Paroo Shire Council

Technical Specification

Cunnamulla Sewage Treatment Plant Upgrade

July 2019
The Following Documents are included in this tender:

1. Information for Tenderers
2. Conditions of Tendering
3. Annexure to Conditions of Tendering (not used)
4. Tender Forms and Schedules
5. General Conditions of Contract including Annexure A & B
6. Special Conditions of Contract
7. Project Specification
8. Technical Specification (this document)
9. Standard Documents & Drawings
# Technical Specification

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<td>D&amp;C</td>
<td>Design and Construct</td>
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<tr>
<td>AS</td>
<td>Australian Standards</td>
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<tr>
<td>HAZOP</td>
<td>Hazards and Operability</td>
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<td>HGL</td>
<td>Hydraulic Grade Line</td>
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<tr>
<td>O&amp;M</td>
<td>Operation and Maintenance</td>
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<td>PSC</td>
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<td>PFD</td>
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<td>PLC</td>
<td>Programmable Logic Controller</td>
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<td>Supervisory Control and Data Acquisition</td>
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<td>VFD</td>
<td>Variable Frequency Drive</td>
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<td>OEM</td>
<td>Original Equipment Manufacturer</td>
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<td>IP</td>
<td>Ingress Protection</td>
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**Definitions**

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<tr>
<td>Contractor</td>
<td>Contractor engaged to execute the works</td>
</tr>
<tr>
<td>Designer</td>
<td>Contractors designers</td>
</tr>
<tr>
<td>Principal</td>
<td>Paroo Shire Council</td>
</tr>
<tr>
<td>SAT</td>
<td>Commissioning, Site Acceptance Test (SAT) and Proof of Performance (POP) testing takes place on site and will culminate in the testing of the entire system under all possible operating conditions.</td>
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1. Preliminaries

1.1 Project Background

Cunnamulla is a regional community situated approximately 800km to the west of Brisbane and is the main commercial centre for the Paroo Shire. The Cunnamulla Sewage Treatment Plant (STP) is owned and operated by Paroo Shire Council (PSC).

The existing STP was originally constructed in the 1930’s and upgraded in the 1970’s to double the plant’s capacity with the addition of a second treatment train. A review undertaken in 2016 identified the that many of the plant components had reached the end of their useful service life.

A Health and Safety (H&S) Audit was undertaken in November 2017 by J.C. Engineers for the Cunnamulla STP which scored the facility at 28% (19/66) in compliance with H&S standards and guidelines Refer to Appendix D - . The Audit Report identified that the existing plant:

- No longer meets the population needs or expectations, and
- Is at high risk of failure that may lead to potential public health and safety concerns.

This technical specification details the technical and performance requirements for the design and construction of the new Cunnamulla STP and associated infrastructure to protect public health and the environment and to enable future reuse of effluent. Council may wish to reuse treated water in a separate future project.

1.2 Site Location

The existing STP is located to the south of Cunnamulla at 106 Wicks St, Cunnamulla QLD 4490 (-28.0764267, 145.6875720). The new plant will be located on the existing site, adjacent to the existing treatment plant.

![Figure 1 - Cunnamulla STP and Lagoons - Site Location](image)

1.3 Existing Infrastructure

1.3.1 Network & Rising Main

Cunnamulla is served by a conventional gravity system. A total of five pump stations are installed throughout Cunnamulla, however, only Sewage Pump Stations (SPS) 1 and 2 transfer sewage directly to the STP via a common rising main (assumed to be DN225 AC).
Record drawings for SPS 1 and 2 are not available. The Contractor will be required to establish the system curves for the pump station and identify whether an upgrade is required due to the changed system conditions (i.e. increase in static head). The Caravan Park is serviced by an independent pump station and rising main which discharges into the Train 1 inlet channel.

1.3.2 **Sewage Treatment Plant (STP)**

A Site Layout and Process Flow Diagram (PFD) plan have been developed for the existing STP, based on a visual site inspection and discussions with operational staff (The Contractor is required to undertake investigations to confirm the extents of existing infrastructure). Refer to Appendix A - for the reference drawings.

The existing STP was constructed in two stages, the first in the 1930’s and the second in the 1970’s. It is proposed that the new STP is constructed within the existing plant boundary.

The existing STP consists of:

- Two (2) inlet channels with manual bar screens,
- Two (2) Primary Treatment tanks (Imhoff Tanks), and
- Two secondary treatment lagoons, and
- A single Evaporation lagoon,
- Sludge drying beds, and
- A Filtrate return pump station.

![Figure 2 – Cunnamulla STP (Lagoons not shown)](image_url)
1.3.2.1 Rising Main
The existing DN225 AC common rising main from SPS 1 and 2 splits into two at the front of the STP. A DN225 AC pipe feeds Primary Treatment Train 1 and a DN150 AC pipeline feeds Primary Treatment Train 2.

1.3.2.2 Primary Treatment (Imhoff Tanks)
The two primary treatment trains (screening channel followed by Imhoff Tank) are operated in parallel, each fed by an independent pipeline connected to the rising main. The Imhoff tanks provide primary liquid/solids separation in addition to the digestion of sludge. Supernatant from the Imhoff tanks flows under gravity, to the Secondary Treatment Ponds. The Primary Treatment trains are to be decommissioned and demolished under this contract.

1.3.2.3 Primary Treatment Effluent
An existing DN450 reinforced concrete (RC) installed from the STP site to the Secondary treatment lagoons is used to convey primary effluent. The pipeline is in poor condition and will require replacement.

1.3.2.4 Secondary Treatment Lagoons
The two secondary treatment lagoons are located to the south-west of the plant (refer to Figure 1 - Cunnamulla STP and Lagoons - Site Location. The lagoons have an estimated combined volume of 13,500m³ (does not account for sludge build-up). The design depth is assumed to be between 1 and 1.5m. The ponds are to be retained and reused as effluent polishing lagoons prior to evaporation. Significant sludge build-up within the lagoons is expected, as they have not been de-sludged in over 20 years. Desludging of existing lagoons is a provisional item under the contract. Council may wish to install solar powered aeration or mixers within the ponds. Supply and installation of aeration/mixing equipment is a provisional item under this contract.

1.3.2.5 Evaporation Lagoon
The existing evaporation lagoon is the means for effluent discharge for the plant. It has an approximate area of 19,800m² and is to be retained and reused.

1.4 Scope of Works
1.4.1 General
Paroo Shire Council (PSC) is seeking proposals from suitably qualified contractors for the design, supply, delivery, construction, installation, testing, commissioning, performance testing, operator training and operational support for the upgrade of the 1,500EP Cunnamulla Sewage Treatment Plant (STP), including the demolition and disposal of existing infrastructure.

Council will accept a bespoke design or a packaged design that meets the requirements of this specification. The scope of works for the project includes, but is not limited to:

1. Design, supply, delivery, construction, installation, testing and commissioning and performance testing of a new 1,500EP Sewage Treatment Plant;
2. Provision of new mains power supply (the site currently does not have mains power), inclusive of all applications, approvals and management of the service provider;
3. Supply, of all new equipment, instrumentation, cabling, piping, valves, fasteners and consumables required for the construction and commissioning of the plant;
4. Supply of construction equipment, carnage, tools and gear to complete the works;
5. Supply of 12 months spares for maintenance and critical equipment;
6. Site investigations including but not limited to; geotechnical investigations, site survey, service location required to complete the work under this contract;
7. All civil earthworks;
8. All structural works;
9. Electrical, instrumentation and controls installation;
10. Commissioning of equipment and plant;
11. "As-constructed" drawings;
12. Operation and maintenance manuals;
13. Operator training; and
14. Provision 12 months of operational support.

1.4.2 Demolition of Existing Assets
Recent condition and safety assessments of the existing plant have deemed both treatment trains are not suitable for refurbishment. Demolition shall form part of the plant upgrade.
It is proposed the new STP is to be constructed on the site of the existing STP. Demolition activities may require staging to facilitate the construction of the new STP, whilst maintaining a satisfactory level of treatment. It is envisaged that one of the Primary Treatment Trains will remain operational until plant cutover.
Note – the sludge drying beds were constructed in 2017 and are to be retained. The Contractor shall inspect the drying beds and the filtrate pump station to determine adequacy for integration into the upgraded plant.

1.5 Provisional Items
The Contractor may be required to complete the following works in addition to the above pending approval from the Principal. The Contractor is required to provide pricing for the following items.

1. **Provisional Item 1** – Desludging Secondary Treatment Ponds,
2. **Provisional Item 2** – Aeration/Mixing of Secondary Treatment Lagoons,
3. **Provisional Item 3** – Relining the existing Secondary Treatment Lagoons,
4. **Provisional Item 4** – Upgrade Plant Access Road,
5. **Provisional Item 5** - Upgrade of SPS 1 and 2 Pumps (if required).
6. **Provisional Item 6** – Primary Effluent Pipeline Replacement

1.6 Responsibility Matrix

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<th>Others</th>
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<td>Site Investigations</td>
<td>Contractor to satisfy itself with the existing data provided by PSC and undertake all site investigations necessary complete the works under this Contract</td>
<td>PSC have undertaken flow monitoring, geotechnical investigation and cadastral survey.</td>
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<tr>
<td>Detailed Design</td>
<td>All design drawings, documentation, calculations etc. as required under this Contract</td>
<td>Nil</td>
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<tr>
<td>Operation of Existing STP during construction (up until cutover)</td>
<td>Contractor to undertake temporary connections, decommissioning, and manage temporary treatment as required.</td>
<td>Paroo Shire Council (PSC) to assist</td>
</tr>
<tr>
<td>Desludging and Refurbishment of existing Secondary Treatment Ponds (Provisional Item)</td>
<td>Everything required under this Contract</td>
<td>Nil</td>
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<tr>
<td>Demolition of existing STP Process Tanks (Excluding sludge drying beds) following successful cutover and commissioning of new STP.</td>
<td>Everything under this Contract</td>
<td>Nil</td>
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<tr>
<td>Equipment Supply and Materials</td>
<td>Everything required under this Contract</td>
<td>Nil</td>
</tr>
<tr>
<td>Services</td>
<td>All services required under this Contract</td>
<td>Nil</td>
</tr>
<tr>
<td>Item</td>
<td>Contractor</td>
<td>Others</td>
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<td>-------------------------------------------</td>
<td>------------------------------------------------</td>
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<tr>
<td>Supply of Chemicals (if proposed)</td>
<td>Everything under this contract</td>
<td>Nil</td>
</tr>
<tr>
<td>Construction</td>
<td>Everything under this Contract</td>
<td>Nil</td>
</tr>
<tr>
<td>Commissioning and Performance Testing</td>
<td>Everything under this Contract</td>
<td>Nil</td>
</tr>
<tr>
<td>Plant Cutover</td>
<td>Contractor to undertake cut ins to existing influent main</td>
<td>PSC to provide isolation of SPS 1 and 2 and flow control as required to undertake the cutover</td>
</tr>
<tr>
<td>Operator Training</td>
<td>Everything under this Contract</td>
<td>Nil</td>
</tr>
<tr>
<td>12 Months Operational Support</td>
<td>Contractor responsible for twelve months of operational support including phone support (7am – 5pm Mon-Fri) and monthly site inspections and reporting.</td>
<td>PSC Operators to perform day to day operation.</td>
</tr>
<tr>
<td>Defects Liability Period (12 Months)</td>
<td>Everything under this Contract</td>
<td>Nil</td>
</tr>
<tr>
<td>Licensing and Approvals</td>
<td>Contractor to Assist PSC with Applications and Approvals as required.</td>
<td>By PSC</td>
</tr>
</tbody>
</table>

1.7 Work to be Carried Out by Others

The following works are excluded from the Contract and will be carried out by others:

1. Licensing and approvals,
2. PSC to assist with the operation of temporary STP during construction (up until cutover to new plant).

1.8 Statutory Requirements, Codes and Guidelines

All materials and workmanship shall comply with the latest revisions of the relevant codes and standards set out herein and within the relevant discipline specifications or in their absence the latest editions of Australian Standards, Australian Water Association (AWA) or Water Services Association of Australia (WSAA).

1.8.1 Standards

In addition to statutory requirements, all goods supplied shall as a minimum, meet all the requirements of the latest issue of appropriate Australian Standards as at date of award of Contract for the specified item type with the respect to design, manufacture, assembly, testing and supply.

Standards applicable to workmanship and goods supply include, but are not limited to:

- AS/NZS 2566.1:1998 Buried flexible pipelines - Structural design;
- AS/NZS 3735 Concrete structures retaining liquids;
- AS/NZS 4833 The storage and handling of mixed classes of dangerous goods;
- AS/NZS 3000:2007 Electrical installations (known as the Australian/New Zealand Wiring Rules);
- AS 2400 Packaging Code
- AS 2700-1996 Colour Standards for general purposes;
- AS 1111 ISO metric hexagon Commercial Bolts and Screws;
- AS 1112 ISO metric hexagon nuts including thin nuts, slotted nuts and castle nuts;
- AS 1214 Hot Dip Galvanised Coatings on threaded fasteners (ISO metric course thread series);
- AS/NZ 2312 Guide to protection of Structural Steel by the Use of Protective Coatings;
• AS 2417 Rotodynamic pumps - Hydraulic performance acceptance tests - Grades 1 and 2;
• AS 1580:408-5 Adhesion – Pull-off Test;
• AS 1580:408-4 Adhesion Cross Cut;
• AS/NZ 3894-all Protective Coatings;
• AS 4100-1998 Steel Structures;
• AS 4024.1-2006 Safety of Machinery;
• AS 4041 – 2006 Pressure Piping or ASME B31 equivalent;
• AS 1345-1995 Identification of the contents of pipes, conduits and ducts;
• AS1657-2013 Fixed platforms, walkways, stairways and ladders - Design, construction and installation;
• AS/NZS 2312:2002 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings;
• Welding to conform to AS1554-2007 structural steel welding set;
• AS 4087-2004 Metallic flanges for waterworks purposes or ANSI equivalent;
• API 594 Wafer and Wafer-lug Check Valves;
• AS 4775-2007 Emergency Eyewash & Shower Equipment;
• AS 60947 4.1 Motor Starters;
• AS 60947 5.1 Circuits;
• AS 3010 Electrical Installations Generating Sets; and
• AS 1359 Rotating electrical machines.

Where an appropriate Australian Standard does not exist, the Equipment shall meet the requirements of an appropriate ISO Standard. Where an appropriate Australian or ISO Standard does not exist, the Equipment shall meet the requirements of other standards nominated or approved by the Principal.

The Contractor shall provide to the Principal for review and approval as applicable, details of any Standard currently used for their Equipment that they believe is better suited to the application than the Standards nominated in this Specification. In the event of a conflict between applicable Acts, Regulations, Codes or Standards, the requirements of the highest level of jurisdiction in the application shall apply.

In the event of a conflict between this specification and any applicable Act, Regulation, Code or Standards, the relevant Act, Regulation, Code or Standard shall take precedence. The Vendor shall immediately advise the Principal of any such conflict.

1.9 Equipment Suppliers

The Contractor shall demonstrate that proposed equipment suppliers have:

• Local experience in the Australian market;
• Same or similar product history in service in Australia or similar climatic conditions;
• After sales maintenance and technical support based in Australia;
• Commitment to carry spares and provide servicing for the life of the product;
• Able to provide compliance test certificates or type test certificates for the proposed equipment from an accredited independent test laboratory; and
• All equipment proposed sourced from local OEM (Original Equipment Manufacturers) Authorised Distributors within Australia.
2. Design Deliverables and Certification

2.1 Design Verification

The design is to be undertaken in conformance with Queensland Legislation with all design and construction activities supervised, assessed and certified by a suitably qualified Registered Professional Engineers of Queensland (RPEQ) for each discipline.

2.2 Design Responsibility

The Contractor is responsible for all design and documentation required to construct the plant, including selection of equipment, plant, systems, materials and services to be used for the planning, investigations, design, construction and commissioning of the plant.

The review of design and construction documentation by the Principal does not constitute a check on compliance with the Specification, regulatory and industry standards and review of process calculations, equipment sizing etc. The Principal will be reliant on the design provided by the Contractor.

The Principal review and approval of design and documentation does not relieve the Contractor of the sole responsibility for the suitability of the design. The suitability of the design will be certified by the Contractors suitably qualified RPEQ.

2.3 Design Stages and Submissions

The Contractor shall undertake the design in such a way that the design drawings and documentation are submitted to the Principal for review at the following design stages:

• 30% Concept Design and Documentation,
• 80% Detailed Design and Documentation,
• 100% Detailed design and Documentation and
• Issued for Construction (IFC) Design and Documentation.

Drawings and documents are to be submitted by the Contractor according to the Programme of Works developed and agreed with the Principal at the Contract Commencement. Complete and full sets shall be submitted at the design stages and are to be clearly marked with the design stage and state the relevant date and revision number.

2.3.1 30% Concept Design and Documentation

The 30% design submission shall consist of:

• General arrangement and sectional drawings,
• Process flow diagram,
• Design report,
• Safety in Design Report,
• Process design report,
• Piping and Instrumentation Diagrams (P&IDs),
• Process control philosophy,
• Hydraulic Profile,
• Equipment, Instrumentation and Valve Schedules.

An allowance of 10 business days shall be provided in the program for Principal review of the design and documentation.

2.3.2 30% Design Review

The Contractor shall facilitate a combined 30% Design Review workshop following the Principal review. The Design Review Workshop is to be undertaken at the Principals offices, unless agreed otherwise.
2.3.3 80% Design
The 80% Design submission will address all Council comments and outcomes from the 30% design reviews. The 80% design submission will include:

- General arrangement drawings,
- Detailed civil, mechanical, electrical, instrumentation and controls, hydraulic and structural drawings;
- Design Report,
- Control Philosophy,
- Functional Specification,
- P&ID’s and Process Flow Diagram,
- Hydraulic Profile,
- Equipment, Instrumentation and Valves Schedules,
- HAZOP Draft Report, and

An allowance for 10 business days shall be provided for Principal review. The Principal will provide a consolidated set of design review comments for inclusion into the IFC set.

2.3.4 80% Design Review, HAZOP and Safety in Design Workshops
The Contractor shall facilitate a combined 80% Design Review workshop following the Principal review. The Design Review Workshop, HAZOP and Safety in Design workshops are to be undertaken at the Principal’s offices, unless agreed otherwise.

2.3.5 100% Design
The 100% Design submission will address all Council comments and outcomes from the combined 80% design review and workshops. The 100% design submission will include:

- General arrangement drawings,
- Detailed civil, mechanical, electrical, instrumentation and controls, hydraulic and structural drawings;
- Design Report,
- Control Philosophy,
- Functional Specification,
- P&ID’s and Process Flow Diagram,
- Hydraulic Profile,
- Equipment, Instrumentation and Valves Schedules,
- HAZOP Final Report, and
- Safety in Design Final Report.

An allowance for 10 business days shall be provided for Principal review. The Principal will provide a consolidated set of design review comments for inclusion into the IFC set.

2.3.6 100% Design Review
No workshops are planned for the 100% design review. The Contactor shall allow 10 days for Council comment.

2.3.7 Issued for Construction (IFC)
The issued for Construction design and documentation will include finalised Drawings and documentation as described in the 100% stage (incorporating Councils comments).

The Contractor shall submit the IFC design and documentation to the Principal for approval prior to commencing construction, unless otherwise agreed. Procurement of equipment and materials prior to receiving approval from the Principal is at the Contractor’s risk and the Principal will take no responsibility.

IFC drawings shall be certified by suitably qualified Registered Professional Engineers of Queensland (RPEQ).
2.3.8 “As-Constructed Drawings” and Documentation
The Contractor shall prepare an As-Constructed drawings and documentation following the completion of construction. The “As constructed” drawings and documentation included, but are not limited to: -

- Updated “As-Constructed” drawing package, showing constructed dimensions, locations (surveyed), actual locations of underground piping, conduits and other services.
- Updated P&ID’s,
- Updated Control Philosophy and Functional Specification representing the “As-Commissioned” plant.

As-construction drawings shall be certified by a suitably qualified Registered Professional Engineer of Queensland (RPEQ).

2.4 Review and Acceptance
The Superintendent’s review of the Contractors design and documentations will be limited to general compliance with the requirements of the Contract. The Contractor shall remain responsible for the adequacy of the drawings for construction and for the correct operation, performance, safety and design of the facility. Documents submitted to the Superintendent will be kept by the Principal. Mark-up copies of design drawings and documentations will be returned to the Contractor generally within 10 business days of receipt of documents.

The Superintendent may require revision of drawings/documents if they are deemed unsuitable at the scale and level of detail submitted. Construction shall not proceed unless the relevant set of drawings has been accepted and the Superintendent has provided written approval. No manufacture or construction work shall be undertaken until the Superintendent has accepted the design drawings and documents, unless otherwise advised in writing by the Superintendent.

Acceptance of a document shall not relieve the Contractor of responsibility for the engineering and drafting correctness. Acceptance of the submissions shall not imply acceptance of any variation from the Contract documents contained thereon. Variations must be identified, and the explicit agreement of the Superintendent obtained.

2.5 Construction Certification
The Contractor shall be responsible for the construction of the plant as per the approved and certified design drawings. The construction shall be certified by suitably qualified Registered Professional Engineers of Queensland (RPEQ) in the appropriate format (Form 16 or similar).
3. Demolition of Existing Assets

This section describes the various existing WWTP assets which must be demolished and removed as required to accommodate the plant upgrade. The Contractor will be responsible for draining, demolition and disposal of redundant infrastructure to facilitate the Construction and Commissioning of the new STP.

Where existing pipelines are to be abandoned, the ends are to be plugged/capped to ensure flow cannot enter the abandoned pipes. Where ends of abandoned pipes are in pits that do not require removal, the pipe ends simply need to be plugged. Where ends of abandoned pipes are buried after the rest of the service has been abandoned (i.e. after removal of pits/connecting pipework), the end of the service shall be surveyed prior to being backfilled such that PSC can retain records of such abandoned assets.

Where pipes are connected to concrete structures that are to be retained under the contract, the anchor bolts are to be cut flush with the concrete surface and localised area coated with corrosion protective coating.

Where existing equipment has associated power supply or control cables and conduits, the abandoned conduits, cable ladders, cables and control panels shall be isolated, removed, terminated and made safe.

Unless noted otherwise, all equipment and materials schedules for demolition and removal must be legally disposed offsite. The following items are scheduled for demolition: -

1. Primary Treatment Train 1,
2. Primary Treatment Train 2,
3. Existing Operator Building,
4. Existing Storage Shed,
5. Effluent Collection Well,
6. Primary treatment effluent pipeline from STP to Lagoons (Provisional Sum Item and may be undertaken by others under a Separate Works Package,
7. STP Boundary Fence, and

The Contractor shall develop a Demolition Plan in accordance with section 2.3.4 Demolition Plan.

3.1 Primary Treatment Trains 1 & 2

The existing Primary Treatment Trains 1 and 2 will become redundant upon construction of the new STP. The Contractor shall safely decommission, demolish and dispose of the tanks in accordance with the agreed demolition plan.

3.1.1 Inlet Pipeline

Removal of the existing DN225 AC (train 1) and DN150 AC (train 2) pipework once Primary Treatment Train is scheduled to be taken offline. Removal of the below ground AC piping shall be undertaken such that the risks of working with asbestos are minimised (i.e. no cutting, removal of piping from socketed joints).

3.1.2 Piping and Steelwork

The Contractor shall remove and dispose of the inlet pipework, bar screen, weirs, launders, sprays, sludge valves etc. prior to undertaking any demolition works. No piping or steelwork shall be left in situ.

3.1.3 Concrete Channel and Tank

The Primary Treatment Train 1 shall be drained, pressure cleaned and demolished to a minimum of 500mm below the existing ground level. All concrete cut and removed shall be disposed in the location agreed with Council. The base of the tank shall be punctured in multiple locations to allow drainage. The tank shall then be backfilled using compacted sand.

3.2 Existing Operator Building and Storage Shed

The existing operator building is to be decommissioned, demolished and removed from site as part of the upgrade. Existing concrete slabs shall be removed from site, unless they form part of the new plant, which will be refurbished including the removal of all trip hazards (i.e. walls, bunding, anchor bolts etc.).
3.3 Effluent Collection Well

The existing effluent collection well, located outside the plant boundary behind the operator buildings, shall be decommissioned, demolished and replaced as part of the upgrade works. The Contractor shall remove all mechanical equipment, piping and steel work.

The contractor shall drain, clean and demolish the existing collection well to a minimum of 500mm below the existing ground level. The base of the well shall be punctured in multiple locations to allow drainage. The well shall be backfilled using compacted sand.

The collection well is to be replaced under the Contract to facilitate connection to the existing effluent pipeline. The new connection well does not necessarily need to be constructed in the same place.

3.4 Effluent Pipeline (Provisional)

The existing DN450 RCP primary treatment effluent pipeline connecting the STP to the Lagoons is in dilapidated condition and has been installed within minimal cove and in some places, no cover. The decommissioning and replacement of the effluent pipeline is a provision item under this Contract, but may be undertaken by others in a separate works package.

If awarded, the Contractor shall detail the proposed decommissioning methodology for the pipeline and connection to the new pipeline and include allowance for this in the Lump Sum amount. The new pipeline is to follow the same alignment.

3.5 STP Boundary Fence

The existing boundary fence is to be demolished and replaced as part of the contract. The Contractor shall demolish and dispose of the existing STP fencing as agreed with the Principal.
4. Process Design Inputs

No sampling or influent profiling is available. Council provided testing results for grab samples in April 2019 which indicated standard influent loading parameters.

4.1 Population

The current population of Cunnamulla is approximately 1,140 (2016 Census). The STP will be designed to cater for current population with standard growth factor of 5% per year applied. The STP will be designed for an ultimate population of 1,500EP, with the provision for future upgrades to cater for increased population growth.

4.1.2 Influent Flows

Typical water usage in remote communities can be up to three (3) times more than urban catchments. No current flow data is available for Cunnamulla, therefore, based on average water usage in remote communities, a value of 500L/EP/day has been adopted. Flow monitoring at the inlet of the existing STP was undertaken during March/April 2019, the data is provided in Appendix D.

Table 1 – Design Flow Rates

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>1140</td>
<td>-</td>
<td>500kL/day</td>
<td>-</td>
<td>5 x ADWF</td>
<td>60L/s*</td>
</tr>
<tr>
<td>Design (Ultimate)</td>
<td>1500</td>
<td>500 L/EP/Day</td>
<td>750kL/day</td>
<td>-</td>
<td>5 x ADWF</td>
<td>-</td>
</tr>
</tbody>
</table>

*Peak instantaneous flow to be confirmed by Contractor, subject to SPS 1 & 2 pump capacities.

2.1.2.2 Influent Loading

Historical influent loadings for the catchment are unavailable. For the purpose of the design, influent loadings are to be based on typical Australian wastewater contributions. The Contractor shall, in their design report, specify the influent envelope that has been adopted.

Table 2 – Nutrient Loading

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Standard Wastewater Loading - Median (g/EP/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochemical Oxygen Demand (BOD)</td>
<td>60</td>
</tr>
<tr>
<td>Chemical Oxygen Demand (COD)</td>
<td>126</td>
</tr>
<tr>
<td>Total Kjeldahl Nitrogen (TKN)</td>
<td>12.6</td>
</tr>
<tr>
<td>Suspended Solids (SS)</td>
<td>65</td>
</tr>
<tr>
<td>Total Phosphorus (TP)</td>
<td>2.7</td>
</tr>
<tr>
<td>pH</td>
<td>6.5 – 8</td>
</tr>
</tbody>
</table>

The design shall consider the elevated water temperature in Cunnamulla. The temperature of the potable water (sourced from the Artesian Basin can reach temperatures of 50°C, however it regularly exceeds 32°C. Additionally, the design shall consider all temperature variations (i.e. winter and summer).

4.2 Hydraulic Design

The treatment plant shall be designed hydraulically for the following:

- Preliminary treatment (i.e. inlet works/screening) – 5 x ADWF,
• Secondary treatment (biological treatment) – 5 x ADWF.
Flows in excess of those listed above may bypass the process units.

4.3 Effluent Quality

Currently, effluent from the existing plant is discharged into the secondary treatment ponds prior to releases via evaporation through the evaporation pond.
The effluent quality from the new STP shall be sampled and tested immediately downstream of the last process unit prior to discharge to the lagoon system.
Council may wish to recycle the treated effluent in the future, therefore the effluent from the new STP is to be treated to suitable level to facilitate the installation of a recycled water system suitable for reuse. The table below describes the proposed effluent quality requirements for the plant.

Table 3 – Effluent Quality Requirements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit</th>
<th>Limit Type</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD</td>
<td>20</td>
<td>Maximum</td>
<td>mg/L</td>
</tr>
<tr>
<td>TSS</td>
<td>15</td>
<td>80th Percentile Maximum</td>
<td>mg/L</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Maximum</td>
<td>mg/L</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>5</td>
<td>80th Percentile Maximum</td>
<td>mg/L</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Maximum</td>
<td>mg/L</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>10</td>
<td>50th Percentile Maximum</td>
<td>mg/L</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Maximum</td>
<td>mg/L</td>
</tr>
<tr>
<td>Ammonia</td>
<td>5</td>
<td>Maximum</td>
<td>mg/L</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>2</td>
<td>Minimum</td>
<td>mg/L</td>
</tr>
<tr>
<td>Oil and Grease</td>
<td>10</td>
<td>Maximum</td>
<td>mg/L</td>
</tr>
<tr>
<td>pH</td>
<td>6.5 – 8.0</td>
<td>Range</td>
<td>-</td>
</tr>
</tbody>
</table>
5. Specific STP Requirements

The STP shall be designed to operate successfully to meet the specified effluent quality requirements. Key outcomes from this project are for the construction of a Sewage Treatment Plant (STP) that:

1. Safe to operate, and where required, providing appropriate walkways, guards, isolations, signage and the like;
2. Minimise ongoing operation and maintenance requirements of the plant;
3. Minimise inoperability due to failure of equipment;
4. Reduce overall power requirements of the plant – Note: Brownouts are common in Cunnamulla;
5. Have no requirement to enter confined spaces, or hazardous gas areas for any anticipated operations or maintenance activities;
6. Limit any environmental impact, including odour, noise and spillages;
7. Comply with relevant design standards, licence conditions and legislative requirements, including State and Australian Standards;
8. Be easily serviceable by providing similar equipment from sole supplier;
9. Have the required redundancy on all equipment to allow the plant to be serviced without loss of treatment;
10. Be able to be monitored remotely, including integration into Council’s existing SCADA system;
11. Eliminate any plant bypass or non-treatment during construction or commissioning;
12. Make safe any unrequired, or retained facilities during demolition and construction;
13. Minimise operational costs by providing efficient treatment processes;
14. Designed with consideration to future capacity upgrades; and
15. Ensure the plant meets its asset life by providing quality products made of robust materials.

5.1 Temporary Treatment

The Contractor shall detail within their Construction Methodology, the proposed methodology for temporary treatment whilst demolition, construction and commissioning activities are occurring. This Contractor is responsible for the supply, installation, construction, commissioning and operation of any piping or equipment required for temporary treatment.

The existing plant is used for Primary Treatment (i.e. solids removal). Any temporary treatment proposed by the Contractor shall include the provision for screening/solids removal. The Contractor may propose to bypass the existing STP completely, discharging directly into the existing Effluent Collection Well for release into the Secondary Treatment Lagoons. A temporary screen will need to be installed upstream of the collection well.

Note – No screenings shall be discharged into the Secondary Treatment Lagoons during the Construction or Commissioning works.

5.2 Operational Considerations

Due to the remote location and difficulties with gaining access to cranage, local Contractors, equipment suppliers and the like, the plant shall be designed to be easy to operate and maintain, with no requirement for cranage for regular maintenance of assets.

5.3 Design Life

The design life of all equipment installed as part of the STP upgrade shall comply with the table below.

<table>
<thead>
<tr>
<th>Description</th>
<th>Minimum Design Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 4 – Minimum Design Life</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Minimum Design Life</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Structural Concrete (slabs, tanks etc.)</td>
<td>75 Years</td>
</tr>
<tr>
<td>Underground Pipework</td>
<td>75 years</td>
</tr>
<tr>
<td>Above Ground Pipework</td>
<td>25 years</td>
</tr>
<tr>
<td>Mechanical Equipment (Pumps, blowers etc.)</td>
<td>15 years</td>
</tr>
<tr>
<td>Electrical Equipment and Instrumentation</td>
<td>15 years</td>
</tr>
<tr>
<td>Steel Tanks / Vessels</td>
<td>50 years</td>
</tr>
<tr>
<td>Structural Elements (walkways, platforms, supports etc.)</td>
<td>25 years</td>
</tr>
<tr>
<td>Buildings</td>
<td>25 years</td>
</tr>
<tr>
<td>Boundary Fencing</td>
<td>10 years</td>
</tr>
<tr>
<td>Roads</td>
<td>25 years</td>
</tr>
</tbody>
</table>

5.4 Battery Limits

The battery limits for the main Contract are detailed in Table 6 – Battery Limits. The below limits to not cover Provisional Items.

Table 5 – Battery Limits

<table>
<thead>
<tr>
<th>Description</th>
<th>Size and Material</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet Sewer Rising Main (SRM)</td>
<td>DN225 AC</td>
<td>Adjacent to plant access road at front of the STP</td>
</tr>
<tr>
<td>Drying Beds Inlet</td>
<td>DN225 DICL 22.5° Bend or Over Wall into Channel (existing inlet to be blanked)</td>
<td>Drying beds inlet channel. Contractor to determine connection details (over wall is suitable)</td>
</tr>
<tr>
<td>Filtrate Pump Station</td>
<td>Contractor to replace pump, instrumentation and install rising main to new inlet work, or provide new packaged pump station to suit proposed process.</td>
<td>Adjacent to drying beds.</td>
</tr>
<tr>
<td>Effluent Tie in Point</td>
<td>Contractor to replace existing DN450 primary effluent pipeline</td>
<td>Tie into Secondary treatment lagoon inlet</td>
</tr>
<tr>
<td>Potable Water Connection</td>
<td>Contractor to confirm Potable Water connection point</td>
<td>Plant access road</td>
</tr>
</tbody>
</table>

5.5 Inlet Screening and Grit Removal

The Contractor shall provide an inlet works inclusive of influent screening and grit removal. The inlet works will receive raw sewage from the common pumped rising main (SPS 1 and 2), Caravan Park rising main, the drying beds filtrate pump station and any other return streams as required within the design. Electromagnetic flowmeters shall be installed on all influent mains, return streams and plant bypass pipelines.

The existing STP currently receives large quantities of grit/sand due to issues within the gravity sewer network. The sewer network is being relined and refurbished under a separate Contract therefore grit loading is expected to reduce following completion of the relining works.

A propriety screening and grit removal system will be considered. Duty screenings and grit bins shall be provided.
Isolation valves shall be provided to allow isolation and bypass of equipment and process units. The inlet works shall be bunded such that contaminated wastewater, screenings and grit are not released to the environment. The inlet works shall drain to the general-purpose pump station for return to the head of works.

5.5.1 Inlet Screen

The Contractor shall in their offer, provide details of the proposed screen. Council will consider both mechanical and static type screens. The inlet screen shall have a minimum aperture of 3mm. If the process design requires screening below 3mm, two stage screening shall be provided.

If static screens are proposed, duty/duty screens shall be provided for redundancy.

If a mechanical screen is proposed, a manually raked bypass screen shall be provided.

Screenings shall be disposed into a bin for removal and disposal. There shall be no requirement for the operator to manually handle screenings. Automatic sprays shall be installed on the inlet screen to prevent solid build-up and provide screening washing.

The design and performance requirements for the inlet screen is described in the table below.

Table 6 – Screen Performance Requirements

<table>
<thead>
<tr>
<th>Description</th>
<th>Minimum Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw sewage flow capacity</td>
<td>60L/s (To be confirmed during detailed design)</td>
</tr>
<tr>
<td>Screen Aperture</td>
<td>3mm</td>
</tr>
<tr>
<td>Material</td>
<td>316L Stainless Steel</td>
</tr>
</tbody>
</table>

5.5.2 Manual Bypass Screen

If a mechanical screen is proposed, the Contractor shall include in their design, the provision of a manually raked bypass screen. The bypass screen shall be manually operated, with a minimum aperture of 20mm.

In the event of flow diversion to the bypass screen (using upstream valving) or failure and blinding of the automatic screen, flow will enter the manually raked bypass screen.

In the event of complete blinding of the manual bypass screen, flow shall overtop to bar screen and continue to the downstream process.

5.5.1 Grit Removal

The Contractor shall, in their offer, provide details of the proposed grit removal system. The grit removal system shall be installed downstream of the inlet screen, designed to settle and remove grit prior to discharge into the secondary treatment process. A combined Inlet Screen/Grit Removal system would be accepted.

Grit removal shall be designed to minimise operator interaction.

5.5.1 Plant Bypass

The provision of an STP bypass shall be provided. The bypass shall be installed such that all raw sewage is screened prior to release. The Contractor shall install an electromagnetic flow meter shall be installed on the plant bypass. The plant bypass shall discharge into the effluent collection well, downstream of the Secondary Effluent Flowmeter.

5.6 Secondary Treatment Process

A conventional activated sludge process is preferred. The following secondary treatment processes, or a combination of, will be considered by the Principal: -

- Modified Ludzack-Ettinger (MLE),
- Intermittently Decanted Extended Aeration (IDEA),
- Sequencing Batch Reactor (SBR),
- Intermittently Decanted Extended Aeration Lagoon (IDAL), and
- Moving Bed Bioreactor (MBBR).

A simplified treatment process is preferred, due to the remote location and operational constraints. The key considerations for the process include: -

- Power consumption - kW/kL of treated effluent,
- Hydraulic loading,
• Provision for future reuse of treated effluent (recycled water for irrigation),
• Capacity of plant and provision for future upgrades, if required,
• Process flexibility considering varying influent nutrient loading and volumes, and
• Constructability – Noting the constraints of working in Cunnamulla.

5.7 Flow Metering

Flowmeters shall be installed on the following, as a minimum:
• Influent rising main,
• Plant/sludge return streams,
• STP plant bypass, and
• Secondary effluent flowmeter.

The flowmeters shall be electromagnetic, unless approved by the Principal. The flowmeters shall provide sized to accurately measure the maximum instantaneous flow, plus 100% with an accuracy of +/-2%.

Each flowmeter shall provide feedback to the plant SCADA system, with the following digital records accessible, as a minimum:

• Instantaneous flow,
• Daily Flow Totaliser (with 14-day history) – reset at 12am (midnight)
• Total hourly flow,
• Accumulative flows from plant inception, and
• Flow trends to be provided for instantaneous and daily flows.

5.8 Secondary Effluent Disposal

The secondary effluent shall be discharged into the existing pipeline feeding the Secondary Treatment Ponds adjacent to the existing effluent collection well. The effluent collection well is to be decommissioned and demolished and a new manhole constructed adjacent to the existing.

An electromagnetic flowmeter shall be installed on the outlet of the final process tank downstream of the future recycled water connection.

5.9 Provision for Future Reuse / Recycled Water System

Following the construction, commissioning and operation of the plant, Council may wish to install a recycled water scheme to allow reuse for irrigation. The plant shall be designed to meet the effluent quality requirements specified within this document. The Contractor shall, in its design, make space allowances and provide connections to facilitate the future installation of a tertiary treatment system for reuse including:

• Connection, including valving and blanked flanges to allow future connection to the effluent pipeline downstream of the final process unit,
• Allowance for the construction/installation of filtration, UV disinfection and chlorine dosing system and recycled water storage tank.

5.10 Chemical Dosing

The Contractor, in their offer, shall provide details of the proposed chemical dosing systems and expected chemical usage, if required.

5.10.1 Delivery and Storage

The delivery and storage of chemical dosing systems shall comply with relevant Australian Standards and Codes, including, but not limited to:

• Dangerous Goods Safety Management Act 2001, and
Bunding shall be provided for chemical storage in accordance with current legislation. Due to the remote location of Cunnamulla, bulk chemical delivery may not be feasible. The Contractor shall provide in their offer the proposed delivery and storage method for proposed chemicals including chemical usage, storage requirements, proposed chemical delivery, frequency of delivery and cost of supply and delivery of chemicals.

5.10.2 Dosing Pumps
Dosing pumps for each chemical shall be installed in a duty/standby configuration with calibration tubes and rotameters (flow measurement) for dilution water. The provision of a potable water connection for flushing dosing lines shall be provided.

5.11 Mains Power
The existing plant does not have a mains power supply or connection to the network. The Contractor is responsible for undertaking any investigations, design of the connection of the new power supply, preparation and lodgement of the power supply applications and management of the energy supplier to achieve the upgrade within the project programme. Paroo Sire Council will pay any application fees direct to the energy provider. The Contractor is responsible for:

- Preparation and submission of required applications to the energy provider for the installation of a new power connection;
- Management of the energy provider;
- Provision of new power supply mains; and
- Provision of new supply authority metering panel.

5.12 Site Facilities

5.12.1 Control Building
The Contractor shall provide a new control building for the STP. A demountable building will be accepted for the control building. The demountable building shall be installed on adjustable supports or be designed to minimise impact of differential settlement. Supports or plinths shall be grouted such that the water does not pool around structural members. The control building shall include, as a minimum:

- Office area and desk suitable for two persons with:
  - A minimum area of 6m²,
  - Desktop for 2 persons,
  - Air conditioning,
  - Lighting, electrical, data etc. for connection of computers,
  - UPS connection for SCADA computer,
- Onsite Laboratory inclusive of:
  - Laboratory bench inclusive of sink, storage cupboard etc.
  - Provision for potable water supply with Hot/cold taps.
  - Suitable flooring,
  - Minimum 4 x GPO’s for equipment connection,
  - Air conditioning, and
  - Ventilation.

The Contractor shall provide unisex ablutions in a stand-alone building or as part of the control building which shall include, as a minimum:

- Toilet,
- Hand basin, and
- Shower.

All drain waste from the control building and ablutions block shall drain to return pump station.
If a custom build operator building is proposed, it shall be constructed using masonry blocks or brickwork with colour bond roofing.

5.12.2 Site Storage
The Contractor shall provide a site storage shed with a minimum useable area of 10m². The storage shed will be utilised for the storage of critical spares and general maintenance equipment. The storage shed shall be constructed on a concrete slab with a suitable grade to avoid pooling of water around the fixings etc. Manually operated lighting shall be provided in the storage shed.

5.12.3 MCC Building
The Contractor shall provide a new MCC building. A demountable building will be accepted for the MCC building. The demountable building shall be installed on adjustable supports or be designed to minimise impact of differential settlement. Supports or plinths shall be grouted such that the water does not pool around structural members. The MCC shall building shall be air conditioned. The design and installation shall be in accordance with AS/NZS 3000.

5.12.4 Operator Parking
No parking is required within the STP boundary. Operators will park vehicles in the current turning area outside of the plant entrance.

5.13 Noise and Odour
The Contractor shall design a treatment plant with the provision of odour mitigation at the source. This is not limited to the inlet works, secondary treatment tanks and pump stations. The plant shall be designed to minimise equipment vibrations. Blowers shall be installed within acoustic enclosures to minimise noise.

5.14 Sludge Handling
5.14.1 Existing Drying Beds
The existing sludge drying beds may be retained and utilised. If the Contractor proposes to utilise the existing drying beds in the upgraded plant design, they shall be included in all design documentation, drawings, safety workshops, HAZOPs and the like. The Contractor shall be responsible for the design of the drying beds and shall provide any capacity upgrades, if required. The Contractor shall inspect and upgrade the existing drying beds drainage system and associated filtrate pump station as required. The pump station consists a precast manhole with a small water pump powered by a single solar panel. The pump station may be decommissioned and replaced with a suitably designed pump station to service all drainage and returns required for the upgraded plant.

5.15 Signage
The Contractor shall provide all relevant signage required by current legislation. The signage shall comply with AS1319 – Safety Signs for the Occupation Environment. The signage shall warn of all occupational safety and environmental hazards associated with the site including, but are not limited to the following:

- Site Personal Protective Equipment (PPE) requirements;
- Eye protection signage;
- Caution – Moving machinery;
- Caution – equipment starts automatically;
- Caution – Aerated water;
- Effluent – do not drink;
- Safety signage, including emergency showers and eyewash;
- Danger – high voltage;
- No smoking;
- HAZCHEM (as appropriate);
• Confined space; and
• Working at heights.
6. Mechanical Equipment

6.1 General

All equipment, pipework, valves, fittings, fixings shall be designed in accordance with this specification, relevant Australian Standards, State and Federal Acts. All major equipment including but not limited to pumps and blowers shall be installed in a duty/standby configuration (i.e. 100% installed capacity) in the case of failure. The remote location and limited resourcing in Cunnamulla may contribute to prolonged equipment unavailability. Common parts of equipment shall be interchangeable wherever possible. The Contractor shall supply all special tools and personnel access necessary to operate and maintain the plant. Special tools are any tools not readily available at standard retain tool outlets in Australia.

Equipment shall be designed to be maintained with minimal disruptions to the operation of the plant. All equipment shall be designed to provide the maximum protection inclusive of, but not limited to equipment guards, covers, emergency stop and safety interlocks. All moving parts shall be provided with guards in accordance with relevant Australian Standards, codes and legislative requirements.

6.1.1 Access

All mechanical equipment shall be designed to provide easy access for operation and maintenance activities. A minimum of 1000 mm clearance shall be provided to facilitate maintenance activities. Access stairs, walkways and platforms shall be provided with a minimum clear width of 800 mm and be designed in accordance with AS1657.

6.1.2 Wetted Steelwork

All wetted steelwork, or steelwork exposed to any corrosive environment shall be grade 316 stainless steel.

6.1.3 Labelling of Assets

All equipment associated with the treatment facility shall be permanently labelled with a grade 316 stainless steel label to allow identification of assets within the field. The tag numbers shall be as per the corresponding Piping & Instrumentation Diagrams (P&ID). All equipment shall have the identification number as shown on the P&IDs permanently affixed to the equipment to facilitate easy identification for operation and maintenance purposes. All submerged equipment shall have a duplicate label supplied and affixed to the platform, guide rails etc. adjacent to the equipment for ease of viewing. All piping shall be labelled in accordance with AS1345.

6.1.4 Grouting of Equipment and Supports

All mechanical equipment, pipe supports, and the like shall be set and aligned using jacking screws, levelling bolts or steel packing, once equipment has been alighted by primary method, the base shall be grouted into position. The grout shall be installed such that pooling of water is avoided. 40 Mpa Non-shrink grout shall be utilised for grouting equipment and pipe supports in place, with a minimum bed height of 35 mm.

6.1.5 Dissimilar Metals

All dissimilar metals shall be isolated using minimum 3 mm barriers installed to prevent galvanic corrosion. For bolted connections, fibre washers with sleeves or an approved equivalent shall be provided. All isolation materials shall be suitable for installation in the intended environment and UV resistant.

6.1.6 Lifting Equipment

Davits or suitable lifting equipment shall be provided for submersible equipment such as mixers or pumps to facilitate the removal for maintenance and inspection without the requirement for draining or dewatering. The davit shall be structurally designed to AS1418 and stamped as lifting equipment with the safe working loads (SWL) and inspection requirements clearly stamped on the lifting equipment. The SWL for the davit shall be load rated for the required masses, with allowance for wet debris (sludge/screenings), lifting chains, piping etc. which may be attached to the unit. The lifting equipment is to include 316 stainless steel manual lifting hoist, which is suitable for exterior mounting and operation (i.e. installation in corrosive environment). The davits shall be manufacture red and coated for exposure to raw sewage.
6.2 Vendor Supplied Equipment

All Vendor supplied equipment shall be incorporated into the Contractors detailed design drawings and documentation. This includes, but is not limited to design drawings, schedules, design reports, equipment data sheets, STP operating philosophy and functional descriptions.
All Vendor supplied equipment shall be submitted to the Principal for approval prior to procurement.
Any changes or modifications to Vendor supplied equipment shall be incorporated into the as-constructed drawings and documentation.

6.3 IP Rating

All equipment and instrumentation shall have a minimum rating of IP56.

6.4 Asset Life

All vendor supplied equipment shall be suitable for operation in the intended service within a corrosive environment.
All vendor equipment shall be designed to provide the minimum design life specified in Table 5 – Minimum Design Life.

6.5 Guarantees

The Contractor shall be responsible for providing guarantees that the equipment or instrumentation provided has been selected to meet the design criteria and is capable of efficiently performing to the requirements of this specification and the Contractors design.

6.6 Centrifugal Pumps

All centrifugal pumps shall be of standard design and incorporate any additional requirements within this specification. Pumps shall be installed as per manufacturers recommendations.
Pumps shall be supplied as a fully assembled unit coupled and aligned in the factory. Each pump and motor shall be single, or multistage as per the Contractors design and electrically driven. The pump Net Positive Suction Head Required (NPSHR) shall exceed the Net Positive Suction Head Available (NPSHA) by at least 1.5 m at all normal pump operating points.
Pumps shall be provided with permanently lubricated mechanical seal to prevent ingress of fluids. The motor shall be a submersible type motor, sized suitable to the process design requirements with thermal overload protection. The motor and propeller shall be integral to the same shaft.
All pumps shall be provided with flanged outlet connections to AS4087 PN16 unless approved otherwise.
All submersible pumps shall be mounted on dual rounded guide rail systems with duckbill type connection of the pump outlet.
The outline pipework shall be designed to support the weight of the pump when in operation. The guiderail shall be designed to ensure accurate alignment of the pump with the outlet piping.
Pumps shall be supplied with grade 316 stainless steel lifting chains. The chain shall have suitably sized lifting eyes and shackles.
Submersible pump shall be designed for continuous submersion in raw sewage.
All electrical cables shall be suitable sized for the motor operation. All cables shall be of a flexible, heavy duty type suitable for continuous operation in full submersion in water/effluent up to a minimum depth of 10 m. All cables shall be tied to the lifting chain to prevent damage during operation from the propeller blade or removal of equipment.
Dry mounted pumps shall be designed for installation in an unprotected environment, capable for unattended operation with minimum maintenance requirements. Dry mounted pump shall be suitable for operating in all climatic conditions in Cunnamulla. Dry mounted pumps may require additional methods of motor cooling.
Pumps shall be capable of continuous or intermittent operation as per the Contractors design.

6.7 Positive Displacement Pumps

All centrifugal pumps shall be of standard design and incorporate any additional requirements within this specification. Pumps shall be installed as per manufacturers recommendations.
Positive Displacement Pumps, such as rotary lobe or progressive cavity pumps shall be suitable for continuous or intermittent operation.
Progressive Cavity (PC) pumps, the rotor shall be manufactured as a single piece throughout the length, accurately machined. The stator shall be of suitable selected materials for pumping sewage and sewage sludge as per the Contractors design.
Pump design shall be such that dismantling for inspection, maintenance and repair can be undertaken in-situ without the requirement to remove the entire pump.
Pumps shall be designed for installation in an unprotected environment, capable for unattended operation with minimum maintenance requirements. Dry mounted pump shall be suitable for operating in all climatic conditions in Cunnamulla. Provision of motor cooling may be required.

6.8 Blowers

All blowers shall be of standard design and incorporate any additional requirements within this specification. Blowers shall be installed as per manufacturers recommendations. Blowers shall be vendor supplied packaged units with acoustic covers inclusive of pressure relief valves, silencers, intake filters, pressure gauges and non-return valves. The blowers shall be electrically driven. Blowers shall be designed for installation in an unprotected environment, capable unattended operation with minimum maintenance requirements. The Blowers shall be provided in a duty/standby arrangement and be designed for 100% of the require duty.

6.9 Submersible Mixers

All mixers shall be of standard design and incorporate any additional requirements within this specification. Mixers be installed as per manufacturers recommendations. The mixers shall be of a submersible compact mixer propeller design with close coupled motor integral to the mixer. The propeller shall be designed for handling sewage and fibres capable of passing through the Contractor supplied inlet screens. Mixers shall be provided with permanently lubricated mechanical seals suitable for continuous submersion. The mixer shall be suitable for both continuous and intermittent operation. Mixers shall be provided with 316 stainless steel guide rails and lifting chains.
7. Pipework

The Contractor shall design, supply and construct all necessary pipework, fittings and valves with connections to existing infrastructure as required.
All piping shall be labelled in accordance with AS1345 including the fluid type (i.e. raw sewage) and flow direction. Pipes cast into concrete shall be flange class DICL or 316 stainless steel.

7.1 Supply

7.1.1 Ductile Iron Pipes
Ductile iron pipes shall, unless approved otherwise, be Fusion Bond Epoxy (FBE) class K9 and comply with Water Services Association of Australia (WSAA) purchase specification WSA PS-200.
Ductile iron fittings shall be manufactured in accordance with AS2280 and comply with WSA PS-201.
Buried pipelines are to comply with AS 2566 – Buried Flexible Pipelines.

7.1.2 Stainless Steel Pipes
All stainless-steel pipes and fittings shall be of stainless-steel Schedule 10 grade 316 pipe. The pipes shall be sized for suitable pressures to a minimum of PN16.
Blower and air distribution pipe shall be spiral wound 316L stainless steel with flanged connections.

7.1.3 PVC Pressure Pipes
PVC-M pressure pipes shall comply with WSA PS-209.
PVC-M pressure pipes shall be PN16 Series 2 conforming to the requirements of AS/NZS 4765.
PVC-O pressure pipes shall comply with WSA PS-210.
PVC-O pressure pipes shall be PN16 Series 2 conforming to the requirements of AS/NZS 4441.
PVC-U pressure pipes shall comply with WSA PS-211.
PVC-U pressure pipes shall be PN16 Series 2 conforming to the requirements of AS/NZS 1477.
Fittings shall comply with WSA PS-212 or WSA PS-213.

7.1.4 Polyethylene (PE) Pipes
PE pipes shall comply with WSA PS-207.
PE pressure pipes shall be of grade PE100 series 1 to pressure rating PN16 complying with AS 4130.
PE fittings shall comply with WSA PS-208.
PE pressure fittings shall be of grade PE100 series 1 to pressure rating PN16 complying with AS 4129.

7.1.5 Flanges
Where pipes, valves or fittings are scheduled as having a flanged end, the end shall comply with the requirements of AS 4087 PN16 unless specified otherwise. Bolt holes on flanges shall be drilled off center in accordance with AS 4087.

7.1.6 Valves

7.1.6.1 Gate Valves
Gate valves shall be resilient seated and comply with WSA PS-260.

7.1.6.2 Knife Gate Valves
Knife gate valves shall comply with WSA PS-266.
The valves body shall be of a lugged pattern body drilled and threaded to AS4087 bolt pattern. The valve shall be drip tight pressure rated to a minimum of PN16. The valve body shall be of grade 316 stainless steel or ductile iron epoxy coated. The gate and bolts shall be of grade 316 stainless steel. The valve spindle and gland box shall be a minimum of grade 304 stainless steel. The packing shall be PTFE based. The gate shall be of beveled edge design and shall be resilient seated.

7.1.6.3 Non-return Valves
Non-return valves shall comply with WSA PS-264.
Cast-iron non-return valves shall comply with the tests and requirements of AS 3578 "Cast-Iron Non-Return Valves for General Purposes."
Non-return valves of nominal diameters equal or greater than 100 mm shall be of full bore, swing action straight pattern PN16. Wafer type valves and tilting disc type valves shall only be accepted for pipelines with nominal diameters less than 100 mm

7.1.6.4 Valve Extension Spindles
Valve extension spindles shall, unless noted otherwise, comply with WSA PS-262. Valve extension spindles shall be machined from either high tensile brass or grade 316 stainless steel where specified. All above ground valves should be provided with removable ‘hand wheels’.

7.1.7 Actuators
Actuators for valves shall be of on/off operation and electrically powered. The actuators shall be powered by an electrical motor driven through a gearbox. Actuators shall provide open and close feedback to the control system. Moving parts on actuators shall be guarded to prevent injury to personnel. Actuators shall be sized to overcome losses in actuation from friction, differential system pressure, seating and fluid service. Automatic actuators are to be provided with a manual override handwheel. Electrical components shall be designed with an IP56 minimum rating. Actuators shall be provided with local and remote controls to allow complete control of the valve at both locations. Position indication shall be provided for all actuated valves.

7.1.8 Fasteners
All bolts, and washers used in the assembly of flanged pipes, joints, valves and fittings shall be of Grade 316 stainless steel. Nuts shall be manufactured from stainless steel Grade 304. Nickel based anti-seize lubricant shall be applied for treatment of all stainless-steel bolts, nuts and washers. Stainless steel bolts and nut shall comply with the metric standards AS 1111 and AS 1112. All fasteners are to be tensioned in accordance with the specific equipment manufacturers recommendations. All bolt lengths shall be selected to ensure no more than three (3) threads are exposed after tightening.

7.1.9 Gibault Joints
Gibault joints and other mechanical couplings shall comply with WSA PS-311 and shall be the elongated type with Grade 316 stainless steel bolts and Grade 304 stainless steel nuts.

7.1.10 Dismantled Joints
Dismantling joints shall be manufactured with dual flanges to AS 4087 dimensions and shall be manufactured in accordance with AS 4998. DI dismantling joints shall be coated/lined with fusion bonded polymeric lining to AS/NZS 4158 and supplied in accordance with WSA PS-201.

7.1.11 Pipe Supports
Where not specifically designed and detailed, pipe supports shall be proprietary supply items. Prior to ordering proprietary pipe supports, the Contractor shall submit support manufacturer and technical details to the Superintendent for review and approval. All pipe supports and saddles shall be hot dip galvanised or stainless-steel grade 316L.

7.1.12 Manholes
Precast concrete manholes shall comply with AS 4198, and cement shall be type SR. The cement content shall not be less than 450 kg/m3 of concrete and the characteristic strength of the concrete shall be 50 MPa minimum. Aggregate durability shall be in accordance with AS 2758.1, Clause 9 and exposure condition C. Minimum cover over reinforcement shall be 40 mm internally and 25 mm externally, except at joint ends where cover shall be not less than 20 mm. Each component shall have two lifting inserts, each having safe-lift rating of at least one (1) tonne. The lifting elements shall be corrosion resistant and shall not affect the corrosion resistance of the reinforcement. The lifting elements shall be fitted such that the pre-cast component will hang horizontally (mating surfaces) when lifted. Elastomeric joint seals shall comply with AS 1646, EPDM. Preformed flexible joint sealants shall comply with ASTM C 990M, butyl rubber sealant. Manholes shall have product certification (ISO Type 5) to AS 4198. All products shall be marked in accordance with the certification body’s requirements. The suppliers of products shall certify that their products comply with the requirements specified.

7.2 Storage and Handling
The ends of all pipes shall be covered to prevent the ingress of debris, wildlife and internal contamination. Flanged and threaded ends of pipe shall be protected to prevent damage to threads and flange faces during transport.
All pipe shall be packaged in such a manner to prevent damage to external coating and lining including strapping to prevent chaffing during transport, unloading and storage at site. Storage of piping shall be on dunnage or pallets not in direct contact with the ground. Rubber and plastic piping and fittings shall be protected from weather and direct ultraviolet light.

7.3 Installation - Buried Pipework

7.3.1 Excavation
A survey of existing services shall be completed prior to excavation for new pipelines. Where services are identified which aren’t on approved drawings the Contractor is to identify the service and advise the Principal to provide direction. Trenches shall be kept free of water during installation to prevent degradation of the trench. Any over-excavation shall be replaced with bedding material compacted to the same density as bedding specified on the approved design drawings.

7.3.2 Bedding, Embedment and Laying
All pipelines shall be bedded within a trench shown on the approved design drawings. The bedding material shall be level across the trench and to a minimum depth as specified on the detailed design drawings. All pipes shall be supported uniformly along the length of the pipe barrel. Where poor ground conditions are encountered, the pipe shall be supported using bridging layers, timber pipes or approved alternatives. Installation of piping and valves should be completed utilising temporary supports to ensure no undue stresses are applied to equipment, piping or valves during the installation process. Alignment of all piping and equipment should be confirmed prior to tensioning of fasteners. Alignment should be checked during the tensioning process to ensure equipment is not pulled out of alignment. Valves shall be installed with the operator nominally vertically upward or aligned between horizontal and vertically up. The angle of the operator is determined based on safe access and operability. Valve operators should never be orientated vertically down. Isolation valves should be provided upstream of all process equipment including actuated valves and pumps and downstream where there is potential for backflow during isolation. All piping connections to equipment and instrumentation shall be accommodate dismantling. This may include dismantling joints, adjacent flanged elbows, couplings, gibaults, unions and loose coupled flange. Instrumentation shall be installed readily accessible with all instrument screens/gauge faces in a readable position during operation. Gravity sewage pipelines shall be bedded, embedded and laid in accordance with WSA-02. Sewage pressure piping shall be bedded, embedded and laid in accordance with WSA-07.

7.3.3 Backfilling
All piping trenches shall be backfilled in accordance with WSA-02 for gravity sewage piping and WSA-07 for pressure sewage piping. For select fill use excavated material, free from organic matter and having a particle size no larger than 20 mm. The material shall be suitable to allow compaction as specified without causing damage to the pipeline. If material from the excavation does not comply, import non-cohesive material. Where the trench is not subject to traffic loading excavated material may be used for fill in the trench fill zone provided it has a particle size no greater than 75 mm across the largest dimension, is free from organic matter and can be placed into a dense mass free of voids and cavities.

7.3.1 Polyethylene Sleeving
Buried ductile and cast-iron items shall be sleeved with polyethylene fixed with PVC tape. The sleeving shall be installed in accordance with AS 3681. The polyethylene shall not be exposed to ultra-violet light both before and after laying for more than a total of seven (7) days. Colored polyethylene sleeving (colour to suit the service application) shall be used throughout, adhesive tape, strap and buckle shall be used in accordance with AS 3680. Rolls shall be supplied with protective end flanges and shall be perforated at 6.1 m intervals.

7.3.2 Thrust Blocks
Thrust blocks shall be designed in accordance with WSA. Thrust blocks shall be installed at all locations nominated on the approved drawings. Contrite shall be installed in accordance with the specific details of the drawings. Thrust blocks shall be built symmetrically around the nominated area and shall not be installed until the line has been laid and jointed.
7.4 Installation – Above Ground Pipework

7.4.1 Site Run Pipework
All above ground pipework of size DN50 or smaller may be site run. Site run piping shall be shown on the P&ID’s. Indicative pipe routes for small bore piping shall be shown on the general arrangement drawings. The site run pipework shall be such that all instruments, valves and fittings are readily accessible for operations and maintenance. The Contractor shall install site run pipework to the approval of the Superintendent as shown on the general arrangement drawings. Site run pipework shall be marked up and clearly shown on the approved As-Constructed drawings, inclusive of general arrangement and sectional drawings.

7.4.2 Aeration Pipework
All nuts, bolts and washers shall be grade 316 stainless steel. Anti-galling paste shall be applied to all threads. All blower pipework accessible to operational personnel shall be lagged to prevent burns.

7.4.3 Pipe Supports
All pipe supports shall be 316L stainless steel or hot dip galvanised mild steel. Mild steel supports shall be fabricated with all bolt holes drilled prior to galvanizing. Site drilling of mild steel galvanised supports will not be permitted. The Contractor shall install 5mm EPDM rubber inserts between pipe supports and pipework to ensure the pipe coating is not damaged or to prevent galvanic corrosion in the case of dissimilar metals. Supports shall be fastened using 316L stainless steel chemical anchors set into the concrete foundation and a 35mm 40MPa non-shrink grout bed between the base plate and foundation. All saddle fasteners shall be 316 stainless steel.

7.4.4 Labelling
All above ground pipework shall be coloured and labelled in accordance with AS1345.

7.5 Cleaning and Flushing
Upon completion of the installation of piping, all pipework shall be flushed and cleared of all debris prior to testing. Temporary strainers shall be utilized when flushing pipework to prevent damage to equipment. Strainers should be checked and cleaned periodically during flushing. All equipment with potential to be damaged during cleaning and flushing shall be bypassed or removed and from the system and replaced with temporary pipework. Temporary pipework shall be removed, and equipment reinstated with new gaskets and fasteners prior to testing commencing.

7.6 Inspection and Testing
All gravity sewage piping shall be inspected and tested in accordance with WSA-02. All pressure sewage piping shall be inspected and tested in accordance with WSA-07.
8. Earthworks

8.1 General

All civil and earthworks workmanship shall be in accordance with the requirements of this specification, WSAA and relevant Australian Standards. A Geotechnical Investigation Report provided by Douglas Partners and is available in Appendix B.

This section of the Specification sets out the requirements for:

a) Bulk excavation of the site;

b) Execution of groundworks necessary to complete the works, including but not limited to site clearing, grading, excavation, dewatering, disposal of spoil, filling and backfilling consolidation and other operations specified herein.

8.1.1 Standards

Pursuant to 1.8.1 Standards, relevant standards include:

- AS 1289 Methods for testing soils for engineering purposes; and

8.1.2 Definitions

The definition of terms used in these specification notes are shown in the table below.

<table>
<thead>
<tr>
<th>Terms</th>
<th>Definition</th>
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<tbody>
<tr>
<td>ROCK</td>
<td>Any natural or artificial material encountered in the excavation which cannot be removed until broken up by explosives or mechanical means such as rippers, jackhammers or percussion drills.</td>
</tr>
<tr>
<td>RIPPABLE ROCK</td>
<td>Means rock which can be removed by a ripper.</td>
</tr>
<tr>
<td>NON-RIPPABLE ROCK</td>
<td>Means all other rock.</td>
</tr>
<tr>
<td>OTHER THAN ROCK</td>
<td>All other material encountered in excavation</td>
</tr>
<tr>
<td>SUB-GRADE</td>
<td>The natural ground below excavations</td>
</tr>
<tr>
<td>FILLING</td>
<td>A general term for all material spread and compacted over the sub-grade to make up finished levels or levels to the underside of the base.</td>
</tr>
<tr>
<td>SUB-BASE</td>
<td>Selected filling spread and compacted over the subgrade to make up levels to the underside of the base.</td>
</tr>
<tr>
<td>BASE</td>
<td>A selected filling layer spread and compacted to form an acceptable working surface directly under the building or building element.</td>
</tr>
</tbody>
</table>

8.2 Erosion and Sedimentation Control

Temporary erosion and sedimentation control measures shall be undertaken by the Contractor to meet the requirements of its Environmental Management Plan. Refer to “Queensland Development Construction Specification C211, Control of Erosion and Sedimentation”.

8.3 Site Investigations

The Contractor shall be satisfied that any site investigation information supplied with the Tender documents is sufficient for their purposes. Otherwise, they shall conduct a site investigation appropriate to the extent of the excavation works. Any site investigation reports or other information which are supplied with the Tender documents or which may be made available are given in good faith as a guide to Tenderers. No responsibility can be taken for their accuracy or applicability over the site.
8.4 Site Clearing
The site shall be cleared existing infrastructure and trees, as required. The earthworks required includes stripping of areas required to allow for the construction and installation of new infrastructure and associated foundations. Stripping shall include removal of any unsuitable materials.
Remove organic debris including peat, timer, tree trumps, roots, logs, branches, scrub and the like from areas to be excavated.
Remove boulders occurring on the surface in areas to be excavated.
Remove rubble remaining from excavations.
Remove all excavated material from the site and dispose of to the satisfaction of the Principal.

8.5 Buried Waste
Areas of the site proposed for the upgrade works are contaminated by buried waste material including screenings and grit. This is generally the area adjacent to Primary Treatment Train 1. The depth and locations of buried waste is unknown, anecdotally it is up to 1m in depth. The geotechnical investigation report indicates uncontrolled fill between 0.4m and 1.3m depth.
Where the waste material impacts on the structural integrity of the proposed upgrade works, it must be removed and replaced with CBR 15 selected fill compacted in layers not exceeding 200mm loose thickness to 95% standard density ratio.

8.6 Site Preparation and Bad Ground
The Contractor shall be completely familiar with the soil conditions likely to be encountered during the excavation works (Geotechnical Investigation Report provided in Appendix B) and shall excavate all types of materials found.
The Contractor shall remove all unsuitable fill material from the base of the dewatering building to a minimum depth of 0.3m below the unsuitable material and replace with approved imported fill material as controlled fill with minimum CBR 15 compacted to 95% standard density.
Full time supervision of fill placement and compaction testing to a ‘Level 1’ standard, as defined in Section 8 of AS 3798-2007 is required. Upon completion of the filling a ‘Level 1’ report must also be prepared, stating that the filling has been completed in accordance with the Geotechnical Investigation Report provided in Appendix B.

8.7 Excavations
Suspend any groundworks during inclement weather which would result in unsatisfactory work. Excavations shall be accurate to shape and profile and free from loose earth and stones.
Excavated material should only be used for backfilling around structures and where approved by the Principal for reuse. All excavations shall be kept dewatered to prevent any degradation to the excavated surface and maintain stability.
The Contractor shall ensure all necessary measures are taken to prevent unauthorised access to all excavations. Hard barricading, security fencing, secure cover or backfilling may be required to prevent access and make the area safe. Any excavations with a depth equal to or greater than one and a half (1.5) meters shall have a provision for benching, battering or shoring.

8.8 Supporting Excavations
Providing all shoring, planking and strutting necessary to retain the sides of the excavations, and to ensure a safe working environment. Provide any necessary needling, shoring and strutting adjacent to existing infrastructure.
If, in the opinion of the Principal, any support provided is insufficient, he may order the provision of additional support. No instruction shall relieve the Contractor of sole responsibility for the sufficient support of the excavation.
Guard against the formation of voids outside sheeting or sheet piling if used, and should any voids form, fill and consolidate them to approval. Remove shoring and timbering progressively as the work proceeds unless otherwise instructed.

8.9 Filling and Compaction
a) SOURCE OF FILLING: Import filling onto the site from an approved source and use of material excavated from site, if approved by Geotechnical Engineer.
b) FILLING TYPES: Filling shall be sounds, free from material which is perishable, or which shall not form stable fill and the following types: -
i) IMPORTED FILL: The imported fill material shall be in compliance with the recommendations from the Geotechnical Engineer and at a minimum should be clean of gravel, sandy gravel, sand or other
predominately granular materials (100% less than 200 diameter and not more than 25% passing through No. 200 sieve)
ii. POROUS FILLING: Crushed rock or clean, hard, unweathered stone, graded from 40mm to 15mm.
c) FILLING LOCATIONS: Fill includes, but is not necessarily limited to the following: -
   i. Backfill: Approved excavated material unless otherwise specified;
   ii. Backfill: Against boundary walls under footpaths; comply with local authority requirements;
   iii. Grub holes and similar voids: Approved excavated material;
   iv. Around sub-soil drains: Porous filling; and,
   v. External unpaved filled areas: Approved excavated material.

Filling and compaction shall be in conformance with the Geotechnical Report provided in Appendix B.

8.10 Footings

Site classification is Class P for the current site due to the presence of uncontrolled fill. Refer to the Geotechnical Investigation Report in Appendix B.

Allowable bearing capacity for high level footings within controlled fill is 100kPa, Loose Sand 150kPa and Medium dense sand of 200kPa in accordance with the Geotechnical Investigation Report.

The Contractor is responsible for satisfying themselves of the existing ground conditions and undertaking any investigations required.

8.11 Retaining Structures

Retaining structures shall be designed in accordance with AS4678:2002 -Earth Retaining Structures. Refer to the Geotechnical Investigation Report provided in Appendix B.

8.12 Excess Excavations

Excess excavation and consequent additional backfilling, compacting or testing shall not justify Contract variation or extension of time.
Where excavation exceeds the required depth, fill back to correct depth with material as follows: -
   • Below slabs on Ground: Imported fill; and,
   • Below Footings, Beams and other Structural Elements: Concrete of strength equal to the structural element, minimum 15 MPa.

In Service Trenches: 1:2:4 concrete or approved compacted pipe bedding material.

8.13 Surplus Material

Tenderers shall familiarize themselves with the site before lodging submissions. Where it is required to remove spoil from site and where such spoil may be subject to any restrictions considerations and associated restrictions, this will be the total responsibility of the Contractor. Any approvals needed for transportation of fill or placement of fill on another site shall be obtained by the Contractor.

8.14 Rehabilitation and Restoration

All areas disturbed, destroyed or demolished during construction shall be restored as near as practicable to their pre-existing condition. The areas shall be restored or improved to a similar or better condition with improvements including revegetation with grass tress and the like.
Topsoil removed shall be stockpiled for later reuse where stockpiles are not sufficient for restoration approved imported topsoil shall be used.
All restoration is to be completed progressively as the works are executed. Temporary restoration may be required to maintain a workable area during construction.
8.14.1  **Turf and grassed areas**

Areas that were previously grassed areas or subject to risk of erosion shall be restored to meet similar conditions of the previous lawns. After earthworks are complete including backfilling and settlement, topsoil shall be spread and levelled to suit the surrounding area. Seeded grass common to the area shall be spread. The newly seed shall be lightly top dressed and watered following installation. The seeded grass area shall require regular watering until growth is established. The seeded area is to remain undisturbed and regularly watered until sufficient regrowth in the area is achieved a minimum of eight (8) weeks.

8.14.2  **Roads**

Temporary restore all trenches through existing roads with backfill and road base and maintain in a trafficable condition until final restoration is completed.

8.14.3  **Settlement**

Settlement of areas during the construction phase and defects liability period from trenching activities or the like shall be made good by backfilling the area with approved fill. Where settlement has occurred in grassed, turfed or road areas the areas shall be back filled and repaired in accordance with applicable sections.
9. Concrete Specification

9.1 General

All structural design, construction and workmanship shall be in accordance with the requirements of this specification, WWSA and Australian standards. This highest requirement shall take precedence.

It is to be noted that the availability and quality of ready mixed concrete in Cunnamulla is poor. The Contractor will be required to work closely with suppliers to ensure quality of concrete is supplied. The Contractor may be required to mobilise a concrete batching plant.

9.1.1 Extent of Works

The extent of the concrete work shall include but not be limited to the following:

- Design, documentation, providing, erecting and removing of all formwork;
- Carrying out the reinforced concrete works in accordance with the construction sequences shown on the approved drawings;
- Supplying and fixing of all reinforcement;
- Supplying and fixing of all inserts, anchor bolts, embedded fixings, waterstops and bars;
- Providing for all core holes and embedded services;
- Providing for all additional formwork and reinforcement for construction joints and materials handling penetrations as required to carry out the works;
- Supplying and placing of all concrete;
- Sampling and testing of concrete and its components;
- Finishing of all concrete surfaces; and,
- Curing and protecting of all concrete.

9.1.2 Responsibility

The Contractor shall be wholly responsible for carrying out all concrete works in accordance with the requirements of this specification and the associated Contract documents.

9.1.3 Standards

All concrete work shall conform to the materials and construction of the current Codes and Standards listed in the appropriate section of this specification, except where modified by this specification.

9.1.4 Supervision by Contractor

The Contractor shall employ on the site, a Foreman Concreter, whose sole responsibility shall be the supervision of the concrete work.

The Foreman shall be in attendance when the Principal inspects the work prior to concreting, and shall organise and direct the placing, compacting and finishing of the concrete, during which operation, he shall be in continuous attendance.

9.1.5 Inspections

The Contractor shall allow for and give sufficient notice of all inspections required by the Principal as stipulated in the various sections of this specification.

The Contractor shall permit and arrange for access to all areas of the works on supplier’s plants to enable the Principal to carry out all necessary inspections.

9.1.6 Samples and Tests

The Contractor shall allow in his price for the taking and testing of all samples and tests specified in this specification.

9.1.7 Acceptance and Rejection

The concrete work shall be accepted or rejected in accordance with the requirements of this specification.
9.1.8 Construction Procedures
The Contractor is responsible for his construction procedure and must ensure that no part of the structure is overstressed as a result of this procedure or as a result of the construction loads which are applied. The Contractor shall provide calculations for examination by the Principal if requested to justify the adequacy of the structure to sustain any loads and/or procedures which he may intend to impose.

9.2 Formwork

9.2.1 General

9.2.1.1 Scope
This section of the specification for concrete sets out the requirements for the design, supply, fabrication, erection, treatment, testing and stripping of the formwork for all the concrete members.

9.2.1.2 Requirements
Formwork shall be designed and constructed to produce concrete members which shall conform within the specified tolerances to the shapes, lines, levels and dimensions and quality of surface finish required by the approved drawings.

9.2.1.3 Responsibility
The responsibility for the sufficiency of the formwork shall rest entirely with the Contractor.

9.2.1.4 Definitions
In this section, "Formwork" shall mean boarding or sheeting designed and erected to contain plastic concrete, form it to required shapes and dimensions in the required location, support it until sufficiently hard to be self-supporting and carry superimposed loads. "Forms" shall mean that part of the formwork which consists of the sheeting and its immediate supporting or stiffening members. "Falsework" shall mean that part of formwork which consists of a temporary structure necessary to keep the forms in their correct position.

9.2.1.5 Codes and Standards
Formwork shall conform to the current requirements of the following Codes and Standards except where modified by this specification:

- AS 3610 Formwork for Concrete

Where applicable, technical terms in this specification shall have the meanings assigned to them in AS 3610 - Formwork for Concrete.

9.2.2 Dimensional Tolerances
The design and construction of the formwork shall be such that the concrete produced from the forms shall conform to the dimensional requirements, lines, levels, cambers and grades given on the approved drawings within the dimensional tolerances specified for each part of the works. The dimensions, lines, levels, cambers and grades of the formwork shall be checked by the Contractor immediately prior to the placing of the concrete. The dimensional tolerance requirements vary according to the quality of the work and the importance of the particular dimension and are controlled by the class of surface finish. Refer to the drawings and "Schedule of Finishes" for classes and locations of finishes. The tolerances of concrete surfaces shall conform with the tolerances of AS 3610 for the specified classes of surface finish.

9.2.3 Formwork Design
The formwork shall be designed in accordance with Section 4 of AS 3610 and in particular with the relevant sections of this specification.

9.2.3.1 Stability
Formwork shall be constructed from sound materials properly supported and braced or tied to maintain position and shape during and after the placing of concrete.

9.2.3.2 Defective Formwork
Should any formwork be displaced during concreting or within the period specified for retention of the formwork so that tolerances on finished concrete shall be exceeded, concrete shall be removed between such limits as the Principal shall
determine. Construction joints shall be formed and the section of work shall be reconstructed after the formwork has been strengthened and adjusted.

9.2.4 Types of Formwork

The types of formwork required throughout the project shall be determined by the Contractor to achieve the surface finishes and the shapes, lines, levels and dimensions of the concrete work required by the approved drawings and this specification. Unless otherwise shown on the drawings, forms shall be chamfered for re-entrant angles and filleted for corners. The face of the bevel in each case shall be 25mm. The materials to be used in the formwork shall comply with the appropriate Australian Standards or in their absence, the appropriate American or British Standards.

9.2.5 Inspection of Formwork

Inspections of formwork shall be carried out by the Contractor prior to placement of concrete to ensure its adequacy.

9.2.6 Treatment

9.2.6.1 Form Linings and Facings

The Contractor shall select the form lining or facing necessary to produce the required quality of finished concrete surface. He shall provide evidence to ensure that no reaction which shall adversely affect the concrete surface shall occur between the form lining, form facing, the release agent, the plastic concrete, any concrete material, admixture, sealant or curing compound. The selection of a suitable lining or facing shall also take into account any effect it may have on subsequent finishes to the concrete such as paint, adhesives and the like.

9.2.6.2 Release Agents

Form linings or form facings shall be coated prior to placing of concrete with a suitable release agent which also satisfies the requirements of "Form Linings and Facings" of this clause. The Contractor shall ensure that the release agent does not "puddle" due to excessive application and so cause staining or retardation of the concrete surface. No part of the reinforcement or construction joints shall be coated with the release agent. Where colour control of a concrete surface is required by this specification, then prior to the first use of a form lining or facing (and subsequent to the application of the release agent), it shall be coated with a cement wash which, after drying, shall be removed and the lining or facing then made ready for use by again coating with the release agent.

9.2.6.3 Cleaning of Forms

Forms shall be thoroughly cleaned and dust, debris, rust or other stains shall be removed. Free water shall also be removed from the forms. Minor debris, dust, etc. shall be removed by vacuum cleaning, compressed air or the equivalent.

9.2.6.4 Re-use of Forms

The number of re-uses and the conditions of faces and edges of forms shall be consistent with the concrete surface finish specified.

9.2.7 Finished from Forms

9.2.7.1 Classification of Form Finishes

The surface finishes required from forms in the various concrete elements of the structure shall be in accordance with AS 3160. Refer to the drawings and "Schedule of Finishes" for the classes and location of finishes.

9.2.8 Form Bolts

Form bolts shall be designed so that they may be extracted without damaging the surrounding concrete. The embedded part of all form ties shall be located no closer than 25mm to the surface of the finished concrete. Where form bolts are used, make allowance for patching to ensure water tightness in accordance with AS 3735.

9.2.9 Stripping and Removal of Formwork

Removal of formwork and falsework shall be in accordance with Clause 19.6.2 of AS 3600 or Clause 5.4.3 of AS 3610 as appropriate, except where varied by this specification or otherwise approved by the Principal. The forms shall not be disturbed until the concrete in contact with them has hardened sufficiently to withstand such action without damage. Formwork shall not be removed until the concrete has acquired sufficient strength to support safely its own mass and any superimposed load without exceeding an acceptable deflection. The stripping procedures shall be carried out in a controlled and planned manner that ensures the gradual transfer of load from the formwork or supports to the permanent structure.
9.2.9.1 Stripping Times - In-situ Suspended Work

The stripping of formwork shall be carried out in accordance with AS 3610.

9.3 Reinforcement Supply

9.3.1 General

9.3.1.1 Scope

This section of the specification for concrete sets out the requirements for the supply of the reinforcement for all reinforced concrete members of the structure.

9.3.1.2 Responsibility

The Contractor shall be responsible for the supply of the reinforcement together with all the wire, support chairs etc., necessary for the fixing of the reinforcement in accordance with this specification and the associated Contract documents.

9.3.1.3 Codes

The reinforcement shall conform to the current requirements of the following SAA Codes, except where modified by this specification.

- AS 3600 Concrete Structures
- AS 3735 Concrete Structures for Retaining Liquid
- AS 1302 Steel Reinforcing Bars for Concrete
- AS 1303 Hard-Drawn Steel Reinforcing Wire for Concrete
- AS 1304 Hard-Drawn Wire Reinforcing Fabric for Concrete

9.3.1.4 Supports and Reinforcement

Chairs, spacers, stools, hangers and ties may be used as supports for reinforcement and shall be made of metal, concrete or plastic but pieces of wood, aggregate, brick or the like shall not be used. Unprotected ferrous metal shall not be used in such supports where they extend to the surface of the concrete or where they are used in conjunction with galvanised or zinc coated reinforcement. The supports shall be adequate to withstand construction traffic and shall be sufficient in number and spacing to maintain the reinforcement in its correct position.

9.3.2 Bending, Splicing and Welding

9.3.2.1 Bending

Reinforcement shall not be bent or straightened in a manner which shall damage it. Where bending of reinforcement is required by the approved drawings, the diameter of such bends shall be restricted to the requirements of Clause 19.2 of AS 3600. Reinforcement shall be bent cold with the exception of bars of Grade 250S, 250R and 400Y which may be bent at temperatures up to 450°C (before it reaches cherry-red colour). Heated bars shall not be cooled by quenching. Bent bars shall not be re-bent within 20 bar diameters of any original bend.

9.3.2.2 Splicing

When splices in reinforcement are not shown on the approved drawings and are required by the Contractor, he shall submit details of the proposed splices and obtain approval from the design engineer and Principal.

9.3.2.3 Welding

Reinforcement shall not be welded except where shown on the approved drawings or as requested by the Contractor and approved by the Principal. Such welding shall comply with the requirements of AS 1554, Part 3, Welding of Reinforcing Steel, except where modified by this specification. Welding shall not be carried out within 75mm of a bend having an internal diameter less than 12 bar diameters or at any point in a bar which has been re-bent.

9.3.3 Surface Conditions of Reinforcement

Reinforcement shall be supplied free from loose mill scale, loose rust, mud, oil, grease and other non-metallic coatings which would reduce the bond between the concrete and the reinforcement.
9.3.4 **Fabrication Tolerances**

Unless shown otherwise on the approved drawings, the reinforcement shall be cut and bent or otherwise fabricated to the dimensional tolerances specified in Clause 19.2 of AS 3600.

9.4 **Reinforcement Fixing**

9.4.1 **General**

9.4.1.1 **Scope**

This section of the specification for concrete sets out the requirements for the fixing of the reinforcement for all reinforced concrete members of the structure.

9.4.1.2 **Responsibility**

The Contractor shall be responsible for the fixing of the reinforcement in accordance with the specification and the associated Contract documents.

9.4.1.3 **Codes**

The reinforcement shall be fixed and maintained in position in accordance with the requirements of AS 3600 - Concrete Structures Code, except where modified by this specification.

9.4.1.4 **Inspection**

The Contractor shall give sufficient notice and in any case not less than 72 hours to the Principal of the completion of fixing of the reinforcement and shall allow a further sufficient time and not less than two (2) working hours for the carrying out of the inspection.

9.4.2 **Bending, Splicing and Welding**

9.4.2.1 **Bending**

Reinforcement shall not be bent or straightened in a manner which shall damage it. Where bending of reinforcement is required by the approved drawings, the diameter of such bends shall be restricted to the requirements of Section 19 of AS 3600.

Reinforcement shall be bent cold with the exception of bars of Grade 250S, 250R and 400Y which may be bent at temperatures up to 450°C (before cherry-red colour). Heated bars shall not be cooled by quenching.

Bent bars shall not be re-bent within 20 bar diameters or any original bend. When bends in reinforcement are not shown on the approved drawings and are required by the Contractor, he shall submit details of the proposed splices and obtain approval from the Principal.

9.4.2.2 **Splicing**

When splices in reinforcement are not shown on the approved drawings and are required by the Contractor, he shall submit details of the proposed splices and obtain approval from the Principal.

9.4.2.3 **Welding**

Reinforcement shall not be welded except where shown on the approved drawings or as requested by the Contractor and approved by the Principal. Such welding shall comply with the requirements of AS 1554, Part 3 - Welding of Reinforcing Steel, except where modified by this specification. Welding shall not be carried out within 75mm of a bend having an internal diameter less than 12 bar diameter or at any point in a bar which has been re-bent.

9.4.3 **Surface Condition of Reinforcement**

Until the concrete is cast, reinforcement shall be maintained in a clean condition such that the surface shall be free from loose mill scale, loose rust, mud, oil, grease and other non-metallic coating which would reduce the bond between the concrete and the reinforcement.

9.4.4 **Placing and Fixing of Reinforcement**

Reinforcement shall be as shown on the approved drawings and shall be securely held in its correct position within the tolerances specified herein until the concrete has hardened.

9.4.4.1 **Supports for Reinforcement**

Chairs, spacers, stools, hangers and ties may be used as supports for reinforcement and shall be made of metal, concrete or plastic, but pieces of wood, aggregate, brick or the like shall not be used. Unprotected ferrous metal shall not be used in
such supports where they extend to the surface of the concrete or where they are used in conjunction with galvanised or zinc coated reinforcement. The supports shall be adequate to withstand construction traffic and shall be sufficient in number and spacing to maintain the reinforcement in its correct position. Particular care shall be given to the support of light gauge reinforcement and of reinforcement in general where the concrete is to be cast against the ground. Care shall be taken that no damage occurs to any waterproofing membrane or vapour barrier and a metal or plastic plate or equivalent shall be placed under each chair.

9.4.4.2 Placing Tolerances on Reinforcement
The tolerances on position of reinforcement and tendons shall be as specified in Clause 19.5 of AS 3600.

9.4.4.3 Integrity of Reinforcement
Reinforcement shall not be cut to provide space for core holes or embedments. Any repositioning of reinforcement to provide for them shall be with the approval of the Principal.

9.4.5 Protection in Hot Weather
Where there is the likelihood of an ambient air temperature greater than 32°C during the placement of the concrete, then the reinforcement shall be adequately shaded or sprayed with water so as to maintain its temperature below 32°C.

9.5 Core Holes, Embedded Services, Inserts and Anchor Bolts

9.5.1 General

9.5.1.1 Scope
This section of the specification for concrete sets out the requirements for the provision of core holes and the embedment of service pipes, conduits, inserts and anchor bolts etc., for all trades in the concrete members of the structure.

9.5.1.2 Responsibility
The Contractor shall be responsible for co-ordinating the core and embedment requirements of all trades and for the provision of them in accordance with the requirements of the Contract documents.

9.5.1.3 Location and Details
Where the location and details of the core holes and embedments are shown on the structural drawings of the Contract documents, then such shall be followed. Where such information is not shown, then the Contractor shall submit the requirements of the trades in this respect to the Principal for approval.

9.5.1.4 Inspection
The Contractor shall give sufficient notice and in any case not less than 72 hours to the Principal of the completion of the provision and fixing of all cores and embedments and shall allow a further sufficient time and not less than two (2) hours for the carrying out of the inspection.

9.5.1.5 Codes
The provision of core holes and embedments shall be in accordance with the requirements of AS 3600 - Concrete Structures Code, except where modified by this specification.

9.5.2 Integrity of Concrete and Reinforcement
Reinforcement shall not be cut to provide space for core holes or embedments, nor shall the hardened concrete be cut or cored without the approval of the Principal.

9.5.3 Size, Spacing and Cover of Embedments
Pipes and conduits embedded in concrete shall comply with Clause 19.4 of AS 3600.

9.5.4 Protection
Inserts, anchor bolts and embedded fixings shall be galvanised unless otherwise indicated on the approved drawings or specified under their particular trade. Threads shall be greased and all embedded items shall be covered and protected against damage.
9.6 Joints and Jointing

9.6.1 Joint Location
Joint locations and details are to be shown on the approved drawings. Do not eliminate, vary the location of, or make additional joints without prior approval of the designer.

9.6.2 Joint Surfaces
Dry and clean joints before any jointing material is applied.

9.6.3 Jointing Material
Comply with the jointing systems where they are specified on the approved drawings:

a. Fibreboard Place bitumen - impregnated fibreboard filler against hardened surface prior to concrete pour.

b. Expanding Cork Install an approved pre-moulded expanding cork joint filler in accordance with the manufacturer's instruction.

Leave filler lower than concrete surface to allow for placing of sealant. Use a filler capable of taking up the shrinkage of the concrete and permanently sealing the joint.

9.7 Concrete Supply

9.7.1 General
It is to be noted that the availability and quality of ready mixed concrete in Cunnamulla is poor. The Contractor will be required to work closely with suppliers to ensure quality of concrete is supplied. The Contractor may be required to mobilise a concrete batching plant.

9.7.1.1 Scope
This section of the specification sets out the requirements for the supply of concrete for all concrete members.

9.7.1.2 Responsibility
The Contractor shall be responsible for the supply of the concrete in accordance with this specification and the associated Contract documents. Note – There is no concrete batching plant available in Cunnamulla.

9.7.1.3 Codes
Concrete and its constituent materials shall comply with the current requirements of the following codes and standards except where modified by this specification.

- AS 1129 Fly ash for use in Concrete
- AS 1315 Portland Cement
- AS 1317 Blended Cements
- AS 1379 Ready-Mixed Concrete
- AS 1478 Chemical Admixtures for use in Concrete
- AS 2758 Aggregates and Rock for Engineering Purposes
- Part 1: Concrete Aggregates
- AS 3600 Concrete Structures Code
- AS3735 Concrete Structures for Retaining Liquid

9.7.2 Materials

9.7.2.1 General
Concrete shall be made with Portland cement, coarse aggregate, water and any admixtures that may be specified or approved.
The concrete for various concrete elements of the structure shall contain the specific types of materials listed on the drawings of Concrete Types and Performance Requirements and these shall satisfy the materials requirements of the codes mentioned in ‘Codes’ above.

Where specific types of materials are not required for a particular structural element, then the Contractor shall make a selection from the general types listed below and these shall also satisfy the relevant materials codes. The Contractor shall obtain approval for the use of these materials from the Principal prior to commencement of the work. If requested, submit details of all concrete and obtain approval from the Principal before commencement of work.

9.7.2.2 Cement

All cement shall comply with AS 1315 or AS 1317 and the requirements of AS 3735. Unless noted to the contrary, all cement shall be Type A Portland cement in accordance with AS 1315 or AS 1317 for blended cements. Other cements may be used if approved and if the resulting concrete has strength, durability and other characteristics not inferior to those required by this specification for Portland cement concrete.

9.7.2.3 Aggregate

Dense aggregate shall comply with AS 2758.1.

9.7.2.4 Water

Water shall be free from matter which in kind and quantity is harmful to concrete or its reinforcement.

9.7.2.5 Chemical Admixtures

An admixture, if approved for use, shall comply with AS 1478 and its use in concrete shall be in accordance with AS 3600.

9.7.2.6 Fly Ash

Fly ash, if approved for use, shall comply with AS 1129 and its use in concrete shall be in accordance with AS 3600.

9.7.2.7 Storage

a. Cement and fly ash shall be stored in weathertight buildings, bins or silos which provide protection from dampness and contamination. Bags shall be stacked so as to permit access for tallying, inspection and identification of each consignment. The stored materials shall be used in chronological order.

b. Aggregate stockpiles shall be arranged and used in a manner which prevents segregation or any contamination with other sizes of aggregate. Stockpiles shall be free draining.

c. Admixtures shall be stored in such a way as to ensure that there is no detrimental effect on their properties. The Contractor shall comply with any special requirement of the manufacturer of the product.

9.7.3 Performance Requirements

9.7.3.1 General

The concrete for the various parts of the work shall be designed and produced that the performance requirements of this specification shall be met. The performance of the concrete shall also comply with Section 4.3 of AS3735. The selection, proportioning and mixing of the concrete materials shall be such as to produce a mix which works readily into corners and angles of the forms and around reinforcement with the method of placement employed on the work, but without permitting the material to segregate or excess free water to collect on the surface. The resultant concrete shall be sound and have other qualities specified.

9.7.3.2 Strength

The characteristic strength of the concrete as defined in AS 3600 that is required for the various parts of the work is limited to 32 MPa. The Contractor shall select a concrete strength in accordance with the standard.

9.7.3.3 Slump

The slump required for the various parts of the work shall be as shown on the Contract drawings and shall be checked adjacent to the formwork for that part. When the slump specified is 80mm or less, the slump shall not vary more than 15mm from that specified. When the slump specified is greater than 80mm, the measured slump shall be within 30mm of that specified.

9.7.3.4 Maximum Aggregate Size

The maximum size of aggregate which shall be used in any particular part of the structure shall be as specified.
9.7.4 **Quality Control**

The Contractor shall implement Quality Control Testing throughout the supply of concrete to the works so as to establish that the performance requirements of this specification are being met. This testing shall be by Project Assessment as defined in AS 3600.

9.7.5 **Ready Mixed Concrete**

Except where specified otherwise, the concrete for every part of the works may be supplied as ready-mixed concrete. Ready-mixed concrete shall be supplied in accordance with AS 1379, except where modified by this specification. The supplier of ready-mixed concrete shall be approved by the Principal prior to the commencement of the works. Ready-mixed concrete shall not be delivered in non-agitating trucks. The Contractor shall ensure that the supplier of ready-mixed concrete shall permit inspection of the plant and material and if so required, shall permit the taking of samples for testing purposes. The Contractor shall advise the ready-mixed concrete supplier of all requirements of this specification and shall require that each truck of ready-mixed concrete be accompanied by a docket bearing the following information:

- a. The specific part of the works for which the concrete was ordered;
- b. The quantity of concrete contained;
- c. The time of despatch;
- d. The type of concrete supplied either by reference number or by listing of the performance requirements and specified materials content;
- e. The type and quantity of admixtures and fly ash if permitted; and,
- f. The total amount of added water and how much remains to be added at site.

These dockets shall be retained by the Contractor as a record of the ready-mixed concrete delivered and this information shall be available to the Principal on request.

9.7.1 **Site Mixed Concrete**

Site mixed concrete shall be produced in accordance with the requirements of Sections 4, 5 and 6 of AS 1379.

9.7.2 **Mixing Hot and Cold Water**

When the air temperature exceeds 32°C, the concrete shall be supplied at a temperature not exceeding 32°C. When the air temperature is below 10°C, the concrete shall be supplied at a temperature not less than 10°C.

9.7.2.1 **Hot Weather Placing**

When the air temperature exceeds 32°C, the concrete shall be placed at a temperature not exceeding 32°C.

9.7.2.2 **Cold Weather Placing**

When the air temperature is below 10°C, the concrete shall be placed at a temperature not less than 10°C.

9.7.3 **Concreting Under Water**

Concrete shall be deposited under water by such methods as shall produce concrete in accordance with this specification. Submit details of the proposed method of placement to the Principal for his examination.

9.8 **Concrete Sampling & Testing**

9.8.1 **General**

The sampling and testing of concrete shall be in accordance with AS 1012 - Methods of Testing Concrete, except where modified by this specification. All aspects of sampling, site treatment and testing of concrete specimens shall be carried out by N.A.T.A. registered laboratory and personnel at the Contractor’s expense. Where concrete is liable to rejection, the costs of any further checking or testing that may be permitted by the Principal shall be borne by the Contractor. Project Assessment, as described in AS 3600, shall apply and samples and specimens shall be taken at the site.

9.8.2 **Sampling**

9.8.2.1 **Location of Sampling**

All concrete samples shall be taken at the site near the location of placing the concrete.
9.8.2.2 Method of Sampling
Sampling and identification shall be carried out in accordance with AS 1012, Parts 1 and 8 respectively.

9.8.2.3 Frequency of Sampling
The minimum frequency of sampling of the concrete of each type shall be in accordance with the requirements of AS 3600, Project Assessment.

9.8.3 Test Specimens

9.8.3.1 General
Generally, at least two (2) specimens shall be taken from the sample to represent a particular property and they shall be prepared and cured in accordance with the relevant section of AS 1012.
Records shall be kept and submitted to the Principal of all aspects of the Project Control Testing. These records shall provide the full history of sampling and testing of all specimens and shall accord with Rule 1.10 of AS 1012, Part 8.

9.8.3.2 Characteristic Compressive Strength $f'_c$ & Characteristic Flexural Strength $f'_{ct}$
At least two (2) specimens 200mm high and 100mm diameter for each test shall be made concurrently from each of the samples required by the Section "Frequency of Sampling" and these shall be taken and tested in accordance with the relevant part of AS 1012.

9.8.3.3 Slump
The slump of the concrete shall be determined in accordance with AS 1012, Part 3. The criterion for compliance shall be as specified in this specification.

9.8.4 Test Results

9.8.4.1 Test Certificates
N.A.T.A. Test Certificates, or facsimile copies of these, shall be forwarded to the Principal immediately they are available.
The results of these tests shall also be kept in tabulated form on the site.

9.9 Acceptance Criteria

9.9.1 General
Concrete which has been specified to satisfy certain performance requirements and which has been tested for such performance in accordance with Section 10.8 shall be deemed to comply if the criteria specified in "Acceptance Criteria" of this section are satisfied. When the concrete fails to satisfy these criteria, it shall be liable to rejection.
The Principal may permit concrete which is liable to rejection to be retained on the following basis:-

a. An appraisal of the statistical information related to the concrete strength;
b. A structural investigation;
c. Additional tests (such as outlined in Section 20 of AS 3600); or,
d. Approved remedial work.

The costs of this further checking, testing or remedial work shall be borne by the Contractor.
Where concrete work has been finally rejected, it shall be removed to the extent determined by the Principal.

9.9.2 Acceptance Criteria

9.9.2.1 Characteristic Compressive Strength $f'_c$
The concrete shall be deemed to comply with the strength requirements of this specification if its characteristic strength is not less than specified herein or otherwise complies with AS 3600.

9.9.2.2 Slump
The slump shall be deemed to comply with the specified requirements if:-

a. When the specified slump is 80mm or less than the measured slump is within 15mm of the specified slump, or
b. When the specified slump exceeds 80mm, the measured slump is within 30mm of the specified slump.

9.9.3 Other Rejection Criteria
Hardened concrete shall also be liable to rejection if any of the following defects occur:-
a. It is porous, segregated or honeycombed;
b. A construction joint has been made at a location or in a manner not in accordance with this specification;
c. The construction tolerances have not been met;
d. The reinforcing steel has been displaced from its correct location;
e. Waterstops, inserts and other items embedded in concrete have been displaced from their correct position;
f. The required surface finish has not been achieved; or,
g. The concrete work can be shown to be otherwise defective.

9.10 Finished to Unformed Concrete

9.10.1 General

9.10.1.1 Scope
This section of the specification sets out the requirements for the finishes to the unformed surfaces of all concrete members.

9.10.1.2 Responsibility
The Contractor shall be responsible for the provision of the finishes in accordance with the specification and the associated Contract documents.

9.10.2 Types of Finishes
The unformed surfaces of each concrete member shall be finished in accordance with the Schedule of Finishes and the relevant Contract drawings.

9.10.2.1 Screeded Finish
The concrete shall be placed, struck off, consolidated and levelled to a Class C tolerance.

9.10.2.2 Scratched Finish
After the concrete has been placed, struck off, consolidated and levelled to a Class C tolerance, the surface shall be roughened with stiff brushes or rakes before the final set.

9.10.2.3 Floated Finish
After the concrete has been placed, struck off, consolidated and levelled, the concrete shall not be worked further until ready for floating. Floating shall begin when the water sheed has disappeared and/or when the mix has stiffened sufficiently to permit the proper operation of a power-driven float. The surface shall then be consolidated with power-driven floats. Hand floating with wood or corked-faced floats shall be used in locations inaccessible to the power-driven machine. Trueness of surface shall be re-checked at this stage with a three (3) metre straight edge applied at not less than two (2) different angles.
All high spots shall be cut down and all low spots filled during this procedure to a Class B tolerance. The slab shall then be re-floated immediately to a uniform smooth, granular texture.

9.10.2.4 Steel Trowelled Finish
Where a trowelled finish is specified, the surface shall be finished first with power floats, as specified above, where applicable, then with power trowels and finally with hand trowels.
The first trowelling after power floating shall be done by a power trowel and shall produce a smooth surface which is relatively free from defects, but which may still contain some trowel marks. Additional trowelling shall be done by hand after the surface has hardened sufficiently. The final trowelling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand trowelling operations. The finished surface shall be free from any trowel marks, uniform in texture and appearance and shall be planned to a Class A tolerance. On surfaces intended to support floor coverings and defects of sufficient magnitude to show through, the floor covering shall be removed by grinding.

9.10.2.5 Broomed Finish
Pavement slabs and slabs in other locations so specified, shall be given a coarse transverse scored texture by drawing a broom or hessian belt across the surface. This operation shall follow immediately after floating and shall be performed as outlined in the Clause “Floated Finish” in the foregoing.
9.10.3 **Tolerances**
The surface of the concrete shall be finished as specified to the tolerances listed below.
Class A: True planes within three (3) mm in three (3) m, as determined by a three (3) m straight edge placed anywhere on the slab in any direction.
Class B: True planes within three (6) mm in three (3) m, as determined by a three (3) m straight edge placed anywhere on the slab in any direction.
Class C: True planes within 6mm in 600mm, as determined by a 600mm straight edge placed anywhere on the slab in any direction.

9.11 **Concrete Curing & Protection**

9.11.1 **Scope**
This section sets out the requirements for the curing and protection of all concrete members.

9.11.2 **Responsibility**
The Contractor shall be responsible for the provisions of the curing and protection requirements of this section of the specification.

9.11.3 **Codes**
The requirements of AS 3799, AS 3600 and AS 3735 shall apply except where modified by this specification.

9.11.4 **Curing**
Freshly cast concrete shall be protected from premature drying and excessively hot or cold temperatures. In windy conditions, wind breaks shall be erected to shield the concrete surfaces during and after placement. The concrete shall be maintained at a reasonably constant temperature with minimum moisture loss for the curing period. Curing methods which do not conform with the requirements of this specification shall not be used without the prior approval of the Principal. Commence material curing as soon as the surface of the concrete has hardened sufficiently to prevent damage but in no case later than two (2) hours after the finishing operation has been completed. Keep concrete continuously moist for seven (7) days by one (1) of the following methods:

a. Continuous sprinkling with water;
b. The use of an absorptive cover kept continuously wet; or,
c. The use of curing compounds conforming to AS 3799.

Only use method (c) with the written consent of the Principal. Prevent rapid drying out at the end of the curing period.

9.11.5 **Curing Compounds**
Where curing compounds permitted by the specification are used, they shall be applied in accordance with the Manufacturer's instructions and shall not be used on any surface until the successful completion of the following tests:

a. Tests for acceptance and uniformity in accordance with AS 3799; and,
b. Tests to show that the adhesion of any applied concrete finish shall not be adversely affected by the compound.

PVA resin based compounds shall only be permitted with the approval of the Principal.

9.11.6 **Protection Against Damage**
The concrete shall be protected from damage due to load overstresses, heavy shocks and excessive vibrations, particularly during the curing period. Construction loads shall not be placed on self-supporting structures which shall overstress them. All finished concrete surfaces shall be protected from damage due to any cause, such as construction activities, rain and running water.

9.12 **Testing for Liquid-Tightness**
Contractor to carry out Liquid-Tightness testing of sewage treatment plant in accordance with AS 3735 and to the satisfaction of the Principal. Passing of this liquid-retaining test, including any remedial works in the initial test is not passed, is considered part of the works to be completed in the construction of the sewage treatment plant.

9.12.1 **Standards**
The water-tightness testing shall be undertaken in accordance with AS 3735.
9.12.2 Liquid Retaining Tests

For a test of liquid retention, a structure shall be cleaned and initially filled with water at a uniform rate generally not greater than two (2) m in 24 h. When first filled, the liquid level shall be maintained by the addition of further liquid for a stabilising period of seven (7) days while absorption and autogenic healing takes place. After the stabilising period, the level of the liquid surface shall be recorded at 24 h intervals, for a test period of seven (7) days. During this seven (7) day test period, the total permissible drop in level, after allowing for evaporation and rainfall (if the test is made for an uncovered structure) shall not exceed 1/500th of the average water depth of the full tank or 10 mm, whichever is less.

Notwithstanding the satisfactory completion of the test, any evidence of seepage of the liquid to the outside faces of the liquid-retaining walls or intensified underdrain flow shall be assessed against the requirements of the specification. Any necessary remedial treatment of the concrete to the cracks or joints shall, where practicable, be carried out from the liquid face. When a remedial lining is applied to inhibit leakage at a crack it shall have adequate flexibility and have no reaction with the stored liquid nor cause contamination of the potable water. Where the structure fails to satisfy the seven (7) day test then, after completion of the remedial work, it shall be refilled and a further seven (7) day test undertaken in accordance with this Section.

9.13 Tanks

Tanks shall be constructed of reinforced concrete as covered above. Precast concrete tanks will be considered by the Principal.

Any precast tanks or pump stations shall be manufactured and supplied with:

- All cored holes;
- Fitted penetration pipework;
- Manhole covers and access grating/panels gatic style lids;
- Benching; and,
- Dedicated load rated lifting points with “swift lift” type lifting points.

The tank manufacturer for all precast tanks shall be supplied a detailed design drawing’s identifying the location and size of all penetrations. Precast tanks shall be certified by an RPEQ Engineer.

Installation and loading of all precast tanks shall utilise a load rated spreader bar.

All buried concrete tanks shall have fully trafficable lids to Class D T44. All buried tanks shall be installed with sufficient ballast to prevent movement under high water table conditions. The supplier shall be consulted to ensure ballast requirements are met for the local area of installation.

Precast buried tanks shall be installed on a compacted base and levelled with a bed of gravel to nominated compaction and gravel depth and size as nominated on the Contract drawings.

Cored holes for penetrations shall be sealed with Megapoxy P1 or approved equivalent.

Pumping stations shall be designed to WSAA Sewage Pumping Code of Australia WSA-04.

9.14 Manholes

All concrete manholes shall be constructed from pre-cast concrete pipe sections in accordance with the Contract drawings and shall, unless noted otherwise, comply with WSA 02.

9.15 Bunds

All bunds shall be sized to adequately capture the contents of the bunded equipment and gravity drain to the nominated location as per the approved drawings. All drains within bunds shall have grating provided to prevent ingress of debris and potential blocking of drainage lines.
10. Structural Steelwork Specification

10.1 Fabrication

10.1.1 Scope

This section includes, without limiting the responsibility of the Contractor to carry out all the work specified herein or in other Contract Documents, the material to be furnished including all bolts and the work to be done to obtain a structural frame of the required standard ready for erection, field welding and bolting.

10.1.2 Materials

All material shall be limited to those permitted by the Australian Standard Specifications AS 4100 unless otherwise permitted by the written approval of the Principal. All material shall be straight and clean. If straightening or flattening is required, it shall be done by a process and in a manner that shall not injure the material. Material with sharp kinks or bends shall be rejected.

10.1.3 Tests

The Contractor shall supply maker's certificates in accordance with AS 4100, stating chemical and mechanical tests for each batch of steel used on the project. Where the Contractor desires to use steel not covered by the maker's certificate, he shall submit samples to an approved N.A.T.A. registered laboratory to prove the mechanical and chemical properties of the steel. The cost of this testing in the absence of maker's certificates, shall be at the Contractor's expense. All plates of 40 mm thickness or over shall be ultra-sonic tested for laminations and impurities by an approved N.A.T.A. registered laboratory. Where these would constitute a weakness to the fabricated structure, the plate shall be rejected. The Contractor shall allow for the laying out of the plate for testing in a convenient manner. The cost of the testing shall be at the Contractor's expense.

10.1.4 Shop Drawings

The Contractor shall allow for the preparation and cost of detail shop drawings. The shop drawings shall give complete information necessary for the fabrication of the component parts of the structure including the location, type, size and extent of all welds and bolt holes. Both shop and field welding shall be indicated on the shop drawings. The drawings shall be prepared from the Engineer's working drawings with reference to the Architectural and Mechanical drawings as required for holes required in beams for any equipment. The Contractor shall provide three (3) copies of the shop drawings to the Engineer for checking. Approval shall be limited to matters relating to structural sufficiency only. Conformity with the Engineer's drawings, dimensions, tolerances and hole positions shall be the responsibility of the Contractor. The Contractor shall allow 14 days for the approval of the shop drawings by the Principal.

10.1.5 Rolling, Marking and Waste

The Contract shall be based on calculated weights. The calculated weights shall be based on 7.85 grams per lineal metre per square millimetre of cross sectional area. In the case of rolled sections, the cross sectional area shall be that listed in AS 3679. Wastage, rolling margin, bolts and welding shall not be included in this weight, but shall be allowed for in the rate per tonne.

10.1.6 Fabrication and Tolerances

All fabrication and tolerances shall conform to AS 4100 except where superseded or varied by this specification. All sizes shown are nett sizes after machining and prices are to allow the difference between this weight and the actual gross weight required. Should the Contractor find that any section shown on the drawings is unobtainable, then he may, subject to the approval of the Principal, substitute a larger section; any additional charge in this respect is to be borne by the Contractor. The unavailability of any section shall not be accepted as grounds for extension of Contract time, and it is the Contractor's responsibility to ensure that he shall be able to obtain the steel or to include any additional costs that may be involved. Ends of column shafts at splices, bases and caps shall be machined square to the longitudinal axis when indicated on the drawings, otherwise column shafts shall be sawn. Adjacent lengths of columns or columns and beams shall be fitted together at the Fabricator's works and lined in all directions. The Building Contractor shall be present during shop matching and shall satisfy himself that the correct erection tolerances are being maintained. Bolt holes required for splicing shall be drilled whilst the sections are fixed together and held in line. Beams and trusses shall be precambered as indicated in the drawings. Should the specified tolerance in AS 4100 or herein be exceeded, then the Principal may reject or require rectification prior to acceptance.
10.1.7 **Bolt Holes**

All bolt holes shall conform to AS 4100 except where superseded or varied by this specification. Holes for turned and fitted bolts shall be of a diameter equal to the nominal diameter of the bolt shank with a tolerance of +0.125mm of -0.000mm.

10.1.8 **Welding**

Welding shall conform to AS 1554. All welding shall be carried out by and under the supervision of persons qualified in accordance with AS 1554 or by experienced welders whose work has been approved by the Principal, or his appointed authority. Welding symbols are shown in AS 1101, part 3. Backing bars, run-on and run-off strips shall be ground or removed when required by the Engineer. The Contractor shall allow for the cost of a minimum of four (4) radiographs. The cost of these tests shall be stated and shall be deducted if not used.

Where noted on the Engineer's or Architect's drawings, steelwork exposed to view shall have the welds ground smooth. All butt welds and fillet welds 10mm and over shall be non-destructively tested for compliance with AS 1554 by an approved N.A.T.A. registered authority. The costs of this testing shall be at the Contractor's expense. Testing reports shall be submitted to the Principal.

10.1.9 **Preheating**

All joints shall be subjected to a degree of preheat consistent with the sections involved. The minimum degree of preheat required shall be calculated from the tables etc. given in AS 1554. Such preheat shall be carried out with an approved torch and shall serve the dual purpose slowing the cooling rate of the weld and ensuring moisture free conditions for welding. In welding, compound beam and column sections, precautions shall be taken to ensure that the amount of twisting or warping of the finished section does not exceed the tolerances specified in the Clause "Fabrication and Tolerances" above. Where special conditions of restraint are present, the Principal may require, at no extra cost, preheating requirements in excess of the minimum requirements stated above.

10.1.10 **Inspection at Fabrication Yard**

The work is to be accessible to the Principal or his representative throughout fabrication. All welds shall be individually inspected and the steelwork shall not be removed from the Contractor's yard until inspected and released for delivery by the Principal or his representative. Such inspection and release shall not relieve the Fabricator of his responsibility to carry out the work in accordance with the specification and drawings. All steel shall be subject to acceptance after erection, completion of welding and/or bolting and submission of acceptable plumbing records as specified under Section 11.2, Erection, of this specification.

10.1.11 **Marking and Shipping**

Each member shall be clearly marked with the identification mark which is shown on the Engineer's drawings or the approved shop drawings, or both. The weight of all major members of weight greater than two (2) tonnes shall be marked on the shop drawings and on the members.

10.1.12 **Preparation and Finishing**

Fabricated steelwork shall be free of dirt, weld slab, oil and grease. Any grease or oil shall be removed by thoroughly washing with white spirit. At the time of application of any priming finish, all surfaces shall be thoroughly dry. Where priming is specified, it shall be carried out immediately on completion of the surface preparation. The required "type" of finish shall be indicated in the drawings and as specified below in Table 9.

<table>
<thead>
<tr>
<th>Type</th>
<th>Surface Preparation</th>
<th>Primer</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hand tool cleaned - the surface shall be free of loose rust and loose rust and loose mill scale at time of delivery</td>
<td>Nil</td>
<td>All encased steelwork</td>
</tr>
<tr>
<td>2</td>
<td>Flame or power tool cleaned - the surface shall be free of all rust and loose mill scale at time of delivery</td>
<td>Nil</td>
<td>All fire-sprayed steelwork</td>
</tr>
<tr>
<td>3</td>
<td>Flame or power tool cleaned - the surface shall be free of all rust and loose mill scale</td>
<td>Apply 0.050mm thickness of red oxide zinc phosphate primer complying with ASK 108</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Abrasive blast cleaned to Class 2 ½ standard. The profile of blasting shall not exceed 0.038mm</td>
<td>Apply 0.050mm min. thickness of red oxide zinc phosphate primer complying with ASK 108</td>
<td></td>
</tr>
</tbody>
</table>
Where steel members are connected with high strength friction grip bolts indicated on the drawings as 8.8/TF, the contact surface shall not be primed. Bolts and washers supplied for surfaces primed with Finishes Types 5-8 inclusive shall be hot dipped galvanised or zinc coated. In the area of the site weld, the steel shall be left free from finish for an area of 70mm either side of the weld.

### Hot Dip Galvanising

All steelwork is to be hot dip galvanised to the designation system HDG900 with a nominal coating thickness of 125microns. Steelwork to be galvanised shall be cleaned by abrasive blast in accordance with AS 1627, Part 4 or chemically descaled in accordance with AS 1627, Part 5 or by an approved immersion bath process to a Class 3 finish as defined in the standard. The zinc coating shall consist of a uniform layer of commercially pure zinc, free from abrasions, cracks, blisters, chemical spots or other imperfections and shall adhere firmly to the surface of the steel. Quality and weight of coating on steel sections, plates and tubes shall be in accordance with AS 1650, unless otherwise specified or noted on the drawings.

### Workmanship

Where work is exposed to view and forms part of the architectural treatment, special attention shall be given to the finish. Shearing, flame cutting and chipping shall be done carefully and accurately, sharp corners and rough edges shall be fairied by grinding or other approved means and, where noted on the drawings, welds shall be made smooth.

### Holding Down Bolts

Holding down bolts shall be cast in position when the concrete is placed, unless otherwise approved by the Principal. They are to be accurately located and rigidly held during concreting. The threads of all holding down bolts shall be protected during concreting.

### Erection

#### Scope

The Contractor shall supply the falsework and all tools, machinery and appliances including drift pins and fitting-up bolts necessary to the expeditious handling of the work. The suitability and capacity of all plant and equipment used for erection shall be to the satisfaction of the Principal. It shall be noted that the no suitable craneage is available in Cunnamulla. The Contractor wil be required to mobilise craneage as required for the project.

#### Storage on Site

All structural steel at the site shall be stored off the ground and handled so that members are not subjected to excessive stresses. Bolts, nuts and washers shall be delivered on site in grit free containers and stored under cover. Damaged or rusted bolts and nuts shall not be used.

#### Setting Out and Erection Tolerances

All steelwork shall be erected, plumbed, bolted and/or welded with erection procedures and tolerances conforming to AS 4100 except where superseded or varied by this specification.

| 5 | Flame and/or power tool cleaned - the surface shall be free of all rust and all mill scale | Apply 0.075mm min. thickness of zinc rich primer in a silica base equal in all respects to "Zincilate 850". |
| 6 | Abrasive blast cleaned to Class 2½ standard. The profile of blasting shall not exceed 0.038mm | Apply 0.075mm min. thickness of zinc rich primer containing not less that 92% metallic zinc in a silica base, equal in all respects to "Zincilate 120" |
| 7 | Abrasive blast cleaned to Class 2½ standard. The profile of blasting shall not exceed 0.038mm | Apply 0.200 min. thickness of tar epoxy protective coating, equal in all respects to "Armourcote 550" |
| 8 | Abrasive blast cleaned to Class 2½ standard. The profile of blasting shall not exceed 0.038mm | Apply 0.075mm dry film thickness of Ethyl Silicate Inorganic Zinc equal to "Carbonzinc 11" and conforming to ASK108 |

members are connected with high strength friction grip bolts indicated on the drawings as 8.8/TF, the contact surface shall not be primed.
These tolerances shall include the fabrication tolerances. The specified tolerances shall be reduced appropriately in cases where acceptance of such tolerances would permit the completed structure to lie outside the property boundary. The Contractor shall submit to the Principal and maintain full written records of the plumbing of steelwork indicating departures from the true position. In welded construction, separate records shall be maintained prior to and after welding. When indicated in the drawings, such records shall be obtained and submitted to the Principal by an approved Surveyor engaged by the Contractor at his own cost.

10.2.4 Inspection
The Contractor shall provide reasonable and safe means of access to the steelwork for inspection. This access shall be to the requirements of the Department of Industrial Relations or to the requirements of other Authorities controlling such matters. All materials and workmanship shall be subject to the Principal's approval and any defective work may be rejected by the Principal.

10.2.5 Temporary Bracing and Scaffolding
Steel framework shall be carried up true and plumb and temporary bracing, to the Principal's satisfaction, shall be introduced wherever necessary to take care of all loads to which the structure may be subjected including equipment, and the operation of same. The Contractor shall allow for the design and supply of this bracing and shall be solely responsible for its adequacy. Such bracing shall be left in place as long as may be required for safety. As the steelwork is erected, it shall be temporarily bolted or welded into position to take care of all dead load, wind and erection stresses until the structure is properly aligned and the final connection can be made. Unless otherwise approved by the Principal, erection may continue not more than four (4) floors above a fully bolted and/or welded floor. The Contractor shall provide all necessary scaffolding, staging etc., required for the proper erection and access to the steelwork in accordance with the Lifts and Scaffolds Act or to the requirements of other Authorities controlling such matters.

10.2.6 Site Welding
All welding shall be carried out in accordance with AS 1554. All welding shall be carried out by and under the supervision of persons qualified in accordance with AS 1554 or by experienced welders whose work has been approved by the Principal or his appointed authority. Welding symbols are shown in AS 1101, Part 3. Backing bars, run-off and run-on strips shall be required for butt welds. Run-on and run-off strips shall be ground or removed when required by the Principal. The electrodes, welding techniques and sequence of operation of all site welding shall be subject to the approval of the Principal or his representative. The preparation of and set up of all site welds shall be examined by an approved welding inspector prior to the commencement of welding. The costs of all inspections of site welding shall be at the Contractor's expense. The preheating requirements of the above section, of this specification shall apply to Site Welding. All completed welding shall be examined by an approved welding inspector and any suspect welds shall be removed and remade at the Contractor's expense. The cost of any special testing techniques necessary to prove the sufficiency of welds shall be borne by the Contractor. The Contractor shall allow for the cost of a minimum of four (4) radiographs. The cost of these tests shall be stated and shall be deducted if not used.

10.2.7 Bolted Connections
All bolts shall be of such length that no threaded portion shall be within the thickness of the parts joined. At least one (1) washer shall be used beneath each nut and one (1) full thread shall project past the end of the nut. Loose shims of 1.5 mm thick shall be provided as required to ensure proper contact of the flaying surface of all connections made with bolts, both high tensile and otherwise. Shims shall cover the entire area of the flaying surface.

10.2.8 High Strength Bolts
High strength bolts include bolts for friction type joints (designated 8.8/TF on the drawings) and bolts for bearing type joints (designated 8.8/TB on the drawings) shall comply with AS 4100. The Contractor shall seek the approval of the Principal of the type of bolt, nut and washer to be used for high strength bolts. The bolts, nuts and washers shall be clearly marked to avoid confusion. High strength steel bolts shall be assembled with a hardened steel flat or tapered washer under the nut. Bolts and nuts shall be supplied with a coating of light oil which shall not be removed. All high strength bolts shall be tensioned (unless otherwise noted on drawings). Tensioning shall be by the "Part-turn Method of Tightening", generally as laid down in AS 4100, to achieve the minimum bolt tensions specified therein. As a guide, the following minimum tensions shall be achieved:-

<table>
<thead>
<tr>
<th>BOLT DIAMETER</th>
<th>MINIMUM TENSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>kN</td>
</tr>
<tr>
<td>16</td>
<td>95</td>
</tr>
</tbody>
</table>

Technical Specification
As a guide, nut rotation from the snug tight condition shall be as specified in Table 11 below:

<table>
<thead>
<tr>
<th>Bolt Length (underside of head to end of bolt)</th>
<th>Disposition of outer face of bolted parts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Both faces normal to bolt axis</td>
</tr>
<tr>
<td>Up to and including 4 diameters</td>
<td>1/3 turn</td>
</tr>
<tr>
<td>Over 4 diameters but not exceeding 8 diameters</td>
<td>1/2 turn</td>
</tr>
<tr>
<td>Over 8 diameters but not exceeding 12 diameters</td>
<td>2/3 turn</td>
</tr>
</tbody>
</table>

NOTES:
1. Tolerance on rotation: for 1/2 turn or less, one-twelfth of a turn (30°) over and nil under tolerance; for 2/3 turn or more, one-eighth of a turn (45°) over and nil under tolerance.
2. Nut rotation is the rotation relative to the bolt, regardless of the component turned.

Match marking of nut and bolt shall be carried out using indelible crayons and only after the "snug-tight" position has been achieved in all bolts in a connection. Once fully tensioned, bolts shall not be re-used.

After completing match marking, the rotations specified in AS 4100 shall be applied for full tensioning. Alternative methods of tightening (e.g. torque control method or load indicating washers) shall not be used unless approved by the Principal. The Contractor shall submit full details to the Principal for approval. The method should be in accordance with the manufacturer's specification and the suitability demonstrated by the procedure set out in AS 4100. Galvanised high strength bolts shall not be tensioned by the torque control method.

10.2.9 Grouting Bases

Column bases, bearings of beams, girders and grillages shall be grouted to obtain full bearing after the structure has been completely levelled and plumbed. Bedding shall be carried out with Portland Cement non-shrink grout having a 40 MPa compressive strength at 28 days. Before grouting, the space between the baseplate and concrete shall be washed, blown dry and inspected. When indicated on the drawings, higher strength grout shall be used.

10.2.10 Site Finish

Where steelwork has been shop painted or otherwise treated, any damaged paintwork or finish as well as bolted, welded joints shall be cleaned of all oil, slag, rust and scale and shall be finished by the Contractor to give a finish equivalent to shop treatment. Steelwork fabricated and delivered with a Type 1 or Type 2 finish shall be maintained by the Contractor so that the specified finish is achieved at the time of encasing or fire-spraying.

10.2.11 Concrete Encasing

Unless otherwise shown on the drawings, all steelwork to be concrete encased shall be wrapped with AS F52 hard drawn wire fabric lapped 300 mm. Concrete for encasing shall have a minimum concrete cover of 50 mm from the faces and edges of flanges, and 32 MPa compressive strength at 28 days and a maximum aggregate size of 20 mm. The Contractor is to maintain the steelwork free of loose rust and loose mill scale up to the time of encasing. The encasing reinforcement shall be arranged and supported, 20 mm away from the flanges of sections. NOTE: This section does not apply to fire protective concrete, details of which are shown on the drawings.
10.3    Stairs, Platforms Walkways and Handrails

All stairs, platforms, walkways, gratings and handrails and kick plates (those above process tanks) shall be hot dip galvanised. The handrails and kick plates above process tanks (excluding the access stairs and platform) shall be aluminium. Design, fabrication and construction of all walkways, platforms, handrails, stairs and ladders shall be to AS 1657. All walkways, platforms, stairs and ladders shall be provided with serrated surfaces. Gratings shall be aligned with the direction of walking over the floor parallel to the loadbars.
11. Electrical, Instrumentation and Control Specification

11.1 Scope

The EI&C scope of works under this contract is for the detailed design and construction for the upgrade of the Cunnamulla STP including new Electrical Mains supply, Main Switchboard (MBS) and Motor Control Centre (MCC) inclusive of new PLC, site run electrical works, lighting and control panels and a new SCADA and Communications system.

11.1.1 Detailed Design Drawings

The contractor shall provide detailed electrical design drawings based on the typical schematic, single line diagrams and the Contractors process design. Drawings shall include switchboard general arrangements, cable route arrangements, schematic diagrams, termination diagrams and PLC schematic diagrams. All detailed design drawings shall be submitted to the Principal for review and approval.

The Contractor will be required to conduct an emergency stop risk assessment before the electrical schematic diagrams are completed.

11.1.2 Mains Power

The site currently does not have mains power. The Contractor will be responsible for the following:

- Application to the service provider (Ergon Energy) for the installation of electricity supply as required.
- Management of Energex to ensure upgrade is completed on-time without delay to project program;
- Installation of new mains power cabling etc. from the supply point to the STP; and
- Provide new consumer mains and supply authority metering panel.

The Contractor is responsible for the installation of new electrical mains from the Electrical supply pillar box to the STP. The Contractor is responsible for sizing the mains power cables in underground conduits.

Supply and install new Supply Authority Metering Panel. The metering panel shall comply with requirements of the Queensland Electricity Metering Manual (QEMM) and Queensland Electricity Connection Manual (QECM).

Paroo Sire Council will pay any application fees direct to the energy provider.

11.1.3 New Switch Room

Install light fittings, light switches, emergency lighting, daylight switch, split system air-conditioning and general power outlets in the new switch room as shown on the building plans. Install galvanized cable ladder above the switchboard inside the building and through conduits below floor level.

Variable speed drives are to be wall mounted inside the new switch room as shown on the approved building plan drawings.

11.1.4 New Main Switchboard and MCC

Supply and install new NHP Cubic or similar type-tested arc-fault containment main switchboard, complete with supply authority current transformers and voltage sensing equipment, metering isolator/main switch and MCCB.

11.1.5 Area Lighting

Site lighting shall be provided and include, as a minimum:

- Security lighting,
- Emergency lighting,
- General lighting adequate to facilitate night time access or work.

Area lighting including walkway lighting and field lighting shall be designed and installed by the Contractor to meet the requirements of AS1680. Emergency lighting shall be designed and installed to meet the requirements of AS2293.

11.1.6 Emergency Generator

Install a new fully enclosed diesel generator with integrated fuel tank and bund. The fuel bund shall be sized to provide a minimum of 48 hours continuous operation.
Install new generator power and control cables in underground conduit, from the emergency generator to the new main switchboard ATS section. The Generator operation shall be automatic. The Generator shall be sized by the Contractor based on the proposed design of the plant. The Generator shall be installed with a colourbond roof structure, designed to facilitate the removal of the generator.

11.1.7 PLC and SCADA

The Contractor shall provide fully integrated and functional electrical and control systems for the STP to control the operation of the STP in three distinct modes:

- **Local Mode:** Equipment controlled locally via selector switches on the main switchboard and push buttons on the motor starter Local Control Stations (LCS);
- **Remote Manual Mode:**
- **Remote Automatic Mode:**

The Contractor SCADA system and data shall have the ability to be accessed from the Workstation at the STP as well as remote access from the Council works depot and via an online portal. The Contractor shall provide a suitable telemetry communications equipment. Radio Telemetry Units are considered suitable for the site.

The system shall include the provision of automatic alarm notifications to telephone numbers by both voice or test. The overall functionality of the SCADA system will be agreed with the Principal during the programming and FAT testing. The PLC and SCADA system shall be provided with an Uninterrupted Power Supply (UPS) backup to prevent failure during power supply changeovers and brownouts. The SCADA system shall provide trending and history for a minimum of 5-years and have the functionality to be exported to Microsoft excel, Word and PDF’s.

Software bench testing, or Factory Acceptance Testing (FAT), shall be undertaken in the presence of the client to prove the functionality of the control system in a simulation environment.

The preferred PLC is:

- Complete Allen Bradley ControLogix PLC system (or approved equivalent).

The preferred SCADA is:

Citect Clear SCADA (or approved equivalent). Council have an existing SCADA system for the Sewage Pump Stations (SPS). The Contractor shall integrate the STP into the existing control system to allow remote monitoring of the plant.

**SCADA Mimic Pages**

The SCADA system provides plant operational staff with process monitoring facilities in the form of mimic screens. Each of the screens shall display an area of the plant. A site Overview mimic will show the entire STP system. The mimic shall be configured so that individual equipment provides a basic overview to the operator which shall include:

<table>
<thead>
<tr>
<th>Item</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motors</td>
<td>Running and Available (Pumps, Aerators, Mixers, Blowers Etc.)</td>
</tr>
<tr>
<td></td>
<td>Shall change to Flashing Red if alarm is active.</td>
</tr>
<tr>
<td>Flow Meter</td>
<td>Current value, accumulated value. Value shall change to Flashing Red if any alarm is active.</td>
</tr>
<tr>
<td>Level</td>
<td>Tanks levels will show the current value both as number and also percentage shown as bar graph on the side of tank image. The value and bar graph shall change colour if any alarm is active</td>
</tr>
<tr>
<td>STP Site</td>
<td>Mains Power Status Security Door Status Etc.</td>
</tr>
</tbody>
</table>

An operator can gain further information about each area by clicking on that area, or a tab, which will bring up the detailed area mimic. The main site overview shall be divided up in the areas as agreed with PSC with each area having its own mimic. The following areas are envisaged:

- **Main Treatment Processes,** including:
  - **Secondary Treatment,**
  - **Waste Streams,**
  - **Chemical storage and dosing etc.**

In addition to the process mimic pages, the following two (2) plant status pages shall be created:
• Station auxiliary status including solar power status, and
• SCADA network status, including telemetry statuses.

The status Auxiliary Status mimic page shall show the power circuit for the site inclusive of Circuit Breakers, Power Fail Relays, Surge Diverter, Power Supplies' and the like. This will provide a simple overview for the operators to quickly determine the power status for the site and includes:
• Station mains power PFR,
• Power meter;
• Surge diverter,
• Generator status,
• UPS system,
• 24VDC control power, and
• PLC power supply.

**Alarms and Events**

The programmer shall configure all alarms and events as agreed during the design development and in accordance with the project specification and applicable Australian Standards. The operator shall be made aware of an alarm irrespective of which page is selected. Alarm acknowledgement shall depend on the current Attendance selection which shall include, as a minimum:

• Attended – In this mode the Operator’s Computer is attended and alarms will be acknowledged via the SCADA system;
• Day – In this mode the Operators Computer is unattended, and the occurrence of any alarm shall cause the system to dial up a configured telephone number and announce the alarm using voice synthesis. A follow up text message shall also be sent to the configured telephone number; and
• Night – In this mode the Operators Computer is unattended and only the occurrence of a critical alarm shall cause the system to dial up a configured telephone number and announce the alarm using voice synthesis. A follow up text message shall also be sent to the configured telephone number.

Each alarm is allocated a priority within the system, as some fault conditions warrant immediate attention, while others are less critical. Critical alarms are those that are a precursor to potential overflow or those that will result in damage to machinery or assets if not attended as soon as possible. Alarm priority details (Cat 1,2,3) shall be confirmed with the Principal before implementation.

**Trending**

The programmer shall configure all analogue signals that require trending for all equipment, instrumentation, valving and the like. The time interval for data to be tended must be clearly specified prior to commissioning otherwise the Contractor shall configure the system as they see fit. When viewing the trended data, the operator shall be able to manipulate the time scale as required.

**11.2 Reference Documents**

All equipment and materials, and their installation and testing shall comply with, but not limited to, the latest edition of the following Australian Standards, Acts and Regulations.

**11.2.1 Australian Standards**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS 1111</td>
<td>ISO Metric Hexagon Bolts and Screws</td>
</tr>
<tr>
<td>AS 1680</td>
<td>Interior Lighting</td>
</tr>
<tr>
<td>AS 1768</td>
<td>Lightning Protection</td>
</tr>
<tr>
<td>AS 2053</td>
<td>Conduits and Fittings for Electrical Installations</td>
</tr>
<tr>
<td>AS 2293</td>
<td>Emergency Escape Lighting and Exit Signs</td>
</tr>
<tr>
<td>AS 3000</td>
<td>Electrical Installations (Australian/New Zealand Wiring Rules)</td>
</tr>
<tr>
<td>AS 3008</td>
<td>Electrical Installations – Selection of Cables</td>
</tr>
<tr>
<td>AS 3011</td>
<td>Electrical Installations – Secondary Batteries Installed in Buildings</td>
</tr>
<tr>
<td>AS 3017</td>
<td>Electrical Installations – Verification Guidelines</td>
</tr>
</tbody>
</table>
### 11.2.2 Acts and Regulations

Table 13 – Acts and Regulations (Electrical)

<table>
<thead>
<tr>
<th>Body</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>QLD GOV</td>
<td>Electrical Safety Act 2002</td>
</tr>
<tr>
<td>QLD GOV</td>
<td>Electrical Safety Regulation 2002</td>
</tr>
<tr>
<td>QLD GOV</td>
<td>Work Health and Safety Act 2011</td>
</tr>
<tr>
<td>QLD GOV</td>
<td>Workplace Health and Safety Regulation 2011</td>
</tr>
</tbody>
</table>

### 11.2.3 Supply Authority Documents

Table 14 – Acts and Regulations (Electrical)

<table>
<thead>
<tr>
<th>Body</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>QEMM</td>
<td>Queensland Electricity Metering Manual</td>
</tr>
<tr>
<td>QECM</td>
<td>Queensland Electricity Connection Manual</td>
</tr>
</tbody>
</table>

### 11.3 General Requirements

All work shall be carried out to a high standard of workmanship. Competent personnel experienced in their respective work shall complete all work in a neat, substantial and tradesman-like manner, in accordance with the best current practice. Personnel carrying out any task shall be suitably qualified, trained and possess the necessary skills to complete the task to a high standard of workmanship.

All electrical works shall be performed by electrical tradesmen with a current Queensland Electrical License working under a person with an Electrical Contractor’s License, licensed under the Queensland Electrical Workers and Contractors Act.

The Contractor shall provide all quality assurance installation verification documents such as ITPs, test and check sheets signed by the Contractor’s Representative.

All welding shall be carried out by personnel holding an appropriate welding certification and shall be in accordance with relevant standards. Welding carried out by electricians with no welding certification will not be accepted. Damage to protective coating and paintwork caused by welding shall be made good to the same standard as the original coating.

Approval from the Principal’s Representative shall be obtained prior to drilling holes and welding in structural members. All holes for fixings shall be drilled and not flame cut. Protection shall be provided when cutting into electrical cabinets or back plates to prevent swarf and cuttings from falling into any equipment.

Building structures and surfaces that are disturbed in effecting the electrical installations shall be restored to their original condition.

The Principal reserves the right to inspect all works and request re-work if the quality of work is not acceptable to the Principal’s Representative. If the Principal’s Representative is not satisfied that the personnel carrying out particular work possess the necessary skills, the Contractor shall provide alternative personnel.
11.3.1 Equipment and Materials

All materials and equipment shall be new, free of defects, of the best quality and of the design most suitable for operating under the conditions prevailing at the site. Materials and equipment shall operate without distortion, deterioration or subject to excessive stresses that might affect the performance or life of the equipment or materials. Materials supplied for the project shall have SDS provided to the Principal’s Representative.

Equipment selection and design shall be based on greater than 20 years reliable operational life.

Unless specified otherwise, all equipment used on the installation shall be selected from the Principal’s – Preferred Electrical & Instrumentation Equipment.

The Contractor shall take delivery of, load or unload as necessary, transport to the site, securely store and protect the equipment and materials.

The Contractor shall submit to the Principal's Representative for approval a list of the materials proposed to be supplied for the installation. The Contractor shall provide complete details, including catalogue information, for the proposed equipment for installation.

Mounting stands and brackets shall be fabricated from galvanised mild steel painted in accordance with an approved painting system. The minimum thickness of mounting plates for equipment shall be 6mm. Plate dimensions will depend on the application and shall include space for labels. Minimum size of channel for fabricating stands shall be 75mm x 50mm.

Stands may be installed by welding or bolting to steelwork, or by fixing to concrete and grouting if required. If a mounting stand is required to be installed on soil, it shall be mounted on and bolted to a concrete footing of sufficient size to provide a stable anchor.

All bolts, nuts, washers, screws and other fastenings shall comply with AS 1111 and any other relevant standards. Bolts shall be selected to give the shortest possible length of thread protruding beyond the nut, with a minimum of one thread pitch and generally not more than two. Excess length of bolt shall be removed and, for those bolts that are not stainless steel, the cut face coated with zinc enriched paint. Flat washers shall be used under all bolt heads and a spring or star washer under all nuts. Nyloc nuts or equivalent shall be used for all locations subject to vibration. Self-threading screws shall not be used other than when specifically allowed.

Fixings into masonry shall be made using an approved type of expansion bolt. Fixings into concrete shall be by means of an approved expansion bolt or chemical anchor. Plastic or metal fibre expansion plugs shall only be used for light duty fixings such as attaching labels or fixings in office facilities. Fixings into timber shall be made using cadmium plated woodscrews screwed into drilled pilot holes of the correct size for the screw.

Brackets, mountings and other steelwork not fabricated from stainless steel, shall be hot dip galvanised or painted prior to installation.

During the installation of any material, any damage to protective coatings of the equipment being installed or of the existing structure shall be made good by the Contractor.

Defective equipment shall be completely replaced with a new unit unless permission to repair such equipment is received in writing from the Principal's Representative.

11.3.2 Equipment Labelling

Each item of electrical and instrumentation equipment, including all internal and external components and accessories, shall be clearly identified by an engraved or etched label. Labels shall be marked with the identification number and name of the equipment. The labels shall be based on the plant standard numbering systems indicated on the drawings or in the relevant standards.

All labels shall clearly identify the equipment and be of appropriate dimensions and size equivalent to the existing plant standards. The minimum height of label characters shall be 5mm.

General identification labels shall be engraved traffolyte material using a system of black letters on a white background, where not otherwise specified.

Danger and warning labels shall be engraved traffolyte material using a system of white letters on a red background.
Caution or advisory labels shall be engraved traffolyte material using a system of black letters on a yellow background.

Cable markers shall be affixed using stainless cable ties for outdoor cables and nylon cable ties for indoor cables.

Safety signage shall be fitted to comply with AS 3000.

11.3.3 Drawings and Documentation

The Contractor shall not carry out any electrical installation works without approved drawings marked ‘For Construction’ and Scope of Work document. All work shall be carried out in accordance with the approved design documentation.

The Contractor shall supply the Principal’s Representative with copies of original Test Certificates, Calibration and FAT Reports for Switchgear, Earthing Tests and Instrumentation.

The Contractor shall maintain a master mark-up set of contract drawings for the duration of the installation work. All changes to the drawings occurring during the installation, variations between the actual installation and the drawings, and errors detected by the Contractor shall be marked on the master mark-up set in red ink as they occur or are discovered. At the completion of the contract, the Contractor shall submit a complete set of the contract drawings to the Principal’s Representative stamped ‘As-Built’ and individually signed and dated by the Contractors Representative. This set of drawings shall reflect and contain all variations between the issued contract drawings and the actual installation marked-up in red ink.

The Contractor shall provide all necessary QA documents to the Principal’s Representative for approval, prior to energising the installation. The QA documents include inspection and test plans, test sheets and check sheets. These documents shall be approved and signed by the Contractor’s Representative.

11.3.4 Change Management

The Contractor shall bring to the attention of the Principal’s Representative any errors or omissions that are detected in the design documentation.

The Contractor shall check and confirm on site all cable lengths and distances prior to cable installation and advise the Principal’s Representative if there are any discrepancies.

The Contractor shall not vary from the approved design documentation without prior approval.

11.4 Installation of Electrical Equipment

11.4.1 General

The location for the installation of equipment shall be determined from the contract drawings and in consultation with the Principal’s Representative on site. All locations shall be selected, and equipment oriented to provide access for maintenance. All locations shall be approved by the Principal’s Representative prior to the equipment being installed.

Unless approved otherwise, all electrical equipment shall be arranged such that cabling is bottom entry.

Following the installation of equipment, protection shall be provided for that equipment against any damage that might occur due to the construction activities taking place.

The Contractor shall be responsible for the manufacture of minor support structures to suit particular requirements.

Any damage that occurs to equipment after installation shall be made good to the satisfaction of the Principal’s Representative, or the equipment replaced.

If damage occurs to the protective coating of any equipment after installation, a temporary protective coating of zinc enriched paint or similar shall immediately be applied to prevent the development of corrosion prior to a full restoration of the protective coating.

At the completion of installation, the equipment shall be left clean, painted, tested, in good and serviceable order and all electrical test sheets shall be submitted to the Principal’s Representative.
At the completion of installation, the equipment shall be left clean, painted, tested, in good and serviceable order and all electrical test sheets shall be submitted to the Principal’s Representative.

Final locations of all equipment, including cable ladder and conduit routes, shall be verified by the Principal’s Representative prior to commencement of equipment installation.

11.4.2 Motor Control Centres (MCC)

Motor Control Centres (MCC) shall be erected and assembled strictly in accordance with the approved ‘For Construction’ drawings, this specification, and with the manufacturer’s installation instructions.

The Contractor shall ensure that there are appropriate clearances between opened panel doors from the MCC and other equipment.

The motor control centre may be shipped in sections which will require joining of the sections and the busbars. Each shipping section shall be provided with lifting lugs. The Contractor shall use the switchboard lifting lugs for lifting and handling so that no distortion will result from lifting. The Contractor shall use rollers to move the MCC sections and take care not to damage the other equipment. The MCC shall be firmly bolted to the foundation steelwork or secured by appropriately sized masonry bolts to a concrete floor. The MCC sectioned busbar joints shall be bolted with a torque wrench using torque settings supplied by the MCC manufacturer.

Cable entries shall preferably be from the top. Cable entry gland plates shall be 6mm thick brass or aluminium plate and solidly bonded to the MCC earth bar with an earth conductor of minimum size 25mm².

11.4.3 Solenoid Valves

Solenoid valves shall be supplied with 24VDC coils with class F insulation and IS 4400 spade plug connectors. Where larger power three phase 400CVAc valves are required, Rotork style three phase valves shall be provided where identified for the design.

11.4.4 Lighting

The Contractor shall ensure that each light is located in a position that provides safe access for maintenance. Preference shall be given to locating light fittings where they can be reached from an existing platform or walkway.

The Contractor shall bring to the Principal’s Representative attention prior to installing the fittings, any lighting locations as shown on the drawings that will not allow safe access for maintenance or are not appropriate in that location. Light fittings shall be installed complete with lamps, lenses, reflectors, guards and covers.

The Contractor shall ensure that light fittings installed in rows are positioned in a straight line and at the same height.

Light fittings shall be securely screwed or bolted directly to building structures, or to brackets that are bolted to mounting poles or welded to the structure. Mounting poles shall be three meters high with a facility to lower the pole for maintenance. The poles shall be located and oriented to allow unimpeded lowering and safe and convenient access to the light fitting when in the lowered position.

Control gear shall be installed within 12m of the light fitting and in locations easily and safely accessible without the use of ladders.

Indoor office light fittings shall be fitted with flexible cables and plug tops. A matching outlet shall be installed adjacent to the fitting and connected to the permanent wiring.

Where required, junction boxes shall be installed at light fittings to permit the looping of wiring from fitting to fitting. These junction boxes shall be installed in easily accessible locations and shall be an approved three-way weather-proof type.

High bay lighting shall be suspended from a galvanised steel bracket by two shackles. Two stainless steel safety chains shall be installed, attached to the light fitting body at one end and the building at the other by threaded nuts and bolts with flat and spring washers. High bay light fittings shall be fitted with a 2.5mm² flexible cables and plug tops. A matching outlet shall be installed adjacent to the fitting and connected to the permanent wiring.

Floodlight fittings shall be provided with an aiming angle indicator and after installation shall be aimed at the angle shown on the approved ‘For Construction’ drawings.
The exterior lighting shall be controlled by a daylight switch. The daylight switch shall be installed in the nominated outdoor location. A bypass control switch, marked MANUAL-OFF-AUTO, shall be installed in the distribution board with the lighting control contactors.

Emergency light fittings shall be in corridors, walkways, and stairs and above exit doors in accordance with AS2293. They shall be connected to the local lighting circuit and arranged to switch on when the local lighting fails, but not when local lighting is switched off.

An inspection of the lighting shall be undertaken during the hours of darkness to verify light levels, glare and the aiming of light fittings. Illuminance readings shall be taken at regular intervals and marked on lighting layout drawings and submitted with the as-built drawings.

11.4.5 Socket Outlets

Socket outlets shall be installed at the locations indicated on the contract drawings and on building columns. If no columns are available, the Contractor shall install a stand for the outlets.

All socket outlets shall be supplied from a circuit breaker with 30mA earth leakage protection.

All socket outlets installed in offices or in control room areas shall be molded plastic, flush mounting and coloured white.

All socket outlets installed in outdoor and plant areas shall be Clipsal 56 series, galvanised cast iron or anodised die-cast alloy, fully protected type with interlocking switch, and shall be dust and weather proof to IP56.

11.4.6 Variable Speed Drives (VSD)

The harmonics generated by VSDs shall not exceed the limits as set by the Supply Authority and in any case to be no greater than 5% total harmonic voltage distortion (THDv) on any 415VAC switchboard bus.

The VSD internal switching frequency shall not generate additional audible noise beyond that which is expected in a 50Hz fixed speed application.

Each type of fault shall be individually indicated on the front of the enclosure or switchboard cell containing the VSD. Fault indications shall remain active after trip until manually reset.

11.4.7 Soft Starters

Motors which may cause the supply transformer voltage to drop by more than 5% during start up shall be driven by soft starters.

11.5 Installation of Instruments

11.5.1 Storage and Handling

Upon receipt, all instruments and ancillary equipment shall be kept in a dust and weatherproof store. When instruments are taken from the store for testing, they shall be returned to the store and repacked. All instruments shall be transported and handled with the utmost care. All covers and plugs on instrument connections shall be left in place until the proper connections are made. Machined surfaces such as flange facings shall be protected by covers until they are installed.

11.5.2 Calibration and Testing

The Contractor shall determine the requirements for calibration and testing of the various instruments according to the manufacturer's recommendations and in consultation with the Principal's Representative. Calibration and function testing (dry commissioning) shall be carried out on the instruments for which it is required, and the results recorded. Where possible, the testing or calibration shall be performed in the Contractor's site workshop prior to installation of the equipment on site.

All test equipment used shall be calibrated to a NATA traceable standard, which has been calibrated within six months of the date of the tests to be performed and shall have accuracy equal to or exceeding that of the manufacturer's stated accuracy of
the equipment under test. The Contractor shall submit copies of the calibration certificates to the Principal's Representative prior to carrying out any calibrations.

The personnel performing the calibrations must be fully conversant with both the equipment to be tested and the test equipment to be used.

11.5.3 Programming and Configuration

Unless directed otherwise, the Contractor shall enter all parameters, settings and configuration data required by any programmable instruments. This data will be the basic data for the application. Fine tuning of the configuration will be carried out by the Principal's Representative.

Program and configuration details and sheets shall be provided to the Principal’s Representative in electronic format.

11.5.4 Layout, Location and Arrangement

The Contractor shall ascertain on site, in consultation with the Principal's Representative, the exact location of all equipment to be installed including the location of instruments, instrument stands and brackets, instrument air reticulation, signal and impulse tubing, and the routing of cable ladders, conduits and cables.

Unless directed by the Principal's Representative, all field equipment shall be arranged so that cabling is bottom entry. The Contractor shall inform the Principal's Representative accordingly, and modify at his own expense, any top or side entry equipment.

Equipment shall have adequate clearance from other services and, when mounted along or in access ways, shall be positioned, modified or protected such that it does not present a hazard to vehicular or pedestrian traffic using the access way, nor be subject to accidental operation or damage. Access for the removal and replacement of in-line measurement and control devices must be considered when the mounting position of devices is being determined.

Instrument stands shall be mounted to structural parts of the building, tank bases or the like in preference to mounting on concrete slabs.

Equipment and/or accessories shall not be mounted on building cladding or top handrails. Where equipment is mounted near handrails, the supporting stands or bracketing shall be spaced to leave the handrails at least 75mm clear of obstruction.

11.5.5 Mounting

All instruments shall be mounted in accordance with the applicable instrument installation detail or manufacturer's recommendation.

All instruments other than types specifically designed for vessel or pipe mounting shall be mounted on stands or within a panel.

All equipment shall be mounted so that it is accessible from the ground or platform without the use of ladders or scaffolding, unless otherwise approved by the Principal's Representative.

11.6 Installation of Cable Ladder and Conduit

Cable ladders shall be manufactured of materials to suit the environment where they are to be installed. Heavy duty galvanised steel cable ladders shall be used for all external installations. Each cable ladder shall have 20% spare capacity.

NEMA 20A, NEMA 20B and NEMA 20C hot dipped galvanised steel ladders shall be used where the cable ladders are installed in process areas. 316L grade stainless steel ladder covers and support brackets shall be used where the cable ladders may be occasionally or frequently subjected to corrosive spray or splashing.

11.6.1 Routing

The Contractor is required to determine cable ladder routes to suit the final Vendor equipment. The routes chosen shall avoid areas of frequent maintenance activity such as above pumps or mechanical equipment, or under tanks. Where possible, the routes chosen shall also avoid areas where cranes may need to swing when dismantling piping, valves or other frequently
dismantled equipment. The route shall strive to provide safe access for personnel required to install cables or access the
ladder and shall be approved by the Principal's Representative prior to installation of cable ladder.

11.6.2 Cable Ladder Supports

Cable ladder shall be supported on pipe racks or on purpose made supports that may either be free standing or fixed to
existing structures. The location of the supports shall be in accordance with the requirements of the NEMA Standard VE-1.
The maximum separation for supports shall be six meters. At any change of direction of the ladder, a support shall be
provided within 750mm of the direction change and on all sides of the direction change.

Minimum cable ladder sizes shall be 300mm.

Vertical ladder runs shall be supported with a maximum spacing of 2.5 meters between supports.

The Contractor shall carry out the design and manufacture of cable ladder supports as required in the Scope of Work. The
design of cable ladder supports shall consider the weight of the ladder when fully loaded and any additional loading due to
wind.

11.6.3 Installation of Cable Ladder

Cable ladder shall be installed to provide a continuous cable support system with no sharp edges or projections. Cable ladder
runs shall be straight and square to the building lines. The Contractor shall not install cable ladder so that it impedes access
to equipment, subjects the cables to high levels of heat or exposes cables to a high risk of mechanical damage. Any cable
ladder routes with these problems shall be brought to the attention of the Principal’s Representative prior to installation.

Separation of at least 100mm from the top of the ladder shall be maintained when the ladder crosses below steel work at
right angles. Cable ladder running parallel to and below steel work shall maintain a minimum clearance of 300mm from the
top of the cable ladder. A minimum clearance of 2200mm shall be maintained under cable ladder in walkways areas.

An expansion splice plate shall be installed at any point where the ladder crosses a building expansion joint, and at any other
point where required as indicated by the manufacturer’s recommendations.

If welding or cutting occurs on any cable ladder, damage to the galvanising shall be made good. The slag and spatter shall
be removed, and the area power tool cleaned before painting with zinc enriched paint.

11.6.4 Covers

Where cable ladder is used outdoors, protective covers or sunshields shall be fitted to the top ladder in the stack in all cases
where the ladder is exposed to direct sunlight or is at risk of mechanical or other damage. If covers are required for ladders
below the top ladder, a gap of 600mm or larger shall be provided between ladders. All covers shall be fixed with the
manufacture’s recommended clips.

Cable ladder covers are not required for indoor installations unless specified otherwise.

Before new cables can be installed, the cable covers on those cable ladders affected must be removed. Cable ladder covers
will not be replaced until all new cables have been properly secured and redundant cables removed.

11.6.5 Mounting of Equipment

Cable ladder shall be used for supporting cables and conduits. Other than 'Unistrut' type brackets for mounting of conduit, no
junction boxes, local control stations or other equipment shall be mounted on cable ladder.

11.6.6 Metallic Conduit

Rigid metallic conduit shall be threaded galvanised steel pipe. Stainless steel conduit shall be used in areas subject to
chemical or acidic corrosion. Flexible metallic conduit shall be PVC insulated steel. Conduit shall be correctly sized for cables
and shall have a minimum diameter of 50mm.

Conduit shall be run straight and parallel to building structural elements. Conduit runs shall maintain a minimum 500mm
clearance from hot water and steam pipes, preferably below, and 150mm clearance from gas and water pipes.
Conduit shall be supported off the surface upon which it is run and shall be saddled to brackets fixed to the surface. Maximum spacing of fixings shall be 1.5m and saddles shall be fitted within 900mm of the conduit entering a fitting. The maximum length of unsupported conduit shall be no more than two meters. Conduit fittings shall be the machine cast type. Solid elbows, bends and tees shall be used. Conduit bends shall have a minimum radius of nine (9) times the nominal diameter of the conduit.

Conduit used for installation of steel wire armored cable is principally for support and need not be continuous. Breaks in the conduit in place of sets and bends to negotiate changes in direction are acceptable. In wet areas, fixings shall include stainless steel U-bolts fixed to fabricated stainless steel brackets, stainless steel flat bar welded to the conduit or stainless-steel clamps to stainless steel Unistrut. In dry areas, fixings shall include galvanised steel U-bolts fixed to fabricated brackets, galvanised clamps to Unistrut or galvanised double-sided saddles. Half saddles shall not be used.

When fixing conduit to cable ladder a Unistrut bracket shall be fixed to the cable ladder and the conduit clamped to the bracket. Flexible conduit shall only be used for protection of cables between cable ladders, fixed conduits or junction boxes and items of equipment. The maximum length of flexible conduits shall not exceed 1500mm. Flexible conduits shall not be installed as underground conduits.

Rigid steel conduit terminated into enclosures not equipped with a threaded entry shall be provided with double locknuts and bushings designed to prevent damage to the cable from the end of the conduit. A short length of flexible steel conduit shall be used to connect the conduit run to electric motors and equipment subject to vibration. Flexible conduit shall also be used to provide vibration isolation at any point where a conduit passes two differentially vibrating structures.

### 11.6.7 Non-metallic Conduit

Non-metallic conduit shall be installed for underground conduit runs. Non-metallic conduit for use in-ground shall be heavy duty (HD) PVC and coloured orange, except for telecommunications conduit which shall be white. Light duty PVC conduit shall only be used in non-plant areas. All conduits exposed to sunlight shall be UV stabilised.

Underground conduits entering buildings shall be continued a minimum of 75mm above the finished floor level on the inside of the building and shall extend at least 1000mm clear of footings or secondary concrete outside the building. Conduit above ground shall be run straight and parallel to building structural elements. Conduit runs shall maintain a minimum clearance of 500mm from hot water and stream pipes, preferably below, and 150mm clearance from gas and water pipes.

Allowance shall be made for expansion in accordance with the manufacturer’s instructions in long conduit runs. Methods of allowing for expansion may include the use of expansion fittings, or not restraining the conduit at changes of direction to allow any expansion to be converted into lateral deflection.

### 11.7 Installation of Cables

All cables shall be as specified on the approved cable schedule. The Contractor shall obtain approval from the Principal’s Representative for any departure from the specified cable types. The Principal will not except any claims based on lengths stated in the cable schedule.

The Contractor shall ensure that cable sizes are rated correctly for current carrying capacity, voltage drop, earth fault-loop impedance and other requirements in accordance with AS/NZS 3000 and AS/NZS 3008. Unless otherwise specified, all electrical cables shall be supplied complete with copper conductors and an integral insulated earth core, shall be a minimum of V90 rating and 0.6/1kV grade, and PVC/PVC or XLPE/PVC orange circular cables to AS/NZS 5000.

#### 11.7.1 Configuration

Underground cables shall be installed in heavy duty PVC conduits. All underground installation of cables shall comply with the requirements specified in AS/NZS 3000.

The following cables shall not be run in the same conduit:
- Cables that differ by more than three standard conductor sizes;
- Cables carrying AC and DC power; and
- Cables for power and control/instrumentation/communications cables.
All single core cables forming a three-phase group shall be run in trefoil for the full route length and shall be securely fastened as a group at 600mm intervals using non-conductive ties.

11.7.2 Installation Details

Cable terminations shall allow sufficient additional length (service loop) for a possible re-termination in the future. In no instance shall the additional length left be less than 200mm. Immediately after installation, each cable shall be marked with its cable number at both ends of the cable using an indelible pen.

The Contractor shall supply all cable numbering markers, cable entry thread adaptors, cable glands, ties, shrouds, ferrules, slabs, marking tape and lugs, and shall terminate both ends of every cable listed in the cable schedule unless otherwise specified. Cable cores shall be ferruled with wire numbers up to six characters.

The conductors of all control and instrument cables shall be terminated with pre-insulated crimp pins of the correct size. All terminations shall be carried out using correct and approved crimping tools. Mechanical protection shall be provided for all cabling within 2000mm of ground level or elevated walkway and platform levels.

All cables shall be installed using approved installation equipment and care shall be taken to limit pulling tensions to within the manufacturer's recommendations. Only approved cable lubricants shall be used. Replacement cables shall not be tied to cable ladders until redundant cable has been removed.

11.7.3 Segregation and Protection

In no case shall control, instrumentation or communications cables be installed in the same conduit or duct as LV cables. Screened signal cables shall not be installed within 300mm of low voltage power and control cables. Where ELV or signal cables run on the same ladder as low voltage power and control cables, a dividing barrier shall be installed on the ladder for the full length and a minimum spacing of 300mm maintained between the cables.

Regardless of the method prescribed for the installation of any cables, the Contractor shall ensure that all cables are protected from the likelihood of damage. Sources of damage against which the cable must be protected include, but are not limited to, mechanical impact, vibration, heat, chemical attack and termites.

During the installation of a cable, the Contractor shall select cable routes to minimize risk of damage and install conduits, brackets, covers, barriers, vibration damping and whatever means are required to protect cables from the likelihood of damage.

11.7.4 Penetrations

Any penetrations created for cable entry shall be sealed after completion of cable laying. Unused holes and conduits shall also be sealed. The sealing method used shall restore the integrity and degree of weatherproofing of the original surface.

A non-combustible foam sealant may be used to create a non-fire rated seal. Any excess foam shall be removed to leave a neat finish. Penetrations through fire rated walls shall be sealed in such a way that the original fire rating is restored. An approved fire rated mortar such as KBS Mortar shall be used. The section of cables inside the area to be sealed shall be carefully cleaned and the mortar installed in accordance with the manufacturer's instructions.

11.7.5 Marking of Cables

All cables shall be identified with an approved cable marker. The marker shall be engraved with the cable number as shown on the cable schedule. Cable markers shall be laser etched stainless steel tags attached to the cable with a minimum of two cable ties. Installation of PVC cable markers shall be approved by the Principal’s Representative.

Cable markers shall be attached at each end of the cable as a minimum.

Cable markers shall be attached at each end of the cable as a minimum. The location of the cable marker shall be selected to allow ease of reading as follows:

- Prior to the cable entering an enclosure for field mounted enclosures and MCC entries;
- Both sides of the gland plate for bottom entry enclosures where both sides of the gland plate cannot be viewed from the one location e.g. bottom entry MCC’s and switchboards inside a substation.
• Single core power cables shall have 150mm of coloured heat shrink applied at the termination point of the cable. The colour of the heat shrink shall indicate the phase of the cable e.g. red, white or blue.

11.8 Cable Termination

All cable cores shall be terminated including earths and shields apart from spare control cable cores. Each core shall be fitted with the correct type of lug or pin and crimped, except when insulation displacement terminals are used. Each core shall be identified, either with a ferrule number or by colour.

Cables not installed in conduit shall be fitted with the correct compression gland. Instrument cable shielding shall be earthed in accordance with the drawings and generally at the source end.

The cable shall be arranged, clamped or otherwise supported so that the termination is not supporting the weight of the cable.

11.8.1 Low Voltage Cable Termination

The cores of LV power cables shall be terminated with the correct size crimp lug. The exposed conductors shall be completely enclosed within the barrel of the lug prior to crimping. Lugs shall be crimped with a crimping device which, if hand operated, shall be of a type that will not release until the correct crimping pressure has been reached. All conductors with a cross-sectional area less than 6mm² shall be terminated by means of insulated crimp (bootlace ferrule) or compression lugs unless otherwise specified. Preferably, only one wire shall be crimped in each lug or pin.

Uninsulated lugs shall be insulated by applying phase coloured heat shrinkable sleeving to the barrel of the lug.

Electrostatic screening present on VSD power cables shall be earthed at both ends of the cable over the largest surface area possible. Earthing at motors shall be achieved using a gland designed for this purpose (EMC), and earthing at the VSD cubicle shall be achieved by clamping the screen to an earthed bar.

All armoring for cables carrying low voltage and higher shall, when entering non-metallic boxes, be earthed through the cable gland to an earthed stud inside the box.

11.8.2 Control and Instrumentation Cable Termination & Ferruling

External sheathing shall be stripped back to the point where the cable enters the termination enclosure. Sufficient length of cable shall always be left to permit re-termination, and the preferred arrangement is for cables cores to be cut such that each core can reach the most distant terminal in the relevant terminal strip. Wiring not contained within a duct shall be neatly loomed and tied with PVC cable ties.

All cores of control and instrument cables shall be terminated at both ends of the cable with the exception of spare cores. Each spare core shall be fitted with a ferrule marked SPARE, boot-laced and terminated. If terminals for termination of spare cores are not available, the spare cores shall be cut off flush with core insulation, terminated to a blue point connector and left in the duct.

For screw type terminals, correct sized crimp lugs or ferrules shall be crimped to the conductor and screen drain wire with a crimping tool of a type that will not release until the correct crimping pressure has been reached. The drain wire shall be sleeved with a clear sleeve prior to crimping. The crimp lug or ferrule shall be inserted into the terminal and the screw tightened to the correct torque.

For insulation displacement type terminals, the wire shall be inserted into the terminal using the correct tool and technique. Drain wires shall be sleeved with clear sleeving prior to termination.

Screen drain wires for instrument cables shall be terminated to an earthed terminal at the substation end. In marshalling boxes, screens shall be cut off at the end of the cable bedding and drain wires shall be fitted with clear PVC insulating tubing. The exposed screen at the end of the bedding shall be insulated with black heat shrink tubing. Drain wires shall be connected at dedicated terminals to ensure continuity of the screen shielding system.

At field equipment, the screens and drain wire shall be cut off at the end of the cable bedding, and the exposed screen at the end of the bedding shall be insulated with black heat shrink tubing.
The requirements for earthing of protective screens may vary from situation to situation and care shall be taken to comply with the drawings in each case.

All control, instrumentation and communications cables shall have numbered ferrules fitted to each core and to the screen drain wire. Numbers shall be in accordance with the contract drawings. Ferrules shall have black characters engraved on a white strip and fitted into a transparent carrier. The carrier shall be a type that encircles the core and shall be sized such that it will not slip off over the lug or pin.

11.8.3 Communication Cable Termination

The termination of communication cables shall be carried out correctly and in accordance with any specific requirements applicable. Communications cables terminated at terminals shall be terminated generally as above with the exception of removal of the outside sheath. The length of cable stripped out of the outside sheath and protective shield for termination shall be kept to a minimum and the twisting of the pairs shall continue up to the terminals.

Where there is a requirement to fit a plug or terminating device to a communications cable, this shall be done correctly, in accordance with the relevant instructions and by personnel skilled in such tasks. Care shall be taken to earth the shield or screen in accordance with the relevant instructions. General practice shall be to make the screen continuous along the communications link and earthed at one end only.

11.9 Earthing

The earthing system is a direct earthed system in accordance with AS/NZS 3000. Low voltage equipment shall be earthed to a common earth bar to form an earthing system as defined in AS/NZS 3000.

11.9.1 Equipment Earthing

All electrical equipment shall be earthed in accordance with the requirements of AS/NZS 3000. All earth cables shall be sized in accordance with the requirements of AS/NZS 3000 and shall be insulated with green/yellow PVC insulation.

The earth connection for equipment with LV electrical supply shall be to the earth terminal or earth bar of the switchboard from which the equipment is supplied. Equipment supplied with multicore cables shall be earthed by a conductor laid up in the multicore cable. Equipment supplied by single core cables shall be earthed by a separate PVC insulated earth conductor. Cable entry gland plates shall be earthed with minimum size 25mm² earth cable for the MCC, and a minimum size 6mm² earth cable for local control stations/ skid mounted equipment and other panels and boxes.

All earth connections to earth bars shall be labelled to identify the cable.

Variable Frequency Drives and corresponding motors shall be earthed in accordance to the manufacturer’s recommendations. The three earth cores in the VSD cable shall be connected to an earth terminal at both ends. Additional earthing to motors may be provided depending on specific installation requirements.

Tanks, vessels and sumps shall be earthed by connection to the earthing system.

Vibrating equipment shall be earthed to the surrounding structure using two flexible earthing cables at opposite sides of the equipment. The cables shall be installed to minimize fatigue in the flexible cable.

1.1.1 Cable Ladder Earthing

All cable ladders in a run shall be considered bonded together by the standard splice plates. The ladders shall be solidly earthed at their point of origin to the earth bar and continuity maintained for the length of the ladder run. Where a gap or hinge between cable ladders occurs, continuity shall be maintained by installing two 35mm² PVC copper earth cables with crimp lugs between both cable ladder ends, one on each side of the ladder, unless otherwise specified.
12. Testing and Commissioning

12.1 General Requirements

All electrical installations shall be verified as safe to energize and will operate correctly in accordance with AS/NZS 3000, project documentation and this specification.

The Contractor shall be responsible for the inspection, testing and commissioning of all electrical equipment installed as part of this project.

The Contractor shall submit all inspection, test and commissioning documents for review prior to any site testing being carried out.

The Contractor shall submit all inspection and test plans, test sheets and check sheets to the Principal’s Representative for approval. These documents shall be signed by the Contractor’s Representative prior to energizing any equipment.

The Contractor shall submit commissioning plans and other relevant commissioning documents to the Principal’s Representative for approval prior to transferring the equipment to operations.

Current calibration certificates shall be submitted to the Principal's Representative prior to the use of all measuring and test equipment. The calibration certificates shall be from recognised calibration laboratories and shall exist for every measurement and test instrument used on the project.

The Contractor shall provide to the Principal’s Representative at least one (1) week's notice of on-site tests.

The Contractor shall provide, within 48 hours of completion, neatly typed copies of test reports for all tests carried out.

12.1.1 Installation Checks and Testing

Checking and testing of equipment installation shall consist of, but may not be limited to, the following:-

- Checking that equipment has been installed in accordance with specifications and drawings;
- Testing the equipment to the requirements of AS/NZS 3000. This includes all electrical equipment such as MCC’s, motors, PLC panels, equipment earthing and earthing systems etc.; and
- Testing and inspection of LV, earthing, control, instrument, communication and fibre cables;

During installation checks, no circuits shall be energized, and no mechanical equipment shall be operated by any electric drive.

12.1.2 Control System Testing

12.1.2.1 Factory Acceptance Testing (FAT)

Factory Acceptance Testing (FAT) of the software shall be carried out at the Contractor’s premises (or nominated control subcontractor’s premises) and will be available to be witnessed by the Principals Representatives. The FAT environment shall consist of the new PLC and Citect SCADA and shall be configured exactly as per the final installation onsite.

The Contractor shall provide Factory Acceptance Testing (FAT) Plans for Principals review and acceptance at least 10 working days prior to the FAT Workshop.

The Contractor’s programmers shall conduct a thorough, integrated FAT of all system functions and performance with the Principals representative in attendance based on the approved FAT Plans. The FAT shall test all aspects of the PLC and SCADA programs to ensure compliance with the Functional Specification and I/O Lists.

The testing shall be conducted with all equipment connected and operating as a system with simulation of the actual field equipment. The testing shall exercise every function and shall include, but not be limited to, the following:-

- Verify the correct inventory of hardware and software;
- Demonstrate correct operation of all system functions; and
- Demonstrate operation of internal communication points.
All software shall be factory tested prior to installation on site. A FAT report shall be submitted within two (2) weeks of the completion of the FAT and shall include all amendment records and remedy exception sheets.

12.1.2.2 Site Acceptance Testing (SAT)

The Control System Site Acceptance Testing (SAT) operations test for PLC and SCADA shall be carried out in the following manner. Testing of each equipment control system shall include, but not be limited to the items noted below:

- Demonstration of manual control mode for the equipment;
- Setup and calibration of instruments at various points in their span;
- Operation of all drives and instruments associated with each sub-system shall be provided to confirm operation in accordance with the Functional Specification;
- All alarms and trips shall be tested by operation of primary initiating device;
- Demonstration of interlocking systems shall be by simulating each condition and checking the correct operation each circuit;
- Verification that the PLC system operates correctly and provides the correct information on the SCADA display;
- Verification of SCADA alarms and status signals in accordance with the Functional Specifications;
- Demonstration of fully automatic operation of all equipment associated with the works;
- Demonstration of failure modes (inconsistent conditions, fail safe shutdown, etc.) and plant recovery (re-sets, auto restart, etc.) in accordance with the Functional Specification to include site power failure, individual drive failures, instrument failures, PLC failure and communications failure. All these tests shall be available to be witnessed by the Principals Representative.
- All equipment under the PLC control shall be displayed on the SCADA and tested; and
- A test report shall be submitted to the Principal within the time frame as specified including the amendment records and remedy/exception sheets.

12.1.2.3 Equipment Commissioning

The objective of this stage is to prove correct mechanical and electrical operation of individual pieces of equipment under no load and non-process fluids (i.e. water). Various disciplines (electrical, mechanical, process etc.) must be involved where appropriate.

Equipment commissioning (wet commissioning) may consist of the following:

- Running drivee systems and checking motor currents, bearing temperature etc.
- Checking instrumentation readings;
- Comprehensive testing of control systems;
- Testing of submerged equipment (i.e. diffusers on water).

12.1.2.4 Process Commissioning

The complete system or process shall operate correctly under load conditions and with accordance with design parameters.

Prior to the introduction of raw sewage wet commissioning shall demonstrate the functional performance of mechanical equipment with water to the designed duty points including confirmation of the hydraulic performance of the facility.

On successful completion of wet commissioning raw sewage can be introduced to commence process commissioning. The plant is to be tested to monitor the growth of biological media and monitor the plant performance until the effluent quality meets the minimum effluent criteria. Up until this point no effluent shall be discharged to the environment. When the minimum effluent criteria is achieved the Proof of Performance Test can commence.

Process commissioning may consist of the following:

- Start up and shutdown performance;
- Proving operation at rated capacity; and
- Proving that the performance meets design parameters including but not limited to meeting effluent quality.

The Contractor shall undertake onsite laboratory testing, and accredited NATA laboratory testing, to prove plant performance during the process commissioning stage of the project.
12.1.2.5 Proof of Performance Testing

The Contractor shall successfully operate the plant under operating conditions for 14 days without interruption following the successful completion of commissioning activities. The performance testing shall include:

- 14-days of uninterrupted performance;
- Influent and Effluent sampling, proving plant performance. Onsite laboratory effluent sampling to confirm effluent quality;
- Weekly influent and effluent samples to be tested and reported by an approved NATA laboratory; and
- Monitoring of chemical consumption, power usage and the like.

The Contractor shall prepare a Commissioning and Proof of Performance Testing report detailing the results of the process and provide commentary on the facility with design expectations.

12.1.2.6 Operator Training

The Contractor shall provide training to the Principal’s personnel during the commissioning and performance testing stage of the project to educate operators on the operation and maintenance procedures associated with the plant.

The training shall include:

- Process fundamentals and background;
- Mechanical plant operation, instrumentation and controls;
- Trouble shooting;
- Daily, Weekly, Monthly, Yearly operational procedures and associated check sheets;
- SCADA Operation and Control; and
- Technical Support procedures.

The Contractor shall submit a ‘Operator Training Plan’ to the Principal for approval a minimum of 4 weeks prior to undertaking operator training.

12.1.2.7 12-Months Operational Support

The Contractor shall provide Council with 12 months operational support following the completion of the Performance Testing. The operational support shall include, as a minimum:

- Remote monitoring,
- Phone support (Monday – Friday 7am – 5pm),
- Monthly site visits, and
- Submission of monthly operational support outlining the operation of the plant over the previous month.

12.1.2.8 Operations and Maintenance Documents

The Contractor shall provide detailed operation and maintenance manuals including standard equipment manuals and site-specific operation manuals (STP User Manual) inclusive of Standard Operating Procedures (SOP) for the ongoing operation and preventative maintenance of the plant.

A logbook shall be provided to capture all daily, weekly monthly tasks required including but not limited to preventative maintenance activities, flow recording, process sampling results and effluent sampling results.

The operation and maintenance manual shall be provided as an electronic copy in native format and PDF. The Contractor shall provide a single hardcopy of the site-specific operation manuals section of the operation and maintenance manual which details in easy to understand wording on the operation of the plant and plant troubleshooting guides.