Port Hinchinbrook STP – Future Upgrade Expansion

Cassowary Coast Regional Council

Future STP Upgrade Staging Report

Doc No. 2011-RPT-0001-Rev B

March 2021

GANDEN
ENGINEERS AND PROJECT MANAGERS

Principal:
Cassowary Coast Regional Council
PO Box 887
Innisfail, Qld 4860

Prepared by:
GANDEN Pty Ltd trading as
GANDEN Engineers and Project Managers
ABN 52 128 434 846
PO Box 461
Varsity Lakes Qld 4227
www.ganden.com.au

Revision	Date	Description	Author	Reviewed	Approved
Rev A	13/01/2021	Draft Issued for Information			
Rev B	26/03/2021	Final Version			

Disclaimer:

GANDEN Engineers and Project Managers has prepared this report for the sole use of the Client and for the intended purposes as stated in the agreement between the Client Representative and GANDEN Engineers and Project Managers under which this work was completed. The report may not be relied upon by any other party without the express written agreement of GANDEN Engineers and Project Managers.
GANDEN Engineers and Project Managers has exercised due and customary care in the creation of this report but has not, save as specifically stated, independently verified information provided by others.
No other warranty, express or implied is made in relation to the conduct of the review or the contents of this report. GANDEN Engineers and Project Managers assumes no liability for any loss resulting from errors, omissions or misinterpretations made by others. The use of this report by third parties without written authorisation by GANDEN Engineers and Project Managers shall be at their own risk and GANDEN Engineers and Project Managers accept no duty of care to any such third party.
Any recommendations, opinions or findings stated in this report are based on circumstances and facts as they existed at the time GANDEN Engineers and Project Managers performed the work.
Any changes in such circumstances and facts upon which this report is based may adversely affect any recommendations, opinions and/or findings contained in this report.
No part of this report may be copied or duplicated without the express written permission of the Client and GANDEN Engineers and Project Managers. Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work referred to in the Agreement however may have been revised between the Client Representative and GANDEN Engineers and Project Managers. This work has been undertaken in accordance with the GANDEN Engineers and Project Managers' third-party-certified Integrated Management System.

Contents

Figures

Tables

Glossary of Terms

Abbreviations	
CAPEX	Capital Expenditure
CCRC	Cassowary Coast Regional Council
CCT	Chlorine Contact Tank
DES	Department of Environment and Science
DSDTI	Department of State Development, Tourism and Innovation
EA	Environmental Authority
EP	Equivalent Population
GANDEN	GANDEN Engineers and Project Managers
GPPS	General Propose Pump Station
IDEA	Intermittent Decanted Extended Aeration
MBBR	Moving Bed Bioreactor
MBR	Membrane Bioreactor
MCA	Multi-Criteria Analysis
OPEX	Operational Expenditure
PHSTP	Port Hinchinbrook Sewage Treatment Plant
PLC	Programmable Logic Controller
RWMP	Recycled Water Management Plan
SBR	Sequencing Batch Reactor
SCADA	Supervisory Control and Data Acquisition
STP	Sewage Treatment Plant
UV	Ultraviolet

1. Executive Summary

Cassowary Coast Regional Council is considering options for the expansion of the existing Port Hinchinbrook Sewage Treatment Plant to cater for the connection of Cardwell and for future growth. The following table summarises the options that were considered.

GANDEN considers options 1, 2 and 3 to be the most viable. Should funding be obtained early, option 3 would be the most practical and cost-effective in the long-term should Cardwell be sewered in the near future.

Table 1 – Staged Upgrade Options

Option	Stage	Treatment Supplied
1	1. Port Hinchinbrook 500 EP	500 EP SBR
	2. Port Hinchinbrook and Cardwell 1500 EP	1500 EP SBR
	3. Port Hinchinbrook and Cardwell 2700 EP	2700 EP SBR
2	1. Port Hinchinbrook 500 EP	500 EP SBR
	2. Port Hinchinbrook and Cardwell 1500 EP	1500 EP SBR
	3. Port Hinchinbrook and Cardwell 2700 EP	2700 EP MBR
3	1. Port Hinchinbrook 500 EP	1500 EP SBR
	2. Port Hinchinbrook and Cardwell 1500 EP	1500 EP SBR
	3. Port Hinchinbrook and Cardwell 2700 EP	2700 EP MBR
4	1. Port Hinchinbrook 500 EP	500 EP SBR
	2. Port Hinchinbrook and Cardwell 1500 EP	1500 EP MBR
	3. Port Hinchinbrook and Cardwell 2700 EP	2700 EP MBR
5	1. Port Hinchinbrook 500 EP	500 EP SBR
	2. Port Hinchinbrook and Cardwell 1500 EP	1500 EP SBR
	3. Port Hinchinbrook and Cardwell 2700 EP	2700 EP MBBR
6	1. Port Hinchinbrook and Cardwell 2700 EP	2700EP SBR (Option 6A)
	2. Port Hinchinbrook and Cardwell 2700 EP	2700EP MBR (Option 6B)

2. Introduction

A design project has recently been completed by GANDEN for the upgrade design of the Port Hinchinbrook Sewage Treatment Plant (STP) to a capacity of 500 EP. The project was commissioned by Department of State Development, Tourism and Innovation (DSDTI) due to the sewage infrastructure being passed its useful asset life and in a poor condition as a result of neglect following the former Port Hinchinbrook developer ceasing trading. The basis of the upgrade for the STP capacity was to service the current Port Hinchinbrook population with an allowance for future growth of Port Hinchinbrook only. Cassowary Coast Regional Council (CCRC) has been temporarily operating the sewerage infrastructure since mid-2018 and are identified to take ownership of the upgraded STP.

As part of CCRC's future planning CCRC has engaged GANDEN Engineers and Project Managers (GANDEN) to develop a report which captures future STP expansion staging options at a preliminary concept level. An objective of the report is to identify future upgrade options, based on staged increases in load provided to the plant with consideration to population growth and, ultimately, the provision of sewerage infrastructure to the nearby town of Cardwell that would connect to the Port Hinchinbrook STP.

Several reports have been commissioned in the past in regard to Cardwell and Port Hinchinbrook's sewage infrastructure, potential for future upgrades to both sewer and STP and CCRC's strategy to achieve the upgrades, these reports include:

- Hunter H2O "Independent Review, Cardwell Sewerage Proposal, March 2019"
- GHD "Report for Cardwell Sewage Treatment Plant Planning Study, February 2012, DRAFT"
- Hydroflux Epco "Hinchinbrook STP 500EP refurbreplace Options report, July 2018"
- Hydroflux Epco "Hinchinbrook STP Staging report with budget – Rev B, August 2019".

These previous reports have been used as a source for the expansion of sewage infrastructure and an assessment of the staged increases in STP capacity.

The staged increases identified with CCRC, based on previous planning reports are:

- Upgrade Stage 1: STP Ultimate Capacity 500 EP (Port Hinchinbrook)
- Upgrade Stage 2: STP Ultimate Capacity 1,500 EP (Port Hinchinbrook and Cardwell), and
- Upgrade Stage 3: STP Ultimate Capacity 2,700 EP (Port Hinchinbrook and Cardwell).

Effluent disposal has previously been highlighted as a challenge. This report will provide high level commentary based on potential solutions. Effluent disposal is recommended to be subject to further planning studies outside the scope of this report, this will include further consultation with the Department of Environment and Science (DES) regarding potential changes to the requirements of the Environmental Authority (EA).

This report is to provide a high-level overview of expansion options available to CCRC, based on potential increases in capacity. The report is to assist CCRC in assessing the level of confidence in endorsing the currently-commissioned 500EP STP design, with consideration for future expansion options for sewerage infrastructure in the region and limitations associated with this.

If CCRC wish to engage in any option further, planning studies and design development would need to be completed.

3. Impact of Sewer Implementation Strategy on STP Upgrade Strategy

The selection of the most suitable STP upgrade staging solution and treatment options are dependent on the Cardwell sewer implementation strategy and timeframes. Sewering Cardwell will require the increase in treatment capacity of the STP beyond the capacity of the current Port Hinchinbrook upgrade. The load delivered to the STP will be proportional to the increase in the connections to the proposed sewage network.

An understanding of the proposed sewer implementation strategy is required to determine the most appropriate STP upgrade strategy. There are a number of factors which will influence the sewer implementation strategy that require further consideration by CCRC including, but not limited to:

- Funding
- Population Growth
- Community Engagement
- Technology Selection
- Timeframes
  - Concept and Detailed Design of Infrastructure
  - Tendering, Design and Construction Phases, and
  - Commissioning of infrastructure.

At the time of writing of this report, the sewer network implementation strategy has not been finalised with CCRC, hence the effect on the STP staging cannot be fully defined. It is recommended that consideration for flexibility in the STP implementation staging be a highly weighted criteria for assessment of the STP options.

It is noted that the influence factors are interdependent where a change in one may likely change several other areas.

A high level overview of how these factors may influence the implementation strategies is as follows.

1. **Funding**

   The source of and extent of funding for the projects will dictate which strategy can be implemented and the timeframes of the staging.

   Two examples of how funding may affect both the implementation strategies for the sewering upgrade and STP upgrades are:

   a) If CCRC have access to a significant amount of initial funding (e.g. State / Federal Government Grants) a compressed timeframe for design and installation of sewers may result in construction of a larger STP initially. Sewer connections may be accelerated resulting in increased loads and flows.

   b) If significant funding is not available and funding is to be accrued over time (e.g. from smaller government grants and rates), implementation may be a number of years away and be construction stretched over a much longer duration which may result in building a smaller capacity STP initially and then staged STP upgrades based on a number of staged sewer implementations over a number of years as capital is raised.

2. **Population Growth**

   As highlighted in the Hunter H2O independent review the residential population in Cardwell and Port Hinchinbrook has been essentially flat for the last 35 years at 1,200 – 1,400 persons with the 2016 census recording 1,309 persons. The GHD report highlighted an increased population growth and additional details on permanent vs transient population for year 2026 refer below extract.

Population Growth in Cardwell is considered low, the potential for growth at Port Hinchinbrook has been considered to have a large transient population assumed based on holiday makers. Should this development commence again this will have an influence on the STP sizing.

Table 6 Population Forecast within the Urban Footprint Area

Sub-Catchment/ Development	Expected Sewerage System	Stage 1 Population (Year 2026)			Ultimate Population
		Permanent	Transient	Peak	
Cardwell PIA	Vacuum	1,493 EP	307 EP	1,800 EP	1,800 EP
Port Hinchinbrook Stage 1	Conventional (Gravity)	105 EP	641 EP	746 EP	1,500 EP
Port Hinchinbrook Stage 2	Vacuum	-	-	-	300 EP
Lots 1 to 4 on RP725423	Vacuum	86 EP	17 EP	103 EP	560 EP
Total rounded up to the nearest 100 EP		**1,700 EP**	**1,000 EP**	**2,700 EP**	**4,200 EP**
		Nominated Design Population:		**2,700 EP**	**4,200 EP**

Figure 1 – Population Forecast (Extract from Report for Cardwell Sewage Treatment Plant Planning Study, February 2012, DRAFT by GHD)

3. Community Engagement

CCRC will need to engage the community as sewering Cardwell will have an impact to residents during construction, ongoing operation of the system and increases in Council rates to name a few, all of which may create opposition to the upgrade. Hunter H2O raised several items in their "Independent Review" which are valid. An extract from the Executive Summary of the report is appended to this report. Acceptance from the community can influence timeframe and budget of the Projects.

4. Technology Selection

The proposed sewer technology selection will influence the sizing of the STP infrastructure for peak loading scenarios. Previous planning reports (GHD, Hunter H2O) have recommended pressure and vacuum sewering in lieu of more traditional gravity sewage systems. One advantage of these technologies over gravity systems is infiltration is minimised which reduces wet weather loading and hence the overall size of the STP infrastructure. The disadvantage is the potential for additional operations and maintenance requirements and costs. Decisions on this direction need to be considered in STP design and management of effluent.

The STP treatment technology and size of assets has several limitations which are dependent on the sewer staging, two examples are:

a) If the STP is built, initially to treat future capacity, and sewering connections are delayed, or aren't implemented, the STP may be too large an asset and be underloaded resulting in inefficient treatment (both biological and energy), a large capital investment not realising returns and, may not meet regulatory licence requirements.

b) If the STP is built, initially to treat the current load without consideration for growth, or there is an acceleration of sewering connections, the STP may be too small without sufficient capacity to treat the load which may result in breaches of regulatory licence requirements as insufficient treatment being provided and triggering further costly treatment expansion upgrades.

5. Timeframes

Timeframes for implementation of the sewering scheme are a significant driver of the STP implementation strategy because of load onto the STP. As highlighted above, timeframe is interdependent on other factors e.g. access to funding may accelerate or delay implementation.

Defined timesteps include:

- Feasibility studies and investigation works
- Concept designs
- Detailed designs
- Regulatory approvals and community consultation
- Construction and strategy i.e. To sewer entire township in at once (e.g. 1-2 year roll out) or do in incremental stages over extended multi-year process (e.g. 5-10 year rollout)
- Tendering periods associated with above design and construction phases
- Funding applications and availability for above stages.

If sewer staging is expected to be rather rapid (e.g. 0 – 5 years), the construction of a much larger STP constructed initially may be preferred strategy for Council.

If sewer staging is expected to be prolonged over longer period (e.g. 10 – 15 years), construction of an initial small plant may be more suited with staged upgrades in the future to meet staged sewerage implementation.

4. Treatment Options

The following options were identified and considered for the future upgrade of the Port Hinchinbrook Sewage Treatment Plant (PHSTP) to accommodate future population growth of 1,500 EP and 2,700 EP:

Option 1: Staged Upgrade to single train Sequencing Batch Reactor (SBR) System, followed by subsequent upgrade to dual train SBR.

Option 2: Staged Upgrade to single train SBR, followed by subsequent upgrade to Membrane Bioreactor (MBR) System.

Option 3: Staged Upgrade to single train SBR, to dual train SBR, followed by MBR with all Civil works and tanks Constructed at Early Stage.

Option 4: Staged Upgrade to SBR, followed by subsequent upgrade conversion to MBR with added capacity.

Option 5: Staged Upgrade to SBR, followed by subsequent upgrade to Moving Bed Bioreactor (MBBR) Systems.

Option 6: (A) Straight Upgrade to 2700EP SBR or (B) MBR (depending on the effluent use)

Each option identified above, except Option 6, is proposed to be implemented as a staged upgrade approach with STP upgrades completed to accommodate the loads of future population growth. The three (3) upgrade stages proposed are based on the following population increments:

- Upgrade Stage 1: STP Ultimate Capacity 500 EP (Port Hinchinbrook)
- Upgrade Stage 2: STP Ultimate Capacity 1,500 EP (Port Hinchinbrook and Cardwell), and
- Upgrade Stage 3: STP Ultimate Capacity 2,700 EP (Port Hinchinbrook and Cardwell).

Each staged upgrade will involve specific works and modifications to the PHSTP to meet the treatment requirements associated with an increase in the hydraulic and biological loading.

4.1 Option 1 – Staged Upgrade to SBR Systems

Option 1 involves the construction of the 500 EP SBR system and then additional SBR tank for the 1,500 EP. The 1,500 EP SBR tank will be duplicated to cater for the 2,700 EP.

Refer to Appendix B for the preliminary layout, drawing number 2011-DWG-SK-0001.

Option 1 Staging:

- Stage 1 – Construction of the 500 EP SBR system as designed to accommodate the current and future population of up to 500 EP. This stage is to cater for the current flows up to 500 EP.
- Stage 2 – This stage is to cater for the additional load up to 1,500 EP and will include the following works:
    - Construction of a single train SBR with internal dimensions of 22m (Length) x 10m (Width) x 5m (Depth).
    - New blowers and blower building with capacity to house additional blowers for the 2,700 EP upgrade.
    - The Inlet Works and Balance Tank from Stage 1 will be retained with installation of new transfer pumps and pipework to transfer the screened sewage to the new SBR tank.
    - Repurpose the Stage 1 SBR to an Aerobic Digester with retention of the existing blowers and diffusers and installation of an additional diffuser grid in the Anoxic Tank. Depending on the asset life, the SBR blowers and diffusers may need to be upgraded.
    - Upgrade the filtration system including feed pumps to accommodate additional flows up to 1,500 EP.

- New on-site dewatering system and sludge transfer pump station with ultimate capacity to handle 2,700 EP flows.
- Extension of the switch room and additional switchboards with spare capacity allowance (space) for additional equipment for the 2,700 EP upgrade.
- Upgrade of chemical dosing tank volumes. The existing bunding is sized to accommodate 2,700 EP.
- Upgrade of PLC and SCADA systems.
- Demolition of existing sewage treatment plant (EPCO plant).
- New civil earthworks and roadworks.
- Power supply upgrade.

- Stage 3 – This stage is to cater for the additional load up to 2,700 EP and will include the following works:
  - Construction of a second train SBR (duplicate of Stage 2 Train 1)
  - Pipework and valving modifications to connect 1,500 and 2,700 EP plants.
  - Additional switchboards
  - Upgrade of PLC and SCADA systems
  - New roadworks, and
  - New Inlet Works and flow splitter.

The following benefits have been identified for this option:

- Stage 1 can cater for the current low flows up to 500 EP, which may not be reached based on current data of incoming flows. This is a very viable solution if the population growth becomes stagnant.
- Consistent treatment technology up to the last Stage which can be beneficial to Council regarding Operations and Maintenance.
- The filtration system and building can be used up to the 1,500 EP upgrade.
- Implementation and staging of works are feasible with minimal interruption to operation. The Stage 1 SBR can continue to operate as the next stage upgrades are being constructed.
- Most equipment (i.e., diffusers, blowers, pumps) in Stage 1 SBR may still be useful when converted to Aerobic Digester depending on the remaining life when Stage 2 is implemented.
- Minimal or no upgrades to chemical dosing system from Stage 1. Potential upgrade will only be for chemical storage.

The following disadvantages have been identified for this option:

- Large footprint required to construct the additional tanks for Stage 2 and 3.
- Major Civil works required for Stage 2 and 3 upgrades.
- Stage 1 SBR may not maximise its useful life if the population growth exceeds the design flows in less than the mechanical equipment's design life.
- Different Filtration Technology Solution required beyond 1,500 EP due to significant increase in quantity of filters for ultimate peak wet weather flows.

4.2 Option 2 – Staged Upgrade to SBR and then to MBR System

Option 2 involves the construction of the 500 EP SBR system, followed by construction of an additional SBR system to cater for the 1,500 EP. The 1,500 EP SBR will then be converted into a MBR system to cater for the 2,700 EP.

Refer to Appendix B for the preliminary layouts, drawing number 2011-DWG-SK-0002.

Option 2 Staging:

- Stage 1 – Construction of the 500 EP SBR system as designed to accommodate the current and future population of up to 500 EP. This stage is to cater for the current flows up to 500 EP.
- Stage 2 – This stage is to cater for the additional load up to 1,500 EP and will include the following works:
    - Construction of a single train SBR with internal dimensions of 16m (Length) x 11m (Width) x 5m (Depth)
    - New blowers and blower building with capacity to house additional blowers for the 2,700 EP MBR upgrade
    - The Inlet Works and Balance Tank from Stage 1 will be retained with installation of new transfer pumps and pipework to transfer the screened sewage to the new SBR tank
    - Repurpose the Stage 1 SBR to an Aerobic Digester with retention of the existing blowers and diffusers and installation of an additional diffuser grid in the anoxic tank. Depending on the asset life, the SBR blowers and diffusers may need to be upgraded.
    - Upgrade the filtration system to accommodate additional flows to up to 1,500 EP
    - New on-site dewatering system and sludge transfer pump station with ultimate capacity to handle 2,700 EP flows
    - Extension of the switch room and additional switchboards with spare capacity allowance (space) for additional equipment for the 2,700 EP upgrade
    - Upgrade of chemical dosing systems tank volumes. The existing bunding is sized to accommodate 2,700 EP.
    - Upgrade of PLC and SCADA systems
    - New GPPS
    - New roadworks
    - Power supply upgrade.
- Stage 3 – This stage is to cater for the additional load up to 2,700 EP and will include the following works: This stage will include the following works:
    - Convert the SBR tank to an MBR system with two membrane cassettes (48 modules/cassette) based on a SUEZ ZeeWeed 500D LEAPmbr membranes (or equivalent)
    - Upgrade inlet works to include 2mm fine screens downstream of primary screens
    - Pipework and valving modifications to incorporate new systems into the existing systems
    - Additional switchboards
    - Upgrade PLC and SCADA systems
    - Decommission the tertiary filters as it becomes redundant with the MBR membranes
    - New chemical dosing system for the MBR membrane cleans
    - New Inlet Works to cater for increased capacity.

The following benefits have been identified for this option:

- Stage 1 can cater for the current low flows up to 500 EP, which may not be reached based on current data of incoming flows. This is a very viable solution if the population growth becomes stagnant
- Stage 2 implementation and staging of works requires minimal interruption to operation. The Stage 1 SBR can continue to operate as the next stage upgrades are being constructed

- Most equipment (i.e., diffusers, blowers, pumps) in Stage 1 SBR may still be useful when converted to Aerobic Digester depending on the remaining life when Stage 2 is implemented
- Smaller footprint required compared to Option 1

The following disadvantages have been identified for this option:

- Stage 1 SBR may not maximise its useful life if the population growth exceeds the design flows in less than the mechanical equipment's design life

4.3 Option 3 – Staged Upgrade to SBR and then into MBR with all Civil works and tanks Constructed at Early Stage

Option 3 involves the construction of a two-train 1,500 EP SBR system at the early stage, utilising a single train for 500 EP to service the Port Hinchinbrook catchment up until Cardwell is sewered. The second train is to be fitted with equipment and brought online for 1,500 EP. The SBR is converted into a MBR system to cater for the 2,700 EP upgrade.

Refer to Appendix B for the preliminary layouts, drawing number 2011-DWG-SK-0003.

Option 3 Staging:

- Stage 1 – This stage will include the following works:
  - Construction of a two-train SBR with internal dimensions of 14m (Length) x 11m (Width) x 5.2m (Depth). To cater for the current and 500 EP flows, a single train will only be operated and fitted with mechanical equipment. The concrete structure will cater for future upgrades with inclusion of isolated connections i.e. blank ended pipe spools, valving and penstocks.
  - New Inlet Works with capacity of up to 2,700 EP (To meet maximum instantaneous flow rates), including 2mm fine screens
  - New Balance Tank sized for 750 EP
  - New blowers for Train 1.
  - New blower building with capacity to house additional blowers for the 1,500 EP and 2,700 EP upgrades
  - New filtration system with capacity to cater for additional flows to up to 1,500 EP only install requirements up to 750 EP
  - New Sludge Thickening Tank with capacity for 1,500 EP upgrade, alternatively an aerobic digester can be installed.
  - New switch room and switchboards with spare capacity (space) for additional equipment for the 1,500.
  - New Septage Receival
  - New chemical dosing systems
  - Upgrade of PLC and SCADA systems
  - New roadworks.
- Stage 2 – This stage will cater for load up to 1,500 EP and will include the following works:
  - Mechanical fit-out of SBR Train 2
  - Additional Filters added to the filtration system to accommodate additional flows up to 1,500 EP
  - Additional switchboards
  - Upgrade SCADA programming for a two-train SBR operation
  - New on-site dewatering system and sludge transfer pump station with ultimate capacity to handle 2,700 EP flows

  - Power supply upgrade
- Stage 3 – This stage will cater for load up to 2,700 EP and will include the following works:
  - Convert the two-train SBR tank to a 4-stage MBR system with two membrane cassettes (48 modules/cassette). Preliminary sizing based on a SUEZ ZeeWeed 500D LEAPmbr membranes. The conversion will involve adjustment of the operating levels and interconnections between tanks.
  - Pipework and valving modifications to incorporate new systems into the existing systems
  - Expansion of switchroom and switchboard to cater for new equipment (depending on timeframe for 2700Ep upgrade, the existing switchboard may be decommissioned and replaced with a larger capacity switchboard)
  - Upgrade PLC and SCADA systems
  - Decommission the tertiary filters as it becomes redundant with the MBR membranes
  - Decommission Sludge Thickening Tank
  - New chemical dosing system for the MBR membrane cleans
  - Upgrade Stage 1 Inlet Works, if required.

The following benefits have been identified for this option:

- Stage 1 can cater for the current low flows up to 500 EP, which may not be reached based on current data of incoming flows. This is a very viable solution if the population growth becomes stagnant
- Stage 2 implementation and staging of works involve very minimal interruption to operation. The Stage 1 Train 1 SBR can continue to operate as the next stage upgrades are being constructed
- The Train 2 can be used as emergency storage
- Minimal civil works for Stage 2 and 3 upgrades

The following disadvantages have been identified for this option:

- Potential process issues on operating a large SBR with the current flows and loadings. May require additional carbon source dosing and operating the SBR at lower levels with a large range gate decanter
- Highest Stage 1 CAPEX due to major civil works
- Larger footprint required at Stage 1 compared to current 500 EP design
- The other train may not be used if population growth becomes stagnant or sewering of Cardwell does not go ahead.
- Potential additional expense to maintain the unused SBR Train and for refurbishment by the time Stage 2 is implemented.
- Stage 3 implementation and staging can be a challenge as one Train may need to be taken offline for short periods to convert to MBR.

4.4 Option 4 – Staged Upgrade to SBR and Convert SBR to MBR

Option 4 involves the construction of the 500 EP SBR system which is converted to an MBR for the 1,500 EP. The 1,500 EP MBR will be expanded with additional tanks stages to cater for the 2,700 EP.

Refer to Appendix B for the preliminary layouts, drawing number 2011-DWG-SK-0004.

Option 4 Staging:

- Stage 1 – Construction of the 500 EP SBR system as designed to accommodate the current and future population of up to 500 EP. This stage is to cater for the current flows up to 500 EP.

- Stage 2 – This stage is to cater for the additional load up to 1,500 EP and will include the following works:
  - Convert Stage 1 SBR to MBR with two membrane cassettes (48 modules/cassette) based on a SUEZ ZeeWeed 500D LEAPmbr membranes. Install half the quantity of modules for the 1,500EP load.
  - New blowers and equipment building to house blowers and pumps for the MBR upgrade (equipment retained for Stage 3)
  - The Inlet Works and Balance Tank from Stage 1 will be retained with new pumps and pipework to cater for the addition flows. Perforated plate on the inlet screen would be upgraded to smaller perforations for membrane protection (maximum 2mm)
  - New on-site dewatering system and sludge transfer pump station with ultimate capacity to handle 2,700 EP flows
  - Extension of the switch room and additional switchboards with spare capacity allowance (space) for additional equipment for the 2,700 EP upgrade
  - New chemical dosing systems
  - Upgrade of PLC and SCADA systems including programming
  - Pipework and valving modifications to incorporate new systems into the existing systems
  - Decommission the tertiary filters as it becomes redundant with the MBR membranes
  - Decommission Sludge Thickening Tank. Repurpose tank for use as a process unit as part of upgrade (i.e. additional biological treatment tank or permeate tank).
  - New roadworks
  - Power supply upgrade.
- Stage 3 – This stage is to cater for the additional load up to 2,700 EP and will include the following works:
  - Upgrade Stage 1 Inlet Works to cater for 2,700 EP may be required (depending on network configuration and peak instantaneous flow rates).
  - Add additional modules to the Stage 2 membrane cassettes.
  - Construction of additional process tanks, mixers and transfer pumps
  - New blowers and diffuser grids and associated building for new process tanks
  - Pipework and valving modifications to incorporate new systems into the existing systems
  - Additional switchboards
  - Upgrade of PLC and SCADA systems including programming.

The following benefits have been identified for this option:

- Stage 1 can cater for the current low flows up to 500 EP, which may not be reached based on current data of incoming flows. This is a very viable solution if the population growth becomes stagnant.
- Stage 3 implementation and staging of works will involve minor interruptions. The additional MBR train can be constructed and commissioned with the Stage 2 train in operation.

The following disadvantages have been identified for this option:

- Stage 2 implementation and staging of works involves significant interruption to operation.

4.5 Option 5 – Staged Upgrade to SBR and Moving Bed Bioreactor (MBBR) Systems

Option 5 involves the construction of the 500 EP SBR system followed by construction of an additional SBR system to cater for the 1,500 EP. The 1,500 EP SBR will then be converted into an MBBR system to cater for the 2,700 EP.

Refer to Appendix B for the preliminary layouts, drawing number 2011-DWG-SK-0005.

Option 5 Staging:

- Stage 1 – Construction of the 500 EP SBR system as designed to accommodate the current and future population of up to 500 EP. This stage is to cater for the current flows up to 500 EP.
- Stage 2 – This stage is to cater for the additional load up to 1,500 EP and will include the following works:
    - Construction of a single train SBR with internal dimensions of 16m (Length) x 11m (Width) x 5m (Depth)
    - New blowers and blower building with capacity to house additional blowers for the 2,700 EP MBBR upgrade
    - The Inlet Works and Balance Tank from Stage 1 will be retained with installation of new transfer pumps and pipework to transfer the screened sewage to the new SBR tank
    - Repurpose the Stage 1 SBR to an Aerobic Digester with retention of the existing blowers and diffusers and installation of an additional diffuser grid in the anoxic tank. Depending on the asset life, the SBR blowers and diffusers may need to be upgraded.
    - Upgrade the filtration system to accommodate additional flows with capacity to cater for the 1,500 EP
    - New on-site dewatering system and sludge transfer pump station with ultimate capacity to handle 2,700 EP flows
    - Extension of the switch room and additional switchboards with spare capacity allowance for additional equipment for the 2,700 EP upgrade
    - Upgrade of chemical dosing systems tank volumes. The existing bunding is sized to accommodate 2,700 EP.
    - Upgrade of PLC and SCADA systems
    - New GPPS
    - New roadworks
    - Power supply upgrade.
- Stage 3 – This stage is to cater for the additional load up to 2,700 EP and will include the following works:
    - Convert the SBR tank to an MBBR.
    - Construction of a new secondary clarifier.
    - Pipework and valving modifications to incorporate new systems into the existing systems.
    - Additional switchboards.
    - Upgrade PLC and SCADA systems.
    - Alternate Filter Technology added to the filtration system to accommodate additional flows up to 2,700 EP will be required downstream of the Secondary Clarifier to meet irrigation requirements.
    - New Inlet Works.

The following benefits have been identified for this option:

- Stage 1 can cater for the current low flows up to 500 EP, which may not be reached based on current data of incoming flows. This is a very viable solution if the population growth becomes stagnant.
- Stage 2 implementation and staging of works involve very minimal interruption to operation. The Stage 1 SBR can continue to operate as the next stage upgrades are being constructed.
- Stage 3 implementation and staging of works will involve minor interruptions. The additional clarifier can be constructed while the Stage 2 SBR operates
- Potential of increasing the biological treatment capacity by adding more media.
- Tank volume required smaller than an SBR.

The following disadvantages have been identified for this option:

- Additional secondary clarifier will be required at Stage 3 which adds in complexity in operations and maintenance.
- May be difficult to operate and maintain as the biofilm on the media will need to be closely examined.
- Media can potentially break and be carried over to clarification and filtration.
- Bigger blowers required in MBBR as compared to an SBR or MBR system.

4.6 Option 6 – (A) Straight Upgrade to 2700EP SBR or (B) MBR (Depending on the effluent use)

Option 6 involves the construction of a 2700 EP treatment plant, with an SBR or MBR process, designed to accommodate the ultimate 2026 peak population of 2700 EP. The proposed method for recycled water storage, ultimate end use and its classification will dictate the treatment technology. For example, if treated effluent is storage in an open lagoon for irrigation to land or site that has no, or limited public access, then a SBR process would be preferred.

If a higher class of effluent is required for unrestricted use, an MBR plant would be recommended. A MBR plant would produce a higher quality of effluent and consideration to release to the environment may be appropriate. Storage of treated effluent from a MBR plant would be in an enclosed tank.

Storage of effluent in an open lagoon provides a point for recontamination, therefore tertiary treatment and a small storage unit may be required downstream of the lagoon. This may comprise of tertiary filters and disinfection, depending on the required recycled water classification.

This option was considered with the assumption of the ultimate capacity of 2,700 EP will be reached in less than 10 years from the time of writing.

Refer to Appendix B for the preliminary layout sketch for Option 6A 2011-DWG-SK-0006 (Option 6A).

4.6.1 Option 6A – 2700 EP SBR

Option 6A includes the construction of a 2700 EP SBR treatment plant to accommodate current and future population, refer to 2011-DWG-SK-006. The works include, but are not limited to: -

- New Inlet Works and flow splitter.
- Construction of the 2,7000 EP SBR system as to accommodate the current and future population of up to 2700EP.
- Construction of a two-train SBR with each train having approximate internal dimensions of 20m (Length) x 16.5m (Width) x 5m (Depth).
- New blowers and blower building with capacity to house blowers for the 2,700 EP.
- New Sludge Thickening Tank with capacity for 2,700 EP upgrade, alternatively an aerobic digester can be installed, or sludge can be wasted directly to the dewatering system.

- New on-site dewatering system and sludge transfer pump station with ultimate capacity to handle 2,700 EP flows.
- New building to house the new tertiary filtration system including feed pumps to accommodate ultimate flows up to 2,700 EP.
- New switch room and switchboards.
- New chemical dosing and bunding.
- New PLC and SCADA systems.
- Demolition of existing sewage treatment plant (EPCO plant).
- New civil earthworks and roadworks.
- Power supply upgrade.

The following benefits have been identified for this option:

- Viable solution if the implementation period is nearing 2026 and population growth is as per forecasted.

The following disadvantages have been identified for this option:

- Not practical to maintain and operate oversized plant if sewering of Cardwell does not go ahead.
- Highest CAPEX and OPEX costs upfront compared to the other options. Additional maintenance requirements to equipment that are being underutilised due to low plant flows and loadings.

4.6.2 Option 6B - MBR

Option 6B includes the construction of a 2700EP 4-stage Membrane Bioreactor (MBR) plant to accommodate current and future population. This option is dependent on the effluent disposal and proposed recycled water storage. The layout for this plant will be a compacted version of option 6A, with the exception of the Tertiary Filters which are not required.

The works include, but are not limited to: -

- New Inlet Works and Balance Tank with new pumps and pipework. Inlet screen will require smaller perforations for membrane protection (maximum 2mm).
- Flow Balance tank to assist with the management of wet weather flows.
- Construction of a 4-stage bioreactor with internal dimensions of 14m (Length) x 11m (Width) x 5.2m (Depth).
- Construction of membrane tanks (SUEZ ZeeWeed 500D LEAPmbr membranes or similar).
- New bioreactor aeration and membrane blowers housed in a dedicated building or structure.
- New on-site dewatering system and sludge transfer pump station with ultimate capacity to handle 2,700 EP flows. Wasting to be undertaken directly from bioreactor, or, installation of sludge holding tank/aeraobic digester if required.
- New switch room and switchboards.
- New chemical dosing systems
- New PLC and SCADA systems including programming.
- New pipework and valving
- Demolition of existing sewage treatment plant (EPCO plant).
- New roadworks.
- Power supply upgrade.

The following benefits have been identified for this option:

- MBR system can be operated at reduced loading. Option to install half of the modules if population becomes stagnant. Tank arrangements will require modification for lower loading to reduce bioreactor size.
- Tertiary filtration is not required.
- Can produce higher effluent quality than SBR.
- Smaller tank volume required than an SBR.

The following disadvantages have been identified for this option:

- Not practical if effluent will be stored in an open lagoon or if a higher classification of recycled water is not required.
- Second highest CAPEX and OPEX costs upfront of the project compared to the rest of the options.
- Additional chemical requirements for membrane cleaning.
- Not practical to maintain and operate oversized plant and equipment if the population becomes stagnant.

5. Effluent Management

Effluent management will be applicable to all the treatment options. Depending on the required class of recycled water, the tertiary treatment may depend on the storage of the effluent from the treatment options.

The following previous documentation was considered for the effluent management:

- Independent Review Cardwell Sewerage Proposal – Prepared by Hunterh2o, dated March 2019, and
- Draft Cardwell Sewage Treatment Plant Planning Study – Prepared by GHD, dated February 2012.

5.1 Effluent Storage

A 5 ML effluent storage was identified during the previous planning study (conducted by GHD) based on the MEDLI modelling and an ultimate population of 4,200 EP.

The end use or disposal of the effluent for the 1500EP and subsequent 2700EP plant upgrades will drive the process treatment requirements. Should 100% reuse be required for the ultimate 2700EP upgrades be required, a large dam may be required to store effluent prior to irrigation. A floating roof, or similar, may be required to allow rainfall runoff and to prevent contamination of treated effluent. Alternatively, installation of tertiary treatment downstream of the lagoon system may be preferred.

The effluent storage can be further investigated depending on the proposed effluent disposal. The implementation of the storage solution can be staged as part of the treatment solution. It is more likely that an effluent storage will be required whether the effluent will be used for irrigation (mostly during dry weather) or via discharge to the ocean based on tidal conditions. Release of effluent to the ocean may be limited to discharge during outgoing tides.

5.2 Effluent Disposal

Various options were investigated on previous studies regarding effluent management. Several options were considered but only few are feasible due to various constraints.

Based on the previous investigations, a combination of irrigation, storage and ocean outfall may be required to fully address the effluent management issues. This will require further investigations and consultations with relevant government regulatory bodies.

The staging for the storage, irrigation and ocean discharges can be undertaken during the treatment plant upgrades implementation.

5.2.1 Irrigation

Several irrigation sites were previously investigated, and the following are the most viable options:

- Gregory Street Sports Oval – Council operated site with 63 ML/annum irrigation acceptance potential.
- Cardwell Golf Course – Privately operated and consultation with the management is required as potential effluent reuse customer.
- Irrigation to nearby Farms – Although this was ruled out as per GHD's report due to complexities on the irrigation objectives for farming, hunterh2o mentioned otherwise with examples of success on similar arrangements. The main issue for this is during the wet season and will require significant and careful planning to minimise over saturation and surface runoff.

5.2.2 Discharge to Watercourse

Previous investigations were undertaken that considered discharging treated effluent to a watercourse. As per the hunterh$_2$o report, discharge to Meunga Creek may be feasible but can be subject to extensive amount of effort, time and costs, with no success guarantees. There were no feasible options for discharging to any other watercourses nearby.

5.2.3 Ocean Outfall

It is understood that the major concern for the effluent disposal is during the wet season when irrigation will not be effective.

Outfall plume modelling was undertaken during previous planning studies. It was concluded that the discharge to ocean is possible given that the discharge is done during high tides with a two hour permissible window available each side of the tide in a 24-hour nominal period.

Further assessment on this option is recommended coupled with further consultation with the government regulatory bodies, community and other stakeholders.

The most cost-effective outfall route should be further investigated.

The treatment options presented herein will produce high quality effluent that will provide negligible environmental impact for ocean discharge. The anticipated effluent quality would be: -

- Ammonia <1mg/L
- BOD <10mg/L
- Total Suspended Solids <1mg/L (Membranes) or <10mg/L (SBR)
- Total Nitrogen <5mg/L
- Total Phosphorus <1mg/L, and
- pH 6.0 – 8.5.

6. Comparison of Options

MBR process is considered the most appropriate option should there be the option to release directly to the environment via an ocean outfall. The MBR will also meet the recycled water requirements, however storage of effluent during wet weather periods may not be possible.

If Council prefer reuse, it is recommended a partial release to the environment is included within the licence to allow release of effluent during wet weather periods when irrigation demand is low.

Should Council wish to maintain 100% reuse for the 2700EP upgrade, MBR technology is recommended as the membranes provide tertiary filtration, replacing the existing pressure filters. Membrane technology will also reduce the overall footprint of the plant, with approximately 50% reduced bioreactor volume.

Tertiary filtration will be required for the SBR and MBBR technologies. Should the SBR be converted to MBBR, a secondary clarifier will be required.

Table 2 – Comparison of Options

Criteria	Option 1 SBR	Option 2 MBR	Option 3	Option 4	Option 5 MBBR	Option 6A	Option 6B
Operability	Simplest to operate and maintain	Highest complexity, however, membranes perform secondary clarification and tertiary filtration steps	Highest complexity, however, membranes perform secondary clarification and tertiary filtration steps	Highest complexity, however, membranes perform secondary clarification and tertiary filtration steps	More complex. Secondary Clarifier and Tertiary Filtration required.	SBR is simple to operate and maintain. Potential of operational issues due to low loading and flows due to oversize bioreactor and equipment.	Highest complexity, however, membranes perform secondary clarification and tertiary filtration steps. MBR can operate under low flows and loadings without major effect on the treatment process.
Additional Tertiary Treatment for Recycled Water	Tertiary filtration and disinfection	Disinfection. Membranes perform secondary clarification and tertiary filtration steps	Disinfection. Membranes perform secondary clarification and tertiary filtration steps	Disinfection. Membranes perform secondary clarification and tertiary filtration steps	Tertiary filtration and disinfection	Tertiary filtration and disinfection May be installed downstream of open storage lagoons	Disinfection. Membranes perform secondary clarification and tertiary filtration steps.
Sludge Handling	500EP Plant Repurposed for Digester. New Dewatering Building to be constructed.	500EP Plant Repurposed for Digester. New Dewatering Building to be constructed.	Additional Aerobic Digester to be constructed. New Dewatering Building to be constructed.	Additional Aerobic Digester to be constructed. New Dewatering Building to be constructed.	500EP Plant Repurposed for Digester. New Dewatering Building to be constructed.	Additional Aerobic Digester to be constructed. New Dewatering Building to be constructed.	Additional Aerobic Digester to be constructed. New Dewatering Building to be constructed.
Hydraulic Capability for Wet Weather Events	2 train system can be operated as IDEA during storm events.	Flow balancing may be required to balance plant peak loading during storm events.	Flow balancing may be required to balance plant peak loading during storm events	Flow balancing may be required to balance plant peak loading during storm events.	Clarifier operation to be monitored to ensure Clarifier does not pop during storm events. Balance or second clarifier may be required.	2 train system can be operated as IDEA during storm events.	Flow balancing may be required to balance plant peak loading during storm events.
Effluent Quality	Good	Highest	Highest	Highest	Good	Good	Highest
Staging / Shutdown Requirements for Upgrades	Staging reduces impact on plant operation as additional process units can be constructed offline	Shutdowns required for tie in of additional process units and conversion of existing tanks	Shutdowns required for tie in of additional process units and conversion of existing tanks	Shutdowns required for tie in of additional process units and conversion of existing tanks	Multiple major shutdowns and bypassing required to upgrade to MBBR (2700 Upgrade)	No staging or upgrade required up to ultimate population of 2,700 EP	No staging or upgrade required up to ultimate population of 2,700 EP
Capital Cost	500EP CAPEX investment. High investment for subsequent 1500 & 2700EP upgrades	500EP CAPEX investment. High investment for subsequent 1500 & 2700EP upgrades	Higher initial investment due to construction of additional civil infrastructure as part of 500EP upgrade. Moderate CAPEX for subsequent 1500EP upgrade (predominately mechanical & electrical upgrade as civil infrastructure constructed as part of initial investment) Moderate investment for 2700EP upgrades	500EP CAPEX investment. Moderate investment for subsequent 1500 & 2700EP upgrades. Additional process units required.	500EP CAPEX investment. High investment for 1500EP and subsequent 2700 EP upgrades.	Highest Investment upfront due to construction of a plant for ultimate population of 2,700EP.	2nd Highest Investment upfront due to construction of a plant for ultimate population of 2,700EP.

7. Cost Estimates

At the request of CCRC, capital cost estimates have been compiled for the following options: -

- Option 1 – Stage 1 (500 EP), Stage 2 (1500EP) the Stage 3 (2700EP)
- Option 3 – Stage 1 & 2 combined (1500EP) and Stage 2 (2700EP), and
- Option 6 – Construct 2700EP facility.

The below cost estimates are for the STP infrastructure only, installed within the existing plant boundary. Additional land acquisition and irrigation infrastructure are excluded from this estimate.

Table 3 – Cost Summary & Comparisons

Stages	Option 1	Option 3	Option 6A (SBR)	Option 6B (MBR)
Stage 1 – 500EP	$5.6M	n/a (inc. stage 2 costs)	n/a	n/a
Stage 2 – 1500EP	$6.27M	$7.86M	n/a	n/a
Stage 3 – 2700EP	$4.85M	$4.11M	$13.19M	$11.37M
Total Capital to 1500EP	**$11.87M**	**$7.86M**	n/a	n/a
Total Capital to 2700EP	**$16.72M**	**$11.97M**	**$13.19M**	**$11.37M**

Estimates are exclusive of Principal costs, project contingencies and are concept level +/-30% accuracy. Refer to the relevant section for assumptions made for each estimate options estimate.

A previous report prepared by hunter h_2O in 2019, provided a cost estimate of **$1,155,000** (Table 4.1 – minus effluent storage allowance as this is captured in Ganden estimates) for the provision of land acquisition, irrigation mains, establishment of vegetation, pump stations, design, and supervision for the disposal of effluent.

7.1 Option 1

The cost estimates for the following stages have been developed: -

- Stage 1 – 500EP STP as designed, and
- Stage 2 – Upgrade to 1500 EP SBR.

Table 4 – Option 1 Cost Estimates Summary

Item	Stage 1 – 500EP	Stage 2 - 1,500EP	Stage 3 – 2700EP
Direct Costs	$4.22M	$4.38M	$3.50M
Commissioning (5% of Directs)	$0.21M	$0.22M	$0.18M
Indirect Cost Allowance (15% of directs)	$0.66M	$0.69M	$0.55M
Contractor Profit (10% of directs)	$0.51M	$0.53M	$0.42M
Design & Investigations (allowance only)	$0 (completed)	$0.45M	$0.2M
Estimated Contract Award	**$5.60M**	**$6.27M**	**$4.85M**
Total Capital to 1,500EP	**$11.87M**		
Total Capital to 2,700EP	**$16.72M**		

7.1.1 Assumptions

- Contingency amounts have been excluded from the cost estimates. Estimates for Stage 2 are concept level and can be considered +/-30 accuracy.
- Principal costs excluded from the estimates.
- All costs are current day costs at the time of compiling the estimates. No provision has been made for inflation or currency fluctuations.
- Stage 2 is constructed within 5 – 10 years of Stage 1 construction.
- No replacement of upgrade of mechanical equipment installed in Stage 1 would be required. It is assumed all assets are operating satisfactorily inline with the asset design life.
- Filter upgrade includes second filter train only.
- Inlet works and balance tank suitable to cater for 1500 EP flows.
- Chemical storage and dosing systems are adequate for upgraded plant.
- Supernatant and general-purpose pump stations are adequate to service the upgraded plant.
- A further $800k has been allowed for the construction of additional effluent storage to cater for 2,700 upgrades.
- Effluent reuse assumed to be via irrigation. No allowances for ocean outfall. Estimate exclusive of Effluent Disposal and associated land acquisition, equipment, and infrastructure costs excluded from the estimate.
- Switchboard/MCC installed as part of Stage 2 to include space for Stage 3 equipment.

7.2 Option 3

The cost estimates for the following stages have been developed: -

- Stage 1 – 1500EP SBR, and
- Stage 2 – Upgrade to 2700 EP SBR.

Table 5 – Option 3 Cost Estimates Summary

Item	Stage 1	Stage 2
Direct Costs	$5.58M	$2.9M
Commissioning (5% of Directs)	$0.28M	$0.15M
Indirect Cost Allowance (15% of directs)	$0.88M	$0.46M
Contractor Profit (10% of directs)	$0.67M	$0.35M
Design & Investigations (allowance only)	$0.45M	$0.25M
Estimated Contract Award	**$7.86M**	**$4.11M**
Total Capital to 1,500EP		**$7,86M**
Total Capital to 2,700EP		**$11.97M**

7.2.1 Assumptions

- Contingency amounts have been excluded from the cost estimates. Estimates for Stage 2 are concept level and can be considered +/-30 accuracy.
- Principal costs excluded from the estimates.
- All costs are current day costs at the time of compiling the estimates. No provision has been made for inflation or currency fluctuations.
- Effluent reuse assumed to be via irrigation. No allowances for ocean outfall. Estimate exclusive of Effluent Disposal and associated land acquisition, equipment, and infrastructure costs excluded from the estimate.
- A further $800k has been allowed for the construction of additional storage to cater for 2,700 upgrades.

7.3 Options 6A & 6B

The cost estimates below are for the construction of a 2,700EP facility, either an SBR (6A) or MBR (6B) plant.

Table 6 – Option 6A & 6B Cost Estimates

Item	Option 6A	Option 6B
Direct Costs	$9.56M	$8.18M
Commissioning (5% of Directs)	$0.48M	$0.41M
Indirect Cost Allowance (15% of directs)	$1.5M	$1.29M
Contractor Profit (10% of directs)	$1.15M	$0.99M
Design & Investigations (allowance only)	$0.5M	$0.5M
Estimated Contract Award	**$13.19M**	**$11.37M**

7.3.1 Assumptions

- Contingency amounts have been excluded from the cost estimates. Estimates for Stage 2 are concept level and can be considered +/-30 accuracy.
- Principal costs excluded from the estimates.
- All costs are current day costs at the time of compiling the estimates. No provision has been made for inflation or currency fluctuations.
- A further $800k has been allowed for the construction of additional storage to cater for 2,700 upgrades.
- Effluent reuse assumed to be via irrigation. No allowances for ocean outfall. Estimate exclusive of Effluent Disposal and associated land acquisition, equipment, and infrastructure costs excluded from the estimate.
- The cost estimate includes an allowance of $550k for an Aerobic Digester. Depending on Councils biosolids management and preferences, wasting directly from the bioreactor to dewatering can be achieved, allowing for the removal of this item.

8. Conclusion and Recommendation

Based on the preliminary comparison between options, GANDEN recommend Council consider the following options for the staged upgrade of the Port Hinchinbrook STP: -

- Option 1 – Staged Upgrade to SBR System
- Option 2 - Staged Upgrade to SBR then to MBR for 2700EP, and
- Option 3 – Staged Upgrade to SBR then MBR for 2700EP, early works civil construction.

Options 4, 5, and 6 (A or B) are not recommended as the constructability and staging of the upgrades will be difficult and require large shutdowns, and the timing of sewering Cardwell may result in operation at much lower loading for a considerable period.

Option 6 (A or B) has the highest risk of all the options in terms of capital investment. Council may end up with an oversized plant and equipment that will potentially be underutilised due to delays in other works and if the population growth becomes stagnant. These options must be reviewed in line with any proposed effluent disposal and reuse options. The required recycled water classification will dictate the effluent quality and treatment requirements. Should a lower class of effluent be required, tertiary treatment systems may be simplified or removed from the plant, resulting in lower capital and operating costs for Council. The options considered were to meet or exceed the current treatment.

The historical population figures and growth forecasts indicate the population in Cardwell is stagnant and may not exceed 1500EP, therefore the consideration for staging should consider the realisation of a 1500EP plant initially, with some consideration to 2700EP upgrades. It should be noted mechanical and electrical infrastructure may have reached its design life by the time the 2700EP upgrade is realised.

Appendix A – Community Consultation Excerpt from hunterh$_2$o Independent Review

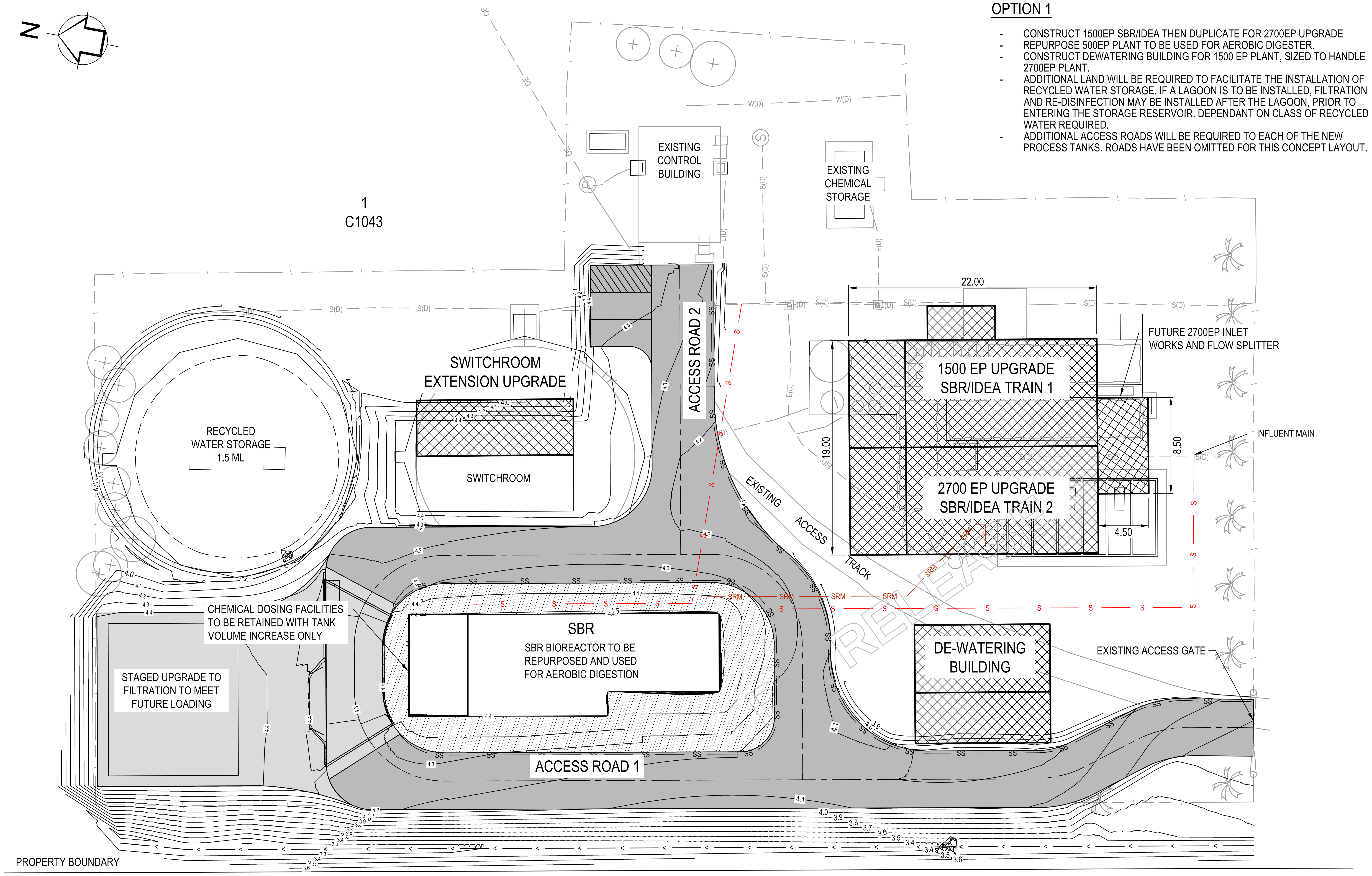
Excerpt below from *"Independent Review, Cardwell Sewerage Proposal, Cassowary Coast Regional Council MARCH 2019"* regarding community consultation.

> *The community will probably not be too concerned about the effluent management or sewage treatment infrastructure – the regulators will be very involved in those aspects. But the community will be very concerned about what's in their backyards. Pressure sewerage is a viable technology but it would have some drawbacks at Cardwell viz.*
>
> - *The community may well consider they are being "short-changed" with a technology that is inferior to gravity sewerage. This attitude may well be exacerbated when they understand they will have an increased (albeit small) electricity bill. Further, a control panel (with alarms) will be attached to their house,*
> - *The annual sewerage charge for Cardwell residents should (at least initially) be less than the other Council sewerage schemes,*
> - *Overall, the Cardwell community is older and has less income than the other Council sewerage scheme areas and there may be opposition (from some parts of the community) to increased Council charges for sewerage (irrespective of the technology),*
> - *A significant community consultation effort will be required to inform the community and to address the issues they will raise,*
> - *Pressure sewerage will require different operations and maintenance skills (to gravity sewerage). These matters will mostly affect Council staff who will need to be trained and consulted to ensure they support the technology. No amount of presentation and reading will adequately convey these matters to the Council staff and it is recommended that site visits to operating schemes be undertaken (early to try to ensure staff "buy-in"),*
> - *Pressure sewerage is a viable, proven technology. As with many engineering decisions the choice between workable options is often a matter of personal choice. There are differences from gravity sewerage, but pressure sewerage is a lower cost solution and if Council and the community can accept the differences there is no technical reason not to proceed with it.*

Appendix B – Layouts of the Concept STP Options

OPTION 1

- CONSTRUCT 1500EP SBR/IDEA THEN DUPLICATE FOR 2700EP UPGRADE
- REPURPOSE 500EP PLANT TO BE USED FOR AEROBIC DIGESTER.
- CONSTRUCT DEWATERING BUILDING FOR 1500 EP PLANT, SIZED TO HANDLE 2700EP PLANT.
- ADDITIONAL LAND WILL BE REQUIRED TO FACILITATE THE INSTALLATION OF RECYCLED WATER STORAGE. IF A LAGOON IS TO BE INSTALLED, FILTRATION AND RE-DISINFECTION MAY BE INSTALLED AFTER THE LAGOON, PRIOR TO ENTERING THE STORAGE RESERVOIR. DEPENDANT ON CLASS OF RECYCLED WATER REQUIRED.
- ADDITIONAL ACCESS ROADS WILL BE REQUIRED TO EACH OF THE NEW PROCESS TANKS. ROADS HAVE BEEN OMITTED FOR THIS CONCEPT LAYOUT.



SITE PLAN
SCALE: 1:200

LEGEND

- ROAD CONTROL LINES
- PROPOSED ASSETS
- ROAD - CONCRETE
- ROAD - CHIP SEAL
- GRAVEL AREA
- EXISTING FENCE
- EXISTING CONTOURS (380.000)
- DESIGN CONTOURS (380.000)
- PROPOSED STORMWATER (SWD)
- PROPOSED GRAVITY SEWER (S)
- PROPOSED RISING MAIN (RM)
- PROPOSED RECYCLED WATER PIPELINE (RW)
- PROPOSED POTABLE WATER (W)
- PROPOSED SERVICE RISING MAIN (SRM)
- BATTER
- SWALE DRAIN (BK)
- BARRIER KERB

GANDEN
ENGINEERS AND PROJECT MANAGERS
WWW.GANDEN.COM.AU

SCALES — 100mm ON ORIGINAL DRAWING
0 5 10 15 20m
1 : 200

ORIG.SIZE A1

REV	DESCRIPTION	DATE	DWN	APP
B	ISSUED FOR INFORMATION	26.03.21	PM	AB
A	DRAFT ISSUED FOR INFORMATION	12.01.21	DV	AB

REVISIONS

AS CONSTRUCTED	REV.
NAME:	
DATE:	
SIGNATURE:	
RPEQ No.	
FOR CONSTRUCTION	REV.
NAME:	
DATE:	
SIGNATURE:	
RPEQ No.	

Cassowary Coast Regional Council

DRAWING STATUS: CONCEPT

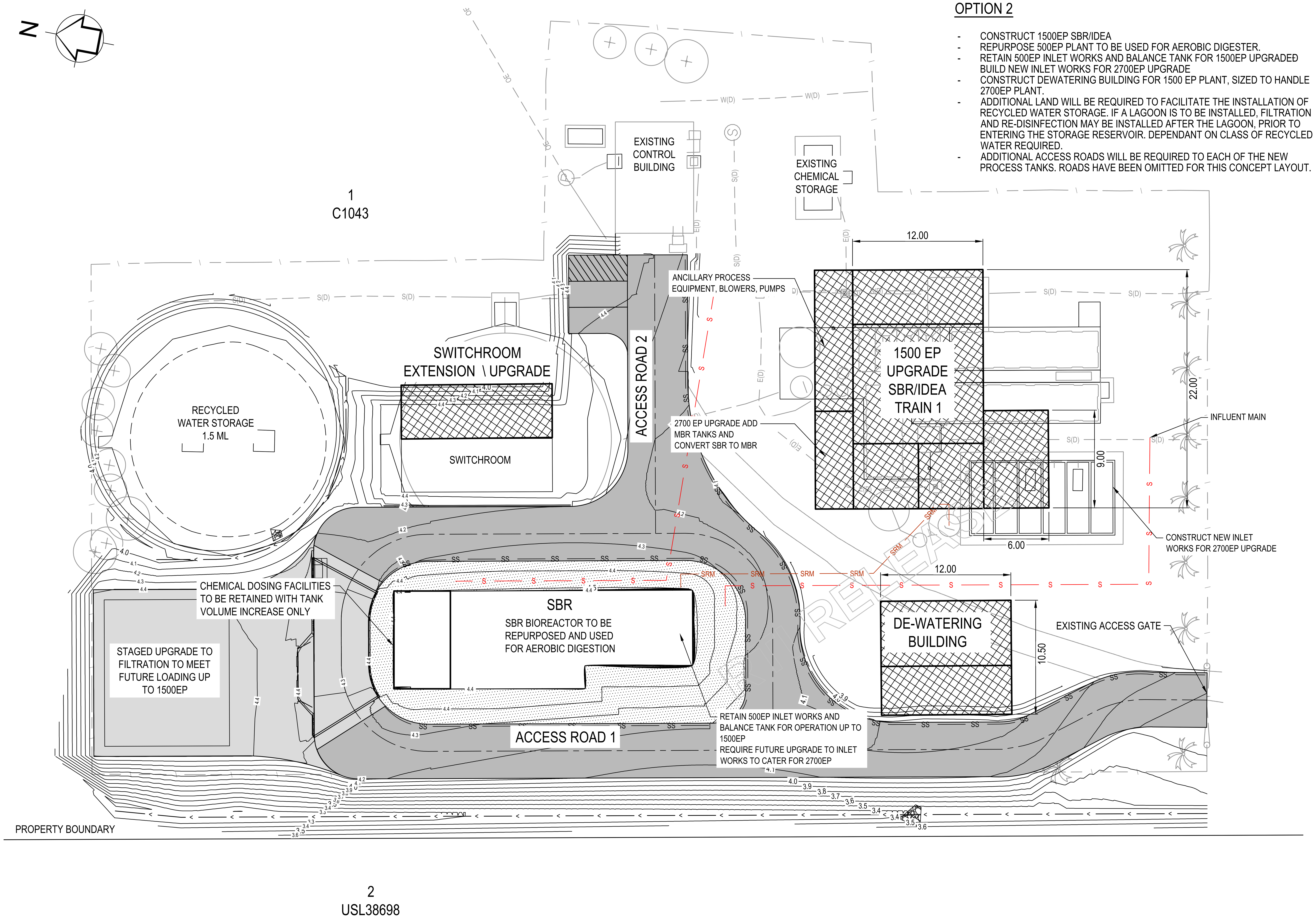
TITLE
PORT HINCHINBROOK SEWAGE TREATMENT PLANT
FUTURE EXPANSION UPGRADE STAGING
OPTION 1 CONCEPT SKETCH

DRAWING NUMBER: 2011-DWG-SK-0001

REVISION: B

OPTION 2

- CONSTRUCT 1500EP SBR/IDEA
- REPURPOSE 500EP PLANT TO BE USED FOR AEROBIC DIGESTER.
- RETAIN 500EP INLET WORKS AND BALANCE TANK FOR 1500EP UPGRADED BUILD NEW INLET WORKS FOR 2700EP UPGRADE
- CONSTRUCT DEWATERING BUILDING FOR 1500 EP PLANT, SIZED TO HANDLE 2700EP PLANT.
- ADDITIONAL LAND WILL BE REQUIRED TO FACILITATE THE INSTALLATION OF RECYCLED WATER STORAGE. IF A LAGOON IS TO BE INSTALLED, FILTRATION AND RE-DISINFECTION MAY BE INSTALLED AFTER THE LAGOON, PRIOR TO ENTERING THE STORAGE RESERVOIR. DEPENDANT ON CLASS OF RECYCLED WATER REQUIRED.
- ADDITIONAL ACCESS ROADS WILL BE REQUIRED TO EACH OF THE NEW PROCESS TANKS. ROADS HAVE BEEN OMITTED FOR THIS CONCEPT LAYOUT.



SITE PLAN
SCALE: 1:200

LEGEND

- ROAD CONTROL LINES
- PROPOSED ASSETS
- ROAD - CONCRETE
- ROAD - CHIP SEAL
- GRAVEL AREA
- EXISTING FENCE
- 380.000 EXISTING CONTOURS
- 380.000 DESIGN CONTOURS
- SWD PROPOSED STORMWATER
- S PROPOSED GRAVITY SEWER
- RM PROPOSED RISING MAIN
- RW PROPOSED RECYCLED WATER PIPELINE
- W PROPOSED POTABLE WATER
- SRM PROPOSED SERVICE RISING MAIN
- BATTER
- BK SWALE DRAIN
- BARRIER KERB

GANDEN
ENGINEERS AND PROJECT MANAGERS
WWW.GANDEN.COM.AU

SCALES — 100mm ON ORIGINAL DRAWING
0 5 10 15 20m
1 : 200

ORIG.SIZE A1

REV	DESCRIPTION	DATE	DWN	APP
B	ISSUED FOR INFORMATION	26.03.21	PM	AB
A	DRAFT ISSUED FOR INFORMATION	12.01.21	DV	AB

REVISIONS

AS CONSTRUCTED	REV.
NAME:	
DATE:	
SIGNATURE:	
RPEQ No.	
FOR CONSTRUCTION	REV.
NAME:	
DATE:	
SIGNATURE:	
RPEQ No.	

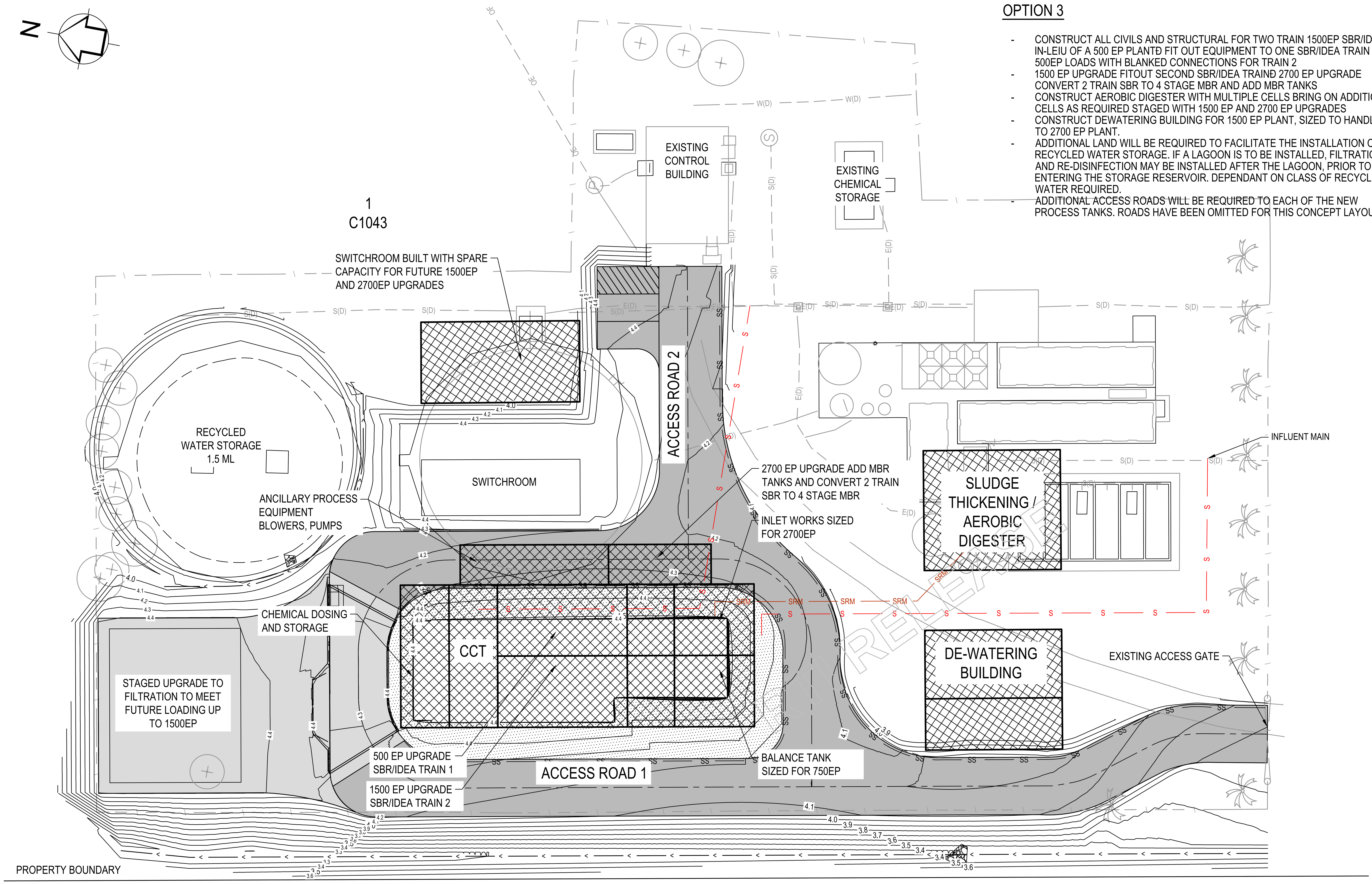
Cassowary Coast REGIONAL COUNCIL

DRAWING STATUS: CONCEPT

TITLE
PORT HINCHINBROOK SEWAGE TREATMENT PLANT
FUTURE EXPANSION UPGRADE STAGING
OPTION 2 CONCEPT SKETCH

DRAWING NUMBER: 2011-DWG-SK-0002

REVISION: B



2
USL38698

SITE PLAN
SCALE: 1:200

OPTION 3

- CONSTRUCT ALL CIVILS AND STRUCTURAL FOR TWO TRAIN 1500EP SBR/IDEA IN-LEIU OF A 500 EP PLANTD FIT OUT EQUIPMENT TO ONE SBR/IDEA TRAIN FOR 500EP LOADS WITH BLANKED CONNECTIONS FOR TRAIN 2
- 1500 EP UPGRADE FITOUT SECOND SBR/IDEA TRAIND 2700 EP UPGRADE CONVERT 2 TRAIN SBR TO 4 STAGE MBR AND ADD MBR TANKS
- CONSTRUCT AEROBIC DIGESTER WITH MULTIPLE CELLS BRING ON ADDITIONAL CELLS AS REQUIRED STAGED WITH 1500 EP AND 2700 EP UPGRADES
- CONSTRUCT DEWATERING BUILDING FOR 1500 EP PLANT, SIZED TO HANDLE UP TO 2700 EP PLANT.
- ADDITIONAL LAND WILL BE REQUIRED TO FACILITATE THE INSTALLATION OF RECYCLED WATER STORAGE. IF A LAGOON IS TO BE INSTALLED, FILTRATION AND RE-DISINFECTION MAY BE INSTALLED AFTER THE LAGOON, PRIOR TO ENTERING THE STORAGE RESERVOIR. DEPENDANT ON CLASS OF RECYCLED WATER REQUIRED.
- ADDITIONAL ACCESS ROADS WILL BE REQUIRED TO EACH OF THE NEW PROCESS TANKS. ROADS HAVE BEEN OMITTED FOR THIS CONCEPT LAYOUT.

LEGEND

- ROAD CONTROL LINES
- PROPOSED ASSETS
- ROAD - CONCRETE
- ROAD - CHIP SEAL
- GRAVEL AREA
- EXISTING FENCE
- 380.000 EXISTING CONTOURS
- 380.000 DESIGN CONTOURS
- SWD PROPOSED STORMWATER
- S PROPOSED GRAVITY SEWER
- RM PROPOSED RISING MAIN
- RW PROPOSED RECYCLED WATER PIPELINE
- W PROPOSED POTABLE WATER
- SRM PROPOSED SERVICE RISING MAIN
- BATTER
- BK SWALE DRAIN
- BARRIER KERB

GANDEN
ENGINEERS AND PROJECT MANAGERS
WWW.GANDEN.COM.AU

SCALES — 100mm ON ORIGINAL DRAWING
0 5 10 15 20m
1 : 200

ORIG.SIZE A1

REV	DESCRIPTION	DATE	DWN	APP
B	ISSUED FOR INFORMATION	26.03.21	PM	AB
A	DRAFT ISSUED FOR INFORMATION	12.01.21	DV	AB

REVISIONS

AS CONSTRUCTED	REV.
NAME:	
DATE:	
SIGNATURE:	
RPEQ No.	

FOR CONSTRUCTION	REV.
NAME:	
DATE:	
SIGNATURE:	
RPEQ No.	

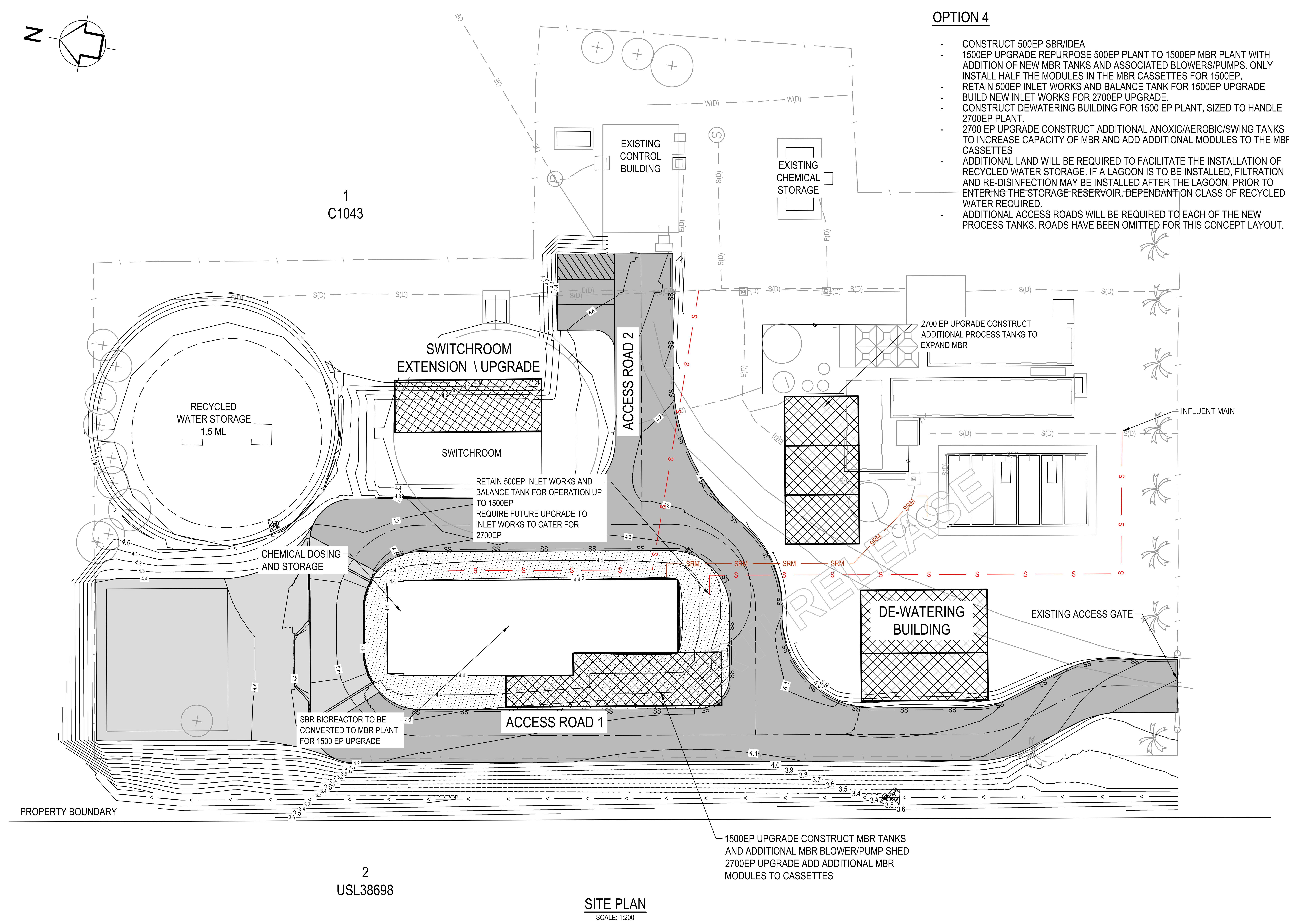
Cassowary Coast Regional Council

DRAWING STATUS: CONCEPT

TITLE
PORT HINCHINBROOK SEWAGE TREATMENT PLANT
FUTURE EXPANSION UPGRADE STAGING
OPTION 3 CONCEPT SKETCH

DRAWING NUMBER: 2011-DWG-SK-0003

REVISION: B



SITE PLAN

SCALE: 1:200

OPTION 4

- CONSTRUCT 500EP SBR/IDEA
- 1500EP UPGRADE REPURPOSE 500EP PLANT TO 1500EP MBR PLANT WITH ADDITION OF NEW MBR TANKS AND ASSOCIATED BLOWERS/PUMPS. ONLY INSTALL HALF THE MODULES IN THE MBR CASSETTES FOR 1500EP.
- RETAIN 500EP INLET WORKS AND BALANCE TANK FOR 1500EP UPGRADE
- BUILD NEW INLET WORKS FOR 2700EP UPGRADE.
- CONSTRUCT DEWATERING BUILDING FOR 1500 EP PLANT, SIZED TO HANDLE 2700EP PLANT.
- 2700 EP UPGRADE CONSTRUCT ADDITIONAL ANOXIC/AEROBIC/SWING TANKS TO INCREASE CAPACITY OF MBR AND ADD ADDITIONAL MODULES TO THE MBR CASSETTES
- ADDITIONAL LAND WILL BE REQUIRED TO FACILITATE THE INSTALLATION OF RECYCLED WATER STORAGE. IF A LAGOON IS TO BE INSTALLED, FILTRATION AND RE-DISINFECTION MAY BE INSTALLED AFTER THE LAGOON, PRIOR TO ENTERING THE STORAGE RESERVOIR. DEPENDANT ON CLASS OF RECYCLED WATER REQUIRED.
- ADDITIONAL ACCESS ROADS WILL BE REQUIRED TO EACH OF THE NEW PROCESS TANKS. ROADS HAVE BEEN OMITTED FOR THIS CONCEPT LAYOUT.

LEGEND

- ROAD CONTROL LINES
- PROPOSED ASSETS
- ROAD - CONCRETE
- ROAD - CHIP SEAL
- GRAVEL AREA
- EXISTING FENCE
- EXISTING CONTOURS
- DESIGN CONTOURS
- PROPOSED STORMWATER (SWD)
- PROPOSED GRAVITY SEWER (S)
- PROPOSED RISING MAIN (RM)
- PROPOSED RECYCLED WATER PIPELINE (RW)
- PROPOSED POTABLE WATER (W)
- PROPOSED SERVICE RISING MAIN (SRM)
- BATTER
- SWALE DRAIN (BK)
- BARRIER KERB

GANDEN ENGINEERS AND PROJECT MANAGERS
WWW.GANDEN.COM.AU

SCALES: 100mm ON ORIGINAL DRAWING — 0 5 10 15 20m — 1 : 200

ORIG.SIZE A1

REV	DESCRIPTION	DATE	DWN	APP
B	ISSUED FOR INFORMATION	26.03.21	PM	AB
A	DRAFT ISSUED FOR INFORMATION	12.01.21	DV	AB

REVISIONS

AS CONSTRUCTED	REV.
NAME:	
DATE:	
SIGNATURE:	
RPEQ No.	
FOR CONSTRUCTION	REV.
NAME:	
DATE:	
SIGNATURE:	
RPEQ No.	

Cassowary Coast Regional Council

DRAWING STATUS: CONCEPT

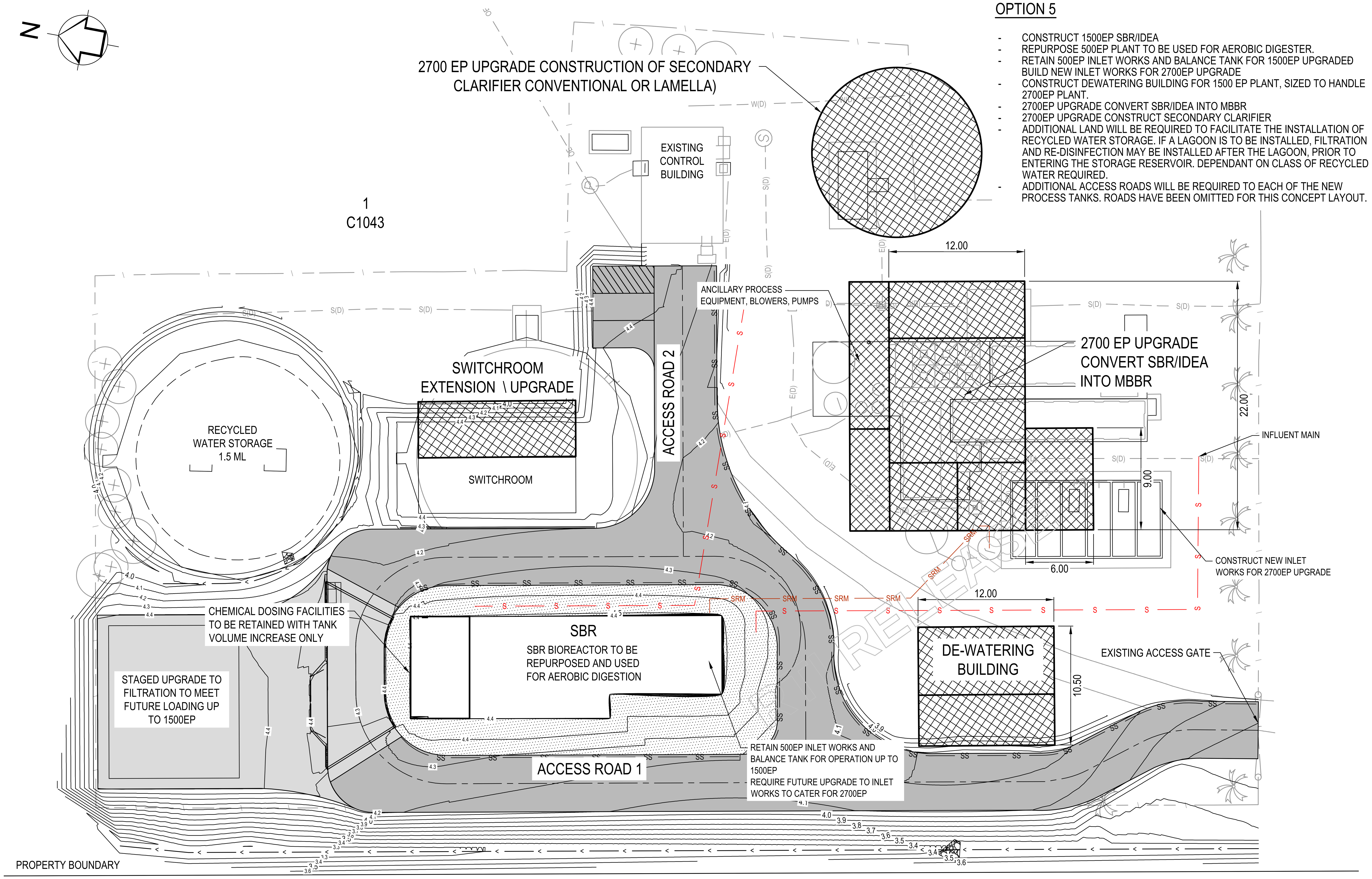
TITLE: PORT HINCHINBROOK SEWAGE TREATMENT PLANT FUTURE EXPANSION UPGRADE STAGING OPTION 4 CONCEPT SKETCH

DRAWING NUMBER: 2011-DWG-SK-0004

REVISION: B

OPTION 5

- CONSTRUCT 1500EP SBR/IDEA
- REPURPOSE 500EP PLANT TO BE USED FOR AEROBIC DIGESTER.
- RETAIN 500EP INLET WORKS AND BALANCE TANK FOR 1500EP UPGRADED BUILD NEW INLET WORKS FOR 2700EP UPGRADE
- CONSTRUCT DEWATERING BUILDING FOR 1500 EP PLANT, SIZED TO HANDLE 2700EP PLANT.
- 2700EP UPGRADE CONVERT SBR/IDEA INTO MBBR
- 2700EP UPGRADE CONSTRUCT SECONDARY CLARIFIER
- ADDITIONAL LAND WILL BE REQUIRED TO FACILITATE THE INSTALLATION OF RECYCLED WATER STORAGE. IF A LAGOON IS TO BE INSTALLED, FILTRATION AND RE-DISINFECTION MAY BE INSTALLED AFTER THE LAGOON, PRIOR TO ENTERING THE STORAGE RESERVOIR. DEPENDANT ON CLASS OF RECYCLED WATER REQUIRED.
- ADDITIONAL ACCESS ROADS WILL BE REQUIRED TO EACH OF THE NEW PROCESS TANKS. ROADS HAVE BEEN OMITTED FOR THIS CONCEPT LAYOUT.



SITE PLAN

SCALE: 1:200

LEGEND

— · —	ROAD CONTROL LINES
(crosshatch)	PROPOSED ASSETS
(light grey)	ROAD - CONCRETE
(dark grey)	ROAD - CHIP SEAL
(stipple)	GRAVEL AREA
— \ —	EXISTING FENCE
— 380.000 —	EXISTING CONTOURS
— 380.000 —	DESIGN CONTOURS
— SWD —	PROPOSED STORMWATER
— S —	PROPOSED GRAVITY SEWER
— RM —	PROPOSED RISING MAIN
— RW —	PROPOSED RECYCLED WATER PIPELINE
— W —	PROPOSED POTABLE WATER
— SRM —	PROPOSED SERVICE RISING MAIN
	BATTER
BK	SWALE DRAIN
	BARRIER KERB

GANDEN
ENGINEERS AND PROJECT MANAGERS
WWW.GANDEN.COM.AU

SCALES — 100mm ON ORIGINAL DRAWING
0 5 10 15 20m
1 : 200

ORIG.SIZE A1

REV	DESCRIPTION	DATE	DWN	APP
B	ISSUED FOR INFORMATION	26.03.21	PM	AB
A	DRAFT ISSUED FOR INFORMATION	12.01.21	PM	AB

REVISIONS

AS CONSTRUCTED	REV.
NAME:	
DATE:	
SIGNATURE:	
RPEQ No.	
FOR CONSTRUCTION	REV.
NAME:	
DATE:	
SIGNATURE:	
RPEQ No.	

Cassowary Coast REGIONAL COUNCIL

DRAWING STATUS: CONCEPT

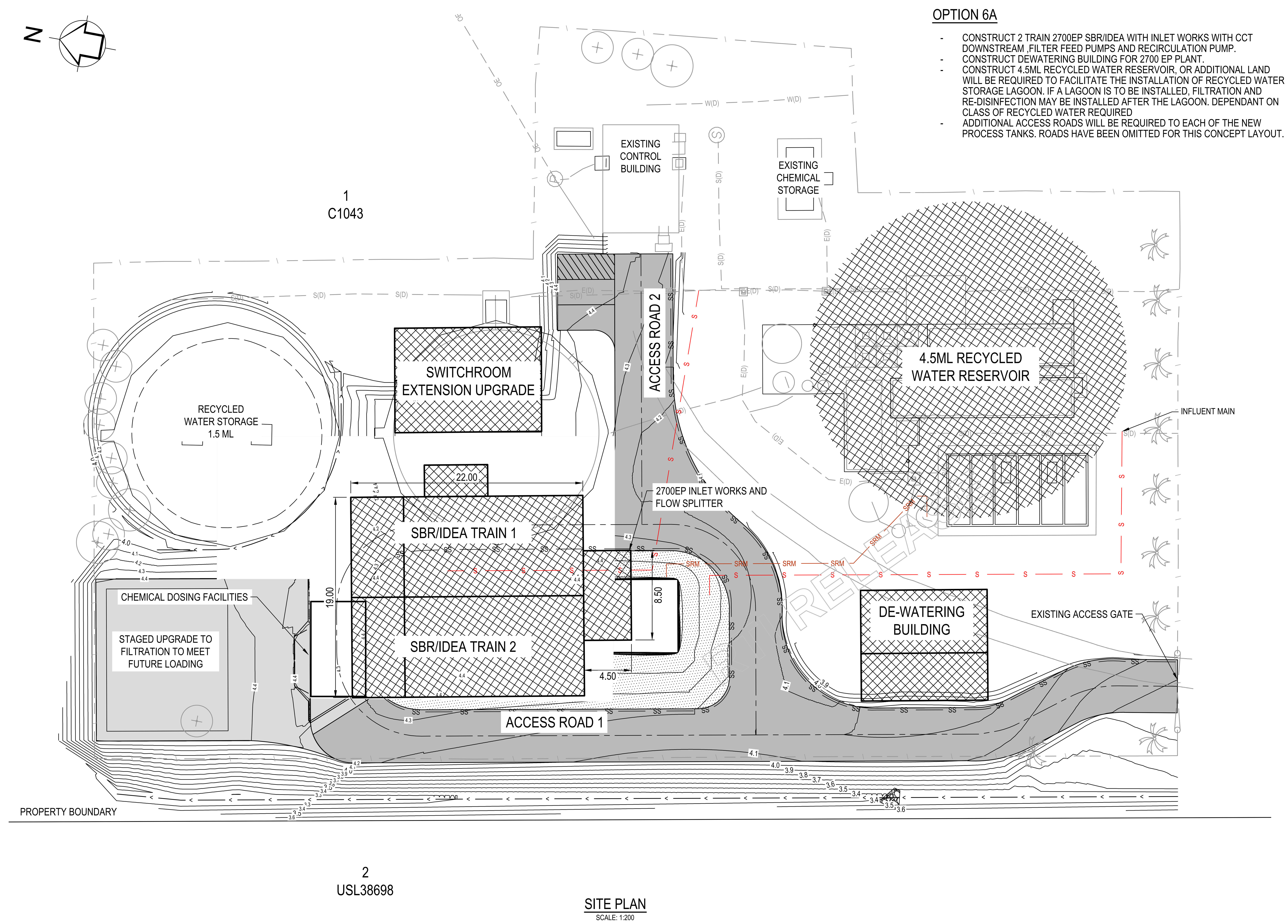
TITLE: PORT HINCHINBROOK SEWAGE TREATMENT PLANT FUTURE EXPANSION UPGRADE STAGING OPTION 5 CONCEPT SKETCH

DRAWING NUMBER: 2011-DWG-SK-0005

REVISION: B

OPTION 6A

- CONSTRUCT 2 TRAIN 2700EP SBR/IDEA WITH INLET WORKS WITH CCT DOWNSTREAM ,FILTER FEED PUMPS AND RECIRCULATION PUMP.
- CONSTRUCT DEWATERING BUILDING FOR 2700 EP PLANT.
- CONSTRUCT 4.5ML RECYCLED WATER RESERVOIR, OR ADDITIONAL LAND WILL BE REQUIRED TO FACILITATE THE INSTALLATION OF RECYCLED WATER STORAGE LAGOON. IF A LAGOON IS TO BE INSTALLED, FILTRATION AND RE-DISINFECTION MAY BE INSTALLED AFTER THE LAGOON. DEPENDANT ON CLASS OF RECYCLED WATER REQUIRED
- ADDITIONAL ACCESS ROADS WILL BE REQUIRED TO EACH OF THE NEW PROCESS TANKS. ROADS HAVE BEEN OMITTED FOR THIS CONCEPT LAYOUT.



SITE PLAN

SCALE: 1:200

LEGEND

	ROAD CONTROL LINES
	PROPOSED ASSETS
	ROAD - CONCRETE
	ROAD - CHIP SEAL
	GRAVEL AREA
	EXISTING FENCE
380.000	EXISTING CONTOURS
380.000	DESIGN CONTOURS
SWD	PROPOSED STORMWATER
S	PROPOSED GRAVITY SEWER
RM	PROPOSED RISING MAIN
RW	PROPOSED RECYCLED WATER PIPELINE
W	PROPOSED POTABLE WATER
SRM	PROPOSED SERVICE RISING MAIN
	BATTER
	SWALE DRAIN
BK	BARRIER KERB

GANDEN
ENGINEERS AND PROJECT MANAGERS
WWW.GANDEN.COM.AU

SCALES 100mm ON ORIGINAL DRAWING

0 5 10 15 20m

1 : 200

ORIG.SIZE A1

REV	DESCRIPTION	DATE	DWN	APP
A	ISSUED FOR INFORMATION	26.03.21	PM	AB

REVISIONS

AS CONSTRUCTED	REV.
NAME:	
DATE:	
SIGNATURE:	
RPEQ No.	
FOR CONSTRUCTION	REV.
NAME:	
DATE:	
SIGNATURE:	
RPEQ No.	

Cassowary Coast Regional Council

DRAWING STATUS: CONCEPT

TITLE

PORT HINCHINBROOK SEWAGE TREATMENT PLANT
FUTURE EXPANSION UPGRADE STAGING
OPTION 6 CONCEPT SKETCH

DRAWING NUMBER: 2011-DWG-SK-0006

REVISION: A