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Engineering Appendix Three

## **Pumping Stations**

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## 1. WASTEWATER PUMPING STATION

All pump station details including drawings, pump station design calculations, system curve control levels, buoyancy calculations, station capacity and pump sets selected are to be provided as part of the engineering approval process.

Ground water level shall be shown on the drawings and the chambers shall be designed against floatation when empty.

At completion of the works, the Contractor will supply to the Engineer with full details of all installed equipment, including drawings and manufacturers' maintenance and operating instructions.

### 1.1 Standards and Regulations

Associated documents include:

AS/NZS 4130	Polyethylene Pipes for Pressure Applications
AS/NZS 1260	PVC-U pipes and fittings for drain, waste and vent application
AS/NZS 4058	Specification for precast concrete pipes (pressure and non-pressure)
AS/NZS 2566 2	Buried Flexible Pipelines - Part 2: Installation
AS 2033	Installation of PE Pipelines
NZS/AS 2638 2	Gate valves for waterworks purposes - Resilient seated
AS/NZS 2280	Ductile iron pipes and fittings
	Code of Practice for the Fabrication of Stainless Steel Plant & Equipment
AS/NZS 1544 6	Welding for the Fabrication of Stainless Steel Plant & Equipment
NZS 3109	Concrete Construction
NZS 3114	Specification for Concrete Surface Finishes
NZS 3121	Specification for Water and Aggregate for Concrete
NZS 3122	Specification for Portland and Blended Cements
WSA 04-2001	Sewage Pumping Station Code of Australia

### 1.2 Siting, Access and Services

Pumping stations are to be located where occasional adverse effects of smell and/or noise will have minimum impact and not within 20m of a residential dwelling.

Public pumping stations shall be sited on separate land not used for roading or pedestrian access. The site shall provide for sufficient vehicle access from the street and a maintenance work area. Both the vehicle access from the kerb to the boundary and internal access and the work maintenance area is to be concreted with 20Mpa, 150mm thick with one layer of 665 mesh placed centrally. A 4m long concreted standing pad shall be provided for lifting equipment. Security fencing may be required.

Cabinet floor levels and slab levels of underground structures shall be at least 200mm above finished ground levels in order to exclude surface water.

A 20mm diameter water supply with a standard 15mm brass hose tap must be provided in the immediate vicinity of the pump station. The supply shall be fitted with an approved backflow preventer and water meter.

Wet wells shall be provided with proper ventilation. Other odour control devices may be approved on a case by case basis.

### **1.2.1 Excavations and Backfilling**

The Contractor shall excavate to the full depth required, provide and place steel and timber shoring (where required), and use appropriate ground water management practices (where required). Excavation shall be completed in accordance with Health and Safety regulations.

Excavated material shall be used for backfilling except when it is unsuitable. Suitable materials shall be well graded, free of any sharp stones or particles larger than 50mm, and free of organic or vegetable material. This suitable material shall be selected, placed and compacted in such a manner that it is not contaminated with other material. If required, the Contractor shall supply imported material for use as backfill.

The pump well valve chamber and magflow chamber shall be bedded on 150mm compacted imported materials. Imported material shall be granular fill to AP40 specification or an approved alternative.

The pump station wet well shall be installed within 5mm/m of plumb. The wet well shall be constructed so that the tops of the lids sit above the finished ground level with the surrounding ground finished so that groundwater cannot normally enter the wet well.

### **1.2.2 Pump Well, Valve Chamber, Magflow Meter Chamber and Storage Chamber**

The pump well, valve chamber and magflow chamber shall be standard grade precast spun concrete flush jointed wastewater manholes manufactured by Hume or Hynds Pipe Systems in accordance with AS/NZS 4058. These manholes shall have integral concrete bases and access rungs.

The drawings show the pump well with an integral concrete base. A caisson type construction method with a concrete plug will be considered subject to provision of a Producer Statement from the Designer.

The pump well chamber shall be sealed watertight. In particular, careful attention to the joint between the lid and risers shall be taken.

The storage chamber shall consist of Class 2 spun RCRRJ wastewater pipes with proprietary precast end panels and access points as shown on the drawings. These shall be manufactured in accordance with AS/NZS 4058.

Precast concrete lids with cast-in cast iron frames shall be supplied. These lids shall be suitable for trafficked areas.

### **1.2.3 Pump Installation**

At least two pumps installed in each wet well shall be Wallace HOMA submersible pumps. The pumps shall be supplied complete with:

- HOMA Auto Coupling Kit
- DN50 stainless steel guide rails and fixing brackets

- Sufficient length of power and control cables to allow removal of pump without disconnecting
- Sufficient length of heavy duty stainless steel lifting chain/cable (4 tonne rated) with integral lifting eye
- All bolts, washers and miscellaneous fittings required for installation.

Each pump unit shall be correctly aligned and bolted down to ensure no undue strain or thrust will be placed on any items including the pipework.

Guide rails with lifting chains shall be installed for each pump, with one acting as duty pump and the other on automatic standby. The duty sequence is to be interchangeable. The standby pump shall be equal in capacity to the duty pump.

#### **1.2.4 Valves**

All pumping stations must be capable of being isolated from the incoming sewer(s). Where possible the isolating valve is to be positioned immediately adjacent to the pump station chamber. If this is not possible the isolating valve shall be located in the first manhole upstream of the pumping station only if no incoming lateral is present in the downstream length.

Each pump set discharge pipe must have an isolating valve and a non-return valve located in a separate or integrated valve pit.

A knife gate isolating valve shall be used. This valve must have a non-rising, flanged and extension spindle, and a valve key which allows the operation of the valve from ground level.

All discharge pipes within the chamber and valves shall be manufactured in accordance with AS 2638 2. Valves shall be resilient seated rated 16 bar minimum and be epoxy coated with Nylon 11 Rilsan or approved equivalent.

#### **1.2.5 Non Return Valves**

Non return valves shall be DN80 Socla 408 Ball Check Valve with sinking ball or an approved equivalent.

#### **1.2.6 DI Fittings**

All DI fittings shall be manufactured in accordance with AS/NZS 2280 DI fittings shall be rated 16 bar minimum and be epoxy coated with Nylon 11 Rilsan or approved equivalent.

#### **1.2.7 Stainless Steel**

All materials nominated as stainless steel (SS) on the drawings shall be grade 316. Apply a suitable non-seize grease to all threaded SS fasteners.

#### **1.2.8 Magflow Meter**

The pump station shall have an ABB magmaster magnetic flow meter installed in accordance with the manufactures instructions. It shall be calibrated to read the rate of flow in L/s and totalised output in m<sup>3</sup>. **Note:** Not all installations will require a magnetic flow meter. Please ensure that a written dispensation is obtained from Council.

## **1.3 Pipework**

### **1.3.1 General**

The pipe work between the pump discharge bends and the check valves shall be DN80 AISI 316L stainless steel schedule 10. Stainless steel pipework shall be supplied and fabricated according to the Stainless Steel Group: Code of Practice for the Fabrication of Stainless Steel Plant & Equipment.

PE pipe laying shall be carried out only by competent and experienced pipelayers and shall be in accordance with AS2033 and AS/NZS 2566 2.

Where appropriate, pipes shall be laid with the manufacturer's identification markings uppermost to allow pipes to be identified from the top.

### **1.3.2 Pipe Bedding**

Pipe bedding material shall be granular with a maximum particle size of 10mm complying with AS/NZS2566.2. Table G3 for 10mm well graded crushed rock. The Contractor may submit alternative materials for the Engineer's approval.

Bedding material shall be used around the pipes and fittings and for a depth of at least 100mm above the crown of the pipe. This material shall be carefully placed so that pipe coatings are not damaged, and shall be firmly compacted but without the use of mechanical compacters.

The trench shall be excavated to grade, with a flat bottom 100mm below the pipeline, invert level. The bedding material shall be placed in the trench to a compacted depth of 100mm.

## **1.4 Concrete Work**

### **1.4.1 Materials**

Concrete shall comply with the requirements of NZS3109 for the grades of concrete shown on the Drawings. Where not otherwise stated, concrete shall be Ordinary Grade with a specified strength of 25MPa.

Cement shall be fresh ordinary Portland cement complying with NZS 3122. Aggregate shall comply with NZS 3121, with coarse aggregate having a nominal maximum size of 19.0mm. If requested, samples and test certificates for concrete materials shall be provided.

### **1.4.2 Construction**

Construction shall comply with the requirements of NZS 3109 'Concrete Construction'.

Concrete shall be protected from drying and the effect of early loading by methods that ensure cracking and distortion are minimised.

Reinforcement steel shall conform to NZS 3404. Particular care shall be taken to ensure the correct grade of reinforcement is provided.

At the time of concreting, all mesh shall be free of foreign coatings, from oil, dried accumulation of mortar, which reduce the effective bond between concrete and steel. Reinforcement shall be firmly supported in position and secured against displacement. Laps and joints in reinforcement shall be made only where unavoidable and at the position agreed by the Designer.

### 1.4.3 Surface Finishes

Surfaces shall be finished in accordance with NZS 3114 'Specification for Concrete Surface Finishes' to the quality set out below:

- Exposed concrete surfaces shall be completed to a U2 finish. This shall be followed by light broom so as to achieve a final U5 finish.
- Manhole hunching shall be completed to a U2 finish.

## 1.5 Testing

The pump station shall be tested and commissioned and records provided to Council.

### 1.5.1 Pump Well and Storage Chamber

The pump well and storage chamber shall be subjected to a hydrostatic test using fresh water once all construction and installation of mechanical plant is complete.

The pump well and storage chamber shall be filled to within 0.1m +/- 0.05m from the underside of the lid and allowed to 'soak' overnight. The water shall then be topped up (if required) and the level measured from a clearly defined point (+/- 1mm accuracy). The level shall be re-measured after 1 hour. A drop of water level in excess of 3mm or any visible leakage constitutes a failed test and the contractor shall locate and remedy the cause (at their cost) and re-test. There shall be no visible infiltration when the pump well is de-watered.

## 1.6 Pressure Testing Pipework

Refer Appendix C NZS 4404.

## 1.7 Commissioning

Once the testing has been completed, the pumps shall be used to pump into the rising main as part of the control system testing (see Electrical Section). Once the control system testing is complete, the pumps shall be left in Auto and the pump well emptied.

## 2. ELECTRICAL

The pump station will include:

- Mains power supply (3-phase)
- Stainless steel pump control cabinet.
- Control & SCADA equipment
- Configuration of the SCADA base station (to be completed at Developer's cost)
- Provision for emergency power supply source
- Electrical works Quality Assurance
- Provision of electrical compliance certificates and approvals relating to the project.

### 2.1 Standards and Regulations

Documents referenced by this section include the following.

### **2.1.1 Regulations**

- New Zealand Electricity Regulations
- New Zealand Electrical Codes of Practice, and Wiring Rules,
- The Handbook to the Electricity Regulations.
- New Zealand Interference Regulations.
- The Radio Interference Notice 1985.
- Electricity supplier requirements.

### **2.2 Equipment Access**

All equipment, requiring adjustment, cleaning, changing or modification in its normal use shall be readily accessible and its function clearly identifiable.

### **2.3 Protection of Works**

Take all reasonable steps to prevent damage to equipment during the contract period. Adequately protect all equipment in dust-laden areas or places exposed to the weather. Take every precaution to protect work by other trades. Ensure all equipment is safe and secure from vandalism.

### **2.4 Existing Services**

Cause no disconnection or disruption of existing services without prior arrangement and written clearance. Keep all necessary disruptions to a minimum and at such times as will avoid unnecessary inconvenience to others.

### **2.5 Seismic Resistance**

The complete installation, including all fixings, shall be designed to withstand normal operating loads plus acceleration forces of not less than 1.0g in a horizontal direction through the centre of gravity of the item fixed.

### **2.6 Main Power Supply**

The main power supply is to be sourced from a suitable location in the proposed subdivision and shall be 3-phase, 400V, 50 Hz MEN. The Contractor shall allow to make all necessary arrangements to establish this power supply to provide a reliable connection that does not adversely affect supply to other users in the area.

The Contractor shall make arrangements with Council's energy company to set up the site as part of Council's account.

The Developer shall at the time of design, provide the estimated electricity demand. The Developer may be required by Council to provide time of use metering.

### **2.7 Pumps**

The preferred pumps for common parts and spares are Wallace Homa pumps.

## **2.8 Control Panel Construction**

### **2.8.1 General**

A stainless steel cabinet built to Council specifications is required to house electrical equipment. Cabinets are to be fitted with a security lock keyed to Council's security system. A flashing alarm beacon is to be installed on the roof of the exterior cabinet. The internal control cabinet shall provide sufficient room for future additional equipment. A minimum allowance of 25% shall be made.

Automatic control of the pump operation, together with a manual override facility is to be provided. Single-phase protection to all pump motors is to be provided.

### **2.8.2 Manufacture**

The manufacture of the control panel shall be by a firm specialising in the type of work.

### **2.8.3 Protective Device Circuit Ways**

- Circuit ways shall be complete with fuse bases, fuse carriers and cartridge fuses or with miniature circuit breakers as indicated for the ways in use only. Spare ways are to be left with blank legs.
- Protection devices on incoming and outgoing switchgear within the switchboard shall be correctly co-ordinated with the protection devices on both the upstream and downstream supplies.
- Generally all protective devices below 80A shall be of the MCB type.

### **2.8.4 Equipment Layout**

- Equipment layouts shall be symmetrical and allow 25% space for future additions.
- Ensure that sufficient space is provided to allow all internal components such that they are mounted to their manufacturer's requirements.

### **2.8.5 Equipment mountings**

- Mounting of equipment inside the cubicle, shall be on either mild steel panels or standard DIN mounting rails.
- Panel mounted equipment and mounting panels shall be fixed by screws into captive nuts using rust resistant screws or tapped for M5 fasteners and below.
- Self-tapping screws are not acceptable.

### **2.8.6 General Purpose Outlets**

A single phase 230V switched socket outlet shall be provided.

### **2.8.7 General Outlet**

A standard three phase industrial power connection shall be supplied such that a portable generator can be connected when power failure occurs together with a single three pin 3-phase plug for portable lighting and equipment.

### 2.8.8 Connections

- Terminate all wiring in tunnel type terminals or with crimped collets or spade type lugs. Spade type lugs are not preferred and should not be used if possible..
- Where several conductors terminate at a common terminal each wire shall be removable without dislodging the remaining conductors.
- Fit coded plastic ferrules on all control wiring. The coding system shall make it possible to identify common circuit wires.
- External connections of non-earthed conductors shall be at rail mounted terminals in compartments at the cable entry point, except where impractical.
- Mount neutral and earth bars in a common compartment.
- Terminal compartments for external cables shall be located a minimum of 500mm above ground level.
- All terminals and live metal shrouds shall be made from clear plastic.

### 2.8.9 Construction Details

Switchboard construction shall be generally as shown in the approved drawings. The following shall also apply:

- a) Door mounted equipment shall be flush.
- b) Stiffen where necessary to prevent panel deformation due to weight of equipment or stresses of switching operations.
- c) Hinges on doors shall be concealed or semi-concealed type.
- d) Door catches shall be of the non-lockable type.
- e) Non-ferrous metal gland plates of the bolted removable type shall be provided for all incoming cable compartments.

### 2.8.10 Wiring

- a) Internal wired connections shall be PVC insulated and shall be:
  - Suitably coloured to indicate their function.
  - Supported adequately using plastic ties or PVC trunking.
  - Terminated in DIN rail mounted terminal blocks as required.
  - Provide separate terminals for every out going connection.
  - Labeled with a proprietary labelling system following a logical labelling sequence.
- b) Cable entries for external cables shall be provided as follows:
  - TPS - bushed holes (sealed).
  - NS - compression type glands
  - XLPE/HT-PVC - compression type glands.
  - XLPE/SWA/PVC and PVC/PVC/SWA/PVC - compression type with armour clamp.
- c) Earthing rings shall be used in conjunction with armour clamps.

### **2.8.11 Labels**

- a) Material: Laminated plastic, Formica as appropriate. Thermal tape only where absolutely necessary.
- b) Use line grill face lettering:
  - 10mm high for board identification and warning labels.
  - 6mm high for major items.
  - 4mm for minor items.
- c) Attach an identifying label to the outside of each cubicle.
- d) Identify each internal item or component such that their function is easily identified.

## **2.9 Control Panel Components**

### **2.9.1 Protection**

Miniature circuit breakers shall be rated in accordance with a category of duty no less than M6.

### **2.9.2 RCD Protection**

Residual current devices (RCD's) shall:

- Be installed in strict compliance with the manufacturer's instructions.
- Have automatic overload circuit breaker protection appropriately rated.
- Have non-automatic interrupting capacity appropriately rated.

### **2.9.3 Isolation Switches**

- Type shall be rotary switches
- Contacts shall be suitable for on load operation.
- Speed of operation shall be independent of the operator.
- Comply with BS EN 60947-3:1992 rated for Utilization Category AC-22 minimum or an approved equivalent standard for general use and Utilization Category AC-23, uninterrupted duty or an approved equivalent standard for use with motor circuits.
- Terminals and contacts fully shrouded.
- Switches fitted with approved operating handle and engraved escutcheon plate.
- Control switches shall be 5 A minimum rating and be fitted with suitable operating handles.
- Control switches flush mounted on door and surface mounted inside.
- Switches rated above 40 A not to be mounted on a door.
- Padlocking provisions in the off position.

### **2.9.4 Terminal Blocks**

- a) Type shall be rail mounted complete with mounting rail, supports, and identification accessories. Connectors, where used, shall provide the following facilities:
  - Testing of circuits connected to the terminal.
  - Linking of adjacent terminals.
  - Screw clamp type connections

- Cross-linking facilities where terminals are associated with current monitoring facilities. This facility shall allow the current source to be short-circuited.
  - Isolation facilities where the terminals are associated with voltage monitoring facilities.
  - Segregation barriers between extra low voltage and low voltage terminals.
- b) Provide terminal blocks correctly sized for the conductors connected thereto.
- c) Terminals shall be arranged so that not more than one conductor is terminated at each terminal.
- d) Allow space for 25% spare terminals.

### **2.9.5 Instrumentation**

Instruments shall be:

- a) Industrial grade to BS 89 or approved equivalent standard.
- b) Flush mounted.
- c) Minimum scale length 72mm.
- d) Ammeters to have the over-scale portion compressed.
- e) Ammeters to be of analogue type.
- f) Accuracy shall be  $\pm 2.5\%$  of full-scale reading.

### **2.9.6 Hour Run Meters**

Hour run meters shall:

- a) be minimum 5 digit type
- b) have provision for retaining their latest value for a minimum of 250 hours on loss of power (when electronic type)

### **2.9.7 Contacts**

Contacts shall:

- a) Comply with BS EN 60947-4-1:1992 Part I or an approved equivalent standard.
- b) Be rated for:
- Continuous operation
  - Intermittent duty Class 0.1
  - Utilisation Category AC-3, under standard conditions and in non-ventilated enclosures.
- c) Have wiring from the coils and auxiliary contacts brought out to accessible terminals.
- d) Be rated for making and breaking short-circuit current in coordination with their associated short-circuit protection devices.
- e) Be fitted with auxiliary contacts, rated at 230V 10A a.c., as necessary, but not less than one set.
- f) Incorporate visual external indication of the open or closed condition.

### **2.9.8 Relays**

- a) Relays shall:
- be plug in type
  - have accessible standard terminations
  - incorporate clear plastic dust-excluding covers
- b) Contact rating shall be suitable for the connected load and in no case shall it be less than 5A.
- c) Interchangeable relays generally shall have coils operating on the same voltages.
- d) Provide indication of the status of the contacts (energised/de-energised).

### **2.9.9 Signal Lamps**

Signal lamps shall be the LED type.

### **2.9.10 Telemetry**

A telemetry link compatible with the Council's telemetry system shall be installed to provide alarm and operational data to the Council's master unit, the transmitter unit shall be capable of operation from the supply provided in the cabinet. The range of data to be included in the telemetry system shall be approved by the Community Assets Manager prior to installation.

## **2.10 Wiring and Cabling**

### **2.10.1 General**

All cabling to the pumps is to be terminated in such a way as to provide for easy disconnection and removal of either pump. Cabling shall be securely suspended within the pump well to ensure there is no possibility of cables becoming entangled in the pump and to ensure easy removal.

- a) Cables and flexible cords shall be:
- Stranded conductor type unless otherwise indicated
  - Minimum size 0.75 mm<sup>2</sup> for cables
  - Minimum size 32/0.20mm<sup>2</sup> for flexible cords.
- b) Joints in point to point cable runs are generally prohibited.
- c) Heat resistant wiring shall be used where ends are exposed to temperatures above 35°C

Cable shall be installed to minimise the thermal resistance between cable and uninsulated zone. Derate cables where exposed to higher than normal cabinet temperatures.

### **2.10.2 Wiring in Conduit or Trunking**

Installation of wiring shall be:

- Simultaneous for all wires in the same conduit.
- Fed as well as pulled into conduits.
- Without crosses or twists.
- Friction reducing substances shall not be used when pulling wiring into conduits.

## 2.11 Underground Cables

### 2.11.1 Existing Services

- Check records to ascertain position of all possible services along route before trenching.
- Locate by hand digging such services as indicated and which could be affected by this work before commencing excavation.

### 2.11.2 Cable Ducts

- The contractor shall liaise as necessary to determine what cable ducts are available for use.
- Cable ducts shall be checked to ensure they are clear of obstructions, have draw wires fitted and are installed to allow easy drawing in of cable.
- Cables in a duct shall all be pulled in simultaneously.

### 2.11.3 Trenches

Provide the minimum cover specified below:

Location and Depth of Cover			
Cable Type	Open areas or under footpaths	Under roadways	Other situations
EHV & LV	600mm	750mm	as indicated
MV & HV	750mm	1000mm	

- Report immediately any services exposed or damaged during trenching.
- Excavations shall be open for the minimum possible time and shall be kept free of water and shored up as necessary.
- Protection in the form of day and night marking, barricades or covers shall be provided.
- Grade trench floors evenly and remove all stones.
- Where cables are buried directly into the ground, the cables shall be enclosed:
  - by a minimum 50mm of sand on all sides of the cables
  - alternatively, by soil which has passed through a sieve with a mesh no greater than 10mm.
- Where cables are buried encased in duct, the duct may be enclosed in the material previously excavated.
- Trenches under roads, walkways and the like shall be covered with suitable material to allow traffic movement to continue during the installation.

### 2.11.4 Cable Installation

- Pull in cable over rollers spaced to avoid the cable rubbing on other cables or suffering mechanical damage.
- Cable stockings shall be used for cable pulling of cables above 40mm outside diameter.

### **2.11.5 Route Identification**

- a) Cable end markers shall be fitted over the ends of all runs giving voltages and depth of cables.
- b) Markers shall be permanent material with red words 'LIVE CABLES UNDERGROUND' and a vertical arrow on a white background nominal size 75 wide by 100mm high.
- c) Cable end markers shall be fitted at all entries and exits of cables at buildings/cabinets.

### **2.11.6 Terminations**

- a) Proprietary cable glands shall be used for "making off" all metal sheathed and armoured cables.
- b) Cable bends shall be followed by a minimum of 50mm of straight cable before the cable enters a gland where practical.
- c) Terminate conductors with compression jointed cable lugs for direct bolting to equipment terminals, except where equipment terminals are designed to accept cable ends directly under clamp fittings.
- d) Soldered ends are not permitted.
- e) Compression joints shall comply with BS 4579 or an approved equivalent standard and be made with correct sized die.
- f) Soldered joints shall be made with Silfos hard solder for copper conductors.
- g) Tinned copper in aluminium to copper joints, or aluminium conductors terminated with bimetal composite cable lugs.
- h) Aluminium surfaces for mechanical jointing shall be prepared and jointed with Utilux No. 4C or equal oxidation inhibiting and jointing compound.
- i) Fit neoprene or PVC insulating sleeves over all exposed cable tails within switchboard enclosures. Cut back PVC serving on cables the minimum necessary. Terminate serving with PVC tape wrapping close to the cable gland.
- j) Fully shroud connections and terminals of switchgear.
- k) Provide phase identification on all cable cores with a coloured PVC sleeve firmly attached to the core.

### **2.11.7 Cable Support Systems**

- a) Bends, tees, and fittings shall be of the same manufacture as the straight lengths and of similar material and finish.
- b) Installation shall be in accordance with the manufacturer's recommendations and when complete shall be free from sharp edges or other such projections.
- c) Ensure that no conflict will occur with other services before installation commences.
- d) Continuity straps shall be fitted between sections.
- e) Material selected shall minimise any corrosion in this area.

### **2.11.8 Conduits**

- a) Installations shall not be:
-

- Embedded partially in concrete or plaster, or placed in floor slabs subject to hydrostatic pressure.
  - Run over seismic joints without provision for movement equal to the width of the joint gap.
  - Installed complete with the cabling.
  - Installed such that the cabling cannot be removed and re-installed.
- b) Accessible runs shall be installed square and parallel with the building features.
- c) Conduit supports shall be at regular intervals of not more than:
- 0.8m horizontal
  - 1.0m vertical
- d) All saddles shall be high impact plastic, zinc plated steel or stainless steel type.
- e) Masonry plugs for screw fixings shall be of the metal or plastic type only.
- f) Terminations into metal enclosures without tapped spouts shall be by means of couplers and smooth bore male bushes.
- g) Bends or other changes of directions may be set on site to suit local conditions.

### **2.11.9 Conduit Types**

Conduits shall be:

- a) Rigid PVC class B conduit to AS/NZS 2053.1 or an approved equivalent standard.
- b) Non-metallic flexible conduit to BS 4607 Part 3 and BS 6099, Part 1: 1988 or an approved equivalent standard.
- c) Flexible conduit shall not be used in any run of rigid conduit except where a conduit is terminated at an appliance or accessory that may be subject to movement and/or vibration.

### **2.11.10 Flexible Conduit**

- a) Adapters shall be impact resistant plastic type and crimped or screwed to the conduit.
- b) Conduit shall be supported to prevent mechanical damage or sagging.

## **2.12 Commissioning**

The contractor shall allow for the testing and commissioning of all electrical works and provide documentation as part of Quality Assurance. This shall include:

- All electrical and control circuits.
- Operation and setting of alarm beacon.
- Configuration and testing of SCADA I/O and alarms (from device to pager).
- Emergency Power Supply.(run for 1 hour)
- Provision of necessary compliance certificates and approvals.
- Provision of As-Built drawings and wiring diagrams.

### **2.13 Maintenance Period**

The Operations and Maintenance Instruction Manual shall be supplied to Council prior to commencement of the 24 months defects maintenance period and the handover of the completed pump station and associated works.

Over this period, the full responsibility for all works or workmanship carried out during the construction stage shall remain with the Applicant or Contractor. A bond may be required to ensure compliance with the Defects Liability Period.