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YARRABILBA

PRECINCT 6

EROSION AND SEDIMENT CONTROL STRATEGY

VERSION 1

DesignFlow

Prepared for Lendlease
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Client:	LendLease
Author(s):	Leon Rowlands, Nic Smith
Reviewed By:	Shaun Leinster
Approved By:	Leon Rowlands CPESC 4364
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Potential implications of climate change

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DesignFlow

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1 INTRODUCTION

1.1 SCOPE AND FRAMEWORK

Precinct 6 is located immediately south of the existing Yarrabilba Drive extension and west of existing Precinct 4 as shown in Figure 1. The precinct is split into 2 areas, with ROL1 in the north and ROL2 in the south. Both areas will have bulk earthworks occurring concurrently with one another.

This Erosion and Sediment Control Strategy (ESCS) has been prepared to support a bulk earthworks application over Precinct 6 and demonstrates how best practice erosion and sediment control will be delivered over the area. Sizing is provided for major controls such as sediment basins and major drainage features. The ESCS will be supported by detailed Erosion and Sediment Control Plans (ESCP's) which will be prepared by the Contractor for individual works areas before works commence and will contain detailed sizing and staging for all components.

This ESCS therefore documents the following:

- Site characteristics and constraints relevant to ESC management
- Design objectives to be achieved by the ESCS and individual ESCPs
- ESC strategy elements for major site catchments, including:
    - location and size of major sediment controls (i.e. basins)
    - key phasing considerations
    - strategies for riparian works
    - approaches to revegetation

The civil design and ultimate stormwater drainage and treatment strategy is still under development for parts of the precinct. An updated ESCS will be required to accompany future civil works design packages.

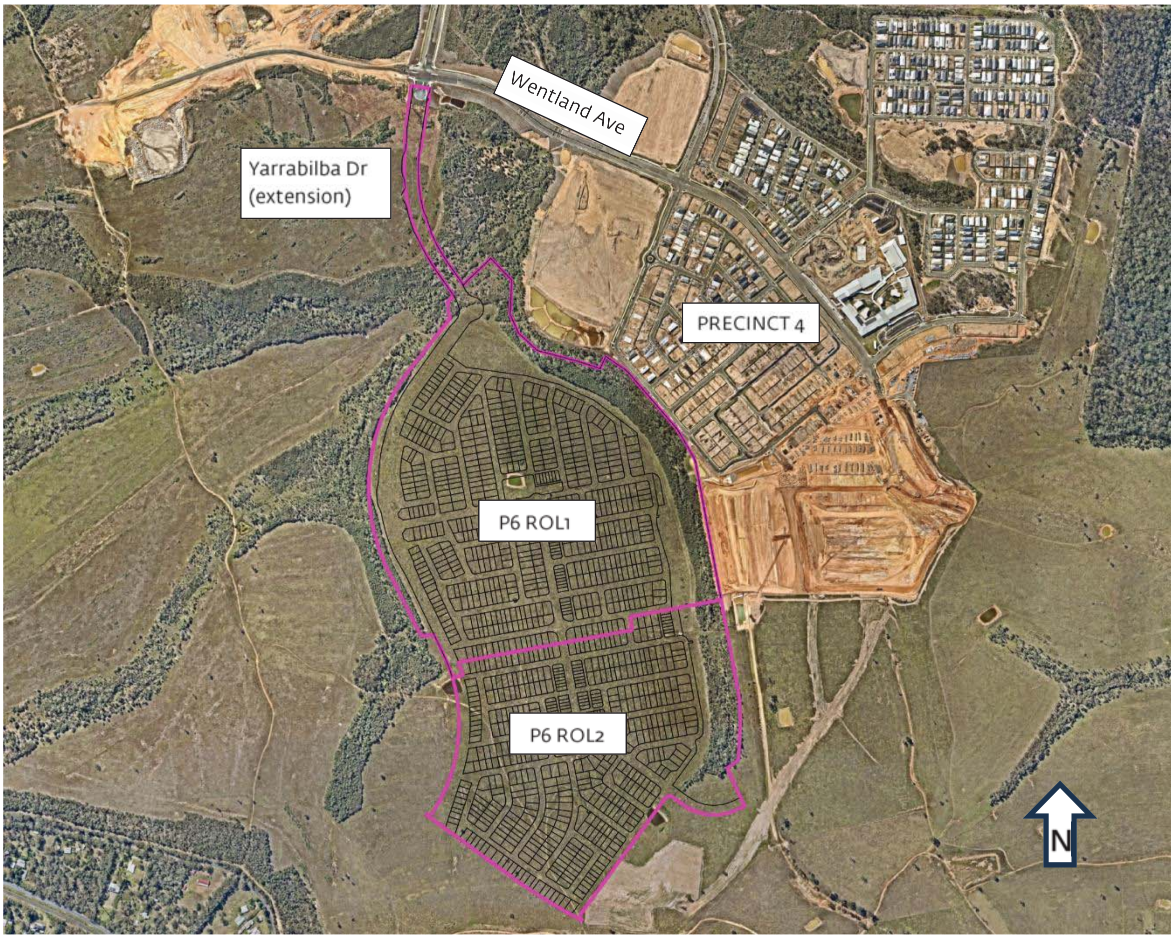


Figure 1: Site locality

2 SITE CHARACTERISTICS

2.1 TOPOGRAPHY, CATCHMENTS AND DRAINAGE

The bulk earthworks catchments based on existing and final earthworks levels are provided in Figure 2.1 and Figure 2.2 respectively. Major existing and proposed drainage features are included in these figures to aid interpretation.

The sub-catchment areas and flow directions are similar between earthworks phases, though some sub-catchments are larger and some smaller when comparing existing and final levels. For this ESCS a conservative approach has been adopted and sediment controls have been sized for each sub-catchment based on the largest of either the existing or final sub-catchment areas. The footprint provided by the end-of-line ultimate WSUD system provides an excellent opportunity for locating sediment basins to control water quality during the construction phase of the development and are a crucial part of the ESCS documented in Section 4.

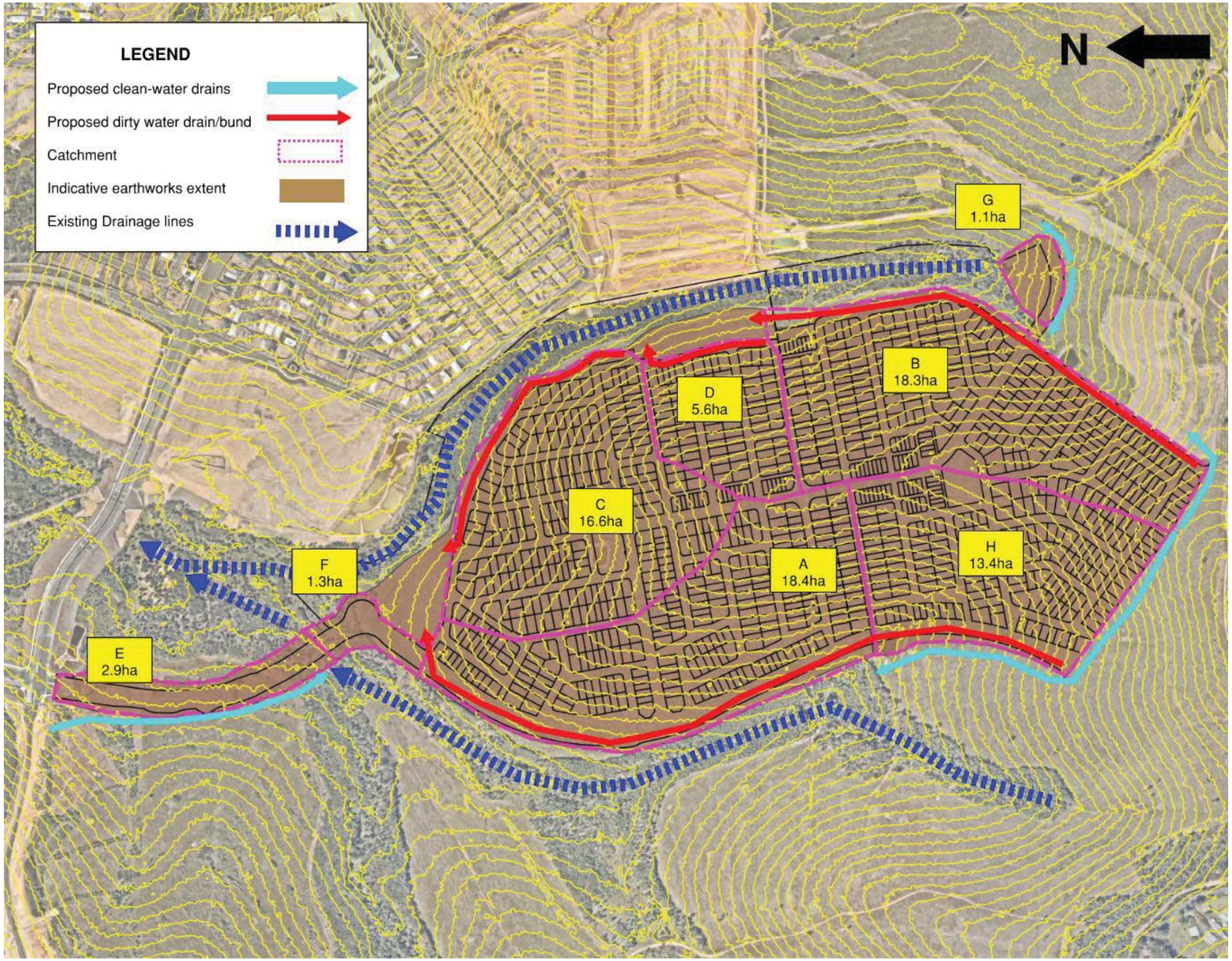


Figure 2.1: Bulk earthworks sub-catchments – existing levels

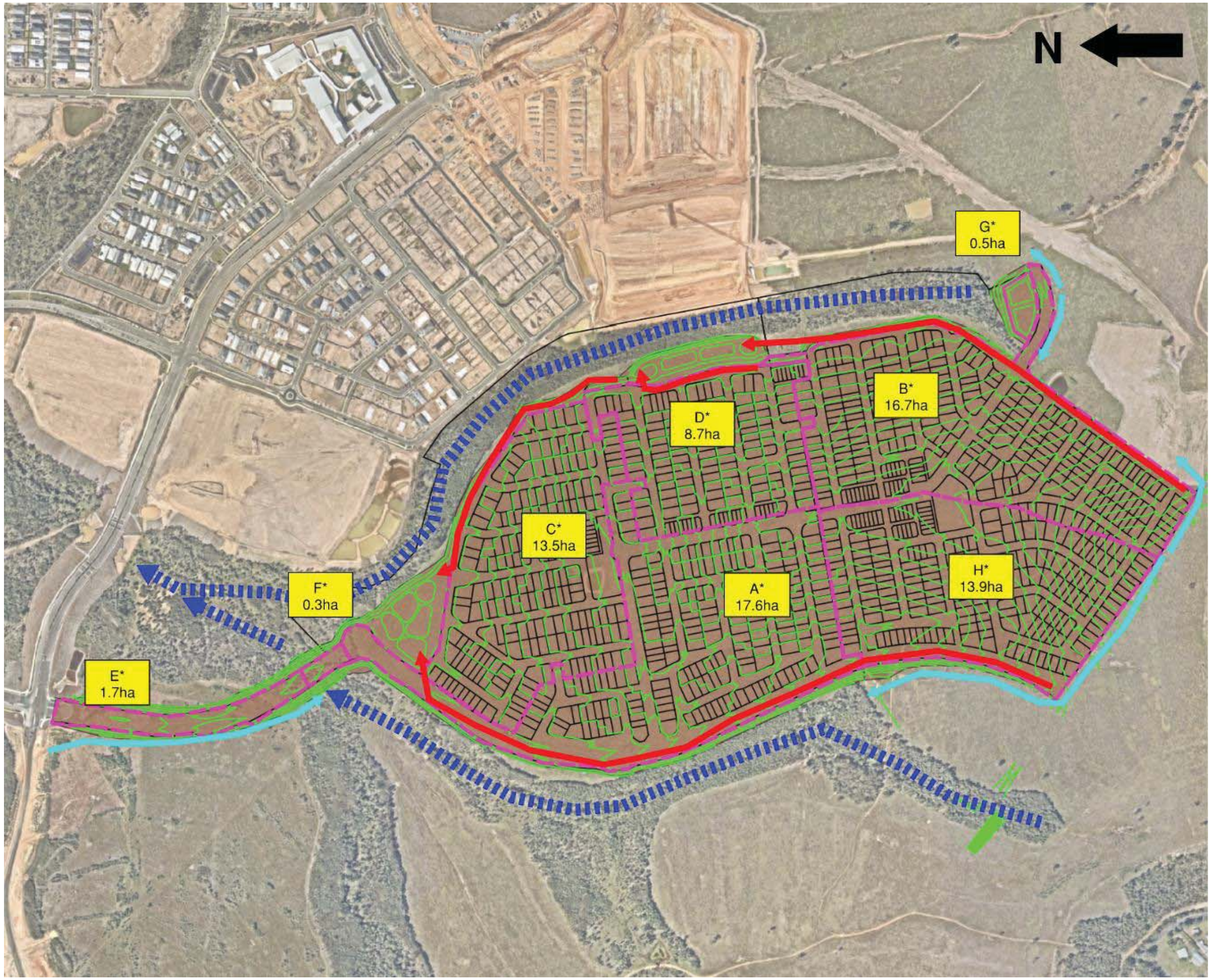


Figure 2.2: Bulk earthworks sub-catchments – final levels

2.2 SOILS

No specific sampling and laboratory testing of soils has been undertaken for the ESCS. It is recommended that prior to works commencing in a specific area, the Contractor should undertake soil sampling and laboratory analysis to inform the detailed ESCP's. Soil testing should be undertaken in accordance with IECA (2008) Chapter 3 and Appendix C9, and should include as a minimum 2 boreholes for each works area and testing of a representative topsoil and sub-soil sample for the following:

- Topsoil:
    - Soil pH
    - EC
    - Organic carbon
    - TN, nitrate
    - Exchangeable basic and acidic cations (Ca, Mg, K, Na, Al)
    - Plant available phosphorus and potassium
- Subsoil
    - PSD
    - pH and EC
    - Emerson Class number
    - Dispersion percentage

Topsoil testing is particularly important in order to ensure successful revegetation and the contractor is to apply ameliorants to topsoil as required based on the results of testing.

In the absence of other information, it has been assumed for this ESCS that site soils will be dispersive and construction runoff will require treatment with a chemical flocculent/coagulant to remove fine and dispersive sediment prior to discharge.

Visually, there are clear signs of dispersive soils within the site, with severe gully erosion present in places. This has specific implications for drainage controls and the construction of sediment basin embankments from in-situ material. These structures can suffer from failure if dispersive soils are not managed appropriately and specific geotechnical advice, based on soil testing, should be sought.

2.3 CLIMATE

Average rainfall data is plotted in Figure 2.3. It can be seen that the lowest rainfall months based on the long-term average are July – September, and high risk works such as riparian activities (i.e. culvert works) should be programmed to occur during this part of the year.

It should however be noted that high rainfall can occur at any time of year in South-East Queensland and controls are still required for works regardless of the month in which they occur.

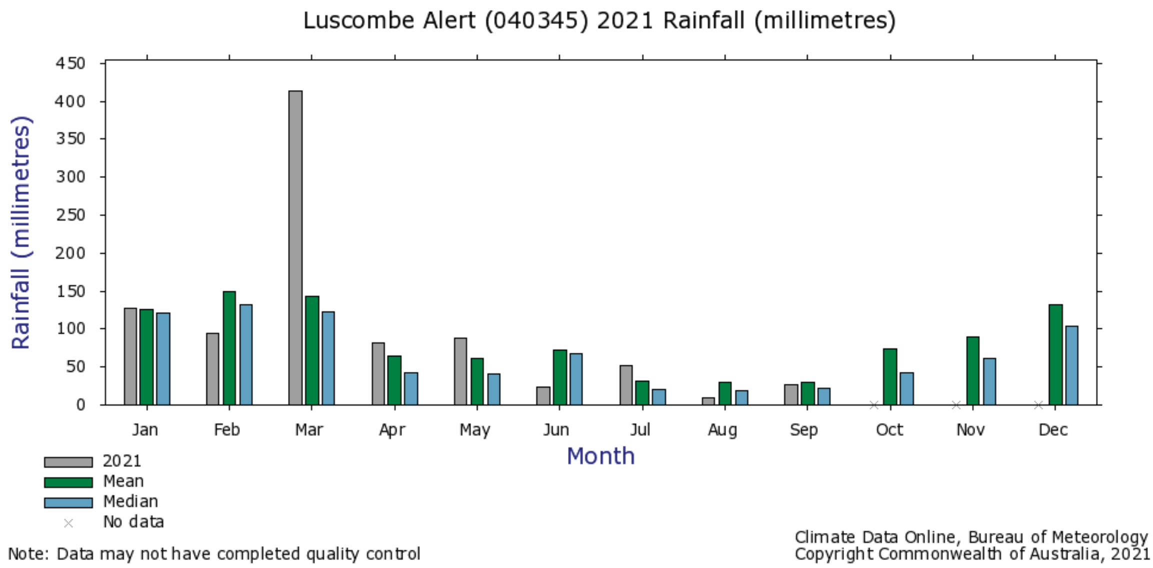


Figure 2.3: Rainfall Statistics

2.4 FLOODING

Flooding characteristics at the site have been established by modelling undertaken by DesignFlow (2017). The ultimate 1%AEP flood event inundation plan is shown below in 2.4. It can be seen that the majority of the bulk earthworks areas are outside of the 1%AEP flood extent, apart from culvert and road embankment works for the creek crossings.

Management of these crossings will require careful planning and management and is discussed further in Section 4.

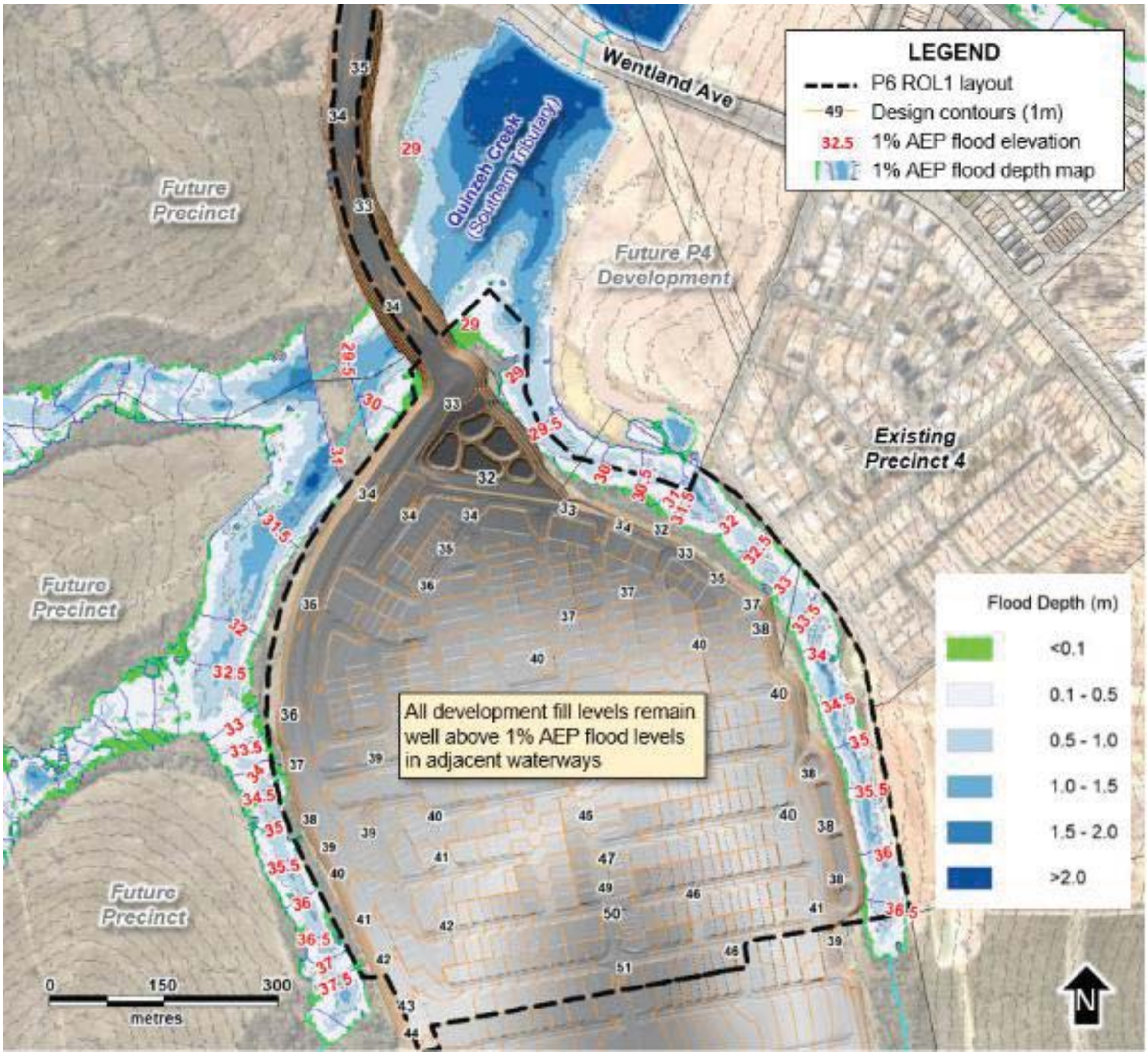


Figure 2.4: 1% AEP flood extent

3 DESIGN OBJECTIVES

The design objectives relevant to the construction phase of development works are specified in Appendix 2 of the State Planning Policy 2017 (SPP2017). These are reproduced in Table 3.1, Table 3.2 and Table 3.3 below.

Table 3.1: Construction Phase Stormwater Design Objectives

Issue	Desired outcomes
Drainage control	1. Manage stormwater flows around or through areas of exposed soil to avoid contamination. 2. Manage sheet flows in order to avoid or minimise the generation of rill or gully erosion. 3. Provide stable concentrated flow paths to achieve the construction phase stormwater management design objectives for temporary drainage works (part 2). 4. Provide emergency spillways for sediment basins to achieve the construction phase stormwater management design objectives for emergency spillways on temporary sediment basins (part 3).
Erosion control	1. Stage clearing and construction works to minimise the area of exposed soil at any one time. 2. Effectively cover or stabilise exposed soils prior to predicted rainfall. 3. Prior to completion of works for the development, and prior to removal of sediment controls, all site surfaces must be effectively stabilised[13] using methods which will achieve effective short-term stabilisation.
Sediment control	1. Direct runoff from exposed site soils to sediment controls that are appropriate to the extent of disturbance and level of erosion risk. 2. All exposed areas greater than 2500 $metres^2$ must be provided with sediment controls which are designed, implemented and maintained to a standard which would achieve at least 80% of the average annual runoff volume of the contributing catchment treated (i.e. 80% hydrological effectiveness) to 50mg/L Total Suspended Solids (TSS) or less, and pH in the range (6.5–8.5).
Litter, hydrocarbons and other contaminants	1. Remove gross pollutants and litter. 2. Avoid the release of oil or visible sheen to released waters. 3. Dispose of waste containing contaminants at authorised facilities.
Waterway stability and flood flow management	1. Where measures are required to meet post-construction waterway stability objectives (specified in table B), these are either installed prior to land disturbance and are integrated with erosion and sediment controls, or equivalent alternative measures are implemented during construction. 2. Earthworks and the implementation of erosion and sediment controls are undertaken in ways which ensure flooding characteristics (including stormwater quantity characteristics) external to the development site are not worsened during construction for all events up to and including the 1 in 100 year ARI (1% AEP).

Table 3.2: Construction Phase Stormwater Design Objectives for temporary drainage works

Temporary drainage works	Anticipated operation design life and minimum design storm event		
	‹ 12 months	12–24 months	› 24 months
Drainage structure	1 in 2 year ARI/39% AEP	1 in 5 year ARI/18% AEP	1 in 10 year ARI/10% AEP
Where located immediately up-slope of an occupied property that would be adversely affected by the failure or overtopping of the structure	1 in 10 year ARI/10% AEP		
Culvert crossing	1 in 1 year ARI/63% AEP		

Table 3.3: Construction Phase Stormwater Design Objectives for emergency spillways on temporary sediment basins

Drainage structure	Anticipated operation design life and minimum design storm event		
	‹ 3 months	3–12 months	› 12 months
Emergency spillways on temporary sediment basins	1 in 10 year ARI/10% AEP	1 in 20 year ARI/5% AEP	1 in 50 year ARI/2% AEP

The design objectives specified in the SPP2017 generally reflect accepted best practice in Australia, however the Sediment Control (2) objective in Table 3.1 is a higher standard than required in most other states and is reflective of both the pronounced wet season and degree of development activity which occur in Queensland.

Healthy Land and Water (2017) provide a range of strategies for achieving the requirements of the sediment control design objective which are summarised below:

1. High Efficiency Sediment (HES) Basins:

   Install and operate Type-A or Type-B sediment basins designed in accordance with IECA Appendix B (2019), described as High-Efficiency Sediment (HES) basins. These are sediment basins which have automated dosing of chemicals which assist flocculation/coagulation of fine and dispersive sediment and which operate on a continuous-flow basis. Type-A basins incorporate a floating decant as the primary outlet while Type-B basins can remain full between events and have only a spillway outlet. A conceptual layout for a Type-B HES basin is provided in Figure 3.1.

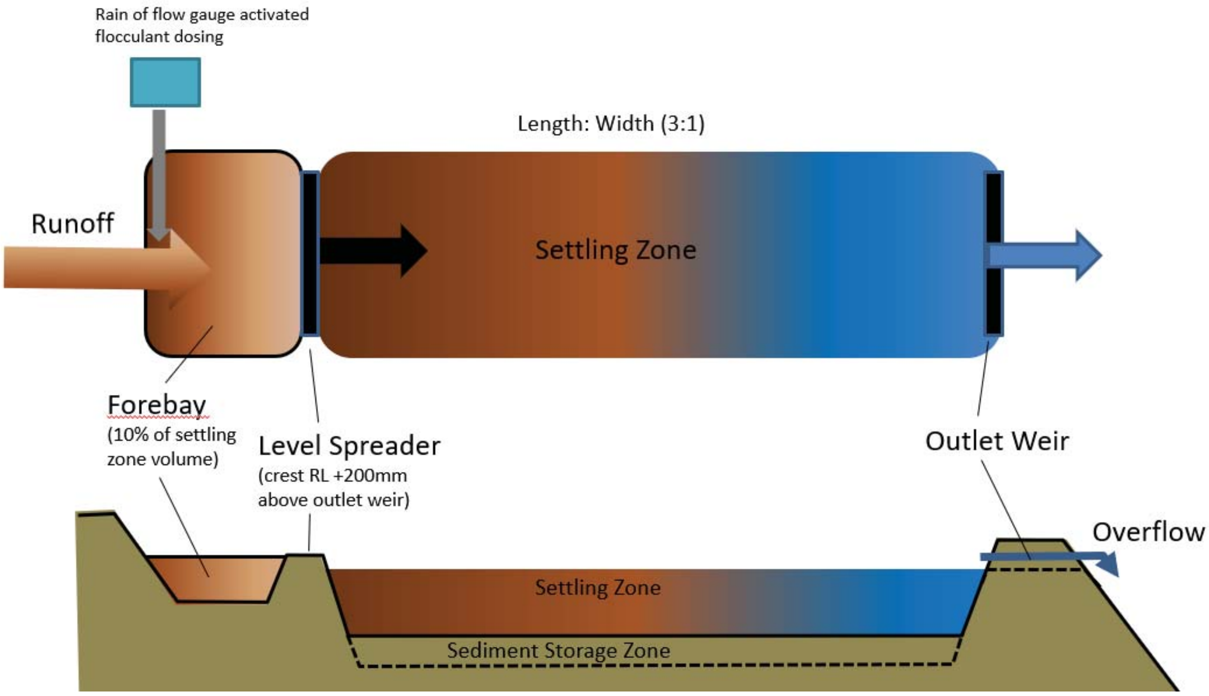


Figure 3.1: Conceptual High-Efficiency Sediment (HES) Basin Type-B Functional Layout

2. **Large Batch Basins:**

Batch sediment basins (Type D) designed in accordance with IECA (2008) will not comply with the SPP2017 design objective. Modified batch basin designs may be possible for some sites, however for most sites the batch basins would need to be impractically large or require impractical treatment and dewatering strategies to meet the design objective.

3. **Total Capture:**

For flat sites, with no external catchment, perimeter bunding may be appropriate where it can be shown that the bund height is sufficient to capture the anticipated (average) wet season rainfall completely (i.e. total capture). A simple water-balance calculation and earthworks sections showing the bund arrangements and capture volumes will be sufficient to show that this strategy can be implemented. However careful consideration will be required for how this strategy can continue to operate beyond earthworks stage to when civil construction is being undertaken or nearing completion.

4. **Alternative Innovative Measures:**

Alternative measures may be implemented where it can be shown through long-term water-balance modelling that the measures will achieve the release criteria of

50mg/L TSS for at least 80% of the average annual runoff volume. This would need to be documented and justified in the detailed ESC Plan(s).

5. Erosion Control:

Effective erosion control can be implemented in lieu of requiring sediment control specified above. For small areas, which are unable to drain to a basin, this could be achieved by implementing contingency measures prior to rainfall, such as covering exposed soil with blankets (mulch or synthetic) or spray-on soil binders. In these circumstances the erosion controls must result in an effectively stabilised surface prior to rainfall to justify the exclusion of sediment controls.

Each of the above approaches has been considered and specific recommendations provided for the site catchments in Section 4.1.

4 EROSION AND SEDIMENT CONTROL STRATEGY

4.1 STRATEGIES FOR SPECIFIC SITE SUB-CATCHMENTS

The overall strategy during construction for each of the site sub-catchments and discharge locations are discussed below and shown in Figure 4.1 and Figure 4.2. Considerations for the detailed design of erosion, drainage and sediment controls are provided in Sections 4.4 to 4.6.

The overall strategy is provided based on two phases – existing levels and final levels. Transition between these two phases is a gradual process and the detailed construction ESCP's (by Contractor) will need to show a number of interim plans to cover this transition.

4.2 EXISTING LEVELS

The strategy for sub-catchments B, D, H, E and F uses Type-B HES basins provided at the low-point of each sub-catchment. The basins are fed through the provision of dirty-water diversion drains, while external 'clean' catchments are diverted around the works by clean water diversion drains. Small areas which fall outside the sediment basin catchments can be managed with sheet-flow sediment controls such as sediment fencing.

Sediment basins SB2 (sub-catchment H), SB3 (sub-catchment B) and SB4 (sub-catchment D) are located in the ultimate footprint of WSUD treatment systems. The basin locations can remain static throughout construction and should be constructed based on the maximum catchment size which will occur at any point during construction. For SB2 and SB4, this will be the catchment based on final levels, while for SB3 this is the catchment based on existing levels.

A number of the sediment basins are located in areas which will ultimately be filled. It is important to note that these basin (as for all controls listed in this section) need to be functional before topsoil stripping occurs throughout the contributing sub-catchments. The temporary sediment basins are likely to be constructed as a combination of cut and filling in order to command the identified sub-catchments based on existing levels. Filling for the WSUD/bioretention footprint would therefore need to be delayed until the last phase of earthworks/civil works, once the contributing catchments have been stabilised and the sediment basin can be decommissioned. However part of the sediment basin earthworks may be able to follow the ultimate WSUD earthworks design subject to an earthworks model being created and only where this does not delay or compromise the function of the temporary sediment basin.

Sediment basin SB3 (sub-catchment C) is not located within any future WSUD footprint and is a temporary basin which will ultimately need to be removed to facilitate filling. The removal of SB3 is dependent on the decommissioning of CW1 and the commissioning of CW1*.

Catchments E and F are associated with the Yarrabilba Drive extension and the entire alignment is in fill. Basins SB5 and SB6 are proposed as Type-B basins provided at the low-point in each catchment and will be in cut and treat flows for the initial footprint. Filling for the road embankment should work towards these basins so they can remain in place for as long as possible.

Catchments A and C are provided with sediment basin SB1. This basin is challenging due to the multiple inflow points, which makes use of a single Type-B basin impractical. Two options are provided for this basin as documented in Section 4.6:

- Two separate Type-B basins could be provided in this location as SB1A (catchment C) and SB1B (catchment A); or
- A Type-E HES basin could be provided. This option has a number of benefits and is discussed further in Section 4.6.

Catchment G is solely associated with construction of a bioretention system and short section of roadway. This catchment can be managed by diverting the upstream clean catchment with diversion drains and creating a containment bund at the downstream face of the works. Captured water may then be treated in-situ and discharged. The required volume is 1,200m^3/ha (based on area of exposed soil). Any works (or fill placement) that occurs on the upslope future sports field site south of catchment G will be subject to a separate ESCS.

4.3 FINAL LEVELS

The strategy based on 'final levels' is similar to the 'existing levels' strategy with the following differences:

- Dirty-water drains will be provided by the road box (as it is formed), with coir-log check dams provided within the road box prior to rainfall, in order to minimise erosion within the road box itself
- External facing batters formed by fill are unable to drain to sediment basins and will be provided with sheet-flow sediment controls (sediment fence) and stabilised once individual areas exceed 2,500m^2
- The fill embankment for the Yarrabilba Drive extension will extend towards the culvert crossing and SB5 and SB6 will need to be removed so the area can be filled. Turkeys-nest containment bunds will need to be created at the top of the embankment and the batters progressively stabilised.

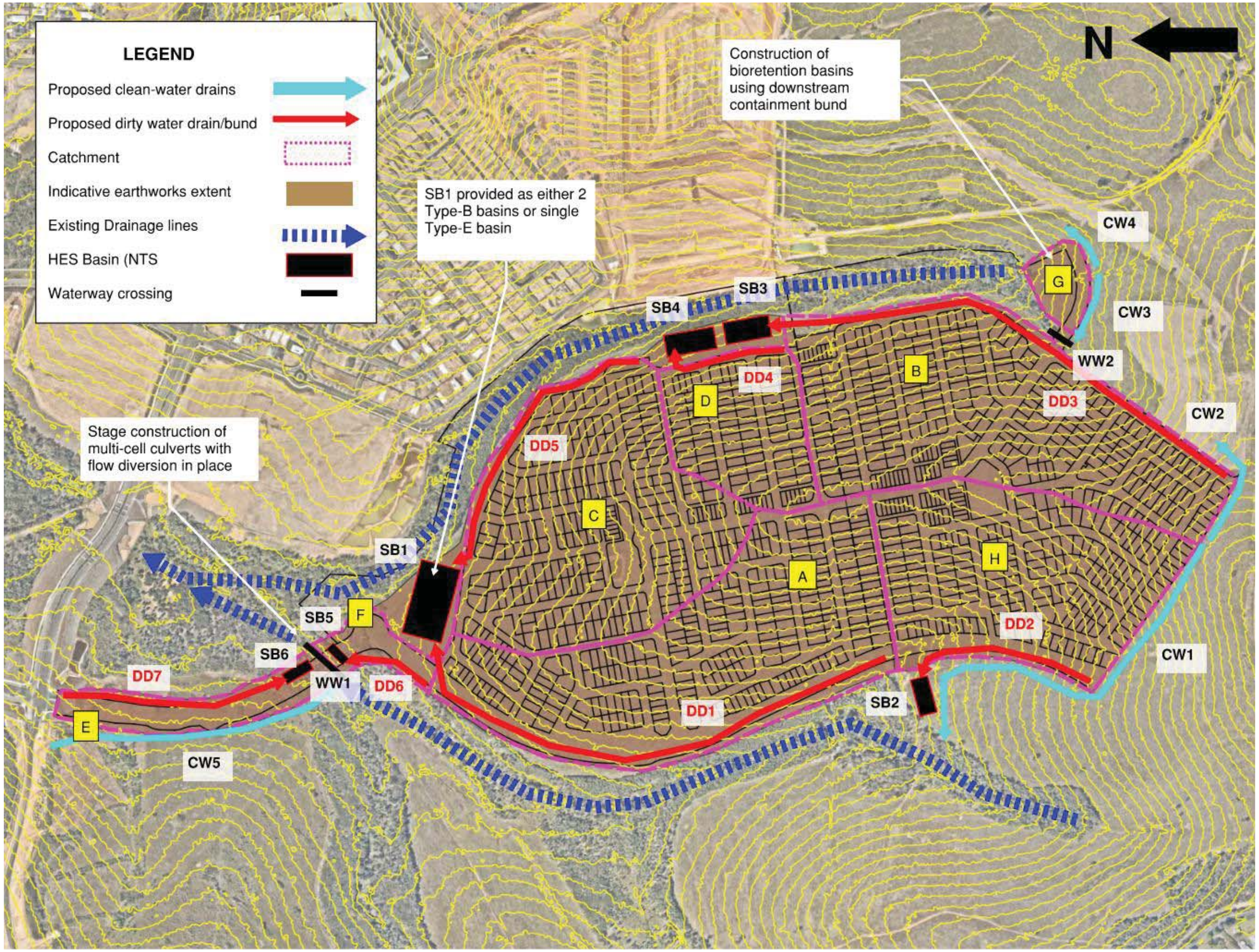


Figure 4.1: Strategy Elements (Existing Levels)

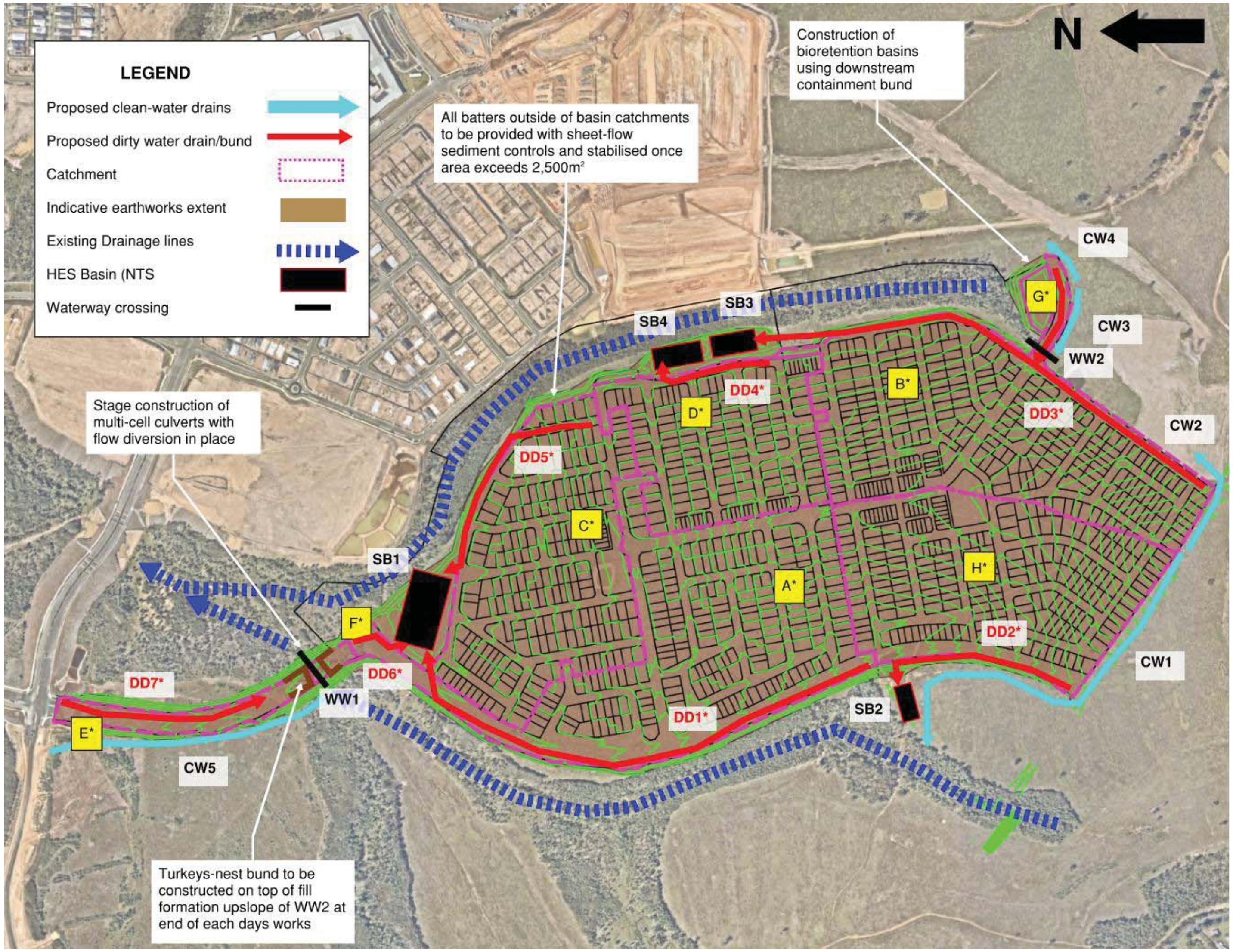


Figure 4.2: Strategy Elements (Final Levels)

4.4 EROSION CONTROL

The following discussion relates to general earthworks areas. Specific discussion on riparian works are provided in Section 4.7.

IECA (2008) identifies erosion risk based on average monthly rainfall and provides best practice rehabilitation requirements for different times of the year based on this risk. The erosion risk for the subject site for different times of the year is shown in Table .1.

Table 4.1: Erosion risk by time of year

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High	High	High	High	High	Moderate	Very Low	Very Low	Very Low	Moderate	Moderate	High

The requirements for land clearing and rehabilitation vary depending on the time of year (i.e. level of risk). The performance targets, based broadly on IECA (2008) and example methods of achieving those targets are provided in Table 4.2. The detailed ESCPs for each works area are to provide specific details on how the performance targets are to be achieved.

Table 4.2: Erosion performance targets and example methods

Erosion Risk	Performance Target	Example Method
Very Low	• Land clearing limited to 8 weeks worth of construction work. • Disturbed areas stabilised with 60% cover within 30 days of finished levels being reached or works delayed for more than 30 days	• Future lots stabilised with drill seeding of annual and perennial grass species, with soil amelioration based on soil tests. • Steep areas where drill seeding not possible stabilised with hydromulch
Moderate	• Land clearing limited to 6 weeks worth of construction work. • Disturbed areas stabilised with 70% cover within 20 days of finished levels being reached or works delayed for more than 20 days	• Future lots stabilised with drill seeding of annual and perennial grass species, with soil amelioration based on soil tests. Soil binder provided for short-term stabilisation over seeded areas. • Steep areas where drill seeding not possible stabilised with bonded-fibre matrix. • Provided within 20 days of final levels being reached.
High	• Land clearing limited to 4 weeks worth of construction work. • Disturbed areas stabilised with 75% cover within 10 days of finished levels being reached or	• Future lots stabilised with drill seeding of annual and perennial grass species, with soil amelioration based on soil tests. Soil binder provided for short-term stabilisation over seeded areas.

Erosion Risk	Performance Target	Example Method
	works delayed for more than 10 days	• Steep areas where drill seeding not possible stabilised with bonded-fibre matrix. • Provided within 10 days of final levels being reached.

Table 4.2 refers to short-term stabilisation requirements. As the earthworks areas may remain undeveloped for an extended period of time, the sediment controls will need to remain in place and continue to be actively managed until effective long-term erosion control (i.e. vegetative cover) is achieved based on the cover requirements for the highest monthly erosion risk (i.e. 75% cover).

4.5 DRAINAGE CONTROL

Drainage controls are required to limit flow path lengths in order to prevent or minimise rill erosion and to ensure clean external catchments are diverted around the works and disturbed catchments are directed to appropriate sediment controls such as HES basins.

Table 3.2 and Table 3.3 provide design standards for drainage controls. As the site exhibits visual signs of the presence of dispersive soils, specific measures will need to be applied to drainage controls to prevent severe erosion, such as topsoil capping or addition of gypsum to diversion drains prior to lining (and must be informed by site soil assessment).

Details of drainage controls will be provided with the detailed ESCP's.

4.6 SEDIMENT CONTROL

4.6.1 High Efficiency Sediment Basins

Type-B Basins

Appendix A contains full calculations for each of the HES basins identified in Figure 4.1 and Figure 4.2. The HES basins are Type-B, with sizing determined from the procedures documented in IECA (2019). The basin and catchment properties are summarised below in Table 4.3.

The scour velocity checks provided in Appendix A indicate that for some basins the velocity may be an issue. It is recommended that permeable baffles be implemented in all HES basins in order to improve the distribution of velocities across the basin section and minimise the risk of resuspension.

Table 4.3: Preliminary Type-B HES Basin Properties

Basin ID	Sub-Catchments	Catchment Area (ha)	Existing or Final Contours?	Basin Volume (m^3)	Basin Area (m^2)
SB1A	C	16.6	Existing	5,002	2,773
SB1B	A	18.4	Existing	4,480	2,539
SB2	H*	13.4	Final	4,768	2,669
SB3	B	18.3	Existing	5,648	3,059
SB4	D*	5.6	Final	2,903	1,814
SB5	F	1.3	Existing	536	565
SB6	E	2.9	Existing	874	795

Each Type-B basin should be provided with an automatic dosing unit. Flow-based dosing would be preferrable compared to rainfall-activated dosing due to the extent of earthworks and changes to the contributing catchment which will occur.

A suitable flocculant and dosing rate will need to be determined based on jar testing. Suitable candidate products would be chitosan and aluminium-chloro-hydrate (ACH).

Standard drawings for HES basins are provided in Appendix B.

<u>Type-E Basins</u>

An alternative to implementing basins SB1A and SB1B is to provide a single Type-E HES basin. The Type-E basin is described in SCC (2018) and TURBID (2023)

The concept for Type-E is to split the basin into 2 cells as follows:

- Cell 1 – Buffer Cell: This cell acts as a detention storage to temporarily store runoff and slowly release it to the treatment cell at a controlled flowrate. When the buffer cell fills, overflows are discharged via a high-flow weir to the waterway
- Cell 2 – Treatment Cell: This cell is essentially a Type-B basin however it is able to be drastically reduced in size compared to a normal Type-B basin due to the restricted treatment flowrate delivered to this cell from the buffer cell. The flocculant dosing occurs to the inflow point to the treatment cell and the restricted flowrate allows the dosing system to operate more optimally and in a narrower range of flowrates than would otherwise occur.

The conceptual arrangements for Type-E HES are shown in Figure 4.3 below.

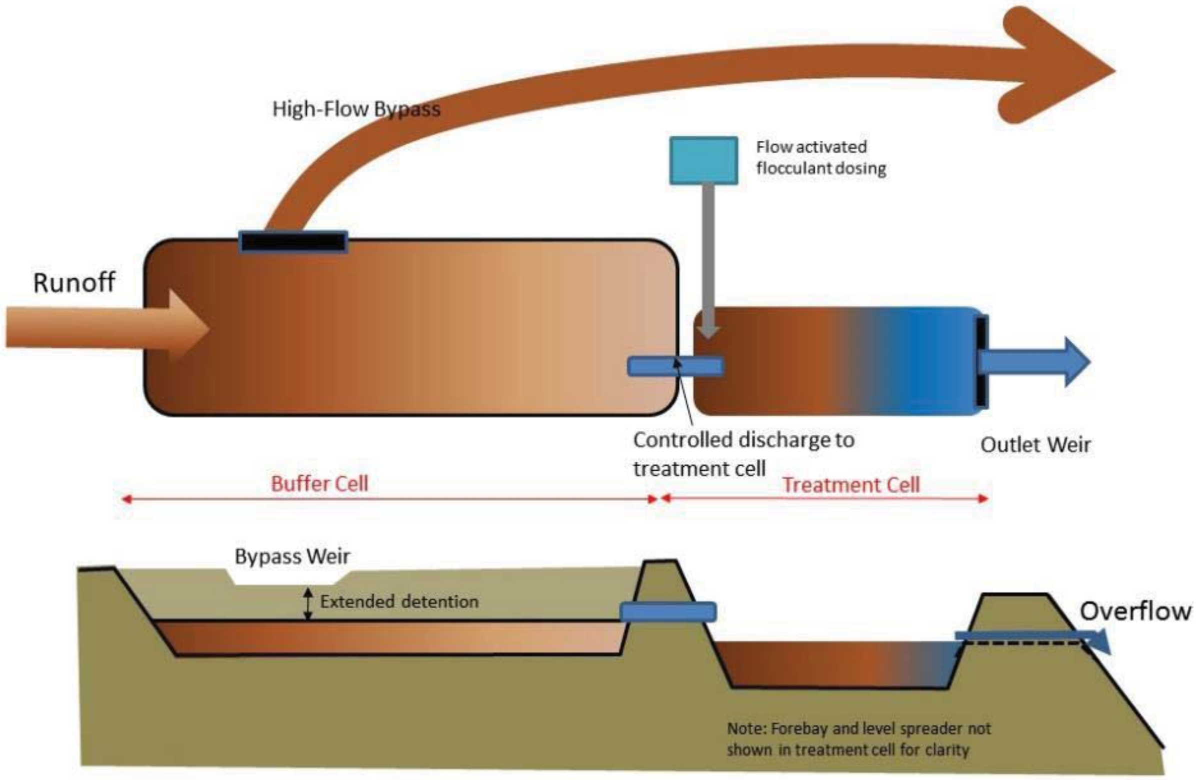


Figure 4.3 – Type-E HES Conceptual Arrangement

The advantages of this arrangement are as follows:

- Flows to the treatment cell are buffered and controlled by the storage cell and hence are a more uniform flowrate which allows the coagulant dosing system to operate optimally;
- High flows (above design flows) can be effectively bypassed around the treatment cell thereby mitigating the risk of potential scour and re-suspension of flocculated sediments in the treatment cell;
- The treatment cell is able to be reduced in size compared to a Type A/B HES system as the storage cell reduces the peak flowrate to the treatment cell and hence the required volume to achieve the nominated residence time is also reduced;
- Construction water is able to be stored (untreated) in the buffer cell by over-excavating this cell below the extended detention level. This means that water that is used for construction purposes is not being unnecessarily treated – saving in flocculant costs

- The smaller size of the treatment cell allows this cell to be cost-effectively lined to prevent groundwater inflows and therefore the cell is not required to be above natural surface levels in high groundwater environments

A preliminary design for the Type-E basin to represent SB1 was undertaken as follows. Final design should be based on an earthworks model for the basin so that the storage volume and depth is accurately represented and optimised.

1. A MUSIC model for Yarrabilba was developed representing the catchment of SB1. Fraction imperviousness was set at 55% to represent the worst-case situation (ultimate development)
2. The area for the buffer cell and available detention storage were determined from the existing contours as 6,000m² and 1m depth respectively
3. The MUSIC model was run to determine the pipe outlet size from the buffer cell which would allow for 80% or more of inflows to be treated. This resulted in a pipe outlet of a single 225mm dia pipe
4. The flowrate for the pipe outlet at maximum head was determined and used as the design flowrate for the treatment cell.

The resulting preliminary design for the Type-E basin is provided below in Figure 4.4 .

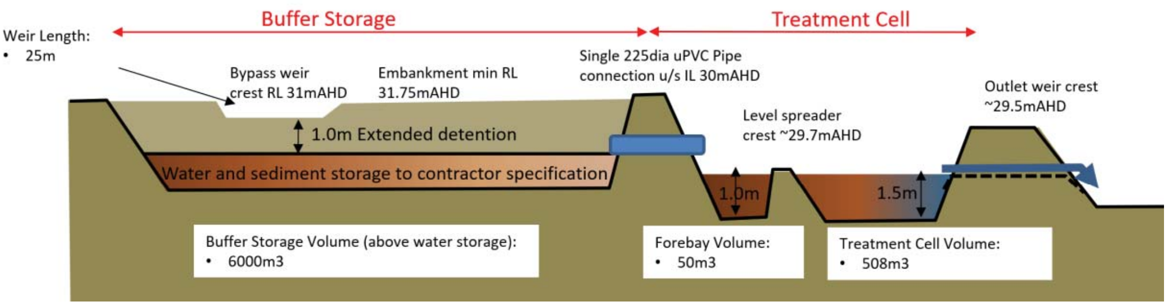


Figure 4.4 – Type-E Basin Design for SB1

4.6.2 Sheet flow controls

Small areas which cannot drain to sediment basins (for example, fill batters) should be provided with sheet-flow sediment controls such as sediment fencing. These areas are expected to be relatively small based on the current earthworks design.

<u>Yarrabilba Drive Controls</u>

The Yarrabilba Drive extension consists of a fill embankment. Although sediment basins (SB5 and SB6) can be provided in cut for the initial phase of works, ultimately these basins will need to be filled.

At this point, a turkeys nest bund should be created at the top of the formation to fully contain any runoff generated by the formation. Captured runoff can either be treated in-situ prior to discharge or pumped to SB1 for treatment.

The batters of the formation which cannot flow to a sediment basin should be provided with sheet-flow sediment controls such as sediment fencing. These areas should also be progressively stabilised as final levels are achieved or as areas outside fo the basin catchment exceed 2,500m² in area.

4.7 RIPARIAN WORKS

Riparian works are required for the construction of the culvert crossings at WW1 and WW2.

For WW2, the catchment is ephemeral and it is proposed that this area is isolated using a cofferdam (earth bund – geofabric covered) on the upslope side of works and either a gravity or pumped flow diversion is provided to convey minor flows around the works area. A contingency should be kept on site consisting of geofabric/erosion control blankets and if rain is forecast then the channel invert in the works area should be stabilised using these blankets in order to prevent erosion caused by overtopping of the upslope bund.

For WW1, there may be a constant low flow in the waterway (depending on preceding months rainfall) and the crossing is a multi-cell culvert. Staged construction of the crossing is proposed, with flow diversions in place during the construction of the initial cell and then flow diversion into the completed cell while the remaining cells are built.

In terms of rehabilitation once WW1 and WW2 are complete, IECA (2008) provides minimum requirements for land clearing and rehabilitation associated with riparian works. These requirements provide generous timeframes for rehabilitation which are inconsistent with the significant water quality risk posed by these types of works.

It is proposed that the following land clearing and rehabilitation performance requirements are adopted instead:

1. Waterway works are scheduled to occur during periods of very low erosion risk (July-September), or at other times of the year only where the exposed area which can be limited to an area which can be stabilised prior to forecast rainfall
2. Flow diversions are to remain in place until the area of work has been stabilised (90% cover) using methods suitable for the expected velocity

Where possible, stabilisation should utilise the ultimate landscape outcome proposed for the riparian area. Where this is not specified, then methods which are suitable for the expected velocities and degree of inundation should be implemented, such as erosion control blankets.

4.8 CONSTRUCTION SEQUENCE

Each of the sub-catchments identified in the strategy are largely stand-alone and not reliant on activities in adjoining catchments. The usual sequencing of works should be undertaken in each sub-catchment:

1. Install clean water diversion drains (where specified)
2. Divert clean water around sediment basin footprint and undertake construction of sediment basins (with sheet flow controls in place for basin works)
3. Construct dirty water drains to service sediment basin
4. Commence topsoil stripping and earthworks within sub-catchment

It is critical that topsoil and stripping and earthworks do not commence until all other measures are in place.

5 MONITORING

Automatic monitoring of water quality (turbidity and pH) should be implemented at the discharge of each Type-B or Type-E sediment basin and an alert generated if the water quality targets specified in Table 3.1 are exceeded.

It is recommended that monthly audits are undertaken of the works by a CPESC independent of the Principal Contractor. Monthly auditing should be undertaken following the procedures which would be followed should a compliance inspection be undertaken by Department of Environment and Science (DES) officers.

These procedures are documented in *Procedural guide – Releases to waters from land development sites and construction sites 2500m2 and greater* (DES, 2021).

6 REFERENCES

Department of Environment and Science (2021) *Procedural guide – Releases to waters from land development sites and construction sites 2500m2 and greater* https://environment.des.qld.gov.au/__data/assets/pdf_file/0021/215418/procedural-guide-water-release-large-sites.pdf

DesignFlow (2017) *Yarrabilba (Quinzeh Creek) Flood Study – Version 1*

Healthy Land and Water (2017) *Sediment Management on Construction Sites – Complying with the SPP (2017) – Technical Note for Local Government Development Assessment and Compliance Officers*

International Erosion Control Association (2008) *Best Practice Erosion and Sediment Control*

International Erosion Control Association (2019) *Appendix B – Sediment Basin Design and Construction*

Sunshine Coast Council (2018) *Sunshine Coast Council Technical Note - Changes to Stormwater Management Requirements for Construction Sites*

The State of Queensland (2017) *State Planning Policy*

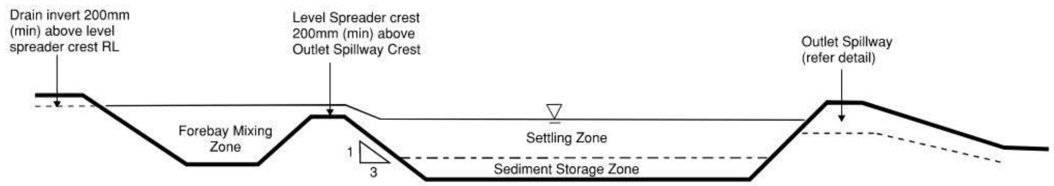
TURBID (2023) Type-E Basin Overview. *https://www.turbid.com.au/tr-wp/wp-content/uploads/Type-E-HES-basin-overview.pdf*

APPENDIX A HES BASIN SIZING CALCULATIONS

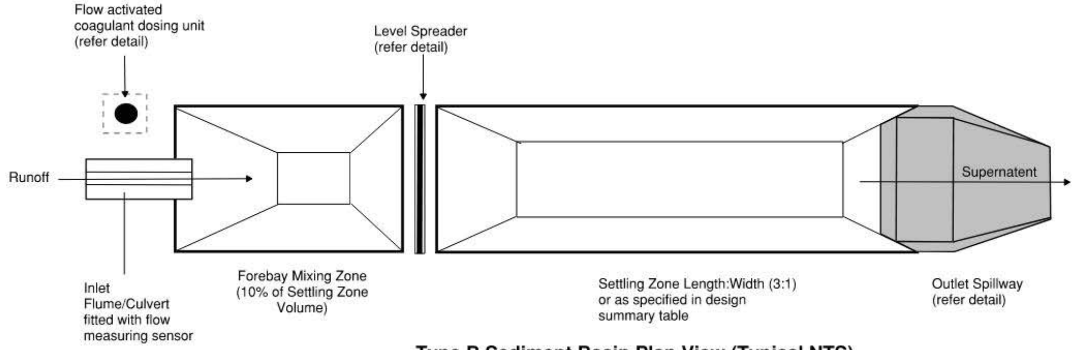
Table A1: HES Basin sizing calculations

		Q3mth Design Flowrate Calc.						Settling Zone						Forebay		Sediment Storage Zone			Overall Dimensions relative to spillway crest (excl. Forebay)						Spillway Calculations								
Basin ID	Catchment Area (Ha)	C_{10}	C_1	tc	$I_{1yr,tc}$ (mm/hr)	Q1yr (m^3/s)	Q3mth (m^3/s)	Residence Time (hr)	Settling Zone Depth (m)	Ave. settling zone area (m2)	Settling Volume (m3)	W:L (1:X)	Scour Velocity (m/s)	Forebay Min. Depth (m)	Forebay Vol (m3)	Sed Storage Vol (m3)	Sed Storage depth (approx.) (m3)	Batter (1:X)	Width (m)	Length (m)	Depth (m)	Area (m2)	Vol Total (m3)	Vol Total (m3/ha)	Basin Design Life	Design ARI	C	I (mm/hr)	Q (m^3/s)	Head over spillway (m)	Spillway crest length (m)	Spillway Crest RL (m)	Min Embankment RL (m)
SB-1A	16.6	0.7	0.56	23	57.8	1.49	0.75	1.33	2	1787	3573	3	0.051	1	357	1072	0.7	3	30.4	91.2	2.7	2773	5002	301	3-12months	1:20yr	0.74	121	4.10	0.3	14.7	0	0.75
SB-1B	18.4	0.7	0.56	33	46.7	1.34	0.67	1.33	2	1600	3200	3	0.048	1	320	960	0.7	3	29.1	87.3	2.7	2539	4480	243	3-12months	1:20yr	0.74	98.6	3.70	0.3	13.3	0	0.75
SB-2	13.9	0.7	0.56	18	65.8	1.42	0.71	1.33	2	1703	3406	3	0.050	1	341	1022	0.7	3	29.8	89.5	2.7	2669	4768	343	3-12months	1:20yr	0.74	137	3.89	0.3	13.9	0	0.75
SB-3	18.3	0.7	0.56	22	59.2	1.69	0.84	1.33	2	2017	4034	3	0.054	1	403	1210	0.7	3	31.9	95.8	2.7	3059	5648	309	3-12months	1:20yr	0.74	124	4.63	0.3	16.6	0	0.75
SB-4	8.7	0.7	0.56	19	64	0.87	0.43	1.33	2	1037	2074	3	0.039	1	207	622	0.8	3	24.6	73.8	2.8	1814	2903	334	3-12months	1:20yr	0.74	133	2.36	0.2	15.5	0	0.65
SB-5	1.3	0.7	0.56	12	79.1	0.16	0.08	1.33	1.5	255	383	3	0.014	1	38	115	0.8	3	13.7	41.2	2.3	565	536	412	3-12months	1:20yr	0.74	164	0.44	0.2	2.9	0	0.65
SB-6	2.9	0.7	0.56	23	57.8	0.26	0.13	1.33	1.5	416	624	3	0.018	1	62	187	0.6	3	16.3	48.8	2.1	795	874	301	3-12months	1:20yr	0.74	121	0.72	0.2	4.7	0	0.65
Type_E Treatment Cell	35.0						0.11	1.33	1.5	338	508	3	0.017	1	51	152	0.7	3	15.1	45.4	2.2	686	711	20	3-12months	1:20yr	0.74	98.6	7.09	0.3	25.4	0	0.75

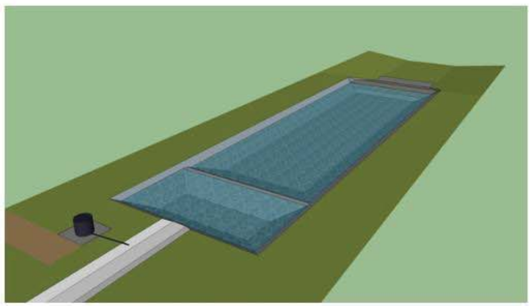
APPENDIX B STANDARD DRAWINGS



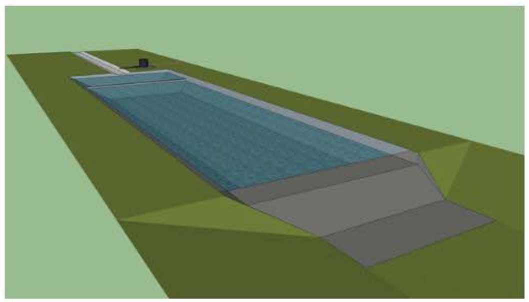
Type B Sediment Basin Long Section (Typical NTS)



Type B Sediment Basin Plan View (Typical NTS)

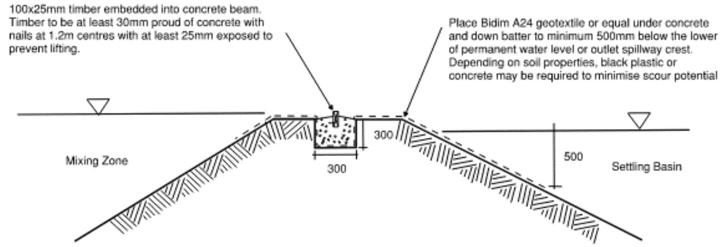


Basin Perspective (looking downstream)

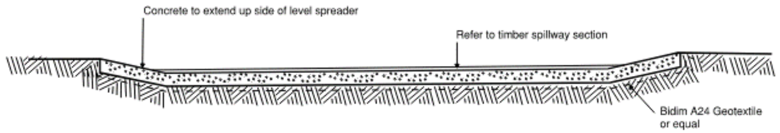


Basin Perspective (looking upstream)

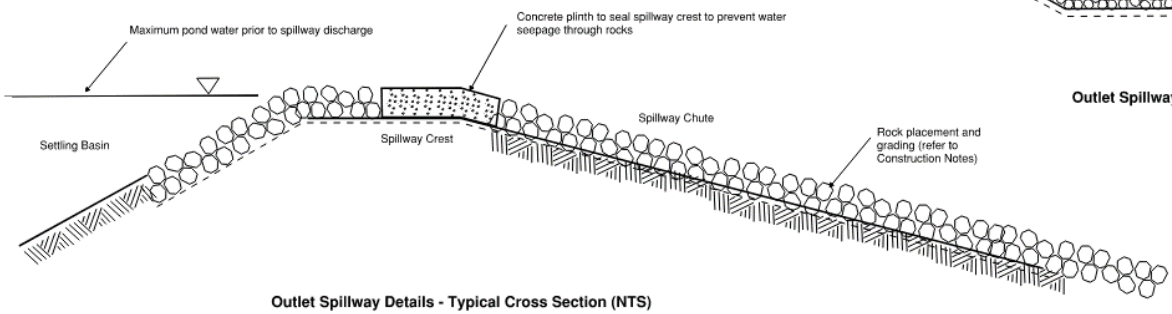
iFOD Flow Dosing Unit (custom built)



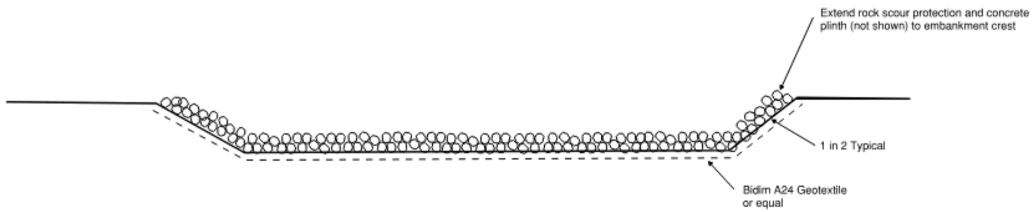
Level Spreader Details - Typical Cross Section (NTS)



Level Spreader Details - Typical Long Section (NTS)



Outlet Spillway Details - Typical Cross Section (NTS)



Outlet Spillway Details - Typical Long Section (NTS)

Notes:

Auto Doser

1. Provided as iFOD-Flow to manufacturers specification.
2. Doser and supply of flocculant to be provided on level pad 4mx4m within 10m of dosing point.
3. All-weather access track to be provided to doser.
4. Flocculant provided as Turbiclear (ACH). If alternative flocculant used then the basin size is to be increased according to jar settlement test (refer to table below.

Jar Settlement after 15 mins (mm)	Multiplication Factor to Settling Zone Volume
50	x3
75	x2
100	x1.5
150	x1

Basin construction:

Materials-

5. Earth Fill: clean soil with Emerson Class 2(1), 3, 4 or 5 and free of roots, woody vegetation, rocks and other unsuitable material. Soil with Emerson Class 4 and 5 may not be suitable depending on particle size distribution and degree of dispersion. Class 2(1) should only be used upon recommendation from geotechnical specialist.
6. Spillway rock: hard, angular, durable, weather resistant and evenly graded rock with 50% by weight larger than the specified nominal (d50) rock size. Large rock should dominate, with sufficient small rock to fill the voids between larger rock. the diameter of the largest rock should be no larger than 1.5 times the nominal rock size. The specific gravity should be at least 2.5.
7. Geotextile fabric: heavy duty, needle-punched, non-woven cloth, minimum 'bidim' A24 or equivalent.

Construction-

8. Notwithstanding any description contained with approved plans or specifications, the Contractor shall be responsible for satisfying themselves as to the nature and extent of the specified works and the physical and legal conditions under which the works will be carried out. This shall include means of access, extent of clearing, nature of the materials to be excavated, type and size of mechanical plant required, location and suitability of water supply for construction and testing purposes, and any other likely matters affecting the construction of the works.
9. Refer to approved plans for location, dimensions, and construction details. If there are questions or problems with the location, dimensions, or method of installation, contact the engineer or responsible on-site officer for assistance.
10. Before starting any clearing or construction, ensure all the necessary materials and components are on the site to avoid delays in completing the sediment basin once works begin.
11. Install requires short term sediment control measures downstream of the proposed earthworks to control sediment runoff during construction of the basin.
12. The area to be covered by the embankment, borrow pits and incidental works, together with an area extending beyond the limits of each for a distance not exceeding five (5) metres all around must be cleared of all trees, scrub, stumps, roots, dead timber and rubbish and disposed of in a suitable manner. Delay clearing the main basin area until the embankment is complete.
13. Ensure all holes made by grubbing within the embankment footprint are filled with sound material, adequately compacted, and finished flush with the natural surface.

Cut-off Trench-

14. Before construction of the cut-off trench or any ancillary works within the embankment footprint, all grass growth and topsoil must be removed from the area to be occupied by the embankment and must be deposited clear of this area and reserved for topdressing the completed embankment.
15. Excavate a cut-off trench along the centre line of the earth fill embankment. Cut the trench to stable soil material, but in no case make it less than 600mm deep. the cut-off trench must extend into both abutments to at least the elevation of the outlet spillway crest. Make the minimum bottom width wide enough to permit operation of the excavation and compaction equipment, but in no case less than 600mm. Make the side slopes of the trench no steeper than 1:1 (H:V).
16. Ensure all water, loose soil, and rock are removed from the trench before backfilling commences. The cut-off trench must be backfilled with select earth-fill of the type specified for the embankment, and this soil must have a moisture content and degree of compaction the same as specified for the core zone.
17. Material excavated from the cut-off trench may be used in the construction of the embankment provided it is suitable and it is placed in the correct zone according to its classification.

Embankment-

18. Scarify areas on which fill is to be placed before placing the fill.
19. Ensure al fill material used to form the embankment meets the specifications certified by a soil scientist of geotechnical specialist.
20. The fill material must contain sufficient moisture so it can be formed by hand into a ball without crumbling. If water can be squeezed out of the ball, it is too wet for proper compaction. Place fill material in 150 to 200mm continuous layers over the entire length of the fill area and then compact before placement of further fill.
21. Unless specified on the approved plans, compact the soil at about 1% to 2% wet optimum and to 95% modified or 100% standard compaction.embankment to an elevation 10% higher than the design height to allow for settling
22. Where both dispersive and non-dispersive classified earth-fill materials are available, non-dispersive earth-fill must be used in the core zone. the remaining classified earth-fill materials must only be used as directed by the site superintendent.

23. Where specified, construct the embankment to an elevation 10% higher than the design height to allow for settling; otherwise finished dimensions of the embankment after spreading of topsoil must conform to the drawing with a tolerance of 75mm from specified dimensions.
24. Ensure debris and other unsuitable building waste is not placed within the earth embankment.
25. After completion of the embankment all loose uncompacted earth-fill material on the upstream and downstream batter must be removed prior to spreading topsoil.
26. Topsoil and re-vegetate/stabilise all exposed earth as directed within the approved plans.

Spillway construction-
27. The spillway must be excavated as shown on the plans, and the excavated material if classified as suitable, must be used in the embankment, and if not suitable it must be disposed of into spoil heaps.
28. Ensure excavated dimensions allow adequate boxing-out such that the specified elevations, grades, chute width, and entrance and exit slopes for the emergency spillway will be achieved after placement of the rock or other scour protection measures as specified in the plans.
29. Place specified scour protection measures on the emergency spillway. Ensure the finished grade blends with the surrounding area to allow a smooth flow transition from spillway to downstream channel.
30. If a synthetic filter fabric underlay is specified, place the fabric directly on the prepared foundation. if more than 1 sheet of filter fabric is required, overlap the edges by at least 300mm and place anchor pins at minimum 1m spacing along the overlap. bury the upstream end of the filter fabric a minimum 300mm below ground and where necessary, bury the lower end of the fabric or overlap a minimum 300mm over the next downstream section as required. Ensure the filter fabric extends at least 1000mm upstream of the spillway crest.
31. Take care not to damage the fabric during or after placement. If damage occurs, remove the rock and repair the sheet by adding another layer of fabric with a minimum overlap of 300mm around the damaged area.3If extensive damage is suspected, remove and replace the entire sheet.
32. where large rock is used, or machine placement is difficult, a minimum 100mm layer of fine gravel, aggregate, or sand may be needed to protect the fabric.
33. Placement of rock should follow immediately after placement of the filter fabric. Place rock so that it forms a dense, well graded mass of rock with a minimum of voids. the desired distribution of rock throughout the mass may be obtained by selective loading at the quarry and controlled dumping during final placement.
34. The finished slope should be free of pockets of small rock or clusters of large rocks. Hand placing may be necessary to achieve the proper distribution of rock sizes to produce a relatively smooth, uniform surface. the finished grade of the rock should blend with the surrounding are. No overfall or protrusion of rock should be apparent.
35. Ensure that the final arrangement of the spillway crest will not promote excessive flow through the rock such that the water can be retained within the settling basin at the elevation no less than 50mm above of below the nominated spillway crest elevation.

Establishing the settling pond-
36. The area to be covered by the stored water outside of the limits of the borrow pits must be cleared rubbish. Trees must be cut down stump high and removed from the immediate vicinity of the work.
37. Establish all required inflow chutes and inlet baffles, if specified, to enable water to discharge into the basin in a manner that will not cause soil erosion or the re-suspension of settled sediment.
38. Install a sediment storage level marker post with a cross member set just below the top of the sediment storage zone (as specified on the approved plans). Use at least a 75mm wide post firmly set into the basin floor.
39. If specified, install internal settling pond baffles. Ensure the crest of these baffles is set level with, or just below, the elevation of the emergency spillway.
40. Install all appropriate measures to minimise safety risk to on-site personnel and the public caused by the presence of the settling pond. Avoid steep, smooth internal slopes. Appropriately fence the settling pond and post warning signs if unsupervised public access is likely or there is considered to be an unacceptable risk to the public.