EARNSHAW STREET INFILTRATION BASIN

GOLDEN BEACH, CALOUNDRA

FUNCTIONAL DESIGN REPORT

DesignFlow

Prepared for Sunshine Coast Council

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APPENDICIES

1 INTRODUCTION

As part of Sunshine Coast Council's (SCC) commitment to water sensitive urban design initiatives, priority stormwater quality improvement works have been identified across the region (DesignFlow, 2012). As part of the study completed by DesignFlow in 2012, opportunities to treat coastal outfalls along Golden Beach, Caloundra, using vegetated infiltration basins constructed in the coastal dune system were identified. Three outfall sites were originally identified for further investigation:

- Earnshaw Street
- Gregory Street
- Wills Avenue

Detail concept feasibility assessments then proceeded at each site. This included feature and drainage surveys at each site. Appendix A provides a summary of the detail concept feasibility assessments completed at each site.

Following discussions with SCC, it was agreed to complete detail designs ready for construction for the Earnshaw Street basin site only.

1.1 INVESTIGATIONS

A number of investigations have been conducted to support the design process:

- Feature survey (completed by Skyline, January 2014 attached Appendix B)
- Piezometer Installation and Groundwater Monitoring, Golden Beach (Golder and Associates, letter report 13 May 2014 – attached Appendix C)

1.2 THIS DOCUMENT

The focus of this report is to document the design of the Earnshaw Street Infiltration Basin and associated diversion works.

This report summarises the functional design elements for the proposed infiltration basin, which forms the basis of the detail design developed. The document is provided to accompany the design drawings submitted to Council for approval (Appendix D).

The scope of works to detail design included:

- Concept refinement including updating modelling and preliminary earthworks models using AutoCAD 12D
- Design development of the infiltration basin including earthworks, operating levels, construction details and accesses
- Functional design of hydraulic structures including inlets and outlets, diversions and high flow management

- Batter stabilisations and erosion control
- Landscape design including basin vegetation planting and dune stabilisations

The infiltration basin will be located off-line from the main drainage pipe discharging to Pumiceston Passage.

This report should be read in conjunction with:

- Golden Beach Stormwater Treatment Devices – Detail Concept Design – Concept Update (DesignFlow, February 2014). Refer to Appendix A
- Feature survey (completed by Skyline, January 2014). Refer to Appendix B
- Piezometer Installation and Groundwater Monitoring, Golden Beach (Golder and Associates, letter report 13 May 2014). Refer to Appendix C
- Design drawing package (4228-0001-0303) which include earthworks, stormwater diversion and planting plans (refer to drawing list: Table 1 and construction drawings Appendix D)
- Technical Specifications (Civil and Planting) (DesignFlow, October 2014)
- Maintenance Plan (DesignFlow, October 2014)

1.3 STRUCTURE

The report is divided into the following sections:

- SECTION 1 Introduction
- SECTION 2 Design considerations – a summary of the main design considerations that guided the detail design process
- SECTION 3 Concept refinement – preliminary earthworks model to define the layout of the basin
- SECTION 4 Basin design - Description of key elements and design details for the infiltration basin and associated works
- SECTION 5 Construction, Establishment and Maintenance – provides an overview of the construction and establishment approach to be adopted to deliver the basin.
- Appendix A – Detailed Concept Feasibility
- Appendix B - Feature survey
- Appendix C - Piezometer Installation and Groundwater Monitoring
- APPENDIX D – Design drawings

The design drawing package (refer to Appendix D) comprises earthworks, hydraulic structures and planting plans as follows (Table 1):

Table 1 –Drawing list for Earnshaw Street Infiltration Basin

Drawing number	Drawing title
D0001	Site locality plan and drawing list
D0002	Notes
D0003	Demolition plan
D0101	General arrangement plan
D0102	Sections and diversion pit details
D0103	Outfall and concrete details
D0301	Cover sheet
D0302	Landscape plan
D0303	Landscape details

2 DESIGN CONSIDERATIONS

Figure 1 shows the overall agreed detail concept plan for the Earnshaw Street infiltration Basin following the concept options assessment phase of the project (refer to Appendix A). This concept formed the basis for detail design.

Figure 1 Agreed concept – Earnshaw Street Infiltration Basin

Design development of the site has been based on a number of specific design considerations relevant to the site. These include:

- Water quality improvements based on best management practice
- No worsening of current flood capacity – retain current outfalls and locate basin offline
- Avoid scour and erosion issues – no overland flows directed to basin; scour protection at outfalls
- Drainage diversion location and level
- Stable batters
- Groundwater interactions

- Tidal influences
- Landscape integration
- Maintenance and provision for suitable access
- Public safety

2.1 WATER QUALITY IMPROVEMENTS BASED ON BEST MANAGEMENT PRACTICE

The main objective of the works is to provide a treatment function for diverted stormwater from the Earnshaw Street catchment, prior to discharge to Pumiceston Passage. Given the nature of coastal dune systems, infiltration of diverted low flows from the catchment provides an ideal opportunity to intercept stormwater prior to discharge at the outfall. The vast majority of treatment will be though infiltration, with some treatment occurring through interaction with basin vegetation. The basin size and low flow diversion considered a target reduction in the main pollutants (suspended sediment and nutrients) of 75-80%.

Periodic maintenance will be required to remove accumulated sediments, particularly at the inlet zone. Long term infiltration capacity of the basin will be maintained by a combination of:

- the high infiltration capacity of the basin floor area
- dense vegetation to retain good aerated soil conditions at surface
- regular wetting and drying cycles to avoid ponded conditions that are prone to algal blockages
- annual removal of accumulated sediments

Accumulated sediments will be of a similar nature to coastal sands and will thus have similar infiltration properties.

Potential blockage of the low flow diversion pipe will reduce the potential for treatment. The low flow diversion pipe is sized to allow frequent flushing velocities within the pipe (i.e. velocities >0.6m/s). Regular inspections are also scheduled to check for potential blockage issues. These are detailed in the Maintenance Plan developed for the basin (DesignFlow, July 2014).

2.2 NO WORSENING OF CURRENT FLOOD CAPACITY

Following discussions with Council, it was agreed that the current drainage outfall is to be retained and that the basin must be located off-line from the main drainage outfall pipe (dia 675 mm pipe).

A new diversion pit is required to divert low flows from the existing stormwater pipe to the basin. High flows are intended to continue to the outfall via the existing

drainage pipe. The operation of the diversion pit over the range of tidal conditions must not adversely impact on the current drainage capacity (refer to Section 4.5 - High Flow By-pass later).

2.3 AVOID SCOUR AND EROSION ISSUES

Construction and operation of the basin must not cause any potential scour or coastal erosion issues. The off-line design of the basin was chosen to minimise any potential overtopping of the basin during flood flows. The basin location was also selected to ensure that overland flows are directed away from the basin footprint (refer to Section 4.6 – Basin Operation later).

Erosion protection using rock has been selected at the pipe outfall to the basin to minimise any potential scouring at the inlet zone. Refer to Section 4.7 – Basin Inlet for further details.

Stabilisation of the basin floor and batters are proposed with a mix of scattered rock and vegetation. During the establishment jute mesh/mat will be used across the basin floor and batters to minimise erosion issues during this stage. Refer to Section 4.3 – Basin layout and batters for more details.

2.4 DRAINAGE DIVERSION LOCATION AND LEVEL

The location of the low flow diversion from the existing stormwater network to the basin needs to be mindful of the diversion levels, which dictate the required basin floor level. The level of the diversion weir to direct low flows to the basin also needs to be mindful of not creating backwater impacts upstream of the diversion point, as well as being high enough to avoid frequent tidal influences into the basin.

The diversion level must be high enough to allow the basin floor level to be above local groundwater levels for the majority of time, and sufficiently high that tidal influences would not adversely impact on the basin operation and vegetation. A minimum diversion invert level of RL0.5m AHD with a diversion weir crest level of RL0.9m AHD was selected to meet these criteria.

Pot hole surveys of the existing stormwater pipe during the investigations identified a suitable diversion point immediately upstream of the concrete path within the adjacent coastal public park zone. This location is to be confirmed during construction.

2.5 GROUNDWATER INTERACTIONS

A groundwater monitoring well was installed at the proposed location of the basin to a depth of approximately 3m, which is approximately 0.5m below the proposed basin floor level. The purpose of this monitoring well was to understand the range of groundwater levels over varying tidal ranges, as well as following periods of high rainfall. This informs the design basin floor level to avoid permanent water in the basin as a result of groundwater interactions.

Monitoring indicated that groundwater levels were relatively insensitive to tidal variations, but were more influenced by rainfall recharge processes. Under normal operating conditions, groundwater levels can be expected to be below RL0.45mAHD. Following periods of high rainfall, groundwater levels may rise above this level (e.g. groundwater levels rose to RL0.59mAHD on March 31 following a period of high rainfall) , however the construction of the proposed infiltration basin, together with proposed plantings will result in localised lowering of groundwater due to evapotranspiration effects, helping to maintain groundwater levels below basin floor level. Refer to Section 3.2 Groundwater monitoring for further details.

Water quality monitoring of groundwater confirmed that the groundwater at the basin location is fresh and will support the vegetation proposed.

2.6 TIDAL INFLUENCES

The operation of the basin needs to be mindful of the impact of tides, particularly during high tide events. Mean high water springs levels at Golden Beach, Caloundra (Bureau of Meteorology) are approximately RL0.5m AHD, with highest astronomical tide level at RL0.9m AHD. The low flow diversion weir to the basin will provide a barrier to tidal inflows to the basin, until tide levels rise above the diversion weir crest level (RL0.9m AHD). This will effectively isolate the basin from tidal influences for all but the extreme high tide events, likely during storm surges.

2.7 LANDSCAPE INTEGRATION

The overall earthworks design requires existing ground levels to be excavated to depths of 1.5 to 2.5m over the basin footprint. To provide visual interest the use of large scattered rock and dense plantings of suitable vegetation will be incorporated into the basin floor and batters. This will also help to stabilise basin batters which will be constructed at 2H:1V, minimising the overall basin footprint.

The basin will be constructed adjacent to the coastal public park zone, where facilities such as a playground, gazebo and toilets are located. A concrete pedestrian path is also located within this area. At present a fence segregates the coastal public park zone from the coastal dune zone.

This location offers opportunities to integrate the basin works with the coastal public park zone, through the inclusion of a viewing area just off the main path and educational signage. Re-alignment of the fence will allow the basin to be constructed closer to the pedestrian path to achieve greater pedestrian viewing interaction. Re-vegetation works will also add to the coastal dune area, which is currently sparsely vegetated. A diverse range of semi aquatic species will be included in the basin to provide an interesting aspect.

Plant selections will be mindful of retaining view lines, with avoidance of the use of shrubs and trees above 1m in height.

Educational signage at the viewing location will offer opportunities to describe the operation of the basin, the positive impact on the coast by capturing and infiltrating stormwater pollutants and the role native vegetation plays in utilising elements of the natural landscape to improve stormwater quality.

2.8 BASIN OPERATION

The proposed infiltration basin will be free of ponded water most of the time, and will typically only pond to shallow depths (less than 0.5 m depth) during rain events, when low flows are diverted to the basin. Any ponded water during rain events will quickly infiltrate to the groundwater system following the end of the storm. This ensure that the basin does not become a breeding ground for mosquitos, and the wetting and drying cycling, together with the dense vegetation proposed will ensure that the infiltration capacity of the basin is retained in the long term.

2.9 PROVISION FOR MAINTENANCE

A maintenance plan has been developed for the basin (refer to DesignFlow, October 2014). This maintenance plan provides simple to use inspection forms and maintenance frequencies. Whilst maintenance of the basin is relatively straightforward, regular inspections and maintenance are important to prevent issues such as un-controlled build-up of sediment, blockages caused by debris, erosion, scour, weed infestation and poor health of the plant community.

The main areas requiring access are the inlet zone of the basin and the diversion pit. Vehicle access to the diversion pit will be available from the Esplanade. A new trafficable reinforced turf path (3m wide) is proposed to connect the Esplanade with the existing concrete pedestrian path allowing access to the pit. Upgrades to the concrete pedestrian path and existing concrete access ramp to the beach are proposed to provide trafficable access to the basin inlet zone.

2.10 PUBLIC SAFETY

The basin represents a low public risk. The basin will be predominantly dry and will not have extended periods where pools of water occur.

The basin is designed to discourage public entry. A viewing area above the basin will encourage the public to view the basin from a safe area, away from the main pedestrian path. A perimeter fence between the coastal public park zone and the basin will provide a barrier preventing ingress to the basin. A minimum buffer distance of 1.5m between the fence and basin is provided to address public safety concerns for safety in case anyone jumps over the fence. Vegetation plantings will also be used to deter entry on the seaward side of the basin.

The nature of the pollutants captured is typical of established coastal residential catchments and do not pose a public health risk. Regular maintenance of the basin will ensure that the basin is maintained in a healthy and safe condition.

3 CONCEPT REFINEMENT

Additional investigation works have been completed as part of the progression of the concept design to detail design stage. These included:

- Feature survey including pot hole survey of the drainage line (Skyline, 2014 – Appendix B)
- Groundwater monitoring (Golder and Associates, 2014 – Appendix C)

The above investigations allowed:

1. the preferred diversion point to be identified;
2. an understanding of the groundwater levels over a range of tidal and rainfall conditions to assist with setting basin floor levels; and
3. confirmation of the groundwater quality to determine suitable vegetation selections.

Concept designs initially considered diversions at or above RL0.5mAHD. The functional feasibility of this level was confirmed from the above investigations, further described below.

3.1 FEATURE SURVEY

Appendix B provides details of the feature survey in and around the basin location. As part of the feature survey, pot hole survey to the top of the existing 675mm dia RCP drainage pipe was completed from the Esplanade to the outfall. Invert levels were taken at the road pit (RL0.73). The overall gradient of the drainage pipe from the road to the outfall, based on the survey, is approximately 1%. Based on the survey data, a suitable diversion point just upstream of the concrete path achieves a minimum invert level of RL0.5.

3.2 GROUNDWATER MONITORING

Appendix C provides details on the groundwater monitoring conducted at the basin location. Summary results are provided in Table 2 below.

Table 2 Groundwater monitoring summary (reproduced from Golder and Associates, 2014 – refer to Appendix C)

Sampling Location										
Location	Date	Sampling Time	Tide	Water Level (RL m AHD)	pH	Conductivity (µs)	Salinity (PPT)	Redox (MV)	DO (mg/L)	Temp
ST1	20/03/2014	10:45am	High @ 10:45am - 1.59m	0.247	6.5	309	0.13	-	-	25.7
ST1	31/03/2014	8:00am	High @ 8:17am - 1.84m	0.594	6.6	266	0.13	66.8	3.36	25.5
ST1	31/03/2014	2:00pm	Low @ 2:27pm - 0.15m	0.407	6.5	296	0.15	39.6	3.21	25.8
Adjacent surface water	31/03/2014	8:30am	High @ 8:17am - 1.84m	-	6.1	58100	29.15	51.1	7.52	26.0
ST1	23/04/2014	3:30pm	High @ 3:25pm - 1.80m	0.451	6.6	463	0.23	42.1	4.10	25.4
ST1	05/5/2014	12.30pm	High @ 12.32pm – 1.60m	0.237	7.2	155	0.05	81.1	5.2	24.6

A number of measurements were taken over a range of high and low tides. Measurements were also taken after a period of rain to review the influence of rainfall recharge on groundwater levels. The sampling event on March 31 had almost 150mm of rain in the preceding 7 days of the measurement, with approximately 110mm of rain falling on March 28.

Groundwater monitoring results indicate that groundwater levels under normal operating conditions are in the range of RL0.45mAHD and below. Groundwater variations are not greatly influenced by tidal variations, but are more influenced by rainfall recharge processes, where the highest groundwater level monitored (RL0.59m AHD) was recorded after a period of high rainfall.

Based on monitored groundwater variations the selected basin floor level at RL0.45 (based on a diversion at RL0.5) is considered appropriate. This avoids permanent water on the basin floor under normal operating conditions and will help support vegetation growth that is in the basin given the proximity of groundwater to the basin floor. Salinity measurements of the groundwater confirmed groundwater is fresh.

It must be noted that the construction of the basin and planting will result in localised lowering of groundwater due to evapotranspiration effects helping to maintain a pond free environment over the basin under normal operating conditions.

3.2.1 Infiltration capacity

Infiltration of stormwater runoff directed to the basin will occur through the basin floors and sides. Given the proximity of the groundwater to the basin floor, the rate of infiltration will be governed by the saturated hydraulic conductivity of the sands. This is the rate water discharges to the local groundwater under a driving head such as ponding over the basin floor in this case. Typical values for medium to fine grained sands, such as coastal dune sands, are in the order of 1,000mm/hr and above. Higher rates would be expected for porous sands.

Note: Falling head tests were attempted on the installed monitoring well to assess infiltration values. Test results are included in Appendix C. Interpretation of the results for estimating saturated hydraulic conductivity values was not considered

reliable, however the test did indicate that 20 L of added water to the 50mm standpipe was fully infiltrated within 2 minutes, confirming high infiltration rates and porous nature of the sands. Use of 1,000mm/hr for the infiltration capacity under a range of groundwater conditions is not considered unreasonable in this case, and is most likely conservative.

3.3 BASIN SIZE AND PRELIMINARY EARTHWORKS

The concept size of the basin footprint was selected at 150m^2 in order to achieve a treatment performance in the order of 75% to 80% reduction in key target pollutants (suspended sediments and nutrients). This was based on an assumed infiltration rate at 1,000mm/hr with a low flow diversion to the basin of 120L/s (refer to Section 4.4 Low flow diversion).

The preferred basin layout and operating levels have been determined using a number of design considerations, as described in Section 2.

A preliminary earthworks model for the proposed works was developed using AutoCAD 12D, and included the proposed diversion, basin floor levels and suitable batters.

The preliminary earthworks model allowed the size and shape of the infiltration basin to be refined considering drainage, groundwater and landscape requirements.

The general arrangement of the proposed works is shown in Figure 2 and indicates the diversion and basin location.

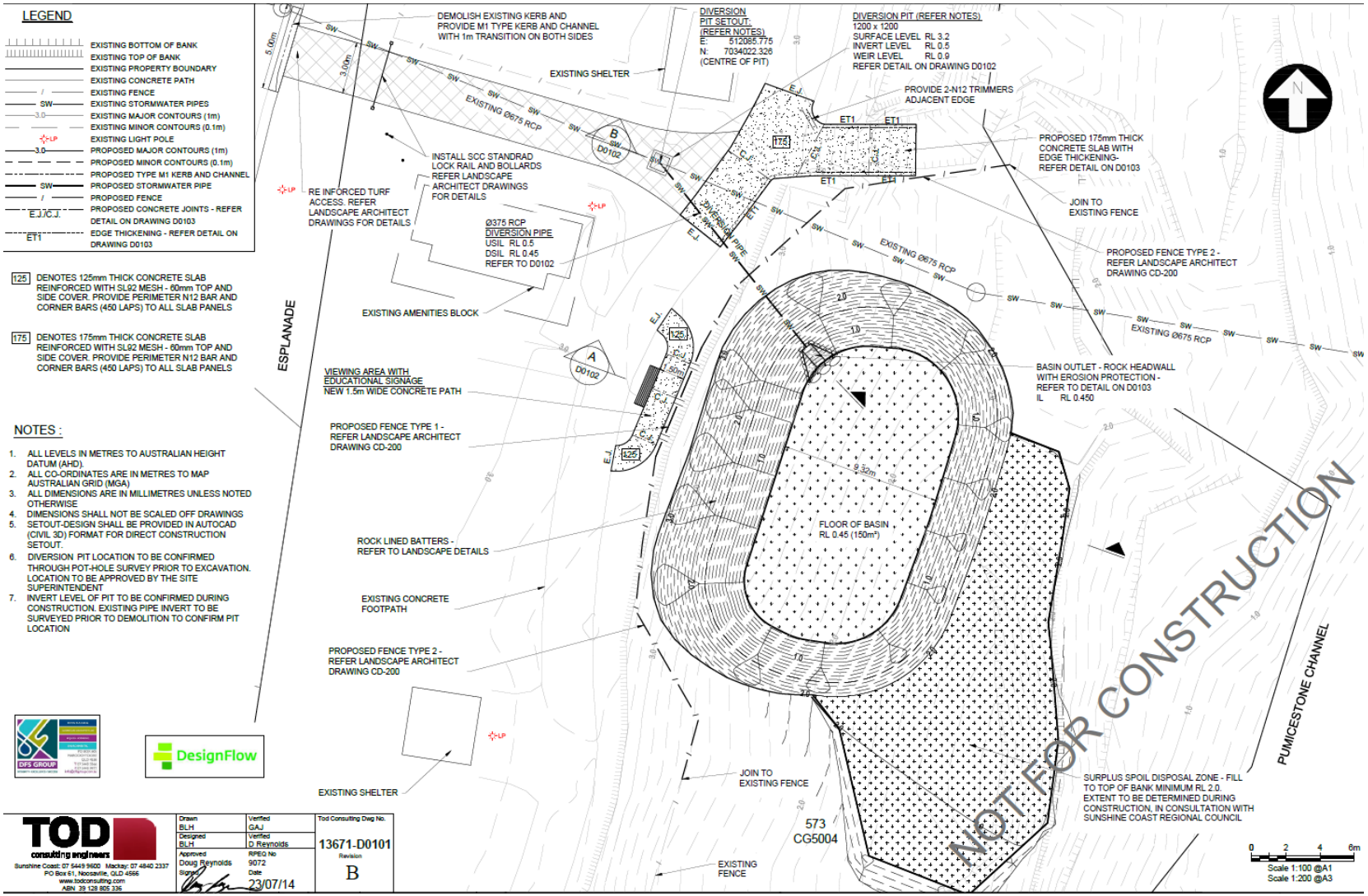


Figure 2 General arrangement of works

4 BASIN DESIGN

4.1 FUNCTIONAL CONSIDERATIONS

The design of the Earnshaw Street Infiltration Basin has considered a number of functional requirements to ensure the works provide the expected outcomes. The following requirements considered were:

- Sufficient area, configuration and diversity of vegetation to provide detention, sedimentation, filtration/infiltration and nutrient uptake to achieve the required water quality improvements.
- Ensuring sufficient low flows are diverted to the basin, whilst high flows continue through the main drainage network without exacerbating flooding upstream
- Scour protection at basin inlet zone
- Stable batters to minimise erosion issues
- Minimal ponding from groundwater
- Integration of the basin within the site constraints, including the coastal dune zone
- Public safety including fencing and vegetated screen to discourage public entry.
- Maintenance access to the diversion pit and basin inlet zone. A 3 m wide trafficable access is considered as a minimum for access from the Esplanade to the basin.
- Capability to isolate the basin from catchment inflows
- Enhanced landscape aesthetic and amenity through re-vegetation and recreational viewing nodes.
- Maximise opportunities for safe public interaction and education.

Further details of the overall operation and performance of the infiltration basin functional elements are discussed in the following sections.

4.2 GENERAL OPERATION

Figure 3 provides an overall schematic representation of the general operation of the infiltration basin.

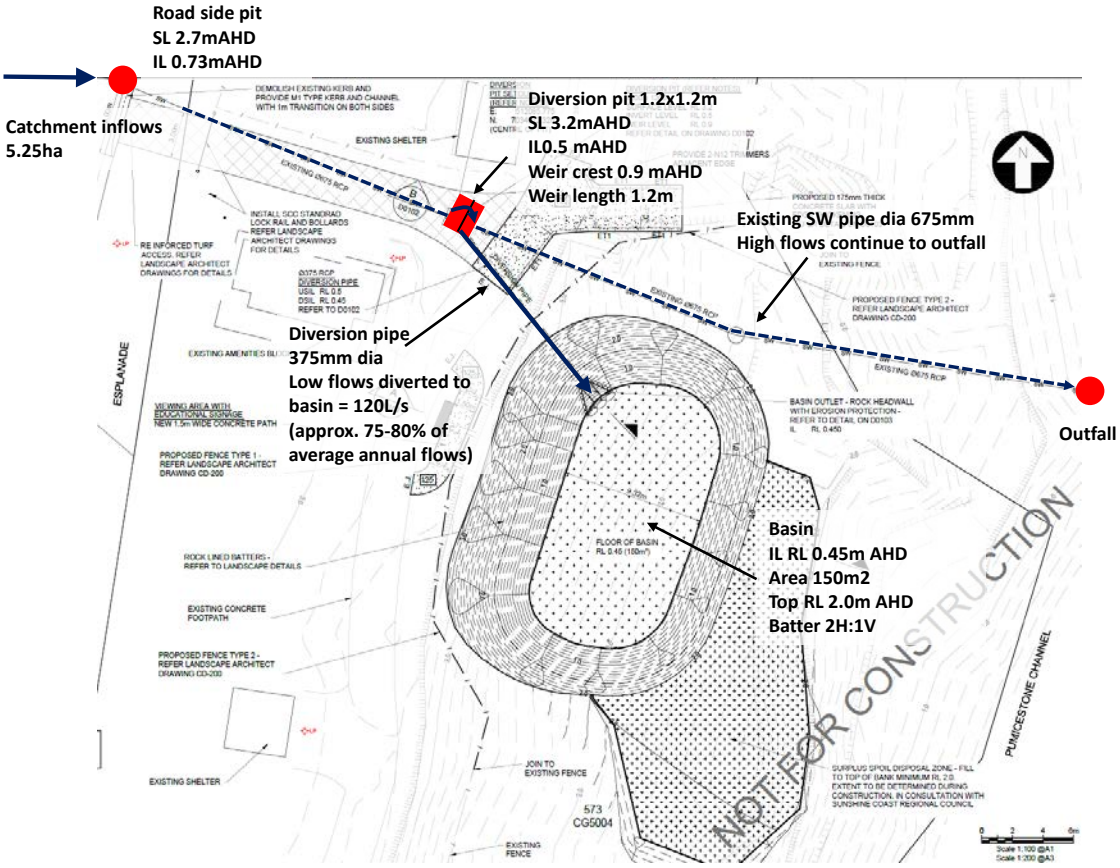


Figure 3 Proposed Earnshaw Street infiltration basin general operation

The total catchment area discharging to the outfall is approximately 5.25ha. A new diversion pit (1200mmx1200mm; invert level RL0.5m AHD) is to be constructed along the existing 675mm dia RCP outfall pipe, just upstream of the concrete path in the coastal public park area. A small diversion weir (400mm high) will direct catchment low flows under gravity to the infiltration basin. Approximately 75-80% of catchment flows will be directed to the basin via a low flow pipe (375mm dia). Diverted inflows will then temporarily pond in the basin and infiltrate.

As catchment flows increase above the capacity of the low flow diversion (approximately 120L/s), flows will spill over the diversion weir and continue to the outfall via the existing 675mm dia RCP outfall pipe.

The basin is sized to allow full infiltration of diverted low flows. Treatment will occur primarily as a result of infiltration; with basin vegetation providing additional natural treatment through interaction with the vegetation.

4.3 BASIN LAYOUT AND BATTERS

The overall basin floor area will be 150m^2 at RL0.45mAHD. The floor of the basin is proposed to be flat and it is proposed to include large scattered rocks (typically 300-1,000mm dia) covering approximately 20% of the floor area with dense vegetation of primarily sedges for stability.

Batter slopes at 2H:1V were selected to minimise the overall footprint of the basin given depths of 1.5-2.5m will be required. The batters will also include large scattered rocks (typically 300-1,000mm dia) covering approximately 50% of the batter area with additional vegetation planting for stability. During the establishment phase jute mesh/matting will be placed on the floor and the batters of the basin to minimise erosion until plants are established.

A minimum basin bund level of RL2.0mAHD was selected to minimise the risk of overtopping during flood events (refer to Section 4.6 for further details). Figure 4 provides typical section details of the basin.

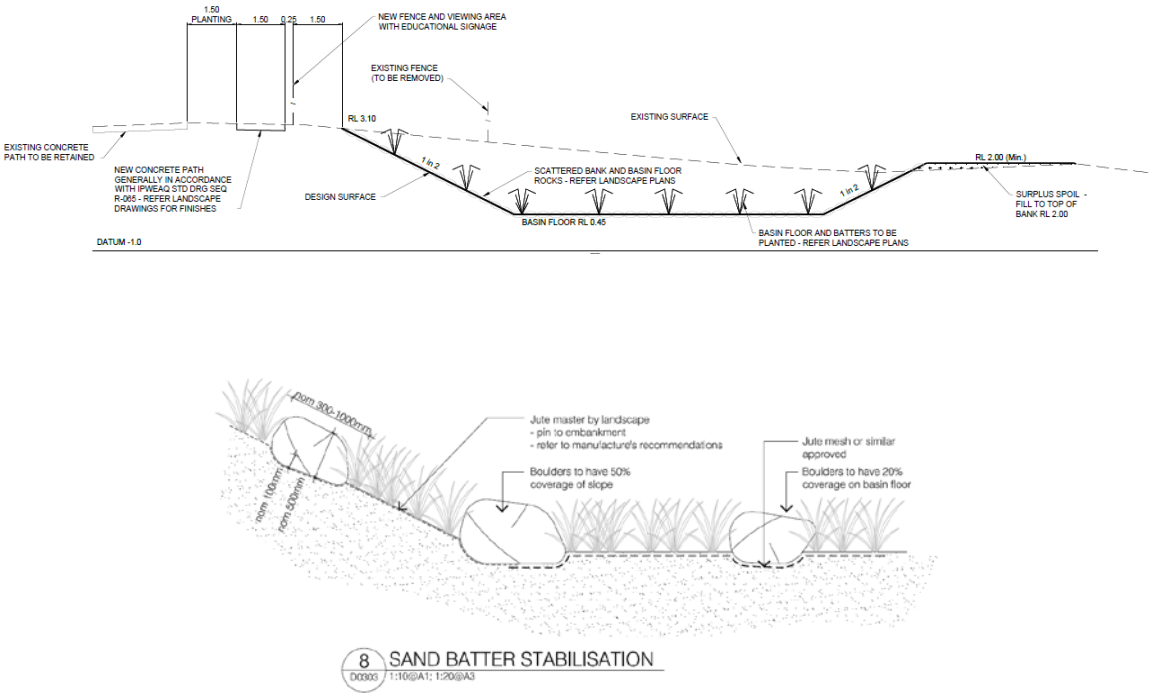


Figure 4 Typical section through basin

4.4 LOW FLOW DIVERSION

The proposed low flow diversion from the existing drainage pipe to the infiltration basin consists of a pit and pipe arrangement with a diversion weir to direct low flows to the infiltration basin. The proposed low flow rate was selected to transfer approximately 75 to 80% of annual flows from the catchment to the basin for treatment. This provides a flow rate that is neither excessively high nor requires expensive hydraulic structures to transfers flows to the basin.

Modelling using MUSIC (Model for Urban Stormwater Improvement Conceptualisation) was completed and identified a low flow diversion rate of approximately 120L/s was sufficient to transfer approximately 75 to 80% of the average annual catchment flows to the basin.

To transfer low flows to the basin a minimum pipe diameter of 375mm was selected to minimise the potential for blockage. To transfer flows at approximately 120L/s a low flow weir 400mm high was selected. With a pit invert of RL0.5mAHD at the diversion point, this sets the diversion weir level at RL0.9mAHD, which corresponds to the highest astronomical tide level. This provides the basin with a barrier to tidal influence to the basin for tides up to RL0.9mAHD.

To facilitate future maintenance and flexibility in operation, a 375mm diameter maintenance valve is included on the low flow pipe within the diversion pit. Figure 5 provides details of the low flow diversion arrangement.

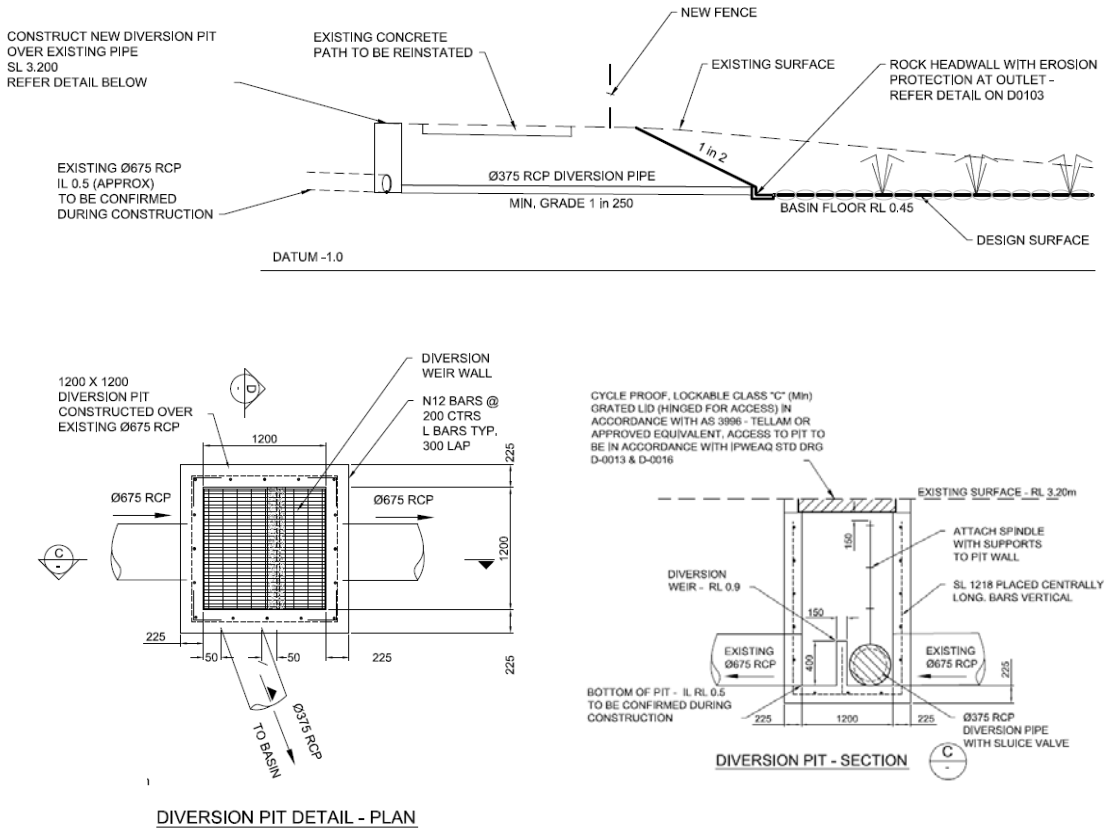


Figure 5 Low flow diversion

The hydraulic design of the diversion pit has considered flow transfers to the basin at the minimum design rate with the diversion operating at the weir crest level (RL0.9mAHD). Pipe sizing considers the low flow pipe operating under inlet control conditions.

Table 3 provides a summary of low flow diversion pipe design details.

Table 3 Low flow diversion summary

Item	Size/level
Diversion pit invert level (mAHD)	0.5
Diversion weir crest level (mAHD)	0.9
Diversion pit size (mm)	1200x1200
Low flow diversion pipe diameter (mm)	375
Low flow pipe U/S invert level (mAHD)	0.5
Low flow pipe D/S invert level (mAHD)	0.45
Design flow conveyed to infiltration basin (L/s)	120
Complies with design objectives	yes

4.5 HIGH FLOW BY-PASS

Flows exceeding the low flow capacity of the proposed diversion pit to the infiltration basin will spill over the low flow diversion weir and continue to the outfall via the existing 675mm drainage pipe. The operation of the diversion pit during high flows must not decrease the drainage capacity of the existing drainage network.

To review the impact of the proposed diversion pit on the existing drainage capacity, an XP-SWMM model was developed. The model considered the drainage network downstream of the Esplanade to the outfall and was run under existing conditions and under proposed conditions with the diversion pit included. The model considered the impact on water levels in the upstream pit at the Esplanade for the critical 2 year and 5 year ARI events. Figure 6 provides a schematic representation of the model.

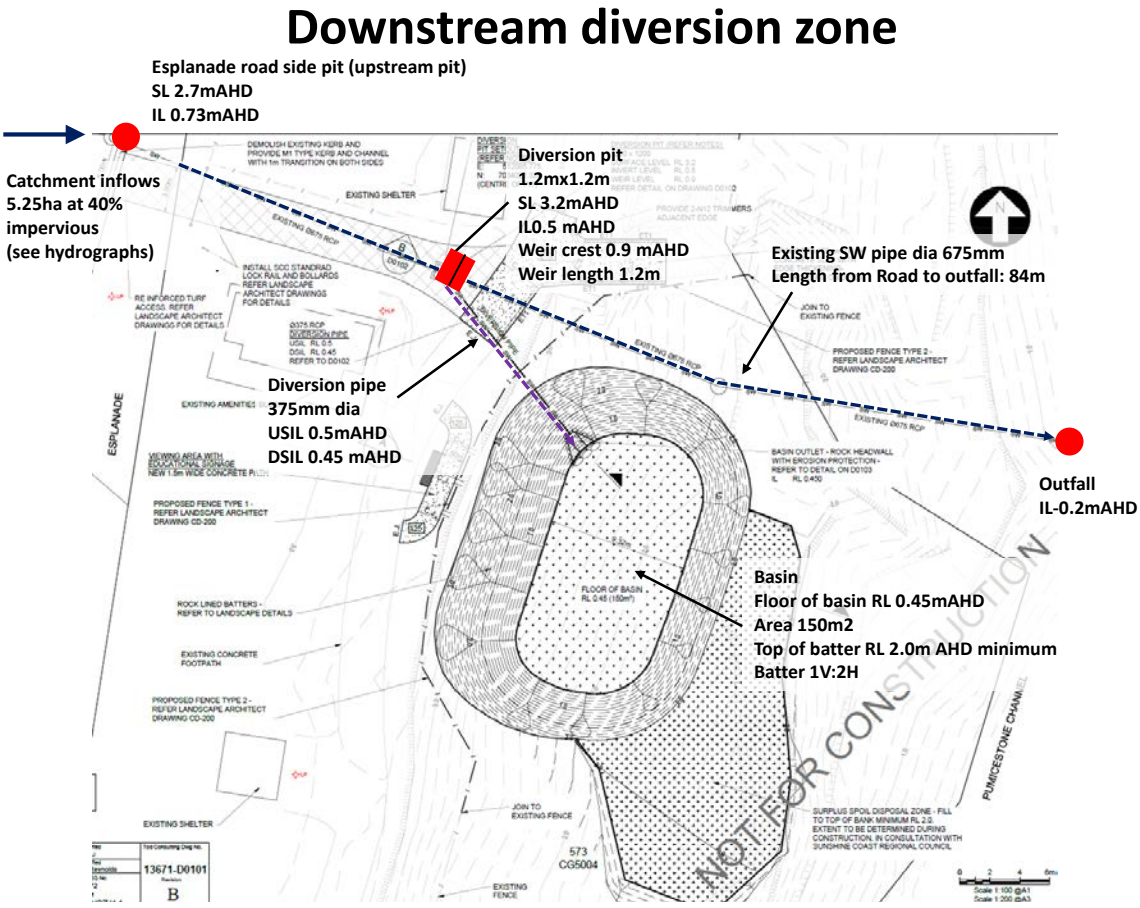


Figure 6 Schematic representation of the XP-SWMM model at the diversion

The following assumptions were made in the modelling:

- Catchment area 5.25ha at 40% impervious
- Impervious losses: initial loss 1mm; continuing loss 0mm/hr
- Pervious losses: initial loss 10 mm; continuing loss 2.5mm/hr

Figure 7 shows the catchment inflow hydrographs for the critical 2 year and 5 year events with the above assumptions.

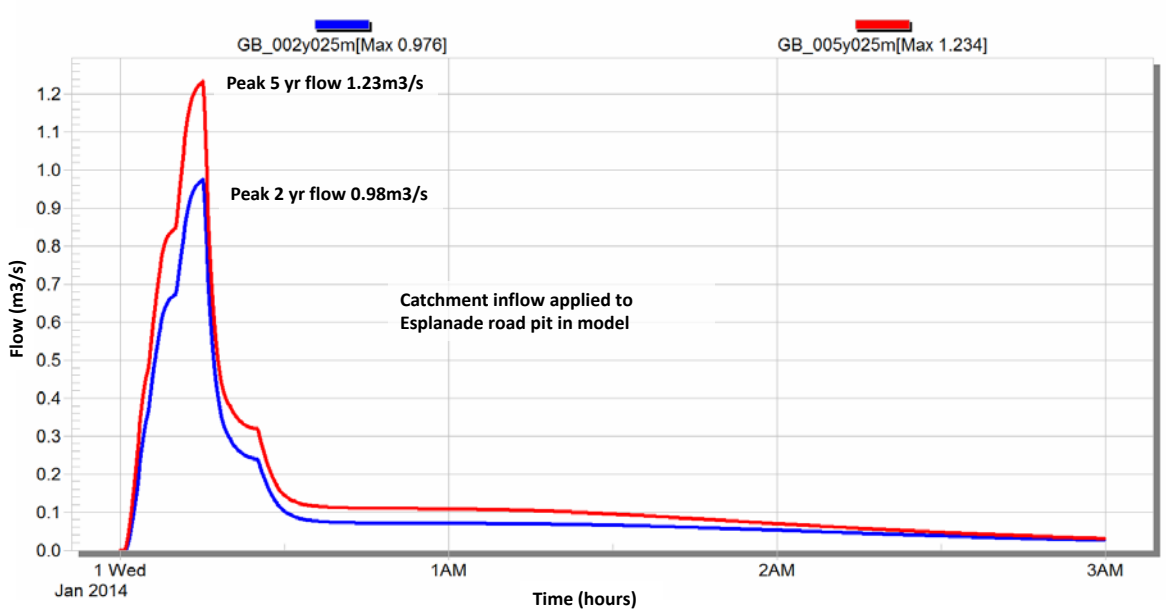


Figure 7 Catchment inflow hydrographs

A number of modelling scenarios were tested:

- Existing drainage from the Esplanade to the outfall
- Proposed diversion weir (weir crest RL0.9mAHD, length 1.2m) – no basin included i.e. diversion pipe blocked or isolated from inflows
- Proposed diversion basin included (basin floor area 150m² at RL0.45mAHD; 2H:1V batters
- Outfall conditions varied from free outfall to high tide at RL1.0m AHD

A summary of the modelled water levels for the scenarios tested is shown in Table 4.

Table 4 XP-SWMM summary

Scenario	Water level mAHD				Comment
	Road pit SL RL2.7; IL0.73	Diversion pit (SL RL3.2; IL0.5) US weir	DS weir	Outfall IL-0.2mAHD	
Free outfall					
2 yr event existing drainage	1.94	na	na	0.37	
5 yr event existing drainage	2.70	na	na	0.44	surcharge occuring at road pit
2 yr event with diversion to basin	1.91	1.44	1.16	0.25	
5 yr event with diversion to basin	2.39	1.67	1.57	0.34	reduced flooding at road pit from existing condition
2 yr event with diversion to basin blocked	2.06	1.60	1.50	0.32	minor increase in water level at road pit. No surcharge occuring
5 yr event with diversion to basin blocked	2.70	2.05	1.99	0.43	surcharge occuring at road pit
Highest astronomical tide (HAT) RL 1.0mAHD					
2 yr event existing drainage	2.51	na	na	1.00	
5 yr event exissting drainage	2.70	na	na	1.00	surcharge occuring at road pit
2 yr event with diversion to basin	2.12	1.67	1.61	1.00	improved condition at road pit
5 yr event with diversion to basin	2.70	2.03	1.98	1.00	marginal surcharge occuring at road pit
2 yr event with diversion to basin blocked	2.49	2.04	2.00	1.00	no impact on exisiting capacity
5 yr event with diversion to basin blocked	2.70	2.26	2.21	1.00	no impact on exisiting capacity

Note: highlighted cells indicate surcharge occurring

The results indicate that the current drainage capacity is less than the 5 year ARI (as indicated by surcharging at the upstream road pit), even under free outfall conditions. With the basin included and operating as intended the flood capacity of the existing drainage system is retained, even under high tide conditions. With the inlet to the basin isolated or blocked the drainage capacity is marginally reduced under free outfall conditions, but no decrease occurs during high tides.

The above modelling demonstrates that the proposed diversion does not adversely impact on the current drainage condition.

4.6 BASIN OPERATION

4.6.1 Normal operation

The proposed infiltration basin will be free of ponded water most of the time, and will typically only pond to shallow depths (less than 0.5 m depth) during rain events, when low flows are diverted to the basin. Any ponded water during rain events will quickly infiltrate following the end of the rain event.

Groundwater monitoring (refer to Section 3.2 Groundwater monitoring, previously) indicates that groundwater levels are expected to be below the basin floor during normal operation. Evapotranspiration due to basin floor vegetation will help retain groundwater level below basin floor level.

The basin low flow weir is set at approximately the highest astronomical tide level (HAT RL0.9mAHD) and will act as a barrier for tidal backwatering to the basin. The proposed infiltration basin will be infrequently affected by the tide for short periods of time and most likely only during storm surge event. This will not have any detrimental impact on the performance of the basin.

4.6.2 Flood flows

The XP-SWMM model was used to review the basin operation, in particular the basin peak water levels during flood events. As a conservative approach no infiltration was modelled in the basin i.e. the basin simply acted as an off-line storage.

During the critical 5 year event with high tide conditions, the peak water level in the basin was estimated at 1 m depth i.e. RL1.45m (refer to Figure 8) with peak flow rates diverted to the basin are estimated at 0.29m^3/s (refer to Figure 9). During this event surcharge has started to occur at the Esplanade road pit upstream of the diversion. Increases in peak flows would thus travel via overland flow away from the basin, as shown on Figure 10.

The peak flow in the drainage network at the diversion (1.23m^3/s – refer to Figure 9) represents flood flow conditions for the basin and thus the peak water levels that could be anticipated.

Minimum basin bund levels at RL2.0mAHD have been selected to provide adequate freeboard (0.5m) to minimise any potential overtopping of the basin (and thus potential dune scour and erosion) during flood flows.

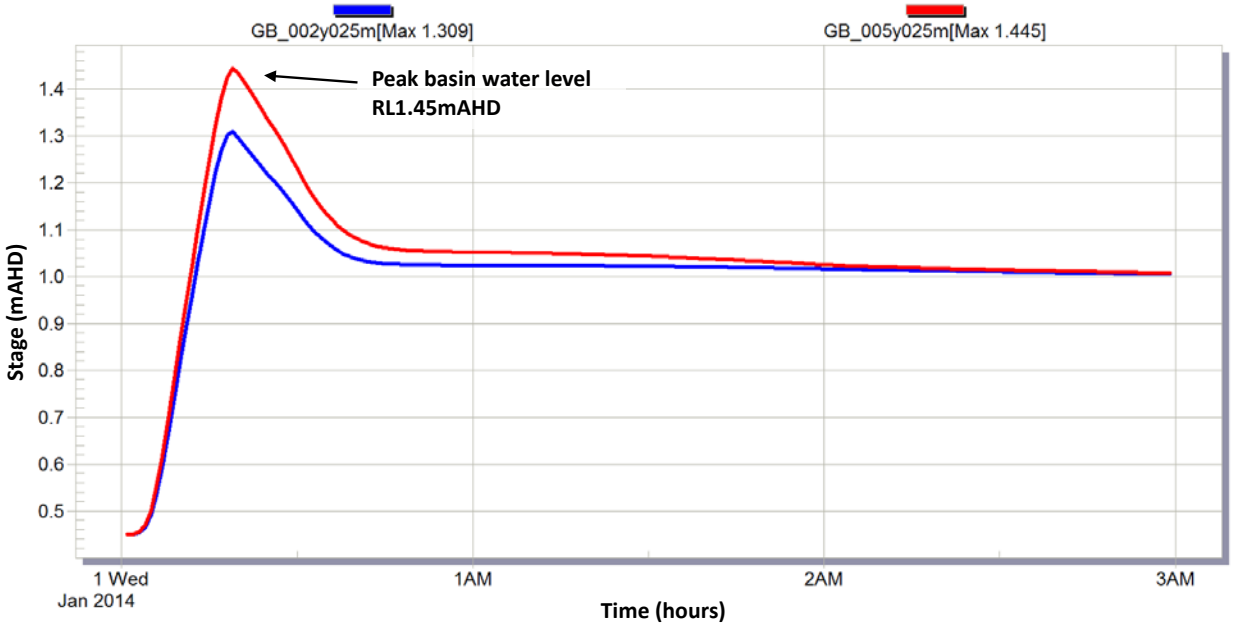


Figure 8 Basin operation during flood events

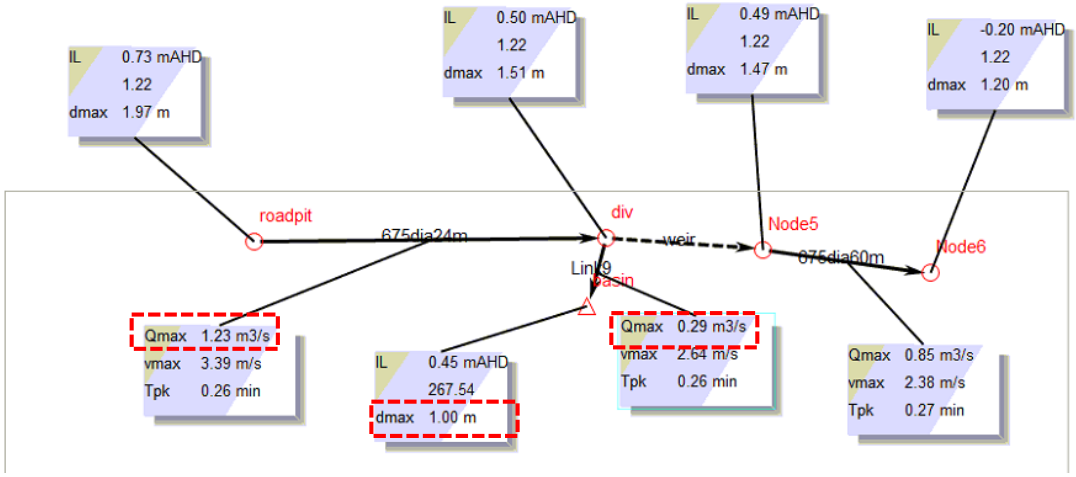


Figure 9 XP-SWMM model outputs 5 year critical event under high tide conditions

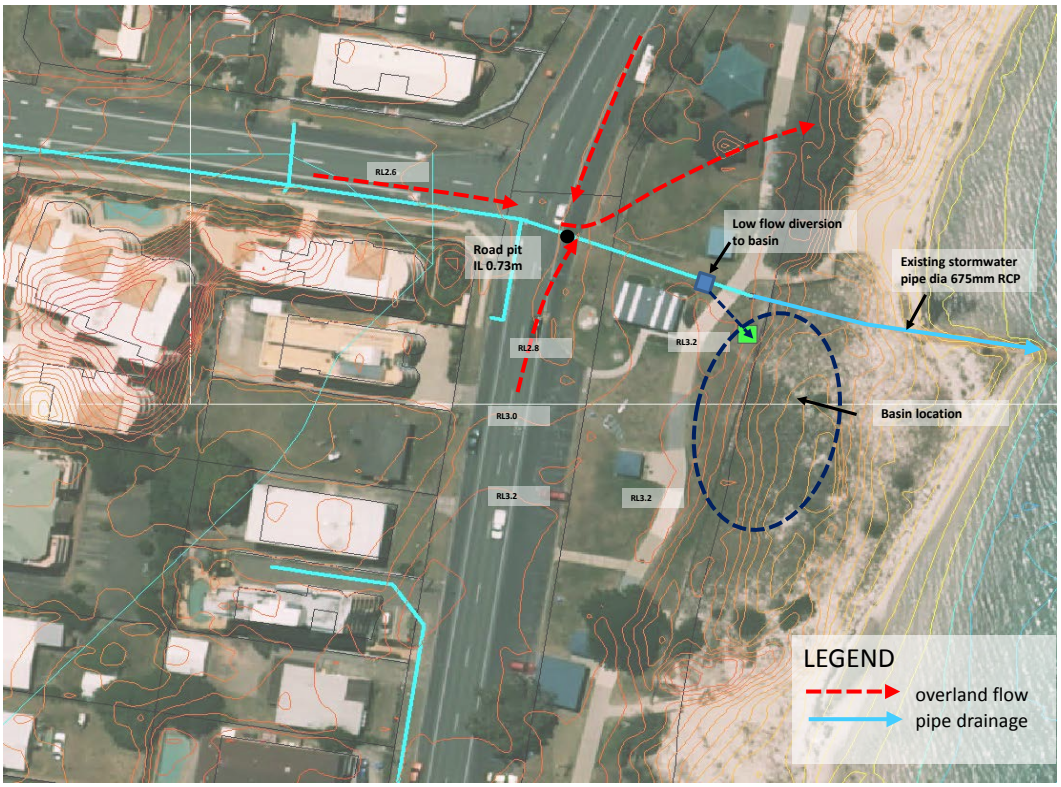


Figure 10 Overland flow path

4.7 BASIN INLET

At the discharge from the low flow pipe to the basin, a rock apron with energy dissipating rocks are provided to manage any scour potential. Under normal low flow diversions (0.12m^3/s) discharge velocities of 1.1m/s are expected, however during flood flow event peak velocities at the discharge to the basin are increased to approximately 2.6m/s are a results of the greater flow diverted (0.29m^3/s – refer to Figure 9 previously). To manage these expected flow discharges the dissipator outlet shown in Figure 11 will be provided.

Toe rocks (600mm dia) are provided to key in the rock outlet, whilst energy dissipator rocks are provided to break up flow discharges. The rock apron is underlaid with geofabric and will be constructed with angular rock 150-200mm diameter for a 300mm depth. Care is required during construction to ensure rocks are hand placed and locked together, with voids backfilled with soil and planted with sedges.

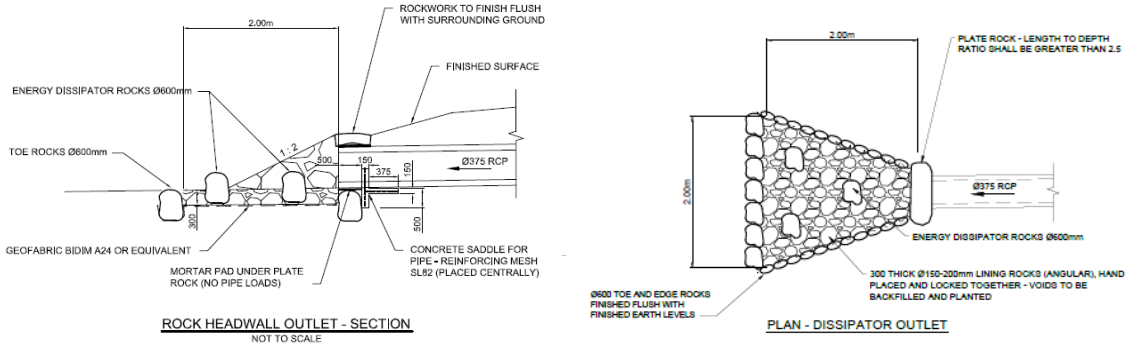


Figure 11 Rock protection at inlet to basin

4.8 LANDSCAPE PLANTING

Figure 12 (also refer to D0301-D0303 in Appendix D) provides a planting plan for the proposed works. Three main planting zones are considered:

- Basin vegetation planting – floor (mix A) and batters (mix B)
- Dune stabilisation planting (mix C)

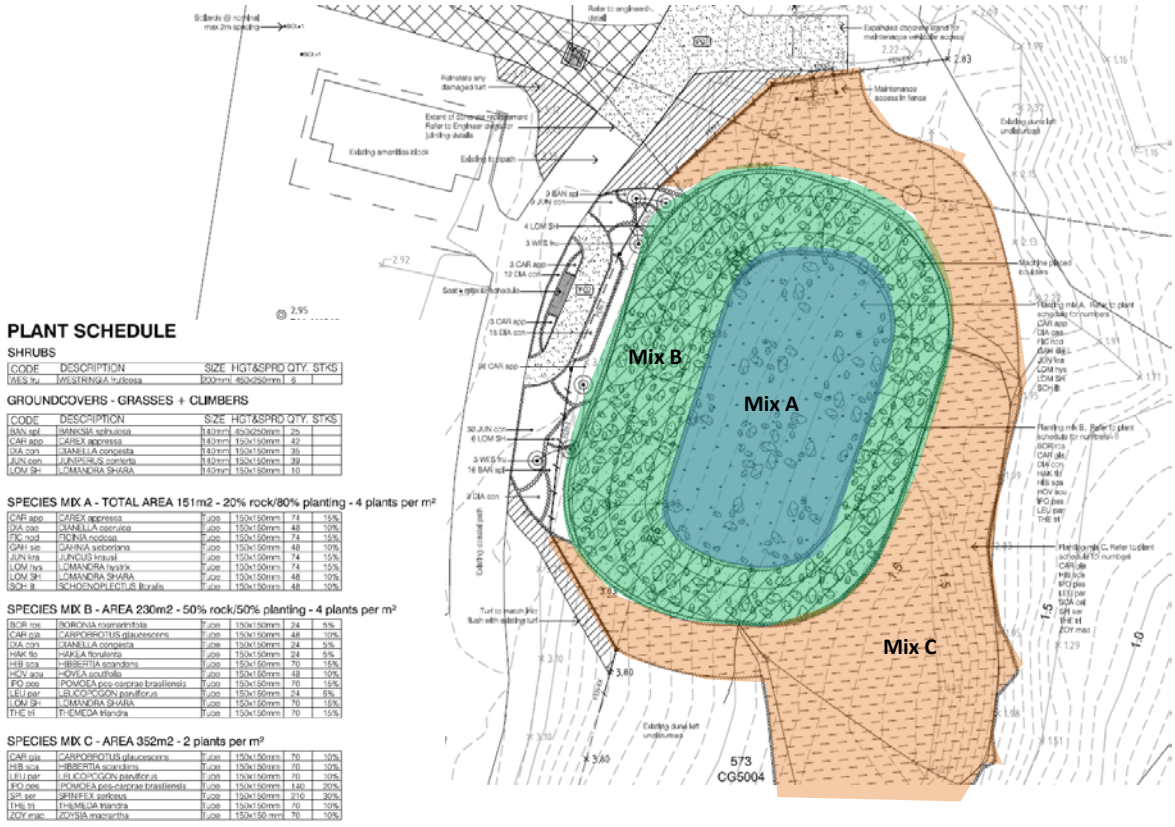


Figure 12 Basin landscape plan

Species selection for the planting zones have been mindful of retaining view lines with avoidance of the use of shrubs and trees above 1m in height.

4.8.1 Basin vegetation

The proposed basin vegetation will include a range of sedges, grasses and ground covers suited to coastal conditions. The proposed vegetation selected considered local coastal species and will extend across the basin floor and batters in the rock voids. The proposed vegetation will provide stabilisation as well as a landscape aesthetic to the proposed basin.

The proposed vegetation will differ depending on whether it is planted on the basin floor or batter given the different moisture conditions of each location. Floor planting are associated with typically sedge type species, suited to more moist conditions.

Groundwater monitoring indicates that freshwater will be available for plants just below the basin floor level and should support a good healthy plant growth in the basin floor. The basin will predominantly be isolated from tidal flows due to the low flow diversion weir, however from time to time, particularly during storm surges, some tidal influence may backwater into the basin. This is anticipated to be an infrequent occurrence and not have a detrimental impact on the plants in the basin.

4.8.2 Dune stabilisation

Areas adjacent to the basin are proposed to be re-vegetated with a range of plants consistent with current species in the area, including species such as Spinifex to stabilise the dune area and increase the diversity of planting around the basin. These planting will also provide a passive barrier to public entry to the basin.

4.9 PUBLIC SAFETY

The basin represents a low public risk. The basin will be predominantly free of ponded water and is unlikely to have extended periods where pools of water occur.

The infiltration basin has been designed with limited public access, primarily as the site will also function as a detention facility for diverted low flows. A viewing area will be provided at the western edge of the basin to allow public interaction with the site. This will consists of a new 1.5m wide concrete path connecting to the existing concrete pedestrian path which runs through the coastal public park.

Educational signage at this location can be provided to describe the overall operation of the basin. This viewing area is located off the existing concrete pedestrian path for safe viewing. A fence will be provided between the basin and the main park area to minimise public entry to the basin. A 1.5m buffer between the fence and the basin edge is provided to provide a safe buffer distance.

Vegetation planting in and around the proposed basin will help provide a further passive barrier to public entry to the basin.

4.10 MAINTENANCE

Maintenance activities associated with the proposed basin may include:

- general maintenance of the diversion pit; and
- removal of accumulated sediments within the basin form time to time.

Further details on expected maintenance activities are provided in Section 5.2 and in the Maintenance Plan for the basin (DesignFlow, October 2014).

Access to undertake maintenance activities will be provided to the diversion pit and the inlet zone of the basin. A new trafficable reinforced turf path (3m wide) is proposed connecting the Esplanade with the existing concrete pedestrian path to allow access to the pit. Upgrades to the existing concrete pedestrian path and existing concrete access ramp to the beach are proposed to provide trafficable access to the basin inlet zone. This will allow maintenance vehicles such as a vacuum truck access to the inlet zone for sediment removal.

Along the fence separating the basin from the access, a new 1.0m wide access gate is proposed and will allow access into the basin by SCC staff for general maintenance such as litter removal and weeding.

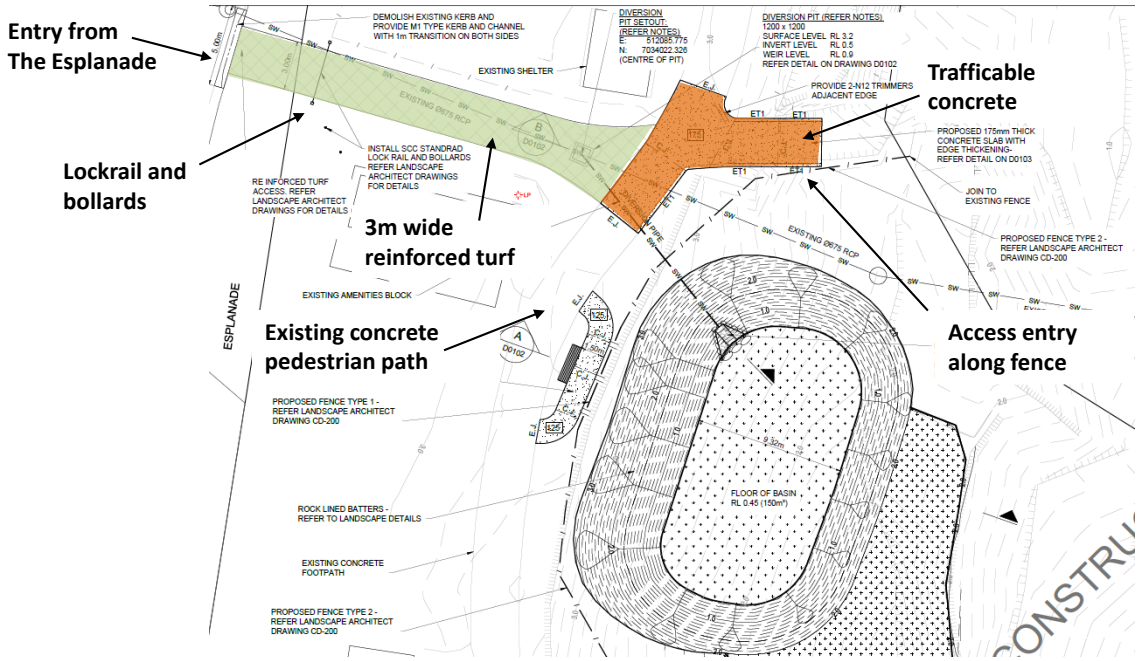


Figure 13 Access path arrangement

5 CONSTRUCTION, ESTABLISHMENT AND MAINTENANCE

The delivery and ongoing success of the proposed Earnshaw Street infiltration basin will require a comprehensive construction and establishment approach coupled with the careful management of its ongoing operation and maintenance.

5.1 CONSTRUCTION AND ESTABLISHMENT

The Earnshaw Street infiltration basin should be delivered in accordance with:

- The detailed design drawings (refer to Appendix D)
- The *Earnshaw Street Infiltration Basin, Golden Beach – Caloundra, Technical Specifications - Civil and Planting* (DesignFlow, 2014)

5.1.1 Construction works

The proposed works comprises primarily of earthworks (cut) to form the basin and associated diversion and landscape works for the effective functioning of the basin.

An important hold point at the start of the project will be to determine the location of the diversion pit. Pot hole survey is required prior to any excavation works to identify the location where existing pipe inverts are at or above RL0.5mAHD.

The works will likely commence with the bulking out of the basin. The low flow diversion pipe can then be constructed with the final works being the diversion pit construction. Temporary diversion works will be required to manage any storm events during this phase of construction.

On-site disposal of excavated material is proposed around the basin footprint, particularly in natural low spots. The extent of this disposal zone will be determined during construction, and disposal of surplus excavated material to other nearby coastal areas may be required, as directed by SCC.

Design drawings have been prepared (refer to Appendix D), together with construction specifications associated with the civil and landscape works.

The proposed works includes but not limited to:

- Setting out of the works
- Site clearance
- Soil erosion and drainage management
- Temporary works
- Earthworks
- Diversions works (pipe and pit, including diversion weir and maintenance valve)

- Construction of permanent accesses and paths
- Stabilisation of batters – placement of rock and jute matting
- Erosion protection works
- Fence re-alignment
- Stockpiling of soils for re-use
- Disposal of surplus soils on-site
- Planting and establishing of basin plants as shown on the construction drawings
- Miscellaneous plantings of dune zones

5.2 MAINTENANCE

Infrastructure such as the proposed infiltration basin requires ongoing inspection and maintenance to ensure they establish and operate in accordance with the design intent. Potential problems as a result of poor maintenance include:

- Decreased aesthetic amenity;
- Reduced functional performance; and
- Public health and safety risks.

5.2.1 Operations and maintenance plan

A separate Maintenance Plan document has been developed for the proposed infiltration basin (DesignFlow, October 2014). The plan provides detailed guidance around maintenance and operation of the basin and associated works, as well as frequency of maintenance activities. The manual includes performance inspection checklists. The document is consistent with the methodologies and principles detailed in *Maintaining WSUD Assets* (Water by Design, 2012).

It is recommended that the personnel who are to undertake the operation and maintenance of the basin be briefed and trained on procedures and protocols prior to commencing these activities. Keeping and maintaining records on the condition of the systems and associated maintenance works required will be important to inform and schedule future maintenance works.

5.2.2 Maintenance tasks

The main tasks associated with maintenance of the proposed infiltration basin involve:

- de-silting the inlet zone (annually)

- routine inspection of the basin to identify any damage to vegetation, scouring, litter and debris build up, particularly at the inlet zone (monthly)
- routine inspection of diversion pit to identify any areas of litter build up and blockages (3 monthly)
- routine inspection of the inlet zone to the basin to identify any areas of scour, litter and sediment build up and blockages (monthly)
- removal of litter and debris (monthly)
- removal and management of invasive weeds (monthly)
- replacement of plants that have died (from any cause) with plants of equivalent size and species as detailed in the planting schedule

Weeding, planting and debris removal are identified as the dominant tasks. Routine maintenance of the basin should be carried out once a month.

The most intensive period of maintenance is during the plant establishment period (first one to two years) when weed removal and replanting may be required. Debris removal is an ongoing maintenance function. If not removed, debris can block inlets or outlets, and can be unsightly if in a visible location. Inspection and removal of debris should be done regularly. Additional inspections are recommended following large storm events to check for scour and damage.

6 REFERENCES

DesignFlow (2012). *Priority Water Quality Infrastructure – 2011-2016.* Prepared for Sunshine Coast Regional Council.

DesignFlow (2014). *Earnshaw Street Infiltration Basin – Golden Beach, Caloundra – Technical Specifications – Civil and Planting.*

DesignFlow (October 2014). *Earnshaw Street Infiltration Basin, Golden Beach, Caloundra – Maintenance Plan.*

Golder and Associates (2014). *Piezometer Installation and Groundwater Monitoring, Golden Beach.* Letter report 13 May, 2014

QUDM (2007). *Queensland Urban Drainage Manual. Second Edition 2007*. Department of Natural Resources and Water.

Water by Design (July 2008). *Water Sensitive Urban Design Construction and Establishment Guidelines – Swales, Bio-retention Systems and Wetlands.*

Water by Design (2012) *Maintaining WSUD Assets* (Water by Design).

APPENDIX A - DETAILED CONCEPT FEASIBILITY

Golden Beach Stormwater Treatment Devices
Detailed Concept Design

Concept Update

February 2014

CONTENTS

- Project objectives
- Site visit
- Survey
- Site appraisal – opportunities and constraints
- Updated concepts
- Summary and recommendations

Project objectives

- Improve the water quality of discharges from coastal outfalls
- Enhance visual amenity of the site
- Innovative ideas to achieve ESD outcomes
- Legacy demonstration project that enables a variety of educational outcomes

Site visit

- Met with Council to understand site and project goals December 2013
- Inspected each proposed basin location
- Reviewed existing vegetation and drainage infrastructure
- Discussed preliminary ideas, constraints and opportunities
- Highlighted drainage inverts critical to functional feasibility
- Agreed to pursue infiltration basin option
- Coordinated feature survey for each site

Survey

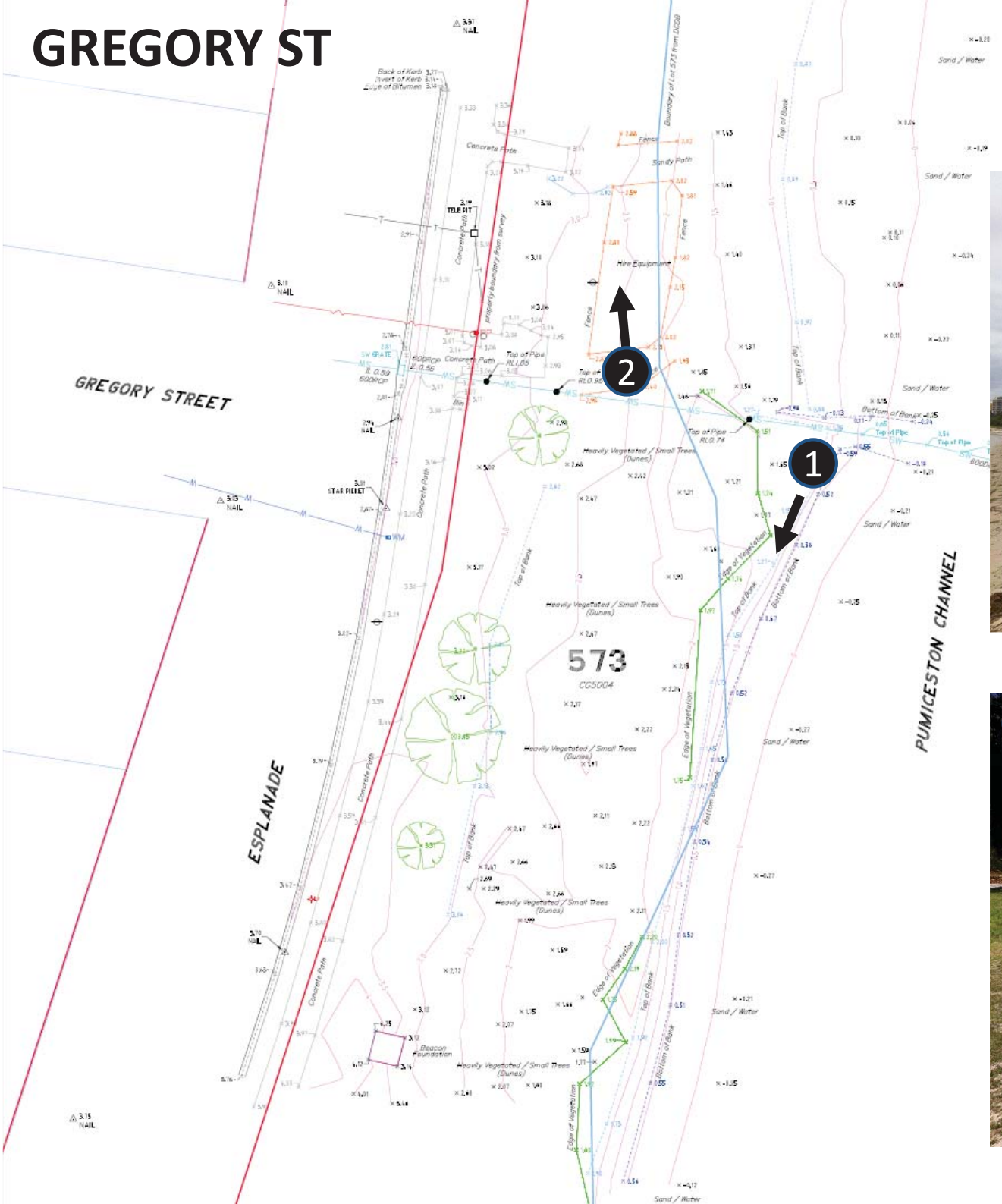
- Completed January 2014
- Topographic survey at each site
- Survey pipe inverts and sizes where access is available
- Pot hole survey along pipe route
- Feature survey including trees >125mm dia at each site

EARSHAW ST

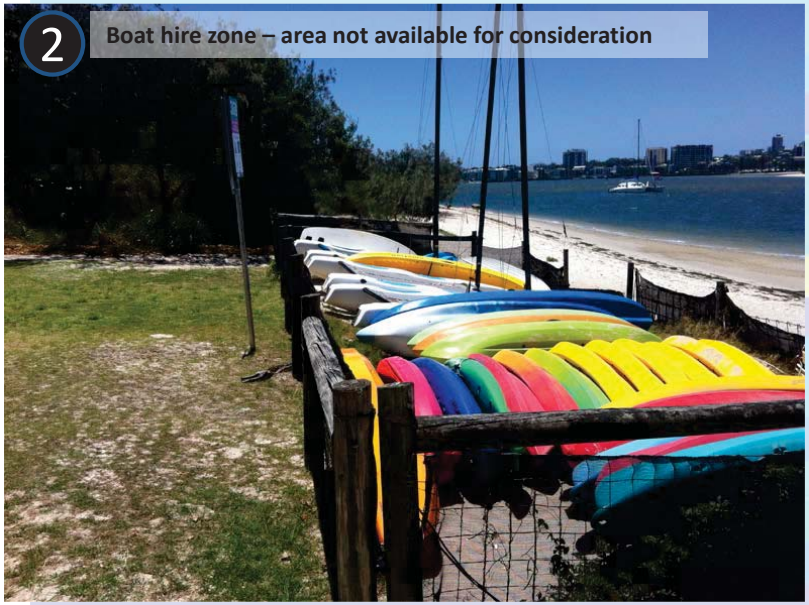
1 Looking upstream from outfall

2 Looking toward proposed basin site

GREGORY ST



Looking south from outfall. Note active erosion



Boat hire zone – area not available for consideration

WILLS AVE

WILLS AVENUE

ESPLANADE

573

CG5004

PUMICESTON CHANNEL

Vegetation/Small Trees

Sand / Water

Concrete Path

Top of Bank

Bottom of Bank

Edge of Vegetation

Top of Pipe RL0.61

Top of Pipe RL0.23

Top of Pipe RL0.20

525RCP Outlet

Boundary of Lot 573 from DCDB

property boundary from survey

3.93 STAR PICKET

3.78 NAIL

Crossing

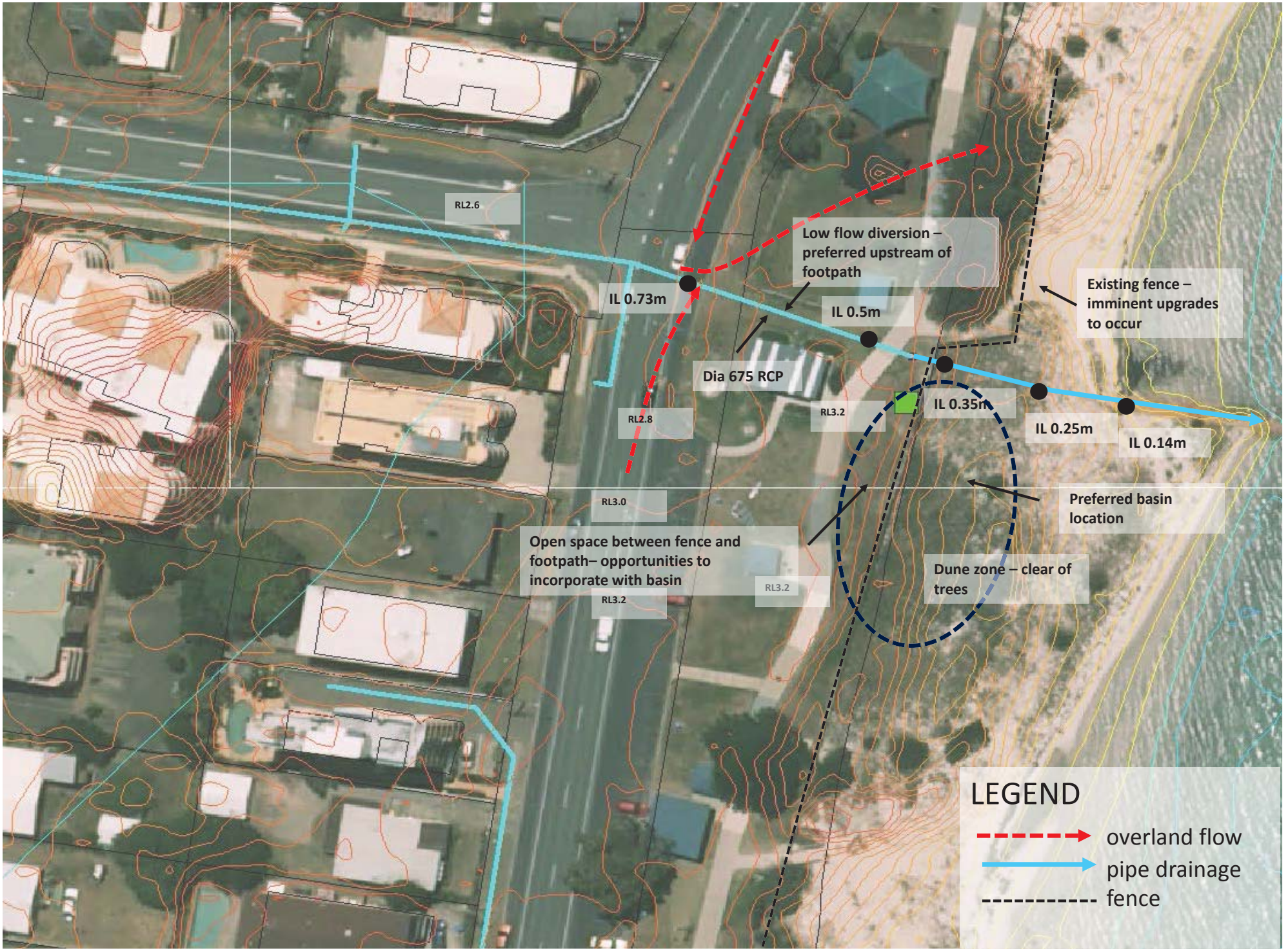
WM

PP

SW

SITE APPRAISAL
OPPORTUNITES AND CONSTRAINTS

EARSHAW STREET BASIN


RL2.6
Low flow diversion – preferred upstream of footpath
IL 0.73m
IL 0.5m
Existing fence – imminent upgrades to occur
Dia 675 RCP
RL2.8
RL3.2
IL 0.35m
IL 0.25m
IL 0.14m
RL3.0
Preferred basin location
Open space between fence and footpath– opportunities to incorporate with basin
RL3.2
RL3.2
Dune zone – clear of trees
LEGEND
overland flow
pipe drainage
fence

Opportunities and constraints summary

- **Existing infrastructure:** existing drainage pipe (675mm RCP) invert levels downstream of footpath considered too low for diversion to proposed basin. Opportunities for diversion between the road and footpath (pipe IL 0.5-0.7m).
- **Space:** good open space available in dune zone without encroaching on main beach zone. Opportunity to use grassed zone between fence and footpath. Allows improved connection to basin for educational opportunities (interpretive signage)
- **Vegetation:** no trees mapped in general basin zone. Vegetation mostly coastal shrubs and grasses. Opportunities to enhance vegetation planting in and around basin location
- **Topography:** existing levels over general basin zone varies from RL2.0-RL3.2. Basin depths from existing ground 1.5-2.7m. Requires batters stabilisation (rock and vegetation)
- **Existing fence:** fence upgrades imminent. Opportunities to re-align in conjunction with basin works
- **Overland flows:** basin location south of main overland flow path
- **Educational opportunities:** Potential to incorporate interpretive signage with coastal path signage strategy. Educational topics include stormwater treatment, dune stabilisation and range of coastal vegetation.

GREGORY STREET BASIN


RL3.2
Low flow diversion – preferred at road – inverts too low downstream
Boat hire – location not available for consideration
IL 0.56m
IL 0.4m
IL 0.3m
RL3.0
Dia 600 RCP
RL3.2
Good value vegetation including Casuarinas
Preferred basin location
Active erosion zone
LEGEND
overland flow
pipe drainage
fence

Opportunities and constraints summary

- **Existing infrastructure:** existing drainage pipe (600m RCP) invert levels downstream of road pit considered too low for diversion to proposed basin. Requires diversion from road pit – reconfiguration of pit required including expensive road works
- **Space:** limited clear space available in dune zone. Beach zone has limited space available.
- **Vegetation:** site is heavily vegetated with shrubs and small trees. Several good value trees (Casuarina) identified and would be impacted by basin works
- **Topography:** existing levels over general basin zone varies from RL2.0-RL3.2. Basin depths from existing ground 1.5-2.7m. Requires batters stabilisation (rock and vegetation)
- **Coastal erosion:** active erosion occurring at interface with beach. High risk to stability of basin if not armoured
- **Overland flows:** basin location south of main overland flow path

WILLS AVENUE BASIN


RL3.2
RL4.0
RL3.8
Low flow diversion – preferred between road and footpath
IL 0.45m (interpreted)
IL 0.66m
IL 0.05m
Dia 525 RCP
Depth to basin fllor approx 3.5m – potential integration issues
Vegetation including small trees
Preferred basin location
LEGEND
overland flow
pipe drainage
fence

Opportunities and constraints summary

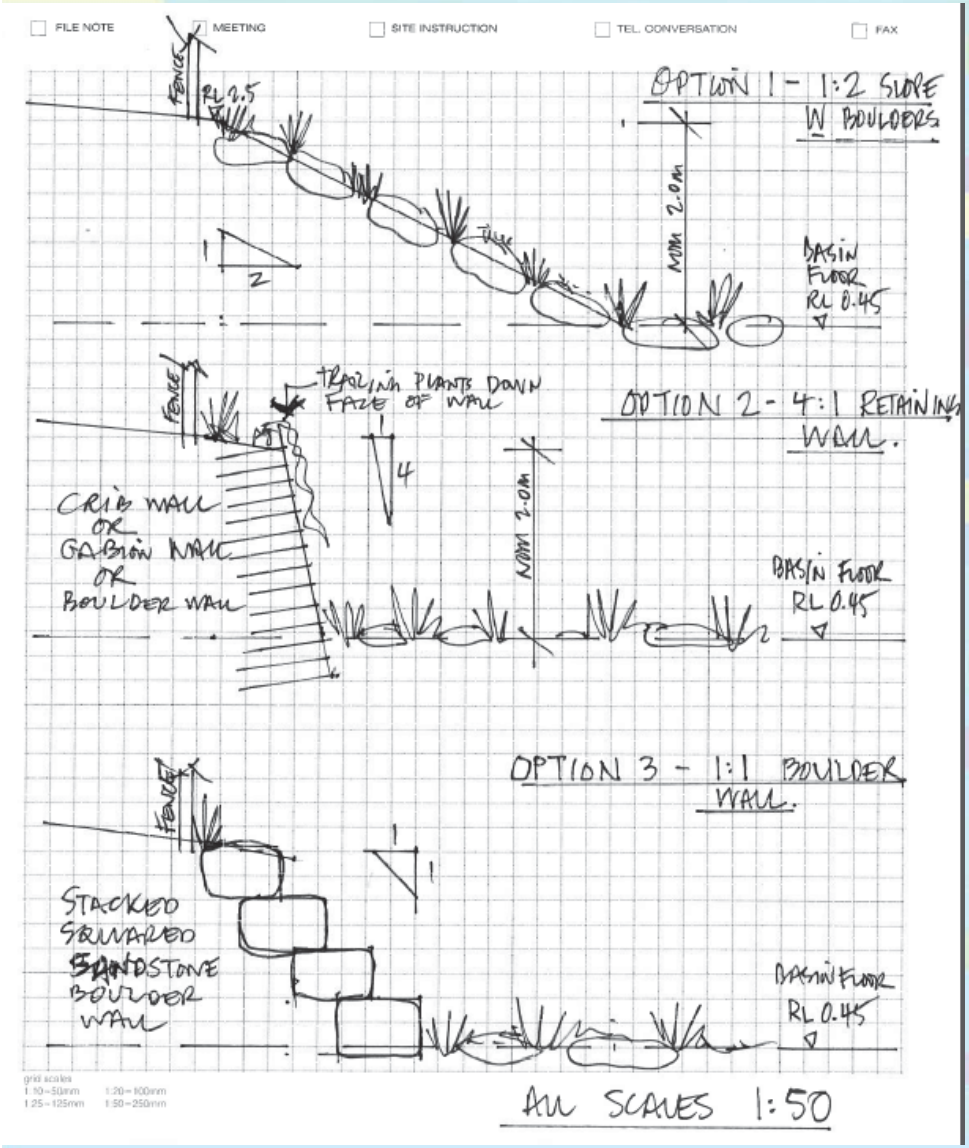
- **Existing infrastructure**: existing drainage pipe (525mm RCP) invert levels downstream of footpath considered too low for diversion to proposed basin. Opportunities for diversion between the road and footpath (pipe IL 0.45-0.65m).
- **Space:** limited clear space available in dune zone. Basin size however could be accommodated within the general site area. Overall land take due to excavation depths will be relatively large however
- **Vegetation:** vegetated is mainly associated with small trees and shrubs. Some Casuarinas may be impacted by basin works, although these can be offset with basin works providing overall longer term vegetation improvements
- **Topography:** existing levels over general basin zone varies from RL2.0-RL4.0. Basin depths from existing ground 1.5-3.5m. Depth from road side batter to basin floor will have a significant visual impact. Requires batters stabilisation (rock and vegetation)
- **Overland flows:** basin location south of main overland flow path

UPDATED CONCEPTS

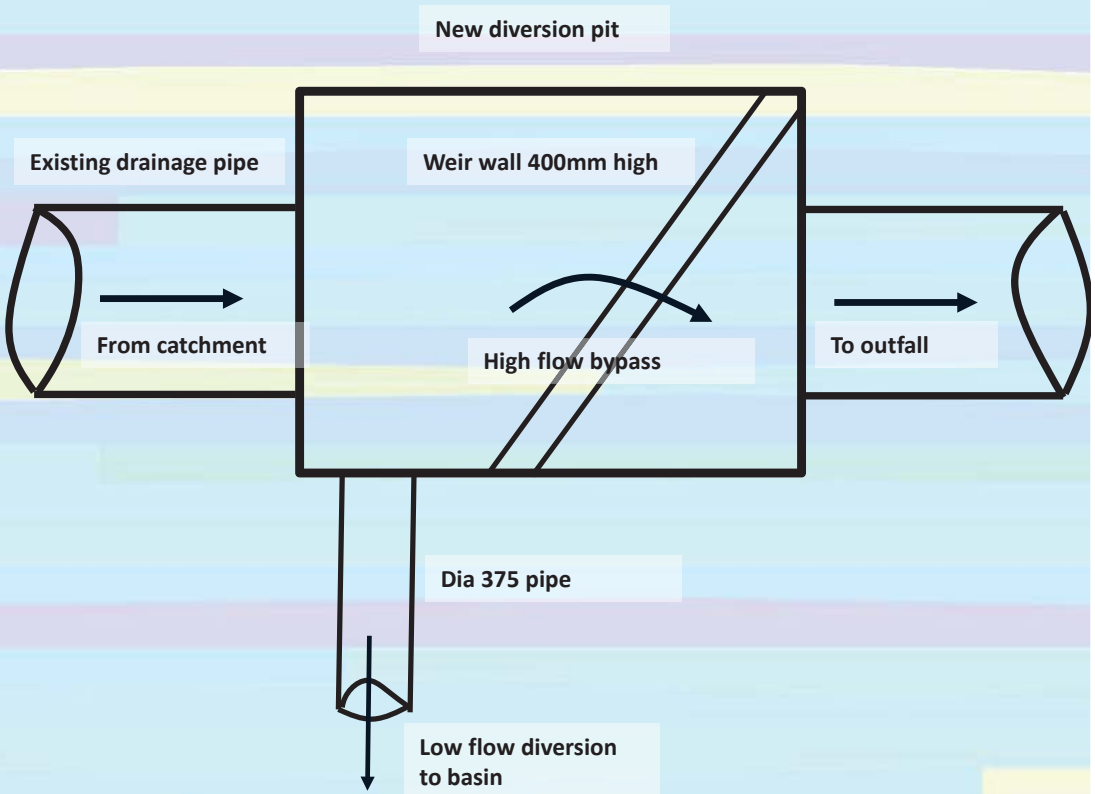
Design considerations

- No worsening of flood capacity – retain current outfalls
- Avoid scour and erosion issues
- No overland flows to basins
- Low flow diversions to basins only – avoid full pipe flow to basins
- Avoid removal of high value vegetation if possible
- Basin floors at or above approx. RL0.5 – minimises potential groundwater issues and deep basins
- Stable batters – rock treatments
- Public safety

Typical details



Typical basin edge treatments



Typical low flow diversion

Example wall/batter treatments

Sandstone blocks

Crib wall

Sandstone boulders

Scattered rocks inter-planted with vegetation