THE IMPORTANCE OF MANAGING THE GROUNDWATER SOURCES IN KOGGALA FREE TRADE ZONE AREA IN ORDER TO PREVENT THE ENVIRONMENTAL HAZARDS.

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Abstract

The Koggala free trade zone is located at the Southern province of Sri Lanka. This is one of the major BOI projects in the country, initiated in the year 1990. The project area is bounded by the sea to the south, Koggala lake to the north, Poloya outfall to the east and connecting the Koggala area to the main land by a narrow land section on the western boundary. As per the request made by the BOI, Water Resources Board has undertaken this project. The main purpose of the project was to supply adequate amount of water for the factories established in the project area.

Reconnaissance surveys were conducted and all the hydrogeological data relevant for the study was collected. Geological, Geophysical and detailed hydrogeological investigations were conducted along with test drilling and pumping test program.

Five number of wells were selected for the water supply project and since 1992 the pumping was continued. The wells are still functioning smoothly. However, a groundwater level and water quality monitoring network has been introduced by the WRB in order to monitor the possible groundwater fluctuations and groundwater quality changes that might taken place during the course of pumping.

Two major environmental problems can be expected in the future with the expansion of this industrial zone. The 1 st problem would be the salinization and the 2 nd problem would be the groundwater quality changes due to activities of the factories.

Therefore, the paper will discuss the groundwater investigation criteria adopted during the study period and the findings related to groundwater occurrences in the project area and also the environmental problems that might happen in the future and the remedials that can be taken to overcome those environmental problems in order to run the project smoothly.

Introduction

The Koggala free trade zone which is one of the major BOI projects in Sri Lanka, initiated in the year 1990. under this project 12 numbers of factories were established and the supply of water was the one of the major problems encountered during the implementation of this project. During the design period it was thought to carry water from the surface water bodies through several miles long supply lines. However finally it was decided to conduct feasibility study in order to develop the groundwater potential within the free trade zone area.

Location of the project

The Koggala free trade zone is located at the Southern province of Sri Lanka (fig 1) is having an area extent of 246 km^2. It covers the coastal stretch of Koggala area, bounded by the sea to the South, Koggala lake to the North, Poloya outfall to the East and connecting the Koggala area to the mainland by a narrow land section on the Western boundary (fig 2)

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Geomorphological and Geological features

The land mass of the project area predominantly covered by coastal sand, beach sand, lake sand and dunesand more than 3 meters above mean sea level, except the lateritic ridges of higher elevation. The South Western part of the area composed of lateritic hillocks rising over 15 meters above mean sea level. The depth to the basement floor in the region varies within the range of 15 - 20 meters. Specially in the Northern area the coastal stretch massive sand dunes, old sand dunes and terraces are clearly visible. The soils in the coastal lowlands are predominantly recent sands deposited along the shore line. In few places of the off shore area coral reefs are also visible.

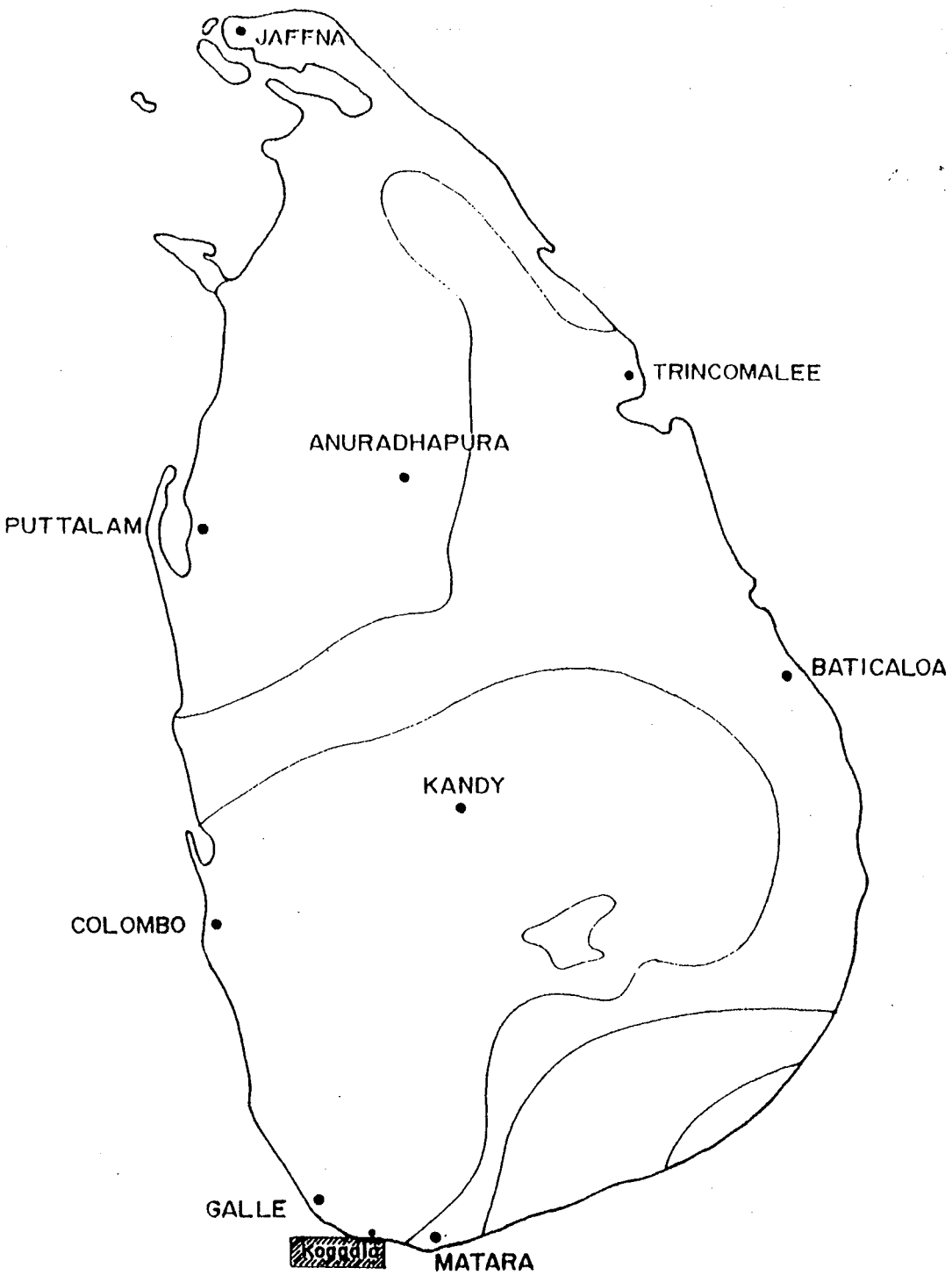
Charnockite exposures are located in some areas of the southern boarder. The sand dunes secure the regions of the project area is about 100 metres wide. Beach sands ridges are gently across the project area covering nearly 0.4 km and a prominently rising sand ridge is found along the edge of the Koggalalake(fig 3). The relief of inland areas are marked by narrow lateritic hills.

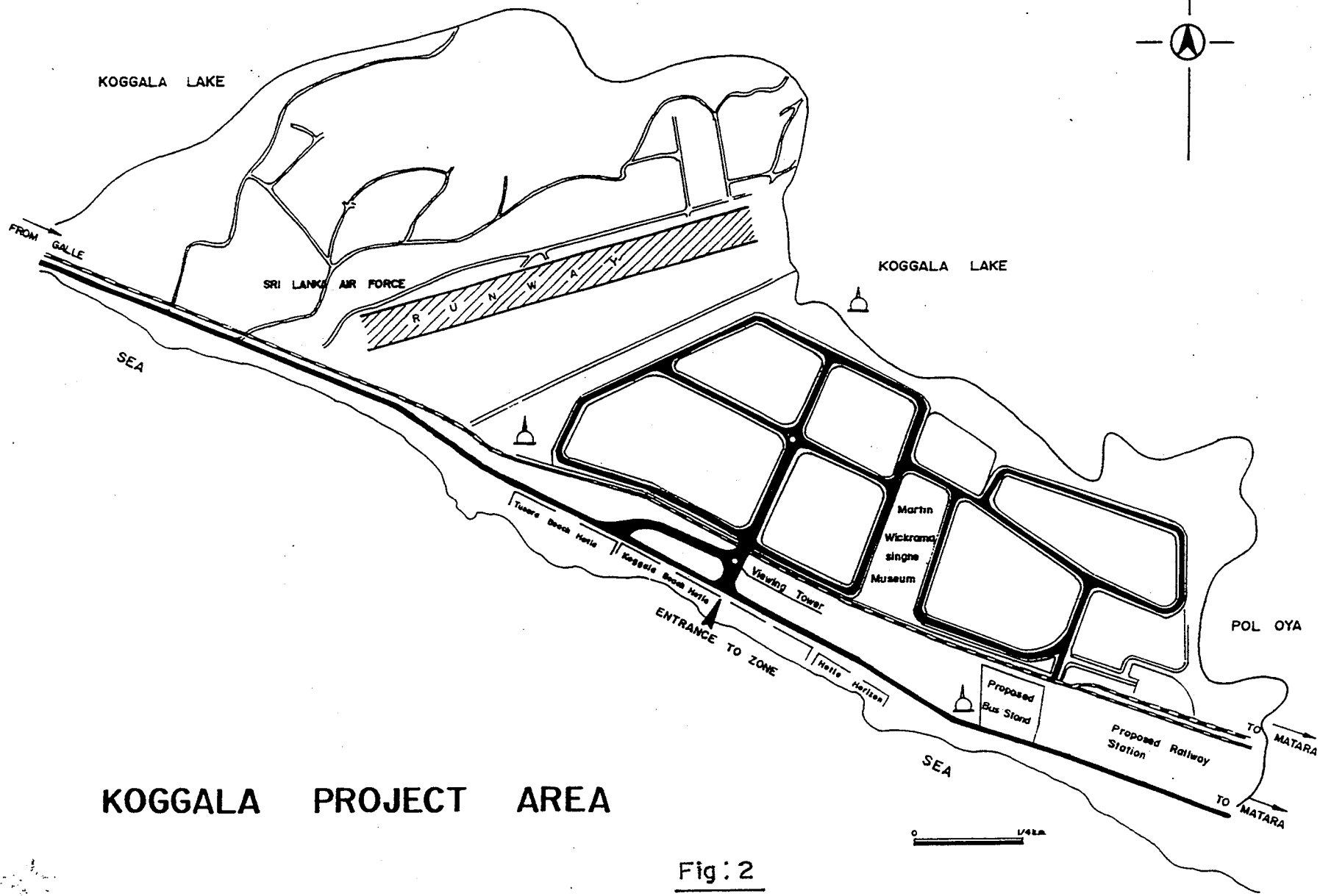
Climate

The climate of Sri Lanka is characterized by two monsoonal periods namely the South West monsoon prevailing from about April to September and the North Eastern monsoon from October to March. The project area is subjected to most of the rainfall of both monsoonal periods. The annual figures of the rainfall data for ten years (1979 - 1988) have been analyzed and it was found that the lowest rainfall experienced in the year 1983 amounting to 1572 mm . Except 1983 and 1986 the annual rainfall of rest of the years are reported well over 2000 mm.

SRI LANKA

Fig : 1





KOGGALA PROJECT AREA

Fig : 2

GEOLOGY MAP OF KOGGALA AREA

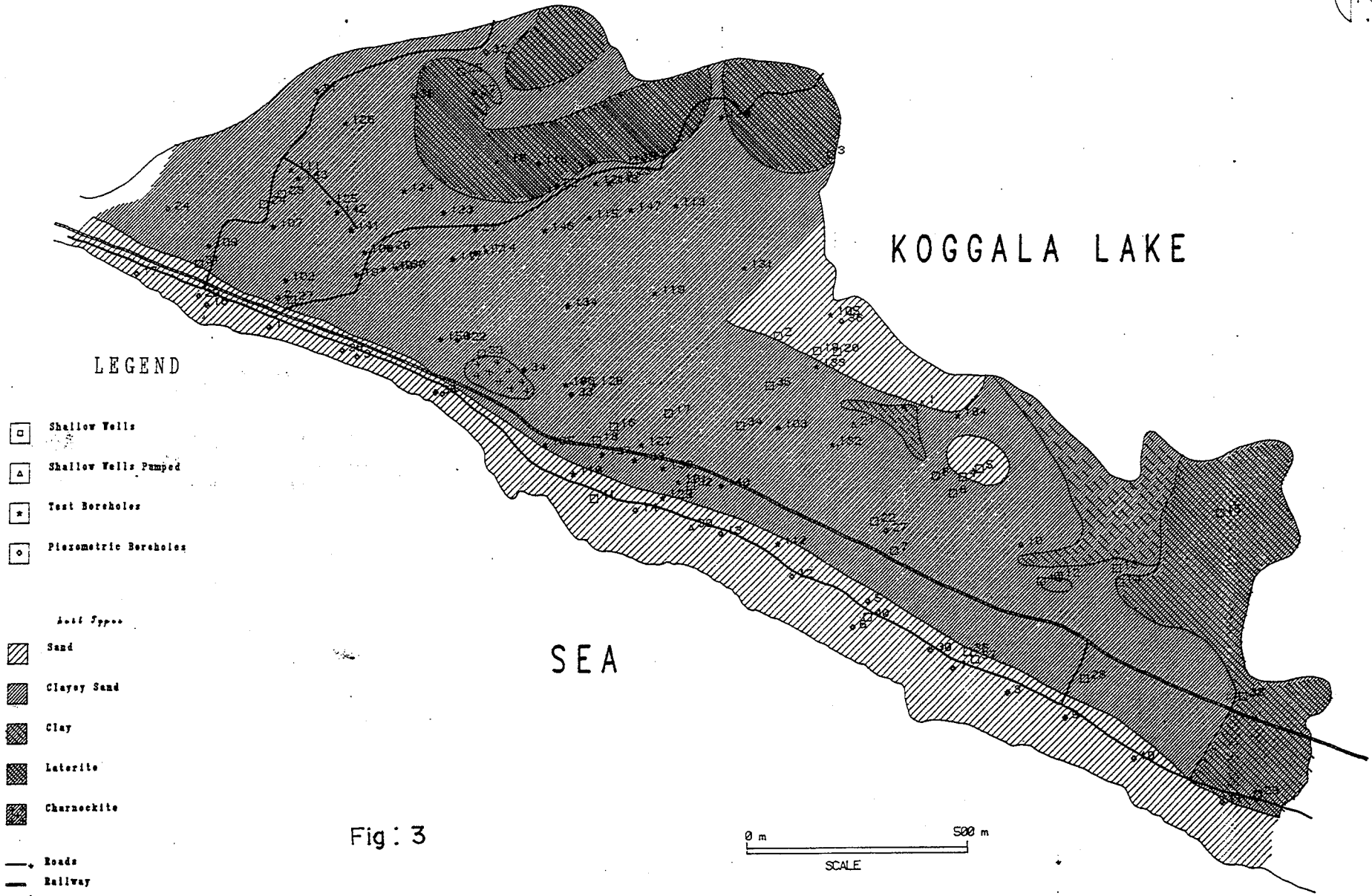


Fig : 3

Methodology

Prior to the surveys conducted, all the existing Geological and Hydrogeological data were collected and reviewed. The available Geological maps, Structural maps and Aerial Photographs were collected and studied in order to determine the potential areas. Once the areas are identified, Geophysical investigations were carried out adopting resistivity method. Profiling traverses were made along several directions. Based on the results of the profiling, vertical electrical soundings were conducted on selected points. All the sounding curves were analyzed.

Geophysical survey techniques

The resistivity survey method is one of the most prominent method in Geophysical survey techniques was applied for the Koggala studies. The terrameter (SAS 300) comprises a battery powered, deep penetration resistivity meter. It measures signal voltages created by the terrameter signal current.

Under the vertical electrical sounding method, a series of apparent resistivity measurements were made with expanding electrode distances.

Pumping tests were conducted on the test bore holes constructed in the project area in order to evaluate the aquifer parameters and also to determine the long term safe pumping limits of the existing aquifer system.

Water of all the bore holes were chemically tested for 17 physical and chemical parameters. Based on the analytical results chemical maps were prepared.

Results of the study

The Geophysical survey results indicated that in Koggala free trade zone area the fresh groundwater occur at shallow depth. Therefore it was suggested to drill 35 number of test bore holes and 40 piezometers for monitoring purposes. The diameter of the test bore hole was 8 inches and the diameter of the piezometer was 2 inches. During the construction period of test bore holes, perforated pvc casings were used within the water bearing zones to collect water into the bore hole.

It was observed that the electrical conductivity of water in those test bore holes were drastically changed with the depth of respective bore holes (fig 4).

Hardness and the presence of chlorides were reported within the permissible levels of the drinking water standards. However water with high concentration of iron was reported specially in the central part of the project area.

According to the survey results it was concluded that the fresh water in the Koggala free trade zone area occur at 10 metre depth, and beyond that level water is saline. It was also

Fig: 4

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KOGGALA GROUNDWATER INVESTIGATION PROJECT

BOREHOLE No – X.101

LOCATION – KOGGALA

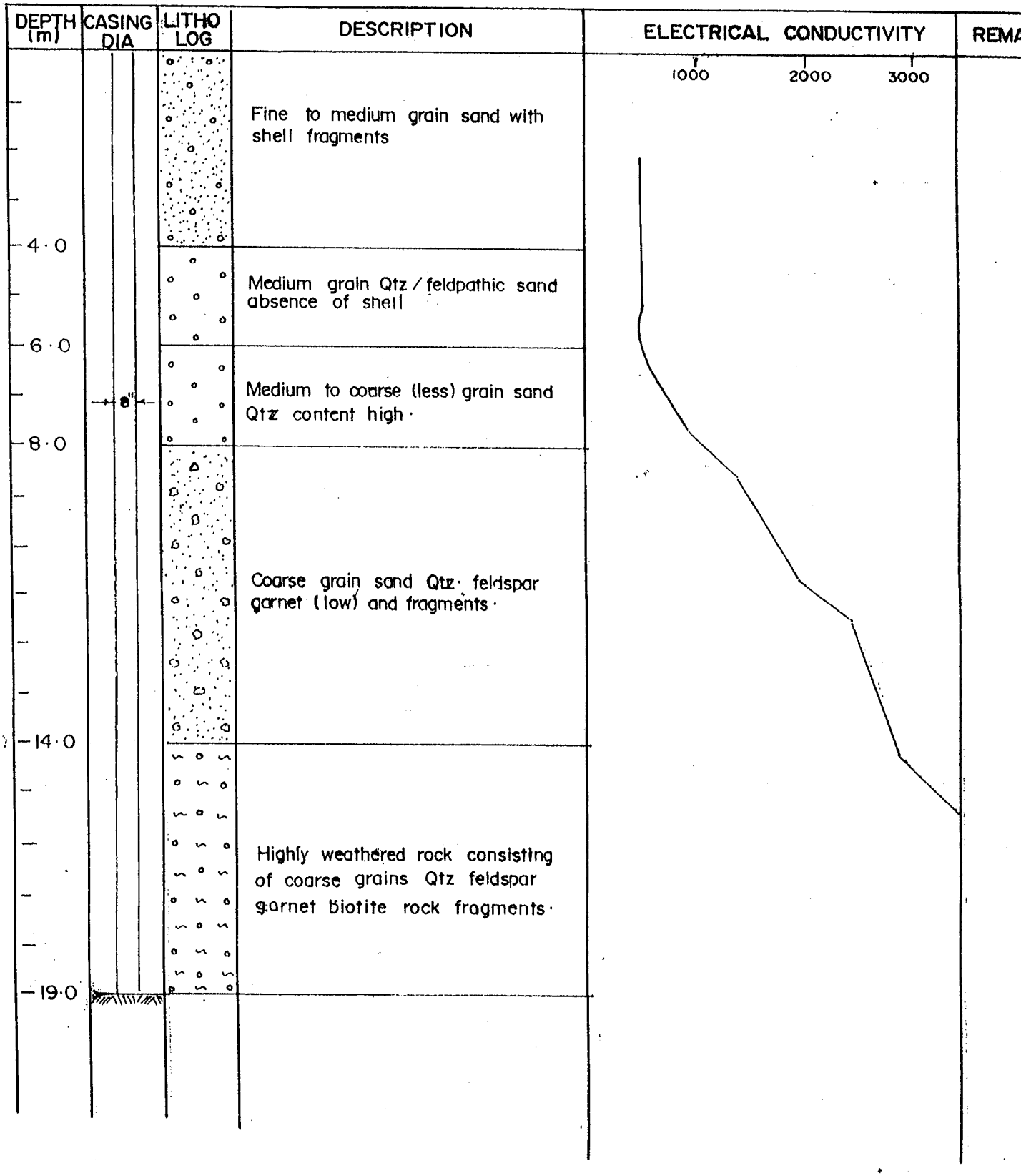
GROUND LEVEL – 3.592 m

DATE – 1990.05.08

DRILLING METHOD – MUD ROTARY

ESTIMATED YIELD – 60 l.pm

WATER LEVEL – 2.78 m



decided groundwater in that range could be used for exploitation purposes. Finally seven number of bore holes were converted to the production wells (fig 5).

Since 1992 pumping has been started on three production wells (x -122 , x -135 , x -137) and the number of pumping wells have been increased up to six at the beginning of the year 1993 (x - 150 , x - 135 , x - 137 , x - 138 , x - 139, x - 140). The present extraction rate is 120000 g/d.

The groundwater contour map indicates a groundwater mound occur at the western part of the project area. The groundwater flow seems to be directed to the Koggala Lake and to the sea.

Environmental aspects

The Koggala project falls on the coastal belt and it composed of sand and sandy clay formations. Because of the high transmissivity values of formations there is a possibility of pollutants to get enter into the groundwater system very easily.

Two incidents were reported.

1. At the end of the year 1992 the salinity level and the cadmium level of groundwater in the production well x -122 was suddenly increased. Investigations were commenced and finally it was found that it was happened due to dumping of salt solutions, chemicals and dyes in unprotected manner. The salts and dyes were gradually entered into the groundwater system through sand and sandy clay formations and caused groundwater pollution. Finally the well had to be abandoned.

2. In late 1995 a softener plant was put-up at the project area in order to reduce the hardness of groundwater. Generally Nacl was used for cleaning the softener plant and after cleaning it, the effluents were dumped into the open ground. As a result of that the salinity levels of water in the well x - 135 was suddenly increased (fig 6) . Therefore this well had to be abandoned.

The project area covers sand, sand clay, clay laterite and charnockite rocks. The main recharge zone of the area is looking like to be the sand and sandy clay formation spreading over the area of 1.4 km^2. The sand formation covers 0.6 km^2 along the coastal belt. Those formations may provide the passage for groundwater recharge. As the groundwater flow directed outwards from the project area a considerable amount of groundwater which is originated within the project area is flowing into the sea or to the Koggala lake. But according to the information available this area has been disturbed by the present infrastructure and the recharge area is reduced by at least 30%, compare to the recharge area available at the initial stage of the project.

As the project area is located in the coastal zone the pumping rates should be managed carefully, otherwise the over pumping may cause salinization problems and also the regional groundwater depletion.

BOREHOLE LOCATIONS - KOGGALA EPZ PROJECT

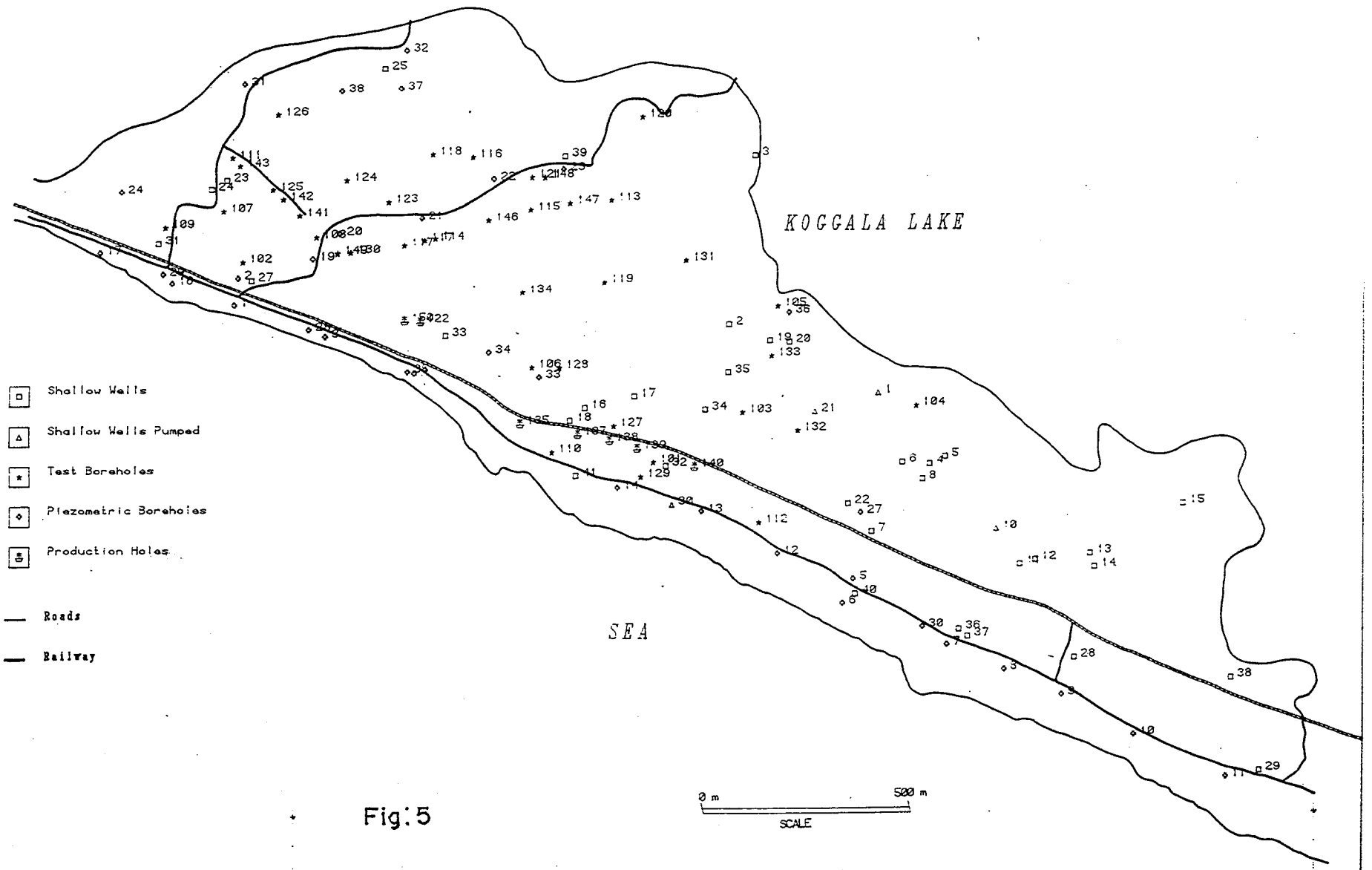
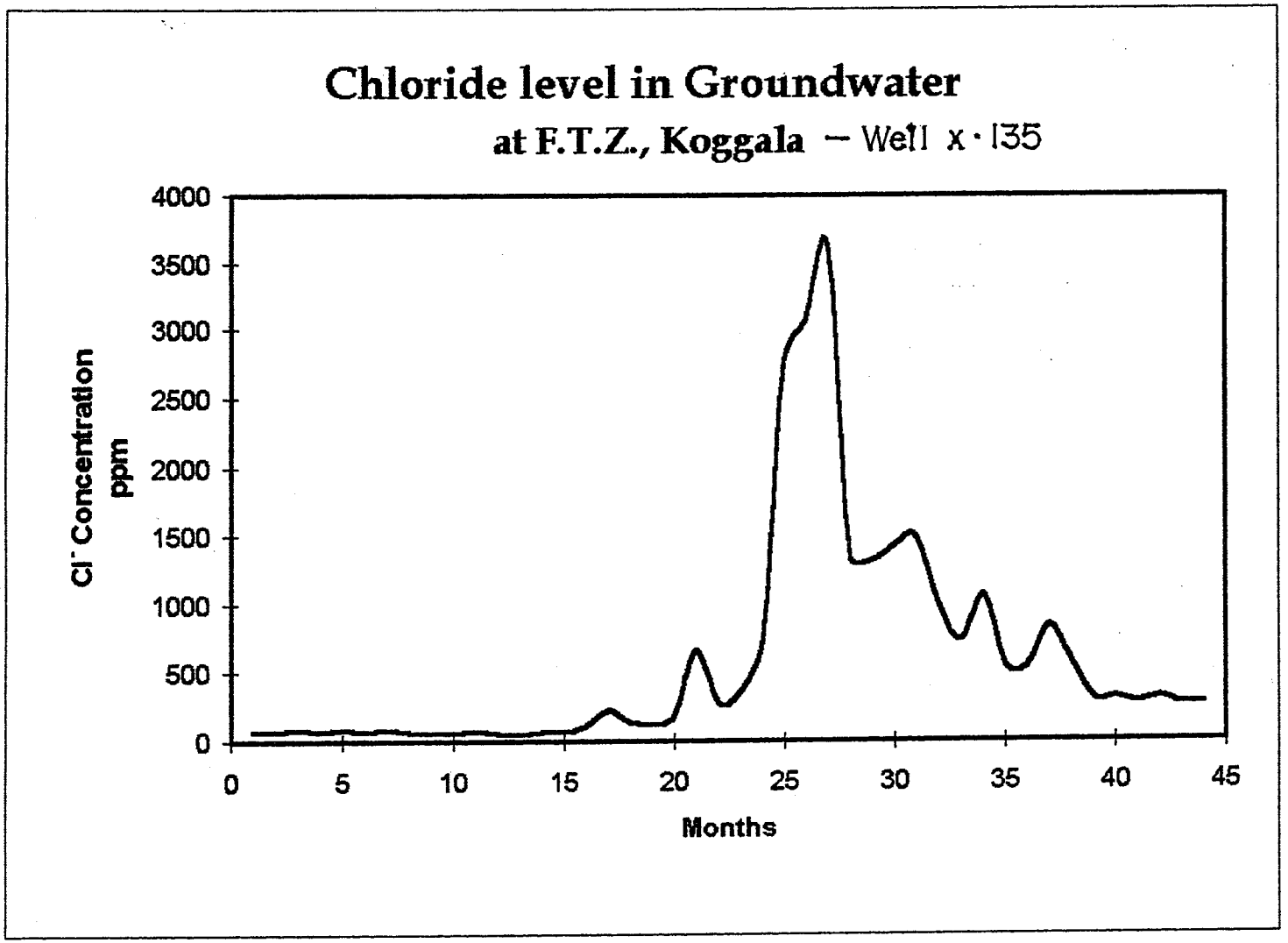


Fig: 5


Chloride level in Groundwater
at F.T.Z., Koggala – Well x · 135
Cl⁻ Concentration ppm
4000
3500
3000
2500
2000
1500
1000
500
0
0
5
10
15
20
25
30
35
40
45
Months

Conclusion

Water supply system of the Koggala free trade zone area is completely depend on the groundwater sources. Based on the results of the study it was attempted to identify the major activities that might cause environmental hazards in the Koggala free trade zone.

1. The study area is located in the coastal zone. Therefore the overextraction of groundwater may cause salinization problem.

2. As the area is composed of sand, sandy clay the tendency for polluting groundwater is relatively high. Therefore the application of various chemicals, dyes, salts and disposal of factory effluents may cause groundwater pollution chemically.

3. Unprotected sewerage system may cause bacteriological pollution.

4. Reduction of the recharge zone will cause regional groundwater depletion.

Extraction of groundwater according to the recommended limits, application of proper system for dumping the factory effluents, introduction of a proper sewerage system and protection of the recharge zone will helpful to overcome the above environmental hazards.