

CONTENTS

	<i>Page</i>
INTRODUCTION	
1- Location	--- 1
2- Climatic condition	--- 2
3- Previous work	--- 9
4- Scope of the present study	--- 12
5- Method of study	--- 13
 I- GEOMORPHOLOGY AND GEOLOGY	
1.1 Geomorphology	--- 15
1.1.1 High land areas	----15
1.1.1.1 Shubrawit ridges	--- 15
1.1.1.2 Ankabia- Iweibid structural plain	--- 17
1.1.1.3 Gebal umm Ragm-Gebel umm katib ridges	--- 17
1.1.2 Table land area	--- 18
1.1.2.1 Belbies-El Tell El Kabier-Salhia old deltaic plains	----18
1.1.2.2 Wadi El Tumilat Stretch	----19
1.1.2.3 Umm Gidam Gravelly slopes	--- 20
1.1.2.4 The hydrographic basins	-- 21
1.1.3 Low land area	--- 23
 1.2. Geology	--- 23
1.2.1 Stratigraphy	--- 23
1.2.1.1 Quaternary	--- 25
1.2.1.1.1 Holocene deposits	-- 25
1.2.1.1.2 Pleistocene deposits	-- 25
1.2.1.1.3 Undifferentiated Quaternary deposits	--- 26

1.2.1.2 Tertiary	26
1.2.1.2.1 Pliocene Rocks - - - - -	26
1.2.1.2.2 Miocene Rocks - - - - -	28
1.2.1.2.3 Oligocene Rocks - - - - -	28
1.2.2 Geological structures - - - - -	28
1.2.3 Geological history - - - - -	30
1.2.3.1 Late Cretaceous — Eocene times - - - - -	30
1.2.3.2 Oligocene time - - - - -	30
1.2.3.3 Miocene — Pliocene times - - - - -	31
1.2.3.4 Pleistocene — Holocene times - - - - -	31

II- HYDROGEOLOGY OF THE QUATERNARY (PLEISTOCENE) AQUIFER

II.1 Surface water system - - - - -	33
II.1.1 Surface water hydrographs of Ismailia canal - - - - -	35
II.1.1.1 Hydrograph of average water level of Ismailia canal during the first stage of enlargement (1950 — 1965)	35
II.1.1.2 Hydrograph of average water level of Ismailia canal during the second stage of enlargement (1970 — 1999)	35
II.1.1.3 Hydrograph of water quantity (m ³ /y) entered Ismailia canal at Sereakus barrage during the first stage of enlargement (1950 — 1965) - - - - -	35
II.1.1.4 Hydrograph of water quantity (m ³ /y) entered Ismailia canal at Sereakus barrage during the second stage of enlargement (1970 — 1999) - - - - -	39
II.1.2 Hydrograph of average water level of El Wadi El Sharqi canal - - - - -	39
II.1.3 Hydrograph of average water level of Saidya canal - - - - -	39

11.2. Groundwater system	--- 42
11.2.1 Quaternary (Pleistocene) aquifer	---- 42
11.2.1.1 Holocene aquitard	--- 42
11.2.1.2 The Pleistocene aquifer	--- 42
11.2.1.3 Hydraulic parameter of the Quaternary (Pleistocene) aquifer	--- 46
11.2.1.3.1 Effective porosity (%)	---- 46
11.2.1.3.2 Hydraulic conductivity (m/day)	---- 46
11.2.1.3.3 Transmissivity (m ³ /day)	-- 46
11.2.1.3.4 Storage coefficient	--- 51
11.2.1.4 Fluctuation of potentiometric surface of the Quaternary (Pleistocene) aquifer.	--- 51
11.2.1.4.1 Fluctuation of potentiometric surface of the Quaternary (Pleistocene) aquifer between years 1975 - 1980	--- 65
11.2.1.4.2 Fluctuation of potentiometric surface of the Quaternary (Pleistocene) aquifer between years 1980 — 1985	-- 69
11.2.1.4.3 Fluctuation of potentiometric surface of the Quaternary (Pleistocene) aquifer between years 1985 —1990	--- 69
11.2.1.4.4 Fluctuation of potentiometric surface of the Quaternary (Pleistocene) aquifer between years 1990- 1995	-- 69
11.2.1.4.5 Fluctuation of potentiometric surface of the Quaternary (Pleistocene) aquifer between July and December 1999	----78

11.2.1.5 Relationship between surface water and groundwater--	78
11.2.1.5.1 Estimation of water seepage (m ³ /y/km) along the course of Ismailia canal between Abu Zaabal and Abbasa during its stages of enlargement	92

III- HYDROGEOCHEMISTRY OF THE QUATERNARY

(PLEISTOCENE) AQUIFER

General outline	100
III 1 Geochemistry of surface water	101
III.1.1 Salinity content of surface water	101
111.1.2 Distribution of major constituents in surface water	102
111.1.2.1 Chloride content in surface water	102
111.1.2.2 Sulphate content in surface water	103
111.1.2.3 Bicarbonate content in surface water	103
111.1.2.4 Potassium content in surface water	103
111.1.2.5 Sodium content in surface water	103
111.1.2.6 Magnesium content in surface water	104
111.1.2.7 Calcium content in surface water	104
111.1.3 Distribution of trace metals in surface water	105
111.1.3.1 Iron concentration in the surface water	105
111.1.3.2 Manganese concentration in the surface water	105
111.1.3.3 Lead concentration in the surface water	105
111.1.3.4 Zinc concentration in the surface water	105
111.1.3.5 Copper concentration in the surface water	106
111.1.4 Hypothetical salts combination of surface water	106
111.1.5 Ion dominance and chemical types of surface water	107
111.1.6 Bacteriological analysis of surface water	107
111.1.7 Evaluation of surface water for irrigation	109

111.2 Geochemistry of groundwater — — — — —

111.2.1 Salinity distribution in the groundwater of the Quaternary (Pleistocene) aquifer - - - - -	1 0 9
111.2.2 Distribution of major constituents in the groundwater of the Quaternary (Pleistocene) aquifer - - - - -	1 1 4
111.2.2.1 Chloride content distribution in the groundwater of the Quaternary (Pleistocene) aquifer - - - - -	1 1 7
111.2.2.2 Sulphate content distribution in the groundwater of the Quaternary (Pleistocene) aquifer - - - - -	1 2 1
111.2.2.3 Bicarbonate content distribution in the groundwater of the Quaternary (Pleistocene) aquifer - -	1 2 1
111.2.2.4 Potassium content distribution in the groundwater of the Quaternary (Pleistocene) aquifer - - - - -	1 2 5
111.2.2.5 Sodium content distribution in the groundwater of the Quaternary (Pleistocene) aquifer - -	1 2 5
111.2.2.6 Magnesium content distribution in the groundwater of the Quaternary (Pleistocene) aquifer - -	1 3 2
111.2.2.7 Calcium content distribution in the groundwater of the Quaternary (Pleistocene) aquifer - -	1 3 8
111.2.3 Hypothetical salts combination in the groundwater of the Quaternary (Pleistocene) aquifer - -	1 4 3
111.2.4 Ion dominance and chemical types in the groundwater of the Quaternary (Pleistocene) aquifer - - - - -	1 4 3
111.2.5 Hydrochemical coefficients (Ion ratio) in the groundwater of the Quaternary (Pleistocene) aquifer - - - - -	1 4 5

IV-GROUNDWATER POLLUTION OF THE QUATERNARY (PLEISTOCENE) AQUIFER IN THE STUDY AREA

IV.1 Contamination of groundwater of the Quaternary

(Pleistocene) aquifer	- - - 153
IV.1.1 Trace metals contaminants	- - 154
IV.1.1.1 Iron content distribution in the groundwater of the Quaternary (Pleistocene) aquifer	- - - 154
IV.1.1.2 Manganese content distribution in the groundwater of the Quaternary (Pleistocene) aquifer	- - 155
IV.1.1.3 Lead content distribution in the groundwater of the Quaternary (Pleistocene) aquifer	- - - 159
IV.1.1.4 Copper content distribution in the groundwater of the Quaternary (Pleistocene) aquifer	- - 162
IV.1.1.5 Zinc content distribution in the groundwater of the Quaternary (Pleistocene) aquifer	- - - 166
IV.1.2. Other Inorganic elements	- - 166
IV.1.3. Organic contamination - - - - -	1 6 9
IV.1.4. Biological contamination	- - 169
IV.2 Evaluation of groundwater of the Quaternary (Pleistocene) aquifer for drinking and domestic purposes - - - - -	1 7 2
IV.2.1 Evaluation of groundwater of the Quaternary (Pleistocene) aquifer for drinking according to salinity content	- - 174
IV.2.2 Evaluation of groundwater of the Quaternary (Pleistocene) aquifer for drinking according to chloride content - - - - -	1 7 4
IV.2.3 Evaluation of groundwater of the Quaternary (Pleistocene) aquifer for drinking according to sulphate content - - - - -	1 7 5

IV.2.4 Evaluation of groundwater of the Quaternary (Pleistocene)	
aquifer for drinking according to sodium content	-- 175
IV.2.5 Evaluation of groundwater of the Quaternary (Pleistocene)	
aquifer for drinking according to magnesium content	---- 176
IV.2.6 Evaluation of groundwater of the Quaternary (Pleistocene)	
aquifer for drinking according to calcium content	----- 176
IV.2.7 Evaluation of groundwater of the Quaternary (Pleistocene)	
aquifer for domestic according to total hardness content	-- 177
IV.2.8 Evaluation of groundwater of the Quaternary (Pleistocene)	
aquifer for drinking according to iron content	-- 177
IV.2.9 Evaluation of groundwater of the Quaternary (Pleistocene)	
aquifer for drinking according to manganese content	---- 178
IV.2.10 Evaluation of groundwater of the Quaternary (Pleistocene)	
aquifer for drinking according to lead content	-- 178
IV.2.11 Evaluation of groundwater of the Quaternary (Pleistocene)	
aquifer for drinking according to copper content	-- 179
IV.2.12 Evaluation of groundwater of the Quaternary (Pleistocene)	
aquifer for drinking according to zinc content	-- 179
IV.3 Evaluation of groundwater of the Quaternary (Pleistocene)	
aquifer for livestock and poultry	----- 180
IV.4- Evaluation of groundwater of the Quaternary (Pleistocene)	
aquifer for irrigation uses	----- 181
IV.4.1 Evaluation of groundwater of the Quaternary (Pleistocene)	
aquifer for irrigation according to Ayers 1977	----- 181
IV.4.1.1 Evaluation of groundwater of the Quaternary	
(Pleistocene) aquifer for irrigation according to	
salinity content	-- 181

IV.4.1.2 Evaluation of groundwater of the Quaternary (Pleistocene) aquifer for irrigation according to chloride content	-- 182
IV.4.1.3 Evaluation of groundwater of the Quaternary (Pleistocene) aquifer for irrigation according to sulphate content	-- 182
IV.4.1.4 Evaluation of groundwater of the Quaternary (Pleistocene) aquifer for irrigation according to electrical conductivity (EC)	-- 182
IV.4.2 Evaluation of groundwater of the Quaternary (Pleistocene) aquifer for irrigation according to U.S. salinity laboratory staff classification	-- 183
IV.4.3 Evaluation of groundwater of the Quaternary (Pleistocene) aquifer for irrigation according to Wilcox classification ----	187
IV.5 Evaluation of surface and groundwater for industrial uses -	187
IV.5.1 Boiler feed water	-- 187
IV.5.2 Fruit and vegetable projects	-- 190
IV.5.3 Building purposes - - - - -	190
SUMMARY AND CONCLUSIONS - - - - -	192
RECOMMENDATIONS - - - - -	203
REFERENCES - - - - -	204
APPENDICES - - - - -	223
ARABIC SUMMARY - - - - -	259