

LPP/11 Stormwater management

1.0 Citation

This is a Local Planning Policy prepared under Schedule 2 of the *Planning and Development (Local Planning Schemes) Regulations 2015* (Regulations). This Policy may be cited as Local Planning Policy #11 *Stormwater management* (LPP/11).

2.0 Purpose

The purpose of this Policy is to assist developers, engineers, landowners and government to integrate suitable design measures into their own stormwater systems. The correct design and construction of appropriate systems will assist with reducing the damaging effects of heavy rainfall events on private and public property and the public drainage network.

A subdivision or development stormwater management plan is required at lodgement of a subdivision or development application to demonstrate in detail that all water matters within or impacting on the site will be appropriately managed.

The Explanatory Guidelines provide reasons for the development of this Policy, common issues and design solutions.

3.0 Objectives

Stormwater management systems should:

- 1. Mimic natural hydrological processes;
- 2. Enhance the water quality, prevent pollution, erosion and land degradation;
- 3. Be integrated within the built form (such as within landscaping areas, road reserves, public spaces and public open space) to enhance amenity;
- 4. Retain and increase vegetation throughout the landscape such as in carparks and in road reserves;
- 5. Be integrated early in the land and water planning process so that the necessary investigations are undertaken to inform decisions at each stage of land planning and ensure enough land is set aside for water management;
- 6. Promote disaster resilient design that protects public and private infrastructure and buildings from flooding and inundation during major rainfall events;
- 7. Prevent off-site impacts; and
- 8. Preserve efficient stormwater management during rainfall events.

4.0 Applications subject of this Policy

4.1 Application

This Policy applies to development, including works or land uses, where the stormwater cycle may be altered or affected, including but not limited to:

- Earthworks;
- Subdivisions;
- Modifications to existing stormwater systems;
- Landscaping, verge modifications or works within the road or drainage reserve;



- Government projects; and
- Industrial, commercial and residential development.

If the Policy is inconsistent with the *Town of Port Hedland Local Planning Scheme No. 7* (LPS7) and the Regulations, LPS7 and the Regulations prevail to the extent of any inconsistency.

This Policy is not intended to replace existing guidelines or policies of the state government, but be complimentary. The intent of this Policy is to assist with a consistent approach to stormwater management design in respect to the unique qualities of Hedland.

4.2 Exemptions

Even where works may be exempt from the need to obtain development approval, the Town may seek to influence the design of development or land uses to ensure the objectives of this Policy are achieved.

5.0 Application requirements

The Town will generally require the following information to support a stormwater management plan:

- Site survey showing existing development and ground levels;
- A plan to scale, showing the proposed development;
- Proposed grading of the site with contours;
- Proposed Finished Ground Levels (FGL) and Finished Floor Levels (FFL);
- Locations for stormwater infrastructure, including but not limited to: kerbing, pipes, silt traps, erosion control measures;
- Size (depth & diameter) and locations of all soakwells, infiltration basins and landscape areas;
- Locations and details of excess water discharge methods to the Town's drainage system;
- Details of proposed roof direction;
- Sealed and unsealed areas (and what they consist of);
- Identify any services or infrastructure on the site that require protection;
- Cross sections of infiltration basins and swales; and
- Information identified under State Planning Policy 2.9 Planning for Water Guidelines Table E.1

6.0 Policy provisions

This policy is intended to compliment the range of policies and guidelines that have been prepared by the State Government. These include, but are not limited to:

- State Planning Policy 2 Environment and Natural Resources (WAPC);
- State Planning Policy 2.9 Water Resources (WAPC);
- Better Urban Water Management and Guidance Notes (WAPC);
- Urban Water Management Plans Guidelines for preparation and compliance with subdivision guidelines (DWER);
- Decision process for stormwater management in Western Australia (DWER);
- Stormwater management manual for Western Australia (DWER); and
- Local Government Guidelines for Subdivisional Development (WAPC).



When dealing with stormwater issues, the Town will consider the above suite of documents. These will need to be satisfied where applicable.

Requirements that have been developed specifically for Hedland are contained within the following table. If one or more of the '*Issues/matters to be considered*' applies to your situation, you can use the '*Acceptable development provisions*' in the design of a stormwater management plan to gain approval.

Where you seek alternative design solutions, you will need to satisfy the '*Design principles*'. The Town will exercise its discretion in this case.



Issues/matters to be considered	Design principles	Acceptable development provisions
All properties e.g. Vacant land, land containing development or uses, etc.	Material does not escape the property boundaries.	The surfaces of lots are stabilised to prevent erosion.
Subdivisions	 Subdivisions shall ensure that life, property and infrastructure are not put at risk of erosion or inundation. Newly created lots do not become inundated. Roads can serve as a back up drain when purpose built drains become inundated. Lots are graded so as to avoid draining onto adjoining lots. Stormwater discharge into the Town's drainage system to be at existing or below pre-development rates unless the developer upgrades the receiving public drainage system to handle the equivalent increase. 	 Newly created lots achieve a FGL that are: A minimum of 300mm above the 1% AEP; and Not lower than the public drainage system, verge or road. The surfaces of lots and all areas subject to earthworks are stabilised to prevent erosion. Lots are graded so as to not drain onto adjoining lots.
New development Finished Ground Levels (FGL) and Finished Floor Levels (FFL)	 Development, assets and infrastructure will not be subject to inundation. Life is not put at risk. Pollution is avoided through separating sources from direct water contact. 	 New development shall ensure that: The FGL of yards, storage areas, car parks and driveways are a minimum of 300mm above the 1% AEP; The FGL for potential sources of pollution (e.g. effluent disposal systems, refuelling stations,



		 fuel and/or waste storage areas) are a minimum of 500mm above the 1% AEP; The FFL of non-habitable buildings are a minimum of 300mm above the 1% AEP; and The FFL of habitable buildings (e.g. dwellings & offices) are a minimum of 500mm above the 1% AEP. New development FFL do not sit lower than the public drainage system, verge or road.
Verges & landscaped areas	 Unsealed areas (e.g. garden beds) shall be designed to prevent loose material eroding. Shall be designed to incorporate stormwater retention or detention. 	 Rock mulch to be a minimum size of 20mm to a depth of 100mm. All mulched areas to be retained with a kerb or other barrier. The use of fines such as crakerdust is not supported unless it is cement stabilised and laid in a non-trafficable area. If within the verge, measures shall be incorporated to prevent vehicles from accessing.
Embankments for swales, roads, infiltration basins, etc.	Embankments are protected from eroding.	 Embankments to be stabilised with: Seeded (endemic species) coir/jute mesh/matting and reticulated (synthetic mesh not supported); Ground stabilisation matting with aggregate infill; Shotcrete or reinforced concrete batters; Geolink or articulated interlocking concrete brick system;



Surface treatments for yards, storage areas, car parks, driveways, etc.	 Shall be designed to prevent stormwater from overflowing onto neighbouring properties. Areas will not erode or cause sedimentation. Designed to last the life of the development with minimal management (e.g. does not require cleaning out or regrading during or after a rainfall event). 	 Concrete canvas; or Cemented rock pitching with 150mm diameter rock. Surface treatements to consist of: Ground stabilisation matting with aggregate infill; Concrete; or Asphalt, chipseal or bitumen seal. 200mm barrier kerbing to all property boundaries, keyed into ground 100mm. The FGL shall be graded to dedicated swales and drainage channels to avoid stormwater discharge over boundaries. The use of fines (such as crackerdust or crusherdust) is not supported.
Areas used for servicing, repairs, vehicle wash down, refuelling and other activities that may result in contaminants such as oils, grease, solvents, acids, fuels, coolants and surfactants accumulating.	 Physical pollution control measures prevent fuel, oils and hydrocarbons from: coming into contact with unsealed surfaces or stormwater; leaving the property; and/or entering the ground or groundwater. 	 To be undertaken in weatherproof contained areas and on sealed concrete floors that prevent contaminants from entering the ground or groundwater. Floors to be designed to drain to an internal collection sump and surrounded with an impervious perimeter bund. Any stormwater to be diverted away from the floor and chemical or parts storage areas. Refuelling areas to be roofed.



		 Chemicals and waste products to be stored in weatherproof and contained areas. This is to prevent weathering of containers and to minimise the risk of contaminants from accidental spillage or ruptures entering the stormwater system or the environment. All loading and unloading to be undertaken in contained areas. Oil-water separators are used to remove remnant pollutants.
Infiltration measures and water conveyance	 Detention or retention as per the Town's Stormwater Design Guidelines contained in Appendix 1. Water ponding does not exceed 72 hours. 	 Detention or retention as per the Town's Stormwater Design Guidelines contained in Appendix 1. Water ponding does not exceed 72 hours.
Swales, drainage channels or infiltration basins	 Can transport excess stormwater away from catchment areas to retention or detention areas and off site efficiently and effectively. Embankments are designed in a way that will not be prone to erosion. Designed to last the life of the development with minimal management (e.g. does not require cleaning out or regrading after a rainfall event). Designed so that water ponding does not exceed 72 hours. 	 Base to be finished with: Ground stabilisation matting with aggregate infill; Loose stone/rock (e.g. river shingle, blue metal) with a minimum size of 50mm to a minimum depth of 150mm; Seeded (endemic species) coir/jute mesh/matting and reticulated (synthetic mesh not supported); Shotcrete or concrete; Geolink or articulated interlocking concrete brick system; Concrete canvas; or Cemented rock pitching with 150mm diameter rock.



Discharge points	 Can effectively dispose of excess water from the property. Will not cause any erosion to receiving infrastructure (e.g. public swales). Sediment does not leave the property. Ties neatly into existing erosion control treatements. 	 Cemented rock pitching with 150mm diameter rock. Ground stabilisation matting with ballast size rock infill. When discharging into the public swale network, the base and opposite side of the embankment protected with cemented rock pitching apron with 150mm diameter rock.
Setbacks of roofs to property boundaries	 Stormwater runoff from roofs is not directed onto neighbouring properties. 	 Where pitched roofs direct stormwater to a boundary, they shall be setback minimum of 750mm. Flat roofs are setback a minimum of 500mm from a boundary. Nil setbacks for a parapet wall boxed gutteror where a skillion roof directs stormwater away from the boundary.



7.0 Consultation

The Town may conduct advertising to owners and occupiers of surrounding neighbouring properties where it believes that a proposed development does not meet the objectives of this Policy.

8.0 Definitions

Ground stabilisation matting

An interlocking mat that is filled with aggregate (to the manufacture's specification) and used to reinforce, stabilise, and protect grass and gravel surfaces. It retains aggregate in vertical cells and prevents horizontal movement. There are differing products that can be used for trafficable areas, porous paving, embankment stabilisation, tree root protection and landscaping.



Left, ground stabilisation matting being installed as a trafficable surface for commercial vehicle parking in Wedgefield. Right, ground stabilisation matting installed for a landscaped swale in Port Hedland.

- Appendix 1 Stormwater Design Guidelines
- Appendix 2 Stormwater Management Explanatory Guidelines

Relevant legislation	Planning and Development Act 2005 Planning and Development (Local Planning Schemes) Regulations 2015			
	Town of Port Hedland Local Planning Scheme No. 7			
Delegated authority	Director Regulatory Services Manager Town Planning and Development Senior Planner			
Business unit	Planning & Development			
Directorate	Regulatory Services			
Governance to complete this section				
Version Control	Version No.	Resolution No.	Adoption date	
	V01	OCM202122/083	24 November 2021	
Review frequency	2 Yearly			



Local Planning Policy

Appendix 1 - Stormwater Design Guidelines



Stormwater Management at Residential Properties

Property owners have a statutory obligation under common law and the Local Government Act 1995 to prevent water from dripping or running from a property onto any other land and are not permitted to allow overflow onto neighbouring properties.

The Town of Port Hedland requires that stormwater within lot boundaries is to be retained on site, either through soakwells, drainage retention cells, landscaped gardens or other approved methods.

Retention of stormwater within the lot shall accommodate a minimum of a 1 in 5 year rainfall event (6 minute duration). Overflow storm water shall be directed towards the Town's existing drainage system.

It is recommended that sufficient fall is provided across the site to allow overflow (excess of the 1 in 5 year) towards the Town's drainage system. Stormwater discharge details can be obtained from TOPH Infrastructure Services.

If stormwater is to be discharged to a Town's stormwater manhole, a gross pollutant trap shall be installed. Refer Stormwater Drainage Connection Drawing No TOPH - 1.0 for connection details.

When soakwells or drainage retention basins are being constructed, excavation shall not undermine fencing, retaining walls and adjacent buildings on boundaries or footings to buildings within the property.

Soakwells located under driveways shall have trafficable lids, liners and bases.

Soakwell capacity:

The calculations provided below are a guide only based on rainfall conditions. Excessive storm conditions may cause overflow depending on soil types.

SIZE	CAPACITY	Area in Square Meter per Soakwell For	
		1 in 5 Year Storm	1 in 10 Year Storm
		Intensity 152 mm/hr	Intensity 182 mm/hr
1.2m dia x 0.9m deep	1.00 m3	Inadequate	Inadequate
1.2m dia x1.2m deep	1.36 m3	1 per 100 m2	Inadequate
1.8m dia x0.9m deep	2.29 m3	1 per 175 m2	1 per 140 m2
1.8m dia x1.2m deep	3.05 m3	1 per 230 m2	1 per 180 m2
1.8m dia x1.8m deep	4.58 m3	1 per 350 m2	1 per 290 m2

Stormwater Drainage Design Guidelines For Commercial/ Industrial/Grouped and Multiple Dwellings Developments



(Development Applications will be assessed on a case by case basis).

Property owners have a statutory obligation under common law and the Local Government Act 1995 to prevent water from dripping or running from a property onto any other land and are not permitted to allow overflow onto neighbouring properties.

All stormwater drainage designs and calculations shall be carried out and certified by a qualified person experienced in hydrologic and hydraulic design. It is a requirement that storm water is retained on site to accommodate a minimum of a 1 in 5 year rainfall event (6 minute duration). Overflow storm water (excess of the 1:5 ARI event) must be directed towards the Town's drainage system.

All stormwater drainage related plans submitted to the Town of Port Hedland, must include a site plan indicating the following drainage details:

- Existing ground levels or contours of the subject property and adjoining land.
- Proposed levels of paved or concrete impervious areas.
- Details of proposed roof and pavement drainage disposal systems.
- Size (depth & diameter) and locations of all soak-wells, retention basins, or landscape garden areas.
- Locations and details of excess water discharge methods towards the Town's drainage system.

Factors such as soil conditions, water table depth and capacity for storm events need to be taken into account by the appointed professional engineer.

The designer shall ensure

- Appropriate methods for discharging of excess stormwater away from habitat areas.
- Floor level of all buildings shall be 500 mm above the 100 year flood level and all non-habitable areas shall be minimum of 300mm above the 100 year flood level to ensure adequate flood protection.

Owner shall install sufficient infrastructure to direct overflow stormwater to the Town's drainage system during a major rainfall event.

SIZE	CAPACITY	Area in Square m per Soakwell For		
		1 in 5 Year Storm 1 in 10 Year Storm		
		Intensity 152 mm/hr Intensity 182 mm/hr		
1.2m dia x 0.9m deep	1.00 m3	Inadequate Inadequate		
1.2m dia x1.2m deep	1.36 m3	1 per 100 m2 Inadequate		

Soakwell capacity: The calculations provided are a guide only based on rainfall conditions.

Stormwater Drainage Design Guidelines For Commercial/ Industrial/Grouped and Multiple Dwellings Developments



1.8m dia x0.9m deep	2.29 m3	1 per 175 m2	1 per 140 m2
1.8m dia x1.2m deep	3.05 m3	1 per 230 m2	1 per 180 m2
1.8m dia x1.8m deep	4.58 m3	1 per 350 m2	1 per 290 m2

Soakwells are generally not suitable for sites with silty sand and clay content as such sites do not allow water to be effectively dispersed. Effective stormwater disposal in these areas will generally require interconnected sumps directing flow to the Town's drainage swales.

Stormwater treatment facilities, in the form of petrol oil traps or sediment traps, shall be provided where appropriate. Any areas where piped drainage is used to discharge stormwater to the Town's drainage system shall have a gross pollutant trap installed.

Refer Drawing No TOPH -1.0

Refer Drawing No TOPH- 2.0 for stormwater connection details via open channel.



General

Stormwater drainage systems are required to provide for effective disposal of stormwater and all drainage designs shall comply with appropriate industry design standards such as:

- Australian Rainfall and Runoff', the Institution of Engineers, Australia, 1977.
- Gross Pollutant Trap Guidelines, Department of the Environment, Land & Planning, Department of Urban Services, April 1992.
- Stormwater Drainage Design in Small Urban Catchments: a handbook for Australian practice, Australian Road Research Board, Special Report No. 34, Argue J.
- Local Government Guidelines for Subdivisional Development October 2017.

Developers are required to submit stormwater management plans to the Town of Port Hedland including the followings.

- 1. Detailed stormwater management design including the location and design of swales, integrating major and minor flood management capability, landscape plants for the swales as related to stormwater function, specific details of local geotechnical investigations, local climate conditions and their impact on stormwater design.
- 2. Detail measures to reduce velocity of stormwater discharge to prevent erosion and sediment transportation.
- 3. Management of sub-divisional works (stabilising soil, dust, erosion, sediment)

All stormwater drainage designs and calculations shall be carried out by a qualified person experienced in hydrologic and hydraulic design.

The objectives of the stormwater management approach are as follows

Small Rainfall Events

Stormwater runoff within the first 6 minutes, up to 15mm rainfall from impervious areas should be retained/detained on-site. Retention areas to be designed to prevent rainfall runoff into receiving water bodies by holding it in a retention storage area. Managing stormwater from a small rainfall event can be done by Implementing one or more of the following structures/systems.

- 1. Vegetated verge and median swales within the road reserve or abutting POS area
- 2. Underground infiltration trenches, infiltration cells, soakwells and porous base catchpits.
- 3. Pervious paving.
- 4. Tree pits.
- 5. Biofilters.



Minor Rainfall Events

Developers are expected construct sufficient infrastructure to manage runoff and discharge stormwater to designated drainage compounds. Scour protection at culvert, pipe system and outlets shall be constructed in accordance with Town of Port Hedland Stormwater Disposal Specifications. Refer Drawing No TOPH 1.0 and TOPH 2.0

Major rainfall event

Developers to provide a detail design showing flood levels, peak flow rates and flood storage volumes. Developer shall mitigate breeding of disease vector and nuisance insects by designing and maintaining stormwater management systems to contain no standing water for more than 72 hours. Finish ground level of the Lots shall be above 100 year flood level.

Recommendations

Open drains and swales shall be designed unless otherwise specified by the Technical Services Unit. The designer shall meet the requirements in current Australian Standards in drainage network designs using a recurrence interval of 5 years except in the case of arterial drains and compensating basins where a recurrence interval of 100 years.

Additionally, the designer shall provide for the adequate discharge of flood flows between the intervals mentioned above and in order that the floor level of all buildings shall be 500 mm above the 100 year flood level and all non-habitable areas shall be minimum of 300mm above the 100 year flood level to ensure adequate flood protection during the cyclonic climate conditions.

It is the responsibility of the Consulting Engineer to examine the total catchment area of which a particular subdivision may form a part, to ensure that any arterial drainage that may pass through the particular subdivision is capable of carrying the ultimate design flow from the upstream catchment. If the capacity of the existing downstream catchment is inadequate to handle the design run-off, the surplus water either be retain within the subdivision in an approved manner or existing downstream drainage catchment shall be upgraded to accommodate additional discharge from the proposed Lots.

Creating drainage low points adjacent to residential properties will not be approved and designers shall ensure that there are overflow surface runoff routes to parks or other drainage basins which will mitigate localised flooding.

A Stormwater Drainage Management Plan will be required for each subdivision.



Drainage Easement

Under common law and the Local Government Act 1995, it is not permitted to allow overflow onto neighbouring properties. In inevitable cases where stormwater is discharged onto private land at downstream of a subdivision or development, arrangements shall be made by the subdivider with the owner(s) of the downstream land to provide an easement in favour of Town of Port Hedland over the route of the drain and to construct and / or improve the drainage outlet to the requirements of the Technical Services unit.

Stormwater Drainage (box culvert/pipe)

- The size of the stormwater pipes/box culverts at the crossovers, verge and roads shall be obtained from the TOPH Technical Services.
- Box culverts shall be installed under all road pavements.
- Reinforced concrete pipes or box culverts in classes appropriate to loadings and cover heights shall be installed at crossovers.
- The velocity in pipes shall be limited to the range 0.8 m/sec-1.2 m/sec. The possibility of a scour shall be considered at outfalls in soil classed clayey sands and scour protection steps to be taken to eliminate it where it may occur.
- Manholes / soak wells shall be provided at each change in direction and at a maximum spacing of 90 metres. Step irons shall be constructed for all pits and manholes where the difference in levels between the base and the surface level exceeds 1.0 metre.

All outlets to pipe/box culvert drainage systems (and inlets in the case of open ended culverts) shall have concrete headwalls with concrete aprons, and shall have anti-scour cemented rock bedding for a minimum distance of 2.0m beyond the edge of aprons and 500mm on sides.

All trenches for pipes laid under road pavements shall be backfilled to the pavement subgrade surface with compacted cement stabilised sand or road base course material. The material shall be placed in even layers not exceeding 225mm in thickness and each layer shall be compacted with a minimum of four (4) passes of a vibratory plate compactor having a minimum static mass of 50kg. Care shall be taken to ensure that the material fills all voids under the haunches and that no damage occurs to the pipe whilst compacting material next to and immediately over the pipe. The cement stabilised sand shall preferably be supplied from a central batch mixing plant.

Any areas where piped drainage is used to discharge stormwater to Town's drainage system shall be installed with gross pollutant traps, a structure designed to intercept and retain sediment transported by water flow. (Refer Drawing No TOPH1.0)



Crossovers at Open Drains

Piped culvert cross-overs are required at the entrance of the new properties, crossing over an open drain to meet the requirements of a subdivision being drained and filled to the satisfaction of the Town of Port Hedland. All culverts shall have appropriate size concrete headwalls, reinforced concrete pipes and open drains with scour protection as per Town of Port Hedland Crossover Policy 9/005. Subdividers shall design culverts required at the proposed crossovers over open drains and submit the final designs to the Town of Port Hedland.

Swales and Drain Batters

Swales located within road verges or within footpaths must consider the standard location for services (such as sewers and underground electricity). In general, a swale should not be in the line of other services.

The most important design consideration for a swale is the longitudinal slope. A flow of less than 1.0 metres/second for the 100 year ARI is recommended to avoid scouring. Swales and buffer strips can use a variety of vegetation types. Vegetated swales shall be planted with local native plant species to enhance biodiversity, reduce the need for watering and reduce the spread of weed species to receiving environments via runoff.

Maximum side slopes of unfenced open drains/swales shall be 1 in 6 and 1.0 m wide base. Flow rates in open drains shall be controlled by engineering controls if surface flows will exceed 1m/s. In areas where soils are subject to scouring and drains shall be lined with suitable type of hessian matting to prevent scouring on banks and bases of the swales. Cement mortared stone pitching shall be provided in open drains at the junctions and bends greater than 22.5 degrees.

Table drains at un-kerbed roads shall be sized so that the top water level in a drain does not rise to within 200mm of the edge of the shoulder for the design recurrence interval flow.

Stone Pitching

Stone Pitching shall consist of sound durable rock not less than 100mm thick, properly bedded on approved loam or sand and mortared to present a uniform surface. The exposed surface of each stone or block shall be approximately flat and not less than 0.05 square metres in area. Spaces between adjacent stones or blocks shall not exceed 20mm in width.

Where road pavements are designed for direct stormwater runoff to adjacent swales, kerb openings shall be located at low points of road pavements and cemented stone pitched



stormwater spoon drains shall be installed in accordance with the Drawing TOPH 2.0. Angle of the kerb openings shall be designed to direct stormwater flow towards the swale.

Sumps

Sumps having side slopes steeper than 1:6 and a maximum depth of 6.0m shall be fenced with no public access.







Appendix 2 - Stormwater management Explanatory Guidelines





Purpose

The purpose of these guidelines is to explain the reasons for this Policy, common issues and design solutions.

Reasons for this Policy

Port Hedland has a semi-arid climate with a tropical savannah influence. The annual average rainfall of 319mm occurs almost wholly between December and June. This is largely influenced by tropical lows and cyclones. These rainfall events often produce the Town's total annual rainfall within a concentrated period of time, often only a few days. For example, Cyclone Veronica delivered 355mm in three days and the highest daily total has been recorded as 387mm.

Much of the soil within Wedgefield, Kingsford Smith and South Hedland consists of collapsible silty sand or clayey sand known as 'Pindan'. These soils are poor draining and can become saturated easily. The high salt content and composition give Pindan its dispersive nature and has a strong tendency to erode once saturated.

Water erosion is a significant problem with pindan soils because of our intense rainfall events. Pindan soil is especially vulnerable to tunnel and gully erosion and can occur even where slopes are less than one percent.



Figure 1: An example of gully erosion in Kingsford Smith

An example of tunnel erosion around the concrete lids in Kingsford Smith

Issues

The rainfall events coupled with poor draining soils and an inadequate design of stormwater systems often results in:

- Stormwater overflowing onto neighbouring sites. This inundates adjoining properties and can lead to flooding.
- Yards and verges eroding onto neighbouring land. This material clogs up the private and public drainage network.
- On-site stormwater systems, such as drains, becoming clogged. This can flood a property and result in a house or business becoming water damaged.
- The public drainage and road network silting up. Roads become flooded and are unsafe to use and access to businesses or houses can be cut off.
- Businesses and local government facing large clean-up costs with additional resources being spent on repairs.

Some examples of common issues are shown in the following pages.





Figure 2: Yards have eroded onto neighbouring land from inadequate use of materials for surface treatments (fines - cracker dust), incorrect grading and no infiltration measures (left Kingsford Smith, right Wedgefield).



Figure 3: Verges and yards consisting of fines, such as cracker dust, are highly prone to erosion (left Port Hedland, right Kingsford Smith).





Figure 4: A public drain that has become blocked from eroded pindan (Kingsford Smith).



Figure 5: Silt from private property has entered a public drain, will reduce its effectiveness and require cleaning out (Kingsford Smith).



Design solutions

Solutions for resilient design are varied and will depend on a case-by-case basis. There are plenty of examples in Hedland where good designs have ensured that a site drains effectively and maintains its integrity during heavy rainfall events. Some of the benefits of good design include:

- Little to no clean up or maintenance. This saves money and resources in the long term.
- A business can be up and running much faster after a significant rainfall event. This minimises loss of income and ensures competitiveness.
- Houses and businesses are not made uninhabitable. People or businesses are not displaced.
- The damage to public infrastructure (drains and roads) is avoided or significantly reduced. This means reduced maintenance costs to the Town and less pressure on operating costs and rates.

The following photos are provided to show examples of design treatments included in this Policy.

Verges



Figure 6: Verges that have been installed with 20-50mm river shingle or blue metal and to a depth of 100mm after experiencing 290mm of rain over three days (South Hedland)



Yards and car parks



Figure 7: Top, a yard that is sealed, kerbed and graded inwards (Kingsford Smith). Bottom left, a car park finished with ground stabilisation matting and an 8mm aggregate after experiencing 290mm of rain over three days (Port Hedland).



Swales & discharge points



Figure 8: A vegetated swale (left) and cemented rock pitched discharge point (right). These have held their form, transported water away efficiently and do not require cleaning out or regrading despite 290mm of rain over three days (South Hedland).

Erosion, flooding and sedimentation are the main issues that occur from poorly designed and constructed developments and subdivisions. This Policy aims to ensure that proven stormwater treatments are incorporated into a design to ensure that future development is resilient to heavy rainfall events.





Figure 9: A swale and discharge point protected with a mixture of ground stabilisation matting, landscaping, cemented rock pitching and larger stones (Port Hedland)





Figure 10: Left, a detention basin that captures this roof's runoff prior to discharging excess water into the public drainage system. Right, the discharge point into the public drainage system (South Hedland)

The following pages contain an example of a stormwater management plan with different design solutions incorporated into it.





Figure 11: Example of stormwater management plan for a development site.

GENERAL NOTES:

- 1. ALL LEVELS, DIMENSIONS, POSITIONS & HEIGHTS TO BE CHECKED AND VERIFIED ON SITE BEFORE COMMENCING ANY BUILDING WORK, DATUM AHD
- 2, FIGURED DIVENSIONS ARE TO BE TAKEN AND NO SCALING OF DRAWINGS WILL BE ALLOWED. ALL DRAMINGS ARE TO BE READ IN CONJUNCTION WITH SPECIFICATIONS AND ALL OTHER RELEVANT DRAMINGS FROM ARCH TECTURAL, STRUCTURAL, ELECTRICAL, HYDRALLICS & MECHANICAL ENGINEER'S,
- 4. ANY DISCREPANCIES ARE TO BE REPORTED TO THE AUTHOR OF THE PLANS IMMEDIATELY. 1. REFER TO STRUCTURAL ENGINEER'S DRAWINGS FOR ALL STRUCTURAL WORKS.
- 6, LARGE SCALE DRAWINGS SHALL TAKE PRECEDENCE OVER SMALL SCALE DRAWINGS,
- CONTRACTOR TO CONFIRM LOCATION, DEPTH, AND EXTENT OF ALL OTHER SERVICES, AS SHOWN ON SERVICES LAYOUT PLAN, PRIOR TO THE COMMENCEMENT OF ANY WORK, ENGINEER TO BE NOTIFIED UPON CISCREPANCIES.
- CONTRACTOR TO CONFIRM GROUND WATER TABLE LEVEL PRIOR TO THE COMMENCEMENT OF MY WORK AND IF MY DEWATERING IS REQUIRED.
- EXISTING GROUND LEVELS AND LOCATION AND INVERT LEVEL OF EXISTING SEWER SHALL BE CONFIRMED PRIOR TO THE COMMENCEMENT OF ANY WORK.
- 10. ALL GRAVITY PIPES SHALL BE PAC SNA UNLESS OTHERWISE SPECIFIED, ALL PIPES TO BE LAD AT MINIMUM GRADE TO FACILITATE SELF OLEANISING
- 11, ALL BACK FILL TO BE COMPACTED TO A DRY DENSITY NOT LESS THAN THAT OF THE SURROUNDING UNDETURBED SOL, BACKFILL OF SEWRER IN ROAD RESERVES SHALL BE COMPACTED TO GIVE A MINIMUM RESISTANCE OF IS LOWS PER SOAMM USING A STANDARD FALLING VIEGHT FENETROADETER FOR THE FULL DEPTIN OF FILL.
- 12. CONTRACTOR TO MAKE GOOD ALL FENCING, KERBING, ROADS, DRIVEWAYS, ETC IN THE AREA OF EXCAVATION, ALL NECESSARY APPROVALS FROM RELEVANT AUTHORITIES TO BE OBTAINED PRIOR TO THE COMMENCEMENT OF ANY WORK.

- THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER CONSULTANTS DRAWINGS AND LOCAL AUTHORITY DRAINAGE CONSTRUCTION DRAWINGS.
- ALL SOANWELLS IN PAVED AREAS SHALL HAVE HEAVY DUTY REINFORCED CONCRETE TRAFFICABLE LIDS.
- SUBGRADE AT BASE OF PRECAST LINER TO BE COMPACTED TO & BLOWS PER 300mm WITH A STANDARD PERTH PENETROMETER OR 86% OF MWDD AS PER AS1288.
- BACKFLL TO PIT TO BE COMPACTED TO 8 BLOWS PER 300mm WITH A STANDARD PERTH PENETROMETER.
- GULLY DRAINS SHALL BE SUPPLIED AND FITTED TO ALL EXTERNAL DOWNPIPES TO ASS600.
- GUTTERS AND DOWNPIPES TO BE DIRECTLY CONNECTED TO STORMWATER SYSTEM INTERNALLY BY DRAINAGE CONTRACTOR TO ASS60
- 7. GROUT (MORTAR) TO BE 4 SAND : 1 CEMENT
- WHERE MANAGLE LINER DEPTH EXCEEDS 2.1m, BOLT ON GAL VANISED DOUBLE STEP IRONS AT 350mm CENTRES, LINER TO BE MADE GOOD EXTERNALLY USING CEMENT MORTAR FOLLOWING STEP IRON INSTALLATION, NOT APPLICABLE FOR SOMWHELS,
- STEP IRONS TO BE LOCATED ON SIDE WITH LEAST INTERFERENCE FROM PIPES ON ALL MANIFOLES, GULLEYS, SIDE ENTRY AND COMBINATION SIDE ENTRY PITS WHERE DEPTH EXCEEDS 2.011.









GENERAL NOTES:

1. ALL LEVELS, DIMENSIONS, POSITIONS & HEIGHTS TO BE CHECKED AND VERIFIED ON SITE BEFORE COMMENCING ANY BUILDING WORK, DATUM AHD

2. FIGURED DIMENSIONS ARE TO BE TAKEN AND NO SCALING OF DRAWINGS WILL BE ALLOWED. ALL DRAWINGS ARE TO BE READ IN CONJUNCTION WITH SPECIFICATIONS AND ALL OTHER RELEVANT DRAWINGS FROM ARCHTECTURAL, STRUCTURAL, ELECTRICAL, HYDRALLICS & MECHANICAL ENGINEER'S,

4. ANY DISCREPANCIES ARE TO BE REPORTED TO THE AUTHOR OF THE PLANS IMMEDIATELY

6. REFER TO STRUCTURAL ENGINEER'S DRAWINGS FOR ALL STRUCTURAL WORKS. 6, LARGE SCALE DRAWINGS SHALL TAKE PRECEDENCE OVER SMALL SCALE DRAWINGS,

CONTRACTOR TO CONFIRM LOCATION, DEPTH, AND EXTENT OF ALL OTHER SERVICES, AS SNOWN ON SERVICES LAYOUT PLAN, PRIOR TO THE COMMENCEMENT OF ANY WORK, ENGINEER TO BE NOTIFIED UPON DISCREPANCES.

8. CONTRACTOR TO CONFIRM GROUND WATER TABLE LEVEL PRIOR TO THE COMMENCEMENT OF ANY WORK AND IF ANY DE WATERING IS REQUIRED.

EXISTING GROUND LEVELS AND LOCATION AND INVERTILEVEL OF EXISTING SEWER SHALL BE CONFIRMED PRIOR TO THE COMMENCEMENT OF ANY WORK.

10. ALL GRAVITY PIPES SHALL BE PVC SNE UNLESS OTHERWISE SPECIFIED, ALL PIPES TO BE LAID AT MINIMUM GRADE TO FACILITATE SELF CLEANSING

11, ALL BACK FLL TO BE COMPACTED TO A DRY DENSITY NOT LESS THAN THAT OF THE SURROWNING UNDISTURBED SOL, BACOVIL, OF SERVERS IN NOUD RESERVES SHALL BE COMPACTED TO GRIVE ANHABINAL RESISTANCE OF BUILDING A STANDARD FALLING WEIGHT PENETROMETER FOR THE FULL DEPTH OF FLL.

12. CONTRACTOR TO WAKE GOOD ALL FENCING, KERBING, ROADS, DRIVEWAYS, ETC IN THE AREA OF EXCAVATION, ALL NECESSARY APPROVALS FROM RELEVANT AUTHORITIES TO BE OBTAINED PRIOR TO THE COMMENCEMENT OF ANY WORK.

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER CONSULTANTS DRAWINGS AND LOCAL AUTHORITY DRAINAGE CONSTRUCTION DRAWINGS.

ALL SOAKWELLS IN PAVED AREAS SHALL HAVE HEAVY DUTY REINFORCED CONCRET TRAFFICABLE LIDS.

SUBGRADE AT BASE OF PRECAST LINER TO BE COMPACTED TO A BLOWS PER 300mm WITH A STANDARD PERTH PENETROMETER OR 80% OF MWDD AS PER AS128.

BACKFILL TO PIT TO BE COMPACTED TO 8 BLOWS PER 300mm WITH A STANDARD PERTY PENETROMETER.

GULLY DRAINS SHALL BE SUPPLIED AND FITTED TO ALL EXTERNAL DOWNPIPES TO ASSAD

GUTTERS AND DOWNPIPES TO BE DIRECTLY CONNECTED TO STORMWATER SYSTEM INTERNALLY BY DRAINAGE CONTRACTOR TO ASS600

7. GROUT (MORTAR) TO BE 4 SAND : 1 CEMENT

WHERE MANHALE LINER DEPTH EXCEEDS 2.5m, BOLT ON GAL VANISED DOUBLE STEP IRONS AT 350mm CENTRES, LINER TO BE MADE GOOD EXTERNALLY USING CEMENT MORTAR FOLLOWING STEP (RON INSTALLATION, NOT APPLICABLE FOR SOMWELLS,

STEP IRONS TO BE LOCATED ON SIDE WITH LEAST INTERFERENCE FROM PIPES ON ALL MANHOLES, GULLEYS, SIDE ENTRY AND COMEINATION SIDE ENTRY PITS WHERE DEPTH EXCEEDS 2 Am.

