THE
FALKLAND ISLANDS
GOVERNMENT

A
REPORT ON THE
STANLEY WATER SUPPLY

THE CROWN AGENTS FOR OVERSEA
GOVERNMENTS & ADMINISTRATIONS
4 MILLBANK
LONDON SW1P 3JD

REF: EM1/367/50

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Crown Agents for Oversea Governments and Administrations
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His Excellency
The Governor
Port Stanley
FALKLAND ISLANDS

Our ref EJ/367/50

Your ref

Date March 1979

Sir

PORT STANLEY WATER SUPPLY

Acting in accordance with the instructions given us by the Ministry of Overseas Development our senior engineer, Mr A A Smith, BSc, CEng, FICE, FIWES visited Port Stanley from 31 January to 21 February 1979 to give further assistance to the Falkland Islands Government in the operation of Port Stanley water supply, particularly in the installation and commissioning of new chemical dosing plant. The opportunity was taken to up-date our 1977 Report on the undertaking.

2 We now have pleasure in submitting 10 copies of our Report. Should there be any further information or explanation which you require, we should be pleased to be of service to you.

Yours faithfully

A Allan K Smith

f.A. J H POTTER, BSc Tech, CEng, FICE, MIWES
Head of Civil and Industrial Engineering Department

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CHAPTER 1

INTRODUCTION

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A REAPPRAISAL OF THE POTABLE WATER SUPPLY TO THE TOWN OF PORT STANLEY, FALKLAND ISLANDS

1. INTRODUCTION

1.1 Origin of the Assignment

1.1.1 On 11 November 1976 the Ministry of Overseas Development commissioned the Crown Agents on behalf of the Government of the Falkland Island (FIG) to inspect the potable water supply to the town of Port Stanley.

1.1.2 The report was made in March 1977 recommending, inter alia, that new chemical dosing equipment should be installed at the Treatment Works to enable more precise treatment to be undertaken than was possible with the then existing gravity dosing equipment.

1.1.3 By telex dated 17 October 1978, the Falkland Islands Government instructed the Crown Agents to procure five chemical metering pumps and associated equipment. The pumps and equipment were delivered to Stanley in the middle of January 1979.

1.1.4 No one of the staff of the Falkland Islands Government had the necessary expertise to arrange the installation and commissioning of the new equipment. The Ministry of Overseas Development was consequently asked to provide the necessary technical assistance to carry out this work.

1.2 The Terms of Reference

1.2.1 On 9 January 1979 by their letter reference OMD 354/56/01 the Ministry of Overseas Development commissioned the Crown Agents "to continue their advice to the Government of the Falkland on the Port Stanley Water Supply".

1.3 The Work

1.3.1 The work was the responsibility of the Head of Civil and Industrial Engineering Department of the Crown Agents, Mr J H Potter, B Sc Tech, C Eng, FICE, MIWES and was carried out by Mr A A Smith, B Sc (Eng) (Hons), C Eng, FICE, FIWES, Senior Water Engineer.

1.3.2 Mr Smith arrived in Stanley on 31 January 1979 and left on 21 February 1979.

1.3.3 A list of officers and members of the staff of the Falkland Islands Government with whom Mr Smith had discussions and to whom he gave instructions and assistance is given in Appendix 1.

1.4 Acknowledgements

1.4.1 We wish to express our gratitude to Mr John Massingham, The Government Chief Secretary, to Mr Alan Mason, the Director of Public Work and the entire staff of the Public Works Department with whom Mr Smith had contact, for the arrangements made and the help they gave him during his visit. Their friendliness and keen co-operation were very much appreciated.

1.5 Responsibility of the Report

Although this Report has been commissioned by the British Government under British Aid arrangements, the British Government bears no responsibility for, and is not in any way committed to, the views and recommendations expressed herein.

SUMMARY OF RECOMMENDATIONS

2.1 Recommendations made in 1977 Report for immediate implementation but not yet implemented.

2.2 New items for immediate implementation.

2.3 Items for implementation before 1984.

2.4 Items for implementation at some future date.

2 SUMMARY OF RECOMMENDATIONS

2.1 Recommendations made in 1977 Report for immediate implementation but not yet implemented.

2.1.1 Clean and paint raw water (low lift) pumps (4.3).

2.1.2 Clean interiors of flocculation and sedimentation tanks and paint two coat epoxy-resin paint or Wailes Dove Bituros solution (4.4).

2.1.3 Clean and paint exterior surfaces of filter shells (4.5.1).

2.1.4 Clean and paint two coats of Bituros solution interior and exterior surfaces of filter outlet chambers (4.5.4).

2.1.5 Clean and paint high lift (treated water) pumps (4.8).

2.1.6 Redecorate interior of Treatment Works and complete the repainting of the exterior of the buildings (4.10).

2.1.7 Clean and repaint booster pump at Dairy Paddock Reservoir (4.13.1).

2.1.8 Clean and redecorate interior of booster pumphouse at Dairy Paddock Reservoir (4.13.1).

2.1.9 Clean and paint interior and exterior of Sapper Hill Tank with two coats of Bituros solution.

2.1.10 Purchase flow, pressure testing and recording equipment for fire hydrants (4.14.3). Approximate cost £530 fob UK Port.

2.1.11 Purchase BS Sluice Valve and Fire Hydrant Indicator plates (4.14.4). Approximate cost £450 fob UK Port.

2.1.12 Prepare a maintenance programme with record book to ensure that no essential work is overlooked (5.2.4).

2.1.13 Provide meters on outlets of Dairy Paddock Reservoir and Sapper Hill Tank and carry out regular periodic night waste detection tests (5.2.5). The approximate cost of the meters is £850 fob UK Port.

2.1.14 Prepare and promulgate Bylaws (5.2.6).

2.1.15 Install meters to register consumption on trade premises (5.2.7). The current fob UK Port prices of suitable meters are approximately:-

1/2 in	-	£10.00
3/4 in	-	£13.00
1 in	-	£20.00

2.1.16 Set up new gauging station on the Murrell River.

2.2 New items for immediate implementation

2.2.1 Make and install new spray rails for post-filtration soda ash and chlorination dosing points (5.2.2).

2.2.2 Provide up-stands and repair or replace access manhole covers to treated water tank to prevent pollution of the treated water.

2.2.3 Line chemical store and provide anti-condensation heating (4.6).

2.2.4 Service float-operated valve in plant inlet chamber (4.2).

2.2.5 Replace coupling on No 1 Low Lift pump (4.3).

2.2.6 Replace filter support media (4.5).

2.2.7 Refurbish or replace duplex pressure gauges on filters (4.5.5).

2.2.8 Order spares for new dosing pumps.

2.2.9 Replace perimeter fence at Dairy Paddock Reservoir (4.12).

2.2.10 Purchase and install settled water pH monitoring equipment with audible alarm and recorder (5.2.1). Approximate cost £1500 C&F Stanley.

2.3 Items for implementation before 1984

2.3.1 Commission Feasibility Report on new Treatment Works (7.3).

2.3.2 Prepare designs and obtain tenders for plant for new Works (7.3).

2.3.3 Construct new Works (7.3).

2.4 Items for implementation at some future date

2.4.1 Construct new intake and raw water pumping station near the estuary of the Murrell River (7.3).

2.4.2 Extend new treatment works to meet increased demand (7.3).

2.4.3 Provide fire-fighting water supply as described in the supplement to our 1977 Report.

PREAMBLE

3.1 Historical

3.2 Format of Report and references to previous reports

3.3 Interpretation of Terms of Reference

3.4 Limitations upon Recommendations

3 PREAMBLE

3.1 Historical

This is the fourth engineering report made on Port Stanley potable water supply since World War II following:

3.1.1 The Pape Report of 1953,

3.1.2 The Casserly Report of 1972 and

3.1.3 The Smith Report of 1977.

Reference was also made to it in Volume 1 of Lord Shackleton's "Economic Survey of the Falkland Islands - Resources and Development Potential" which is herein referred to as "the Shackleton Report".

The present Treatment Works, abstracting water from the Moody Brook about 1750 metres from where the stream discharges into Stanley Harbour was built as the result of recommendations made in the Pape Report and were commissioned in 1956.

Early in 1972 Mr M J Casserly, BSc C Eng, FICE carried out a survey of the Works and Distribution System under assignment by the Overseas Development Administration of the Foreign and Commonwealth Office on behalf of the Falkland Islands Government.

In January 1977 Mr A A Smith, B Sc(Eng), C Eng, FICE, FIWES visited Stanley for purpose of up-dating the Casserly Report and with the assistance of Assistant Divisional Office D J Davis of the Cheshire Fire Brigade made recommendations for improving the supply of water for fire-fighting in Stanley. This work was carried out under assignment by the Ministry of Overseas Development.

3.2 Format of Report and references to previous reports

For convenience of cross-referencing the format adopted for our 1977 Report has been retained and unless otherwise indicated the same chapter, paragraph and sub-paragraph numbers have been used for the same subject matter. References to the Pape and Casserly Reports are prefixed by the letters 'P' and 'C' respectively.

3.3 Interpretation of Terms of Reference

In carrying out our assignment "to continue our advice to the Government of the Falkland Islands on Port Stanley Water Supply", by agreement with the DPW we have:

3.3.1 Reviewed what changes have taken place in the Undertaking since 1977.

3.3.2 Assisted in the installation and commissioning of new chemical dosing equipment recommended by the 1977 Report (S Appendix i3 Item 4).

3.3.3 Trained plant operators in the use of the new dosing equipment and instituted new procedure for filter washing made necessary by the new installation.

3.3.4 Made recommendations for improving the security of the supply against contamination.

3.3.5 Made recommendations for improvement of the chemical storage and weighing facilities.

3.3.6 Made recommendations for improvement of runs of chemical hoses to ensure satisfactory mixing of chemicals.

3.3.7 Instituted new plant performance surveillance procedure.

3.3.8 Supervised the re-sanding of the filters and examined the sand support layers of pebbles.

3.3.9 Examined the interior of the sedimentation and mixing tanks.

3.3.10 Examined the structures of Dairy Paddock Reservoir and Sapper Hill High Level Storage Tank.

3.4 <u>Limitations upon recommendations</u>

We repeat what was said in the previous report (3.4) as it is equally applicable to this:

"In making our recommendations we have been particularly careful not to overlook the limited resources of local funds and of labour and also the rising costs of imports"

"In considering recommendations involving capital expenditure we have kept in mind that the cheapest to buy is unlikely to be the cheapest to run and maintain, that installations should be easy to operate and maintain with minimum of labour and imported materials.

REPORT ON CURRENT STATE OF THE PLANT

4.1 The Source

4.2 The Intake and Raw Water Main

4.3 The Raw Water (Low Lift) Pumps

4.4 The Flocculation (Mixing) and Sedimentation Tanks

4.5 The filters

4.6 The Chemical Dosing Plant, Stores and Laboratory

4.7 The Workshop and Spares Stores

4.8 The Treated Water (High Lift) Pumps

4.9 The Electrical Equipment

4.10 The Treatment Works Buildings

4.11 The Treated Water Pumping Main

4.12 The Low Level Reservoir at Dairy Paddock

4.13 The High Level Booster Pump and Sapper Hill (High Level) Storage Tank

4.14 The Distribution System

4 THE CURRENT STATE OF THE PLANT

The general description of the plant on Mr Smith's arrival in Stanley was as described first by Casserly (C1) and amended by Smith in 1977 subject to the following observations:

4.1 The Source

At the time of Mr Smith's 1977 visit the Falkland Islands had experienced a period of relatively dry weather and in consequence the flow in the Moody Brook was very low. The amount of water then available provided extremely valuable information for future planning. However the quality of the water under low flow conditions is likely to be at its best and easiest to treat. It therefore gave no indication of the treatment required when at its worst. This will occur after heavy rainfall. Fortunately for the purpose of Mr Smith's recent visit there was unusually heavy rainfall during the night of 4/5 February when about 38mm (1 1/2 inches) fell. The brook water the following morning was extremely acid, 4.6 pH and very coloured 300 Hazen whereas under dry conditions the pH may rise to about 5.4 with colour down to 50 Hazen. At all times there appears to be very little turbidity. The major treatment problem is therefore colour removal.

4.2 The Intake and Raw Water Main

The intake and raw water main appear to remain in good repair except for the float operated valve in the raw water pump sump which regulates the flow of raw water to the plant. This valve does not shut off properly and thereby causes the dilution of the chemicals in the sump when the plant is shutdown. Since this sump contains about 10 minutes supply of water, the probability exists of about 1000 gallons of undosed water will enter the plant on start-up. This valve must be made to close drop-tight urgently.

4.3 Raw Water (Low Lift) Pumps

The designed output of the works is 6000 gph (7.5 l/s) At the time of Mr Smith's previous visit, the throughput of the Works was limited by the poor performance of the Treated Water (High Lift) Pumps to about 5400 gph (6.82 l/s). Fortunately one of these pumps has now been replaced and the new unit, although designed for the same duty, delivers 6500 gph (8.1 l/s). Its standby still only delivers about 5500 gph (6.9 l/s). This causes a problem which is referred to in paragraph 5.2.1. The older of the raw water pumps required a new motor to pump coupling. A temporary repair has been made to the coupling whilst awaiting supply of the replacement from the UK but this repair had prevented the refixing of the coupling guard. It was therefore extremely dangerous. At Mr Smith's instigation the temporary coupling was modified to enable the coupling guard to be re-fitted.

4.4 Flocculation and Sedimentation Tanks

A method was devised by Mr Smith before arriving in Stanley whereby the existing Braithwaite steel tanks could be replaced by the glass reinforced plastic (GRP) sectional plate tanks referred to in our previous report which are now on site. The problem of finding sufficient skilled labour to effect the demolition and erection of the GRP tanks on new foundations is formidible when at the same time supply of water has to be maintained. The mixing tank and the two halves of the sedimentation tank were drained and a fire tender was used to provide a high pressure cleaning jet to enable a close inspection of the fabric of the tanks to be carried out. It was found that the deterioration of the internal faces of the tanks was not as bad as previously reported. Resulting from this inspection and bearing in mind the difficulty of doing so, it was agreed that their replacement should be deferred. A supply of Bituros solution is on order and when this arrived the tank should again be drained, washed down, all loose rust removed, wire brushed and painted two coats of Bituros solution. It is possible that the replacement of the tanks can be delayed for a number of years provided they are kept well painted inside and out. There are a number of badly rusted nuts and bolts which were used for assembling these tanks. These should be replaced at an early opportunity.

4.5 The Filters

4.5.1 The condition of the filter shells is as reported in 1977. Plans have been made to paint the whole plant and building which is now badly in need of redecoration.

4.5.2 On Mr Smith's arrival both filters were badly deficient of sand. The correct depth of the bed is 2 ft - 4 in (711 mm). No 1 had about 1 ft - 6 in (457 mm) and No. 2 only about 6 in (152 mm). The cause of the loss is not the usual reason of excessive back-washing rate but that the supporting beds are failing in their purpose and the sand is passing through the support beds to be deposited in the filter outlet valve chambers. Knowing of the sand defieiency the PWD had obtained a replacement supply from the Murrell River estuary from which a filter sand of reasonable grading can be obtained, but awaited Mr Smith's arrival before placing it in the filters. This enabled Mr Smith to inspect the condition of the support layers both of which appeared either badly graded or alternatively mixed up. Whichever is the cause these defective beds should be replaced by properly graded layers of shingle in accordance with the suppliers drawings. It is understood that a supply of shingle can be obtained from a beach not too distant from Stanley from which correctly graded beds can be laid. This work should be undertaken at the earliest opportunity as the current loss of sand from the beds will continue until the support beds are replaced. Both beds were resanded on Saturday 17 February.

4.5.3 At the time of Mr Smith's arrival in Stanley the practice of using bars to close the filter outlet valves, first reported by Casserly (C4.3.2) and again referred to in our 1977 Report, was still in force. This not only prevented the slow-starting of filtration but was also exacerbating the problem of sand passing through the support layers of shingle. The plant was consequently shut-down on Tuesday 20 February and the filter throughput control mechanisms were closely examined. It was found that the floats within the filters were insufficiently weighted with water to ensure drop-tight closure of the outlet valves when the filters were drained down for washing and that the linkages required lubrication. These faults were corrected and the valves then worked perfectly, not only did they produce drop-tight closure but also a very satisfactory slow start which made it unnecessary to filter to waste on returning filters to service after washing. It is recommended that the oil lubricating holes in the linkages should be drilled out, tapped and fitted with grease nipples. The current use of oil is not only a possible source of contamination of the filtered water but also it does not appear to be very effective. A note on the design, adjustment, operation and maintenance of the filter throughput control appears in Appendix I hereof.

4.5.4 Since our previous report no attention has been given to painting the plates of the filter outlet valve chambers and in consequence further deterioration has taken place. However it is understood that these chambers will be cleaned out, descaled and painted two coats of Wailes Dove Bituros Solution as soon as a supply arrives on the next charter vessel.

4.5.5 The two duplex pressure gauges mounted on the panel at the front of the filters require refurbishing. The accuracy of the gauges is in doubt and the dials require repainting. It was our intention to recommend the replacement of these gauges but we now find that major manufacturers in the UK no longer make gauges of this type. The choise appears either to refurbish them locally or to replace them with four simplex gauges.

4.6 The Chemical Dosing Plant, Stores and Laboratory

4.6.1 Resulting from the recommendation contained in our 1977 Report the Falkland Island Government has acquired five Model K Simplex Metripump each driven by a 1/3 hp (0.25KW) 400/440V, 3-phase, 50 Hz electric motor, each having an output of 0-3.9 gph (0-295 ml/min). Four of these pumps were installed and commissioned under Mr Smith's direction. The fifth has been put in store as a replacement for a defective pump. By varying the saturation of the reagents used it has been made possible to use a single model pump for all four of the reagents used despite the large range of dosages. The four installed pumps have been allotted the duties of dosing Aluminium Sulphate (Alum), Pre-flocculation Sodium Carbonate (Soda Ash), Sodium Aluminate and

Post-filtration Sodium Carbonate for pH correction. The existing gravity doser for Magnafloc LT24 has been retained as variation of this dosage is not required. At one time Mr Smith was hopeful of being able to dispense with the dosing of Sodium Aluminate as laboratory tests carried out in 1972 following Mr Casserley's visit by Paterson Candy International Ltd had indicated that by dosing with alum, lime and Magnafloc LT24 produced an excellent sedimentation rate with colour removal. It would appear that PCI were not told that Soda Ash was used at Stanley in place of lime. Laboratory flocculation tests carried out at the Works using the equivalent quantities of soda ash do not produce similar high sedimentation rates. These tests showed that satisfactory flocculation and colour removal could be achieved using alum, soda ash and Magnafloc alone, but the extra dosage of alum required would make the abandonment of sodium alummate uneconomical. Had it been possible to dispense with Sodium Aluminate the fourth metering pump could have been allotted to dosing Magnafloc. However having to retain the gravity doser for this reagent presents no difficulty. The four installed pumps have been mounted at 12 in (305 mm) centres on a 6 in (152 mm) high plinth in the pump room. Their starters are mounted on the wall immediately above them. The orifices of the old gravity dosers were drilled out to the diameter of the draw-off pipe and used to hold gauze suction strainers. The vents in the float units, previously provided to ensure that the orifices discharged to atmosphere were plugged to ensure that air is not drawn into the pump suctions. Two spare 3-phase ways were found on the main power distribution board. One of these has been used to supply the metering pumps through a 4 way, 3-phase board, one way supplying each pump. All wiring has been carried out in PVC Cable in plastic conduit. The opportunity was taken to replace all chemical hoses with polythene tubing and uPVC piping. The suction hoses from the reagent holding tanks to the pumps are in 1/2 in. polythene to 1/2 in. uPVC adjacent to the pumps terminating in 1/4 in. polythene to the pumps. The deliveries are initially in 1/4 in. polythene to 1/2 in. uPVC and terminate in 1/2 in. polythene. A syphon break is incorporated in each delivery to prevent gravity flow when the pumps are idle.

4.6.2 Reference was made in our previous report to a new Clorocel electrode unit which was due for delivery at the end of January 1977. This unit was duly received, installed and commissioned. Since then it has worked satisfactorily.

4.6.3 The chemical store was adequately stocked. A large stock of sodium aluminate was held at the German Camp due to insufficient space in the Treatment Works store. It would be an advantage if the Nissen hut in which the chemicals are kept could be lined and provided with a small heater.

At present there is evidence that condensation dampness is causing caking of some of the chemicals. More suitable chemical weighing equipment has now been acquired and is in use.

4.6.4 The equipment of the Chemical Laboratory has been improved since our previous report by the addition of a mains powered Laboratory pH meter, acquired from the airport construction contract and a battery powered portable pH meter bought as recommended in our 1977 Report. In consequence of these purchases it is now possible to carry out flocculation tests with the accuracy previous unattainable and also to keep a close supervision of the performance of the plant, thereby maintaining a high standard of fitrate.

4.7 The Workshop and Stores

These have now been tidied up and are as they should be.

4.8 The Treated Water (High Lift) Pumps

The two sets currently installed deliver 5500 gph (6.95 litre/s) and 6500 gph (8.21 litres/s) to Dairy Paddock Reservoir. Both sets require painting but otherwise appear to be in good order.

4.9 The Electrical Equipment

This equipment at the Treatment Works is in first class condition. The need for additional socket outlets in the laboratory has been recognised and arrangements have been made for some to be installed. The electric fire and pipe heaters at Dairy Paddock Booster Station are dangerous and require immediate attention. Due to wrongly rated overload units having been supplied with the new dosing pump starters they have been bypassed pending replacement by correct units. In the meantime the motors are adequately protected by fuses.

4.10 Treatment Plant Buildings

Very little improvement in the state of the buildings and staff accommodation has taken place in the past two years. It is understood that tenders have been invited for re-painting the building. Upstands should be provided wherever there is access to the treated tank to prevent floor washing polluting the supply.

4.11 Treated Water Pumping Main

It was suggested in our 1977 Report that the then low Hazen Williams friction constant 'C' value of 84 was possibly due to a deposit of slime on the inside of the pipes brought about by the excessive quantity of alum being used in the treatment of the water. During the period between Mr Smith's visits the amount of alum used was reduced although not nearly enough, but even this reduction appears to have improved the conditions within the main. The friction head now gives a C value of 114. A Head/Flow graph is included as Appendix J. This current value of 'C' is much more in keeping with what might be expected after 23 years of service. Nevertheless it is still possible that an improvement may result from pumping water in future at the correct pH viz about 8.1.

4.12 The Low Level Reservoir at Dairy Paddock

The damaged roof of this reservoir referred to in our previous report has been repaired but the replacement or painting over of the transparent roof sheets has not been done. Reference was previously made to alum in this reservoir, on this occasion this was not so evident although excessive amounts of alum had been used at the treatment works. The roof structure has yet to be painted as previously recommended. As an additional precaution against contamination we recommend the replacement of the boundary fence at this site.

4.13 High Level Booster Pump and Storage Tank on Sapper Hill

The supply to the storage tank is still supplied by a single electrically operated pump. A float switch has now been installed to control the pump but its installation is in need of attention to avoid overloading the motor starter. The recommendation we made in 1977 for the duplication of this pump still holds.

4.13.1 The booster pumphouse is still to be repainted.

4.13.2 It is the PWD's intention of repainting the interior and exterior of the High Level Tank as soon as the supply of Bituros Solution which has been ordered for this purpose has been received.

4.14 The Distribution Reticulation

We have nothing to add to what was stated in our previous report. No improvements have been made.

CHAPTER 5

REPORT ON STAFFING AND OPERATION OF PLANT

5.1 Staffing

5.2 Plant Operation

5.1 STAFFING

Since our last report considerable changes have taken place in the organisation of the Public Works Department.

The Department now comes under the control of Mr A F Mason, the Director of Public Works who is responsible for the whole of the infrastructure, viz buildings, roads, jetties electricity and water supplies and sewerage. In this he is assisted by a number, of Superintendents of Works. The one in charge of water supply is the Superintendent of Works (Buildings) Mr N Laughna. Responsible to him for the water undertaking is the Water Supervisor, Mr D Price. His staff is divided into two groups, first, three treatment plant attendants and second, a team of plumbers and laborers who attend to the distribution system, services and plumbing within government property. The impression given is that the Department now has a sense of direction and urgency which was missing before. We have no doubt that with the new management every endeavour will be made, with the limited funds available, to improve the quality of the water supply and service given to consumers. A good start has been made in repairing the damage resulting from the paucity of maintenance over the years. Bringing the undertaking up to the standard one normally expect of a water works will take time and patience. The installation of the new chemical dosing equipment at the Treatment Works has given the attendants there a new interest in their job. They appear to understand that the new equipment will enable them to produce consistently high quality water, as indeed it should. In fine we are very impressed by the all-round improvements made since the new organisation took over.

5.2 Plant Operation

5.2.1 Pre-sedimentation Chemical Dosing

We made reference in our previous report to the vast wastage of alum which was then taking place. Without the proper laboratory equipment at the time it was not possible to offer more specific advice than was given. Had we been able to do so, it is certain that with our present knowledge it would have been extremely difficult, if not impossible, to act upon this advice. With the installation of the new dosing pumps and the acquisition of a laboratory type pH meter it is now possible to monitor and regulate the chemical treatment applied from hour to hour to compensate for the continuous variations in the water characteristics which have been found to take place. Reference has already been made in paragraph 4.1 to the ranges of pH and colour of the raw water witnessed during Mr Smith's two visits to Stanley. The figures given are not necessarily the limits to which the water may vary. We do not think that it is likely the pH will drop below about 4.6, neither would we expect the colour to be worse than 300 Hazen but we would not be at all surprised if that after a prolonged dry spell the pH may rise to about 5.4 and colour drop to 50 Hazen or less.

When Mr Smith arrived at the Works a considerable overdose of alum was being applied and consequently the soda ash dosage had to be equally heavy to react with the alum.

The following table has been prepared from the Treatment Works records and shows the amount of chemical reagents used in 1977 and 1978.

CHEMICAL	DOSAGES: mg/LITRE					
	1977			1978		
	Average	Max	Min	Average	Max	Min
Alum	163.7	276.3	89.1	196.4	272.2	140.5
Pre-Soda Ash	62.8	145.4	25.1	62.8	83.3	50.5
Sod Al	10.5	20.9	4.1	6.0	7.7	4.5
Magnafloc	0.44	0.71	-	0.23	0.39	0.11
Post Soda Ash	82.5	125.7	56.3	99.4	139.6	41.2

The new metering pumps were installed during the week beginning Monday 5 February. To enable the correct dosages of Alum and Soda Ash to be applied a series of Laboratory Flocculation Tests was undertaken. The results of these tests are set out in Appendix K and from them we make our recommendation that the following nominal doses of reagents should be applied.

Pre-sedimentation:

Aluminium Sulphate (Alum)	:	90 mg/l
Sodium Aluminate	:	10 mg/l
Magnafloc LT24	:	0.5 mg/l
Sodium Carbonate (Soda Ash)	:	sufficient to bring pH to 5.8.

5.2.2 Post-filtration Chemical Dosing

5.2.2.1 pH Correction: The filtered water in the future will have a pH of approximately 5.8 but this is too corrosive to be pumped to supply without further treatment. The stable pH of this water is about 8.1. To achieve this a post-filtration dose of about 30 mg/l soda ash is required.

5.2.2.2 Chlorination

As reported in paragraph 4.6.2 the Chlorinator is now back in service and during Mr Smith's visit the chlorine residual in the water in the treated water sump was kept at 0.2 mg/l. This is barely enough as it is necessary that the residual in Dairy Paddock Reservoir should be maintained at 0.2 mg/l. A sample from the reservoir should be taken daily - say when the water level is taken - and the residual measured. The residual in the treated water pump sump should be increased to such a figure as will ensure a residual of about 0.2 mg/l. in the reservoir. At no point in the distribution reticulation should the residual be allowed to drop below 0.05 mg/l.

5.2.2.3 Mixing of Soda Ash and Chlorine within the treated water pump sump.

It was found during Mr Smith's 1977 visit that the chemical mixing within the treated water pump sump was very poor and tended to give misleading results when samples were taken from the treated water sample tap in the pump room. In an endeavour to improve the situation a new soda ash hose was run during his recent visit and set to deliver solution at the same dosing point as the chlorinator. This made a small improvement but the mixing is still far from satisfactory. It is recommended that two distribution rails should be fabricated from 12mm (1/2 in) dia uPVC pipe. They should each be 1 ft 9 in (533mm) long, with a central tee and a cap on each end. Each tee should be fitted with a hose tail to which the delivery hose should be connected. 7 No 1/16 in (1.5mm) dia holes should be drilled in line at 3 in (152mm) centres along the length of the pipes. The holes should be on the soffit of the pipe with the hosetailed orientated to receive the delivery hose. Both distribution rails should be fixed across the narrow opening into the pump sump from the filter outlet channel adjacent to the present dosing point. This should improve the mixing but if perchance it still required improvement it would be necessary to built baffle walls within the sump.

5.2.3 Operation of Filters and Pumping Equipment

It is to be hoped that with the adjustments made to the filter outlet valves referred to in paragraph 4.5 the use of a bar to close a filter outlet valve will be banned.

Mr Smith found one of the Attendants back-washing two filters simultaneously. This practice is wrong as it reduces the backwash rate to an unacceptable low value. Even backwashing filters singly the rate is only 5.4 gpm/sq ft (4.4 mm/s). A rate of about 7 gpm/sq ft (5.7 mm/s) would have been more appropriate. The cause of this discrepancy could be in the condition of the supporting layers in the filter bed. The backwash rate should again be checked when the support layers have been replaced by properly graded pebbles.

The Pumping Equipment is operated in accordance with accepted practice.

5.2.4 Reticulation Maintenance

There is no evidence that the recommendations on this subject contained in our 1977 Report have yet been implemented. Every effort should be made to do so at the earliest opportunity as dirty mains will negate the success of producing high quality water from the Works.

5.2.5 Waste Detection

The waste detection procedure recommendations contained in our 1977 Report have yet to be implemented. It may be of significance that the increase in demand from 22.7 Mgal in 1977 to 25.3 Mgal in 1978 was due to extra wastage through leaks and not genuine extra demand. Until a proper waste detection drill is put into practice none can tell which it is.

5.2.6 Plumbing Standards

No Bylaws have yet been enacted and the wastage caused by the lack of suitable provisions still obtains.

5.2.7 Metering Policy

It is gratifying to learn that the view of the Falkland Islands Government on metering policy concurs with our own and that in accordance with our previous recommendation metering will be restricted to trade supplies.

CHAPTER 6

WATER CONSUMPTION AND FUTURE DEMAND

6.0 WATER CONSUMPTION AND FUTURE DEMAND

6.1 Consumption 1976-1978 (Recorded in Gallons).

	1976*		1977	1978
January	1 092 490	(x)	1 994 080	1 900 385
February	1 694 080	(x)	1 507 740	1 972 211
March	1 880 030	(x)	2 081 970	2 259 620
April	1 893 420		1 793 540	1 916 980
May	1 823 630		1 962 160	2 220 540
June	1 808 730		1 631 500	2 031 840
July	2 780 020		1 917 060	2 075 560
August	1 871 480		2 102 020	2 332 050
September	1 940 950		1 756 040	2 007 170
October	3 156 610	(?)	1 817 790	1 988 740
November	2 354 610	(?)	1 825 600	2 114 970
December	3 322 080	(?)	2 308 420	2 475 480
TOTAL 5	25 618 130		22 697 920	25 285 546

* Repeated from our previous report.

(x) Figures not in agreement with those recorded at the Treatment Works.

(?) Figures not recorded at the Treatment Works.

The totals for 1974 and 1975 were 19 400 785 and 20 305 020 respectively.

We suggested in our previous report that the total demand for 1976 was unreasonably high and that the discrepancy was probably due to the poor records then being kept. We considered an increase of about 5% per annum would be nearer the correct figure. On this basis and assuming the 1974 total to be accurate the annual demands since then would be approximately as follows:

1974	-	19 400 785
1975	-	20 370 824
1976	-	21 389 365
1977	-	22 458 833
1978	-	23 518 774
1979	-	24 760 865

Of the above supply 1975 and 1977 are on target. The demand in 1978 is well over what might have been expected. It will be noted that the winter month figures are up on the previous year. This could have been due to wastage from burst pipes. Until a proper waste detection procedure is put into effect it is not possible to be certain as to the true cause of the registered increase in demand. We did not obtain figures for water supplied to ships. This possibly would throw some light on the differences recorded. From the evidence before us, we have no reason to change the opinion expressed in our previous report.

6.2 Future Demand

The political situation has barely changed since our 1977 Report. The factors which would affect future demand remain unaltered. The capacity of the present plant based on a 20 hour day is 120 000 gallons (0.546 Ml) or 43.8 million gallons per year (199 Ml/year). If the current average increase in demand of 5% per annum is maintained the present capacity (not necessarily the present works) will suffice until the year 1990. However if new industry is to be brought into Stanley this figure would have to be reviewed taking into account not only the new trade demand but also the requirements of any immigrants brought in to man the plant.

CHAPTER 7

FUTURE OF SOURCES AND TREATMENT PLANT

7.1 Current Availability of Water

7.2 Future Sources

7.3 Future of the Treatment Works

7.4 Future of Storage

7.0 FUTURE OF SOURCES AND INSTALLATION

7.1 Current Availability of Water

Nothing which has transpired during the past two years has changed the observations and recommendations made in our previous report on this subject. The following should therefore be considered as complementary to that report.

7.1.1 Moody Brook

Until the heavy rainfall which occurred on the night of 4/5 February Stanley had enjoyed a relatively dry spell and consequently the flow in the Moody Brook was low, the yield being similar to that obtaining in January 1977. The rain which fell on the night of 4/5 February ran off very rapidly causing the brook to break its banks and flood the ground within the confines of the Treatment Works. No further rainfall of any consequence fell after that night before Mr Smith left Stanley on 21 February. During the period 5/19 February the flow in the brook gradually decreased with improvement in water quality until by 19 February it was back to where it was before the downpour. Unfortunately it was not possible to gauge the brook in spate. In view of the amount of peat in the catchment area the rate of run-off was surprisingly quick and the storage in the peat less than might have been expected. Nothing observed during this visit prompts us to revise our opinion that the safe yield of the Moody Brook is of the order of 144 000 gpd (0.655 Ml/d).

7.1.2 Mount William Springs and

7.1.3 Mullet Creek Springs

On these two sources we have no further comment to make.

7.1.4 Murrell River

This river remains the only convenient source from which the supply to Stanley could be augmented. In our previous report we recommended that the gauging weir across the river should be replaced and weekly gaugings taken. We consider that this recommendation should be implemented as soon as possible, certainly before next summer so that the minimum flow of this river can be ascertained. It is essential that this information should be available to any engineer given the responsibility of developing the source.

7.2 Future of Sources

In our previous report we assumed that the actual consumption of water in 1976 was 23 million gallons. This we now believe was on the high side and that a figure of about 21 1/2 million gallons would have been nearer the truth. On this basis assuming a 20 hour productive day, 7-days a week and a 5% annual increase in demand, the Moody Brook should meet Stanley's requirements until 1990 still assuming a 20 hour productive day, the demand could be met until 1983 by working a 5-day week and until 1987 by working a 6-day week. After 1990 on this basis resort to getting water from the Murrell River would be essential but there are other factors which require consideration which are dealt with in the following paragraph.

7.3 Future of the Treatment Works

We have little to add to what was stated in our previous report except that the plant is now two years older and much of it approaching the end of its economic life. After this it will become increasingly expensive to maintain. A decision on the future should not be long delayed. The time required to plan and construct a new works would be of the following order:

Prepare Feasibility Report	- 6 Months	Stage I
Study Feasibility Report and arrange funding	- 6 Months	Stage I
Prepare designs and tendering documents	- 9 Months	Stage II
Obtain tenders for plant	- 3 Months	Stage II
Adjudicate tenders and enter into contract	- 3 Months	Stage II
Manufacture and deliver plant	- 9/12 Months	Stage III
Building Construction	- 18/24 Months	Stage III
Install and Commission Plant	- 6 Months	Stage III

Time required:	Stage I	- 12 Months
	Stage II	- 15 Months
	Stage III	- 30/36 Months

7.4 Future of Storage

As previously reported the present storage capacity in Dairy Paddock Reservoir and Sapper Hill Tank is adequate for a foreseeable future.

APPENDIX A

LIST OF OFFICIALS AND STAFF WITH WHOM DISCUSSIONS WERE HELD

1	Mr J Massingham	-	Chief Secretary
2	Mr A Mason	-	Director of Public Works
3	Mr N Laughna	-	Supt of Works (Buildings)
4	Mr D Price	-	Water Supervisor
5	Mr C Jones	-	Treatment Plant Attendant
6	Mr W Duncan	-	- do -
7	Mr G Morrison	-	- do -
8	Mr R Stewart	-	Plumber

APPENDIX B

1977 REPORT

CHAPTERS 4, 5, 6 & 7

FALKLAND ISLANDS

A REPORT ON THE STANLEY WATER SUPPLY

(pp 10-35)

Crown Agents for Oversea
Governments and Administrations
4 Millbank
LONDON SW1P 3JD

Ref Q 267/44
March 1977

CHAPTER 4

REPORT ON CURRENT STATE OF THE PLANT

4.1 The Source

4.2 The Intake and Raw Water Main

4.3 The Raw Water (Low Lift) Pumps

4.4 The Flocculation and Sedimentation Tanks

4.5 The Filters

4.6 The Chemicals Dosing Plant, Stores and Laboratory

4.7 The Workshop and Stores

4.8 The Treated Water (High Lift) Pumps

4.9 The Electrical Equipment

4.10 The Treatment Works Buildings

4.11 The Delivery Main

4.12 The Low Level Reservoir - (Dairy Paddock Reservoir)

4.13 The High Level Booster Pump and Storage Tank (Sapper Hill Tank)

4.14 The Distribution System

4 THE CURRENT STATE OF THE PLANT

The general description of the plant remains as described by Casserly (C1) with a few exceptions which are hereinafter mentioned.

4.1 The Source (C3.1)

Prior to our survey the Islands had experienced a period of relatively dry weather and in consequence the flow of water in the Moody Brook was low and very little more than the abstraction rate.

4.2 The Intake and Raw Water Main (C3.3)

Repairs recommended by Casserly to prevent water by-passing the weir were carried out shortly after his visit and there was no visual evidence of any water finding its way past the weir. There was no evidence of deterioration of the raw water main and the float-operated plant inlet control valve was working properly.

4.3 Raw Water (Low Lift) Pumps

These pumps are both capable of meeting the current output of the works viz 5400 gph (6.82 litre/second). They require cleaning and painting and adjustment of glands to avoid excessive leakage. Adequate lubrication is provided by a small weepage past the glands.

4.4 Flocculation and Sedementation Tanks

The tanks are of sectional plate steel construction by Braithwaites and, as a result of lack of maintenance have deteriorated to the state of requiring repair or replacement. We are advised by the Falkland Islands Government that glass reinforced plastic (GRP) sectioned plate replacement units are on order. It is difficult to see how it is possible to remove the old units and install the new ones without causing a considerable disruption of the supply of colour-free water. We are of the opinion that it would have been easier to have cleaned out the tanks and applied an epoxy resin lining, which would not only have made them waterproof but also have protected them from further internal corrosion.

If these tanks are to be retained in service for any length of time they should be both cleaned internally and painted with a non-taste producing bitumastic solution such as Wailes Doves Bituros.

4.5 The Filters

4.5.1 The condition of the filter shells is excellent internally and is an example of what can be achieved by providing the correct initial protection. The shells should be repainted externally to bring the protection up to the necessary standard.

4.5.2 The filter media is deficient in both filters. We were shown a sample of sand from the Murrel River which it was intended should be used to make the top layers up to the correct thickness. This sample was sieved at the new airport by kind permission of Preece, Cardew and Rider's Representative, Mr Brian Ashfield. The replacement sand should be uniformly grade 14/30 using BS Sieves. From the result of the sieving - Appendix 3 it can be seen that only 50%, or thereabouts, of the sample is suitable. However in view of the small quantity required the sieving out of the unwanted fines would not be a costly task. The replacement sand must not be placed in the filters without first having been properly graded as with the correct rate of backwash the fines will be washed out of the filters and deposited in the drain whence they would have to be manually removed. Neither should the rate of backwash be reduced to prevent these fines being washed out of the filters. Such action would reduce filter runs between washes and also prevent the correctly graded sand being properly cleansed.

4.5.3 Both filter outlet float operated valves require attention. Probably adequate greasing of the operating linkage would enable them to work freely and enable the weight of the linkage to be sufficient to keep the outlets drop-tight during backwashing as intended and thus obviate the long established custom of jamming them closed with a bar during backwashing.

4.5.4 The condition of both plate steel filter outlet inspection chambers is poor. They urgently require cleaning out and repainting to prevent further corrosion which is already extensive.

4.6 <u>The Chemical Dosing Plant, Stores and Laboratory</u>

The chemical dosing equipment now comprises five gravity dosers with dissolving and mixing tank together with a 'Clorocel' chlorinator.

4.6.1 The condition of the gravity doser tanks is satisfactory. Unfortunately a number of orifices, the means by which the flow of solution is regulated, have been tampered with and many of those examined did not produce the flow engraved on them. No confidence can now be placed on these engravings and after changing an orifice to alter the dosage, the actual discharge must be calculated by timing the filling of a litre flask. A record should be made, (a chalked figure on the side of the solution tank would suffice) of the flow passing the installed orifice, after which minor dosage changes can best be achieved by altering the concentration of the solution.

4.6.2 Unfortunately the Clorocel Unit went unserviceable a few days before Mr Smith's arrival and replacement parts had not arrived in Stanley. Since it was no longer possible to sterilise the water pumped to supply, the Senior Medical Officer was advised and he authorized the broadcasting of a warning to consumers over the local radio to boil all drinking water as a precaution against water-borne pathogenic diseases. It had a further unfortunate effect that we were unable to check the working of the chlorinator or the effectiveness of the sterilisation both at the Works and in the distribution reticulation. The replacement unit was on board the chartered supply ship due in Stanley on 31 January 1977.

4.6.3 The chemical Store appears adequately stocked.

4.6.4 The Chemical Laboratory is well stocked both with equipment and reagents but there are a few additions which are desirable. They are:-

4.6.4.1 Only two pH range comparator discs are there covering 6.0 - 7.6 and a universal disc covering 5.0 - 10.0. The latter is used to determine in which pH range a sample lies. Smaller range discs are then used to determine the pH more accurately. Since coagulation is best achieved with a pH 5.6 - 6.1 and the treated water should have a pH 8.1 - 8.3, it is recommended that discs covering pH ranges 5.2 - 6.8 and 7.0 - 8.6 should be purchased together with a supply of appropriate indicators.

4.6.4.2 Whilst the provision of further discs is essential, it is also desirable that a laboratory type pH meter should be purchased. This is easier to use than a comparator which is dependent upon the operator's ability to compare colours.

4.6.4.3 Whilst an excellent laboratory balance is available, someone has removed the tweezers from the weight box. These should be replaced.

4.6.4.4 The laboratory is clean and tidy.

4.6.4.5 The sampling cocks recommended by Casserly (C4.33c) have not yet been provided. This recommendation should be implemented.

4.7 The Workshop and Stores

The Workshop and Stores are not as tidy as they should be. There are parts of plant in the room which have been removed due to defects. These should either be renovated or discarded.

4.8 The Treated Water (High Lift) Pumps

Both sets are currently delivering 5,400 gph (6.82 litre/s) to the low level service reservoir at Dairy Paddock. Until about a year ago the output of both was around the designed figure of 6,000 gph (7.58 litre/s). The decline in output is probably due to the condition of the interior of the pumping main (see para 4.11). Both pumps require cleaning and painting and their glands adjusted to prevent excessive leakage. One air-release valve is leaking and should be attended to or replaced. Since one pump is a recent replacement, it is reasonable to assume there is no deterioration in the performance of the old one.

4.9 The Electrical Equipment

This equipment is in good working order and appears to be properly serviced.

4.10 Treatment Plant Building

The building generally badly needs painting. A start has been made on the exterior but the Contractor failed to complete his contract. It should be remembered that it is easier to retain staff if one provides them with pleasant conditions in which to work. In this connection the heating provided is poor and should be improved or new equipment installed.

4.11 Treated Water Pumping Main

Since the output of both the old pump and the new one is the same it is reasonable to conclude that the decline in output is due to the interior condition of the main. A series of flow and pumping head readings were taken and these were plotted. The result is appended (Appendix 4). In his design Pope (P10.4) allowed for 14,000 ft of 6in NB cement lined pipe, 5.82in id, having a C value in Hazen William's pipe friction formula of 130. He gives a total friction head allowing 6.2 ft for specials of 30ft. The loss through 14000 ft of main given by Pope corresponds to a C value of 143 not 130. A value of 143 however is acceptable. The current value of C is only 84 indicating that there is probably a considerable deposit within the main or that the cement lining has been attacked by low pH treated water. In paragraph 5.3.1 mention is made of excessive alum and low pH of the final water. Both of these conditions are probably contributing to the increased pipe friction. The first requisite is that the treatment should be corrected and the second that the main should be cleaned out using a pig, sometimes referred to as a swab, to dislodge any slime adhering to inside of the pipe, followed by a flushing. This should restore the main to its original capacity, unless the low final pH found has had an opportunity to attack the cement lining in which case there may be little improvement.

4.12 The Low Level Reservoir at Dairy Paddock

This reservoir supplies the lower areas of the town. It existed as an open reservoir supplied from the Mount William springs until the works recommended by Pope were constructed. At the same time a roof was put over the reservoir to protect the water from contamination. The roof of the reservoir is now in need of repairs to the asbestos cement sheeting which has been holed in a number of places. This damage is apparently not the result of human vandalism but from stones dropped by seagulls. The reservoir, we understand, has to be cleaned out at least once a year. This is probably due to existance of perspex transparent sheets in the roof which let in the daylight and promote algal growth. These sheets should either be replaced by asbestos cement sheets or simply painted over. Thereafter cleaning out should be carried with the assistance of artificial lighting. There is also evidence in the reservoir of excessive alum carry-over which also has to be avoided. This can be achieved by correct treatment. This is referred to later. The roof structure appears to be in good condition. Provision should be made for re-painting this within the next two years.

4.13 High Level Booster Pump and Storage Tank on Sapper Hill

The higher areas of the town are supplied from Sapper Hill Tank. This is a Braithwaite tank, with central dividing wall, having a total capacity of 100,000 gallons. It is fed by a single electrically driven booster pump installed in a small pumphouse adjacent to Dairy Paddock Reservoir whence the supply is obtained.

4.13.1 The booster pump and pumphouse are badly in need of cleaning and repainting. Whether or not our recommendations for the supply of water for fire-fighting are implemented, this pump should be duplicated and the duty pump should be controlled by an electrode relay with the electrodes installed in the high level tank. The existing pushbutton starter with inherent no-volts release has to be manually reset to start the pump after the briefest power interruption. This is an undesirable feature. The starter should be replaced by one of a more suitable type.

4.13.2 The Sapper Hill tank is built on sleeper walls with the floor about 3 feet off the ground. There is ample evidence both on the exterior surfaces and soffit of the floor plates that the tank is badly corroded within. It is confirmed locally that this is so and that the division has been equally attacked. Unless urgent remedial measures are taken this tank will soon become a write-off. At the moment it appears structurally sound and could be preserved by applying an epoxy resin lining. This tank forms an essential part in our proposals for providing an adequate supply of water for fire-fighting and should be properly protected as soon as possible.

4.14 The Distribution Reticulation

4.14.1 All the distribution mains are of the order of 50 years or more old. None of them is more than 4in NB. There is evidence from the poor flow from fire hydrants that many must be badly tuberculated or the flow otherwise impaired. To provide an adequate supply to all consumers it is necessary that the flow in some mains should be improved. This can best be achieved by providing cross-connection to the proposed new fire mains. (See 8.3).

4.14.2 As recommended by Casserly (C5.1) all air valves have been made to work correctly.

4.14.3 All fire hydrants are properly maintained but the flow from most, it is understood, is virtually useless for fire-fighting. No equipment is available for flow-testing hydrants. A set of this equipment should be procured so that flow and residual pressure available at hydrants, essential information for fire services, can be found and scheduled.

4.14.4 All valves and hydrants should be provided with British Standard Indicator Plates. Such indications that exist are not sufficiently prominent.

4.14.5 One cross-connection between the high and low level systems mentioned by Casserly (C7.4) is still the only one in existence.

CHAPTER 5

REPORT ON STAFFING AND OPERATION OF PLANT

5.1 Staffing

Casserly recommended (C8) a re-organisation of the Public Works Department to provide adequate staffing of the Waterworks under the Superintendent of Works. Due to shortage of labour it has not been found possible to implement the recommendation completely but at the time of the inspection three full-time plant operators were employed under the immediate supervision of the Senior Plumber, Mr R Smith. The principal deficiency is the absence of a senior plant operator knowledgeable of the fundamentals of water supply chemistry and capable of giving the operators instructions regarding the correct doses of the various chemical reagents to apply. It is unfortunate in the circumstances that the quality and characteristics of the raw water drawn from Moody Brook are subject to frequent variations which in turn call for constant surveillance and adjustment to dosages particularly after heavy rainfall. At the time of Mr Casserly's visit Mr R Stewart was Senior Plant Operator and, implementing Casserly's recommendation (C8.5), Mr Stewart was sent to the UK where he underwent a course of training at West Pennine Water Board. From discussions our Mr Smith had with Mr Stewart he obviously benefitted greatly from attending this course and until he was transferred to become Fire Brigade Superintendent about 18 months ago all was going well at the treatment works including the keeping of records recommended by Casserly (C4.2). From August 1975 to November 1976 the plant was run by a number of untrained part-timer workmen without any technical supervision. This resulted in improper dosing, neglect of maintenance and the failure to keep proper records. As previously mentioned they now have three full-time operators but no technical supervision. Proper records are again being kept but the gap in these was a considerable handicap during our survey. It is understood that a chemist is shortly to join the Government staff in Stanley and it is possible that he may have sufficient knowledge of water treatment to advise on treatment on a part-time basis. In the meantime it is recommended that the expertise and experience of Mr Stewart should be used say for a couple of hours each week to ensure that the usage of chemicals is kept as little as possible consistent with obtaining a water of adequate clarity and sterility.

5.2 Plant Operation

5.2.1 Pre-Sedimentation Chemical Dosing

Reference has previously been made (4.12) to the evidence of excessive carry-over of alum found in Dairy Paddock Reservoir. This was investigated and all dosages were checked. It was found that the following were being administered:

Sodium Carbonate (Soda Ash)	-	42 mg/l
Aluminium Sulphate (Alum)	-	292 mg/l
Sodium Aluminate	-	10 mg/l
Magnafloc LT 24	-	0.44 mg/l

There is ample evidence (P Appendix 9, Table 1) and (C Appendix II, Sheet 2) that the dosages of Sodium Carbonate and Aluminium Sulphate were grossly in excess of those necessary to obtain satisfactory flocculation and colour removal. Reference to Appendix 5 will provide the reader with the chemistry of flocculating this water. From these notes it will be seen that satisfactory flocculation and colour removal should be possible from the following dosages when using first Alum, Soda Ash and Magnafloc and second when using Alum Soda Ash, Sodium Aluminate and Magnafloc:

5.2.1.1	Alum	40.0 mg/l
	Soda Ash	39.0 mg/l
	Magnafloc LT 24	0.5 mg/l
5.2.1.2	Alum	54.0 mg/l
	Soda Ash	40.0 mg/l
	Sodium Aluminate	10.0 mg/l
	Magnafloc LT 24	0.5 mg/l

The amount of Soda Ash administered should be varied to maintain a pre-flocculation pH of 6.1 and a further dose of Soda Ash is required after filtration to bring the pH of the supplied water to about 8.1. This should be about 20 mg/l.

It will be noted that the additiona of Sodium Aluminate as well as Magnafloc should not be necessary as the purpose of both is to give more weight to the floc. We recommend that the dosages of Alum and Soda Ash should be adjusted to those recommended above. This is best done by adjusting the solution strengths. The way of doing this is shown in Appendix 6. At the moment all three pre-flocculation chemicals are being added simultaneously in the raw water pump sump. Better results are often obtained by dosing one before another. Trials would show which order would produce the best results. Unfortunately using gravity type dosers it is not possible to make these trials as the float-operated flow control valve is immediately upstream of the raw water pump sump and pressure upstream of this valve is too high to allow the solution to flow by gravity into the raw water. There is a further disadvantage of these gravity dosers in that it is practically impossible to make rapid fine adjustments to the dosages. It is necessary that this should be possible to cope with rapid change in water characteristics following heavy rainfall. It is recommended that five electric motor driven dosing pumps should be purchased and installed. Four of these would be duty dosers and the other standby to the four. The duty units would be used to dose Alum, Soda Ash and Magnafloc prior to flocculation and Soda Ash after filtration for final pH correction. A further advantage which would accrue from the installation of these dosers is that the strengths of the solutions could be increased to 10% thereby minimising the labour necessary to replenish the tanks.

5.2.2 Post-filtration Chemical Dosing

5.2.2.1 Satisfactory control of the final pH, the accurancy of which is essential to provide a stable non-corrosive water, is thwarted first by difficulty of making a fine adjustment to the dosage and second by the point of dosing the solution. At present this takes place in a pocket of dead water upstream of the filter outlets and results in very poor mixing. This in turn results in almost hourly changes in the final pH although treatment has remained unaltered and one cannot be certain at any time that a sample examined will have the true pH corresponding to the dosage of Soda Ash administered. To overcome this defect a threader pipe should be fixed to the wall of the clear water tank through which the solution hose should be run to a point to discharge downstream of the outlet of No 2 Filter. The mixing would then be sufficient to give a steady final pH.

5.2.2.2 The effect of chlorination could not be observed due to the failure of the chlorinator. Recommendations mad made by Casserly (C4.3.5) should be followed closely.

5.2.3 Operation of Filters and of Pumping Equipment

The recommendations made by Casserly (C4.3.1 and C4.3.2) are being implemented except that it still appears necessary to use a bar to ensure that the filter outlet control valves remain closed during filter washing. Proper maintenance would make this practice unnecessary.

5.2.4 Reticulation Maintenance

We are advised that the periodical flushing out of mains (C7.3) is undertaken but it seems that no specific record of these operations is made. It is recommended that a book should be made available especially for recording where and when maintenance operations on the distribution reticulation are carried out. A programme should be compiled to ensure that all essential work is carried out at appropriate intervals.

5.2.5 Waste Detection (C7.5)

Meters have not yet been provided on the outlets of Dairy Paddock Reservoir and Sapper Hill Tank. It is still therefore not possible to carry out routine night flow tests. A relatively small leak on such a small system can result in a loss which is quite a large percentage of the true daily demand. Without regular checks on night flow one cannot be sure if the steady increase in annual consumption is due to increased demand by the consumer or the accumulation of undetected leaks. We strongly recommend that the necessary meters should be installed as soon as possible and regular night flow tests undertaken.

5.2.6 Plumbing Standards

To ensure that wastage does not take place on consumers' premises it is necessary that fittings and installations should conform to minimum standards. This is achieved in the UK by the enforcement of bylaws made in accordance with Water Acts of Parliament. Enabling powers exist in local Ordances in the Falkland Islands to allow the 'Waterworks' to require standards of consumers' installations but to date no action has been taken to put in print what standards are required. Hence both the consumer and the inspector have no reference by which to work and the inspector's view of what is or is not satisfactory is all that exists. Further no right of entry upon consumers premises exists to enable inspections of installations to be carried out. In the UK this right exists during normal working hours. Whilst we understand most consumers are co-operative and allow inspection of their installations, a few do not. We recommend that to assist in maintaining essential standards that Bylaws based on the model Bylaws used in the UK should be brought into force. In preparing these Bylaws the need for lagging of hot water pipes feeding wash basins and baths should not be overlooked. As point out by Casserly (C2.5) the necessity to run a hot water tap for an unduly long time to obtain hot water is a common form of wastage.

5.2.7 Metering Policy (C11.0)

As a means of restricting consumption Casserly recommended that universal metering of consumers' premises should be undertaken. He set out the extra labour and test equipment necessary to implement this policy. Due to the shortage of suitable labour this has not been found possible. Neither is it likely that such labour will become available in the foreseeable future. The writer does not completely share Mr Casserly's view that universal metering would have a significant effect. It could well do so initially but unless a punitive price is put on the water it is more than likely that the existence of a meter would soon be forgotten. Above all it should not be overlooked that the majority of the water used on domestic premises is for sanitation purposes and any restriction on its correct use for these purposes is highly undesirable. However water used for business purposes, whether it be for manufacturing or for a hotel, should be paid for in proportion to the amount used. This is the more usual in the UK and we recommend that the same policy should be adopted in Stanley.

CHAPTER 6

WATER CONSUMPTION AND FUTURE DEMAND

6.0 WATER CONSUMPTION AND FUTURE DEMAND

6.1 Consumption 1973 - 1976 (Recorded in Gallons)

January	1,688,893	1,921,326	1,092,490 (X)
February	1,702,375	1,259,654	1,694,080 (X)
March	2,160,000	1,477,540	1,880,030 (X)
April	1,368,000	1,755,980	1,893,420 (X)
May	1,700,106	1,684,540	1,823,630
June	1,586,263	1,373,150	1,808,730
July	1,482,890	1,988,820	2,780,020
August	1,289,180	1,625,550	1,871,480
September	1,857,078	1,673,400	1,940,950
October	1,542,000	1,819,530	3,156,610 (?)
November	1,398,000	1,667,790	2,354,610 (?)
December	1,626,000	2,057,740	3,322,080 (?)
TOTALS	19,400,785	20,305,020	25,618,130

(X) figures not in agreement with those at the treatment works.

(?) figures not recorded at treatment works.

The figures for January to May 1975 recorded at the Treatment Works were:

January	2,034,329
February	1,715,200
March	1,958,740
April	1,979,330
May	1,788,850

These figures together with those for October to December 1975 given by Lord Shackleton, which are extremely dubious, give a total consumption for 1975 of 26,710,929 gallons. This total is more than that given by Lord Shackleton who explains the high consumption in the later part of the year as being due to the construction of the new airport.

We were told that the whole of the water for the airport construction was carried by a 500 gallon tanker and that about five trips a day were undertaken. Assuming a seven day working week this amounts to 77,500 gallons a months, which does not equal the 1.1/2 million gallons above a normal consumption for the month recorded. We must confirm our opinion that the high figures given for October to December are extremely dubious and should be discounted in considering future requirements.

It has already been mentioned that due to staffing problems there was a period from October 1975 to December 1976 when few records were kept at the Treatment Works. The plant output flow meter readings are amongst those missing. It might be thought that the last reading before the break together with the first after the break would give an indication of the output over that period. Unfortunately this is not so as the meter integrator only reads up to 9,999,999 gallons and then returns to zero. From the recorded readings the consumption in 1976 was 9 9,783,400 gallons plus some multiple of 10,000,000 gallons. In practice it could have been either 19,783,000 or 29,783,000 gallons. Both these figures however appear unrealistic, the first being too low and the second too high. Bearing in mind the doubtful figures given for the latter part of 1975 it is reasonable to assume that the true figure for 1975 was more likely to have been about 22,500,000 gallons and that for 1976 about 23,000,000 gallons. This gives an average increase over the past four years of about 5%. The Chief Secretary has said that the "water population" of Stanley has remained sensibly constant during this period at about 1250. This means that the current consumption is about 50 gallons per head per day (gpcpd) including trade and shipping supplies. Without having detailed knowledge of these it is difficult to say if the consumption is reasonable or not. It is however not in excess of the per capita figures quoted by Casserly (C2.2) which also included an unrecorded trade demand.

6.2 Future Demand

In calculating estimates of future demand we are faced with a problem in that the future development or even lack of development will be materially affected by political issues now facing HM Government in the UK. If the economy of the Islands remains as at present, that is to say, principally dependent upon the growing of wool, there seems no reason to expect that the population of Stanley will increase much beyond its present 1250. If however the runway at the new airport is extended beyond its present 1250 m, as recommended by Lord Shackleton, it is possible that improved communications with the outside world would increase demand. As the prospect of any extension of the runway being constructed appear, at the moment at least, to be somewhat distant, we are lead to conclude that unless there is some industrial development in Stanley, the current supply of potable water should, with the minimisation of waste; suffice for the foreseeable future. It would however be prudent to consider the possibility of a small increase in demand of about 5% per annum which is about the present average rate of increase. If on the other hand industrial development does take place, it would then be necessary to make an estimate of the future demand based on the known requirements of those industries and of the number of immigrant workers who would be brought to live in Stanley.

CHAPTER 7

FUTURE OF SOURCES AND TREATMENT PLANT

7.0 FUTURE OF SOURCES AND INSTALLATIONS

7.1 Current Availability of Water

At the time of Mr Smith's inspection Stanley had enjoyed a period of dry weather and it remained mainly dry throughout the fortnight he was there. Consequently it was possible to observe the various sources available at a low yield. This advantage had been denied both Pope and Casserly.

7.1.1 Moody Brook

It was not possible to gauge the flow in the Moody Brook but when the supply to the treatment plant was 5,400 gph there was very little surplus passing over the intake weir (see photograph). It is unlikely that the quantity of water available much exceeded the designed capacity of plant, namely 6,000 gph. We must conclude that this source cannot be relied on to provide more than 144,000 gpd.

7.1.2 Mount William Springs

These springs which, together with the springs in Mullet Creek, provided the supply to Stanley before the construction of the present Works, were inspected and gauged and were found to be yielding only 4750 gpd. Pope (P7.3) noted at the end of his visit that after a short period of dry weather the yield had fallen to 11,000 gpd and went on to assume that the minimum could drop below 10,000 gpd. It is obvious that the quantity of water available from these springs is negligible and there is no point in spending money on providing any pipes to divert the water into Moody Brook.

7.1.3 Mullet Creek Springs

These springs were inspected and although it was not possible to gauge the yield, there appeared to be very little water flowing.

7.1.4 Murrel River

The Murrel River, as concluded by both Pope (P9.3) and Casserly (C3.4), remains the only source of sufficient yield to supplement the present supply to Stanley. This source was visited and despite a prior period of some weeks of practically dry weather, it showed a flow much in excess of anything likely to be required in Stanley for domestic use. It is unfortunate that the gauging weir constructed some time ago on the river has now been washed away, otherwise it would have been possible to quote the actual flow. In view of our conclusions it would be desirable that a new gauging station should be constructed on the river before next summer so that minimum flows can be measured. The flow should be recorded at least weekly during periods of dry weather and monthly at other times. The recorded flows should prove invaluable if it is ever decided to supplement the Moody Brook supply.

7.2 Future of Sources

It is obvious that the Moody Brook, even if supplemented from Mount William Springs, cannot meet the future needs of Stanley during the summer should there be any sizeable increase in demand. Lord Shackleton reported that during November 1970 there was a shortage which called for an appeal for restraint in the use of water. It would appear that this need was principally due to the leakage of water past the extremities of the weir. Since the wing walls were extended there has been no recorded instance of any shortage of water from this source. It would however be imprudent to assume that the safe yield of Moody Brook exceeds 6,000 gph, which is the designed throughput of the existing works. Both Casserly (C4.4) and Lord Shackleton are misleading when they conclude that because filter washing can be accomplished in 1/2 hour per day the output of the plant is 23.1/2 times 6,000 gpd viz 141,000 gpd. Unfortunately 5,600 gallons of this is required for the replenishment of the washwater tank. In our opinion however it would be unwise bearing in mind the need for flushing mains and other maintenance uses, to assume that more than 22 hours output a day viz 132,000 gpd are available for public consumption. At the moment due to the state of the rising main this figure is reduced to 123,200 gpd. Assuming that the demand for 1976 was 23,000,000 gallons and that the increase is 5% per annum, then the demand in 1981 will be 29.35 million gallons per annum or about 112,600 gpd if a 5-day week is still worked. This represents just over 85% of the available water with the delivery main in prime condition or 91% of the water currently available. Provided there is ample storage of treated water to ensure that peak demands are met, the current source at Moody Brook will be able to provide the demand until at least 1981 unless as aforesaid the town's population and industrial demands increase. However, in view of the time that would be necessary to develop any new source, should the need arise, it would be prudent to undertake the necessary engineering survey and design work as soon as any industrial development calling for a substantial amount of water and/or involving immigration of large numbers of persons is projected. It is envisaged that from the start of surveying to the conclusion of construction the time needed would be in the region of three years. On this time scale it would be wise to proceed at once to the tender stage, leaving the tendering and construction till it is apparent that the increased supply will be needed. We do not feel competent, in the view of the political and financial issues involved, to judge exactly when this work should be carried out. In the event of the water from the Murrel River being used to supplement the supply from the Moody Brook we envisage that an intake and pumping station would be constructed as near to the existing works as possible and that raw water would be pumped to a tank built adjacent to the existing works whence a supply of water could be drawn for either the existing or proposed new treatment plant. It is suggested that the new raw water pumping plant should be remotely controlled from the proposed new treatment works. We would not advise that the water from the new station should be delivered into the Moody Brook as the watertightness of the formation through which the brook runs is in doubt.

7.3 Future of the Treatment Works

It has been shown that provided the increase in demand does not exceed 5% per annum the existing source can provide the required water. It was also shown that the expected demand in 1981 would take up between 85% and 91% of the capacity of the plant. This was calculated on the assumption that all maintenance work could be undertaken at weekends when the plant is normally idle. Not having had at least 50% spare capacity for many years has made proper maintenance at all times difficult and often impossible. The state of the plant after 20 years of usage is now such that many replacements in the not too distant future will be essential. This essentially applies to the Braithwaite tank plates. The question arises as to whether it would be better in the long run to install a completely new plant rather than spend money on a plant which, even if it were possible to recondition, would remain difficult to operate and maintain. The present capacity not only calls for three working shifts, summer and winter but also is such that it is impossible to reduce the number of shifts when ample water is available in the winter. Again the ability to cut out the night shift in the winter would be conducive to retaining operating staff. We are of the opinion that, taking into account the current state of the plant with its method of treating an acknowledged difficult water and its manning difficulties, the construction of a completely new plant within the coming five years is the best solution. The new plant should be designed to use modern methods of treatment of highly coloured waters and have a large enough capacity to enable proper regular maintenance to be carried out. This presupposes that at least a third of the plant could be taken out of service without preventing the average demand being met and it should be capable of being extended in stages to meet future needs. To facilitate operation and maintenance standby units should be provided for all items of plant essential for the continuous production of potable water together with instrumentation indicating and recording raw treated and wash water flows, pH of raw, settled and treated waters and residual chlorine. The flow meters should be provided with integrators.

We recommend that the new plant should have a maximum capacity of 9,000 gph (11.4 litre/s) and arranged in three units each of 3,000 gph (3.8 litr/s) capacity. The flocculation and sedimentation tanks should be of concrete or glass reinforced plastic (GRP) construction with 3 No 7ft dia steel rapid gravity filters. The low and high lift pumps should also be rated at 3,000 gph. Each filter should be capable of passing 4,500 gph so as to enable one filter to be washed whilst maintaining normal throughput. This arrangement would be convenient for staffing and maintaining in that when more than 9000 gph is available from Moody Brook, the estimated daily demand in 1981 of 112,600 gpd could be treated in about 14 hours including replenishment of the washwater tank. When the flow in the brook falls below 9000 gph a third shift would have to be worked. To enable a check to be made on the yield of the brook a vee-notch should be installed in the intake weir with a flow recorder in the Treatment Works. When the plant is running this would show the surplus water and when the plant is not running, the total yield. There should be three duty pumps of each type, with a standby unit. The three duty high lift pumps when running together should be capable of delivering 9,000 gph through the existing main to Dairy Paddock Reservoir.

7.4 Future Storage

It is normally considered adequate to have storage equal to two days supply. In 1981 this will amount to about 225,000 gallons on the basis of a five day working week.

The existing storage of 500,000 gallons, of which 350,000 gallons is in Dairy Paddock Reservoir and 150,000 gallons in Sapper Hill Tank, is therefore adequate for the supply of potable water. However if our proposals for the provision of an adequate fire-fighting water supply are adopted Sapper Hill Tank would have to be duplicated (see Chapter 8). If this is done at an early date it would facilitate the re-conditioning of the existing tank (4.13.2).

APPENDIX C

GRADUATION GRAPHS FOR NEW METERING PUMPS

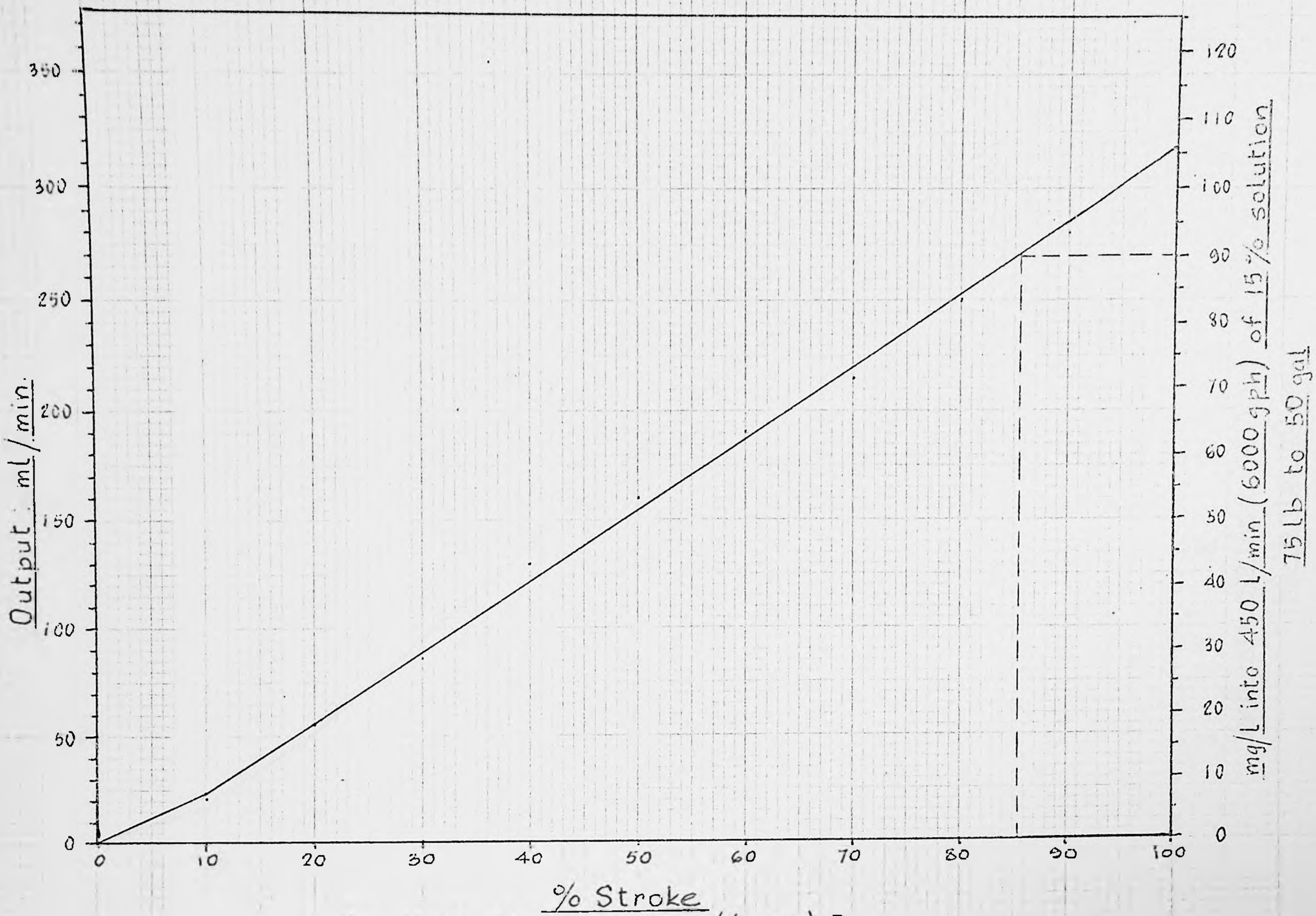
GRAPH 1 - Aluminium Sulphate (Alum) Pump

GRAPH 2 - Pre-flocculation Sodium Carbonate (Soda Ash) Pump

GRAPH 3 - Sodium Aluminate Pump

GRAPH 4 - Post filtration Sodium Carbonate (Soda Ash) Pump

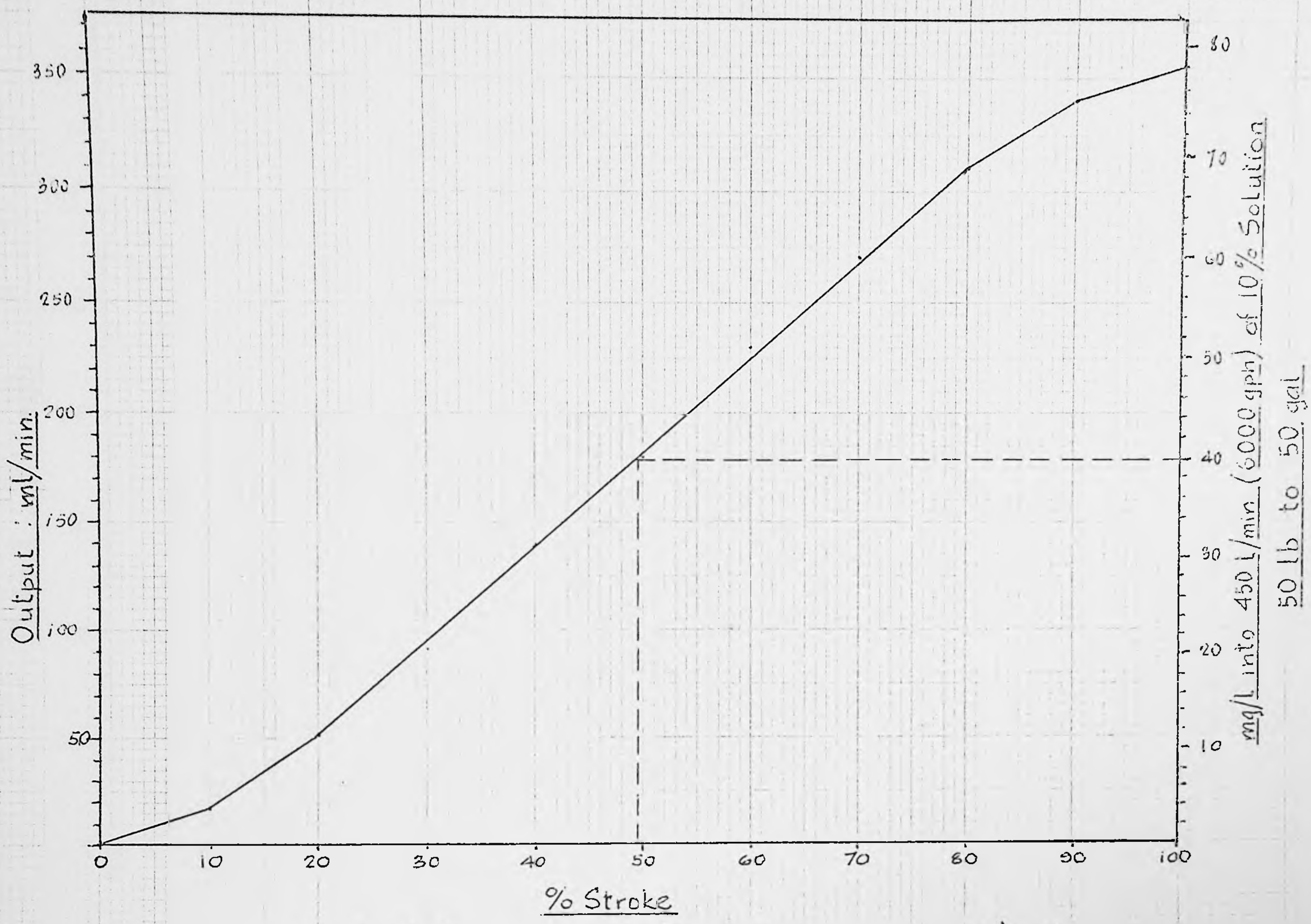
GRAPH I



ALUMINIUM SULPHATE (ALUM) PUMP

A. A. S.
25·2·79

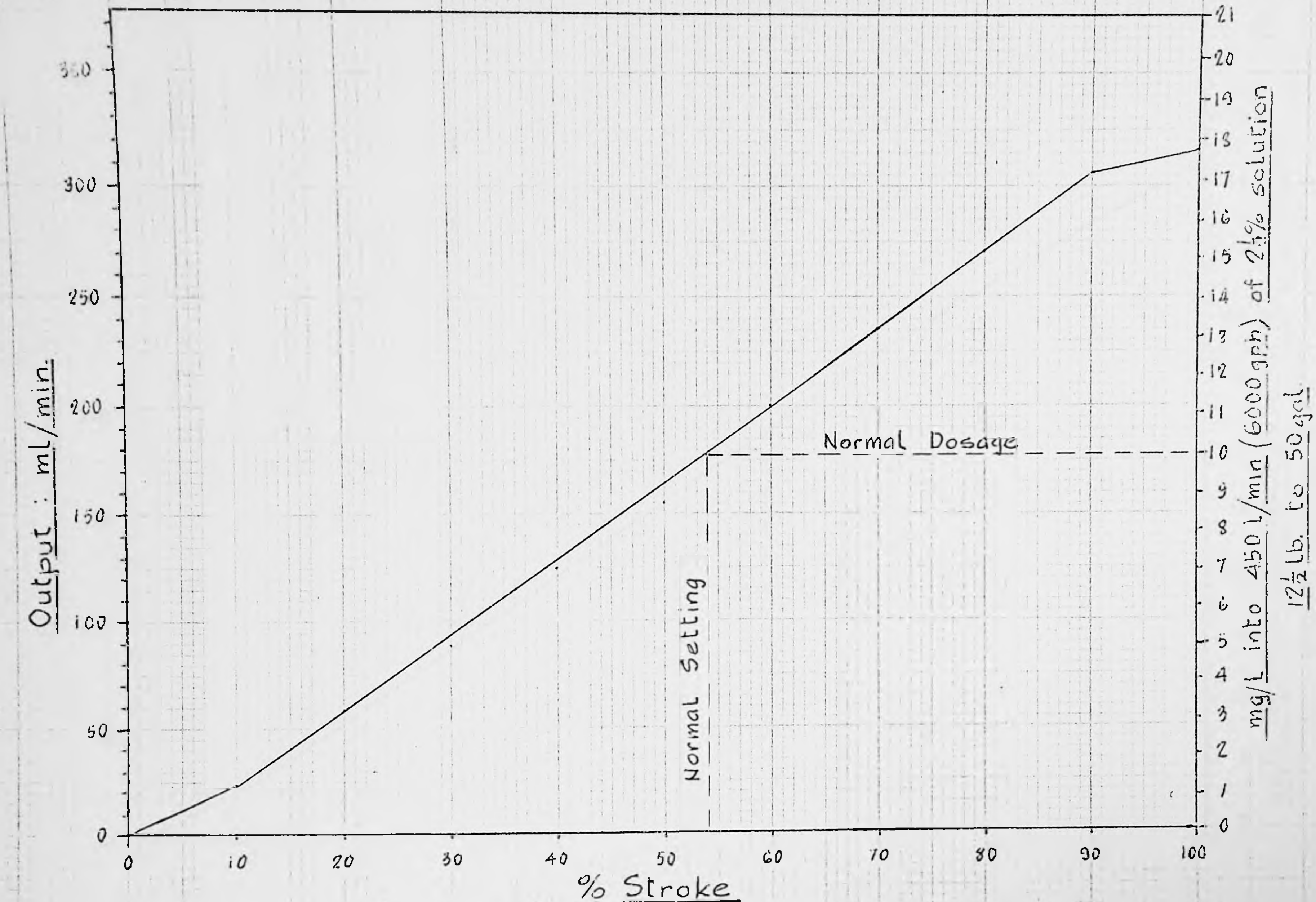
GRAPH 2



PRE-FLOCCULATION SODIUM CARBONATE (SODA ASH) PUMP

A.A.S.
28.2.79

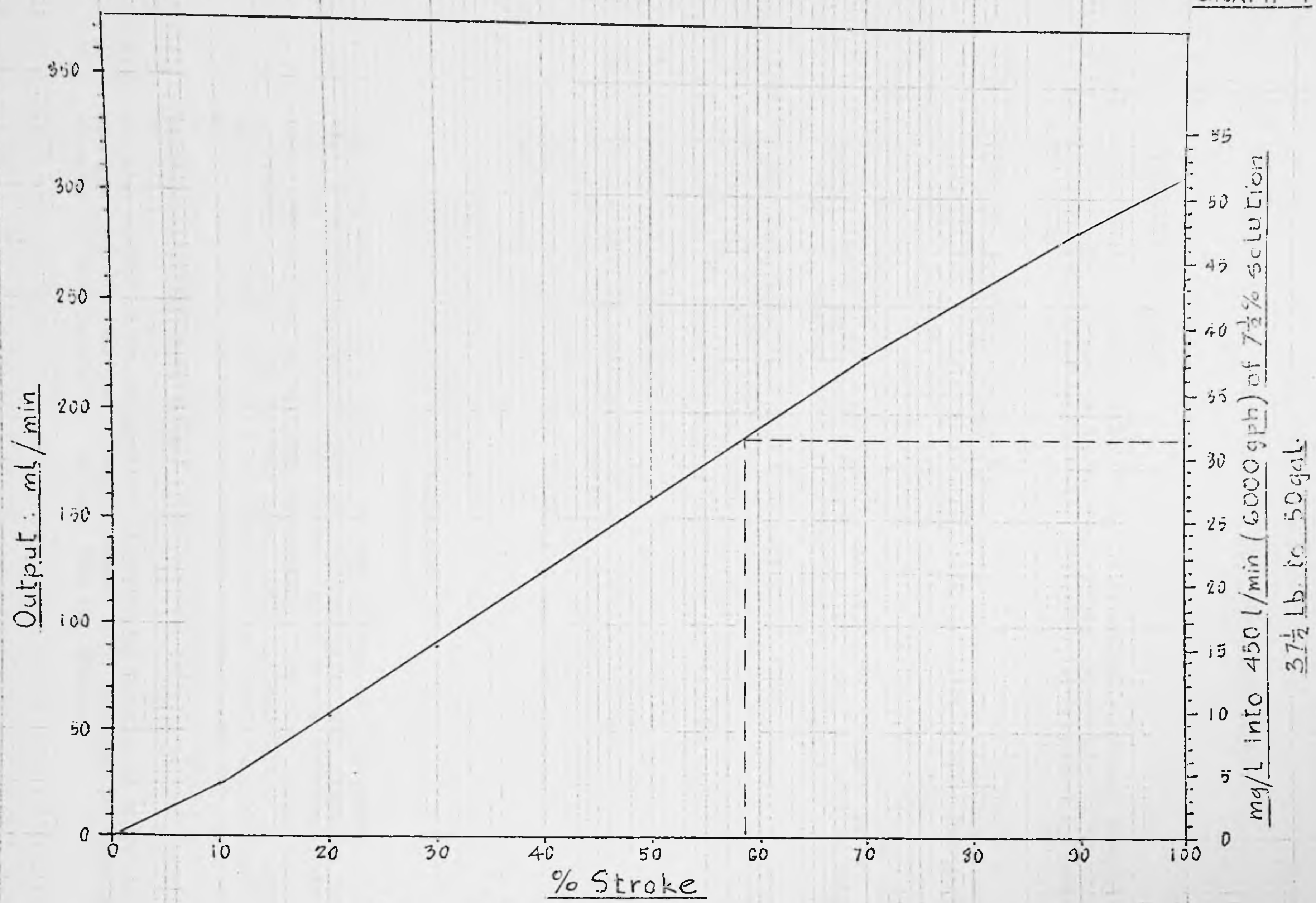
GRAPH 3



SODIUM ALUMINATE PUMP

A.A.S.
28.2.79

GRAPH 4



POST-FILTRATION SODIUM CARBONATE PUMP.

A.A.S.
28.2.70

INSTRUCTION FOR CARRYING OUT FLOCCULATION TESTS

1 REAGENTS REQUIRED

1.1 Aluminium Sulphate (Alum) as a 1% solution of $Al_2(SO_4)_3 \cdot 18H_2O$ 1ml of this solution added to 1 litre of sample is equivalent to a dosage of 10 mg/litre. Solution is prepared by dissolving 10 grams of Alum in 1 litre of distilled water.

1.2 Sodium Carbonate (Soda Ash) as a 1% solution of Na_2CO_3. 1 ml of this solution added to 1 litre of sample is equivalent to a dosage of 10 mg/litre. Solution is prepared by dissolving 10 grams of Soda Ash in 1 litre of distilled water.

1.3 Sodium Aluminate as a 0.1% solution of $Na_3Al\,O_3$. 1 ml of this solution added to 1 litre of sample is equivalent to a dosage of 1 mg/litre. Solution is prepared by dissolving 1 gram of reagent in 1 litre of distilled water.

1.4 Magnafloc LT24 as a 0.01% solution of Magnafloc LT24. 1 ml of this solution added to 1 litre of sample is equivalent to a dosage of 0.1 mg/litre. Solution is prepared by dissolving 0.1 gram of Magnafloc in 1 litre of distilled water.

2 METHOD OF CONDUCTING

2.1 The following instructions are formulated for the beginning of the day test when either the raw water colour or pH has changed significantly over night. Assume satisfactory results during the previous day's pumping was achieved with the following dosing:-

Alum 90 mg/litre (p p m)
Soda Ash 41 mg/litre
Sodium Aluminate 10 mg/litre
Magnafloc LT24 0.5 mg/litre

The raw water had a pH of 5.0 and colour of 150 Hazen. In the intervening period the pH of the water had changed to 5.3 and the colour to say 100 Hazen. Both these changes could have the effect of saving chemicals. The rise in pH indicates a probable increase in the alkalinity of the water in which case less Soda Ash will be required to obtain a settlement pH of 5.8 (the optimum for colour removal) and the lessening of colour suggests that satisfactory colour removal may be possible using less alum.

2.2 In the above it is suggested that tests should be made with dosages of 70, 80 and 90 mg/l alum. The dosages of sodium aluminate and Magnafloc should not be changed.

2.3 Take 3 clean 1/2 litre beakers. In each pour 400 ml (0.4 litre) of raw water. To each add 2 ml of 0.01% solution of Magnafloc and and 4 ml of 0.1% solution of sodium aluminate. It would be satisfactory to measure these quantities in a 10 ml measuring flask. Stir each sample.

2.4 Add 2.8 ml of 1% alum solution to the first sample, 3.2 ml of solution to the next and 3.6 ml to the third. These quantities are the equivalent of 70, 80 and 90 mg/l respectively and are best measured using a burette. Stir the samples well.

2.5 Check the pH of each sample at this stage. Allow the meter to settle to a steady reading. This may take time if the instrument has been used previously for the measurement of a much higher pH.

2.6 Take the first sample - that with 70 mg/l alum say - place under the burette containing the soda ash solution. The soda ash dose will be about 45% of the alum dose, therefore to start put in about 40% of the alum dose which is 28 mg/l or 1.1ml of 1% solution. Stir well with the pH probe and note pH of the sample. At this stage the pH should be less than 5.8 but approaching this figure. Now add a drop of solution at a time, stirring well after each and noting the pH. Continue adding a drop at a time, stirring well and reading the pH until 5.8 is reached. Read off the burette in ml the volume of soda ash solution added to the sample. Multiplying the reading by 2.1/2 will give the required dosage of soda ash in mg/litre. Carry out the same procedure with the other samples.

2.7 Place all three samples in the Laboratory Flocculator and stir for 5 minutes at about 50 rpm. Reduce speed to about 15 rpm for a further 5 minutes, after which the flocculator should be switched off and the samples removed and allowed tc settle for 30 minutes.

2.8 After the 30 minutes settlement carefully take a sample of the supernatent water from each sample and find its colour. The sample with the lowest colour, or in the event of two samples each having the same lowest colour the one with the lower alum dosage gives the most economical dosages for the treatment of the raw water.

3 APPLICATION OF RESULTS

3.1 The sample with an alum dose of 90 mg/l - the same as the previous day's alum dose - was introduced as a control sample so that the change in dosages caused by the change in raw water pH and possible minor changes in the solution strengths in the reagent holding tanks can be noted.

PREPARATION OF REAGENTS FOR FLOCCULATION TESTS

For accurate measurement the least concentration of the reagent without the need for excessive volume is desirable.

Maximum dosages to be expected are :-

Alum	-	100 mg/l
Pre Soda Ash	-	60 mg/l
Post Soda Ash	-	80 mg/l
Sodium Aluminate	-	10 mg/l
Magnafloc	-	0.5 mg/l.

Since the sample will be of 400 ml the maximum doses will be :-

				Suitable Vol
1	Alum	-	40 mg	4 ml
2	Pre Soda Ash	-	24 mg	2.4 ml
3	Post " "	-	32 mg	3.2 ml
4	Sodium Aluminate	-	4 mg	4 ml
5	Magnafloc	-	0.2 mg	2 ml

Reagents 1, 2 and 3	1ml = 10 mg/l	=	1%	solution
Reagent 4	1ml = 1 mg/l	=	0.1%	solution
Reagent 5	1ml = 0.1 mg/l	=	0.01%	solution

For each litre of reagent prepared

Reagents 1, 2 and 3 will require		.001 kg	=	1g
Reagents 4	" "	.0001 kg	=	0.1g
Reagent 5	" "	.00001 kg	=	0.01g

Greater accuracy can be achieved in mixing at 10 times the above strength and diluting to required strength when required to replenish stock bottles.

NOTES ON WATER COAGULATION TEST USING A LABORATORY FLOCCULATOR

These tests, usually referred to as "Jar Tests", are conducted for the purpose of determining the least quantities of chemical reagents required to produce a settled water of acceptable colour within half an hour from the conclusion of 10 minutes mixing. Up to four tests can be carried out simultaneously with the laboratory flocculator available at Stanley Treatment Works.

First it is necessary to prepare solutions of the various reagents to be used. (See Appendix E). At the Stanley Treatment Works these are Aluminium Sulphate (Alum), Sodium Carbonate (Soda Ash), Sodium Aluminate and Magnafloc LT 24. The latter two reagents assist in the formation of floc and are usually referred to as "Coagulant Aids". The alum and soda ash react together to form "floc" which is Aluminium Hydroxide - $Al(OH)_3$ - Two reactions are possible as follows:

a) $Al_2(SO_4)_3 + 3Na_2CO_3 + 3H_2O = 2Al(OH)_3 + 3Na_2SO_4 + 3CO_2$

Alum	Soda Ash	Water	Aluminium Hydroxide (Floc)	Sodium Sulphate	Carbon Dioxide

b) $Al_2(SO_4) + 6Na_2CO_3 + 6H_2O + 2Al(OH)_3 + 3Na_2SO4 + 6NaHCO$

Sodium Bicarbonate

Reaction a) will require 2.1 parts of alum of commercial grade - $Al_2(SO_4)_3 .18H_2O$ - 1 part of soda ash.

Reaction b) will require 1.05 parts of Alum of commercial grade to each part of soda ash. It should be noted that in each reaction the same quantity of floc is produced. Clearly the second reaction is to be preferred on economic grounds which will be achieved by adding the correct quantity of soda ash. The molecular weight of commercial grade alum is 666 and that of soda ash 106 so that in Reaction a) we have 1 molecule of Alum combining with 3 molecules of Soda Ash having weight ratio 666:318 ie 1:0.48 or 2.1:1. In Reaction b) we have 1 molecule of Alum combining with 6 molecules of Soda Ash, a weight ratio of 666:636 or 1:0.955 or 1.05:1.

At Stanley Treatment Works sodium aluminate is also used.

This reacts with alum in the following manner:

$$2Na_3\ AlO_3 + Al_2(SO_4)_3.18\ H_2O = 4Al(OH)_3 + 3\ Na_2SO_4 + 12H_2O$$

	Sodium Aluminate		Alum (Commercial Grade)		Aluminium Hydroxide (Flve)		Sodium Sulphate		Water
M W's	228	+	666		312	+	426	+	216

Hence 0.43 parts of sodium aluminate are required to each part of commercial grade alum. The dose however, may be much smaller when the aluminate serves only to start flocculation.

OPERATING INSTRUCTIONS FOR USE IN CONNECTION WITH NEW CHEMICAL METERING PUMPS

1 EQUIPMENT

1.1 Five Metering Pumps Ltd Model K Simplex Metripump each driven by a 1/3 hp (0.25kW) 400/440 V, 3-phase, 50 Hz electric motor having an output 0-3.9 gph (295 ml/min) have been supplied. Four pumps have been installed and the fifth put into store as a replacement for any failed pump.

1.2 The four installed pumps have been graduated (the gradulation curves are appended to these instructions) and allotted to dose Alum (Aluminium Sulphate), Pre-flocculation Soda Ash (Sodium Carbonate), Post filtration Soda Ash and Sodium Aluminate.

1.3 The original chemical solution tanks have been retained together with the draw-off arms. The original metering orifices have been replaced by gauze pump suction strainers.

1.4 The polyelectrolyte (Magnafloc LT24) gravity dosing arrangements have been retained since dosing is constant and not requiring extreme accuracy. The intention is that, if it is found possible to dispense with the addition of sodium Aluminate, a flocculant aid, to the raw water, the duty of dosing polyelectrolyte could be transferred to the redundant Sodium Aluminate pump.

2 CHEMICAL REAGENTS

2.1 The solution strengths of the reagents dosed by the metering pumps have been arranged so that normal stroke setting (ie the means of varying the output) will fall within the 50% - 100% of maximum stroke. Dosage scales based on the selected solution strength into a plant output of 450 litres/minute (approximately 6000 gph) have been added to the graduation graphs referred to in para 1.2, thus relating dosing rates with pump stroke settings.

2.2 The solution strength adopted are as follows:

2.2.1	Aluminium Sulphate (Alum)	- 15% -	150g/l
2.2.2	Pre-flocculation Sodium Carbonate (Soda Ash)	- 10% -	100g/l
2.2.3	Post-filtration Sodium Carbonate (Soda Ash)	- 10% -	100g/l
2.2.4	Sodium Aluminate	- 2.1/2% -	25g/l
2.2.5	Magnafloc LT24	- 0.06% -	0.6g/l

2.3 The treatment works continue to work in imperial units for chemical mixing and the following weights of chemicals and volumes of water needed to produce the above mentioned solution strengths are as follows:

2.3.1	Aluminium Sulphate (Alum)	75 lb to 50 gal.
2.3.2	Pre-flocculation Sodium Carbonate (Soda Ash)	50 lb to 50 gal.
2.3.3	Post-filtration Sodium Carbonate (Soda Ash)	50 lb to 50 gal.
2.3.4	Sodium Aluminate	12.1/2lb to 50 gal
2.3.5	Magnafloc LT24	5 oz to 50 gal.

2.4 In the preparation of solutions the utmost care should be taken to ensure accuracy of measurements of weight of reagent and volume of water. The treatment of the Moody Brook water must be precise to be effective. The new dosing pumps are capable of the required degree of accuracy in metering the solutions but this accuracy will be of no avail if the solution strengths are not what they are intended to be. Having taken the necessary care in weighing any batch of reagent, make absolutely sure that all reagents are dissolved in the dissolving tank before the concentrated solution is deposited in the holding tank. If any reagent is accidently left in the dissolving tank add more water and dissolve it before adding water in the holding tank to bring the batch to the correct strength. All the weight of reagent for a batch must arrive in the holding tank before the make-up water is added.

3 DAILY PROCEDURE: To be undertaken before starting plant or each day at 0800 hrs if plant has been worked through the night.

3.1 Check pH and colour of raw water. Be sure to let sample tap to run to waste for a while before taking sample so that the pipe from the raw water main to the sample tap is filled with fresh water. If pH has changed by more than 0.1 unit since previous day change Soda ash dosage by $\pm$ 1.3mg/l per 0.1 unit change remembering that increasing Soda ash dosage will raise the pH and vice versa. If colour has increased by 50 or more Hazen units check flocculation by carrying out jar test. Also determine the colour of the settled water. If the colour is in excess of 10 Hazen units, increase alum by 10 mg/l and soda ash by 4.5 mg/l. Always keep alum dosage as low as is consistent with obtaining a settled water with colour of 10 Hazen units or less. Over a period records will show the optimum alum dosage for any colour intensity. Never forget to lower the alum and soda ash dosage as soon as possible after the colour of the raw water has improved. It should never be necessary to increase the alum dosage beyond 100 mg/litre.

3.2 Always check the pH of the dosed raw water 1/2 hour after starting up and thereafter every half hour. The pH should lie between 5.7 and 6.0. If it is outside these limits change the soda ash dosage by ± 1.3 mg/l to bring the pH back within the range 5.7 to 6.0. If for no apparent reason the pH goes far outside the acceptable range, the cause will probably be that one of the reagents is not being delivered. Check that all the pumps are running, that the pump suction filters are clear and that there is no air in any suction pipe. If all appears well check that the pumps are delivering solution. If any pump is found not to be delivering, shut the plant down and check for fouling of the pump valves. Remember if pH goes high the faulty pump will be the alum pump and if the pH goes low it will be either the pre-flocculation soda ash pump or the sodium aluminate pump which requires attention.

3.3 After plant has been running at least 1/2 hour and is delivering water to supply for that period take a sample of treated water, again remembering to clear the supply pipe of unrepresentative water before taking the sample. Check the sample for pH and colour. The pH should be within the range 8.1 to 8.3. If the pH falls outside this range correct the post-filtration soda ash dosage. Again a change of ± 1.3 mg/litre will raise or lower the final pH by 0.1 units. Should colour of sample exceed 10 Hazen unit the cause could be either excessive carry-over of floc from the sedimentation tanks or that there is a break-through on the filters. If the former is the cause check the dosed water pH, see para 3.2. If this is within the accepted range then one or both of the filters require washing in which case the plant should be shut down and both filters washed.

4 LABORATORY FLOCCULATION TESTS:

The purpose of carrying out laboratory flocculation tests, commonly called "jar tests", is to determine the most economical treatment of the raw water to produce a settled water of accepted standard. Results obtained from these tests will not necessarily prove equally satisfactorily in the plant, but at least they will give good guidance as to the correct treatment. When jar test results are applied to the plant dosage rates may have to be adjusted to bring the water pH within the required ranges.

4.1 A laboratory flocculation test consists of taking a sample of known volume of the raw water, adding the chemical reagents required to produce a floc in measured quantities in order to effect colour removal. The sample, after the addition of the reagents is stirred in the laboratory flocculator at about 49 rpm for five minutes and then at about 14.1/2 rpm for a further five minutes. This change is achieved by changing the belt drive ratio. The sample is then allowed to settle for thirty minutes after which time the colour is measured. If the colour is ten Hazen units or less, the dosages applied are satisfactory and suitable for use in the plant.

WHAT TO DO IN THE EVENT OF A DOSING PLANT FAILURE

5 Flocculation tests in the laboratory have shown that when using alum, soda ash, sodium aluminate and Magnfloc LT 24 as flocculants the Moody Brook water will produce an excellent floc if the pH of the settled water lies within the range 5.6 to 6 and that the best colour removal is obtained when the pH is 5.8. The operator should therefore seek to keep the pH of the water delivered by the raw water pumps to 5.8.

6 A failure of any dosing pump to deliver the correct amount of solution for its setting will be indicated initially by the pH of the raw water delivery pump going outside the range 5.6 to 6.0. Should this happen the first thing to do is to shut down the plant and drain the mixing tank. This will contain water unsuitable to be delivered into the sedimentation tanks.

7 If the pH of the dosed water went high, that is beyond 6.0 the cause will be due to insufficient alum, so check firstly that the gauze strainer on the draw-off arm is not fouled. Put a clean one on in any case. Secondly make sure there is no air in the pump suction hose and finally and only if the first and second checks reveal nothing wrong, remove the pump valves and check that they are not fouled. The failure of any pump will, without doubt, be due to one of these causes. Always be extremely careful assembling pump hose unions they can easily be cross-threaded.

8 If the pH went low, then either the soda ash or the sodium aluminate feed could be at fault. Apply the three checks as described for the alum pump.

9 To start the plant, leave the mixing tank drain valve open. Start the alum, pre-soda ash and aluminate pumps and open the magnafloc delivery valve. Start raw pump allow to pump to waste. After fifteen minutes, check pH of pump delivery. If within the acceptable range ie 5.6 to 6.0 close mixing tank wash-out and resume treated water pumping when mixing tank is full. If the pH is not within required range, pump to waste for another fifteen minutes and try pH again. By this time it should be alright. If not the cause of the trouble has not been eliminated. Look again!

INSTRUCTION FOR FILTER WASHING

1 STOP Raw Water Pump, alum, pre-filtration soda ash and sodium aluminate dosing pumps and Magnafloc doser.

2 CLOSE both filter Inlet valves and allow filter to filter-down to supply for fifteen minutes. OPEN both filter Washwater Outlet valves. CLOSE both 'filter to supply' valves and open both 'filter-to-waste' valves.

3 STOP Treated Water Pump, Post-filtration Soda Ash dosing pump and chlorinator.

4 START Air Blower. When No 1 Filter has drained down to the washout weir level OPEN No1 Filter Air Scour valve and air scour filter for five minutes. OPEN No 2 Filter Air Scour valve, CLOSE No 1 Filter Air Scour valve and allow No 2 Filter to air scour for five minutes. CLOSE No 2 Filter Air Scour valve then STOP Air Blower.

5 After closing No 1 Filter Air Scour valve, OPEN No 1 Filter Washwater Inlet valve and allow half the contents of a full washwater Storage Tank to discharge through No 1 Filter then CLCSE No 1 Filter Washwater Inlet valve. Then OPEN No 2 Filter Washwater Inlet valve and allow the remainder of the contents of the Washwater Tank to discharge through No 2 Filter. CLOSE No 2 Filter Washwater Inlet valve. After both filter are clear of dirty washwater CLOSE both Wash-out valves.

6 OPEN both filter inlet valves and allow filters to filter to waste until effluents are clear. Then OPEN both 'filter-to-supply' valves and CLOSE both 'filter-to-waste' valves.

7 START Chlorinator, Post-filtration Soda Ash dosing pump and treated Water pump. START Alum, Sodium Alummate, Pre-flocculation Soda Ash and Magnafloc dosers and Raw Water pump last.

SCHEMATIC DIAGRAMS OF FILTER
THROUGHPUT CONTROL MECHANISM

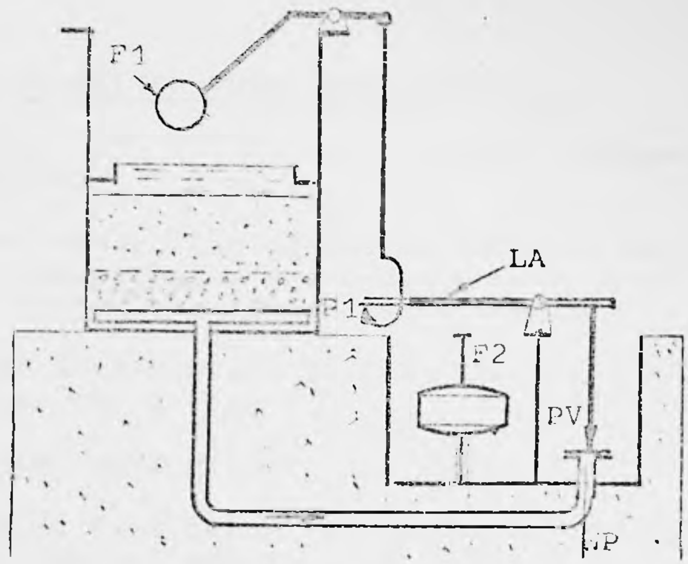


Fig 1. FLOW UNDER CONTROL OF FILTER FLOAT

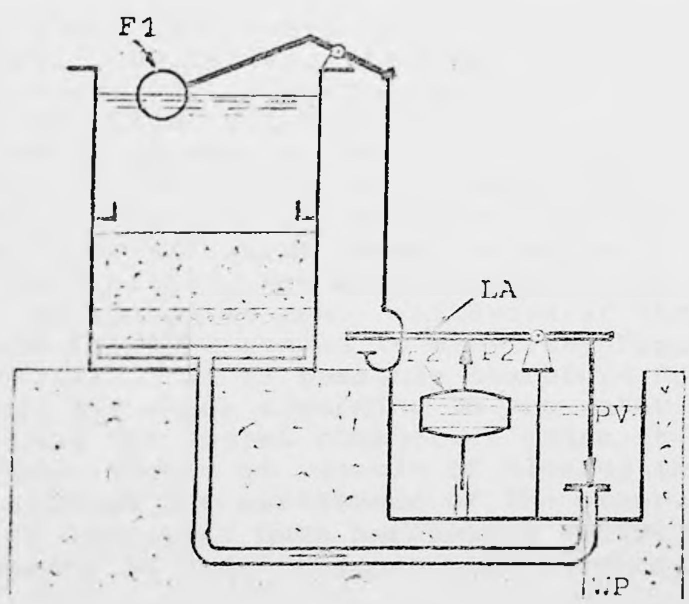


Fig 2. FLOW UNDER CONTROL OF OUTLET CHAMBER FLOAT

APPENDIX I

NOTES ON FILTER THROUGHPUT CONTROL

1 PURPOSE: The filter outlet valve performs three distinct functions:

1.1 To stop water leaving the filter when the water level in the filter drops below a pre-determined level i.e. when the float within the filter is not buoyant.

1.2 To give a slow-start to filtration after filter washing. This has two effects:

1.2.1 It avoids having to filter to waste after filter washing and

1.2.2 It avoids sand being forced through the support bed by a sudden gush of water.

1.2.3 To prevent water filling and overflowing the filter outlet chamber in the event of either the filter-to-waste or filter-to-supply valves being shut or not sufficiently open to allow the water passing through the filter to go to waste or supply.

2 OUTLET VALVE ACTUATION

Filter float (F1) exercises an upward force P1 on the lever arm (LA). Outlet chamber float (F2) also exercises an upward force P2. Together P1 and P2 exert a downward force PV on the outlet valve disc tending to close the valve. Force PV is opposed by the force WP created by the water pressure in the filter outlet acting on the valve disc. The linkage is designed so that the floats can only exert a force on the lever arm in an upward direction. Hence if Float F1 rises sufficiently see Fig 2 it can cease to exert any force at all on the lever arm. Likewise if the outlet chamber is empty float F2 ceases to exert any force on the lever arm (see Fig 1). It is possible therefore for either float to override the other according to the water levels in the filter and the outlet chamber. Hence it is necessary that each float should be capable of closing the outlet valve drop-tight without the assistance of the other. In the case of float F1 this must have sufficient weight when not supported by buoyancy to exert the necessary closing force on the valve disc. At the same time it must not be so heavy as to sink. Weight is added by putting water inside the float. Practice has shown that if the float is submerged half its diameter when supporting its arm and linkage to the lever arm, it will have sufficient weight to close the valve when out of the water. On the other hand float F2 must have sufficient buoyancy to exert enough force on the outlet valve disc to stop the flow of water from the filter. This it does adequately.

3 OPERATION OF MECHANISM

3.1 The description of the operation will assume firstly that there is enough water available from the sedementation tanks to provide the designed plant throughput, that the filter has just been washed and has its inlet valve closed, the water level is at or just below the washout weir level and the filter-to-waste valve in the outlet chamber is fully open and the filter-to-supply valve closed.

3.2 In the state described in 3.1, the filter outlet valve will be completely closed by the weight of the filter float (F1). The filter inlet valve is now opened fully.

3.3 The outlet valve being closed the water level within the filter will begin to rise and will continue to do so until the out-flow from the filter equals the in-flow. For any water to pass the outlet valve float F1 must have enough buoyancy so that the force PV is less than force WP. As soon as this happens the valve will begin to pass water but as soon as flow starts WP becomes less by having to exchange some potential energy into kinetic energy. Since the water level rises so slowly and immediate rebalance of forces on the valve disc occurs at the same time permitting a very small flow. As the water level in the filter continues to rise float F1 exerts less and less force on the valve disc thus allowing the throughput to increase but only slowly. About fifteen minutes after the filter inlet valve has been opened, full flow through the filter will be reached. Since the filter-to-waste valve is fully open the water level in the outlet chamber will not rise beyond the small head necessary to pass the flow through the filter-to-waste valve.

3.4 Now if the filter inlet valve were to be closed, the water level in the filter would begin to drop and float F1 would attempt to follow but is unable to do so without exerting force on the filter outlet valve thus lessening the outflow. This sequence will continue until the water level has receded sufficiently to fully close the filter outlet valve.

3.5 Returning to the state of full flow which obtained before the inlet valve was closed and assume that this valve was only half closed thus allowing some water to pass but not the full flow.

As before the water will begin to fall and float F1 will again attempt to follow beginning to close the filter outlet valve. This time a water level in the filter will be reached at which the outflow from the filter will equal its inflow. This in many filters in existence, is the only method of controlling the throughput. At Stanley Treatment Works the effect of the outlet chamber float (F2) also has to be considered.

3.6 Again returning the state of full flow with float (F1) in control. If now the filter-to-waste valve in the outlet chamber were to be closed, the water level in the outlet chamber would rise quickly and eventually the buoyancy of float (F2) will take over control from float (F1) and close the filter outlet once sufficient buoyancy has been attained. The outlet chamber will not overflow.

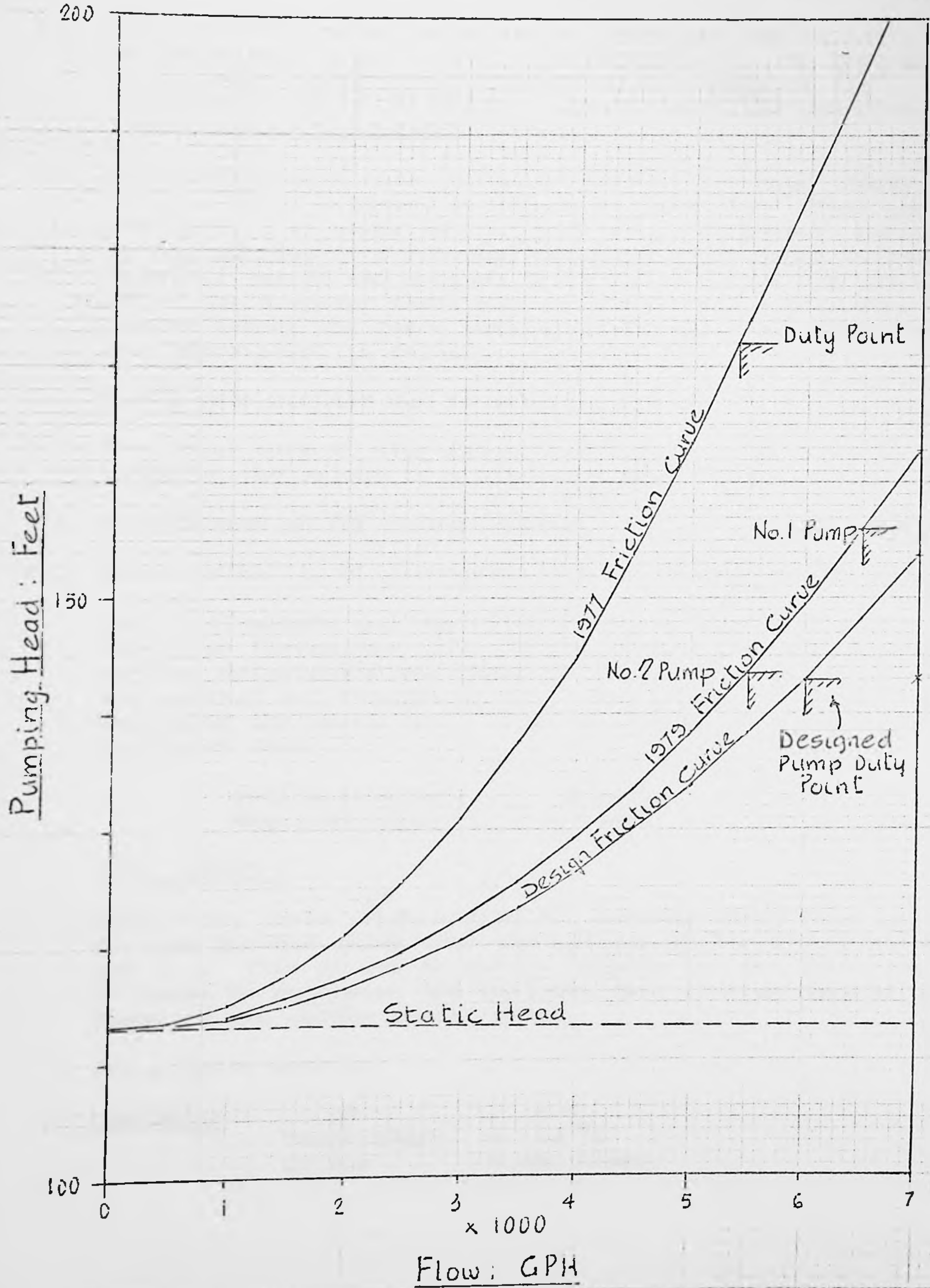
3.7 If after closing the filter-to-waste valve the filter-to-supply valve had been fully opened the low water level in the outlet chamber would have remained and the throughput would have continued under the control of the filter float (F1). If now the filter-to-supply valve were to be closed it would have the same effect as described in paragraph 3.6. On the other hand if the valve were to be closed gradually the water level in the outlet chamber would only rise enough to provide the necessary head to force the throughput through the filter-to supply valve. Eventually the water level will rise sufficiently to give the chamber float (F2) buoyancy and the float will begin to take over the filter throughput control from the filter float. When the nut on the filter float tracker arm ceases to have contact with the lever arm the chamber float is in full control of the throughput. This is the state at which the throughput is usually controlled as the identical design and installation of the filter-to-supply valves means that the total plant throughput can be equally shared between the two filters by maintaining the same water level in the two outlet float chambers with the floats fully in control.

4 ADJUSTMENT AND MAINTENANCE

4.1 To enable the plant throughput to be shared equally between the two filters it is necessary that the plant should be hydraulically and mechanically symmetrical at all times. It has been described in paragraph 3.7 how the flow is shared between the two filters when under the control of the outlet chamber valves but equating the chamber water levels will only equate the filter flows if both floats exert the same force on their respect lever arms at that level. Both floats have the same shape and dimensions but in addition they must both have the same weight. This condition also applies to the filter floats. Due to the hydraulic symmetry of the sedimentation tanks and filter inlet pipework, the amount of water entering the filters will only be the same if their water levels are the same. At the same time it is necessary for the filter floats to exert the same closing force of their respective valves. This will only take place with equal filter water levels if both floats have the same buoyancy. Hence being dimensionally similar, they must also weigh the same.

4.2 Ideally the linkages operating the filter outlet valve should be frictionless so that each float faithfully follows the slightest change of water level in which it is floating. Unfortunately the ideal is not attainable but it can be approached by keeping all hinged joints clean and well lubricated. It is recommended that a graphited grease should be used in preference to oil which if it found its way into the filtered water would foul the supply.

H/Q CURVES OF TREATED WATER PUMPING MAIN



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APPENDIX K

REPORT ON LABORATORY FLOCCULATION TESTS

1 This report covers the principal tests carried out by Mr Smith during the period 7/16 February for the determination of the most effective and economical treatment of the Moody Brook water using the reagents available and plant installed at the Treatment Works.

2 Laboratory tests carried out in 1972 by Paterson Candy International Limited, following Mr Casserly's visit showed that the pH of water was 5.3 and colour 50 Hazen. However on the morning of 5 February following very heavy overnight rainfall the pH had dropped to 4.57 and colour was 300 Hazen. After the downpour there was no rain of any consequence during the period of the tests resulting a gradual increase in pH and improvement in colour.

3 Tests were carried out to determine:

3.1 The least dose of alum (aluminium sulphate) capable of reducing the colour to 5 Hazen or less

3.2 The optimum pH for colour removal

3.3 The possibility of dispensing with sodium aluminate dosing.

4 Sodium Aluminate and Magnafloc LT24 are used at Stanley purely as flocculant aids. The aluminate promotes flocculation and the polyelectrolyte gives it weight. In this usage doses are nominal and throughout the tests (except in those examining the possibility of dispensing with sodium aluminate) the doses were:

Sodium Aluminate	-	10 mg/l
Magnafloc LT24	-	0.5 mg/l

5 TEST SERIES I

Laboratory tests conducted by PCI Limited using lime instead of soda ash had shown that the optimum pH for flocculation was 6.1. This pH was therefore adopted for the first series of tests to determine the smallest dose of alum capable of removing the colour in the water.

The results were:-

Raw Water :	pH	=	4.6
	Temperature	=	10 °C
	Colour	=	300 Hazen

Settled water:

pH		6.1	6.1	6.1	6.1
Alum	mg/l	60	80	100	120
Soda Ash	mg/l	29	46	53	68
Sod Aluminate	mg/l	10	10	10	10
Magnafloc LT24	mg/l	0.5	0.5	0.5	0.5
Colour	Hazen	60	5	5	10
Settlement rate		Poor	Fair	Good	Fair

Conclusions: Optimum colour removal at 6.1 pH can be obtained with an alum dosage of from 80 to 100 mg/l.

6 TEST SERIES II

This series of tests was conducted to ascertain whether 6.1 pH was the best for flocculation and colour removal. In the previous series of tests an alum dose of 100 mg/l had given the best results. This was therefore adopted for this series.

The results were:-

Raw water: pH - 5.0
Colour - 200 Hazen

Settled water:

pH		5.9	6.1	6.3	6.6
Alum	mg/l	100	100	100	100
Soda Ash	mg/l	45	49	53	60
Sod Aluminate	mg/l	10	10	10	10
Magnafloc LT24	mg/l	0.5	0.5	0.5	0.5
Colour	Hazen	5	5	15	40
Settlement Rate		Good	Poor	Poor	Fair

Conclusions: The optimum pH for colour removal could be either less than 5.9 or greater than 6.6. The reason for the two possibilities being the two reaction which take place between alum and soda ash - see Appendix F.

7 TEST SERIES III

This series of tests was carried out to determine if pH less than 5.9 or greater than 6.6 gave better colour removal.

The results were:-

Raw water : pH - 5.28
Colour - 200 Hazen

Settled water:

pH		5.7	6.9
Alum	mg/l	100	100
Soda Ash	mg/l	34	67
Sod Aluminate	mg/l	10	10
Magnafloc LT24	mg/l	0.5	0.5
Colour	Hazen	10	50
Settlement Rate		Good	Good

Conclusions: Both tests confirmed that flocculation will take place with either possible reaction but only that which took place at 5.7 pH was effective in colour removal.

8 TEST SERIES IV

The amount of alum required for effective colour removal is a function of the amount of colour present. Therefore since the colour of the water had dropped from 300 to 200 Hazen since Series I tests were carried out, this series was conducted to see if the alum dose could be reduced from 100 to 80 mg/l and still remove the colour.

The results were:-

Raw water: pH - 5.28
Colour - 200 Hazen

Settled water:

pH		5.78	5.98	6.28	6.44
Alum	mg/l	80	80	80	80
Soda Ash	mg/l	36	37.5	39.8	41
Sod Aluminate	mg/l	10	10	10	10
Magnafloc LT24	mg/l	0.5	0.5	0.5	0.5
Colour	Hazen	5	20	20	40
Settlement Rate		Good	Good	Fair	Good

Conclusions: Effective colour removal could be obtained with an alum dose of 80 mg/l and pH of 5.8

9 At this stage it was decided to reduce the alum dosage on the plant from 100 mg/l to 80 mg/l. Since one treated water pump was delivering 6500 gph (8.2 l/s) and the other 5500 gph (6.95 l/s). To give an exact dose all the reagents would have required a change in stroke setting on the metering pumps every time the duty pump was changed. At the time the attendants had yet to become familiar with the metering pumps. It was decided therefore to avoid confusing them and adopt 'nominal' doses, those being doses into 6000 gph (7.58 l/s). Consequently when the better pump was being used the actual doses were 92% of the 'nominal' doses and when the other pump was in use they were 109% of the 'nominal' doses. So that the actual alum dose did not fall below 80 mg/l a 'nominal' dose of 90 mg/l alum was adopted. This gave actual doses of 83 mg/l and 97 mg/l depending upon which treated water pump was in use. A satisfactory settled water continued to be produced.

10 TEST SERIES V

This series of tests was conducted to find out if the use of sodium aluminate could be dispensed with:

Raw Water: pH - 4.95
Colour - 300

Settled water:

pH		6.1	6.1	6.1	6.1	6.1	6.1
Alum	mg/l	50	60	70	80	90	100
Soda Ash	mg/l	34.4	39.0	43.5	48.0	52.5	60.0
Magnafloc LT24	mg/l	0.5	0.5	0.5	0.5	0.5	0.5
Colour	Hazen	100	40	30	30	20	20
Settlement rate		Poor	Poor	Fair	Fair	Fair	Fair

Conclusion: 6.1 might not be the best settled water pH.

11 TEST SERIES VI

This series was carried out to see if an answer could be found to the question posed by the results of Series V.

Raw water: pH - 4.95
Colour - 300 Hazen

Settled water:

pH		5.7	5.8	5.9	6.0
Alum	mg/l	100	100	100	100
Soda Ash	mg/l	52.5	55	57.5	60
Magnafloc LT24	mg/l	0.5	0.5	0.5	0.5
Colour	Hazen	15	20	30	30
Settlement rate		Fair	Fair	Fair	Fair

Conclusions: From the above there is evidence to suggest that by increasing the alum dose beyond 100 mg/l satisfactory flocculation and colour removal may be possible but on economic grounds any further such increase was unattractive particularly in view of the large stocks of sodium aluminate held. This investigation was therefore discontinued.

12 OVERALL CONCLUSIONS:

During the two weeks of commission and running it was found that a nominal dose of 90 mg/l alum, 10 mg/l sodium aluminate, 0.5 mg/l Magnafloc LT24 with soda ash dose to bring the pH of the settled water to 5.8 produced water of colour of 5 Hazen or less consistently particularly after the filters had been re-sanded. The settlement pH of 5.8 was more critical as the colour increased. For instance with a raw water colour of 200 Hazen good colour removal could be obtained with a pH range of 5.7 to 5.9 but when the raw water colour fell to 100 Hazen just before Mr Smith left Stanley the satisfactory range had extended to from 5.6 to 6.0.

13 ECONOMIC EFFECT OF RESULTS

Unless raw water conditions fall outside those observed during Mr Smith's visit it has been found that if the following doses of chemicals are applied, a considerable saving in the cost of chemicals used at the Works will accrue:-

For flocculation:	Alum	-	90 mg/l
	Soda Ash	-	to bring pH to 5.8 (about 42 mg/l)
	Soda Aluminate	-	10 mg/l
	Magnafloc	-	0.5 mg/l
For pH correction:	Soda Ash	-	to bring pH to 8.1 (about 30 mg/l)

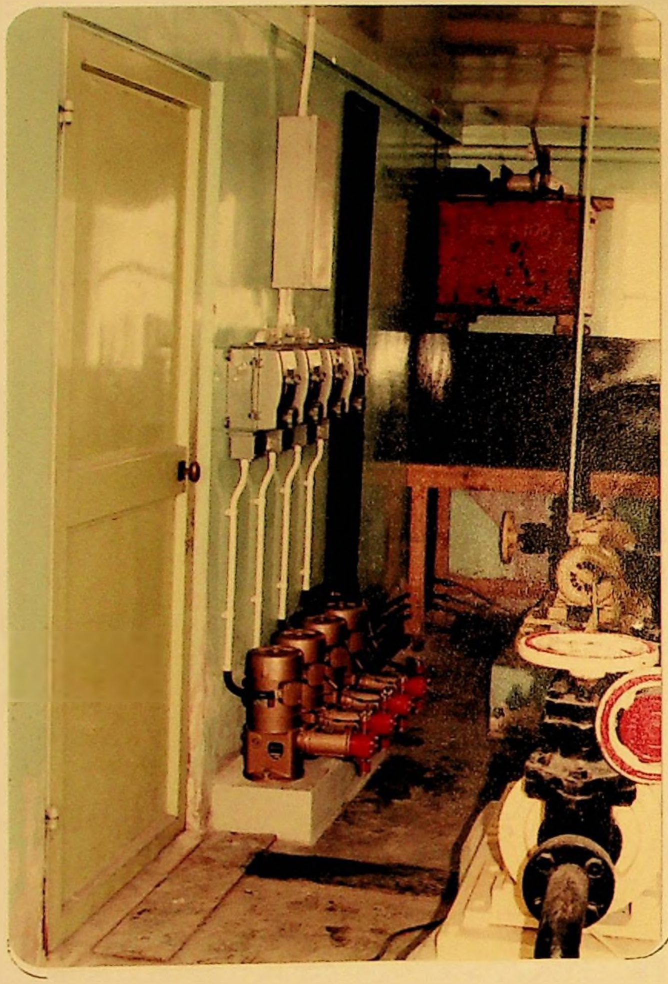
In 1978 about 26.4 million gallons (118.5 Ml) of water were treated of which about 25.3 million gallons were pumped to supply:

Alum:	Usage in 1978 = 49 655lb	=	22519 kg
	Future usage 90 x 118.5	=	10665 kg
	Saving	=	11854 kg
	at £154.8 per tonne	=	£1835
Soda Ash:	Usage in 1978 = 40968lb	=	18580 kg
	Future usage = 72 x 118.5	=	8532 kg
	Saving	=	10048 kg
	at £121.5 per tonne	=	£1221

Estimated Total Saving = £3056

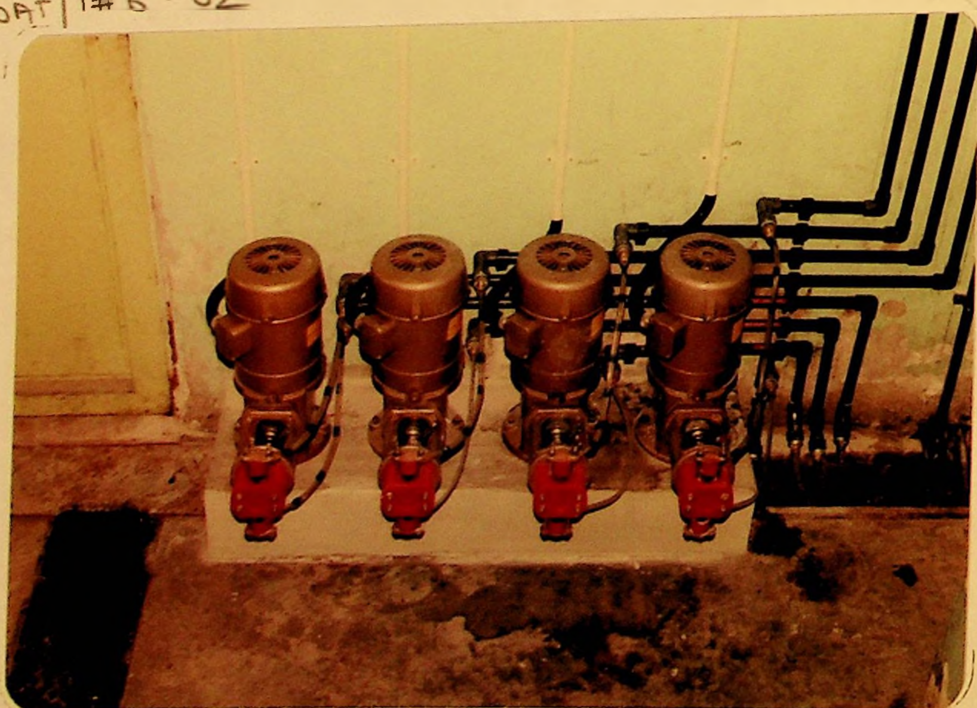
PHOTOGRAPHIC SUPPLEMENT

R/UTI/WAT/1#6-01



No.1 - New Metering Pumps showing Starters and Power Distribution Board

R/UTI/WAT/1#6-02



No.2 - New Metering Pumps showing Suction and Delivery Pipework