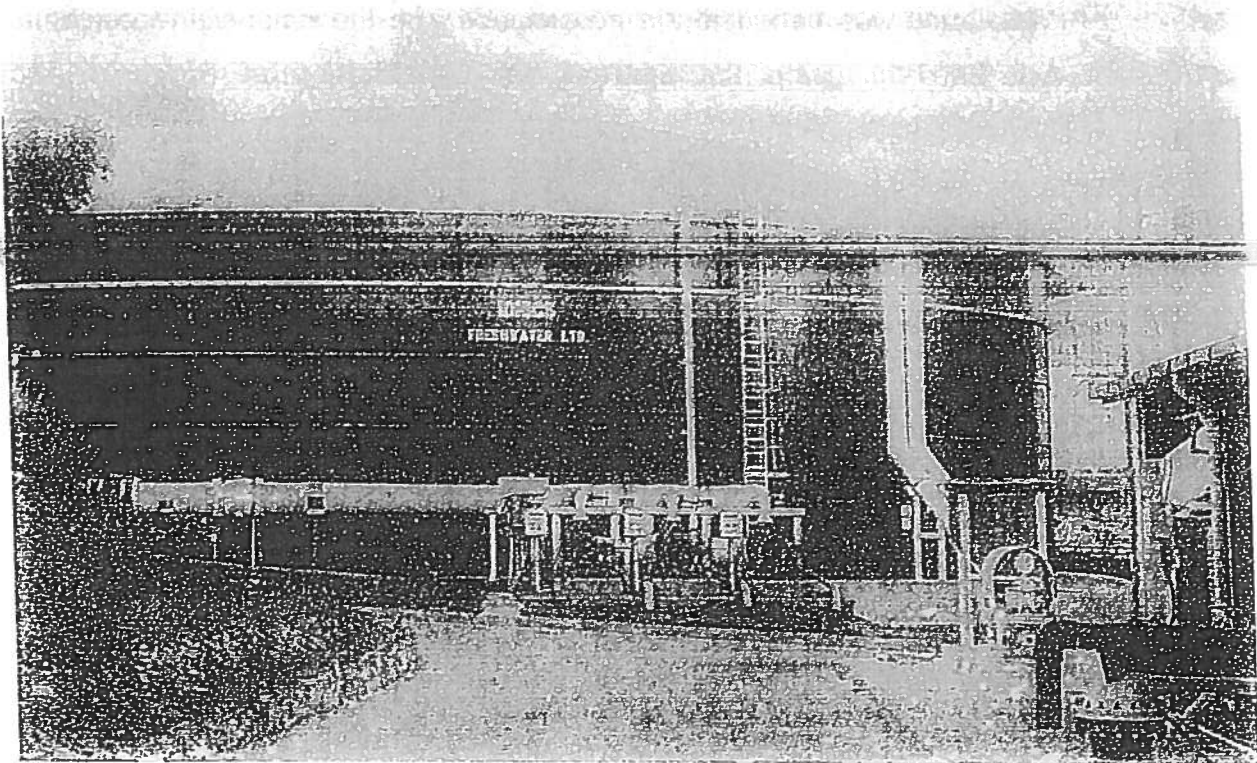


CHAPTER 2

The Reverse Osmosis Desalination Facility



Background Information

In August 1995 the Board of Directors of the Authority contracted Mr. Ambrose Johnson, a Consultant, to examine the feasibility of establishing a desalination facility in Barbados. The consultant was later retained for the construction of the facility.

2.2 In 1998, the Barbados Water Authority entered into a Build-Own-Operate (BOO) Agreement with Ionics Incorporated. The agreement was for the construction of a Reverse Osmosis Desalination Facility at Spring Garden, St. Michael to augment the potable water supply.

2.3 The Authority was required to supply the land on which the plant is sited and ancillary works for the distribution of the desalinated water. Ionics Incorporated was required to construct, operate, maintain and supply the Authority with 27,000 cubic meters of desalinated water daily over a fifteen (15) year period. The plant was also built with a reserve capacity of 3,000 cubic meters.

2.4 The Planning and Priorities Committee (PPC) of the Government agreed that the BWA Desalination Project tender should include an option to purchase at any time. In discussion surrounding the Water Supply Agreement it was stipulated that the pre-determined price for purchase of the plant would be included in the agreement. In the event that the BWA elected to exercise the option to buy, the price would be known up front.

2.5 The Desalination Plant was constructed at a cost of \$24,180,888. In addition, funds were expended on external system modifications for the effective introduction of desalinated water into the distribution system. The Plant was commissioned on February 15, 2000.

2.6 The Desalination Plant was constructed to:

- help augment the ground water reserves;
- prevent water shortage;
- reduce pumping from the Belle and other sources which have been systematically over-pumped;
- reduce the pace of the deteriorating water quality;
- ensure that consumers are supplied with enough water to at least satisfy their basic needs.

2.7 The Desalination Plant was constructed with a capacity of 27,000 cubic meters per day. Operationally it can produce as much as 30,000 cubic meters per day.

2.8 The Desalination Plant, located at the Spring Garden, St. Michael, extracts brackish water from wells which is processed using the Reverse Osmosis process.

Brackish water contains a low salt content. The Reverse Osmosis process results in fresh water being derived from the brackish water. This water is transferred to a BWA reservoir for distribution.

Audit Findings

Tariff Computation

2.9 The Total Dissolved Solids (TDS) are the total weight of all solids that are dissolved in a given volume of water. When TDS levels exceed 1000mg/L it is generally considered unfit for human consumption. The TDS level in the brackish water supply influences the cost of the process. For Reverse Osmosis Plants, TDS level below 10,000 milligrams is an attractive medium since a content of between 1,000 and 10,000 milligrams per litre constitutes water that is less costly to treat.

2.10 The larger the amount of the TDS, the more expensive it is to produce fresh water. In the Agreement, the feed water TDS was stated as between 1,000 and 10,000 milligrams parts per million and this formed the basis for the tariff. However, in our review of data for the period April 1, 2008 to March 31, 2011 the average TDS only exceeded 1,000 milligrams on one occasion.

2.11 This brings into question whether adequate testing of the TDS in the supplying wells were conducted prior to entering an agreement with IONICS. There was no documentation presented for audit inspection outlining that a thorough analysis was done on the TDS in the feed water at the Desalinated plant. This analysis could have resulted in the Authority paying considerably less tariff fees as more favourable terms could have been negotiated.

2.12 The Water Supply Agreement provides a pricing formula for calculating the price paid for water on a monthly basis. Central to the rate charged is an electricity factor which was estimated at \$1.111kwh/m³ water produced. The amount of electricity used depends on the TDS in the water being processed.

2.13 In July 2008, Ionics voluntarily reduced the electricity factor to 0.94 kWh/cubic meters. This reduction was based on the low TDS in the feed water. A sliding scale was introduced by IONICS as outlined in **Table 1** below:

Table 1: Sliding Scale Electricity Factor

Feed Water TDS (mg/l)	Electricity Factor kWh/m ³ Product Water Produced
4000-5000	1.111
3000-4000	1.04
2000-3000	0.099
Under 2000	0.94

Source: Barbados Water Authority

2.14 The sliding scale formula for electricity is based on the salt content of the feed water. As feed water becomes more saline the amount of electricity required to desalinate the water increases and vice versa.

2.15 The reduction in this electricity factor provides a huge saving as outlined in an example below:

Water invoice for the month of July 2008 calculated at:

Electricity factor of 1.111 kWh/cm	\$1,187,968.04
Electricity factor of 0.94 kWh/cm	<u>\$1,117,001.87</u>
Savings using the lower electricity factor	\$ 70,966.17

Audit Comment

2.16 The amount of TDS found in the water and the estimated use of electricity are key components in determining the tariff rate. It would appear that both of these factors were substantially overstated when the formula for the price of water was determined. This would have resulted in the Authority paying significantly more for water than was required.

2.17 Provisions for tariff reductions when the TDS levels fell should also have been included in the agreement. It should be noted that it was IONICS who volunteered to reduce the electricity factor and hence the amount charged for the supply of water.

Plant Capacity

2.18 The Desalination Plant has been contracted to supply the BWA with 27,000 cubic meters of water a day. From inception, this level has not been provided primarily because the Authority does not have the capacity to receive this amount.

2.19 At the time of the review desalinated water was purchased at \$1.50 per cubic meter. A standby charge is payable at a rate of seventy-five cents (\$0.75) per cubic meter if the quota of 27,000 cubic meters is not met. In 2008, the output of the Plant was increased to 20,000 and even if this volume is purchased, a shortfall of 7,000 cubic meters of the contracted amount would exist. The cost paid for this standby charge is approximately \$1.9 million a year or \$19 million over the past ten (10) years.

2.20 The Facility was never run at full capacity. Therefore, it is not known whether the facility can be sustained over the long term or under drought conditions.

Desalination Plant Financial Arrangements

2.21 The Water Supply Agreement provides a pricing formula for calculating the water charges. The nature of this arrangement includes a price adjustment factor since the price of components change overtime. The water charges include:-

- capital recovery;
- chemical usage;
- spare parts and equipment consumables;
- labour;
- electricity; and
- annual price escalation indices and adjustments.

2.22 The audit revealed that bills in respect of price adjustments from 2002 and 2003 were included in the billings in 2008. These late payments exposed the Authority to the risk of making double payments. In this regard, adjustments charges from February 2007 of \$1,872,358.63 remained outstanding as at March 31, 2011.

2.23 There was no evidence provided that the Authority undertook any analysis of the financial arrangement surrounding this project. i.e the reasonableness of the rate of return paid to IONICS or the pursuit of other financial models to finance the construction of the plant. This should have been undertaken given the novelty of the Build–Own–Operate Agreement and the 18% rate of return paid to the company

The Desalination Plant Administrative Arrangements

2.24 The administrative arrangements for the desalination plant required that Ionics notify the BWA's General Manager of any major plant problems and shutdowns. Currently Ionics provides monthly maintenance and production reports. This arrangement is in place because an officer is not assigned to the plant.

2.25 In accordance with the agreement the Authority reserves the right to:

- station an Engineer at the Plant to observe operations;
- review maintenance logs; and
- monitor water quantity, quality and the usage of consumables.

2.26 In accordance with the Agreement, an Engineer was stationed at the Desalination Plant from March to September 2000 to monitor and observe operations. However, there is currently no officer stationed at the plant to monitor and observe operations.

2.27 It should be noted that the Water Supply Agreement makes provision for Ionics, when requested by the Authority in writing, to familiarize the Authority's personnel or accredited representatives in the on-going operations and maintenance of the Plant.

Audit Comment

2.28 Officers of the BWA are not knowledgeable about the procedures required for the operations and maintenance of the Plant. This would be a significant issue if the Authority exercised its option to acquire the Plant since it would not have officers who are familiar with its operations.

Infrastructure

2.29 At the inception of the Plant, St. Stephens, Grand View, Cave Hill-Hanson, Lodge Hill, Shop Hill-Warleigh, Orange Hill and Apes Hill areas were earmarked to receive the desalinated water.

2.30 The BWA also recognized that an increase demand for water in the north was imminent due to economic development as well as their need to improve the level of service to its existing customers. Hence, in 2004, the 16" West Coast Main Project was commenced to augment the desalinated water to the north of the island.

2.31 Nevertheless, the 16" West Coast Main is not functioning due to failure of pressure tests. The non-functioning of the 16" West Coast Main has hindered the Authority's ability to distribute the contracted capacity of desalinated water.

Water Tariff Meter

2.32 Ionics and the Authority both maintain water meters at the Plant. However, it is the Authority's meter which is used as the Water Tariff Meter. The Water Supply Agreement stipulates that the Water Tariff Meter shall be calibrated no less than once every six months or as often as is necessary to maintain its accuracy. These meters are not calibrated.

2.33 In October 2009, Ionics water meter average deviation was recorded as 14.6% higher than the BWA's meter. At March 31, 2010 the Ionics meter deviation recordings were (17%) percent higher than the BWA water meter. These differences

highlight the need for BWA's meter to be calibrated as this would ensure accurate readings.

2.34 The possibility therefore exists that the Authority calculations could be based on inaccurate figures.

Water Quality

2.35 Prior to May 2010, there were no inspections of the Plant. Currently, the BWA is in the process of developing a protocol to address inspections. Nevertheless, from commencement of the Plant's operations, the quality of the desalinated water is monitored by a Water Quality Technologist. The Government Analytical Services Laboratory tested the water to ensure the water is in compliance with the World Health Organization (WHO) Water Quality Standards. The water quality is in compliance with WHO standards which is commendable.

Attempt to Purchase the Plant

2.36 The Water Supply Agreement stipulates the price at which the Authority could purchase the plant at any time during the fifteen (15) year life of the Agreement.

2.37 In 2005, the option to purchase the Plant and take possession of the facility was considered. At the point of option to purchase, the Authority discovered that the Plant could only be purchased in the event Ionics or the Authority is placed in the following situations:

- Provisional or final liquidation or under judicial management;
- Material default;
- Ionics failure to deliver satisfactory desalinated water for a period of thirty (30) consecutive days;
- Ionics failure to provide at least two million four hundred and thirty thousand (2,430,000) cubic meters during any period of one hundred and eighty (180) consecutive days; and

- Ionics failure to meet the guaranteed quantity for a total of ninety (90) days in any period of one hundred and eighty (180) consecutive days inter alia.

2.38 None of the conditions that provided a basis for the Authority acquiring the Plant existed and as a result, the BWA was unable to purchase the facility.

Maintenance Manual

2.39 In accordance with the Water Supply Agreement, Ionics Incorporated was required to give the BWA an Operation and Maintenance Manual. The Authority stated that the manual was not presented; neither did they ensure it was delivered. It would be difficult for the BWA to evaluate the effectiveness of the maintenance activities carried out without a manual.

Future of the Plant

2.40 Plans are in place to put in additional mains to distribute water from the Desalination Plant. The Authority has indicated that the water will be distributed to areas currently fed from the Belle Pumping Station as well as the Christ Church dome and the St. Philip area.

2.41 The Authority is currently reviewing three (3) options for the management of the Desalination Plant at the end of the agreement:

- BWA takeover of the ownership, operation and maintenance of the plant;
- BWA takeover of ownership of the plant and contracting out of the operation and maintenance of the Plant to Ionics or any other interested and capable parties; and
- Negotiation of a new contract with Ionics Freshwater Ltd.

2.42 The most advantageous option for the desalination plant has not been worked out to date. Amendments to the Agreement can only be varied by mutual agreement between Ionics Inc. and the Authority. This is a stipulation of the present

agreement that is legally binding until February 2015 when the Plant will become the property of the Authority.

Conclusion

2.43 Considerable amounts have been paid for water under the agreement without the BWA having the capacity to receive it. This is in part as a result of the necessary infrastructure not being in place for distribution of the desalinated water.

2.44 The Authority because of its unfamiliarity with the Plant has challenges in monitoring the Plant operations and maintenance as per the Agreement.

2.45 There is no evidence that the Authority conducted the necessary due diligence to determine whether the rate of return received by Ionics was good value for money.

2.46 Enough research was not conducted on the quality of the water to be desalinated, resulting in the Authority paying higher tariffs than should be required.

2.47 **It is recommended that:-**

- The West Coast Main is made functional to allow the desalinated water to be distributed to the north;
- BWA assigns officers to the plant and trained them in the operations and maintenance of the plant;
- The Desalination Plant is run at its full capacity during the dry season to verify its sustainability over the long haul; and
- BWA develops a protocol for inspections that describes each party's responsibilities and provides a format to demonstrate compliance.