

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

**E21 : ELECTRICAL LIGHTING AND
ILLUMINATION**



Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

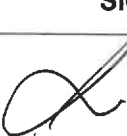


DOCUMENT CONTROL SHEET

Document Title: Particular Specification – E21 : Electrical Lighting and Illumination

JW Reference: BWW523C

Document Ref. No: E21

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
Reviewed	Director	R Baard	August 2019	
Approved	Regional Maintenance Manager	T Thabeng	August 2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
1	2019-08-20	B Pieterse	First Issue

PARTICULAR SPECIFICATION: VOLUME E21: ELECTRICAL LIGHTING AND ILLUMINATION
CONTENTS

E21.1	SCOPE	3
E21.2	STANDARDS	3
E21.3	SPECIFICATIONS	3
E21.3.1	Manufacture and Assembly of Luminaires	3
E21.3.2	Manufacturing and assembly of Fluorescent luminaires	4
E21.3.3	Manufacturing and assembly of LED luminaires	5
E21.3.4	Manufacturing and assembly of Emergency fittings	7
E21.3.5	High Masts Lighting	7
E21.3.6	Sensors.....	8
E21.4	LIGHTING DESIGN	9
E21.5	INSPECTION AND TESTING	10
E21.5.1	General	10
E21.6	COMMISSIONING	11
E21.7	GUARANTEE	11
E21.8	TRANSPORTATION/SHIPPING	11
E21.9	DRAWINGS & DOCUMENTATION.....	11
E21.10	MEASUREMENT AND PAYMENT.....	11

E21.1 SCOPE

This section covers the requirements for lighting and illumination. Lighting and illumination shall be supplied, delivered, installed and commissioned as specified.

E21.2 STANDARDS

The latest edition, including all amendments up to date of tender of the following particular national specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

- | | | |
|--------------------|---|--|
| (a) SANS 475 | : | Luminaires for interior lighting, street lighting and floodlighting
- Performance requirements |
| (b) SANS 10389-1 | : | Exterior lighting Part 1: Artificial lighting of exterior areas for work and safety |
| (c) SANS 10114-1 | : | Interior lighting Part 1: Artificial lighting of interiors |
| (d) SANS 10114-2 | : | Interior lighting Part 2: Emergency lighting |
| (e) SANS 10142-1 | : | The wiring of premises Part 1 Low-voltage installations |
| (f) SANS 1019 | : | Standard voltages, currents and insulation levels for electricity supply |
| (g) SANS 60081 | : | Double-capped fluorescent lamps - Performance specifications |
| (h) SANS 60598-1 | : | Luminaires - Part 1: General requirements and tests |
| (i) SANS 60901 | : | Single-capped fluorescent lamps - Performance specifications |
| (j) SANS 60968 | : | Self-ballasted lamps for general lighting services - Safety requirements |
| (k) SANS 61547 | : | Equipment for general lighting purposes - EMC immunity requirements |
| (l) SANS 1777 | : | Photoelectric control units for lighting (PECUs) |
| (m) SANS 60947-4-1 | : | Low-voltage switchgear and controlgear Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters |
| (n) SANS 10225 | : | The design and construction of lighting masts |
| (o) IEC 62031 | : | LED modules for general lighting – Safety specifications |
| (p) IEC 61347-2-13 | : | Lamp controlgear - Part 2-13: Particular requirements for d.c. or a.c. supplied electronic controlgear for LED modules |
| (q) IEC 62560 | : | Self-ballasted LED-lamps for general lighting services by voltage > 50 V-Safety specifications |

E21.3 SPECIFICATIONS

E21.3.1 Manufacture and Assembly of Luminaires

Body

- (a) The bodies and relevant sheet metal parts of all fittings shall be manufactured from minimum 0,8mm sheet steel, to precise tolerances, with joints neatly formed and spot-welded.
- (b) Metal parts shall be painted with a suitable primer utilized for epoxy or polyester powder coat finishes. The final finish shall be a high reflectance, white epoxy or polyester powder coating (other colours applicable as well).
- (c) Bodies of lay-in fittings shall fit neatly into the specified ceiling grid, with no visible light

leaks from below.

- (d) Access for lamp replacement and maintenance shall be simple and easy.

Lamp holders

- (a) Lamp holders shall be of a good quality, manufactured from polycarbonate, with heat resistant centres.
- (b) Lamp holders for all fluorescent luminaires (recessed, surface, open channel) shall be good quality roto-lock type from a known manufacturer.

Control gear

- (a) All luminaires, except the metal halide types, shall be equipped with electronic ballast/control gear. Metal halide/High pressure Sodium fittings shall use ballasts/chokes.
- (b) Ignitors shall be digital in nature with time control pulse break for optimum control gear and lamp protection. (Ignitors will also allow enclosed rated lamps to be used in open luminaires).
- (c) Only capacitors supplied by reputable manufacturers shall be offered. Power factor correction in luminaires shall be done to ≥ 0.90 .

Wiring

- (a) All internal wiring shall be done with high temperature PVC insulation (105°C).
- (b) Wiring shall be neatly grouped and retained.
- (c) The wiring shall terminate in a 3-way, 6A screw terminal block, with the earth conductor terminated onto a welded earth stud.

Cord Sets

- (a) Cord sets shall be fitted on all indoor luminaires and as specified in the luminaire schedule.
- (b) Cord sets will be 3m long as a minimum.
- (c) Cord sets shall 3-core PVC cabtyre cable, 0.75mm² measured from the side of the fittings with a 6A, three pin moulded plug top. The cord shall terminate in the luminaire by means of compression gland.

Lamps

- (a) All lamps shall be as specified in the lamp schedule.
- (b) Only lamps from known manufacturers shall be offered.
- (c) All fluorescent tubes shall be tri-phosphor.

E21.3.2

Manufacturing and assembly of Fluorescent luminaires

- (a) Luminaires shall be supplied and delivered complete with lamps, control gear and flexible cords and plug tops as specified.
- (b) Luminaires shall be designed to prevent excessive high temperatures and components and materials shall be selected so that they are not adversely affected by the operating temperature.
- (c) The voltage and wattage ratings shall be clearly and indelibly marked on control gear and related control equipment and apparatus.
- (d) Bodies of lay-in fittings shall fit neatly into the specified ceiling grid, with no visible light leaks from below.
- (e) Access for lamp replacement and maintenance shall be simple and easy.
- (f) Lamp holders shall be of a good quality, manufactured from polycarbonate, with heat resistant centres.
- (g) Lamp holders for all fluorescent luminaires shall be good quality roto-lock type.

- (h) All luminaires shall be equipped with quick start electronic ballast/control gear.
- (i) All internal wiring shall be done with high temperature PVC insulation (105C).
- (j) Wiring shall be neatly grouped and retained.
- (k) The wiring shall terminate in a 3-way, 6A screw terminal block, with the earth conductor terminated onto a welded earth stud.
- (l) Cord sets shall be fitted as specified in the luminaire schedule.
- (m) Cord sets shall consist of 3 metre 0.75mm² 3-core PVC cabtyre cable with a 6A, three pin moulded plug top. The cord shall terminate in the fitting by means of compression glands.
- (n) Integrated dimming and or switching control capability utilizing an external 0-10 VDC control signal, dry NO or NC contact.

E21.3.3 Manufacturing and assembly of LED luminaires

General

- (a) The life of all led luminaires and lamps shall be >50 000 hours.
- (b) Output beam angle shall be as specified.

Construction

- (a) Preference shall be given to modular luminaires designed for ease of component replacement: LED luminaires shall be equipped with replaceable or upgradable LED modules.
- (b) Ingress protection rating of the LED luminaire should be prescribed for the intended applications under specific environmental conditions.
- (c) Housing to be manufactured from die cast or extruded aluminium.
- (d) There should be additional room available in the wiring compartment for third-party adaptive controls to be retrofitted.
- (e) Luminaires should be designed for ease of component replacement, including LED engines/modules, drivers, surge devices, and they should accommodate end-of-life disassembly.
- (f) Power supply driver shall be specified as dimmable or non-dimmable in the luminaire schedule and will operate as follows:
 - Reliable operation up to $\geq 45^{\circ}\text{C}$ ambient temperature;
 - Will last >80,000 hours;
 - Driver housing IP66 rated
 - Integrated dimming and or switching control capability utilizing an external 0-10 VDC control signal, dry NO or NC contact, DALI shall be specified if required.

2ft/4ft/5ft Vapour Proof LED Light

- (a) Body length : 660mm or 1277mm or 1572mm
- (b) Body construction : Polycarbonate with stainless steel latches and mounting hangers
- (c) Cover lens : UV stable Polycarbonate
- (d) Lumen : 660mm: 25W - 3200 lumen
1277mm: 50W - 6400 lumen
1573mm: 90W - 12000 lumen
- (e) CCT options : 4000K or 5000K
- (f) Supply voltage : 230V AC
- (g) IP rating : IP 65

LED Flood light

City of Johannesburg
Johannesburg Water (Pty) Ltd

- | | | | |
|-----|-----------------------|---|--|
| (a) | Wattage | : | 220W, 440W, 880W |
| (b) | Body construction | : | Die cast LM6 aluminium - powder coated |
| (c) | Front glass cover | : | 5mm tempered safety glass |
| (d) | Lighting performance | : | 146 lumens per W at source |
| (e) | CCT | : | 4000K or 5000K |
| (f) | CRI | : | +80 minimum |
| (g) | Supply voltage | : | 230V AC/50hz |
| (h) | Additional protection | : | 10KV |
| (i) | IP rating | : | IP 65 |

LED Bulkhead/Street light

- | | | | |
|-----|-------------------|---|---|
| (a) | Body construction | : | Glass filled Nylon / Yoke and Bulkhead bracket
Stainless Steel 316 |
| (b) | Lens type | : | 3mm Polycarbonate (UV stabilised) toughened glass
or impact modified Acrylic |
| (c) | Wattage | : | 20W/40W/50W |
| (d) | Lumen options | : | 20W – 3520 Lumens at source
40W – 7040 Lumens at source
50W – 8800 Lumens at source |
| (e) | CCT | : | 4000K or 5000K |
| (f) | CRI | : | +80 minimum |
| (g) | Supply voltage | : | 230V AC/50hz |
| (h) | IP Rating | : | IP65 |
| (i) | Power factor | : | 0.94 or better |

2ft/4ft/5ft Utility LED light

- | | | | |
|-----|----------------------|---|--|
| (a) | Body Construction | : | Extruded aluminium - either anodized or powder coated |
| (b) | Lens and Reflector | : | 190-degree ultra wide distribution
Opal lens with 80% transmission. |
| (c) | Length/Lumen options | : | 600mm – 24W 3072 lumens at source
1200mm – 48W 6144 lumens at source
1800mm – 72W 9216 lumen as source |
| (d) | Supply Voltage | : | 230V AC 50HZ |
| (e) | CCT options | : | 4000K or 5000K |
| (f) | CRI | : | +80 minimum |
| (g) | IP Rating | : | IP 44 |
| (h) | Control Gear | : | Internally mounted |

LED High bay

- | | | | |
|-----|-------------------|---|---|
| (a) | Body construction | : | ABS end caps
Anodised aluminium reflectors
Powder coated or anodised aluminium body |
| (b) | Lens type | : | 4mm Polycarbonate or toughened glass |
| (c) | Supply voltage | : | 230V AC 50HZ |

City of Johannesburg
Johannesburg Water (Pty) Ltd

- (d) Load/lumen options : 75W – 13200 lumens at source
90W – 15750 lumens at source
150W – 26400 lumens at source
180W – 31500 lumens at source
300W – 52800 lumens at source
360W – 63000 lumens at source
- (e) CRI : +80 minimum
- (f) CCT : 4000K and 5000K
- (g) IP Rating : IP 65
- (h) Power factor : Better than 0,97

Luminaire LED Performance

- (a) Minimum Luminaire Efficacy : 75 lumens per watt
- (b) Correlated Colour Temperature (CCT) : 4000K - 5000K
- (c) Minimum Colour Rendering Index (CRI) : 80
- (d) Lumen Output: - Initial lumen output shall be $\geq 10\%$ higher than required for the luminaire to meet recommended values for the specific locations indicated, in order for the luminaire to maintain compliance over its entire lifetime.

E21.3.4 Manufacturing and assembly of Emergency fittings

General

- (a) The fittings shall be manufactured according to the standard fittings as described above.
- (b) The fittings shall be self-contained emergency modules. I.e. The modules (emergency control units plus battery packs) can be fitted inside recessed and surface mounted luminaires including CFL bulkhead fittings.
- (c) The emergency fittings should have a switched live for Normal ON/OFF operation and an unswitched live for Emergency light battery charging.
- (d) The module should be able to maintain 50% light output for 1hour or alternatively 100% light output for ½ hour.

E21.3.5 High Masts Lighting

General

- (a) All work on the high mast lighting must be done from ground level.
- (b) All high mast poles will be of the hinging/tilting type. The hinging action allows the floodlights to be lowered to the ground for ease of access. Enough clearance space must be allowed to lower the pole.

Mast Shaft

- (a) All poles must be designed to SABS 0225 by a registered Professional Engineer.
- (b) The mast shall be constructed to form an enclosed tapered shaft. All steelwork must be hot dip galvanised, by an SABS approved galvaniser, to SABS ISO1461.
- (a) The lower mast portion shall be fitted with a suitably designed base plate bolted onto the mast foundation. The bolts will be reusable security bolts (tamper proof bolts) where a special tool is required to remove the bolts.
- (c) All mast foundations must be designed by a professional engineer, taking into account the mounting requirements of the pole baseplate.
- (d) The upper portion will be counterbalanced and hinged at midpoint.
- (e) The mast must be designed to safely withstand any loading (wind and own weight) in the upright and hinged position.

Floodlight Mounting Assembly

- (a) The mast shall be fitted with a suitable luminaire mounting assembly fabricated from steel sections and capable of carrying the specified number and type of luminaires.

Electrical Equipment

- (a) The Electrical distribution board shall be mounted in the base section of the mast and accessible only once the lid cover has been removed. The cover will be permanently fixed to the mast by means of a chain.
- (b) The lid cover will be fitted with reusable security bolts (tamper proof bolts) where a special tool is required to remove the bolts.
- (c) A multicore trailing cable shall be installed from the distribution board to a splitter box mounted on top of the mast.
- (d) The cable supplying power to the floodlight luminaires need not be disconnected during the lowering procedure thus allowing testing of the floodlights with the mast in the hinged down position.

E21.3.6

Sensors

Daylight Sensors

Daylight sensors must be provided to switch lights on at dusk and off at dawn by detecting natural light changes. All day light sensors shall have the following minimum requirements:-

- (a) Conduit entry with wall bracket mounting.
- (b) Efficient lighting solution.
- (c) Ultra violet stabilized materials.
- (d) Fail-safe position "ON".
- (e) Capacity switching - Incandescent or fluorescent 2.2Kw HID 1,8W.
- (f) Impact and hail resistant 0-4mm.
- (g) IP Rating: 54.
- (h) Amp Rating: 16A.
- (i) Voltage: 200 - 250Vac (50Hz).

Occupancy Sensors

- (a) Sensor shall activate the electrical load upon entry into the controlled area and deactivate it after the area is vacated.
- (b) Sensor shall be able to detect moderate types of motion.
- (c) Sensor shall maintain a constant level of sensitivity to motion regardless of changes in environmental conditions including airflow.
- (d) Sensor shall utilize passive infrared sensing technology to activate lights and other equipment connected to it.
- (e) Sensor shall contain timing circuitry to provide adjustable "time to lights off" delay of 15 seconds or less (for installer checkout) to 30 minutes. A 10-minute delay shall automatically default if the potentiometer is left at minimum.
- (f) Sensor shall provide a ten-second "grace period" that allows lights to be turned on by motion anywhere in an area after they are turned off due to inactivity.
- (g) Sensor shall self-adjust sensitivity (range) and time delay in real-time to optimize performance.
- (h) Sensor shall provide a Building Automation system (BAS) option interface via (1) a built-in isolated Form C relay output, (2) an open collector output, with or without pull-up option, or (3) a direct BAS connection.
- (i) Sensor shall be designed for parallel wiring to allow coverage of large areas.

E21.4

LIGHTING DESIGN

- (a) The contractor must do an area illuminance design in accordance with the applicable lux levels listed in SANS 10389-1 (Table 7 — Recommended values for illuminance, uniformity ratios and glare rating limits) and SANS 10114-1 (Table 1 — Minimum maintained illuminance values).
- (b) All exit routes must be lit with emergency lights in accordance with the latest Occupational Health and Safety Act (Act 85 of 1993) and the Building Code.
- (c) The contractor must submit the design to the Engineer for approval prior to the procurement of any material.
- (d) After installation, the contractor must do an illuminance study to confirm compliance to SANS 10389-1. The contractor must supply calibrated instruments to be used during the study. The compliance study must be witnessed by the Engineer.
- (e) Should the illuminance study indicated insufficient lux levels, the contractor must take steps to increase the lux levels to the required level.
- (f) Luminaire must be supplied as listed in the table below, specific to the area of installation (see paragraph E21.3.3 for minimum requirements)

#	AREA	LUMINAIRE (See E21.3.3)
1	Analyser Rooms	2ft/4ft/5ft Vapour Proof LED Light
2	Balancing Tanks	LED Flood Light on high mast
3	Belt Filter Press Sludge Dewatering	2ft/4ft/5ft Vapour Proof LED Light or LED Bulkhead/Street light
4	Biogas Collection and Storage (Gas Holder)	LED Flood Light on high mast
5	Bioreactors	LED Flood Light on high mast
6	Boiler Rooms	2ft/4ft/5ft Vapour Proof LED Light Ex-Rated fittings (Zone 2)
7	Chemical Dosing areas (Ferric Chloride and Hypochlorite)	LED Flood Light on high mast or 2ft/4ft/5ft Vapour Proof LED Light
8	Control Rooms	2ft/4ft/5ft Vapour Proof LED Light
9	Degritters	LED Flood Light on high mast In case of shed, use LED High bay
10	Digester Area	LED Flood Light on high mast
11	Fermenters	LED Flood Light on high mast
12	Final Clarifiers	LED Flood Light on high mast
13	Head Of Works (Buildings)	2ft/4ft/5ft Vapour Proof LED Light (LED High bay for areas under Sheds)
14	Head Of Works (Open area)	LED Flood Light on high mast (LED High bay for areas under Sheds)
15	Lime Preparation and Dosing (Open Area)	LED Flood Light on high mast
16	Liquor treatment (Open Area)	LED Flood Light on high mast
17	MCC/PLC Rooms	Utility LED
18	Open channels	LED Flood Light on high mast
19	Poly make-up, storage and transfer (Buildings)	2ft/4ft/5ft Vapour Proof LED Light
20	Poly make-up, storage and transfer (Open area)	LED Flood Light on high mast
21	PSTs	LED Flood Light on high mast

#	AREA	LUMINAIRE (See E21.3.3)
22	Screening and Washing areas (Buildings)	2ft/4ft/5ft Vapour Proof LED Light
23	Screening and Washing areas (Open area)	LED Flood Light on high mast
24	Screw Pump Station	2ft/4ft/5ft Vapour Proof LED Light or LED Flood Light on high mast
25	Skip areas for grit or screenings removal	2ft/4ft/5ft Vapour Proof LED Light
26	Sludge Pumping Station	2ft/4ft/5ft Vapour Proof LED Light
27	Sludge storage sumps or tanks (Open area)	LED Flood Light on high mast
28	Solar Sludge Drying Slabs (Drying Beds)	LED Flood Light on high mast
29	Thickeners	LED Flood Light on high mast
30	Perimeter of the sites	LED Bulkhead/Street light
31	Cable tunnels (Inside/Underground)	LED Bulkhead/Street light
32	Drying Bed Conveyors	2ft/4ft/5ft Vapour Proof LED Light
33	Perimeter of the sites (outside)	LED Flood Light on high mast
34	Access gates (Outside)	LED Bulkhead/Street light
35	Cable Pipe Bridge/Gantry (with walkway)	2ft/4ft/5ft Vapour Proof LED Light
36	Blower House (Inside)	2ft/4ft/5ft Vapour Proof LED Light
37	Digester Feed Sump	LED Flood Light on high mast
38	GTL pump station	LED Bulkhead/Street light or 2ft/4ft/5ft Vapour Proof LED Light
39	BPU (Belt Press Underflow) pump station (Inside and outside)	LED Bulkhead/Street light or 2ft/4ft/5ft Vapour Proof LED Light
40	Biogas Generator plant (Inside and outside)	LED Bulkhead/Street light
41	Elutriation (Inside)	2ft/4ft/5ft Vapour Proof LED Light
42	Compost Shed (Inside)	LED High bay
43	Flammable Stores	2ft/4ft/5ft Vapour Proof LED Light Zone 2 Ex Rated
44	Workshops	2ft/4ft/5ft Utility LED light
45	Admin Buildings	Architect to specify: For refurbished offices - check and propose to Joburg Water
46	Change Rooms (showers)	2ft/4ft/5ft Vapour Proof LED Light
47	Laboratory	2ft/4ft/5ft Vapour Proof LED Light

E21.5

INSPECTION AND TESTING

E21.5.1

General

All tests in accordance with the test requirements of this specification shall be performed prior to shipment.

Test certificates will be submitted with tender submission for all the units that are proposed.

All fittings shall be tested in accordance with SANS 475 and shall bear the performance mark.

The fittings shall also comply with ISO 9000 certification and the testing requirements of IEC 60598-1 publication.

E21.6 COMMISSIONING

The datasheet shall indicate whether the contractor is to allow a site technician to be present when the lighting system is to be commissioned. In such a case, the contractor shall quote a separate price for the provision of all personnel, materials and equipment for the site commissioning of the lighting.

Contractors shall provide a commissioning procedure, stating the tests that shall be performed with the results forecast.

The commissioning tests carried out on site shall be tests stipulated in the contractor's commissioning procedure.

E21.7 GUARANTEE

All equipment shall be guaranteed against defect for a period of twelve months, from the date of mutually agreed successful hot commissioning, fair wear and tear accepted.

Tenderers shall submit a written undertaking at the time of tender that a complete range of spares for the equipment offered will be held by the manufacturer for a minimum period of 10 years from the date of tender.

E21.8 TRANSPORTATION/SHIPPING

The costs of preparation for shipping will be included in the contractor's price.
The contractor is responsible to ensure that no damage will be sustained while shipping and he will prepare the appropriate packaging to ensure this.

The specification sheet shall indicate whether the contractor is to deliver the luminaires to site and whether the contractor is to offload the luminaires on site or if the delivery and offloading on site shall be carried out by a third party.

Where delivery and/or offloading by the contractor are specified on the specification sheet, the costs thereof shall be included in the contractor's price.

E21.9 DRAWINGS & DOCUMENTATION

The contractor shall supply all drawings and documentation as indicated in the Specification sheet.

E21.10 MEASUREMENT AND PAYMENT

<u>Item</u>	<u>Unit</u>
Supply and delivery of luminaire	No

The unit of measure shall be the number of luminaire supplied and delivered.

The tendered rate shall include all costs related to the manufacture, supply and delivery of the luminaire (as detailed in the schedule of quantities), including the additional requirements detailed in the detail specification.

Separate items will be scheduled in the schedule of quantities for different types and sizes, defined by the type of luminaire.

<u>Item</u>	<u>Unit</u>
Install luminaire	No

The unit of measure shall be the number of luminaire installed.

The tendered rate shall include full compensation for installing, testing and commissioning of the luminaire as specified. The rate shall further include for an illuminance study.

Separate items will be scheduled in the schedule of quantities for different types of luminaire.

Separate items will be scheduled in the schedule of quantities for different types and sizes, defined by type of luminaire.

<u>Item</u>	<u>Unit</u>
Supply and delivery of high mast lighting	No

The unit of measure shall be the number of high masts supplied and delivered.

The tendered rate shall include all costs related to the manufacture, supply and delivery of the high mast (as detailed in the schedule of quantities), including the additional requirements detailed in the detail specification.

Separate items will be scheduled in the schedule of quantities for different types and lengths, defined by the type of high mast.

<u>Item</u>	<u>Unit</u>
Install high mast lighting	No

The unit of measure shall be the number of high masts installed.

The tendered rate shall include full compensation for installing, testing and commissioning of the high mast lighting as specified. The rate shall further include for the pole plinth, crainage and other services required completing the installation.

Separate items will be scheduled in the schedule of quantities for different types of high masts.