

PN-1112-512

65141

A NOTE ON THE SALINITY OF  
GROUNDWATER FROM RIVERSDALE #1 WELL  
CAYMANAS AREA, ST. CATHERINE PLAINS

A NOTE ON THE SALINITY OF  
GROUNDWATER FROM RIVERSDALE #1 WELL  
CAYMANAS AREA, ST. CATHERINE PLAINS

D. V. RAMANAMURTY  
AND  
B. FERNANDEZ

NATIONAL IRRIGATION COMMISSION  
14-20 PORT ROYAL STREET  
KINGSTON

JULY, 1989

Project No.: 532-0123  
Loan No.: 532-T-046  
AND  
532-T-046a

Date: September 25, 1985

### INTRODUCTION

The Crop Diversification and Irrigation Project (CDI) started functioning officially from October 1985, to reinforce the institutional capacity of Agro-21 Corporation Limited to promote and develop private commercial agricultural investment in Jamaica. One of the activities of the CDI project was to rehabilitate and construct irrigation infrastructure such as wells, canals, pumping stations, fencing and storage facilities. On the reorganization of the activities of the Agro-21 Corporation Limited, with effect from April 1, 1989, the CDI project was merged with the National Irrigation Commission. The area of activity is a part of the St. Catherine Plains mostly on the western outskirts of Kingston where it is divided into five (5) sub-areas which are designated as Project - A, Project - B, Project - C (Horticulture), Project-C (small farmers' area) and Project-E. Other areas of small farmer activity include Hill-Run, and Bushy Park. The Hydrogeologist working with the project executed the programme of rehabilitating the old wells and constructing the new ones and also carried out other hydrogeological activities all of which are indicated below:

- a) Three old wells in Project-A were rehabilitated in late 1985.
- b) Fourteen (14) wells were constructed in Projects - A, B, C (Horticulture) and E during the period September, 1985 to February, 1988.
- c) Six (6) old wells in Project-E and two (2) old wells in Project-C (small farmers' area) were tested for their yield and quality of water during the period April, 1987 to February, 1988.
- d) Four (4) observation wells were constructed in coastal area to the east, south-east and south of the project areas and one in the Hill-Run area to monitor the quality of groundwater.
- e) Two (2) exploratory wells were drilled in the Hill-Run area tapping the limestone aquifer.
- f) Water levels and quality of groundwater in the general area were monitored.

As specified in the project document, environmental monitoring of the project activities will be the responsibility of the Underground Water Authority which will include monitoring of:

- a) Water quality with respect to both salinity and contamination by pesticides and other pollutants.
- b) Groundwater extraction.

Monitoring of groundwater levels is necessary to relate any changes in the quality of groundwater with extraction. Monitoring of water levels and the quality of groundwater and preparation of respective project reports were done in collaboration with Underground Water Authority.

Major hydrological work carried out has been described in the following reports:

1. Ramanamurty, D.V. December, 1988. A report on the groundwater resources of horticulture Project-C, Caymanas area, St. Catherine Plains. Land Utilization Department, Agro-21 Corporation Limited, Kingston.

Contains reports on the construction, development and testing of two wells viz. Watson Grove #3 and Riversdale #1 and the recommended rates of extraction of groundwater from these wells. Describes the chemical characteristics of water required for use in horticulture and the suitability of groundwater in the area for this purpose.

2. Ramanamurty, D.V., and B. Fernandez. March, 1989. A report on the salinity of and groundwater in the alluvial aquifer in parts of Bernard Lodge and Caymanas Areas and the adjoining coastal area, St. Catherine Plains. Land Utilization Department, Agro-21 Corporation Limited, Kingston.

Contains chemical analyses data of groundwater from 38 wells in the area; historical data from 1963 to 1982 and recent data from 1985 to 1988; shows areas of groundwater contamination with sea water and other pollutants.

3. Ramanamurty, D.V. May, 1989. A report on the groundwater resources of Project-A, Bernard Lodge area, St. Catherine Plains. National Irrigation Commission, Kingston.

Contains reports on testing of one old well, Half Way Tree #6, reconstruction, development and testing of three old wells, Half Way Tree #4, #5 and Cookson #3 and construction, development and testing of five new wells, Half Way Tree #2, Cookson #4, Newlands #2, #2A and #3, recommended rates of groundwater extraction from the wells, chemical characteristics of water required for irrigation and the suitability of groundwater for this purpose.

4. Ramanamurty, D.V. July, 1989. A report on the groundwater resources of Project-B, Caymanas area, St. Catherine Plains. National Irrigation Commission, Kingston.

Contains reports on the construction development and testing of wells, Cowpark-A, North Syndicate #2, South Syndicate #2, Naggo Head and Guinep Pen and testing of old well, Cedar Grove #2, recommended rates of groundwater extraction from the wells, chemical characteristics of water for irrigation and suitability of groundwater in the area for this purpose.

5. Ramanamurty, D.V. July, 1989. A report on the groundwater resources of Project-E, Bernard Lodge area, St. Catherine Plains. National Irrigation Commission, Kingston.

Contains reports on the construction, development and testing of three new wells Goshen #3A, Clifton #B, and Clifton #5 and testing of 6 old wells, Limetree #1, Government Park, Clifton #3 Congrieve Park #4, Salt Pond #7, and Reidspen #1, recommended rates of groundwater extraction from the wells, chemical characteristics of water required for irrigation and suitability of groundwater in the area for this purpose.

6. Ramanamurty, D.V. July, 1989. A report on the groundwater resources of Project-C (small farmers area), Caymanas area, St. Catherine Plains. National Irrigation Commission, Kingston.

Contains reports on testing of two old wells, Phoenix Park #1 and #3 and drilling of five coreholes, Lawrencefield, Riversdale #2 and #3 Cowpark B and C.

7. Ramanamurty, D.V., K. Mulchansingh and B. Fernandez. July, 1989. A report on the ground water levels in parts of Bernard Lodge and Caymanas areas and adjoining coastal area, St. Catherine Plains. National Irrigation Commission, Kingston.

Contains water level data and hydrographs for 27 wells and descriptions on the fluctuations in water levels.

8. Ramanamurty, D.V., and B. Fernandez. July, 1989. A note on the salinity of and groundwater from Riversdale #1 well, Caymanas area, St. Catherine Plains. National Irrigation Commission, Kingston.

Contains chemical analyses results of water samples collected from Riversdale #1 well from August, 1986 to March 1989 and description on the changes in the quality of groundwater with pumping time. Attempts to explain the unusually high concentrations of sodium and chloride in water just at the beginning of pumping.

9. Ramanamurty D.V. and B. Fernandez. July, 1989. A note on the water levels and quality of groundwater from the observation well at Hill-Run, St. Catherine Plains. National Irrigation Commission, Kingston.

Contains water level data, hydrographs and chemical analyses results of water samples from the Hill-run observation well.

Reports on the construction of five (5) observation wells along the coast and in the Hill-Run area, and on the drilling of two (2) exploratory wells tapping the limestone Aquifer in the Hill-Run area and on the organic contamination of groundwater in parts of Bernard Lodge area have been issued by the Underground Water Authority under the titles listed below:

1. Fernandez, B. January, 1988. The drilling of monitoring wells, South St. Catherine. Underground Water Authority, Kingston.

The Crop Diversification Project on the South St. Catherine alluvial plains, required high quality groundwater, necessitating the replacement of older sand pumping wells. The quality of groundwater must remain high and the monitoring well network is one early warning system put in place to detect any changes in groundwater quality. The five monitoring wells are aligned in a crescent between the well field and the sea. Multi-level (piezometers) and single level completion using 3" O pvc have been constructed.

2. Fernandez, B. July, 1988. Well completion report, Hill-Run Drive #1, exploratory Well, South St. Catherine. Underground Water Authority, Kingston.

Contains drilling, and testing information. The hole was drilled down to 200 ft. Groundwater from the well was highly saline in the deep zone and moderately saline in the top zone. The well was abandoned.

3. Fernandez, B. August 1988. Well completion report, Pepper Pot Drive exploratory well #2, Hill Run area, St. Catherine. Underground Water Authority, Kingston.

Contains drilling and testing information. The hole was drilled down to 80 ft. Testing could not be completed due to caving of the hole and it was abandoned.

4. Fernandez, B. and D.V. Ramanamurty. July 1989. Ground-water monitoring for organic contamination. Bernard Lodge, St. Catherine Plains. Underground Water Authority, Kingston.

Six water samples one each from six wells in and around the project areas were analysed. Concentration of organophosphorous pesticides in the groundwater were below the detectable limit. Concentration of organochlorine pesticides were also less than the detectable limit except in one sample.

Facilities extended by Agro-21 Corporation Limited, Underground Water Authority and National Irrigation Commission Limited, in furtherance of the work and in the preparation of the reports are gratefully acknowledged.

**A NOTE ON THE SALINITY OF  
GROUNDWATER FROM RIVERSDALE #1 WELL  
CAYMANAS AREA, ST. CATHERINE PLAINS**

**CONTENTS**

1. Introduction
  2. Salinity of Groundwater
  3. Quality of Groundwater for Horticulture
  4. Conclusions
  5. Recommendations
- References
- Map - 1 Map of Caymanas Area - Project C
- Table 1 - Chemical Analyses of Water Samples
- Figure 1 - Graph Showing the Concentration of anions  
and cations in Well Water



**A NOTE ON THE SALINITY OF  
GROUNDWATER FROM RIVERSDALE #1 WELL  
CAYMANAS AREA, ST. CATHERINE PLAINS**

**1. INTRODUCTION**

Riversdale #1 well is to the north of the dyke road near the horticulture project-C and is one of the two wells which supply water to the project. It was constructed in August, 1986 and has been occasionally in use pumping at the rates of 350-400 USgpm. Map-1 shows the location of the well.

**2. SALINITY OF GROUNDWATER**

Chemical analyses results of water samples collected from the well at the time of its construction in August, 1986 and periodically afterwards are given in Table-1. The concentrations of the constituents are expressed in mg/l in the Table. These have been converted to milliequivalents/litre and plotted on a graph which is given as Figure 1.

The water is of calcium bicarbonate type. However, chloride which is normally less than sodium in the groundwater in the area is more than sodium in the Riversdale #1 well water. Chloride and sodium gradually increased from 43.9 and 23.4 mg/l on July 21, 1980 to 125.1 and 38.0 respectively on November 4, 1988. Tests were therefore conducted from time to time to find out if there is any variation in the quality of water with pumping time. Results of 4 tests conducted are given in Table 2.

1

TABLE - 2: CHANGES IN SODIUM AND CHLORIDE IN WATER WITH PUMPING TIME

	Date of Test	Time of Starting the Test	Time of Sample Collection	Time Elapsed Since Test Started	Chloride Content (mg/l)	Sodium Content (mg/l)	Pumping Water Level (b.g.l) ft.	Discharge USgpm	
1.	24 11/88	10:30am	10:30am	-	126.9	46.0	45.0	360	
	25 11/88		4:00pm 9:30am	5.5 hrs. 23 hrs.	51.9 53.4	25.0 25.0			36.0
2.	26 1/89	10:50am	10:50am	-	128.8	53.6	38.22	300	
	27 1/89		11:00am	10mts.	-	-			43.51
			4:00pm	5hrs.10mts	51.5	26.8			44.05
			10:30am	23 hrs.40mts.	50.0	25.8			44.12
28 1/89	3:30pm 11:50am	49hrs.	51.9 51.9	24.0 25.8	44.25	350			
3.	4 2/89	11:15am	11:15am		176.5	80.0	42.0	350	
			11:45am		105.3	43.0			
			12:20pm		68.9	31.5			
4	15 3/89	09:25am	9:25am		81.8	39.0	43.4	350	
			09:35am	10mts.	51.8	25.0			
			09:55am	30mts.	45.8	27.0			
			10:25am	1hr.	44.7	27.0			
	15 3/89	11:25am	2hr.	43.9	25.0				
		12:55pm	3hr.30mts.	43.9	25.0				
		1:25pm	4hr.	47.0	25.0				

It is seen from the Table that on 24/11/88 chloride and sodium decreased from 126.9 mg/l and 46 mg/l to 51.9 mg/l and 25 mg/l respectively within 5.5 hours of pumping and remained more or less the same after 23 hours of pumping.

On 26/1/89, the chloride and sodium decreased from 128.8 mg/l and 53.6 mg/l to 51.5 mg/l and 26.8 mg/l respectively in about 5 hours of pumping and remained more or less the same after 49 hours of pumping.

On 4/2/89, chloride and sodium decreased from 176.5 mg/l and 80 mg/l to 68.9 mg/l and 31.5 mg/l respectively in 1 hour and 10 minutes of pumping.

On 15/3/89 chloride and sodium decreased from 81.8 mg/l and 39 mg/l to 51.8 mg/l and 25 mg/l respectively in 10 minutes of pumping and further decreased to 47 mg/l and 25 mg/l respectively in 4 hours of pumping.

### 3. QUALITY OF WATER FOR HORTICULTURE

Limits of sodium and chloride in water that is used for horticulture are given below:

- a) Sodium is less a problem in most foliage media that contain high amounts of organic matter. Less than 20 mg/l is desirable but 50 mg/l is not considered excessive.
- b) less than 50 mg/l of chloride is desirable under proper culture techniques.

Chloride and sodium are higher than the desirable limits in the water, immediately after pumping starts but in course of time they decrease to almost desirable limits.

### 4. CONCLUSION

It is seen from results of the tests conducted so far that the sodium and chloride contents are high in the water at the time of the start of pumping and then considerably decrease within half an hour of pumping and thereafter remain more or less the same even after two days of continuous pumping.

Fluctuations are seen simultaneously in sodium and chloride indicating that sodium chloride is contributing to the high sodium and chloride content in water.

Detailed studies on the salinity of groundwater in the area showed that contamination of groundwater with sea water takes place in stages - first sodium exceeding magnesium and then calcium resulting in the formation of sodium bicarbonate type of water; then exceeding the bicarbonate at which stage chloride exceeding calcium and magnesium. Finally the formation of sodium chloride type of water takes place in which chloride exceeds bicarbonate and finally sodium. No such transformation of water is observed at Riversdale #1 well. It is therefore concluded that the high sodium and chloride in the water from Riversdale #1 well is due to contamination of groundwater with some local sodium chloride

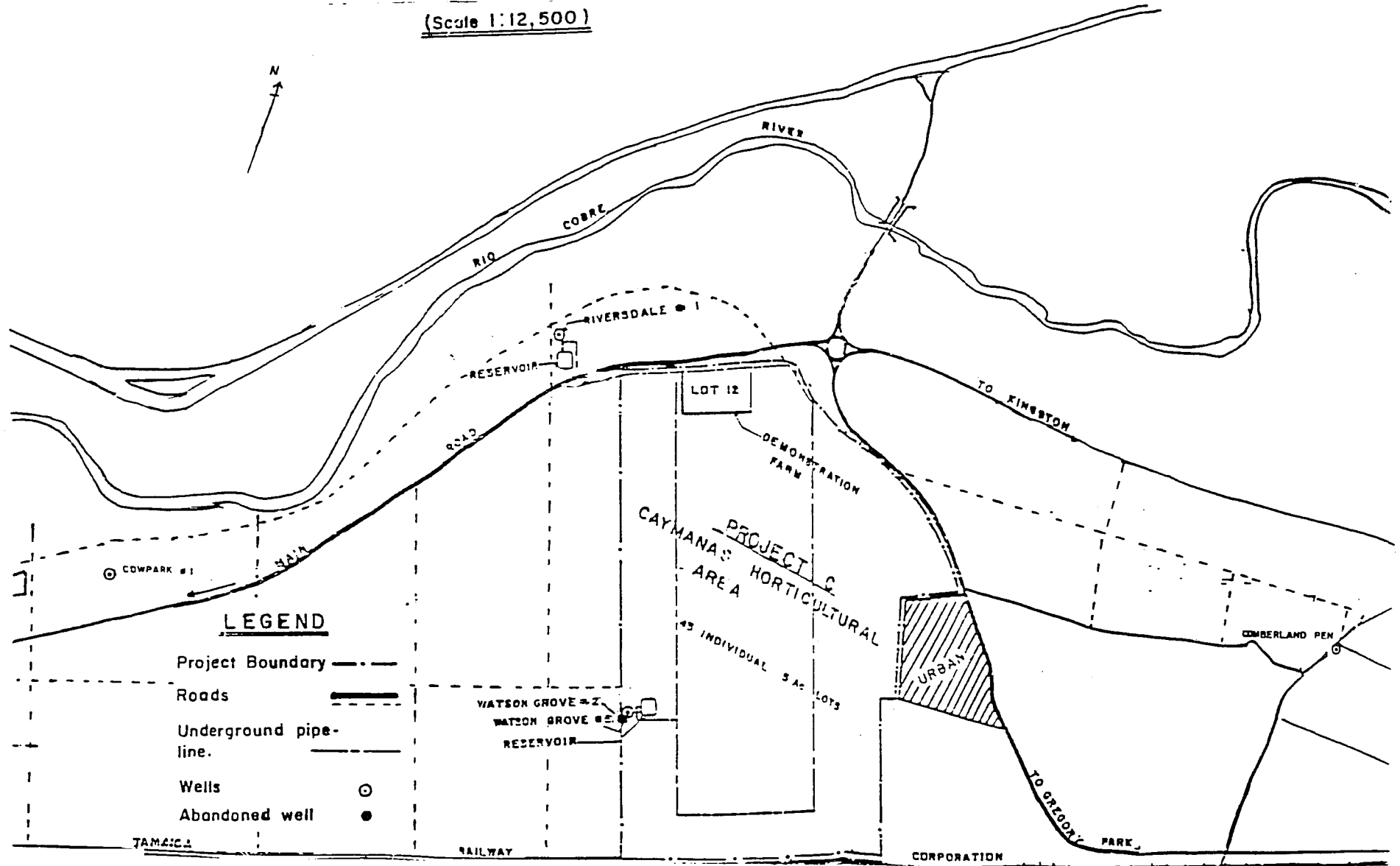
5. **RECOMMENDATIONS**

Variations in the quality of water from Riversdale #1 well are to be observed at least once in a month for a pumping period of 48 hours at a time for one year and attempts be made to establish a pattern for the variation in the concentration of sodium and chloride in the water. Further programme of studies can be drawn up based on the results obtained.

Map of Caymanas Area Project C

Map 1

(Scale 1:12,500)



LEGEND

- Project Boundary
- Roads
- Underground pipe-line.
- Wells ○
- Abandoned well ●

JAMAICA

RAILWAY

CORPORATION

Chemical Analysis of Water Samples

Table- 101

Location: Riversdale #1

Area: Caymanas Area - Project 'C'

SL NO.	DATE	pH	@ Sp. Conductance	TDS	Ca	Mg	Na	K	Fe	Cl	SO <sub>4</sub>	B	F	PO <sub>4</sub>	NO <sub>3</sub>	* Alkalinity			SAR/	
																HCO <sub>3</sub>	CO <sub>3</sub>	Total		Total* Hardness
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	20.8.86	7.95	717	444	96.59	26.16	25.5	0.70	0.06	47.98	11.77	-	-	-	-	315.78	0	315.78	350	
2	21.8.86	8.15	708	444.7	95.59	26.64	25.0	0.70	0.34	49.98	12.26	-	-	-	-	315.77	0	315.77	349.5	
3	9.12.87	7.75	771	501.1	102.6	30.2	27.5	0.65	2.20	59.7	0.2	0.12	0.3	-	-	296.4	24.4	320.8	382	
4	8.3.88	7.2	750	508	99.8	30.0	30.6	0.6	0.08	63.5	18.6	0.08	0.09	-	-	232.3	28.7	261.0	374	
5	21.7.88	7.2	698	392.9	88.2	32.1	23.4	2.7	0.22	43.9	11.8	0.06	0.21	-	-	308.7	15.7	232.8	352	
6	9.8.88	7.2	860	-	-	-	33.5	-	-	84.1	-	-	-	-	-	342.9	-	342.9	-	
7	5.9.88	7.7	975	613	114.6	30.2	43.5	1.2	1.8	106.1	0.0	-	-	-	-	345.0	15.6	360.6	412	
8	4.11.88	-	1020	-	-	-	38.0	-	-	125.1	-	-	-	-	-	354.2	0.0	354.2	-	

µmhos/cm at 25°C \* as CaCO<sub>3</sub>

Analysis by Jamaica Bauxite Institute, Kingston)

Chemical Analyses of Water Samples

Location: Riversdale #1

Area:

SL NO.	DATE	pH	e Sp. Conductance	TDS	Ca	Mg	Na	K	Fe	Cl mg/l	SO <sub>4</sub>	B	F	PO <sub>4</sub>	NO <sub>3</sub>	* Alkalinity			SAR	
																HCO <sub>3</sub>	CO <sub>3</sub>	Total		Total* Hardness
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	24 <u>11</u> 88 (10-30 am)	7.4	1,056	-	121.8	35.0	46.0	-	0.09	126.9	30.40	0.02	1.70	-	9.08	346.4	0.0	346.4	450.0	-
	24 <u>11</u> 88 4-pm	-	742	-	-	-	25.0	-	-	51.9	-	-	-	-	4.65	-	-	-	-	-
	25 <u>11</u> 88 9-30 am	-	741	-	-	-	25.0	-	-	53.4	-	-	-	-	4.65	-	-	-	-	-

e/μ/mhos/cm at 25°C \* as CaCO<sub>3</sub>

(Analysis by Jamaica Bauxite Institute, Kingston)

12

St. Catherine Plains

table 1(3)

Chemical Analyses of Water Samples

Location: RIVERSDALE #1

Area: CAYMANAS

SL NO.	DATE	pH	e Sp. Conductance	TDS	Ca	Mg	Na	K	Fe	Cl mg/l	SO <sub>4</sub>	B	F	PO <sub>4</sub>	NO <sub>3</sub>	* Alkalinity			Total * Hardness	SAR
																HCO <sub>3</sub>	CO <sub>3</sub>	Total		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	26/89 11:50am	7.1	1070	-	-	33.4	53.6	-	-	128.8	-	-	-	-	-	358.1	0.0	358.1	-	-
	26/89 4:00pm		741	-	-	26.2	26.8	-	-	51.5	-	-	-	-	-	-	-	-	-	-
	27/89 10:30am		742	-	-	25.2	25.8	-	-	50.0	-	-	-	-	-	-	-	-	-	-
	27/89 5:30pm		704	-	-	25.4	24.0	-	-	51.9	-	-	-	-	-	-	-	-	-	-
	28/89 10:30am	7.3	730	-	-	25.2	25.8	-	-	51.9	-	-	-	-	-	338.5	0.0	338.5	-	-
	4/89 11:15am		1260	-	-	-	80.0	-	-	176.5	-	-	-	-	-	-	-	-	-	-
	4/89 11:45am		957	-	-	-	43.0	-	-	105.3	-	-	-	-	-	-	-	-	-	-
	4/89 12:20pm		503	-	-	-	31.5	-	-	68.9	-	-	-	-	-	-	-	-	-	-
	15/89 7:25am	7.3	575	62	105.2	31.6	39.0	1.3	0.07	81.8	13.7	0.09	-	-	-	277.3	27.0	324.3	400	-
	15/89 9:25am		734	-	-	-	25.0	-	-	51.8	-	-	-	-	-	262.2	45.9	308.1	-	-
	15/89 7:55am		727	-	-	-	27.0	-	-	45.8	-	-	-	-	-	225.7	51.4	277.1	-	-

e/μmhos/cm at 25°C \* as CaCO<sub>3</sub>

(Analysis by Jamaica Bauxite Institute, Kingston)



## St. Catherine Plains

## Chemical Analyses of Water Samples

Location: RIVERSDALE #1

Area:

SL NO.	DATE	pH	e Sp. Conductance	TDS	Ca	Mg	Na	K	Fe	Cl mg/l	SO <sub>4</sub>	B	F	PO <sub>4</sub>	NO <sub>3</sub>	* Alkalinity			Total* Hardness	SAR
																HCO <sub>3</sub>	CO <sub>3</sub>	Total		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	15 3/87 10 25am		727	-	-	-	270	-	-	447	-	-	-	-	-	3257	000	3257	-	
	15 3/87 11 25am		720	-	-	-	250	-	-	431	-	-	-	-	-	2473	541	3014	-	
	15 3/87 12 05pm		710	-	-	-	250	-	-	437	-	-	-	-	-	3150	000	3150	-	
	15 3/87 1 25pm		725	400	454	277	250	11	005	470	76	0.23	-	-	-	2514	1622	3136	352	

e/μ/mhos/cm at 25°C \* as CaCO<sub>3</sub>

(Analysis by Jamaica Bauxite Institute, Kingston)

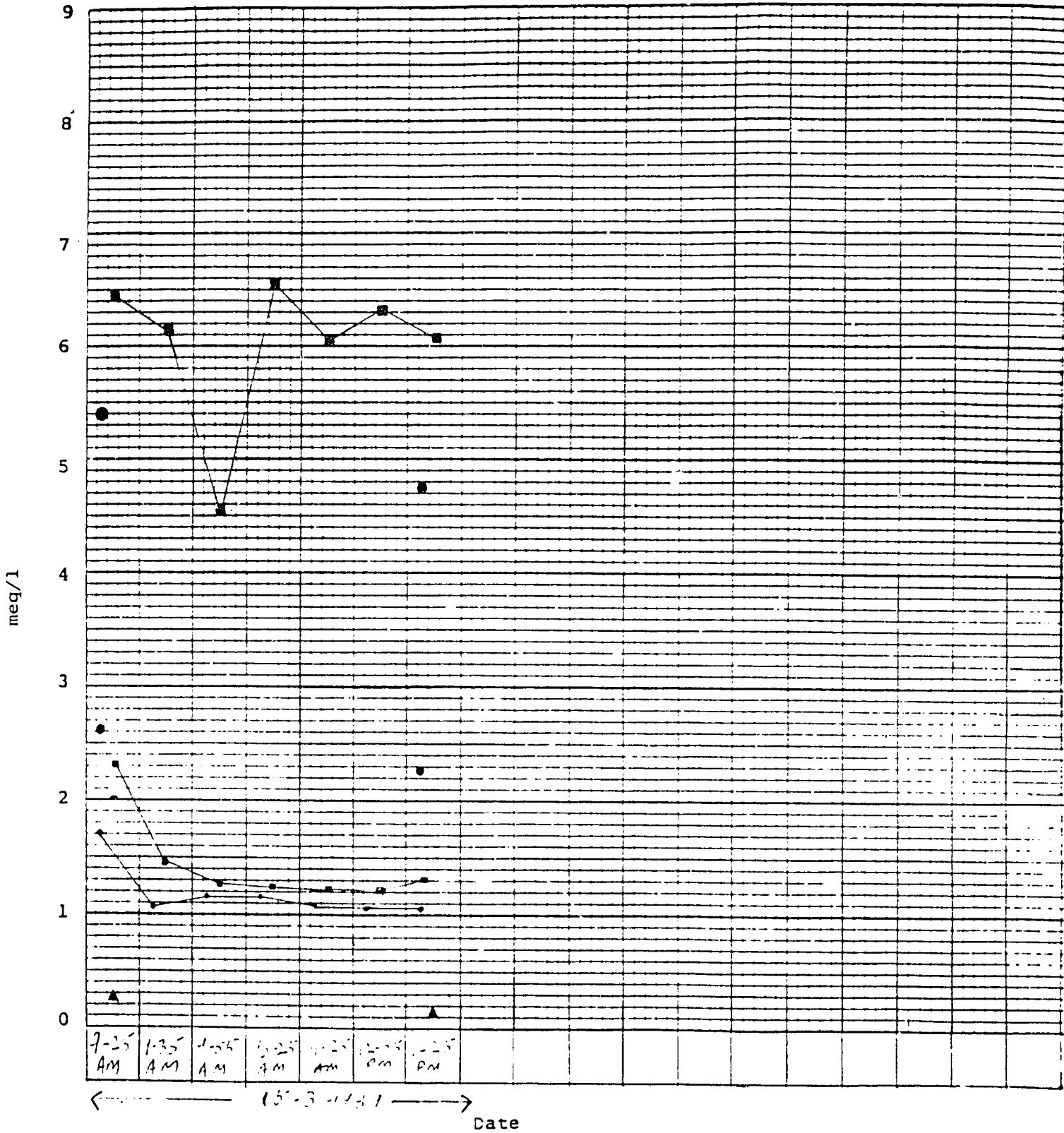


GRAPH SHOWING THE CONCENTRATION OF ANIONS AND CATIONS IN WELL WATER

Fig 1 (2)

AREA:

WELL NAME: RIVERDALE R 2



- calcium
- magnesium
- sodium and potassium
- chloride
- ▲ sulphate
- bicarbonate and carbonate