OPERATION AND MAINTENANCE MANUAL FOR WASTE WATER TREATMENT WORKS

DPW's BASIC REQUIREMENTS

CONTENTS

1. PURPOSE OF MANUAL

The purpose of this manual is to direct Consulting Engineers, appointed by DPW to design, extend or upgrade Waste Water Treatment Plants (WWTP) for the Department, as to their responsibility towards providing and submitting an acceptable, appropriate and inclusive Operation & Maintenance (O & M) manual for that particular plant, on completion of the project. The chief plant operator must be able to be completely informed of the details, the operation and the maintenance of the plant without having to revert back to the Consulting Engineer or to the respective equipment suppliers.

2. GENERAL REQUIREMENTS

2.1 Copies: Two complete hard copies plus one electronic copy of the approved and accepted O & M Manual shall be provided to DPW, in English, upon completion and start-up of the WWTP. "Practical Completion" of the plant will not be considered unless DPW is satisfied with the manual.

2.2 Responsibility: The O & M Manual shall be the responsibility of the Consulting Engineer. Should there be a delay in submitting the acceptable O & M Manual to the extend that a claim(s) be forwarded by the Contractor(s) for unwarranted delays or late payment, as a result of such delay on producing the acceptable O & M Manual, such claim will be for the account of the Consulting Engineer.

2.3 Equipment Manuals: The Consulting Engineer must ensure that correct, appropriate Mechanical Equipment O & M Manuals, deprived of superfluous reading matter, be obtained from the Mechanical Contractor(s) and be bound into the Main O & M Manual as appendices thereof.

2.4 Electrical Manuals The Consulting Engineer must also ensure that correct, appropriate electrical line diagrams and other relevant information (like cable layout drawings, setting procedures for timers, etc.) be obtained for all the switchgear and electrical work, from the Electrical Contractor(s) (or Consulting Electrical Engineer) and also be bound into the Main O & M Manual as appendices thereof.

2.5 As Built Drawings: Accurately completed up-to-date "As Built" drawings form an integral part of the O & M Manual. One complete set in full scale (unbound) and one complete set in 50% scale, bound in "Drawing Book" format, are required for each copy of the Main O & M Manual.

2.6 Mythology: In producing the O & M Manual, the Consulting Engineer shall present a draft copy to DPW. DPW will comment on the draft within 5 working days. The Consulting Engineer shall then amplify and amend the draft until DPW is satisfied that it will fulfill the purpose of ensuring that DPW's staff is adequately informed to operate and maintain the plant. Once the draft has been approved by DPW, the Consulting Engineer shall prepare two complete hard copies of the O & M Manual, suitably bound; one to be kept on site (at the plant) and one at Head Office (as backup). The whole O & M Manual, including the 'as built' drawings must also be submitted in an acceptable electronic format (but excluding broachers or pamphlets of equipment suppliers). The manuals shall be drawn up in English.

2.7 Size: The manual shall be concise but conclusive. No superfluous reading matter shall be added to have the manual appear more comprehensive.

3 FORMAT

The manual shall be compiled in the sequential format shown below. Only applicable units shall be included.

Daily Tasks and Monthly Program
Contents

1. Description & Flow Diagram
2. Monitoring and Reporting
3. Flow Measurement
4. Inlet Works (IW)
   - 4.1 General
   - 4.2 Flood Diversion Box (if any)
   - 4,3 Screen structure
   - 4.4 Grit Channels or vortex degritters
5. Primary Sedimentation
6. Biological Trickling Filtration (BF) (or Biological discs, etc.)
7. Activated Sludge Reactor (ASR) or Sequential Batch Reactor (SBR)
8. Final Clarifier (FC) or Humus Tank (HT)
9. Disinfection Structure/System (DS)
10. Tertiary Treatment (TT)
11. Irrigation System
12. Final Effluent Discharge
13. Pumping Systems
    - 13,1 Raw sewage pumping system
    - 13.2 Biofilter pumping system
    - 13.3 Sludge pumping systems (including RAS & WAS)
    - 13.4 Supernatant pumping system
    - 13.5 Final effluent or Irrigation pumping system
    - 13.6 Chlorination motive water pumping system
14. Sludge Handling
15. Sizes, Capacities and Criteria
16. Safety Aspects
17 Power Interruptions & Standby Generator
18 Classification of Plant
19 Water Quality Standard – chart

APPENDICES

A Flow Diagram
B Tables and graphs for manual determination of flow rates
C Equipment manuals for flow meters
D Equipment manual for …….
E Equipment manual for …….
……
…….
……..
K Electrical line diagrams and sketches of DB's/MCC's
L Electrical layout drawings (folded into main manual)
……..
N As built drawings – Electronic format
O As built drawings – Half scale book of drawings
P As built drawings – Full scale roll

4 DESCRIPTION & FLOW DIAGRAM

The Manual shall start off with a short description of the purpose and logic of the plant resulting from recent occurrences which lead to the implementation of the project. The whole plant (whether it be part of the particular project under consideration, or not) shall then be shortly described, unit by unit, with each unit's main function, starting with the Head of Works (or Inlet Works) and following the flow sequence up to the discharge point of the final effluent. Sludge handling on this site shall also be shortly described.

The original capacity, added design capacity and new total capacity of the plant as well as the peak dry weather flow (PDWF) and peak wet weather flow (PWWF) applied to the plant shall be clearly stated. This must also be reflected on an appropriate and comprehensive flow diagram which is added as an appendix and referred to under "Description".

5 MONITORING AND REPORTING

The manual shall point out the importance of the Operator being dedicated to his plant and faithfully monitor all aspects as set out in the manual, report those that need attention and log what must be logged, as well as keeping an eye on general aspects like good housekeeping and attend to deteriorating items in time (like touch-up of corroded paint, tighten loose bolts, etc.)

The manual shall further contain a list of items, with their positions, that must be monitored on a regular basis, as well as the frequency to monitor. The lists of daily and monthly tasks shall include sample-collection and meter-readings for monitoring purposes. Influent and final effluent flow meter-readings must be performed daily. Pumps and equipment hour-meter readings shall be taken weekly.

The way (method) that samples must be collected, must be described in detail, as well as all positions where it shall be collected and the frequency of such collections. The various tests that need to be performed on the samples must be stated and the manual must contain a conspicuous table that reflects the required minimum standard (in terms of the National Water Act – Act no 36 of 1998) for the final effluent of that particular plant.

The Consulting Engineer shall acquaint himself as to which tests can be performed adequately by the plant operating staff and then recommend a proficient laboratory where the rest of the tests should be performed.

6 DAILY TASKS & MONTHLY PROGRAM

The manual shall also contain a conspicuous list/table of daily tasks (including those during night time) to be performed by the operating staff as well as a monthly program to include those tasks that did not have to be performed on a daily basis. The monthly program needs not to repeat the daily tasks but merely refer to it. Consider the front pages of the manual for this.

7 FLOW MEASUREMENT

The total raw sewage inflow as well as the total final effluent shall be measured as a minimum flow measuring requirement. (There may be more flow meters for side streams, recirculation, etc.). The method of flow measurement employed at the different points, shall be motivated

and be described in detail. Refer to the "as built" drawing(s) where the applicable instruments are clearly indicated.

The metering instruments employed, shall be pointed out and shall be referred to the respective mechanical manuals in the appendices for installation and maintenance requirements.

Tables or graphs shall be included in the manual (as appendices) to reflect the various flow-rates against water depths at all flow metering points. The purpose of this is to be able to manually determine the flow rate in case the corresponding meter is out of order. It can also be employed to periodically check whether the meter is still recording correctly.

8 INLET WORKS

The Inlet Works (or Head of Works) shall be described in detail with particular emphasis on:

- Method and frequency of removing inorganic and indigestible matter
- Method and frequency of removing grit that may cause damage (abrasion) to equipment
- Motivation for applying particular design
- Motivation for employing particular equipment
- Operation methods and requirements for each part of the Inlet Works
- Maintenance requirements for each part of the Inlet Works. Refer to applicable equipment documentation in the appendices.
- Procedure to revert to when power interruption occurs.
- Describe any flood-diversion measures (if applicable).

The importance of keeping the whole Inlet Works in a tidy and neat condition, including concrete slabs and mechanical equipment, by regular washing down thereof, shall be stated.

The size and capacity of the Inlet Works (or parts thereof) shall be reflected under Clause 19 " Sizes, Capacities and Criteria"

9 PRIMARY SEDIMENTATION

Describe the shape, upward flow rate, inlet and outlet of the structure as well as the method of sludge collection and withdrawal and scum removal.

The structure and method of sedimentation employed, shall be described. Refer to the "as built" drawing(s) for the applicable structure where particular valves, weirs, etc. are clearly indicated. Any mechanical equipment employed in the structure shall be pointed out and shall be referred to the respective mechanical manuals in the appendices for installation and maintenance requirements.

Actions like removal of scum and floating matter or withdrawal of sludge shall be described in detail. An example of the description for sludge withdrawal, is as follows:

"*Sludge Withdrawal:* Sludge is withdrawn by opening the sludge withdrawal valve (valve no. ? on drawing no ??). As soon as the sludge starts running out, immediately start closing the valve until a steady, controlled flow occurs. Observe the condition of the out flowing sludge carefully and as soon as water is following the sludge, close the valve and allow any possible "funneling" that might have occurred in the sludge hopper, to settle out (+- 2 minutes). Repeat this exercise until no more sludge can be withdrawn. To ascertain whether desludging was adequately performed, wait one hour (or more) and perform the settlable solids test on a homogeneous sample of water taken from between the scum baffle and overflow weir of the

tank. The test, performed by employing an Imhoff cone, must not exceed 0,4 ml/l settlable solids."

The frequency of desludging and scum removal shall also be stated.

Imaginable difficulties, like blockage of a sludge pipe, shall also be addressed. An example of such a description, is as follows:

"To open a blocked sludge withdrawal pipe: The sludge withdrawal pipe is fitted with a small (20 mm) boss & valve from where compressed air can be forced into the pipe. The sludge withdrawal valve (next to the boss) shall first be closed in order that the air pressure applied, can clear the pipe of a sludge blockage."

The size and capacity of the primary sedimentation structure(s) (or parts thereof) shall be reflected under Clause 19 "Sizes, Capacities and Criteria"

10 BIOLOGICAL TRICKLING FILTRATION

The structure and method of operation employed, shall be described, including the recirculation rate and purpose thereof. Refer to the "as built" drawing(s) for the applicable structure where particular valves, weirs, etc. are clearly indicated. Any mechanical equipment employed (like rotating distributor) on the structure, shall be pointed out and shall be referred to the respective mechanical manuals in the appendices for installation and maintenance requirements. The method of propulsion and speed adjustments shall be clearly described.

The purpose of this filter and importance of keeping the distributor nozzles clear from blocking matter (which is not covered by the mechanical manual) must be emphasized as well as keeping the collector channel clean and tidy. Mention purpose and application of end flushing valves on the distributor arms. Frequency of actions must be stated.

Imaginable difficulties, like 'sloughing' and 'ponding on top of the filter media', shall be properly addressed and remedial measures be described in detail.

The size and capacity of the biological trickling filter structure(s) (or parts thereof) shall be reflected under Clause 19 "Sizes, Capacities and Criteria"

11 ACTIVATED SLUDGE REACTOR

Activated sludge reactors normally consist of more than one compartment – different compartments for Anaerobic, Anoxic, Aerobic and Clarification processes. In the case of small (Package) units, as in the case of sequential batch reactors (SBR) systems, the different processes can occur in the same chamber, but at different times. Clearly describe the system employed with all compartments, their sizes and functions. Refer to the "as built" drawings concerned where particular valves, weirs, etc. are clearly indicated.

These reactors are usually fitted with a multitude of mechanical equipment. Care shall be taken in describing each and every piece of equipment, explaining their function and necessity, with due reference to the mechanical manual concerned and referred to in the appendices.

The flow configuration and applied mythology, used in the reactor, shall be explained and motivated. This shall include the magnitude of the various flow rates and their intake and

discharge positions. This shall also be indicated on the comprehensive flow diagram of the whole plant.

Operation techniques of certain equipment, not covered by the mechanical manual, must also be addressed. In most cases the clarifier (settling tank), following the reactor, forms an integral part of the reactor because all the settled sludge in the clarifier is fed back to the reactor on a continuous basis. This means that sludge withdrawal (or wasting of sludge) can be effected also from the reactor. This must be explained and addressed properly. The mythology of wasting sludge and corresponding "sludge age" is crucial and must be easily and logically determinable from the manual.

Methods of adjusting certain concentrations in the reactor effluent, like the pH, the oxygen content, the ammonia content, etc. to keep them within the required limits, shall also be addressed. The mixed liquor suspended solids (MLSS) value at which the plant must be operated and the methods of how to achieve and determine it, must also be stated.

Imaginable difficulties, like excessive scum or foam or matter caught up in equipment, etc., shall also be addressed.

The size and capacity of the activated sludge reactor structure(s) (or parts thereof) shall also be reflected under Clause 19 "Sizes, Capacities and Criteria"

12 FINAL CLARIFIER (OR HUMUS TANK)

Describe the shape, upward flow rate, inlet and outlet of the structure as well as the method of sludge collection and withdrawal and scum removal.

The structure and method of sedimentation employed, shall be described. Refer to the "as built" drawing(s) for the applicable structure where particular valves, weirs, etc. are clearly indicated. Any mechanical equipment employed in the structure shall be pointed out and shall be referred to the respective mechanical manuals in the appendices for installation and maintenance requirements.

The frequency of desludging and scum removal shall also be stated.

Imaginable difficulties, like blockage of a sludge pipe, shall also be addressed.

The size and capacity of the final clarifier or humus tank structure(s) (or parts thereof) shall be reflected under Clause 19 "Sizes, Capacities and Criteria"

13 DISINFECTION

The importance of disinfection and dangers in mal-applying it, shall be properly addressed.

The structure and method of disinfection employed, shall be motivated and be described in detail. Refer to the "as built" drawing(s) for the applicable structure (and building) where particular valves, weirs, etc. are clearly indicated. (The building for chlorine gas shall consist of two compartments – one for gas containing and one for gas applying/controlling). Any mechanical equipment employed in the disinfection process, shall be pointed out and shall be referred to the respective mechanical manuals in the appendices for installation and maintenance requirements.

Capacities and retention times at different flow rates shall be stated as well as the required dosing rate and way of adjusting dosing rates to suit the variable flow rate.

The size and capacity of the disinfection structure(s) (or parts thereof) shall also be reflected under Clause 19 "Sizes, Capacities and Criteria"

14 TERTIARY TREATMENT

Should there be any further tertiary treatment over and above disinfection, like maturation ponds, reed beds, etc. The motivation therefore, as well as full particulars, shall be included in the manual in a similar way that the various units are described above. Should there be existing ponds or reed beds, they shall also be addressed. Should they be included or excluded from the upgraded plant, either way, the decision shall be motivated.

15 IRRIGATION

Should the plant employ an irrigation system, whether it be for the disposal of the final effluent or whether it be for irrigation of the plant site itself and/or for wash down of equipment, or whether it be for both applications, the system shall be described in detail and all relevant criteria shall be addressed in similar manner as stated above.

Should the system be employed for disposal of the final effluent, then a note shall be added on the layout drawing (that shows the final effluent discharge point) stating the area irrigated, the distance from the discharge point and the size and class of pipe employed.

Should the plant site be provided with an irrigation or wash down system, then a complete layout drawing for this system shall be included in the as built drawings. This layout shall indicate the pipe positions, sizes and classes and the positions of taps, hose connections and sprinklers

16 FINAL EFFLUENT DISCHARGE

The position and method of discharging the final effluent, must be motivated and described and any action required from the operator in this regard, clearly stated. The position and method of taking samples for monitoring the performance of the plant must be stated and referred to on the "as built" drawings.

17 PUMPING SYSTEMS

Care shall be taken in describing each and every pump employed in the plant, explaining their function and necessity and how they are controlled, with due reference to the mechanical manual concerned and referred to in the appendices.

The system curve for each pumping system shall be produced with the particular pump curves super-imposed thereon. This can either be reflected in the mechanical manual or in the main manual but must be on an appropriate scale. Noteworthy conclusions from these curves, shall be mentioned. (like influence of change in head due to sump levels or pipe/valve-alterations, etc.).

Imaginable difficulties, like blockage of impellers or airlocks, etc. shall also be addressed. Means of preventing such difficulties shall be suggested.

18 SLUDGE HANDLING

There are numerous ways of sludge handling. To address all of them is beyond the scope of this manual, but it is expected from the Consulting Engineer concerned, to include the complete sludge handling system employed, from sludge withdrawal to final disposal of digested (dry) sludge. He shall motivate the system and describe in detail each and every structure and piece of equipment utilized in a similar manner than was done for the units mentioned above.

Factors like expected volume of sludge produced per day, number and size of drying beds employed, depth that they should be filled, clearing methods, frequency of actions, etc. must be stated in detail.

Should digesters or anaerobic reactors be employed, the volumes, capacities, sludge ages, etc shall be motivated and stated. For the draw off of supernatant, the method, sequence and frequency must be stated and explained.

The sizes and capacities of the various sludge handling structures (or parts thereof) shall also be reflected under Clause 19 "Sizes, Capacities and Criteria"

19 SIZES, CAPACITIES AND CRITERIA

The manual shall contain in concise and conclusive tabular manner, the sizes, capacities and criteria of the various units of the plant. An example of what is required in this regard, is as follows:

"15. SIZES, CAPACITIES AND CRITERIA

15.1 **Activated Sludge Reactor**

ADWF	35 l/s
Peak Flow	70 l/s
Form of reactor	Rectangular
Length (internal)	32 000 mm
Width (internal)	20 250 mm
Depth (Water level)	3 500 mm
Surface area (internal)	648 m^2
Volume anaerobic basin	168 m^3
Volume anoxic basin	721 m^3
Volume aeration basin	1 344 m^3
Total volume of reactor	2 233 m^3
Number of 1,3 kW mixers	6
Number of 22 kW aerators	1
Number of 30 kW aerators	2
RAS rate	35 l/s
Internal recirculation rate	105 l/s
Designed sludge age	19 days
WAS rate	117 kl/day
Designed oxygen added (average)	55 kg/hr

15.2 **Final Clarifier (Circular)**

Diameter (internal)	14,6 m
Surface area (internal)	167 m²
Side wall depth	4,0 m
Slope of floor	9,5°
Tank type	Bottom scraped
ADWF	35 l/s
Peak flow	70 l/s
Upflow velocity (ADWF)	0,75 m/h
Upflow velocity (Peak)	1,50 m/h
Suspended Solids removal	90 %

15.3 **Chlorination Structure**

ADWF	35 l/s
Peak Flow	70 l/s
Cross area of channel	1000 x 1200 mm
Length of channel	103 m
Total volume of channel	124 m³
Retention period at ADWF	60 minutes
Retention period at peak flow	30 minutes
Dosing rate	5 mg/l
Motive water	Refer to clause 5 above Small pump with standby
Gas cylinder arrangement	Two sets, each consisting of Two x 67 kg cylinders on one manifold.
Automatic change-over?	In place yes.
Determination of remaining gas available	Electronic scale to weigh cylinders

15.4 **Anaerobic Reactor**

Type and form	Rectangular open pond with two compartments and sides sloping at 1:2
Length (at water level)	62 m
Width (at water level)	42 m
Depth (deepest compartment)	6,0 m
Surface area	2 564 m²
Volume	4 770 m³
Age of digested sludge	150 days at 3 Ml/d
Frequency of sludge withdrawal	Once every day
Sludge pumping rate	15 l/s

15.5 **Sludge Drying Beds**

Sludge volume (wet, digested)	25 m³/d
Sludge application rate on drying bed	0,25 m
Drying area required per day	100 m²
Drying area required for 2 days	200 m²
Size of each drying bed	5 m x 20 m = 100 m²
Drying period	14 days
Total drying area required	100 x 14 = 1 400 m²
Number of beds required	1 400/100 = 14
Number of beds provided	12

15.6 **Existing Pond System**

Number of ponds	7 (including anaerobic reactor)
Total water surface area (all ponds)	33 350 m²
Average depth of existing ponds	1,2 m
Total volume (all ponds)	40 000 m³
Retention time at 3 Ml/d	13 days

20 SAFETY ASPECTS

It is not required from the consulting engineer to include in the manual the Occupational Heath & Safety Act with all the applicable regulations to be observed on a WWTP. He shall however clearly refer to the fact that the plant shall abide by it and then highlight certain safety aspects related to that particular plant.

21 POWER INTERRUPTIONS & STANDBY GENERATOR

The manual shall also describe in detail what actions shall be taken when power interruptions occur and how the operator shall start-up the various units when the power is back on line again.

If a standby diesel generator is provided, it must be clearly stated which units are supposed to receive power from this generator and the motivation for selecting the particular units. The operation of the generator shall be explained whether automatic or manual "switch-on" and how (in what sequence) the operator must employ the generator power and deploy again when line power is back.

The care of the generator, its batteries and fuel supply must be addressed – running the generator once per month to stay in practice. The period which the generator is expected to keep the units running with a full tank of fuel, shall also be stated.

Detailed operating and maintenance instructions for the generator shall be obtained and shall be included in the appendices for installation and maintenance requirements and duly referred to under this paragraph.

22 CLASSIFICATION OF PLANT

The new or upgraded WWTP shall be classified in terms of the Plant Classification Schedules for Wastewater Treatment Works (Shown below) and its classification stated and certified by the Consulting Engineer under the appropriate paragraph.

Schedule II: Registration and Classification of a water work used for the treatment of waste and the disposal or re-use of the treated waste

To use the table below every section and sub-section is rated and allocated points.

Points to be awarded at the discretion of the Director-General in accordance with the following criteria:

			Maximum
Population supplied		Up to 5 000	1
		5 001 to 50 000	2
		50 001 to 250 000	3
		> 250 000	4
Infrastructure	Design Capacity in kilolitres per day (kℓ/d)	0 to 500	2
		501 to 2 500	4
		2 501 to 7 500	6
		7 501 to 25 000	8
		>25 000	10
		Actual volume:_____k-ℓ/d	
	Versus peak day	Design more than peak day use	0
		Design = peak day use	1
		Design < peak day use	3
	Final water storage capacity	>60 hours during peak	0
		30 - 60 hours during peak	1
		<36 hours during peak	2
	Installed power (kilowatts of installed power to operate)	0-5 kW	1
		5 – 100 kW	3
		101 – 1000 kW	5
		>1000 kW	10
Operating Procedures	Raw water flow rate	No variation	0
		Little variation (<5%)	1
		Controlled variation with automatic adjustments	2
		Uncontrolled variation with automatic adjustments	3
		Controlled variation with manual adjustments	4
		Uncontrolled variation with manual adjustments	5
	Raw water quality	No adjustments needed in operating procedures	0
		Seasonal adjustments needed in procedures	1
		Monthly adjustments needed in procedures	2
		Weekly adjustments needed in procedures	3
		Daily adjustments needed in procedures	4
		Hourly adjustments needed in procedures	5
	Chemical dosing	No chemicals added	0
		Disinfection chemical	2
		+1 flocculation chemical without pH control	4
		+2 flocculation chemicals without pH control	6
		+1 flocculation chemical with pH control	8
		+2 flocculation chemicals with pH control	10

Operating Processes	**Desludging**	Automatic desludging	1
		Manual desludging	2
		Automatic fixed schedule of desludging	3
		Manual fixed schedule of desludging	4
		Optimised desludging	5
	Filter Backwash	Automatic controlled by timer	1
		Automatic controlled by pressure	2
		Manual with fixed time schedule	3
		Manual with fixed pressure schedule	4
		Optimised filter backwash	5
	Settling Process	Uncontrolled process	2
		Controlled process (sludge blanket)	5
	Stabilisation	pH correction with automatic dosing	1
		pH correction with manual dosing	2
		pH correction according to Langelier/Razner index	3
		pH correction according to Stasoft programme	4
		Complete stabilisation with CO_2	5
	Disinfection	Uncontrolled with tablets	1
		Dosing with liquids or powder	2
		Dosing with chlorine gas or ozone	3
		Optimum chlorine gas or ozone dosing	4
		Combination chlorine and ozone	5
	Recirculation	Without any adjustments in procedure	1
		With automatic adjustments in procedure	2
		With separate settling tanks	3
		Controlled recirculation with adjustments	4
		Uncontrolled recirculation with adjustments	5
	Sludge handling	Sludge lagoons	3
Control Processes	**Water Losses**	On works only	2
	Water Management	Different reservoirs	2
		Different pressure zones	4
	Pumping	Gravitation only	2
		Gravitation and pumping	4
		Raw or final pumping	4
		Raw, Final and other pumping	6
	Level	Indicators	2
		Telemetric	4
	Maintenance	None by operators	0
		Basic maintenance by operators	1
		Specialised maintenance by operators	2
	Lab services	Reading with instrumentation by operators	2
		Full lab service on site but not done by operators, although still a management function	3
		Chemical analyses done by operators	4
		Jar tests to maintain optimum dosing by operators (more than 2x daily)	5
	Administration	Record readings	1
		Calculate daily flow and stock taking	2
		Calculate dosing and generate reports	4
		Work on computer (not just check screen)	5

Special Processes	**Demineralisation**	Mechanical – Air	2
		Chemical*	1 – 5*
	Fluoridation		5
	Reverse Osmosis		5
	Activated carbon		5
	Softening		5

* need to motivate number of points claimed eg. combination of chemicals.

After adding all the points allocated, the total is checked against the classification range below.

Class of works Range of points	E <30	D 30 - 49	C 50 – 69	B 70 – 90	A >90

23 EQUIPMENT MANUALS

It is expected of the Consulting Engineer to obtain all relevant equipment manuals and to scrutinize them for sufficiency but also for superfluous material that may never be of any value to the plant operator. "Nice-to-have" literature can be added if the volume of the manual is still within practical limits, otherwise the omission thereof should rather be opted for.

24 ELECTRICAL WORK

Clear and complete electrical line diagrams shall be included. A separate diagram for every type and size of switchgear, indicating the size and application thereof, is required. The diagrams shall be to such detail that any qualified electrician will be able to follow the logic, and effect repairs when necessary.

Front view sketches of all DB's (distribution boards) and MCC's (motor control centers) are required.

Details of site lights shall be given with replacement parts (bulbs/elements) and method of replacement fully described.

Included with the "as built" drawings shall also be submitted Electrical Cable Layout drawings – two full scale and two half scale hard copies plus one electronic copy. The layouts shall also indicate the various positions of the DB's/MCC's, the site lights, the transformer and the earth mats (if applicable).

25 AS BUILT DRAWINGS

Each and every drawing shall be controlled to ensure that it reflects the true situation regarding the final outcome of the structure as it has been actually built. Of utmost importance is the final levels constructed. Invert levels of the various pipe positions and flumes, weir crest levels, overflow levels, sump floor levels, etc. shall be re-surveyed after construction and the "as built" values stated on the as built drawings.