.	X
To ensure financial sustainability to meet statutory requirements.	X
To ensure an efficient and effective organisation supported by a competent and skilled workforce.	X
To provide and maintain the required physical infrastructure and to ensure sustainable and affordable services	X
To plan, promote investment and facilitate economic growth.	X
To facilitate, support and promote social and community development.	X

Key Performance Areas (KPAs) and Pre-Determined Objective (PDOs)

KPAs refer to the areas within the business unit for which an individual or group is logically responsible. PDOs are the areas identified as important or crucial, where a result will assist in the achievement of the set objectives or goal (DM IDP, 2024:67).

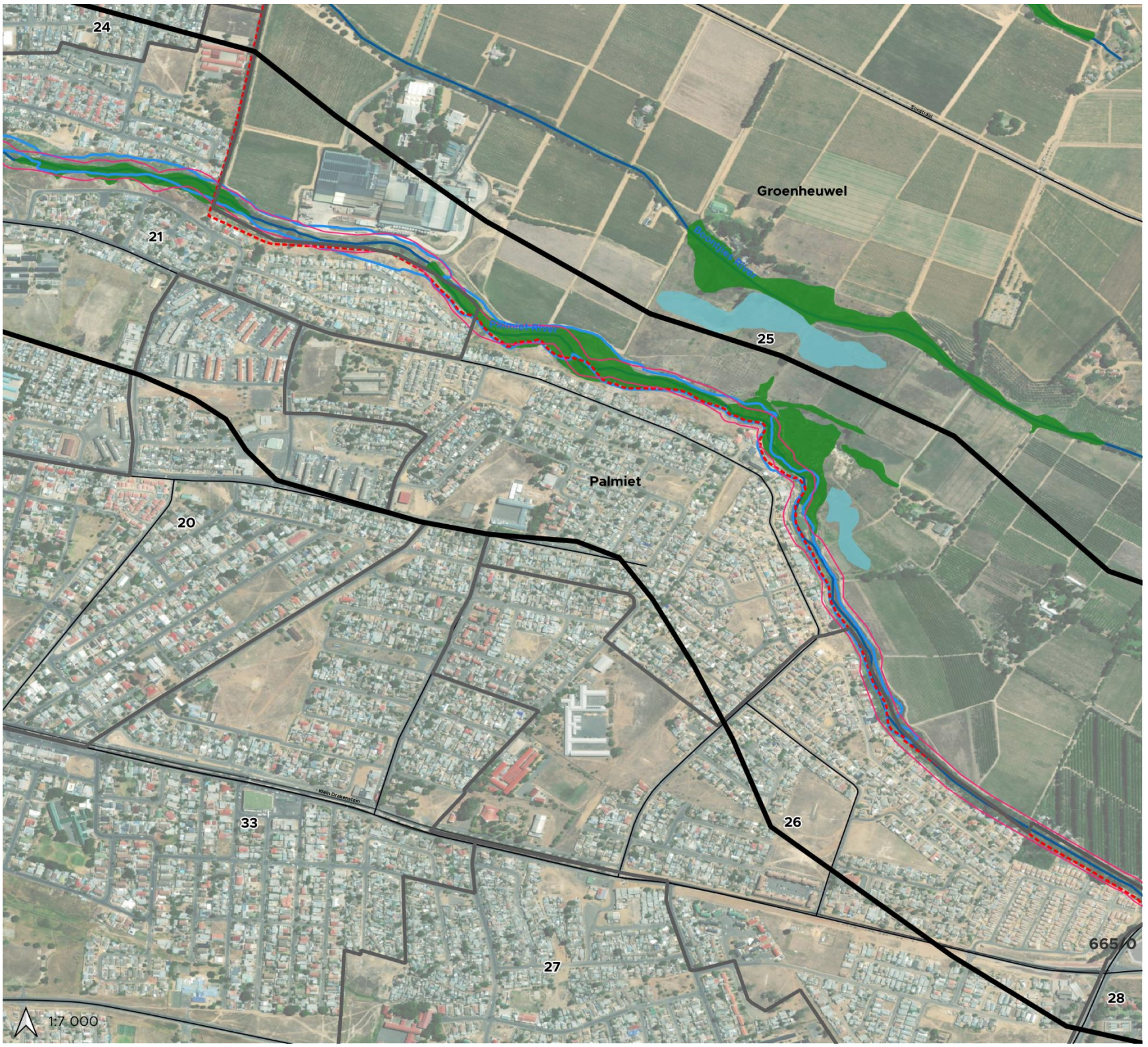
It is recommended that this project be located within **KPA 4: Infrastructure and Services**, under **PDO 23: Transport, Roads, and Stormwater. This is directly aligned with the Strategic Objective *to provide and maintain the required physical infrastructure and to ensure sustainable and affordable services.***

Estimated total project cost

The following table provides a summary of the estimated costs associated with the project.

Cost Category	CAPEX vs OPEX	Total Amount (ZAR)
Planning and Design Cost	CAPEX	7 976 141,38
Construction and Implementation Costs	CAPEX	54 951 624,00
Operation and Maintenance Costs	OPEX	1 381 032,48
Miscellaneous Costs	CAPEX/OPEX	350 000,00
Grand Total		**64 658 797,86**

The estimated total project cost is based on information available at the time of developing the concepts. The Planning and Design costs must be further refined upon the final determination of the specialist studies required. Construction and Implementation Costs as well as Monitoring and Maintenance Costs will be further refined based on detailed designs. As the engineering design progresses, refined estimates can be prepared by the Quantity Surveyor / Cost Estimating Consultant. This would consider local and context specific considerations for the various items.



Palmiet River (Sonstraal to Van Der Stel)

- Roads
- Watercourses
- Urban Edge (2024)
- Catchment Boundaries
- Site Boundary
- Affected Erven

Wetlands

- Channelled valley-bottom
- Seep
- 100yr Floodline
- Ward Boundaries

Drakenstein's Prioritisation Project and Capital Expenditure Criteria

	CRITERIA FOR PRIORITISATION	Y/N
1	Is **legislation regulating this project?**	
	Legislation regulates this project. A non-exhaustive list of national legislation is provided. The Constitution of the Republic of South Africa, 1996; The National Water Act, 1998 (Act No. 36 of 1998); The National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998); The Municipal Systems Act, 2000 (Act No. 32 of 2000); The Disaster Management Act, 2002 (Act No. 57 of 2002); The Water Services Act, 1997 (Act No. 108 of 1997), Spatial Planning and Land Use Management Act (Act No. 16 of 2013), Climate Change Act (Act No. 22 of 2024); Republic of South Africa (2000). Promotion of Equality and Prevention of Unfair Discrimination Act. Act No 4 of 2000. Chapter 5, Section 28; Additional provincial and local legislation and by-laws may also be applicable.	**Y**
2	Will this project **enhance service delivery (roads and storm water, electricity, water, sanitation, and refuse)?**	
	This project will **enhance service delivery (stormwater, water, sanitation, and refuse).** The river management interventions envisaged as part of this project will support the improvement of stormwater management and solid waste management at the site. The project incorporates the use of check dams, plunge pools and river widening which **serves to facilitate more resilient stormwater management services and serves to protect communities and municipal and private infrastructure through flood risk reduction**. **The PCSWMM results undertaken for the DM HFA Project** (AIVIA, 2024) shows that the Palmiet River's (Strelitzia Focus Area) current flood extents for the 100-year flood spills into the residential area to the north of the Palmiet River. This is due to this area being low-lying compared to the residential area to the south. Once the 100-year flood has 'broken' the Palmiet River's banks, it flows through the residential area in a westerly direction. This flow is then largely trapped in Van der Stel Street by the existing landfill to the west due to the landfill being significantly higher than Sonstraal Street and preventing flow back into the Palmiet River. **There is therefore a need for flood alleviation interventions.**	**Y**
3	Is this **project an essential service?**	
	This project is an essential service.	**Y**

	The project supports essential service delivery functions related to stormwater, water, sanitation and refuse removal. It will also provide essential community facilities and supports the reduction of flood risk experienced by the community	
4	Will the execution of this project **stimulate investment in the local economy?**	
	The project will lead to the creation of permanent and temporary jobs linked to Planning and Design, Construction and Implementation, and Operation and Maintenance phases of the project. The improved urban environment and showcasing of successful implementation with community buy-in may also serve to improve investor confidence in the area. The level of investment estimated in the planning, design, and construction phase of this project will create an estimated 114 indirect jobs in the national economy, from the supply of inputs required for the project. Estimated level of expenditure is expected to induce 185 jobs in the economy as project workers spend their wage. Many of these will be in Drakenstein if local suppliers are used. It is estimated that this investment will return 1.68 times the investment, in income for the economy, an estimate R105 million. Wages paid by construction firms during the construction phase will also stimulate economic activity and lead to investment.	**Y**
5	Will this project **enhance the quality of life our local community and be for the benefit of the local community?**	
	The project aims to enhance the quality of life the local community and be for the benefit of the local community. The communities who reside on the banks of the Palmiet have noted that the presence of the river and their recent experiences of flooding (in 2023 and 2024) have created an awareness of the potential flood impacts and have also caused significant anxiety relating to these impacts. Communities along the Palmiet have experienced significant property damage as a result of heavy rainfall events, and therefore the river management and flood attenuation infrastructure will aim to improve the flood resilience of the community whilst also helping to reduce the fear associated with heavy rainfall.	**Y**
6	Will this **project lead to permanent job creation?**	
	The project components will include opportunities for job creation for local communities during the construction phases and operation and maintenance phases. The operation and maintenance in relation to the open spaces, landscaping, solid waste management, play area equipment and the stormwater ponds will require on-going human resource contributions. This may include the involvement of community members in voluntary project stewardship, the leveraging of the	**Y**

	enhanced public works programme (EPWP), as well as other job creation opportunities. Secondary effects of expenditure in the local economy will also create permanent jobs in the local and national economy. A high-level estimate of permanent direct and induced jobs is provided in the jobs estimates**.** The proposed intervention is expected to create approximately 2 permanent jobs in maintenance from the following jobs: Foreman, Mower operators, Planters, Driver and General worker. It is important to note that the 2 permanent jobs are a collection of fractions of jobs, therefore, there are more job types than jobs. The level of investment estimated in the planning, design, and construction phase of this project will create an estimated 114 indirect jobs in the national economy, from the supply of inputs required for the project. Estimated level of expenditure is expected to induce 185 jobs in the economy as project workers spend their wage. Many of these will be in Drakenstein if local suppliers are used. See also the Job Creation Potential Section E3.7.	
7	Is this project labour intensive/ will this project lead to **temporary job creation?**	
	The project components will include opportunities for job creation for local communities during the construction phases and operation and maintenance phases. The operation and maintenance in relation to the open spaces, landscaping, solid waste management, play area equipment and the stormwater ponds will require on-going human resource contributions. This may include the involvement of community members though voluntary project stewardship, the leveraging of the enhanced public works programme (EPWP), as well as other job creation opportunities. Jobs estimate in this report are based on typical construction techniques. The is some scope to increase the labour intensity of these by using more labour-intensive techniques, particularly in relation to earth moving work. This would likely increase the estimated delivery times. The proposed intervention will likely create an estimated 25 job-years in the design and construction phase. In the design phase the eight temporary job years created will nearly all be highly skilled jobs in professional firms (Engineering, Landscape Architecture, Planning, Scientific Services). All of these will be green jobs. In the construction phase, the 17 job years created will include three highly skilled job years, nine semi-skilled job years and five low-skilled job-years. All of these will be green jobs except seven semi-skilled jobs, which will be made up of guards for 24-hour site security. All maintenance job are green jobs. Other semi-skilled jobs include security will be excavator operators, TLB operators, dump truck operators, planter, and gabion basket makers. See also the Job Creation Potential Section E3.7.	**Y**
8	**Will this capital expenditure / project generate significant additional revenue for the municipality?**	

	The project is not likely to generate significant additional revenue for the municipality. However, the components of the project provide essential basic services to communities and aims to respond to the need for flood risk reduction in the area. As such, the benefit of this project includes the protection of municipal and private infrastructure, the protection of livelihoods and community assets, and may result in cost savings due to improved infrastructure maintenance and management. This infrastructure does not sit in any of the trading services departments and is therefore not a direct revenue generator. Some elements may have access charges (such as braai facilities, and bird watching facilities) but these revenues will be small. They are likely to have operating cost reduction impacts on both water services and solid waste services. Natural water treatment services provided by these interventions will reduce water treatment costs for water abstracted form the Berg River. Increased litter trapping mechanisms provided by the intervention will also reduce damage to water infrastructure and cost of ad hoc waste removal elsewhere in the stormwater system and the municipality. The net effect is likely an increased surplus or reduced deficit in water services and solid waste management and reduced operating costs in stormwater management.	**N**
9	Will this **project improve the aesthetical appearance of the city / town?**	
	Creating an aesthetically pleasing urban river system will improve the appearance and cleanliness of the river, which will in turn improve the overall value to the municipality.	**Y**
10	Will the execution of this project **contribute to the social upliftment of the community?**	
	The project will reduce the vulnerability and direct flood exposure of the communities adjacent to the Palmiet River and aims to create recreational and economic contributions to the local communities along the riverbanks.	**Y**
11	Does this project comply with the **developmental directions of the municipality's spatial development framework?**	
	River management and flood attenuation interventions are aligned with the DM SDF given that the waterways and riverbanks are designated as Green Space. Land use change will have a significant impact on catchment hydrology and flood risk. Development is associated with an increase in impermeable surfaces which will contribute to increased runoff and peak discharges in the absence of attenuation interventions.	**Y**
12	**Must this project be implemented now?**	

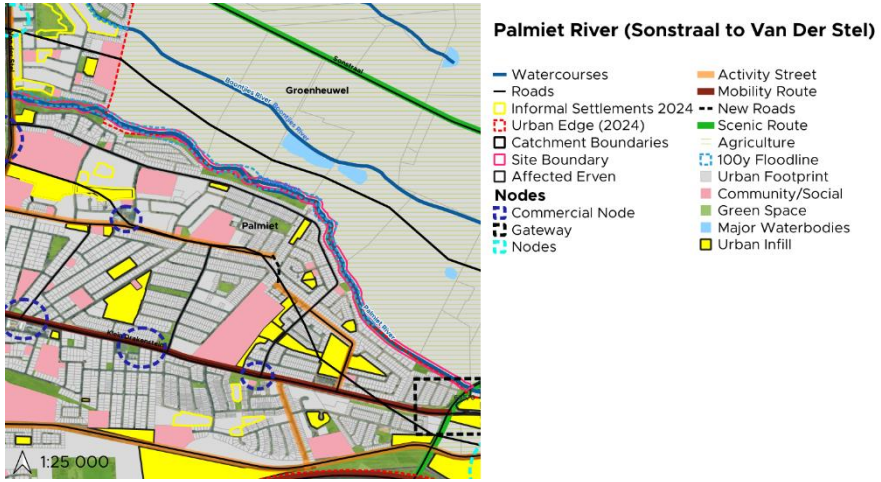
	The project is essential to achieve the required flood risk reduction outcomes necessary to alleviate flooding. See also Point 2 in this table. Without intervention municipal infrastructure and residences will be lost and/or damaged, which will incur direct and indirect costs in terms of emergency response and repair/replacement of infrastructure.	**Y**
13	**Is there a time factor involved for this capital expenditure / project that will negatively influence any other capital expenditure / project or foreign investment in infrastructure?**	
	The project forms part of a broader Hybrid Flood Alleviation Programme, and this project was identified as part of the Stage 1 Priority/ Catalytic Projects.	**Y**

E3.1. Informants: Palmiet River (Sonstraal to Van der Stel Street) Hybrid Flood Alleviation Project

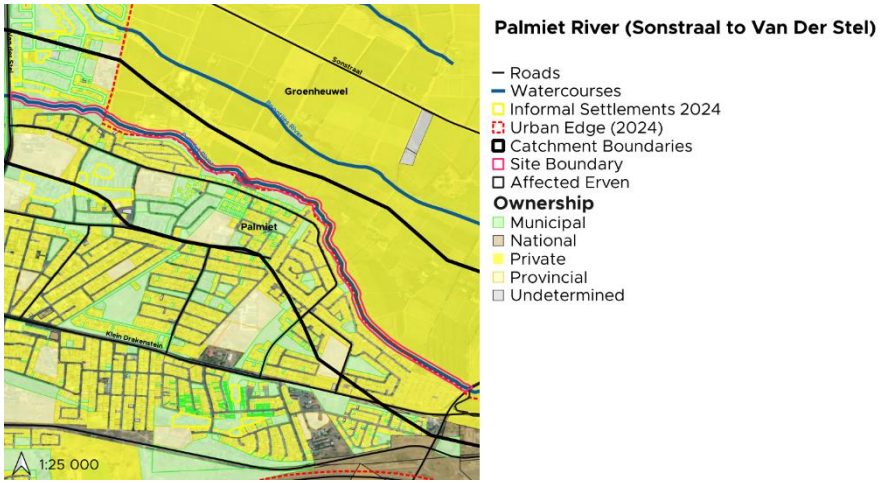
Urban Context

This site is located upstream along the Palmiet River, between Sonstraal and Van der Stel Street. This stretch of the Palmiet River flows east to west, passing through Klein Nederburg and Charleston Hill/ Chicago. Two sections of this stretch of the Palmiet River formed part of the landscape character assessment. The first was an area in proximity to Lloyd Street and was classified as having an "**eroded gully**" character. The Strelitzia Street area further downstream also formed part of the LCA and was identified to have a "**Polluted Waterway**" character. This stretch of the Palmiet River runs from Ward 25 on the northern bank and Ward 26 in south-west toward Ward 21. The banks are designated as Green Space in the **2024 DM SDF**.

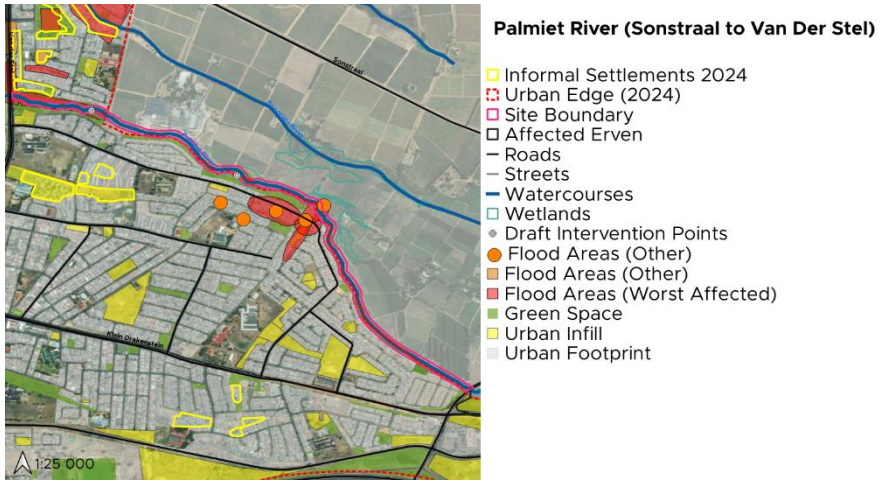
The banks of this stretch of the Palmiet includes both privately owned and municipal owned properties. The project site is located on **Erf: 613/0, 665/0, 1675/0, 17607, 665/6, 665/1, 17608, 17604, 17603, 17600, 17599, 17596, 17595, 17592, 17591, 17588, 17587, 17584, 17610, 17583, 17579, 17578, 17577, 17576, 17575, 17574, 17573, 17570, 17489, 17488, 17470, 17480, 17479, 17478, 17477, 17476, 17475, 17474, 17473, 17469, 17464, 17463, 17490, 625/0, 612/8, 22062, 10490. 22160, 10284, 15547, 15548, 15549, 15550, 10449, 10296, 1635/0, 612/13, 612/11, 31542, 31540, 31541, 9335, 31039, 8811.** Ten properties (Erf 17610, 1750, 17490, 612/8, 10490, 22160, 10284, 10449, 10296 and 9335) on which the site is located are **municipal-owned** and the site totals 212 hectares in size.



Part E Chapter 3 Map 1. Project Site in the context of the SDF



Part E Chapter 3 Map 2. Land Ownership



Part E Chapter 3 Map 3. Flood Areas identified by CFRPS Participants

In July 2024, a Community Flood Risk Perception Study (Community Flood Risk Perception Study Report (Phase 2) AIVIA, 2024) was undertaken with community members from wards (9,11,12,16,19,21,22,24,25, and 28 – based on the DM 2021 ward boundaries). Community Flood Risk Perception is defined as the understanding of **community and individual experiences of flooding including the causes, impacts and perspectives on required flood alleviation interventions** and as such, the fieldwork findings of the study are inherently subjective. As part of this session, community members were asked to identify the areas where they personally experienced the worst flooding impacts. They were then also asked to identify any other flooding areas they were aware of. This data was mapped during the participation sessions and subsequently digitised. The areas identified by the CFRPS participants are shown in Part E Chapter 3 Map 3 and reflect the experiences of the community (and are therefore subjective and based only on the views of the participants of the session).

The areas between Stein Street and Kanna Street were identified by the Participants of the Community Flood Risk Perception Study as being among the worst flooding areas along the Palmiet. Flooding typically occurs just east of Van der Stel Street. These areas are also prone to damage due to riverbank erosion.

Landscape Character

Two sections of this stretch of the Palmiet formed part of the LCA: - Lloyd Street and Strelitzia Street Sites.

Lloyd Street

Dominant landcover & Landscape elements include:

- Large-scale erosion of embankments
- Steep embankments
- Alien vegetation within waterway
- Deep incision of riverbed
- Surrounding residential community and vineyards
- Visible dumping on adjacent open land

Landscape Elements & Features: Settlement, vegetation, hydrology & movement: There are surrounding residences with boundary walls close to the river edge. The highly erosive character of this stretch of river, particularly during flooding poses an increased safety risk for residences. The river is deeply incised with unstable vertical, near vertical, and undercut banks. There is an open section of land adjacent to the river that is currently being polluted by dumping. This section is accessible to the surrounding residential community with no existing safety measures in place. The river corridor at this point is narrow, constrained by agricultural land on the northern bank and residential properties on the southern bank.

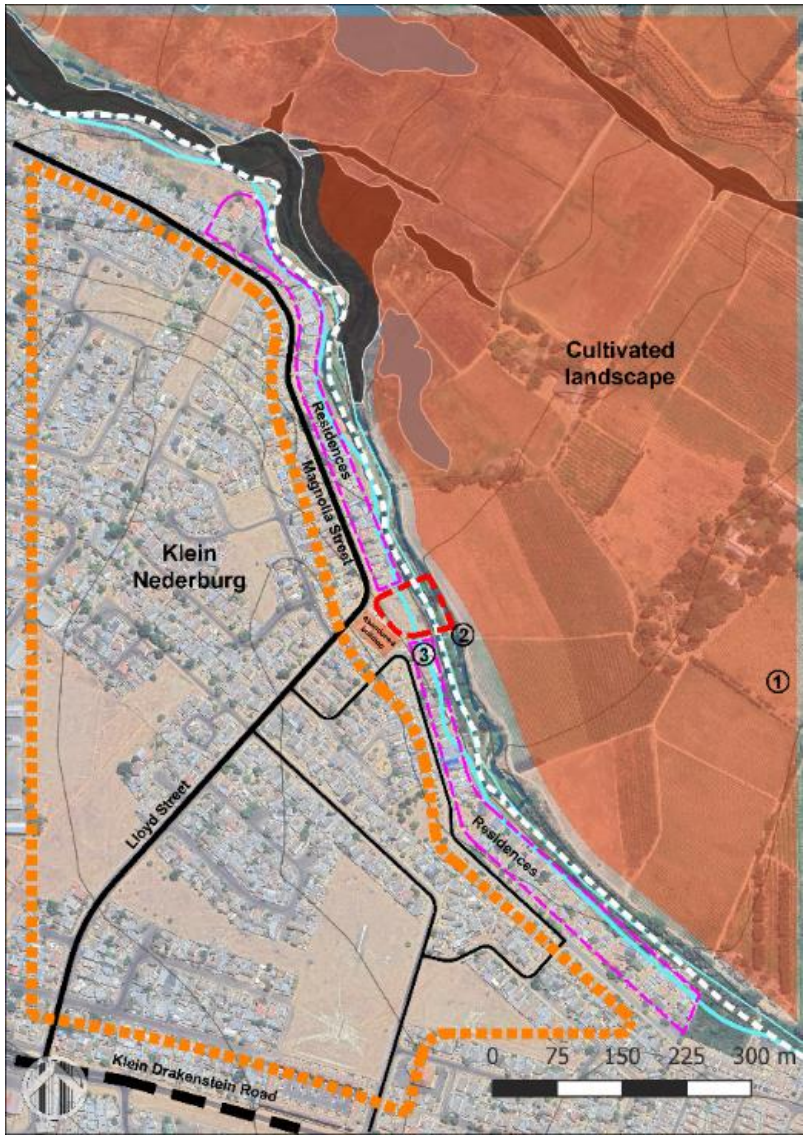
Landscape Perception & Viewshed: The landscape can be perceived as unsafe because of the steep eroded embankments of the Palmiet River with no safety barriers in place. Additional security concerns are the blind corners created by the edges of the residential houses and an abandoned building that may be used for antisocial activities. The viewshed includes the Hawequas mountain range as a backdrop to the existing residential neighbourhood. The river creates the perception that it delineates the urban edge with different land uses on either bank. The site is enclosed and unsafe with views only opening up across the river to the east. The water in the river during low flow is mostly not visible due to the depth of the incision and the invasive vegetation growth, leading it to be perceived as a gully rather than a functional river.

Landscape Condition: This section of the Palmiet River has highly eroded and steep embankments with loose soils and limited indigenous vegetation. Existing vegetation consists of a community of predominantly alien invasive plant species that have a fast growth rate. There is a deep incision of the riverbed that is indicative of high water-flow velocities. This narrow channel can increase waterflows resulting in greater erosive potential of embankments.

Landscape Constraints: The transformed landscape of surrounding vineyards presents a risk of increased nutrient load entering the waterway through stormwater runoff from nearby cultivated landscapes and activities that use fertilisers. This provides favourable conditions for the growth of alien vegetation and decreased indigenous biodiversity. Illegal dumping on the residential edge negatively affects the health of the river and the perceived value of the river corridor. The depth of the river along this stretch and the lack of space for intervention pose significant constraints.

Landscape Opportunities: Vegetated terraced gabions with reno mattress can stabilise and rehabilitate loose soils of the embankments and dissipate water-flow velocities. A phased approach to the removal of alien vegetation and a robust revegetation strategy would reduce the risk of increasing embankment instability. Upstream interventions such as connecting the river with the adjacent floodplain, rock riffles and cascades can be considered to reduce the flow rates entering this stretch of the river, and to counter riverbed incision. Identification of the nick point at the head of

the incision would be beneficial in developing an overall strategy to deal with this challenge.



Part E Chapter 3 Map 4. LCA: Lloyd Street Character Area Map

Part E Chapter 3 Image 1. The photograph shows overgrown vegetation around the Palmiet River, with the cultivated landscape and Hawequas mountain range in the background.

Part E Chapter 3 Image 2. This section of the river is deeply incised with eroded embankments.

Part E Chapter 3 Image 3. The eroded embankments pose a safety risk to the stability of residential development close by.

Strelitzia Street - Polluted waterway

Dominant landcover & Landscape elements include:

- **Encroachment into river corridor**
- **Residential settlement edging the river**
- **Dumping within waterway and surrounds**
- **Visible alluvial sediment from erosion upstream**

Landscape Elements & Features: Settlement, vegetation, hydrology & movement

The residential community (Charleston Hill) to the east of Van Der Stel Street is situated adjacent to the Palmiet River where some homes have encroached the edge of the waterway. There is an existing waste drop-off area immediately adjacent to the river, and a transformed cultivated landscape adjacent to the community along the river. The embankments are grassed with limited riparian vegetation and tall established pine trees near Van Der Stel Street. The river widens out in this stretch and develops a riffle-pool sequence. Sedimentation and active low-flow channel migration are evident in this stretch. The southern bank is much higher than the northern bank and some of the stormwater pipe outfalls on the southern bank have eroded back, creating steep channels. The river is fragmented by roads, edged by residential development and steep eroded topography. Children were seen playing in the river in this area during both site visits, and desire lines indicate that people regularly cross the river.

Landscape Perception & Viewshed:

The topography slopes upwards to the south of the Palmiet River. There is a residential community on higher ground (Klein Nederburg) and one at a lower elevation (Charleston Hill), adjacent to the river. The steep slope is not a welcoming interface from below as it is not easily accessible. There is no connection between the two communities. The urban and cultivated landscape of Paarl is largely visible at the top of the slope with the Paarl Mountains to the West and Hawequas Mountains to the East. The river corridor is a harsh landscape with limited trees for passive recreation. The landscape is exposed and there are views both towards the mountains and over the valley.

Landscape Condition:

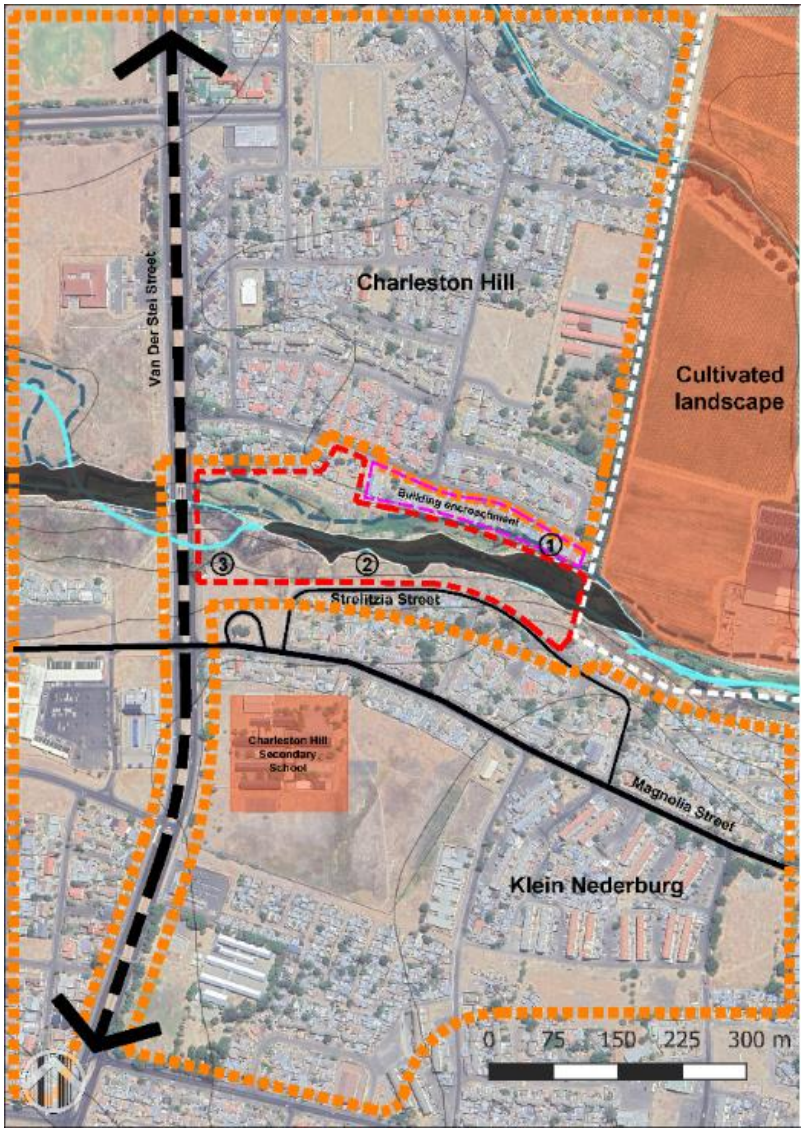
There is an accumulation of sediment at this downstream section. The river's buffer zone is grassed. Encroachment of residential developments within the river corridor can be seen, as well as visible dumping.

Landscape Constraints:

Over time, the clearing of land for cultivation can disturb existing soils as naturally growing vegetation is removed. This can destabilize the surrounding soils of nearby rivers, resulting in erosion and the widening of river profiles that presents a safety risk. Eroded soil is transported as sediment downstream and as it deposits, the build-up reduces the capacity of river to hold high water volumes of water during seasons of increased inundation. This can increase the flood zone and is a safety risk; especially for residents on lower elevations and close to the river. Encroachment onto the river and active infilling of the floodplain are potential concerns.

Landscape Opportunities:

Activating the edge of Strelitzia Street and engaging with the residents along the street would improve the perception of the river corridor. The connection of the community can be strengthened through education and recreation.



Part E Chapter 3 Map 5. LCA: Strelitzia Street Character Area Map

Part E Chapter 3 Image 4. This photograph shows where dwellings are encroaching on the river's banks and buffer edge.

Part E Chapter 3 Image 5. This shows the Palmiet River with a wide profile and grassed edges that are not maintained.

Watercourses, Wetlands and Flood Risk

Rivers and Stormwater Infrastructure

The Palmiet Catchment in the south is drained by the Palmiet River. For most of its length, the river is a cobble, boulder, and gravel river, with pools, riffles and runs.

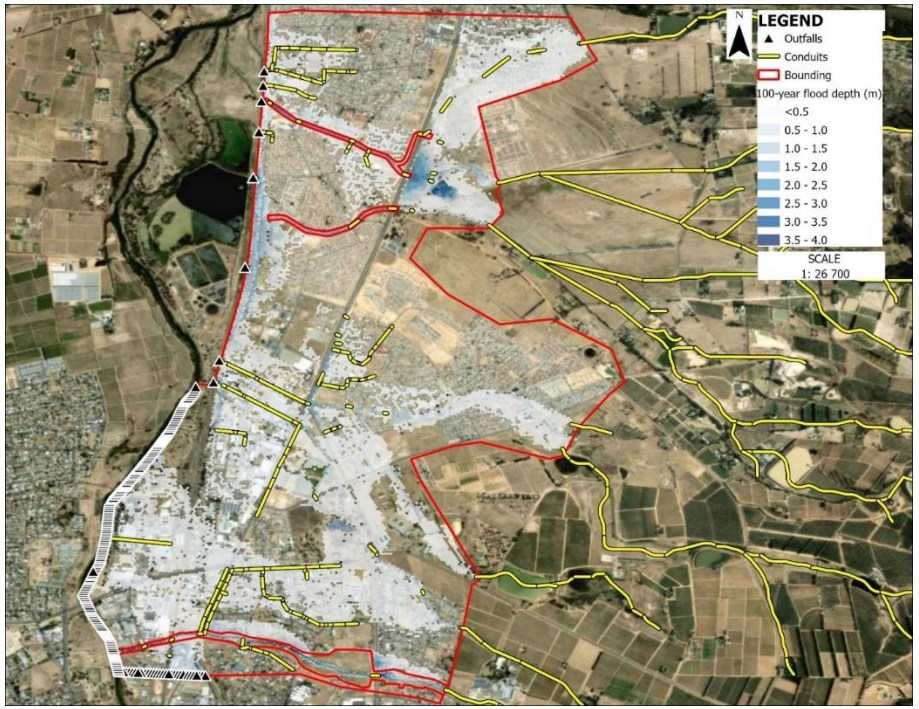
The PCSWM modelling results (current)

The PCSWMM results indicate that the residential area east of Van der Stel Street will be flooded during the 20- and 100-year flood event. Flood depths of up to 1.5 m are anticipated for the 20-year event while **depths of up to 2.3 m are anticipated for the 100-year flood**. It should be noted that these deep flood depths are confined to specific areas and that the majority of the area will experience flood depths of below 0.5 m. **Flooding of the northern residential area to the east of Van der Stel Street can be attributed to the height difference between the low-lying residential area and the elevated rehabilitated landfill which impedes water flow causing stormwater to flow into the low-lying residential area. The areas east of Van der Stel are included within the stretch of the Palmiet from Sonstraal to Van der Stel.**

The 5-, 20- and 100-year floods lead to flooding of the residential area between Jan van Riebeek Drive and Van der Stel Street. Flood depths associated with the 5-year flood flooding are below 0.5 m with only selected areas experiencing flood depths of greater than 0.5 m. Flood depths associated with the 20- and 100-year flood range up to 1.5 m, with flood depths in excess of 0.5 m being more widespread.

For the 100-year flood, flood depths in the order of 1.5m could be experienced in the industrial area west of Jan van Riebeek Drive towards the outlet of the Palmiet catchment. Flooding of this area can be attributed to the area's low-lying topography and railway line which acts as a berm or dyke preventing the free flow of runoff.

The simulated flooding in this catchment is a result of the steep slopes and the high design rainfall depths (in the order of 321 mm for a 24-hour period) associated with the Palmiet's headwaters. The Palmiet River channel transitions from an incised, deep and narrow channel to a relatively shallow braided river. Steep slopes, high rainfall intensities and insufficient capacity within the river channel leads to flooding of the residential and industrial areas adjacent to the Palmiet River towards the bottom of the catchment.



Part E Chapter 3 Map 6. 100-year flood

Wetlands

Wetlands offer three flood alleviation ecosystem services (FAES) – namely Flood Attenuation, Streamflow Regulation, and Water Quality Enhancement, where the following ratings apply:

- 0= absence
- 1 = poor
- 2 = moderate
- 3 = high
- 4 = very high

These FAES differ in relation to the position of the wetland relative to the overall catchment. In the DM HFA Programme, the catchments were each divided into upper, middle and lower reaches. The FAES also differ depending on the type of wetland, as different wetland types are able to offer different levels for each respective FAES. The ability of a specific wetland to provide the three FAES in relation to their location in the catchment is detailed in the DM HFA Ecological Assessment (Ecological, Infrastructure and Infrastructure Assessment, AIVIA, 2024), where the rating of the potential for supply of ecosystem services by a wetland or river, based on hydrogeomorphic (HGM) type, and climatic setting (humid to sub-humid, and semi-arid) is further explained. For this study, all scores apply to wetlands and rivers in good condition and the process was adapted from WET-EcoServices Version 2 (Kotze et al., 2020). This provides guidance on the nature of intervention that might be required to rehabilitate, restore or protect the wetlands to enable them to offer the maximum FAES as they would if they were in good condition. The actual condition of the wetland is also known, based on the DM HFA Ecological Assessment, which used the rapid Level 1A WET-Health assessment protocol (MacFarlane et al., 2020) to determine the **Present Ecological State of the hydrology, geomorphology, water quality and vegetation of the wetlands in the three catchments forming part of the DM HFA**. The method is based on the hydrogeomorphic (HGM) approach to wetland typing, providing a PES score for a wetland within each of the four condition modules – hydrology, geomorphology, water quality and vegetation - and a combined overall score for wetland health. The PES score provides a quantitative measure of the extent, magnitude and intensity of deviation from the reference or unimpacted condition, and places the wetland in a wetland health category, A – F. The Level 1A WET-Health assessment uses land cover as a surrogate for the severity or magnitude of an impact, where this is assumed to be linked to land use.

Part E Chapter 3 Table 1. Present Ecological State categories used to define the overall health or integrity of a wetland (from MacFarlane et al., 2020). Colour-coding is according to the River EcoStatus Monitoring Programme of DWS.

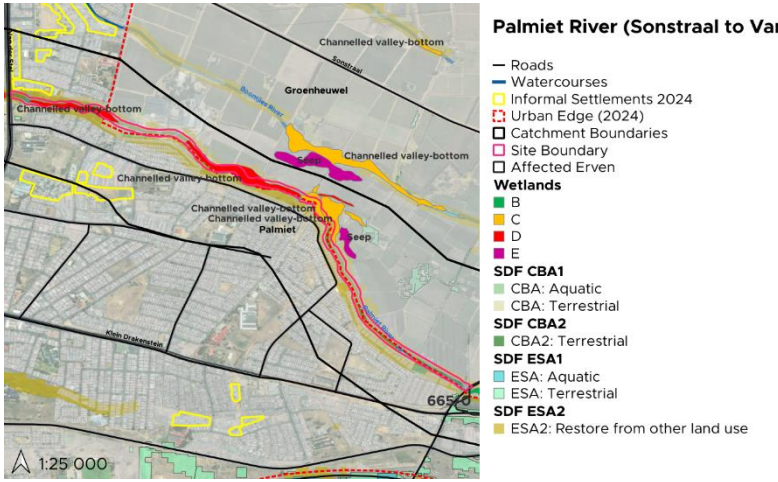
CATEGORY	PES SCORES (%)	DESCRIPTION
A	90 – 100	Unmodified, natural.
B	80 – 89	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.
C	60 – 79	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats and biota may have taken place.
D	40 – 59	Largely modified. A large change in ecosystem processes and loss of natural habitats and biota has occurred.
E	20 – 39	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognisable.

CATEGORY	PES SCORES (%)	DESCRIPTION
F	**0 – 19**	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.

A channelled valley-bottom wetland runs through this stretch of the Palmiet.

Part E Chapter 3 Table 2. Flood Alleviation Ecosystem Services Provided by wetlands in relation to the project site based on optimal condition. (Ecological, Infrastructure and Land Use Report, AIVIA, 2024)

HGM types:	Ecosystem services:		
	Flood attenuation	Streamflow regulation	Water quality regulation
Channelled valley-bottom wetland	2	2	3.5
	3	1.5	3



Part E Chapter 3 Map 7. Wetlands and Watercourses

With a PES score of D, the wetland condition has been largely modified, and a large change in ecosystem processes and loss of natural habitats and biota has occurred.

Informants Summary

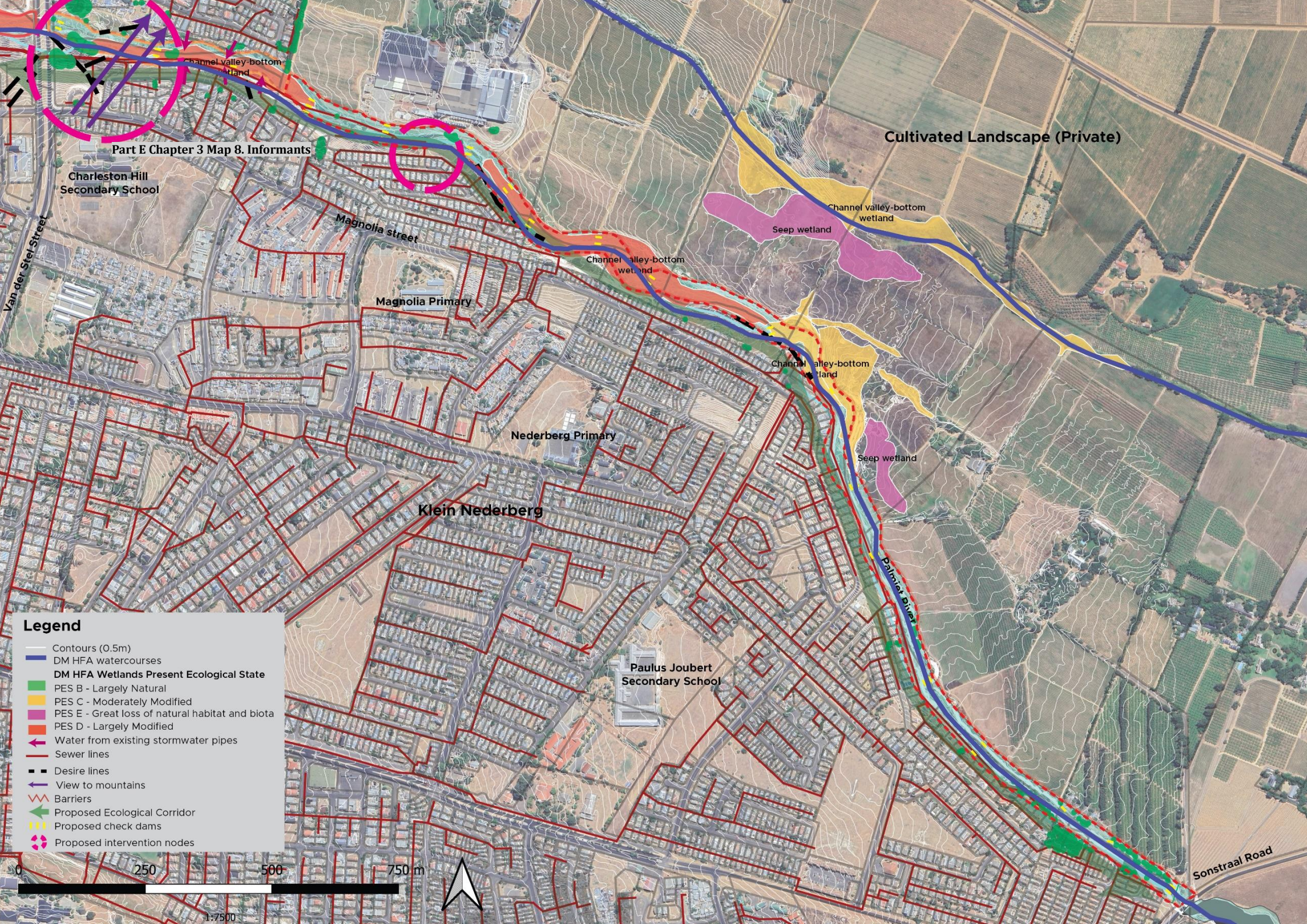
The Palmiet River experiences high velocity flows, erosion and incision, and communities located in urban areas along the Palmiet have experienced the effects of these characteristics. Some properties have been totally destroyed (Ward 25), and others have experienced significant property damage (Ward 21- Chicago).

During the flood risk perception study, communities in these areas expressed the need for the improved management of the rivers to reduce flood risk to their properties.

The river flows from upstream of the urban areas, and the management of flow velocity points to the need for the strong consideration of implementing interventions in the upstream areas. Beyond this concept note, proposed interventions in upstream areas have also been identified.

Key Opportunities:

- Promote flood alleviation in areas of attenuation wherever possible.
- Manage flow velocity though rehabilitation and revegetation of riparian zones, including implementation of check dams.
- Reduce bank erosion; remove alien vegetation; promote solid waste management, and reduce peak flow to promote flood alleviation in **Strelitzia Street** and further downstream.
- Identification of the Strelitzia Street section of the Palmiet River as focus area.


Part E Chapter 3 Map 8. Informants
Charleston Hill Secondary School
Van der Stel Street
Magnolia street
Magnolia Primary
Nederberg Primary
Klein Nederberg
Paulus Joubert Secondary School
Cultivated Landscape (Private)
Channel valley-bottom wetland
Seep wetland
Palmiet River
Sonstraal Road
Legend
Contours (0.5m)
DM HFA watercourses
DM HFA Wetlands Present Ecological State
PES B - Largely Natural
PES C - Moderately Modified
PES E - Great loss of natural habitat and biota
PES D - Largely Modified
Water from existing stormwater pipes
Sewer lines
Desire lines
View to mountains
Barriers
Proposed Ecological Corridor
Proposed check dams
Proposed intervention nodes
0
250
500
750 m
1:7500

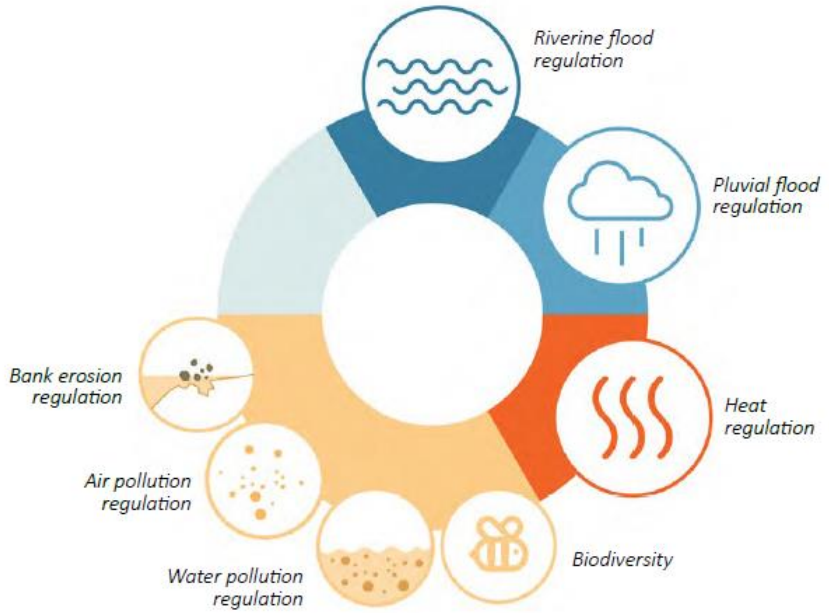
E3.2.Concept Design: Palmiet River (Sonstraal to Van der Stel Street- Strelitzia Street Focus Area) Hybrid Flood Alleviation Project

The proposed Hybrid Flood Alleviation Measure for the Palmiet River between Sonstraal and Van der Stel Street focuses on managing flood risk while incorporating environmental restoration and management, and the development of recreational features. The intervention prioritises bank stabilisation, flood management, and improving community use through green infrastructure along the river. The site boundary spans the stretch of the Palmiet River that runs from Sonstraal Road in the east toward Van der Stel in the west. The concept plan focuses on a specific component of this stretch where space was identified for flood attenuation infrastructure on the banks of the river – referred to as the Strelitzia Street Focus Area.

Palmiet River - Strelitzia Street Focus Area

The concept includes:

- Check dams with fishways
- Bank Stabilisation and Erosion Control
- Riparian Planting and Ecological Restoration
- Trapezoidal Retaining Wall
- Stormwater Management
- Recreational and Green Space



Part E Chapter 3 Figure 1. Functions of River Rehabilitation (Source: World Bank, 2021)

The Concept is shown in Part E Chapter 3 Map 9, and is attached in Appendix hereto.

Part E Chapter 3 Map 9 Concept Plan for Palmiet (Strelitzia Street Focus Area) Hybrid Flood Alleviation Project

PALMIET RIVER

Sonstraal to Van der Stel (Strelitzia Street Focus Area)
Landscape Concept Plan

1:1000 on A1 or 1:2000 on A3
Date: 30 October 2024

0 50 100 150 200m

DRAKENSTEIN MUNISIPALITEIT • MUNICIPALITY • UMASIPALA

AVIA

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

C40 CITIES FINANCE FACILITY

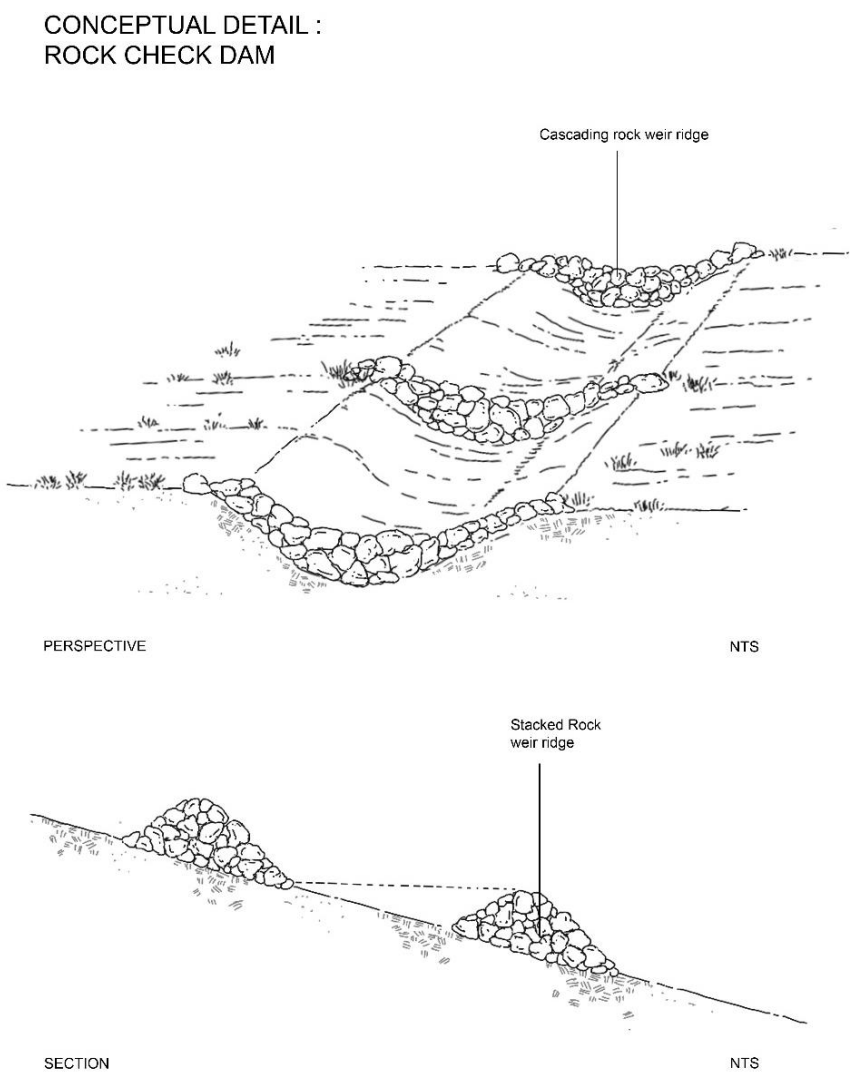
ARLA Consulting Landscape Architects

Components of the Concept Layout Design

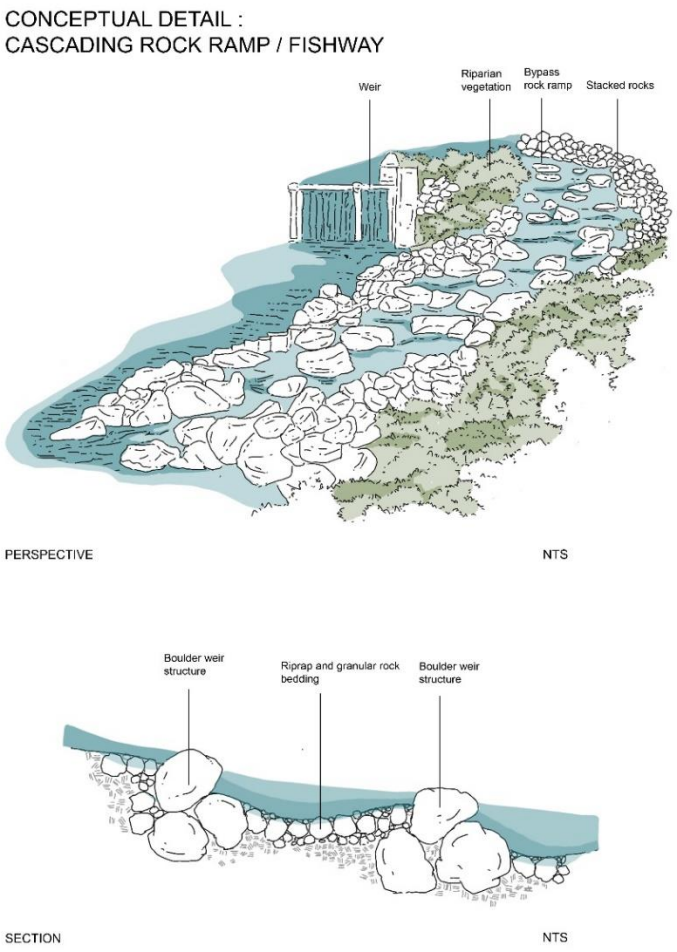
Check Dams with Fishways

Check dams designed to engineered specifications are proposed at the narrowest points of the river. Fishways can be incorporated where required. These structures aim to manage the flow rates by slowing water down when streamflow increases during rainfall events. This will support the management of peak discharge and subsequent streamflow to reduce the potential for flash flooding and incision. Check dams may also contribute to sediment capture, helping to improve water quality and reduce erosion.

Fishways are proposed with the check dams, where this is possible, to facilitate fish movement and migration as well as restore and maintain habitat connectivity.



Part E Chapter 3 Figure 2. Conceptual Detail: Rock check dam (not drawn to scale)

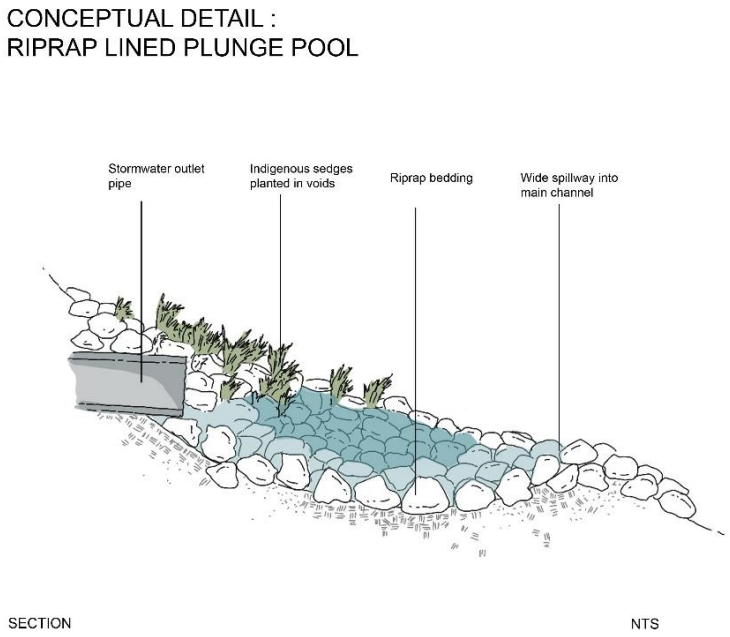


Part E Chapter 3 Figure 3. Conceptual Detail: Cascading Rock Ramp / Fishway (not drawn to scale)

Part E Chapter 3 Figure 4. Examples of constructed natural bypasses for fish movement in Germany (above) and Finland (below) (from Bok et al., 2007).

Plunge Pools

Plunge pools are proposed along the river channel at this site. Plunge pools are specially designed basins or depressions located at the outlet of a stormwater drainage system, such as a pipe or culvert, where fast-moving stormwater is discharged. The purpose of the plunge pool is to dissipate the energy of the incoming water, reduce its velocity, and control erosion at the discharge point. By slowing down the water, plunge pools help prevent scouring of the surrounding soil and stabilise the area. They are proposed as small, riprap-lined ponds in the riverbed, where stormwater can be discharged to dissipate the energy of the water before it overflows into the river.



Part E Chapter 3 Figure 5. Conceptual Detail: Riprap-lined plunge pool (not drawn to scale)

Gabion retaining walls

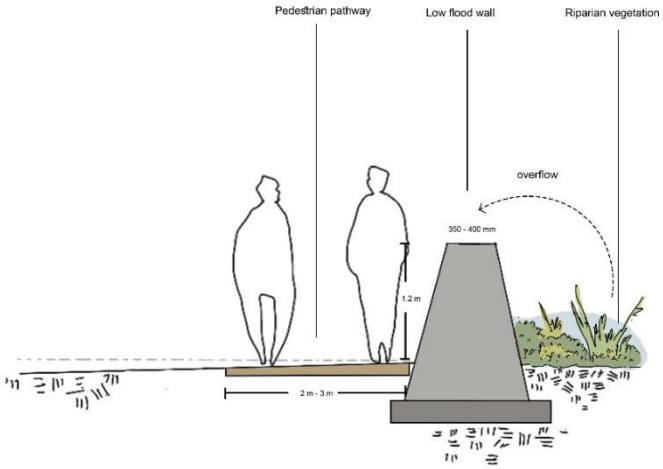
Gabion retaining walls are proposed along the outside bend of the river, along the northern bank behind Ribbok street. The gabion walls are designed to stabilise slopes, prevent erosion and act as a flood barrier to protect adjacent properties and municipal infrastructure from erosion and flood damage.

Part E Chapter 3 Figure 6. Terraced gabions

Low flood wall/ berm

A low flood wall or berm constructed from rock and concrete will be built along certain sections of the river to provide further bank stabilisation and to alleviate flooding. A trapezoidal wall (1.2m high) is proposed in areas where there is less space and a low berm in areas with sufficient space. The wall/berm is intended to serve as a flood barrier to protect adjacent properties and municipal infrastructure from erosion and flood damage. The trapezoidal wall can be incorporated with a pedestrian pathway to allow movement, and the wall is proposed to be kept low to keep the community connected to the river and allow passive surveillance.

CONCEPTUAL DETAIL :
LOW FLOOD WALL AND PEDESTRIAN PATHWAY



Part E Chapter 3 Figure 7. Conceptual Detail: Low Flood Wall and Pedestrian Pathway (not drawn to scale)

Pedestrian Pathway

A landscaped greenbelt with pedestrian pathways is integrated into the design, allowing the community to access the riverbank for recreational activities while maintaining its flood management function. These pathways will be surrounded by new vegetation, offering both aesthetic and functional benefits. The greenbelt will not only enhance public spaces but will also serve as a natural buffer zone that supports flood attenuation and protects infrastructure.

A formalised pedestrian pathway is proposed on the southern end of the bank along the top of the bank, as well as north of the flood wall/berm, which will encourage passive surveillance to promote the safety of the area.

Part E Chapter 3 Figure 8. Example of a pedestrian pathway

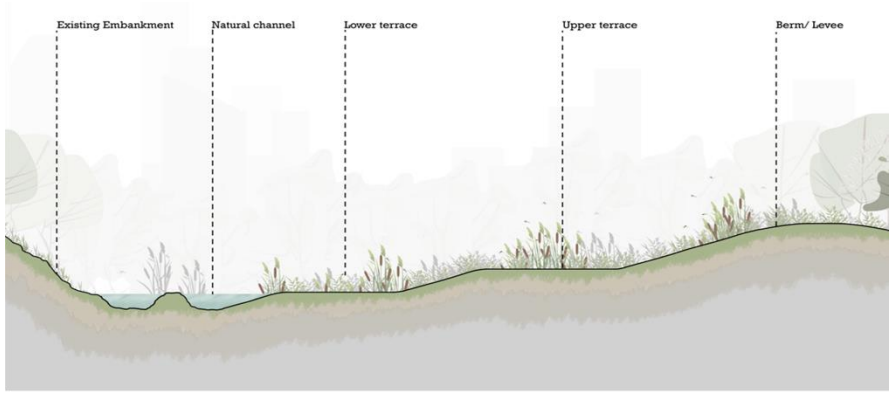
Informal timber hiking trail-type steps

Informal hiking trail-type steps down to the river are proposed on the northern bank of the river. The steps provide a recreational opportunity for the community members as well as easier access to the river for recreational activities such as fishing and swimming.

Part E Chapter 3 Figure 9. Hiking trail steps

Widening of the River

The riverbank is to be widened at the western end to allow for additional retention capacity and heavy rain events. Implementing a multistage channel approach can be considered. This intervention aims to increase the river's capacity to manage stormflows to reduce flood risk downstream. The widened areas will act as floodplains that absorb excess water during peak flows, offering additional natural flood attenuation.



Part E Chapter 3 Figure 10. Multi-stage channel incorporating terraces to function as floodplains under high flow - illustrating river widening.

New seating area underneath existing trees

A new seating area underneath existing trees is proposed along a new path on the western end of the southern side of the bank. The seating area promotes recreational activity in the area, as well as encouraging active river corridor use and passive surveillance to promote safety.

Riparian Planting and Ecological Restoration

The plan incorporates riparian planting along the gabion edges, improving the ecological health of the river by restoring native vegetation. The vegetation will

enhance the biodiversity of the area, create natural filtration for water quality improvement, and contribute to the stabilisation of the banks.

New trees will also be planted along the landscaped greenbelt, further enhancing the area's environmental benefits.

The Palmiet River Hybrid Flood Alleviation Measure combines flood risk reduction with ecological restoration and community engagement. By widening the river, implementing bank stabilisation measures, and integrating stormwater management systems, the project seeks to protect nearby properties and infrastructure, particularly up to Sonstraal Road. The use of riparian planting and recreational greenbelts ensures that the intervention enhances both the environmental and social value of the river, creating a resilient and multifunctional urban landscape.

Solid Waste Management

The site will include public refuse bins to be collected at regular intervals, particularly along pedestrian pathways. The cleaning of the site may make use of local labour through programmes such as the Expanded Public Works Programme (EPWP).

Litter traps have not been integrated into the concept design as litter traps are vulnerable to vandalism, which can compromise their effectiveness and require additional maintenance. People can intentionally dispose of trash into the trap and steal materials (e.g. metal) from the trap, damaging it.

Community Inputs and Feedback

Plunge pools

The community expressed concern around the plunge pools posing a risk to children. It was explained during the session that the plunge pools envisaged in the concept will not be designed to hold water, but rather to slow down/ dissipate the energy of the stormwater discharge before it enters the river and should not pose a hazard to children or community members.

Key community ideas and inputs:

- The community noted that they are willing to become involved in regular inspections and cleaning.

Flood wall/ berm

The community supported the proposed development of a flood wall/ berm as it will provide protection to properties and infrastructure alongside the river course. The community also noted concern of the flood wall being designed too high. There were safety concerns raised as children may walk on top of the wall, and the community suggested that the top of the wall should be very narrow to prevent this.

Key community ideas and inputs:

- Walls to be designed to withstand long-term pressure from flood water
- Walls to not exceed approximately 1.2m in height
- Walls to have a narrow or angled top to prevent children from walking on top of them
- Where suitable, walls to be coupled to an adjacent pedestrian pathway to maximise the recreational access along the river
- Berms to serve as a raised pedestrian walkway to maximise the recreational access along the river

Check dams

The community supported the idea of check dams. The community raised concern around the risk of children drowning in the dams if the walls are too high or if the dams are too deep. The community noted that they can be involved in the maintenance of the dams through regular inspections and cleaning.

Key community ideas and inputs:

- The community to be involved in regular inspections and cleaning
- The design and management of the check dams to incorporate concerns about potential drowning risk
- The community supported having check dams along the river course, especially where the gradients are steeper.

Widening of the river

The community supported the widening of the river and noted that the river widening will increase the river's recreational potential.

Key community ideas and inputs:

- The community can assist with regular inspections and cleaning.

Pedestrian pathway

The community noted that a key concern around the pedestrian pathways was safety and security concerns and potential muggings. The community suggested that adequate area lighting and neighbourhood watch activities can be used to promote the safety of the area. They also noted that adding refuse receptacles/ bins along the pathway will reduce littering/dumping at this site.

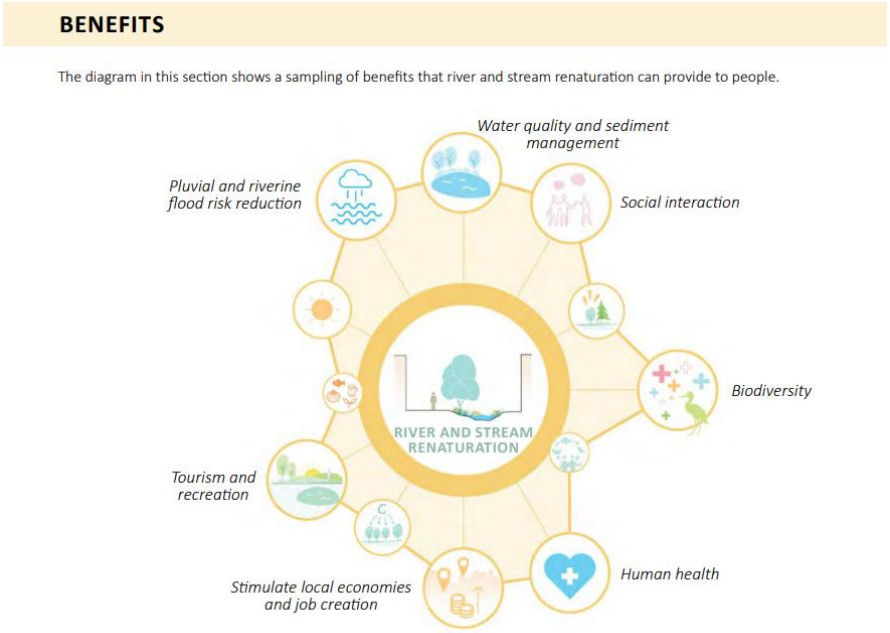
Key community ideas and inputs:

- Ensuring adequate lighting along the pathway
- Neighbourhood watch activities in the area
- Potentially having the pathway along most of the embankment where there is adequate municipal land available
- The community noted that they can become involved in regular inspections and cleaning.

E3.3.Benefits and Impact Potential: Palmiet River (Sonstraal to Van der Stel Street) Hybrid Flood Alleviation Project

The primary objective and benefit to be achieved from this project is Flood Risk Reduction, aligned to the overarching programme objective of building flood resilience. It is critical that flood risk reduction measures are not developed in isolation from the broader urban and natural environment and community context. As such, these four **interrelated** areas – **1) Flood Risk Reduction**, **2) Urban Management and Open Space Optimisation**, **3) Adaptation and Climate Resilience**, and **4) Community Empowerment and Participation** are identified as four broad groups of benefits that should be sought to give effect to the programme objectives at the project level.

A summary of the benefits that can be achieved through improved river management is provided in Part E Chapter 3 Figure 11:



Part E Chapter 3 Figure 11. Benefits of River Rehabilitation (Source: World Bank, 2021)

Improved Stormwater Management and Flood Risk Reduction Potential

The Upper Palmiet PSCWMM results indicate that the low-lying residential area to the north of the Palmiet River is susceptible to flooding. This is due to this area being low-lying compared to the residential area to the south. Once the flow has 'broken' the Palmiet River's banks, it flows through the residential area in a westerly direction. This flow is then largely trapped in Sonstraal Street by the existing landfill to the west due to the landfill being significantly higher than Sonstraal Street and preventing flow back into the Palmiet River. In addition, the low point in the road appears to be located here according to the LiDAR data.

The proposed intervention from a flood prevention point of view that has been included in the hydraulic modelling is the inclusion of a flood berm / flood wall of 1.2m height along the length of the northern bank as close to the residential area as possible. Due to the limited space and opportunity for the implementation of significant attenuation features the impact of generating additional retention area along the river course could not be accurately modelled. The results to indicate the importance of exploring opportunities to achieve this during detailed design. A key concern relates to the impact of the landfill site on river and overland flow. While the cost has been noted as a barrier, the lowering of the existing landfill area in the Lower Palmiet (just downstream of van der Stel Street) will offer significant flow alleviation benefits and will provide an overland flow escape route for flows back into the Palmiet.

It is understood that the northern bank is susceptible to erosion and requires erosion protection. While erosion protection will protect the properties against any further damage, this intervention has not been included in any hydraulic modelling as it likely wouldn't have any significant impact on flood extents and depths.

Need for Further Analysis of Flood Risk Reduction Potential in the Palmiet River

The proposed flood interventions for the upper and lower Palmiet sections, modelled using PCSWMM, demonstrate a notable reduction in flood exposure immediately adjacent to the project sites, confirming the effectiveness of the planned measures for these areas. A key intervention—the construction of a flood wall along the project site—aims to protect nearby communities by containing river flow and reducing flood exposure. However, the wall may also channel a larger volume of water downstream, particularly during peak flow events, potentially increasing flood extents west of Jan van Riebeeck Drive. By containing water flow in this section, the wall could inadvertently transfer flood risk downstream, where flood extents may increase as a result.

Additionally, the current PCSWMM has limitations in terms of accurately representing certain interventions, such as the impact of check dams and the potential for flood attenuation provided by widening the river channel. These measures could be optimised to positively influence flood dynamics, but their effects could not be fully captured in the initial modelling.

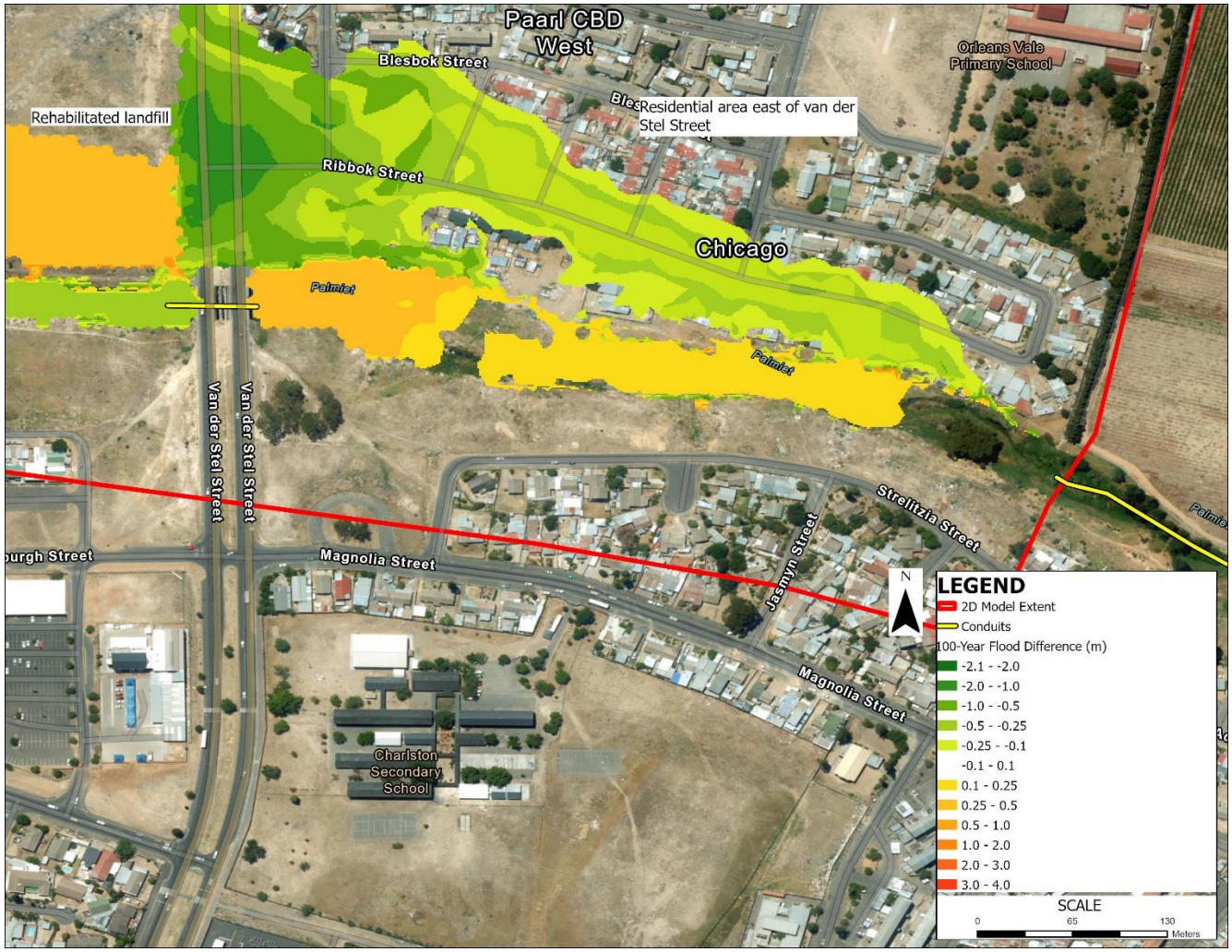
To address these issues, the Drakenstein Municipality must conduct further modelling and testing during the detailed design phase. This should include exploring the downstream impact of the flood wall and evaluating the section of the Palmiet River below Jan van Riebeeck Drive for intervention. This additional analysis should aim to provide a refined understanding of flood dynamics and support a design that enhances flood resilience without inadvertently shifting risks downstream.

Part E Chapter 3 Map 10. Current Flood Extent (1:100yr)

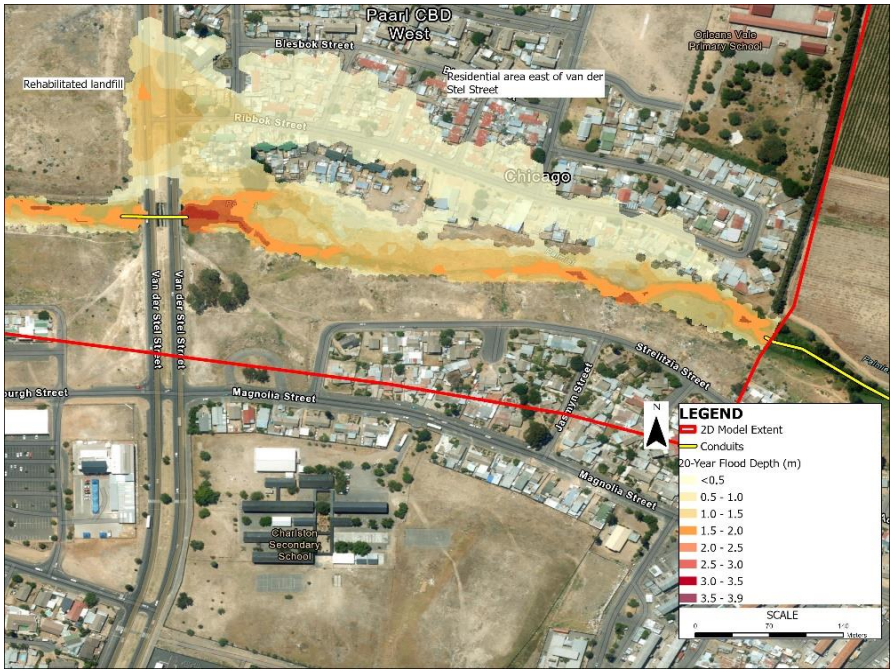
Part E Chapter 3 Map 11. Flood Extent (1:100yr) after intervention

The Upper Palmiet status quo for the 100-year flood indicates that the low-lying residential area to the north of the Palmiet River is exposed to flooding. This is due to this area being low-lying compared to the residential area to the south. Once the 100-year flood has 'broken' the Palmiet River's banks, it flows through the residential area in a westerly direction. This flow is then largely trapped in Van der Stel Street by the existing landfill to the west due to the landfill being significantly higher than Van der Stel Street, preventing flow back into the Palmiet River. In addition, the low point in the road appears to be located here according to the LiDAR data.

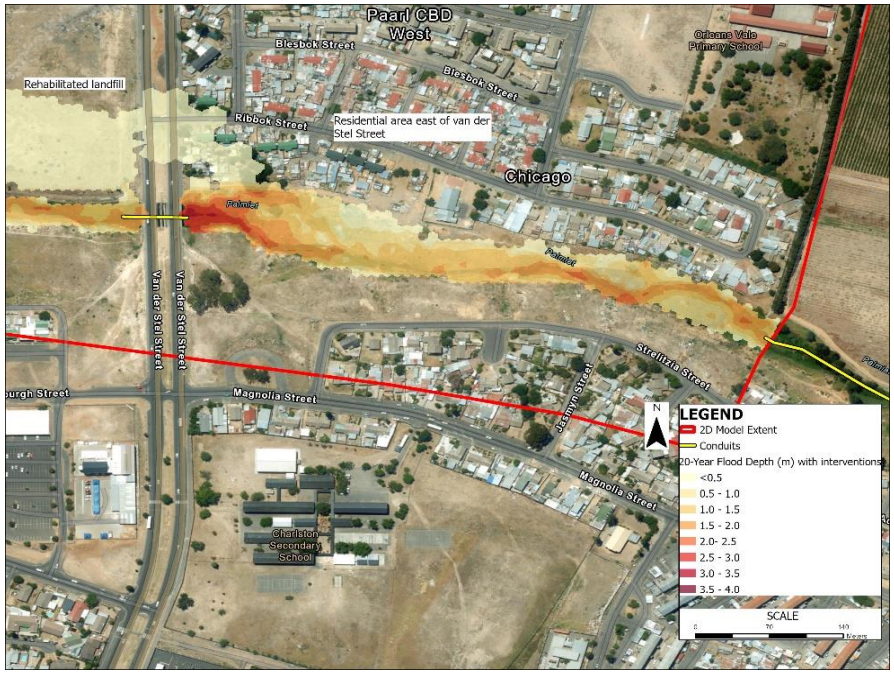
The impact of the proposed intervention of a flood berm / flood wall is that the flood extent and depth is significantly reduced compared to the status quo. This can be seen in Part E Chapter 3 Map 12 which shows the decrease in flood depth (*light* green to *dark* green) and increase in flood depth (*yellow* to red). Increases in flood depth within the attenuation interventions are anticipated due to increased water storage. The reduction in flood depths in the northern residential area ranges from 0.25m to up to 2.0m in some areas. The flood berm / flood berm does however result in an increase in flood depths in the Palmiet itself but appears to be contained within the Palmiet only. An increase in the flood berm / flood wall could be explored to effectively remove floods in the northern residential area in the 100-year flood.



Part E Chapter 3 Map 12. Difference in Current Flood Extent vs After Intervention Flood Extent (1:100yr)



Part E Chapter 3 Map 13. Current Flood Extent (1:20yr)

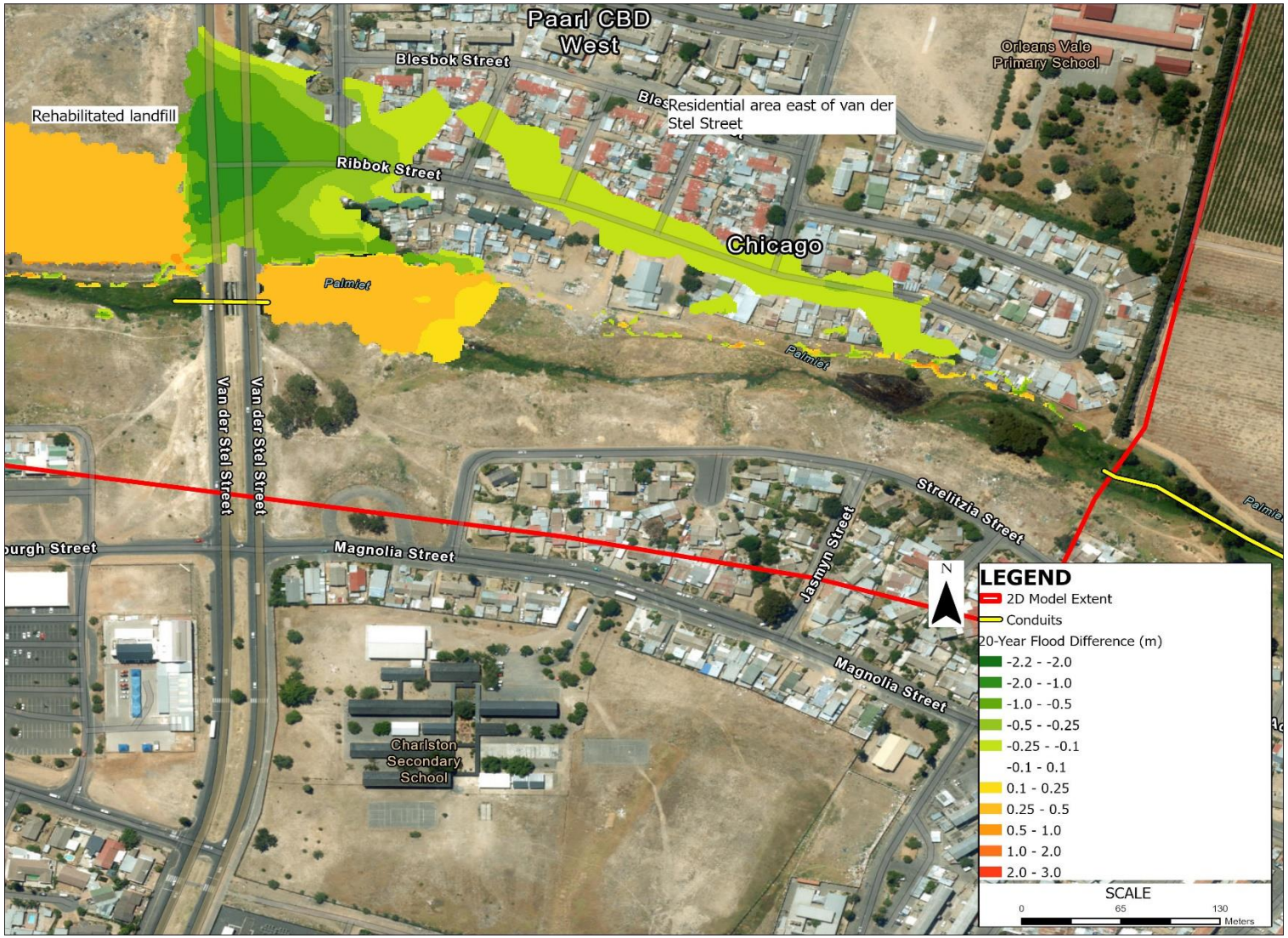


Part E Chapter 3 Map 14. Flood Extent (1:20yr) after intervention

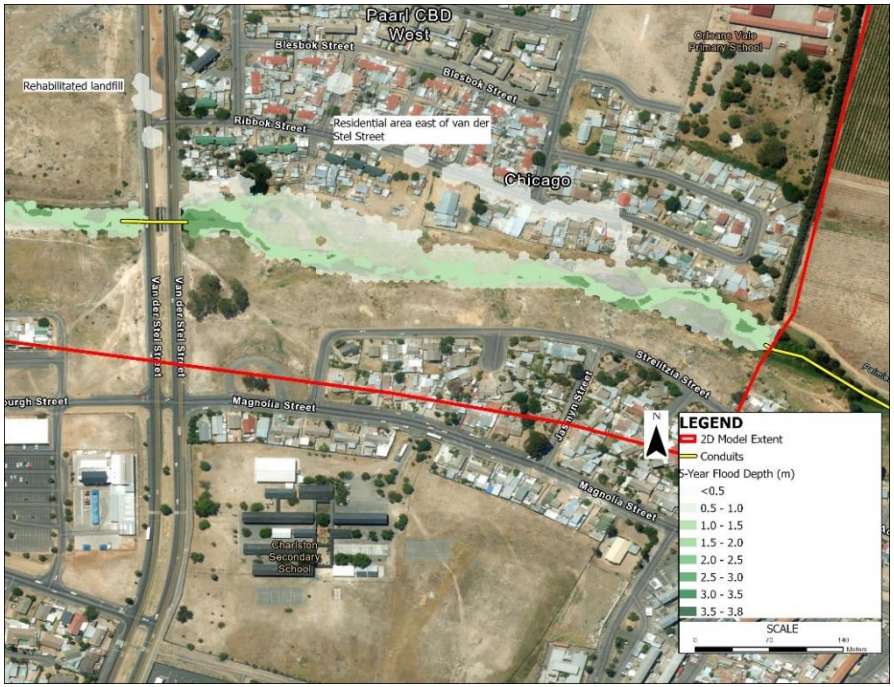
The Upper Palmiet status quo for the 20-year flood indicates that the low-lying residential area to the north of the Palmiet River is exposed to flooding. This is due to this area being low-lying compared to the residential area to the south. Once the 20-year flood has 'broken' the Palmiet River's banks, it flows through the residential area in a westerly direction. This flow is then largely trapped in Sonstraal Street by the existing landfill to the west due to the landfill being significantly higher than Van der Stel, preventing flow back into the Palmiet River. In addition, the low point in the road appears to be located here according to the LiDAR data.

The impact of the proposed intervention of a flood berm / flood wall is that the flooding extent and depth is almost completely reduced compared to the current situation. This can be seen in Part E Chapter 3 Map 15 which shows the decrease in flood depth (*light* green to *dark* green) and increase in flood depth (*yellow* to red). Increases in flood depth within the attenuation interventions are anticipated due to increased water storage.

The reduction in flood depth in the northern residential area ranges from 0.25m to up to 2.0m in some areas. The flood berm / flood wall does however result in an increase in flood depths in the Palmiet itself but appears to be contained within the Palmiet only. An increase in the flood berm / flood wall could be explored to effectively remove floods in the northern residential area in the 20-year flood.



Part E Chapter 3 Map 15. Difference in Current Flood Extent vs After Intervention Flood Extent (1:20yr)



Part E Chapter 3 Map 16. Current Flood Extent (1:5yr)

Part E Chapter 3 Map 17. Flood Extent (1:5yr) after intervention

The Upper Palmiet status quo for the 5-year flood indicates that the low-lying residential area to the north of the Palmiet River is potentially exposed to flooding. This is due to this area being low-lying compared to the residential area to the south. The 5-year flood slightly 'breaks' the northern bank of the Palmiet and causes some localised flooding in the residential area.

The impact of the proposed intervention of a flood berm / flood wall is that the flooding extent and depth is completely reduced compared to the current situation. This can be seen in Part E Chapter 3 Map 18 which shows the decrease in flood depth (*light* green to *dark* green) and increase in flood depth (*yellow* to red). Increases in flood depth within the attenuation interventions are anticipated due to increased water storage.

The reduction in flood depth in the northern residential area ranges from 0.25m to up to 0.5m in some very localised areas. The flood berm / flood wall does however result in a small, localised increase in flood depths in the Palmiet itself but is contained within the Palmiet only.

Part E Chapter 3 Map 18. Difference in Current Flood Extent vs After Intervention Flood Extent (1:5yr)

Urban Management and Open Space Optimisation

The following key benefits can be achieved through this project:

Accessibility and Recreational benefits for surrounding communities

Recreational benefits are achieved through promoting safe access to the river through hiking trail-type steps.

Further planning and design should demonstrate the detail of how these principles can be achieved, which will require participatory planning and meaningful engagement with intended end-users in surrounding communities.

National Strategic Framework on Universal Design and Access - Principles of Universal Design:

- **Equitable use -** Design that is useful and marketable to persons with diverse access needs
- **Flexibility in use** - Design that accommodates a wide range of individual preferences and access needs
- **Simple and intuitive use** - Design that is easy to understand regardless of the users experience, knowledge, language, skills or concentration level (in loco use)
- **Perceptible information** - Design that communicates necessary information effectively to the user regardless of ambient conditions or the users sensory access needs
- **Tolerance for error** - Design that minimises hazards and adverse consequences of accidental or unintended actions
- **Low physical effort** - Design that can be used efficiently and comfortably and with a minimum of fatigue or struggle
- **Size and space for approach and use** - Design that provides appropriate size and space for approach, reach, manipulation and use regardless of the users body size, posture or mobility

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Improved Spatial Alignment and Land Use Management

Land use change will have a significant impact on catchment hydrology and flood risk. Development is associated with an increase in impermeable surfaces which will contribute to increased runoff and peak discharges in the absence of attenuation interventions. River management and flood attenuation interventions are aligned with the DM SDF given that the waterways and riverbanks are designated as Green Space.

Placemaking and improvement to the aesthetic appearance of the city

The project seeks to achieve an improved urban realm and placemaking to support the functionality and improvement of the urban environment. The site was identified as having a polluted floodplain landscape character, and therefore the active use of this area as an open space for the public good will serve to improve the character of the area, and in so doing, the use of this area can promote its upkeep by the surrounding

communities, including promotion of passive surveillance to reduce illegal dumping. This should also be supported by a solid waste management strategy.

Ecological Restoration and Rehabilitation and Water Quality Improvement

The proposed interventions along the Palmiet River work towards the rehabilitation and management of riparian zones, to achieve a dynamic and resilient system that can respond to change in a sustainable manner. Rehabilitation efforts should consider the catchment context and address the upstream and downstream causes of degradation. The interventions along this stretch of the Palmiet include nature-based solutions that **improve flow and water quality** through braiding of the river and facilitate the establishment of a **healthy and diverse riparian, marginal and instream plant community**, which will increase the assimilation of pollutants in the water. This will also include improving biodiversity and ecological functioning of the river reach, ensuring long-term sustainability of the rehabilitated areas, and will in some instances rely on the removal and control of invasive alien plants.

The concept incorporates the existing wetland areas and will aim to achieve the optimal condition of these waterbodies to achieve the optimal **flood alleviation ecosystem services** (FAES) potential for these wetlands, including **achieving the FAES benefits of channelled valley bottom wetlands (high) and depression wetlands.** The implementation of stormwater ponds and constructed wetlands can also serve to improve water quality.

Education and Awareness

The incorporation of additional signage and information boards to provide information about the river and the rehabilitation work can be incorporated. partnerships with schools can also be forged to increase awareness of the importance of river management and improve the understanding of the components of the project.

Urban Cooling and Air Quality

In urban areas, green infrastructure such as parks and urban wetlands help to cool surrounding areas by providing shade and reducing the urban heat island effect. This improves air quality and liveability, and creates more pleasant environments for residents, while also reducing energy demand for cooling.

Carbon Sequestration

Nature-based solutions, particularly those involving revegetation and wetland restoration, act as carbon sinks, helping to mitigate climate change by sequestering carbon dioxide from the atmosphere. This not only supports local climate goals but also contributes to global efforts to reduce greenhouse gas emissions.

Solid Waste Management

Improved solid waste management aims to support a clean and healthy environment and limit the maintenance requirements arising from blockages of stormwater infrastructure resulting from litter.

Adaptation and Climate Resilience - Toward a Climate Resilient Pathway

Drakenstein's Climate Change Action Plan (CCAP) includes a series of climate change objectives. The Sonstraal to Van der Stel Street Hybrid Flood Alleviation Project will support the following DM climate change objectives:

- **Water security and efficiency**
- **Climate resilient and low carbon development**
- **Biodiversity and ecosystem management**
- **Public health**
- **Disaster management**
- **Building response capacity through improved coordination and awareness**

In addition, the DM HFA identified the following core requirements for responsiveness to projected climate change:

- **Responsiveness to the changing catchment hydrology**
- **Responsiveness to more extreme drought and flood cycles**
- **Responsible land use management to protect ecological infrastructure and enhance urban permeable surfaces**

The Palmiet River - Sonstraal to Van der Stel Street Hybrid Flood Alleviation Project is responsive to these requirements, whereby the hybrid solutions for the project include:

Check dams, plunge pools and low flood walls/ berms, to improve resilience to provide resilience to droughts and floods: Check dams and plunge pools provide climate change adaptation benefits as they reduce water velocity, minimise erosion and trap sediment which reduces flood risk. Plunge pools and check dams also support groundwater recharge which promotes resilience to droughts as this will increase groundwater availability. Low flood walls/ berms reduce flood risk as they protect against floodwater and stabilise the soil.

Widening of the river and bank stabilisation through gabions, riparian planting and low flood walls/ berms, to improve resilience to address changing catchment hydrology: Along the Palmiet River, river widening will improve resilience to the changing catchment hydrology and provide climate change adaptation benefits by allowing the river to carry more water; reducing flood peaks, decreasing water velocity and increasing storage which will reduce downstream flooding. Bank stabilisation and erosion control through a low flood wall/ berm, gabions, and riparian planting will provide soil stabilisation, reduction of stormwater runoff, water quality improvement, as well as the creation of habitats.

The active use and protection of open space, the retaining of permeable surfaces and the enhancement of infiltration areas through riparian planting in urban areas is responsive to the need for sound land use management that will have a positive impact on the hydrology of the catchment and in reducing flood risk, while achieving carbon sequestration benefits.

Sustainable Development Goals

The Sonstraal to Van der Stel Street interventions align with the following Sustainable Development Goals (SDGs):

SDG 11: Sustainable Cities and Communities – through green infrastructure, increased climate resilience and reduced flood risk

SDG 13: Climate Action – Climate change adaptation through flood risk reduction

SDG 14: Life Below Water – Protection of riverine ecosystems through water quality improvement

SDG 15: Life on Land – Ecological restoration through alien invasive clearing

Illustrated through the above-listed SDGs, the site has high sustainable development potential that promotes climate change adaptation through a reduction in flood risk while benefitting terrestrial and riverine ecosystems. The project has been developed allowing for an expansion of the proposed interventions across the Palmiet River

Community empowerment, participation and governance

The project offers the opportunity for meaningful engagement across a range of stakeholders.

- **Ward Councillors and Ward Committees:** These municipal structures should be leveraged as intermediaries with local communities and to support the attainment of community accountability.

- **NGOs and NPOs and Civil Society:** The NGO and NPO sectors should be mobilised to support the project. the mobilisation of civil society to act as stewards of the river will also act as opportunity to involve and meaningfully engage communities.

- **Youth and adult education and awareness** should be facilitated. Schools and other educational institutions could be encouraged to visit the site for educational purposes, supported by appropriate signage with educational materials.

- **Job Creation Potential:** Project implementation will provide opportunities for job creation for local communities during the construction phases and operation and maintenance phases. While the construction phase job creation is set to be applicable only in the short term, the operation and maintenance in relation to the clearing of invasive alien plants, open spaces, landscaping, solid waste management, play area equipment and the stormwater ponds will require on-going human resource contributions. This may include the involvement of community members in voluntary project stewardship, the leveraging of the enhanced public works programme (EPWP), as well as other job creation opportunities. See also the Job Creation Potential Section.

E3.4.Project Lifecycle Stages and Duration: Palmiet River (Sonstraal to Van der Stel Street) Hybrid Flood Alleviation Project:

The following sections provide an overview the typical phases of a project including:

- **Planning and Design of the Project**
- **Construction and implementation**
- **Operation and Maintenance**

This Section also provide an overview of the typical studies that may be required in relation to the project.

The typical phases of a project lifecycle include:

Planning and Design of the project

This includes detailed feasibility studies, and the detailed design of the project. Importantly, this phase in the project lifecycle should see the meaningful engagement of potential project beneficiaries (local communities) and ensure that they are adequately engaged in the ideation of solutions and ensure that the stakeholder input is a key informant to the project components.

The following activities typically form part of this Phase:

Feasibility Study and Initial Assessments

A **Basic Assessment** or full **Environmental Impact Assessment**. This may also include other specialist studies across a range of disciplines. The final list of specialist studies required should be determined during the feasibility study process, and can be guided by the Department of Forestry, Fisheries and Environment's (DFFE) Screening Tool. **The results of the screening tool are contained in Appendix: Palmiet River (Sonstraal to Strelitzia) DFFE Screening Tool Results.**

The environmental application (BA or EIA) as well as the Land Use Application forming part of the Permitting and Regulatory Approvals) will include a legally required public participation process. In order to maximise the opportunity for participatory planning, it is proposed that the project include additional stakeholder engagement (beyond the legally required public participation processes) to engage community members on a continuous basis in order to continue to the engagement process that has commenced in the design of the DM HFA Programme though the Community Flood Risk Perception Study (July 2024), and the Concept Design Community Workshop (October 2024).

Engineering design and planning

This will include the detailed design of the proposed hybrid flood alleviation infrastructure and other elements of the site layout.

Landscape Design and Planning

Landscape design and planning of hard and soft surfaces and river rehabilitation components of the site layout will be designed as part of this process.

Permitting and Regulatory Approvals

This refers to the relevant approvals necessary to proceed with the development. This will typically include **Land Use Applications (See Land Use Appendix) –** The details of the land use application can be determined during the pre-application meeting with the municipality, and the land use approval is typically contingent upon the completion of all specialist studies. The regulatory approvals will also include a **Water Use License Application (WULA).** The nature of the project is likely to trigger a full Water Use License (WULA) (as opposed to a General Authorisation). From time to time, the WULA process triggers additional specialist studies.

Additional approvals could be required throughout various phases, and specifically highlighted at this point in the sequence due to the development and environmental approvals that will likely be necessary from with the municipality and from the relevant competent authorities.

Part E Chapter 3 Table 3. Specialist studies required for the Project (subject to refinement) as part of the Planning and Design Phase of the Project

Feasibility Study and Assessment	
Environmental Authorisation (EA) (Basic Assessment or Environmental Impact Assessment)	Assumes a Basic Assessment. Detailed requirements to be determined by the competent authority. Full EIA will incur a greater cost. Specialist studies may include those listed below. The specialist studies will require confirmation from the local authority.
Geotech Investigation	
Topographical Surveys	
Urban Planning and Landscape Architecture	
Traffic Impact Assessment or Statement	Not applicable
Heritage Impact Assessment	
Visual Impact Assessment (Level 3)	
Terrestrial Biodiversity Assessment	
Freshwater Impact Assessment (Aquatic Biodiversity Assessment Report)	
Ichthyology/Fish Ecology Studies	Typically incorporated into the Aquatic Biodiversity Assessment Report
Constructed wetland technical assessment and planning (Treatment Wetland Specialist)	Will inform the Aquatic Biodiversity Assessment Report
Botanical Assessment	
Waste Management Impact Assessment	
Detailed Flood Study	
Stakeholder Engagement/Consultation Services	Mobilisation and community meetings. Excludes the engagements forming part of the EA or Land Use Application Process. Assumes 80-120 days of professional time.

Feasibility Study and Assessment	
Project Management (Feasibility Studies and Assessments)	
Engineering and Design	
Stakeholder Engagement/Consultation Services and Socio-economic Assessment	Mobilisation and community meetings. Excludes the engagements forming part of the EA or Land Use Application Process. Socio-economic Assessment can also be included.
Project Management (Engineering and Design)	
Water Use License (WULA)	A full WULA is assumed.
Land Use Application(s)	Detailed requirements (and therefore cost) to be determined based on requirements set out by the local authority
Project Management (Permitting and Regulatory Approvals)	
Detailed Design (Landscape Architectural Design)	
Tender Documentation (Landscape Architectural Design)	
Project Management (Landscape Architecture)	

Construction and implementation

This refers to the on-site construction of infrastructure and the delineation of space through landscaping, planting and movement corridors.

The following activities typically form part of this Phase:

- Site Preparation
- Construction of Infrastructure (e.g., levees, storm drains)
- Installation of Nature-based Solutions (e.g., wetlands, green infrastructure)
- Planting and Vegetation
- Materials and Equipment
- Transport and Logistics
- Construction Supervision and Oversight

For this project, the following components were incorporated into the cost estimates:

- Earthworks
- Earthworks
- Erosion protection
- Flood walls / dykes
- Culverts and outlets
- Landscaping
- Site establishment
- Professional fees (Site staff)
- Contingencies

Operation and Maintenance

Critical to the long-term success of the project, operation and maintenance efforts will be required from a wide range of stakeholders. This may include the involvement of community members through voluntary project stewardship, the leveraging of the enhanced public works programme (EPWP), as well as other job creation opportunities.

The following activities typically form part of this Phase:

- Post-Implementation Monitoring
- Maintenance of Infrastructure (e.g. stormwater systems)
- Maintenance of Nature-Based Solutions (e.g. replanting, erosion control)
- Reporting and Evaluation
- Labour (Monitoring & Maintenance)

This also includes:

- Legal and Insurance Costs
- Administrative and Overhead Costs

Project Duration

While the river and riverbanks are under the care of the municipality, and the waterway in this stretch of the Palmiet is largely on municipal-owned properties. However, works along the river is likely to directly impact households living along the riverbanks on privately owned properties. Further engagements with communities to enlist their support for the project will be required.

Project Phase	Y1	Y2	Y3	Y4	Y5
Planning and Design:					
Construction and Implementation					
Operation and Maintenance (ongoing)					
Stakeholder Engagement and Community Participation					

The starting year will be dependent upon the prioritisation of the DM HFA Stage 1 projects to be undertaken by the Drakenstein Municipality.

E3.5.Institutional Capacity, Alignment and Resource Requirements: Palmiet River (Sonstraal to Van der Stel Street) Hybrid Flood Alleviation Project

The following table sets out the typical resources required during each phase of the project. This list is not exhaustive and should be read together with the **Appendix: Palmiet River (Sonstraal to Strelitzia) DFFE Screening Tool Results.**

Part E Chapter 3 Table 4. Anticipated specialist inputs during the project lifecycle phases

Resource	Typical Role	Planning and Design	Construction and Implementation	Operation and Maintenance
Project Manager (Professionally registered engineer/ Professionally registered urban planner / Professionally registered construction project manager	Oversee the delivery of the project, may require professionally registered engineer or urban planner (Detailed Design); Professionally Registered Engineer or Construction Project Manager (Construction and Implementation)			
Professionally Registered Environmental Impact Assessment Practitioner (EAP)	Undertake EIA or BA; coordination of relevant specialist studies; Undertake and oversee the WULA process.			
Environmental Control Officer (ECO)	An EAP may also be required for Environmental Compliance during construction and operation phases.			

Resource	Typical Role	Planning and Design	Construction and Implementation	Operation and Maintenance
Professionally Registered Geotechnical Engineer (ECSA)	Geotechnical investigations			
Professionally Registered Land Surveyor (SAGC)	Conduct topographical survey			
Professionally Registered Town Planner (SACPLAN)	Oversee site design, provide urban planning specialist input, conduct the land use application, provide project management or support services to the project manager.			
Professional Registered Engineers (ECSA)	Detailed flood study (stormwater engineer); Roads Engineer (Traffic Impact Assessment			
GIS Specialist	Undertake mapping and spatial analysis			
Heritage Practitioner	Heritage Impact Assessment and associated studies			
Professionally Registered Landscape Architect	Visual Impact Assessment			
Ecologist	Terrestrial Biodiversity Impact Assessment; Freshwater Impact Assessment			
Ichthyologist	Specialist study in relation to fish			

Resource	Typical Role	Planning and Design	Construction and Implementation	Operation and Maintenance
Treatment Wetland Specialist	Provision of technical details of the design of treatment wetlands			
Botanist	Botanical Assessment			
Waste Management Specialist	Waste Management Impact Assessment			
Public Participation Professional	Mobilisation and community meetings. Excludes the engagements forming part of the EA or Land Use Application Process. Socio-economic Assessment can also be included.			

In addition to the requirements in Part E Chapter 3 Table 4, which will typically be supplied by specialists, the DM will require the internal institutional capacity to support the successful delivery of the project through its lifecycle phases. The recommendation is therefore that this team be formed on the basis of the Departments, Divisions, and Sections that formed part of the DM HFA Programme design. This will therefore include, but not be limited to, the following:

Part E Chapter 3 Table 5. Recommended Municipal representation and roles

Municipal Representation	Typical Role
Environmental Manager/ EAP	Programme Co-ordinator; Environmental Expertise, Guidance on Land Use Application
Roads and Stormwater Engineer	Municipal Project Manager, Rodas and Stormwater Division, Guidance on Land Use Application, Construction Project Management

Municipal Representation	Typical Role
Spatial Planner	Spatial planning inputs, Guidance on Land Use Application
Land Use Planner	Land Use Planning inputs, Guidance on Land Use Application
Supply Chain Management Practitioner	Support with Supply Chain related activities in the procurement of services and materials
Water and Sanitation Engineer	Provide inputs on water and sanitation related matters
Parks section representative	Guidance and support in relation to the establishment of public parks and sport facilities, input and oversight of operation and maintenance of planting and fields.
Solid Waste Management	Responsible for the planning and operation of a site-based solid waste management strategy
EPWP, Projects, Programmes and Funding	
Portfolio Councillors	
Ward Councillors and Committee Members	Support to mobilise the community.

Part E Chapter 3 Table 6. Suggested Stakeholders and Roles

Other stakeholders	Typical Role
Provincial Government	Competent Authority for relevant permitting and approvals

Other stakeholders	Typical Role
National Government	Department of Water and Strategy
NGOs	Intermediary Support

In order to achieve the mainstreaming and integration of this project, the following additional recommendations are offered:

- Programme Coordination role should be fulfilled by the Environmental Section;
- Project Management for each of the Stage 1 DM HFA Priority Projects should be championed by Stormwater Management and be situated within the stormwater management plan.

The coordinator and Project Manager should also develop a project-specific operation plan to develop detailed roles and responsibilities for each of the identified stakeholders. The way forward should include:

- Adopting the DM HFA Programme as part of the Stormwater Master Plan
- Assigning the programme to a KPA 4 and PDO 23
- Development of a detailed Implementation Plan for each of the Stage 1 DM HFA Projects, and aligning the project with additional PDOs
- Development of a detailed Scheule of responsibilities per stakeholder at all stages of the project lifecycle
- Ensuring ongoing community engagement and participatory planning

Alignment With Municipal Objectives:

The project aligns will all municipal objectives. It is particularly relevant to Strategic Objective 4, given the strong alignment with infrastructure provision.

Part E Chapter 3 Table 7. Project Alignment with Municipal Strategic Objectives

Municipal Strategic Objective	Alignment
To ensure good governance and compliance.	X
To ensure financial sustainability to meet statutory requirements.	X
To ensure an efficient and effective organisation supported by a competent and skilled workforce.	X
To provide and maintain the required physical infrastructure and to ensure sustainable and affordable services	X
To plan, promote investment and facilitate economic growth.	X
To facilitate, support and promote social and community development.	X

Key Performance Areas (KPAs) and Pre-Determined Objectives (PDOs)

KPAs refer to the areas within the business unit for which an individual or group is logically responsible. PDOs are the areas identified as important or crucial, where a result will assist in the achievement of the set objectives or goals (DM IDP, 2024:67).

It is recommended that this project be located within **KPA 4: Infrastructure and Services**, under **PDO 23: Transport, Roads, and Stormwater. This is directly aligned with the Strategic Objective *to provide and maintain the required physical infrastructure and to ensure sustainable and affordable services.***

E3.6.Cost Estimates: Palmiet River (Sonstraal to Van der Stel Street- Strelitzia Street Focus Area) Hybrid Flood Alleviation Project

This section provides cost estimates for the project. These estimates are based on the draft concepts and are indicative fees only. The construction and implementation costs are dependent on the outcomes of the Design and Planning process. The detailed costing of the Design and Planning process will be dependent upon the outcomes of the preapplication meeting and the requirements for feasibility studies, approvals and licences as set out by the relevant competent authorities. *It is important to note that a Quantity Surveyor / Cost Estimating Consultant should be appointed to determine more accurate Construction and Implementation Costs. This would take into account local and context-specific considerations for the various items. As the engineering design development progresses, refined estimates can be prepared by the Quantity Surveyor / Cost Estimating Consultant.*

The costing in Part E Chapter 3 Table 8 includes the words for the Strelitzia Street Focus Area only.

Part E Chapter 3 Table 8. Estimated project costing

SONSTRAAL TO VAN DER STEL STREET COSTING

Design and Planning Costs

Item Description	Estimated Cost (ZAR)	Comments (if a)
Feasibility Study and Initial Assessments	2 472 751,60	
Detailed Engineering Designs and Tender Documentation	4 932 104,66	No complexity factor has been applied
Detailed Landscape Architectural Design and Tender Documentation	274 285,12	
Permitting and Regulatory Approvals	297 000,00	
Subtotal	**7 976 141,38**	

SONSTRAAL TO VAN DER STEL STREET COSTING

Construction and Implementation Costs

Item Description	Estimated Cost (ZAR)	Comments (if any)
Earthworks	4 891 500,00	1m imported fill over entire site area
Erosion protection	10 200 000,00	3m high gabion wall (3m3/m with 6m reno mattress beneath) for 500m
Flood walls/dykes	6 732 000,00	1.2m high flood wall for 550m
Culverts and outlets	5 300 000,00	6 stormwater outlets plus R5mil allowance for localised stormwater
Hard Landscape works	2 000 700,00	Pedestrian pathways, Seating/ pause areas
Soft Landscape Works	189 500,00	Berm
Riverine rehabilitation	3 395 600,00	Rehabilitate riverine areas, Terrestrial vegetation
Total (1)	32 709 300,00	
Site establishment	6 541 860,00	20% of Total (1)
Total (2)	39 251 160,00	
Professional fees	7 850 232,00	20% of Total (2)
Contingencies	7 850 232,00	20 %
Subtotal	**54 951 624,00**	

SONSTRAAL TO VAN DER STEL STREET COSTING

Operation and Maintenance Costs

Item Description	Estimated Cost (ZAR)	Comments (if any)
Maintenance of Infrastructure (e.g., stormwater systems)	1 099 032,48	Recurring maintenance costs (Annual)
Maintenance of Nature-based Solutions (e.g., replanting, erosion control)	132 000,00	Cost for the first year. The first year of maintenance would be the most intensive, thereafter (especially once 80% plant cover has been achieved) maintenance cost should reduce by one third.
Reporting and Evaluation	150 000,00	Annual reviews, audits
Subtotal	**1 381 032,48**	

Other Miscellaneous Costs

Item Description	Estimated Cost (ZAR)	Comments (if any)
Community Awareness, Skills Transfer and Education Campaigns	**350 000,00**	Detail of scope/cost to be defined at the discretion of the local authority
Subtotal	**350 000,00**	

Grand Total	64 658 797,86

Total Estimated Cost (Summary)

TOTAL ESTIMATED COST (SUMMARY) - SONSTRAAL TO VAN DER STEL STREET		
Cost Category	**Total Amount (ZAR)**	**CAPEX vs OPEX**
Planning and Design Cost	7 976 141,38	CAPEX
Construction and Implementation Costs	54 951 624,00	CAPEX
Operation and Maintenance Costs	1 381 032,48	OPEX
Miscellaneous Costs	350 000,00	CAPEX/OPEX
Grand Total	**64 658 797,86**	

Additional notes

The Design and Planning costs for the engineering design and tender documents can be split according to the ECSA guideline on Civil engineering projects (here): refer to Table 1 in the document.

Cost of the Works		**Basis of Fee Calculation**		**Total (Primary fee plus secondary fee)**
For projects up to R850 000		**Lump Sum or Time Basis**		
Where the cost of the works:		**Primary fee**	**Secondary fee**	
Exceeds	**But does not exceed**			
850 000	1 899 000	106 300	15%	
1 899 000	9 347 000	237 400	12%	
9 347 000	19 066 000	982 400	10.5%	
19 066 000	47 372 000	1 857 000	9.5%	
47 372 000	94 960 000	4 121 400	7%	
94 960 000	572 000 000	7 065 000	6.5%	
572 000 000		33 233 200	6%	

The portion of what is included in the design stage and what is included in the construction stage can be determined by using ECSA guidelines again (here) for civil engineering projects. These are as follows in terms of the engineering design split. Stage 1-4 could be classified as engineering design. Stage 5 and 6 are the construction monitoring and close-out of the project.

Stage	Stage of Services Civil: Engineering Projects:	Typical percentage points for each stage
1	**Inception**	5
2	**Concept and Viability**	25
3	**Design Development**	25
4	**Documentation and Procurement**	25
5	**Contract Administration and Inspection**	15
6	**Close-Out**	5
		100%

E3.7.Job Creation Potential: Palmiet River (Sonstraal to Van der Stel Street) Hybrid Flood Alleviation Project:

This section of the report provides an analysis of the Job Creation Potential for the Project.

The table shows the temporary and permanent jobs created by the project, temporary jobs are measured in job years, which are defined in the table, while permanent jobs are counted as jobs. An assessment is made of the jobs created as to how many constitute green jobs, in terms of the DFFE's definition. as well as the job-years. The table also provides an estimate of direct Jobs per skill level, as well as indirect and induced jobs, for the given level of investment estimated. The job seekers are based on the Drakenstein Municipality's database of job seekers dated to October 2024.

Part E Chapter 3 Table 9. Job Creation Potential.

SONSTRAAL TO VAN DER STEL STREET DM HFA PROJECT										
Site: Palmiet (Sonstraal/Strelitzia)			**Total direct jobs**	**Direct Jobs per skill level** *Direct jobs are the extra jobs created in the delivery (design, construction/development) of an output and the operation of that output for the duration of its expected life. These direct jobs can be both temporary and permanent.*						**Estimated investment**
	Component	**Disciplines**		**Skilled (PSOC Level 3 and 4)**	**Semi-skilled (PSOC Level 2)**	**Low-skilled (PSOC level 1)**	**Green skilled**	**Green semi-skilled**	**Green low-skilled**	

SONSTRAAL TO VAN DER STEL STREET DM HFA PROJECT										
Temporary *A temporary job means an employment opportunity created, for a limited time span, typically during the design and development of the infrastructure, project of program.* **(Job years)** *A job-year is a measure of the proportion of time a job is created for. One job year means one job for one year.*	Planning and design	Civil engineering (multiple disciplines), Landscape architects, Planner, EIA practitioner, Technical environmental specialists, Lawyer, Geotechnical engineer, Surveyor, Electrical engineer, Quantity surveyor	8	8	0	0	8	0	0	R7 976 141.38
Temporary (Job years)	Construction and implementation	Civil engineer, Landscape architect, Planner, Scientific specialist, OHSA officer, EC officer, Quantity surveyor, Site manager, Foreman, Site agent, Excavator operator, TLB Operator, Dump truck operator, Planter, Security, General worker	17	3	9	5	3	2	5	R54 951 624.00

SONSTRAAL TO VAN DER STEL STREET DM HFA PROJECT										
Permanent *Means a full-time equivalent position which endures beyond the development phase of the intervention, through the expected useful life of the infrastructure, plan or program.*	Maintenance and miscellaneous	Foreman, Mower operators, Planters, Driver, General worker	2	0	1	1	0	1	1	R1 731 032.48
Total			27	11	10	6	11	3	6	R64 658 797.86
Jobseekers in ward			682							
Jobseekers in adjacent wards			2047							
Indirect jobs *Indirect jobs are the jobs created to supply inputs into the output creation to provide inputs that the project requires.*			114							
Induced jobs *Induced jobs are the jobs created in all sectors by the increase in household spending created by the wages paid in the direct jobs and indirect jobs created, following the initial increase in demand in the given sector.*			185							
Discussion	• The proposed intervention in Strelitzia Avenue will likely create an estimated 25 job-years in the design and construction phase and an estimated 2 permanent jobs in maintenance. In the design phase the eight temporary job years created will nearly all be highly skilled jobs in professional									

SONSTRAAL TO VAN DER STEL STREET DM HFA PROJECT	
	firms (Engineering, Landscape Architecture, Planning, Scientific Services). All of these will be green jobs. In the construction phase, the 17 job years created will include three highly-skilled job years, nine semi-skilled job years and five low-skilled job-years. All of these will be green jobs except seven semi-skilled jobs, which will be made up of guards for 24-hour site security. All maintenance jobs are green jobs. Other semi-skilled jobs include security will be excavator operators, TLB operators, dump truck operators, planters, and gabion basket makers. • There is a significant job seekers database for the ward (21) and adjacent wards (25, 24, 22, 20), with over 600 job seekers in the ward and over 2,000 in the adjacent wards to the Strelitzia Avenue intervention will take place. The low skilled jobs could be sourced entirely from the ward and adjacent wards, with the potential for upskilling these workers into the roles of security guard, planter, and gabion basket maker. • The level of investment estimated in the planning, design, and construction phase of this project will create an estimated 114 indirect jobs in the national economy, from the supply of inputs required for the project. The estimated level of expenditure is expected to induce 185 jobs in the economy as project workers spend their wages. Many of these will be in Drakenstein if local suppliers are used. • It is estimated that this investment will return 1.68 times the investment, in income for the economy, an estimated R105 million. • This infrastructure does fall under any of the trading services departments and is therefore not a direct revenue generator. Some maintenance and rehabilitation costs for infrastructure will be reduced. It may help reduce solid waste and stormwater management operational costs.

E3.8.Barriers and Risks: Palmiet River Management (Sonstraal to Van der Stel Street) Hybrid Flood Alleviation Project:

The following register summarises the risks identified across the various phases of the project. The risks and mitigation measures should be refined as part of further design phases.

Part E Chapter 3 Table 10. Barriers, Risks and Mitigation Measures

Phase of project lifecycle	Risk	Mitigation Measures
Planning and Design	**Community:** Lack of community buy-in and support.	• Community participation during all phases of the project. • Consideration of the development of social compact. • Mobilisation of NGOs and NPOs to support the initiatives. • Ward Councillor and Ward Committee mobilisation to ensure an understanding of the local context and to promote meaningful engagement with community members.
Planning and Design	**Community:** Lack of meaningful engagement.	• Community participation during all phases of the project. • Ward Councillor and Ward Committee mobilisation to ensure an understanding of the local context and to promote meaningful engagement with community members. • Hosting events to raise awareness on the project.
Planning and Design	**Political:** Political acceptance.	• Gaining political buy-in through engagement with relevant political stakeholders and explaining the potential project impact and benefit.

Phase of project lifecycle	Risk	Mitigation Measures
Planning and Design	**Institutional:** Lack of transversal collaboration.	• Defining roles within each department for undertaking the project, and development Key Performance Indicators (KPIs) to create accountability for these responsibilities. • Development of Standard Operating Procedures (SOPs) for each of the relevant department to provide a clear overview of their roles and responsibilities.
Construction and Implementation	**Safety and security**: There is potential for safety and security concerns posed to workers during the construction and maintenance of the project.	• Ensuring the presence of law enforcement during construction and implementation to mitigate potential safety and security concerns. • Involvement of the Drakenstein Municipality Smart Safety Network (DM SSN) to enhance security on site.
Operation and Maintenance	**Solid waste management**: Solid waste dumping and limited solid waste management.	• SOPs to be developed for the Solid Waste Management Department, outlining roles and responsibilities. • The community requested the addition of more refuse bins at the site.
Operation and Maintenance	**Safety and Security**: Risk of children drowning in check dams	• Ensuring adequate lighting in the area. • Mobilising community/ neighbourhood watches at the site. • Ensuring that the walls of the check dams are not too high to reduce the risk of drowning. • Ensuring that the check dams are not designed to 'hold' water.
Operation and Maintenance	**Safety and Security:** Children may walk on top of the flood wall which poses a safety risk.	• Ensuring that the top of the flood wall is narrow to prevent children from walking along the top of the wall.

Phase of project lifecycle	Risk	Mitigation Measures
Operation and Maintenance	**Safety and security:** There is a potential risk of muggings along the proposed pedestrian pathway.	• Ensure adequate lighting along the pathway. • Mobilising neighbourhood/ community watches at this site. • Involvement of the Drakenstein Municipality Smart Safety Network (DM SSN) to enhance security on site.
Operation and Maintenance	**Safety and Security**: Vandalism and theft of intervention materials.	• Mobilising community/ neighbourhood watches at the site. • Patrols at the site to be undertaken by law enforcement officers. • Involvement of the Drakenstein Municipality Smart Safety Network. • Use of intervention materials that have no 'resale value' that are embedded into the ground/ too large to steal.
Operation and Maintenance	The flood wall may restrict easy access to the river.	• Walls where suitable should be coupled to an adjacent pedestrian pathway in order to maximise the recreational access along the river. • Berms can also serve as a raised pedestrian walkway in order to maximise access to the river.
Operation and Maintenance	Social acceptance/ ownership	• Involvement of Mayoral Committee Members (MMCs) in the project to enhance communication to community members, to provide local knowledge and to provide a representation of community members and concerns. • Development of Public-Private Partnerships (PPP) to develop a sense of ownership. • Inclusion of the project in budgeting processes. • Enhance job creation potential for community members as part of the operation and maintenance of the intervention. • Host events to spread knowledge and awareness on the project.

Phase of project lifecycle	Risk	Mitigation Measures
Funding	Cost of implementation and ongoing maintenance.	• Integration of the project into the Service Delivery and Budget Implementation Plan (SDBIP) to receive priority funding allocation and increased visibility to potential funders. • Integration of the project into the IDP.

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